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Volume I

AmerenCIPS Newton Lake Project

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CHAPTER 1. OVERVIEW OF RESULTS

Introduction:

The AmerenCIPS Newton Lake Project was initiated primarily to determine additional biological impacts, if any, on the biota of Newton Lake from increased thermal loading when Newton Power Station is operated under a new "Variance." The Variance allows increases of maximum thermal discharges to the extent that water temperatures during June-October will not exceed a monthly average of 106EF and a maximum of 111EF for no more than 3% of the hours. During the remaining months, discharge limits are to be similar to those prior to the Variance. Thus, average monthly water temperatures may not exceed 102EF and maximum temperatures will be no more than 111EF.

The thermal discharge on Coffeen Lake was also modified in 1997. The historic variance was as follows:

> "The thermal discharge to Coffeen Lake from Central Illinois Public Service's Coffeen Power Station shall not result in a temperature, measured at the outside edge of the mixing zone in Coffeen Lake, which: 1) exceeds 105 degrees Fahrenheit as a monthly average from June through September and 112 degrees Fahrenheit as a maximum for more than three percent of the hours during that same period; 2) exceeds 89 degrees Fahrenheit as a monthly average from October through May and 94 degrees Fahrenheit as a maximum for more than two percent of the hours during the same period."

This was changed so that the summer time frame of June through September was changed to May through October.

This study was designed to examine effects of the Variance thermal regime in Newton Lake at trophic levels encompassing primary producers to tertiary consumers. Ecological principles dictate that adverse effects on lower trophic levels will be manifested at higher trophic levels. Since fish tend to integrate thermal effects in aquatic systems and they are of particular importance to the public, considerable emphasis is placed on this taxon. In order to monitor changes in the lower trophic levels, phytoplankton, macrophytes, zooplankton, benthos, and phytomacrobenthos were monitored in Newton Lake.

Newton Lake has 1,750 acres to service two electrical generating units with a design capacity of 1,234 GMW. Coffeen Lake (1,100 acres) was chosen as a study lake because it has similar thermal loading from its two electrical generating units that have a total capacity of 1,005 GMW. Thermal loading affects Lake of Egypt much less. This 2,300-acre lake, located in southern Illinois, supports four units with a total design capacity of 272 GMW. All three power plants are coal fired.

A portion of this study compares the health and condition of Newton Lake fish species to those in Lake of Egypt and Coffeen Lake. Growth is an excellent indicator of health and condition of fish because it integrates all of the biotic and abiotic factors acting on them. Age and growth analysis is especially appropriate for this study because average growth rates for age classes within species can be determined via back-calculation for several years prior to plant operation under the new variance. With additional years of study a comparisons of growth rates before and after operation under the new variance would provide key information on how fishery resources is affected in the long term. Age and growth analysis also permits direct comparisons of growth among the three lakes for the various species. Even if fish are growing well, a desirable fishery will not exist unless recruitment is adequate. Ichthyoplankton as well as recruitment to age-1 was also monitored.

Fish health assessments were made not only by growth analysis but also with condition factors and stress indicators. The effects of stress depend upon the fishes' ability to acclimate not only to higher temperature extremes and lower oxygen but also to the wide temperature fluctuations that occur in cooling ponds.

If the fish require refuge from the potentially stressful temperatures, then it is important to determine if suitable habitat is available. Fish movement was monitored to determine habitat utilization. Since movement of largemouth bass (*Micropterus salmoides*) and to a much lesser degree channel catfish (*Ictalurus punctatus*) was monitored in all three lakes, habitat utilization can be compared among lakes as well as seasonally within each lake.

For sampling purposes Newton Lake was divided into four segments (Figure 1.1), and Coffeen Lake and Lake of Egypt into two segments (Figure 1.2; Figure 1.3). The basic sampling regime is outlined in Table 1.1.

This report is separated into sixteen chapters, and primarily includes an analysis of the data collected in August 1997 through August 31, 1999. An effort has been made to address the magnitude, cause, and significance of the fish kill that occurred in Newton Lake and Coffeen Lake in July of 1999.

Plant Operation in Relation to the Variance

Newton power plant discharge temperatures never exceeded the new variance criteria in 1997 or 1998. Thus, 1998 can be considered a pre-variance year. Newton power plant discharge temperatures in the summer of 1999 reached but did not exceed the new variance levels. The highest monthly average of 104°F occurred in July 1999 (Table 1.2) Mean daily temperatures exceeded 105°F in all three years (Figures 1.4, 1.5, 1.6). All of the 100 hours of discharge temperature equal to or above 111°F occurred between July 22, 1999 and July 31, 1999 (Table 1.3). The new variance allowed 110 hours.

July 1999 had the highest mean monthly temperature (103°F) in Coffeen Lake (Table 1.4). Thus mean month temperatures did not exceed the 105°F mean monthly maximum allowed by the variance. Only 83 of the allowable 132 hours above or equal to 112°F were used in 1999. All except 3 hours occurred between July 23, 1999 and July 31, 1999. Three hours associated with start up above 120°F occurred on September 7, 1999 (Table 1.5). Mean daily temperatures were above 105°F and peaked in July 1997, 1998, and 1999 (Figures 1.7, 1.8, 1.9).

Characteristics of the Fish Community

The fish community has undergone many changes since 1976. Fishing started in 1980. Initially crappie were abundant and grew well in Newton Lake. Although they still continue to grow well, recruitment was greatly reduced by 1987. Crappie from a recently built nursery area on the lake probably accounts for their slight increase in the 1999-electrofishing catch (Table 1.6). Historically, except for the first few years, very few bluegill reached 7 inches in total length (Table 1.7). Except for the 1998 spring sample, less than 5% of the bluegill were larger than 6 inches since 1994. During the late 1970's and early 1980's, a significant number of channel catfish exceeded 20 inches in total length. After the mid 1980's fewer than 7 percent of the sampled channel catfish exceeded 20 inches (Table 1.8). Largemouth bass are the most sought after sport-fish 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 then in the fall samples (Table 1.9). Since 1990 the percentage of large bass appears to be decreasing, although spring samples in 1997 and 1998 show 14 and 15 percent of the bass sampled were over 18 inches in total length.

The growth rate of white crappie in Newton Lake was faster than in Coffeen Lake but slower than in Lake of Egypt (Table 1.10). Bluegill were growing slowly in all three lakes (Table 1.11). Channel catfish were growing very slowly in Newton Lake. Their weight (0.6 lb) at age-10 was only about half of a 10-year-old channel catfish (1.1 lb) in Coffeen Lake. Ten-year-old channel catfish in Lake of Egypt averaged 2.9 pounds (Table 1.12). Largemouth bass grew fairly fast for the first two or three years in Newton Lake and Coffeen Lake (Table 1.13). Their growth rate then slowed down; however, there are significant numbers of three to five pound bass in Newton Lake and three to four pound bass in Coffeen Lake. Bass larger than six pounds are relatively rare in both lakes. Noteworthy is the fact that growth rate of largemouth bass in the cooler Lake of Egypt is slower than in either Newton Lake or Coffeen Lake.

Mean relative weights of largemouth bass were higher in Newton Lake and Coffeen Lake than in the cooler Lake of Egypt (Table 1.14). Except for their August average of 82 in Lake of Egypt, all mean relative weights were within the desirable range of 100 plus or minus 10. Except for the fall (November) values in Newton Lake (91) and Coffeen Lake (92), the mean relative weight of bluegill tended to be below the desirable range at all other times of the year and in all three lakes. Channel catfish in Lake of Egypt tended to have mean relative weights above 90; whereas, catfish in both Newton Lake and Coffeen Lake had relative weights less than 90.

During the three years of this study, largemouth bass in Newton Lake had a higher percentage of empty stomachs (60.2%) than either Coffeen Lake (40.6%) or Lake of Egypt (40.7%). Channel Catfish from Coffeen Lake had the highest percentage of empty stomachs (55.8%) and channel catfish from Lake of Egypt had the lowest (34.3%). Largemouth bass had a higher percentage of empty stomachs in 1999 than in 1998. Channel catfish also had a higher percentage of empty stomachs in Newton Lake and Coffeen Lake in 1999 than in 1998, but in Lake of Egypt channel catfish had a lower percentage of empty stomachs in 1999 (Table 1.15).

Based on the catch curve method, the mean annual mortality of largemouth bass in 1997-1999 was highest in Newton Lake (51%) and lowest in Lake of Egypt (28%) with Coffeen Lake falling in between (36%) the other two lakes (Table 1.16). Bluegill follow the same trend with a 72% annual mortality rate in Newton Lake, 45% in Lake of Egypt and 63% in Coffeen Lake (Table 1.16). Channel catfish, on the other hand, had the highest annual mortality rate in Lake of Egypt (50%) followed by Newton Lake with 37% and those in Coffeen Lake with 23%. The mortality rate calculations for channel catfish from Lake of Egypt were based on very few specimens. All of the values from all three lakes for all three species were well within the ranges reported in the literature.

Growth rates, mortality rates and recruitment rates determine the structure of a fish population. Larval fish densities were monitored in Newton Lake, Coffeen Lake, and Lake of Egypt. Most fish species in Illinois spawn in the spring when water temperatures reach a certain level. As water temperatures continue to increase, essentially, a temperature is reached where a given species stops spawning. It seems logical to assume that this "spawning window" may be narrowed by rapidly adding heat to a lake; however, the hatching date ranges were not restricted in Newton Lake or Coffeen Lake and were actually extended when compared to the cooler Lake of Egypt (Table 1.17). Except for *Pomoxis* in Lake of Egypt and *Lepomis* in Coffeen Lake, spawning took place over more days in 1999 than in 1998 in all three lakes (Table 1.17).

In Newton Lake and Coffeen Lake, the densities of larval *Lepomis* and *Dorosoma* in ichthyoplankton tows were the same in 1999 as they were in 1998 (Table 1.18). In Lake of Egypt, the density of *Dorosoma* in 1998 was the same as in 1999, but the density of *Lepomis* was greater in 1998 than in 1999 (Table 1.18). There was no difference in catch per hour for *Lepomis, Dorosoma* or *Micropterus* in light traps between 1998 and 1999 in any of the three lakes (Table 1.19).

Zooplankton, the initial food supply for larval fish was also relatively abundant. During the spawning of the various species of fish mean total zooplankton ranged from approximately 100 to 800 zooplankters per liter of lake water (see Chapter 8).

It is possible to have large numbers of larval fishes and still have a weak year class of fish. Shoreline seining captures larger, thus older fish, than ichthyoplankton net tows. In all three lakes, there was no difference in the catch per unit effort of all fish (primarily young of the year) collected by shoreline seining in 1998 versus 1999 (Table 1.20). Nor was there any difference in the shoreline seining catch per unit effort for young of the year largemouth bass between 1998 and 1999 in Newton Lake or Coffeen Lake. In Lake of Egypt more largemouth bass were captured in 1999 than in 1998.

Most biologists prefer to measure recruitment after the fish go through the first winter, in other words at age-1. In Newton Lake, our fall electrofishing samples indicated a drop in catch per hour of age-1+ largemouth bass in 1999 over 1998 (Table 1.21). The information in Table 16 is based on a relatively small sample size. In 1998 and 1999, IDNR made a much larger fall electrofishing collection of largemouth bass in Newton Lake. These fish were not aged, but they were measured. If we assume that an age-1+ largemouth bass captured in the fall would have a total length up to 11.8 inches, then in 1998, out of the 705 largemouth bass collected there were 287 age-1+ bass. In 1999, out of the 514 largemouth bass sampled there were 255 age-1+ bass. This is equivalent to 23.9 age-1+ bass per hour in 1998 and 21.2 age-1+ bass per hour in 1999. Since we have not received the 1999 fall sampling data for Coffeen Lake from IDNR, we can not make the same calculations for this lake. Actually, the best estimate can be made only after the spring 2000 electrofishing data are obtained. These data will allow us to compare spring to spring recruitment for age-1+ largemouth bass.

Creel Harvest Data

Creels were not run on either Coffeen Lake or Lake of Egypt in 1997-1999. AmerenCIPS provided historical 12-month creel data for Newton Lake. Evidently, these historic creels were designed to yield harvest but not catch data. AmerenCIPS contracted with the Illinois Natural History Survey to conduct a creel survey on Newton Lake in 1998 and 1999. The 1998 creel survey was for only 9 months. The heavily fished November, December, and January months were evidently not creeled. To date we have not received the 1999 survey data.

Yearly angling effort dropped from a high of 150,814 hours in 1986 (12 months) to a 12 month low level of 70,330 hours in 1991 (Table 1.22). In 1998 fishing pressure was back up to 105,931 hours for the 9 months of the creel. The harvest of largemouth bass has remained remarkably consistent since 1986 ranging from 731 to 1,743 fish (Table 1.23). In 1998 a total of 1,289 largemouth bass was harvested. A size limit of 18 inches total length and a harvest limit of3 fish per day has been in place since Newton Lake was opened to fishing in 1980.

Bluegill harvest has been very low throughout all creel years. The harvest of 947 bluegill in 1998 approaches the 1986 high of 1,009 fish (Table 16.24). Crappie harvest fell from a high of 89,499 in 1986 and 66,971 in 1987 to 69 in 1988. This drastic decrease in harvest reflects the classical significant reduction in recruitment of crappie, which is well documented but not understood, in older and warmer power cooling lakes. Since angler harvest of crappie tends to be dominated by 3 and 4-year-old fish, the reduction in recruitment probably started in 1985.

Channel catfish harvest in Newton Lake in 1998 was approximately one-half that of previous years (Table 1.25). The harvested fish average approximately one pound in weight, which reflects the relatively slow growth rate of the channel catfish in Newton Lake. Since a 10-year-old catfish in Newton Lake only averages approximately 0.6 pounds, the harvested fish are probably the faster growing portion of the population.

Significant changes in the structure and utilization by anglers of the fish community in Newton Lake have taken place, but as far as the data show, these changes occurred before the new variance was placed into effect.

In addition to describing the fish community and its utilization by anglers, other components of the flora and fauna were monitored in Newton Lake. Since the power plant did not operate within the new variance parameters until 1999, the 1997-1998 data can be viewed as base line information.

Primary Productivity/Phytoplankton

Primary productivity and phytoplankton densities were monitored only in Newton Lake. During both 1998 and 1999, net photosynthesis tended to be higher during the summer months (Figure 1.10). The values of net photosynthesis fall well within the range of values found for other lakes (Table 1.26). Since the highest temperatures occurred in Newton Lake in July of 1999, the effects of these temperatures on the flora and fauna were investigated, where possible, by comparing data from July and August 1998 to similar data collected in July and August 1999.

Phytoplankton cell counts peaked in June 1998 and in January 1999 (Figure 1.11). Even though there was a decrease in mean total phytoplankton densities in July and August 1999 over July and August 1998 (Table 1.27) there were no differences in the rate of photosynthesis (Table 1.28) or chlorophyll a levels, probably due to a deeper euphotic zone (Table 1.29). There was a very slightly higher OD664/OD665 ratio in July and August 1998 than in 1999 (Table 1.30). The net photosynthetic rate and not the number of phytoplankters is the factor that ultimately determines the amount of oxygen in the euphotic zone of the lake.

Macrophytes

By producing shade, macrophytes reduce the temperatures in shallow water. Unfortunately, macrophytes cover a very small portion of Newton Lake. The dominant plant in Newton Lake is water willow (*Dianthera americana*). Water willow covered approximately 35 acres in August 1998, 22 acres in August 1999, and 15 acres in 1997 (Table 1.31). The lower coverage in 1999 over 1998 was a function of water level. In August 1998, Newton Lake was at pool level; whereas, in August 1999 it was 5.2 feet below pool. Within the vegetation beds, there was no difference in stem density per unit of surface area between 1998 (4.94 lb/m^2) and 1999 (4.00 lb/m^2) (Table 1.31). Since in all three years, the area of macrophyte coverage was only 0.9-2% of the lake, it would be highly desirable to find a way to increase this coverage.

Zooplankton

As expected, zooplankton fluctuated widely throughout the year (Figure 1.12). Densities ranged from approximately 100 to 800 organisms per liter. Peak densities occurred in the winter and early spring. Zooplankton densities from April through August fell within the middle of the range for 12 other Illinois lakes (Figure 1.13). Mean zooplankton densities were actually higher by 40% in July and August 1999 (239/L) than in July and August 1998 (171/L) (Table 1.32).

Benthos

Diptera comprised 82% of the benthos numerically and 76% by weight. Haplotaxidae (tubificids) made up 14% by numbers, but only 8% by weight; whereas Veneroida (clams) comprised only 1% of the benthos by number, but 12% by weight. The highest mean number and weight of the benthos per meter squared occurred in the winter of 1998 (Figure 1.14). Benthos densities in Newton Lake from May through October tended to fall within the lower third of the densities found in 12 Illinois lakes (Figure 1.15). Both the density (74%) and weight (46%) of the benthos per meter squared were considerably higher in 1999 than in 1998 (Table 1.33).

Phytomacrobenthos

Phytomacrobenthos are the macroinvertebrates that are attached to the aquatic vegetation. In Newton Lake, the phytomacrobenthos are primarily found on water willow. The numbers of phytomacrobenthos peaked in August 1998 and 1999. Their weight peaked in August 1998 and in September 1999 (Figure 1.16). The mean number of phytomacrobenthos in July and August 1999 was 93% higher than their density in 1998 (Table 1.34). Likewise, the mean weight of phytomacrobenthos in July and August 1999 was 140% higher than in July and August 1998 (Table 1.34).

Fish Kill

Temperature related fish kills occurred in Coffeen Lake and Newton Lake in 1999. A fish kill did not occur in Lake of Egypt in 1999 nor did a kill occur in any of the three lakes in 1998. The following discussion concerning the fish kills emphasizes largemouth bass.

In Coffeen Lake, the fish kill probably started on July 27, 1999, peaked on July 28, 1999, with no other fish except for one gizzard shad and one white crappie found after July 28 (Table 1.35). SIUC personnel counted a total of 121 dead largemouth bass. In addition to the fish that died, large numbers of the exotic Asiatic clam (*Corbicula sp.*) were also killed. Unlike the fish, the number of clams that died was not quantified. In both lakes, fish that were not too decayed were measured for total length. The six dead channel catfish that were measured from Coffeen Lake were not among the larger individuals in the population (Figure 1.17) and many large individuals were present in the population in the fall of 1999 (Figure 1.18). The dead largemouth bass tended to be among the larger fish in the population (Figure 1.19). This is not unexpected since large bass are more susceptible to higher temperatures and low dissolved oxygen stress than are small bass; however, there was no discernible difference in their fall 1999 length frequency distribution from that of the fall of 1998 (Figure 1.20).

In Newton Lake, there were two distinct fish kills. The first occurred on June 9, 1999 when 27 largemouth bass were found (Table 1.36). No other species of fish were found at this time or over the next few weeks. Maximum hourly discharge temperatures were approximately 96°F for two hours on June 8, 1999, and temperatures approached 95°F on the afternoon of June 9, 1999, but by this time the fish were already dead. There was a considerable amount of oxygenated deeper cooler water in segment 1 on June 2 and June 8

(Figure 1.21). Since no other species were found, it is possible that these fish died as a result of an informal bass club tournament instead of a thermal kill.

A definite temperature related fish kill probably started on July 27, 1999, in Newton Lake. On this date, 18 largemouth bass and 33 other fish from 5 different taxa were found. Unlike the kill on Coffeen Lake, which lasted only a couple of days, fish died in Newton Lake from July 27, 1999--August 31, 1999. During the first couple of days, primarily dead bass and not morbid bass were found. Later, especially in August both dead and dying fish were observed. Externally, the dying fish were heavily infected with bacteria and fungus. Thus, it appears that the stress in late July made the fish vulnerable to bacteria and fungus infections in August. We collected both dying fish and apparently healthy fish by electrofishing in late July. The fish health assessment index proposed by Goede (1993, see chapter 9 for citation) was not sensitive enough to delineate between these two groups of bass (Table 1.37). Thus, this index is not suitable for monitoring short-term thermal stress events. The larger largemouth bass (Figure 1.22) and channel catfish (Figure 1.23) died in the kill, but no change could be detected in the 1999 versus 1998 fall length frequency distributions for either species (Figures 1.24-1.25).

Significance of Dead Largemouth Bass

A few calculations will show that the number of largemouth bass that died in Coffeen Lake and Newton Lake pose no significant long-term effect on the two bass populations. Assuming that we counted only 50% of the largemouth bass that died, then 242 bass died in Coffeen Lake (0.22 per acre) and 454 in Newton Lake (0.26 per acre). If there are 20 bass per acre in Coffeen Lake (1100 acres), then the death of 242 bass represents only 1% of the population. Although we have no recent creel data for Coffeen Lake, this is probably well below what is removed by anglers each year and, in fact, the approved sampling protocol for this study kills approximately 150 bass per year in each lake. Average total annual mortality for largemouth bass in Coffeen Lake is approximately 36% (Table 1.16).

Assuming 20 largemouth bass per acre in Newton Lake (1750 acres), there were 35,000 bass in the lake. If anything, this is an underestimate considering that from February through October of 1998 the creel results indicated that 56,339 bass were caught. In other words if there were 35,000 bass, each bass on average was caught 1.6 times. Based on a population of 35,000 bass, the death of 454 bass in Newton Lake would equal only 1% of the population. In both lakes, the fish that died were large fish in the population but based on the 1998 nine month creel, which does not include the heavily fished late fall and winter months, anglers removed 1289 bass that were 18 inches or larger (Table 1.23). Also, to place the loss into perspective, average total annual mortality for bass in Newton Lake is 51% (Table 1.16).

Temperature/Depth/Oxygen Profiles

Temperature-depth-oxygen profiles were routinely taken every two weeks in each of the three lakes near the middle of each segment (Figures 1.1-1.3). Unfortunately, no profiles were scheduled for the day of the fish kills. Additional profiles were taken during the fish health and fish movement portions of the study. These profiles are given in Chapter 15.

It is difficult to interpret the full meaning of depth-temperature-oxygen profiles by inspection. Estimated percent habitat tables were constructed as an alternative approach (Table 1.38). Basically, the percent of depth is calculated at each sampling station where temperature is at or *below* a given value (from 87-97°F) and dissolved oxygen is at or *above* 1-4 ppm. This percent of depth is assumed to equal the percent by volume of the lake in that section of the lake where the sample was taken. The percent habitat value could be calculated more accurately if a good map of the lake was available with bottom contours. A current map does not exist for either lake. Modeling of this approach on graph paper with lakes of different basin shapes indicates that the habitat values are conservatively within plus or minus 20% of the true value. Thus a habitat value of 50% should be considered to have a range of 40% to 60%. By far the greatest error would occur if the sampling station is located on top of a sharply elevated underwater island or over a creek that is very deep relative to the average depth of the lake. We do not believe that either condition exists at any of our sampling stations.

Unfortunately, we do not have a depth-temperature-oxygen profile in any of the three lakes on July 27, 1999, when the fish kill probably started. In Lake of Egypt, on July 22, 1999 18% of the habitat (lake volume) in segment one (warm area) and 50% of the habitat in segment two (cool area) was 90°F or less and contained at least 4 ppm dissolved oxygen (Table 1.38).

In Coffeen Lake on July 23, 1999, the habitat available at or below 94°F and 4 ppm or more dissolved oxygen was 10% in segment 1 and 5% in segment 2 (Table 1.39). One of the few nighttime profiles that we have shows that by August 1, 1999, habitat conditions were even more restrictive in these areas (Table 1.40); however, we do not have a sampling station on the large cove or the area of the lake north of the plant's intake that are out of the cooling loop. These areas may have had much better water quality than that part of the lake that is in the cooling loop.

Habitat availability conditions on July 24, 1999, and July 18,1998, in Newton Lake are given in Table 1.41. Since the four sampling segments essentially cover the entire lake and they are approximately equal in size, the total habitat available can be estimated. By August

5, 1999, there was a considerable improvement in the amount of suitable habitat (Table 1.42). Almost all of the depth-temperature-oxygen profiles that were used to construct the percent suitable habitat tables were taken during the day. Since photosynthesis only occurs during daylight hours, available habitat for the fish at night was almost certainly less than shown because of lower dissolved oxygen. Cooler water does exist in both Newton Lake (Table 1.43) and Coffeen Lake (Table 1.44) throughout the year. The problem is that this cooler waster has 0-1 ppm dissolved oxygen during the summer.

Summer Habitat Utilization by Largemouth Bass

The fish movement portion of this study gives considerable insight on how largemouth bass react to high summer temperatures and relatively low dissolved oxygen concentrations. During the summer, largemouth bass in both Newton Lake and Coffeen Lake tended to move 1 to 1.5 miles in 24 hours (Figure 1.26). They also tended to use most of the lake, even in the summer (Figures 1.27-1.29).

Individually identifiable, temperature-sensitive sonic transmitters were placed in largemouth bass. These transmitters not only allowed us to locate individual fish but the internal body temperature of the bass could also be determined. By taking a depth/temperature/oxygen profile each time a bass was located, it was possible to determine the location, depth, temperature and dissolved oxygen concentration where the bass was located. These determinations are not exact because it takes 30-60 minutes for the internal body temperature of a bass to equilibrate to the water temperature after a change of 18°F.

Mean summer internal body temperatures (IBT) of largemouth bass ranged from 79-90°F (Figure 1.30). In Coffeen Lake, the mean IBT ranged from 75-97°F (Figure 1.31) and in

Newton Lake mean IBT range was from 75-92°F (Figure 1.32). In both Newton Lake and Coffeen Lake mean maximum internal temperatures occurred in July 1999.

By assuming internal body temperature equaled the external water temperature, it was possible to calculate the oxygen concentration at the fishes' location. In all three lakes, largemouth bass were found at the lowest mean dissolved oxygen concentrations in July 1999 (Figures 1.33-1.35). In Newton Lake for example, in July 1999 largemouth bass were primarily found at oxygen concentrations between 1.9-3.0 ppm (Figure 1.35).

Conclusions:

Since the fish kill on Coffeen Lake occurred with the plant operating at a level that existed under the old variance and the kill on Newton Lake occurred while operating under the new variance, the two cases need to be separated when considering variances. Clearly the habitat that the fish were able to live in was being reduced in the summer of 1999 over 1998, but except for the fish kill there was no indication that the added heat loading in Newton Lake had any negative effect. The fish appeared to be sacrificing higher oxygen levels for lower temperatures. Unfortunately, we do not know where the fish that died were when they were exposed to the critical levels of heat. In both lakes, the kill took place approximately five or six days after the hourly temperatures in the discharge water of Coffeen Lake were exceeding 112°F and those in Newton Lake were exceeding 111°F. It is possible that the dead fish were trapped in an area where their livable habitat was finally eroded away.

To date, there is scant evidence that the fish kills in Newton and Coffeen Lake resulted in significant damage to the fisheries, due to the relatively low proportions of fish that died relative to the numbers of fish in these lakes; however, future creel and relative abundance data collected subsequent to the kills need to be examined to determine whether this view is correct. Other measures, such as fish health assessments, condition factors, relative weights, etc., did not indicate substantial long-term impacts on fish that survived the kill. It is possible that conditions in Newton and/or Coffeen Lakes during summer 1999 will diminish recruitment from 1999 year classes; spring 2000 sampling for relative abundance of age 1 fish needs to be completed before this question can be resolved.

On the other hand, habitat in which fish can survive, based on vertical temperature and dissolved oxygen profiles and the behavior of largemouth bass in the telemetry studies, appears to have been nearly completely lost towards the end of July in Newton Lake, based on our present knowledge of the tolerance of species such as largemouth bass, bluegill, and channel catfish to low dissolved oxygen and elevated temperature. Had habitat conditions been marginally better, there may not have been any kills at all. Conversely, had lake temperatures continued to rise and dissolved oxygen continued to degrade for a few more days, it is possible that the magnitude of the resulting fish kills would have had substantial impacts on the fisheries, especially in Newton Lake and possibly in Coffeen Lake. An apparent decline in electrical power demand, the concomitant reductions in thermal loading, and reduced air temperatures towards the end of July and not the variances led to improving temperature and dissolved oxygen conditions in both Newton Lake and Coffeen Lake.

If the survival of *all* fish is the only consideration, then clearly the thermal loading in the summer needs to be cut way back, even below the old variances, in Newton Lake and Coffeen Lake. This, however, is not the only consideration. These lakes exist so that electrical power can be produced, and the high quality fisheries for largemouth bass in Newton and Coffeen Lakes are probably attributable to thermal loading. Assuming that at the present time there is a critical need to maximize power generation especially during the summer months, and that the old variances were protecting the fish, whereas the new variances are not, then the key question becomes: Is there an acceptable level of thermal loading between the old and new variances?

Table 1.1 Basic sampling schedule for AmerenCips Newton Lake Project.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
				Newton Lake									
Phytoplankton	0	1	1	2	2	2	2	2	2	1	0	1	24 samples per date: Sampled at 3 stations in each of 4 segments; 2 samples per station.
Zooplankton	0	1	1	2	2	2	2	2	2	1	0	1	Same as phytoplankton.
Primary productivity	1	1	1	1	1	1	1	1	1	1	1	1	Same as phytoplankton.
Chlorophyll a	1	1	1	1	1	1	1	1	1	1	1	1	Same as phytoplankton.
Benthos	1	1	1	2	2	2	2	2	2	1	1	1	24 samples per date: 6 stations per transect. Transects at midway between segment borders.
Phytomacrobenthos	0	0	0	0	1	1	1	1	1	0	0	0	40 samples per date: 5 stations per segment where vegetation present; 2 samples per station. Random in areas sampled that had vegetation.
Aquatic vegetation	0	0	0	0	0	0	0	1	0	0	0	0	80 random stations, 20 per segment
Ichthyoplankton	0	0	1	2	2	2	2	1	1	1	0	0	Tows 48 samples per date: 10-min per tow, 6 stations per segment, 2 samples per station. Light traps: 16 per date; 4 traps per segment, 2-hr sets. 1/2 pelagic - 1/2 littoral for both methods.
Health-stress	0	0	1	0	0	0	0	1	0	0	0	0	
Food habits	1	0	1	1	1	1	1	1	1	1	1	1	Until numbers satisfied. Sampling completed as necessary in each segment to satisfy number requirements.
Age and growth, mortality	0	0	0	0	0	0	0	0	0	1	1	1	October (1998 and 1999); November (1997) for mortality. Extra sampling in following months as necessary for age and growth requirements.
Seine / recruitment	0	0	0	2	2	2	2	2	0	0	0	0	40 samples per date. 10 stations per segment.
DC electrofishing	0	0	0	0	0	0	0	1	0	0	0	0	Six zones per ESE Report (1995).
Fish movement	1	1	1	4	4	4	4	4	4	1	1	1	Entire lakes per date; 24-hr sampling 3 seasons (spring, summer, winter), twice per season.
Temp/DO	2	2	2	2	2	2	2	2	2	2	2	2	4 samples per date: midway between segment borders; 1/2 meter intervals from surface to bottom.

Table 1.1. Continued.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Lake of Egypt							
Ichthyoplankton	0	0	1	2	2	2	2	1	1	0	0	0	Tows 24 samples per date. Light traps 8. samples per date.
Age and growth, mortality	0	0	0	0	0	0	0	0	0	1	1	1	Same as Newton.
Seine / recruitment	0	0	0	2	2	2	2	2	0	0	0	0	20 samples per date: Same as Newton - 2 segments.
AC Electrofishing CPUE	0	0	0	0	0	0	0	0	1	1	1	0	Sept - Oct 1997 and 1998.
Fish movement	1	1	1	4	4	4	4	4	4	1	1	1	Same as Newton - 2 segments.
Temp/DO	2	2	2	2	2	2	2	2	2	2	2	2	Same as Newton - 2 segments.
Food habits	0	0	1	0	0	0	0	1	1	1	1	0	Only taken during mortality and age/growth.
						Coffeen Lake							
Ichthyoplankton	0	0	1	2	2	2	2	1	1	0	0	0	Tows 24 samples per date. Light traps 8. samples per date.
Age and growth, mortality	0	0	0	0	0	0	0	0	0	1	1	1	Same as Newton.
Seine / recruitment	0	0	0	2	2	2	2	2	0	0	0	0	20 samples per date: Same as Newton - 2 segments.
Fish movement	1	1	1	4	4	4	4	4	4	1	1	1	Same as Newton - 2 segments.
Temp/DO	2	2	2	2	2	2	2	2	2	2	2	2	Same as Newton - 2 segments.
Food habits	0	0	1	0	0	0	0	1	0	1	1	1	Only taken during mortality and age/growth.

Table 1.2. Mean monthly water surface temperatures of the Newton Lake discharge.

Year	Month	Number	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	67.0
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	54.0
1999	February	28	67.0
1999	March	31	72.3
1999	April	30	77.3
1999	May	31	88.4
1999	June	30	97.0
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

Table 1.3. Hourly temperatures that exceeded 111 F, Newton Lake discharge, 1998 – 1999. Within a year total hours above 111 F were not to exceed 110 (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.
07/22/1999	13:34:28	111.22	07/24/1999	20:34:28	111.47	07/28/1999	0:34:28	111.36
07/22/1999	14:34:28	111.39	07/24/1999	21:34:28	111.18	07/29/1999	12:34:28	111.33
07/22/1999	15:34:28	111.48	07/24/1999	22:34:28	111.01	07/29/1999	13:34:28	111.79
07/22/1999	16:34:28	111.65	07/25/1999	13:34:28	111.53	07/29/1999	14:34:28	111.99
07/22/1999	17:34:28	111.84	07/25/1999	14:34:28	111.5	07/29/1999	15:34:28	111.87
07/22/1999	18:34:28	112.03	07/25/1999	15:34:28	111.71	07/29/1999	16:34:28	111.99
07/22/1999	19:34:28	112.09	07/25/1999	16:34:28	111.77	07/29/1999	17:34:28	112.31
07/22/1999	20:34:29	112.06	07/25/1999	17:34:28	112.03	07/29/1999	18:34:28	111.43
07/22/1999	21:34:28	111.93	07/25/1999	18:34:28	112.13	07/29/1999	19:34:28	112.61
07/22/1999	22:34:28	111.85	07/25/1999	19:34:28	112.06	07/29/1999	20:34:28	112.85
07/22/1999	23:34:28	111.74	07/25/1999	20:34:28	112.11	07/29/1999	21:34:28	113
07/23/1999	0:34:28	111.48	07/25/1999	21:34:28	112.44	07/29/1999	22:34:28	112.39
07/23/1999	10:34:28	111.59	07/25/1999	22:34:28	112.53	07/29/1999	23:34:28	112.85
07/23/1999	11:34:29	112.01	07/25/1999	23:34:28	112.32	07/30/1999	0:34:28	112.79
07/23/1999	12:34:28	112.32	07/26/1999	11:34:28	111.15	07/30/1999	11:34:28	111.81
07/23/1999	13:34:28	112.53	07/26/1999	12:18:32	111.28	07/30/1999	12:34:28	111.85
07/23/1999	14:34:28	111.93	07/26/1999	16:34:28	111.35	07/30/1999	14:34:28	112.99
07/23/1999	15:34:28	112.06	07/26/1999	17:34:28	112.57	07/30/1999	15:34:28	113.31
07/23/1999	16:34:28	112.05	07/26/1999	18:34:28	112.46	07/30/1999	16:34:28	113.27
07/23/1999	17:34:28	111.98	07/26/1999	19:34:28	112.47	07/30/1999	17:34:28	113.35
07/23/1999	18:34:28	111.84	07/26/1999	20:34:28	112.34	07/30/1999	18:34:28	113.37
07/23/1999	19:34:28	111.77	07/26/1999	21:34:28	112.31	07/30/1999	19:34:28	113.51
07/23/1999	20:34:28	111.73	07/26/1999	22:34:28	112.33	07/30/1999	20:34:28	113.56
07/23/1999	21:34:28	111.79	07/26/1999	23:34:29	112.29	07/30/1999	21:34:28	113.63
07/23/1999	22:34:28	111.75	07/27/1999	0:34:28	112.23	07/30/1999	22:34:28	113.66
07/23/1999	23:34:28	111.49	07/27/1999	14:34:28	111.37	07/30/1999	23:34:28	113.64
07/24/1999	11:34:28	111.54	07/27/1999	15:34:28	111.54	07/31/1999	0:34:28	113.48
07/24/1999	12:34:28	111.96	07/27/1999	16:34:28	111.71	07/31/1999	1:34:28	111.98
07/24/1999	13:34:28	112.18	07/27/1999	17:34:28	111.82	07/31/1999	2:34:28	112.8
07/24/1999	14:34:28	112.27	07/27/1999	18:34:28	111.78	07/31/1999	3:34:28	112.67
07/24/1999	15:34:28	112.09	07/27/1999	19:34:28	111.57			
07/24/1999	16:34:28	112.05	07/27/1999	20:34:29	111.59	TOTAL	HOURS	100
07/24/1999	17:34:28	111.77	07/27/1999	21:34:28	111.7			
07/24/1999	18:34:28	111.7	07/27/1999	22:34:28	111.71			
07/24/1999	19:34:28	111.75	07/27/1999	23:34:28	111.6			

Table 1.4. Mean monthly surface water temperatures in the Coffeen Lake discharge.

Year	Month	Number	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	76.0
1997	December	31	73.3
1998	January	23	68.2
1998	February	0	
1998	March	0	
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 1.5. Hourly temperatures that exceeded 112 F, Coffeen Lake discharge, 1998 – 1999. 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.
07/23/1999	16:00:00	112	07/29/1999	13:00:00	112.89
07/23/1999	17:00:00	112.5	07/29/1999	14:00:00	114.24
07/23/1999	18:00:00	112.21	07/29/1999	15:00:00	114.02
07/23/1999	19:00:00	112.59	07/29/1999	16:00:00	114.14
07/23/1999	20:00:00	112.16	07/29/1999	17:00:00	114.56
07/25/1999	14:00:00	112.09	07/29/1999	18:00:00	114.67
07/25/1999	15:00:00	112.72	07/29/1999	19:00:00	114.19
07/25/1999	16:00:00	112.72	07/29/1999	20:00:00	114.21
07/25/1999	17:00:00	112.43	07/29/1999	21:00:00	113.6
07/25/1999	18:00:00	113.34	07/29/1999	22:00:00	114
07/25/1999	19:00:00	112.95	07/29/1999	23:00:00	113.89
07/25/1999	20:00:00	112.2	07/30/1999	1:00:00	113.24
07/25/1999	23:00:00	112.8	07/30/1999	2:00:00	113.9
07/26/1999	12:00:00	113.01	07/30/1999	3:00:00	113.11
07/26/1999	13:00:00	113.48	07/30/1999	4:00:00	112.34
07/26/1999	14:00:00	113.75	07/30/1999	12:00:00	112.74
07/26/1999	15:00:00	113.87	07/30/1999	13:00:00	114.2
07/26/1999	16:00:00	112.19	07/30/1999	14:00:00	114.3
07/26/1999	18:00:00	112.36	07/30/1999	15:00:00	114.65
07/26/1999	19:00:00	113.4	07/30/1999	16:00:00	114.88
07/26/1999	20:00:00	114.35	07/30/1999	17:00:00	115.05
07/26/1999	21:00:00	112.96	07/30/1999	18:00:00	115.39
07/26/1999	22:00:00	114.17	07/30/1999	19:00:00	114.06
07/26/1999	23:00:00	113.93	07/30/1999	20:00:00	113.44
07/27/1999	0:00:00	112.9	07/30/1999	21:00:00	113.52
07/27/1999	14:00:00	113.62	07/30/1999	22:00:00	112.95
07/27/1999	15:00:00	113.22	07/30/1999	23:00:00	113.64
07/27/1999	16:00:00	113.81	07/31/1999	1:00:00	112.54
07/27/1999	17:00:00	113.31	07/31/1999	2:00:00	112.31
07/27/1999	18:00:00	113.68	07/31/1999	14:00:00	113.02
07/27/1999	19:00:00	113.43	07/31/1999	15:00:00	112.88
07/27/1999	20:00:00	113.81	07/31/1999	18:00:00	113.29
07/27/1999	21:00:00	114	07/31/1999	19:00:00	113.83
07/27/1999	22:00:00	113.29	07/31/1999	20:00:00	114.09
07/27/1999	23:00:00	112.91	07/31/1999	21:00:00	114.2
07/28/1999	15:00:00	112.41	07/31/1999	22:00:00	113.68
07/28/1999	16:00:00	112.95	07/31/1999	23:00:00	112.83
07/28/1999	17:00:00	113.17	09/07/1999	14:00:00	120.27
07/28/1999	18:00:00	113.86	09/07/1999	15:00:00	120.08
07/28/1999	19:00:00	113.91	09/07/1999	16:00:00	122.49
07/28/1999	20:00:00	113.58			
07/28/1999	21:00:00	113.37	TOTAL HOURS 83		
07/28/1999	22:00:00	112.17			

Table 1.6. Size frequency distributions for white crappie in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999. The electrofishing effort was not constant over all sampling periods.

Year	Sample size	Total length (inches)		
		6	7	10
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

Table 1.6. Continued.

Year	Sample size	Total length (inches)		
		6	7	10
1995 Fall	2	100	100	50
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	--	--	--	--
1999 Fall	22	100	100	5

Table 1.7. Size frequency distributions for bluegill in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

		Total length (inches)		
Year	Sample size	6	7	8
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	0.8	0
1980 Spring	113	15	0	0
1980 Fall	262	13	0.8	0
1981 Spring	379	15	2	0
1981 Fall	264	20	0	0
1982 Spring	1,026	13	0.2	0
1982 Fall	363	3	0.3	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	0.5	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	0.7	0
1988 Fall	376	3	0	0
1989 Spring	120	9	0.8	0
1989 Fall	628	5	0	0
1990 Spring	95	17	4	2
1990 Fall	107	5	2	2
1991 Spring	512	5	0.8	0
1991 Fall	108	4	0	0
1992 Spring	108	14	1	0
1992 Fall	78	15	0	0
1993 Spring	112	21	3	0.9
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 1.7. Continued.

Year	Sample size	Total length (inches)		
		6	7	8
1995 Fall	1,236	<1	0	0
1996 Spring	434	5	2	0.5
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	--	--	--	--
1999 Fall	832	1	0	0

Table 1.8. Size frequency distributions for channel catfish in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

		Total length (inches)		
Year	Sample size	12	16	20
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 1.8. Continued.

Year	Sample size	Total length (inches)		
		12	16	20
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	--	--	--	--
1999 Fall	142	37	1	0

Table 1.9. Size frequency distributions for largemouth bass in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

Year	Sample size	Total length (inches)			
		12	14	16	18
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	85	73	43	9

Table 1.9. Continued.

Year	Sample size	Total length (inches)			
		12	14	16	18
1996 Fall	1,000	58	47	27	7
1997 Spring	718	84	70	46	14
1997 Fall	357	24	19	12	5
1998 Spring	691	63	53	41	15
1998 Fall	705	53	41	31	6
1999 Spring	--	--	--	--	--
1999 Fall	514	50	38	13	4

Table 1.10. The numbers, mean back-calculated length (inches) and mean derived weight (pounds) for white crappie from Newton Lake, Coffeen Lake and Lake of Egypt collected from 1997 through 1999.

	Newton Lake			Coffeen Lake			Lake of Egypt		
Age	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)
1		4.26	0.04	1	4.45	0.03		4.46	0.10
2	21	8.38	0.30	13	6.70	0.10	56	8.80	0.40
3				88	8.02	0.20	82	10.97	0.70
4				30	9.04	0.30	20	11.74	0.80
5				2	11.77	0.90	10	12.04	0.90
6							4	12.83	1.10
7								14.99	1.60
8							1	15.55	1.80

Table 1.11. The numbers, mean back-calculated length (inches) and mean derived weight (pounds) for bluegill sunfish from Newton Lake, Coffeen Lake and Lake of Egypt collected from 1997 through 1999.

	Newton Lake			Coffeen Lake			Lake of Egypt		
Age	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)
1	71	2.45	0.01	95	2.64	0.01	5	2.61	0.01
2	202	3.87	0.03	214	3.76	0.03	78	4.10	0.04
3	76	4.88	0.07	125	4.50	0.05	85	5.38	0.10
4	29	5.70	0.11	17	5.03	0.08	98	6.20	0.14
5	10	6.06	0.14	3	5.47	0.10	34	6.51	0.17
6	1	6.10	0.14				22	6.76	0.20
7							1	7.99	0.33

Table 1.12. The numbers, mean back-calculated length (inches) and mean derived weight (pounds) for channel catfish from Newton Lake, Coffeen Lake and Lake of Egypt collected from 1997 through 1999.

Age	Newton Lake			Coffeen Lake			Lake of Egypt		
	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)
1		3.73	0.1		4.16	0.1		4.93	0.1
2	13	6.09	0.1	5	7.24	0.1	1	9.83	0.3
3	28	7.81	0.1	27	9.34	0.2	1	13.22	0.8
4	42	9.11	0.2	32	10.93	0.4	3	15.74	1.3
5	60	10.12	0.3	43	12.30	0.5	5	17.56	1.8
6	65	10.84	0.3	50	13.52	0.7	15	18.80	2.2
7	65	11.60	0.4	39	14.59	0.9	21	19.80	2.6
8	55	12.36	0.5	54	15.52	1.1	17	20.48	2.9
9	27	13.14	0.6	45	16.01	1.2	19	20.91	3.1
10	18	13.06	0.6	13	15.74	1.1	6	22.39	3.7
11	4	12.07	0.5	4	15.64	1.1	4	25.41	5.4
12	4	11.71	0.4	4	15.33	1.0			

Table 1.13. The numbers, mean back-calculated length (inches) and mean derived weight (pounds) for largemouth bass from Newton Lake, Coffeen Lake and Lake of Egypt collected from 1997 through 1999.

Age	Newton Lake			Coffeen Lake			Lake of Egypt		
	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)	Number	Length(in)	Weight(lb)
1	232	6.80	0.1	135	7.50	0.2	25	6.38	0.1
2	152	13.14	1.2	115	12.50	1.1	56	10.61	0.6
3	59	16.11	2.3	95	15.25	2.0	78	12.93	1.0
4	37	17.31	2.9	57	16.57	2.6	45	14.41	1.4
5	32	18.01	3.3	25	17.60	3.2	43	15.41	1.7
6	11	18.70	3.8	9	18.46	3.7	22	16.11	1.9
7	8	19.13	4.1	11	19.05	4.1	19	16.90	2.2
8	1	19.51	4.3	3	19.11	4.2	12	17.40	2.5
9		20.64	5.2	2	19.07	4.1	8	17.92	2.8
10	1	21.10	5.5	1	18.74	3.9	3	18.97	3.3
11							1	19.52	3.6
12							1	18.58	3.1
13							1	19.41	3.7

Table 1.14. Summary of mean relative weights for largemouth bass, bluegill, and channel catfish captured in each lake during November 1997, and March, August, and November of 1998 and 1999.

	Newton Lake			Lake of Egypt			Coffeen Lake		
Year	March	August	November	March	August	November	March	August	November
				Largemouth Bass					
1997	--	--	105	--	--	89	--	--	99
1998	105	96	106	89	82	95	104	96	105
1999	108	97	105	98	82	--	110	93	105
Mean	107	97	105	93	82	92	107	95	103
				Bluegill					
1997	--	--	85	--	--	81	--	--	82
1998	92	84	85	90	84	93	--	88	97
1999	78	89	98	82	82	--	83	90	96
Mean	81	87	91	86	83	87	83	88	92
				Channel Catfish					
1997	--	--	82	--	--	87	--	--	82
1998	86	90	84	100	87	107	89	83	92
1999	86	82	84	96	94	--	79	95	91
Mean	86	86	83	98	89	103	84	88	89

Table 1.15. Mean percentage of largemouth bass, and channel catfish with empty stomachs from the three Illinois power-cooling reservoirs (Newton Lake, Coffeen Lake, and Lake of Egypt) during 1997, 1998, and 1999.

		Newton Lake		Coffeen Lake		Lake of Egypt	
Species	Year	% Empty	Months[a]	% Empty	Months[a]	% Empty	Months[a]
Largemouth Bass	1997	49.9	4	33.6	2	36.4	1
	1998	51.7	9	29.4	5	30.4	4
	1999	70.0	12	54.6	5	55.4	2
	Mean	60.2		40.6		38.4	
Channel Catfish	1997	30.6	4	46.3	2	25.0	1
	1998	48.6	9	43.1	6	39.4	4
	1999	59.2	10	87.5	3	28.6	2
	Mean	51.0		55.8		34.3	

[a]/ Number of months that samples were taken.

Table 1.16. 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, 1998 and 1999 (-- indicates an undeterminable value).

Year	Newton Lake		Lake of Egypt		Coffeen Lake	
	C-R	C-C	C-R	C-C	C-R	C-C
			Largemouth Bass			
1997	73	63	30	28	40	37
1998	56	34	39	28	50	35
1999	61	55	--[1]	--[1]	40	38
Mean	63	51	35	28	43	36
			Bluegill			
1997	73	72	59	38	69	58
1998	88	78	36	52	70	69
1999	88	67	--[1]	--[1]	56	61
Mean	83	72	48	45	65	63
			Channel Catfish			
1997	54	41	67	50	32	13
1998	44	38	11	--	33	18
1999	40	32	--[1]	--[1]	36	38
Mean	46	37	39	50	34	23

1/ No sampling scheduled.

Table 1.17. Hatching date ranges for 1998-99 by taxa in three Illinois power cooling reservoirs. In 1998 and 1999, hatching dates were calculated using the 1998 aged larvae and their subsequent length-age linear regression prediction equations. The initial temperature is the lowest temperature at the beginning of the hatching range. The ending temperature is the highest temperature at the end of the hatching range.

Lake	Year	Taxa	Hatching date range	Days	Hatching temp. range (°F) Initial	Ending
Newton Lake	1998	*Lepomis*	4/15-9/19	158	56	94
		Dorosoma	3/27-6/30	96	60	100
		Morone[2]	4/04-5/15[1]	42		
		Micropterus	4/05-5/09[1]	35		
	1999	*Lepomis*	3/31-10/01	185	70	87
		Dorosoma	3/11-7/01	113	52	92
		Morone[2]	3/14-5/03[1]	51		
		Micropterus	3/27-5/11[1]	44		
Coffeen Lake	1998	*Lepomis*	4/23-10/04	165	78	84
		Dorosoma	3/29-6/27	81	62	97
		Morone[2]	4/04-4/28[1]	25		
		Pomoxis	4/08-5/14[1]	37		
	1999	*Lepomis*	5/02-9/10	132	80	103
		Dorosoma	3/21-7/09	111	67	100
Lake of Egypt	1998	*Lepomis*	5/09-9/05	120	67	91
		Dorosoma	4/03-6/29	88	63	92
		Pomoxis	4/01-5/05[1]	35		
		Micropterus[2]	4/26-5/20[1]	25		
	1999	*Lepomis*	5/01-9/08	131	74	87
		Dorosoma	4/08-7/16	100	63	89
		Pomoxis	4/04-5/06[1]	33		
		Micropterus[2]	4/19-5/24[1]	36		

[1]Hatching range temperatures fall within the ranges for those of *Dorosoma* for that year.
[2]Hatching range was calculated from a length-age linear regression equation developed from a small sample size of fish and having relatively low R^2 values.

Table 1.18. Mean densities (n/m^3) for larval fish (all segments combined) in three Illinois power cooling lakes. Superscripts with different letters are significantly different between years, within taxa, at $\alpha = 0.05$. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Year	Taxa	Density	Range	Std.dev.
Newton Lake	1998	*Lepomis*	0.0129[a]	0-0.0842	0.0174
	1999	*Lepomis*	0.0146[a]	0-0.0970	0.0244
	1998	**Dorosoma**	0.7992[a]	0-4.6318	1.1534
	1999	*Dorosoma*	0.9326[a]	0-5.5988	1.5106
Coffeen Lake	1998	*Lepomis*	0.0067[a]	0-0.0441	0.0106
	1999	*Lepomis*	0.0015[a]	0-0.0075	0.0024
	1998	*Dorosoma*	0.1123[a]	0-0.6234	0.1931
	1999	*Dorosoma*	0.1038[a]	0-0.8778	0.2312
Lake of Egypt	1998	*Lepomis*	0.0946[a]	0-0.4197	0.1266
	1999	*Lepomis*	0.0245[b]	0-0.1107	0.0326
	1998	*Dorosoma*	0.3407[a]	0-3.9256	1.0363
	1999	*Dorosoma*	0.3691[a]	0-1.833	0.6348

Table 1.19. Mean CPUE (n/hr) for larval fish (all segments combined) collected with light traps in three Illinois power cooling lakes. Superscripts with different letters are significantly different between segments, within taxa, at $\alpha = 0.05$. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Year	Taxa	CPUE	Range	Std.dev.
Newton Lake	1998	*Lepomis*	5.18[a]	0-30.35	8.01
	1999	*Lepomis*	26.75[a]	0-383.37	68.26
	1998	*Dorosoma*	2.45[a]	0-32.00	6.74
	1999	*Dorosoma*	6.26[a]	0-49.94	12.77
	1998	*Micropterus*	1.27[a]	0-4.53	1.81
	1999	*Micropterus*	2.72[a]	0-40.72	9.29
Coffeen Lake	1998	*Lepomis*	2.4[a]	0-14.94	3.56
	1999	*Lepomis*	17.01[a]	0-152.57	37.38
	1998	*Dorosoma*	0.64[a]	0-2.69	0.98
	1999	*Dorosoma*	1.48[a]	0-9.68	2.76
	1998	*Micropterus*	0.04[a]	0-.12	0.06
	1999	*Micropterus*	0.31[a]	0-1.00	0.47
Lake of Egypt	1998	*Lepomis*	2.84[a]	0-15.47	4.43
	1999	*Lepomis*	5.44[a]	0-46.09	12.35
	1998	*Dorosoma*	6.96[a]	0-56.64	14.96
	1999	*Dorosoma*	3.74[a]	0-36.29	9.36
	1998	*Micropterus*	0.8[a]	0-2.12	0.91
	1999	*Micropterus*	1.35[a]	0-7.75	3.13

Table 1.20. Mean number[1] of all fish collected in seine hauls in August 1997 and April through August 1998 and 1999. Number of largemouth bass are in parenthesis.

Lake	Year		
	1997	1998	1999
Newton	[a]2.98 (1.58)[a]	[a]16.38 (5.90)[a]	[a]7.89 (3.49)[a]
Coffeen	[a]8.80 (1.50)[a]	[a]11.96 (0.40)[b]	[a]8.83 (0.17)[b]
Lake of Egypt	[a]28.85 (1.25)[b]	[a]12.44 (1.29)[b]	[a]30.56 (2.64)[b]

[1]/ Numbers with same superscript are not significantly different at the $\alpha = 0.05$ level.

Table 1.21. Electrofishing catch per hour for age-1+ largemouth bass collected by Southern Illinois University personnel during fall of each year. Largemouth bass ages were determined by examining their saggittae otoliths.

	1997			1998			1999		
Lake	Effort (hrs)	Sample[a] size	Catch per hour	Effort (hrs)	Sample[a] size	Catch per hour	Effort (hrs)	Sample[a] size	Catch per hour
Newton	9.3	132	1.94	6.3	111	9.84	9	187	3.11
Coffeen	4.8	106	3.33	7.3	109	6.03	5.1	141	7.06
Lake of Egypt	12.6	98	1.83	10.2	105	2.25	---	---	---

[a]/ Total number of all aged largemouth bass examined for age-1+ fish.

Table 1.22. Summary of fishing and harvest effort on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 were taken from Merle Price's report to Ameren CIPS (Table 50). Creel data for 1998 was taken from INHS April 12, 1999, report to Ameren CIPS.

	Angling	Total No. Fish		Fish/acre		Fish/hr.	Total pounds		Pounds/acre		Pounds/acre	
Year	hours	Caught	Harvested	Caught	Harvested	caught	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986	150,814		125,746		72			76,368		43.6		0.51
1987	119,609		90,018		51			64,448		36.8		0.54
1988	73,395		25,537		15			26,630		15.2		0.36
1989	84,022		24,942		14			29,146		16.6		0.35
1990	82,351		32,102		18			44,356		25.3		0.34
1991	70,330		21,029		12			23,142		16.1		0.33
1992	78,531		24,320		14			30,514		17.4		0.39
1993	51,152		10,495		6			14,991		8.6		0.29
1998	105,931	89,726	12,432	127	7	1	114,902	11,937	66	6.8	0.68	0.08

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Table 1.23. Summary of largemouth bass catch and harvest on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 were taken from Merle Price's report to Ameren CIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to Ameren CIPS.

	Total no. fish		Fish/acre		No. fish.hr.		Total pounds		Pounds/acre		Pounds/hr.	
Year	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986		1,743		1.0		0.01		7,033		4.0		0.05
1987		1,278		0.7		0.01		5,409		3.0		0.04
1988		1,231		0.7		0.02		5,322		3.0		0.07
1989		1,141		0.6		0.01		5,160		3.0		0.06
1990		1,216		0.7		0.01		5,248		3.0		0.06
1991		1,143		0.7		0.02		4,883		2.8		0.07
1992		1,441		0.8		0.02		6,351		3.6		0.08
1993		731		0.4		0.01		3,465		2.0		0.07
1998	56,339	12,432	32	0.7	0.35	0.01	103,364	4,752	59	2.7	0.60	0.03

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Table 1.24. Summary of bluegill and white crappie harvest, on Newton Lake (1,750 acres), from 1986-1993 and 1998. Creel data for 1986-1993 were taken from Merle Price's report to AmerenCIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to AmerenCIPS.

	Number of bluegill		
Year	Harvested	Caught	Number of harvested white crappie
1986	1,009		89,499
1987	619		66,971
1988	90		69
1989	283		141
1990	281		199
1991	112		3
1992	29		0
1993[a]	91		0
1998[b]	947	4,482	?[c]

a Lake was closed 5/20/93 - 8/31/93

b In 1998 creel was only run from 2/01/98 through 10/31/98 (9 months).

c Some of the miscellaneous category that contains 61 fish may be crappie.

Table 1.25. Summary of channel catfish catch and harvest on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 were taken from Merle Price's report to Ameren CIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to Ameren CIPS.

	Total no. fish		Fish/acre		No. fish.hr.		Total pounds		Pounds/acre		Pounds/hr.	
Year	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986		32,280		18.0		0.21		35,231		20.0		0.23
1987		20,691		12.0		0.17		21,398		12.0		0.18
1988		23,939		14.0		0.33		21,070		12.0		0.29
1989		22,887		13.0		0.27		23,605		13.0		0.28
1990		30,133		17.0		0.37		38,824		22.0		0.47
1991		19,500		11.0		0.28		23,154		13.0		0.33
1992		22,755		13.0		0.29		24,058		14.0		0.31
1993		9,642		6.0		0.19		11,486		7.0		0.22
1998		9,720		5.6		0.19		6,984		4.0		0.05

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Table 1.26. Primary production values from several studies (after Kimmel et al. 1990)[a].

Reservoir, Location	Year	Production	Units	Comments	Reference
Francis Case, SD	1968	260	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Novotny (1975)
Lewis and Clark, NB	1968	530	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Novotny (1975)
Hebgen, MT	1965	658	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Arneson (1978)
Canyon Ferry, MT	1958	1125	mg C m^{-2} d^{-1}	Net O_2 change, April – September	Wright (1958, 1959, 1960)
Ashtabula, ND	1966 - 68	1828	mg C m^{-2} d^{-1}	Net O_2 change	Peterka and Reid (1966), Knuston (1970), cited in Soltero et al. (1975)
Newton Lake, IL	1997 – 98	944	mg C m^{-2} d^{-1}	Net O_2 change	this study

[a]/ See Chapter 4 for citations.

Table 1.27. Mean total phytoplankton cells per L (Coccoid singles excluded) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	41,524,675[a]	±	5021267	48	16.4%	0.0001
1999	26,716,306[b]	±	2867931	48		

Table 1.28 Mean net photosynthesis (mg C m^{-2} day^{-1}) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	1340.7[a]	±	381.1	16	0.0 %	0.8379
1999	1392.5[a]	±	219.6	16		

Table 1.29. Mean chlorophyll *a* (μg / L) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	14.6[a]	±	0.8	70	0.6 %	0.3623
1999	13.8[a]	±	1.2	72		

Table 1.30. Mean OD 664 / OD 665 ratio (range 1.0 – 1.7) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	1.37[a]	±	0.01	70	9.6 %	0.0002
1999	1.32[b]	±	0.01	72		

Table 1.31. Density of macrophytes, primarily water willow, in Newton Lake. Superscripts indicate statistical differences between weights ($p = 0.0001$).

Date	Pool elevation (ft)	Macrophyte area in acres (%[a])	Pounds per m^2	Mean maximum depth (ft)
August 1977	-2.1	15.1 (0.9)	1.00^b	0.96
August 1998	0	34.8 (2.0)	4.94^a	1.59
August 1999	-5.2	21.9 (1.2)	4.00^a	1.05

[a]/ Percent of lake based on a lake area of 1,750 acres.

Table 1.32. Mean zooplankton densities in Newton Lake with all four sampling segments combined.

Date	Number per L
August 1997	146^a
July – August 1998	171^b
July – August 1999	239^c

[a] / Means with different superscripts are different at α=0.05.

Table 1.33. Mean July and August benthos densities for all four segments combined. Superscripts indicate statistical differences between years at $\alpha = 0.05$.

Date	Density (n per m^2)	Weight (g per m^2)
1998	966^b	0.9733^b
1999	1,683^a	1.418^a

Table 1.34. Densities of phytomacrobenthos over time in Newton Lake with all four segments combined.

Date	Mean Number (m^2)	Mean Weight g/m^2
July 1997	1,628^a	0.369^a
July – August 1998	4,519^b	1.337^b
July – August 1999	8,729^c	3.220^c

Means with different superscripts are different at the $\alpha = 0.05$ level.

Table 1.35. 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
4/9/99	0	0	2	0	0	1	0
6/2/99	0	0	0	0	0	0	0
6/3/99	0	0	0	0	0	0	0
6/8/99	0	0	0	0	0	0	0
6/15/99	0	0	0	0	0	0	0
6/16/99	0	0	0	0	0	0	0
6/29/99	0	0	0	0	0	0	0
6/30/99	0	0	0	0	0	0	0
7/8/99	1	0	0	0	0	0	0
7/9/99	0	0	0	0	0	0	0
7/13/99	0	0	0	0	0	0	0
7/16/99	0	0	0	0	0	0	0
7/21/99	0	0	0	1	1	0	0
7/23/99	0	0	0	0	0	0	0
7/27/99	15	31	0	0	0	0	5
7/28/99	105	0	5	11	0	0	7
8/1/99	0	0	0	0	0	0	0
8/2/99	0	0	0	0	0	0	0
8/6/99	0	0	0	0	0	0	0
8/10/99	0	0	1	0	1	0	0
8/11/99	0	0	0	0	0	0	0
8/19/99	0	0	0	0	0	0	0
8/20/99	0	0	0	0	0	0	0
8/24/99	0	0	0	0	0	0	0
8/25/99	0	0	0	0	0	0	0
8/26/99	0	0	0	0	0	0	0
8/27/99	0	0	0	0	0	0	0
Total	121	31	8	12	2	1	12

Table 1.36. Numbers of dead and morbid fishes observed by SIU personnel in Newton Lake in 1999.

Date	Largemouth bass	Lepomis	Channel catfish	Morone	Carp	Shad
3/23/99	1	0	0	0	0	0
5/20/99	1	0	0	0	0	1
6/1/99	0	0	0	0	0	0
6/2/99	0	0	0	0	0	0
6/3/99	0	0	0	0	0	0
6/4/99	0	0	0	0	0	0
6/8/99	0	0	0	0	0	0
6/9/99	27	0	0	0	0	0
6/14/99	0	0	0	0	0	0
6/15/99	0	0	0	0	0	0
6/19/99	0	0	0	0	0	0
6/22/99	4	0	0	0	0	0
6/23/99	0	0	0	0	0	0
6/24/99	0	0	0	0	0	0
6/29/99	0	0	0	0	0	0
7/6/99	0	0	0	0	0	0
7/7/99	1	0	0	0	0	0
7/8/99	0	0	0	0	0	0
7/14/99	0	0	0	0	0	0
7/15/99	0	0	0	0	0	0
7/16/99	0	0	0	0	0	0
7/20/99	1	0	0	1	0	0
7/21/99	0	0	0	0	0	0
7/23/99	0	0	0	0	0	0
7/24/99	0	0	0	0	0	0
7/27/99	18	1	22	1	1	8
7/29/99	60	4	36	1	0	15
7/30/99	5	0	0	0	0	0
7/31/99	0	0	0	0	0	0
8/5/99	3	0	9	0	0	2
8/9/99	3	0	2	0	0	0
8/10/99	0	0	0	0	0	0
8/11/99	20	0	0	0	0	35
8/18/99	24	0	1	2	0	0
8/19/99	18	0	0	0	0	0
8/24/99	6	0	0	0	0	0
8/25/99	9	0	0	0	0	0
8/26/99	14	0	0	0	0	0
8/27/99	11	0	0	0	0	0
8/31/99	1	0	0	0	0	0
Total	227	5	70	5	1	59

Table 1.37. FHAI scores for largemouth bass, 1998-1999. No differences occurred among the lakes within a season. Asterisks indicate differences between seasons at the $\alpha = 0.05$ level.

Year	Season	Lake	N	FHAI	Std. err.
1998	Spring	Newton*	36	103	5.12
		Coffeen*	30	100	5.79
		Egypt*	31	97	4.79
	Summer	Newton	26	59	5.65
		Coffeen	30	71	4.38
		Egypt	30	53	6.15
1999	Spring	Newton	31	81	5.91
		Coffeen	30	90	6.04
		Egypt	32	91	8.65
	Summer	Newton	17	70	6.52
		Coffeen	31	76	6.50
		Egypt	28	74	7.92
		Newton Moribund	10	102	7.29
		Non-power cooling lakes	23	71	5.66

Table 1.38. Estimated percent habitat available in Lake of Egypt, July 22, 1999 (Segment 1 = 5:26 PM, Segment 2 = 4:20 PM). Habitat is 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	5	29
4	88	14	43
4	89	18	43
4	90	18	50
4	91	23	61
4	92	23	61
4	93	23	61
4	94	23	61
4	95	23	61
4	96	23	61
4	97	23	61
3	87	14	36
3	88	23	50
3	89	27	50
3	90	27	57
3	91	32	68
3	92	32	68
3	93	32	68
3	94	36	68
3	95	36	68
3	96	36	68
3	97	36	68
2	87	18	36
2	88	27	50
2	89	32	50
2	90	32	57
2	91	36	68
2	92	36	68
2	93	36	68
2	94	41	68
2	95	45	68
2	96	45	68
2	97	45	68
1	87	23	50
1	88	32	64
1	89	36	64
1	90	36	71
1	91	41	82
1	92	41	82
1	93	41	82
1	94	45	82
1	95	50	82
1	96	52	82
1	97	52	82

Table 1.39. Estimated percent habitat available in Coffeen Lake, July 23, 1999 (Segment 1 = 3:10 PM, Segment 2 = 2:50 PM). Habitat is 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[a]	
		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

[a]/ Habitat at the sampling station. Coffeen Lake has a large cove and an area north of the intake that may have had better conditions.

Table 1.40. 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 is considered available if it contains 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 1.41. 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 is considered available if it contains no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum oxygen (ppm)	Maximum temperature (°F)	% Habitat available				Total habitat	
		Segment 1	Segment 2	Segment 3	Segment 4	1999	1998[a]
4	87	0	0	0	0	0	2
4	88	0	0	0	0	0	7
4	89	0	0	0	0	0	12
4	90	0	0	0	0	0	16
4	91	0	0	0	0	0	27
4	92	0	0	0	10	3	34
4	93	0	0	6	20	7	37
4	94	0	0	18	50	17	39
4	95	0	0	24	80	26	42
4	96	0	0	38	85	31	44
4	97	0	0	38	85	31	44
3	87	0	0	0	0	0	2
3	88	0	0	0	0	0	7
3	89	0	0	0	0	0	12
3	90	0	0	0	0	0	16
3	91	0	0	0	0	0	27
3	92	0	0	0	10	3	36
3	93	0	0	6	20	7	39
3	94	0	0	18	50	17	41
3	95	0	0	24	80	26	47
3	96	0	6	38	85	32	48
3	97	0	6	38	85	32	48
2	87	0	0	0	0	0	2
2	88	0	0	0	0	0	7
2	89	0	0	0	0	0	12
2	90	0	0	0	0	0	16
2	91	0	0	0	0	0	27
2	92	0	0	0	10	3	36
2	93	0	6	6	20	8	39
2	94	0	6	18	50	19	41
2	95	0	6	24	80	28	47
2	96	0	13	38	85	34	48
2	97	0	13	38	85	34	48
1	87	0	0	0	0	0	6
1	88	0	0	0	0	0	13
1	89	0	0	0	0	0	18
1	90	0	0	0	0	0	22
1	91	13	0	6	0	5	33
1	92	13	0	6	10	7	42
1	93	13	6	12	20	13	44
1	94	25	6	24	50	26	47
1	95	25	6	29	80	35	52
1	96	25	13	44	85	42	54
1	97	25	13	44	85	42	54

[a]/ July 18, 1998.

Table 1.42. 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 is considered available if it contains 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	Total habitat
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 1.43. Estimated percent habitat available in Newton Lake based upon temperature only. Habitat is considered available if it contains no more than the maximum temperature indicated.

Date	Maximum temperature	% Habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
06/02/99	70	0	31	26	0	14
06/02/99	75	17	47	32	0	24
06/02/99	80	28	69	100	100	74
06/02/99	85	28	75	100	100	76
06/18/99	70	0	10	21	0	8
06/18/99	75	0	17	26	0	11
06/18/99	80	0	30	50	77	39
06/18/99	85	17	57	100	100	68
07/02/99	70	0	9	25	0	8
07/02/99	75	0	21	31	0	13
07/02/99	80	0	38	42	0	20
07/02/99	85	6	62	75	86	57
07/13/99	70	0	15	15	0	7
07/13/99	75	0	21	21	0	10
07/13/99	80	0	32	32	0	16
07/13/99	85	0	38	50	75	41
07/24/99	70	0	9	15	0	6
07/24/99	75	0	16	21	0	9
07/24/99	80	0	28	32	0	15
07/24/99	85	0	41	44	5	22
08/05/99	70	0	9	19	0	7
08/05/99	75	0	16	25	0	10
08/05/99	80	0	22	31	0	13
08/05/99	85	0	28	36	0	16
08/18/99	70	0	9	9	0	4
08/18/99	75	0	15	15	0	7
08/18/99	80	0	21	21	0	10
08/18/99	85	19	50	44	35	37
08/31/99	70	0	0	0	0	0
08/31/99	75	0	9	3	0	3
08/31/99	80	0	16	9	0	6
08/31/99	85	0	53	84	100	59

Table 1.44. Estimated percent habitat available in Coffeen Lake based upon temperature only. Habitat is considered available if it contains no more than the maximum temperature indicated.

Date	Maximum temperature	% Habitat available		
		Segment 1	Segment 2	Mean
06/02/1999	70	3	23	13
06/02/1999	75	18	35	27
06/02/1999	80	39	56	48
06/02/1999	85	71	100	86
06/16/1999	70	0	11	6
06/16/1999	75	3	16	9
06/16/1999	80	13	30	21
06/16/1999	85	61	100	80
07/08/1999	70	0	7	3
07/08/1999	75	0	11	6
07/08/1999	80	8	20	14
07/08/1999	85	34	39	36
07/23/1999	70	7	0	4
07/23/1999	75	12	3	7
07/23/1999	80	17	8	12
07/23/1999	85	21	18	19
08/06/1999	70	0	7	3
08/06/1999	75	0	11	6
08/06/1999	80	0	16	8
08/06/1999	85	0	20	10
08/19/1999	70	0	7	3
08/19/1999	75	0	7	3
08/19/1999	80	0	11	6
08/19/1999	85	0	25	13

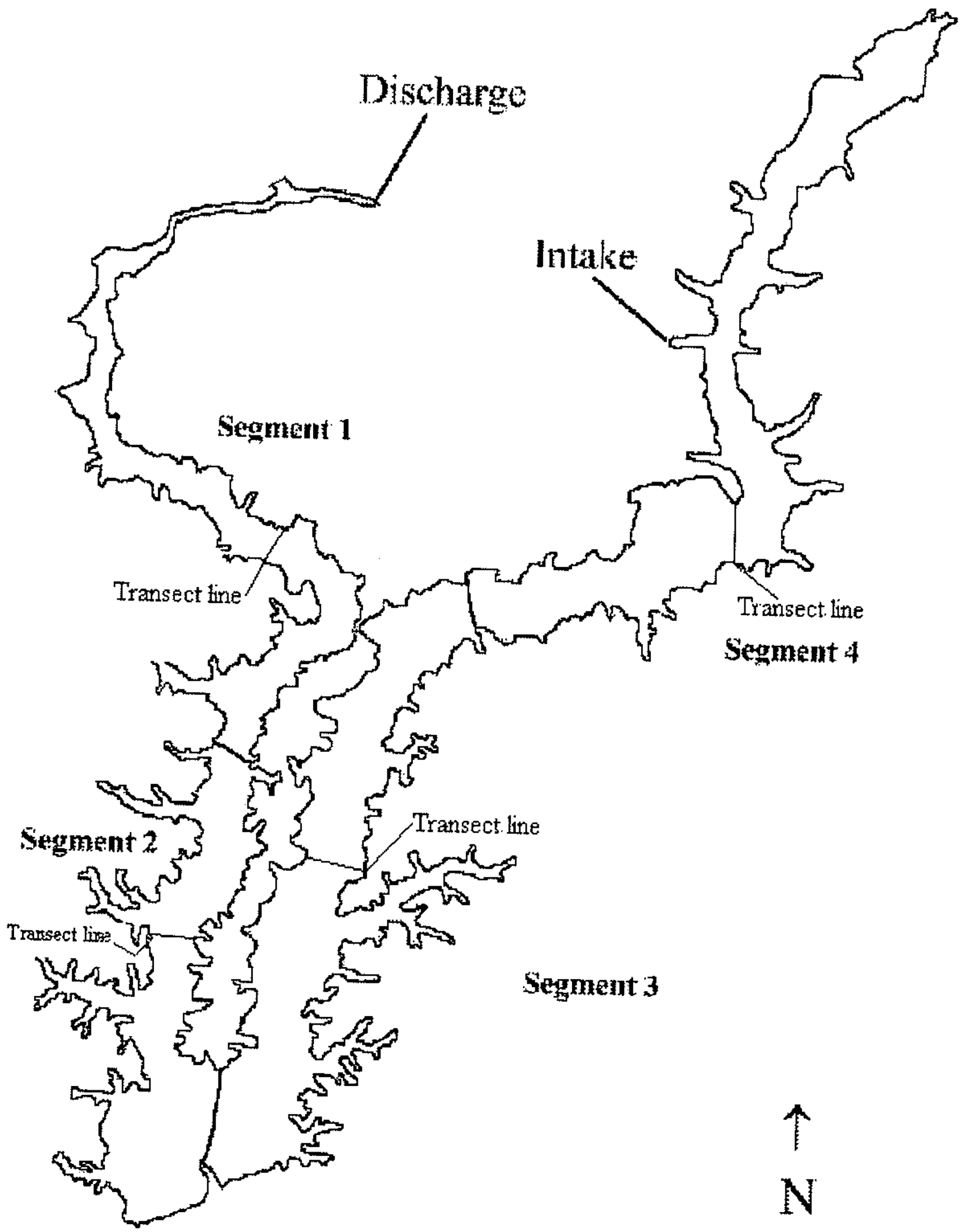


Figure 1.1. Newton Lake with four segments and transect lines where sampling was conducted for water quality, benthos, and zooplankton from August 1997 through 1999.

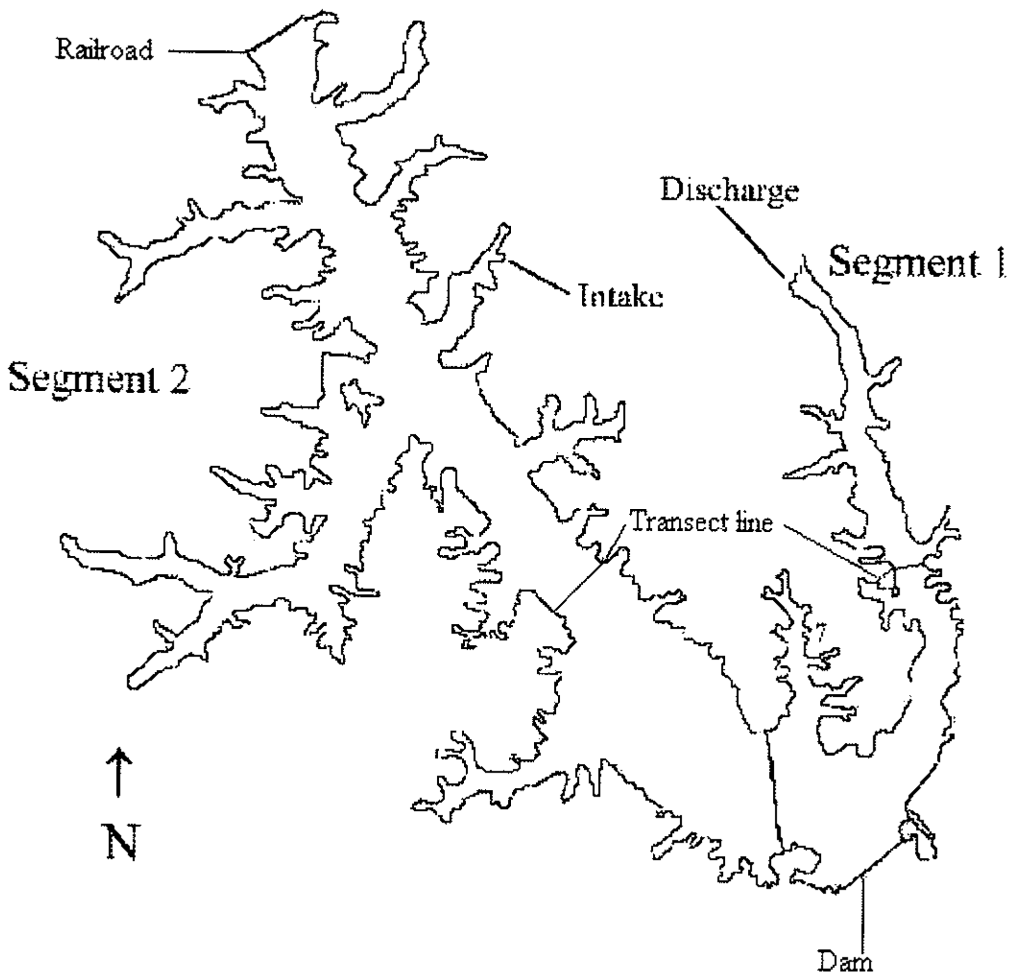


Figure 1.2. Coffeen Lake with two segments and transect lines where sampling was conducted for water temperature and dissolved oxygen from August 1997 through 1999.

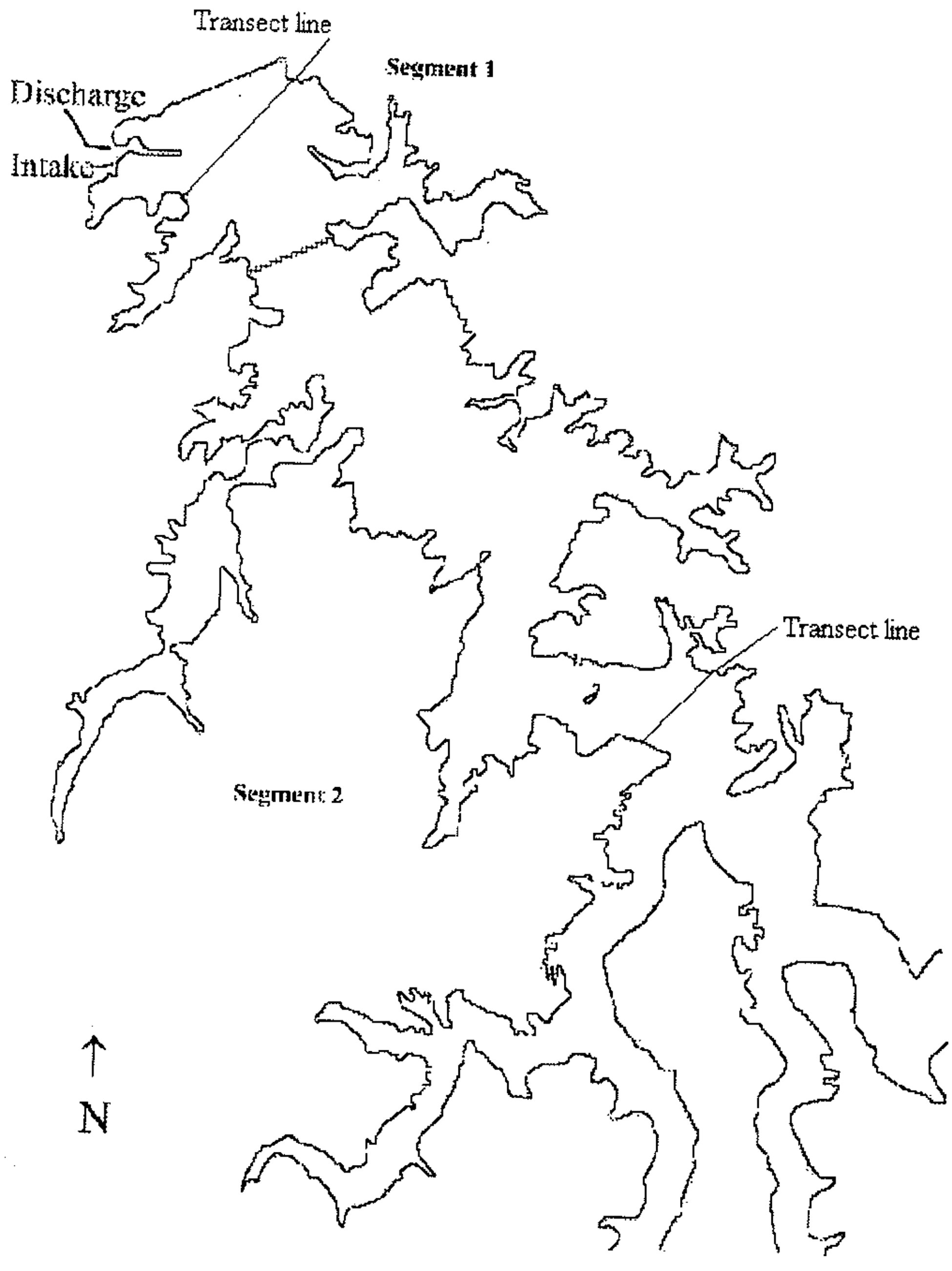


Figure 1.3. Lake of Egypt with two segments and transect lines where sampling was conducted for water temperature and dissolved oxygen from August 1997 through August 1999.

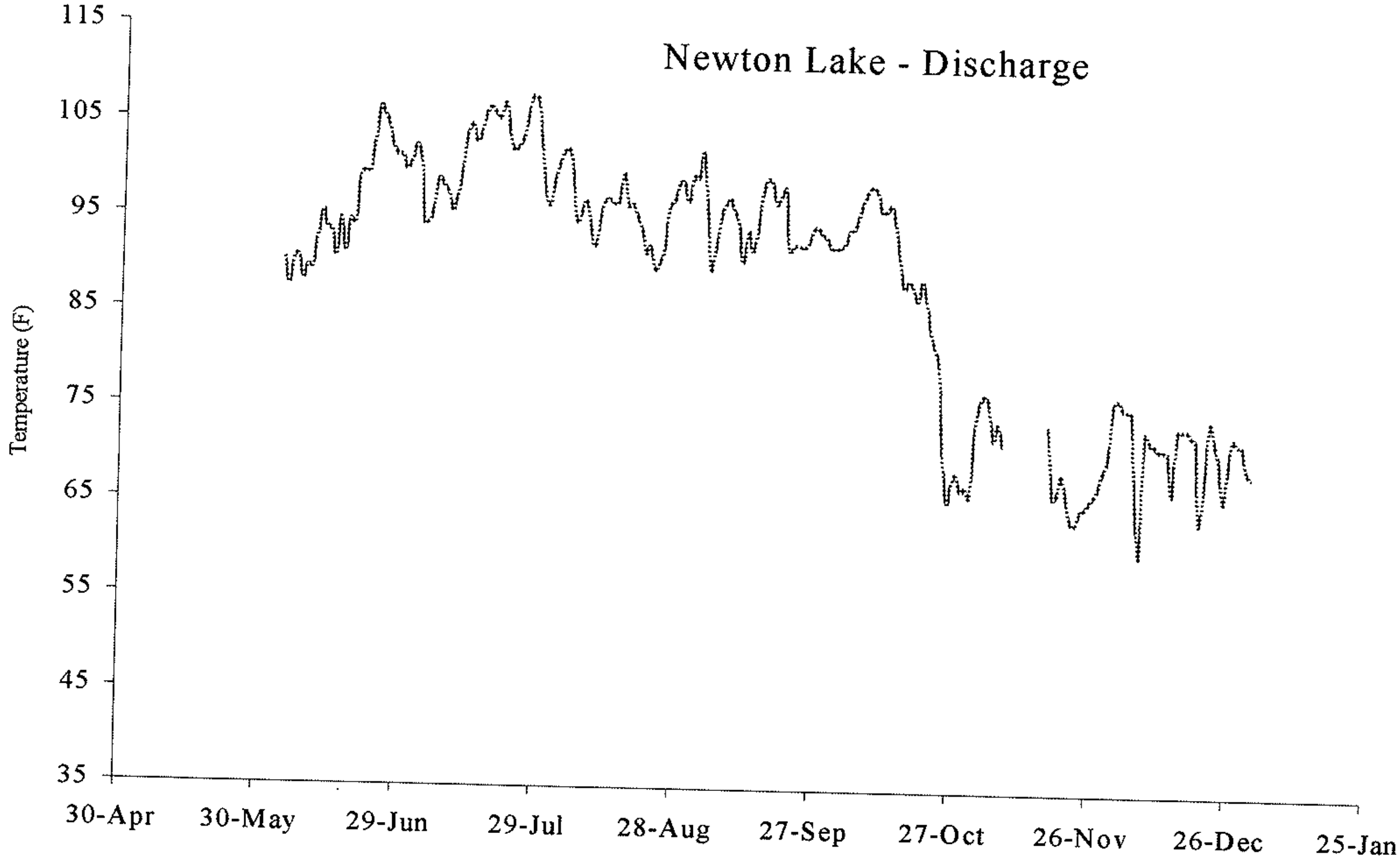


Figure 1.4. Mean daily surface temperatures during 1997 at the Newton Lake discharge.

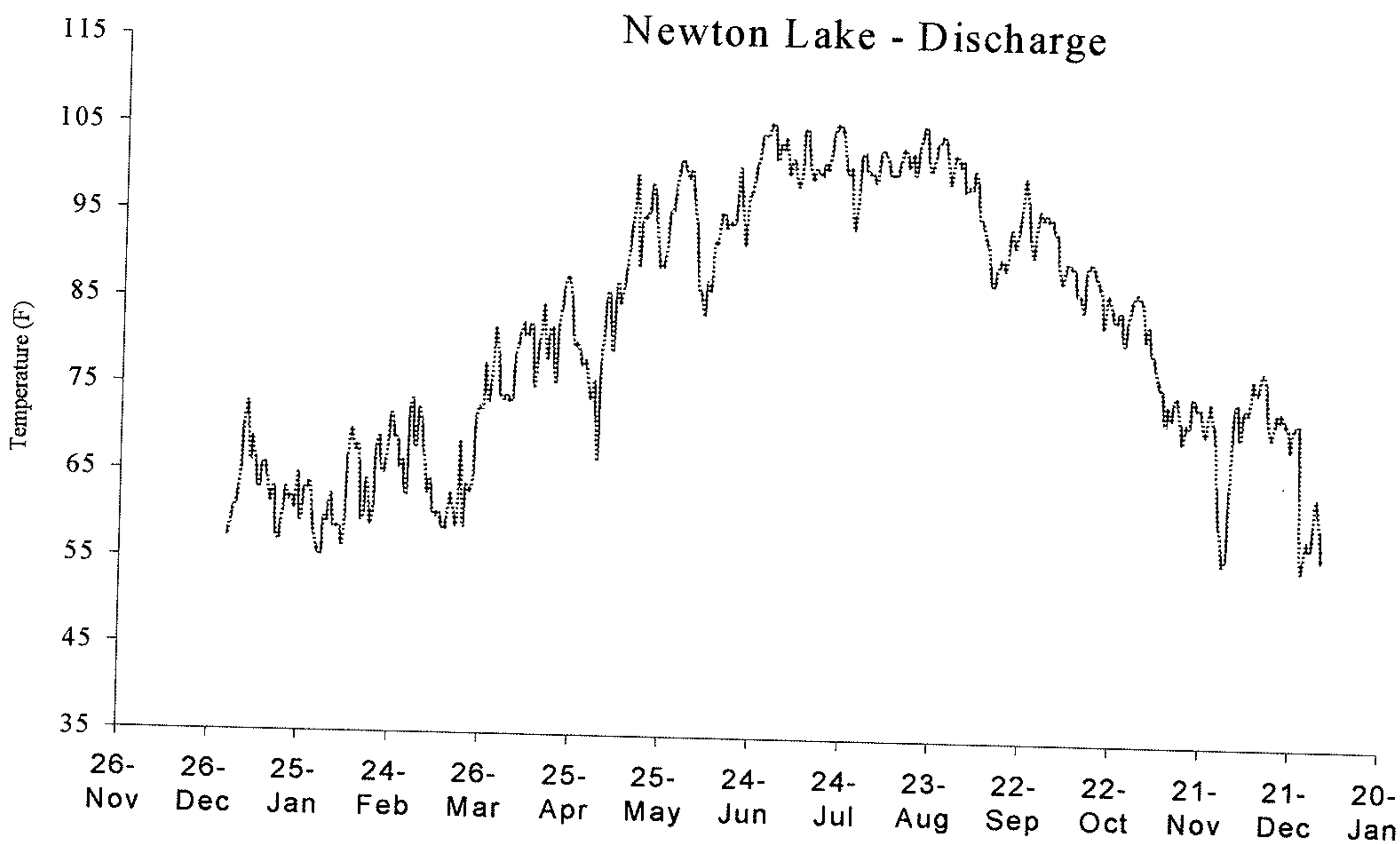


Figure 1.5. Mean daily surface temperatures during 1998 at the Newton Lake discharge.

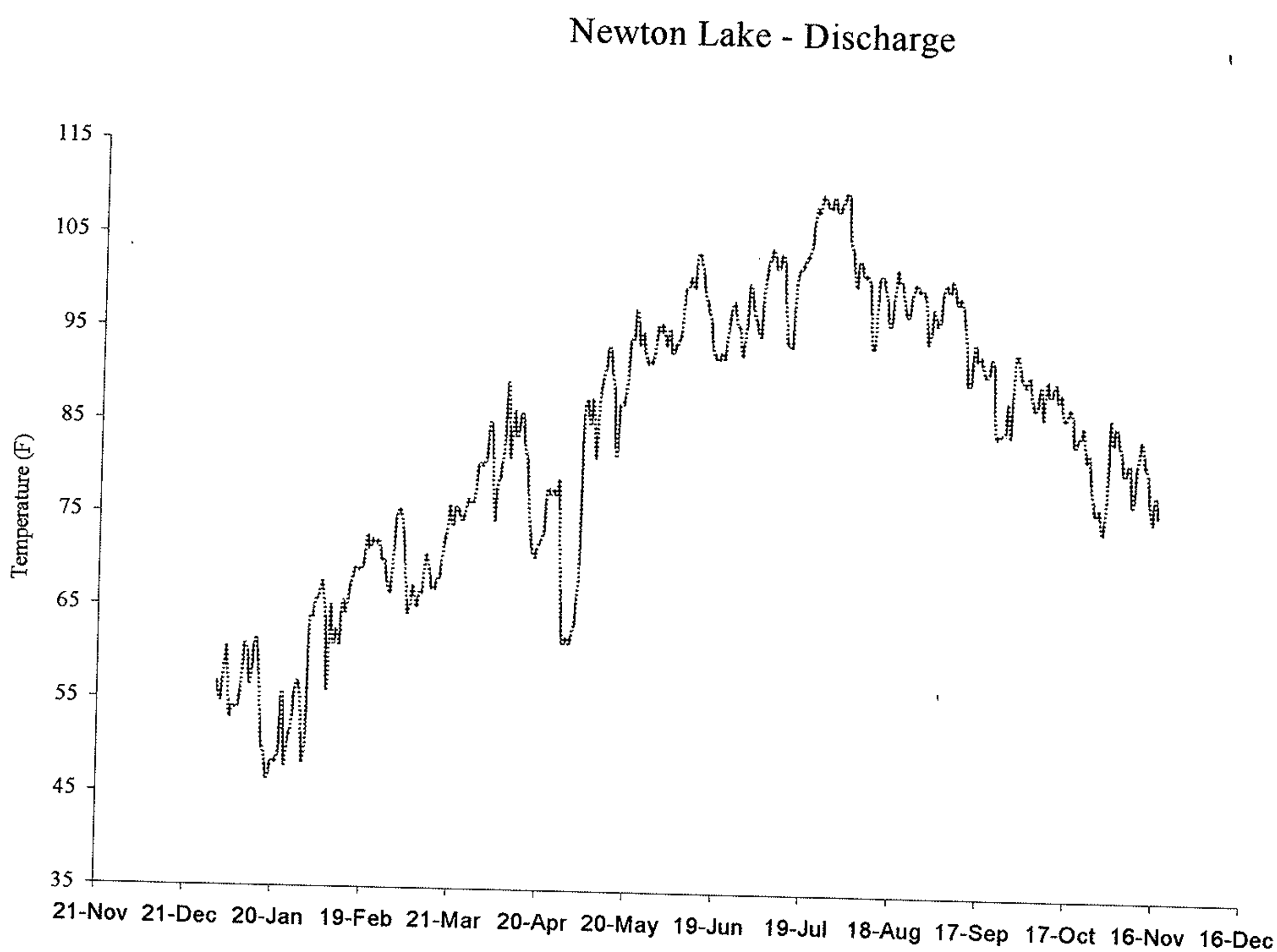


Figure 1.6. Mean daily surface temperatures during 1999 at the Newton Lake discharge.

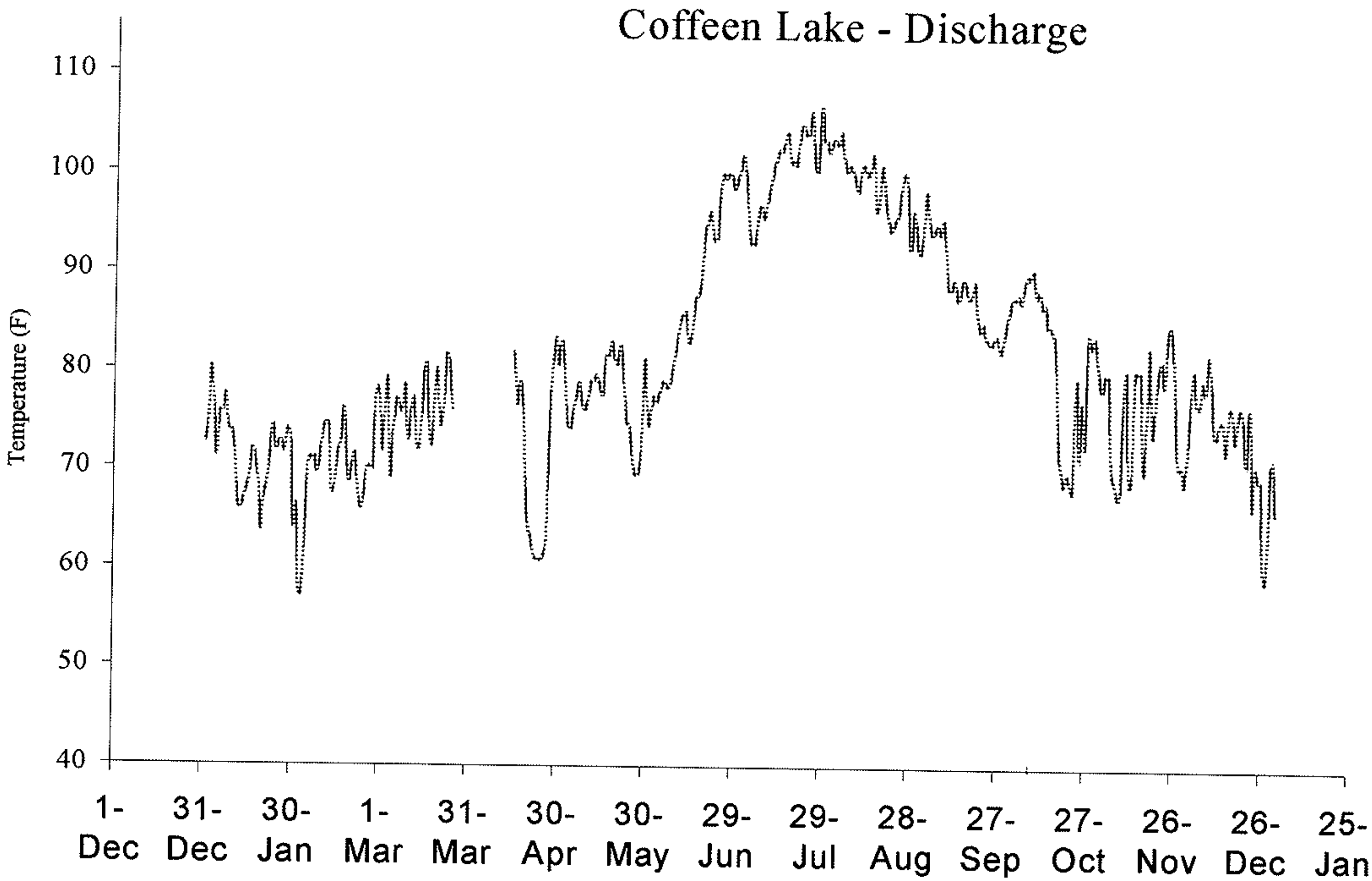


Figure 1.7. Mean daily surface temperatures during 1997 at the Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

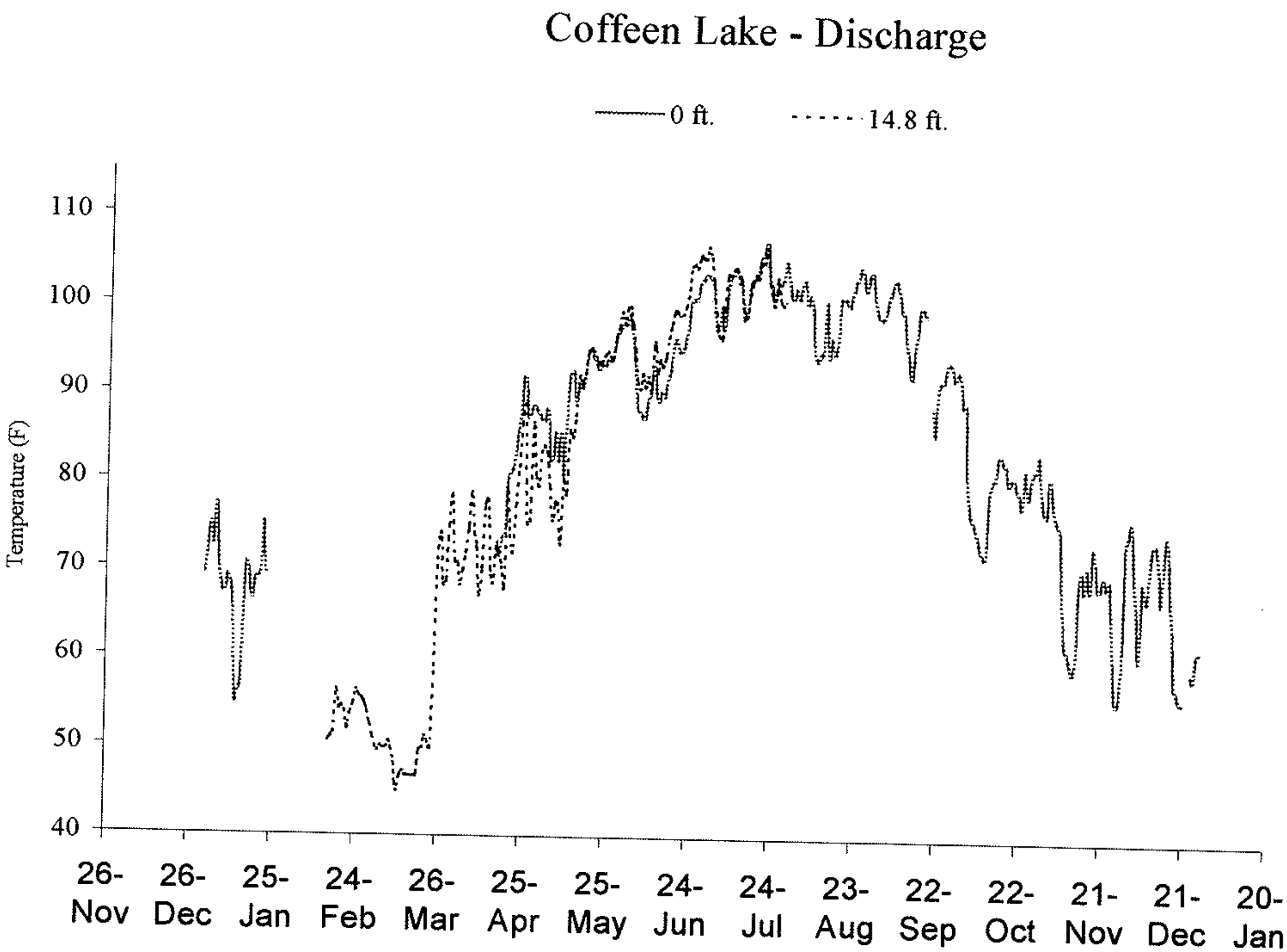


Figure 1.8. Mean daily temperatures during 1998 at the Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

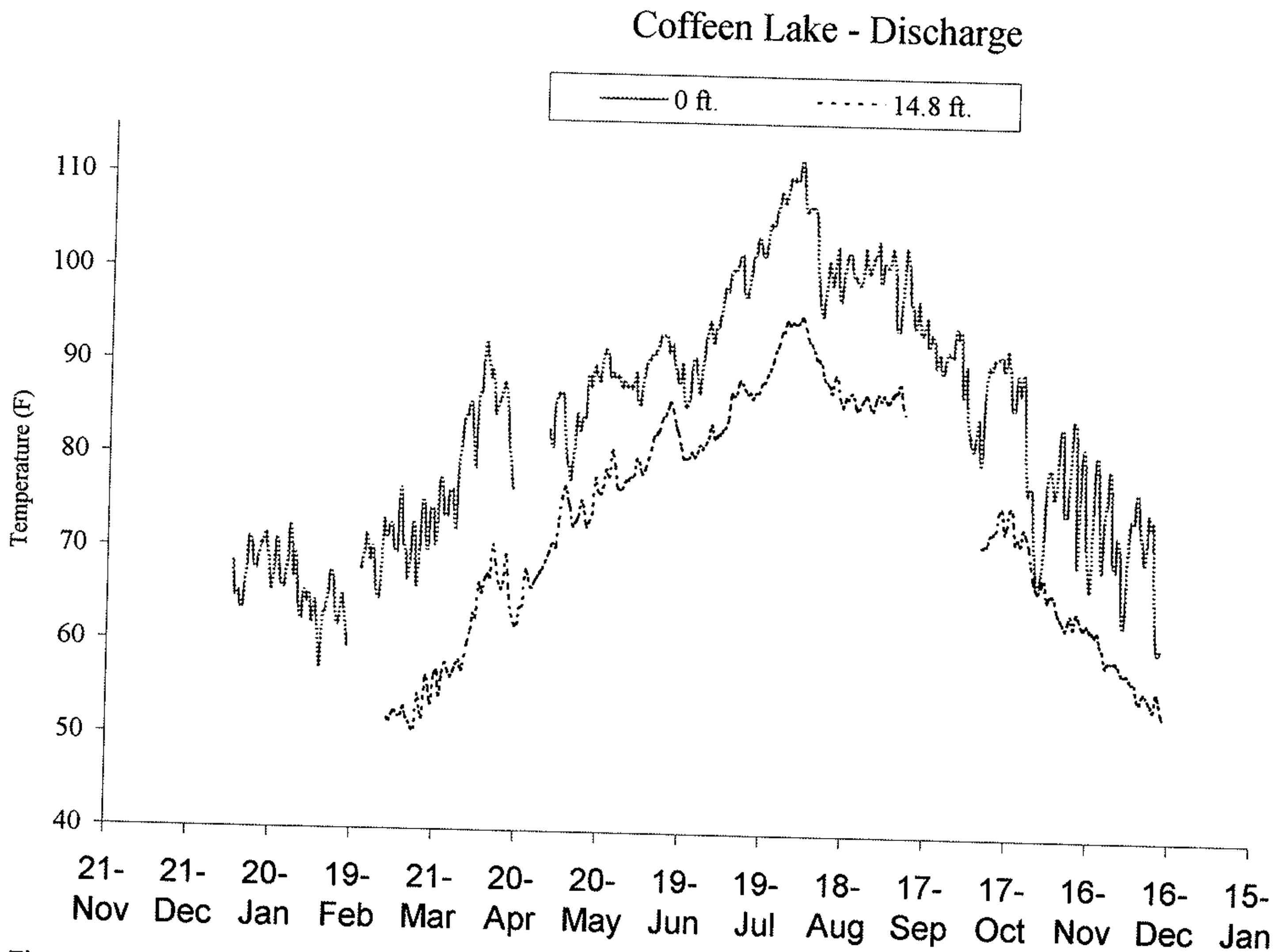


Figure 1.9. Mean daily temperatures during 1999 at the Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

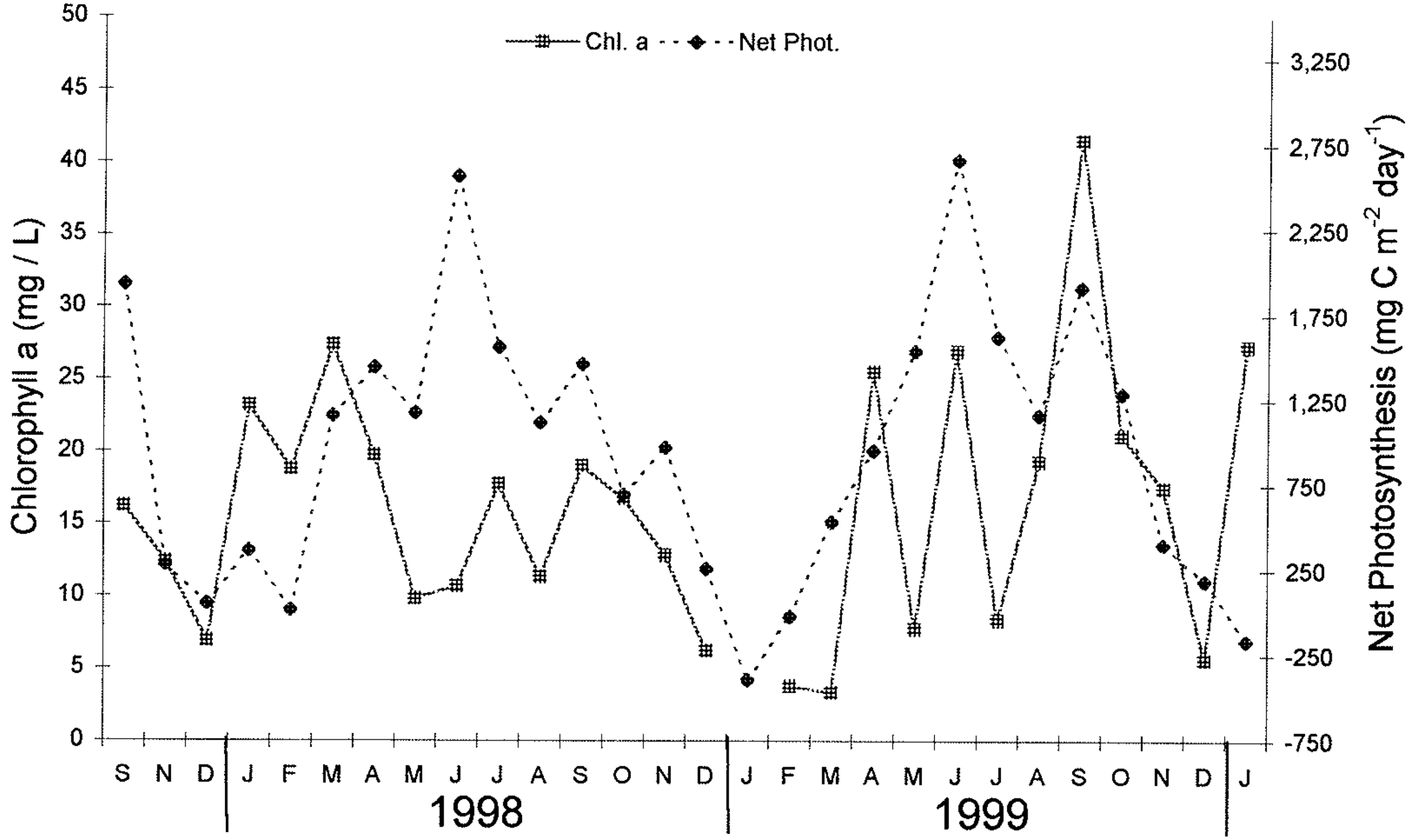


Figure 1.10. Mean chlorophyll *a* (μg / L) and mean net photosynthesis (mg C m^{-2} day^{-1}), Newton Lake, all segments combined. Note that during the winter months some negative photosynthesis occurred and the date axis does not intersect the net photosynthesis axis at 0.

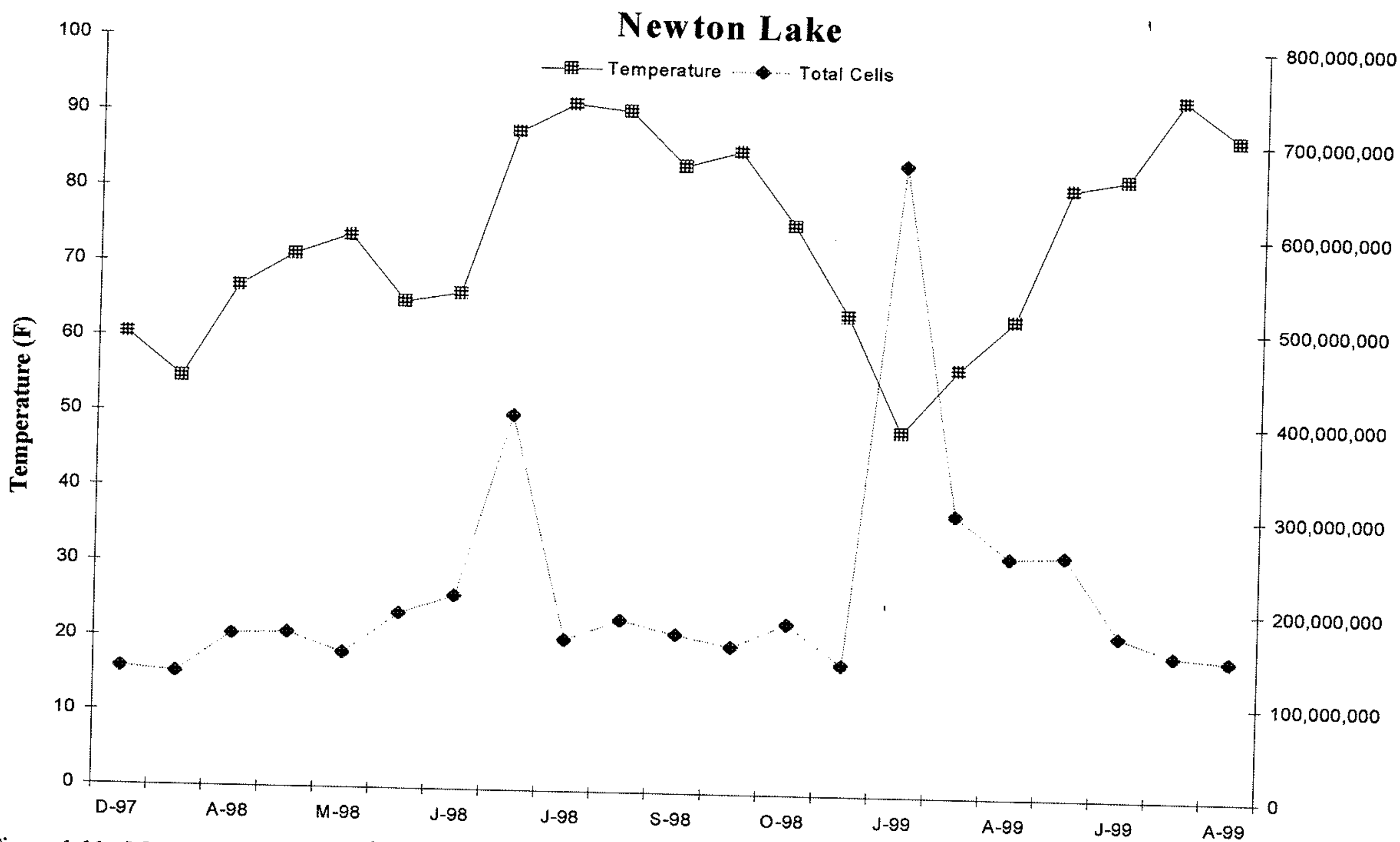


Figure 1.11. Mean total cell count L^{-1} (Coccoid singles included) and mean euphotic temperature (F) for Newton Lake, all segments combined, 1997 – 1999.

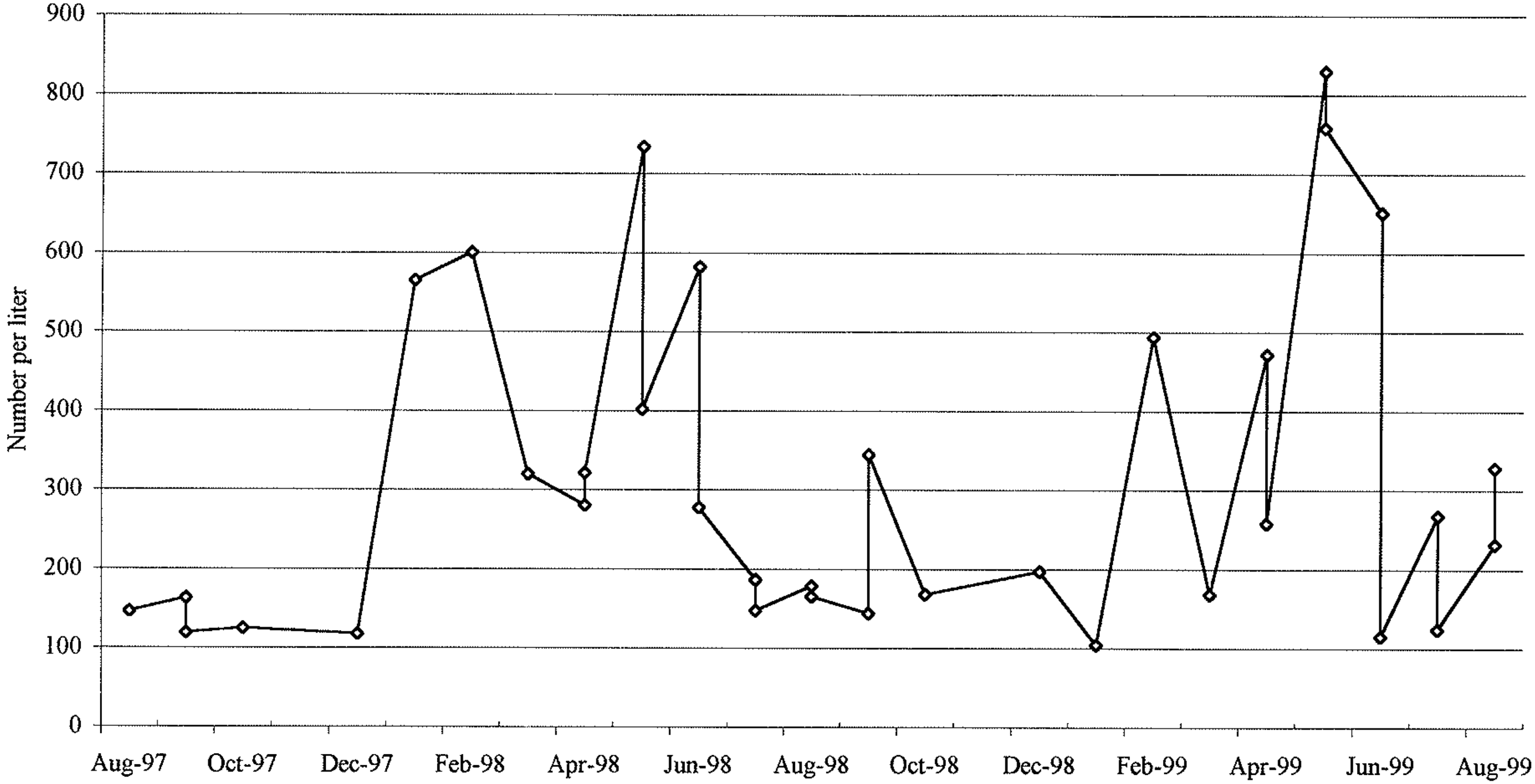


Figure 1.12. Mean densities of zooplankton by date collected in Newton Lake (12 stations, all segments combined) from August 1997 through August 1999.

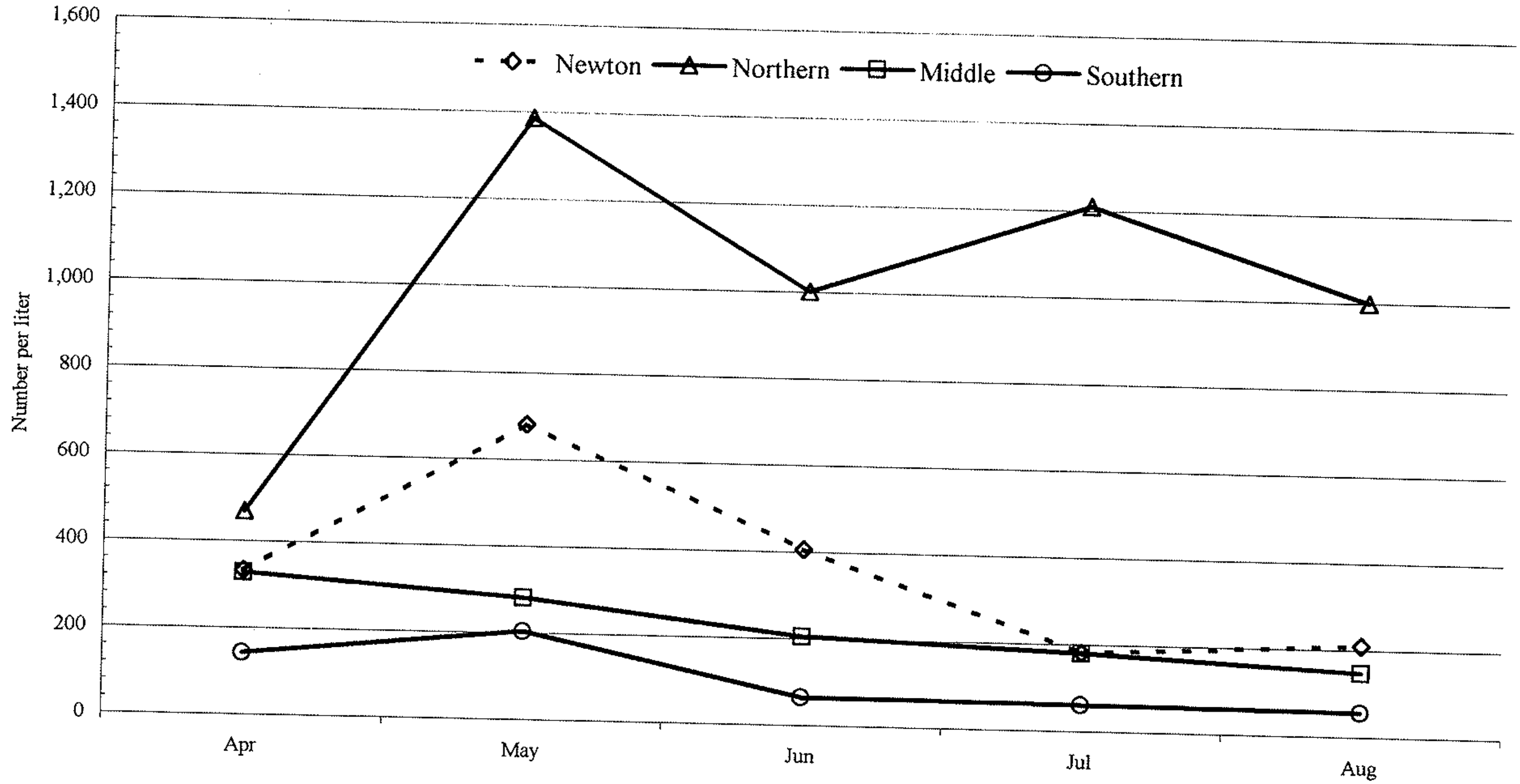


Figure 1.13. Mean monthly densities of zooplankton collected in Newton Lake compared to 12 lakes grouped into three regions of Illinois. Zooplankton was collected from the Illinois lakes during April through August of 1993 through 1997. Five lakes were sampled in the northern zone, six in the middle zone, and four in the southern zone. Four to six samples were taken from the Illinois lakes each month for five years.

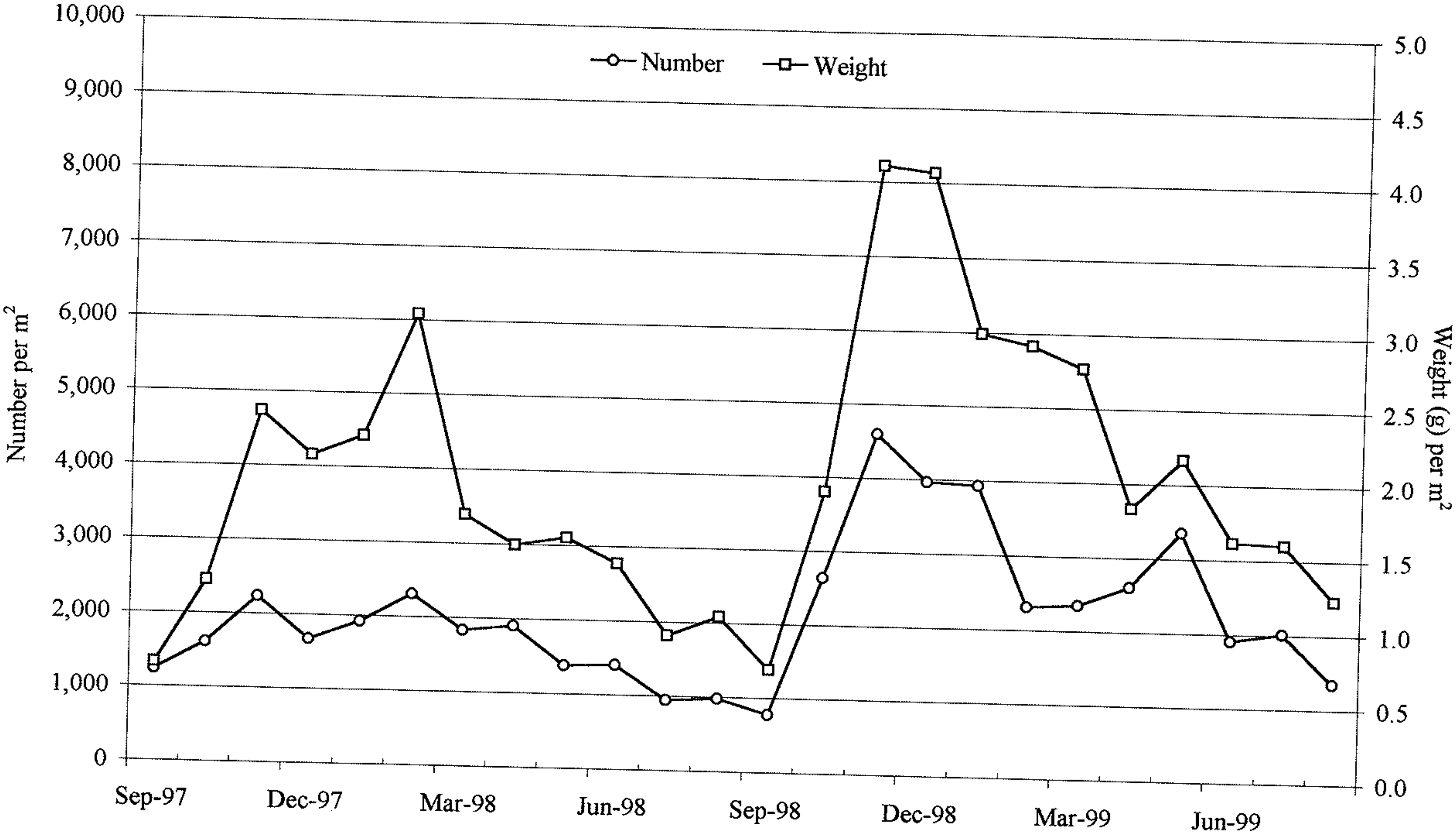


Figure 1.14. Mean monthly densities and weights of benthos collected in Newton Lake (24 stations for all segments combined) from September 1997 through August 1999. Benthos was collected using a ponar dredge.

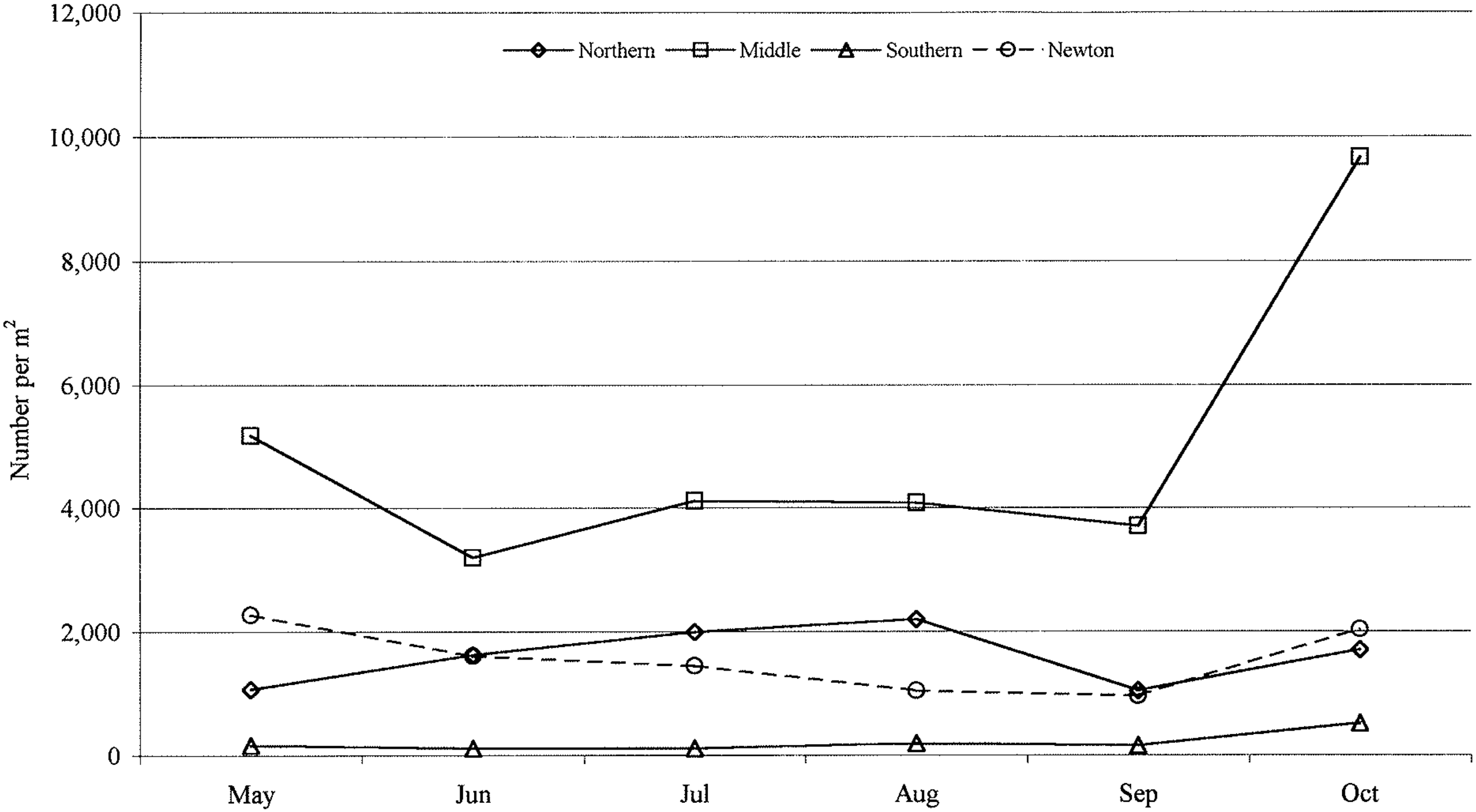


Figure 1.15. Mean benthos densities in 12 lakes located in three regions of Illinois compared to densities in Newton Lake from May through October. Benthos was collected each year during 1993 through 1997 from the 12 Illinois lakes and in 1998 and 1999 in Newton Lake. Four to six samples were taken each month from each of the 12 lakes for five years. Five lakes were sampled in the northern zone, six in the middle zone, and four in the southern zone.

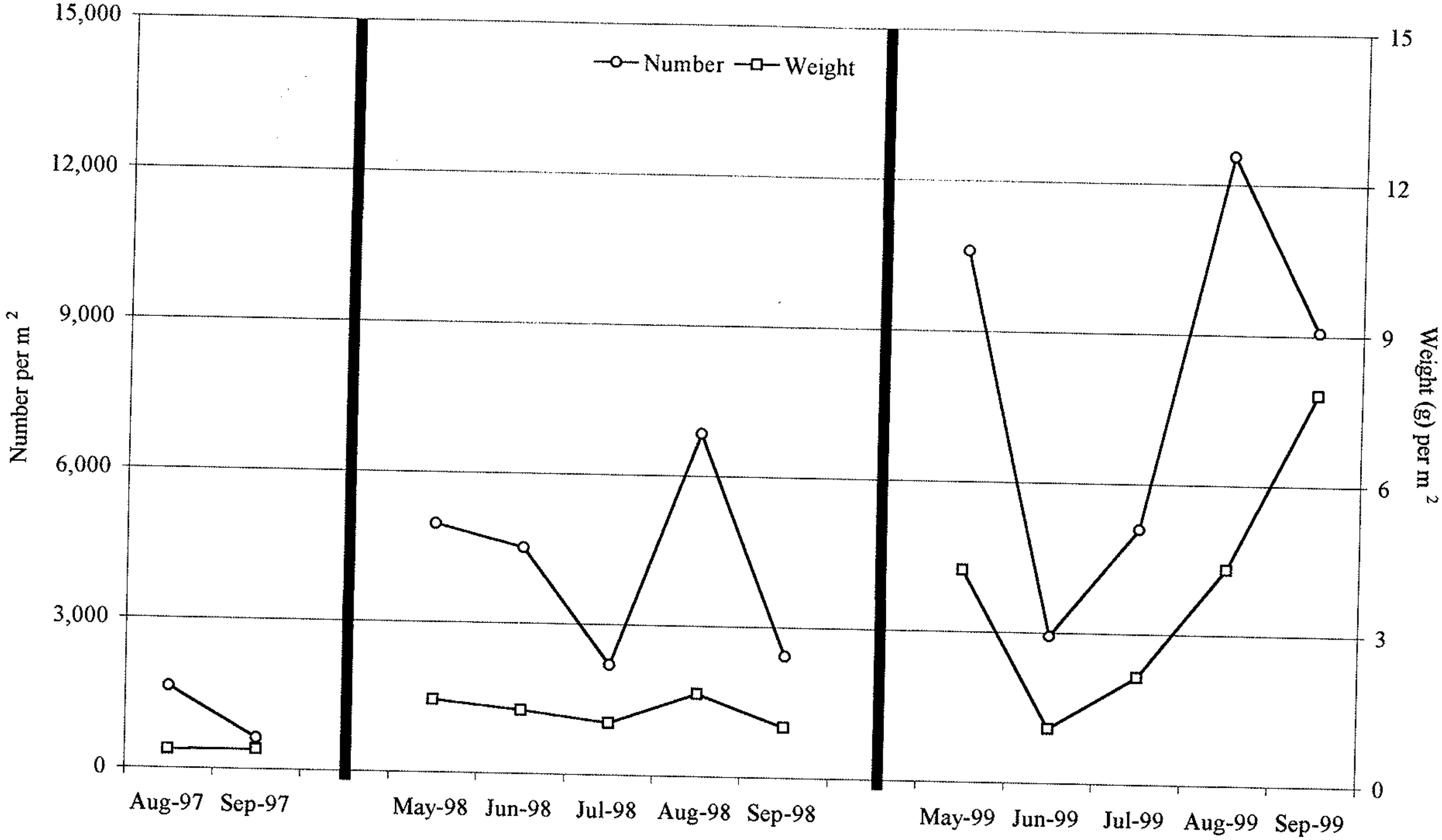


Figure 1.16. Mean monthly densities and weights of phytomacrobenthos collected in Newton Lake during August and September 1997 and May through September 1999. Two samples were collected from each of twenty stations (when possible) located throughout Newton Lake.

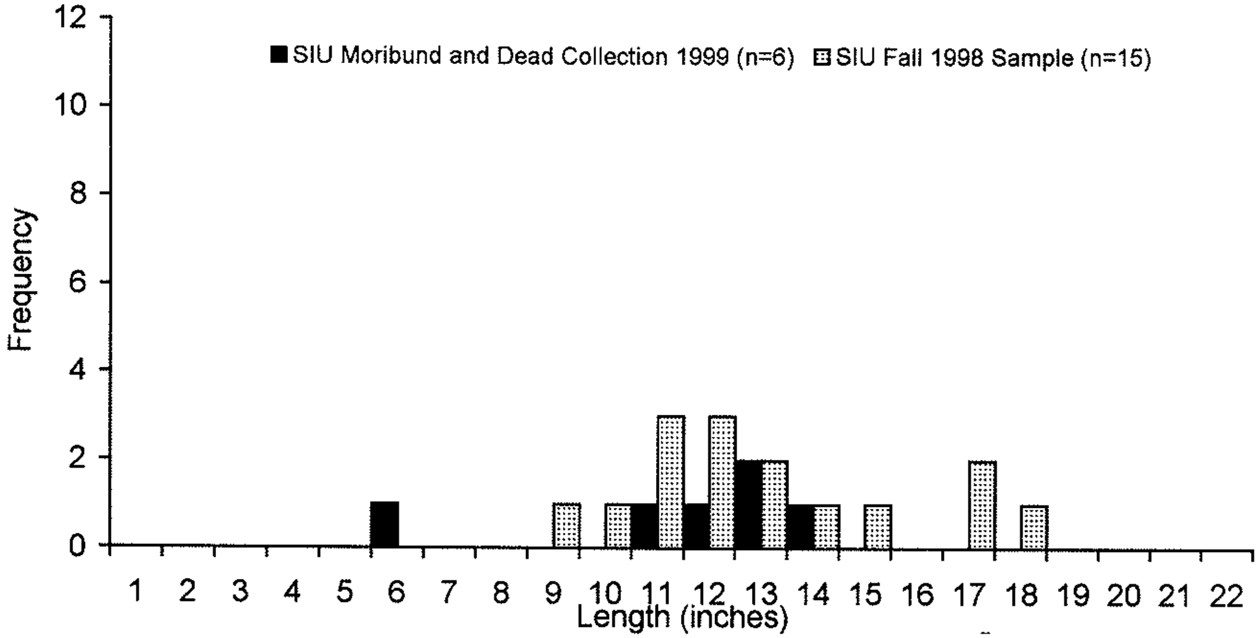


Figure 1.17. Comparison of the length frequency histograms of channel catfish obtained by electrofishing during fall 1998 on Coffeen Lake by Southern Illinois University Fisheries Research Lab (N=15), and dead and moribund fish collected during between 1 June 1999 and 31 August 1999 by SIU during routine sampling trips (N=6).

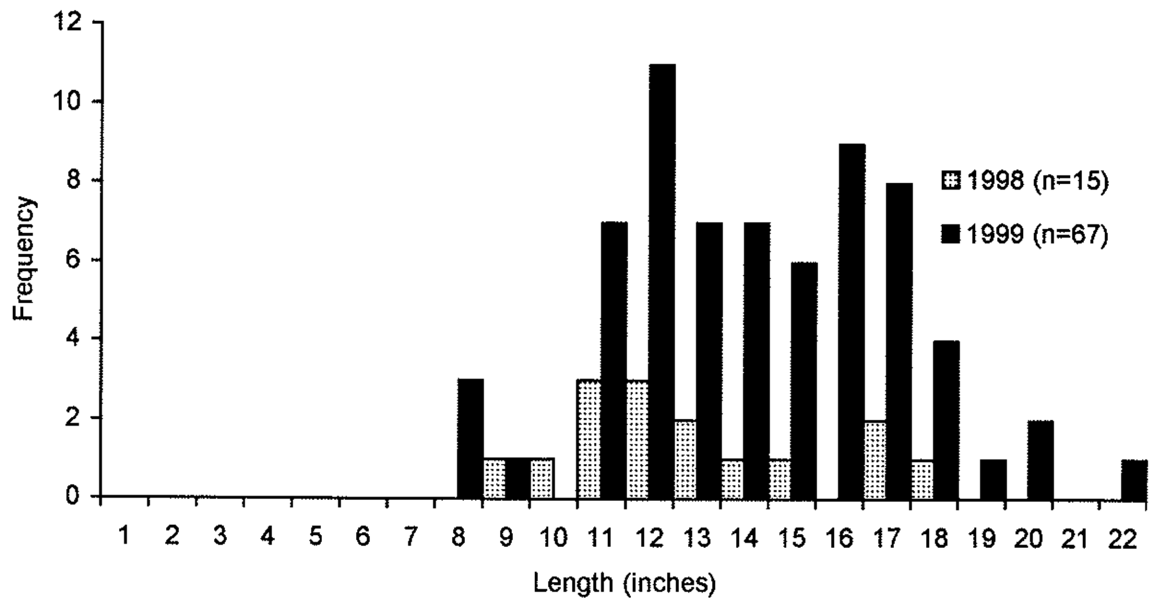


Figure 1.18. Comparison of the length frequency histograms of channel catfish obtained in fall of 1998 (N=15) and 1999 (N=67) by electrofishing on Coffeen Lake by Southern Illinois University Fisheries Research Lab.

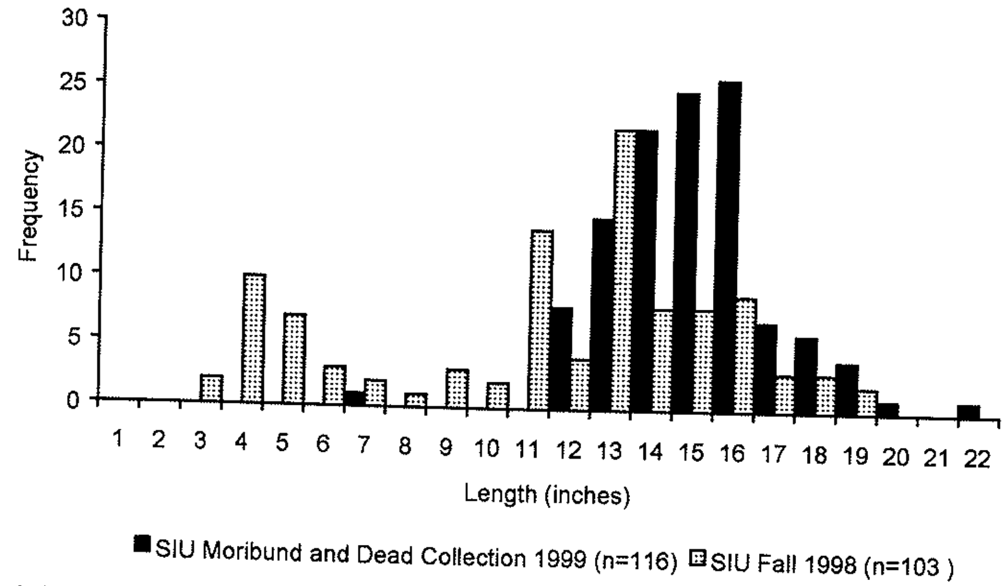


Figure 1.19. Comparison of the length frequency histograms of largemouth bass obtained by electrofishing during fall 1998 on Coffeen Lake by Southern Illinois University Fisheries Research Lab (N=103), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by SIU during routine sampling trips (N=116).

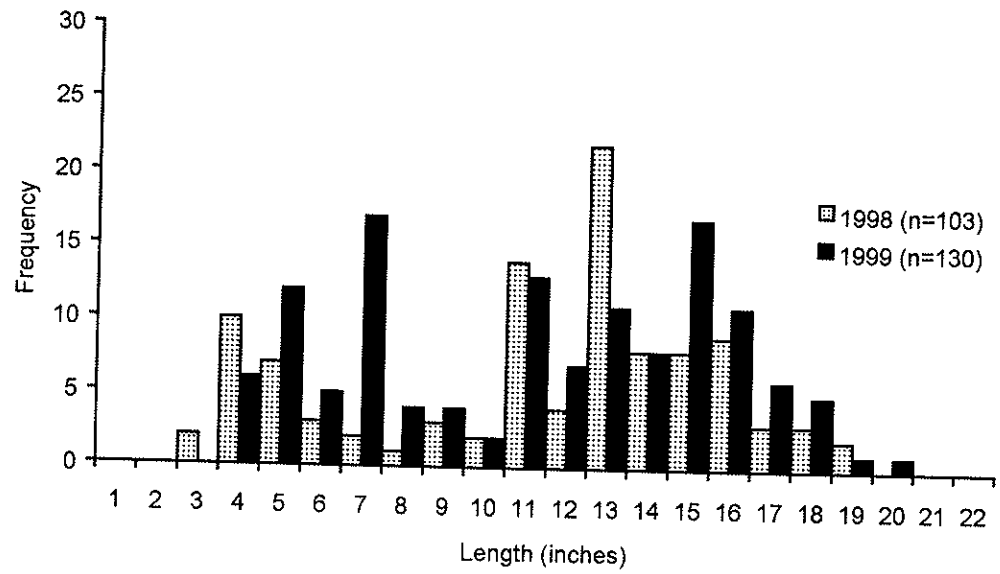
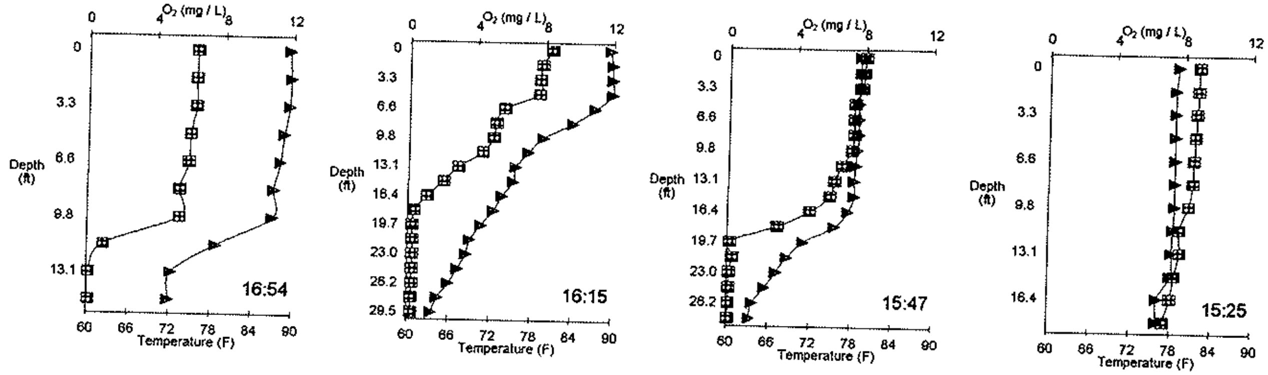


Figure 1.20. Comparison of the length frequency histograms of largemouth bass obtained in fall of 1998 (N=103) and 1999 (N=130) by electrofishing on Coffeen Lake by Southern Illinois University Fisheries Research Lab.

Newton Lake – June 2, 1999



Newton Lake – June 18, 1999

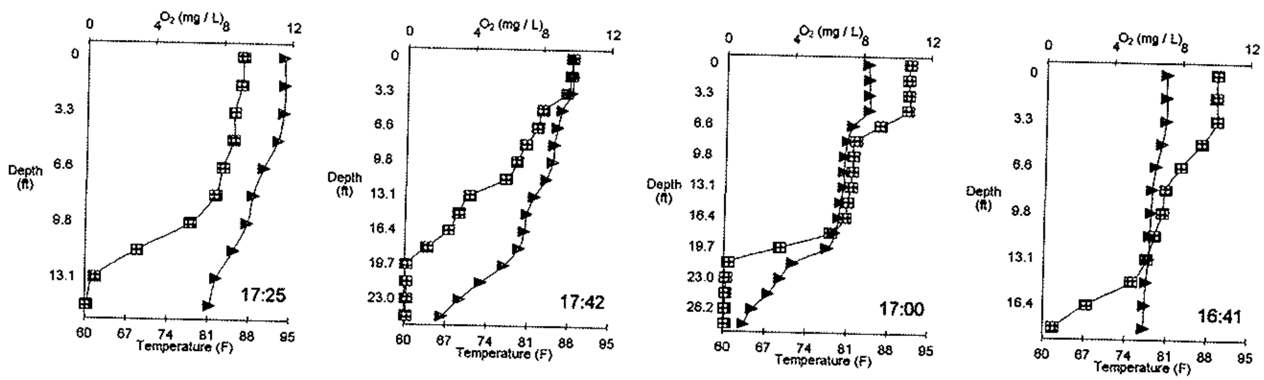


Figure 1.21. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / L). Time of measurement is indicated on each graph.

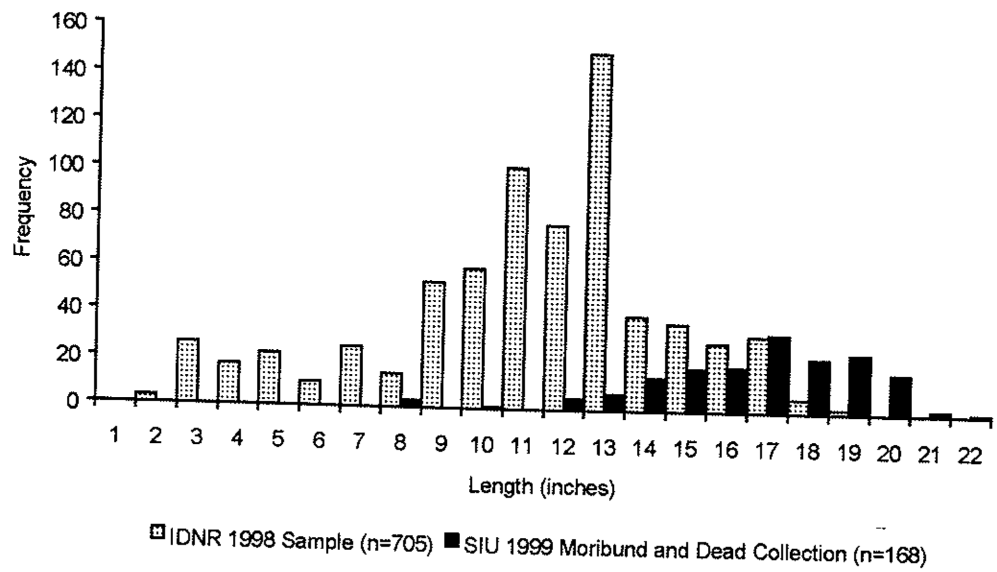


Figure 1.22. Comparison of the length frequency histograms of largemouth bass obtained by 12 hours of electrofishing during fall 1998 on Newton Lake by the Illinois Department of Natural Resources (IDNR)(N=705), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by Southern Illinois University Fisheries Research Lab (SIU) during routine sampling trips (N=168).

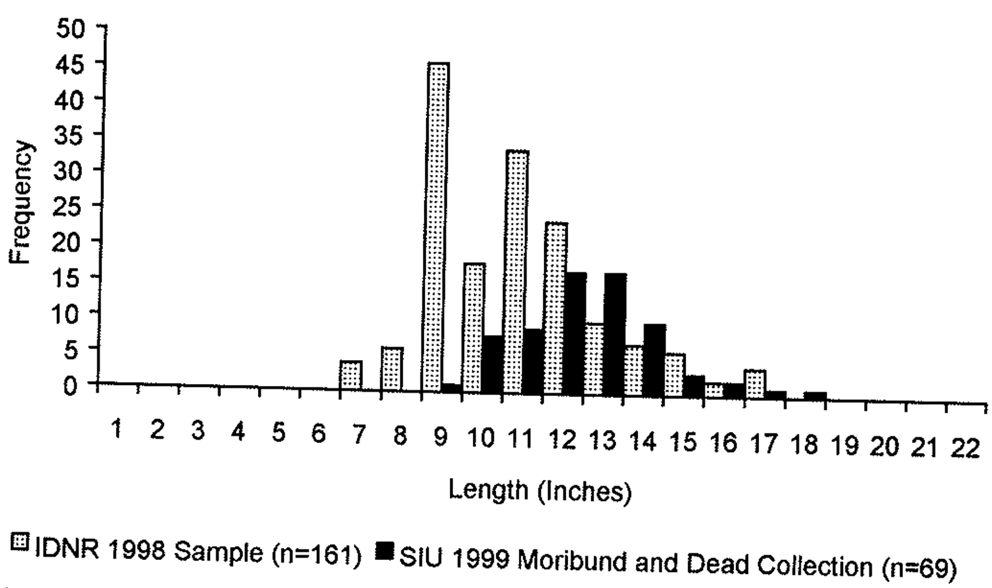


Figure 1.23. Comparison of the length frequency histograms of channel catfish obtained by 12 hours of electrofishing during fall 1998 from Newton Lake by the Illinois Department of Natural Resources (IDNR)(N=161), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by Southern Illinois University Fisheries Research Lab (SIU) during routine sampling trips (N=69).

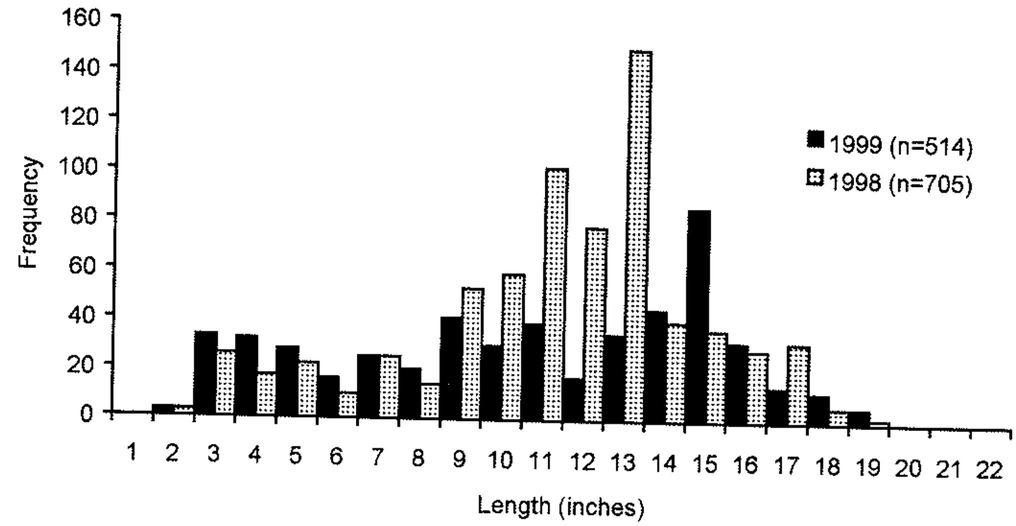


Figure 1.24. Comparison of the length frequency histograms of largemouth bass obtained in fall of 1998 (N=705) and 1999 (N=514) from 12 hours of electrofishing on Newton Lake, data provided by the Illinois Department of Natural Resources.

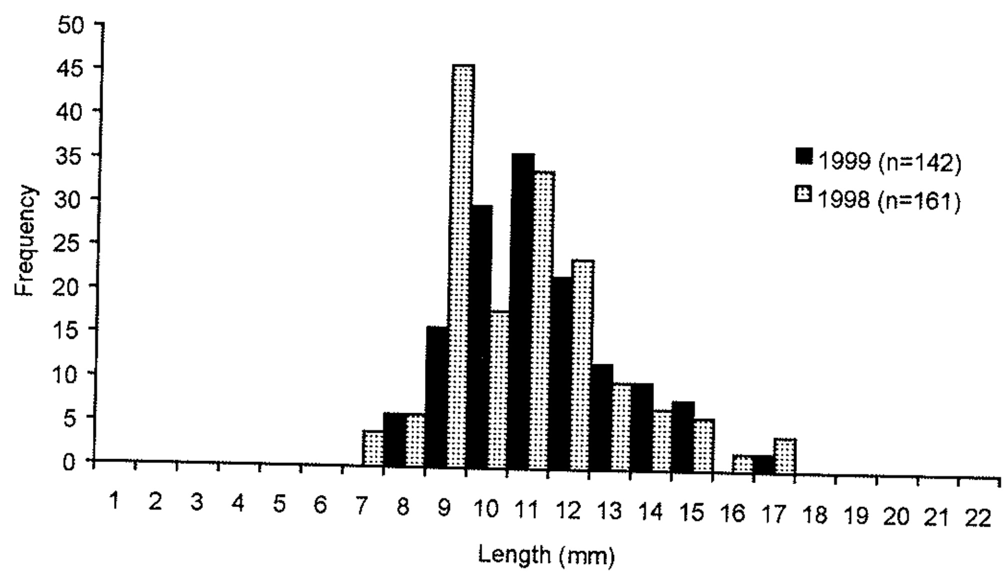


Figure 1.25. Comparison of the length frequency histograms of channel catfish obtained in 1998 (N=161) and 1999 (N=142) from 12 hours of electrofishing during fall on Newton Lake, data provided by the Illinois Department of Natural Resources.

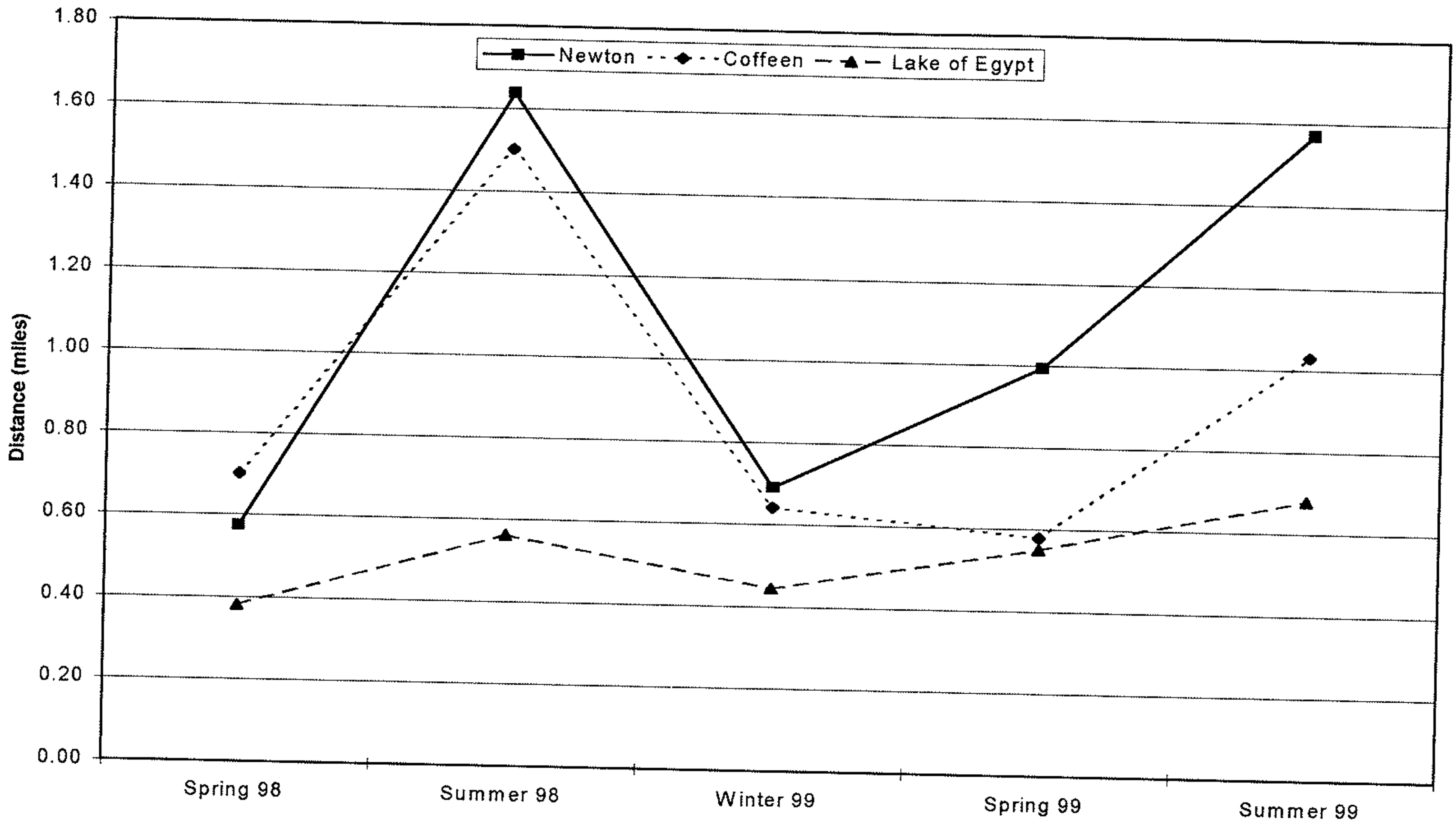


Figure 1.26. Comparison among sampling seasons for largemouth bass mean observed diel movements in three Illinois power cooling reservoirs.

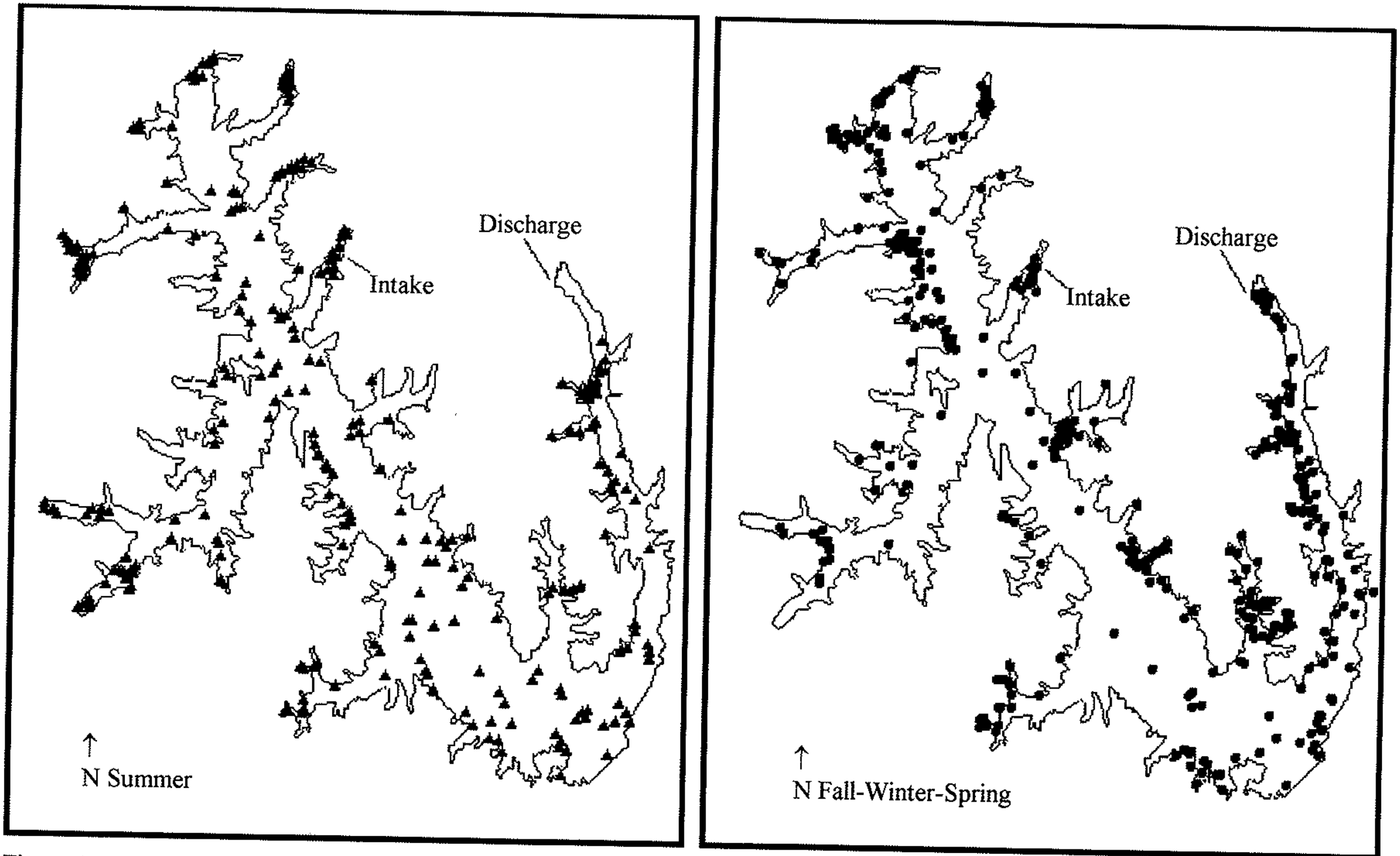


Figure 1.27. Seasonal largemouth bass locations in Coffeen Lake, Montgomery Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

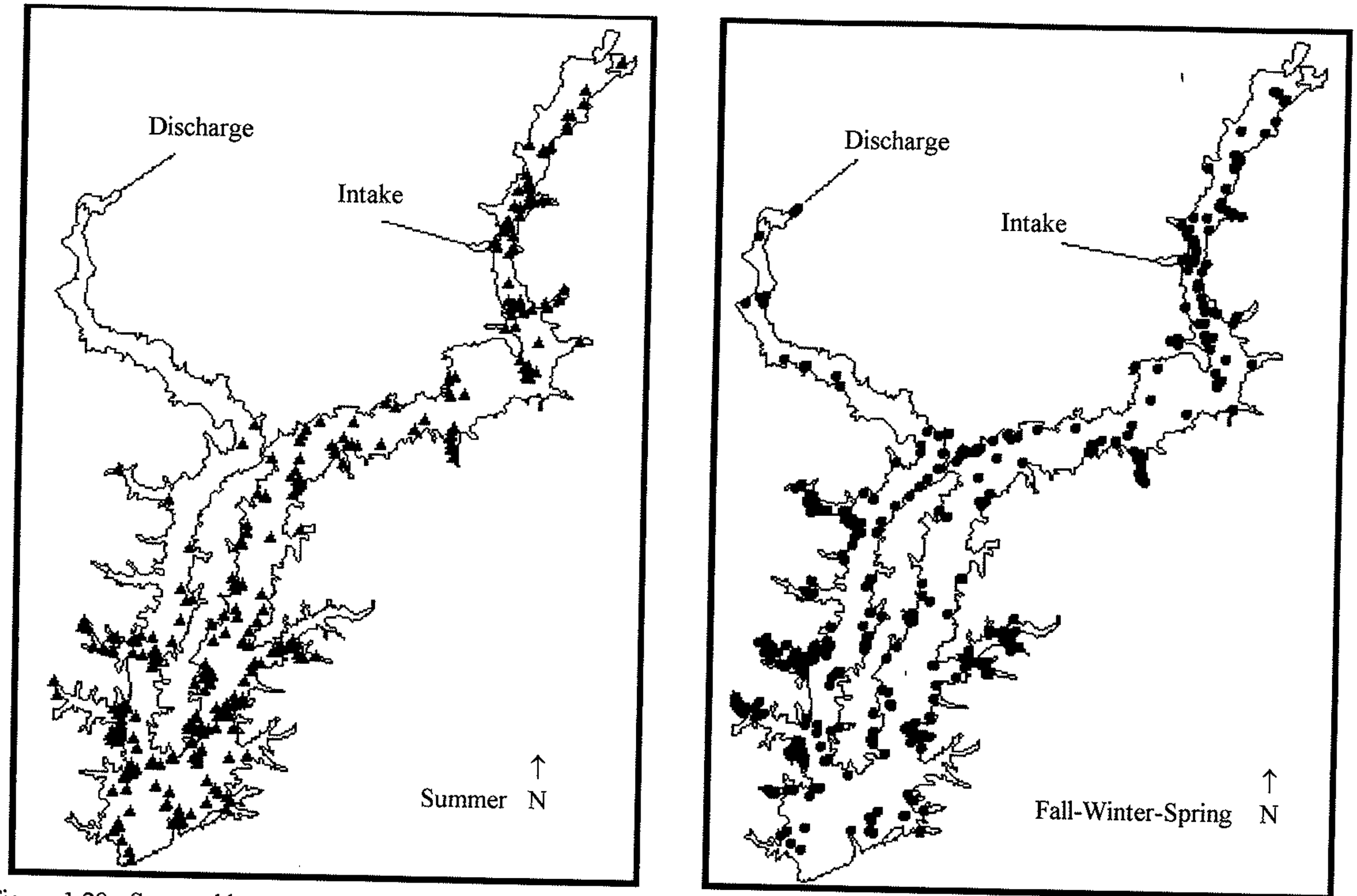


Figure 1.28. Seasonal largemouth bass locations in Newton Lake, Jasper Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

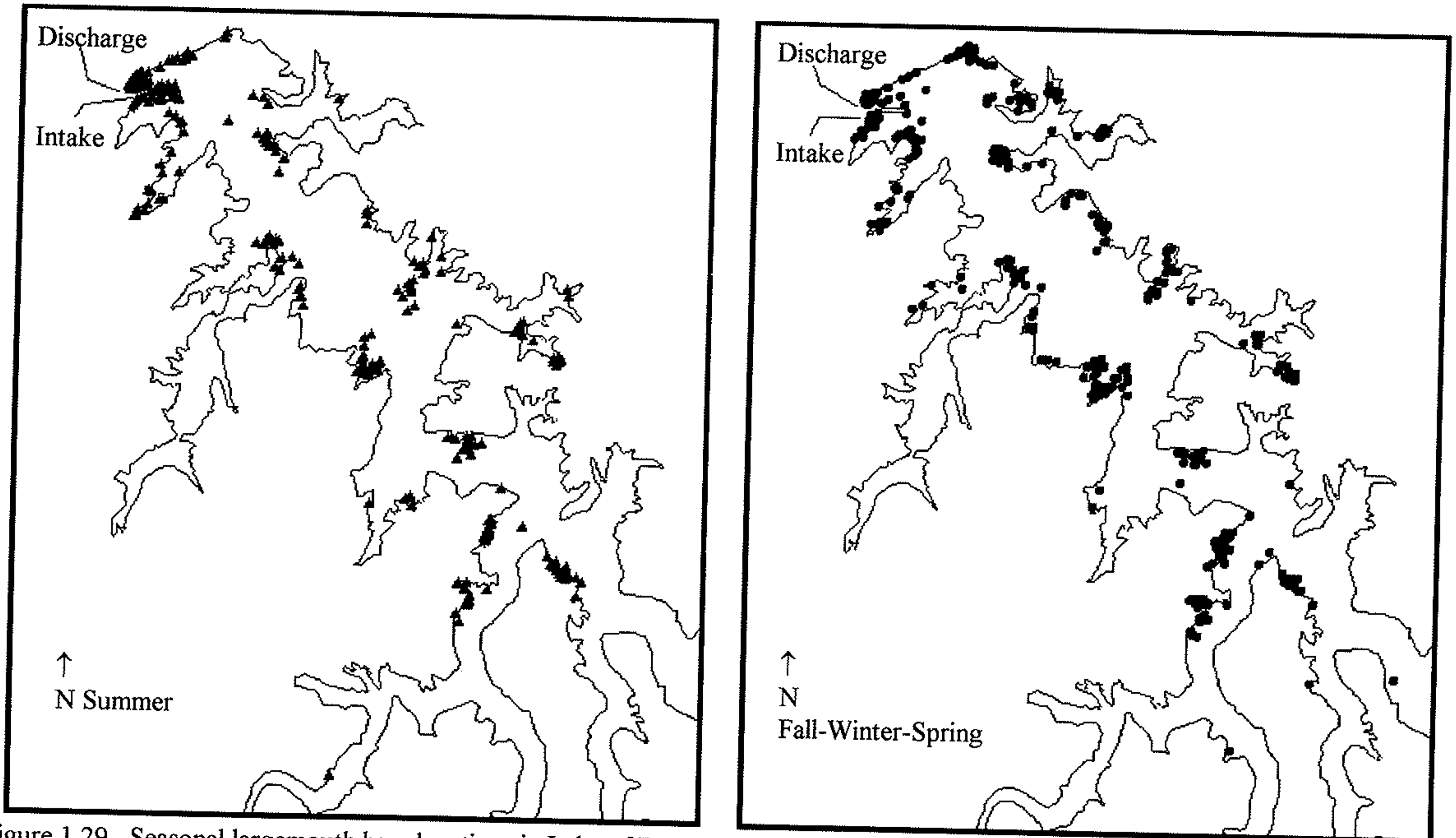


Figure 1.29. Seasonal largemouth bass locations in Lake of Egypt, Williamson / Johnson Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

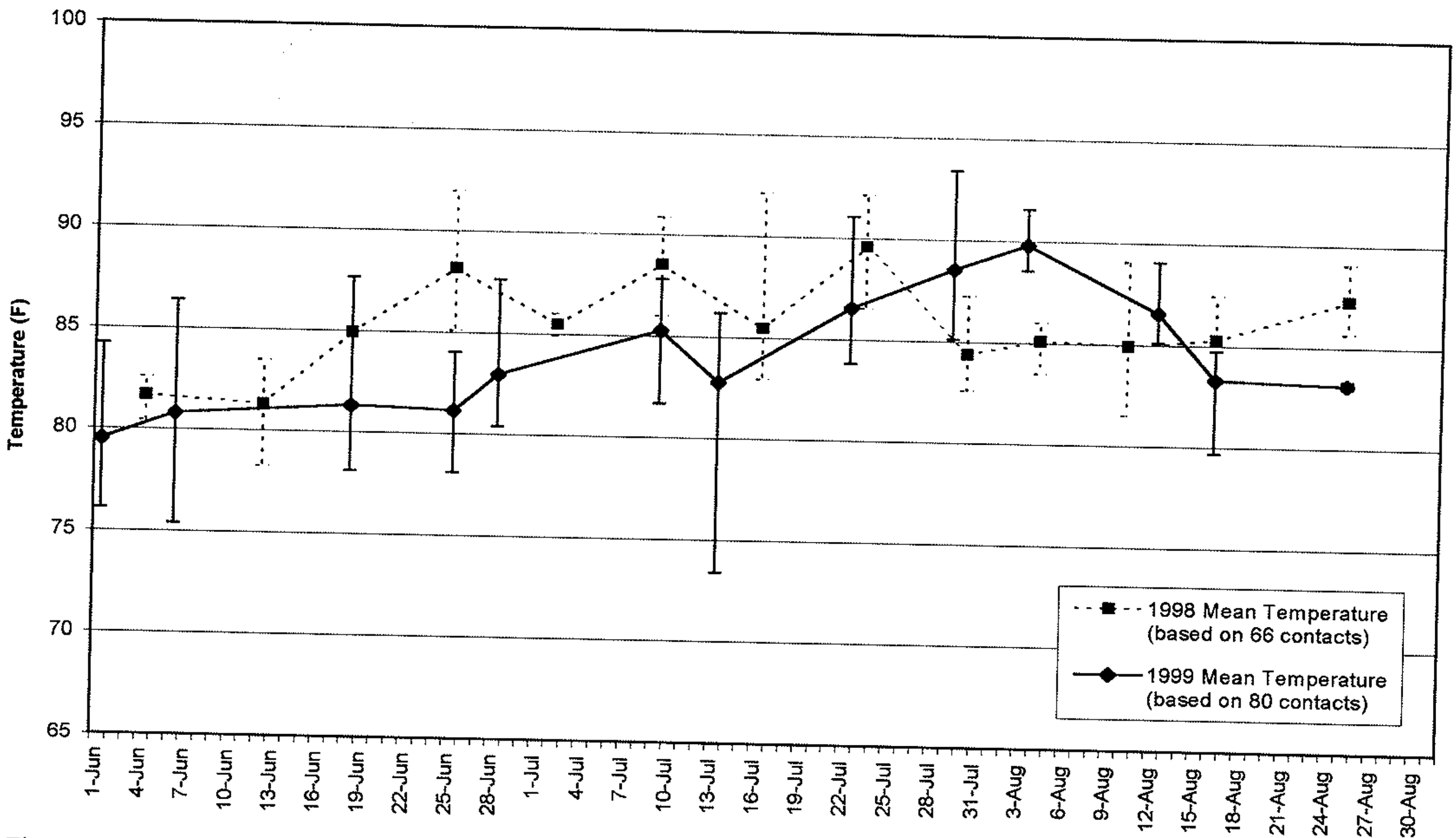


Figure 1.30. Internal body temperatures of largemouth bass in Lake of Egypt, Williamson / Johnson Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

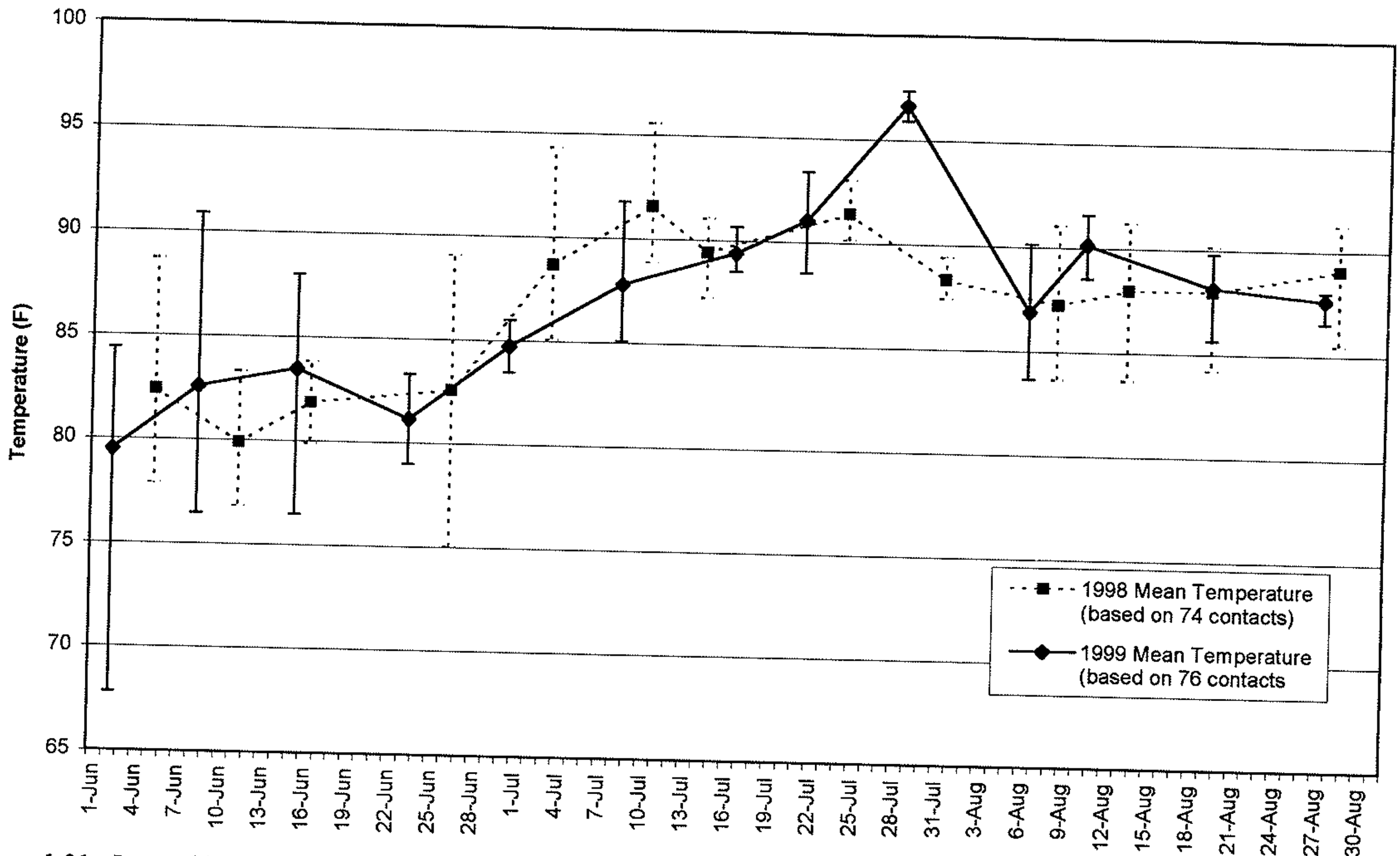


Figure 1.31. Internal body temperatures of largemouth bass in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

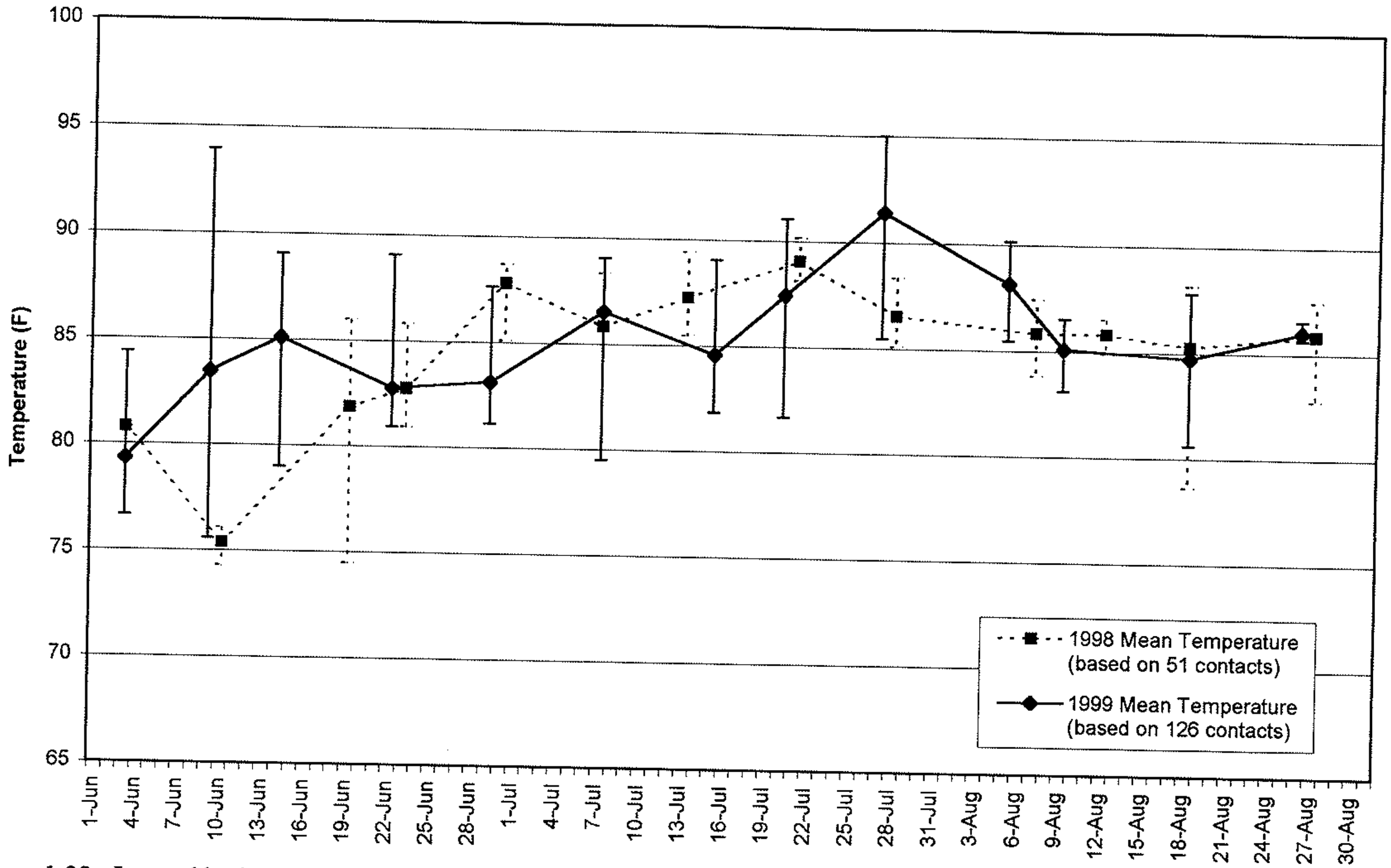


Figure 1.32. Internal body temperatures of largemouth bass in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

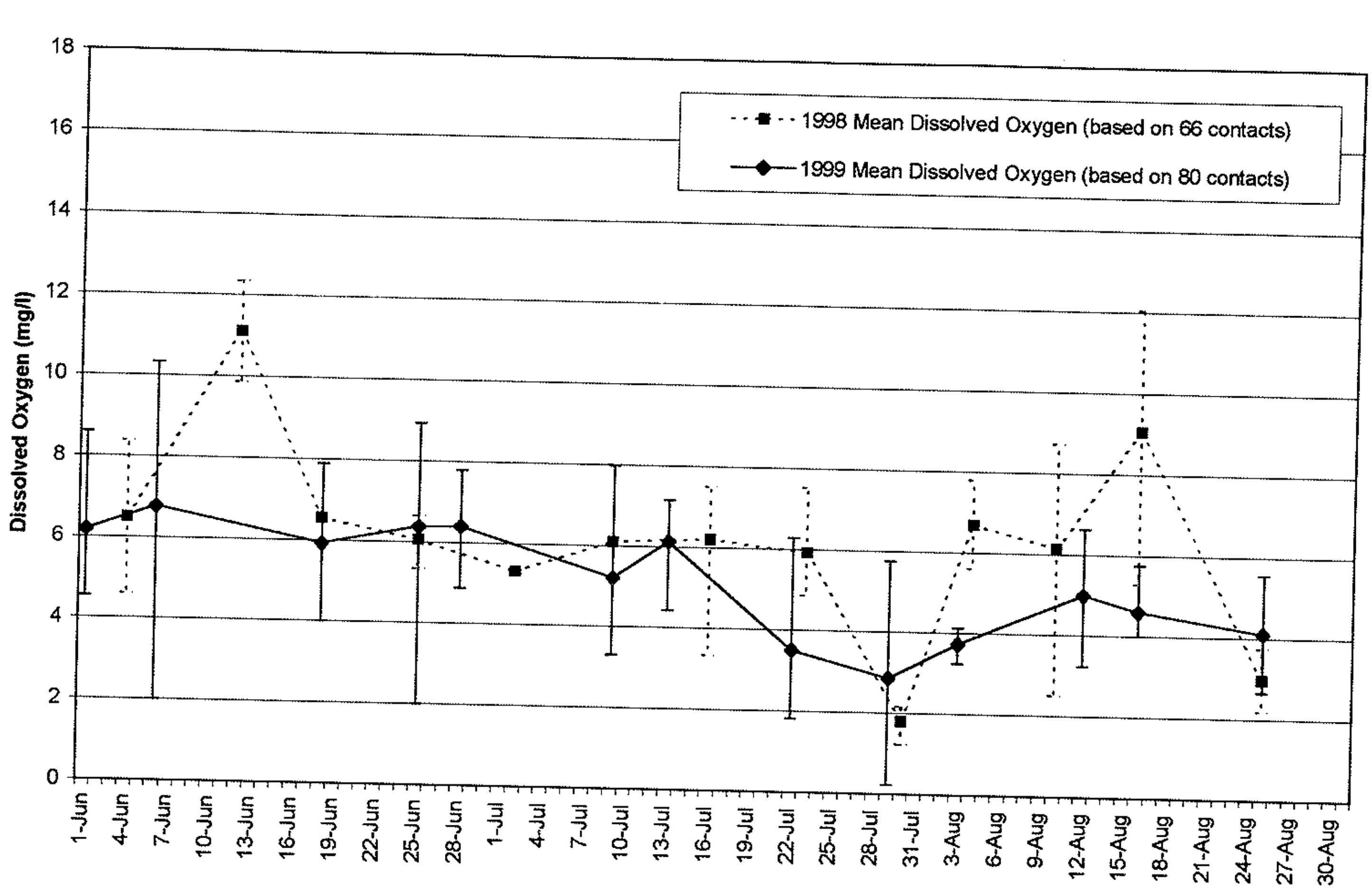


Figure 1.33. Dissolved oxygen levels at the depth where largemouth bass where located in Lake of Egypt, Williamson / Johnson Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

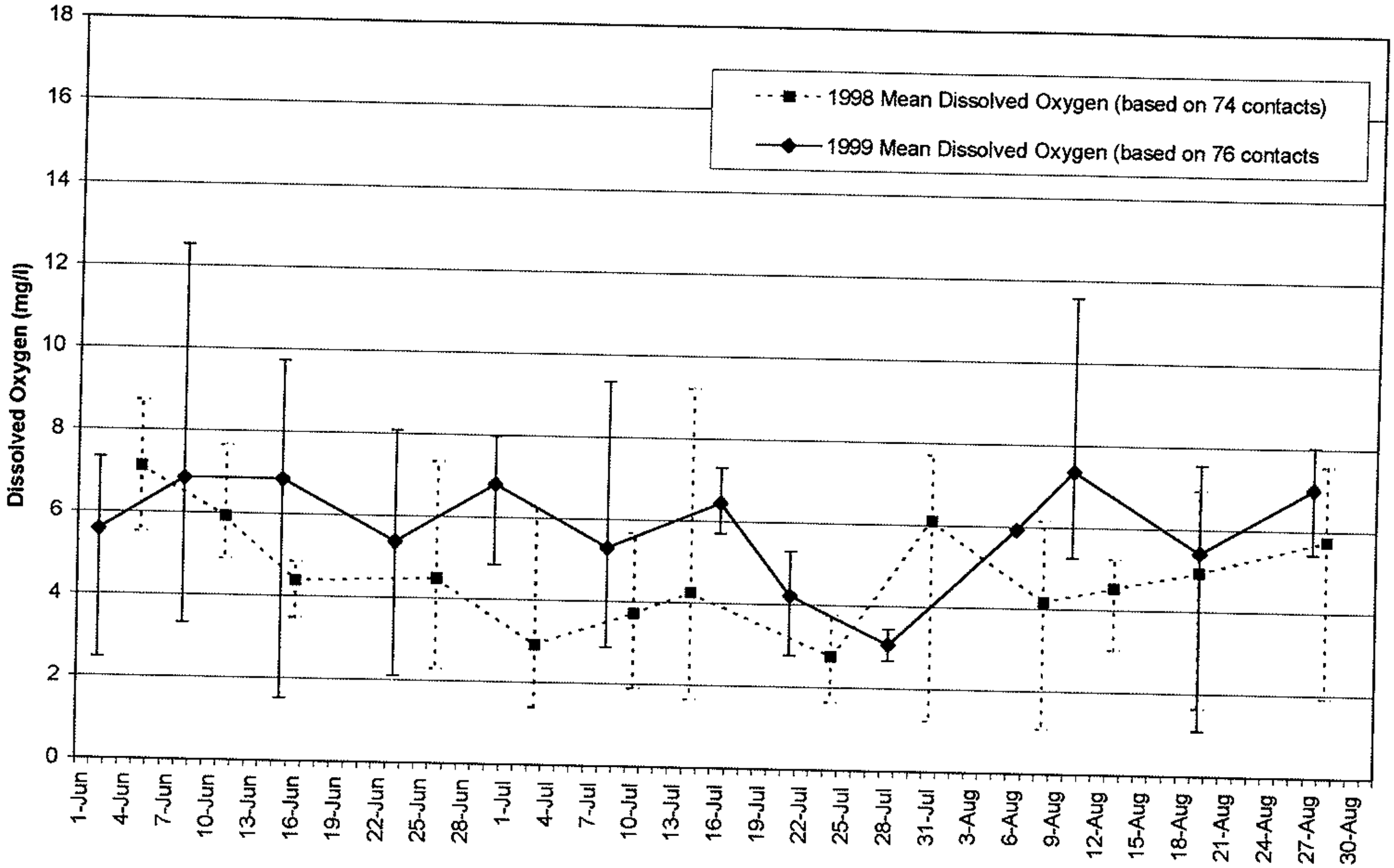


Figure 1.34. Dissolved oxygen levels at the depth where largemouth bass where located in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

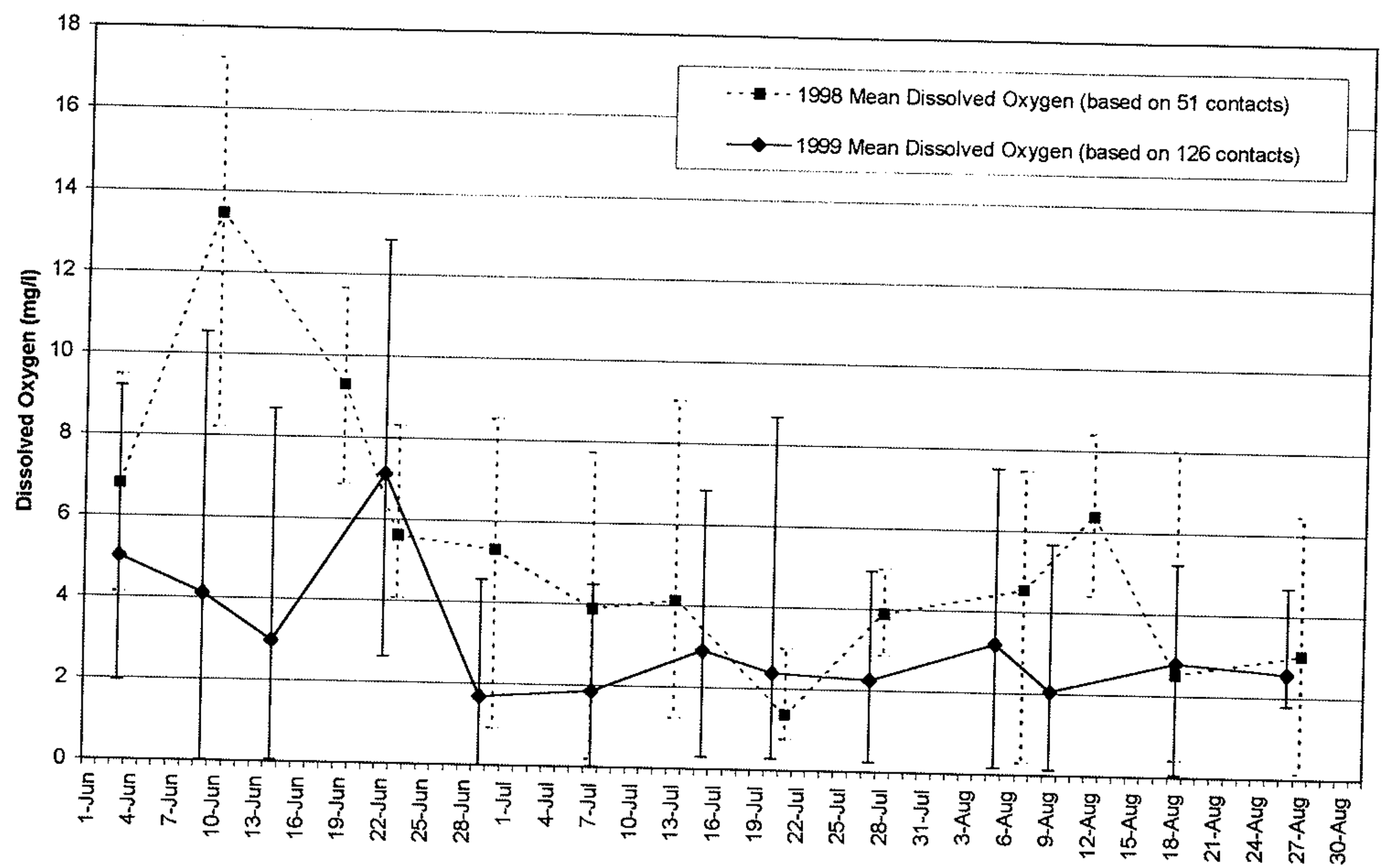


Figure 1.35. Dissolved oxygen levels at the depth where largemouth bass where located in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

Chapter 2. Phytoplankton (See Chapter 4)

Chapter 3. Zooplankton

Introduction:

Zooplankton are an integral part of the food web since they are forage for fish and other invertebrates at one time or another in the fishes' life cycles. Larval and early fingerling stages of most sport fish species feed on zooplankton. The spawning season for a given fish species tends to correlate with water temperature and day length. In order to survive and grow, young fish an abundant supply of zooplankton. Since water temperatures in a power cooling lake are influenced by sources other than ambient temperatures and daylight length, the question arises – do the pulses of zooplankton abundance correspond with the pulses of larval fish production.

Sampling was conducted for zooplankton at various times throughout the year in an attempt to determine effects of water temperature and season on zooplankton abundance in Newton Lake's four segments.

Methods:

Zooplankton was sampled with the same frequency from the same segments, transects, and sampling stations previously described in Chapter 2 (Phytoplankton). To obtain species composition as well as abundance, two vertical tows were taken at each sampling station. A conical net (0.5-m diameter, 64Φ mesh, 5:1 length to diameter) was lowered to the bottom of the euphotic zone (see Chapter 2) and then raised at a timed speed of 0.5 m/sec. Samples were preserved in 4% Lugol's solution (50 ml 8% Lugol's + 50 ml sample). Samples were appropriately labeled and taken to Southern Illinois University's Cooperative Fisheries Laboratory where subsamples of the invertebrates were identified as members of the Phylum Rotatoria (rotifers), or the subclasses Cladocera and Copepoda. Enumeration of each were further subdivided by grouping Cladocera and Copepoda that were known to be particularly important to diets of larval fish. These groups included the Families Daphnidae and Bosminidae, Orders Cyclopoida and Calanoida, other Cladocera, and the juvenile stage of copepods (nauplii). The Genera *Leptidora* and *Diaphanosoma* were also enumerated separately. Reference literature included Merritt and Cummins (1996) and Pennak (1989). Individuals from each subsample were quantified by groups and as total zooplankton. Dilution methods described by Wetzel and Likens (1991) were used. Samples collected were enumerated by placing the entire samples in a specific volume of water and then stirred with a magnetic stirrer. A Hansen-Stemple volumetric pipette was used to collect and place a subsample in a Wards zooplankton counting wheel, and the number of each taxa present in the subsamples was extrapolated according to the dilutions and initial volume of water sampled. Exact laboratory protocol depended upon the density of organisms in the samples collected.

Zooplankton sampled during August 1997 through August 1999 were included in this report (Appendix 3.1), and sampling was completed as scheduled throughout the study period. For general comparison of abundance, nauplii and rotifers, and the adult taxa remaining are often analyzed separately.

Results and Discussion:

Zooplankton total densities were dependent upon year, month, and segment in which they were collected ($p = 0.0001$, $R^2 = 0.4391$). Zooplankton were collected at significantly ($p = 0.0261$) higher densities in segments 1 and 2 (336 - 339 per L) than in the remaining segments (294 – 298 per L, Table 3.1). During the two-year study, mean zooplankton densities were significantly higher in May than all other months (*p* = 0.0001) and were lowest in October and December (Table 3.2, Figure 3.1, Appendix 3.2). Zooplankton densities among segments fluctuated widely throughout the study period, and there were no specific trends of abundance due to season and segments over time (Figure 3.2). Total seasonal zooplankton numbers in Newton Lake are well within the range of average densities during April through August in twelve other non-power cooling, Illinois lakes (Figure 3.3). Zooplankton totals in Newton Lake during July and August were significantly (*p*=0.0001) higher in 1999 (239 per L) than in 1998 (171 per L) and in August of 1997 (146 per L). Expectations of lower densities possibly due to peaking lake temperatures during the two summer months were not entirely met since zooplankton numbers increased in late August of 1999. Low zooplankton abundance also apparent during fall of 1997 and 1998.

Total zooplankton numbers were primarily due to representatives of the Phylum Rotatoria (Table 3.1). High rotifer densities are important since they are forage for most larger zooplankton. Mean rotifer numbers for each date sampled ranged from 62 to 736 per L (Appendix 3.3) and averaged 278 per L. Densities of rotifers were significantly higher in segments 1 and 2 than in segments 3 and 4 (*p* = 0.0005, Table 3.1). Although density differences among segments were significant, large fluctuations are evident by large standard deviations and apparent by inconsistent density patterns for each segment over time (Figure 3.4). There was more consistency of rotifer densities by month in both years. Densities were consistently higher in May and June of both years (Figure 3.5), and

May densities were significantly higher than all other months sampled ($p = 0.0001$, Table 3.2).

Adequate rotifer densities are essential for the survival and reproduction of larger zooplankton. Most sportfish larvae rely on adult Cladocera and copepods for forage until they are large enough to switch diets that include macroinvertebrates or other larval fish. Thus, low numbers of the larger zooplankton may limit survival of the larval sportfish and, ultimately, recruitment. Adult zooplankton (Orders Cyclopoida and Calanoida) densities in Newton Lake were lower during April through July than in the twelve, non-power cooling, Illinois lakes (Figure 3.6). Mean densities of samples examined each date for adult zooplankton ranged from <1 to 31 per L from August 1997 through August 1999 (Appendix 3.2). Densities were dependent on year, month, and segment sampled ($p=0.0001$; $R^2=0.4243$). Mean densities were significantly ($p=0.0001$) higher in October, January, April, and May than all other months (Table 3.2). Adult zooplankton densities collected during July, August, and September ranged from 1 to 4 per L and were significantly lower than all other months. Lowest densities were sampled during the three month period in 1999 (1 per L). The densities were significantly ($p = 0.0001$) lower than for the same period in 1998 (2 per L) and during August and September 1997 (3 per L). Although adult zooplankton were collected at significantly higher densities in segments 3 and 4 ($p = 0.0001$) than in segments 1 and 2 (Table 3.1), the mean densities for all segments only ranged from 8 to 15 per L. As was evident with rotifers, each segment contained the highest densities of adult zooplankton at one time or another (Figure 3.7). There were no trends of abundance among the segments based on season or water temperatures.

Nauplii are also potentially important forage for larvae of smaller fish including bluegill. Nauplii were twice as abundant as the adult zooplankton. Their numbers were dependent on month and segment that they were collected ($p = 0.0001$). Their mean densities were significantly highest in segment 3 (34 per L) and lowest in segment 1 (17 per L, Table 3.1). They had highest mean densities in April, May, and October (Table 3.2), and the peak densities in those months were evident during both years of the study (Figure 3.5). There were no evident trends of abundance among segments due to season (Figure 3.8).

Abundance of each of the adult zooplankton taxon fluctuated throughout the annual period (Table 3.2, Appendix 3.3). Densities of the individual taxa ranged from 0 to 81 per L. Calanoid copepods had a significantly (p=0.001) higher mean density (7 per L) than all other individual taxa collected. However, percent contribution of each taxa to the samples collected fluctuated by time of year (Figure 3.9). For instance, *Diaphanosoma* spp. contributed 20-80% during May through September of each year, but very few (<2%) were present in our samples during October through April. In contrast, Calanoid copepods contributed to over 50% of the total zooplankton collected between October and June and were by far the most dominant taxon present during that time. *Bosminus* spp. contributed most (10-25%) from December 1997 through May 1998, but were much less prevalent in 1999. Endemic *Daphnia* sp. were most prevalent from December through April in both years of the study. *Daphnia lumholtzi* is an exotic species that has only been recently described in North America. Although its presence in Newton Lake was observed throughout most the year, it contributed most to the total zooplankton in July and September 1998 and June 1999. Although there was some fluctuation in contribution, Cyclopoid copepods were present throughout the study.

The most important aspect of zooplankton numbers to larval fish is their abundance during periods between first feeding (beyond yolk sac stages) and when they convert to larger prey. For piscivorous fish species, the life stage at which zooplankton are used exclusively for forage is usually spans a very short period. For instance, largemouth bass may require zooplankton for only a few weeks. This is especially true if smaller larval fish such as gizzard shad and bluegill spawn shortly after the bass and become available prey. Since densities of adult zooplankton were among their highest during April and May, larval largemouth bass were probably not adversely affected by the low densities during the summer months. Fish species that are not piscivorous and spawn later than bass require higher numbers of zooplankton to persist throughout the summer months. In Newton Lake, very low zooplankton numbers during July and August would most likely negatively affect survival of larval *Lepomis* species that hatch during the entire summer and require zooplankton well into the fall..

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Pennak, R.W. 1989. Fresh-water invertebrates of the United States. *Protozoa to Mollusca* (3rd edition). John Wiley & Sons, Inc., New York.

Wetzel, R.G., and G.E. Likens. 1991. Limnological Analyses, 2nd edition. Springer Verlag, New York.

Table 3.1. Mean densities of zooplankton collected from four segments in Newton Lake during August 1997 through August 1999. The zooplankton was collected from three stations per segment, and two vertical tows were taken at each station (n = 834). Superscripts with the same letter are not statistically different (p=0.0001).

Taxa	Segment	Mean density (n per L)	Range		Standard deviation	Number of samples
Nauplii	1[c]	17	0	120	18.65	210
	2[a,b]	29	<1	511	45.39	208
	3[a]	34	<1	198	41.15	207
	4[b]	27	<1	149	30.47	209
Total		**27**	**0**	**511**	**35.91**	834
Rotifers	1[a]	311	0	1,426	299.06	210
	2[a]	299	4	1,511	276.84	208
	3[b]	247	10	697	174.66	207
	4[b]	257	0	1,031	198.06	209
		278	**0**	**1,511**	**244.08**	834
Zooplankton	1[c]	8	0	81	10.98	210
	2[b]	11	<1	62	12.31	208
	3[a]	14	0	76	15.21	207
	4[a]	15	<1	66	16.18	209
Total		**12**	**0**	**81**	**13.99**	834
Total Zooplankton	1[a]	336	0	1,459	311.40	210
	2[a]	339	13	1,527	290.96	208
	3[b]	294	21	863	196.95	207
	4[b]	298	9	1,099	211.89	209
Total		**317**	**0**	**1,527**	**258.00**	834

Table 3-2. Mean densities of zooplankton collected from four segments in Newton Lake during August 1997 through August 1999. The zooplankton was collected from three stations per segment, and two vertical tow were taken at each station. Superscripts with the same letter are not statistically different (p=0.0001).

Taxa	Date	Mean density (n per L)	Range		Standard deviation	Number of samples
Total Zooplankton	January[d]	335	23	747	255.24	48
	February[b]	547	155	1,203	238.33	48
	March[e]	242	36	993	191.05	47
	April[d]	333	75	936	161.09	96
	May[a]	681	180	1,527	330.34	96
	June[c]	407	9	1,302	277.52	93
	July[e,f]	181	33	689	98.52	94
	August[e,f]	210	0	645	122.10	120
	September[e,f]	193	21	534	121.53	96
	October[f]	146	13	346	74.78	48
	December[f]	157	28	305	70.39	48
Rotifers	January[d]	295	10	653	230.37	48
	February[b]	518	150	1,181	229.55	48
	March[e,f]	198	0	889	163.66	47
	April[d,e]	252	0	849	143.54	96
	May[a]	614	141	1,511	326.65	96
	June[c]	368	7	1,216	261.34	93
	July[f]	176	29	681	99.64	94
	August[e,f]	203	0	635	119.80	120
	September[f]	180	10	514	119.30	96
	October[g]	67	4	202	44.68	48
	December[c]	109	16	275	54.11	48

Table 3-2. Continued.

Taxa	Date	Mean density (n per L)	Range		Standard deviation	Number of samples
Adult zooplankton	January[b,c]	19	0	62	16.71	48
	February[e]	10	0	25	7.91	48
	March[c]	17	2	51	12.55	47
	April[a,b]	23	4	76	16.32	96
	May[b,c]	19	1	48	12.58	96
	June[d,e]	13	0	81	15.78	93
	July[f]	1	0	8	1.52	94
	August[f]	2	0	17	2.74	120
	September[f]	4	0	14	3.37	96
	October[a]	24	3	65	16.47	48
	December[c,d]	16	1	37	11.80	48
Nauplii	January[d]	20	1	49	15.60	48
	February[d]	19	2	49	12.44	48
	March[c,d]	28	3	120	23.27	47
	April[a]	61	5	511	57.33	96
	May[b]	48	4	198	40.49	96
	June[c,d]	27	1	173	31.49	93
	July[e]	4	0	27	5.06	94
	August[e]	5	0	40	6.27	120
	September[e]	8	0	36	6.46	96
	October[a,b]	56	3	143	40.54	48
	December[c]	33	2	98	30.12	48

Table 3-3. Mean densities of zooplankton collected from Newton Lake during August 1997 through August 1999. Zooplankton samples (834) were collected from four segments, three stations per segment and two vertical tows per station. Tows were conducted with 0.5 m diameter, 63-*u*mesh plankton nets. Superscripts indicate statistical significance among taxa (p=0.0001).

Taxa	Number (n per L)	Range		Standard deviation
Bosminidae	$1^{b,c}$	0	29	3.25
Calanoid Copepod	7^{a}	0	69	9.37
Cyclopoid Copepod	1^{b}	0	20	2.09
Daphnia spp.	^{1c}	0	20	2.03
Diaphanosoma spp.	1^{c}	0	13	1.84
Leptodora kindti	$<1^{d}$	0	1	0.03
Daphnia lumholtzi	$<1^{d}$	0	11	1.15
Other Cladocera	$<1^{d}$	0	1	0.12
Others	$\leq 1^{d}$	0	3	0.19
Total Zooplankton	**12**	**0**	**81**	**13.99**
Nauplii	27	0	511	35.91
Rotifera	278	0.00	1510.62	244.08

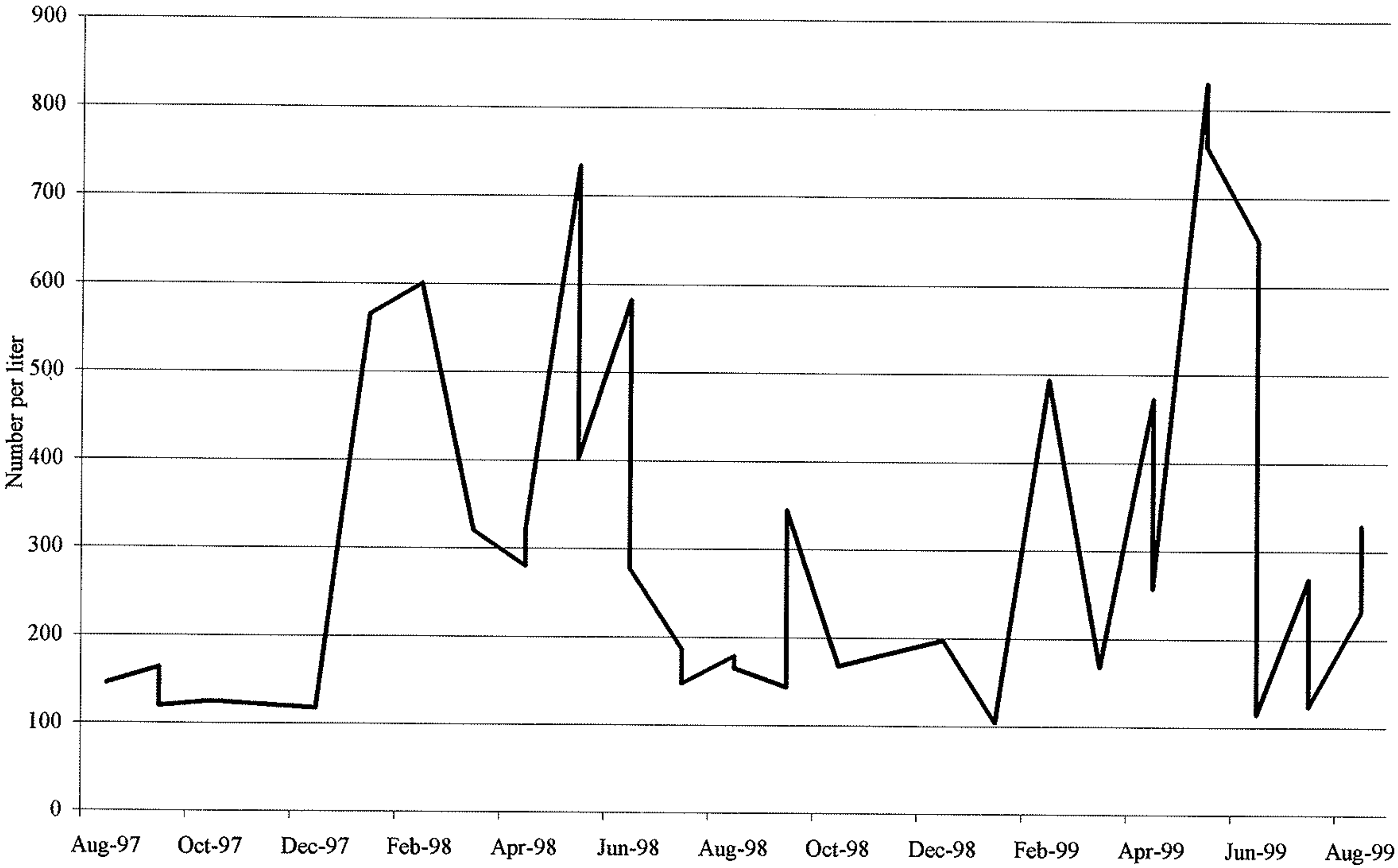

Figure 3.1. Mean densities of all zooplankton by date collected in Newton Lake (12 stations) from August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-u mesh plankton net.

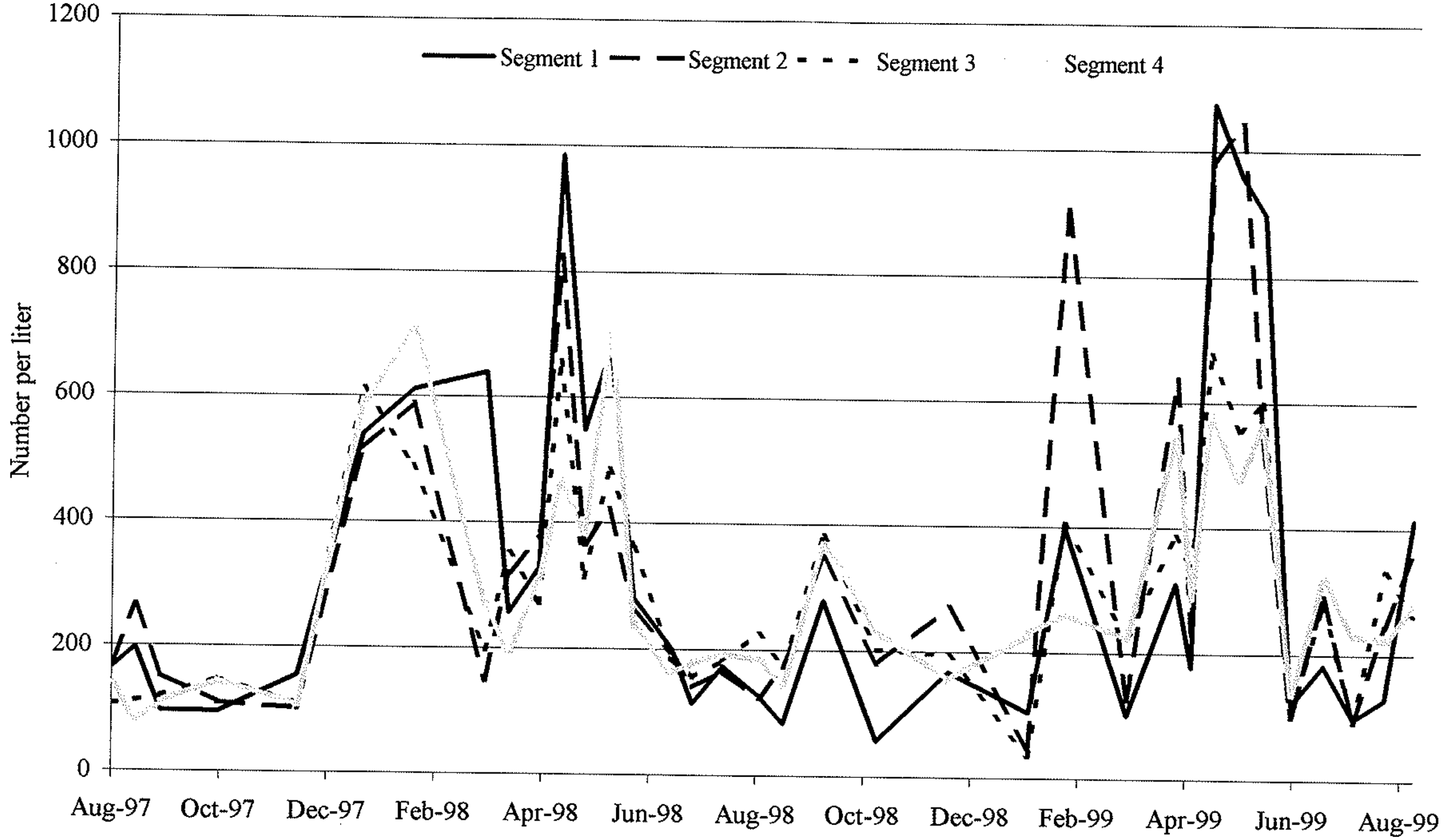

Figure 3.2. Mean densities by date of all zooplankton collected in Newton Lake in four segments and three stations per segment during August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-*u* mesh plankton net.

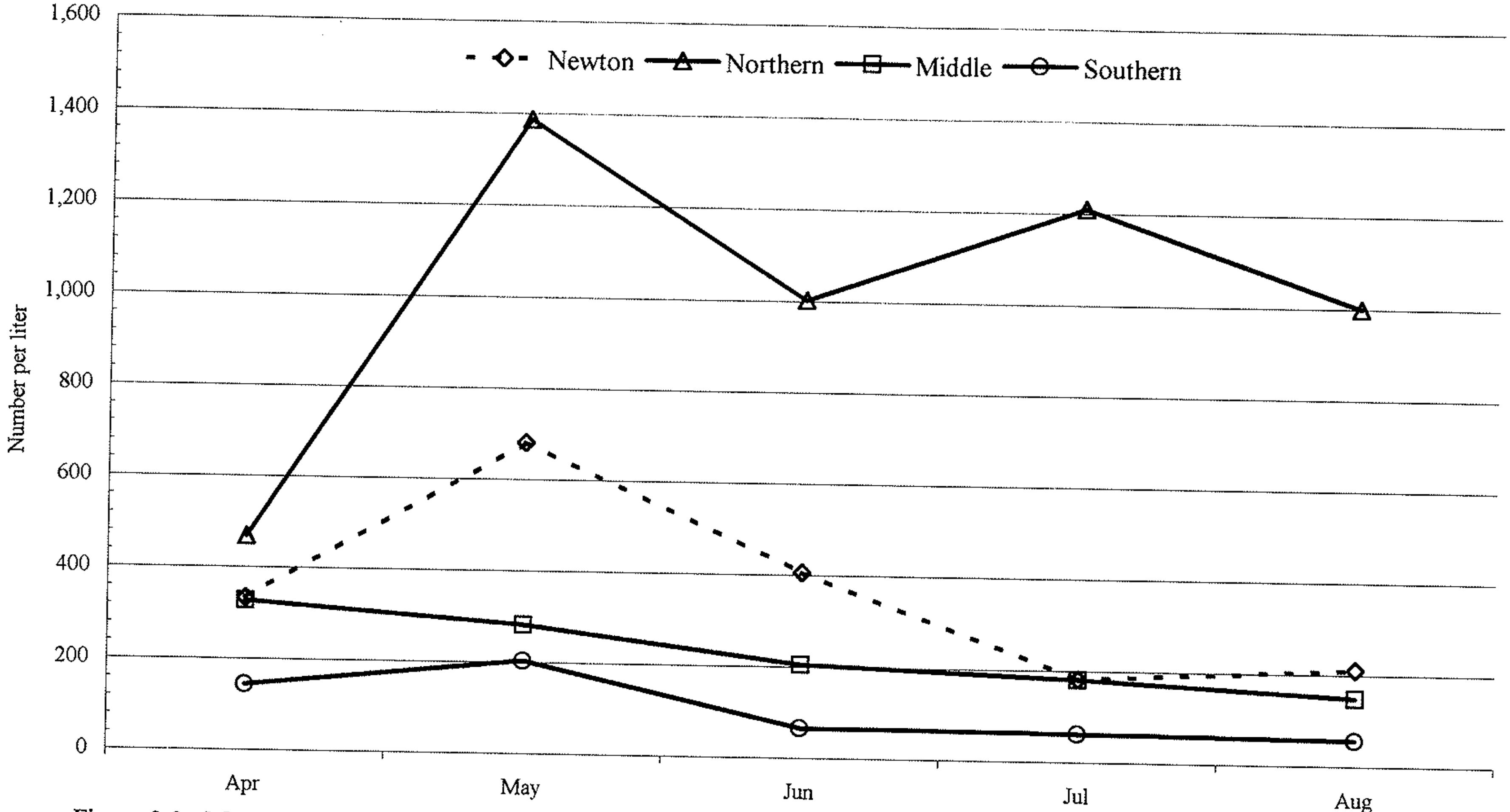

Figure 3.3. Mean monthly densities of zooplankton collected in Newton Lake compared to 12 lakes grouped into three regions of Illinois. Zooplankton was collected from the Illinois lakes during April through August of 1993 through 1997. Five lakes were sampled in the northern zone, six in the middle zone, and four in the southern zone. Four to six samples were taken from the Illinois lakes each month for five years.

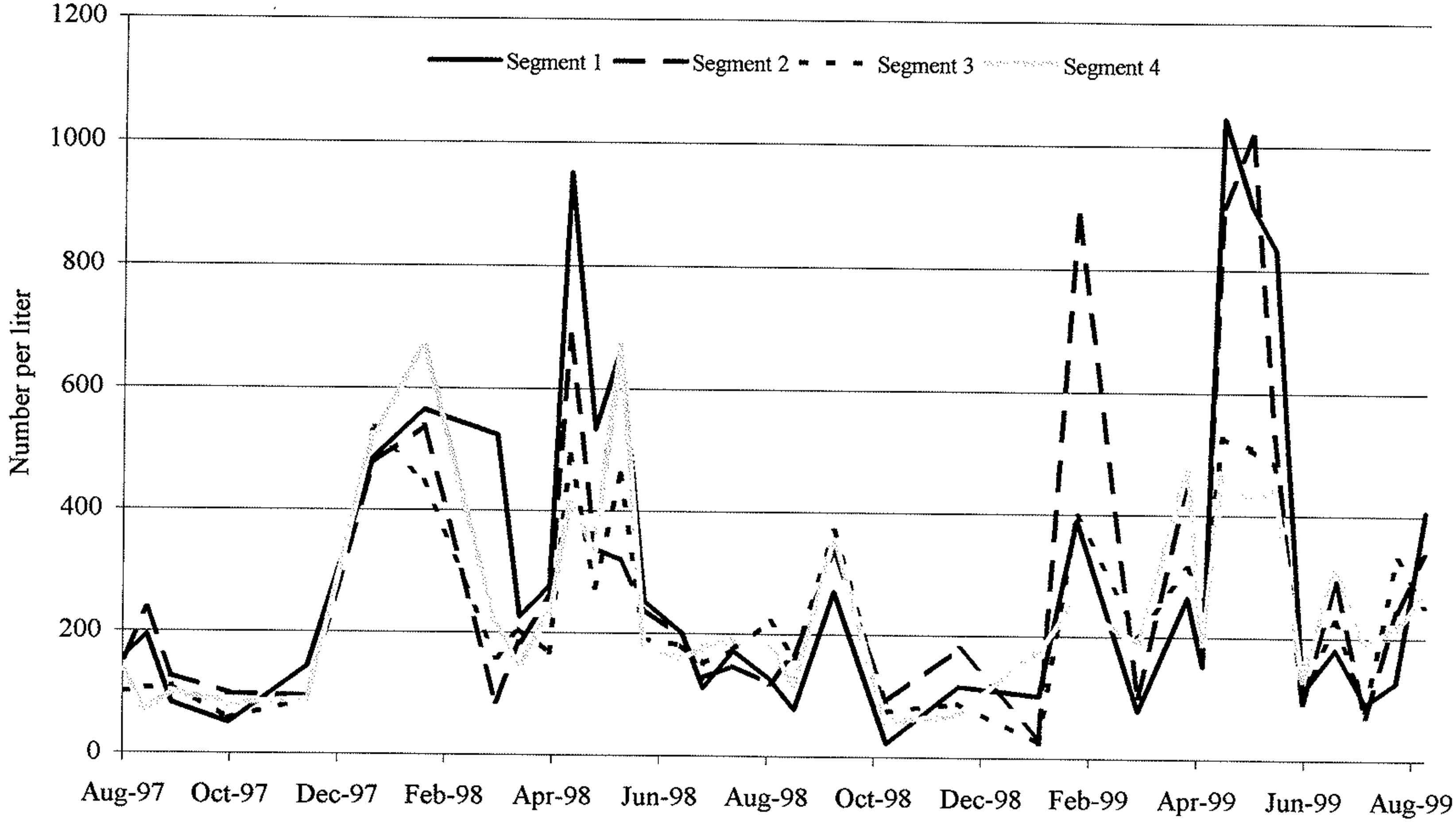

Figure 3.4. Mean densities by date of rotifers collected in Newton Lake in four segments and three stations per segment during August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-*u* mesh plankton net.

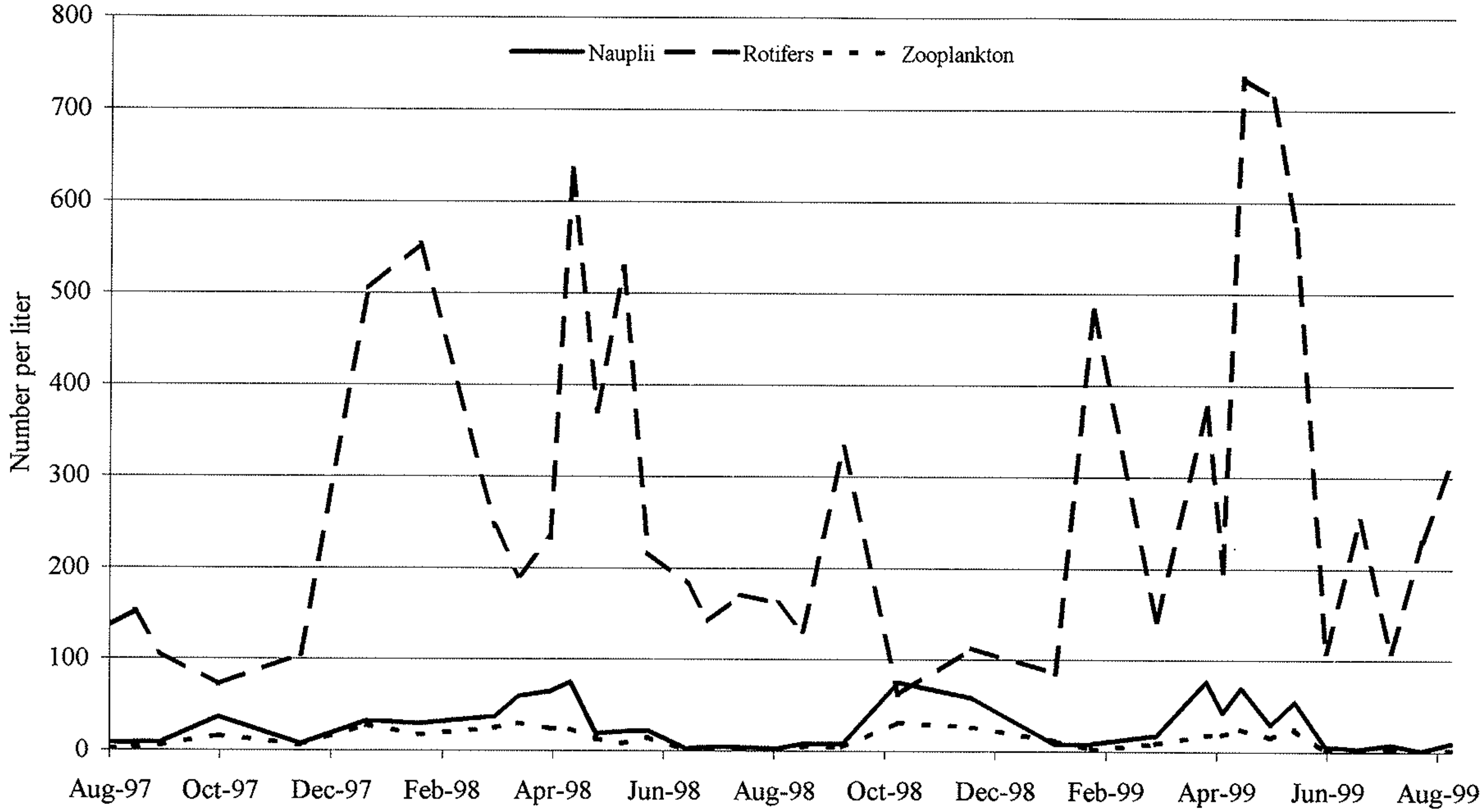

Figure 3.5. Mean densities by date of rotifers, nauplii, and remaining adult zooplankton collected in Newton Lake in four segments and three stations per segment during August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-*u* mesh plankton net.

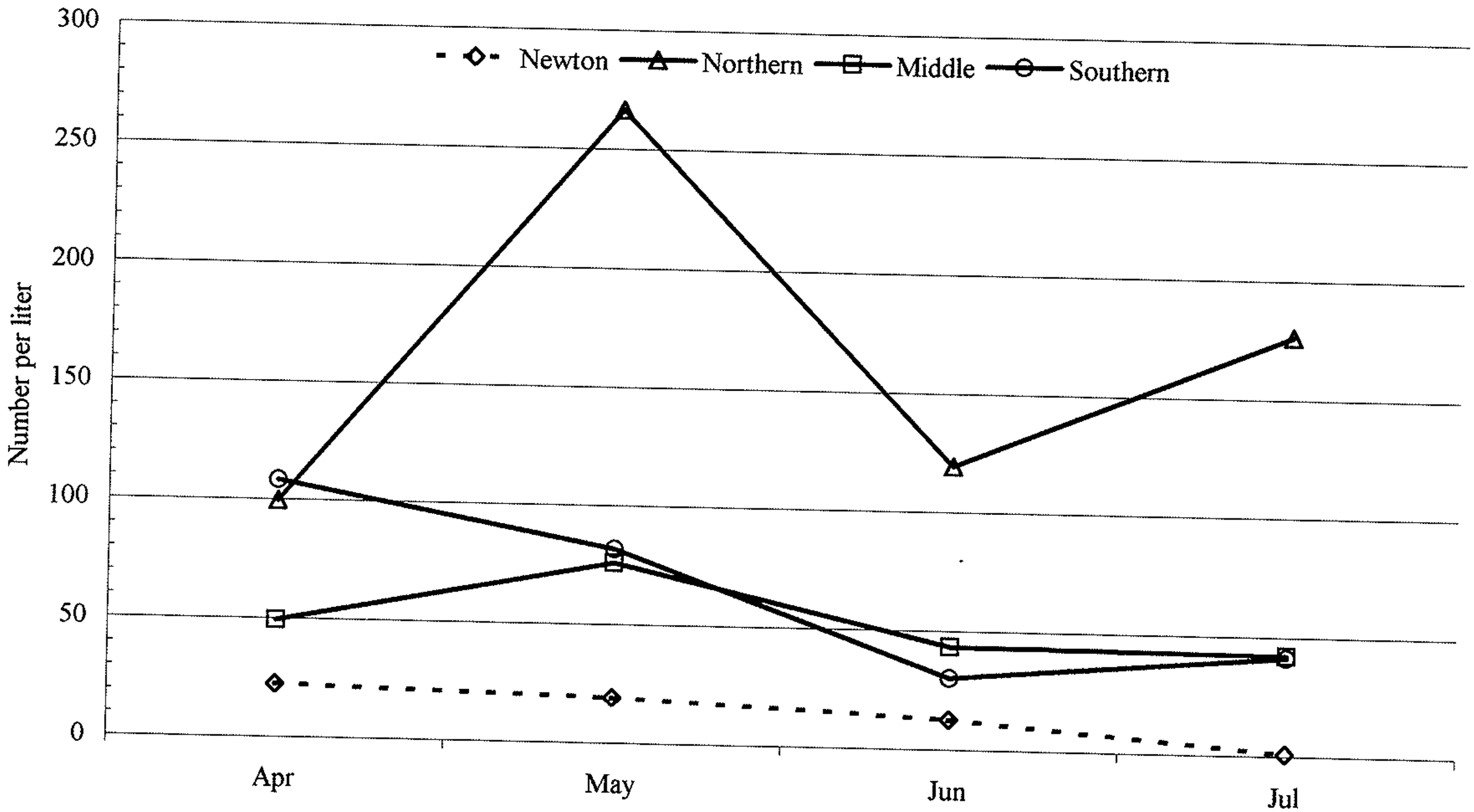

Figure 3.6. Mean monthly densities of adult cladocera and copepod zooplankton collected in Newton Lake compared to 12 lakes grouped into three regions of Illinois. Zooplankton was collected from the Illinois lakes during April through August of 1993 through 1997. Five lakes were sampled in the northern zone, six in the middle zone, and four in the southern zone.

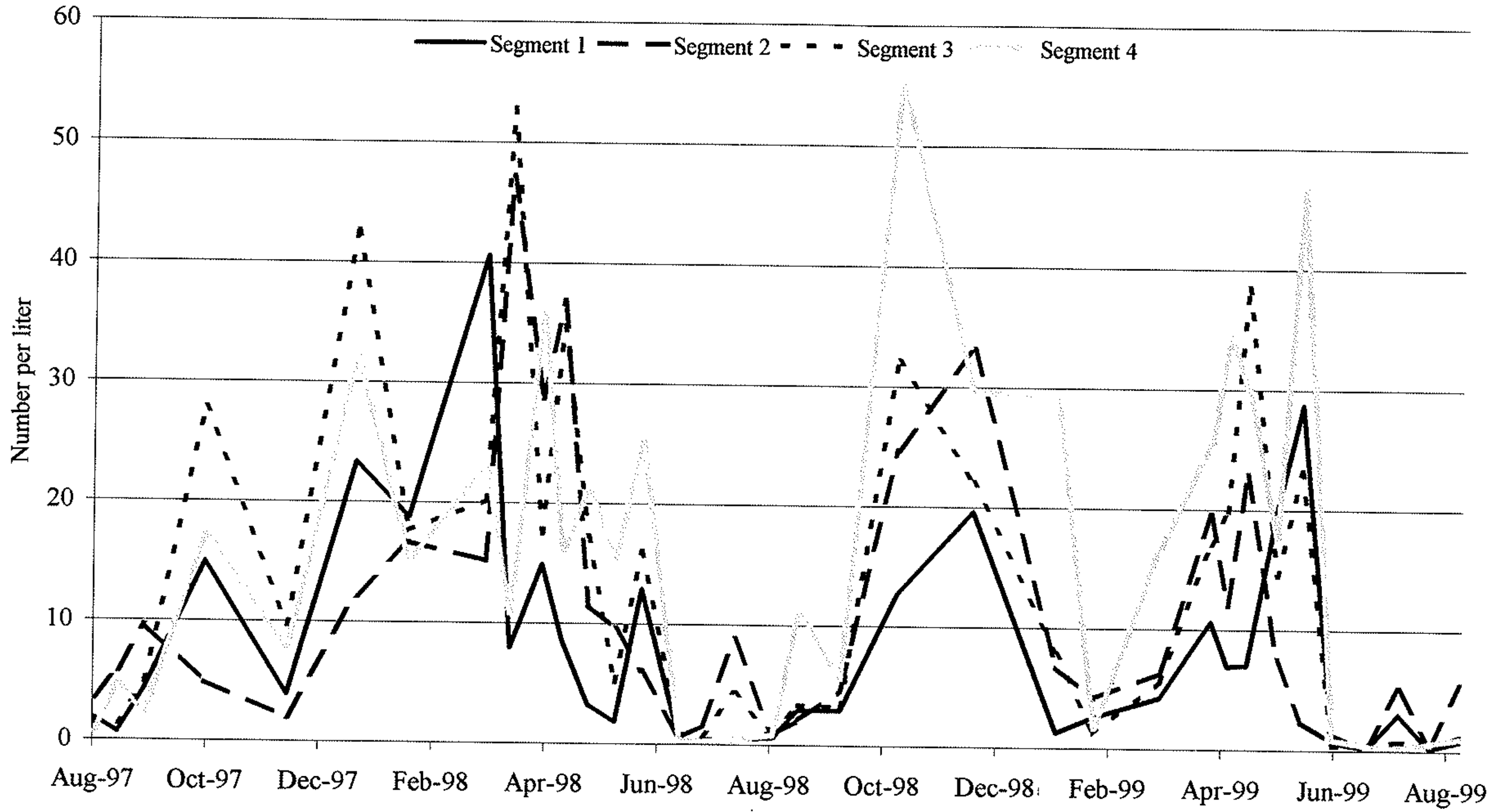

Figure 3.7. Mean densities by date of zooplankton (excluding nauplii and rotifers) collected in Newton Lake in four segments and three stations per segment during August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-*u* mesh plankton net.

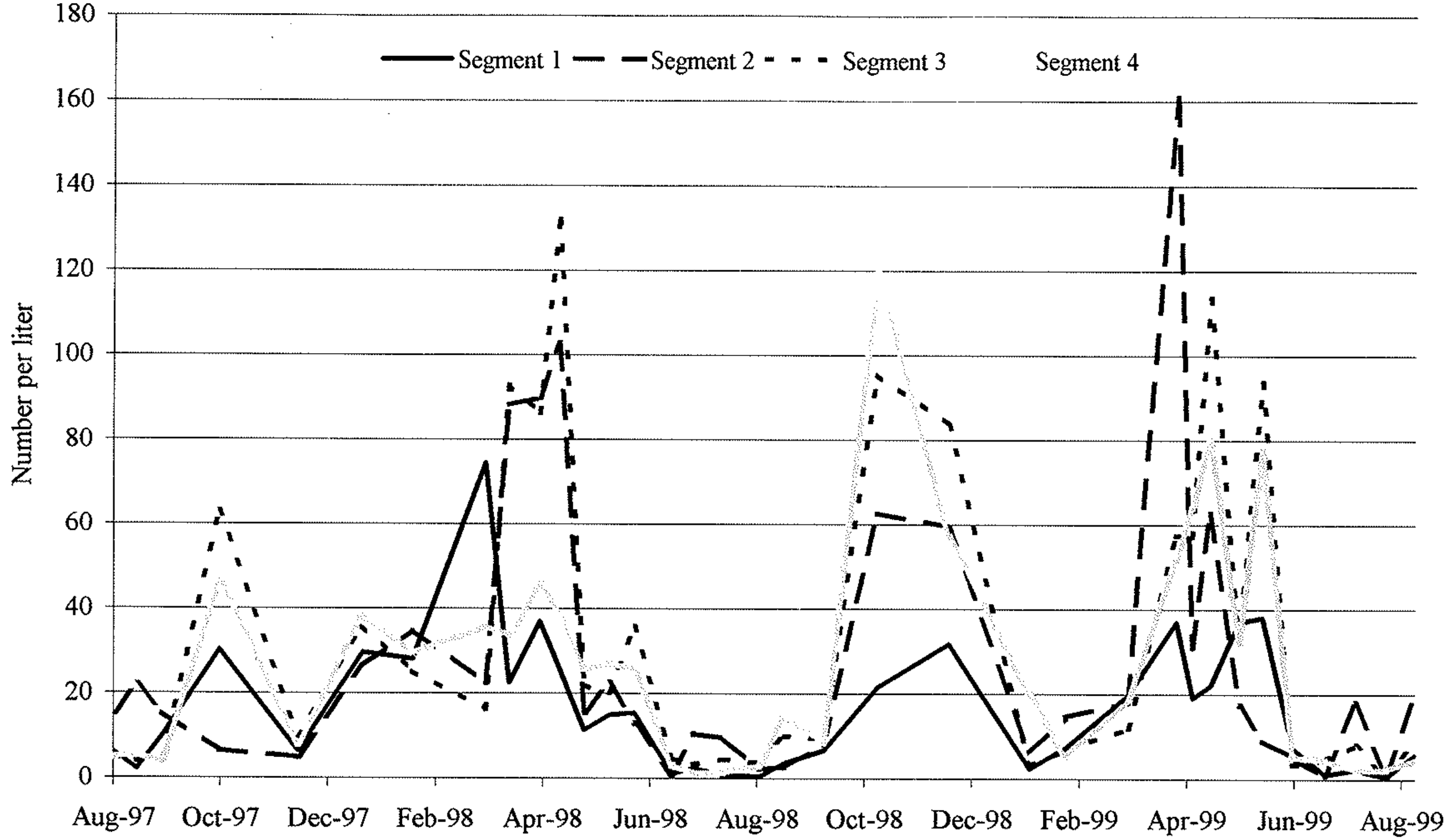

Figure 3.8. Mean densities by date of nauplii collected in Newton Lake in four segments and three stations per segment during August 1997 through August 1999. Two vertical tows were taken per station using a 0.5-m, 63-*u* mesh plankton net.

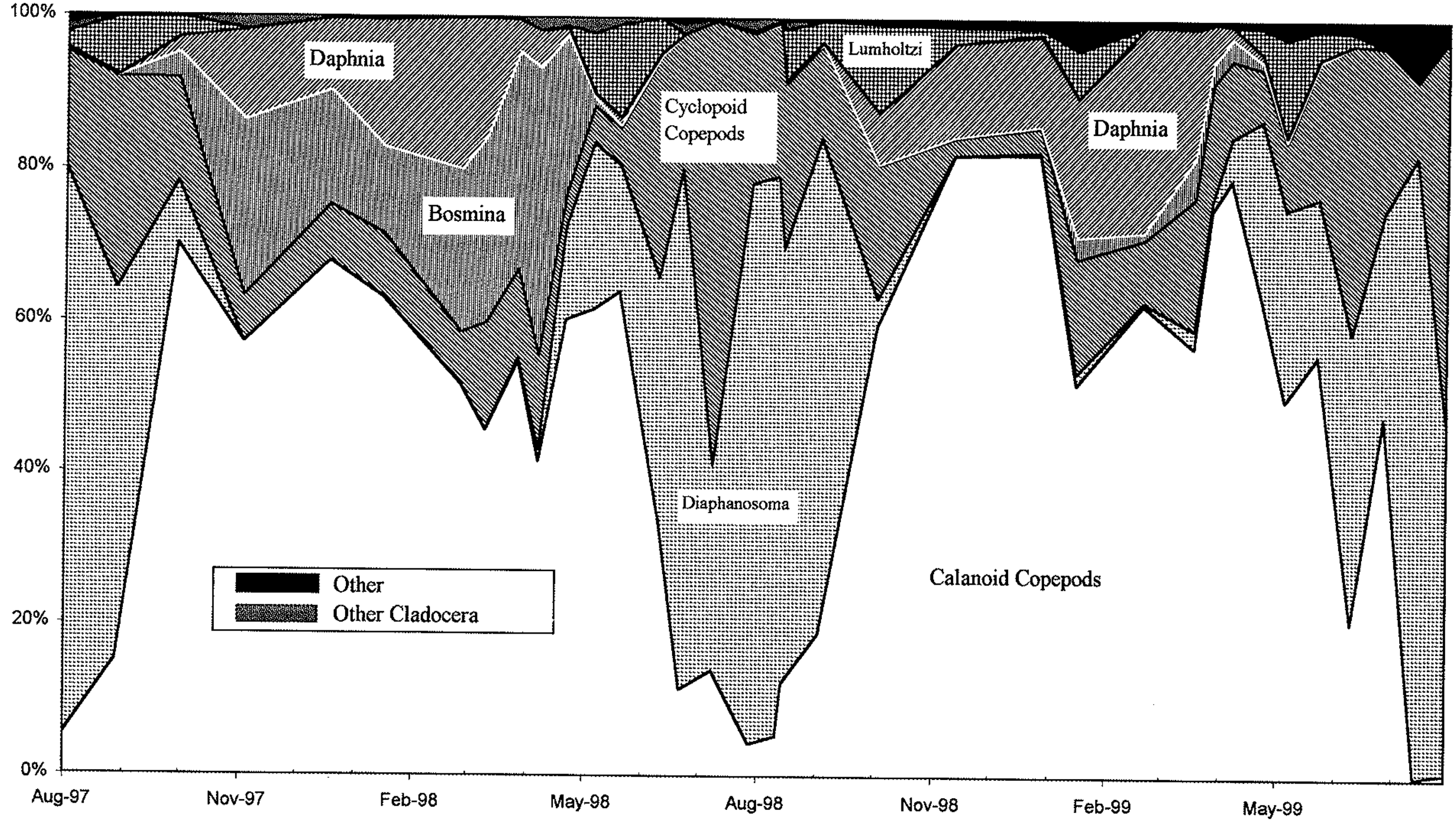

Figure 3-9. Percent contribution of zooplankton taxa collected in Newton Lake from August 1997 through August 1999.

Chapter 3. Appendix: Supplemental Data Tables

Appendix 3.1. Zooplankton samples were collected from Newton Lake on dates, segments, and stations listed. Two samples were taken per station with vertical tows using a 63-*u* mesh plankton net.

Date	Segments	Stations
08/29/97	1-4	1-3
09/11/97	1-3	1-3
09/25/97	1-4	1-3
10/27/97	1-4	1-3
12/10/97	1-4	1-3
01/15/98	1-4	1-3
02/12/98	1-4	1-3
03/25/98	1-4	1-3
04/07/98	1-4	1-3
04/24/98	1-4	1-3
05/05/98	1-4	1-3
05/19/98	1-4	1-3
06/02/98	1-4	1-3
06/16/98	1-4	1-3
07/07/98	1-4	1-3
07/19/98	1-4	1-3
08/05/98	1-4	1-3
08/25/98	1-4	1-3
09/08/98	1-4	1-3
09/30/98	1-4	1-3
10/30/98	1-4	1-3
12/09/98	1-4	1-3
01/23/99	1-4	1-3
02/12/99	1-4	1-3
03/19/99	1-4	1-3
04/15/99	1-4	1-3
04/24/99	1-4	1-3
05/04/99	1-4	1-3
05/20/99	1-4	1-3
06/02/99	1-4	1-3
06/19/99	1-4	1-3
07/07/99	1-4	1-3
07/24/99	1-4	1-3
08/10/99	1-4	1-3
08/26/99	1-4	1-3

Appendix 3.2. Mean densities of zooplankton collected from Newton Lake during August 1997 through August 1999. Zooplankton samples (834) were collected from four segments, three stations per segment and two vertical tows per station. Tows were conducted with 0.5 m diameter, 63-*u* mesh plankton nets. Superscripts indicate statistical significance among months (p=0.0001).

Taxa	Date	Number per L	Range		Standard deviation	Number of samples
All Zooplankton	August-97	146	25	479	104.37	24
	September-97	141	21	372	89.67	48
	October-97	124	13	217	50.86	24
	December-97	117	28	294	56.29	24
	January-98	565	337	747	110.99	24
	February-98	600	382	1,099	168.54	24
	March-98	320	103	993	235.94	23
	April-98	301	111	519	95.79	48
	May-98	568	191	1,459	278.25	48
	June-98	433	20	1,059	224.30	45
	July-98	167	56	276	62.89	48
	August-98	172	0	645	101.79	48
	September-98	244	44	534	127.97	48
	October-98	168	43	346	88.65	24
	December-98	197	69	305	60.39	24
	January-99	104	23	403	99.68	24
	February-99	493	155	1,203	285.88	24
	March-99	168	36	361	88.88	24
	April-99	365	75	936	202.99	48
	May-99	794	180	1,527	342.24	48
	June-99	383	9	1,302	319.97	48
	July-99	196	33	689	124.45	46
	August-99	280	51	564	115.86	48

Appendix 3.2. Continued.

Taxa	Date	Number per L	Range		Standard deviation	Number of samples
Rotifers	August-97	136	21	463	100.82	24
	September-97	129	10	371	84.70	48
	October-97	72	4	192	44.05	24
	December-97	104	24	275	54.18	24
	January-98	505	315	653	97.81	24
	February-98	554	344	1,031	162.04	24
	March-98	256	65	889	204.40	23
	April-98	212	88	420	75.24	48
	May-98	503	148	1,426	261.68	48
	June-98	398	16	1,022	223.62	45
	July-98	163	54	275	62.50	48
	August-98	166	0	635	99.66	48
	September-98	232	41	514	127.07	48
	October-98	62	14	202	45.71	24
	December-98	113	16	202	54.85	24
	January-99	85	10	345	82.89	24
	February-99	483	150	1,181	280.67	24
	March-99	143	0	334	84.07	24
	April-99	287	0	849	182.03	48
	May-99	725	141	1,511	349.39	48
	June-99	340	7	1,216	291.96	48
	July-99	189	29	681	126.79	46
	August-99	273	51	557	112.70	48

Appendix 3.2. Continued.

Taxa	Date	Number per L	Range	Standard deviation	Number of samples
Zooplankton	August-97	2	<1 4	1.20	24
	September-97	4	<1 14	3.64	48
	October-97	16	3 37	11.90	24
	December-97	6	1 14	3.77	24
	January-98	28	10 62	14.62	24
	February-98	17	10 25	3.62	24
	March-98	26	11 51	11.03	23
	April-98	27	6 76	18.85	48
	May-98	19	2 46	13.20	48
	June-98	12	1 44	10.33	45
	July-98	1	<1 4	0.61	48
	August-98	2	0 17	3.77	48
	September-98	5	1 14	3.12	48
	October-98	31	5 65	17.17	24
	December-98	26	10 37	7.42	24
	January-99	11	<1 60	14.73	24
	February-99	2	0 7	1.61	24
	March-99	8	2 25	6.40	24
	April-99	18	4 63	11.98	48
	May-99	20	1 48	12.04	48
	June-99	12	<1 81	18.61	48
	July-99	1	0 8	2.04	46
	August-99	1	<1 11	1.93	48

Appendix 3.2. Continued.

Taxa	Date	Number per L	Range		Standard deviation	Number of samples
Nauplii	August-97	8	2	40	7.55	24
	September-97	8	<1	36	7.98	48
	October-97	37	3	87	25.51	24
	December-97	7	2	17	3.72	24
	January-98	32	9	49	9.08	24
	February-98	29	20	49	8.09	24
	March-98	39	9	120	28.63	23
	April-98	62	13	170	36.46	48
	May-98	47	4	198	45.90	48
	June-98	23	1	109	17.25	45
	July-98	3	<1	19	3.66	48
	August-98	3	0	24	3.98	48
	September-98	8	1	24	4.53	48
	October-98	75	10	143	44.12	24
	December-98	58	9	98	22.24	24
	January-99	8	1	39	9.89	24
	February-99	8	2	20	4.99	24
	March-99	17	3	38	7.66	24
	April-99	60	5	511	72.87	48
	May-99	50	4	129	34.69	48
	June-99	30	1	173	40.51	48
	July-99	5	0	27	6.07	46
	August-99	5	<1	34	6.94	48

Appendix 3.3. Mean densities (n per L) of zooplankton taxa collected with vertical tows from 12 stations in Newton Lake using 0.5-m diameter, 63-μ mesh plankton nets. Samples (834) were collected during August 1997 through August 1999

Taxa	08/29/97	09/11/97	09/25/97	10/27/97	12/10/97	01/15/98	02/12/98	03/25/98	04/07/98	04/24/98	05/05/98
Bosminidae	0.01	0.01	0.00	0.54	1.35	4.14	1.95	5.31	7.27	6.93	9.11
Calanoid Copepod	0.10	0.39	0.81	11.38	3.36	18.76	10.80	12.82	13.57	13.30	10.00
Cyclopoid Copepod	0.28	0.67	1.47	2.19	0.36	2.05	1.43	1.69	4.18	2.83	3.00
Daphnia spp.	0.00	0.00	0.00	0.33	0.68	2.57	2.84	4.91	4.64	1.02	1.18
Diaphanosoma spp.	1.39	1.79	2.61	1.33	0.00	0.00	0.01	0.01	0.03	0.10	0.37
Leptodora kindti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daphnia lumholtzi	0.04	0.21	0.41	0.43	0.01	0.01	0.00	0.00	0.01	0.01	0.00
Other Cladocera	0.02	0.03	0.01	0.00	0.10	0.07	0.03	0.03	0.03	0.07	0.42
Others	0.02	0.01	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Total Zooplankton	**1.86**	**3.12**	**5.31**	**16.22**	**5.86**	**27.59**	**17.10**	**24.77**	**29.73**	**24.26**	**24.08**
Nauplii	7.76	8.31	8.34	36.58	7.24	32.50	29.26	37.19	59.34	64.64	75.02

Appendix 3.3. Continued.

Taxa	05/19/98	06/02/98	06/16/98	07/07/98	07/19/98	08/05/98	08/25/98	09/08/98	09/30/98	10/30/98	12/09/98
Bosminidae	2.77	0.09	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
Calanoid Copepod	8.05	4.94	9.71	0.18	0.09	0.49	0.03	0.26	0.78	18.62	21.50
Cyclopoid Copepod	0.58	0.38	0.74	0.15	0.13	2.05	0.15	0.98	0.51	5.51	0.60
Daphnia spp.	0.12	0.05	0.16	0.00	0.00	0.00	0.00	0.01	0.01	2.14	3.21
Diaphanosoma spp.	1.64	1.75	2.54	0.17	0.51	0.95	0.55	3.63	2.69	1.13	0.01
Leptodora kindti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daphnia lumholtzi	0.04	0.63	1.86	0.02	0.00	0.00	0.00	0.01	0.11	3.64	0.56
Other Cladocera	0.15	0.16	0.13	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.27
Total Zooplankton	**13.35**	**8.01**	**15.17**	**0.53**	**0.75**	**3.51**	**0.74**	**4.92**	**4.11**	**31.24**	**26.19**
Nauplii	18.54	21.14	22.43	2.41	4.32	4.01	2.23	7.79	8.02	74.79	58.03
Rotifera	370.5298	528.8198	217.0196	183.6111	141.8928	171.0278	161.9282	130.9985	332.8115	61.8512	112.8595

Appendix 3.3. Continued.

Taxa	01/23/99	02/12/99	03/19/99	04/15/99	04/24/99	05/04/99	05/20/99	06/02/99	06/19/99	07/07/99	07/24/99
Bosminidae	0.02	0.07	0.08	0.98	0.50	0.73	0.14	0.05	0.00	0.00	0.00
Calanoid Copepod	9.22	1.27	5.18	10.34	13.73	19.50	9.50	12.02	0.46	0.06	1.09
Cyclopoid Copepod	0.36	0.37	0.69	3.16	2.83	2.51	1.01	2.14	0.15	0.10	0.49
Daphnia spp.	1.32	0.45	2.24	3.08	0.93	0.39	0.16	0.13	0.00	0.00	0.00
Diaphanosoma spp.	0.04	0.04	0.02	0.44	0.22	1.38	3.46	6.09	0.17	0.10	0.62
Leptodora kindti	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daphnia lumholtzi	0.08	0.15	0.01	0.02	0.00	0.01	0.50	3.09	0.03	0.00	0.00
Other Cladocera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.13	0.10	0.06	0.17	0.07	0.17	0.14	0.58	0.01	0.00	0.08
Total Zooplankton	**11.20**	**2.44**	**8.28**	**18.19**	**18.28**	**24.67**	**14.92**	**24.10**	**0.82**	**0.27**	**2.29**
Nauplii	7.85	8.45	17.13	76.78	42.71	69.79	29.45	54.59	5.23	2.73	7.62
Rotifera	85.23	482.53	142.53	376.85	196.50	735.43	713.75	571.74	108.57	253.83	108.60

Appendix 3.3. Continued.

Taxa	08/10/99	08/26/99
Bosminidae	0.00	0.00
Calanoid Copepod	0.00	0.02
Cyclopoid Copepod	0.04	1.10
Daphnia spp.	0.00	0.00
Diaphanosoma spp.	0.36	0.98
Leptodora kindti	0.00	0.00
Daphnia lumholtzi	0.00	0.00
Other Cladocera	0.00	0.00
Others	0.03	0.05
Total Zooplankton	**0.44**	**2.15**
Nauplii	1.02	9.53
Rotifera	230.11	316.84

Chapter 4. Chlorophyll, Primary Productivity, and Phytoplankton (Primary Responsibility – Timothy Spier)

Introduction:

The primary producers are important to any ecosystem, as they are responsible for capturing sunlight, fixing carbon, and making this energy and biomass available to the other organisms in the ecosystem. In most aquatic ecosystems, the algae bear most of this responsibility. Algae are important in aquatic ecosystems not only because they capture sunlight and fix carbon, but also because they produce oxygen during photosynthesis. Thus, any stress which reduces the productivity of the phytoplankton can adversely affect the entire ecosystem. Conversely, stimulation of phytoplankton productivity can increase productivity of all trophic levels.

Operation of the Newton Lake generating station might influence the primary productivity of Newton Lake. An increase in discharge temperature as per the Newton Lake variance might reduce primary productivity by subjecting the phytoplankton to intolerable temperatures. Or, since phytoplankton are poikilothermic, an increase in discharge temperature might stimulate primary productivity by keeping the algae at their physiological optimum temperature for longer periods of time. Phytoplankton might be especially sensitive to increases in thermal loading as they have limited locomotion and thus limited ability to escape intolerable temperatures. Horizontal thermal clines may lead to horizontally stratified primary productivity.

Other than increasing temperature, the generating station might influence productivity in other ways. For example, entrainment of phytoplankton within the plant might affect primary productivity as phytoplankton might be subjected to mechanical, thermal, or chemical stress while traveling through the generating station.

High currents near the discharge might also influence productivity. An increase in current might increase turbidity in some segments, lowering productivity by limiting light or stimulating productivity by increasing the amount of available nutrients in the water column.

This study analyzed the effect that the Newton Lake generating station had on the primary productivity in Newton Lake. Data was collected on chlorophyll *a*, net rate of photosynthesis, and phytoplankton cell counts as well as factors which can influence these values, such as temperature, nutrients, light, and zooplankton.

Materials and Methods:

Sampling Sites

Newton Lake was divided into 4 segments (segment 1 = discharge, segment 4 = intake). Transects were established at the midpoint of each segment with 3 stations spaced equidistant from each other along the transect (Figure 4.1). All segments were sampled on the same day.

Euphotic Zone

The euphotic zone is defined as the upper portion of the water column in which oxygen evolution from photosynthesis exceeds oxygen consumption from phytoplankton respiration. In aquatic ecosystems, although much light hits the surface of the water, light is quickly attenuated with depth. At least 1% of the light incident to the surface of the water must be present to drive photosynthesis so that the plants produce more oxygen than they use up in respiration. Thus, the depth at which 1% of the incident light is present (the compensation point) is taken as the bottom of the euphotic zone. Below the compensation point more oxygen is used up by the plants than they produce.

A LiCor model LI-250 photometer with a spherical quantum sensor was used to measure the amount of light at the surface of the lake. Then, the sensor was lowered until a reading was obtained which was 1% of the incident light value. This depth was measured, and the process was repeated two more times. The average of these three measurements was considered the bottom of the euphotic zone. Euphotic zone depth was calculated once at each segment.

Nutrients

A composite water sample was obtained by combining samples taken at equal intervals from the surface to the compensation point. A 1 L water sample was obtained from one of the composite samples at each station of each segment, totaling 3 samples per segment per month. Samples were collected in acid washed bottles and kept on ice or at 4 C until being analyzed for nitrate, total ammonia, and total phosphorus. All analyses were performed within 48 hours of sampling except total phosphorus, which was performed within 20 days of sampling after samples were fixed with 2.0 ml of concentrated sulfuric acid.

All colormetric analyses were read using a Hach model DR / 3000 spectrophotometer. Methods were adapted from the Hach DR / 3000 procedures manual and from *Standard Methods for the Analysis of Water and Wastewater, 19th edition* (APHA 1995). Nitrate was determined using cadmium reduction. Ammonia was determined by Nesslerization. Total phosphorus concentrations were found using persulfate oxidation. For all chemical tests, samples of known concentration were run with each analysis for quality control.

Chlorophyll a

One - 300 ml water sample was obtained from each composite sample and immediately filtered through a Whatman GF – F filter. Under conditions of extremely high turbidity only 150 mLs was filtered. One ml of saturated $MgCO_3$ solution was added prior to filtration. The filter was immediately wrapped in foil, placed in a waterproof bag, and placed on ice. Upon return to the laboratory, the filters were ground with a Teflon - glass tissue grinder for 1 minute in 90%

acetone. The ground filter and acetone slurry was placed in a capped test tube and stored at 4 C in the dark for approximately 20 hours. Samples were then centrifuged, and the acetone supernatant placed in a 10 cm cell. Optical density was read at 664 nm with a spectrophotometer before acidifying the sample with 1 ml of 0.1 N HCl. Ninety seconds after acidification, the sample was again read at 665 nm. Application of the optical density before and after acidification allows us to determine the amount of chlorophyll *a* and pheophytin as well as the ratio of the optical density at 664 nm (OD 664) to the optical density at 665 nm (OD 665) . A specific absorption coefficient of 90 was used as reported in *Standard Methods for the Analysis of Water and Wastewater* (APHA 1995). Three composite water samples were obtained at each station, and there were 3 stations per segment, for a total of 9 chlorophyll *a* samples per segment per month.

Primary Production

Primary production was measured once per month in the middle station of each segment using dissolved oxygen changes and the light bottle – dark bottle (LB – DB) method. At least 3 water samples were obtained from within the euphotic zone using a 3.2 L acrylic water sampler. One sample was taken from the surface, one from the bottom of the euphotic zone, and the remaining samples were dispersed throughout the euphotic zone. Samples were transferred to one clear (LB), one opaque (DB), and one initial (IB) 300 ml BOD bottles. The LB and DB were resuspended at their initial depth from a floating platform, while the IB was used to determine initial dissolved oxygen concentration using a YSI model 50 – B oxygen meter with BOD probe. All bottles were kept in darkness until initiation of the experiment. Two series of LB's and DB's were sampled each month at each segment.

Once resuspended, each series of bottles remained in the water for several hours. Peak light occurs during the interval 10:00 – 14:00 hours, thus all samples were obtained as near to this period as possible. Incident light data was collected from sunup to sundown to create a profile of diurnal light.

At the termination of the sample period, final oxygen concentration was determined for each bottle.Net photosynthesis was calculated at each sampling depth by subtracting the initial oxygen concentration from the final oxygen concentration. These values (in mg O_2 L^{-1}, equal to g O_2 m^{-3}) were plotted against depth (in m), a quadratic function was fitted to the data, and this curve was integrated from the surface to the compensation point to estimate the total production in the euphotic zone under 1 m^2 of surface water. Daily light data (in $\mu E\ m^{-2}\ s^{-1}$) was also plotted against time (in s) and integrated from sunup to sundown to obtain total incident light per m^2 of surface area. Integrating this curve for the sample period for each segment gave the total light per m^2 of surface during the sample period. By comparing the total light hitting the surface during the sample period to the total light hitting the surface during the entire day, a scaling factor was calculated which was used to adjust each segment's productivity to reflect the entire day's production. In this way, differences in light during each segment's incubation period do not influence productivity estimations. This procedure does not properly adjust negative net photosynthesis values. More appropriate adjustments were investigated but did not appear to impact the negative net photosynthesis values. Daily production values were converted from g $O_2\ m^{-2}\ day^{-1}$ to mg C $m^{-2}\ day^{-1}$ by multiplying by 1000 (to convert to mg $O_2\ m^{-2}\ day^{-1}$), then multiplying by 0.375 (12 g mol^{-1} C / 32 g mol^{-1} O_2) and dividing by 1.2 (the photosynthetic quotient) (Cole 1994).

Phytoplankton Cell Counts

A 1 L water sample for phytoplankton cell counts was obtained from two of the composite samples at each station of each segment, totaling 6 samples per segment per sampling trip. Samples were collected bi – monthly from April – September and every six weeks from October – March.

Samples were preserved in 1.0 ml buffered Lugol's solution per 100 ml sample solution. Samples were appropriately labeled, stored in amber bottles, and returned to the laboratory. Phytoplankton were allowed to settle in graduated cylinders for 2 days, after which the top 900 mls of sample were poured off, leaving approximately 100 mls of concentrated sample. This sample contained all the phytoplankton originally present in the 1 L water sample. A 2 ml subsample was drawn from this concentrated sample and allowed to settle in a sedimentation chamber equipped with a Whipple ocular micrometer. Phytoplankton were enumerated using an inverted compound Wild microscope. In addition, samples of live phytoplankton were frequently brought back to the laboratory to aid in the identification of the preserved specimens.

Phytoplankton were enumerated to the lowest taxon possible. Cell counts are reported in numbers L^{-1}. A total of 5 fields were counted per subsample, and 2 subsamples were enumerated from each concentrated sample. Mean number of phytoplankters per field was determined for each subsample. The field area was compared to the sedimentation chamber area to determine the number of cells per sedimentation chamber, and thus the number of cells in a 2 ml subsample. This number was multiplied by the volume of the concentrated sample to obtain the number of cells per concentrated sample, which, due to our settling procedure, is equal to the number of cells per liter of lake water. Averaging this value over 2 subsamples for each taxon gave the mean number of cells per liter for a sample. Summing the mean number of cells per liter for all taxa gave the mean total cell count per sample.

Reference literature included Tiffany and Britton (1992), Prescott (1962), and Smith (1950).

Statistical Analyses

Values of chlorophyll *a*, OD 664 / OD 665 ratio (hereafter referred to as OD ratio), daily net photosynthesis, and phytoplankton cell count were compared between segments after partitioning out the date and segment * date interaction using SAS general linear model procedures (SAS Institute 1995). Univaritate plots were created to check for outliers and to obtain an understanding of the general relationship between variables. Assumptions of normality and homogeneity of variance were investigated by comparing within – group sample sizes and variances; all comparisons had large, nearly equal sample sizes, and group variances were similar for all comparisons. Under these conditions, analysis of variance is robust in relation to normality and homogeneity assumptions. Frequency distributions of the standardized residuals were plotted to visually check for normality of the residuals. Standardized residuals were also plotted against predicted values to visually check for homoscedasticity. Transformations of the data were performed when necessary. Significant segment effects were investigated using Scheffe's post hoc test. All tests were performed at $\alpha = 0.05$.

Several linear regressions were also performed using data from this experiment. Similar methids were used to check assumptions of linearity, homoscedasticity, and normality.

Results:

Nutrients

Mean values with 95% confidence intervals of nitrate, ammonia, and total phosphorus by segment for each sampling date are given in Tables 4.1 – 4.3. Mean values with 95% confidence intervals of nitrate, ammonia, and total phosphorus for each segment are given in Tables 4.4 – 4.6. Tables 4.4 – 4.6 also contain results from the statistical comparison of segments.

On March 29, 1998, extremely high turbidity levels in segment 1 led to high total phosphorus levels. Since the phosphorus in these samples was likely unavailable to phytoplankton, these values were considered outliers and were excluded from statistical analyses.

Ammonia values are reported in mg L^{-1} NH_3. However, no measurement was made of temperature or pH of the lake water at the time of sampling, so we were unable to determine what percentage of the ammonia was in the un – ionized form. At 30 C and pH = 7 only 0.8% of the total ammonia nitrogen (TAN) is expected to be in the toxic NH_3 form, but as temperature remains at 30 C and pH increases to 8, 8% of the TAN becomes toxic, and at pH = 9 44% of the TAN is in the un – ionized form. Ameren – CIPS periodically measured pH in Newton Lake as part of the routine water quality sampling; several times during 1999 pH was measured greater than 8 with a high of 8.62.

Segments had significanlty different levels of nitrate after controlling for the date and the date * segment interaction (omnibus R^2 = 94.9%, segment effect p value = 0.0209). However, post hoc tests did not produce a clear pattern of differences among segments. Segment 1 had the highest nitrate values and was significantly different from segment 4, which had the lowest nitrate values. Segments 2 and 3 had values in between segments 1 and 4 and were not significantly different from either of these segments.

Segments had significantly different levels of ammonia after controlling for the date and the date * segment interaction (omnibus R^2 = 96.1%, segment effect p value = 0.0001). All segments were significantly different from each other. Ammonia levels were highest in segment 1 and decreased as water travelled around the lake to segment 4.

Segments had significantly different levels of total phosphorus after controlling for the date and the date * segment interaction (omnibus R^2 = 87.9%, segment effect p value = 0.0001). Total phosphorus levels were highest in segment 1 and decreased as water travelled around the lake to segment 4. Segment 4 was significantly lower than all other segments, and segment 1 was significantly higher than all segments other than segment 2. Segments 2 and 3 were not different from each other.

Chlorophyll a

Mean values with 95% confidence intervals of chlorophyll *a*, OD ratio, and pheophytin *a* are given in Tables 4.7 – 4.9. Mean values with 95% confidence intervals of chlorophyll *a* and OD 664 / OD 665 ratio for each segment are given in Tables 4.10 and 4.11. Tables 4.10 and 4.11 also contain results from the statistical comparison of segments. Values of chlorophyll *a* and OD ratio for each segment are also represented graphically in Figures 4.2 and 4.3.

Segments had significantly different chlorophyll *a* values after controlling for the date and the date * segment interaction (omnibus R^2 = 94.6%, segment effect p value = 0.0001). Chlorophyll *a* levels were lowest in segment 1, peaked in segments 2 and 3, and were lower in segment 4.

Similar effects were found for the OD ratio. Segments were significantly different after controlling for the date and the date * segment interaction (omnibus R^2 = 92.8%, segment effect p value = 0.0001). The OD 664 / OD 665 distribution in Newton Lake mimiced the chlorophyll *a* pattern. Comparing Figures 4.2 and 4.3 suggests that chlorophyll *a* levels and OD ratios are tightly linked. In fact, the Pearson correlation coefficient between chlorophyll *a* and OD ratio was $r = 0.88494$ ($p = 0.0001$), suggesting that chlorophyll *a* levels are driving the OD ratio.

Primary Productivity

Mean values with 95% confidence intervals of net photosynthesis are given in Table 4.12. Mean values with 95% confidence intervals of net photosynthesis for each segment are given in Table 4.13. Table 4.13 also contains results from the statistical comparison of segments. Values of net photosynthesis for each segment are also represented graphically in Figure 4.4.

Segments had significantly different net photosynthesis levels after controlling for the date and the date * segment interaction (omnibus $R^2 = 98.7\%$, segment p value = 0.0001). The pattern for net photosynthesis was similar to the chlorophyll *a* pattern: segment 1 was significantly lowest, segments 2 and 3 were significantly highest, and segment 4 had intermediate levels of net photosynthesis.

Phytoplankton Cell Counts

Initial calculations of total phytoplankton counts indicated that densities were much higher than normally found in the literature. Further investigation showed that the total cell counts were dominated by the extremely small Coccoid single phytoplankters (Division Cyanophyta, Order Chroococcales) which on average made up approximately 75% of the total cell counts. Consequently, this group was analyzed seperately from all other phytoplankton taxa. Removal of the Coccoid singles reduced the total cell counts to levels more similar to other studies (Moran 1981). It is unknown if other studies include the Coccoid singles in their numbers. Since the Coccoid singles are so small, conversion of phytoplankton numbers to biomass or biovolume might demphasize this taxon.

Mean values with 95% confidence intervals of total phytoplankton counts for Coccoid singles and other taxa are given in Tables 4.14 and 4.15. Mean values with 95% confidence intervals of total phytoplankton counts for Coccoid singles and other taxa for each segment are given in Tables 4.16 and 4.17. Tables 4.16 and 4.17 also contain results from the statistical comparison of segments. Values of total phytoplankton counts for Coccoid singles and other taxa for each segment are also represented graphically in Figures 4.5 and 4.6.

Segments had significanlty different mean total numbers of Coccoid single phytoplankton cells after controlling for the date and the date * segment interaction (omnibus $R^2 = 83.6\%$, segement effect p value = 0.0001). Segment 1 had significanlty higher Coccoid single numbers than the other segments, while segment 3 had significanly lower Coccoid single numbers than the other segments. Segments 2 and 4 has similar Coccoid single numbers. Further analysis of the standardized residuals from this procedure suggested that the data needed to be transformed. Log base 10 transformation of the Coccoid single numbers improved the distribution of the standardized residuals without changing the pattern of the results (omnibus $R^2 = 72.9\%$, segment effect p value = 0.0001).

Segments did not differ in mean total numbers of phytoplankton cells (Coccoid singeles excluded) after controlling for the date and the date * segment interaction (omnibus $R^2 = 72.4\%$, segement effect p value = 0.4576). Further analysis of the standardized residuals from this procedure suggested that the data needed to be transformed. Log base 10 transformation of the total phytoplankton numbers improved the distribution of the standardized residuals. Segments had significantly different log of total phytoplankton numbers after controlling for the date and the date * segment interaction (omnibus $R^2 = 73.8\%$, segment effect p value = 0.0286). Log of total phytoplankton count was no different for segments 1, 2, and 4, while segment 3 was significantly lower than the other 3.

Discussion:

Nutrients

Water samples were obtained from the composite samples used in chlorophyll analysis. These samples were analyzed for ammonia, nitrate, and total phosphorus. Ammonia and nitrate can be important sources of nitrogen for phytoplankton, while phosphorus is often the limiting nutrient in freshwater ecosystems and thus total phosphorus levels can influence primary production.

Ammonia, nitrate, and total phosphorus concentrations were typical for midwestern reservoirs. Hoyer and Jones (1983) reported total phosphorus levels in 96 reservoirs in Missouri and Iowa ranged from 0.0052 - 0.2653 mg L^{-1} with a mean of 0.0384 mg L^{-1} ; total nitrogen ranged from 0.3 – 3.4 mg L^{-1} with a mean of 0.7 mg L^{-1} . Mean surface total phosphorus ranged from 0.008 – 0.145mg L^{-1} and nitrate ranged from 0.02 – 0.11 mg L^{-1} across 7 cooling reservoirs in the southeast U.S. (Mallin et al. 1994). Newton Lake total phosphorus mean value was 0.201 mg L^{-1} PO_4. Mean total inorganic nitrogen in Newton Lake was 1.514 mg L^{-1} NO_3 + NH_3, which does not include organic forms of nitrogen. Mean nitrate for Newton Lake was 1.195 mg L^{-1} NO_3 while mean ammonia was 0.319 mg L^{-1} NH_3.

While some overlap exists between segments for nutrient levels, a general pattern is evident. Nutrients are generally highest in segments 1 and 2 and decrease in the cooler segments 3 and 4. No information is available concerning the watershed for different segments of the lake; however, considering that segments 1 and 2 comprise the west arm of Newton Lake and segments 3 and 4 comprise the east arm of the lake, it is not surprising that nutrient levels were similar for segments 1 and 2 and segments 3 and 4. Anectdotal evidence suggests that segment 1 receives a great deal of agricultural runoff which carries a high sediment load. High sediment levels in this segment likely influenced the high total phosphorus levels in segment 1.

Chlorophyll a

Missouri and Iowa reservoirs had a mean chlorophyll *a* concentration of 0.0170 mg L^{-1} and the range was 0.0007 – 0.1422 mg L^{-1} (Hoyer and Jones 1983). For 7 southeastern U.S. cooling reservoirs, chlorophyll *a* ranged from 0.0032 – 0.0766 mg L^{-1} (Mallin et al. 1994). In this study, Newton Lake mean chlorophyll *a* was 0.0156 mg L^{-1} .

Results from this study indicate that chlorophyll *a* levels were depressed in the warm water near the discharge, increased to a maximum in the slightly cooler water near the boat ramp (segments 2 and 3), then decreased in the cool water arm (segment 4). These results suggest that algal productivity was lowest in the discharge water and stimulated in the next segment before falling to intermediate levels in the coolest arm. Several factors could influence chlorophyll *a* levels and lead to the differences seen between segments. Such factors include nutrient concentrations, light availability, herbivore densities, water temperature, and stress as algae travel through the power plant,.

As noted above, nutrient levels were highest in segment 1, but chlorophyll *a* was lowest in this segment, suggesting that chlorophyll *a* is influenced less by nutrients and more by other factors discussed below.

Available light can also affect photosynthesis and thus chlorophyll *a*. Total incident light was considered equal for all segments; however, differences in turbidity can affect the amount of light available in the water column. Although turbidity was not measured directly, depth of the euphotic zone can be used to investigate the extent of turbidity in the water. Segment 1, with the lowest chlorophyll *a* levels, also had significantly lower mean euphotic zone depth than the other segments (Table 4.18). Along with the already mentioned high turbidity during precipitation events, the high current due to the proximity of the discharge might also increase abiogenic turbidity in segment 1. Note that this measure of turbidity is affected by both biogenic and abiogenic factors. For example, an algae bloom can decrease light penetration, as can an increase in suspended solids.

Herbivore (zooplankton) density has been shown to control plankton productivity in a "top down" manner (Carpenter and Kitchell 1993). Since herbivores were expected to have a more direct influence on phytoplankton numbers than chlorophyll *a* values, the effect of zooplankton on primary productivity will be discussed with the total cell numbers.

Central to this study is the effect increased temperature will have on productivity. The significanly different chlorophyll *a* levels found in the segments, which also differ in temperature, implies that temperature is influencing primary productivity to some extent. To further investigate the effect of temperature, data from the temperature loggers (see Job 15) were compared to chlorophyll *a* levels for each segment. Since sampling sites were located several hundred meters upstream from the nearest loggers for each segment, a regression equation was developed which adjusted the temperature logger data to reflect the cooling of the water as it passed from the sampling site to the logger buoy. To create the equation, data from the temperature profiles (which were obtained at the sampling site) were matched with the appropriate logger data. Temperature data from different depths of the profile was paired with surface logger data taken within ½ hour of the profile data, allowing the regression to predict the temperature at any depth at the sampling site given the temperature taken from the nearest surface logger. A similar equation was developed using data from the logger located at 1.5

meters. Note that adjusting temperature in this manner will not influence statistical analyses in any way. The temperature was adjusted in order to create a more intuitively understandable relationship between chlorophyll *a* and temperature. Also, the temperature loggers often malfunctioned, and by creating two seperate equations using the surface and 1.5 meter loggers allowed for more complete sample day coverage.

For chlorophyll *a* analysis, mean daily temperature for the midpoint of the euphotic zone on the sample date was compared to mean chlorophyll *a* levels for each segment. Figure 4.7 graphically compares chlorophyll *a* and mean daily euphotic temperature. Linear regression analysis shows that there was no relationship between chlorophyll *a* and mean euphotic temperature ($R^2 = 0.2$ %, p value = .6391). Since it was expected that chlorophyll *a* levels would increase with increasing temperature but then decrease once temperature levels became too high, a second regression was developed which compared chlorophyll *a* to the square of temperature; however, this regression was also not significant. Phytoplankton likely require some time to synthesize chlorophyll *a*, so comparisons were made between chlorophyll *a* and mean euphotic temperature for several days prior to the sampling date. No relationship was found with temperatures up to 1 week in advance of sampling.

Previous studies have suggested that phytoplankton are subjected to several stresses as they travel through a power plant. Mechanical, chemical, and thermal stress all can affect the algae (Morgan and Stross 1969). Segment 4, at the intake, had significantly higher chlorophyll *a* levels than segment 1, which lies below the discharge. Destruction of the plankton as they travel through the plant could lead to the lower chlorophyll *a* levels in segment 1 and also might lead to the increased nutrient levels in this segment due to leaching from damaged cells. However, it is not known how many phytoplankters are actually entrained in the plant. The sampling station in segment 1 is several hundred meters from the discharge, and while high currents in this segment might carry phytoplankton a long distance, it is not known if the samples taken there contained phytoplankton that actually traveled through the plant.

OD Ratio

The OD ratio is used as an indicator of the physiological condition of the phytoplankton. This ratio ranges from 1.0 to 1.7 (using 90% acetone), with larger values indicating better physiological condition. The OD ratio was lowest in segment 1, highest in segments 2 and 3, and in between in segment 4 (Table 4.11). Thus, the algae in the coolest portion of the lake did not have the highest OD ratio. The OD ratio pattern mirrored that of chlorophyll *a*. Theoretically, chlorophyll *a* levels could be high while the OD ratio was low, for example if a large number of phytoplankton were present which were in poor physiological condition. However, the previously mentioned strong correlation between chlorophyll *a* and OD ratio suggests that the OD ratio might not provide any information beyond that given by chlorophyll *a* levels.

Net Photosynthesis

Both chlorophyll *a* and net photosynthesis rates are important to understanding primary productivity in lake ecosystems. Most of the above discussion concerning chlorophyll *a* can also be applied to net photosynthesis

Data obtained from the light bottle – dark bottle (LB – DB) experiments can give rates of respiration, net photosynthesis, and gross photosynthesis. Respiration might be a useful number, as poikilothermic organisms can be expected to increase their metabolism as temperature increases. However, respiration as measured in the LB – DB experiment includes not only algal but also zooplankton and bacterial respiration.

Of net and gross photosynthesis, net photosynthesis is an indicator of the biomass and energy made available for higher trophic levels. Thus, when discussing primary productivity this report only discusses the net photosynthesis rates in Newton Lake.

Mean daily productivity for Newton Lake was 944 mg C m^{-2} day^{-1}, which is considered nearly eutrophic by Kimmel et al. (1990). Mean production values calculated with the oxygen evolution method for several North American lakes are compared to Newton Lake in Table 4.19. Newton Lake productivity fell nearly in the middle of the range of productivities given in Table 4.19.

Photosynthesis values followed the same pattern as chlorophyll *a*: lowest at the warm segment, highest in the next two segments, and intermediate values in segment 4. Again, possible influences on productivity include nutrients, light, herbivores, temperature, and entrainment stress. However, not all of these factors were expected to influence the net photosynthesis rates. Herbivore density and entrainment stress did not likely affect the photosynthesis measurements due to the relatively short time scale of this experiment.

Light levels as measured by euphotic zone depths were expected to affect photosynthesis values as the euphotic depth is used to create these values. Indeed, mean euphotic zone depths varied in an expected manner with net photosynthesis values. Segments with deeper euphotic zones tended to have higher net photosynthesis values. This effect is most likely due to the fact that photosynthetic rates are integrated over a greater depth in segments with more clear water.

Mean euphotic temperature was determined for productivity samples in the same way it was determined for chlorophyll *a* samples. Since net photosynthesis values were extrapolated for an entire day, mean daily temperature was once again used. Mean euphotic zone temperature and net photosynthesis are compared graphically in Figure 4.8. Linear regression analysis showed that temperaature had a significant, positive relationship with net photosynthesis (R^2 = 36.3 %, p value = 0.0001). Analysis of residuals and univariate plots suggested that a transformation was appropriate, but several different transformations did not improve the regression.

Phytoplankton Cell Count

In the following discussion of phytoplankton cell counts, all references to "cell counts" or phytoplankton relate to all phytoplankton enumerated except the Coccoid singles group which was excluded from analyses because of its undue influence on total cell numbers.

Mean phytoplankton numbers per liter were determined by Division in order to compare the green (Division Chlorophyta) and blue – green (Division Cyanophyta) algae. These two Divisions made up the majority of the total phytoplankton cell counts. Mean values for each Division are represented graphically in Figure 4.9. Comparison of Figure 4.9 to Figure 4.6 shows that the summer bloom of algae, which occured in June of 1998 and May of 1999, is comprised mostly of blue – green algae, while the winter bloom that was observed in January of 1999 was made up of green algae.

There existed no difference among segment mean total cell counts although segments differed in both chlorophyll *a* and net photosynthesis values. Linear regression analysis found no relationship between total phytoplankton cells and chlorophyll *a* levels (R^2 = 2.1%, p value = 0.3480) or net photosynthesis (R^2 = 1.9%, p value = 0.3478). Since each segment had the same number of phytoplankters but segments 1 and 4 had lower productivity, factors such as temperature and light availabilty are very likely influencing rates of primary production. Herbivorous zooplankton were expected to influence cell counts more directly than they would influence chlorophyll *a* or net photosynthesis, so mean zooplankton density was compared to phytoplankton cell counts. Rotifers and nauplii were excluded from this analysis since larger

Cladocerans and Copepods have a greater effect on phytoplankton (Carpenter et al. 1993). A linear regression comparing mean phytoplankton cell count and mean zooplankton density was not significant (R^2 = 0.3%, p value = 0.6394).

To estimate the relative photosynthetic efficiency of the phytoplankton, mean net photosynthesis and mean chlorophyll *a* per phytoplankton cell per liter were calculated. Values for mean net photosynthesis were in mg C m^{-2} day^{-1}, while values for phytoplankton counts were in cells L^{-1}, so mean net photosynthesis per cell per liter has the units mg C L m^{-2} day^{-1} $cell^{-1}$. Values for chlorophyll *a* were in μg chlorophyll *a* L^{-1}, so values for chlorophyll *a* per cell per liter has the units μg chlorophyll *a* $cell^{-1}$. These values are represented graphically in Figures 4.10 and 4.11.

Summer Comparisons

The fish kill in July of 1999 stimulated an interest in comparing productivity between summer of 1998 and summer of 1999. Specifically, July and August values for chlorophyll *a*, OD ratio, net photosynthesis, and total cell counts were combined for all segments and compared between years. Comparisons were also made between years within each month.

Tables 4.20 and 4.21 give mean values of chlorophyll *a* and OD ratio for summer 1998 and summer 1999. These tables also give results from the statistical comparison between years. Chorophyll *a* values did not differ between summer 1998 and summer 1999 (R^2 = 0.6%, p value = 0.3623) while OD ratio was significanlty higher during summer 1998 (R^2 = 9.6%, p value = 0.0002) although this model did not account for much of the OD ratio variability. Within month comparisons showed that both chlorophyll *a* and OD ratio were significantly higher in July 1998 than in July 1999 (R^2 = 79.9%, p value = 0.0001 for chlorophyll *a*, R^2 = 68.9%, p value = 0.0001 for OD ratio) and each was significantly lower in August 1998 than in August 1999 (R^2 =

68.1%, p value = 0.0001 for chlorophyll *a*, $R^2 = 16.5\%$, p value = 0.0005 for OD ratio) (Tables 4.22 and 4.23).

Table 4.24 gives mean values of net photosynthesis for summer 1998 and summer 1999. This table also give results from the statistical comparison between years. Net photosynthesis values did not differ between summer 1998 and summer 1999 ($R^2 = 0.0\%$, p value = 0.8379). Within month comparisons also showed that net photosynthesis was not different between 1998 and 1999 for July ($R^2 = 0.0\%$, p value = 0.9008) or August ($R^2 = 0.0\%$, p value = 0.7578) (Table 4.25). Low sample size and high variability of the dependent variable likely limited the power of this test.

Table 4.26 gives mean values of total phytoplankton cell counts for summer 1998 and summer 1999. This table also give results from the statistical comparison between years. Total phytoplankton cell counts were significanlty higher in summer 1998 than in summer 1999 ($R^2 = 16.4\%$, p value = 0.0001). Within month comparisons also showed that phytoplankton cell counts were significantly higher in 1998 than in 1999 for July ($R^2 = 16.9\%$, p value = 0.0037) and August ($R^2 = 23.2\%$, p value = 0.0005) (Table 4.27). Note that although cell counts were lower during summer 1999, net photosynthesis remained the same, most likely due to the deeper euphotic zone in 1999 (Figure 4.12).

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Table 4.1 Mean euphotic zone nitrate concentration with confidence intervals (C. I.) from Newton Lake. Values are in mg / L NO_3. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	0.98 ± 2.17	2	0.94 ± 1.53	2	0.88 ± 0.90	2	0.91 ± 0.54	2
10/29/97	.		.		.		.	
11/19/97	0.57 ± 0.45	3	0.69 ± 0.63	3	0.92 ± 0.18	3	0.88 ± 0.34	3
12/18/97	0.54 ± 0.59	3	0.28 ± 0.30	3	0.59 ± 0.12	3	0.63 ± 0.46	3
01/31/98	1.16 ± 0.49	3	1.12 ± 0.20	3	1.18 ± 0.04	3	1.16 ± 0.15	3
02/21/98	1.18 ± 0.35	3	1.49 ± 0.55	3	1.24 ± 0.22	3	1.03 ± 0.26	3
03/29/98	.		0.70 ± 0.06	3	0.87 ± 0.11	3	0.53 ± 0.18	3
04/24/98	0.77 ± 0.23	3	0.87 ± 0.39	3	0.92 ± 0.15	3	1.02 ± 0.61	3
05/20/98	1.06 ± 0.06	3	0.94 ± 0.28	3	1.08 ± 0.20	3	1.07 ± 0.34	3
06/26/98	1.03 ± 0.04	3	0.99 ± 0.09	3	1.01 ± 0.22	3	1.02 ± 0.41	3
07/19/98	0.67 ± 0.45	3	0.87 ± 0.57	3	0.71 ± 0.57	3	0.67 ± 0.14	3
08/25/98	0.98 ± 0.17	3	0.96 ± 0.75	3	1.09 ± 0.41	3	0.92 ± 0.10	3
09/30/98	1.05 ± 1.23	3	0.77 ± 0.19	3	1.45 ± 0.57	3	0.93 ± 0.25	3
10/30/98	1.07 ± 0.54	3	0.86 ± 0.29	3	0.91 ± 0.54	3	0.98 ± 0.52	3
11/24/98	1.76 ± 0.41	3	1.75 ± 0.53	3	1.84 ± 0.17	3	1.74 ± 0.23	3
12/18/98	2.04 ± 0.34	3	2.06 ± 0.37	2	1.86 ± 1.86	2	1.46 ± 0.97	3
02/20/99	3.28 ± 0.73	3	3.10 ± 0.49	3	3.20 ± 0.28	3	3.37 ± 0.80	3
03/19/99	3.48 ± 1.22	3	3.73 ± 1.04	3	3.22 ± 0.25	3	3.12 ± 0.34	3
04/24/99	1.66 ± 0.16	3	1.62 ± 0.21	3	1.61 ± 0.12	3	1.78 ± 0.24	3
05/20/99	0.96 ± 0.32	3	0.80 ± 0.39	3	0.79 ± 0.13	3	0.62 ± 0.11	3
06/19/99	1.05 ± 0.05	3	0.95 ± 0.08	3	0.87 ± 0.10	3	0.96 ± 0.22	3
07/24/99	0.67 ± 0.78	3	0.61 ± 0.35	3	0.70 ± 0.64	3	0.87 ± 0.14	3
08/26/99	1.19 ± 0.70	3	1.10 ± 0.19	3	1.05 ± 0.46	3	0.87 ± 0.76	3
09/28/99	1.05 ± 0.94	3	1.20 ± 0.27	3	0.64 ± 0.95	3	0.69 ± 1.08	3
10/29/99	0.97 ± 0.53	3	0.89 ± 1.24	3	0.84 ± 0.55	3	0.61 ± 0.22	3
11/23/99	0.74 ± 0.52	3	0.69 ± 0.53	3	0.91 ± 0.40	3	0.55 ± 0.89	3
12/21/99	1.42 ± 0.45	3	1.26 ± 0.55	3	1.20 ± 0.29	3	1.16 ± 0.43	3
01/20/00	1.17 ± 0.24	3	0.85 ± 0.79	3	1.00 ± 0.23	3	1.12 ± 0.17	3

Table 4.2. Mean euphotic zone total ammonia nitrogen concentration with confidence intervals (C. I.) from Newton Lake. Values are reported in mg / L NH_3. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	0.21 ± 0.01	2	0.16 ± 0.47	2	0.18 ± 0.51	2	0.19 ± 0.55	2
10/29/97	0.42 ± 0.08	3	0.44 ± 0.17	3	0.59 0.17	3	0.53 0.11	3
11/19/97	0.28 ± 0.01	3	0.28 ± 0.05	3	0.28 ± 0.05	3	0.30 ± 0.10	3
12/18/97	0.23 ± 0.04	3	0.23 ± 0.05	3	0.19 ± 0.02	3	0.18 ± 0.04	3
01/31/98	0.27 ± 0.02	3	0.24 ± 0.01	3	0.26 ± 0.05	3	0.26 ± 0.01	3
02/21/98	0.53 ± 0.07	3	0.51 ± 0.11	3	0.47 ± 0.05	3	0.24 ± 0.01	3
03/29/98	0.63 ± 0.05	3	0.49 ± 0.11	3	0.47 ± 0.08	3	0.42 ± 0.06	3
04/24/98	0.40 ± 0.04	3	0.31 ± 0.03	3	0.29 ± 0.05	3	0.28 ± 0.04	3
05/20/98	0.51 ± 0.51	2	0.40 ± 0.05	3	0.31 ± 0.01	3	0.31 ± 0.04	2
06/26/98	0.42 ± 0.16	3	0.42 ± 0.09	3	0.35 ± 0.04	3	0.32 ± 0.05	3
07/19/98	0.40 ± 0.04	3	0.35 ± 0.03	3	0.30 ± 0.01	3	0.29 ± 0.03	3
08/25/98	0.32 ± 0.04	3	0.28 ± 0.05	3	0.22 ± 0.05	3	0.25 ± 0.03	3
09/30/98	0.34 ± 0.07	3	0.29 ± 0.07	3	0.23 ± 0.02	3	0.23 ± 0.02	3
10/30/98	0.37 ± 0.04	3	0.26 ± 0.01	3	0.25 ± 0.02	3	0.24 ± 0.03	3
11/24/98	0.28 ± 0.03	3	0.25 ± 0.02	3	0.26 ± 0.04	3	0.23 ± 0.00	3
12/18/98	0.29 ± 0.02	3	0.33 ± 0.32	2	0.27 ± 0.04	2	0.24 ± 0.02	3
02/20/99	0.46 ± 0.17	3	0.40 ± 0.03	3	0.37 ± 0.01	3	0.42 ± 0.04	3
03/19/99	0.54 ± 0.04	3	0.53 ± 0.01	3	0.54 ± 0.02	3	0.51 ± 0.01	3
04/24/99	0.40 ± 0.02	3	0.36 ± 0.11	2	0.31 ± 0.02	3	0.37 ± 0.03	3
05/20/99	0.47 ± 0.05	3	0.35 ± 0.03	3	0.30 ± 0.01	3	0.28 ± 0.02	3
06/19/99	0.36 ± 0.03	3	0.30 ± 0.03	3	0.27 ± 0.03	3	0.27 ± 0.06	3
07/24/99	0.29 ± 0.01	3	0.30 ± 0.10	3	0.23 ± 0.03	3	0.23 ± 0.03	3
08/26/99	0.32 ± 0.02	3	0.27 ± 0.01	3	0.23 ± 0.03	3	0.24 ± 0.01	3
09/28/99	0.29 ± 0.03	3	0.28 ± 0.01	3	0.28 ± 0.00	3	0.28 ± 0.01	3
10/29/99	0.32 ± 0.02	3	0.31 ± 0.04	3	0.27 ± 0.03	3	0.26 ± 0.06	3
11/23/99	0.31 ± 0.07	3	0.23 ± 0.05	3	0.24 ± 0.07	3	0.21 ± 0.01	3
12/21/99	0.34 ± 0.07	3	0.31 ± 0.04	3	0.28 ± 0.04	3	0.25 ± 0.03	3
01/20/00	0.32 ± 0.07	3	0.28 ± 0.03	3	0.23 ± 0.00	3	0.23 ± 0.01	3

Table 4.3. Mean euphotic zone total phosphorus concentration with confidence intervals (C. I.) from Newton Lake. Values are in mg / L PO_4. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	0.23 ± 0.10	2	0.18 ± 0.03	2	0.17 ± 0.09	2	0.17	1
10/29/97	0.19 ± 0.01	3	0.19 ± 0.02	3	0.17 ± 0.01	3	0.17 ± 0.03	3
11/19/97	0.13 ± 0.01	3	0.15 ± 0.04	3	0.13 ± 0.01	3	0.10 ± 0.04	3
12/18/97	0.13 ± 0.00	3	0.10 ± 0.00	3	0.11 ± 0.01	3	0.10 ± 0.01	3
01/31/98	0.16	1	0.15 ± 0.06	3	0.16 ± 0.09	3	0.14 ± 0.10	3
02/21/98	0.42 ± 0.13	3	0.40 ± 0.05	3	0.40 ± 0.04	3	0.14 ± 0.02	3
03/29/98	1.44 ± 0.03	3	0.40 ± 0.01	3	0.38 ± 0.01	3	0.32 ± 0.02	3
04/24/98	0.25 ± 0.09	3	0.27 ± 0.01	3	0.23 ± 0.06	3	0.21 ± 0.05	3
05/20/98	0.38 ± 0.03	3	0.32 ± 0.02	3	0.26 ± 0.03	3	0.26 ± 0.01	3
06/26/98	0.20 ± 0.13	3	0.16 ± 0.11	3	0.13 ± 0.17	2	0.06 ± 0.35	2
07/19/98	0.25 ± 0.03	3	0.23 ± 0.03	3	0.18 ± 0.01	3	0.17 ± 0.03	3
08/25/98	0.21	1	0.17 ± 0.11	2	0.17 ± 0.02	3	0.12 ± 0.10	3
09/30/98	0.20 ± 0.02	3	0.11 ± 0.64	2	0.16 ± 0.28	3	0.12 ± 0.01	3
10/30/98	0.30 ± 0.06	3	0.26 ± 0.01	3	0.22 ± 0.10	3	0.24 ± 0.02	3
11/24/98	0.16 ± 0.01	3	0.13 ± 0.03	3	0.14 ± 0.04	3	0.13 ± 0.03	3
12/18/98	0.12 ± 0.06	3	0.14 ± 0.07	2	0.12 ± 0.09	2	0.10 ± 0.01	3
02/20/99	0.34 ± 0.50	3	0.33 ± 0.14	3	0.32 ± 0.41	3	0.37 ± 0.33	3
03/19/99	0.46 ± 0.03	3	0.45 ± 0.04	3	0.44 ± 0.01	3	0.44 ± 0.05	3
04/24/99	0.24 ± 0.05	3	0.20 ± 0.02	3	0.21 ± 0.04	3	0.21 ± 0.13	3
05/20/99	0.22 ± 0.11	3	0.18 ± 0.08	3	0.13 ± 0.12	3	0.09 ± 0.16	3
06/19/99	0.19 ± 0.22	3	0.20 ± 0.03	3	0.10 ± 0.20	3	0.12 ± 0.06	3
07/24/99	0.15 ± 0.11	3	0.12 ± 0.06	3	0.12 ± 0.07	3	0.12 ± 0.10	3
08/26/99	0.26 ± 0.06	3	0.21 ± 0.04	3	0.19 ± 0.03	3	0.18 ± 0.03	3
09/28/99	0.22 ± 0.09	3	0.20 ± 0.13	3	0.20 ± 0.07	3	0.20 ± 0.10	3
10/29/99	0.16 ± 0.11	3	0.15 ± 0.12	3	0.13 ± 0.17	2	0.12 ± 0.08	3
11/23/99	0.14 ± 0.21	2	0.08 ± 0.22	2	0.11 ± 0.50	2		
12/21/99	0.12 ± 0.14	3	0.08 ± 0.12	3	0.10 ± 0.07	3	0.08 ± 0.15	2
01/20/00	0.24 ± 0.09	3	0.19 ± 0.17	3	0.16 ± 0.04	3	0.16 ± 0.02	3

Table 4.4. Mean nitrate (mg / L NO_3) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the $\alpha = 0.05$ level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.	n	omnibus R^2	p value
1	$1.253^{a} \pm 0.139$	77	94.9%	0.0209
2	$1.180^{ac} \pm 0.142$	79		
3	$1.203^{ac} \pm 0.125$	79		
4	$1.148^{bc} \pm 0.140$	80		

Table 4.5. Mean ammonia (mg / L NH_3) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the $\alpha = 0.05$ level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.	n	omnibus R^2	p value
1	$0.358^{a} \pm 0.015$	79	96.1%	0.0001
2	$0.329^{b} \pm 0.016$	81		
3	$0.304^{c} \pm 0.019$	82		
4	$0.288^{d} \pm 0.016$	82		

Table 4.6. Mean total phosphorus (mg / L PO_4) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the $\alpha = 0.05$ level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.	n	omnibus R^2	p value
1	$0.228^{a} \pm 0.019$	75	87.9%	0.0001
2	$0.210^{ac} \pm 0.019$	79		
3	$0.194^{bc} \pm 0.019$	79		
4	$0.174^{d} \pm 0.018$	77		

Table 4.7. Mean euphotic zone chlorophyll *a* concentration with confidence intervals (C. I.) from Newton Lake. Values are in μg / L chlorophyll *a*. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	10.5 ± 2.0	9	13.8 ± 1.2	9	18.2 ± 4.2	9	14.0 ± 4.2	9
10/29/97	7.6 ± 0.5	9	15.7 ± 3.6	9	4.7 ± 1.2	9	5.3 ± 1.0	8
11/19/97	7.9 ± 1.7	9	20.1 ± 2.7	9	13.0 ± 1.3	9	8.7 ± 1.7	9
12/18/97	4.9 ± 0.9	9	8.1 ± 1.3	9	7.9 ± 1.1	9	6.7 ± 1.3	9
01/31/98	25.5 ± 2.2	9	23.7 ± 1.4	9	21.2 ± 0.8	8	22.0 ± 1.0	9
02/21/98	20.5 ± 6.2	9	18.1 ± 1.8	9	16.3 ± 2.5	9	20.2 ± 1.1	9
03/29/98	12.8 ± 3.0	8	32.5 ± 5.2	9	24.0 ± 1.8	9	38.5 ± 3.1	9
04/24/98	17.7 ± 1.9	9	26.2 ± 1.9	9	20.5 ± 1.1	9	14.6 ± 1.0	9
05/20/98	3.3 ± 0.3	9	10.9 ± 1.5	9	14.3 ± 1.8	9	10.8 ± 0.6	8
06/26/98	5.6 ± 0.5	9	9.1 ± 1.4	9	17.4 ± 1.7	9	10.5 ± 2.1	9
07/19/98	16.1 ± 0.9	9	19.4 ± 1.2	9	18.8 ± 0.8	9	16.6 ± 1.0	9
08/25/98	9.4 ± 1.2	9	10.5 ± 0.8	8	12.5 ± 1.3	9	12.7 ± 0.5	8
09/30/98	19.0 ± 1.4	7	23.0 ± 0.8	9	17.2 ± 0.7	9	16.5 ± 1.1	8
10/30/98	10.1 ± 1.6	9	19.7 ± 1.1	9	19.1 ± 1.0	9	18.1 ± 0.7	9
11/24/98	7.1 ± 0.7	9	11.4 ± 1.9	9	20.4 ± 3.7	9	12.3 ± 1.8	9
12/18/98	6.5 ± 0.9	9	5.2 ± 0.5	9	6.9 ± 0.8	4	6.6 ± 0.6	9
02/20/99	1.0 ± 0.5	9	2.4 ± 0.5	9	9.5 ± 0.7	9	2.3 ± 0.8	9
03/19/99	2.6 ± 0.8	8	3.9 ± 1.2	9	2.2 ± 1.8	9	4.6 ± 1.0	9
04/24/99	21.5 ± 2.0	9	26.5 ± 2.7	9	29.1 ± ,3.8	9	25.0 ± 1.7	8
05/20/99	0.7 ± 1.1	9	8.6 ± 0.7	9	12.9 ± 1.3	9	8.7 ± 0.6	9
06/19/99	33.1 ± 2.3	9	28.0 ± 2.0	9	23.3 ± 0.7	9	23.4 ± 2.0	9
07/24/99	6.6 ± 1.5	9	5.1 ± 0.6	9	10.4 ± 1.2	9	11.0 ± 0.6	9
08/26/99	14.8 ± 1.6	9	20.5 ± 1.5	9	22.4 ± 1.9	9	19.4 ± 0.5	9
09/28/99	43.3 ± 1.9	9	47.0 ± 2.1	9	38.4 ± 1.9	9	37.4 ± 1.1	9
10/29/99	13.8 ± 1.3	8	24.2 ± 1.5	8	20.8 ± 2.9	6	25.5 ± 1.0	8
11/23/99	13.7 ± 0.4	9	17.7 ± 2.1	8	15.8 ± 0.9	9	22.6 ± 2.2	9
12/21/99	3.5 ± 0.5	9	4.2 ± 0.6	11	6.7 ± 0.6	9	8.7 ± 0.8	8
01/20/00	28.6 ± 2.5	6	23.5 ± 4.8	6	29.9 ± 2.9	6	27.0 ± 2.9	5

Table 4.8. Mean euphotic zone OD 664 / OD 665 ratio with confidence intervals (C. I.) from Newton Lake. Values range from 1.0 (no chlorophyll *a* present) to 1.7 (no pheophytin *a* present). Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	1.27 ± 0.03	9	1.34 ± 0.01	9	1.37 ± 0.04	9	1.31 ± 0.08	9
10/29/97	1.23 ± 0.01	9	1.35 ± 0.04	9	1.16 ± 0.03	9	1.18 ± 0.03	8
11/19/97	1.25 ± 0.03	9	1.40 ± 0.02	9	1.32 ± 0.01	9	1.27 ± 0.03	9
12/18/97	1.18 ± 0.03	9	1.26 ± 0.03	9	1.26 ± 0.02	9	1.23 ± 0.03	9
01/31/98	1.42 ± 0.02	9	1.41 ± 0.01	9	1.39 ± 0.01	8	1.40 ± 0.01	9
02/21/98	1.35 ± 0.05	9	1.34 ± 0.03	9	1.32 ± 0.04	9	1.34 ± 0.02	9
03/29/98	1.23 ± 0.05	8	1.44 ± 0.02	9	1.38 ± 0.03	9	1.48 ± 0.01	9
04/24/98	1.36 ± 0.05	9	1.41 ± 0.01	9	1.37 ± 0.01	9	1.32 ± 0.01	9
05/20/98	1.13 ± 0.01	9	1.28 ± 0.02	9	1.33 ± 0.03	9	1.28 ± 0.01	8
06/26/98	1.17 ± 0.01	9	1.26 ± 0.03	9	1.36 ± 0.02	9	1.28 ± 0.04	9
07/19/98	1.39 ± 0.01	9	1.43 ± 0.01	9	1.41 ± 0.01	9	1.40 ± 0.01	9
08/25/98	1.29 ± 0.04	9	1.32 ± 0.01	8	1.35 ± 0.02	9	1.33 ± 0.01	8
09/30/98	1.37 ± 0.01	7	1.41 ± 0.01	9	1.36 ± 0.01	9	1.35 ± 0.01	8
10/30/98	1.24 ± 0.03	9	1.38 ± 0.02	9	1.35 ± 0.02	9	1.35 ± 0.01	9
11/24/98	1.23 ± 0.01	9	1.32 ± 0.03	9	1.41 ± 0.04	9	1.32 ± 0.03	9
12/18/98	1.20 ± 0.02	9	1.17 ± 0.01	9	1.20 ± 0.02	4	1.21 ± 0.01	9
02/20/99	1.04 ± 0.02	9	1.09 ± 0.02	9	1.28 ± 0.01	9	1.09 ± 0.03	9
03/19/99	1.07 ± 0.02	8	1.10 ± 0.03	9	1.07 ± 0.06	9	1.12 ± 0.03	9
04/24/99	1.38 ± 0.02	9	1.43 ± 0.02	9	1.44 ± 0.02	9	1.40 ± 0.01	8
05/20/99	1.00 ± 0.05	9	1.24 ± 0.01	9	1.30 ± 0.02	9	1.25 ± 0.01	9
06/19/99	1.48 ± 0.01	9	1.45 ± 0.01	9	1.42 ± 0.00	9	1.41 ± 0.01	9
07/24/99	1.26 ± 0.04	9	1.21 ± 0.02	9	1.31 ± 0.02	9	1.34 ± 0.01	9
08/26/99	1.27 ± 0.04	9	1.40 ± 0.02	9	1.41 ± 0.02	9	1.39 ± 0.01	9
09/28/99	1.47 ± 0.01	9	1.49 ± 0.01	9	1.45 ± 0.01	9	1.43 ± 0.01	9
10/29/99	1.31 ± 0.02	8	1.41 ± 0.01	8	1.38 ± 0.03	6	1.40 ± 0.01	8
11/23/99	1.30 ± 0.01	9	1.37 ± 0.02	8	1.34 ± 0.01	9	1.40 ± 0.02	9
12/21/99	1.12 ± 0.02	9	1.16 ± 0.02	11	1.22 ± 0.01	9	1.27 ± 0.01	8
01/20/00	1.41 ± 0.02	6	1.41 ± 0.03	6	1.45 ± 0.02	6	1.43 ± 0.02	5

Table 4.9. Mean euphotic zone pheophytin *a* concentration with confidence intervals (C. I.) from Newton Lake. Values are in µg / L pheophytin *a*. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
09/25/97	16.4 ± 0.6	9	14.2 ± 0.5	9	15.8 ± 0.8	9	17.2 ± 4.1	9
10/29/97	15.8 ± 0.5	9	15.2 ± 0.5	9	15.3 ± 0.6	9	15.6 ± 0.5	8
11/19/97	13.5 ± 0.7	9	14.6 ± 0.9	9	15.3 ± 0.5	9	13.9 ± 1.0	9
12/18/97	14.0 ± 1.2	9	13.4 ± 0.4	9	13.6 ± 0.4	9	13.7 ± 0.4	9
01/31/98	16.7 ± 0.8	9	16.9 ± 0.5	9	16.8 ± 0.5	8	16.8 ± 0.7	9
02/21/98	18.8 ± 1.1	9	18.6 ± 1.4	9	19.1 ± 3.3	9	21.7 ± 1.2	9
03/29/98	26.1 ± 2.4	8	19.1 ± 1.2	9	20.8 ± 4.0	9	17.0 ± 1.3	9
04/24/98	16.5 ± 2.3	9	18.6 ± 0.4	9	18.0 ± 0.8	9	17.1 ± 0.4	9
05/20/98	14.4 ± 0.4	9	15.8 ± 0.7	9	16.1 ± 0.8	9	16.3 ± 0.7	8
06/26/98	16.9 ± 0.4	9	15.0 ± 0.9	9	16.0 ± 0.4	9	15.4 ± 0.5	9
07/19/98	12.6 ± 0.6	9	11.9 ± 0.4	9	13.1 ± 0.3	9	12.5 ± 0.5	9
08/25/98	13.3 ± 1.6	9	12.4 ± 0.3	8	12.6 ± 0.4	9	14.4 ± 0.7	8
09/30/98	16.5 ± 0.2	7	15.9 ± 0.3	9	16.6 ± 0.5	9	16.8 ± 0.4	8
10/30/98	19.0 ± 0.9	9	16.5 ± 1.4	9	19.1 ± 1.9	9	18.1 ± 0.7	9
11/24/98	14.2 ± 0.3	9	13.5 ± 0.3	9	13.5 ± 0.3	9	14.0 ± 0.3	9
12/18/98	15.7 ± 0.3	9	16.4 ± 0.5	9	17.4 ± 0.6	4	15.8 ± 0.4	9
02/20/99	15.3 ± 0.8	9	15.1 ± 0.5	9	14.4 ± 0.4	9	14.5 ± 1.1	9
03/19/99	23.4 ± 0.4	8	23.8 ± 0.6	9	21.4 ± 3.3	9	22.4 ± 2.1	9
04/24/99	17.8 ± 0.4	9	16.7 ± 0.5	9	17.4 ± 0.7	9	19.0 ± 0.8	8
05/20/99	25.8 ± 2.8	9	16.3 ± 0.6	9	17.0 ± 0.6	9	15.7 ± 0.4	9
06/19/99	15.5 ± 0.5	9	15.1 ± 0.5	9	15.3 ± 0.3	9	16.1 ± 0.3	9
07/24/99	11.1 ± 0.4	9	11.6 ± 0.5	9	12.7 ± 0.3	9	11.8 ± 0.3	9
08/26/99	23.7 ± 2.9	9	15.0 ± 0.5	9	15.5 ± 0.5	9	15.7 ± 0.6	9
09/28/99	20.8 ± 0.9	9	20.7 ± 1.0	9	20.8 ± 0.5	9	24.1 ± 0.9	9
10/29/99	17.1 ± 1.2	8	17.2 ± 0.8	8	17.4 ± 0.8	6	18.8 ± 1.5	8
11/23/99	18.4 ± 0.6	9	16.0 ± 0.6	8	16.7 ± 0.4	9	16.4 ± 0.5	9
12/21/99	16.0 ± 0.8	9	13.8 ± 0.2	11	14.7 ± 0.5	9	13.8 ± 0.8	8
01/20/00	19.7 ± 0.7	6	16.5 ± 1.6	6	16.6 ± 0.5	6	16.5 ± 1.0	5

Table 4.10. Mean chlorophyll *a* (µg / L) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the α = 0.05 level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.	n	omnibus R^2	p value
1	$12.9^{a} \pm 1.1$	244	94.6%	0.0001
2	$16.9^{b} \pm 1.1$	248		
3	$16.9^{b} \pm 0.9$	240		
4	$15.9^{c} \pm 1.0$	241		

Table 4.11. Mean OD 664 / OD 665 ratio and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the α = 0.05 level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.	n	omnibus R^2	p value
1	$1.265^{a} \pm 0.013$	244	92.8%	0.0001
2	$1.329^{b} \pm 0.012$	248		
3	$1.337^{b} \pm 0.010$	240		
4	$1.319^{c} \pm 0.010$	241		

Table 4.12. Mean net photosynthesis values with confidence intervals (C. I.) from Newton Lake. Values are in mg C m^{-2} day^{-1}. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.			n	Segment 2 95 % C. I.			n	Segment 3 95 % C. I.			n	Segment 4 95 % C. I.			n
09/25/97	1695.8	±		1	2262.2	±		1	2383.3	±		1	1383.2	±		1
11/18/97	15.3	±	874.8	2	557.8	±	250.2	2	378.7	±	473.3	2	184.4	±	34.0	2
12/17/97	397.4	±	1377.0	2	323.8	±	418.4	2	-306.5	±	35.7	2	-189.6	±	301.1	2
01/30/98	434.5	±		1	416.1	±	416.1	2	262.6	±		1	291.3	±		1
02/20/98	-232.9	±	986.6	2	-214.6	±	1151.1	2	44.9	±	325.7	2	466.7	±	1126.0	2
03/28/98	1198.7	±	1570.9	2	499.6	±	241.1	2	865.6	±	2174.8	2	2073.9	±	888.2	2
04/23/98	1073.7	±	2139.1	2	1983.6	±	2556.9	2	1557.1	±	899.3	2	1160.4	±	824.9	2
05/19/98	545.9	±	880.8	2	1548.8	±	1631.4	2	1225.9	±	350.6	2	1381.3	±	4247.2	2
06/25/98	1847.6	±	1093.1	2	2452.9	±	2975.8	2	3359.1	±	267.1	2	2612.0	±	1187.2	2
07/18/98	1851.4	±	1191.1	2	3013.1	±	171.7	2	1455.9	±	1121.1	2	-68.9	±	984.9	2
08/24/98	1192.9	±	3090.2	2	1324.9	±	47.4	2	1286.7	±	3364.7	2	669.4	±	860.1	2
09/29/98	825.0	±	391.5	2	996.6	±		1	1970.5	±	781.0	2	1823.7	±	1439.0	2
10/29/98	239.2	±	239.2	2	1077.6	±	114.4	2	743.1	±	781.0	2	728.4	±	1013.4	2
11/23/98	772.8	±		1	725.2	±	41.3	2	996.1	±	423.9	2	1302.1	±	905.4	2
12/17/98	364.7	±	188.4	2	261.5	±	648.3	2	27.8	±	353.9	2	385.4	±	573.5	2
01/22/99	-77.9	±	261.7	2	-723.5	±	1293.8	2	-669.1	±	65.9	2	-94.6	±	-94.6	2
02/19/99	60.2	±	95.7	2	51.9	±	109.9	2	119.2	±	43.3	2	-311.3	±	157.1	2
03/18/99	492.1	±	284.9	2	776.0	±	648.2	2	330.7	±	477.5	2	549.7	±	66.3	2
04/23/99	645.4	±	343.8	2	709.5	±	976.1	2	1091.0	±	430.3	2	1369.6	±	1111.6	2
05/19/99	791.3	±	1358.8	2	2124.8	±	419.0	2	1673.5	±	398.7	2	1577.6	±	171.7	2
06/18/99	1944.0	±	244.2	2	2802.6	±	490.3	2	3259.6	±	2094.8	2	2648.1	±	2468.9	2
07/23/99	1055.2	±	4324.1	2	1207.3	±	3098.7	2	2321.5	±	2297.3	2	1906.6	±	2937.3	2
08/25/99	1030.5	±	327.1	2	1425.1	±	899.6	2	1203.1	±	1335.4	2	990.9	±	46.2	2
09/27/99	1716.5	±	328.9	2	1985.2	±	212.9	2	2373.7	±	1785.7	2	1575.4	±	293.3	2
10/28/99	795.3	±	1502.1	2	1354.4	±	399.5	2	1449.8	±	1567.5	2	1554.6	±	663.2	2
11/22/99	114.0	±	68.6	2	361.8	±	112.7	2	452.1	±	216.2	2	685.6	±	389.2	2
12/20/99	240.6	±	1542.7	2	561.9	±	1567.1	2	-68.0	±	1212.2	2	19.3	±	73.4	2
01/19/00	-97.6	±	45.6	2	-269.9	±	1033.7	2	61.0	±	479.3	2	-347.6	±	632.3	2

Table 4.13. Mean net photosynthesis (mg C m^{-2} day^{-1}) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the α = 0.05 level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.			n	omnibus R^2	p value
1	735[a]	±	149	53	98.7%	0.0001
2	1036[b]	±	217	54		
3	1057[b]	±	236	54		
4	944[c]	±	197	54		

Table 4.14. Mean euphotic zone total phytoplankton cells (Coccoid singles, Division Cyanophyta, Order Croococcales) with confidence intervals (C. I.) from Newton Lake. Values are in cells L^{-1}. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.		n	Segment 2 95 % C. I.		n	Segment 3 95 % C. I.		n	Segment 4 95 % C. I.		n
12/18/97	88528190	± 7066438	6	91724154	± 10243481	6	84053841	± 11327849	6	81305313	± 4402892	5
01/31/98	81816667	± 18664335	3	83414648	± 11468386	4	104028613	± 26610291	4	91775289	± 11291716	5
04/08/98	190319629	± 33028269	6	95399512	± 13034482	6	96518099	± 13803296	6	94920117	± 12075684	6
04/25/98	87569401	± 11128386	6	156762012	± 37976745	6	141517266	± 29744113	5	121286816	± 2839215	4
05/07/98	124067305	± 47072194	5	137298594	± 32067873	5	116013477	± 39655540	5	98180000	± 20820638	5
05/20/98	181019375	± 9195690	5	144137956	± 10856737	6	105236688	± 15072631	5	100263768	± 15978605	6
06/03/98	140558477	± 39357318	5	110580339	± 13520977	6	98333406	± 17400790	5	107863770	± 15128568	6
06/16/98	321833529	± 6942092	6	202112734	± 128335385	2						
07/08/98	137426432	± 21314427	6	130555111	± 23925784	6	96997493	± 16860684	6	103549219	± 17671962	6
08/04/98	166113401	± 24007114	6	146541320	± 26042337	6	135828451	± 10059635	6	134709863	± 22474197	6
09/09/98	121127018	± 17471339	6	142987409	± 23803001	6	119049642	± 12049037	6	156602214	± 21226685	6
09/30/98	166330727	± 53275309	5	125745186	± 43711049	4	116524831	± 31023581	6	102973945	± 20978164	5
10/30/98	166829297	± 31133149	5	137373166	± 28773957	6	119273359	± 14533914	5	142859570	± 35597153	5
12/09/98	149698932	± 28872849	6	120487826	± 9152990	6	100481094	± 16723297	5	116013477	± 12540691	6
01/22/99	1208074219	± 280347368	6	421227995	± 83535788	6	138640898	± 70021548	5	687611556	± 112691261	6
03/19/99	346418159	± 169220520	6	319367268	± 214440963	5	224883335	± 59425135	6	206239363	± 56779293	6
04/15/99	266952443	± 71986349	6	217352367	± 95216718	6	136394775	± 22467795	6	247109344	± 125745359	6
05/20/99	149089142	± 37810144	6	135460276	± 38858003	6	133463438	± 23608832	6	143433991	± 70131994	6
06/19/99	196618234	± 124773748	6	163036327	± 110482440	6	80484078	± 20666018	6	81972118	± 24256249	6
07/24/99	146605240	± 46039040	6	140961168	± 89577125	6	121267641	± 44496875	6	106811658	± 26122951	6
08/26/99	140047122	± 12743025	6	115753964	± 11034848	6	95660302	± 16372657	6	135786264	± 36790788	6

Table 4.15. Mean euphotic zone total phytoplankton cells (excluding Coccoid singles) with confidence intervals (C. I.) from Newton Lake. Values are in cells L[-1]. Segment 1 = discharge, segment 4 = intake.

Date	Segment 1 95 % C. I.	n	Segment 2 95 % C. I.	n	Segment 3 95 % C. I.	n	Segment 4 95 % C. I.	n
12/18/97	38121453 ± 4956912	6	41470823 ± 5006212	6	43331641 ± 12224523	6	38942177 ± 7064791	5
01/31/98	29837516 ± 14787243	3	24746346 ± 8494491	4	31361990 ± 12082420	4	40951798 ± 7061659	5
04/08/98	71672678 ± 15603882	6	32445422 ± 7597531	6	39131378 ± 8853513	6	33410603 ± 6887933	6
04/25/98	30131544 ± 5257166	6	48265441 ± 11281254	6	40161756 ± 6713727	5	34688988 ± 5798441	4
05/07/98	22834520 ± 4315996	5	26991830 ± 11224395	5	23939045 ± 9974356	5	28395497 ± 12368552	5
05/20/98	49941405 ± 3904775	5	55609766 ± 5441576	6	55609766 ± 8855895	5	58798570 ± 4381111	6
06/03/98	78950527 ± 28902895	5	92721294 ± 10070118	6	106134114 ± 25979194	5	93590596 ± 21789118	6
06/16/98	125831477 ± 14136246	6	152179000 ± 136568221	2				
07/08/98	51656998 ± 33493085	6	57207747 ± 21603046	6	32982344 ± 16825729	6	37916911 ± 17615894	6
08/04/98	39703583 ± 6299193	6	42118197 ± 6113927	6	35897063 ± 2031653	6	34714556 ± 7214914	6
09/09/98	33186885 ± 3320334	6	37693194 ± 6307647	6	31927676 ± 3687262	6	35967374 ± 4024435	6
09/30/98	32483773 ± 4224372	5	30508668 ± 12887040	4	29185539 ± 5516930	6	26301502 ± 8008207	5
10/30/98	43298914 ± 14061092	5	39048283 ± 5172369	6	37201016 ± 7468376	5	46520445 ± 6507370	5
12/09/98	20971913 ± 3830556	6	16606227 ± 3887537	6	15892888 ± 3639324	5	18696387 ± 3326269	6
01/22/99	109838875 ± 14253351	6	44014810 ± 5707367	6	18646530 ± 6698726	5	64513720 ± 9847061	6
03/19/99	23365459 ± 5531348	6	22953011 ± 8794951	5	30918774 ± 16164830	6	31253149 ± 16420313	6
04/15/99	36988292 ± 15980537	6	47645782 ± 32440260	6	23626148 ± 3071589	6	52305446 ± 20856266	6
05/20/99	62852927 ± 24316250	6	124993452 ± 43720619	6	144461592 ± 72180620	6	143280176 ± 43890377	6
06/19/99	41735500 ± 13036227	6	42866308 ± 13144174	6	51132093 ± 18452126	6	40341906 ± 8073232	6
07/24/99	29461057 ± 10199005	6	24500921 ± 16756623	6	25933940 ± 6015029	6	22665467 ± 5736174	6
08/26/99	24332941 ± 3594912	6	24035384 ± 3028789	6	24686543 ± 4639773	6	38114192 ± 15852360	6

Table 4.16 Mean total phytoplankton cells L^{-1} (Coccoid singles only) and confidence interval (C. I.) from Newton Lake by segment, December 1997 – August 1999. Means with different superscripts are significantly different at the $\alpha = 0.05$ level after controlling for the date and date X segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.			n	R^2	p value
1	224050868[a]	±	39144643	118	83.6%	0.0001
2	158157237[b]	±	15887764	116		
3	118561720[c]	±	6932111	111		
4	155822462[b]	±	22337513	113		

Table 4.17. Mean total phytoplankton cells L^{-1} (Coccoid singles excluded) and confidence interval (C. I.) from Newton Lake by segment, December 1997 – August 1999. Means with different superscripts are significantly different at the $\alpha = 0.05$ level after controlling for the date and date * segment interaction. Reported p value is for the segment effect.

Segment	95% C. I.			n	omnibusR^2	p value
1	48018371[a]	±	4896994	118	72.4%	0.4576
2	46573798[a]	±	5163255	116		
3	42276233[a]	±	5893780	111		
4	46705552[a]	±	5140237	113		

Table 4.18. Mean euphotic zone depth (m) and confidence interval (C. I.) from Newton Lake by segment, September 1997 – January 2000. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Segment	95% C. I.	n	omnibusR^2	p value
1	1.95^{a} ± 0.11	69	13.2%	0.0001
2	2.27^{b} ± 0.13	70		
3	2.61^{cd} ± 0.12	70		
4	2.40^{bd} ± 0.14	70		

Table 4.19. Primary production values from several studies (after Kimmel et al. 1990).

Reservoir, Location	Year	Production	Units	Comments	Reference
Francis Case, SD	1968	260	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Novotny (1975)
Lewis and Clark, NB	1968	530	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Novotny (1975)
Hebgen, MT	1965	658	mg C m^{-2} d^{-1}	Net O_2 change, summer estimates	Martin and Arneson (1978)
Canyon Ferry, MT	1958	1125	mg C m^{-2} d^{-1}	Net O_2 change, April – September	Wright (1958, 1959, 1960)
Ashtabula, ND	1966 - 68	1828	mg C m^{-2} d^{-1}	Net O_2 change	Peterka and Reid (1966), Knuston (1970), cited in Soltero et al. (1975)
Newton Lake, IL	1997 – 98	944	mg C m^{-2} d^{-1}	Net O_2 change	this study

Table 4.20. Mean chlorophyll *a* (µg / L) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the α = 0.05 level.

Year	95% C. I.	n	R^2	p value
1998	14.6[a] ± 0.8	70	0.6 %	0.3623
1999	13.8[a] ± 1.2	72		

Table 4.21 Mean OD 664 / OD 665 ratio (range 1.0 – 1.7) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the α = 0.05 level.

Year	95% C. I.	n	R^2	p value
1998	1.37[a] ± 0.01	70	9.6 %	0.0002
1999	1.32[b] ± 0.01	72		

Table 4.22. Mean chlorophyll *a* (μg / L) and confidence interval (C. I.) from Newton Lake for July and August, all segments combined. July 1998 mean was compared to July 1999 mean, and August 1998 mean was compared to August 1999 mean. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	Month	95 % C. I.	n	R^2	p value
1998	July	$17.7^a \pm 0.5$	36	79.9 %	0.0001
1999	July	$8.3^b \pm 0.8$	36		
1998	August	$11.3^a \pm 0.6$	34	68.1 %	0.0001
1999	August	$19.3^b \pm 1.0$	36		

Table 4.23. Mean OD 664 / OD 665 ratio (range 1.0 – 1.7) and confidence interval (C. I.) from Newton Lake for July and August, all segments combined. July 1998 mean was compared to July 1999 mean, and August 1998 mean was compared to August 1999 mean. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	Month	95 % C. I.	n	R^2	p value
1998	July	$1.41^a \pm 0.01$	36	68.9 %	0.0001
1999	July	$1.28^b \pm 0.02$	36		
1998	August	$1.32^a \pm 0.01$	34	16.5 %	0.0005
1999	August	$1.37^b \pm 0.02$	36		

Table 4.24. Mean net photosynthesis (mg C m^{-2} day^{-1}) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	1340.7[a]	±	381.1	16	0.0 %	0.8379
1999	1392.5[a]	±	219.6	16		

Table 4.25. Mean net photosynthesis (mg C m^{-2} day^{-1}) and confidence interval (C. I.) from Newton Lake for July and August, all segments combined. July 1998 mean was compared to July 1999 mean, and August 1998 mean was compared to August 1999 mean. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	Month	95 % C. I.			n	R^2	p value
1998	July	1562.9[a]	±	791.2	8	0.0 %	0.9008
1999	July	1622.6[a]	±	412.1	8		
1998	August	1118.5[a]	±	229.8	8	0.0 %	0.7578
1999	August	1162.4[a]	±	131.2	8		

Table 4.26. Mean total phytoplankton cells L^{-1} (Coccoid singles excluded) and confidence interval (C. I.) from Newton Lake for July and August combined, and with all segments combined. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	95% C. I.			n	R^2	p value
1998	41524675[a]	±	5021267	48	16.4%	0.0001
1999	26716306[b]	±	2867931	48		

Table 4.27. Mean total phytoplankton cells L^{-1} (Coccoid singles excluded) and confidence interval (C. I.) from Newton Lake for July and August, all segments combined. July 1998 mean was compared to July 1999 mean, and August 1998 mean was compared to August 1999 mean. Means with different superscripts are significantly different at the $\alpha = 0.05$ level.

Year	Month	95 % C. I.			n	R^2	p value
1998	July	44941000[a]	±	9908026	24	16.9 %	0.0037
1999	July	25640346[b]	±	4317158	24		
1998	August	38108350[a]	±	2521312	24	23.2 %	0.0005
1999	August	27792265[b]	±	4017142	24		

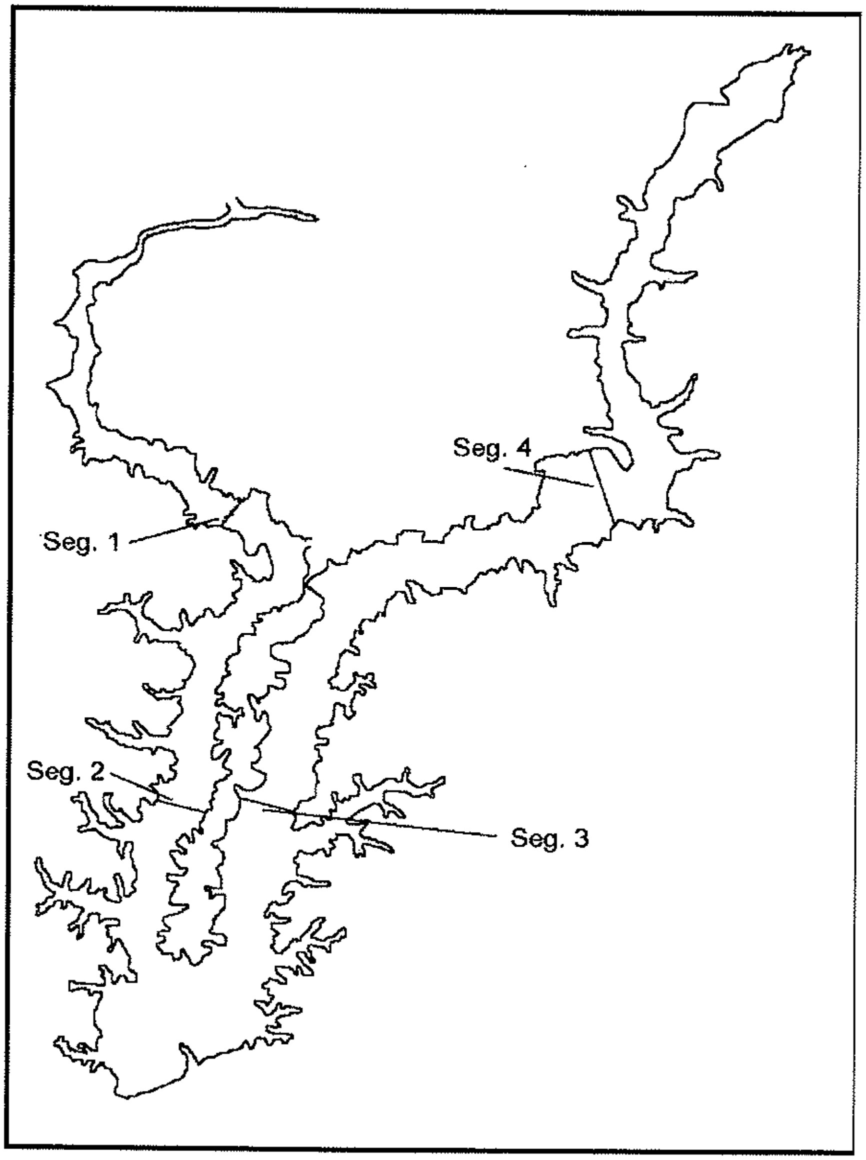
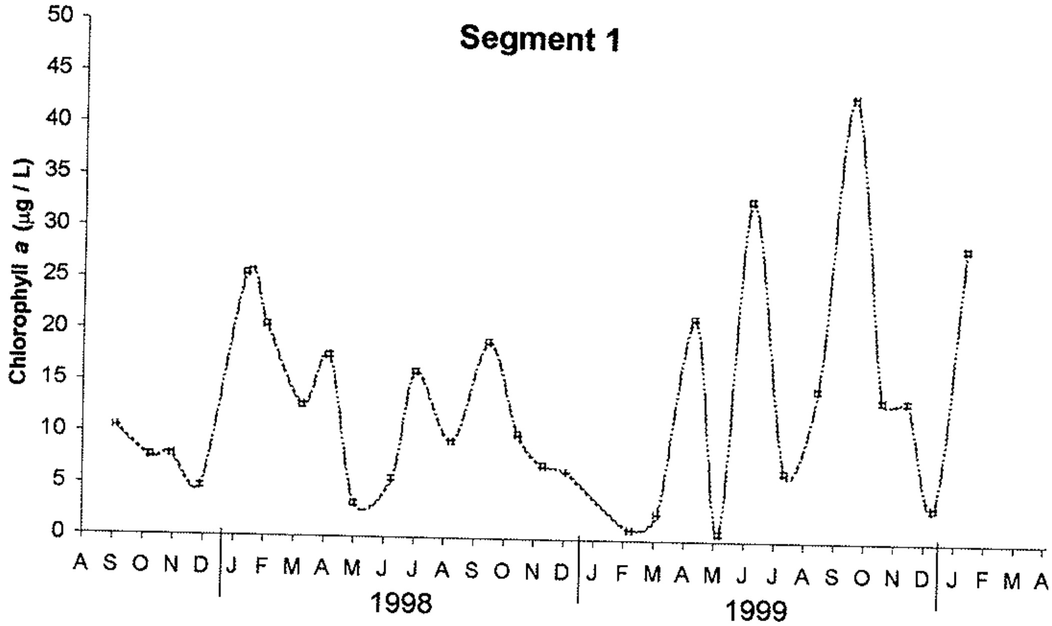


Figure 4.1. Sampling stations on Newton Lake.



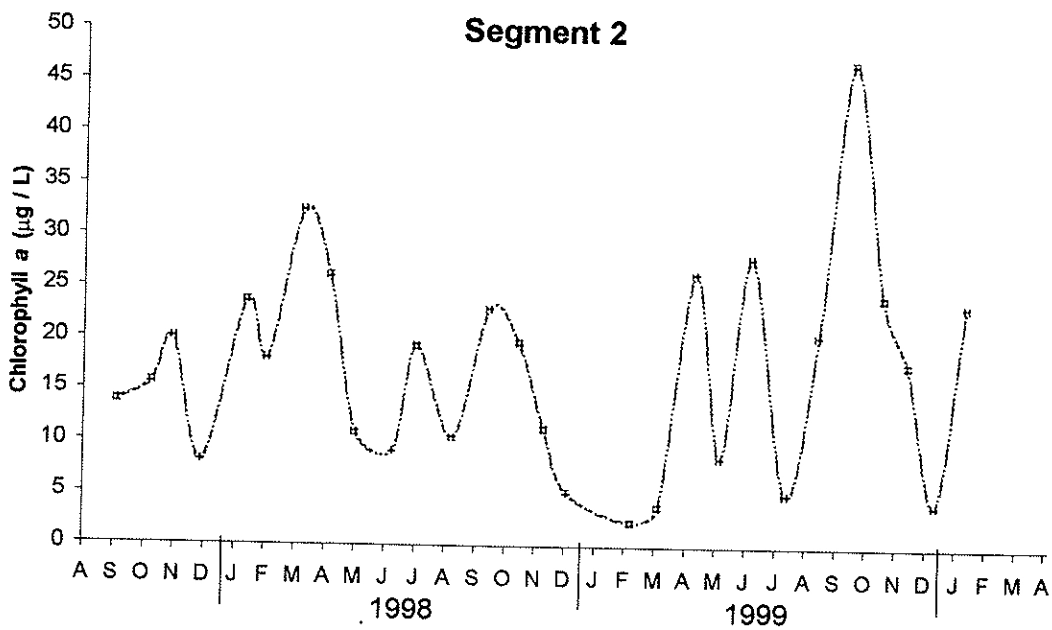
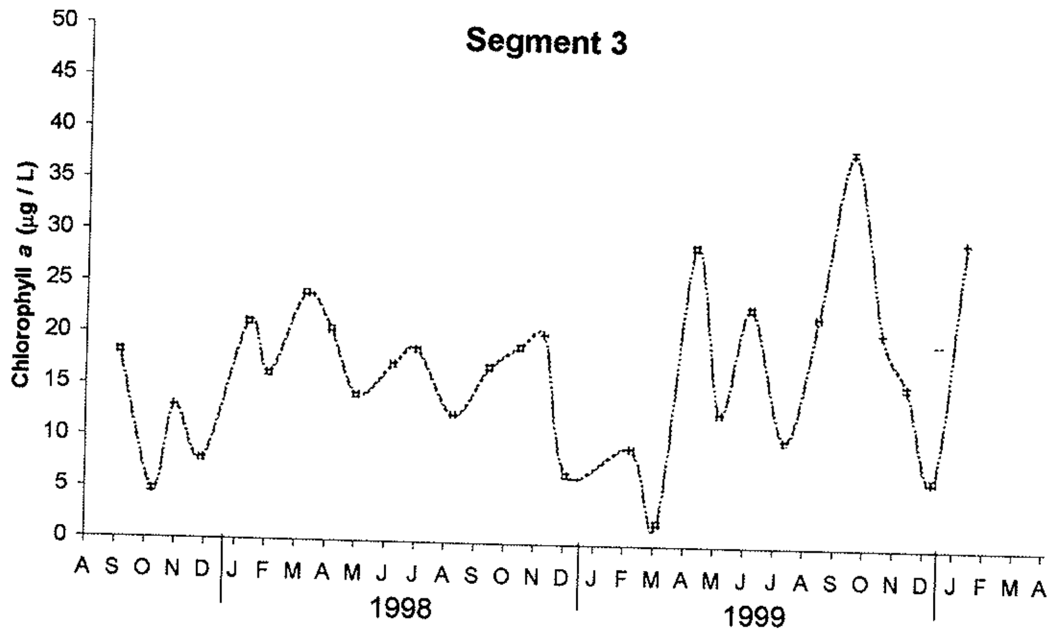


Figure 4.2. Mean chlorophyll *a* concentration (µg / L) from Newton Lake.



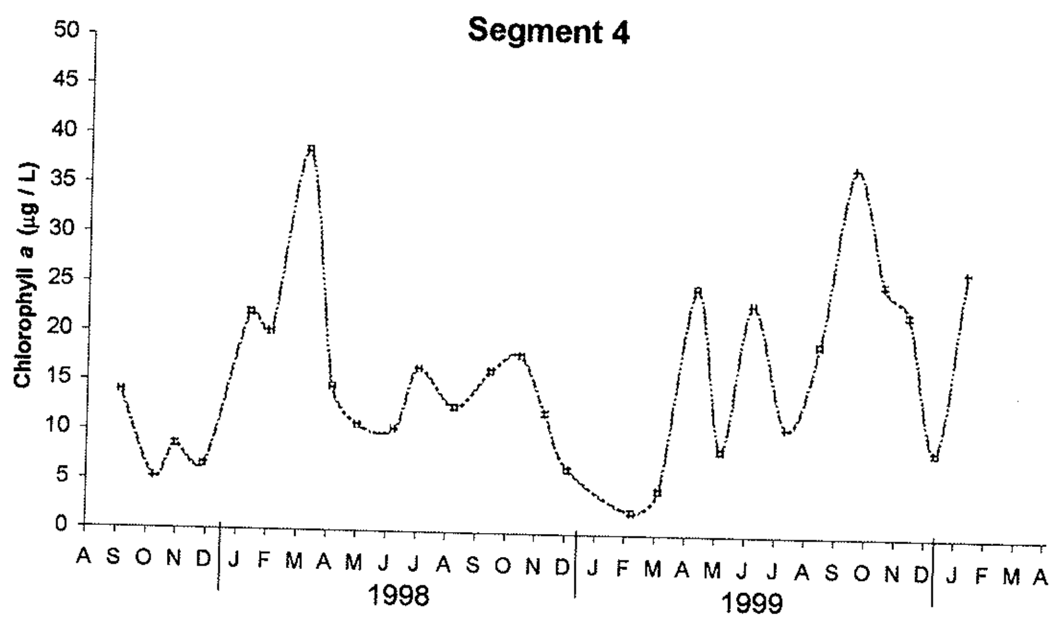
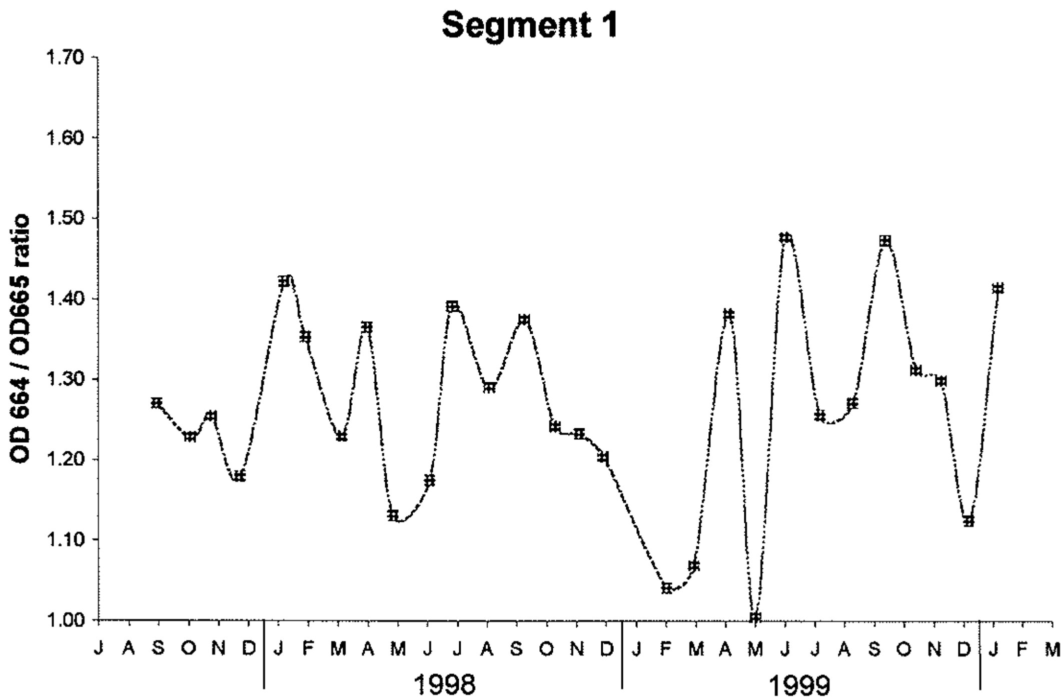


Figure 4.2 (continued). Mean chlorophyll *a* concentration (µg / L) from Newton Lake.



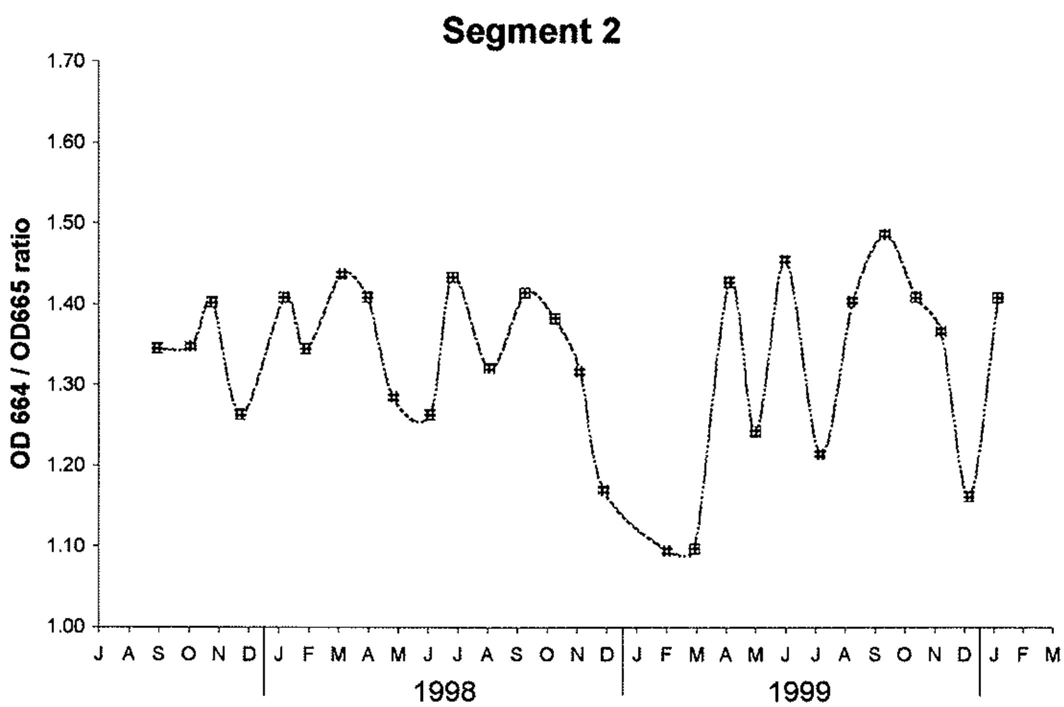
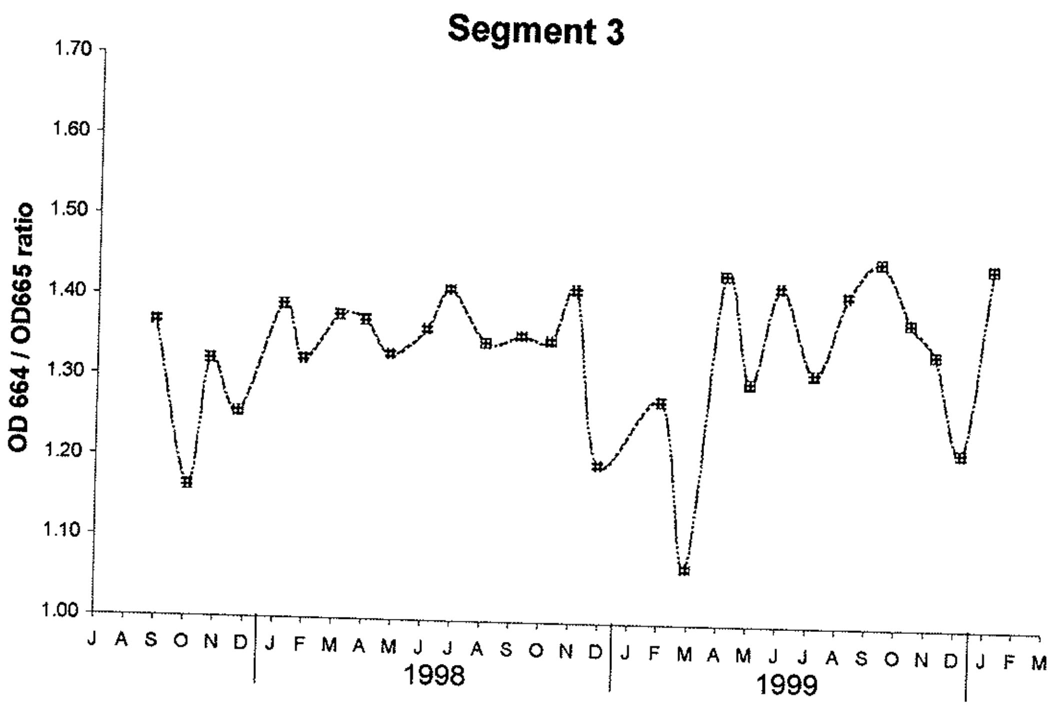


Figure 4.3. Mean OD 664 / OD 665 ratio from Newton Lake.



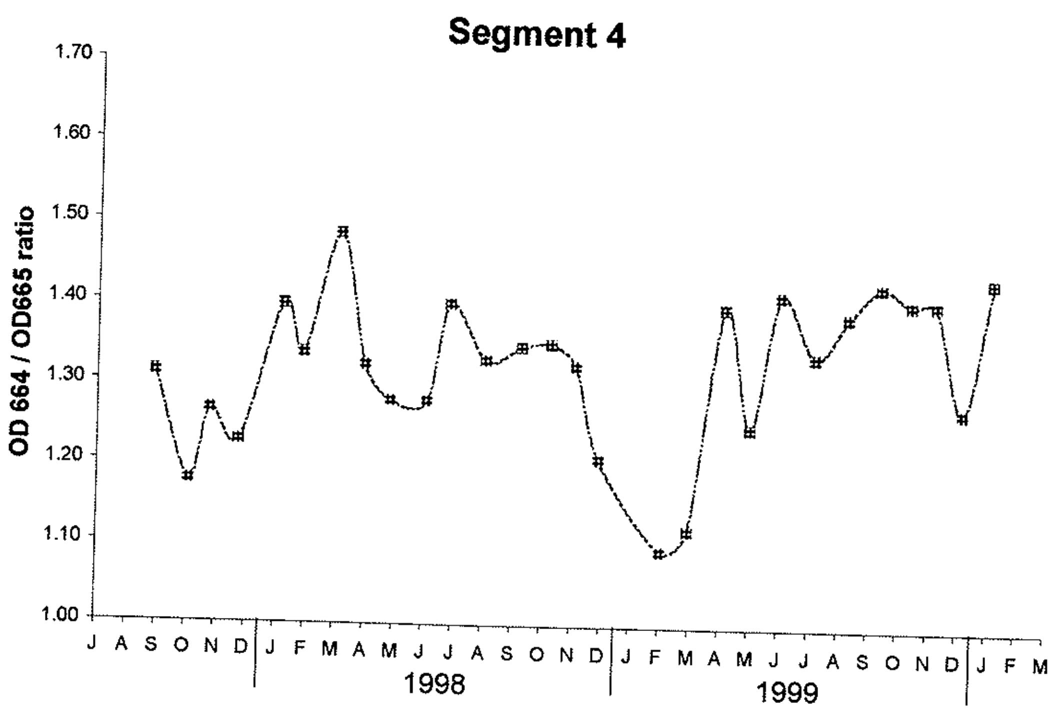
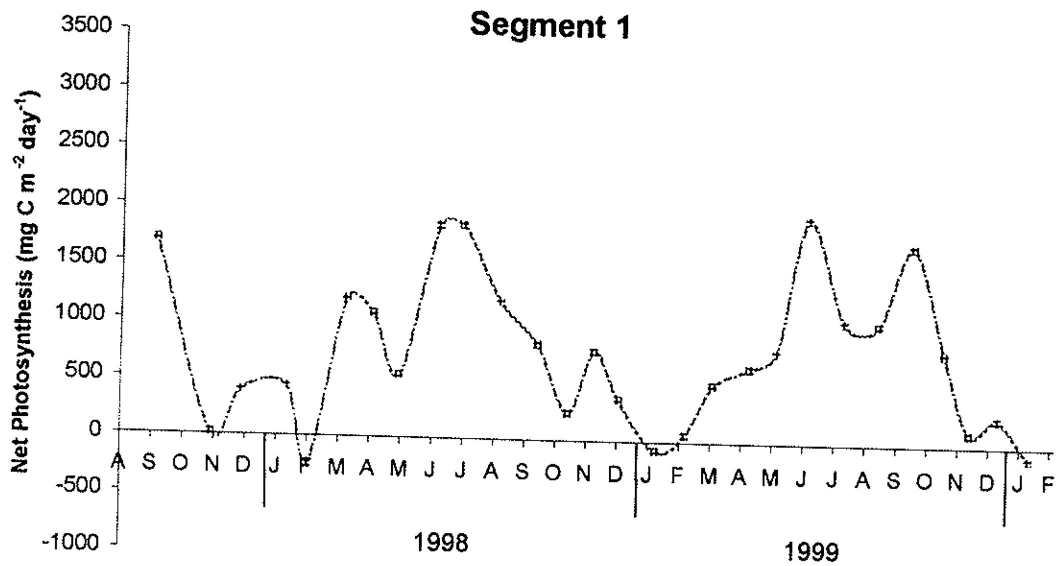


Figure 4.3 (continued). Mean OD 664 / OD 665 ratio from Newton Lake.



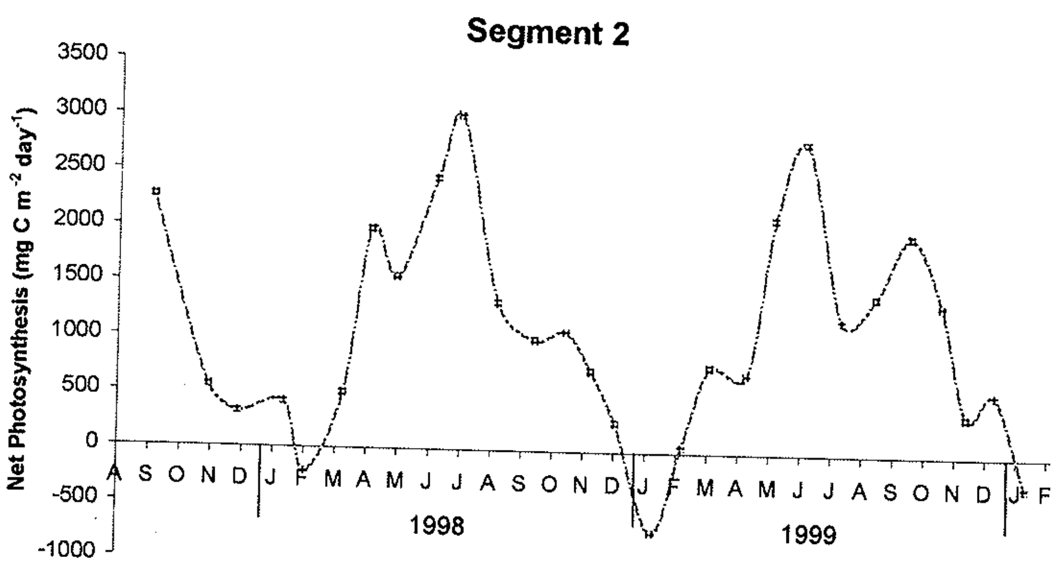
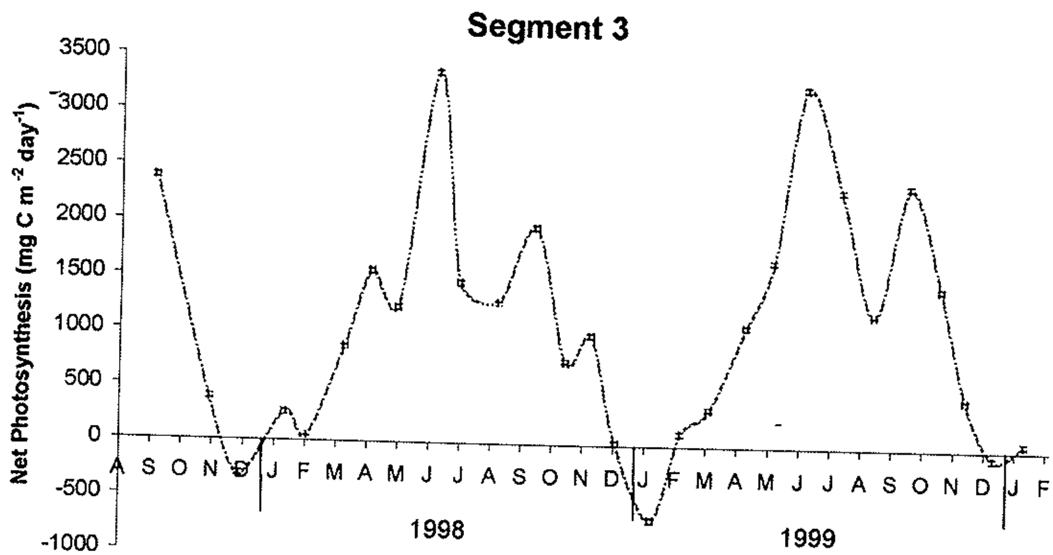


Figure 4.4. Mean net photosynthesis values (mg C m^{-2} day^{-1}) from Newton Lake.



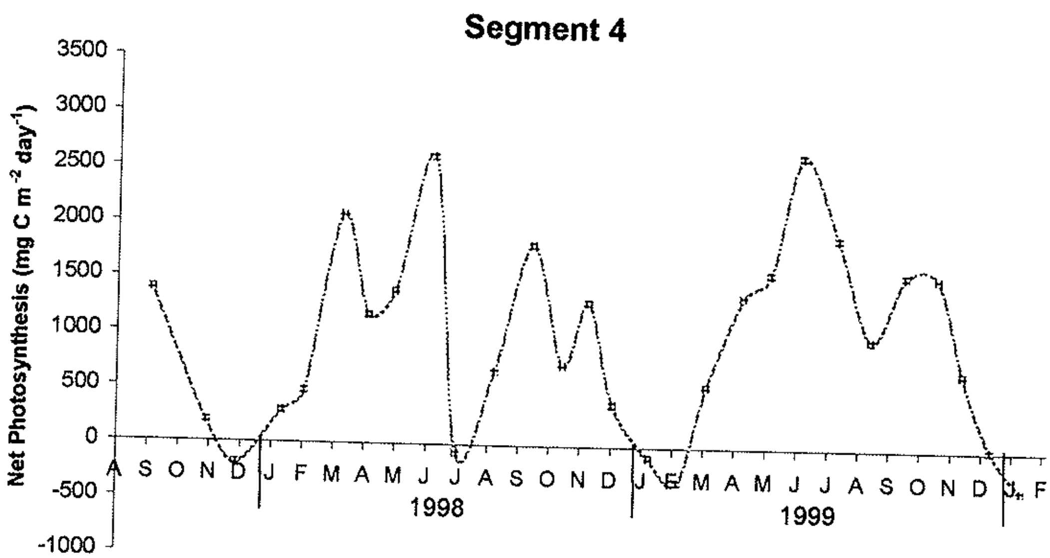


Figure 4.4 (continued). Mean net photosynthesis values (mg C m^{-2} day^{-1}) from Newton Lake.

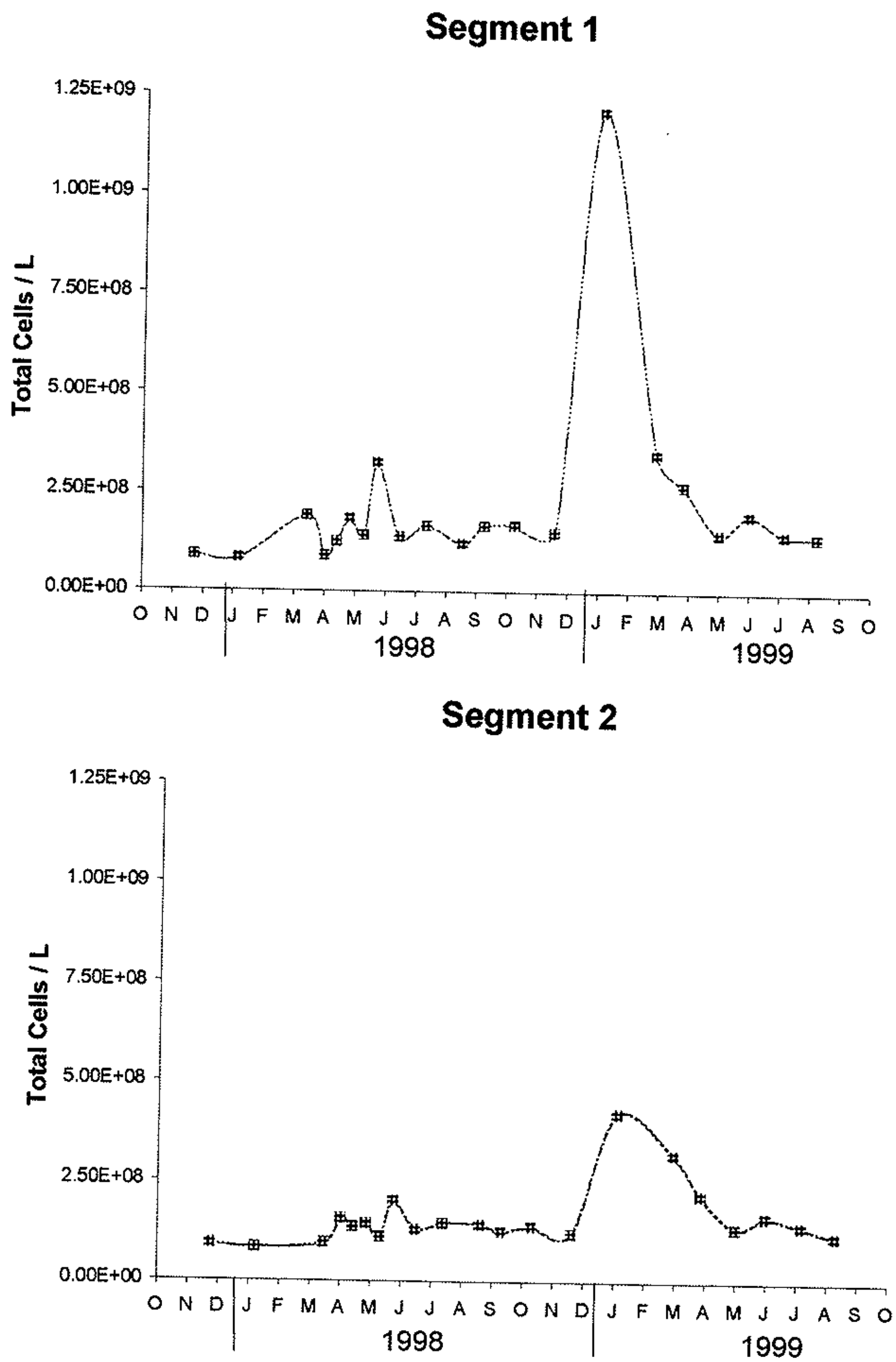
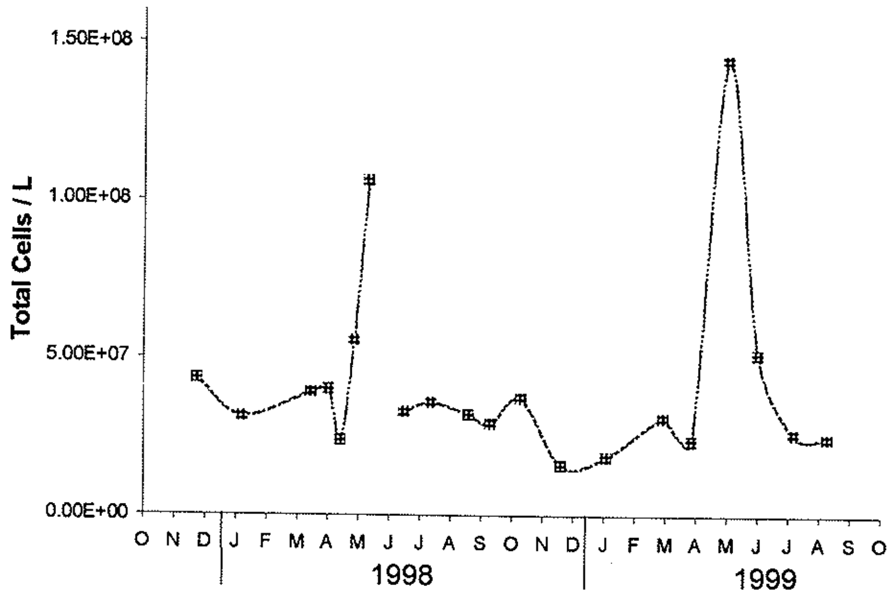


Figure 4.5. Mean total phytoplankton cells L^{-1} (Coccoid singles, Division Cyanophyta, Order Croococcales) from Newton Lake.

Segment 3



Segment 4

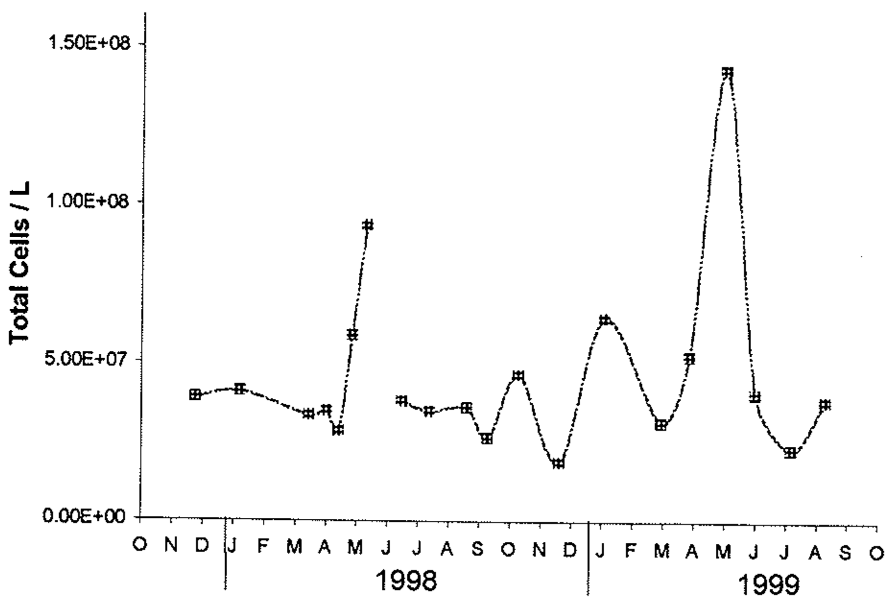
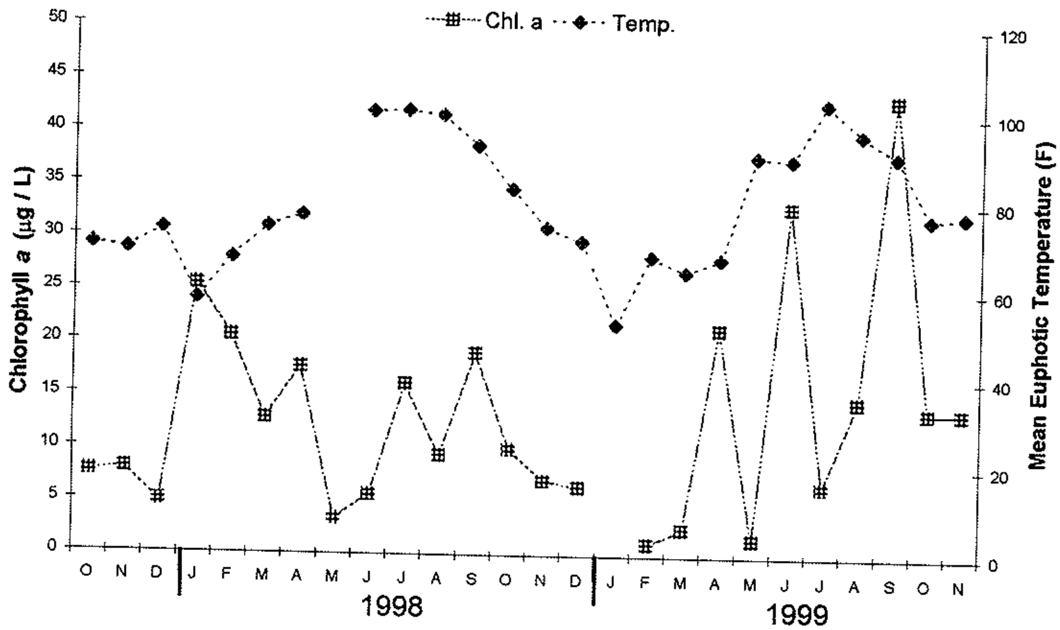


Figure 4.6 (continued). Mean total phytoplankton cells L^{-1} (Coccoid singles excluded) from Newton Lake.

Segment 1



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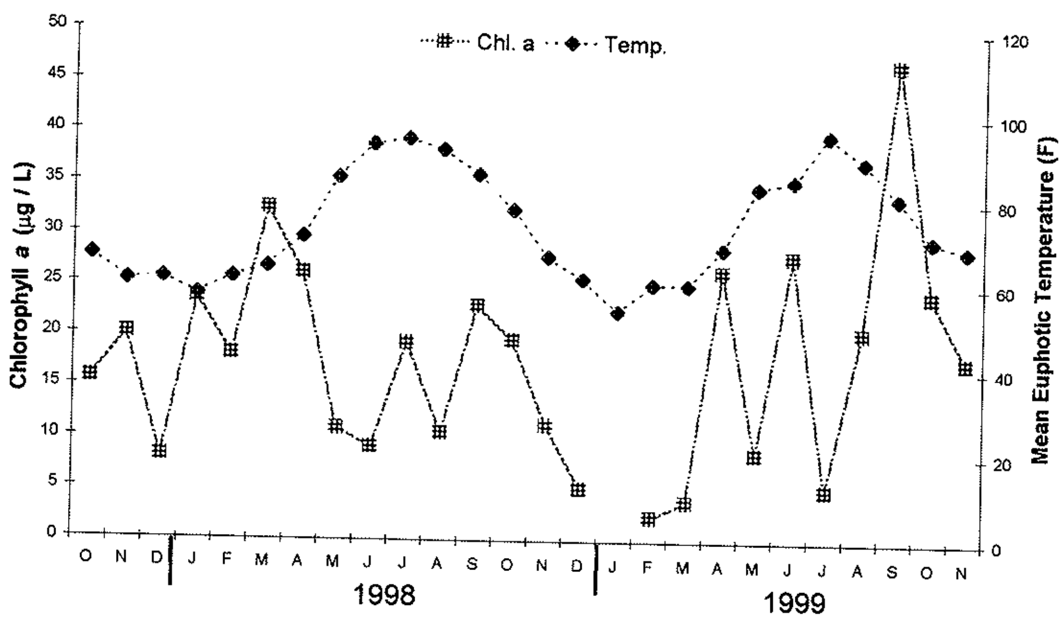
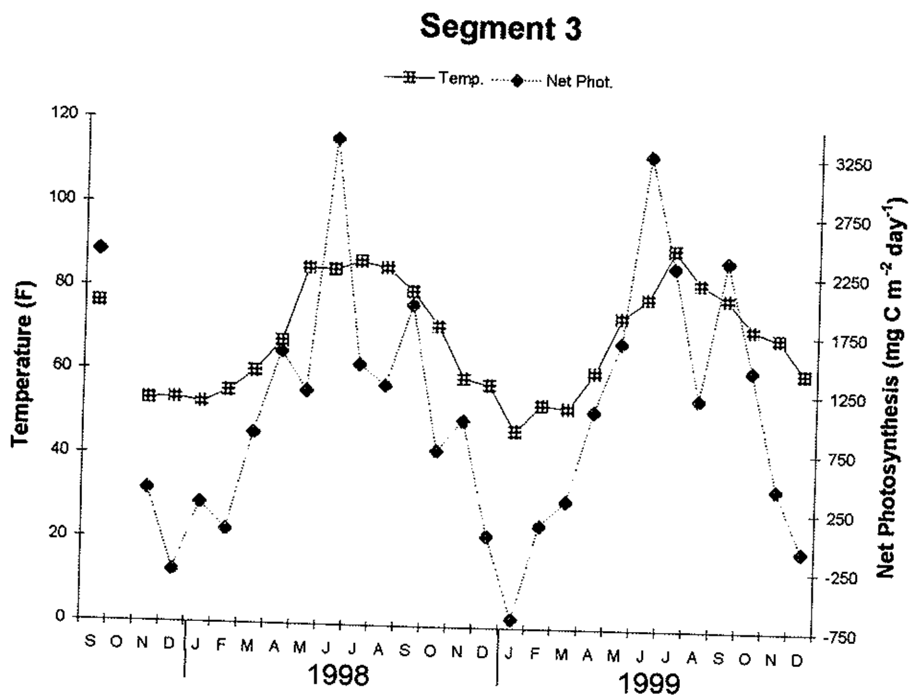


Figure 4.7. Mean chlorophyll *a* (µg / L) and mean daily euphotic temperature (F), Newton Lake. Euphotic temperature is the mean temperature recorded by temperature loggers and adjusted for sampling site on the day of chlorophyll sampling.



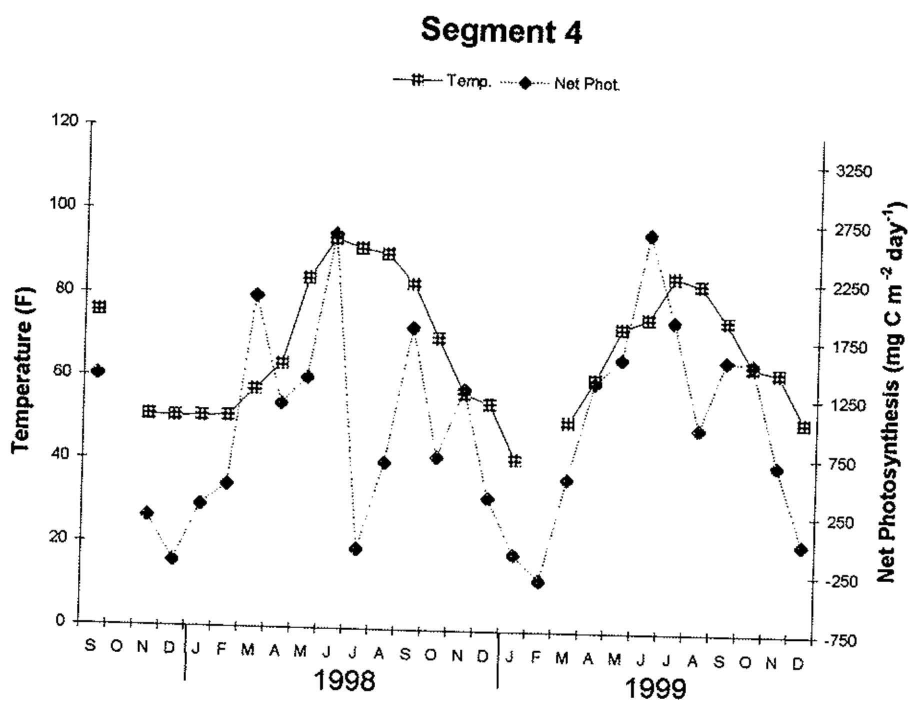


Figure 4.8 (continued). Mean net photosynthesis (mg C m^{-2} day^{-1}) and mean euphotic temperature (F), Newton Lake. Euphotic temperature is the mean temperature recorded by temperature loggers and adjusted for sampling site on the day of chlorophyll sampling.

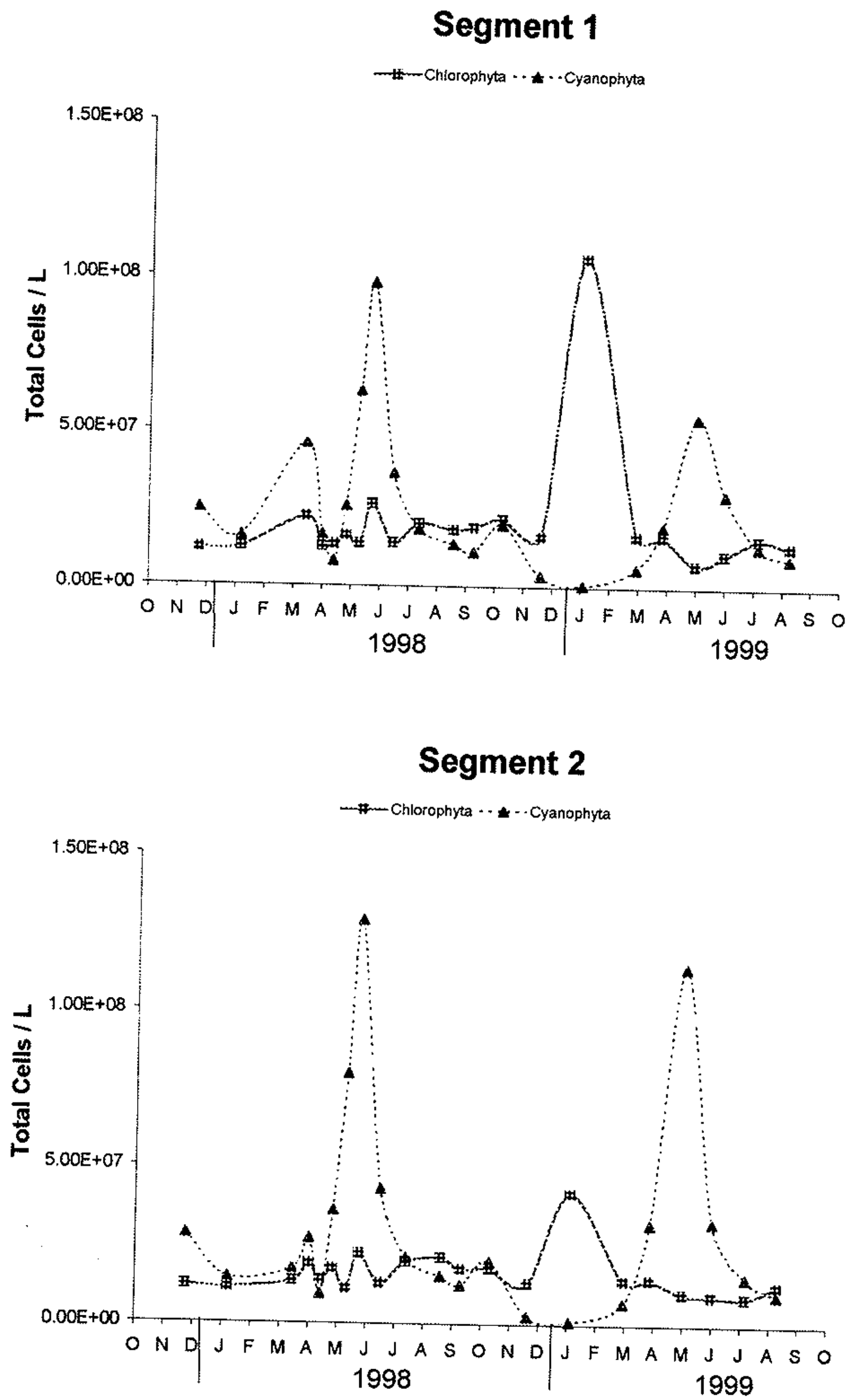
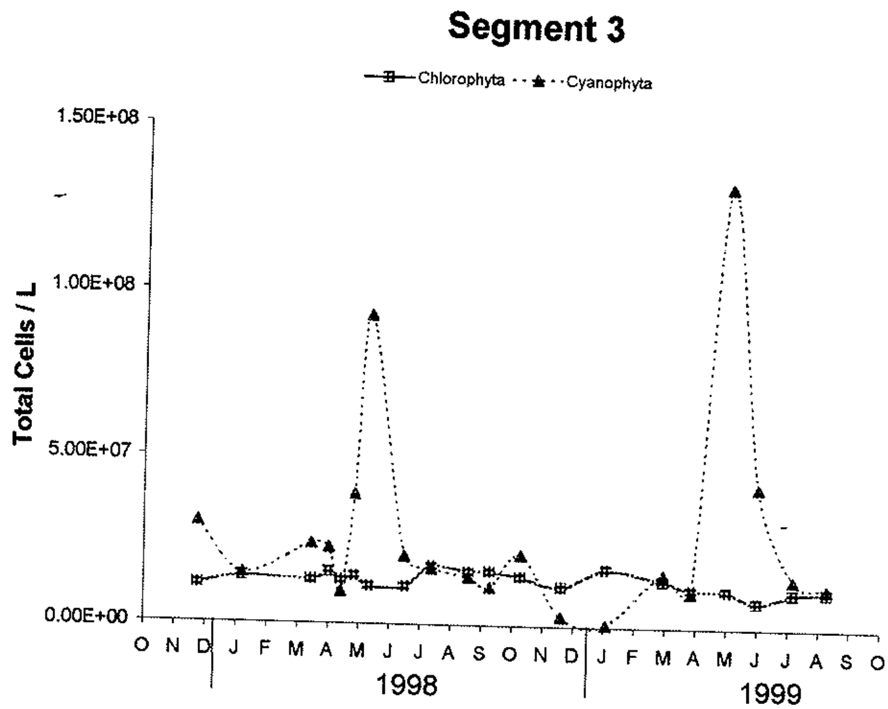


Figure 4.9. Mean total phytoplankton cells L^{-1} Divisions Chlorophyta and Cyanophyta (excluding Coccoid singles, division Cyanophyta) from Newton Lake.



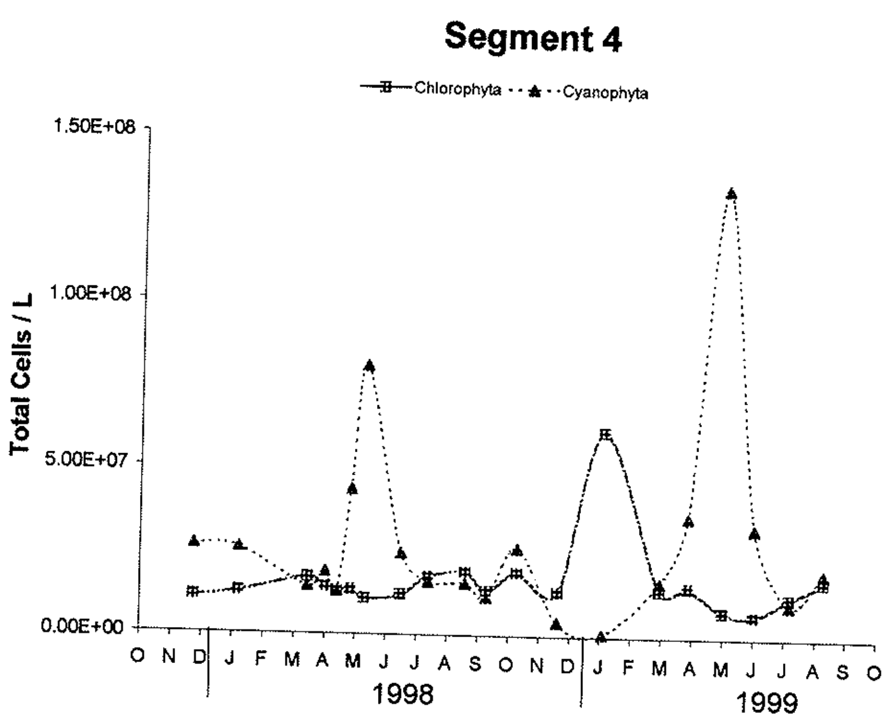
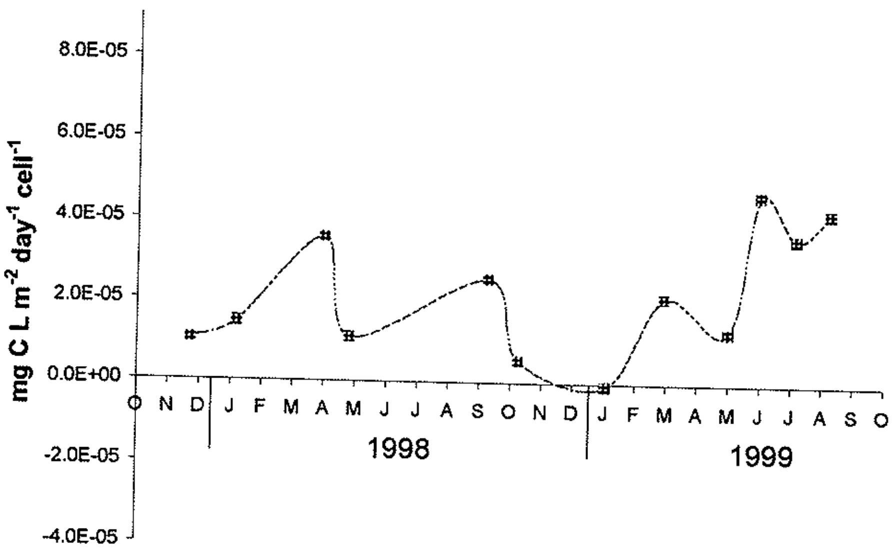


Figure 4.9 (continued). Mean total phytoplankton cells L^{-1} Divisions Chlorophyta and Cyanophyta (excluding Coccoid singles, division Cyanophyta) from Newton Lake.

Segment 1



Segment 2

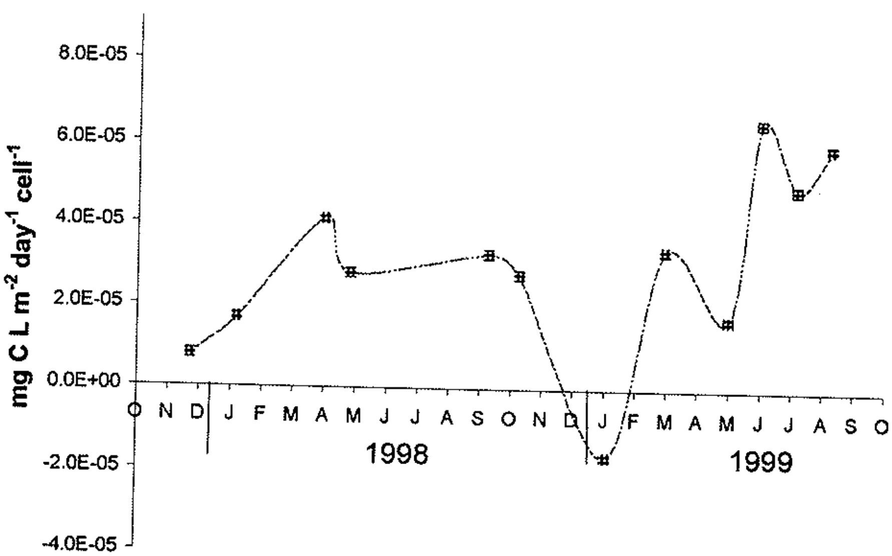
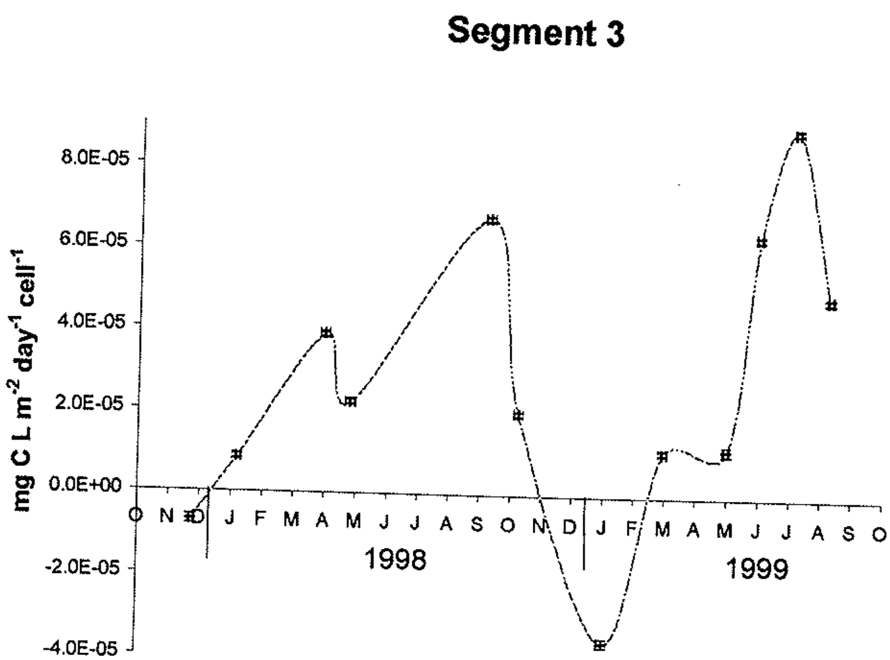


Figure 4.10. Mean net photosynthesis per total phytoplankton cells L^{-1} (Coccoid singles excluded) from Newton Lake.



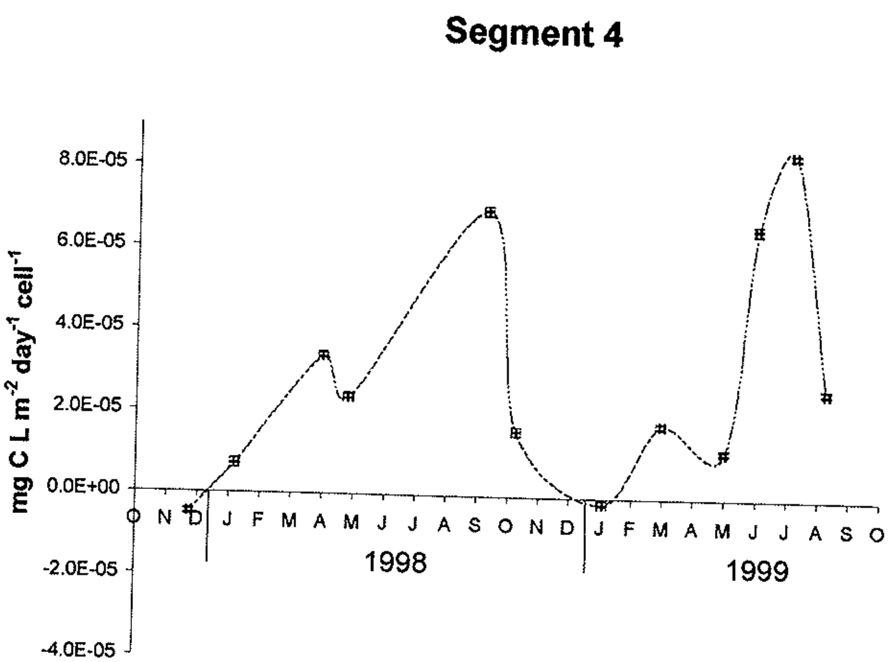
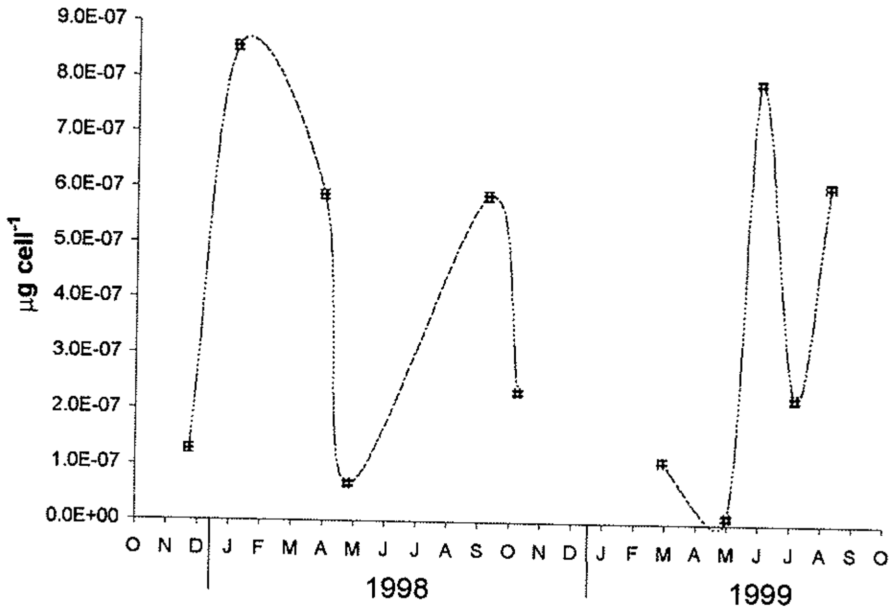


Figure 4.10 (continued). Mean net photosynthesis per total phytoplankton cells L^{-1} (Coccoid singles excluded) from Newton Lake.

Segment 1



Segment 2

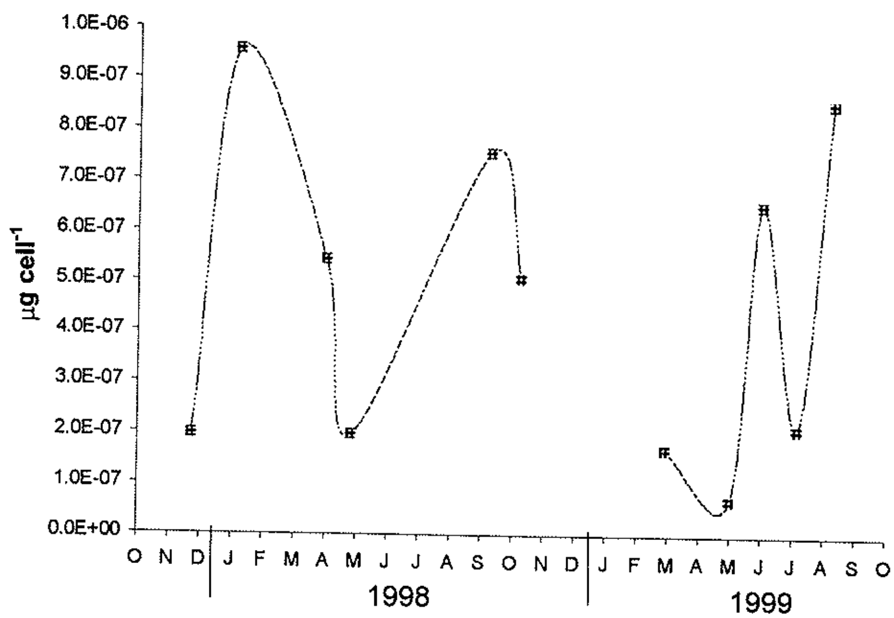
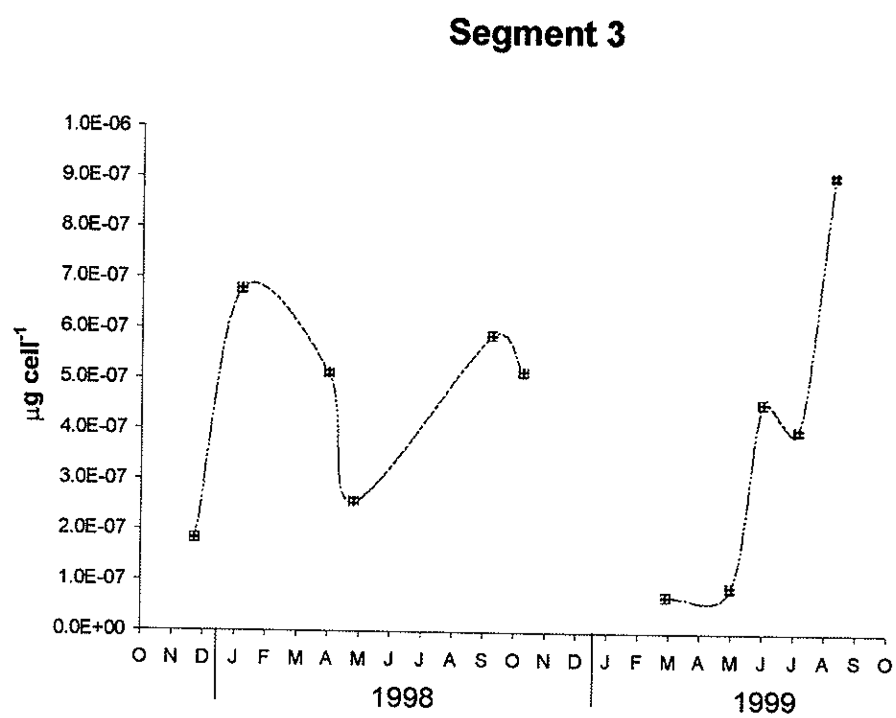


Figure 4.11. Mean chlorophyll *a* per total phytoplankton cells L^{-1} (Coccoid singles excluded) from Newton Lake.



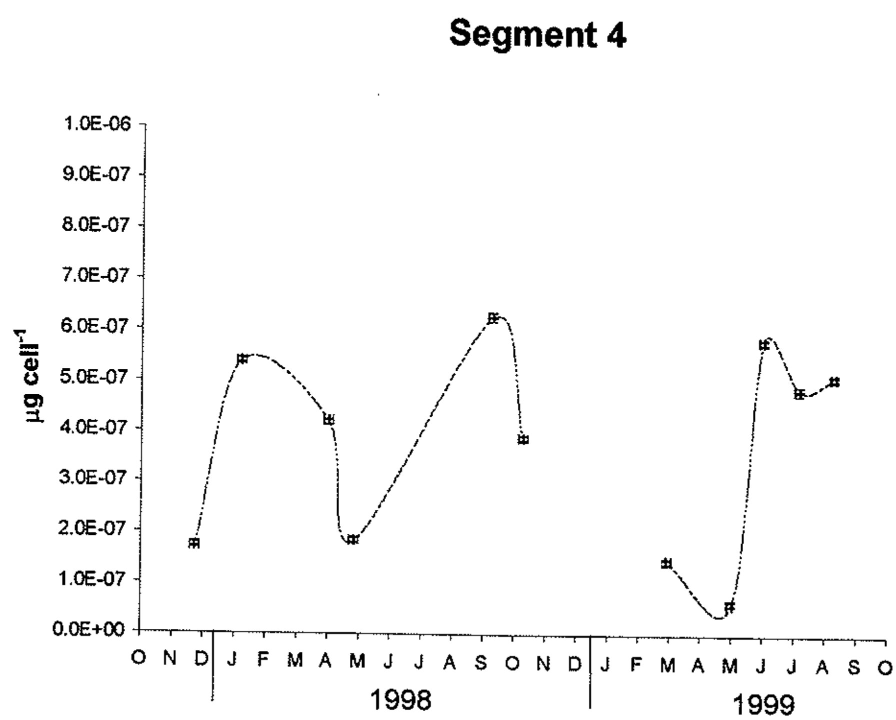


Figure 4.11 (continued). Mean chlorophyll *a* per total phytoplankton cells L^{-1} (Coccoid singles excluded) from Newton Lake.

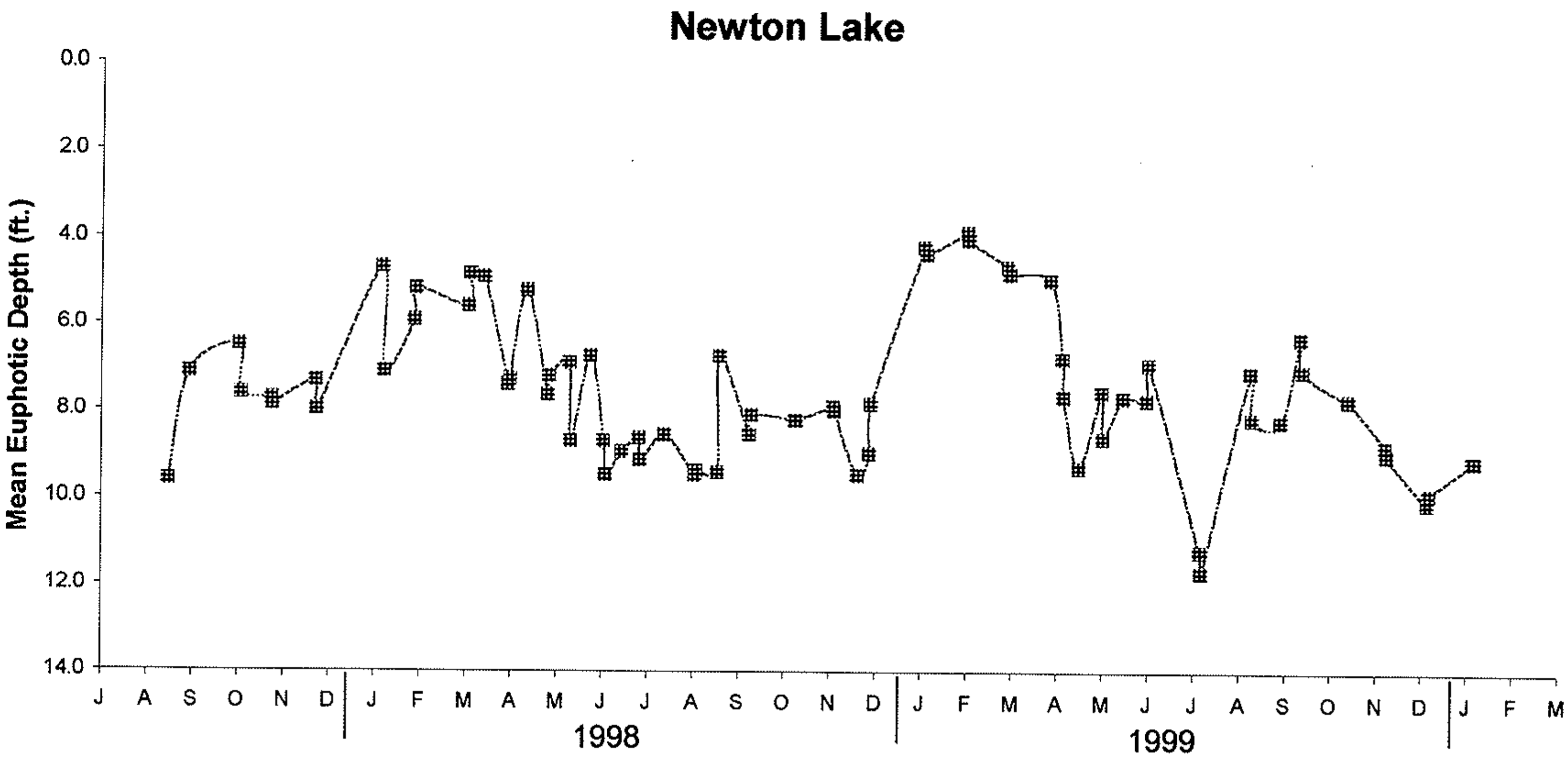


Figure 4.12. Mean euphotic depth (ft.), all segments combined, Newton Lake 1997 – 2000. Note reversal of depth axis to mimic lake cross section

Chapter 5. Benthos

Introduction:

Benthic macroinvertebrates (benthos) are an important part of the aquatic food web since most species of sport fishes feed on them at some stage in their life cycles. Their numbers are not only dependent on substrate types but also cyclic temperature regimes normally associated with seasonal light and ambient temperature changes. The effects of thermal loading in power cooling ponds are poorly understood. The goal of Chapter 5 is to determine seasonal and bathymetric distributions and monitor changes that may occur in the various benthic macroinvertebrate populations in Newton Lake.

Methods:

Sampling for benthos was only done in Newton Lake. Benthos was sampled once a month during October through March and twice a month from April through September, using a standard Ponar dredge (23 cm x 23 cm). Each of the four segments were bisected perpendicularly to the shore with one transect. Six Ponar dredge samples were taken at approximately equal distances from the shore and each other along each of the four transects. The number of samples given in the research protocol were increased from four to six so that benthos in water less than 1-m deep would be sampled. The type of substrate sampled was recorded in the field after the contents of the dredge were placed in a bucket. Invertebrates were initially separated from inorganic material in the field or in the laboratory using a #30 sieve and placed in either 10% buffered formalin or 70% ethanol. Rose Bengal (200 mg/L) was added to the sample to facilitate sorting. At the laboratory, all remaining material was placed in a shallow, white, porcelain-lined pan. A 2x-power, illuminated magnifying lens was used for final removal of invertebrates from the samples. Macroinvertebrates were identified at least to Order. After identification, all macroinvertebrates were stored in 70% ethanol for future reference. The data is reported as mean numbers of invertebrates per square meter and mean number of taxon per square meter. Wet weights were estimated as described in Peterka (1972) and used to estimate total biomass of the benthic macroinvertebrates per square meter. A few clams were collected. Their numbers were included in the density data but their biomass is not included in the weight data.

Analysis for benthic macroinvertebrates that were sampled from September 1997 through August 1999 is summarized in this report. Sampling days and locations are given in Appendix 5.1.

Results and Discussion:

Total benthos densities (n per m^2) were dependent upon year, month, segment, substrate type and depth (p=0.0001; R^2=0.3188).

Mean monthly benthos densities fluctuated in Newton Lake from a low of 780 organisms per m^2 in September of 1998 to a high of 4,597 organisms per m^2 in November 1998 (Table 5.1, Figure 5.1). Densities were generally highest during October through February and lowest in the summer months (June – September). These lower densities are, at least in part, the result of emerging insects. Segment 2 had the highest mean monthly density (3,050) and segment 4 (intake end of the lake) had the lowest mean monthly density (1,285) of benthos (Table 5.2, Figure 5.2). Segment 1 (intake end of the lake) and Segment 3 had intermediate densities. There was no significant difference between densities in Segment 1 and Segment 3.

Average monthly density of benthos found in the warmest months of July and August of 1999 (1,683 per m^2) was 74% higher (p=0.0004) than that found in July and

August 1998 (966 per m^2). The wide ranges and large standard deviations of the samples evidence the variability in the number of benthos collected within each segment.

The mean monthly numbers of benthos that were found in Newton Lake were compared to mean monthly benthos samples found in 12 other Illinois lakes (Hoxmeier et al. 1999). Benthos numbers in Newton Lake are very similar to those in northern Illinois lakes during May through October (Figure 5.3). Lakes located at latitudes similar to Newton Lake had densities that were at least twice those of Newton Lake, but lakes in southern Illinois had densities that were ten times less than the densities in Newton Lake.

Benthos densities' differences among stations and segments were a result of a combination of factors including substrate type and sampling depths (Table 5.3). Highest densities were associated with organic detritus (3,218 per m^2) in the deepest (28 – 31 ft) water sampled (Table 5.4). Substrates with clay and detritus, sand and clay, sand-gravel and clay or sand-gravel-clay and detritus had intermediate densities of benthos. Segment 4 (intake arm of the lake) had the lowest mean densities of all the segments but had no stations deeper than 16 ft and no substrates consisting exclusively of organic detritus. All stations, except Station 1, in Segment 4 had substrates consisting of various amounts of clay, which is a poor substrate for most benthic organisms. Conversely, densities were highest in Segment 2 where four of the six stations consisted of organic detritus in deep-water areas. Water depths at stations sampled in Segment 1 were similar to Segment 4. However, four of the six stations in Segment 1 had substrate containing organic detritus. Thus, except in the summer months, higher densities of benthos were usually present in Segment 1 than in Segment 4 (Figure 5.2). The fact that mean densities and fluctuations of benthos densities were less in

Segment 4 reinforces the hypothesis that substrate quality was a major factor influencing benthos density in that area of Newton Lake.

Biomass was dependent on segment and sampling period (p=0.0001). The mean monthly weight of the benthic macroinvertebrates ranged from a high of 4.1093 g per m^2 in November 1998 to a low of 0.6660 g per m^2 in September 1997 (Figure 5.4, Table 5.5). Both the seasonal changes in weight and weight differences among the four segments almost exactly mirrors that of density. As was the case with densities, the highest mean monthly weight of benthos was in Segment 2 and the lowest was in Segment 4. Segments 1 and 3 had intermediate densities and were not significantly different from each other (Table 5.6, Figure 5.5, Appendix 3).

To a large extent, the number of macroinvertebrate taxa depends upon how far down the specimens are identified. The invertebrates collected from Newton Lake were separated into 19 major taxa (Table 5.7). Eighty-two percent of the organisms collected were in the Order Diptera and 14 percent were in the order Haplotaxida (tubificids). *Chaoborus* spp. and Chironiminae were the dominant subtaxa collected within the orders (Table 5.8). Benthos in the Family Tubificidae represented over 82 percent of the invertebrates included in Haplotaxida. Mean densities of other taxa collected were under 30 individuals per m^2 for the two-year period.

The highest densities of Diptera were collected at stations where substrate consisted of organic detritus (2,599 per m^2) and a mixture of sand, clay, and detritus (1,570 per m^2, Table 5.9). As with invertebrates in the Order Diptera, Haplotaxida were collected from a variety of substrate types. However, the highest densities were collected in substrates that consisted of a mixture of sand and detritus (854 per m^2).

Densities of the individual taxa fluctuated throughout the two-year period (Appendix 5.4). The mean densities of benthos from the Orders Haplotaxida and Diptera were higher than all other taxa collected each sampling date. Thus, trends of abundance for individual taxa were similar to their combined densities as discussed earlier. The two orders were collected at densities that were usually lowest during late July and August of both years sampled and highest in the fall and winter months.

As was the case with density, benthic macroinvertebrates in the Order Diptera contributed most to the total biomass (Table 5.10). Diptera contributed a mean of 1.49 g per m^2 of the total mean of 1.96 g per m^2. Venerioda (clams) and Haplotaxida (tubificids) were the next highest contributors to benthic biomass at 0.24 g per m^2 and 0.16 g per m^2, respectively. *Chaoborus* spp. was the subtaxa that contributed most (1.26 g per m^2) to the mean biomass in the substrate (Table 5.11). Tubificidae and Chironominae contributed approximately 0.32 g per m^2 to the mean benthic, macroinvertebrate biomass in Newton Lake.

Literature Cited:

Hoxmeier, J. H., D. F. Clapp, D. H. Wahl, R. C. Brooks, and R. C. Heidinger. 1999. Final report, Evaluation of walleye stocking program. Division of Fisheries, Illinois Department of Natural Resources, Federal Aid Project F-118-R. 76 p.

Peterka, J.J. 1972. Benthic invertebrates in Lake Astabula Reservoir, North Dakota. American Midland Naturalist 88(2):408-418.

Table 5.1. Mean monthly densities (n per m^2) of benthic macroinvertebrates collected with a ponar dredge from four segments (24 stations) in Newton Lake during September 1997 through August 1999.

Date	Mean density	Range		Standard deviation	Number of samples
September-97	1,237	40	4,772	1,038	46
October-97	1,607	142	7,604	1,738	24
November-97	2,236	61	7,321	1,901	24
December-97	1,671	344	5,440	1,750	22
January-98	1,922	485	7,745	1,633	23
February-98	2,307	182	5,925	1,518	24
March-98	1,830	324	5,116	1,171	23
April-98	1,900	142	5,238	1,372	48
May-98	1,388	20	2,791	703	48
June-98	1,429	121	4,206	1,133	45
July-98	949	0	5,056	1,064	47
August-98	983	20	3,215	832	47
September-98	780	40	3,741	872	47
October-98	2,636	81	7,907	2,073	24
November-98	4,597	162	21,941	5,048	24
December-98	3,964	344	12,315	3,653	23
January-99	3,929	526	15,470	3,505	24
February-99	2,310	61	6,370	1,932	24
March-99	2,342	61	6,491	1,761	24
April-99	2,600	404	7,118	1,571	48
May-99	3,354	506	17,007	2,651	48
June-99	1,904	182	4,449	1,040	48
July-99	2,015	0	7,826	2,002	48
August-99	1,351	0	5,905	1,284	47

Table 5.2. Mean benthic macroinvertebrate densities (n per m^2) in four segments of Newton Lake. Six stations were sampled in each segment during September, 1997 through August, 1999. Superscripts indicate statistical significance among segments ($p=0.0001$).

Segment	Mean density	Range		Standard deviation	Number of samples
1	1,778[b]	0	9,141	1,614	212
2	3,050[a]	40	21,941	2,944	210
3	1,838[b]	40	17,007	1,786	213
4	1,285[c]	20	5,359	968	215

Table 5.3. Substrate types and depths for each of the stations sampled in Newton Lake during 1997, 1998, and 1999. Segment 1 was located nearest to the power cooling discharge, and Segment 4 was nearest to the intake.

Segment	Station	Depth (ft)	Description
1	1	1.15	sand and gravel
1	2	14.44	organic detritus
1	3	13.94	organic detritus
1	4	13.62	organic detritus
1	5	13.12	organic detritus
1	6	2.46	sand and gravel
2	1	2.46	sand and gravel
2	2	28.71	organic detritus
2	3	30.00	organic detritus
2	4	30.51	organic detritus
2	5	27.89	organic detritus
2	6	1.97	sand and gravel
3	1	2.95	sand and gravel
3	2	18.05	sand and clay
3	3	28.22	organic detritus
3	4	28.22	organic detritus
3	5	29.53	sand, clay and detritus
3	6	1.97	sand and detritus
4	1	0.82	sand and detritus
4	2	14.76	clay and detritus
4	3	16.24	clay and detritus
4	4	14.11	sand and clay
4	5	14.93	sand, gravel, clay and detritus
4	6	2.46	sand, gravel, and clay

Table 5.4. Mean densities (n per m^2) of benthic invertebrates collected from Newton Lake during September 1997 through August 1999. The densities are given according to substrate types and depths. A Ponar dredge was used to collect samples from four segments, each consisting of six stations.

Substrate description	Depth (ft)	Mean density	Range		Standard deviation	Number of samples
Clay and detritus	13 - 18	1,286	100	5,055	936	72
Organic detritus	13 - 18	1,958	40	9,141	1,592	143
Organic detritus	28 – 31	3,218	40	21,941	2,665	210
Sand and clay	13 - 18	996	40	3,721	861	72
Sand and detritus	1 – 3	1,950	101	17,007	2,298	72
Sand and gravel	1 – 3	1,629	0	15,471	1,916	174
Sand, clay, and detritus	28 – 31	1,746	60	5,885	1,498	36
Sand, gravel, and clay	1 – 3	1,198	262	4,206	769	36
Sand, gravel, clay, and detritus	13-18	1,002	20	3,094	787	35

Table 5.5. Mean monthly weights (g per m^2) of benthic macroinvertebrates collected with a ponar dredge from four segments (24 stations) in Newton Lake during September 1997 through August 1999.

Date	Mean weight	Range		Standard deviation	Number of samples
September-97	0.6660	0.0141	4.9888	0.9604	46
October-97	1.2213	0.0262	4.4611	1.3750	24
November-97	2.3703	0.0263	8.9606	2.2219	24
December-97	2.0767	0.0525	10.2386	2.7880	22
January-98	2.2137	0.1476	9.9494	2.3646	23
February-98	3.0412	0.0384	12.8837	3.2416	24
March-98	1.6958	0.0910	6.7745	1.8233	23
April-98	1.4964	0.0080	5.7047	1.5733	48
May-98	1.5517	0.0162	5.7776	1.3551	48
June-98	1.3850	0.0283	5.6036	1.4682	46
July-98	0.9078	0.0000	5.0698	1.2367	47
August-98	1.0388	0.0020	5.3144	1.1327	47
September-98	0.6913	0.0020	4.8433	0.9812	47
October-98	1.9035	0.0101	7.4621	1.9259	24
November-98	4.1093	0.1112	18.0121	4.6180	24
December-98	4.0672	0.3498	16.9828	4.8270	23
January-99	2.9939	0.3053	12.8271	3.2010	24
February-99	2.9158	0.0081	12.0566	3.1908	24
March-99	2.7687	0.0061	12.7422	3.0467	24
April-99	1.8326	0.2204	7.8504	1.9272	48
May-99	2.1673	0.1759	6.5380	1.7308	48
June-99	1.6145	0.0647	4.6412	1.2040	48
July-99	1.6014	0.0000	7.0455	1.7784	48
August-99	1.2267	0.0000	6.4429	1.4152	46

Table 5.6. Mean weights (g per m^2) of benthic macroinvertebrates collected and analyzed by segments. The benthos was collected from Newton Lake during September 1997 through August 1999 using a ponar dredge. Benthic samples were collected from six stations along each transect that bisected each of the four segments. Superscripts indicate statistical significance among segments (p=0.0001).

Segment	Mean weight	Range		Standard deviation	Number of samples
1	1.5446[b]	0.0000	9.9090	1.6376	211
2	3.0190[a]	0.0061	18.0121	3.3269	210
3	1.5314[b]	0.0081	10.2386	1.5595	213
4	1.0334[c]	0.0000	12.8837	1.3980	215

Table 5.7. Mean densities (n per m^2) of macroinvertebrate taxa collected in Newton Lake during September 1997 through August 1999. Samples (851) were collected from 24 stations located at four transects (6 stations per transect) within the lake.

Taxon	Mean density	Contribution (%)	Range		Standard deviation
Ephemeroptera	15	1	0	910	64
Hydracarina	1	<1	0	162	8
Diptera	1,619	82	0	21,941	1,950
Odonata	<1	<1	0	81	4
Coleoptera	<1	<1	0	20	2
Bryozoa	1	<1	0	303	12
Trichoptera	9	<1	0	789	40
Pelecypoda	18	1	0	2,063	134
Hemiptera	<1	<1	0	20	1
Gastropoda	<1	<1	0	40	2
Nematoda	6	<1	0	2,427	87
Nematomorpha	1	<1	0	81	5
Veneroida	29	1	0	1,719	123
Haplotaxida	275	14	0	12,659	675
Podocopa	<1	<1	0	40	2
Lumbriculida	<1	<1	0	81	3
Isopoda	<1	<1	0	20	1
Basomatophora	<1	<1	0	81	3
Amphipoda	<1	<1	0	162	6
Total	**1,980**		**0**	**21,941**	**2,057**

Table 5.8. Mean densities (n per m^2) of primary macroinvertebrate subtaxa collected in Newton Lake during September 1997 through August 1999. Samples (841) were collected from 24 stations located at four transects (6 stations per transect) within the lake.

Taxon	Mean density	Range		Standard deviation
Ceratopogonidae	25	0	2,508	136
Chaoborus spp.	1,210	0	21,941	1,973
Tubificidae	227	0	12,659	642
Nematoda	6	0	2,427	88
Chironominae	379	0	11,325	795

Table 5.9. Macroinvertebrate mean densities (n per m^2) from various substrates of twenty-four stations sampled with a ponar dredge in Newton Lake during September 1997 through August 1999.

Taxon	Sand and gravel	Sand, gravel and clay	Sand, gravel, clay and detritus	Sand and clay	Sand, clay and detritus	Sand and detritus	Clay and detritus	Organic detritus
Ephemeroptera	40	8		2	2	71	2	1
Hydracarina	2	2				8		
Diptera	1,009	509	455	698	1,571	795	1,029	2,599
Odonata	2					<1		
Coleoptera	<1	1				1		<1
Bryozoa	2			1	1	1	2	1
Trichoptera	24	6		1		37	1	1
Pelecypoda	25	60	6	<1	39	92	9	1
Hemiptera								<1
Gastropoda	<1	1						<1
Nematoda	4	7	91	6	2	1	4	1
Nematomorpha	1	2		1		1	2	<1
Veneroida	48	138	15	29	28	85	11	2
Haplotaxida	457	466	432	251	103	854	226	64
Podocopa	<1				1	1		
Lumbriculida			2		1			
Isopoda	<1							
Basomatophora			1			1		
Amphipoda	<1							<1

Table 5.10 Mean weight (g per m^2) of benthic macroinvertebrate taxa collected from Newton Lake during September 1997 through August 1999 using a ponar dredge. Benthic samples (857) were collected from six stations along each transect that bisected each of the four segments.

Taxa	Mean weight	Contributi (%)	Range		Standa deviatio
Ephemeroptera	0.0076	<1	0.0	0.5	0.0
Hydracarina	0.0001	<1	0.0	0.0	0.0
Diptera	1.4896	76	0.0	18.0	2.2
Odonata	0.0013	<1	0.0	0.3	0.0
Coleoptera	0.0003	<1	0.0	0.1	0.0
Bryozoa	0.0006	<1	0.0	0.2	0.0
Trichoptera	0.0113	1	0.0	0.7	0.0
Pelecypoda	0.0380	2	0.0	3.4	0.2
Hemiptera	0.0002	<1	0.0	0.1	0.0
Gastropoda	0.0034	<1	0.0	2.0	0.0
Nematoda	0.0011	<1	0.0	0.3	0.0
Nematomorpha	0.0001	<1	0.0	0.0	0.0
Veneroida	0.2383	12	0.0	155.3	5.3
Haplotaxida	0.1591	8	0.0	12.4	0.6
Podocopa	0.0000	<1	0.0	0.0	0.0
Lumbriculida	0.0004	<1	0.0	0.2	0.0
Isopoda	0.0015	<1	0.0	1.2	0.0
Basomatophora	0.0006	<1	0.0	0.2	0.0
Amphipoda	0.0004	<1	0.0	0.2	0.0
Total Mean Weight	**1.9549**		**0.0**	**155.4**	**5.7**

Table 5.11. Mean weights (g per m^2) of benthic macroinvertebrate subtaxa collected in Newton Lake during September 1997 through August 1999. Samples (846) were collected from 24 stations located at four transects (6 stations per transect) within the lake.

Taxon	Mean weight	Range		Standard deviation
Ceratopogonidae	0.0183	0.0000	3.4803	0.1980
Chaoborus sp.	1.2721	0.0000	18.0121	2.2277
Tubificidae	0.1224	0.0000	12.3195	0.5591
Nematoda	0.0011	0.0000	0.3741	0.0180
Chironominae	0.1966	0.0000	3.6097	0.3601

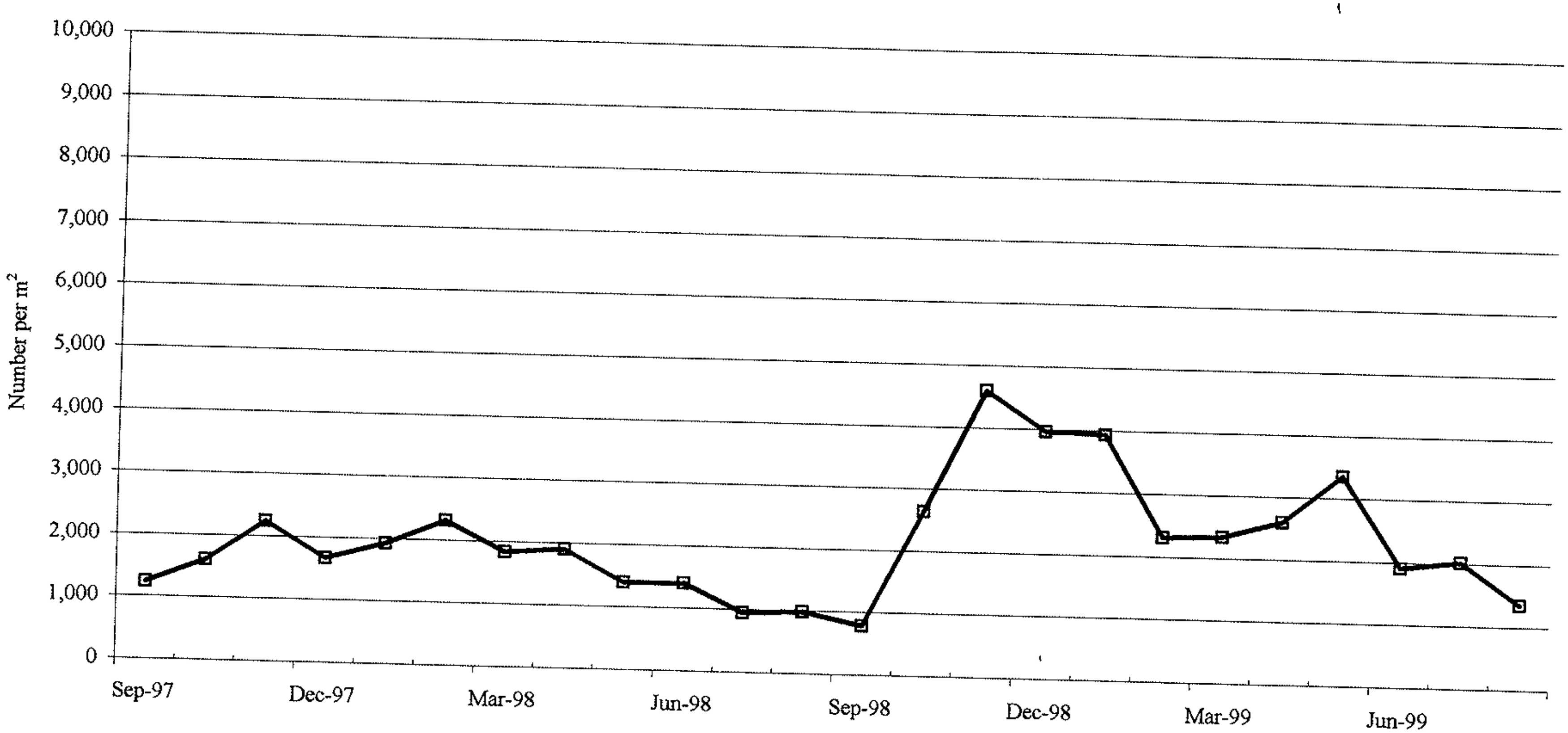


Figure 5.1. Mean monthly macroinvertebrate densities collected in Newton Lake (24 stations) from September 1997 through August 1999. Benthos was collected using a ponar dredge.

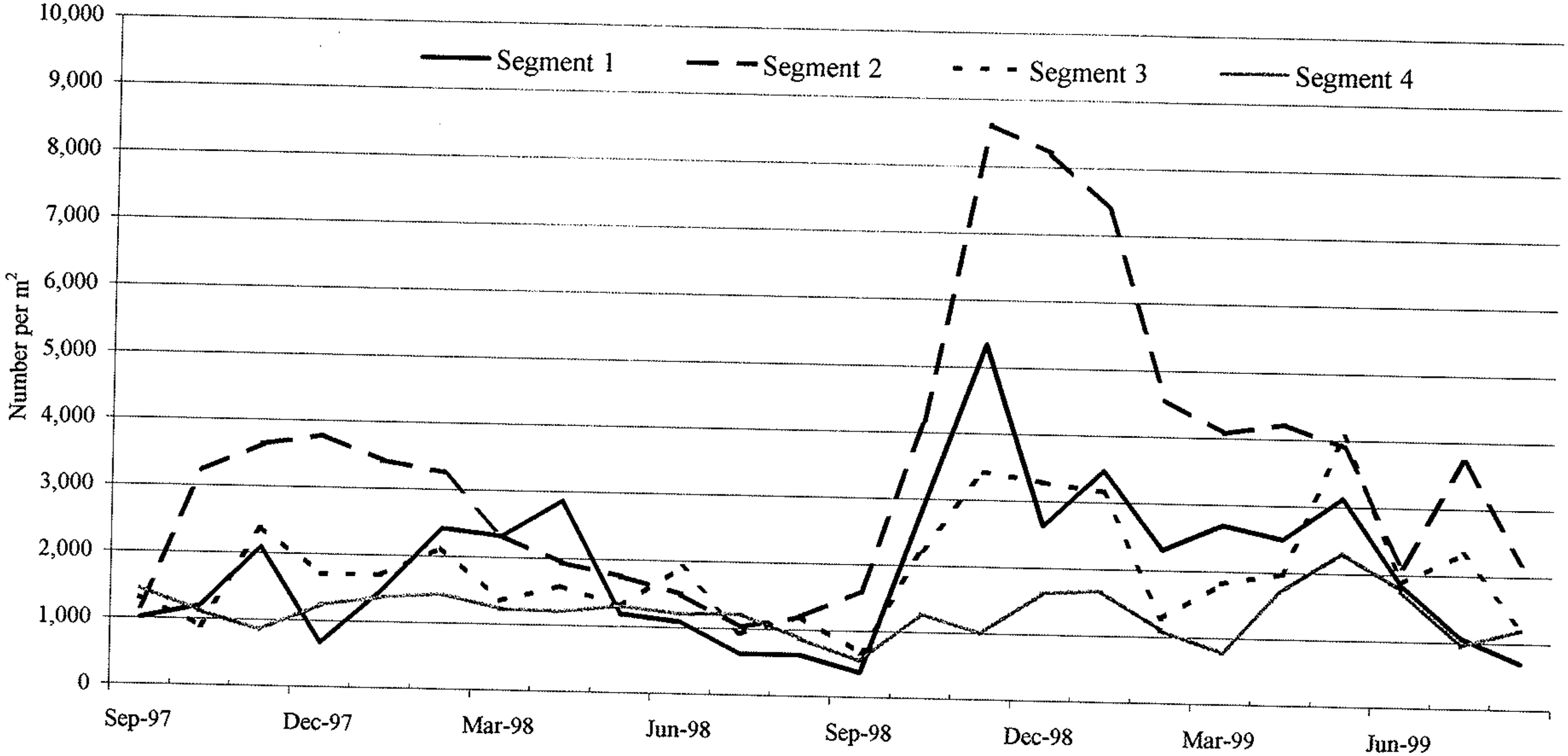


Figure 5.2. Mean monthly macroinvertebrate densities collected in Newton Lake (24 stations) from September 1997 through August 1999. Benthos was collected using a ponar dredge. Segment 1 is at the discharge end of the lake and Segment 4 is at the intake end of the lake.

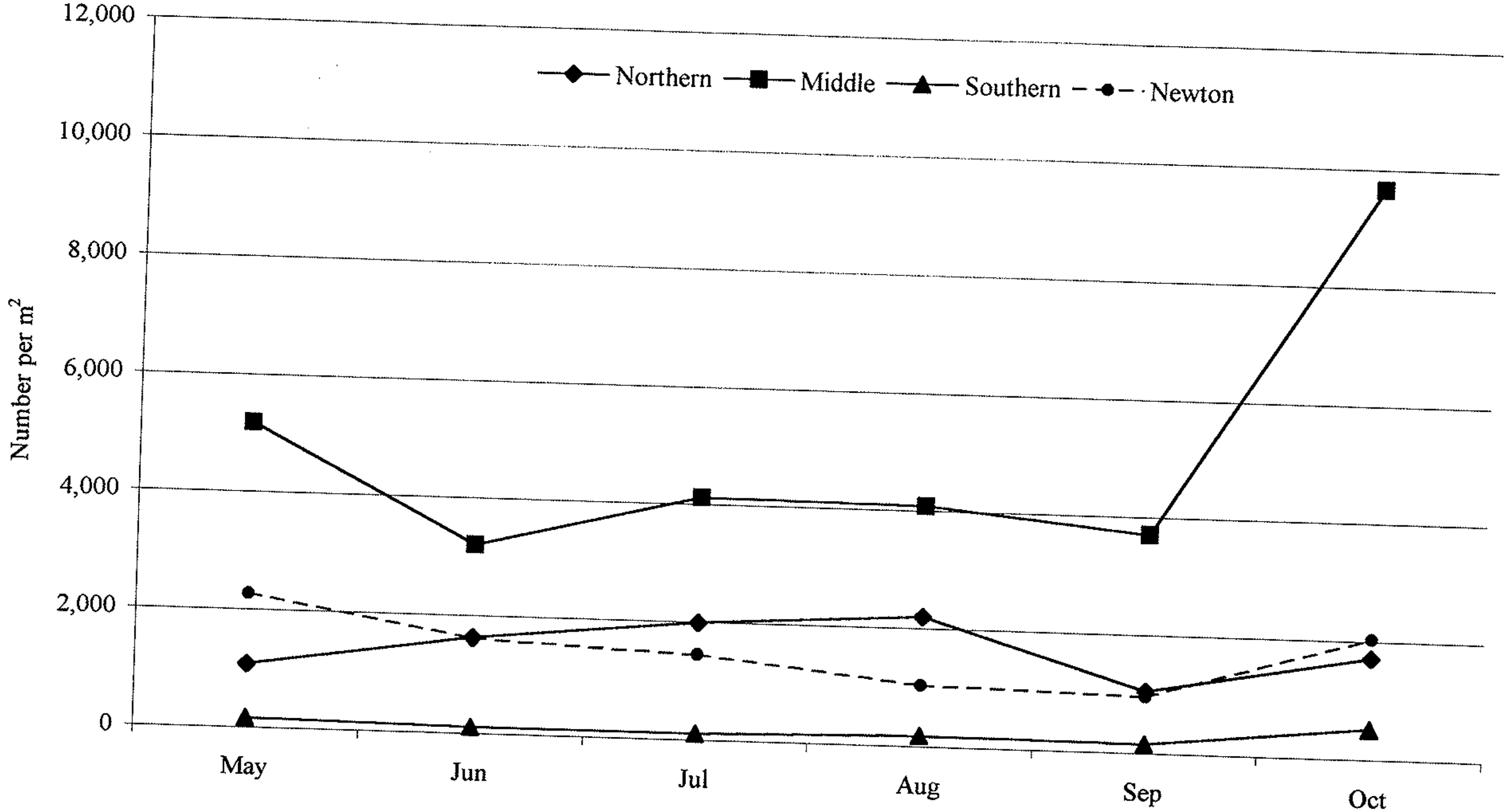


Figure 5.3. Mean benthos densities in 12 lakes located from three regions of Illinois compared to densities in Newton Lake from May through October. Benthos was collected each year during 1993 through 1997 from the 12 Illinois lakes and in 1998 and 1999 in Newton Lake. Four to six samples were taken each month from each of the 12 lakes for five years. Five lakes were sampled in the northern zone, six in the middle zone, and four in the southern zone.

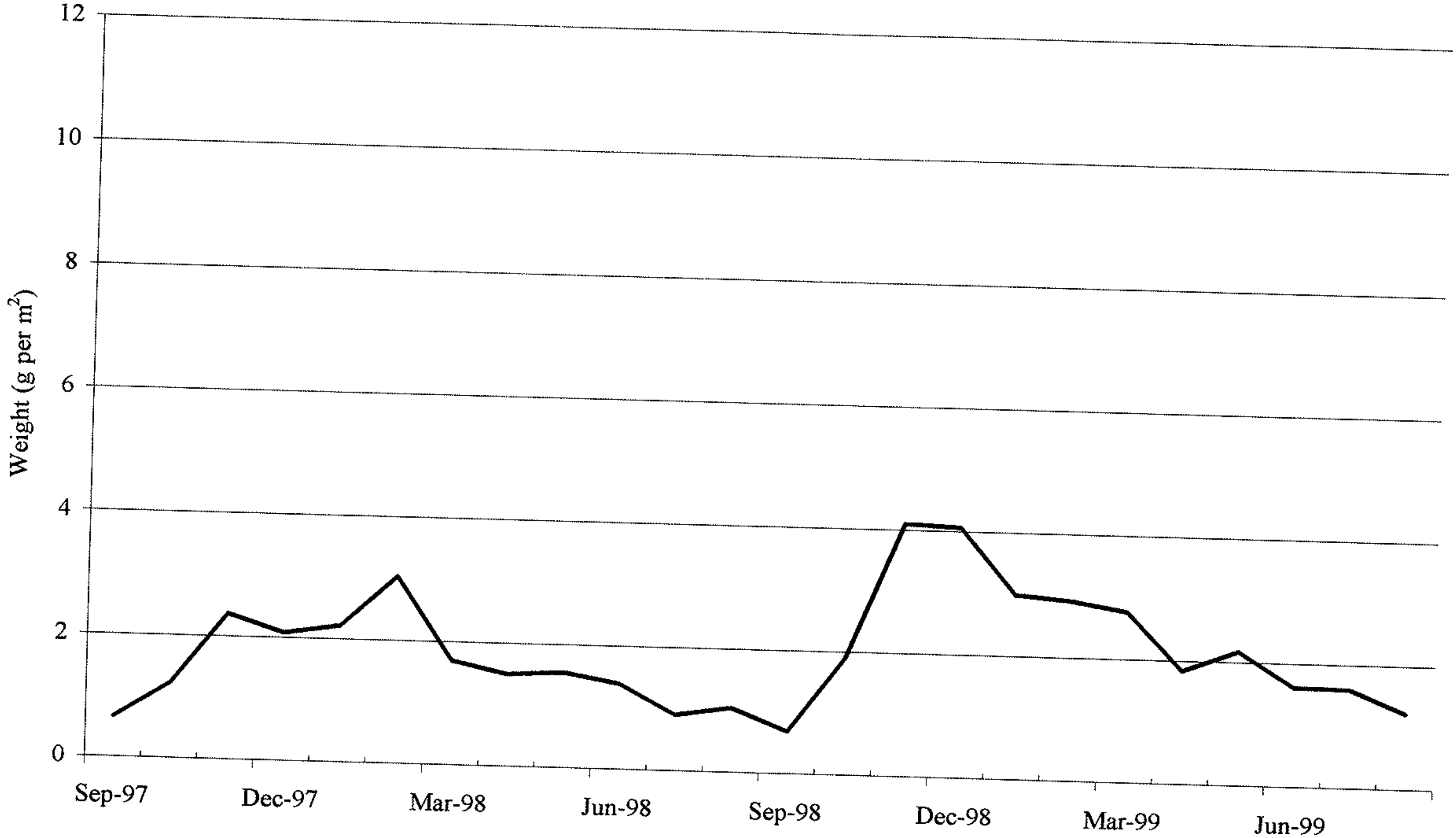


Figure 5.4. Mean monthly weights of macroinvertebrates collected in Newton Lake (24 stations) during 1997 through 1999. Benthos was collected using a ponar dredge.

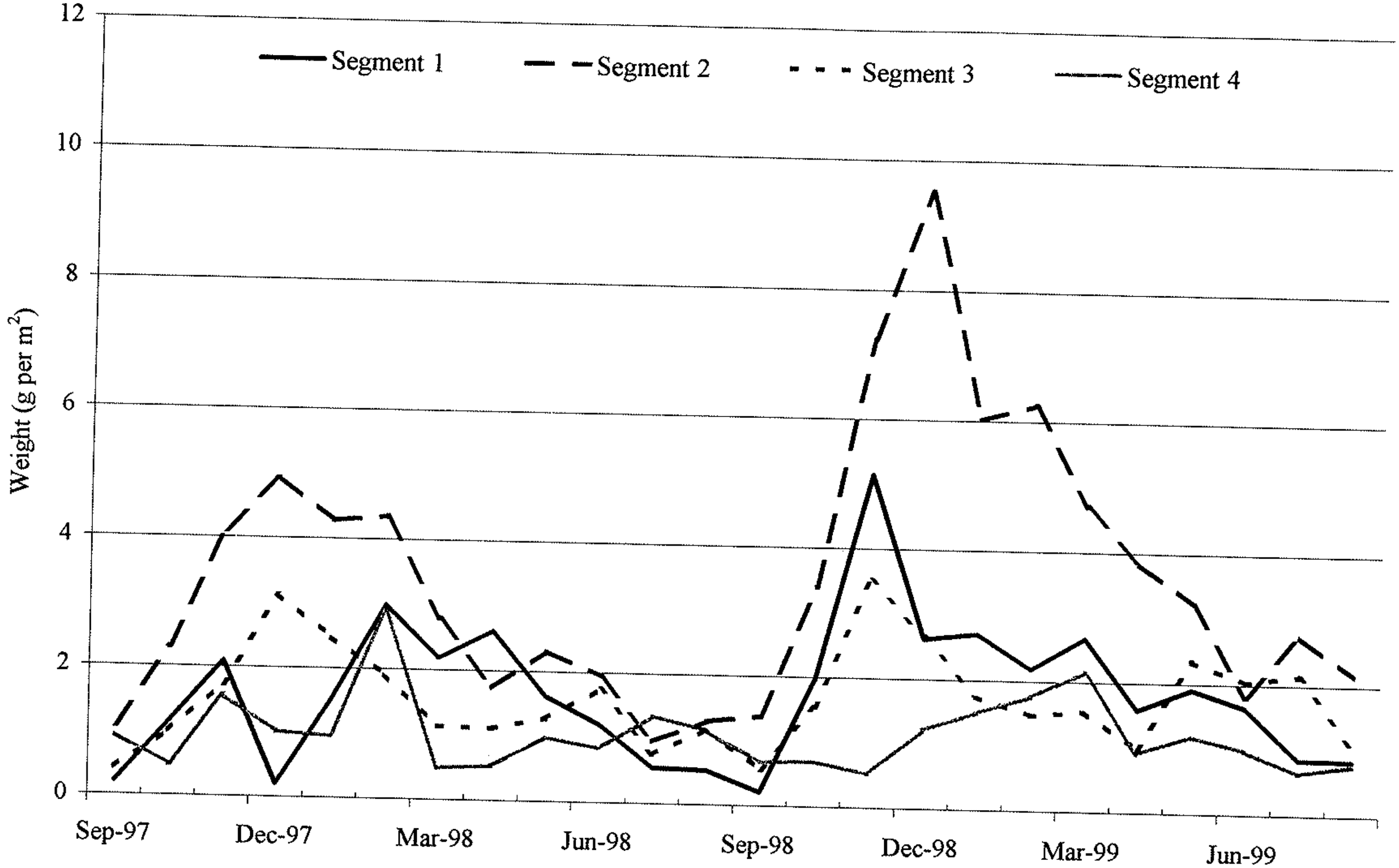


Figure 5.5. Mean monthly weights of macroinvertebrates collected in Newton Lake (24 stations) from September 1997 through August 1999. Benthos was collected using a ponar dredge. Segment 1 is at the discharge end of the lake and Segment 4 is at the intake end of the lake.

Chapter 5. Appendix: Supplemental Data Tables

Appendix 5.1. Collection dates and stations sampled in Newton Lake for benthos during 1997 through 1999. A ponar dredge was used for benthos collection.

Date	Segments	Stations	Date	Segments	Stations
09/11/97	1	1-5	12/10/98	1,2,4	1-6
09/11/97	2	1-6	12/10/98	3	1,2,4,5,6
09/11/97	3	1,5,6	01/28/99	1-4	1-6
09/11/97	4	1,3-6	02/10/99	1-4	1-6
09/12/97	2-3	4	03/22/99	1-4	1-6
09/12/97	4	1	04/15/99	1-4	1-6
09/19/97	3	2,3	04/28/99	1-4	1-6
09/19/97	4	2	05/13/99	1-4	1-6
09/20/97	1	6	05/27/99	1-4	1-6
09/23/97	1-4	1-6	06/09/99	1-4	1-6
10/08/97	1-4	1-6	06/24/99	1-4	1-6
11/24/97	1-4	1-6	07/13/99	1-4	1-6
12/10/97	1-4	1-6	07/30/99	1-4	1-6
01/15/98	1-4	1-6	08/12/99	1-4	1-6
02/12/98	1-4	1-6	08/24/99	1-4	1-6
03/25/98	1-4	1-6			
04/08/98	1-4	1-6			
04/22/98	1-4	1-6			
05/06/98	1-4	1-6			
05/19/98	1-4	1-6			
06/02/98	1-4	1-6			
06/16/98	1	1-5			
06/16/98	2	1,3,4,5			
01/06/00	3-4	1-6			
07/08/98	1	1-5			
07/08/98	2-4	1-6			
07/21/98	1	2-6			
07/21/98	2-6	1-6			
08/05/98	1	2-6			
08/05/98	2-4	1-6			
08/26/98	1-4	1-6			
09/08/98	1-4	1-6			
09/21/98	1-4	1-6			
10/08/98	1-4	1-6			
11/03/98	1-4	1-6			

Appendix 5.2. Mean density (n per m^2) of benthic macroinvertebrates collected from Newton Lake during September 1997 through August 1999. Benthos were collected using a ponar dredge in four segments (24 stations). Segment 1 is at the discharge of the lake and Segment 4 is at the intake end of the lake.

Segment	9/11/97	9/23/97	10/8/97	11/24/97	12/10/97	1/15/98	2/12/98	3/25/98	4/8/98	4/22/98	5/6/98	5/19/98
1	1,638	485	1,193	2,093	674	1,459	2,413	2,312	2,194	3,525	1,591	775
2	735	1,594	3,222	3,630	3,777	3,414	3,256	2,322	2,093	1,786	1,817	1,692
3	1,328	1,294	893	2,380	1,695	1,695	2,127	1,352	967	2,214	1,227	1,389
4	1,419	1,476	1,119	843	1,240	1,368	1,432	1,234	1,105	1,311	1,443	1,170

Segment	6/16/98	7/8/98	7/21/98	8/5/98	8/26/98	09/08/98	09/21/98	10/08/98	11/03/98	12/10/98	01/28/99	02/10/99
1	1,298	897	354	352	856	165	580	2,848	5,349	2,629	3,475	2,302
2	1,567	1,726	330	870	1,523	1,281	1,974	4,176	8,615	8,214	7,408	4,550
3	1,507	1,205	684	762	1,648	425	920	2,241	3,424	3,276	3,158	1,284
4	846	1,753	688	637	1,112	489	603	1,277	1,001	1,621	1,675	1,102

Segment	04/15/99	04/28/99	05/13/99	05/27/99	06/09/99	06/24/99	07/13/99	07/30/99	08/12/99	08/24/99
1	3,340	1,641	4,183	2,073	2,157	1,523	859	1,271	400	944
2	4,149	4,287	3,819	3,977	2,181	2,066	3,707	3,718	2,396	2,016
3	1,665	2,278	4,911	3,219	2,103	1,658	2,653	2,016	1,011	1,473
4	1,736	1,705	2,366	2,282	1,827	1,716	1,065	829	1,170	1,240

Appendix 5.3. Mean weight (g per m^2) of benthic macroinvertebrates collected from Newton Lake during September 1997 through August 1999. Benthos were collected using a ponar dredge in four segments (24 stations).

Segment	9/11/97	9/23/97	10/8/97	11/24/97	12/10/97	1/15/98	2/12/98	3/25/98	4/8/98	4/22/98	5/6/98	5/19/98	6/2/98
1	0.2851	0.1422	1.1392	2.0893	0.2036	1.5106	2.9852	2.1786	2.1196	3.1011	2.0368	1.1975	1.0229
2	0.9404	1.1975	2.2787	4.1075	4.9338	4.2790	4.3539	2.7937	1.7486	1.7233	2.8386	1.7968	1.5797
3	0.4035	0.4169	0.9933	1.7280	3.1112	2.4631	1.9168	1.1220	0.6589	1.5578	1.0414	1.5156	2.2619
4	0.5821	1.2555	0.4742	1.5564	1.0108	0.9464	2.9090	0.4873	0.4273	0.6343	0.6359	1.3512	1.1982

Segment	6/16/98	7/8/98	7/21/98	8/5/98	8/26/98	09/08/98	09/21/98	10/08/98	11/03/98	12/10/98	01/28/99	02/10/99	03/22/99
1	1.4168	0.9066	0.1982	0.2087	0.7971	0.0806	0.3350	1.9886	5.1547	2.6181	2.7142	2.1824	2.6653
2	2.5005	1.7128	0.2025	0.7550	1.8197	1.1759	1.6254	3.3910	7.2444	9.5336	6.0199	6.2555	4.7199
3	1.2255	0.9359	0.6070	0.7654	1.5487	0.2454	0.8756	1.5356	3.5136	2.6621	1.7442	1.4678	1.5430
4	0.4682	2.2174	0.4870	0.5773	1.7000	0.5059	0.8426	0.6990	0.5244	1.2208	1.4975	1.7577	2.1466

Segment	04/15/99	04/28/99	05/13/99	05/27/99	06/09/99	06/24/99	07/13/99	07/30/99	08/12/99	08/24/99
1	2.1115	1.0499	2.5376	1.2700	1.3910	1.8763	0.6400	1.0768	0.3094	1.3767
2	4.0061	3.6832	2.6697	3.7938	2.4550	1.1729	3.4456	2.0681	2.3937	1.9120
3	1.0606	0.9265	1.7617	2.9222	2.0246	2.0411	2.3428	1.9430	0.9175	1.2336
4	0.8750	0.9477	1.0701	1.3131	0.8901	1.0654	0.7489	0.5457	0.7535	0.7897

Appendix 5.4. Mean densities (n per m^2) of macroinvertebrate taxa collected from Newton Lake during September 1997 through August 1999. Twenty-four stations were sampled using a ponar dredge on each date.

Taxa	09/11/97	09/23/97	10/08/97	11/24/97	12/10/97	01/15/98	02/12/98	03/25/98	04/08/98	04/22/98	05/06/98	05/19/98	06/02/98
Ephemeroptera	<1	8	2	43	13	<1	7	8	<1	15	2		7
Hydracarina	<1					<1	2						
Diptera	518	851	1,316	1,797	1,333	1,560	1,982	1,592	1,271	1,624	1,314	1,128	1373
Odonata			<1	3									
Coleoptera			2								<1		
Bryozoa										<1	2	3	13
Trichoptera	<1	3	5	2	3		2						8
Pelecypoda	5	28	93	142	24	16	3	2		45	<1		
Gastropoda			<1										
Hemiptera													
Nematoda		122					<1	4				8	4
Nematomorpha				5	4					2		114	
Veneroida				3	27	<1	19	69	19	48	18		
Haplotaxida	642	194	188	241	268	343	291	152	297	474	181	<1	151
Podocopa									<1			<1	
Lumbriculida										<1			3
Basomatophora													
Amphipoda													

Appendix 5.4. Continued.

Taxa	06/16/98	07/08/98	07/21/98	08/05/98	08/26/98	09/08/98	09/21/98	10/08/98	11/03/98	12/10/98	01/28/99	02/10/99	03/22/99
Ephemeroptera	24	25	14	9	11	<1	13	13	56	7	56	16	17
Hydracarina		<1		<1	2			2	7	4	<1	<1	
Diptera	1,057	1,309	433	504	1,195	548	858	2,400	4,291	3,218	276	1,896	1,998
Odonata						2		2	2		2		
Coleoptera	<1		2										
Bryozoa			<1		4							2	<1
Trichoptera	18	16	3	7	<1	3	4	13	31	18	43	4	8
Pelecypoda						<1	10		2	98	159	30	
Gastropoda											<1		
Hemiptera		<1											
Nematoda				<1		<1		3		<1	33	<1	3
Nematomorpha		<1	<1	3	<1				<1	2		2	
Veneroida	3	3		5	3			2	8	155	2	43	75
Haplotaxida	191	108	82	137	69	28	92	197	197	47	871	316	236
Podocopa									2				
Lumbriculida													
Basomatophora								4					
Amphipoda						7			<1				

Appendix 5.4. Continued.

Taxa	04/15/99	04/28/99	05/13/99	05/27/99	06/09/99	06/24/99	07/13/99	07/30/99	08/12/99	08/24/99
Ephemeroptera	6	5	14	19	3	13	22	9	10	2
Hydracarina	2		2	4	5	<1	2	2	4	2
Diptera	2,283	1,842	2,347	2,463	1,699	1,470	1,696	228	1,132	135
Odonata				<1				1		
Coleoptera			<1							
Bryozoa	5			<1		3		1	3	5
Trichoptera	6	6	1	23	41	8	22	2	4	
Pelecypoda		3								
Gastropoda			2							
Hemiptera										
Nematoda	3	3	9	8	3	5	8	1	5	<1
Nematomorpha								1		
Veneroida	8	35	55	83	75	83	74	6	4	16
Haplotaxida	318	581	137	282	215	158	246	83	92	20
Podocopa										3
Lumbriculida										
Basomatophora										
Amphipoda										

Chapters 6 and 7. Phytomacrobenthos and Aquatic Vegetation

Introduction:

Due to the interaction between the presence of aquatic vegetation and phytomacrobenthos densities and weights, Chapter 6 (Phytomacrobenthos) and Chapter 7 (Aquatic Vegetation) have been combined for this report.

The presence and coverage of aquatic macrophytes plays an important role in the basic ecological functions of a power cooling reservoir such as Newton Lake. Spawning and recruitment of fish are both related to aquatic vegetation in some manner. Some fish use vegetation for spawning, while others require spawning areas devoid of vegetation. The abundance or presence of small fish, whether they are juvenile stages of species that can become very large or species that will not grow more than a few inches, is largely dependent on structure that aquatic macrophytes can provide.

The availability of insects as fish forage is also related to aquatic vegetation coverage. Aquatic invertebrates living on macrophytes - phytomacrobenthos - are an important food item of both juvenile and adult fish.

Chapters 6 and 7 assess the presence and coverage of aquatic macrophytes and the identification, density, and weights of the phytomacrobenthos associated with them. Changes in macrophyte diversity and coverage are being monitored over time and by segments within Newton Lake. Relationships of macrophytes to water levels and invertebrates to water temperature are assessed. Changes in phytomacrobenthos taxa, densities, and weights are also analyzed.

Methods:

Changes in total macrophyte coverage were determined in August 1997, 1998, and 1999 by measuring the extent of the macrophyte beds. Twenty sampling stations, 10 on each side of the lake in each of the four segments, were randomly selected on a map of Newton Lake (Figure 6.1). A numbered metal stake was driven into the shore at each station at pool elevation (505.0). From each stake, a measuring tape was extended out perpendicularly to the shoreline to the outer edge of the vegetation and the distance recorded. The depth of water was recorded at one-meter intervals from the stake to the outer edge of the vegetation. A one-meter long rod was run perpendicularly to the transect line from the shore to the outer edge of the vegetation bed, and the occurrence by plant species was visually noted.

Invertebrates on aquatic vegetation were collected in August and September 1997, and from May through September in 1998 and 1999 from five sampling stations where macrophytes were abundant in each lake segment (Appendix 6.1). Two samples were collected at each station (Figure 6.2). A 1.0-m diameter sampler consisting of a 400-*u* mesh, 3-m long bag with a collapsible opening (Peterka 1972) was used to collect the aquatic vegetation and associated invertebrates in 1997. During the remaining sampling period a 0.5-m (1998) or a 0.291- m (1999) diameter sampler consisting of a 400 *u* mesh, 3-m long bag with a collapsible opening was used. Aquatic macrophytes were cut at the sediment, the bag was closed around the aquatic vegetation, and the contents were immersed in 70% formalin to dislodge the invertebrates from the vegetation. Invertebrates were then stored in a 70% ethanol – rose bengal solution until they were separated and identified as described for Chapter 5 (Benthos). Density of the phytomacrobenthos was estimated as invertebrates per m^2 of water surface area (Downing and Rigler 1984). Wet weights were estimated as described in Peterka (1972) and used to estimate total biomass of the invertebrates per-gram wet weight of the aquatic vegetation. Total biomass and number of phytomacrobenthos at each sampling date was extrapolated from estimated total aquatic macrophytes in the littoral zone.

Results:

The amount and diversity of macrophytes present in Newton Lake during the three-year study was generally due to differences to water levels and not water temperatures. The effect of the low water levels in August 1997 (2.13 ft below pool) and 1999 (5.20 ft below pool) is best described by comparing the total amount of macrophyte coverage for the entire lake. There are approximately 40.887 miles of shoreline in Newton Lake. The average feet (rounded) that macrophytes extended from the water's edge in August of each year for all 80 sites was 3.04 (1997), 7.03 (1998), and 4.43 (1999). Thus, there were 656,642 ft^2 of macrophytes present in 1997 and 955,603 ft^2 of macrophytes in 1999. The water in Newton Lake in August 1998 was at pool level, and there were 1,517,164 ft^2 of macrophytes. Particularly noteworthy is the fact that there were more macrophytes present in 1999 than in 1997 despite the lower water levels and extremely high water temperatures in 1999. In fact, macrophyte mean densities (lbs per m^2) were highest during May 1998 and August 1999 (Figure 6.3). Several factors could affect macrophyte presence and density in Newton Lake including (but not limited to) water clarity, changes in nutrient loading, and the amount of macrophytes present in the previous years.

The percent of stations with some type of macrophyte was highest during the 1998 sampling when 32.3% of the 80 stations did not have macrophytes. In August 1997 and 1999, macrophytes were not present in 52.5% and 39.5% of the stations in the respective years. The same was basically true when the lakes were divides by segments (Table 6.1). Except for Segment 2 in 1999, percent occurrence and the highest macrophyte diversity was in 1998 when the water level was at pool. Water willow (*Dianthera americana*) was the only macrophyte present in 1997 and was most the prevalent plant in all years. *Phragmites australia and* spike rush (*Eleocharis* spp) were present in the latter two years, but they were most abundant in the water during 1998. The percent occurrence of macrophytes usually decreased from Segment 1 (discharge segment) to Segment 4 (intake segment) of all years.

Distances from the shoreline to the outer edge of macrophytes for the sites containing macrophytes ranged from 0.19 ft to 24.71 ft. The mean was highest in 1998 (Table 6.2). Although water levels were lowest in 1999, the distances that macrophytes were found from shore were not always less than in 1997.

Mean depths at which macrophytes occurred in all years ranged from 0.02 ft to 2.82 ft (Table 6.2). Maximum depths of which macrophytes were sampled were not always due to August water levels. Based on the lack of correlation between water levels and depths of which macrophytes occurred in each year, the plant depths were likely dependent on water clarity and lake contour. Even plant diversity was not water level dependent. This was surprising since many plant species that were identified in 1997 existed in areas that were marginally aquatic. Higher water levels in 1998 did result in more inundated macrophyte species. However, lowest water levels were recorded in August 1999, but macrophytes diversity was higher than in the previous years.

Macrophytes were collected and weighed during May through September when phytomacrobenthos samples were collected (Appendix 6.1). Approximate sample locations for the four lake segments are shown in Figure 6.2. Macrophyte densities (weight per m^2) were generally higher in each month during 1998 than in the other years. Sample weights were variable among the months and years (Figure 6.3). Mean densities during July and August were higher in 1998 and 1999 than in August 1997. As with the 80 sites sampled each August, water willow was the primary species sampled at stations where phytomacrobenthos were collected (Table 6.3), and their percent contribution (by wet weight) was higher than all other macrophyte taxon (Table 6.4).

Plant diversity in the twenty stations sampled May - September increased slightly each year (Table 6.4). Macrophyte taxa collected included water willow, phragmites, cattails (*Typha* spp.), spike rush (*Eleocharis* spp.), primrose (*Jussiaea repens var. glabrescens*, pond weed (*Potomogeton* spp), and other rushes (*Scirpus* spp.). Taxa diversity increased from Segment 1 to Segment 4 each year).

The phytomacrobenthos (invertebrates) mean density for all samples combining the entire sampling period was 5,326 organisms per m^2 with a standard deviation of 7,972 per m^2 (Table 6.5). Such a high standard deviation resulted from individual samples ranging from 31 to 99,844. The highest densities were collected in May (10,605 per m^2) and August (12,566 per m^2) 1999. August densities were significantly (p=0.0006) higher in 1999 than 1997 (1,628 per m^2) and 1998 (6,849 per m^2). The differences were not significant between 1997 and 1998. Examination of abundance trends over time indicate that there was a slight decrease in the aquatic invertebrates during June and July 1998 and 1999, but numbers increased during the following months in each year (Figure 6.4). Trends of abundance by month and year within segments were similar to the combined segments except in Segment 4 where abundance patterns over time were less evident (Figure 6.5). There were no significant differences among the segments (Table 6.6).

Mean densities of the different invertebrate taxon collected ranged from 0.04 per m^2 of Order Decapoda to 3,863.54 per m^2 of Order Diptera (Table 6.7). Diptera were present in all samples and occurred at higher densities than all other organisms (Appendix 6.2). Haplotaxida (mostly Tubificidae) and Trichoptera were present in the second highest densities. Invertebrates of the Family Chironomidae represented 98.8 percent of all the Diptera collected (Table 6.8).

In order to detect the effects of plant densities on phytomacrobenthos densities, plant biomass is included in the analysis. The highest number of invertebrates per pound of macrophytes were collected during May, August, and September 1999 (p=0.0001, Table 6.9). Segment 4 had the highest mean densities per pound when all sampling dates were included in the analysis (p=0.0001, Table 6.10). The higher densities in Segment 4 were mostly evident in months other than in May (Figure 6.6).

The mean weight of phytomacrobenthos per m^2 for the entire sampling period was 2.1283 g per m^2 with a standard deviation of 3.6457 g per m^2 (Table 6.11). Such a large standard deviation is a result of individual samples ranging from 0.0000 to 39.7136 g per m^2. Mean weights were also significantly (p = 0.0001) different across collection dates. September 1999 had significantly higher mean weights than all other months sampled. May and August 1999 were higher than all months except September 1999. As was true for the phytomacrobenthos numbers, mean August weights were significantly higher (p=0.0001) in 1999 (4.313 g per m^2) than in 1998 (1.646 g per m^2) or 1997 (0.369 g per m^2). Biomass trends among dates and segments for phytomacrobenthos were similar to those described for the invertebrate numbers (Figure 6.7). Phytomacrobenthos mean weights in our samples were significantly (p =0.0001) greater in Segments 1 and 2 than in the remaining segments (Table 6.12). Diptera comprised over 72% of the weight of all the organisms collected (Table 6.13) and usually contributed most to biomass on each sampling date (Appendix 6.3).

In order to determine if invertebrate mass was a function of macrophyte densities, we compared the mass per sample means by per pound of macrophytes. This analysis compensates for changes in plant biomass (lbs per m^2) over time. The highest (p = 0.0001) mean weight per pound of macrophytes was collected in September 1999 followed by May and August 1999 (Table 6.14). There were no significant differences in the weight of organisms per pound of macrophytes across segments (Table 6.15). High standard deviations were seen for both collection dates and segments. No trends were apparent for weight of organisms per pound of macrophytes over time for all segments (Figure 6.8). Lower weights during July of both the respective years may have been due to emergence of invertebrates as adults rather than temperature related.

Discussion:

Macrophyte taxa diversity increased in Newton Lake from August 1997 through September 1999. Diversity increased somewhat from Segment 1 to Segment 4 (warm water to cold water). This increase in diversity included a change to such macrophytes as phragmites, bulrush, spike rush, and cattails. Submergent macrophytes other than algae were not found at any sample location. Macrophyte coverage increased from 1997 to 1998, and the increase was related to water levels. However, the lowest water levels were during 1999, and macrophyte coverage and diversity was higher than in 1997.

Considerable variability existed in plant weights sampled for phytomacrobenthos assessment. Due to seasonal plant growth in the lake, it is hard to collect samples over time without confounding variables. We would expect to see seasonal changes in phytomacrobenthos densities and weights per meter squared. This was the case in some instances, but not all.

There does not appear to be a correlation between phytomacrobenthos densities/weights and plant biomass. Macrophyte weights collected in 1998 were significantly higher than in 1997 or 1999. In 1997 and 1998, as plant weights decreased significantly in the samples, invertebrate densities did not. However, there appeared to be a positive correlation between macrophyte and invertebrate densities in 1999 (Figures 6.3 and 6.4). Most of the phytomacrobenthos sampled from all segments were of the Family Chironomidae. One reason for this may be an association of chironomids with water willow, which also comprised the vast majority of macrophytes in Newton Lake. It does not appear that water temperature had an adverse effect on macrophyte or phytomacrobenthos densities.

Macrophyte density was more related to water levels than temperature, and phytomacrobenthos numbers were apparently unaffected by the high water temperatures in 1999.

Literature Cited:

Downing, J.A., and F.H. Rigler. 1984. A manual on methods for the assessment of secondary productivity in fresh water. Blackwell Scientific Publications, Boston, Massachusetts.

Peterka, J.J. 1972. Benthic invertebrates in Lake Astabula Reservoir, North Dakota. American Midland Naturalist 88(2):408-418.

Table 6.1. Percent of stations with no vegetation or occurrence of macrophyte taxa in Newton Lake during August of 1997, 1998, and 1999. Twenty stations were selected in each of four segments. Numbers in parenthesis represent feet below pool in August of each year..

Taxa	1997 (-2.13)	1998 (0.00)	1999 (-5.20)
		Segment 1	
None	20.00	5.00	30.00
Dianthera americana	80.00	95.00	70.00
		Segment 2	
None	35.00	20.83	15.00
Dianthera americana	65.00	62.50	80.00
Phragmites australia		12.50	5.00
Eleocharis spp.		4.17	
		Segment 3	
None	65.00	29.63	33.33
Dianthera americana	35.00	44.44	61.90
Phragmites australia		14.81	4.76
Eleocharis spp.		3.70	
Scirpus spp.		3.70	
Najas spp.		3.70	
		Segment 4	
None	90.00	72.73	80.00
Dianthera americana		13.64	15.00
Eleocharis spp.	10.00	9.09	
Scirpus spp.		4.55	5.00

Table 6.2. Mean distances (ft) from shore to outer edge of macrophytes, and mean depths (ft) macrophytes were found in 20 stations in each of four segments in Newton Lake in August of 1997, 1998, and 1999. Stations without macrophytes were not included in the computations.

Year	Segment	Stations with macrophytes	Mean	Range		Standard deviation	Mean	Range		Standard deviation
			Distance				Depth			
1997	1	16	4.43	0.98	11.21	3.02	0.76	0.24	1.24	0.32
	2	13	8.46	4.92	12.80	2.14	1.12	0.56	1.78	0.40
	3	7	7.63	1.97	12.04	3.18	1.40	0.26	2.59	0.88
	4	2	4.59	3.94	5.25	0.93	0.58	0.53	0.62	0.06
Weighted mean		38	6.40	0.98	12.80	3.24	0.99	0.24	2.59	0.53
1998	1	19	8.30	0.66	24.61	5.40	1.62	0.92	2.36	0.43
	2	16	14.45	7.78	23.95	4.42	2.05	0.91	2.82	0.45
	3	13	10.55	2.30	22.64	5.38	1.14	0.21	2.36	0.70
	4	4	9.05	6.59	10.99	1.95	1.10	0.69	1.49	0.44
Weighted mean		52	10.81	0.66	24.61	5.48	1.59	0.21	2.82	0.62
1999	1	14	6.17	0.19	24.71	6.85	0.88	0.02	1.97	0.71
	2	17	9.85	1.78	17.68	4.22	1.36	0.26	2.26	0.55
	3	13	6.48	0.33	15.72	4.53	0.83	0.03	2.28	0.69
	4	4	4.01	2.00	7.87	2.75	1.00	0.08	2.69	1.16
Weighted mean		48	7.38	0.19	24.71	5.35	1.05	0.02	2.69	0.71

Table 6.3. Percent occurrence of macrophytes in samples collected from Newton Lake during August and September 1997 and May through September 1998 and 1999. When possible, two samples were collected from each of five stations within four segments of the lake.

Macrophyt taxa	Common name	Number of samples	Percent occurrence
	1997		
Dianthera americana	Water willow	66	98.51
Pithophora spp.	Algae	1	1.49
	1998		
Dianthera americana	Water willow	166	83.00
Phragmites australia	Phragmites	11	5.50
Typha spp.	Cattails	2	1.00
Eleocharis spp.	Spike rush	5	2.50
Scirpus spp.	Bulrush	16	8.00
	1999		
Dianthera americana	Water willow	158	68.10
Phragmites australia	Phragmites	14	6.03
Eleocharis spp.	Spike rush	15	6.47
Jussiaea repens var. glabrescens	Primrose	2	0.86
Scirpus spp.	Bulrush	10	4.31
Potomogeton nodosus	Pondweed	1	0.43
Pithophora spp.	Algae	32	13.79

Table 6.4. Percent occurrence by weight (g) of macrophytes in samples collected during 1997, 1998, and 1999 in Newton Lake. Samples were collected at five stations located in four segments.

Year	Segment	Macrophyt taxa	Number of samples	Pounds per m^2	Range		Standard deviation	Percent by weight
1997	1	*Dianthera americana*	10	0.704	0.269	2.291	0.604	100
1997	2	*Dianthera americana*	10	1.394	0.435	3.340	0.886	100
1997	3	*Dianthera americana*	10	0.844	0.137	2.748	0.752	100
1997	3	*Pithophora* spp.	1	0.034	0.034	0.034	0.000	<1
1997	4	*Dianthera americana*	4	1.094	0.135	2.201	0.982	100
	Mean of plants combined by sample		34	0.995	0.135	3.340	0.798	
1998	1	*Dianthera americana*	49	6.426	0.426	17.567	4.663	100
1998	2	*Dianthera americana*	50	7.477	0.673	27.494	5.686	100
1998	3	*Dianthera americana*	46	3.277	0.684	17.948	2.881	92
1998	3	*Phragmites australia*	2	3.449	2.636	4.263	1.150	4
1998	3	*Scirpus* spp.	2	3.051	2.569	3.534	0.682	4
1998	4	*Dianthera americana*	20	1.749	0.370	4.498	1.259	38
1998	4	*Phragmites australia*	1	1.795	1.795	1.795	0.000	2
1998	4	*Typha* spp.	2	3.612	3.006	4.218	0.857	8
1998	4	*Eleocharis* spp.	5	4.063	2.973	5.160	1.075	22
1998	4	*Scirpus* spp.	14	1.925	0.437	5.485	1.396	30
	Mean of plants combined by sample		191	4.941	0.370	27.494	4.577	
1999	1	*Dianthera americana*	42	4.022	1.391	12.386	2.715	96
1999	1	*Jussiaea repens var. glabrescens*	2	0.563	0.397	0.729	0.234	1
1999	1	*Pithophora* spp.	4	1.316	0.033	4.405	2.083	3
1999	2	*Dianthera americana*	49	6.461	0.232	34.442	7.230	99
1999	2	*Phragmites australia*	3	0.243	0.132	0.364	0.116	<1
1999	2	*Pithophora* spp.	3	0.342	0.232	0.497	0.138	<1
1999	3	*Dianthera americana*	46	2.121	0.166	6.624	1.291	84
1999	3	*Phragmites australia*	6	0.684	0.132	1.954	0.662	4
1999	3	*Eleocharis* spp.	3	0.464	0.099	0.795	0.349	1
1999	3	*Scirpus* spp.	2	0.513	0.099	0.927	0.585	1
1999	3	*Pithophora* spp.	16	0.762	0.066	2.649	0.768	10
1999	4	*Dianthera americana*	20	2.671	0.331	9.107	2.274	61
1999	4	*Phragmites australia*	5	1.351	0.232	2.285	0.775	8
1999	4	*Eleocharis* spp.	12	0.803	0.199	1.855	0.501	11
1999	4	*Scirpus* spp.	8	0.861	0.066	2.285	0.966	8
1999	4	*Potomogeton nodosus*	1	0.431	0.431	0.431	0.000	21
1999	4	*Pithophora* spp.	9	1.163	0.099	2.550	0.957	12
	Mean of plants combined by sample		180	4.004	0.068	35.585	4.631	

Table 6.5. Mean number of phytomacrobenthos per m^2 in Newton Lake during August and September 1997 and May - July 1998 and 1999. Superscripts indicate numbers that were significantly different at the $\alpha = 0.05$ level.

Month collected	Number of samples	Number	Range		Standard deviation
Aug-97[d,e]	30	1,628	94	8,399	1,977
Sep-97[e]	30	615	31	4,604	912
May-98[c,d]	39	4,968	331	13,771	3,261
Jun-98[c,d]	38	4,508	509	12,742	3,345
Jul-98[d,e]	40	2,188	209	11,398	2,333
Aug-98[b,c]	40	6,849	311	99,844	15,621
Sep-98[d,e]	40	2,414	173	21,329	4,292
May-99[a]	40	10,605	1,087	48,933	9,889
Jun-99[d,e]	40	2,936	140	17,756	3,419
Jul-99[c,d]	40	5,084	249	27,185	6,161
Aug-99[a]	38	12,566	1,895	33,554	9,869
Sep-99[a,b]	26	9,065	948	28,692	7,933
Weighted mean	**441**	**5,326**	**31**	**99,844**	**7,972**

Table 6.6. Mean density (n per m^2) of phytomacrobenthos collected in four segments of Newton Lake during August and September 1997, and May - September in 1998 and 1999. Five stations were sampled in each segment when possible, and two samples were taken per station. Superscripts with the same letter indicate the means were not statistically significant at the $\alpha = 0.05$ level.

Segment	Number of samples	Mean density	Range		Standard deviation
1^a	106	5,353	31	31,007	6,392
2^a	117	6,671	140	48,933	8,662
3^a	115	3,850	65	21,173	4,390
4^a	103	5,417	94	99,844	10,986

Table 6.7. Mean densities (n per m^2) of phytomacrobenthic invertebrates collected in Newton Lake during August and September 1997 and May - August 1998 and 1999. Collections were made from 20 stations (441 samples) were sampled throughout the lake when vegetation was present.

Taxa	Mean density	Range		Standard deviation
Ephemeroptera	86.79	0.00	1,894.52	190.98
Hydracarina	5.56	0.00	683.51	39.80
Diptera	3,863.79	1.27	93,228.51	6,415.42
Odonata	113.70	0.00	6,369.09	438.72
Coleoptera	16.23	0.00	1,115.32	76.55
Bryozoa	0.30	0.00	31.07	2.34
Trichoptera	226.72	0.00	3,572.90	467.22
Pelecypoda	0.19	0.00	56.02	2.78
Hemiptera	3.26	0.00	728.27	36.44
Gastropoda	4.10	0.00	453.26	29.89
Nematoda	6.22	0.00	295.15	27.07
Nematomorpha	0.18	0.00	20.37	1.57
Veneroida	0.27	0.00	76.39	3.77
Haplotaxida	739.83	0.00	20,163.60	2,164.96
Podocopa	21.25	0.00	4,225.35	211.50
Lumbriculida	4.86	0.00	1,102.94	54.67
Isopoda	0.17	0.00	56.02	2.78
Ostracoda	1.75	0.00	728.27	34.71
Oligochaeta	118.05	0.00	18,940.06	1,021.52
Acarina	0.72	0.00	56.02	4.89
Amphipoda	4.21	0.00	699.05	37.57
Hirudinea	0.63	0.00	53.47	4.48
Basomatophora	39.64	0.00	1,211.68	137.15
Decapoda	0.04	0.00	15.53	0.74
Tricladida	23.57	0.00	2,050.54	150.49
Other	43.68	0.00	6,741.91	346.97

Table 6.8. Number and percent of invertebrates of the Order Diptera grouped by family that were collected from Newton Lake in association with macrophytes. The phytomacroinvertebrates were collected during August and September 1997 and May - August 1998 and 1999.

Family	Number collected	Percent
Chironomidae	217,858	98.80
Ceratopogonidae	2,483	1.13
Chaoboridae	138	0.06
Tabinidae	18	0.01
Stratiomyidae	6	0.00
Tipulidae	7	0.00

Table 6.9. Mean number of phytomacrobenthos per pound of macrophytes in Newton Lake during August and September 1997 and May - July 1998 and 1999. Superscripts indicate numbers per kilogram that were significantly different at the $\alpha = 0.05$ level.

Month collected	Number of samples	Number per pound	Range		Standard deviation
Aug-97[c,d]	2	1,075.55	521.32	1,629.77	783.80
Sep-97[d]	30	1,005.58	60.53	9,713.99	2,093.32
May-98[d]	39	866.43	78.50	2,651.44	534.58
Jun-98[b,c,d]	38	1,505.66	193.26	4,139.53	1,038.69
Jul-98[d]	40	473.38	31.70	2,259.95	511.82
Aug-98[b,c,d]	39	2,066.42	26.84	22,705.79	3,641.71
Sep-98[d]	40	842.87	28.41	9,274.89	1,617.56
May-99[a]	40	3,941.90	954.56	18,160.00	3,419.60
Jun-99[b,c,d]	40	1,359.85	21.39	4,797.08	1,215.23
Jul-99[b,c,d]	39	1,841.78	132.42	10,669.00	2,092.45
Aug-99[a,b,c]	38	2,768.39	304.12	9,031.36	2,426.01
Sep-99[a,b]	23	3,036.76	1,064.55	6,088.64	1,540.95

Table 6.10. Mean number of phytomacrobenthos per pound of macrophytes collected in four segments of Newton Lake during August and September 1997 and May - August 1998 and 1999. Five stations were sampled in each segment when possible, and two samples were taken per station. Numbers with different superscripts are significantly different at the α = 0.05 level.

Segment	Number of samples	Number per pound	Range		Standard deviation
1[b]	98	1,351.47	26.84	9,713.99	1,614.24
2[b]	109	1,426.34	21.39	10,940.29	1,845.92
3[b]	105	1,731.69	92.22	9,461.36	1,943.64
4[a]	96	2,560.07	110.11	22,705.79	3,355.12
Weighted mean	**408**	**1,753.70**	**21.39**	**22,705.79**	**2,310.67**

Table 6.11. Mean weights (g) of phytomacrobenthos per m^2 in Newton Lake during August and September 1997 and May - September 1998 and 1999. Superscripts indicate numbers that were significantly different at the α = 0.05 level.

Month collected	Number of samples	Weight (g per m^2)	Range		Standard deviation
Aug-97[d]	30	0.3691	0.0000	1.9255	0.4371
Sep-97[d]	30	0.3930	0.0194	2.8518	0.6050
May-98[c,d]	39	1.4415	0.0530	4.2331	0.9883
Jun-98[c,d]	38	1.2560	0.1090	3.6744	0.8671
Jul-98[c,d]	40	1.0279	0.0738	4.9339	1.0944
Aug-98[c,d]	40	1.6455	0.1329	9.7746	1.9942
Sep-98[c,d]	40	0.9976	0.0499	9.3251	1.6490
May-99[b]	40	4.2294	0.1988	17.8366	4.1618
Jun-99[c,d]	40	1.0878	0.0435	4.0172	0.9425
Jul-99[c]	40	2.1275	0.0482	10.7218	2.8286
Aug-99[b]	38	4.3130	0.5049	28.2679	5.0490
Sep-99[a]	26	7.8171	0.5561	39.7136	8.7448
Weighted mean	**441**	**2.1283**	**0.0000**	**39.7136**	**3.6457**

Table 6.12. Mean weights (g per m^2) of phytomacrobenthos collected in four segments of Newton Lake during August and September 1997 and May - August 1998 and 1999. Five stations were sampled in each segment when possible, and two samples were taken per station. Segments with different superscripts have significantly different mean weights at the α = 0.05 level.

Segment	Number of samples	Mean Weight	Range		Standard deviation
1[a]	106	2.6769	0.0000	23.8670	3.9940
2[a]	117	2.7115	0.0102	39.7136	4.7131
3[b]	115	1.5800	0.0214	28.2679	3.0962
4[b]	103	1.5134	0.0274	9.7746	1.8746

Table 6.13. Mean weights (g per m^2) of phytomacrobenthic invertebrates collected in Newton Lake during August and September 1997 and May - August 1998 and 1999. Twenty stations (two samples per station) were sampled (441 samples) throughout the lake when vegetation was present.

Taxa	Mean weight	Range		Standard deviation
Ephemeroptera	0.0550	0.0000	1.3409	0.1369
Hydracarina	0.0012	0.0000	0.1693	0.0098
Diptera	1.5411	0.0000	32.8458	2.8118
Odonata	0.2028	0.0000	14.2807	0.8755
Coleoptera	0.0371	0.0000	6.9035	0.3434
Bryozoa	0.0021	0.0000	0.8062	0.0387
Trichoptera	0.0910	0.0000	1.7088	0.2126
Pelecypoda	0.0001	0.0000	0.0295	0.0016
Hemiptera	0.0150	0.0000	2.3348	0.1574
Gastropoda	0.0103	0.0000	0.9525	0.0725
Nematoda	0.0002	0.0000	0.0171	0.0013
Nematomorpha	0.0000	0.0000	0.0051	0.0003
Veneroida	0.0009	0.0000	0.2237	0.0120
Haplotaxida	0.0541	0.0000	2.7651	0.2134
Podocopa	0.0033	0.0000	0.7410	0.0368
Lumbriculida	0.0003	0.0000	0.0575	0.0030
Isopoda	0.0001	0.0000	0.0367	0.0019
Ostracoda	0.0002	0.0000	0.0922	0.0044
Oligochaeta	0.0075	0.0000	1.1540	0.0656
Acarina	0.0003	0.0000	0.0811	0.0039
Amphipoda	0.0025	0.0000	0.3961	0.0227
Hirudinea	0.0050	0.0000	1.7026	0.0823
Basomatophora	0.0607	0.0000	2.8148	0.2527
Decapoda	0.0149	0.0000	6.5571	0.3122
Tricladida	0.0069	0.0000	0.5437	0.0406
Other	0.0157	0.0000	0.6198	0.0652

Table 6.14. Mean weight (g) of phytomacrobenthos per pound of macrophytes in Newton Lake during August and September 1997 and May - July 1998 and 1999. Numbers with different superscripts are significantly different at the $\alpha = 0.05$ level.

Month collected	Number of samples	Weight per pound	Range		Standard deviation
Aug-97[c,d]	2	0.4934	0.1121	0.8746	0.5392
Sep-97[c,d]	30	0.5263	0.0399	6.0172	1.1111
May-98[d]	39	0.2316	0.0149	0.4604	0.1194
Jun-98[c,d]	38	0.3993	0.0463	1.1218	0.2689
Jul-98[d]	40	0.1919	0.0192	0.7714	0.1536
Aug-98[c,d]	39	0.5459	0.0179	3.1118	0.6289
Sep-98[d]	40	0.2853	0.0287	1.5485	0.3209
May-99[b]	40	1.3756	0.2936	3.8668	0.8853
Jun-99[c,d]	40	0.5179	0.0067	2.0598	0.4796
Jul-99[c,d]	39	0.6010	0.0166	2.3116	0.5850
Aug-99[b,c]	38	1.0008	0.1032	7.9437	1.3466
Sep-99[a]	23	2.5487	0.4031	7.6207	2.0173

Table 6.15. Mean weight (g) of phytomacrobenthos per pound of macrophytes collected in four segments of Newton Lake during August and September 1997 and May - August 1998 and 1999. Five stations were sampled in each segment when possible, and two samples were taken per station. Numbers with different superscripts are significantly different at the $\alpha = 0.05$ level.

Segment	Number of samples	Weight per pound	Range		Standard deviation
1[a]	98	0.6838	0.0149	7.6207	1.0947
2[a]	109	0.5318	0.0067	3.8668	0.7074
3[a]	105	0.7605	0.0166	7.9437	1.3042
4[a]	96	0.7537	0.0176	3.2104	0.7298
Total	**408**	**0.6794**	**0.0067**	**7.9437**	**0.9931**

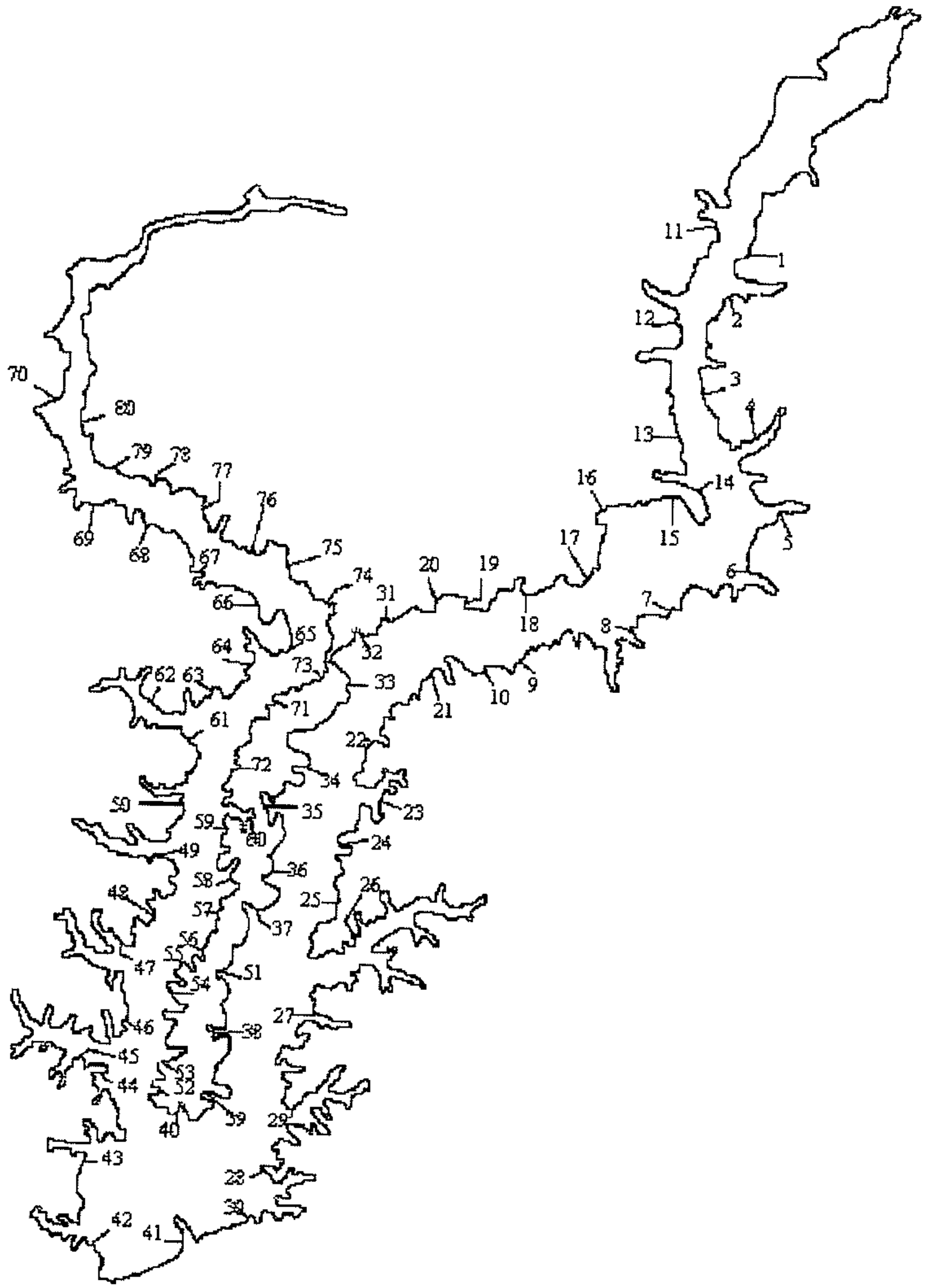


Figure 6.1. Locations where vegetation was identified in August of 1997, 1998, and 1999.

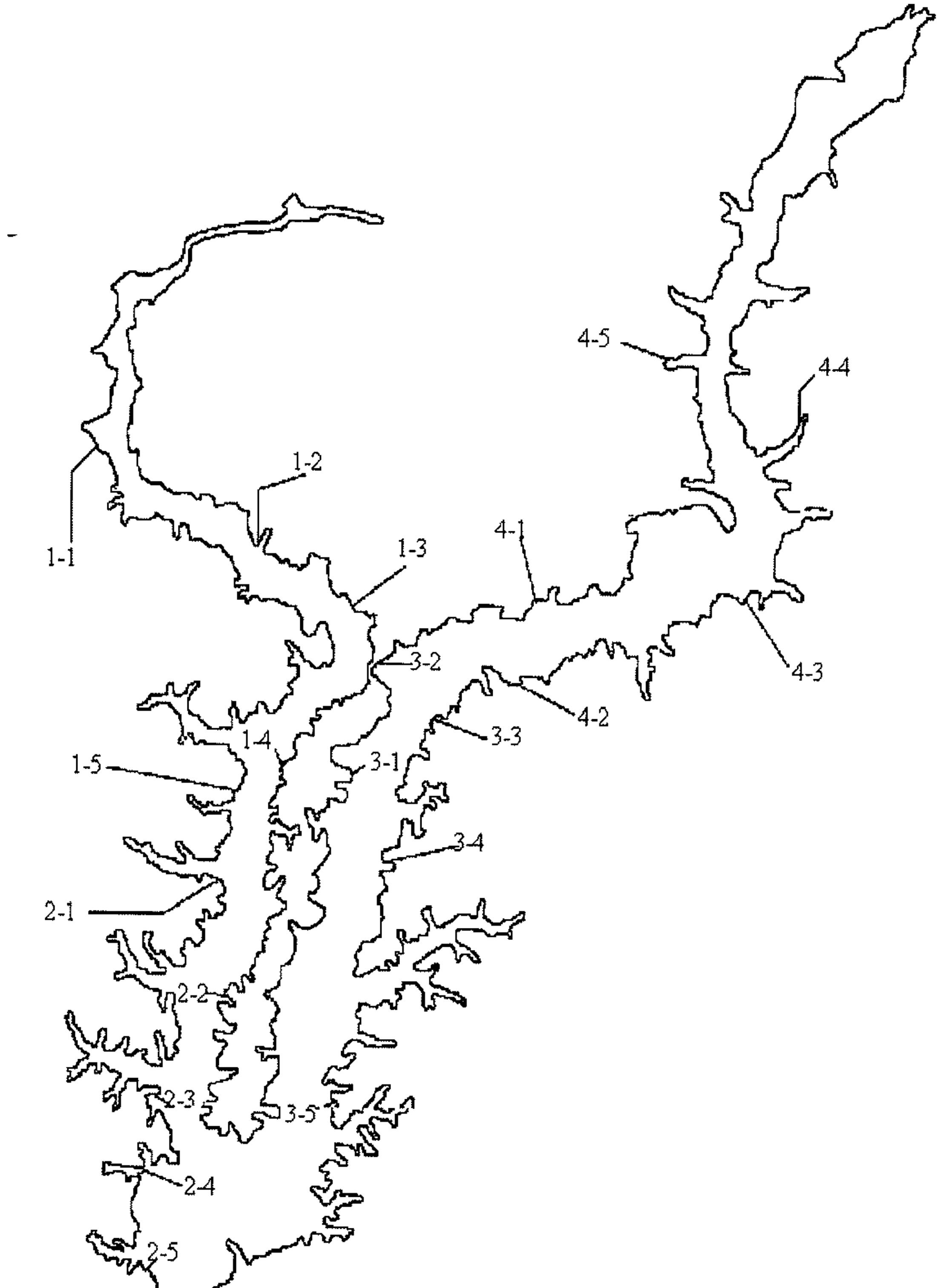


Figure 6.2. Approximate locations of stations in four segments of Newton Lake where phytomacrobenthos was collected during August and September 1997 and May - September 1998 and 1999. Numbers indicate segment - station

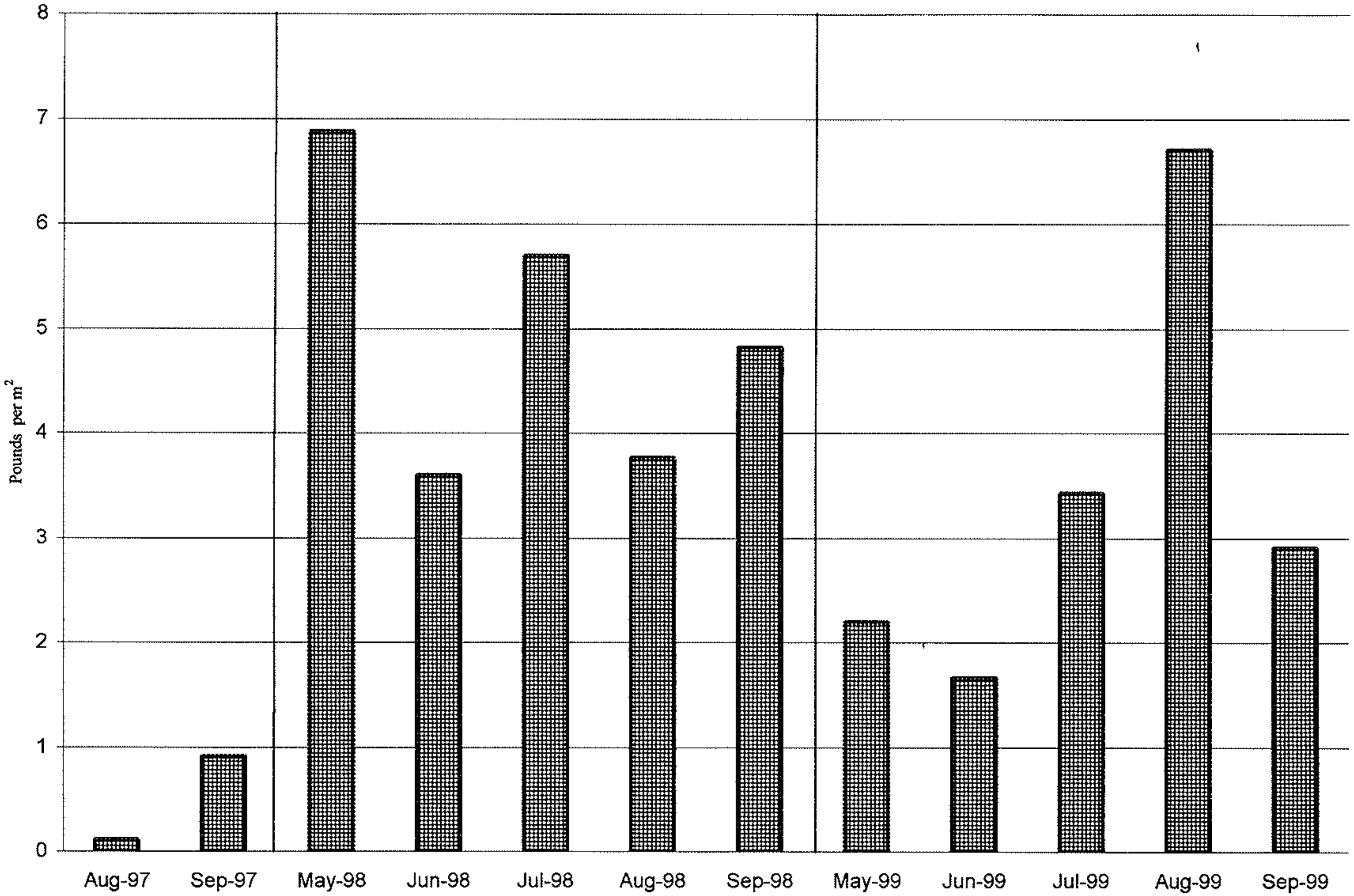


Figure 6.3. Mean weights (lbs per m^2) of macrophytes collected from four segments in Newton Lake. The macrophytes were collected with a 1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh net at 5 stations per segment, and two samples per station. The macrophytes were collected at random areas within each station.

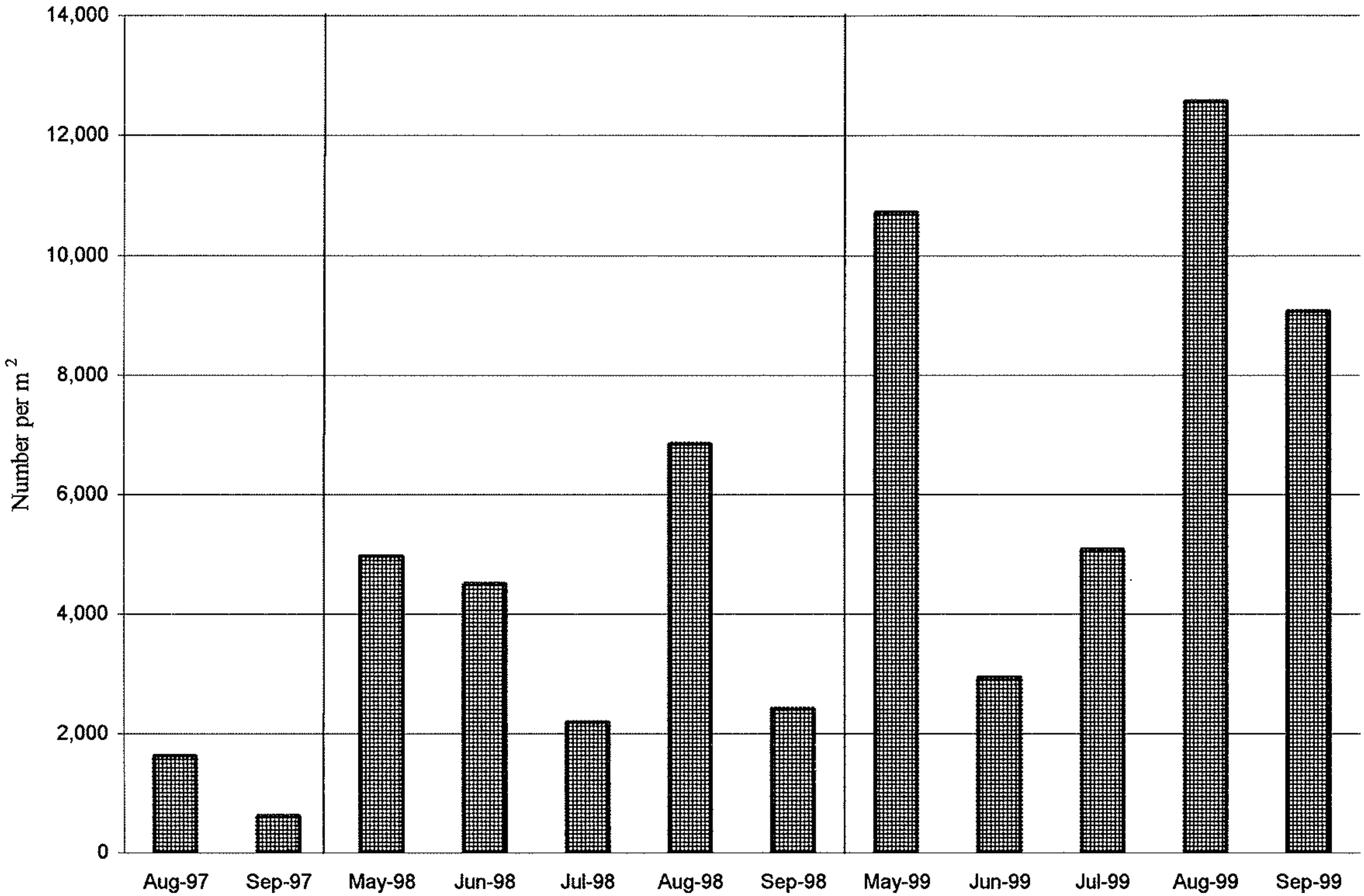


Figure 6.4. Mean number of phytomacrobenthos per m^2 collected from Newton Lake. The invertebrates were collected with1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh plankton net at 5 stations in each of four segments. Two samples were taken per station.

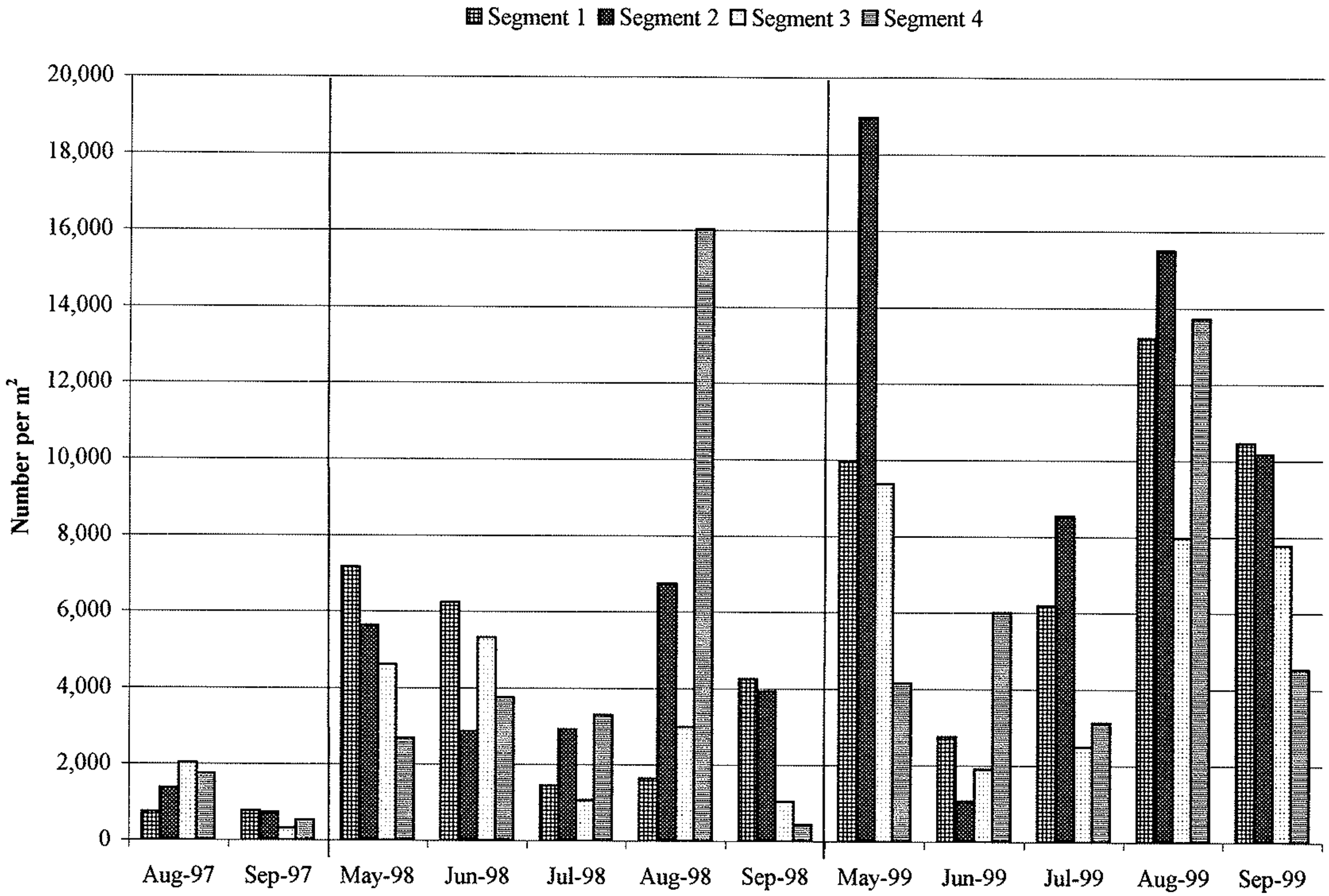


Figure 6.5. Mean number of phytomacrobenthos collected from four segments in Newton Lake. The invertebrates were collected with a 1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh plankton net at 5 stations per segment. Two samples were taken per station.

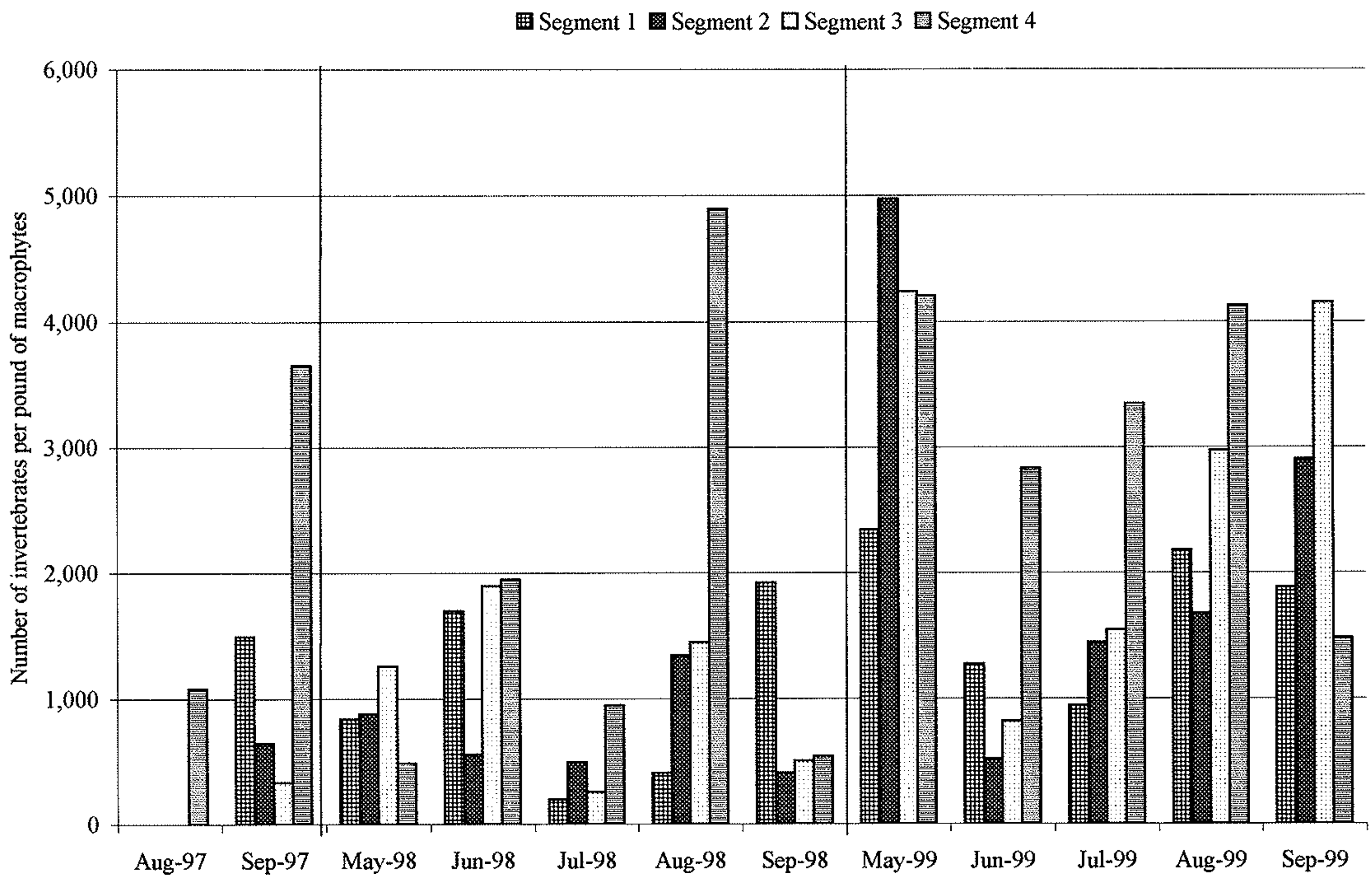


Figure 6.6. Mean number of phytomacrobenthos per pound of macrophytes collected from four segments in Newton Lake. The invertebrates were collected with a 1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh plankton net at 5 stations per segment. Two samples were taken per station.

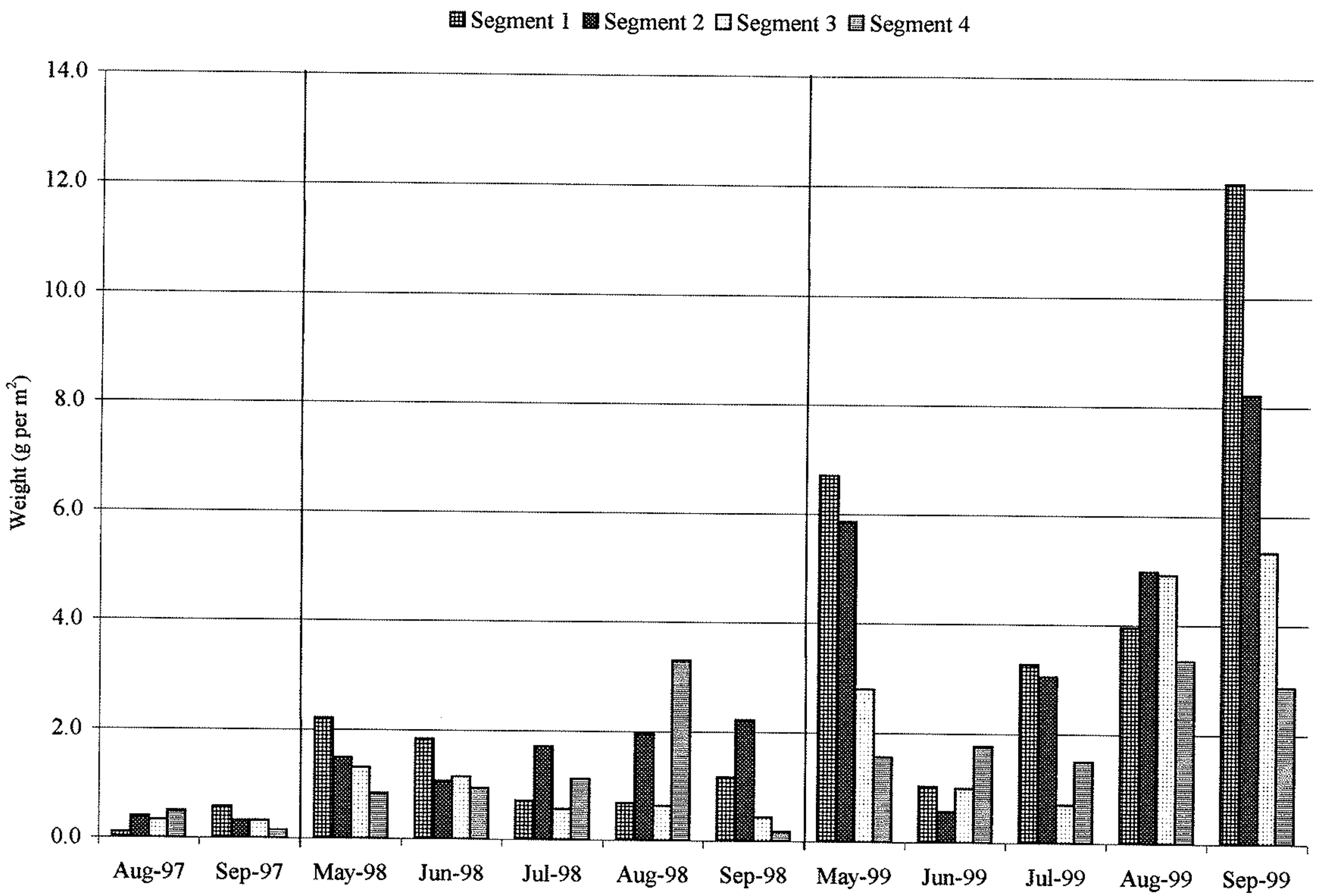


Figure 6.7. Mean weight (g) of phytomacrobenthos per m^2 collected from four segments in Newton Lake. The invertebrates were collected with a 1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh plankton net at 5 stations per segment. Two samples were taken per station.

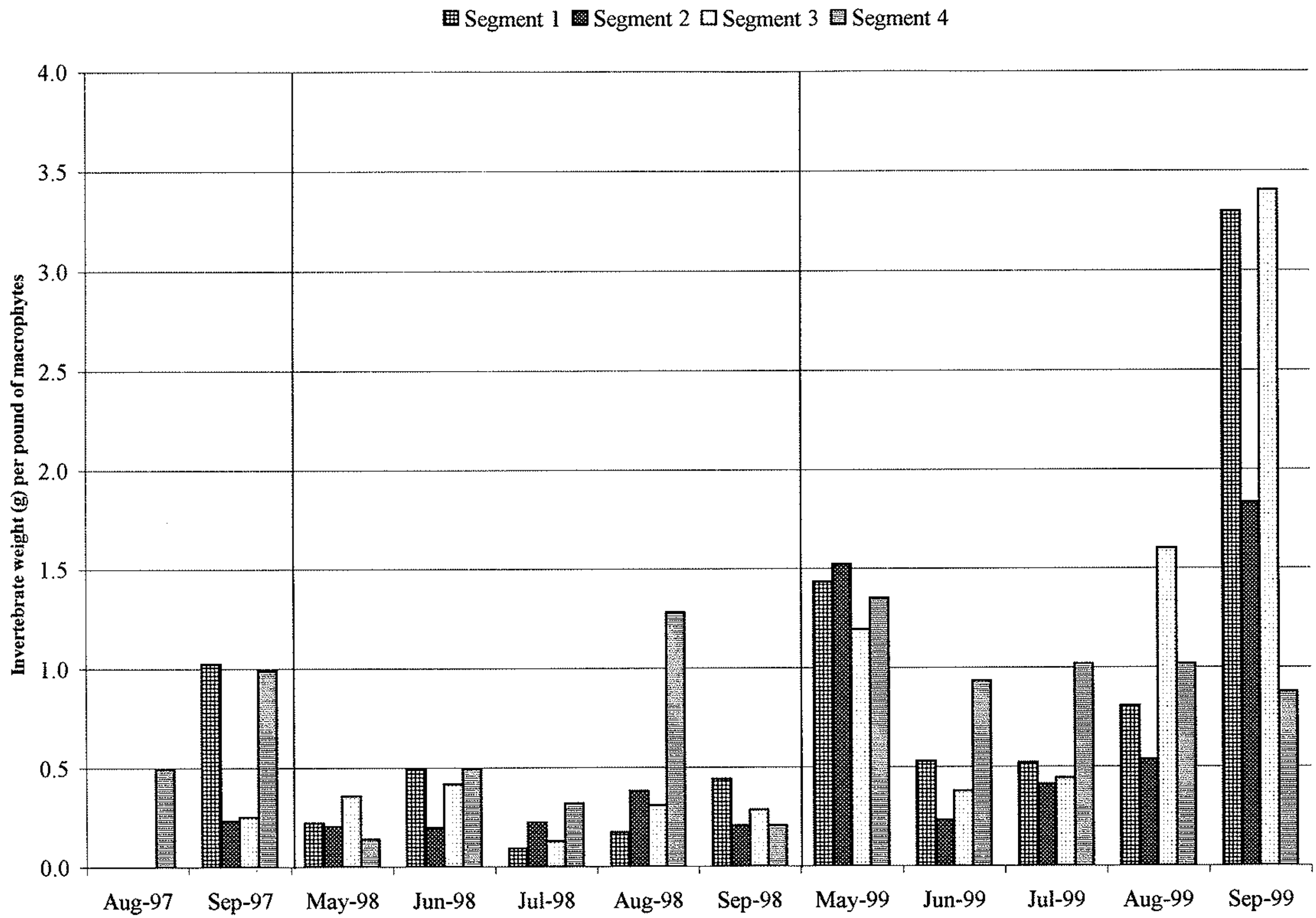


Figure 6.8. Mean weight of phytomacrobenthos per kilogram of macrophytes collected from four segments in Newton Lake. The invertebrates were collected with1.0-m (1997), 0.5-m (1998), or a 0.29-m (1999) diameter, 400-*u* mesh plankton net at 5 stations per segment. Two samples were taken per station.

Chapter 6,7. Appendix: Supplemental Data Tables.

Appendix 6.1. Dates when phytomacrobenthos samples were collected from Newton Lake. The number of samples taken in a given month was dependent upon available macrophytes within a segment. Two samples were collected at each station.

Dates sampled	Segments	Stations
	1997	
8/29/97	1	1,2
8/29/97	2-4	1-5
9/18/97	1,2	1-5
9/18/97	3	5
9/19/97	3	1-4
9/19/97	4	1
	1998	
5/5/98	1-4	1-5
6/4/98	1-4	1-5
7/11/98	1-4	1-5
8/18/98	1-4	1-5
9/2/98	1-4	1-5
	1999	
5/5/99	1-4	1-5
6/3/99	1-4	1-5
7/16/99	1-4	1-5
8/18/99	1	2-5
8/18/99	2-4	1-5
9/23/99	1	1,2,3,5
9/23/99	2-4	1-5

Appendix 6.2. Phytomacrobenthos mean densities (n per m^2) collected from four segments in Newton Lake. Numbers in parenthesis represent total number of samples collected. Number of samples through September 1999 were dependent upon available sites with macrophytes.

Taxa	Aug-97 (30)	Sep-97 (30)	May-98 (39)	Jun-98 (38)	Jul-98 (40)	Aug-98 (40)	Sep-98 (40)	May-99 (40)	Jun-99 (40)	Jul-99 (40)	Aug-99 (38)	Sep-99 (26)
Ephemeroptera	62	13	13	129	207	175	110	23	38	80	102	57
Hydracarina	0	0	<1	5	3	<1	<1	<1	40	5	7	2
Diptera	1,117	455	3,953	3,617	1,556	5,605	1,315	7,756	1,673	3,512	8,127	7,681
Odonata	56	41	1	16	25	61	75	3	57	58	363	831
Coleoptera	11	3	3	5	14	67	3	10	30	2	32	5
Bryozoa	<1	0	0	0	0	0	<1	3	0	0	0	0
Trichoptera	249	37	1	172	209	333	246	4	86	644	498	191
Pelecypoda	<1	0	0	0	0	1	0	0	0	0	0	<1
Hemiptera	<1	<1	<1	<1	3	19	<1	3	0	5	4	1
Gastropoda	9	23	2	1	<1	1	<1	6	10	0	0	<1
Nematoda	<1	1	8	9	<1	2	<1	31	7	5	4	<1
Nematomorpha	<1	<1	<1	<1	0	<1	0	<1	0	0	0	0
Veneroida	<1	<1	0	0	0	2	<1	0	0	0	0	0
Haplotaxida	57	12	945	496	138	285	111	1,812	628	643	3,217	61
Podocopa	30	17	0	<1	1	34	8	<1	0	19	139	6
Lumbriculida	24	0	0	0	0	2	<1	<1	0	28	0	7
Isopoda	0	0	2	0	0	0	0	<1	0	0	0	0
Ostracoda	1	0	0	0	0	18	0	0	0	0	0	0

Appendix 6.2. Continued.

Taxa	Aug-97	Sep-97	May-98	Jun-98	Jul-98	Aug-98	Sep-98	May-99	Jun-99	Jul-99	Aug-99	Sep-99
Oligochaeta	4	<1	22	0	3	214	539	521	0	0	0	0
Acarina	2	<1	<1	6	0	0	0	0	0	0	0	0
Amphipoda	0	2	0	0	<1	<1	<1	9	<1	0	5	46
Hirudinea	0	4	<1	<1	<1	0	0	<1	2	0	<1	0
Basomatophora	2	4	2	44	18	11	2	37	177	51	13	122
Decapoda	0	0	0	0	0	0	0	0	0	0	<1	0
Tricladida	0	0	0	0	0	0	0	23	167	6	39	41
Other	2	2	13	7	7	18	3	362	24	24	15	12
Total	**1,628**	**615**	**4,968**	**4,508**	**2,188**	**6,849**	**2,414**	**10,605**	**2,936**	**5,084**	**12,566**	**9,065**

Appendix 6.3. Phytomacrobenthos mean weights (g per m^2) collected from four segments in Newton Lake. Numbers in parenthesis represent total number of samples collected . Number of samples were dependent upon available sites with macrophytes.

Taxa	Aug-97	Sep-97	May-98	Jun-98	Jul-98	Aug-98	Sep-98	May-99	Jun-99	Jul-99	Aug-99	Sep-99
Ephemeroptera	0.0259	0.0065	0.0238	0.0764	0.1531	0.0998	0.0726	0.0390	0.0066	0.0241	0.0631	0.0481
Hydracarina	0.0000	0.0000	0.0000	0.0008	0.0004	0.0002	0.0000	0.0001	0.0088	0.0015	0.0009	0.0006
Diptera	0.1515	0.1096	1.2577	1.0478	0.6644	1.1389	0.6560	3.4633	0.6623	1.6885	3.0988	5.1622
Odonata	0.0571	0.1548	0.0203	0.0168	0.0420	0.0943	0.1002	0.0573	0.0540	0.0952	0.4181	1.8472
Coleoptera	0.0139	0.0125	0.0058	0.0028	0.0119	0.0645	0.0039	0.2023	0.0231	0.0014	0.0749	0.0045
Bryozoa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0233	0.0000	0.0000	0.0000	0.0000
Trichoptera	0.0869	0.0160	0.0029	0.0628	0.0941	0.1265	0.0883	0.0038	0.0465	0.2197	0.1865	0.1656
Pelecypoda	0.0002	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007
Hemiptera	0.0000	0.0048	0.0006	0.0007	0.0006	0.0697	0.0068	0.0006	0.0000	0.0003	0.0256	0.0898
Gastropoda	0.0169	0.0794	0.0129	0.0003	0.0008	0.0033	0.0022	0.0118	0.0099	0.0000	0.0000	0.0003
Nematoda	0.0000	0.0001	0.0005	0.0002	0.0000	0.0001	0.0000	0.0009	0.0000	0.0003	0.0003	0.0000
Nematomorpha	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Veneroida	0.0075	0.0000	0.0000	0.0000	0.0000	0.0003	0.0040	0.0000	0.0000	0.0000	0.0000	0.0000
Haplotaxida	0.0034	0.0014	0.0807	0.0183	0.0124	0.0092	0.0033	0.2428	0.0555	0.0309	0.1471	0.0050
Podocopa	0.0024	0.0012	0.0000	0.0000	0.0002	0.0052	0.0010	0.0000	0.0000	0.0038	0.0238	0.0013
Lumbriculida	0.0010	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0014	0.0000	0.0008
Isopoda	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
Ostracoda	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix 6.3. Continued.

Taxa	Aug-97	Sep-97	May-98	Jun-98	Jul-98	Aug-98	Sep-98	May-99	Jun-99	Jul-99	Aug-99	Sep-99
Amphipoda	0.0000	0.0005	0.0002	0.0000	0.0000	0.0000	0.0001	0.0054	0.0002	0.0000	0.0028	0.0292
Hirudinea	0.0000	0.0010	0.0009	0.0009	0.0018	0.0000	0.0000	0.0000	0.0079	0.0000	0.0448	0.0000
Basomatophora	0.0015	0.0001	0.0055	0.0197	0.0193	0.0104	0.0088	0.0814	0.1668	0.0424	0.0309	0.4389
Decapoda	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1726	0.0000
Tricladida	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0088	0.0436	0.0015	0.0126	0.0161
Other	0.0005	0.0022	0.0273	0.0078	0.0269	0.0073	0.0159	0.0531	0.0027	0.0166	0.0101	0.0068
Total	**0.3691**	**0.3930**	**1.4415**	**1.2560**	**1.0279**	**1.6455**	**0.9976**	**4.2294**	**1.0878**	**2.1275**	**4.3130**	**7.8171**

Chapter 8. Ichthyoplankton (Primary Responsibility - John Ackerson)

Introduction:

Ichthyoplankton is defined as small, planktonic stages of fish (Snyder 1983). Fish larval stages are often represented in ichthyoplankton sampling. The beginning of the larval period is categorized by the ability to first capture food organisms and significant absorption of the yolk sac. Completion of the larval period consists of the formation of adult fin rays (Moyle and Cech 1988). Fish larvae studies can be utilized to assess and monitor fish populations and to predict and monitor environmental impacts on these populations. When evaluating an environmental impact of a fishery, early life stages of fish are more sensitive to biological changes than adult fish and are good indicators of pollution factors (Snyder 1983). Larval fish samples are frequently used to identify nursery areas and approximate spawning grounds and seasons. Distribution and abundance data can assess the current status, document yearly fluctuations, and detect long-term trends of a particular fishery (Snyder 1983). The purpose of this study was to evaluate the relative abundance and temporal and spatial distribution of larval fishes using two sampling methods in Newton Lake as compared to Coffeen Lake, and Lake of Egypt.

Methods and Materials:

Ichthyoplankton sampling began in August of 1997 on Newton Lake, Lake of Egypt, and Coffeen Lake. In 1998-99, sampling frequency was twice per month from mid-March through July and once a month from August until larval fish capture had ceased. Sampling design divided Newton Lake into four segments Coffeen Lake and Lake of Egypt into two segments. Segment 1 was the discharge (warmer water) area in all three lakes while the intake (cooler water) was in segment 4 for Newton and segment 2 for Coffeen and Lake of Egypt.

Conical plankton nets

Two conical plankton nets were towed in tandem from the bow of the boat during daylight hours. Net construction included 500μ mesh size, 0.5m diameter opening, minimum 5:1 (length to diameter) ratio, and a catch basin. Tranter and Smith (1968) recommended combination conical nets with a minimum 5:1 ratio. A calibrated General Oceanic Model 2030 flow meter was mounted at the net opening to measure total water volume sampled. Brass depressors and boat velocities were used to keep the tow depth just below the water surface. The duration of each tow was ten minutes (± 1 min). Six towing stations were sampled per segment, three paired tows in the littoral (shoreline) and three in the pelagic (open-water or limnetic) areas. Sampling stations for Newton, Coffeen, and Lake of Egypt are in Figures 8.1, 8.2, and 8.3, respectfully. Net tow densities were calculated as the number of fish per cubic meter of water sampled.

Light Traps

At dusk, four floating lights traps were set in each segment (two littoral, two pelagic) in conjunction with the ichthyoplankton tow sampling periods. Each set required a minimum of two hours. Light trap construction included an 18.9-L translucent, white, plastic chamber illuminated by a 1.5-V light bulb and charged by a 6-V lantern battery. Styrofoam was the floatation device and anchoring was provided by cement weights tied onto the catch basin. This particular design has been used by Southern Illinois University successfully as well as the Illinois Department of Natural Resources at LaSalle Hatchery to assess stocking success in rearing ponds. Catch per unit of effort (CPUE) of fish collected by the light traps was calculated as the number of fish sampled per hour.

Identification

Larval fish were transported to SIUC in labeled plastic bags stored on ice. Larval fish were identified and measured to the nearest mm before preserving in order to obtain accurate total lengths. Taxonomic identification of target fish were to species for largemouth bass (*Micropterus salmoides*) and genus for shad (*Dorosoma*), temperate basses (*Morone*), crappie (*Pomoxis*), and sunfishes (*Lepomis*) species. All other non-target larval fish captured were counted and identified to family. Auer (1982) and Hogue et al. (1976) were the primary keys used for identification. A common criteria used for larval fishes identification are myomere (muscle tissue) counts, both pre and post anal. A common problem in larvae identification is the geographical and temporal variation in myomere counts (Bosley and Conner 1984). Variations from these keys were found in myomere counts when differentiating between *Pomoxis* and *Lepomis* in early spring. For example, according to the keys, *Lepomis* spp. postanal myomeres are usually 14-18 and our *Lepomis* spp. were 16-19. *Pomoxis* spp. postanal myomeres are usually listed as 19-21 and our *Pomoxis* spp. were always 21. A sample was used to identify problem fish genetically with starch-gel electrophoresis. This data allowed us to easily identify these fish with the aid of myomere counts. In each sample, up to 20 of each target taxon were measured randomly for total length to the nearest millimeter. All measurements were taken with a microscope equipped with a digitizing camera, frame grabber, monitor, and a computer using BioScan's OPTIMAS digital image software.

Aging

Larval fish to be aged were frozen until sagittal otoliths were removed for counting daily rings (Pannella 1973). When available in 1998, 20 fish per taxon were aged from each segment for each sampling date. Using the method described by Miller and Storck (1982), otoliths were mounted on glass microscope slides and aged by counting daily rings. Two experienced readers aged the otoliths and the counts were averaged if they were within 10% of each other. More than 10% differences were reconciled by recounting. Hatch dates were determined by subtracting the number of rings from the collection date. A length-age prediction equation for each taxa was developed from larvae that were aged in 1998. In both 1998 and 1999 all other larvae measured for total length were then aged using the appropriate prediction equation.

The results were analyzed for differences in abundance and time of hatching among segments and between spatial locations. This includes the temporal (by segment) and the spatial (littoral vs. pelagic) differences. A general linear model was used to test for significant differences, followed by Tukey's post hoc test when there was a significant difference (SAS Institute 1995). All significant differences were determined at alpha ≤ 0.05. The majority of larval fish collected were ≤13 mm in total length. Only light traps collected larvae larger than 13mm in total length. Mean densities and CPUE used larvae ≤13mm because it helps eliminate fish that have developed beyond the larval stage and helps prevent counting larvae twice from a spawning cohort. For example, when including larger fish, they may be from a previous spawning cohort and counting these fish again would artificially increase the CPUE or density for that capture date. Some fish captured and analyzed exceeded the larvae stage and developed into the juvenile stage (aging portion of this study). These fish are an important early life stage and are termed "larvae" in this report to maintain consistency. Mean densities and CPUE were calculated using samples from the capture duration of each taxa. For example, if *Dorosoma* in Newton Lake were captured from April 10 to June 09, then only samples between those dates were included in the mean abundance estimates.

Results:

1997 Net Tows

Sampling began in August and was completed in September on Lake of Egypt and October on Newton Lake and Coffeen Lake in 1997. Sampling was stopped after no ichthyoplankton were captured. Only *Lepomis* were captured in 1997. Mean densities (#/m^3) of *Lepomis* in Newton Lake were higher (P = 0.0257) in segment 2 (0.0433/m^3) than segment 4 (0.0031/m^3). There were no other significant differences among segments.

In Coffeen Lake there were no significant differences in density of larvae between segments. Mean densities of *Lepomis* were 0.0230/m^3 for segment 1 and 0.0042/m^3 for segment 2. In September, no fish larvae were collected in segment 2 and a low density of *Lepomis* (0.0046/m^3) were collected in segment 1.

In August, *Lepomis* in Lake of Egypt had a low density (0.0090/m^3) in segment 1 and no fish were collected in segment 2.

1998 Net Tows

When densities were broken down by taxa and segment in Newton Lake (Table 8.1), mean densities ranged from 0.000/m^3 for Percidae in segment 1 to 1.4203/m^3 for *Dorosoma* in segment 4. *Dorosoma* mean densities were significantly higher (P=0.0001) than all other larval fish in Newton Lake. Also, *Dorosoma* mean density (Table 8.1) in segment 4 was higher than segments 1 and 2 (P=0.0014). Those mean densities were due to the peak density difference in early-May (Figure 8.4). *Morone* mean densities (Table 8.1) were higher in segment 4 than segment 2 (P=0.0239). *Lepomis* mean densities were not different (Table 8.1) but two summer peaks occurred in the cooler water areas of segments 3 and 4. This biological pattern may suggest gradual movement to cooler water as temperature increases in the late summer months (Figure 8.5). Other larvae represented no additional differences in the 1998 Newton net tow densities (Table 8.1).

In 1998, *Dorosoma* densities in Coffeen Lake were higher (P=0.0001) than all other larval fish. In Coffeen, larval fish mean densities ranged from Cyprinidae 0.0000/m^3 in segment 2 to *Dorosoma* 0.1916/m^3 for segment 2 (Table 8.2). Larval fish mean densities were higher in segment 2 than in segment 1 for three larval fish taxa, *Lepomis*, *Dorosoma*, and *Pomoxis* (Table 8.2). Throughout most of the year, *Dorosoma* capture duration was very similar but an early April peak in segment 2 (Figure 8.6) of *Dorosoma* caused a higher density (P=0.0001) than in segment 1. A higher segment 2 mean density (P=0.0001) of *Pomoxis* followed a trend similar to *Dorosoma* with one large peak in April. In segment 2, *Lepomis* mean density was also higher (P=0.0005) than segment 1 but didn't have a similar distribution. By the time *Lepomis* densities in segment 2 reached a peak in late July, segment 1 densities had greatly declined (Figure 8.7). *Morone* and Cyprinidae taxa were captured but at low densities and there were no differences between segments (Table 8.2).

Mean density of *Dorosoma* was higher (P=0.0001) than any other taxa in Lake of Egypt. Mean densities of larval fish in Lake of Egypt ranged from Cyprinidae (0.0000/m^3) in segment 1 to *Dorosoma* (0.6134/m^3) in segment 2. The cooler water (segment 2) of Lake of Egypt contained significantly higher (P=0.0103) *Dorosoma* densities than the warmer water of segment 1 (Table 8.2). A high early-May density in segment 2 (cooler water) was the main difference between the segments (Figure 8.8). Atherinidae showed opposite trends than other taxa (Table 8.2) because the density of *Dorosoma* in segment 1 (0.0116/m^3) was significantly higher (P=0.0001) than in segment 2 (0.0011/m^3). Although not significantly different between segments, *Lepomis* mean densities (Table 8.2) by date showed two distinct peaks, early summer in segment 1 and late summer in segment 2 (Figure 8.9). Other larval fish collected in Lake of Egypt were Cyprinidae and Percidae but in low densities (Table 8.2).

1999 Net Tows

Dorosoma densities were significantly higher (P=0.0001) than other taxa in Newton Lake. When densities were broken down by taxa and segment for Newton Lake (Table 8.3), mean densities ranged from Cyprinidae 0.0000/m^3 (segments 2 and 3) to *Dorosoma* 1.0510/m^3 (segment 3). Only *Morone* density was significantly different (Table 8.3), with segment 4 (cooler water) higher (P=0.0371) than segments 2 and 3. *Dorosoma* densities by date peaked earlier in the warmer water (segment 1) with a second peak in the cooler water (segments 3 and 4) (Figure 8.4). *Lepomis* densities by segment were not different, but warmer water segment 1 peaked earlier than cooler water segments 3 and 4 (Figure 8.10).

When densities were broken down by taxa and segment for Coffeen Lake (Table 8.4), mean densities ranged from *Lepomis* 0.0007/m^3 (segment 1) to *Dorosoma* 0.1809/m^3 (segment 2). *Dorosoma* mean density was higher in segment 2 (cooler water) (P=0.0001) than segment 1 (Figure 8.6). *Lepomis* initially were captured in late May and June in both segments but were captured again in the cooler water (segment 2) in August (Figure 8.11).

When densities were broken down by taxa and segment for Lake of Egypt (Table 8.4), mean densities ranged from *Morone* 0.0000/m^3 (segment 1) to *Dorosoma* 0.4557/m^3 (segment 1). Cyprinidae and Atherinidae families had significantly higher mean densities in segment 1 than segment 2 (Table 8.4). *Lepomis* mean densities by date were similar between segments (Figure 8.12).

1997 Light Traps

No larval fish were collected in light traps that were first set in September on Newton Lake. Light traps were not set on Coffeen or Lake of Egypt in 1997.

1998 Light Traps

When analyzing Newton Lake data for differences among taxa and segments (Table 8.5), *Lepomis* mean CPUE increased from the discharge to intake segments with the intake (segment 4) (8.48/hour) being significantly higher (P=0.0218) than the discharge (segment 1) (1.21/hour). Mean CPUE by date explained the overall differences among segments (Figure 8.13). *Dorosoma* mean CPUE also increased from discharge to intake, but was not significantly different (Table 8.5). Only the cooler water portion (segments 3 and 4) of the lake in early-May had significant *Dorosoma* CPUE peaks (Figure 8.14). All other larval fish mean CPUE were not different among segments. Largemouth bass were present in low densities in Newton Lake light traps (Table 8.5).

Lepomis CPUE was significantly higher (P=0.0137) than any other larval fish in Coffeen Lake, however, between the two segments no single taxon was collected at significantly different mean densities (Table 8.6). *Lepomis* CPUE had similar seasonal distribution when comparing segments. *Lepomis* CPUE in segment 2 had a high peak in July but there were no significant differences between the segments (Figure 8.15).

Dorosoma had higher mean CPUE than all other taxa (P=0.0001) in Lake of Egypt (Table 8.6). *Dorosoma* CPUE had a significantly higher peak in segment 2 than segment 1 on 5/19/98 (P=0.0001) but did not produce significant overall segment differences (Figure 8.16). *Lepomis* had a higher CPUE (P=0.0170) in segment 2 than in segment 1 (Table 8.6). *Lepomis* CPUE in both segments peaked in late May but in segment 2 (cooler water) there was a second peak in July (Figure 8.17).

1999 Light Traps

Lepomis had higher mean CPUE than all other taxa (P=0.0001) in Newton Lake. *Lepomis* in segment 4 had a higher CPUE (P=0.0358) than segment 1 (Table 8.7). A strong peak in early-July was the primary reason for these differences (Figure 8.18). Other taxa had a trend of higher mean CPUE in the cooler water segments but no significant differences were found.

Lepomis had higher mean CPUE than all other taxa (P=0.0018) in Coffeen Lake. An early-July peak of *Lepomis* (Figure 8.19) was responsible for the higher segment 1 mean CPUE (Table 8.8). *Dorosoma* segment 1 CPUE was higher than segment 2 due to a mid-May CPUE peak (Figure 8.20).

There were no taxa with differences in CPUE by segment in Lake of Egypt (Table 8.8). Mean CPUE in segment 2 was higher for *Dorosoma* (Figure 8.16) and *Lepomis* (Figure 8.21) and each taxon displayed two distinct peaks of fish density.

Net Tow Spatial Locations (pelagic vs. littoral)

In 1998, mean densities of larvae in Newton Lake by spatial location ranged from Percidae 0.0002/m^3 (pelagic) to *Dorosoma* 0.9233/m^3 (littoral). Mean densities were higher in the littoral locations for *Lepomis* (P=0.0001), *Pomoxis* (P=0.0207), and Percidae (P=0.0002) taxa than the pelagic locations (Table 8.9). In 1999, mean densities of larval fish in Newton Lake by spatial location ranged from Percidae 0.0001/m^3 (pelagic) to *Dorosoma* 1.2287/m^3 (littoral). Mean densities were higher in the littoral locations for *Lepomis* (P=0.0001), *Dorosoma* (P=0.0327), and Percidae (P=0.0045) taxa than the pelagic locations (Table 8.10).

In 1998, mean densities of larval fish in Coffeen Lake by spatial location ranged from Cyprinidae 0.0000/m^3 (pelagic) to *Dorosoma* 0.1444/m^3 (littoral). Mean densities were higher in the littoral locations for *Lepomis* (P=0.0001) and *Dorosoma* (P=0.0207) taxa than the pelagic locations (Table 8.11). In 1999, spatial location mean densities in Coffeen Lake were not different for any taxa (Table 8.12).

In 1998, mean densities in Lake of Egypt by spatial location ranged from Percidae 0.0010/m^3 (pelagic) to *Dorosoma* 0.3940/m^3 (pelagic). Mean densities were higher in the littoral locations for Percidae (P=0.0008) and Atherinidae (P=0.0200) taxa than the pelagic locations (Table 8.11). In 1999, mean densities in Lake of Egypt by spatial location ranged from *Morone* 0.0000/m^3 (pelagic) to *Dorosoma* 0.4619/m^3 (pelagic). Mean densities were higher in the littoral locations for *Lepomis* (P=0.0003), Percidae (P=0.0013), and Atherinidae (P=0.0208) taxa than the pelagic locations (Table 8.12).

Light Trap Spatial Locations (pelagic vs. littoral)

In 1998, mean CPUE in Newton Lake by spatial location ranged from *Pomoxis* 0.00/hour (pelagic) to *Lepomis* 9.45/hour (littoral). Mean CPUE was higher in the littoral locations for *Lepomis* (P=0.0001), *Dorosoma* (P=0.0211), and *Micropterus* (P=0.0315) taxa than the pelagic locations (Table 8.13). In 1999, mean CPUE in Newton Lake by spatial location ranged from Percidae 0.00/hour (pelagic) to *Lepomis* 49.89/hour (littoral). Mean CPUE was higher in the littoral locations for *Lepomis* (P=0.0050), Cyprinidae (P=0.0361), and Percidae (P=0.0044) taxa than the pelagic locations (Table 8.14).

In 1998, mean CPUE in Coffeen Lake by spatial location ranged from Cyprinidae 0.00/hour (pelagic) to *Lepomis* 4.26/hour (littoral). Mean CPUE was higher in the littoral location for *Lepomis* (P=0.0032) than the pelagic location (Table 8.15). In 1999, mean CPUE in

Coffeen Lake by spatial location was not different for any taxa (Table 8.16).

In 1998, mean CPUE in Lake of Egypt by spatial location ranged from *Pomoxis* 0.00/hour (pelagic) to *Dorosoma* 10.40/hour (littoral). Mean CPUE was higher in the littoral location for *Lepomis* (P=0.0129) than the pelagic location (Table 8.15). In 1999, mean CPUE in Lake of Egypt by spatial location ranged from Percidae 0.00/hour (pelagic) to *Lepomis* 10.02/hour (littoral). Mean CPUE was higher in the littoral location for *Lepomis* (P=0.0330), than the pelagic location (Table 8.16).

Hatching Dates

Hatching dates were calculated by subtracting the age of the larvae(days) from the collection date. Hatching data used larvae from both net tows and light traps. The majority of the larvae aged and the following discussion will be based on *Lepomis* and *Dorosoma* data; however, *Pomoxis* spp. in Coffeen Lake and Lake of Egypt, as well as *Micropterus* in Newton Lake also had a sufficient sample size to create prediction equations. Length-age prediction equations using aged 1998 larvae from the previously mentioned taxa for all three lakes (Figures 8.22-8.30) had significant positive relationships (P=0.0001) and high correlation coefficients. As one would expect, as total length increased, age prediction variance surrounding the regression line increased. This trend is expected, as growth rates can be drastically different as the larvae develop. Hatching date ranges by lake, year, and taxa are listed in Table 8.17.

In Newton Lake, hatching date ranges were slightly extended for *Lepomis* (3/31-10/01) and *Dorosoma* (3/11-7/01) in 1999 when compared to *Lepomis* (4/04-9/17) and *Dorosoma* (3/31-6/29) in 1998 (Table 8.17). In 1998, *Dorosoma* in Newton Lake had three distinct hatching pulses in all four segments (Figures 8.31-8.34). The three pulses were in early-April, late-April, and early-May in all four segments. A smaller pulse of *Dorosoma* hatched in mid-May in all four segments. In 1999, *Dorosoma* in Newton Lake had four distinct hatching pulses in all four segments (Figures 8.35-8.38). These pulses were in early-April, mid-April, late-April, and mid-May in all four segments. An additional hatching pulse in early-May of 1999 coincides with the last distinct hatching pulse in 1998. In 1998, *Lepomis* in Newton Lake hatched sporadically throughout the hatching date range (Figures 8.39-8.42). There was a greater overall number of *Lepomis* hatched in the cooler water segments 3 and 4 but in all four segments, *Lepomis* had a hatch in mid-September as mean daily temperatures declined. In 1999, *Lepomis* in Newton Lake hatched sporadically throughout the hatching date range (Figures 8.43-8.46). In segments 2-4, a hatching pulse in early August coincides with the peak mean daily temperatures of 1999. When those temperatures declined, another hatch of *Lepomis* occurred in mid-August.

In Coffeen Lake, hatching date ranges for *Lepomis* and *Dorosoma* were similar between years (Table 8.17). In 1998 and 1999, *Dorosoma* in Coffeen Lake had three distinct hatching pulses in both segments but segment 2 (cooler water) had a higher number of fish than segment 1 (Figures 8.47-8.50). The hatching pulses were similar to the pulses in Newton Lake in 1998, early-April, late-April, and early-May. In 1998, *Lepomis* in Coffeen Lake had continuous hatching from early-May to early August with sparse hatching numbers in late August and September (Figures 8.51-8.54). In 1999, hatching in both segments virtually stopped in late June as the water temperature increased. After the rapid decrease in water temperature in early August, *Lepomis* hatching proceeded again in both segments (Figures 8.53-8.54).

In Lake of Egypt, hatching date ranges for all taxa were similar between years (Table 8.17). In 1998, *Dorosoma* hatching in segment 1 began earlier than segment 2 but both segments had four distinct hatching pulses (Figures 8.55-8.56). In 1999, *Dorosoma* had four hatching pulses that were similar between segments (Figures 8.57-8.58). In segment 1, the majority of *Lepomis* hatched was during May and early June, while hatching continued through July and August in segment 2. This trend continued for both 1998 and 1999 (Figures 8.59-8.62).

When comparing between years, Newton Lake density and CPUE were higher in 1999 when compared to 1998 but there were no significant differences (Tables 8.18-8.19). Lake of Egypt had higher densities of *Lepomis* in net tows in 1998 (Table 8.18) when compared to 1999 but no other abundance differences in Lake of Egypt or Coffeen Lake were detected.

Discussion:

Gizzard shad (*Dorosoma cepedianum*) are consider to be spring spawners with one dominant density peak (Bodola 1966). Threadfin shad (*D. petenense*) spawn throughout the summer and fall (Heidinger 1977). The *Dorosoma* species sampled with both methods in all lakes were collected no later than late July with peaks in April or May. Adult threadfin shad were not collected in Newton or Coffeen so we are assuming all *Dorosoma* species captured are gizzard shad. Lake of Egypt has a threadfin shad population but no *Dorosoma* larvae were collected past mid-July.

Net Tows-Temporal and Spatial Distribution

Dorosoma was the dominant taxon in all three lakes over both years. In 1998, *Dorosoma* and *Lepomis* mean densities were higher in the cooler water than the warmer water segments. This coincides with Newman's (1981) findings that densities of larvae in Coffeen Lake increased with increased distance from the thermal discharge. Bergmann (1981), on the other hand found that densities of *Lepomis* larvae were highest in the discharge (warmer water) arm in Lake Sangchris, IL. Bergmann (1981) also found no temporal distribution differences in densities of

Dorosoma. In 1999, only *Dorosoma* in Coffeen Lake was significantly higher in the cooler water segment. Density trends in temporal distributions in Newton Lake and Coffeen Lake were similar to Lake of Egypt.

Lepomis mean densities were higher in the littoral versus pelagic locations for all three lakes and both years. Newman (1981) reported that *Lepomis* densities in Coffeen Lake were higher in shoreline areas than mid-lake areas. Storck et al. (1978) also reported higher littoral densities of *Lepomis* in Lake Shelbyville, IL. *Dorosoma* mean densities were higher in the littoral locations in 1998 Coffeen Lake and 1999 Newton Lake samples. In our study overall *Dorosoma* densities were evenly distributed throughout the spatial locations. Storck et al. (1978) reported similar results with large numbers of *Dorosoma* larvae in the pelagic locations.

In our study, in all lakes, all larvae captured were less than 13 mm in total length, suggesting gear avoidance by the larger, more mobile larvae. Largemouth bass were not captured with net tows. Largemouth bass males guard the schools of larvae after absorption of the yolk sac and their common habitat is shallow *water* close to or in dense vegetation (Holland and Huston 1983). After the schools break up, the bass move into heavily vegetated, shallow water. Net tows are not effective in this type of habitat.

Light Traps-Temporal and Spatial Distribution

Lepomis CPUE were significantly higher than any other taxa in Newton Lake and Coffeen Lake but not in Lake of Egypt. Perry (1981) also found light traps to be effective in attracting *Lepomis* larvae in Coffeen Lake. In Newton Lake, the cooler water intake segment had higher CPUE than the warmer water discharge segment in both years, similar to the supporting net tow data. The littoral location in Lake of Egypt also had higher CPUE of *Lepomis* than the pelagic location in 1998. *Lepomis* CPUE were higher in the littoral versus the pelagic locations for all three lakes and both years, similar to the net tow data. Fewer numbers of largemouth bass were captured in light traps from late April to early June in Newton Lake and Lake or Egypt. These largemouth bass were larger (8-32 mm total length) than the majority of larvae captured in the study. Largemouth bass seemed to be attracted to the light and were observed feeding on other larval fish.

Hatching Dates

Since the cooler water segments had higher mean densities and CPUE, we wanted to determine if hatching times were different among segments in each lake. In Newton Lake, the first hatching pulse of *Dorosoma* occurred in early April in all four segments in both years. This was somewhat surprising since mean daily surface temperatures ranged from 52-74°F. The first *Dorosoma* hatching pulse was also in early April in Coffeen Lake and Lake of Egypt with mean daily surface temperatures ranging from 63-78°F and 63-67°F, respectively. The *Dorosoma* hatching temperatures are similar to the range of spawning temperatures (62-73°F) reported by Bodola (1966) in Lake Erie. The number of *Dorosoma* hatching was higher in the cooler portion of all three lakes but the hatching date range was not altered among segments. This suggests that photoperiod had a greater influence on the hatching of *Dorosoma* than did the temperature.

Lepomis hatching began at the same time as *Dorosoma* so beginning hatching temperature ranges were similar to that of *Dorosoma*. *Lepomis* hatching began earlier in Newton Lake (early-April) when compared to Coffeen Lake (late-April) and Lake of Egypt (early-May). The end of the hatching date range of *Lepomis* extended into September in all three lakes. In all three lakes there were higher numbers of *Lepomis* in the cooler water segments than the warmer water segments. In Newton Lake, *Lepomis* hatching peaks in the non-discharge segments (2-4) coincided with the highest temperatures of the summer. After the surface temperatures in each segment declined, hatching continued in late August and early September in both 1998 and 1999. The same trend occurred in Coffeen Lake in 1998, but in 1999 *Lepomis* hatching virtually stopped in July as temperatures increased from 95-112°F. After the surface temperatures declined in the August, hatching continued. In Lake of Egypt, *Lepomis* hatching in the warmer segment virtually stopped in late-May in both years, while in the cooler segment, *Lepomis* hatching continued well into August. This suggests that *Lepomis* hatching were dictated by photoperiod and increasing and decreasing temperatures in all three lakes, especially in Newton Lake and Coffeen Lake.

The beginning of *Dorosoma* and *Lepomis* hatching date ranges in Newton Lake were similar and both larvae consume zooplankton when exogenous feeding begins. Garvey and Stein (1998) reported that *Dorosoma* deplete zooplankton and reduce *Lepomis* growth when *Dorosoma* spawn earlier than *Lepomis*. Even though the beginning hatching ranges were similar, the majority of *Lepomis* hatch in June and July, while by that time the hatching of *Dorosoma* had virtually stopped. In Newton Lake, total zooplankton (#/L) had decreased before many *Lepomis* had hatched and after many *Dorosoma* hatched (Figures 8.63-8.66). Due to reduced mobility in early development, larvae need food items in close proximity after their yolk sac in absorbed (Jobling 1995). *Lepomis* that hatched later in the summer may have lower recruitment through the winter and increased predation than larvae hatched earlier because of smaller size. This may be related to stored energy and increased vulnerability to predation.

In conclusion, larval fish mean densities and CPUE were higher in the cooler water segments of all three lakes. Net tows primarily captured *Dorosoma* while light traps primarily captured *Lepomis*. It is important to note that largemouth bass were only captured in light traps.

In Newton Lake, *Dorosoma* and *Lepomis* densities and CPUE increased from 1998 to 1999 but were not significantly different. The only significant difference in any of the three lakes was higher 1998 *Dorosoma* densities in net tows in Lake of Egypt. In all three lakes, *Lepomis* were concentrated in littoral locations while *Dorosoma* were more evenly distributed between littoral and pelagic locations. Contrary to Newman's (1981) findings, spawning duration was not restricted in the warmer water segments but overall numbers were lower when compared to the cooler water segments for all three lakes. The hatching date ranges were not restricted in Newton Lake or Coffeen Lake and were actually extended when compared to Lake of Egypt. Declining July and August total zooplankton abundance in Newton Lake could result in reduced fitness of late hatching *Lepomis*. Extreme summer temperatures in 1999 in Coffeen Lake reduced *Lepomis* hatching but after temperatures declined, hatching continued. Extreme temperatures in 1999 in Newton Lake did not reduce the hatching of *Lepomis* in non-discharge segments. Further research would be needed to determine if these trends are indicative of the long-term effects of the variance on Newton Lake.

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Table 8.1. Larval fish mean densities (#/m^3) in Newton Lake sampled with net tows in 1998. Superscripts with different letters are significantly different among segments, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Taxa	Segment	Density	Range	Std. dev.
Lepomis	1	0.0068^{a}	0 - 0.0832	0.0148
Lepomis	2	0.0129^{a}	0 - 0.1981	0.0255
Lepomis	3	0.0146^{a}	0 - 0.2089	0.0343
Lepomis	4	0.0174^{a}	0 - 0.3742	0.0498
Dorosoma	1	0.2998^{a}	0 - 1.9898	0.4702
Dorosoma	2	0.5334^{a}	0 - 3.3347	0.7858
Dorosoma	3	0.9434^{ab}	0 - 10.7906	1.9364
Dorosoma	4	1.4203^{b}	0 - 12.9895	2.5033
Morone	1	0.0013^{ab}	0 - 0.0242	0.0047
Morone	2	0.0000^{a}	0 - 0.0000	0.0000
Morone	3	0.0006^{ab}	0 - 0.0147	0.0029
Morone	4	0.0062^{b}	0 - 0.1309	0.0213
Cyprinidae	1	0.0011^{a}	0 - 0.0147	0.0036
Cyprinidae	2	0.0007^{a}	0 - 0.0129	0.0029
Cyprinidae	3	0.0000^{a}	0 - 0.0000	0.0000
Cyprinidae	4	0.0072^{a}	0 - 0.1163	0.0240
Pomoxis	1	0.0059^{a}	0 - 0.0253	0.0075
Pomoxis	2	0.0006^{b}	0 - 0.0132	0.0027
Pomoxis	3	0.0011^{b}	0 - 0.0137	0.0038
Pomoxis	4	0.0011^{b}	0 - 0.0137	0.0038
Percidae	1	0.0000^{a}	0 - 0.0000	0.0000
Percidae	2	0.0004^{a}	0 - 0.0145	0.0024
Percidae	3	0.0065^{ab}	0 - 0.0822	0.0171
Percidae	4	0.0080^{b}	0 - 0.0555	0.0155

Table 8.2. Larval fish mean densities (#/m^3) sampled with net tows in 1998. Superscripts with different letters are significantly different between segments, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Segment	Density	Range	Std. dev.
Coffeen	*Lepomis*	1	0.0030[a]	0 - 0.0614	0.009
	Lepomis	2	0.0103[b]	0 - 0.1341	0.022
	Dorosoma	1	0.0340[a]	0 - 0.6437	0.086
	Dorosoma	2	0.1916[b]	0 - 1.5038	0.321
	Morone	1	0.0022[a]	0 - 0.0395	0.008
	Morone	2	0.0032[a]	0 - 0.0236	0.007
	Cyprinidae	1	0.0000[a]	0 - 0.0000	0.000
	Cyprinidae	2	0.0029[a]	0 - 0.0303	0.007
	Pomoxis	1	0.0045[a]	0 - 0.0383	0.008
	Pomoxis	2	0.0511[b]	0 - 0.1816	0.053
Lake of Egypt	*Lepomis*	1	0.0678[a]	0 - 1.1457	0.2050
	Lepomis	2	0.1215[a]	0 - 4.8619	0.5383
	Dorosoma	1	0.0681[a]	0 - 0.8888	0.1530
	Dorosoma	2	0.6134[b]	0 - 12.9930	2.1139
	Cyprinidae	1	0.0028[a]	0 - 0.0602	0.0106
	Cyprinidae	2	0.0000[a]	0 - 0.0000	0.0000
	Pomoxis	1	0.0315[a]	0 - 0.1278	0.0418
	Pomoxis	2	0.0496[a]	0 - 0.2346	0.0541
	Percidae	1	0.0096[a]	0 - 0.4359	0.0442
	Percidae	2	0.0084[a]	0 - 0.4570	0.0445
	Atherinidae	1	0.0232[a]	0 - 0.2390	0.0515
	Atherinidae	2	0.0021[b]	0 - 0.0372	0.0062

Table 8.3. Larval fish mean densities (#/m^3) in Newton Lake sampled with net tows in 1999. Superscripts with different letters are significantly different among segments, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Taxa	Segment	Density	Range	Std. dev.
Lepomis	1	0.0112[a]	0 - 0.2727	0.0340
Lepomis	2	0.0120[a]	0 - 0.2533	0.0323
Lepomis	3	0.0186[a]	0 - 0.2666	0.0476
Lepomis	4	0.0169[a]	0 - 0.4291	0.0558
Dorosoma	1	0.7009[a]	0 - 13.3963	2.0462
Dorosoma	2	1.0190[a]	0 - 9.8992	2.0290
Dorosoma	3	1.0510[a]	0 - 38.7903	4.2898
Dorosoma	4	0.9595[a]	0 - 8.3818	1.7038
Morone	1	0.0004[ab]	0 - 0.0126	0.0021
Morone	2	0.0000[a]	0 - 0.0000	0.0000
Morone	3	0.0000[a]	0 - 0.0000	0.0000
Morone	4	0.0023[b]	0 - 0.0292	0.0068
Cyprinidae	1	0.0004[a]	0 - 0.0138	0.0023
Cyprinidae	2	0.0000[a]	0 - 0.0000	0.0000
Cyprinidae	3	0.0000[a]	0 - 0.0000	0.0000
Cyprinidae	4	0.0007[a]	0 - 0.0123	0.0028
Percidae	1	0.0013[a]	0 - 0.0155	0.0042
Percidae	2	0.0006[a]	0 - 0.0285	0.0041
Percidae	3	0.0040[a]	0 - 0.1108	0.0166
Percidae	4	0.0028[a]	0 - 0.0414	0.0091

Table 8.4. Larval fish mean densities (#/m^3) sampled with net tows in 1999. Superscripts with different letters are significantly different between segments, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Segment	Density	Range	Std. dev.
Coffeen	*Lepomis*	1	0.0007[a]	0 - 0.0468	0.0055
	Lepomis	2	0.0024[a]	0 - 0.0406	0.0078
	Dorosoma	1	0.0212[a]	0 - 0.1889	0.0400
	Dorosoma	2	0.1809[b]	0 - 2.1079	0.3754
Lake of Egypt	*Lepomis*	1	0.0255[a]	0 - 0.4620	0.0661
	Lepomis	2	0.0235[a]	0 - 0.3763	0.0513
	Dorosoma	1	0.4557[a]	0 - 20.6104	2.1793
	Dorosoma	2	0.2823[a]	0 - 5.5845	0.7496
	Morone	1	0.0000[a]	0 - 0.0000	0.0000
	Morone	2	0.0013[a]	0 - 0.0152	0.0044
	Cyprinidae	1	0.0067[a]	0 - 0.0299	0.0105
	Cyprinidae	2	0.0006[b]	0 - 0.0148	0.0030
	Pomoxis	1	0.3685[a]	0 - 12.3662	2.0572
	Pomoxis	2	0.0130[a]	0 - 0.0631	0.0168
	Percidae	1	0.0049[a]	0 - 0.0440	0.0096
	Percidae	2	0.0071[a]	0 - 0.0601	0.0153
	Atherinidae	1	0.0077[a]	0 - 0.2310	0.0294
	Atherinidae	2	0.0010[b]	0 - 0.0156	0.0037

Table 8.5. Larval fish mean CPUE (#/hour) in Newton Lake sampled with light traps in 1998. Superscripts with different letters are significantly different among segments, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Taxa	Segment	CPUE	Range	Std. dev.
Lepomis	1	1.21[a]	0 - 13.35	2.89
Lepomis	2	4.16[ab]	0 - 55.28	9.94
Lepomis	3	6.87[ab]	0 - 63.56	14.26
Lepomis	4	8.48[b]	0 - 78.33	17.39
Dorosoma	1	0.58[a]	0 - 5.75	1.36
Dorosoma	2	0.89[a]	0 - 9.16	2.10
Dorosoma	3	3.11[a]	0 - 66.36	12.47
Dorosoma	4	5.19[a]	0 - 62.81	15.42
Pomoxis	1	0.73[a]	0 - 5.45	1.91
Pomoxis	2	0.00[a]	0 - 0.00	0.00
Pomoxis	3	0.00[a]	0 - 0.00	0.00
Pomoxis	4	0.23[a]	0 - 1.40	0.50
Morone	1	0.08[a]	0 - 0.34	0.17
Morone	2	0.10[a]	0 - 0.40	0.20
Morone	3	0.09[a]	0 - 0.39	0.19
Morone	4	0.10[a]	0 - 0.41	0.20
Cyprinidae	1	0.88[a]	0 - 8.92	2.54
Cyprinidae	2	0.00[a]	0 - 0.00	0.00
Cyprinidae	3	0.00[a]	0 - 0.00	0.00
Cyprinidae	4	0.03[a]	0 - 0.46	0.13
Micropterus	1	1.22[a]	0 - 8.90	2.54
Micropterus	2	2.57[a]	0 - 12.08	4.40
Micropterus	3	1.31[a]	0 - 13.95	3.99
Micropterus	4	0.00[a]	0 - 0.00	0.00
Percidae	1	0.00[a]	0 - 0.00	0.00
Percidae	2	0.03[a]	0 - 0.44	0.12
Percidae	3	1.13[a]	0 - 9.79	2.82
Percidae	4	0.00[a]	0 - 0.00	0.00

Table 8.6. Larval fish mean CPUE (#/hour) sampled with light traps in 1998. Superscripts with different letters are significantly different between segments, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Segment	CPUE	Range	Std. dev.
Coffeen	*Lepomis*	1	1.64[a]	0 - 11.80	3.29
	Lepomis	2	3.16[a]	0 - 40.80	7.34
	Dorosoma	1	0.70[a]	0 - 8.64	2.17
	Dorosoma	2	0.57[a]	0 - 8.36	1.75
	Pomoxis	1	4.43[a]	0 - 30.00	10.44
	Pomoxis	2	0.61[a]	0 - 2.00	0.78
	Cyprinidae	1	0.12[a]	0 - 0.48	0.24
	Cyprinidae	2	0.12[a]	0 - 0.49	0.24
	Micropterus	1	0.04[a]	0 - 0.48	0.14
	Micropterus	2	0.04[a]	0 - 0.49	0.14
Lake of Egypt	*Lepomis*	1	1.21[a]	0 - 13.50	2.93
	Lepomis	2	4.46[b]	0 - 36.00	8.23
	Dorosoma	1	2.90[a]	0 - 39.16	7.96
	Dorosoma	2	11.01[a]	0 - 153.97	32.01
	Pomoxis	1	0.00[a]	0 - 0.00	0.00
	Pomoxis	2	3.07[a]	0 - 19.30	6.19
	Cyprinidae	1	0.00[a]	0 - 0.00	0.00
	Cyprinidae	2	0.12[a]	0 - 0.48	0.24
	Micropterus	1	1.06[a]	0 - 8.03	2.82
	Micropterus	2	0.54[a]	0 - 2.34	0.85
	Percidae	1	0.03[a]	0 - 0.44	0.12
	Percidae	2	0.83[a]	0 - 6.56	1.93
	Atherinidae	1	8.16[a]	0 - 100.62	18.25
	Atherinidae	2	0.65[b]	0 - 7.93	1.48

Table 8.7. Larval fish mean CPUE (#/hour) in Newton Lake sampled with light traps in 1999. Superscripts with different letters are significantly different among segments, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Taxa	Segment	CPUE	Range	Std. dev.
Lepomis	1	1.66[a]	0 - 17.35	4.34
Lepomis	2	18.90[ab]	0 - 250.26	44.15
Lepomis	3	18.73[ab]	0 - 314.42	54.27
Lepomis	4	71.04[b]	0 - 1010.42	200.96
Dorosoma	1	3.44[a]	0 - 63.45	12.29
Dorosoma	2	5.25[a]	0 - 80.54	16.24
Dorosoma	3	8.21[a]	0 - 110.23	22.60
Dorosoma	4	8.49[a]	0 - 184.83	34.70
Morone	1	0.22[a]	0 - 0.88	0.44
Morone	2	0.00[a]	0 - 0.00	0.00
Morone	3	0.12[a]	0 - 0.48	0.24
Morone	4	0.11[a]	0 - 0.44	0.22
Cyprinidae	1	0.18[a]	0 - 1.45	0.43
Cyprinidae	2	0.00[a]	0 - 0.00	0.00
Cyprinidae	3	0.03[a]	0 - 0.48	0.12
Cyprinidae	4	0.07[a]	0 - 0.92	0.26
Micropterus	1	0.28[a]	0 - 2.41	0.62
Micropterus	2	0.14[a]	0 - 1.00	0.28
Micropterus	3	8.19[a]	0 - 158.57	35.40
Micropterus	4	2.86[a]	0 - 24.00	7.32
Percidae	1	0.04[a]	0 - 0.48	0.13
Percidae	2	0.04[a]	0 - 0.50	0.14
Percidae	3	0.32[a]	0 - 1.41	0.52
Percidae	4	0.10[a]	0 - 0.93	0.31

Table 8.8. Larval fish mean CPUE (#/hour) sampled with light traps in 1999. Superscripts with different letters are significantly different between segments, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Segment	CPUE	Range	Std. dev.
Coffeen	*Lepomis*	1	25.03[a]	0 - 579.66	102.25
	Lepomis	2	8.98[a]	0 - 85.00	19.82
	Dorosoma	1	2.35[a]	0 - 36.80	7.38
	Dorosoma	2	0.61[a]	0 - 10.67	2.17
	Micropterus	1	0.50[a]	0 - 3.50	1.22
	Micropterus	2	0.12[a]	0 - 1.01	0.35
	Percidae	1	0.12[a]	0 - 0.50	0.25
	Percidae	2	0.00[a]	0 - 0.00	0.00
	Atherinidae	1	0.05[a]	0 - 1.00	0.19
	Atherinidae	2	0.09[a]	0 - 1.50	0.31
Lake of Egypt	*Lepomis*	1	1.26[a]	0 - 21.50	4.04
	Lepomis	2	9.62[a]	0 - 99.50	23.86
	Dorosoma	1	0.34[a]	0 - 5.50	1.03
	Dorosoma	2	7.14[a]	0 - 109.00	21.73
	Pomoxis	1	0.02[a]	0 - 1.04	0.15
	Pomoxis	2	0.62[a]	0 - 16.63	2.89
	Cyprinidae	1	1.97[a]	0 - 18.00	5.15
	Cyprinidae	2	1.70[a]	0 - 23.69	5.90
	Micropterus	1	2.58[a]	0 - 30.50	8.79
	Micropterus	2	0.12[a]	0 - 1.00	0.31
	Percidae	1	0.00[a]	0 - 0.00	0.00
	Percidae	2	0.25[a]	0 - 1.50	0.50
	Atherinidae	1	19.54[a]	0 - 308.50	70.68
	Atherinidae	2	0.16[a]	0 - 2.50	0.46

Table 8.9. Larval fish mean densities (#/m^3) in Newton Lake sampled with net tows in 1998. Superscripts with different letter are significantly different between locations, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Taxa	Location	Density	Range	Std. dev.
Lepomis	Littoral	0.0206[a]	0 - 0.3742	0.0449
Lepomis	Pelagic	0.0053[b]	0 - 0.0961	0.0120
Dorosoma	Littoral	0.9233[a]	0 - 10.7906	1.6217
Dorosoma	Pelagic	0.6751[a]	0 - 12.9895	1.7570
Morone	Littoral	0.0032[a]	0 - 0.1309	0.0154
Morone	Pelagic	0.0008[a]	0 - 0.0145	0.0033
Cyprinidae	Littoral	0.0039[a]	0 - 0.1163	0.0172
Cyprinidae	Pelagic	0.0005[a]	0 - 0.0264	0.0034
Pomoxis	Littoral	0.0033[a]	0 - 0.0253	0.0063
Pomoxis	Pelagic	0.0010[b]	0 - 0.0134	0.0035
Percidae	Littoral	0.0072[a]	0 - 0.0822	0.0163
Percidae	Pelagic	0.0002[b]	0 - 0.0145	0.0017

Table 8.10. Larval fish mean densities (#/m^3) in Newton Lake sampled with net tows in 1999. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Taxa	Location	Density	Range	Std. dev.
Lepomis	Littoral	0.0249[a]	0 - 0.4291	0.0583
Lepomis	Pelagic	0.0044[b]	0 - 0.1124	0.0136
Dorosoma	Littoral	1.2287[a]	0 - 38.7903	3.5439
Dorosoma	Pelagic	0.6204[b]	0 - 7.9568	1.2721
Morone	Littoral	0.0004[a]	0 - 0.0134	0.0023
Morone	Pelagic	0.0007[a]	0 - 0.0292	0.0041
Cyprinidae	Littoral	0.0003[a]	0 - 0.0123	0.0020
Cyprinidae	Pelagic	0.0002[a]	0 - 0.0138	0.0016
Percidae	Littoral	0.0042[a]	0 - 0.1108	0.0137
Percidae	Pelagic	0.0001[b]	0 - 0.0137	0.0014

Table 8.11. Larval fish mean densities (#/m^3) sampled with net tows in 1998. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Location	Density	Range	Std. dev.
Coffeen	*Lepomis*	Littoral	0.0107[a]	0 - 0.1341	0.0220
	Lepomis	Pelagic	0.0027[b]	0 - 0.0379	0.0076
	Dorosoma	Littoral	0.1444[a]	0 - 1.5038	0.2962
	Dorosoma	Pelagic	0.0803[b]	0 - 1.1966	0.1818
	Morone	Littoral	0.0012[a]	0 - 0.0152	0.0041
	Morone	Pelagic	0.0041[a]	0 - 0.0395	0.0095
	Cyprinidae	Littoral	0.0019[a]	0 - 0.0303	0.0068
	Cyprinidae	Pelagic	0.0000[a]	0 - 0.0000	0.0000
	Pomoxis	Littoral	0.0339[a]	0 - 0.1816	0.0533
	Pomoxis	Pelagic	0.0208[a]	0 - 0.1111	0.0327
Lake of Egypt	*Lepomis*	Littoral	0.1072[a]	0 - 1.1457	0.2258
	Lepomis	Pelagic	0.0821[a]	0 - 4.8619	0.5310
	Dorosoma	Littoral	0.2875[a]	0 - 12.9930	1.4421
	Dorosoma	Pelagic	0.3940[a]	0 - 12.8420	1.5991
	Cyprinidae	Littoral	0.0017[a]	0 - 0.0602	0.0100
	Cyprinidae	Pelagic	0.0012[a]	0 - 0.0145	0.0039
	Pomoxis	Littoral	0.0478[a]	0 - 0.1874	0.0501
	Pomoxis	Pelagic	0.0333[a]	0 - 0.2346	0.0472
	Percidae	Littoral	0.0170[a]	0 - 0.4570	0.0615
	Percidae	Pelagic	0.0010[b]	0 - 0.0295	0.0043
	Atherinidae	Littoral	0.0188[a]	0 - 0.2390	0.0493
	Atherinidae	Pelagic	0.0065[b]	0 - 0.1412	0.0204

Table 8.12. Larval fish mean densities (#/m^3) sampled with net tows in 1999. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Location	Density	Range	Std. dev.
Coffeen	*Lepomis*	Littoral	0.0022[a]	0 - 0.0468	0.0085
	Lepomis	Pelagic	0.0009[a]	0 - 0.0311	0.0045
	Dorosoma	Littoral	0.1195[a]	0 - 2.1079	0.3228
	Dorosoma	Pelagic	0.0792[a]	0 - 1.5296	0.2176
Lake of Egypt	*Lepomis*	Littoral	0.0396[a]	0 - 0.4620	0.0782
	Lepomis	Pelagic	0.0094[b]	0 - 0.1087	0.0206
	Dorosoma	Littoral	0.2761[a]	0 - 5.5845	0.7908
	Dorosoma	Pelagic	0.4619[a]	0 - 20.6104	2.1641
	Morone	Littoral	0.0013[a]	0 - 0.0152	0.0044
	Morone	Pelagic	0.0000[a]	0 - 0.0000	0.0000
	Cyprinidae	Littoral	0.0031[a]	0 - 0.0289	0.0075
	Cyprinidae	Pelagic	0.0042[a]	0 - 0.0299	0.0091
	Pomoxis	Littoral	0.0163[a]	0 - 0.1573	0.0310
	Pomoxis	Pelagic	0.3652[a]	0 - 12.3662	2.0577
	Percidae	Littoral	0.0101[a]	0 - 0.0601	0.0158
	Percidae	Pelagic	0.0019[b]	0 - 0.0340	0.0068
	Atherinidae	Littoral	0.0077[a]	0 - 0.2310	0.0292
	Atherinidae	Pelagic	0.0011[b]	0 - 0.0433	0.0052

Table 8.13. Larval fish mean CPUE (#/hour) in Newton Lake sampled with light traps in 1998. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Taxa	Location	CPUE	Range	Std. dev.
Lepomis	Littoral	9.45[a]	0 - 78.33	16.62
Lepomis	Pelagic	0.91[b]	0 - 8.76	2.11
Dorosoma	Littoral	4.43[a]	0 - 66.36	13.91
Dorosoma	Pelagic	0.46[b]	0 - 7.96	1.28
Morone	Littoral	0.14[a]	0 - 0.41	0.20
Morone	Pelagic	0.04[a]	0 - 0.39	0.14
Pomoxis	Littoral	0.48[a]	0 - 5.45	1.37
Pomoxis	Pelagic	0.00[a]	0 - 0.00	0.00
Cyprinidae	Littoral	0.44[a]	0 - 8.92	1.81
Cyprinidae	Pelagic	0.01[a]	0 - 0.45	0.09
Micropterus	Littoral	2.20[a]	0 - 13.95	4.39
Micropterus	Pelagic	0.34[b]	0 - 2.95	0.77
Percidae	Littoral	0.57[a]	0 - 9.79	2.04
Percidae	Pelagic	0.01[a]	0 - 0.39	0.08

Table 8.14. Larval fish mean CPUE (#/hour) in Newton Lake sampled with light traps in 1999. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Taxa	Location	CPUE	Range	Std. dev.
Lepomis	Littoral	49.89[a]	0 - 1010.42	145.18
Lepomis	Pelagic	3.54[b]	0 - 58.98	8.68
Dorosoma	Littoral	9.24[a]	0 - 184.83	27.56
Dorosoma	Pelagic	3.22[a]	0 - 110.23	15.04
Morone	Littoral	0.22[a]	0 - 0.88	0.34
Morone	Pelagic	0.00[a]	0 - 0.00	0.00
Cyprinidae	Littoral	0.13[a]	0 - 1.45	0.35
Cyprinidae	Pelagic	0.00[b]	0 - 0.00	0.00
Micropterus	Littoral	5.37[a]	0 - 158.57	25.63
Micropterus	Pelagic	0.23[a]	0 - 2.62	0.52
Percidae	Littoral	0.25[a]	0 - 1.41	0.43
Percidae	Pelagic	0.00[b]	0 - 0.00	0.00

Table 8.15. Larval fish mean CPUE (#/hour) sampled with light traps in 1998. Superscripts with different letters are significantly different between locations, by taxa, at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Location	CPUE	Range	Std. dev.
Coffeen	*Lepomis*	Littoral	4.26[a]	0 - 40.80	7.45
	Lepomis	Pelagic	0.53[b]	0 - 10.41	1.82
	Dorosoma	Littoral	0.80[a]	0 - 8.64	2.19
	Dorosoma	Pelagic	0.47[a]	0 - 8.36	1.71
	Pomoxis	Littoral	5.05[a]	0 - 30.00	10.17
	Pomoxis	Pelagic	0.00[a]	0 - .00	0.00
	Cyprinidae	Littoral	0.24[a]	0 - 0.49	0.28
	Cyprinidae	Pelagic	0.00[a]	0 - 0.00	0.00
	Micropterus	Littoral	0.04[a]	0 - 0.48	0.14
	Micropterus	Pelagic	0.04[a]	0 - 0.49	0.14
Lake of Egypt	*Lepomis*	Littoral	4.54[a]	0 - 36.00	8.40
	Lepomis	Pelagic	1.14[b]	0 - 9.42	2.26
	Dorosoma	Littoral	10.40[a]	0 - 153.97	32.20
	Dorosoma	Pelagic	3.51[a]	0 - 39.16	7.78
	Pomoxis	Littoral	3.07[a]	0 - 19.33	6.19
	Pomoxis	Pelagic	0.00[a]	0 - 0.00	0.00
	Cyprinidae	Littoral	0.12[a]	0 - 0.48	0.24
	Cyprinidae	Pelagic	0.00[a]	0 - 0.00	0.00
	Micropterus	Littoral	1.54[a]	0 - 8.03	2.74
	Micropterus	Pelagic	0.05[a]	0 - 0.46	0.16
	Percidae	Littoral	0.83[a]	0 - 6.56	1.93
	Percidae	Pelagic	0.03[a]	0 - 0.44	0.12
	Atherinidae	Littoral	5.07[a]	0 - 100.62	16.63
	Atherinidae	Pelagic	3.74[a]	0 - 42.32	9.29

Table 8.16. Larval fish mean CPUE (#/hour) sampled with light traps in 1999. Superscripts with different letters are significantly different between locations, by taxa at alpha 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Taxa	Location	CPUE	Range	Std. dev.
Coffeen	*Lepomis*	Littoral	31.36^{a}	0 - 579.66	102.44
	Lepomis	Pelagic	2.65^{a}	0 - 41.37	7.92
	Dorosoma	Littoral	2.49^{a}	0 - 36.80	7.63
	Dorosoma	Pelagic	0.46^{a}	0 - 2.43	0.69
	Micropterus	Littoral	0.56^{a}	0 - 3.50	1.23
	Micropterus	Pelagic	0.06^{a}	0 - 0.50	0.17
	Percidae	Littoral	0.12^{a}	0 - 0.50	0.25
	Percidae	Pelagic	0.00^{a}	0 - 0.00	0.00
	Atherinidae	Littoral	0.09^{a}	0 - 1.00	0.26
	Atherinidae	Pelagic	0.05^{a}	0 - 1.50	0.26
Lake of Egypt	*Lepomis*	Littoral	10.02^{a}	0 - 99.50	23.93
	Lepomis	Pelagic	0.86^{b}	0 - 12.89	2.46
	Dorosoma	Littoral	4.86^{a}	0 - 109.00	19.80
	Dorosoma	Pelagic	2.61^{a}	0 - 56.50	10.11
	Pomoxis	Littoral	0.61^{a}	0 - 16.63	2.86
	Pomoxis	Pelagic	0.02^{a}	0 - 0.99	0.14
	Cyprinidae	Littoral	2.39^{a}	0 - 23.69	6.36
	Cyprinidae	Pelagic	1.28^{a}	0 - 18.00	4.50
	Micropterus	Littoral	2.70^{a}	0 - 30.50	8.75
	Micropterus	Pelagic	0.00^{a}	0 - 0.00	0.00
	Percidae	Littoral	0.25^{a}	0 - 1.50	0.50
	Percidae	Pelagic	0.00^{a}	0 - 0.00	0.00
	Atherinidae	Littoral	9.83^{a}	0 - 308.50	51.44
	Atherinidae	Pelagic	9.87^{a}	0 - 302.47	50.42

Table 8.17. Hatching date ranges for 1998-99 by taxa in three Illinois power cooling reservoirs. In 1998 and 1999, hatching dates were calculated using the 1998 aged larvae and their subsequent length-age linear regression prediction equations. The initial temperature is the lowest temperature at the beginning of the hatching range. The ending temperature is the highest temperature at the end of the hatching range.

Lake	Year	Taxa	Hatching Date Range	Days	Hatching Range Temp (°F)	
					Initial	Ending
Newton Lake	1998	*Lepomis*	4/15-9/19	158	56	94
		Dorosoma	3/27-6/30	96	60	100
		Morone[2]	4/04-5/15[1]	42		
		Micropterus	4/05-5/09[1]	35		
	1999	*Lepomis*	3/31-10/01	185	70	87
		Dorosoma	3/11-7/01	113	52	92
		Morone[2]	3/14-5/03[1]	51		
		Micropterus	3/27-5/11[1]	44		
Coffeen Lake	1998	*Lepomis*	4/23-10/04	165	78	84
		Dorosoma	3/29-6/27	81	62	97
		Morone[2]	4/04-4/28[1]	25		
		Pomoxis	4/08-5/14[1]	37		
	1999	*Lepomis*	5/02-9/10	132	80	103
		Dorosoma	3/21-7/09	111	67	100
Lake of Egypt	1998	*Lepomis*	5/09-9/05	120	67	91
		Dorosoma	4/03-6/29	88	63	92
		Pomoxis	4/01-5/05[1]	35		
		Micropterus[2]	4/26-5/20[1]	25		
	1999	*Lepomis*	5/01-9/08	131	74	87
		Dorosoma	4/08-7/16	100	63	89
		Pomoxis	4/04-5/06[1]	33		
		Micropterus[2]	4/19-5/24[1]	36		

[1]Hatching range temperatures fall within the ranges for those of *Dorosoma* for that year.
[2]Hatching range was calculated from a length-age linear regression equation developed from a small sample size of fish and having relatively low R^2 values.

Table 8.18. Mean densities (#/m^3) of larval fish (all segments combined) in three Illinois power cooling reservoirs. Superscripts with different letters are significantly different between years, within taxa, at alpha = 0.05. Mean densities were calculated using samples within the time period of capture of each taxa.

Lake	Year	Taxa	Density	Range	Std.Dev.
Newton Lake	1998	*Lepomis*	0.0129[a]	0-0.0842	0.0174
	1999	*Lepomis*	0.0146[a]	0-0.0970	0.0244
	1998	*Dorosoma*	0.7992[a]	0-4.6318	1.1534
	1999	*Dorosoma*	0.9326[a]	0-5.5988	1.5106
Coffeen Lake	1998	*Lepomis*	0.0067[a]	0-0.0441	0.0106
	1999	*Lepomis*	0.0015[a]	0-0.0075	0.0024
	1998	*Dorosoma*	0.1123[a]	0-0.6234	0.1931
	1999	*Dorosoma*	0.1038[a]	0-0.8778	0.2312
Lake of Egypt	1998	*Lepomis*	0.0946[a]	0-0.4197	0.1266
	1999	*Lepomis*	0.0245[b]	0-0.1107	0.0326
	1998	*Dorosoma*	0.3407[a]	0-3.9256	1.0363
	1999	*Dorosoma*	0.3691[a]	0-1.833	0.6348

Table 8.19. Mean CPUE (#/hour) of larval fish (all segments combined) collected with light traps in three Illinois power cooling reservoirs. Superscripts with different letters are significantly different between segments, within taxa, at alpha = 0.05. Mean CPUE was calculated using samples within the time period of capture of each taxa.

Lake	Year	Taxa	CPUE	Range	Std.Dev.
Newton Lake	1998	*Lepomis*	5.18[a]	0-30.35	8.01
	1999	*Lepomis*	26.75[a]	0-383.37	68.26
	1998	*Dorosoma*	2.45[a]	0-32.00	6.74
	1999	*Dorosoma*	6.26[a]	0-49.94	12.77
	1998	*Micropterus*	1.27[a]	0-4.53	1.81
	1999	*Micropterus*	2.72[a]	0-40.72	9.29
Coffeen Lake	1998	*Lepomis*	2.4[a]	0-14.94	3.56
	1999	*Lepomis*	17.01[a]	0-152.57	37.38
	1998	*Dorosoma*	0.64[a]	0-2.69	0.98
	1999	*Dorosoma*	1.48[a]	0-9.68	2.76
	1998	*Micropterus*	0.04[a]	0-.12	0.06
	1999	*Micropterus*	0.31[a]	0-1.00	0.47
Lake of Egypt	1998	*Lepomis*	2.84[a]	0-15.47	4.43
	1999	*Lepomis*	5.44[a]	0-46.09	12.35
	1998	*Dorosoma*	6.96[a]	0-56.64	14.96
	1999	*Dorosoma*	3.74[a]	0-36.29	9.36
	1998	*Micropterus*	0.8[a]	0-2.12	0.91
	1999	*Micropterus*	1.35[a]	0-7.75	3.13

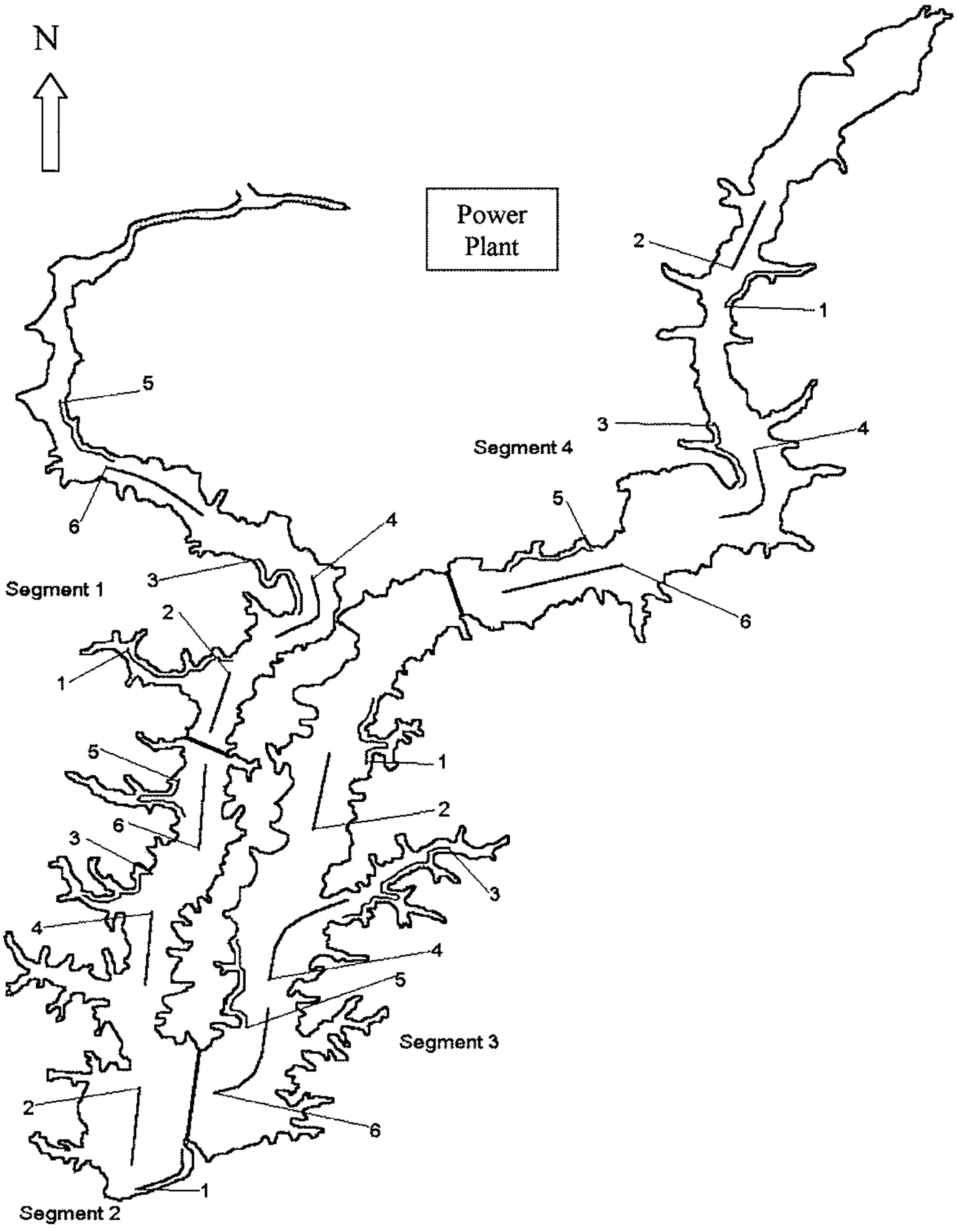

Figure 8.1. Ichthyoplankton sampling stations for net tows in 1997-99 on Newton Lake, IL.

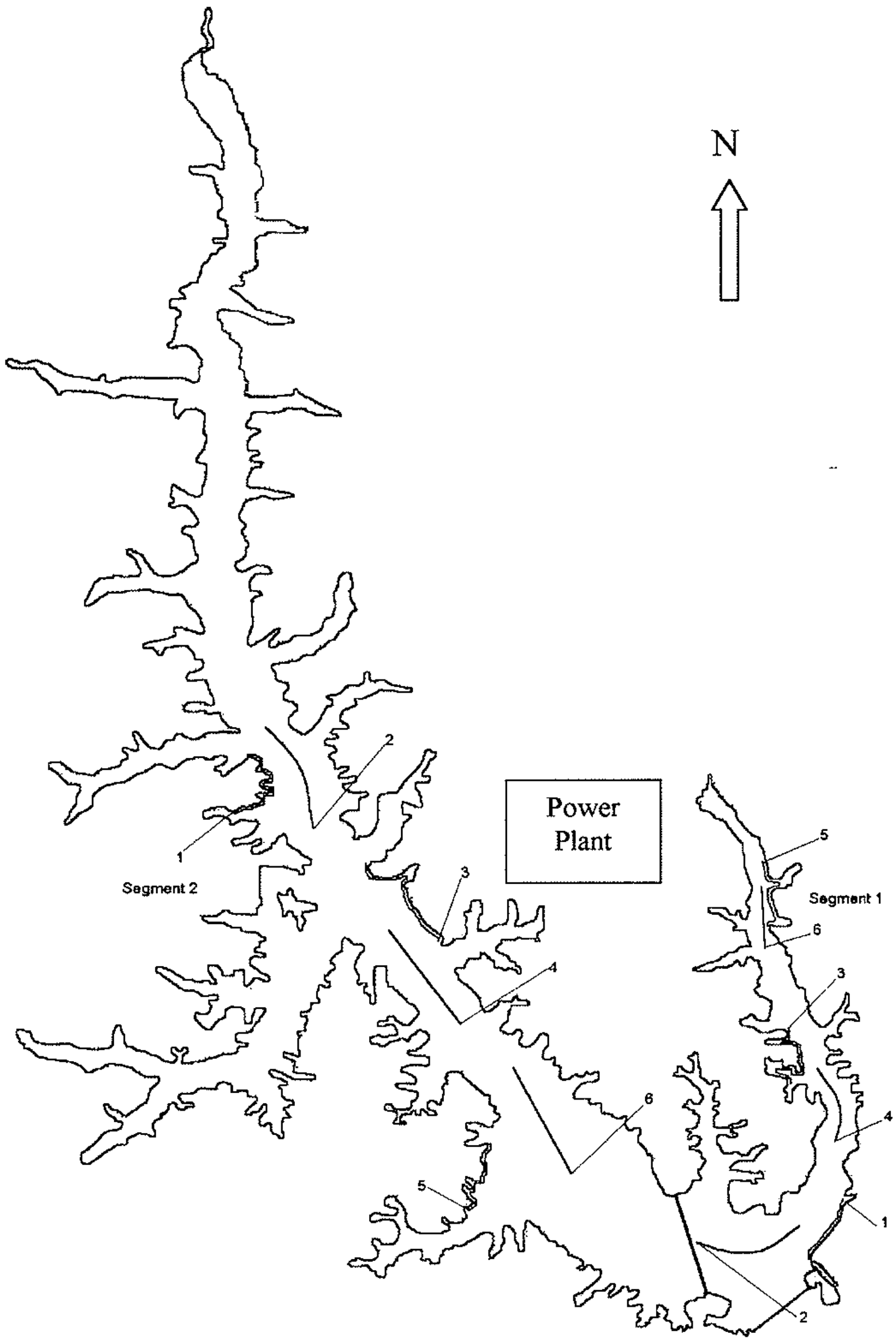

Figure 8.2. Ichthyoplankton sampling stations for net tows in 1997-99 on Coffeen Lake, IL.

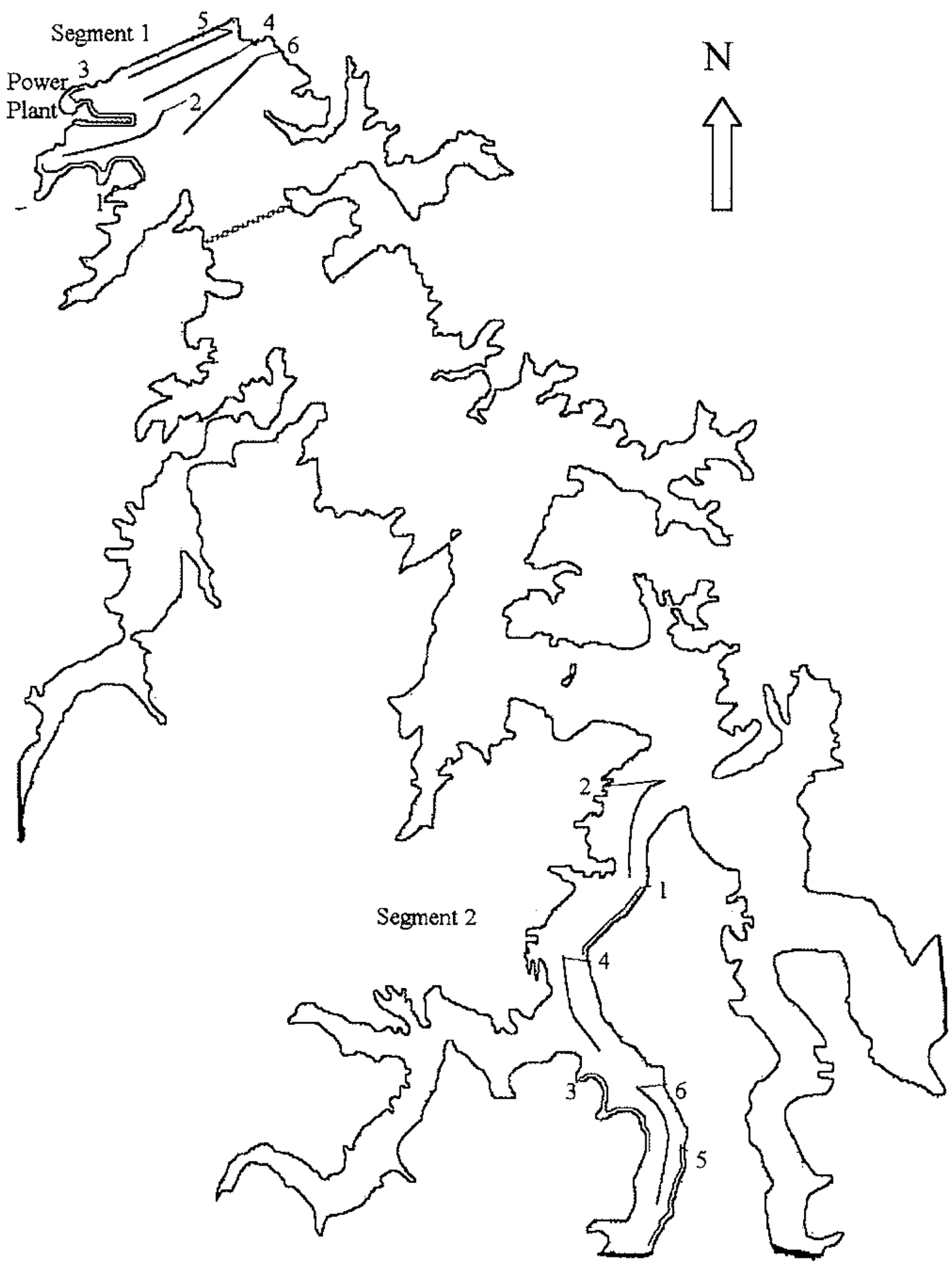

Figure 8.3. Ichthyoplankton sampling stations for net tows in 1997-99 on Lake of Egypt, IL.

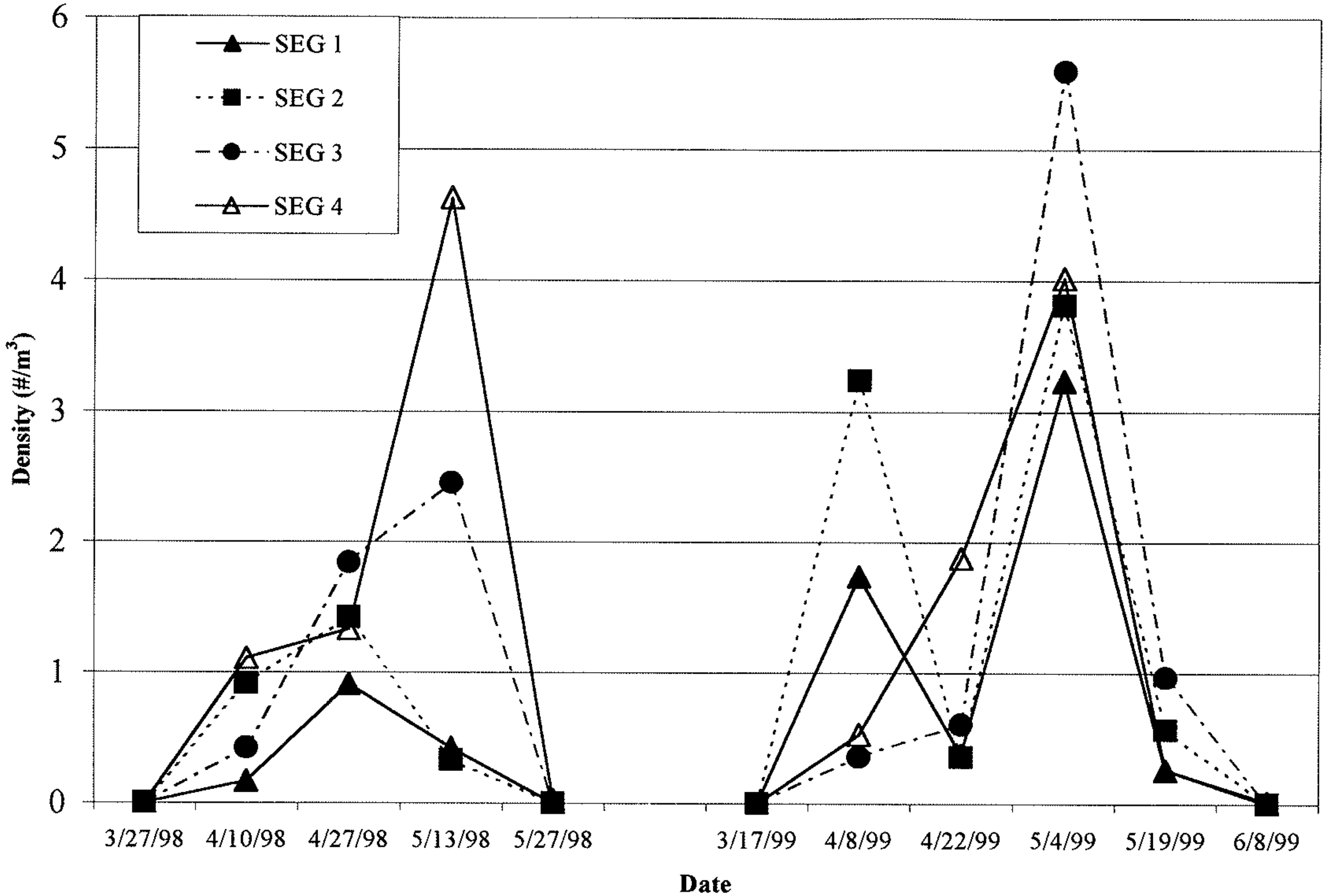

Figure 8.4. Mean densities (#/m^3) of *Dorosoma* sampled with net tows in Newton Lake in 1998-99.

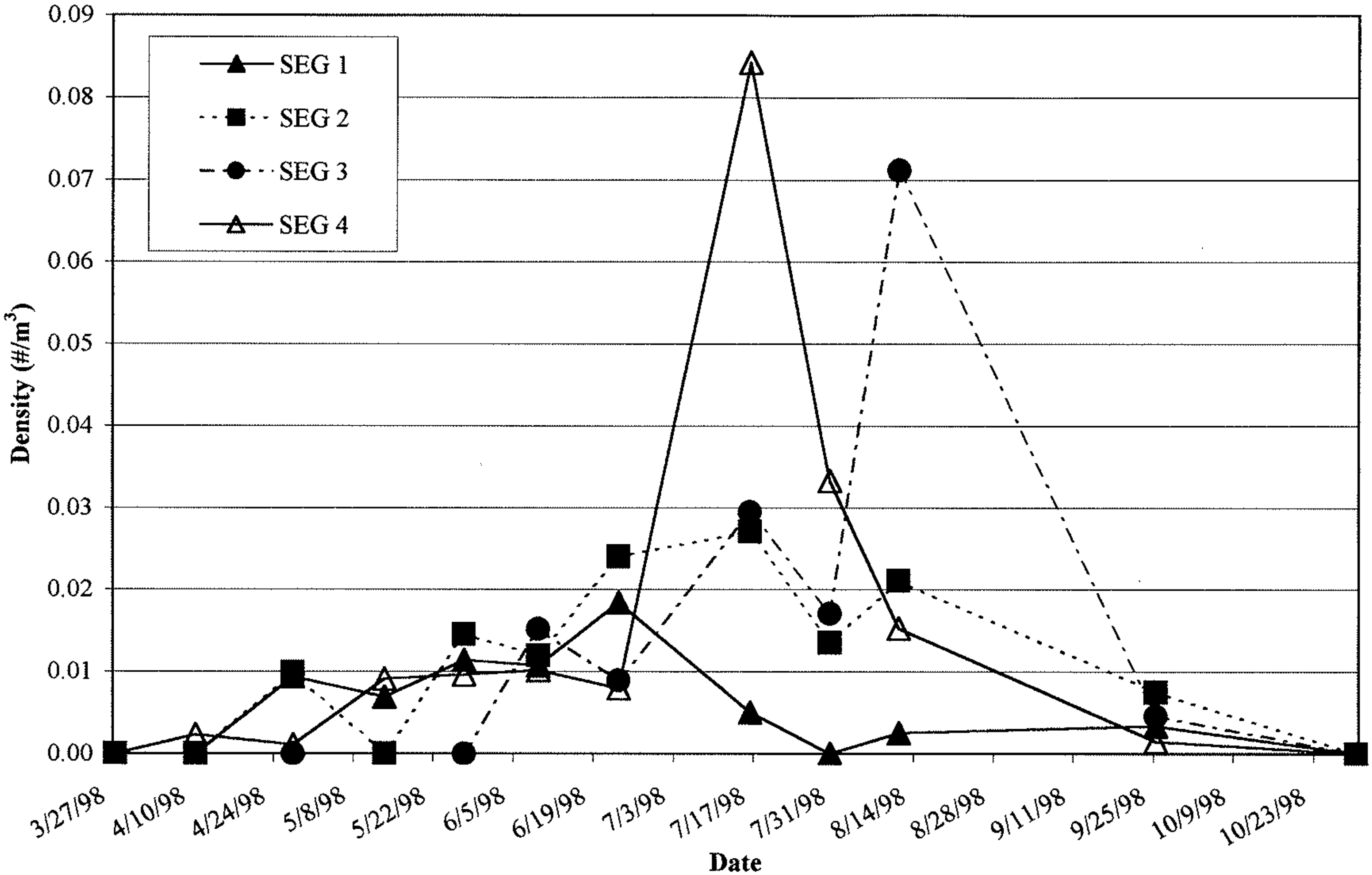

Figure 8.5. Mean densities (#/m^3) of *Lepomis* sampled with net tows in Newton Lake in 1998.

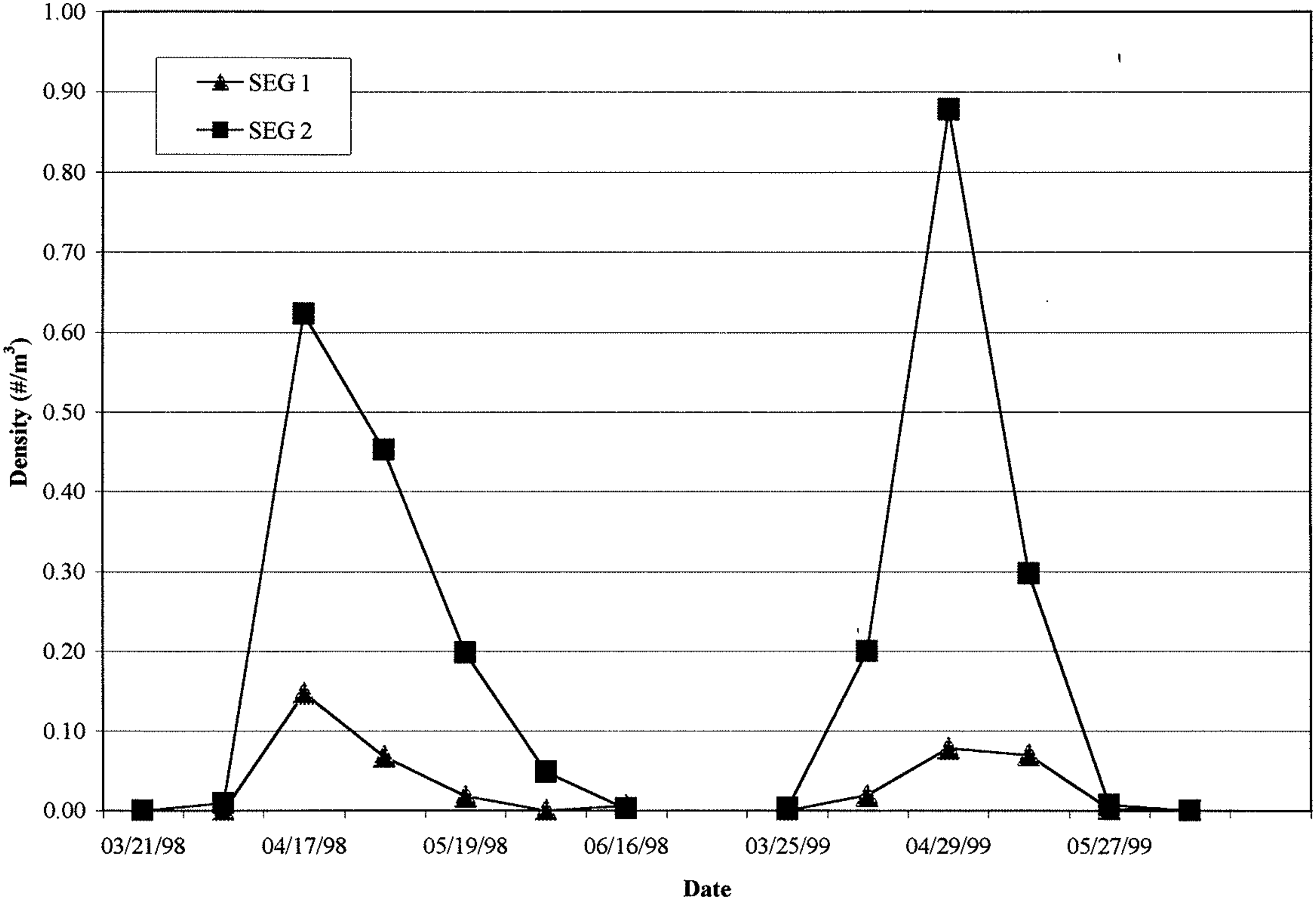

Figure 8.6. Mean densities (#/m^3) of *Dorosoma* sampled with net tows in Coffeen Lake in 1998-99.

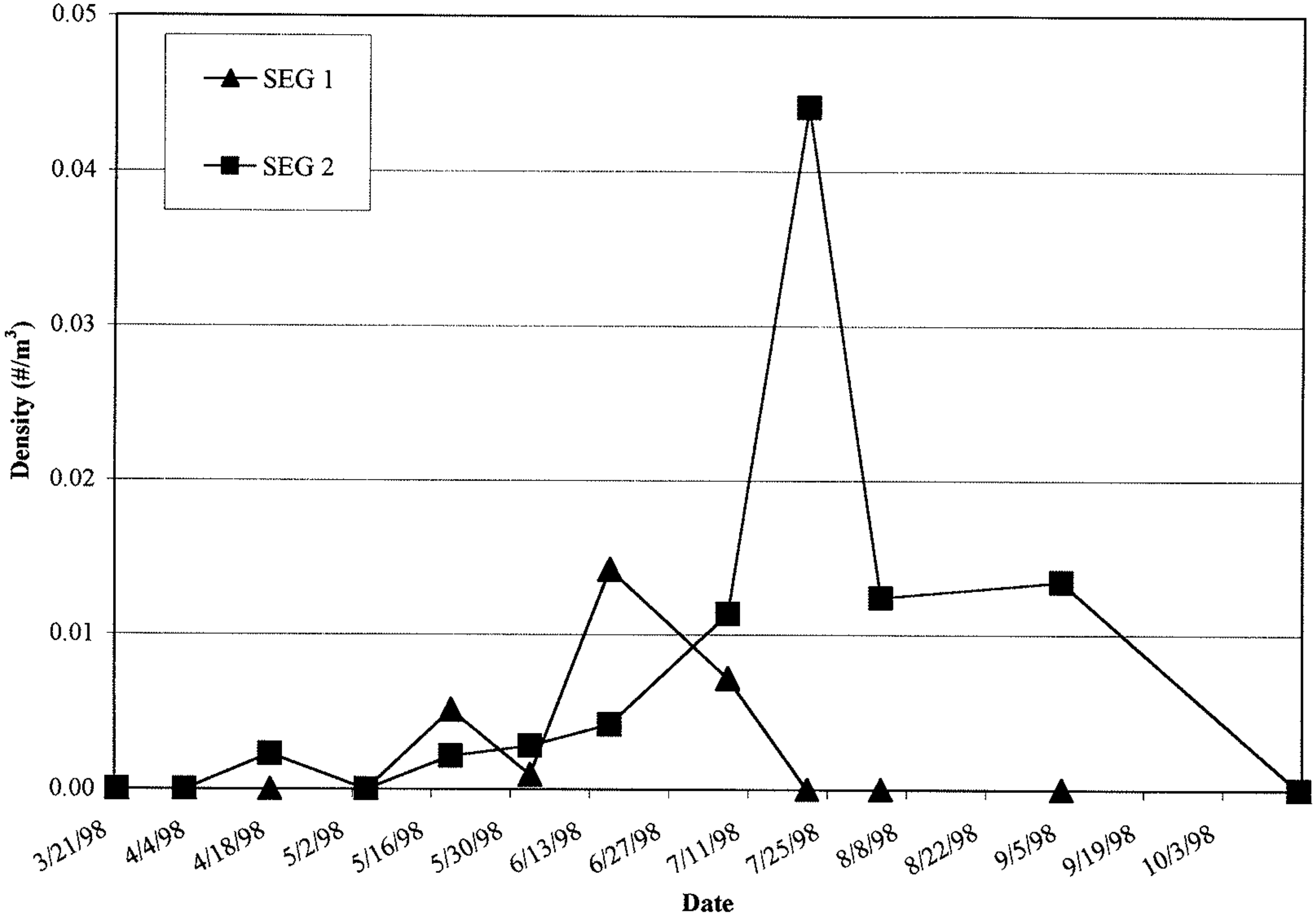

Figure 8.7. Mean densities (#/m^3) of *Lepomis* sampled with net tows in Coffeen Lake in 1998.

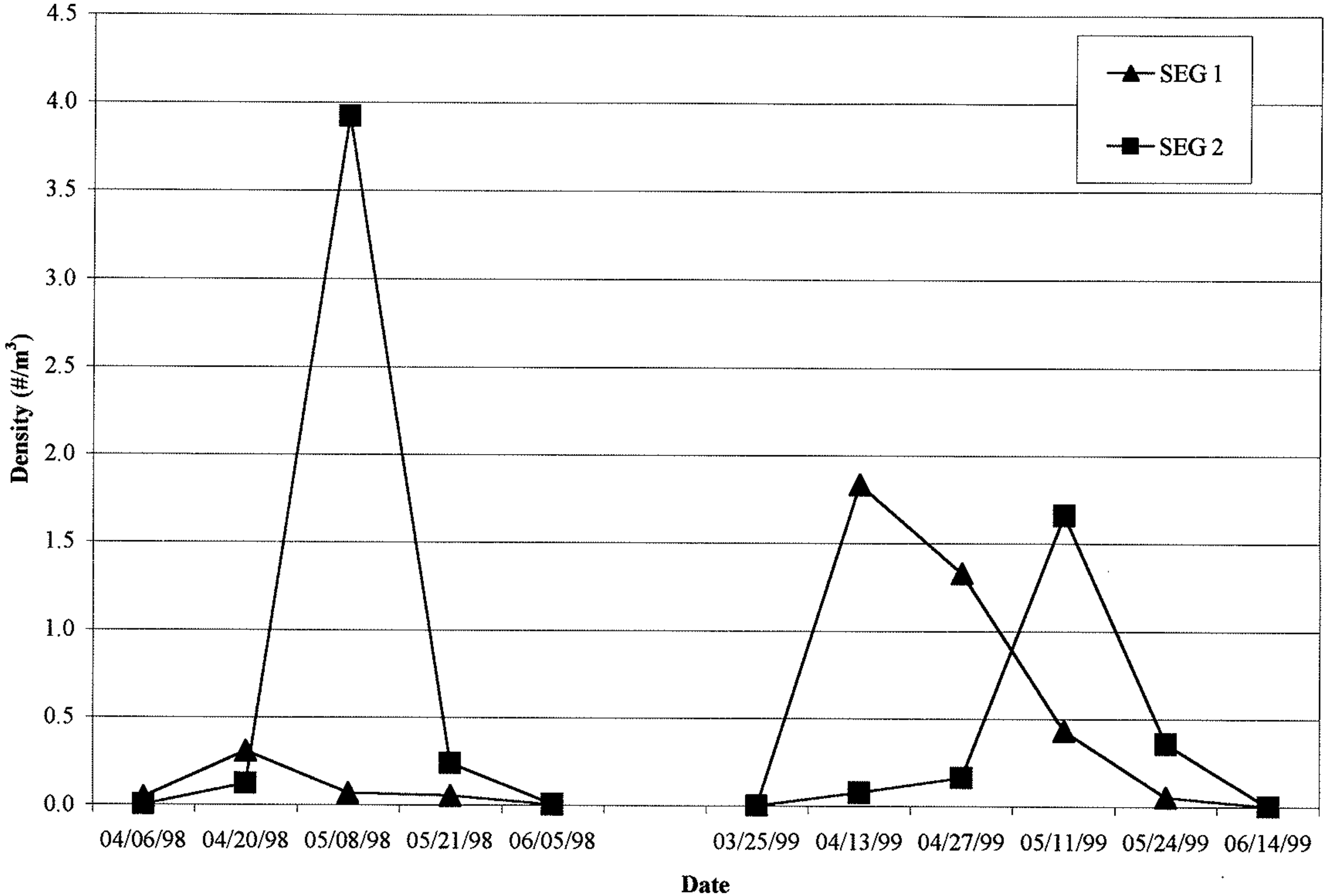

Figure 8.8. Mean densities (#/m^3) of *Dorosoma* sampled with net tows in Lake of Egypt in 1998-99.

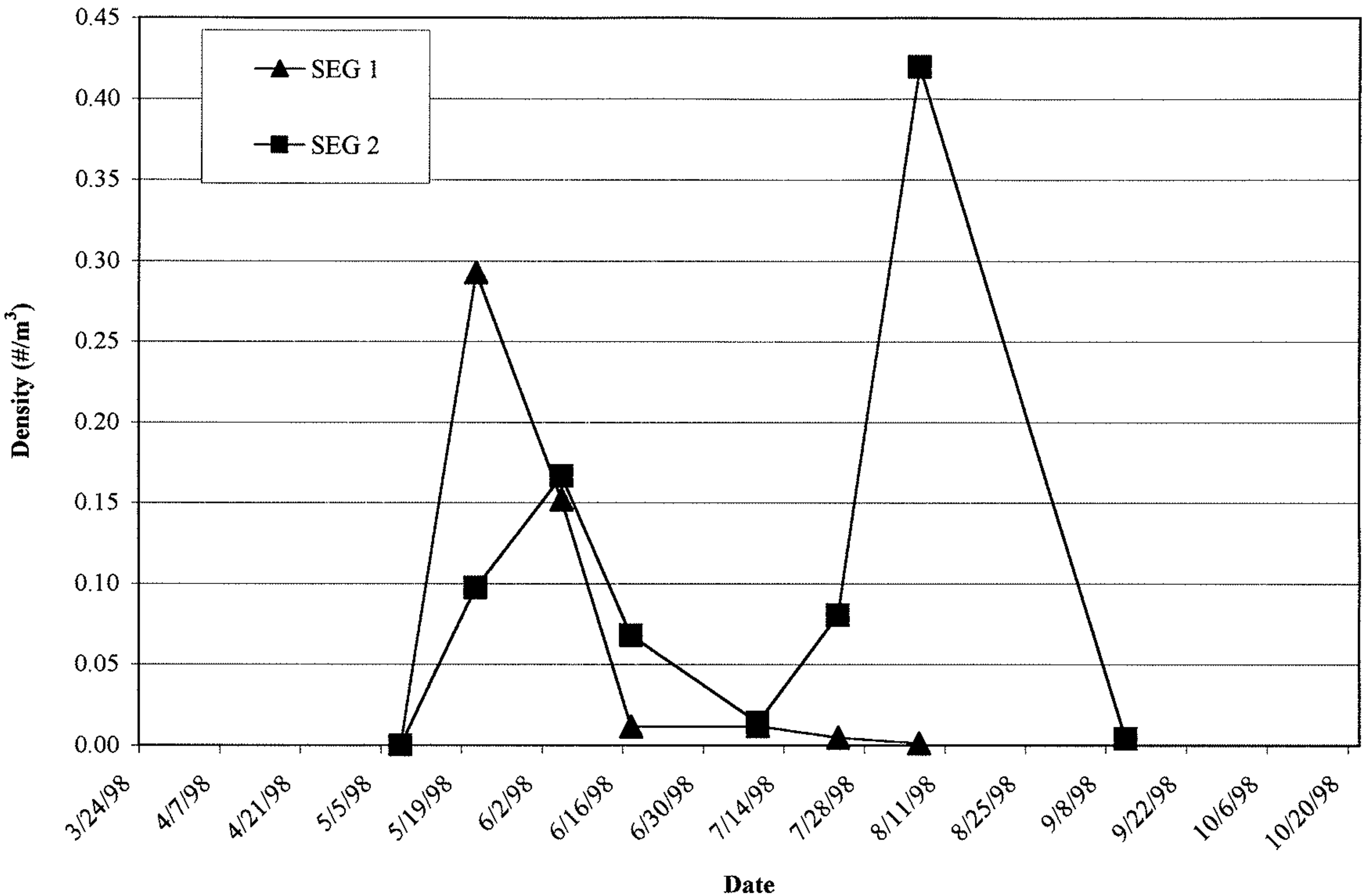

Figure 8.9. Mean densities (#/m³) of *Lepomis* sampled with net tows in Lake of Egypt in 1998.

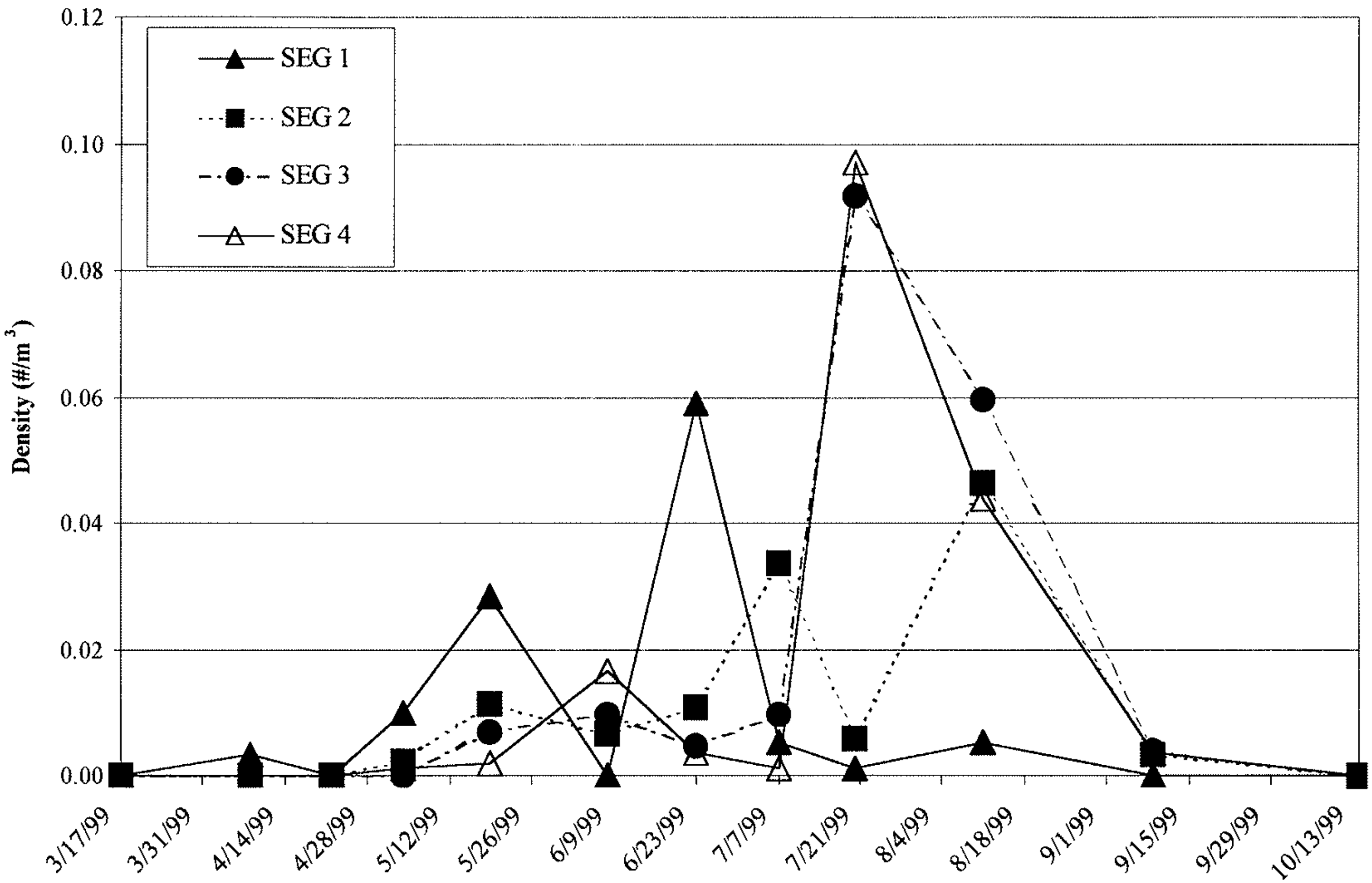

Figure 8.10. Mean densities (#/m^3) of *Lepomis* sampled with net tows in Newton Lake in 1999.

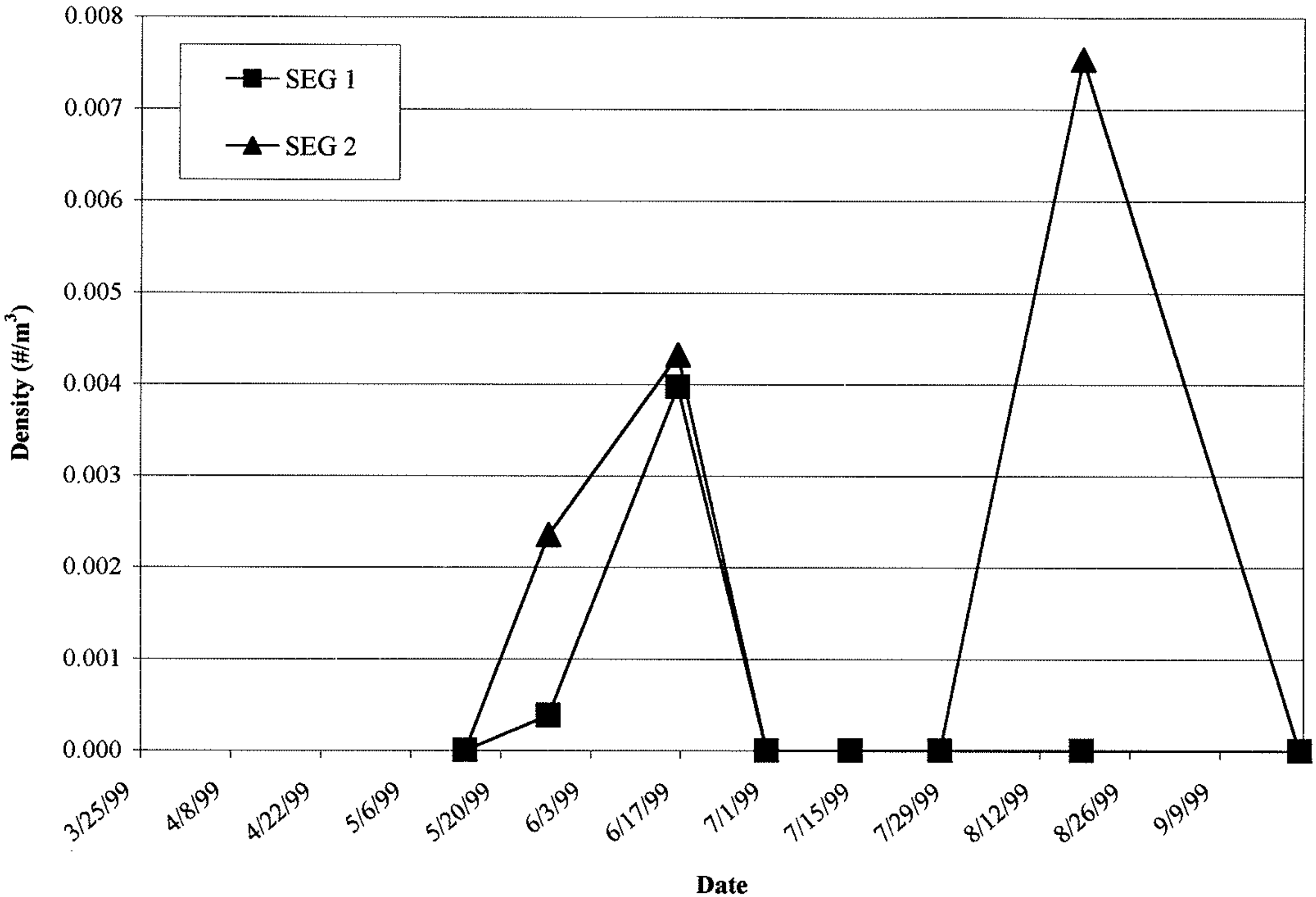

Figure 8.11. Mean densities (#/m³) of *Lepomis* sampled with net tows in Coffeen Lake in 1999.

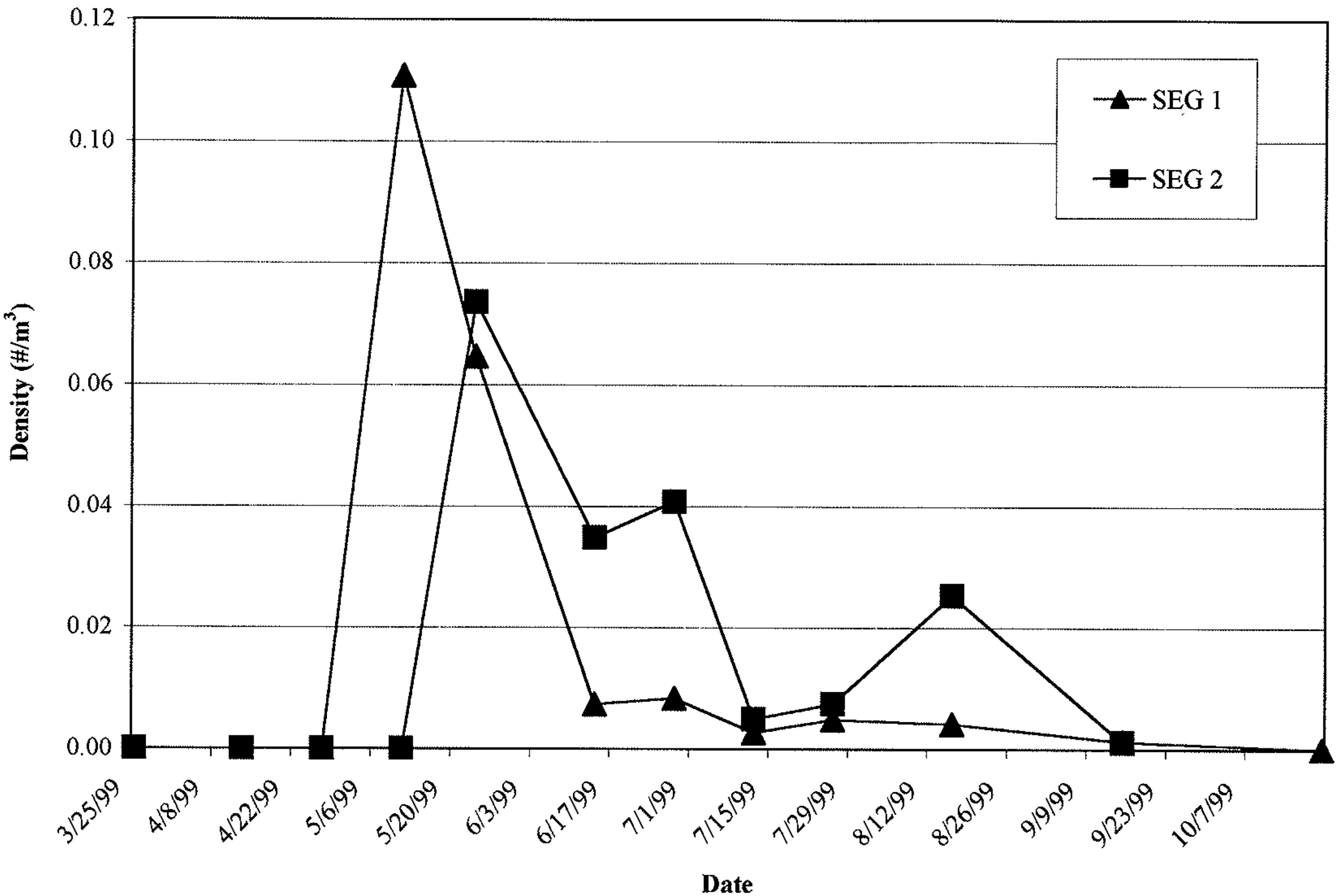

Figure 8.12. Mean densities (#/m^3) of *Lepomis* sampled with net tows in Lake of Egypt in 1999.

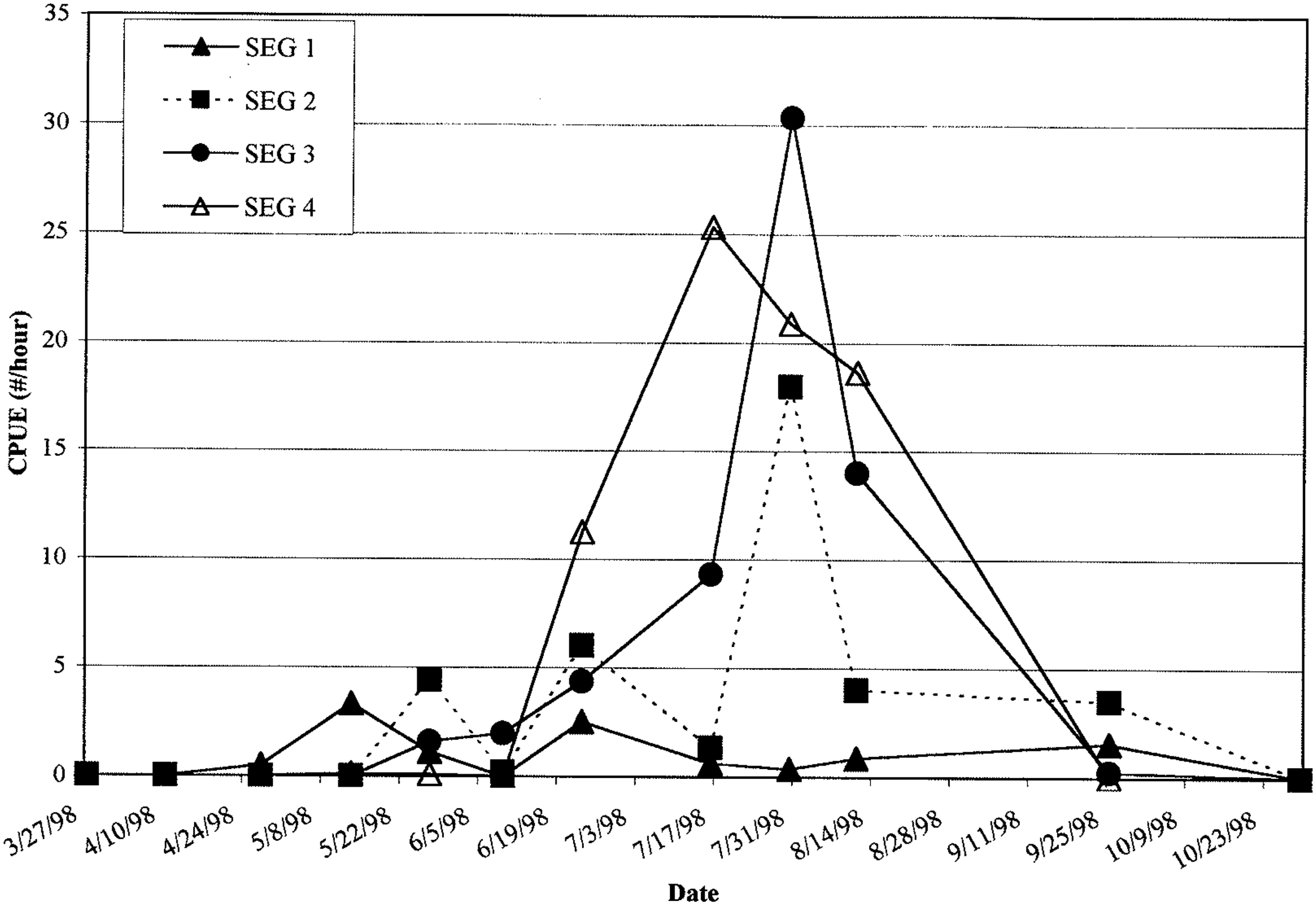

Figure 8.13. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Newton Lake in 1998.

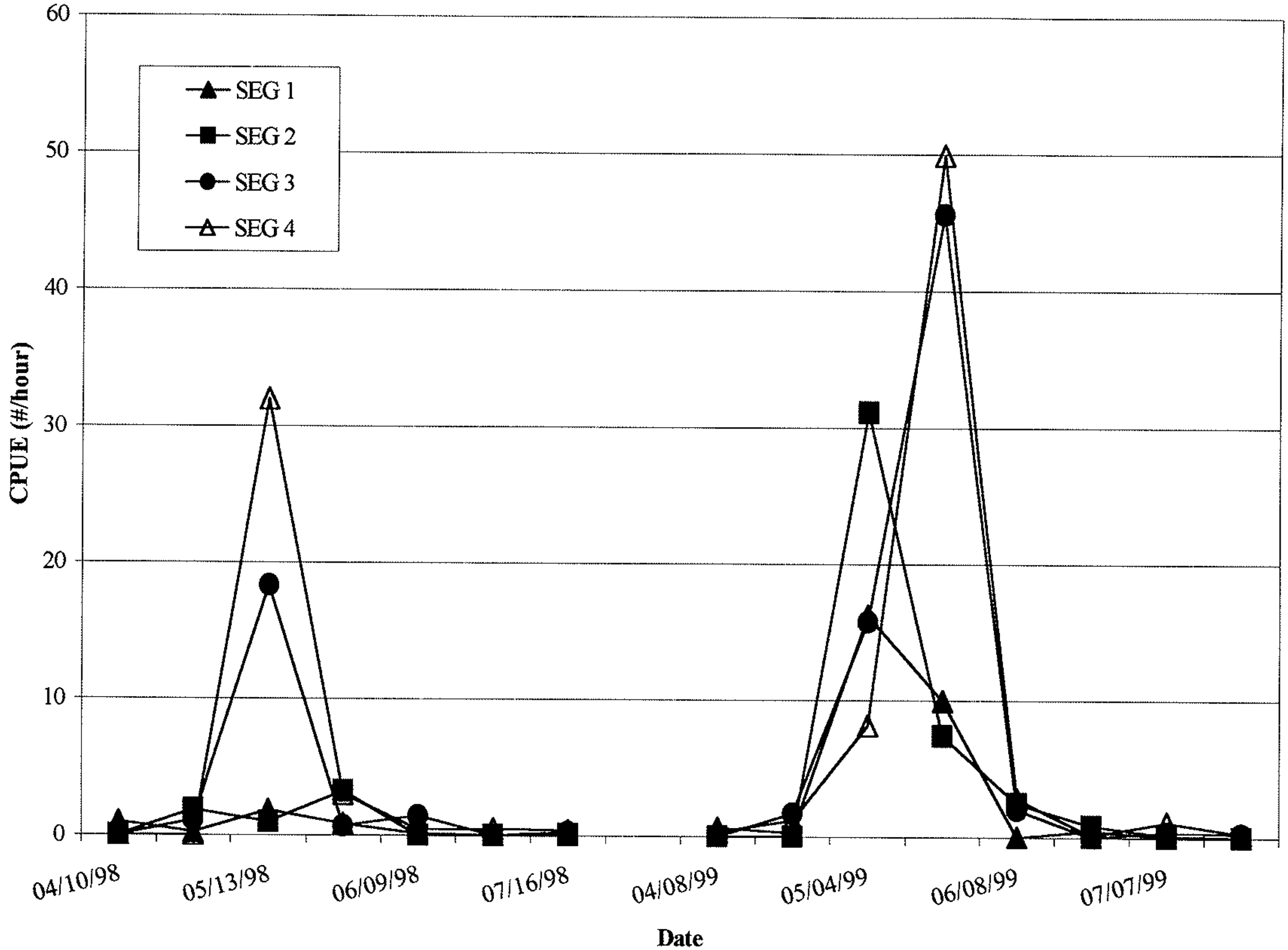

Figure 8.14. Mean CPUE (#/hour) of *Dorosoma* sampled with light traps in Newton Lake in 1998-99.

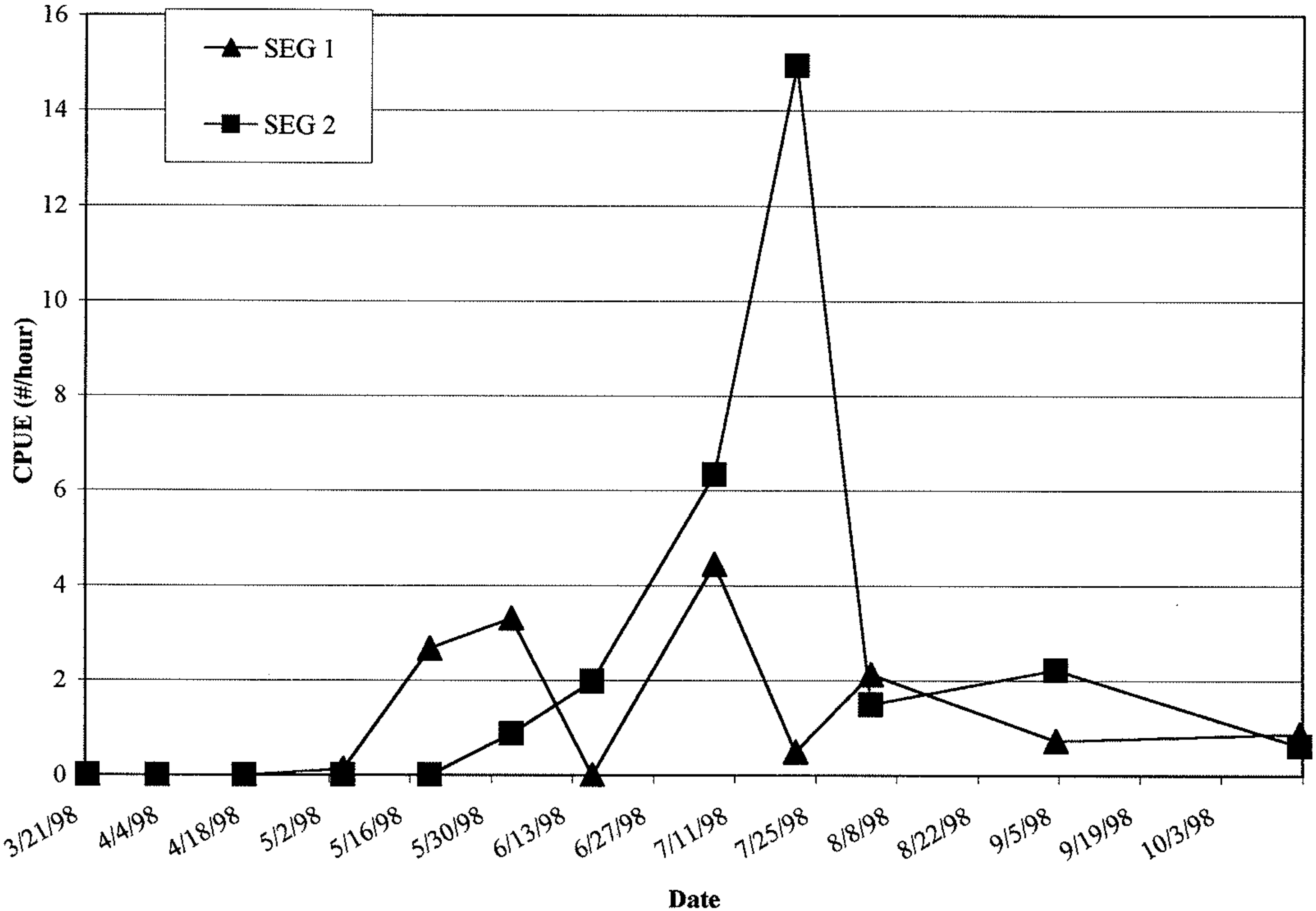

Figure 8.15. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Coffeen Lake in 1998.

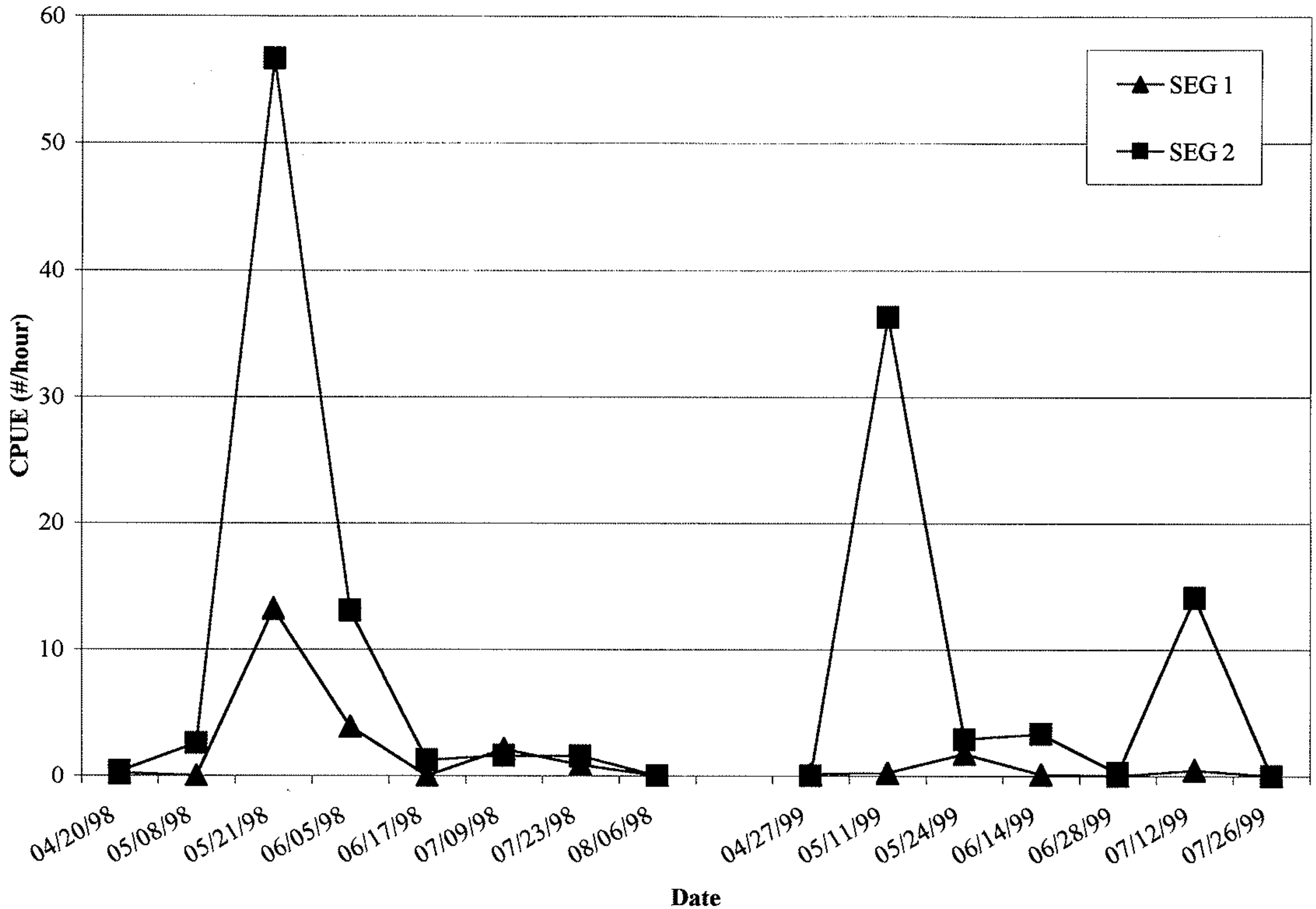

Figure 8.16. Mean CPUE (#/hour) of *Dorosoma* sampled with light traps in Lake of Egypt in 1998-99.

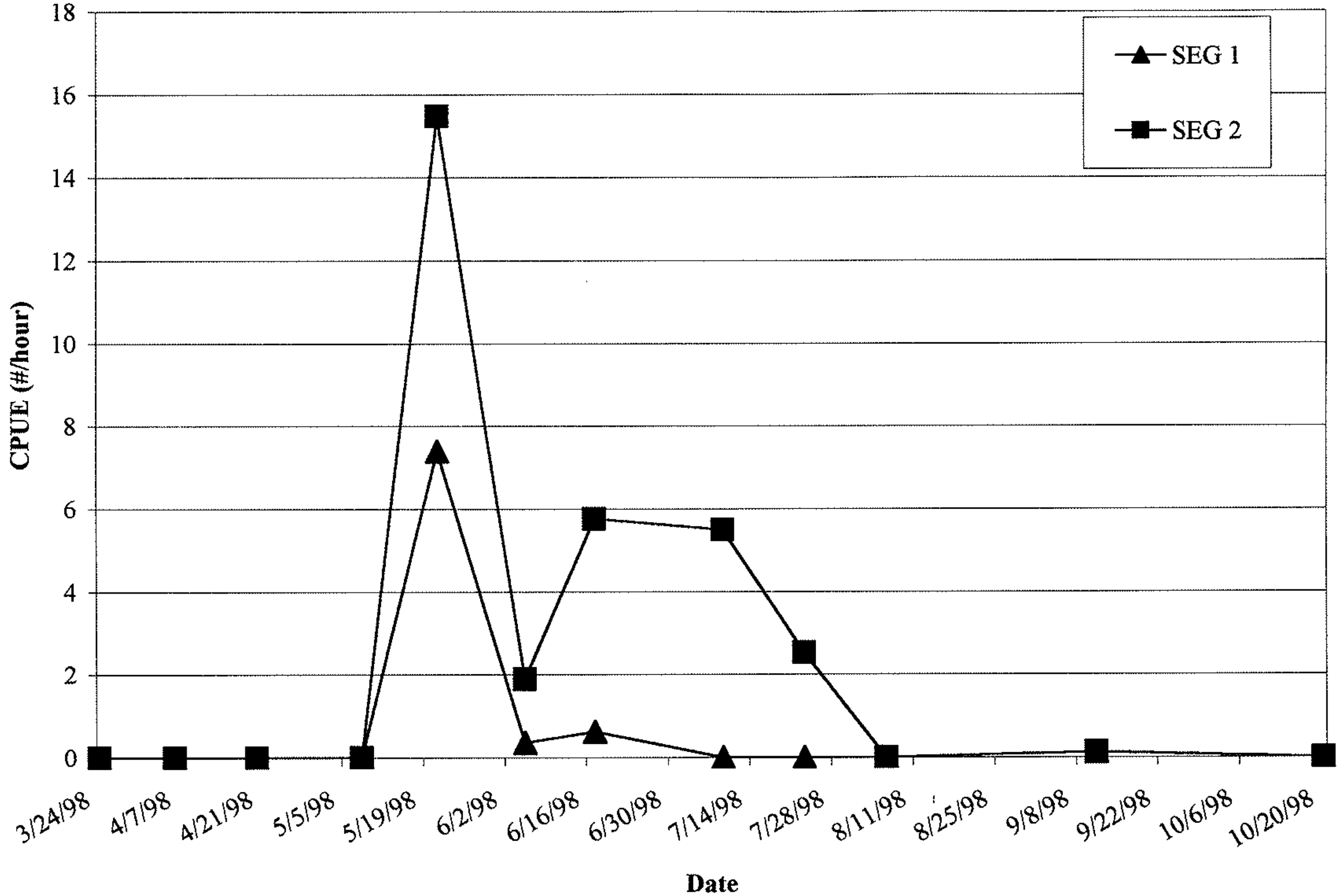

Figure 8.17. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Lake of Egypt in 1998.

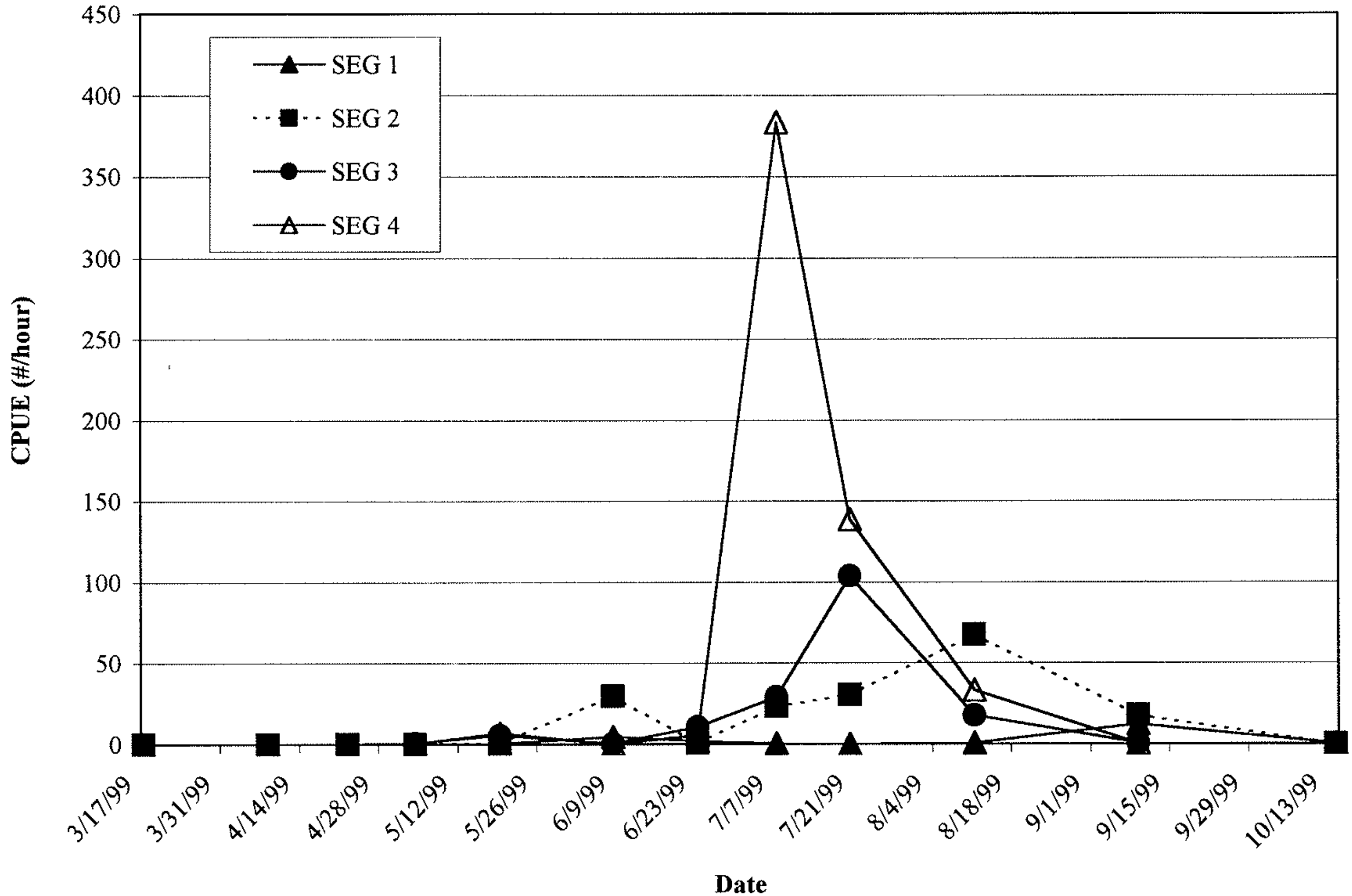

Figure 8.18. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Newton Lake in 1999.

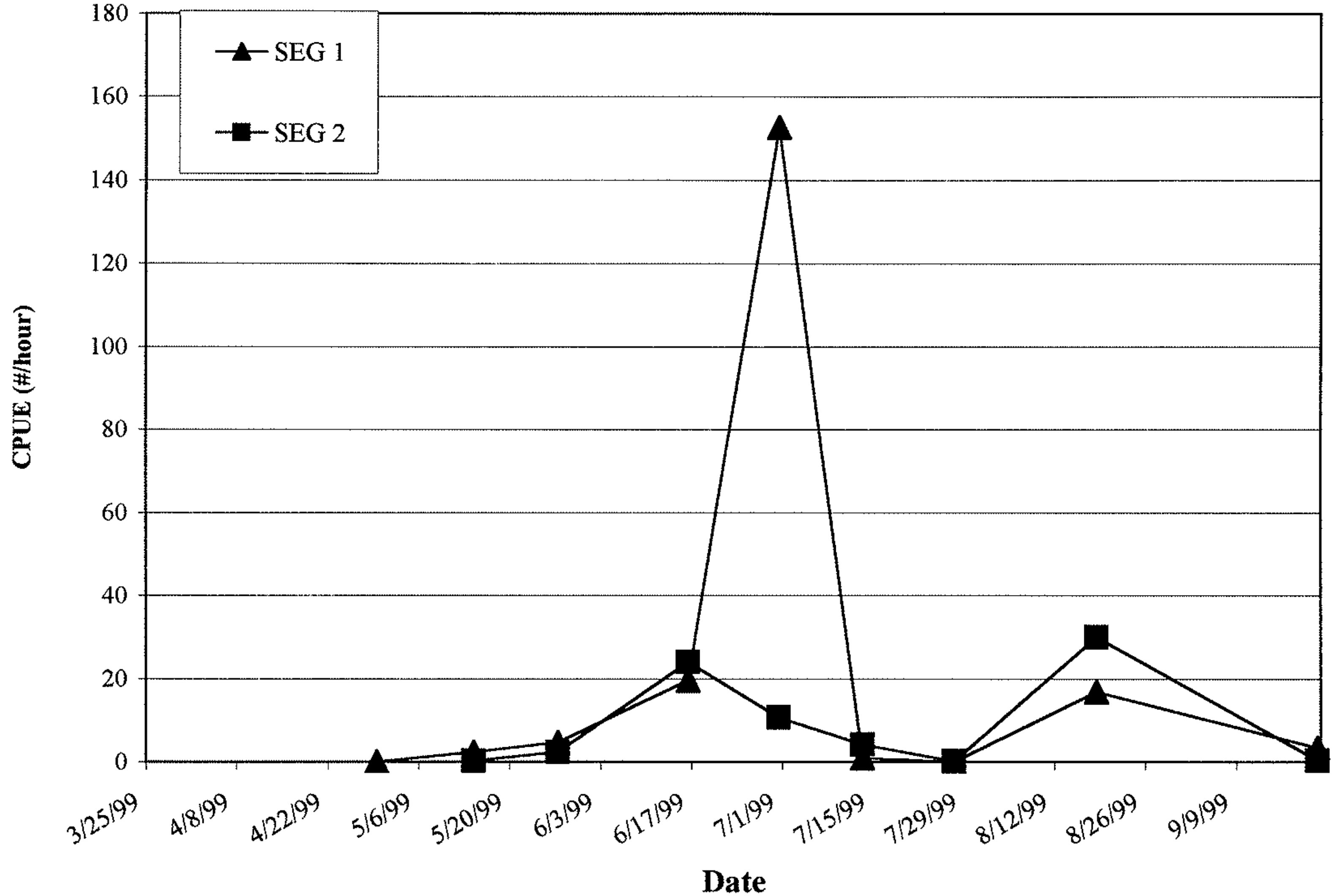

Figure 8.19. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Coffeen Lake in 1999.

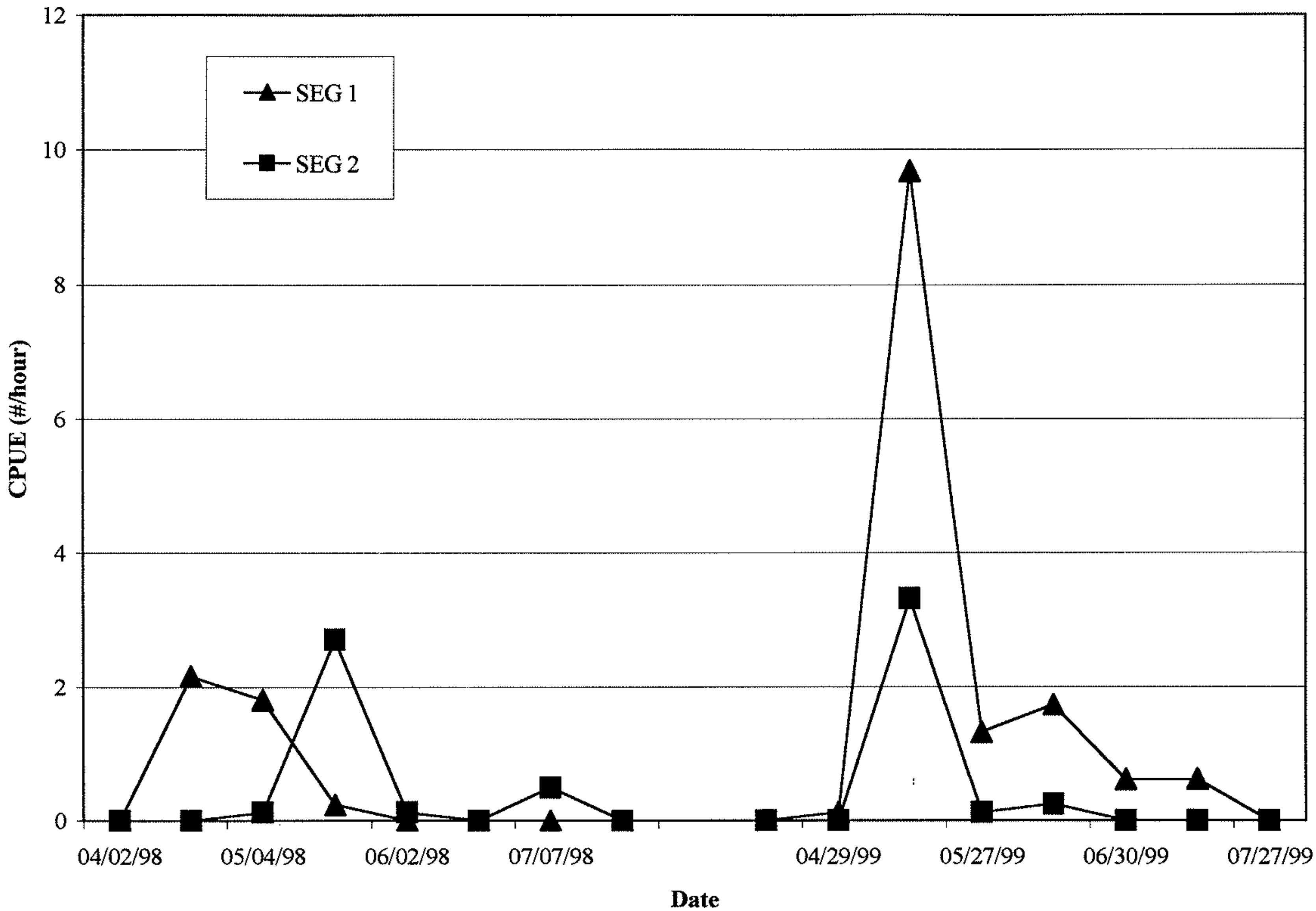

Figure 8.20. Mean CPUE (#/hour) of *Dorosoma* sampled with light traps in Coffeen Lake in 1998-99.

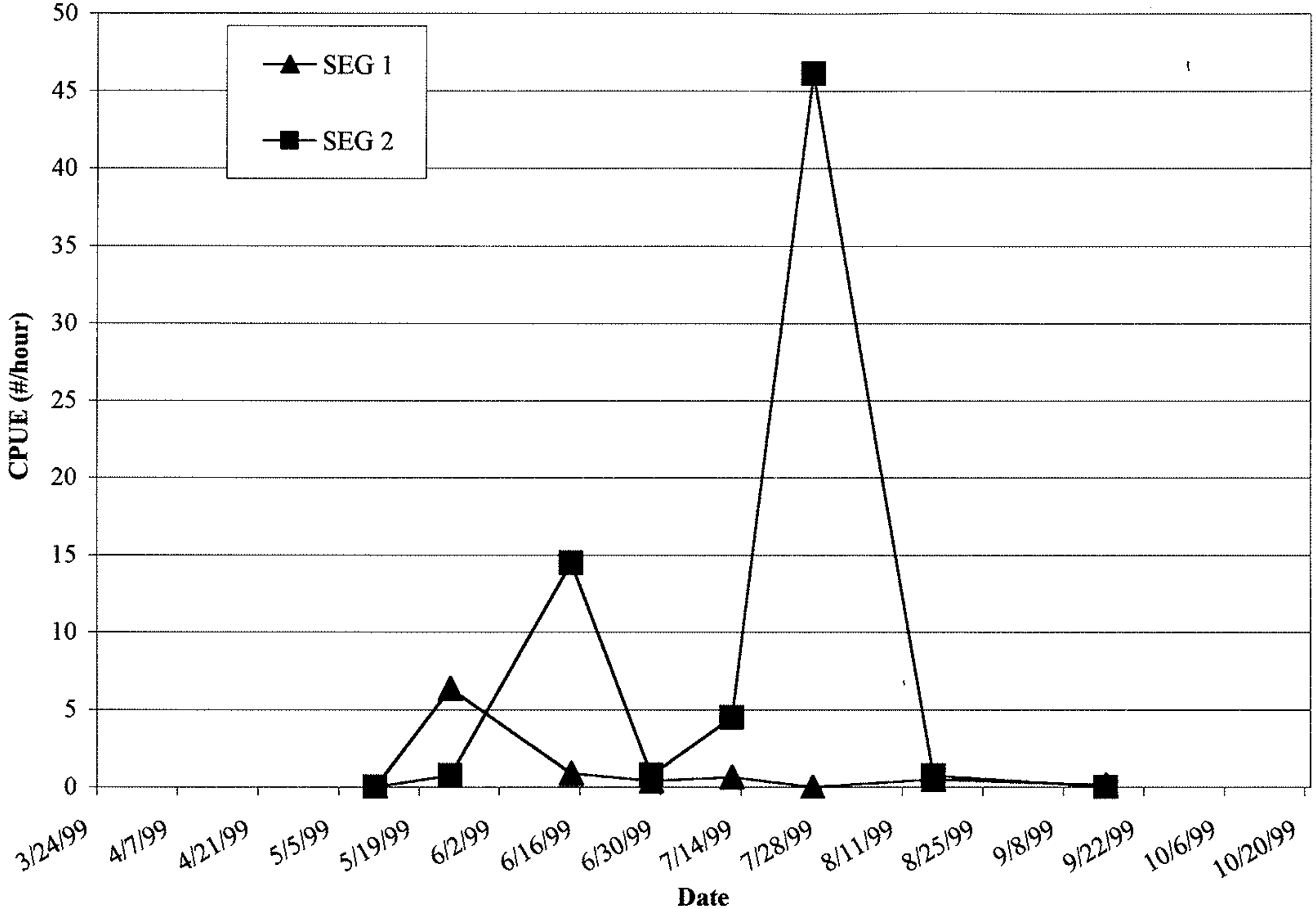

Figure 8.21. Mean CPUE (#/hour) of *Lepomis* sampled with light traps in Lake of Egypt in 1999.

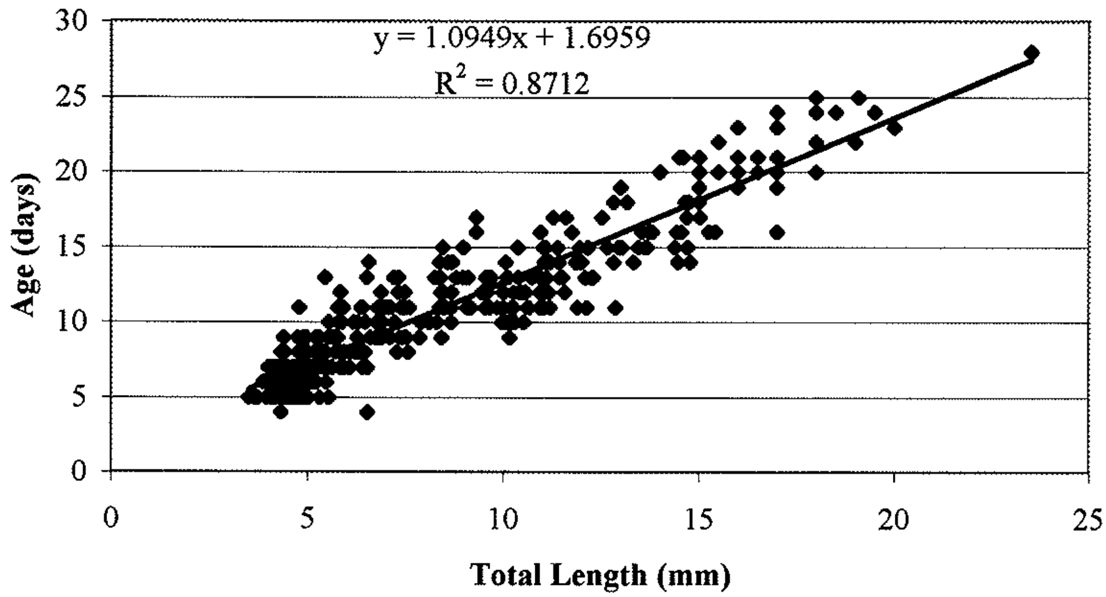

Figure 8.22. Length-age data and regression line of *Lepomis* sampled with net tows and light traps in Newton Lake in 1998. The regression line is significantly positive (P=0.0001).

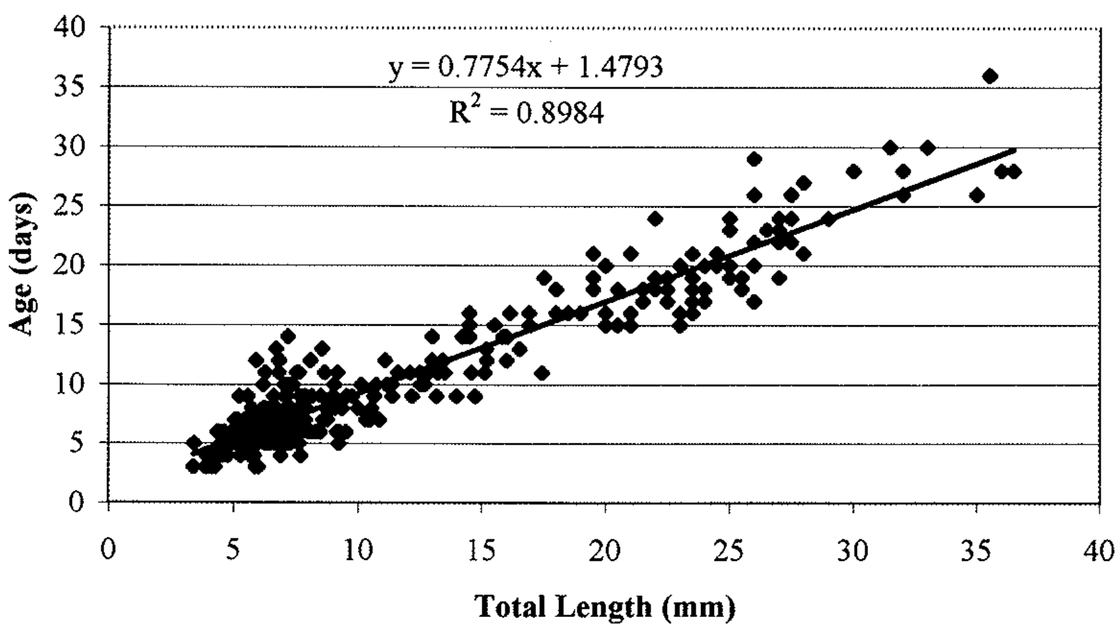

Figure 8.23. Length-age data and regression line of *Dorosoma* sampled with net tows and light traps in Newton Lake in 1998. The regression line is significantly positive (P=0.0001).

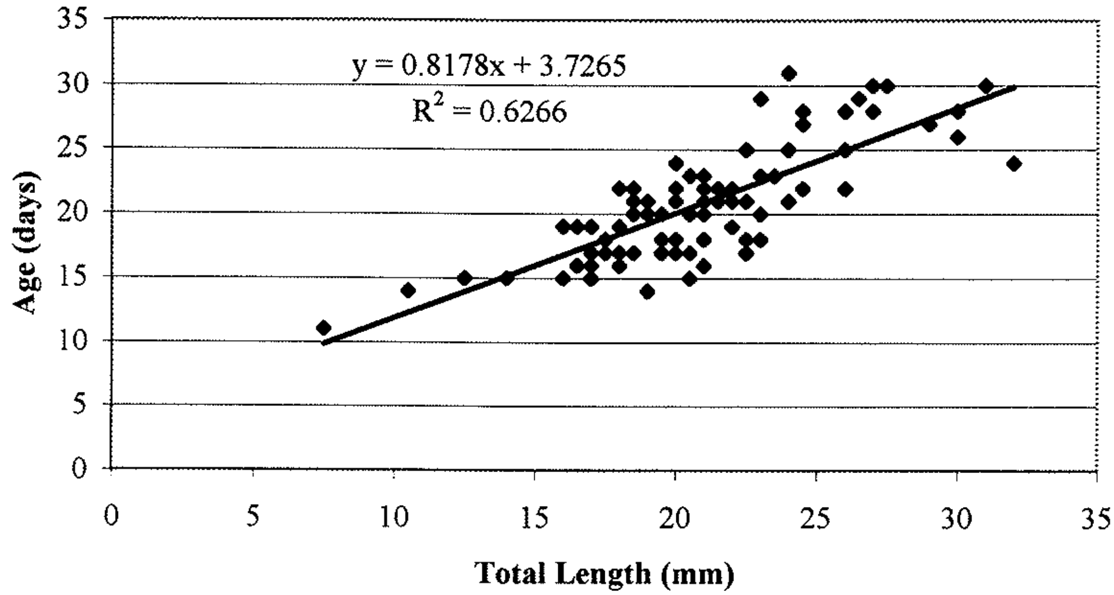

Figure 8.24. Length-age data and regression line of largemouth bass sampled with net tows and light traps in Newton Lake in 1998. The regression line is significantly positive (P=0.0001).

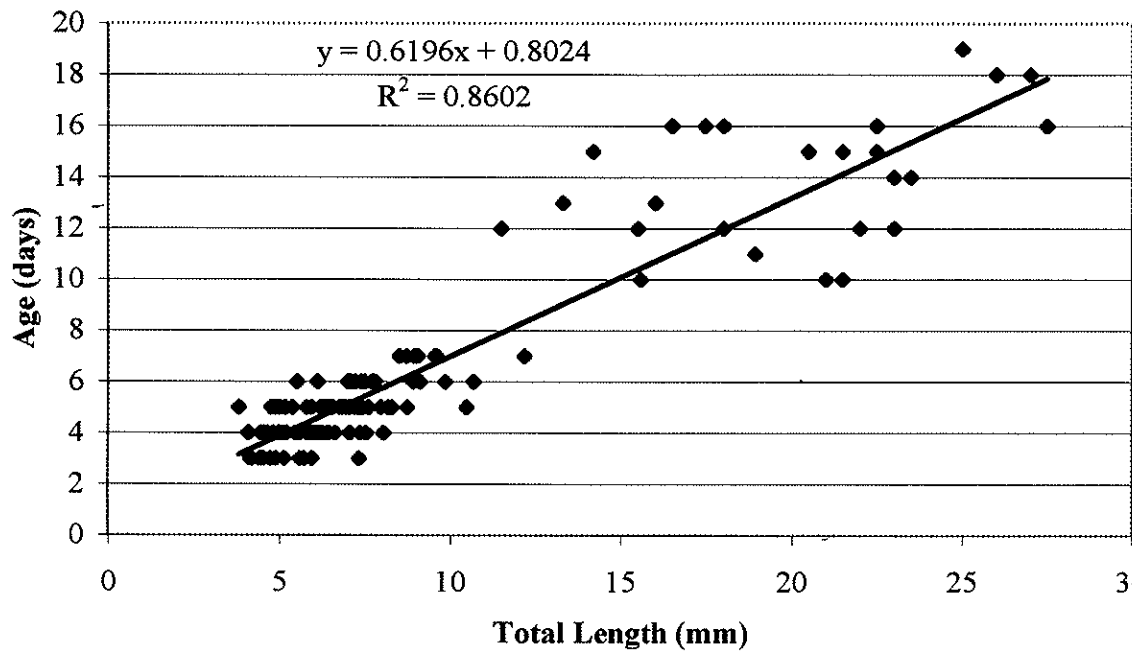

Figure 8.25. Length-age data and regression line of *Dorosoma* sampled with net tows and light traps in Coffeen Lake in 1998. The regression line is significantly positive (P=0.0001).

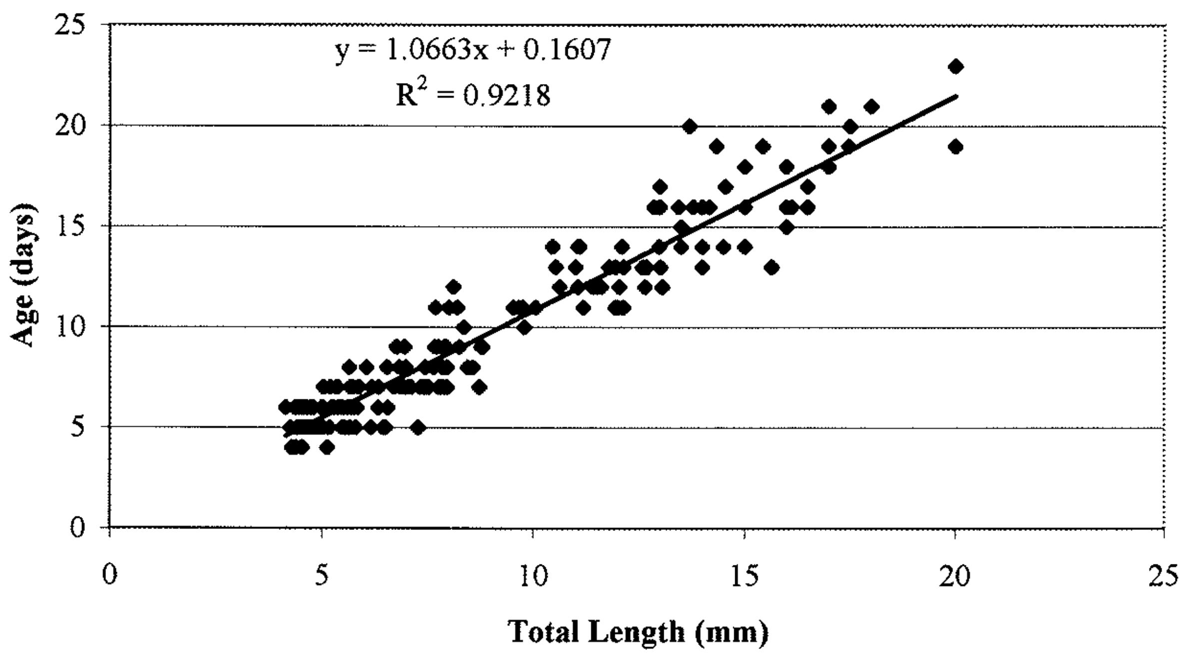

Figure 8.26. Length-age data and regression line of *Lepomis* sampled with net tows and light traps in Coffeen Lake in 1998. The regression line is significantly positive (P=0.0001).

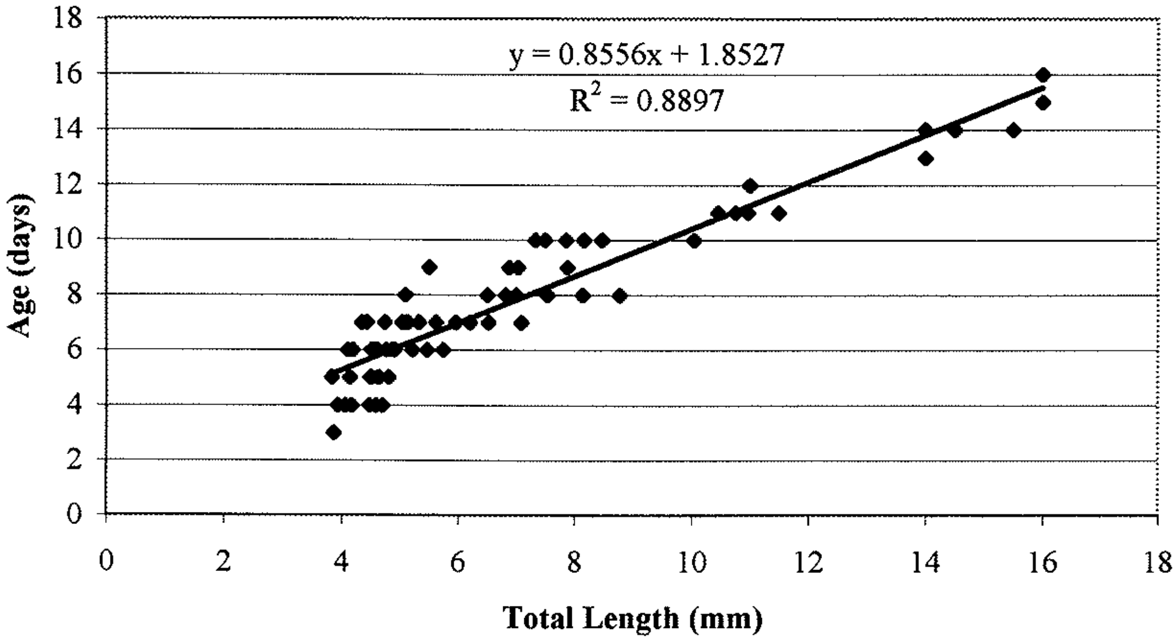

Figure 8.27. Length-age data and regression line of *Pomoxis* sampled with net tows and light traps in Coffeen Lake in 1998. The regression line is significantly positive (P=0.0001).

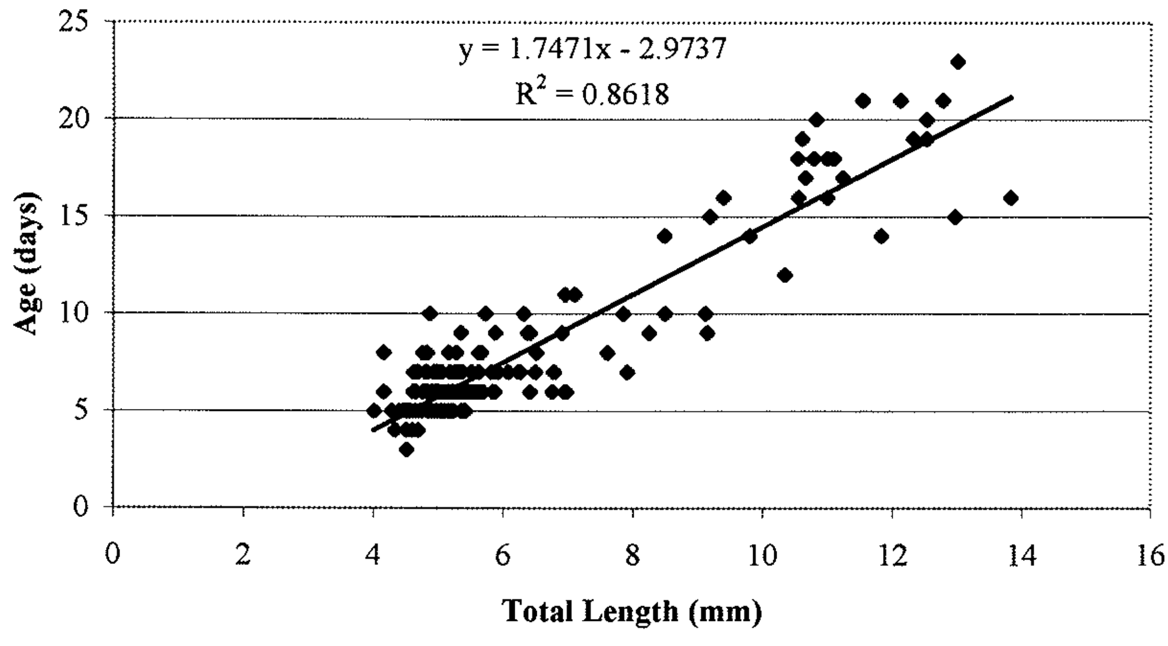

Figure 8.28. Length-age data and regression line of *Lepomis* sampled with net tows and light traps in Lake of Egypt in 1998. The regression line is significantly positive (P=0.0001).

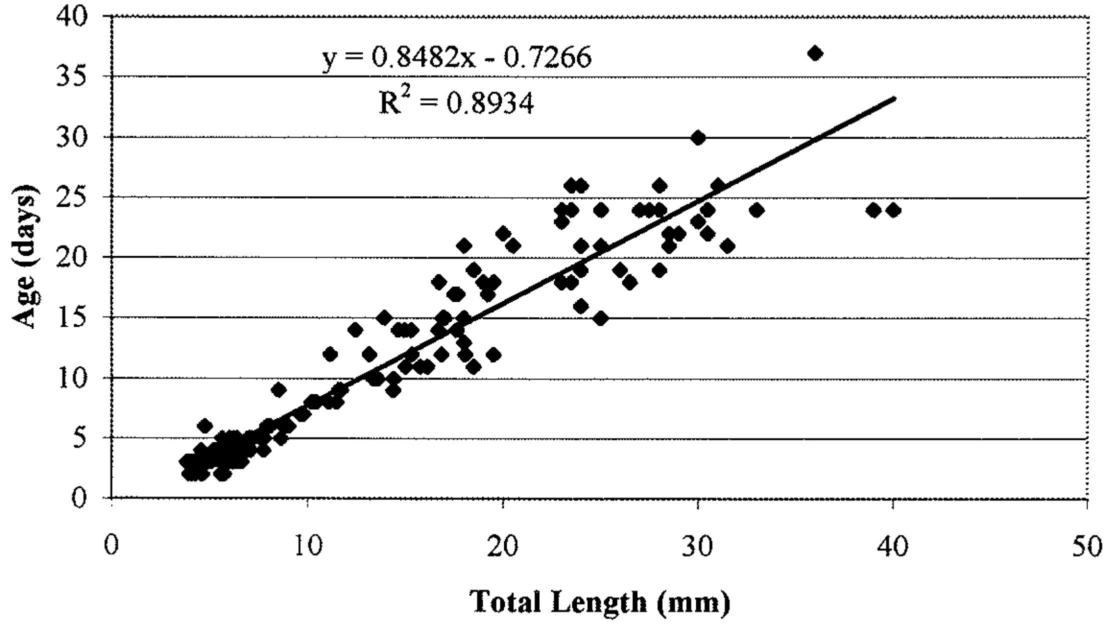

Figure 8.29. Length-age data and regression line of *Dorosoma* sampled with net tows and light traps in Lake of Egypt in 1998. The regression line is significantly positive (P=0.0001).

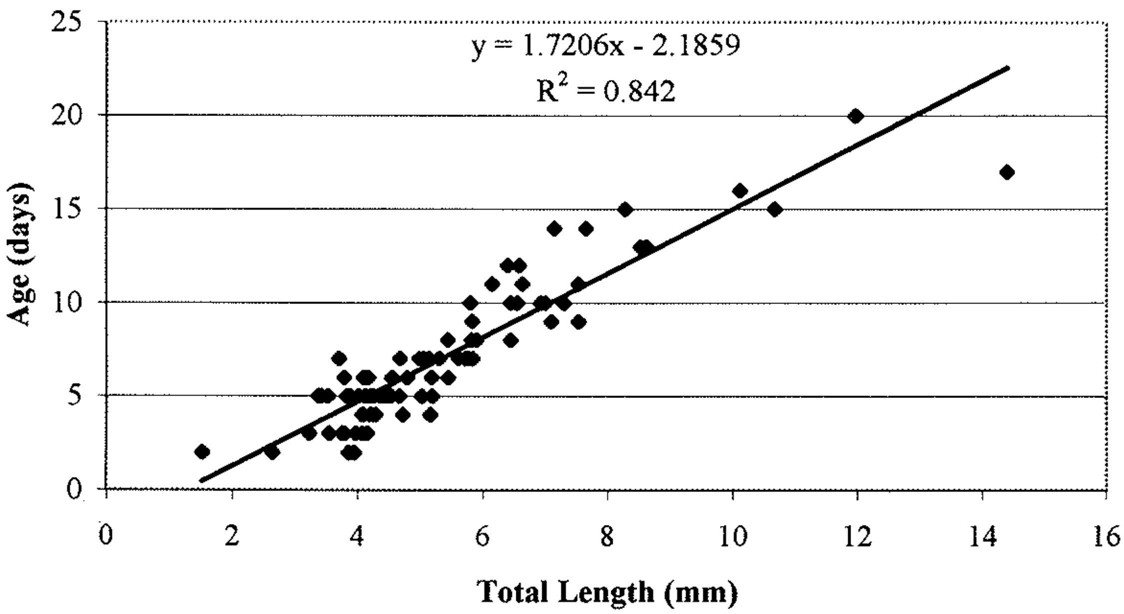

Figure 8.30. Length-age data and regression line of *Pomoxis* sampled with net tows and light traps in Lake of Egypt in 1998. The regression line is significantly positive (P=0.0001).

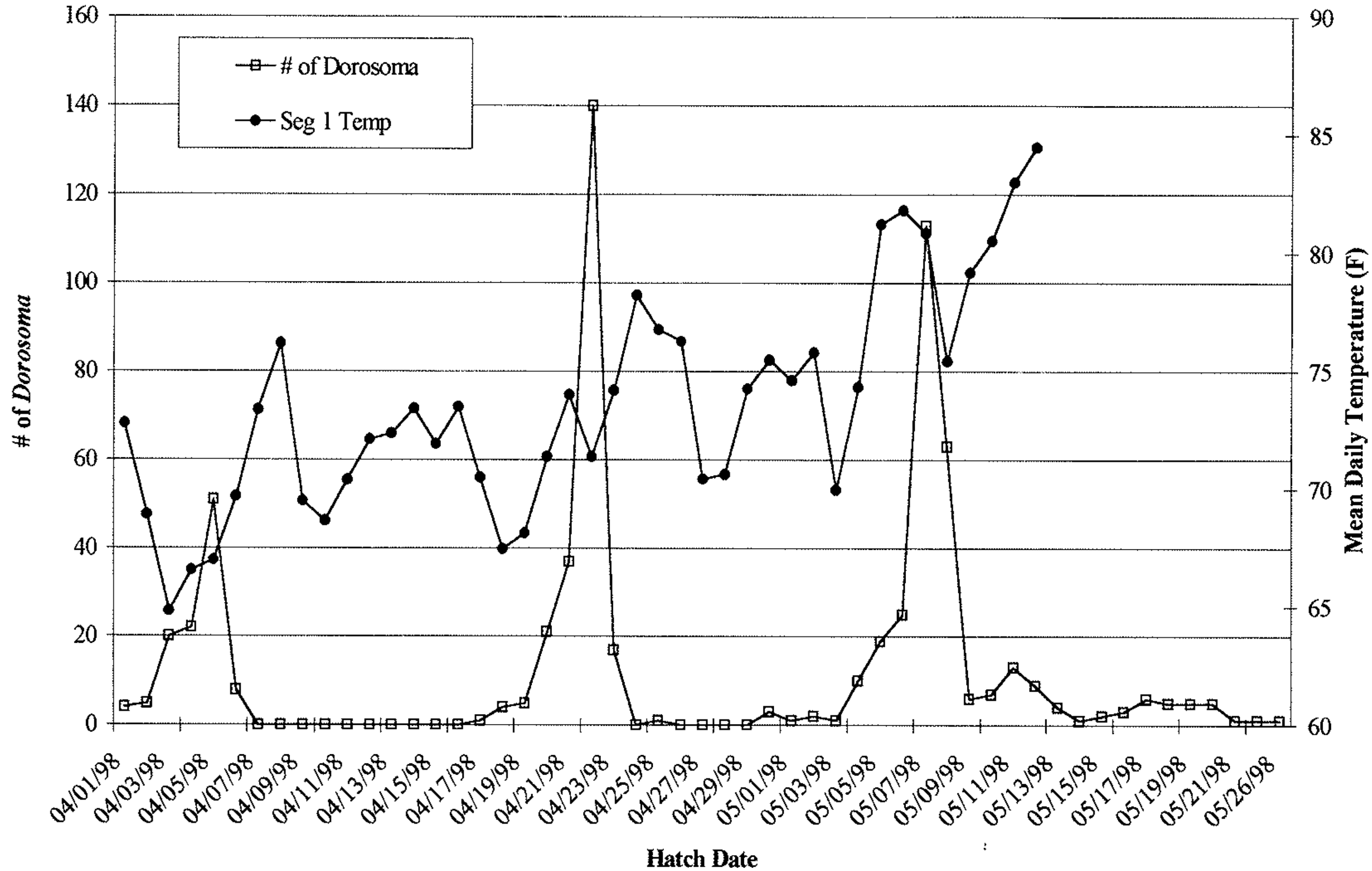

Figure 8.31. Number of *Dorosoma* by hatch date in Newton Lake (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

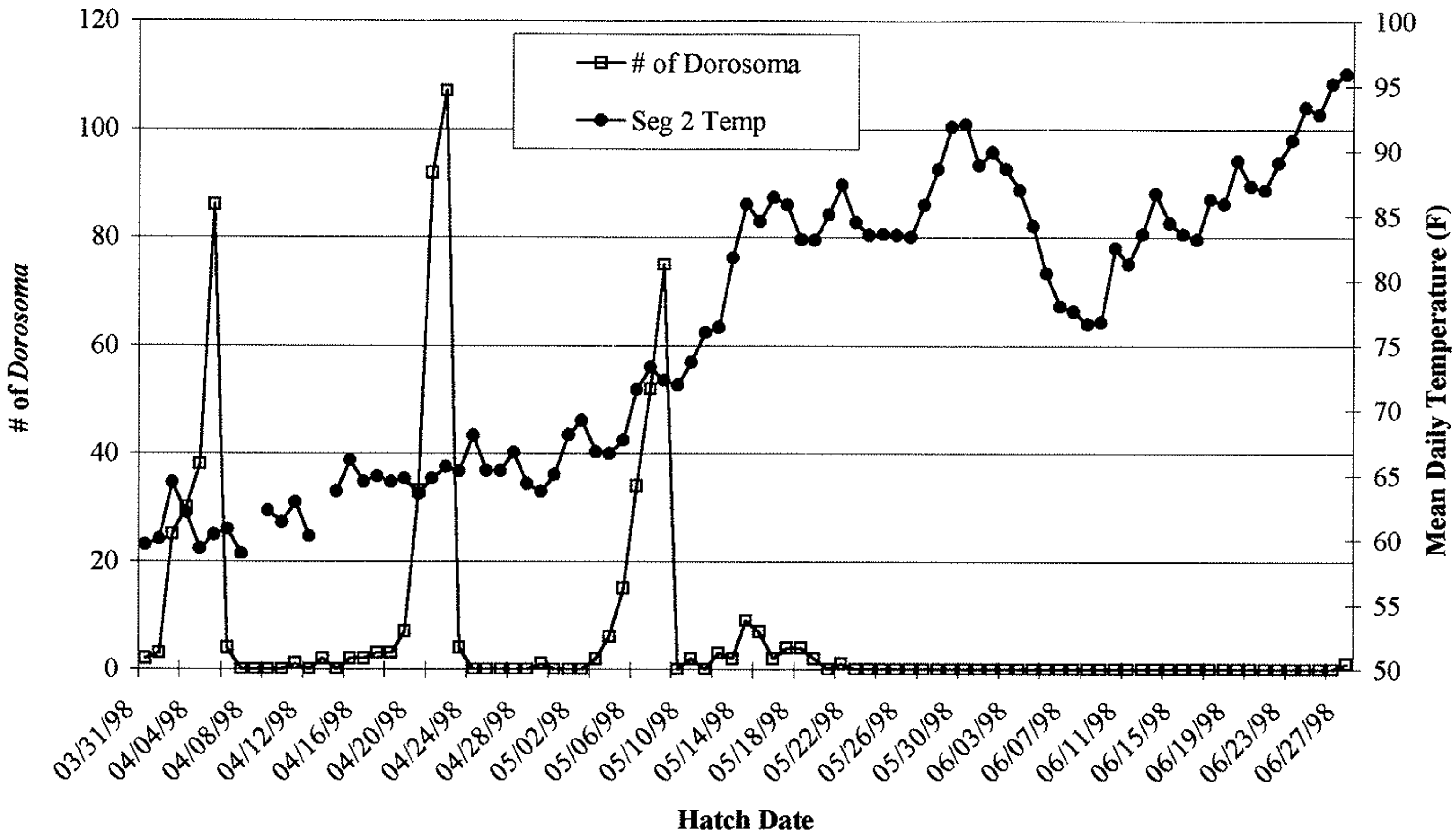

Figure 8.32. Number of *Dorosoma* by hatch date in Newton Lake (segment 2) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

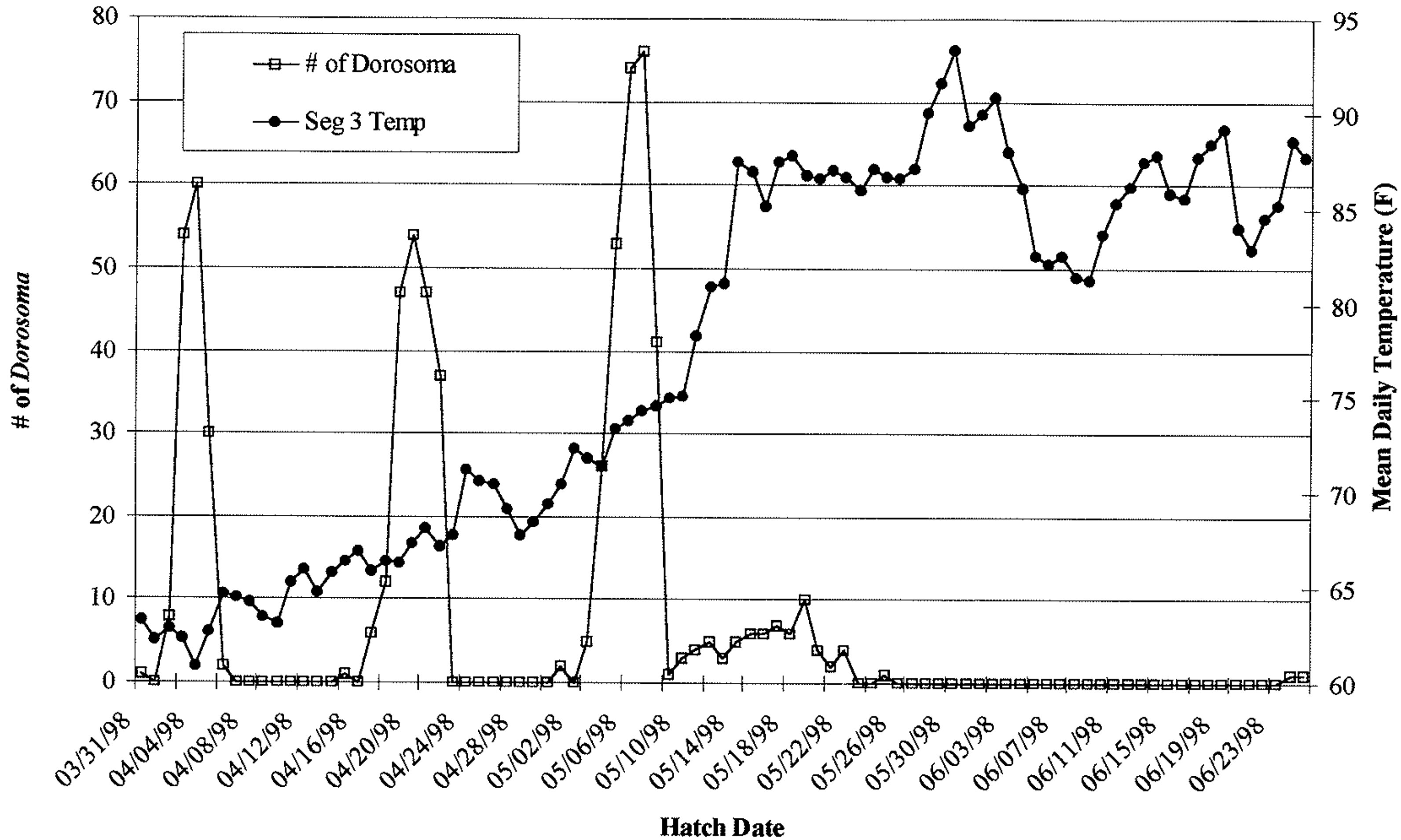

Figure 8.33. Number of *Dorosoma* by hatch date in Newton Lake (segment 3) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

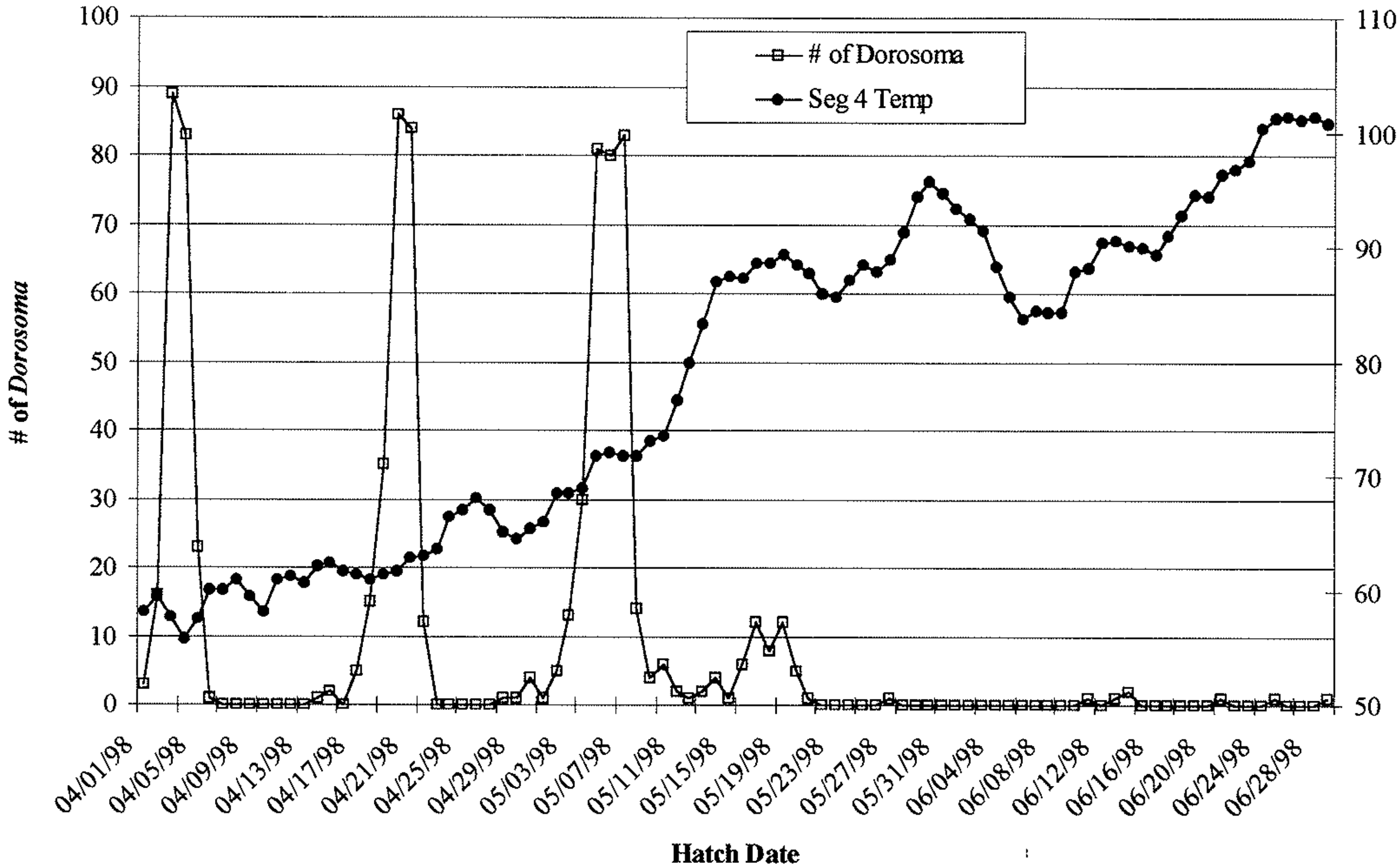

Figure 8.34. Number of *Dorosoma* by hatch date in Newton Lake (segment 4) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

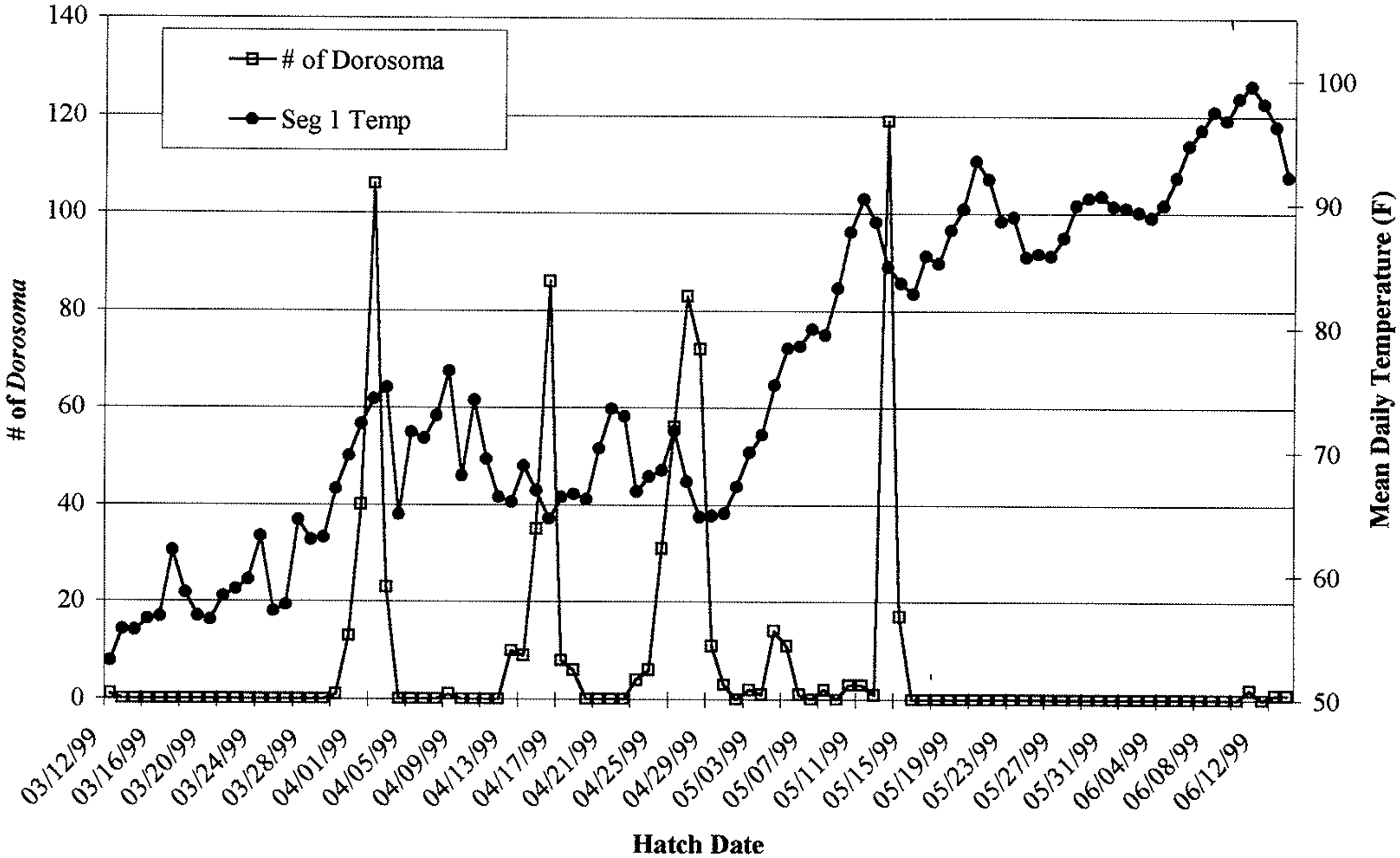

Figure 8.35. Number of *Dorosoma* by hatch date in Newton Lake (segment1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

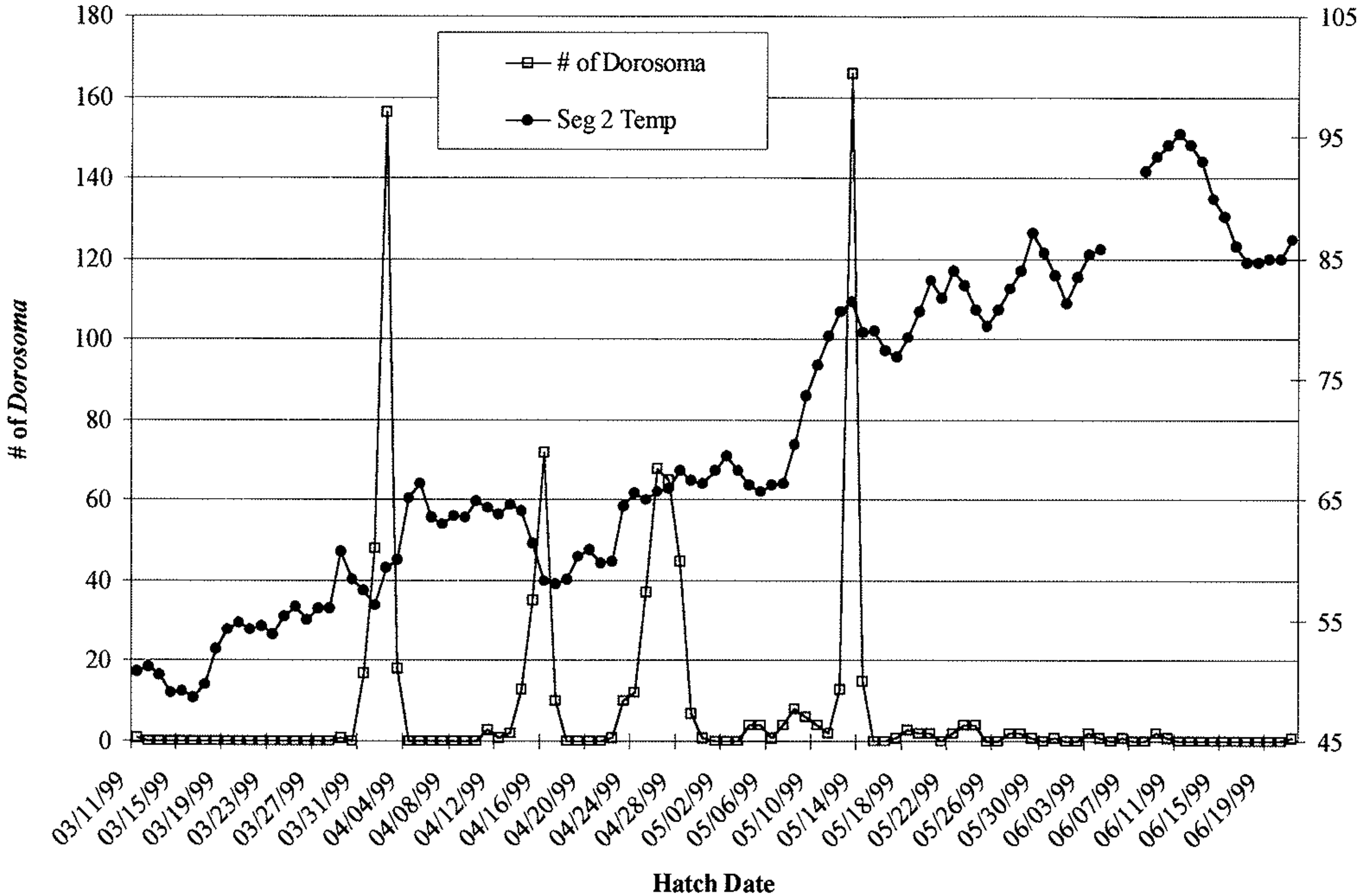

Figure 8.36. Number of *Dorosoma* by hatch date in Newton Lake (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

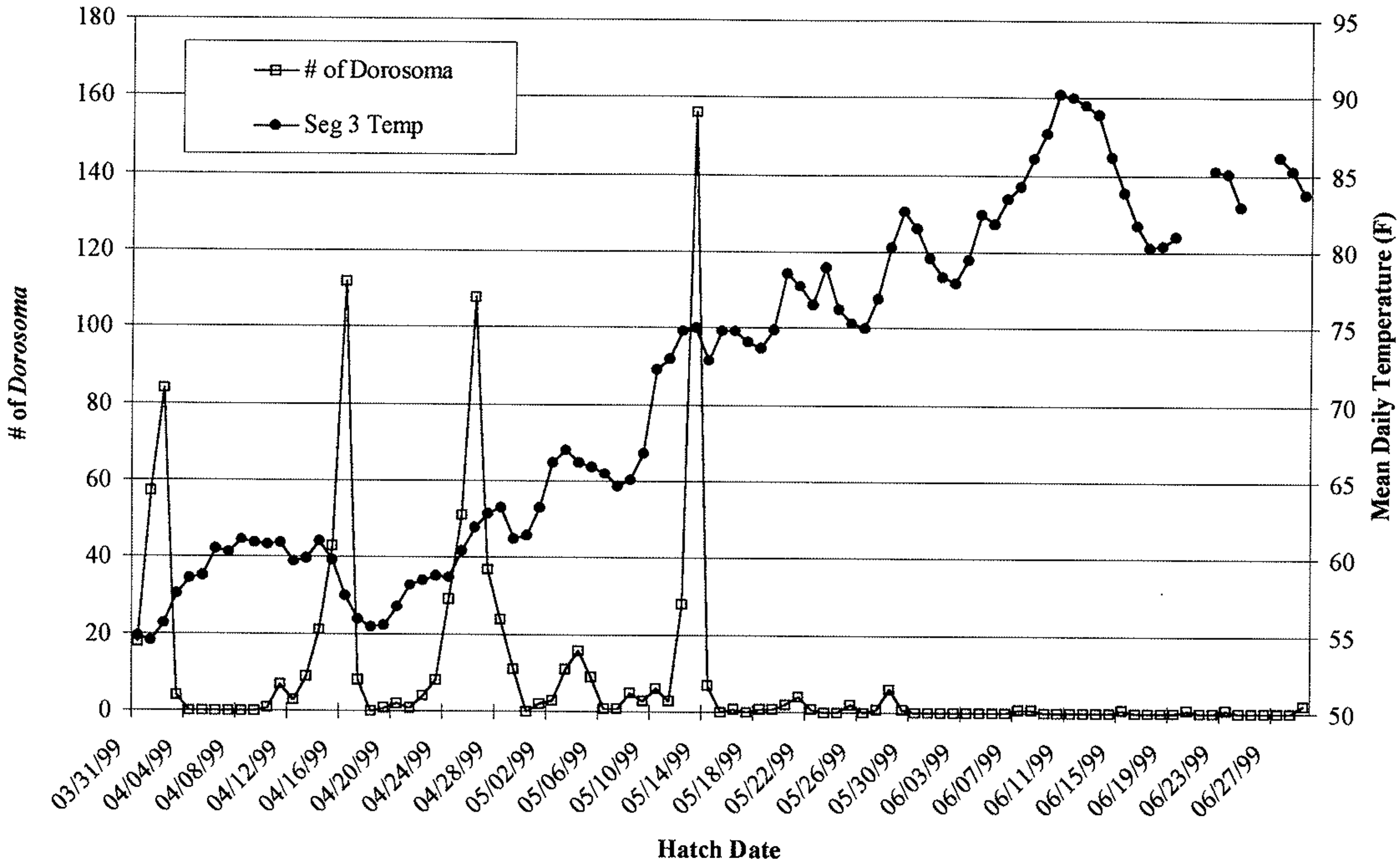

Figure 8.37. Number of *Dorosoma* by hatch date in Newton Lake (segment 3) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

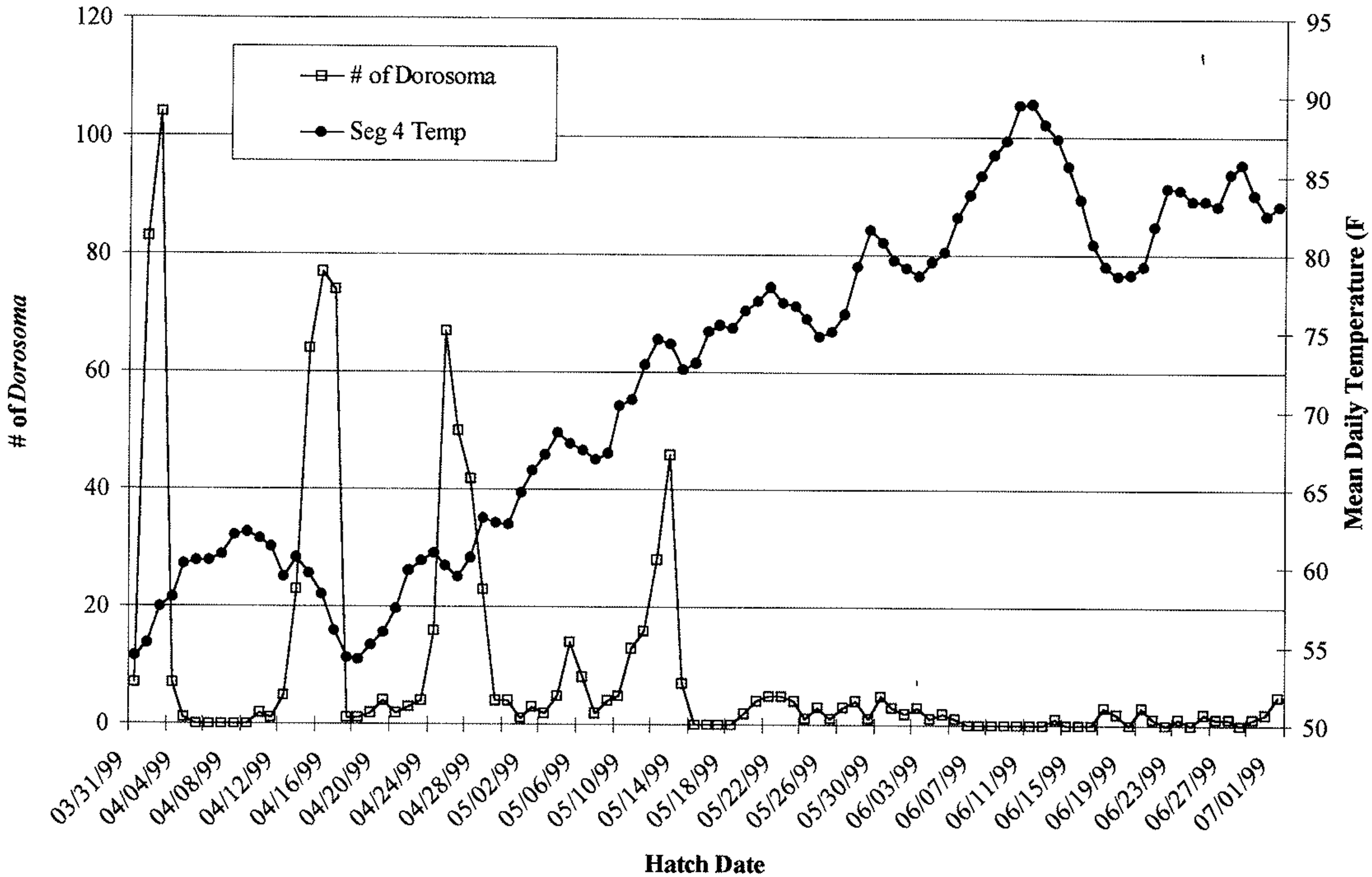

Figure 8.38. Number of *Dorosoma* by hatch date in Newton Lake (segment 4) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

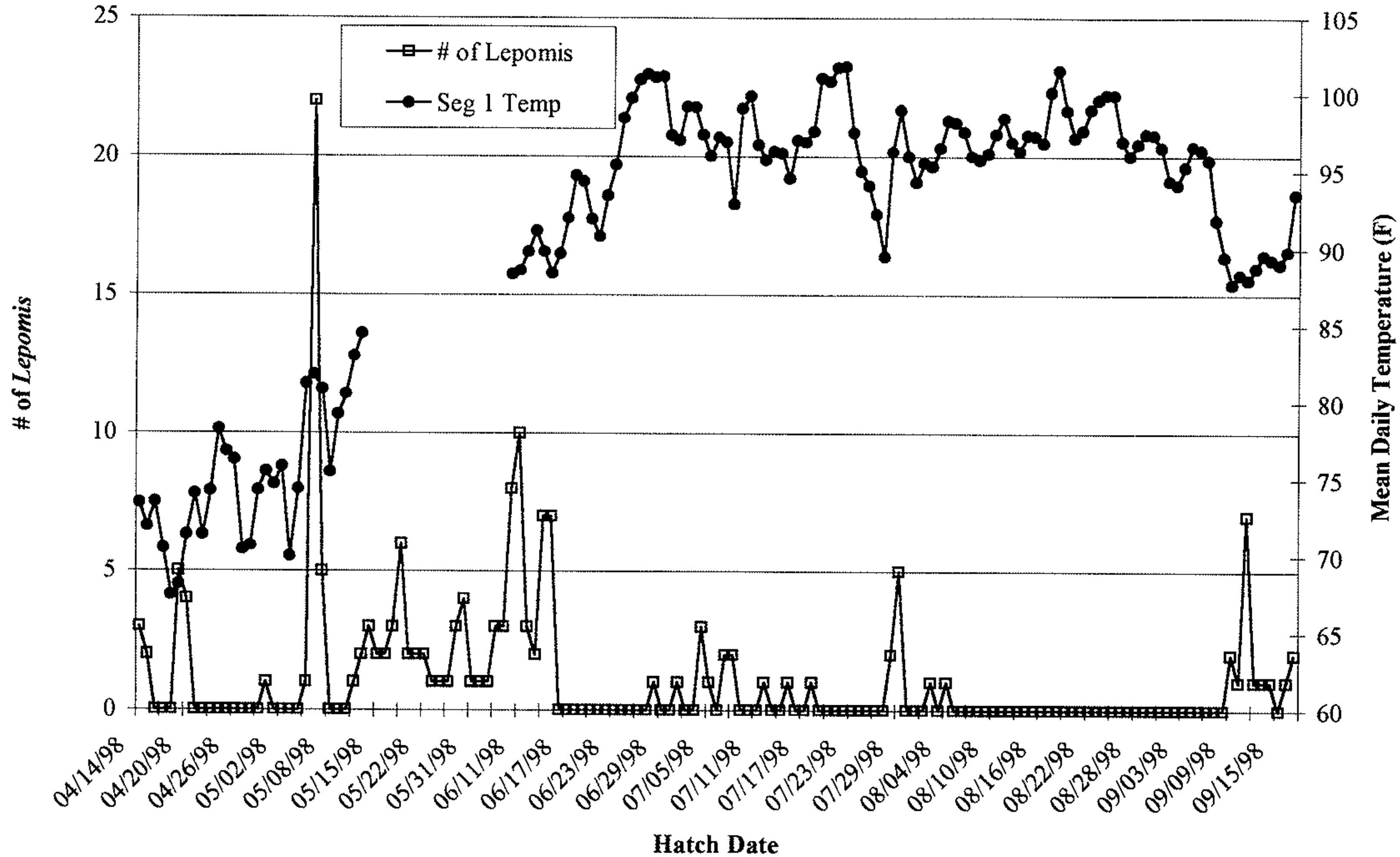

Figure 8.39. Number of *Lepomis* by hatch date in Newton Lake (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

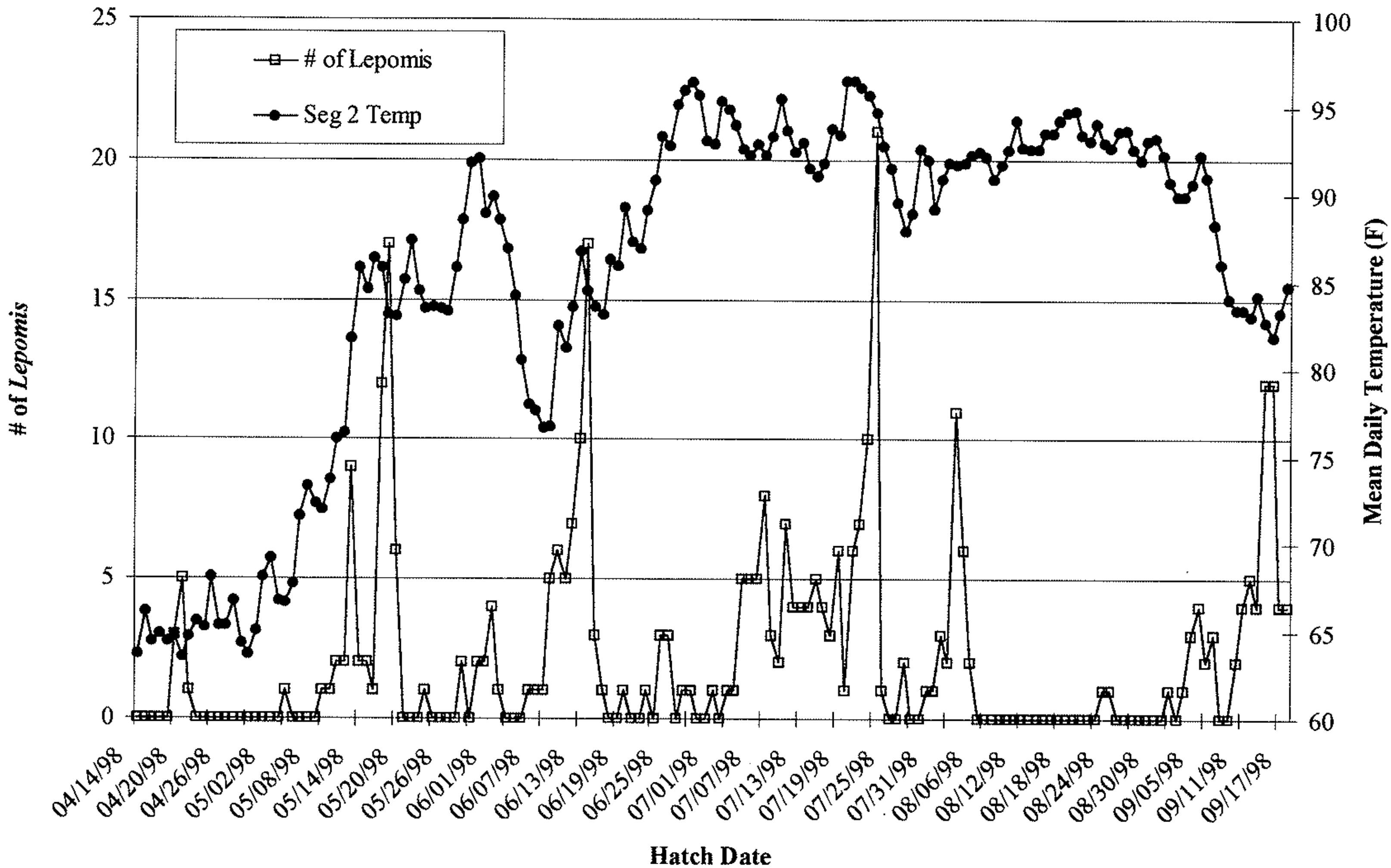

Figure 8.40. Number of *Lepomis* by hatch date in Newton Lake (segment 2) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch date were calculated by subtracting the age (days) from the collection date.

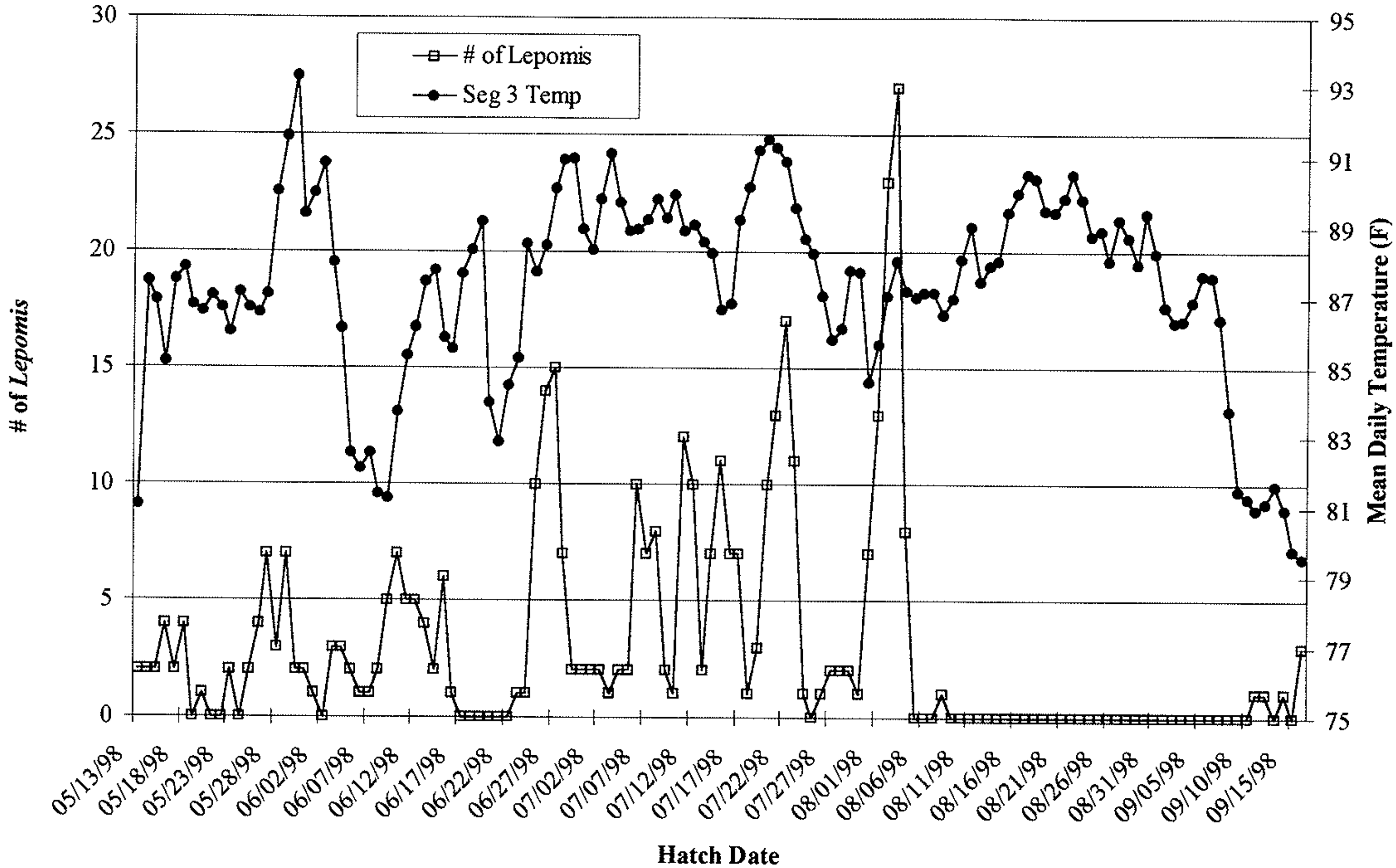

Figure 8.41. Number of *Lepomis* by hatch date in Newton Lake (segment 3) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

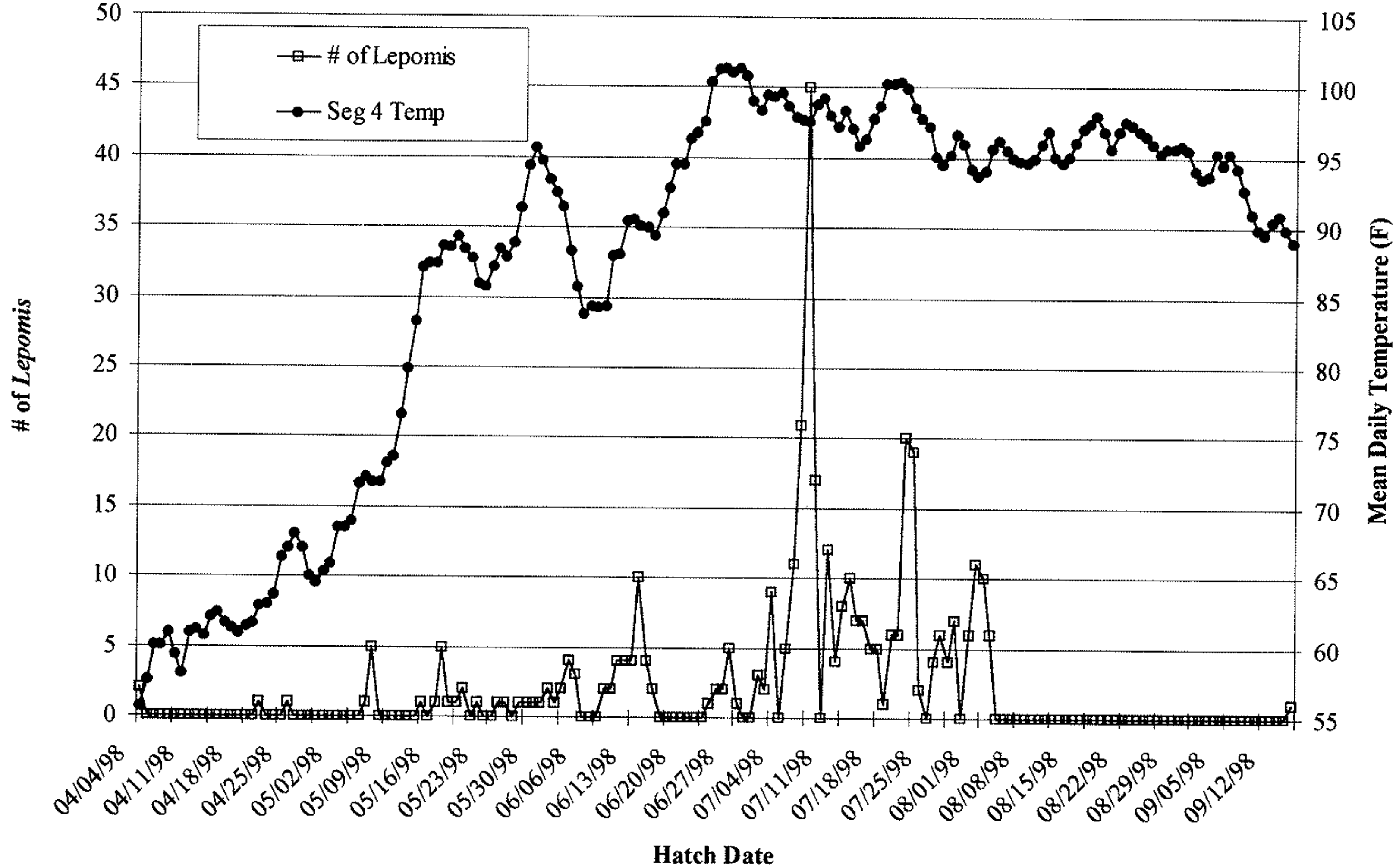

Figure 8.42. Number of *Lepomis* by hatch date in Newton Lake (segment 4) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

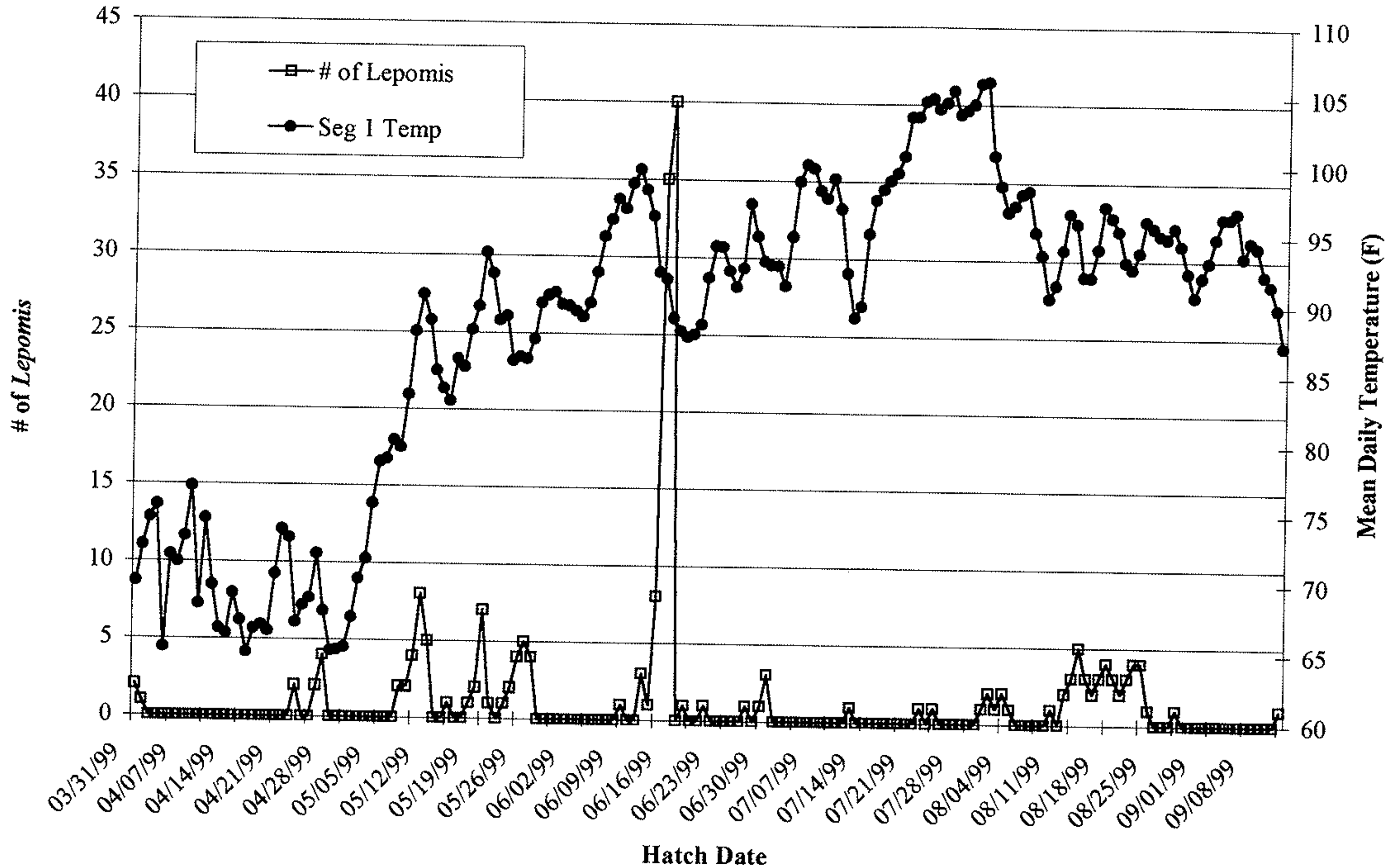

Figure 8.43. Number of *Lepomis* by hatch date in Newton Lake (segment 1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

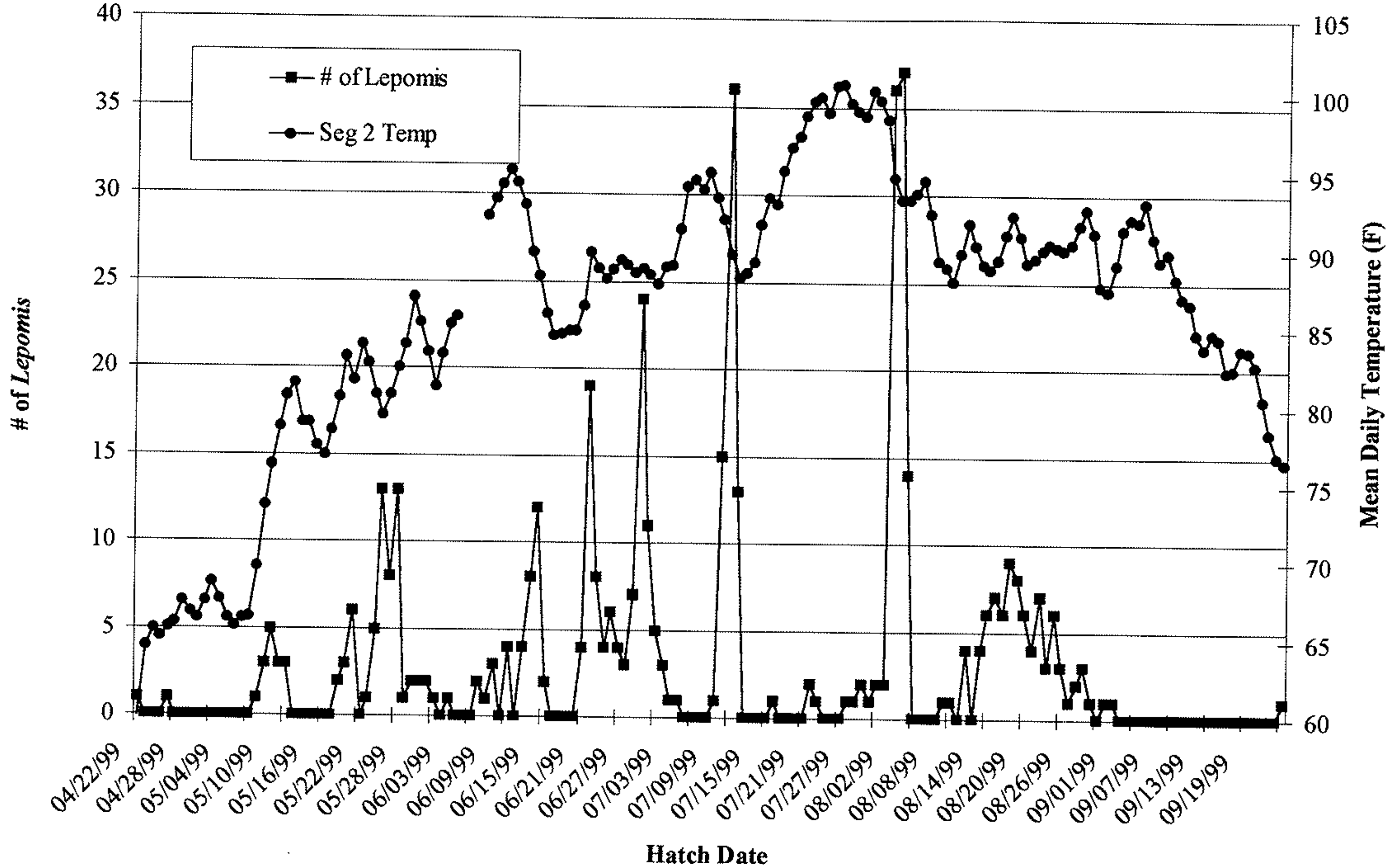

Figure 8.44. Number of *Lepomis* by hatch date in Newton Lake (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

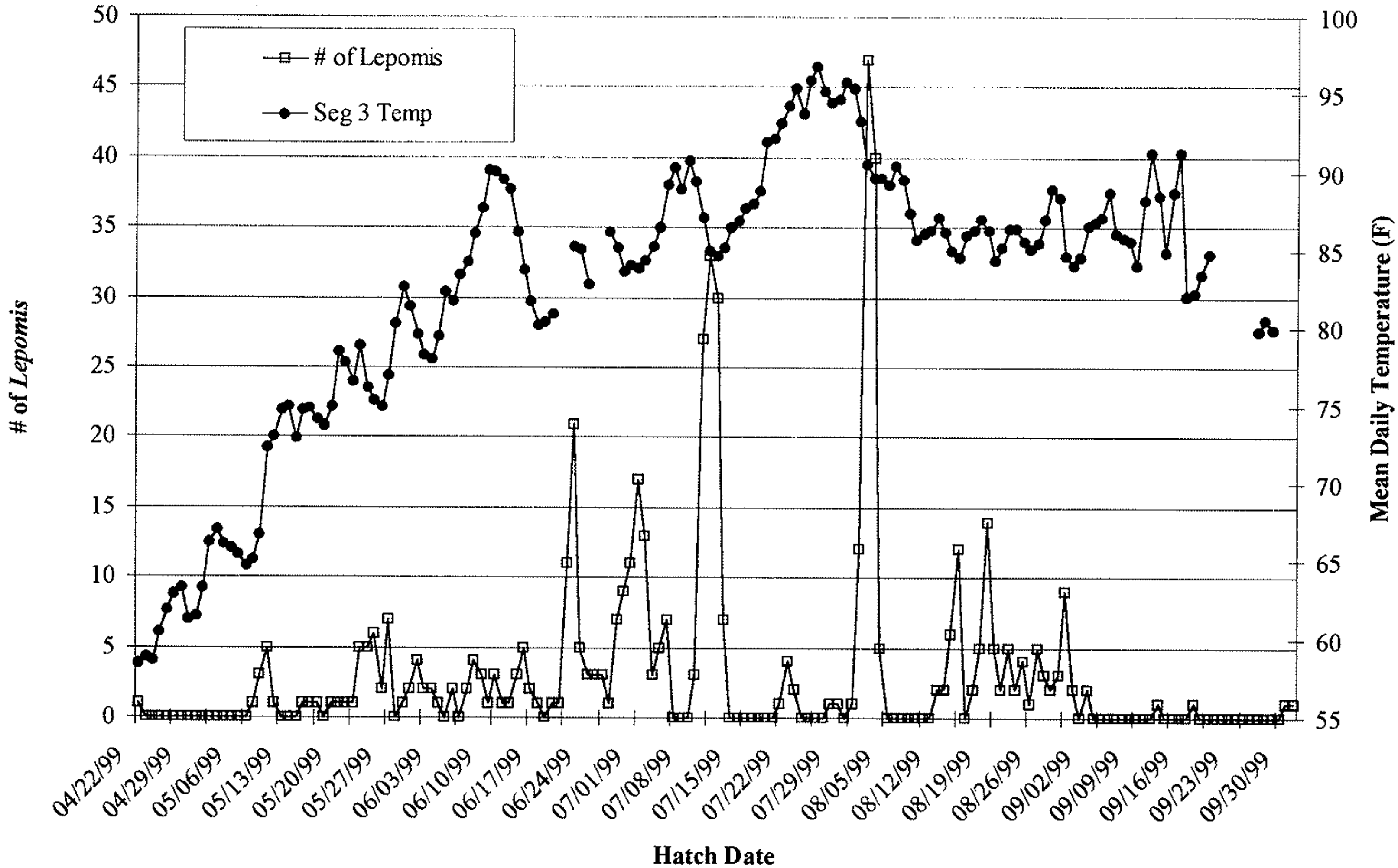

Figure 8.45. Number of *Lepomis* by hatch date in Newton Lake (segment 3) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

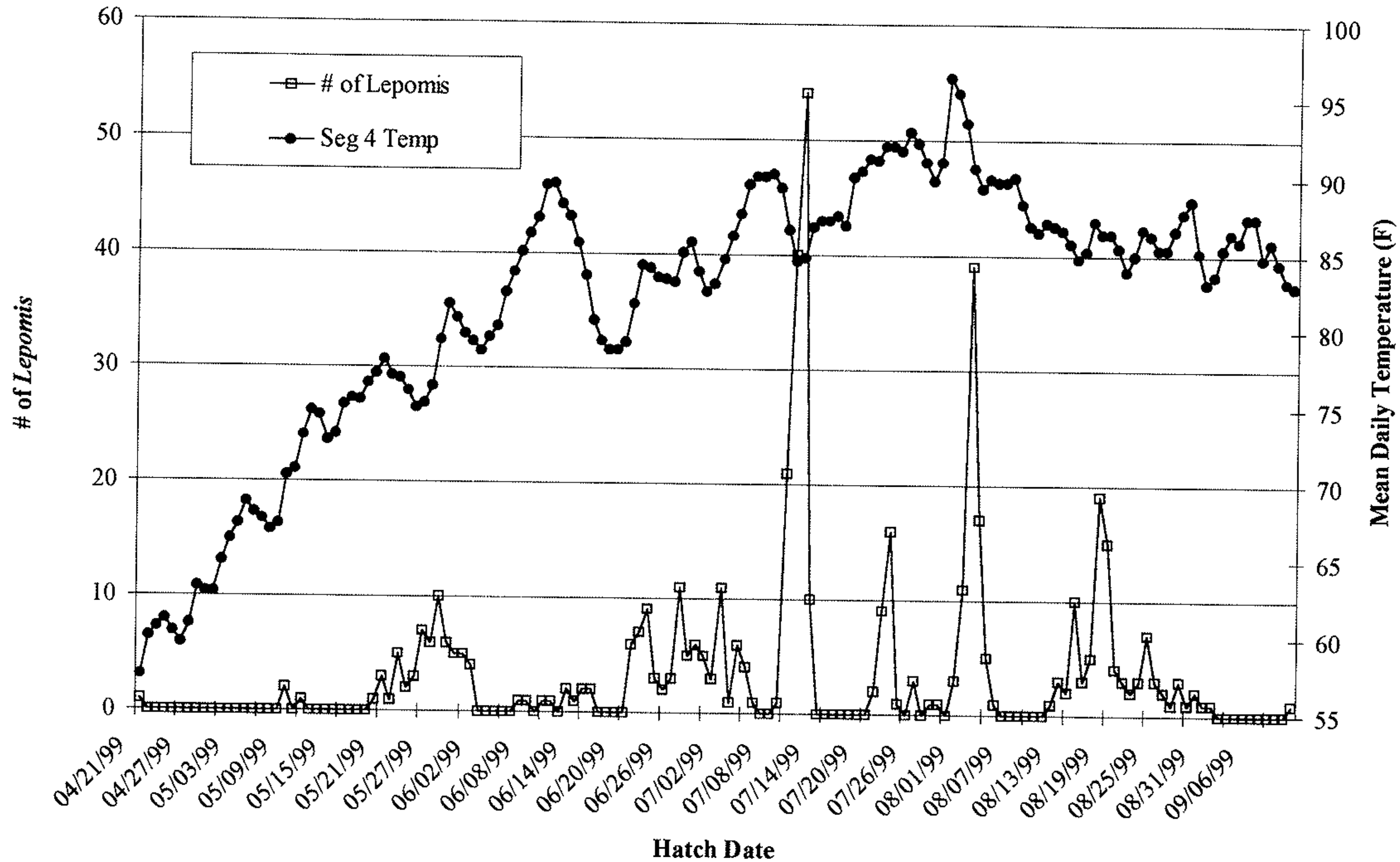

Figure 8.46. Number of *Lepomis* by hatch date in Newton Lake (segment 4) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

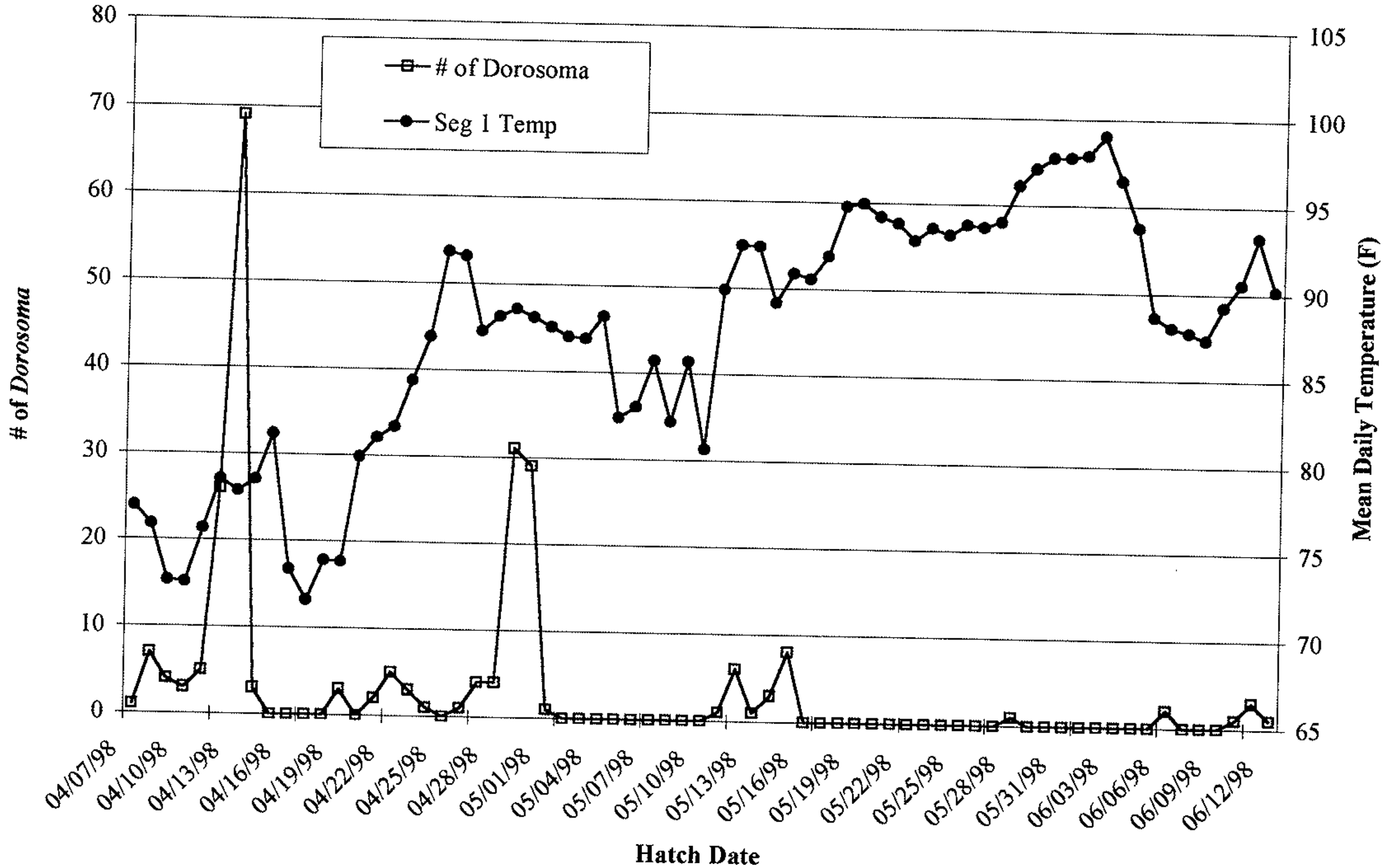

Figure 8.47. Number of *Dorosoma* by hatch date in Coffeen Lake (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

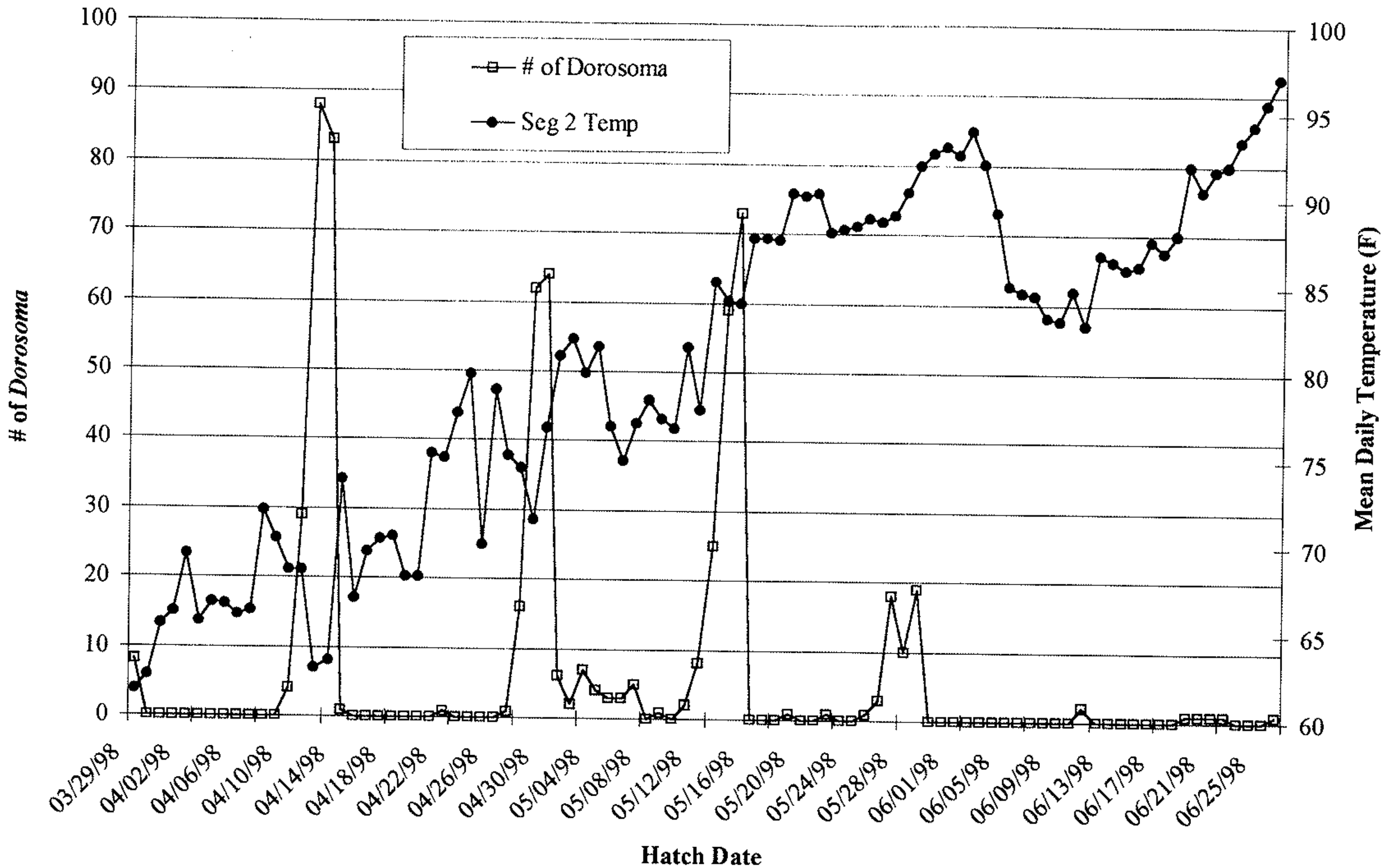

Figure 8.48. Number of *Dorosoma* by hatch in Coffeen Lake (segment 2) in 1998. Mean daily temperatures were from the surface or (if available) 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

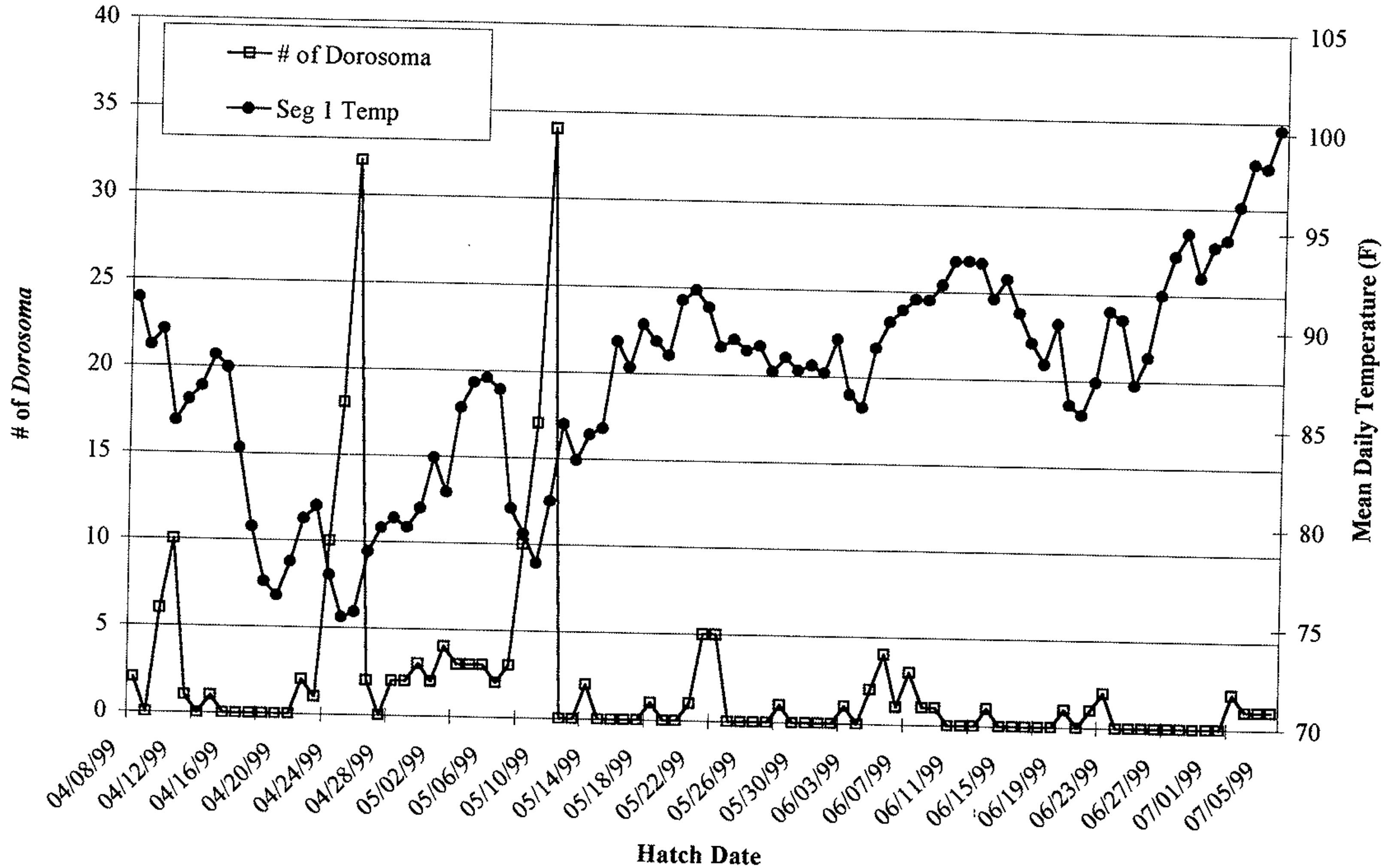

Figure 8.49. Number of *Dorosoma* by hatch date in Coffeen Lake (segment 1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

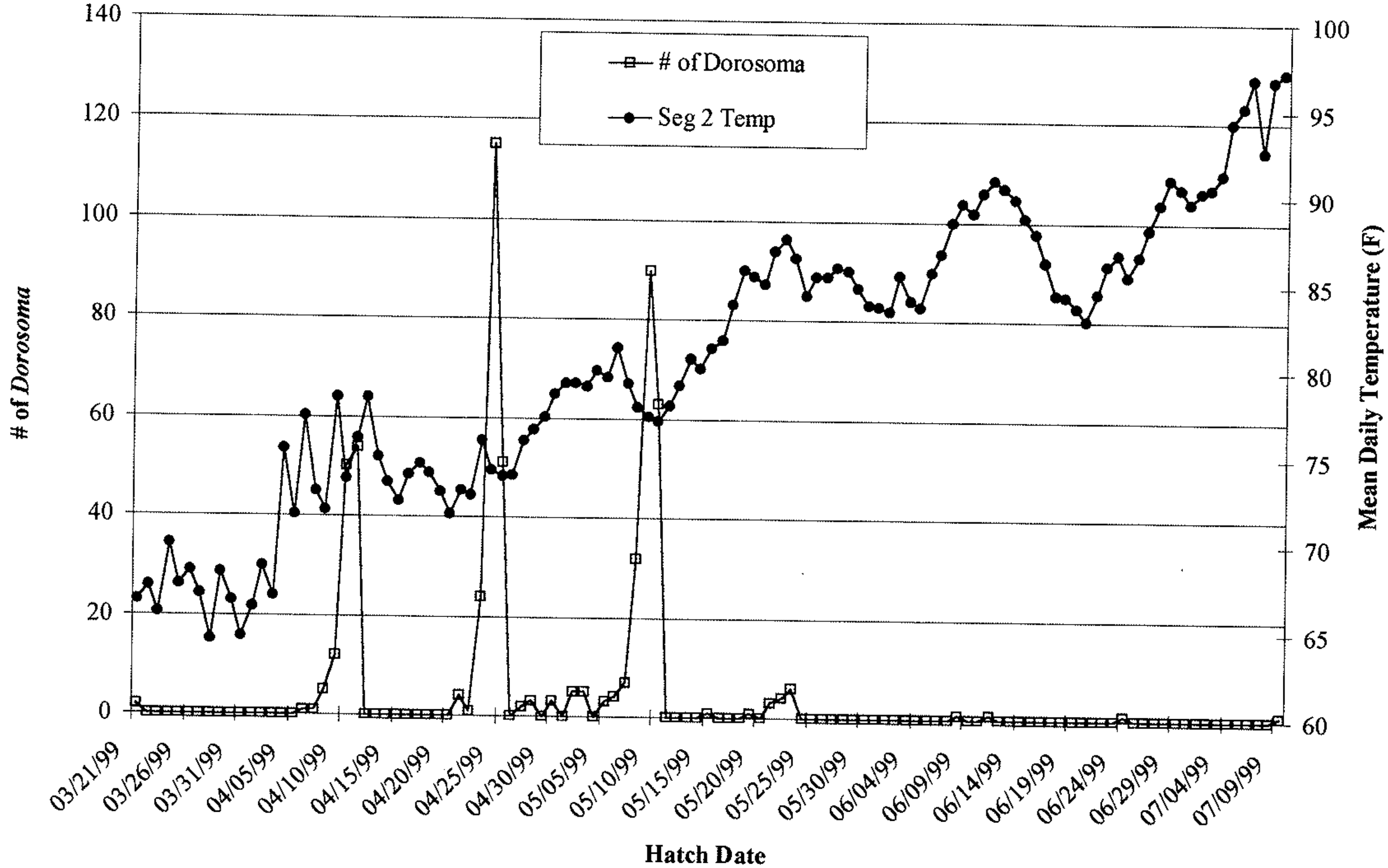

Figure 8.50. Number of *Dorosoma* by hatch date in Coffeen Lake (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

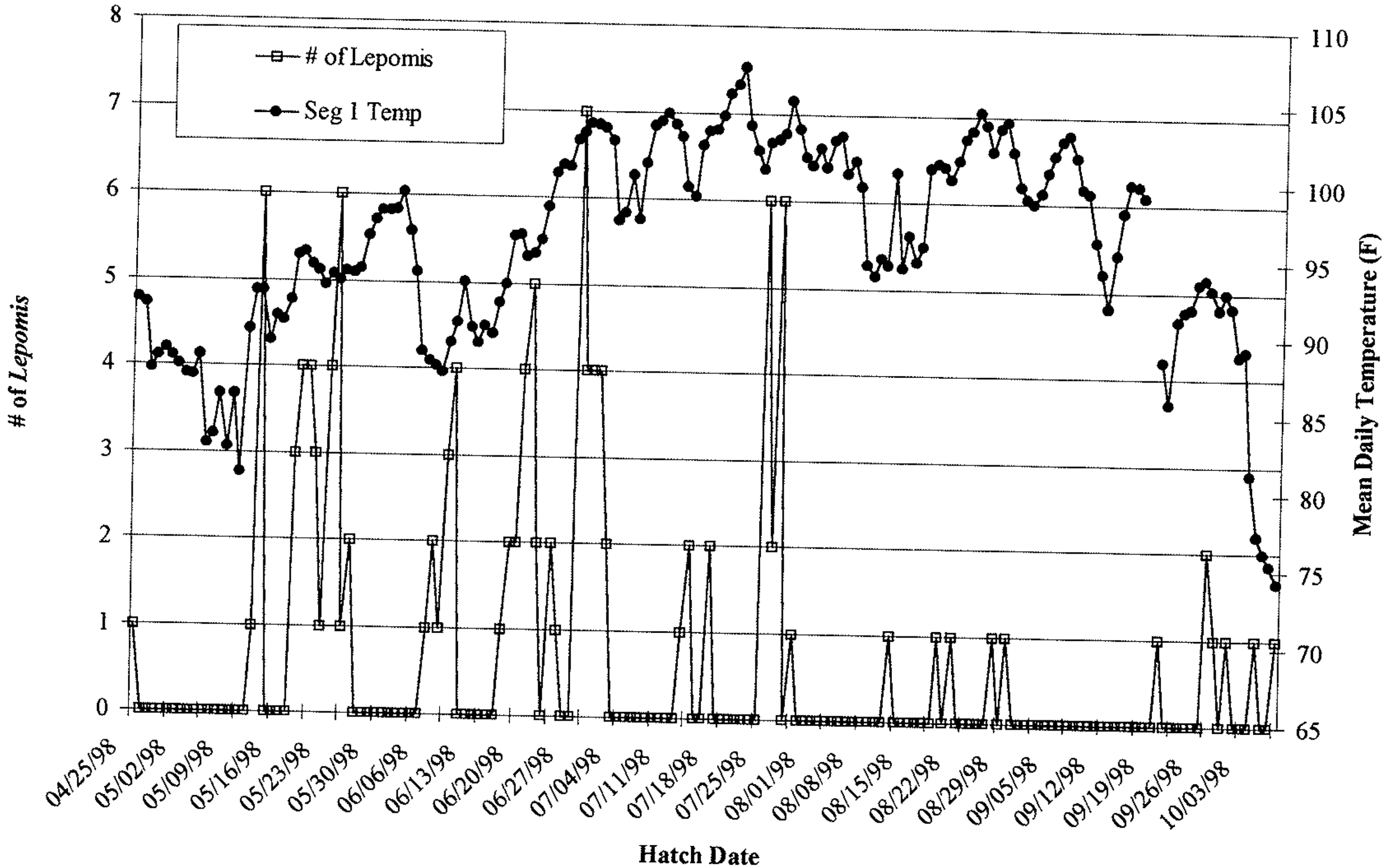

Figure 8.51. Number of *Lepomis* by hatch date in Coffeen Lake (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

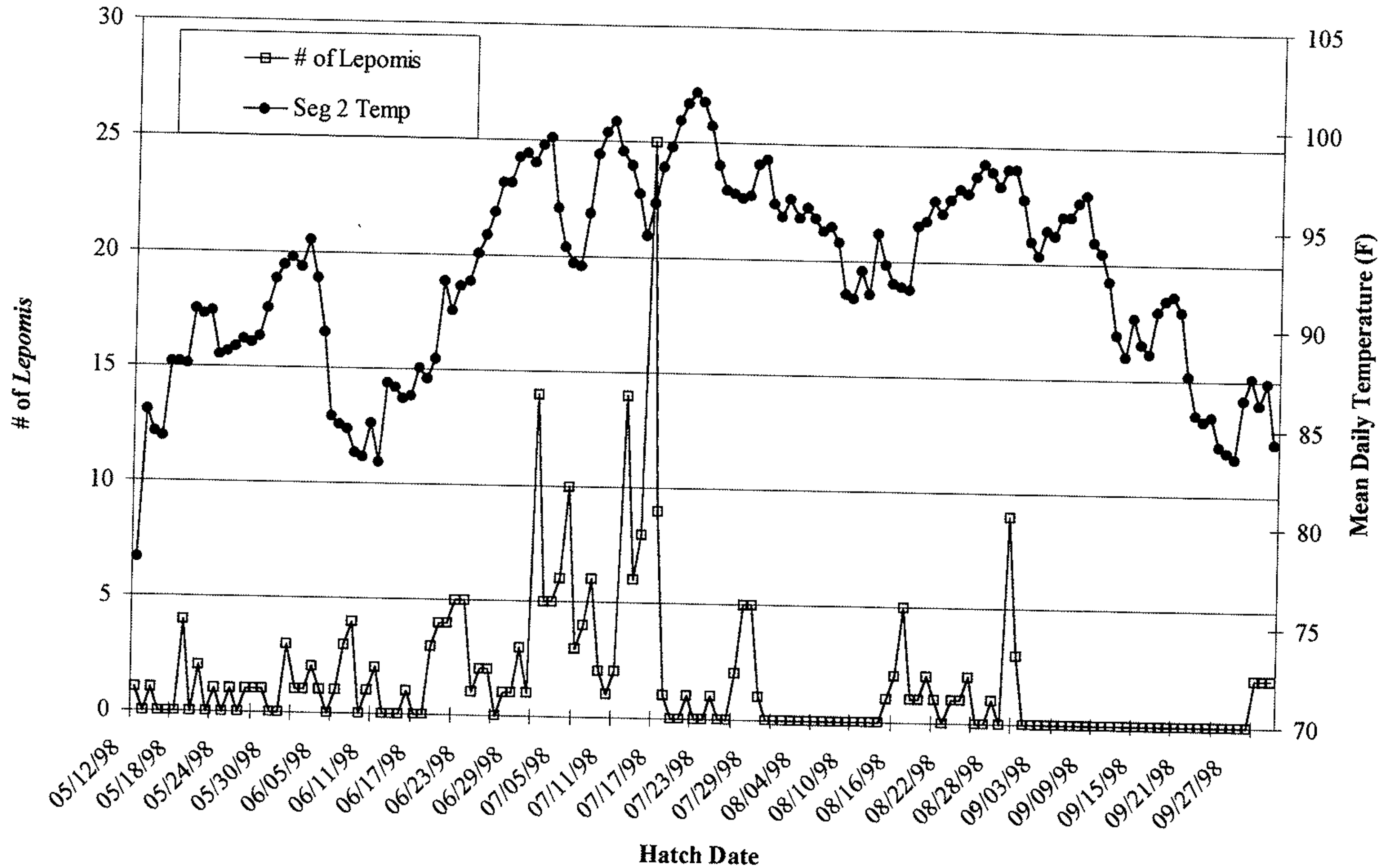

Figure 8.52. Number of *Lepomis* by hatch date in Coffeen Lake (segment 2) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

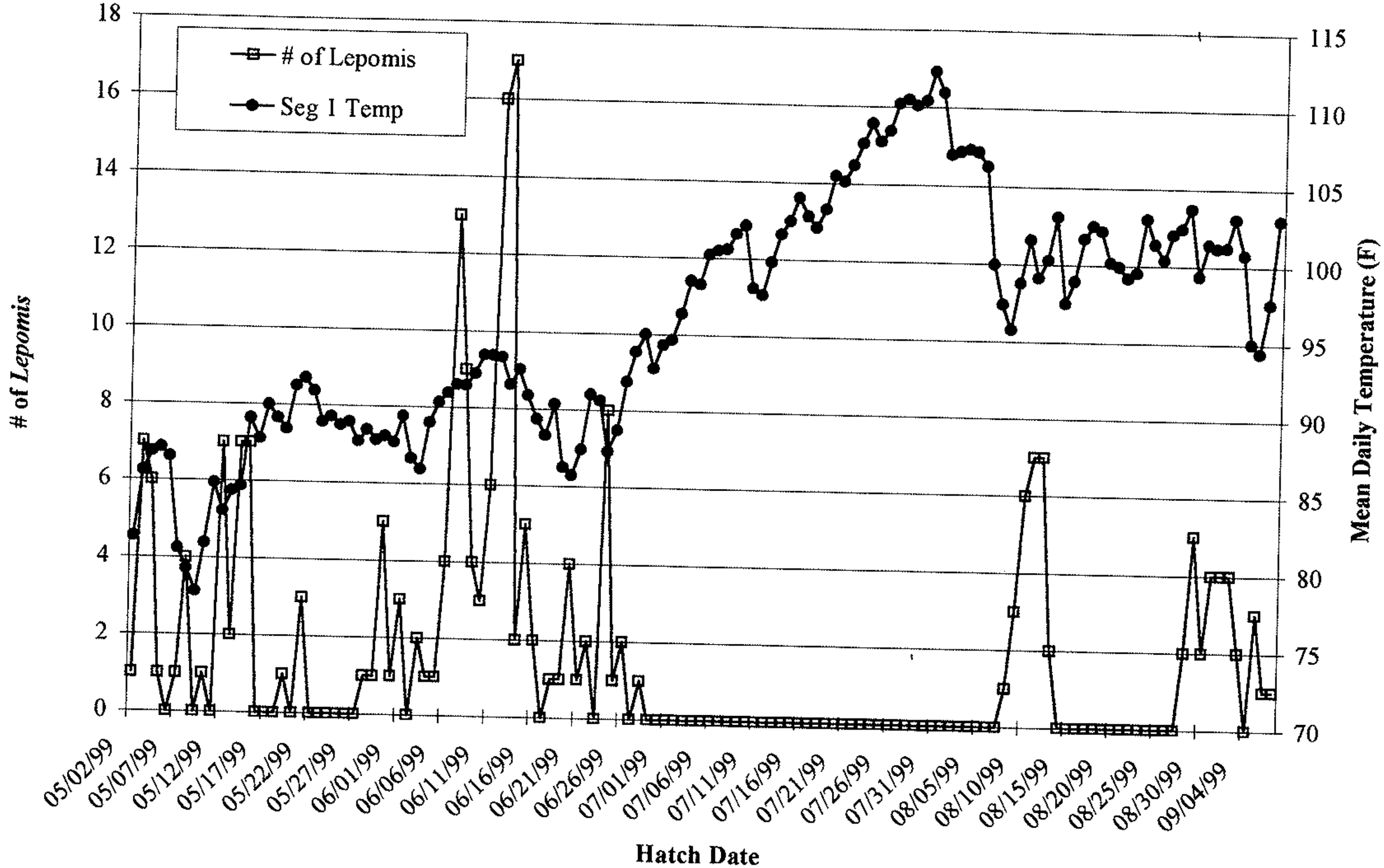

Figure 8.53. Number of *Lepomis* of hatch date in Coffeen Lake (segment 1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

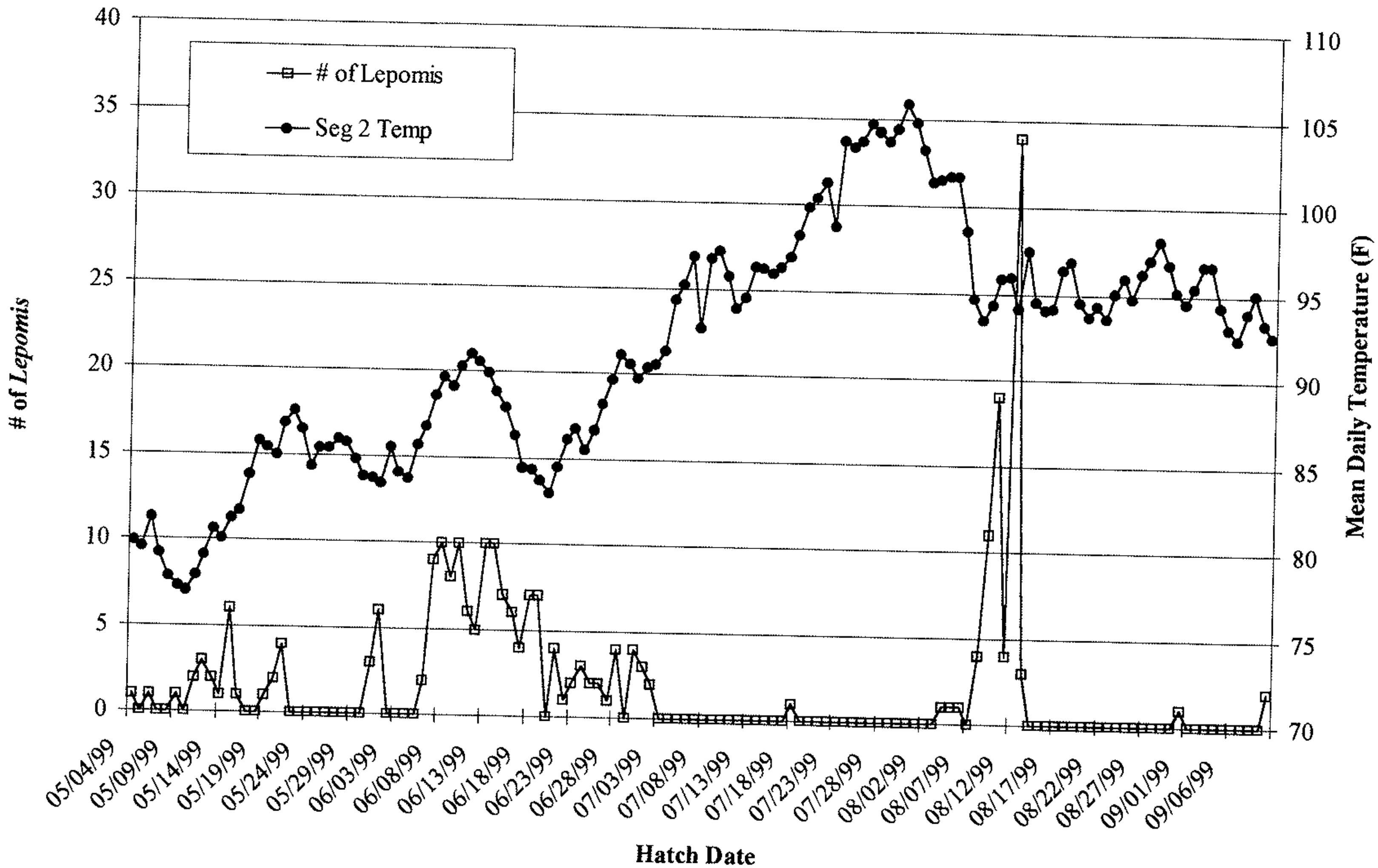

Figure 8.54. Number of *Lepomis* by hatch date in Coffeen Lake (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

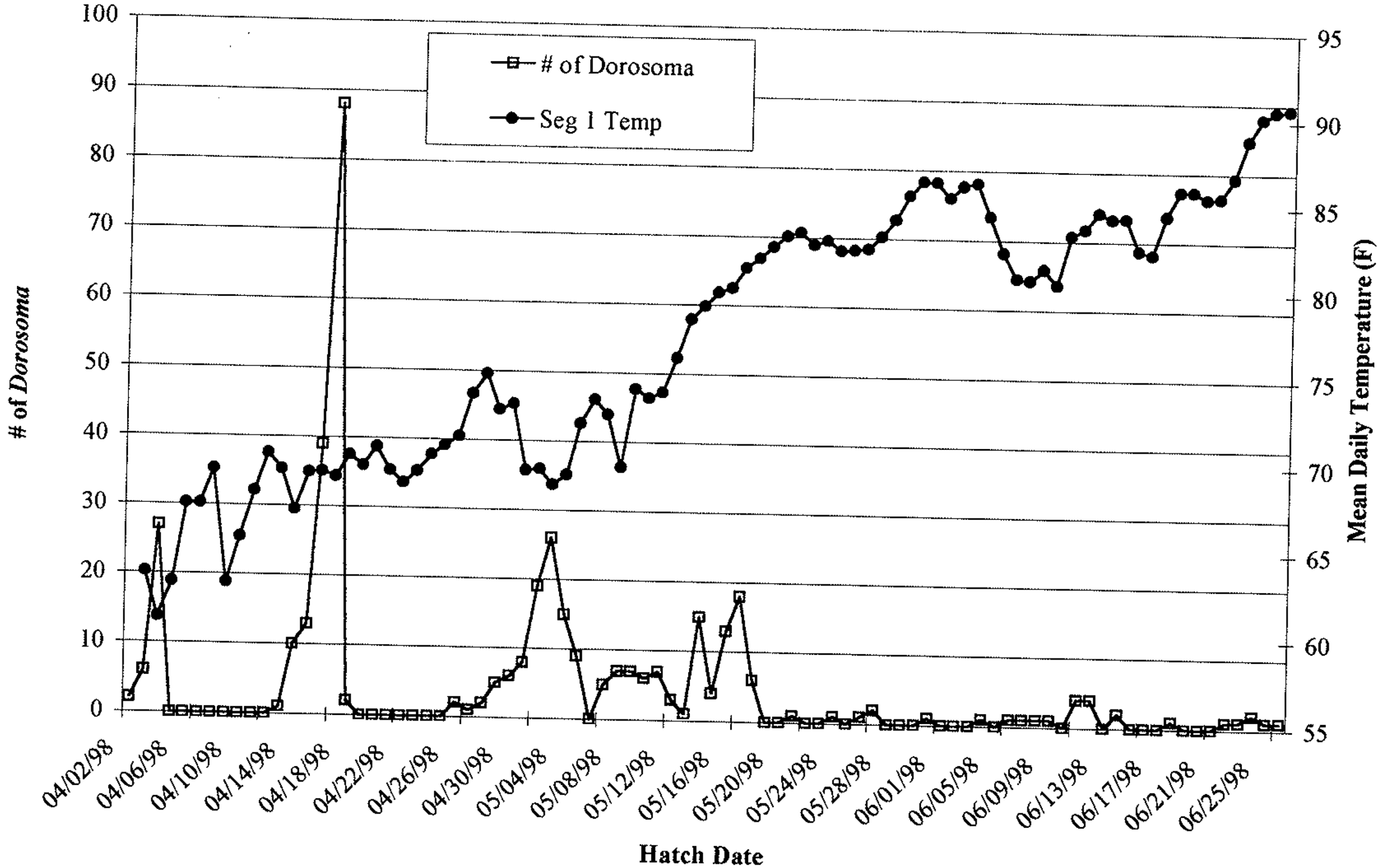

Figure 8.55. Number of *Dorosoma* by hatch date in Lake of Egypt (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

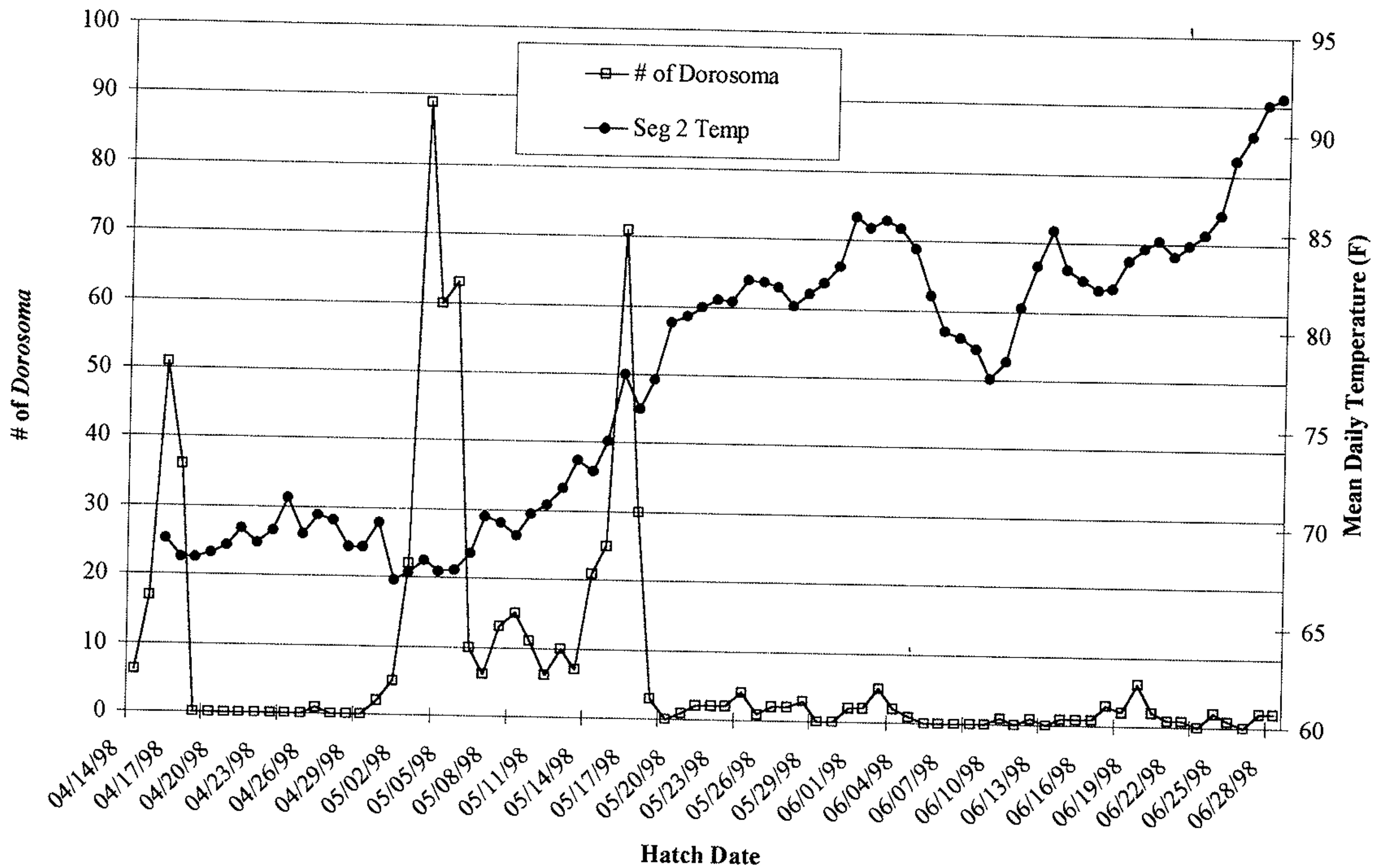

Figure 8.56. Number of *Dorosoma* by hatch date in Lake of Egypt (segment 2) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

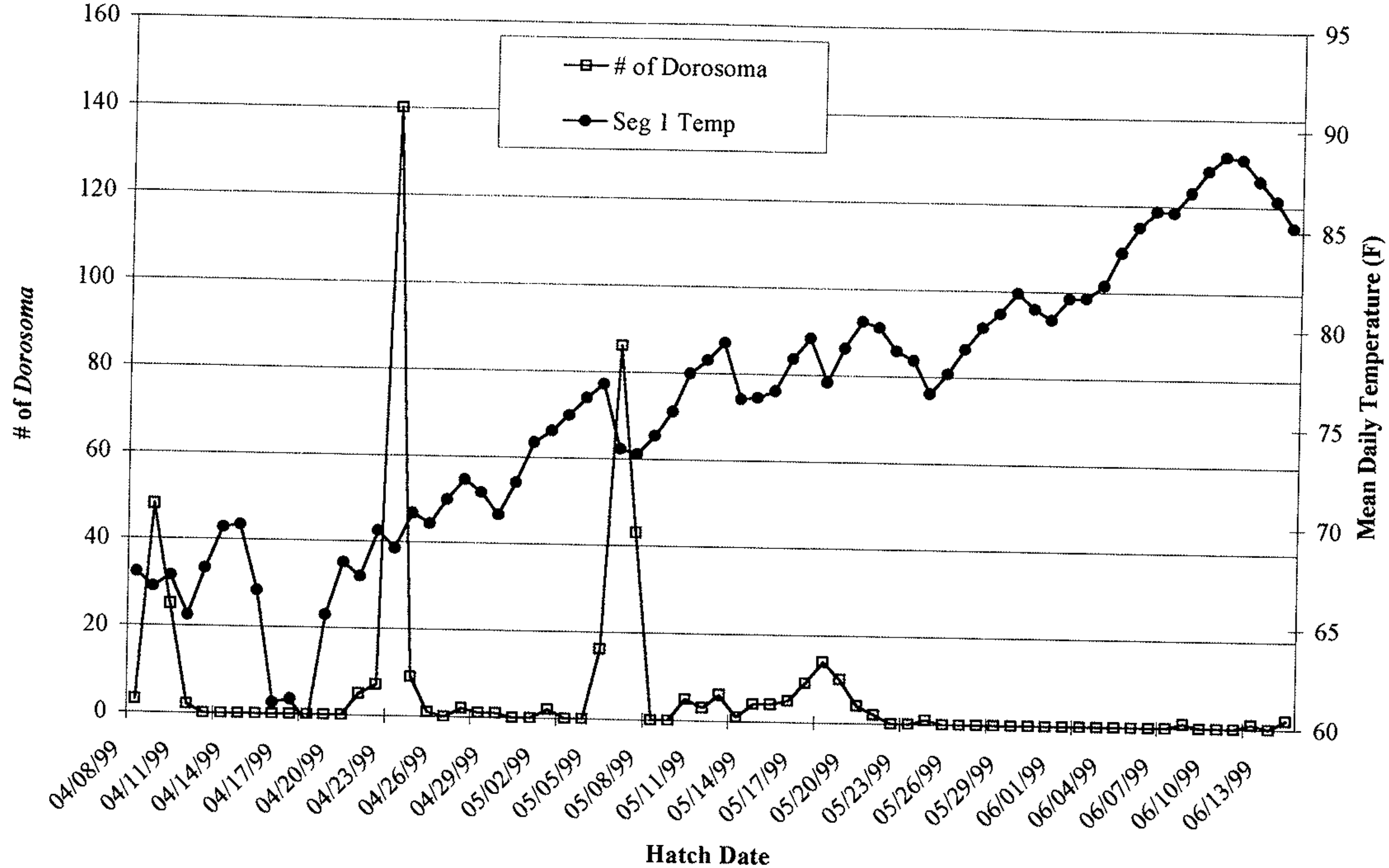

Figure 8.57. Number of *Dorosoma* by hatch date in Lake of Egypt (segment 1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

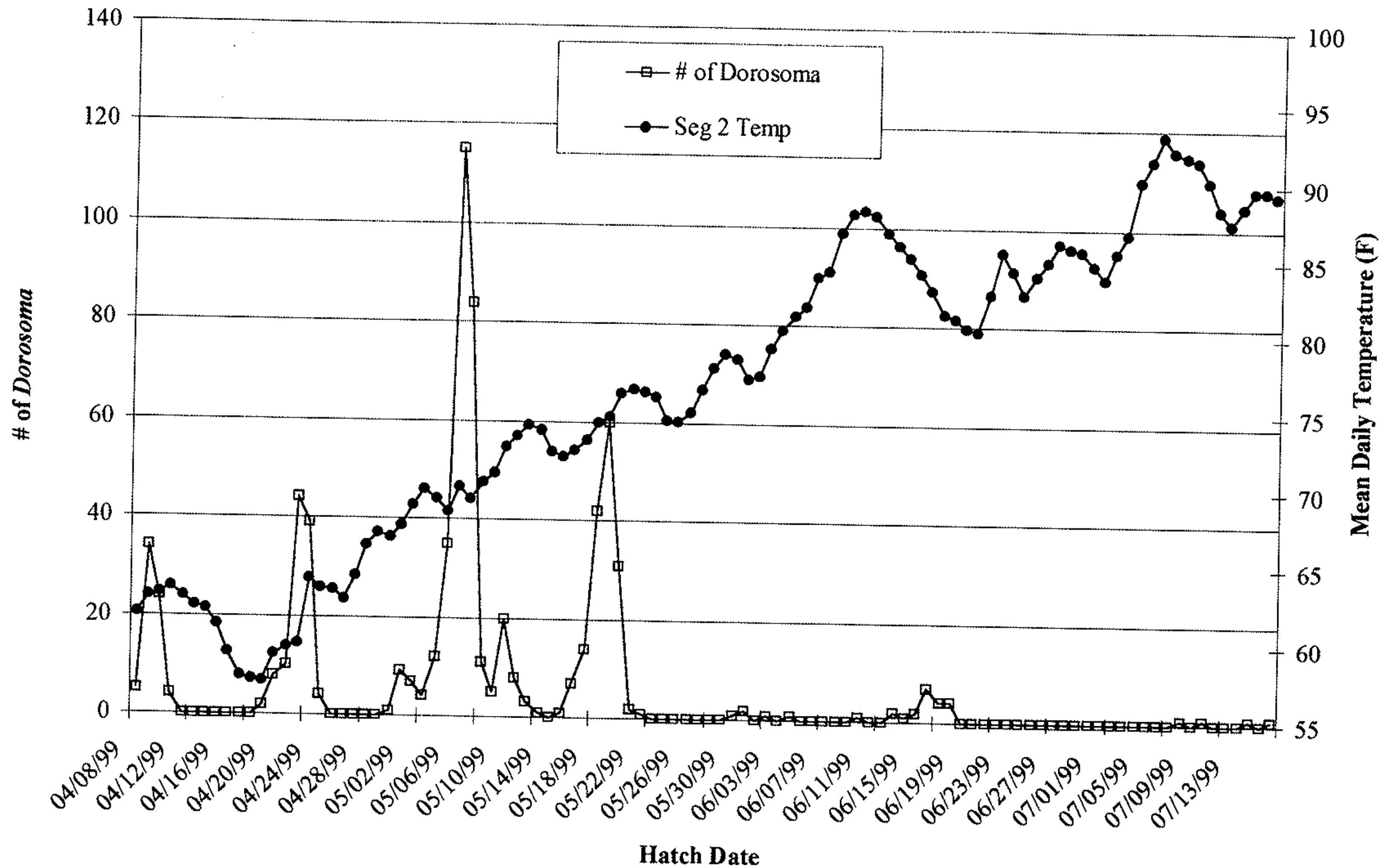

Figure 8.58. Number of *Dorosoma* by hatch date in Lake of Egypt (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

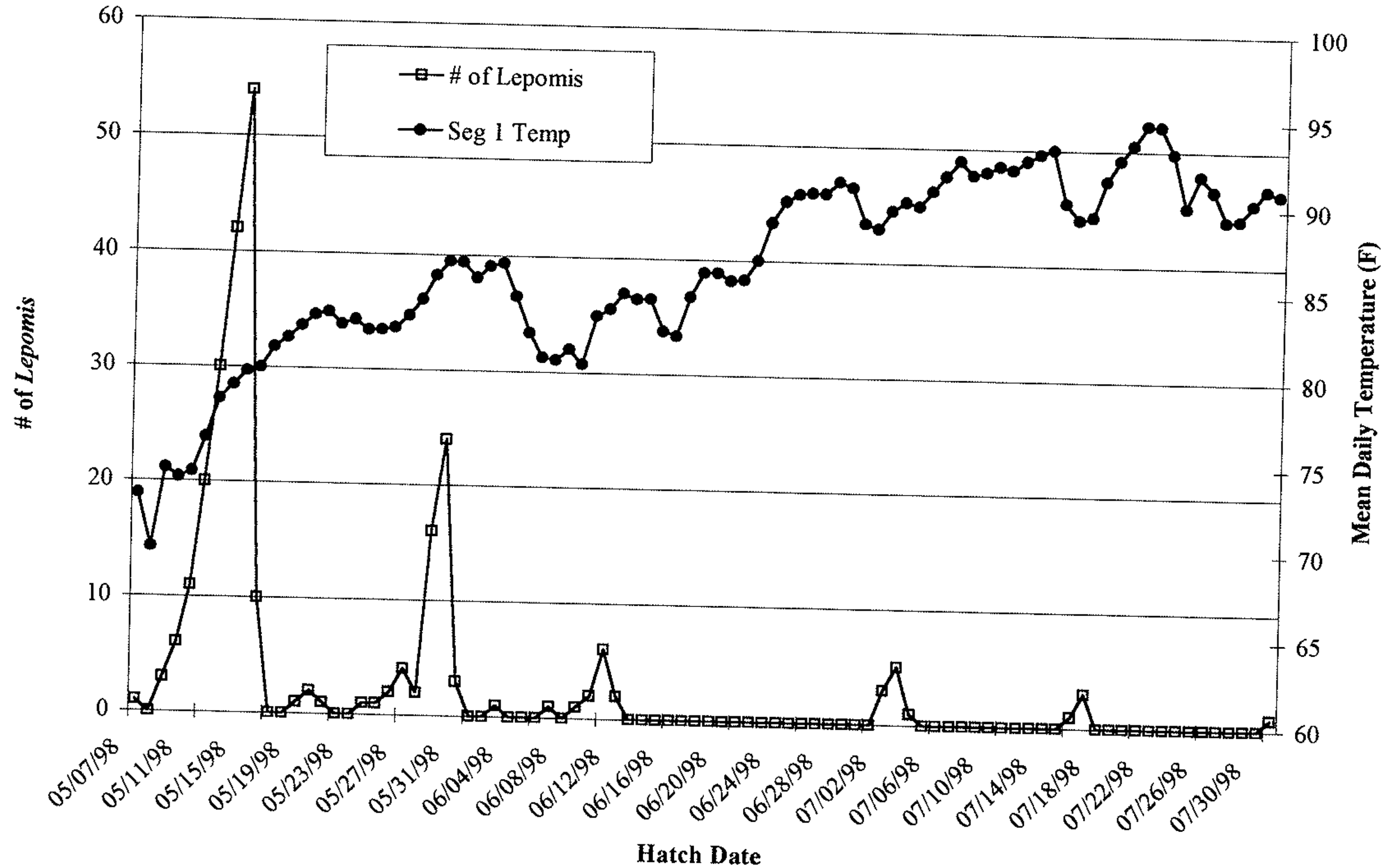

Figure 8.59. Number of *Lepomis* by hatch date in Lake of Egypt (segment 1) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

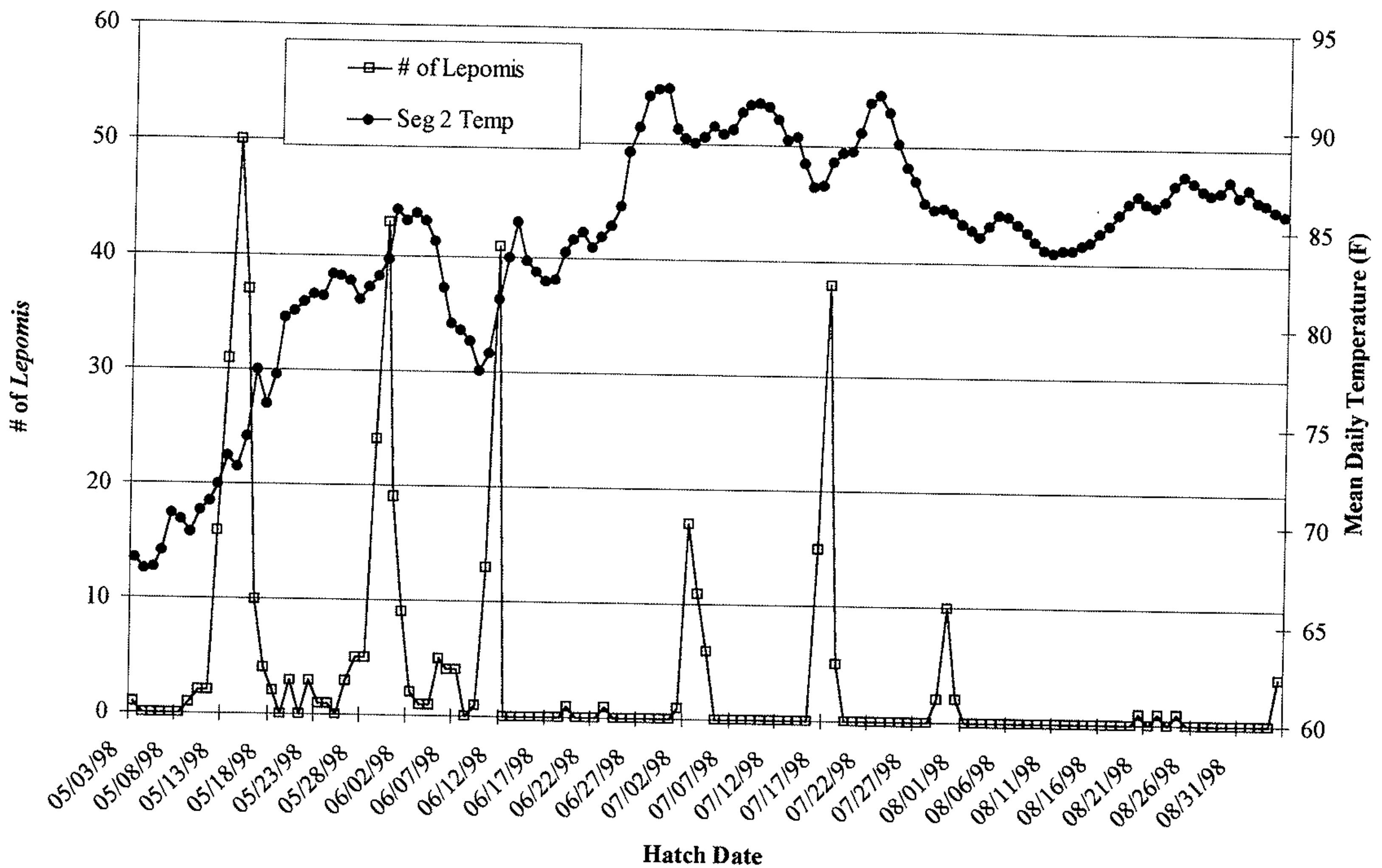

Figure 8.60. Number of *Lepomis* by hatch date in Lake of Egypt (segment 2) in 1998. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

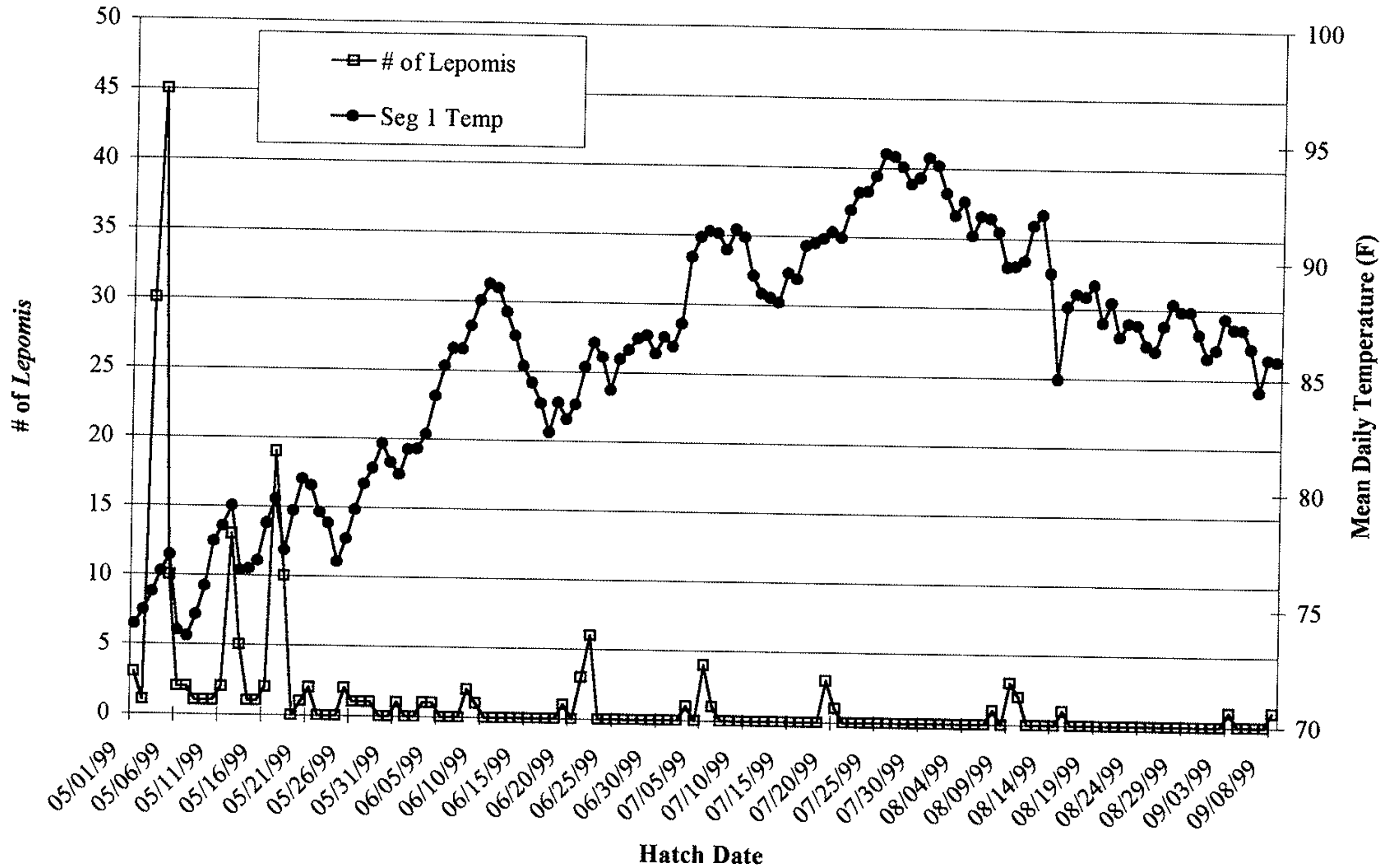

Figure 8.61. Number of *Lepomis* by hatch date in Lake of Egypt (segment 1) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

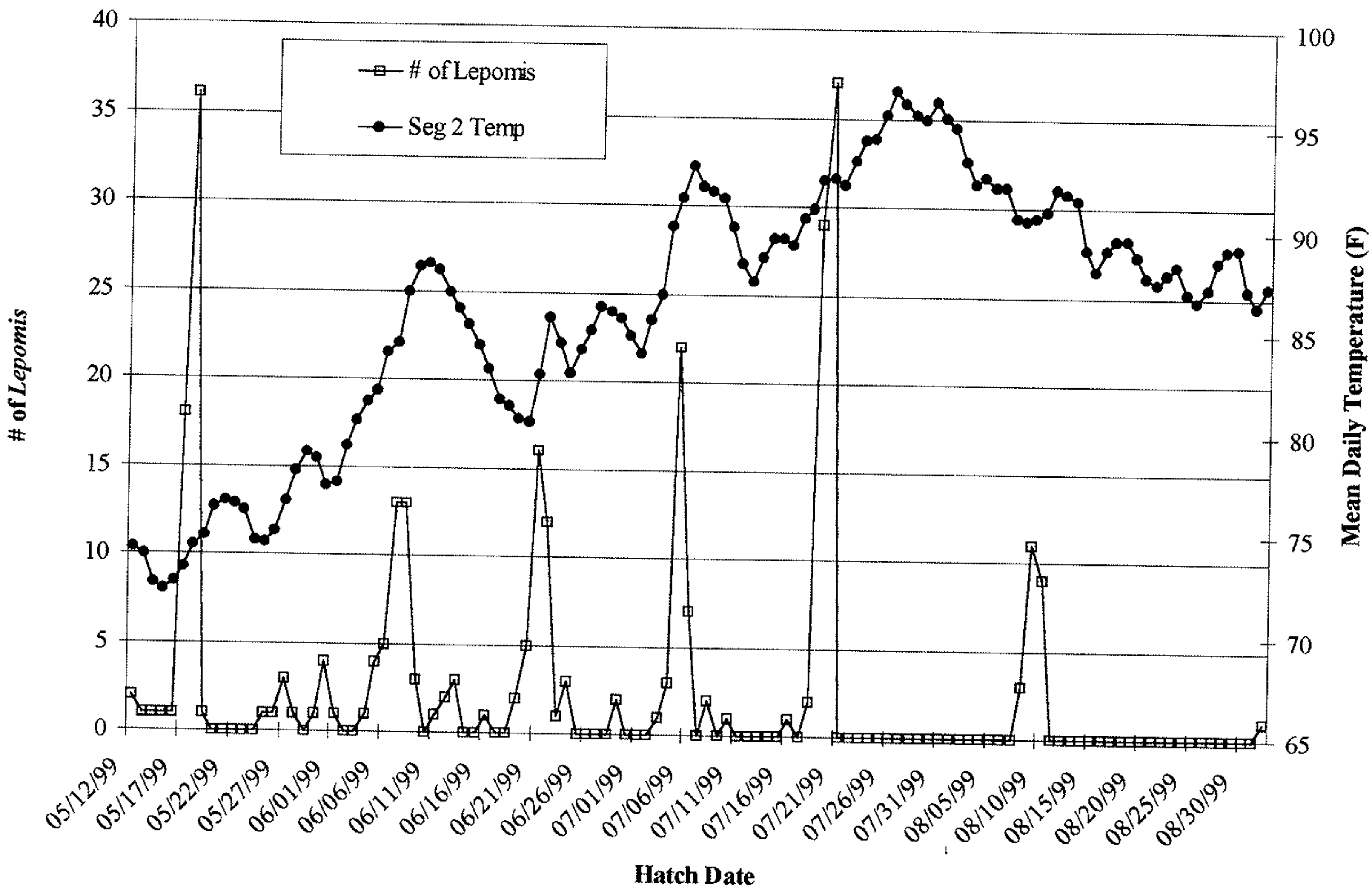

Figure 8.62. Number of *Lepomis* by hatch date in Lake of Egypt (segment 2) in 1999. Mean daily temperatures were from the surface (if available) or 1.5m depth. Hatch dates were calculated by subtracting the age (days) from the collection date.

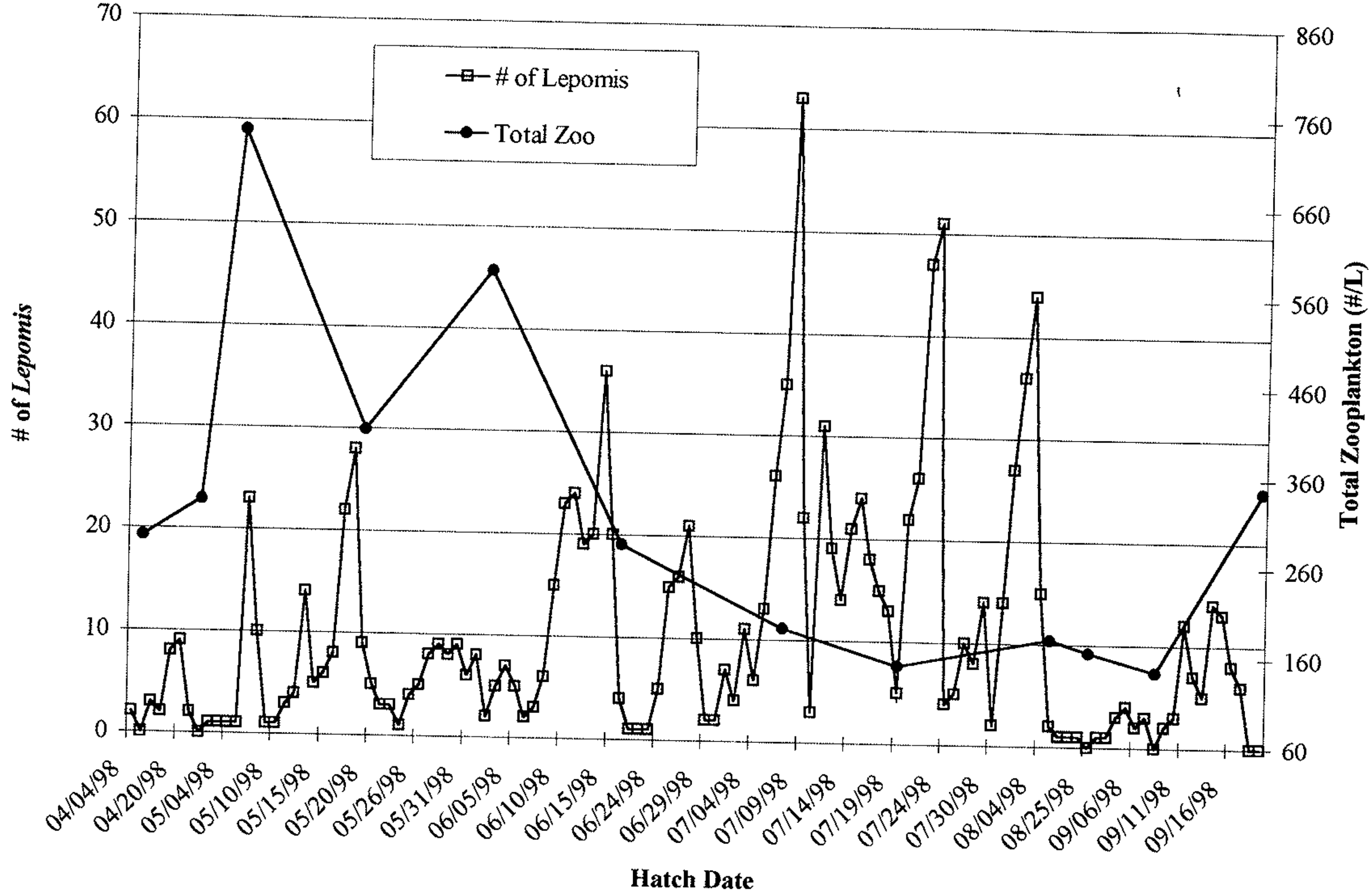

Figure 8.63. Number of *Lepomis* by hatch date in Newton Lake (all segments combined) in 1998. Total zooplankton (#/L) is from bi-monthly samples in 1998. Hatch dates were calculated by subtracting the age (days) from the collection date.

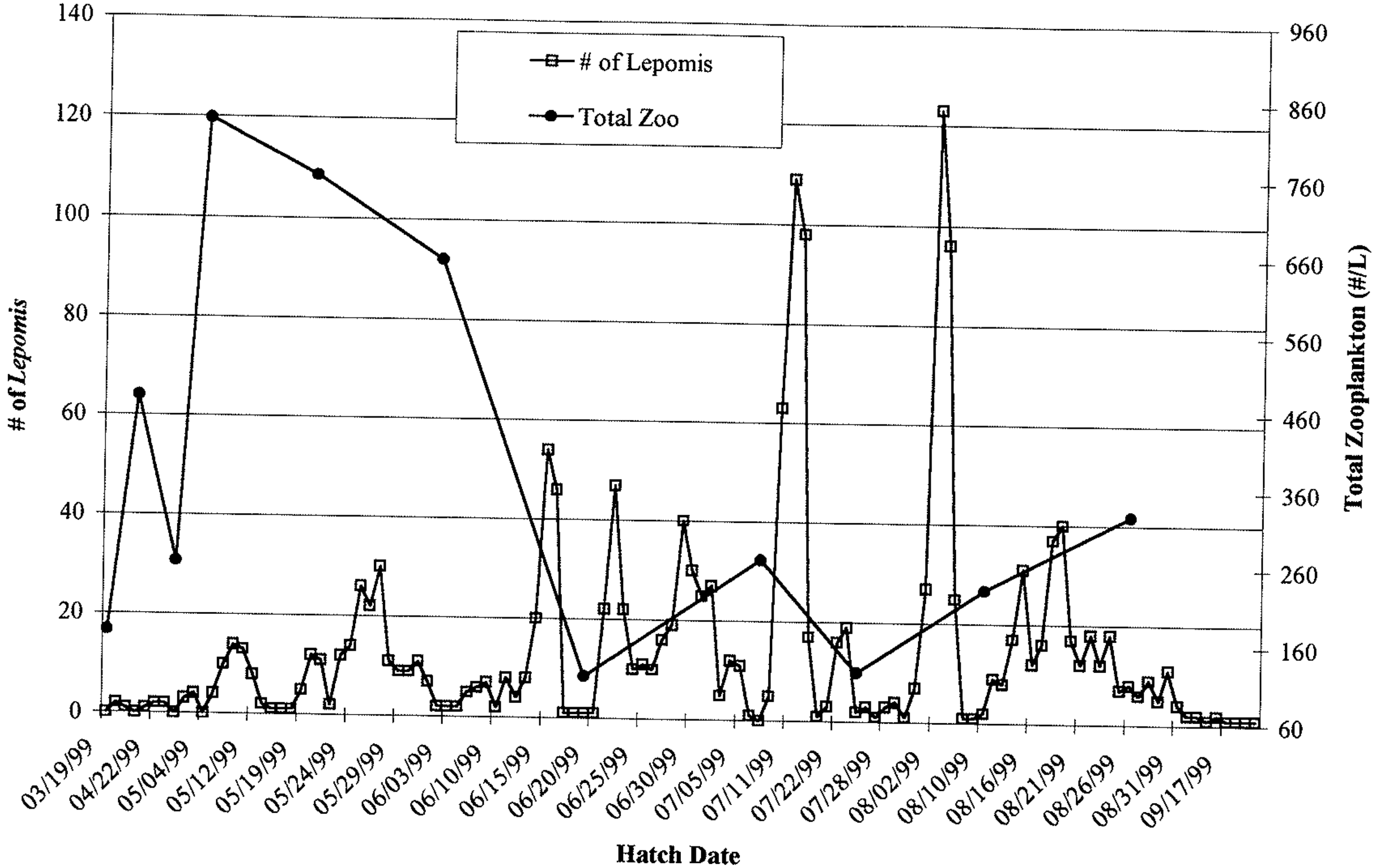

Figure 8.64. Number of *Lepomis* by hatch date in Newton Lake (all segments combined) in 1999. Total zooplankton (#/L) is from bi-monthly samples in 1999. Hatch dates were calculated by subtracting the age (days) from the collection date.

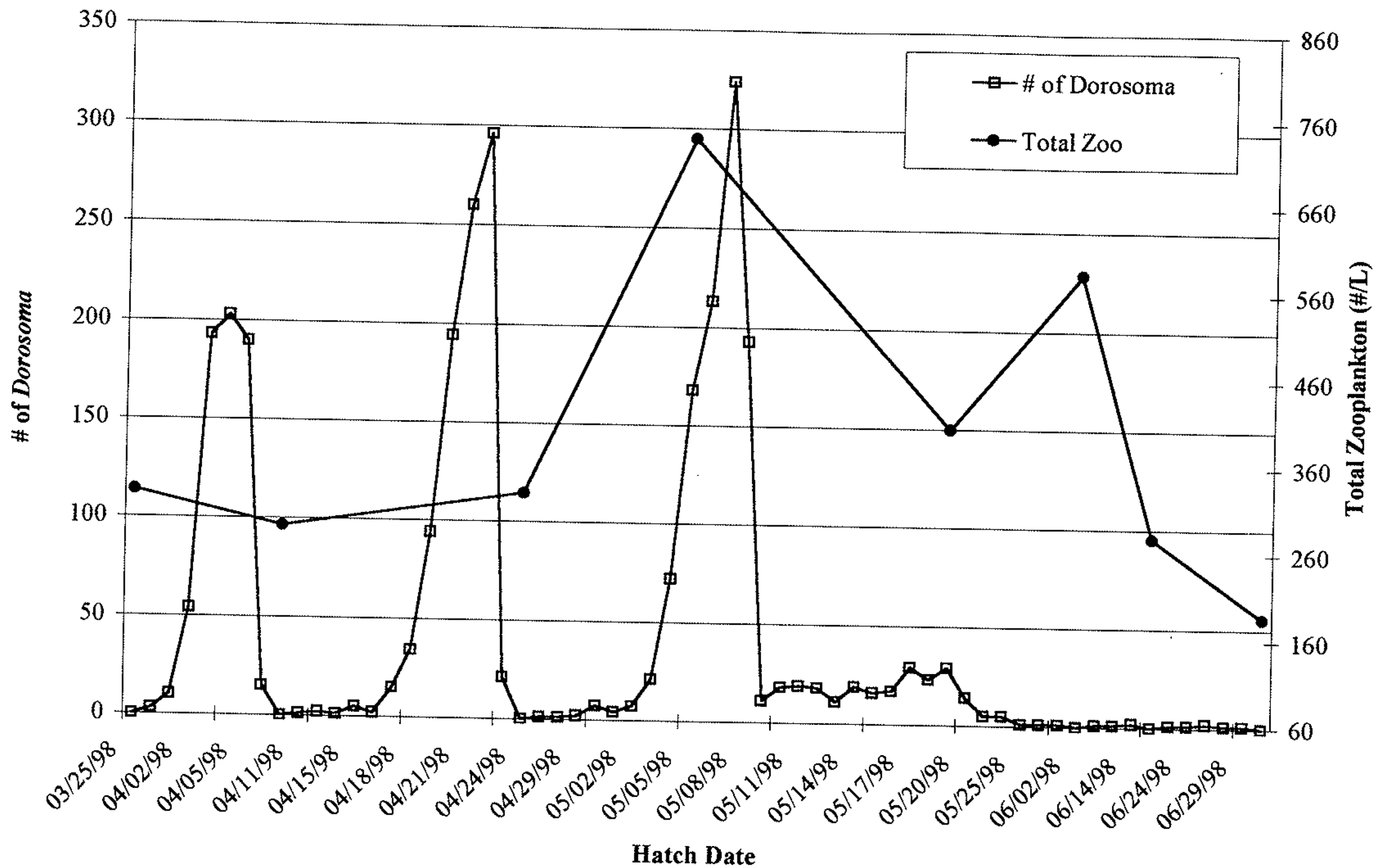

Figure 8.65. Number of *Dorosoma* by hatch date in Newton Lake (all segments combined) in 1998. Total zooplankton (#/L) is from bi-monthly samples in 1998. Hatch dates were calculated by subtracting the age (days) from the collection date.

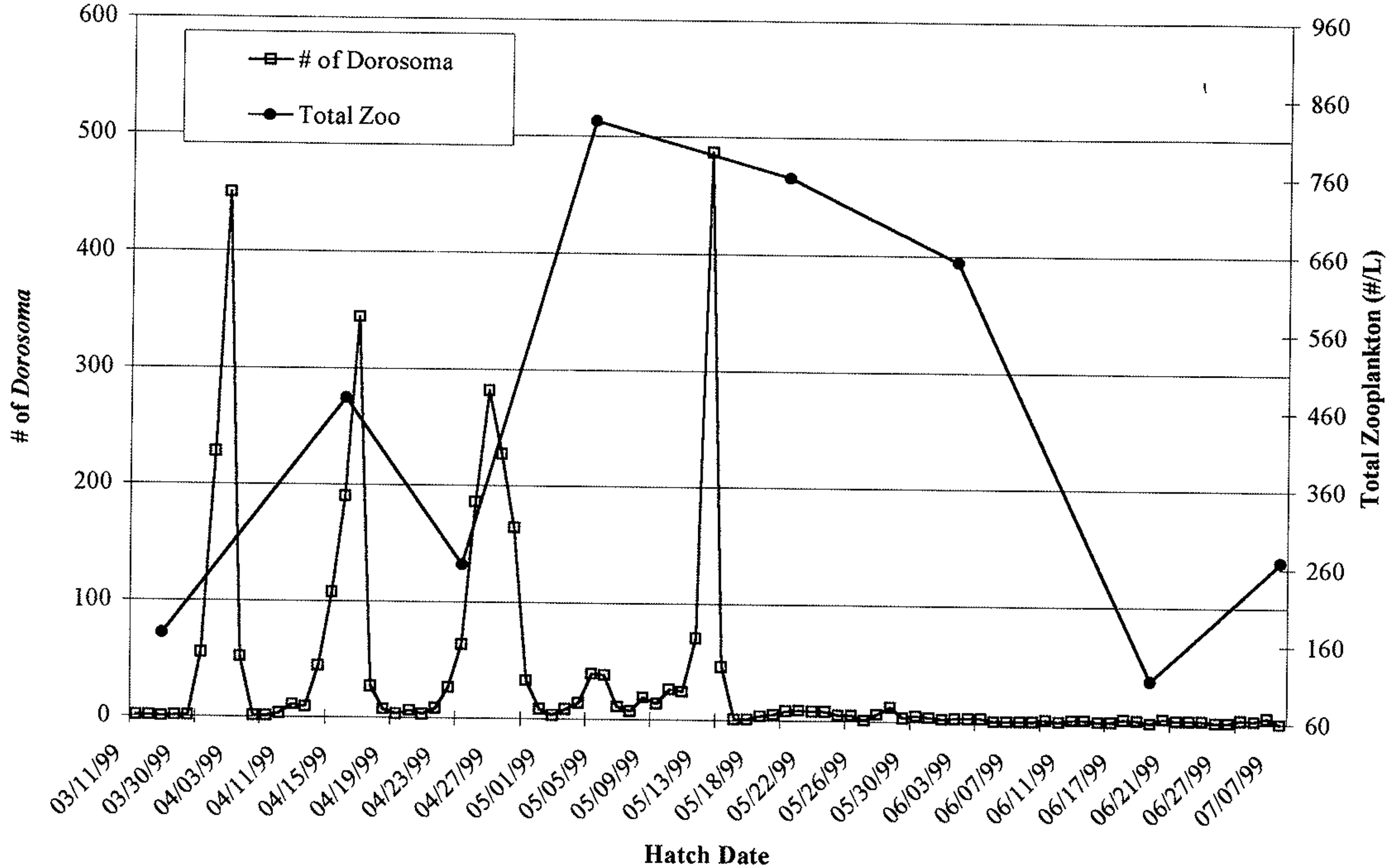

Figure 8.66. Number of *Dorosoma* by hatch date in Newton Lake (all segments combined) in 1999. Total zooplankton (#/L) is from bi-monthly samples in 1999. Hatch dates were calculated by subtracting the age (days) from the collection date.

Chapter 9. Fish Health (Primary responsibility --Melissa Goerlitz)

Introduction:

In 1997, the Newton Power Plant was granted a Variance to increase the thermal loading in Newton Lake. Newton Lake is a power cooling lake designed to take waste heat from the Newton Power Plant and dissipate it into the environment. Power cooling lakes are able to serve as heat sinks and store heat for various lengths of time (Larimore and Tranquilli 1981). Power cooling lakes can store considerable heat due to the high specific heat of water. The amount of heat that can be stored is related to the water volume and other factors.

In some cases, the thermal discharge from the power plant enters the deeper waters of the lake, eliminating temperature gradients and summer stratification (Larimore and Tranquilli 1981). This can increase heat storage, since the coldest waters, waters with the greatest capacity to store heat, are found below the epilimnion during the summer.

Much of the heat absorbed by the lake from the sun and the thermal discharge is dissipated through evaporation, back radiation, and conduction. As temperature and thermal discharge increase, evaporation also increases, thus moderating the thermal loading that occurs in a power cooling lake. Exposure of the lake's surface to wind, general lake morphology, elevation, barometric pressure, and salinity can all also affect evaporation rates. Back radiation is independent of temperature. Conductive heat losses to the air and lake basin occur to a lesser degree than heat losses due to evaporation and back radiation (Larimore and Tranquilli 1981).

Each organism can survive only within some range of temperatures. Each organism grows and survives best over some temperature range. Thermal discharges can cause stress in aquatic organisms, if resulting water temperatures approach their thermal tolerance limits. Low dissolved oxygen can also induce stress in aquatic organisms. The health of a fish can be used as an indicator of the amount of stress it is undergoing over a period of days, weeks, and/or years. Wedemyer et al. (1984) defined a stressor as being an environmental alteration, such as an increase in temperature, and the stress being the fish's response to the stressor. Stress has the potential to load or limit a fish's physiological system, reduce growth, impair reproduction, and reduce the integrity of the immune system, making the fish more susceptible to disease and additional stressors (Adams 1990).

Fish exposed to a stressor undergo a physiological stress response. The stress response primarily occurs through two physiological pathways: a nervous pathway involving the sympathetic branch of the autonomic nervous system and a blood pathway, involving hormonal mechanisms. The nervous pathway mediates changes in cardiac output, ventilation rate, and other processes. It can also stimulate the release of catecholamines from the chromaffin cells into the blood stream. What is commonly referred to as the blood pathway also has a neural component to it. The hypothalamus signals the pituitary to secrete adrenocorticotropic hormone (ACTH). ACTH then travels via the blood to the interrenal cells, stimulating them to release corticosteroids, such as cortisol (Davin et al. 1992; Wedemeyer et al. 1990). The secretion of catecholamines and certain corticosteroids are considered to be the "primary effects of stress". These primary-effect hormones orchestrate physiological adjustments made by the animal during stress.

Corticosteroids and catecholamines act on target tissues producing the "secondary effects of stress". Catecholamines increase blood pressure, blood lactate, and ventilation along with other effects (Davin and Sheehan 1992). Corticosteroids cause catabolism of muscle and liver glycogen, declines in white blood cell counts, immunosuppression and other physiological changes (Davin and Sheehan 1992).

A fish's exposure to a stressor may result in either acute or chronic stress. Acute stress can occur from a single or several short-term exposures to a stressor. Examples of an acute stress include radical changes in temperature or dissolved oxygen (Adams 1990). A stress response can occur immediately or may be prolonged. Sub-lethal or chronic stress has a long-term effect on the health of the fish. Its effects usually will be seen at a suborganismal level first, such as a change in the condition of the liver or a change in plasma osmolality. Exposure to low levels of a stressor over a long period of time or in cycles can provoke a stress response in fish well. These stressors will ultimately affect the reproduction, growth, physiological variables; and the overall future health of the fish (Adams 1990).

Hematological Effects of Stress

Hematological parameters are often used as indicators of sub-lethal stress because of the close relationship that the circulatory system of a fish has with the environment (Casillas and Smith 1977). Elevations in blood sugars can occur in response to the actions of adrenaline and other primary effect stress hormones as a means to provide energy for the "fight-or-flight" response. As glucose concentrations increase, there is a corresponding decrease in glycogen concentrations in the liver, due to glycogenolysis. Therefore, the nutritional status of the fish will affect the magnitude of the response to blood stress hormone concentrations (Davin et al. 1992; Wedemeyer et al. 1990). Casillas and Smith (1977) found that increases in blood glucose concentrations in rainbow trout were correlated with the magnitude of the stressor.

Plasma proteins are largely divided into fibrinogens and albumin (Heath 1995). Fibrinogens play an essential role in the clotting process. Albumin is involved in maintaining normal osmotic pressure, blood pH buffering, serving as an amino acid source, and transporting hormones and exogenous chemicals (Heath 1995). Each of the above can be influenced by factors such as size, sex, state of maturity, and environmental factors such as temperature or food availability (Houston 1997).

Hematocrits measure the packed cell volume of erythrocytes in the blood. McLeay (1973) found decreases in hematocrits in fish exposed to pulp mill effluent. He attributed this to either a decrease in erythrocyte production, an increase in erythrocyte destruction or hemodilution caused by the prolonged exposure to the effluent. Low hematocrits are generally associated with acute stress, while high hematocrits are associated with disease (Goede and Barton 1990).

Differential blood cell counts can aid in detecting stress and disease. This can also aid in verifying hematocrit, leucocrit, and clotting time results. These counts differentiate leukocytes, which include lymphocytes, heterophils, neutrophils, thrombocytes, basophils, esonophils, and monocytes. Lymphocytes are primarily involved in immunoactivity. Heterophils and neutrophils aid in injury repair, e.g. mechanical injury, and bacterial and or parasite infection. Thrombocytes take part in the clotting process. Basophils play a role in inflammatory responses. Esonophils and monocytes are involved with phagocytic activity (Ellis 1977).

Heat shock proteins are biochemical markers of thermal stress. Four universal families of heat shock proteins (hsp90, hsp70, hsp60, and small heat shock proteins) exist in eukaryotes (Kothay and Candido 1982). These families can be classified by their molecular weights on SDS-polyacrylamide gel electrophoresis. Heat shock proteins are typically found in low concentrations in the blood under normal conditions in the absence of a stressor. They serve as protein folders or chaperones that aid in the folding, unfolding, assembly, disassembly and translocation processes (Parcel and Lindquist 1993). Increased concentrations of blood heat shock proteins have been found in trout subjected to a thermal stressor (Vijayan et al. 1997), diptera (Ritossa 1962), and sea urchins (Roccheri et al. 1981) among other eukaryotes.

Effects of Stress on Condition

Coughlan et al. (1996) reported that Ronald Goede first developed a condition assessment procedure in the 1970's to evaluate hatchery raised trout. This necropsy-based condition assessment was developed as a quick, inexpensive procedure to detect a stressed population while corrective actions could still be taken. It was not developed as a diagnostic tool, but rather as a means for following trends in the health and condition of a fish population (Goede and Barton 1990). Adam's et al. (1993) quantified Goede's method (1993) for simplification in statistical analyses.

Several assumptions are made when using this method (Goede and Barton 1990).

(1) An organ or tissue under stress will change in order to maintain homeostasis.

(2) A long-term change in function will result in a gross overall change in structure of an organ or tissue.

(3) If the organ or tissue appears normal, then it probably is normal.

(4) If the organ departs from what is considered normal or the control condition, it is responding to an environmental stressor.

Data acquired from the condition-based assessment can be further supplemented with organosomatic indices and condition factors. The liver-somatic index (LSI) can be used as an indirect indicator of growth (Busacker et al. 1990) and nutritional status (Adams et al. 1982). Heidinger and Crawford (1977) found that as temperatures increased, the liver-somatic index decreased. Adams and McLean (1985) also concluded that the LSI was not only an indicator of food intake, but also an indicator of reproductive and temperature induced demands. Adams and

McLean (1985) also found the LSI to be a better indicator of growth at lower temperatures where a large part of the energy stores were not needed for metabolism.

The visceral-somatic index (VSI) is also an indicator of growth and stress. Adams and McLean (1985) and Adams et al. (1982) found that VSI was lowest during the warmest periods and then decreased again in the winter after a fall increase. Other organosomatic indices used as indicators of growth and stress include: the spleenosomatic index (Payne et al. 1978), the gonadalsomatic index (Adams et al. 1982), relative heart weights, increases in eye lens diameter (Payne et al. 1978), changes in relative weight (Wege and Anderson 1978), and condition factors (Adams and McLean 1985; Busacker et al. 1990; Heidinger and Crawford 1977). These indices along with organ and tissue condition may vary by age, sex, energy demand and season (Heidinger and Crawford 1977; Adams et al. 1982).

Study Objectives

The goal of this study was to determine the health effects of increased thermal loading on the health of fish populations of Newton Lake as compared to those of two other power cooling lakes. The emphasis on fish health is appropriate, since fish are of significant importance, both as a food source and for recreational fishing. The following were the specific objectives of this study:

- to evaluate and detect trends in the health of the fish populations of Newton Lake and two reference power cooling lakes;
- to utilize an necropsy based condition assessment to detect trends in the health of the fish populations in question;
- to compare the short term growth of fishes among the three lakes, within and between species, and between seasons; and

- to compare the long term growth of fishes among the lakes and by species.

Materials and Methods:

Long term population growth and short term stress responses of the fish populations in Newton Lake and two other cooling lakes, Coffeen Lake and Lake of Egypt, was assessed. Coffeen Lake was chosen because it has a thermal regime similar to Newton Lake. Lake of Egypt was chosen as the third power cooling lake because a significantly lower amount of thermal loading occurs in this lake as compared to the other two lakes. Thermal loading in Lake of Egypt results in substantially elevated temperatures only in the immediate vicinity of the thermal discharge. Newton Lake was divided into four segments, with segment one being warmest and four being coolest. Coffeen Lake and Lake of Egypt were both divided into two segments, with one being warmest and two being coolest.

We examined the health of twenty to thirty adult specimens for each of three species, largemouth bass, *Micropterus salmoides*; channel catfish, *Ictaluris punctatus,* and bluegill *Lepomis macrochirus,* from Newton Lake, Coffeen Lake, and Lake of Egypt using procedures outlined and modified from Goede (1993). Hematological effects of secondary stress responses were also determined for a sample of fish representing each species using procedures outlined by Houston (1990). Sampling was conducted in the spring before spawning as well as in the warmest part of the year (July/August) in 1998 and 1999. In the spring, fish were collected throughout each lake, whereas sampling was focused on the warmest areas of each lake in the summer. Fish kills occurred on Newton and Coffeen Lakes in the summer of 1999. The health of moribund largemouth bass from Newton Lake was evaluated at this time. Largemouth bass were also sampled from five non-power cooling lakes in the summer of 1999. This was done to establish the health of largemouth bass in waters with no thermal discharge. The five lakes included East Fork, Sam Dale, Rend, Kinkaid and Cedar Lakes. The necropsy-based health assessment was performed on five largemouth bass from each lake.

Fish Collection

Fish were collected by electrofishing to minimize the stress effects associated with collection time and handling. Clark et al. (1979) stated that previous studies by McCarthy et al. (1973) and Soivio and Oikari (1976) found that the stress of netting and angling caused altered hematological parameters in fish. In our study, there was no more than a 30-minute interval between capture and data collection. This is consistent with previous studies by Casillas and Smith (1977) and Clark et al. (1979). Temperature and dissolved oxygen profiles were also recorded near fish collection sites.

Hematological Tests

Blood samples were drawn from anesthetized fish to determine hematocrit, leucocrit, glucose, osmolality, clotting time, plasma proteins, and heat shock protein levels. Tricaine (MS-222) buffered with $CaCO_3$ was used as the anesthetic. Blood samples were obtained through transection of the caudal peduncle (Houston 1990). Heparinized capillary tubes were used to take blood samples. Three to fourteen hematocrit tubes per fish, depending upon fish size, were filled and immediately sealed with Critoseal™. Samples were centrifuged in a standard microhematocrit centrifuge at 8,000 RPM for 5 minutes. Hematocrits (the relative volumes of the packed red cells as a percentage of the total column height; Houston 1990) were then measured. A leucocrit reading, a volume percentage of leucocytes in the packed column, was also taken. These measurements were taken with a nomograph (Goede 1993).

Glucose concentrations were determined using a Sigma Test Kit 510A™. This test uses an enzymatic colorimetric determination using glucose oxidase and peroxidase (Sigma Technical Bulletin No. 510). A Bausch and Lomb Spectronic 1001™ split-beam spectrophotometer was used to read the samples.

Plasma osmolality was determined by placing an 8μL sample of plasma on to a solute-free paper disc and then analyzing it with a Wescor 1500 vapor pressure osmometer. Measurements were taken as mmol/kg, an indication of the total concentration of dissolved particles. Total plasma proteins(g/100ml) were determined using a standardized refractometer.

Coagulation time was measured in non-heparinized capillary tubes. Each sample was broken at fixed intervals that were determined in the field based on preliminary coagulation time observations for each species. Coagulation time is determined when a clot strand remains suspended between broken segments of the tube as they are pulled apart (Casillas and Smith 1977). Timing began as the caudal peduncle was severed (Casillas and Smith 1976).

Blood smears were made from blood that had been treated with an anti-coagulant. The smears were fixed for five minutes in ethanol and dried. The personnel of the Southern Illinois University School of Medicine Histology Center determined appropriate stains (Wright-Giemsa) and staining times. A differential blood cell count was done on two hundred leucocytes from each specimen (Stoskopf 1993).

Serum samples were also analyzed for the presence of heat shock proteins. This involved taking a 1-2 mL sample of blood from the fish and injecting it into a serum separator tube. The blood was then allowed to coagulate in the tube for up to four hours. The blood was then spun in a centrifuge at 10,000 RPMs for 15 minutes in order to separate the serum from the other blood components. The serum was then removed from the vials and stored in Eppendorf™

microcentrifuge tubes at -80°C. These samples were then sent to Dr. Thomas Eurell at the University of Illinois College of Veterinary Medicine to be analyzed for the presence of heat shock proteins.

Before the serum samples were analyzed for the presence of heat shock proteins, serum proteins were determined. . Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) was performed in 10% gels using the Laemmli buffering system. Serum samples were diluted (1:4) with sample buffer containing 2-mercaptoethanol and heated for 4 minutes at 100° C Molecular mass markers (BioRad) were rabbit skeletal muscle myosin (200-kDa), *E. coli* β-galactosidase (116- kDa), rabbit muscle phosphorylase B (97.4-kDa), bovine serum albumin (66-kDa), and hen egg white ovalbumin (45-kDa). Duplicate gels were produced using identical samples.

After electrophoresis, gels were stained for total protein, using a BioRad silver stain kit. Images of the gels were captured on a Kodak digital science camera (DC120) and used to create a database of fish serum protein profiles.

For western blot analysis following SDS-PAGE, serum samples were electroblotted onto a PVDF membrane for 30 minutes at 15 V using a BioRad Trans-Blot semidry electrophoretic transfer cell. Before the transfer, the gel was rinsed in double deionized water and equilibrated for 15 min in CAPS buffer containing 5% methanol. The blot was then blocked with 2% non-fat dried milk and rinsed with 10mM PBS and Tween-20 (Sigma). Incubation of the blot was done using either mouse monoclonal antibody (1:200 dilution in PBS/Tween) to catfish vitellogenin (Gift from Auburn University, clone 1D8-A11) or heat shock protein 72/73 (StressGen, lot 611411) at 4°C overnight. After the incubation, the blot was rinsed with PBS/Tween to reduce non-specific protein binding. The membrane was then incubated with goat anti-mouse polyclonal antibody (1:2000 dilution in PBS/Tween) conjugated to an alkaline phosphatase label (Fisher). Several rinses containing only PBS were preformed after the second antibody incubation. Then 5-bromo-4-chloroindoly phosphate/nitroblue tetrazolium (Sigma) was used to develop a colored reaction product from the activity of the alkaline phosphatase label.

Necropsy-Based Condition Assessment and Condition Indices

Goede and Barton (1990) proposed a qualitative necropsy-based health assessment incorporating condition indices and organosomatic indices as overall indicators of fish health. The condition of the eyes, fins, opercales, pseudobranchs, thymus, liver, spleen, bile, fat, hindgut, kidney, and state of maturity were examined using guidelines modified from those originally outlined by Goede and Barton (1990) and Adams et al. (1993) (Appendix 9.1). When Adams et al. (1993) quantified the necropsy-based health assessment procedure, viscera were evaluated as either being normal (0) or abnormal (10 - 60). Modifications were made to this procedure for the current study. In this study, the liver, kidney, and eyes were given possible scores of 0, 30, or 60. This modification allowed viscera exhibiting multiple symptoms to be properly represented in the final fish health assessment index score. Parasite loads in each organ were also assessed on a scale of 0 to 5 with 5 being the heaviest load. Fish with total health scores of 115 or greater are considered to be in poor health (Adams et al. 1990).

This systematic approach was integrated with other condition indices and physiological variables to determine the effects of thermal loading on the fishes of Newton Lake, Coffeen Lake, and Lake of Egypt. Long-term growth indicators that were assessed include weight, length, and gonadalsomatic index (GSI). Only the GSI's of female fish are reported. Liver somatic indices (LSI; Heidinger and Crawford 1977), condition factor (C), relative weight, visceral somatic index (VSI; Adams and McLean 1985), spleenosomatic index (SSI), relative heart weight (HRT), and eye diameter relative to total length (Payne 1978) were assessed as short term indicators of growth. All indices were calculated as the weight of the organ divided by the weight of the fish. The VSI was calculated by dividing the weight of the organs minus the stomach contents by the weight of the fish.

Results:

During the spring and summer of 1998 sampling periods, an attempt was made to collect thirty fish of each species by electrofishing. Gill nets could not be used because this type of sampling would distort the blood parameters. In the spring of 1998, only nineteen bluegill were collected from Newton Lake, and no bluegill, of a suitable size range, were collected from Coffeen Lake. In the summer of 1998, nineteen channel catfish were collected from Lake of Egypt after approximately 360 minutes of electrofishing. Ten channel catfish were collected from Lake of Egypt in the summer of 1999 after 300 minutes of electrofishing. In the summer of 1999, fish kills occurred on both Newton and Coffeen Lakes. Health data was taken on ten moribund largemouth bass from Newton Lake. Normal summer sampling on Newton Lake was conducted during the fish kill as well. Samples were taken on Coffeen Lake in the week directly following the fish kill on this lake. Sampling was concentrated on segment 1 (warm water segment) of each lake until a significant portion of the area was covered. Sampling was then done throughout the lake in the next cooler segment until the desired number of fish was collected. In the summer of 1999, largemouth bass were collected in Newton Lake mainly in segment 4 (cold water segment), the only portion of the lake in which they were found to any great extent. There was period of at least six hours before any areas were electrofished for a second time.

The location, water temperature, and dissolved oxygen concentration at the site of capture was determined for each fish (Tables 9.1-9.4). Surface temperatures in Newton Lake ranged from 49-63°F during fish sampling in the spring of 1998 and 47-71°F in the spring of 1999. Summer temperatures during fish sampling in 1998 for Newton Lake ranged from 90-98°F, while 1999 temperatures ranged from 93-101°F. Sampling temperatures for Coffeen Lake in the summer of 1998 ranged from 90-97°F and 93-96°F in 1999. Sampling temperatures for Lake of Egypt ranged from 87-98°F in both sampling years. Surface temperatures in the five non-power cooling lakes sampled in the summer of 1999 ranged from 80-84°F (Table 9.1).

Statistical analyses in this report are focused on comparisons among lakes with in a season, differences between spring and summer within a given year, and differences among segments within a lake. Percentages were arcsine transformed for statistical analysis. Analysis of variance was used, followed by Tukey's post hoc test when there was a significant difference. Power may have suffered in some comparisons due to low sample sizes.

Hematological testing

Mean hematocrit, leucocrit, plasma proteins, and plasma osmolality along with standard error are reported lake-wide by season and year in Tables 9.5-9.8 and by lake segment in Appendix 9.1-9.9 for each species. Largemouth bass had similar hematological values among the three lakes during each of the seasons. Summer 1999 hematocrit values increased in largemouth bass (Table 9.5) for both Coffeen Lake ($p=0.0001$) and Lake of Egypt ($p=0.001$) as compared to the spring. Comparisons made in the summer of 1999 for largemouth bass (Table 9.6) included the summer samples from the power cooling lakes, the moribund largemouth bass sample from Newton Lake, and samples of five fish from each of th five non-power cooling lakes. Hematological values from fish sampled from the five non-power cooling lakes were pooled.

Overall, little variation in the means occurred among these samples. Variables for the five non-power cooling lakes are broken down by lake in Appendix 9.10.

Summer 1998 hematocrit values (Table 9.7) for channel catfish in Newton Lake were significantly lower than Coffeen Lake (p=0.0002). In the summer of 1999, channel catfish in both Newton and Coffeen Lakes had lower hematocrit values than Lake of Egypt (p=0.0110).

Bluegill in Newton Lake (summer of 1999) had hematocrit values (Table 9.8) lower than bluegill in Lake of Egypt (p=0.0007). Leucocrit values for bluegill in Newton Lake during the summer of 1999 were higher than for bluegill from both Coffeen Lake and Lake of Egypt (p=0.0001). No differences were detected across the segments for most of the hematological measures for any of the species reported in Appendix 9.1-9.9.

Lymphocyte percentages were significantly lower in the spring of 1998 as compared to summer 1998 percentages for Newton Lake (p=0.0432) largemouth bass (Table 9.9). Conversely, lymphocyte percentages were higher for largemouth bass in the spring of 1999 than in the summer for Newton Lake (p=0.0367). Thrombocyte percentages were lower in the spring than in the summer of 1999 for largemouth bass in Newton Lake (p=0.0128). Moribund largemouth bass from Newton Lake had significantly lower lymphocyte percentages (Table 9.10) than the other samples taken in the summer of 1999 (p=0.0001). Heterophil percentages were higher for the moribund largemouth bass than the other samples (p=0.0025). Neutrophil percentages were higher in the power cooling lake samples and the moribund sample than the pooled non-power cooling lake sample (p=0.0048). The thrombocyte percentages in the pooled non-power cooling lake sample was lower than those of the rest of the samples taken in the summer of 1999 (p=0.0021). Differential blood cell counts by lake, including the five non-power cooling lakes are reported in Appendix 9.11.

Channel catfish in Lake of Egypt had lower lymphocyte percentages (p=0.0058) and higher thrombocyte percentage (p=0.0448) in the spring of 1998 than channel catfish in Newton Lake (Table 9.11). Seasonal differences occurred in thrombocyte percentages for channel catfish in both Coffeen Lake (p=0.0453) and Lake of Egypt (p=0.0152) in 1998.

Mean blood glucose concentrations (mg/dL) and standard errors are reported lake-wide by season and year in Tables 9.13-9.15 and by lake segment in Appendix 9.12-9.14 for each species. In general, glucose concentrations tended to be higher in the summer than in the spring except in Coffeen Lake. Largemouth bass in Coffeen Lake had significantly higher blood glucose concentrations in the spring of 1998 (p=0.0001) and 1999 (p=0.0001) than the other two cooling lakes (Table 9.13). Bluegill blood glucose concentrations in Coffeen Lake were higher than Lake of Egypt bluegill (p=0.0352) in the spring of 1999 (Table 9.15).

Blood clotting times were highly variable within all lakes (Tables 9.16-9.18, Appendix 9.15-9.17). Clotting times were generally substantially longer, however, in the spring than in the summer in general for largemouth bass and channel catfish. For example, 48% of the largemouth bass sampled had clotting times of 4 minutes or greater in the spring of 1998. In the summer, average clotting times for largemouth bass were about 1/3 shorter than in the spring of 1998. Clotting times were longer for largemouth bass from Coffeen Lake in the spring (p=0.0122) of 1998 than those of largemouth bass in Newton Lake (Table 9.16). Channel catfish in both Coffeen Lake and Lake of Egypt had significantly longer clotting times than those fish in Newton Lake the spring of both years (Table 9.17). Clotting times for channel catfish ranged from approximately 2 minutes to 30 minutes in the spring of both years. Fifty percent of the channel catfish sampled in the spring of 1998 had a clotting time of 4 minutes or greater. The median clotting time in Coffeen Lake for the spring of 1998 was 11 minutes for channel catfish. In the spring of 1999, channel catfish from Coffeen Lake and Lake of Egypt had significantly higher clotting times than those of Newton Lake (p=0.0001). Overall, clotting times decreased significantly for largemouth bass and channel catfish in the summer. Spring and summer clotting times were found to be similar for bluegill. Heat shock proteins were not detected in significant amounts in samples ran from 1998 or 1999.

Necropsy-based condition assessment and condition indices

A mean fish health assessment index (FHAI) score is reported along with standard deviation and coefficient of variation for each fish collected (Tables 9.19-9.25). Higher FHAI scores indicate poorer health. The criteria used to evaluate the fish are found in Appendix 9.23 "Normal" ranges of hematocrits, leucocrits, and plasma proteins were determined from the mean values for these variables found in Lake of Egypt. In the summer of 1999, these ranges were established for largemouth bass using the data collected on the five non-power cooling lakes. It is our belief that the effects of thermal loading were minimal in this lake as compared to the other two lakes. The area between the warm water discharge and the cold water intake in Lake of Egypt is significantly smaller than that of Newton and Coffeen Lakes. It is assumed from this that the area affected by thermal discharge is greater in Newton and Coffeen Lakes.

The mean health assessment index scores were lower for each species in the three lakes for the summer than for the spring of 1998 (Tables 9.19-9.25). FHAI scores dropped by 43% for largemouth bass in Newton Lake from the spring to the summer of 1998 (Table 9.19). Lake-wide, largemouth bass in Newton Lake FHAI scores dropped by 23% from the spring to the summer of 1999 (Table 9.20). Largemouth bass in Lake of Egypt showed a decrease in FHAI scores of 45% from the spring to the summer of 1998. FHAI scores were generally lower in the spring of 1999 than those in the spring of 1998, but higher than the summer FHAI scores. No differences were found among the lakes within a season for largemouth bass during 1998 and 1999. Table 9.21 reports mean FHAI scores for largemouth bass sampled in the summer of 1999 from the power cooling lakes, Newton moribund fish, and a pooled sample of the 5 non-power cooling lakes. The Newton Lake moribund fish had the highest mean FHAI score, however, no statistical differences were found between the health of the moribund fish and the other largemouth bass sampled in the summer of 1999.

Newton Lake channel catfish were in the poorest health in the spring of 1998 as compared to those from Coffeen Lake and Lake of Egypt (p=0.0002), according to the FHAI reported in Table 9.22. Channel catfish FHAI scores were otherwise similar among the lakes across seasons with the exception of spring 1998 scores. Similar to largemouth bass, spring 1998 FHAI scores (Table 9.22) were higher than the summer FHAI scores in each of the lakes (Newton Lake p=0.0001, Coffeen Lake p=0.0002, and Lake of Egypt p=0.0104). Spring 1999 scores (Table 9.23) decreased by 36% from spring 1998 scores.

Coffeen Lake bluegill had the highest FHAI scores (p=0.0001) for this species in the summer of 1998 (Table 9.24). Mean FHAI scores increased from the spring to the summer for bluegill from both Newton Lake (p=0.0001) and Lake of Egypt (p=0.0001). In the summer of 1999, lake-wide FHAI scores (Table 9.25) for bluegill in Newton Lake showed almost a two-fold increase from the spring.

Parasite loads were generally found to be extremely heavy in bluegill in the three power cooling lakes, with Newton and Coffeen Lake bluegills showing the most severe infestations. Largemouth bass also had heavy parasite loads in each of the three lakes. Observations indicated that in the summer of 1999 moribund largemouth bass had lower parasite loads than fish in the normal summer sample from Newton Lake. The organs most heavily infested with parasites in both largemouth bass and bluegill were the kidneys and the liver.

Condition indices are reported by size range (Tables 9.26-9.34). Lake of Egypt largemouth bass 9.8-15.7 inches in length had a significantly larger eye diameter to length ratio in the spring of both years (p=0.0005, 0.0011) as reported in Table 9.27. Largemouth bass (9.8-15.7 in) from Coffeen Lake had the lowest spleenosomatic index (SSI) values among the lakes in all of the seasons. Seasonal differences in spleenosomatic index and liver somatic (LSI) values occurred in largemouth bass (9.8-15.7 in) in all lakes except for Coffeen Lake 1998 (SSI) and Newton Lake 1998 (LSI). Visceral somatic index values for largemouth bass (9.8-15.7 in) were higher in Newton and Coffeen Lakes as compared to Lake of Egypt during the summer of 1998 (p=0.0001). VSI values for largemouth bass (9.8-15.7 in) in Newton Lake were highest in the summer of 1999 (p=0.0001). SSI values for largemouth bass, 15.8-21.7 in, also tended to be lowest for Coffeen Lake. Seasonal differences occurred in all lakes for both the LSI and SSI for largemouth bass in this size range.

Channel catfish (7.9-13.8 in), similar to largemouth bass, showed seasonal differences in all lakes for both the LSI and the SSI (Table 9.29). VSI values for channel catfish (7.9-13.8 in.) were significantly lower in Newton Lake than Coffeen Lake in the spring of 1999 (p=0.0001). Channel catfish (13.9-19.7 in) had significantly higher LSI's in the summer than in the spring of 1999 (p=0.0001). Bluegill (5.6-7.1 in) LSI values (Table 9.33) for the summer of 1999 were significantly different in each of the three lakes(p=0.0001).

Condition factors and relative weights generally did not vary among lakes within a season for largemouth bass (Tables 9.35-9.37). Condition factors for moribund largemouth bass fell into a range in the middle of the five non-power cooling lakes and the three cooling lakes. Relative weights for channel catfish generally were higher in Lake of Egypt throughout the seasons (Table 9.39). Bluegill, similar to largemouth bass, did not vary among the lakes within a season (Tables 9.41-43).

Discussion:

Hematological testing

The results suggest that season and lake segment in which fish were collected did not substantially influence many of the physiological measures monitored. Physiological stress appeared to be minimal in fish populations during the summer and spring of 1998 in all three lakes based on most measures, with the exception of clotting time. Clotting times were high in largemouth bass and channel catfish in each of the three lakes during the spring. This may be attributable to water temperature and photoperiod, although similar findings have not been reported in the literature to our knowledge. Fish naturally undergo physiological changes with the seasons; however, in power cooling lakes water temperatures warm up faster than they would in a non-power cooling lake. In the case of the high clotting times in the spring, catch and release could be lethal if a fish was injured upon capture.

Differential blood cell counts for channel catfish in Coffeen Lake and Lake of Egypt were not consistent with expectations based on clotting times. Thrombocytes, an essential part of the clotting process, were present in higher numbers in the spring than in the summer. As the stress response is initiated, thrombocyte counts should increase (Mazeaud et al. 1977) leading to a decrease in clotting time. The reverse of this was found in both Coffeen Lake and Lake of Egypt. Channel catfish from Coffeen Lake and Lake of Egypt could also be lacking an essential component in the clotting process. As the stress response is initiated, lymphocyte counts should be declining, as was seen in all channel catfish sampled in the spring of both year.

Differential blood cell counts supported clotting time results for largemouth bass in the summer of 1999. Again, as expected in the stress response, lymphocyte counts should decline and thrombocyte counts should increase. Moribund largemouth bass taken during the fish kill in Newton Lake exhibited these signs, indicating physiological stress, in the summer of 1999.

Blood glucose concentrations were lower in the spring than in the summer for both largemouth bass and channel catfish in each of the lakes. High glucose concentrations in the summer may be attributed to short-term stress and or greater metabolism demands. An increase in blood glucose concentrations is consistent with stress response intiation.

Fish health assessment index and condition indices

According to the fish health assessment index, largemouth bass and channel catfish were in poorer health in the spring than in the summer. This may be attributable to the increased physiological demands placed on fish in the spring. We sampled each lake prior to the spawning periods for the three species we examined, a time when energy is diverted to reproduction. The poorer condition of fish in the spring may also have been due to reduced food consumption coupled with harsh conditions during the winter. Both largemouth bass and channel catfish health improved from the spring to the summer in both years. The lower FHAI summer scores may be attributable to the fish repairing their tissues during the summer.

The mean FHAI score for moribund fish from Newton Lake, although approaching levels considered to be in poor health (FHAI scores of 115 or greater), did not statistically differ from other samples taken in the summer of 1999. The majority of the abnormalities in the moribund largemouth bass occurred in the livers, kidneys, and eyes. These abnormalities do not likely develop quickly (i.e. in the time period in which the extreme heat event took place on Newton Lake in the summer of 1999) suggesting that the moribund fish may have already been unhealthy.

Differential blood cell counts for the moribund largemouth bass indicated some kind of stress response was occurring as compared to the other samples taken in the summer of 1999. Condition factors of largemouth bass sampled in Newton and Coffeen Lakes, during normal summer sampling, were highest among all samples in the summer of 1999. As measured by condition factor, largemouth bass in power cooling lakes did not appear to be adversely affected by warm summer temperatures.

While, fish in the summer where in better condition overall, slight decreases in condition indices such as the VSI and LSI were found. These findings concur with those of Bulow (1981) and Adams and McLean (1985). They believed that greater metabolism demands at warmer temperatures allow fewer nutrients to be stored in organs such as the liver.

Relative weight data suggested that largemouth bass in Newton and Coffeen Lakes were in better condition than in Lake of Egypt. This may be attributable to the extended growing period occurring in the former two lakes, due to warmer annual temperatures. Relative weights for channel catfish and bluegill (Tables 9.16-9.17) were slightly low. This may be caused by an imbalance between predator and prey.

Parasite infestations in the kidneys and livers of largemouth bass and bluegill contributed to the most obvious pathological changes in the organs. It is not known to what extent these parasite infestations affect the health of fish in the three lakes. The majority of the parasites observed appear to be Trematoda.

In conclusion, the FHAI did not appear to be a good indicator of thermal stress events. It should also be noted that dissolved oxygen concentrations were relatively low in Newton and Coffeen Lakes during the fish kill, indicating that the FHAI did not appear to be sensitive to this stressor or the combined stressor of high temperatures and low dissolved oxygen. This index was developed to detect trends and abnormalities in the health of a fish population while corrective actions could still be taken. Water temperatures in Newton and Coffeen Lakes reached or approached the chronic thermal maxima, 99°F, (acclimated at 89.6°F with 1°C change/day) for northern largemouth bass (Fields et al. 1987) and the upper incipient lethal temperature, 93°F, (Hart 1952) for largemouth bass, yet most variables measured in this study did not adequately indicate stress occurring in largemouth bass during the summer of 1999. Previous studies (see Coutant 1975 for a review) have shown that largemouth bass generally grow, swim, and feed well at high temperatures approaching their lethal limit, perhaps making it hard to detect changes in health before death resulting from exposure to temperatures outside of their tolerance range. Overall, the results indicate that the fish in the three cooling lakes are in similar health. It is our feeling that fluctuations in condition and physiological variables (with the exception of clotting time) seen in the fishes of Newton Lake, Lake of Egypt, and Coffeen Lake can be primarily attributed to season, forage base, reproductive demands, and size.

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Table 9.1. Mean lake surface temperatures (°F), dissolved oxygen concentrations (mg/L), and ranges for 1998 and 1999 fish health sampling periods. Sampling took place within the time periods listed.

Year	Season	Sampling Dates	Lake	Mean Surface Temperature (F)	Range	Dissolved Oxygen (mg/L)	Range
1998	Spring	3/13-3/30	Newton	55	49-63	11.98	9.70-18.30
		3/31-4/1	Coffeen	67	62-78	9.37	8.65-11.30
		3/23-3/27	Egypt	54	50-57	10.81	10.05-11.70
	Summer	8/17-8/18	Newton	92	90-98	8.33	6.75-10.67
		8/12-8/13	Coffeen	91	90-97	8.83	6.40-13.90
		8/10-8/27	Egypt	92	88-98	5.52	1.66-9.10
1999	Spring	3/16-3/17	Newton	55	47-71	11.59	9.60-12.90
		3/11-3/12	Coffeen	62	56-69	9.62	8.78-10.35
		3/19,3/26	Egypt	53	50-56	12.17	9.45-13.20
	Summer	7/29-7/30	Newton	96	93-101	8.34	7.60-9.60
		7/31-8/1	Coffeen	94	93-96	6.64	4.80-9.44
		8/5-8/6	Egypt	90	87-98	5.55	2.11-7.27
		8/19	Sam Dale	80	--	652	5.80-7.30
		8/19	East Fork	82	82-84	9.64	8.20-11.80
		8/18	Rend	80	80-81	6.46	5.70-7.50
		8/16	Kinkaid	83	83-84	6.92	6.20-7.50
		8/16	Cedar	80	80-81	7.38	7.30-7.50

Table 9.2. Mean surface temperatures (°F), dissolved oxygen concentrations (mg/L), and ranges by segment for Newton Lake in 1998 and 1999.

Year	Lake	Season	Segment	Mean Surface Temperature (F)	Range	Dissolved Oxygen (mg/L)	Range
1998	Newton	Spring	1	59	49-52	11.56	9.70-18.30
			2	51	49-52	10.79	10.30-12.10
			3	50	49-51	13.12	11.63-13.50
			4	58	49-61	13.25	12.10-14.43
		Summer	1	96	--	7.32	--
			2	93	91-98	7.90	6.75-9.25
			3	92	--	7.41	--
			4	90	--	10.11	9.60-10.67
1999	Newton	Spring	1	66	54-71	10.32	9.60-11.88
			2	54	54-55	11.83	11.46-12.11
			3	51	48-52	12.02	11.56-12.83
			4	48	47-50	12.13	11.55-12.90
		Summer	1	99	--	8.60	--
			2	100	98-101	9.03	8.50-9.60
			3	--	--	--	--
			4	94	93-95	8.10	7.60-8.30

Table 9.3. Mean surface temperatures (°F), dissolved oxygen concentrations (mg/L), and ranges by segment for Coffeen Lake in 1998 and 1999.

Year	Season	Segment	Mean Surface Temperature (F)	Range	Dissolved Oxygen (mg/L)	Range
1998	Spring	1	72	65-78	9.48	9.20-9.80
		2	63	62-63	9.25	8.65-11.30
	Summer	1	91	91-97	7.54	6.40-10.60
		2	90	90-93	10.90	7-13.90
1999	Spring	1	68	67-69	9.02	8.78-9.50
		2	58	56-62	10.02	9.45-10.35
	Summer	1	--	--	--	--
		2	94	93-96	6.64	4.80-9.44

Table 9.4. Mean surface temperatures (°F), dissolved oxygen concentrations (mg/L), and ranges by segment for Lake of Egypt in 1998 and 1999.

Year	Season	Segment	Mean Surface Temperature (F)	Range	Dissolved Oxygen (mg/L)	Range
1998	Spring	1	55	50-57	10.57	10.05-11.62
		2	53	51-55	11.2	10.74-11.70
	Summer	1	92	88-98	5.17	1.66-9.10
		2	91	--	7.94	6.42-8.14
1999	Spring	1	55	52-56	11.86	11.30-13.00
		2	51	50-53	12.48	9.45-13.20
	Summer	1	91	87-98	4.67	2.11-6.71
		2	87	87-88	7.17	7.04-7.27

Table 9.5. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality and standard errors for largemouth bass in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences within a season among the lakes for individual variables at the $\propto=0.05$ level. Asterisks indicate seasonal differences for individual variables occurring within a lake during a year at the $\propto=0.05$ level.

Year	Season	Lake	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	Newton	34	37^{a}	0.96	36*	0.56^{a}	0.09	30*	$6.66^{a,b}$	0.19	34	346^{a}	13.71
		Coffeen	30	$36^{a,b}$	0.72	30	0.09^{b}	0.04	22*	6.97^{a}	0.20	28	322^{a}	2.38
		Egypt	31*	33^{b}	0.64	31*	0.92^{a}	0.17	26	6.07^{b}	0.20	23*	313^{a}	1.93
	Summer	Newton	20	39^{a}	0.93	20	0.00^{a}	0.00	16	5.37^{a}	0.23	19	323^{a}	3.56
		Coffeen	20	39^{a}	1.05	20	0.00^{a}	0.00	18	5.44^{a}	0.16	19	321^{a}	2.92
		Egypt	28	37^{a}	0.58	28	0.00^{a}	0.00	23	5.69^{a}	0.15	24	324^{a}	1.89
1999	Spring	Newton	25	37^{a}	1.21	25*	0.37^{a}	0.07	21*	6.79^{a}	0.20	21	315^{a}	1.94
		Coffeen	20*	31^{b}	0.89	20*	0.19^{a}	0.08	19	6.54^{a}	0.19	19	327^{b}	1.56
		Egypt	23*	29^{b}	0.67	23*	0.17^{a}	0.05	19	5.68^{b}	0.13	22	316^{a}	2.49
	Summer	Newton	17	$42^{a,b}$	1.2	17	0.00^{a}	0.00	11	$5.69^{a,b}$	0.28	17	318^{a}	5.58
		Coffeen	27	43^{a}	0.81	27	0.00^{a}	0.00	25	6.53^{a}	0.13	25	323^{a}	4.2
		Egypt	22	37^{b}	0.93	22	0.02^{a}	0.01	22	5.73^{b}	0.14	23	318^{a}	5.35

Table 9.6. Largemouth bass mean hematocrit, leucocrit, and plasma proteins for Newton Lake, Coffeen Lake, Lake of Egypt, and a pooled sample from five non-power cooling lakes in the summer of 1999. Values with different superscripts indicate differences among the lakes for an individual variable at the α=0.05 level.

Lake	N	Hematocrit (%)	N	Leucocrit (%)	N	Plasma Proteins (g/100ml)
Newton	17	$42^{b,c,d}$	17	0.00^{a}	11	5.69^{a}
Coffeen	27	$43^{c,d}$	27	$0.00^{a,b}$	25	6.53^{c}
Egypt	22	37^{a}	22	$0.02^{a,b}$	22	$5.73^{a,b}$
Newton Moribund	10	$41^{a,b,c}$	10	0.92^{c}	6	$6.78^{a,b,c}$
Pooled 5 Lakes	25	$38^{a,b}$	25	0.47^{c}	25	$6.03^{a,b,c}$

Table 9.7. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for channel catfish in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences within a season among the lakes for individual variables at the ∝=0.05 level. Asterisks indicate seasonal differences for individual variables occurring within a lake during a year at the ∝=0.05 level.

Year	Season	Lake	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	Newton	31*	25^{a}	1.05	31	0.86^{a}	0.19	9	3.19^{a}	0.18	23	285^{a}	10.99
		Coffeen	30*	33^{b}	1.28	30	0.60^{b}	0.13	25	4.38^{b}	0.19	27	278^{a}	2.79
		Egypt	20	31^{b}	1.53	20*	1.02^{a}	0.12	17	5.99^{c}	0.42	11	277^{a}	2.66
	Summer	Newton	20	30^{a}	1.60	20	0.50^{a}	0.08	14	4.20^{a}	0.18	15	287^{a}	3.13
		Coffeen	20	39^{b}	1.39	20	0.48^{a}	0.06	12	4.40^{a}	0.14	17	276^{b}	1.99
		Egypt	18	$34^{a,b}$	0.97	18	0.56^{a}	0.00	13	4.47^{a}	0.18	14	$282^{a,b}$	2.47
1999	Spring	Newton	26	28^{a}	1.00	26	0.81^{a}	0.11	17	4.09^{a}	0.16	21	268^{a}	2.16
		Coffeen	19	28^{a}	1.55	20	0.80^{a}	0.09	17	3.54^{a}	0.19	19	270^{a}	2.81
		Egypt	21*	30^{a}	1.89	21*	0.57^{a}	0.07	18	5.27^{b}	0.24	19	276^{a}	3.85
	Summer	Newton	17	30^{a}	0.94	17	$0.71^{a,b}$	0.09	5	4.62^{a}	0.43	17	281^{a}	3.82
		Coffeen	21	31^{a}	1.18	21	0.57^{a}	0.06	20	6.06^{b}	0.25	20	286^{a}	3.52
		Egypt	10	36^{b}	2.48	10	1.07^{b}	0.04	10	4.62^{a}	0.36	10	287^{a}	4.23

Table 9.8. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for bluegill in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences within a season among the lakes for individual variables at the ∝=0.05 level. Asterisks indicate seasonal differences for individual variables occurring within a lake during a year at the ∝=0.05 level.

Year	Season	Lake	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	Newton	5	36[a]	2.23	5*	0.90[a]	0.40		--	--	5	280[a]	6.92
		Coffeen		--	--		--	--		--	--		--	--
		Egypt	13*	31[a]	1.77	13*	0.80[a]	0.12	3	5.35	0.55	10	297[b]	4.14
	Summer	Newton	10	33[a]	1.62	10	0.00[a]	0.00	2	5.75[a]	0.65	6	291[a]	5.17
		Coffeen	9	40[b]	2.24	9	0.00[a]	0.00	6	4.58[a]	0.37	8	301[a]	4.77
		Egypt	10	38[a,b]	1.74	10	0.00[a]	0.00	9	5.24[a]	0.28	10	291[a]	5.94
1999	Spring	Newton	15	31[a]	1.57	15*	0.10[a]	0.05	6	5.33[a]	0.25	13	288[a]	3.32
		Coffeen	16	34[a]	1.18	16	0.23[a]	0.08	5*	4.14[b]	0.21	15	272[a]	19.3
		Egypt	10*	29[a]	1.7	10	0.15[a]	0.07	7	5.47[a]	0.17	11*	285[a]	7.6
	Summer	Newton	14	32[a]	0.87	14	0.64[a]	0.09		--	--	14	297[a]	5.13
		Coffeen	4	34[a,b]	2.18	4	0.13[b]	0.13	1	5.60[a]	--	4	301[a]	12.3
		Egypt	22	37[b]	0.92	22	0.08[b]	0.04	8	4.88[a]	0.48	16	302[a]	3.84

Table 9.9. Mean differential blood cell counts and standard errors for largemouth bass in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences among the lakes within a season, for each blood cell type, at the ∝=0.05 level. Asterisks indicate seasonal differences within a lake in a given year at the ∝=0.05 level. LYM=lymphocytes, HET = heterophils, NEUT = neutrophils, THROM = thrombocytes, BASO = basophils, ESO = esonophils, MONO = monocytes, Unknown = unidentifiable white blood cell types.

Year	Season	Lake	N	%LYM	S.E.	%HET	S.E.	%NEUT	S.E.	%THROM	S.E.	%BASO	S.E.	%ESO	S.E.	%MONO	S.E.	Unknown	S.E.
1998	Spring	Newton	22	*51.80^{a}	3.44	0.32^{a}	0.23	3.66^{a}	1.46	38.41^{a}	3.95	0.02^{a}	0.02	0.09^{a}	0.07	1.30^{a}	0.41	4.41^{a}	0.96
		Coffeen	23	49.46^{a}	3.36	0.24^{a}	0.20	3.50^{a}	1.44	39.17^{a}	3.47	0.15^{a}	0.10	0.02^{a}	0.02	0.63^{a}	0.29	6.83^{a}	1.63
		Egypt	23	56.24^{a}	3.41	0.57^{a}	0.25	1.89^{a}	0.55	33.65^{a}	3.22	*0.20^{a}	0.09	*0.22^{a}	0.08	*1.80^{a}	0.51	*5.43^{a}	1.26
1998	Summer	Newton	15	61.83^{a}	2.63	0.33^{a}	0.17	1.30^{a,b}	0.35	32.37^{a}	2.52	0.03^{a}	0.03	0.03^{a}	0.03	1.00^{a}	0.41	3.10^{a,b}	0.64
		Coffeen	18	45.56^{b}	3.32	0.44^{a}	0.17	2.53^{a}	0.73	45.39^{a}	3.63	0.06^{a}	0.06	0.17^{a}	0.14	1.08^{a}	0.40	4.78^{a}	1.14
		Egypt	20	57.48^{a}	4.18	0.18^{a}	0.11	1.03^{b}	0.47	39.35^{a}	4.09	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{b}	0.00	1.98^{b}	0.61
1999	Spring	Newton	25	*62.40^{a}	2.57	1.30^{a}	0.33	2.46^{a}	0.74	*29.82^{a}	2.75	0.06^{a}	0.06	0.00^{a}	0.00	0.00^{a}	0.00	3.96^{a}	0.76
		Coffeen	25	63.36^{a}	3.37	*0.53^{b}	0.47	2.83^{a}	1.35	30.61^{a}	3.79	0.08^{a}	0.06	0.00^{a}	0.00	0.00^{a}	0.00	2.58^{a,b}	0.70
		Egypt	20	*65.34^{a}	2.87	0.55^{a,b}	0.19	2.89^{a}	0.47	*29.42^{a}	2.81	0.00^{a}	0.00	0.00^{a}	0.00	0.05^{a}	0.05	*1.74^{b}	0.66
1999	Summer	Newton	16	54.09^{a}	2.69	0.53^{a}	0.19	2.56^{a}	0.47	40.84^{a}	2.64	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00	1.97^{a}	0.55
		Coffeen	25	54.32^{a}	3.54	2.06^{a}	0.89	4.66^{a}	1.63	35.28^{a}	2.80	0.02^{a}	0.02	0.00^{a}	0.00	0.02^{a}	0.02	3.64^{a}	1.10
		Egypt	20	48.00^{a}	3.81	0.55^{a}	0.29	4.00^{a}	1.00	40.58^{a}	2.85	0.05^{a}	0.05	0.00^{a}	0.00	0.63^{a}	0.63	6.20^{a}	1.10

Table 9.10. Mean differential blood cell counts and standard errors for largemouth bass in (summer of 1999) Newton Lake, Coffeen Lake, Lake of Egypt, and a pooled sample of five non-power cooling lakes. Values with different superscripts indicate differences among the lakes within the summer of 1999, for each blood cell type, at the ∝=0.05 level. LYM=lymphocytes, HET = heterophils, NEUT = neutrophils, THROM = thrombocytes, BASO = basophils, ESO = esonophils, MONO = monocytes, Unknown = unidentifiable white blood cell types.

Lake	N	%LYM	S.E.	%HET	S.E.	%NEUT	S.E.	%THROM	S.E.	%BASO	S.E.	%ESO	S.E.	%MONO	S.E.	Unknown
Newton	16	54.09^{a}	2.69	0.53^{a}	0.19	2.56^{a}	0.47	$40.84^{a,b}$	2.64	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00	1.97^{a}
Coffeen	25	54.32^{a}	3.54	$2.06^{a,b,c,d}$	0.89	4.66^{a}	1.63	35.28^{a}	2.80	0.02^{a}	0.02	0.00^{a}	0.00	0.02^{a}	0.02	$3.64^{a,b}$
Egypt	20	48.00^{a}	3.81	$0.55^{a,b}$	0.29	4.00^{a}	1.00	$40.58^{a,b}$	2.85	0.05^{a}	0.05	0.00^{a}	0.00	0.63^{a}	0.63	$6.20^{b,c,d}$
Newton Moribund	9.00	19.94^{b}	2.96	5.89^{d}	3.22	13.11^{b}	2.89	52.00^{b}	3.39	0.00^{a}	0.00	0.00^{a}	0.00	0.06^{a}	0.06	$9.00^{c,d}$
Pooled 5 Lakes	20	54.73^{a}	2.93	$0.98^{a,b,c}$	0.38	$6.98^{a,b}$	2.28	32.20^{a}	2.80	0.00^{a}	0.00	0.00^{a}	0.00	0.10^{a}	0.07	$5.03^{a,b,c}$

Table 9.11. Mean differential blood cell counts and standard errors for channel catfish in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences among the lakes within a season, for each blood cell type, at the ∝=0.05 level. Asterisks indicate seasonal differences within a lake in a given year at the ∝=0.05 level. LYM=lymphocytes, HET = heterophils, THROM = thrombocytes, BASO = basophils, ESO = esonophils, MONO = monocytes, Unknown = unidentifiable white blood cell types.

Year	Season	Lake	N	%LYM	S.E.	%HET	S.E.	%THROM	S.E.	%BASO	S.E.	%ESO	S.E.	%MONO	S.E.	Unknown	S.E.
1998	Spring	Newton	14	*71.29[a]	4.07	1.14[a]	0.30	25.82[a]	4.11	0.00[a]	0.00	0.00[a]	0.00	0.04[a]	0.04	1.71[a]	0.49
		Coffeen	24	*66.02[a,b]	2.48	*2.56[b]	0.50	*28.54[a,b]	2.59	0.00[a]	0.00	0.00[a]	0.00	0.15[a]	0.08	2.73[a]	0.70
		Egypt	17	*56.32[b]	2.81	2.38[a,b]	0.65	*37.59[b]	3.19	0.03[a]	0.03	0.00[a]	0.00	0.00[a]	0.00	3.68[a]	1.42
1998	Summer	Newton	9	76.39[a]	3.56	1.28[a]	0.62	17.56[a]	4.13	0.00[a]	0.00	0.00[a]	0.00	0.06[a]	0.06	4.72[a]	2.04
		Coffeen	13	76.77[a]	3.53	1.27[a]	0.51	19.96[a]	3.41	0.00[a]	0.00	0.00[a]	0.00	0.00[a]	0.00	2.00[a]	0.83
		Egypt	13	70.62[a]	3.13	3.23[a]	2.00	24.35[a]	3.71	0.00[a]	0.00	0.00[a]	0.00	0.08[a]	0.05	1.73[a]	0.87
1999	Spring	Newton	24	*65.98[a]	2.15	2.56[a]	0.51	23.67[a]	1.96	0.02[a]	0.02	0.21[a]	0.21	0.02[a]	0.02	*7.54[a]	1.82
		Coffeen	8	*65.00[a,b]	3.60	*0.88[a]	0.25	31.88[a,b]	3.20	0.00[a]	0.00	0.00[a]	0.00	0.00[a]	0.00	2.25[a]	1.33
		Egypt	18	*55.14[b]	3.17	*1.97[a]	0.38	*36.31[b]	3.01	0.69[a]	0.69	0.00[a]	0.00	0.08[a]	0.08	5.81[a]	0.93
1999	Summer	Newton	13	74.42[a]	2.24	4.50[a]	0.84	18.73[a]	2.19	0.00[a]	0.00	0.00[a]	0.00	0.00[a]	0.00	2.35[a]	1.90
		Coffeen	17	66.18[a]	2.55	5.74[a]	0.94	23.68[a]	2.80	0.15[a]	0.15	0.00[a]	0.00	0.12[a]	0.09	4.15[a]	0.99
		Egypt	9	64.33[a]	4.72	9.39[a]	2.34	22.72[a]	4.45	0.00[a]	0.00	0.00[a]	0.00	0.11[a]	0.11	3.44[a]	0.96

Table 9.12. Mean differential blood cell counts and standard errors for bluegill in the spring and summer of 1998 and 1999. Values with different superscripts indicate differences among the lakes within a season, for each blood cell type, at the ∝=0.05 level. Asterisks indicate seasonal differences within a lake in a given year at the ∝=0.05 level. LYM=lymphocytes, HET = heterophils, NEUT = neutrophils, THROM = thrombocytes, BASO = basophils, ESO = esonophils, MONO = monocytes, Unknown = unidentifiable white blood cell types.

Year	Season	Lake	N	%LYM	S.E.	%HET	S.E.	%NEUT	S.E.	%THROM	S.E.	%BASO	S.E.	%ESO	S.E.	%MONO	S.E.	Unknown	S.E.
1998	Spring	Newton	1	45.50	--	0.00	--	*2.00	--	52.50	--	0.00	--	0.00	--	0.00	--	0.00	--
		Coffeen		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Egypt	9	52.78	6.69	0.00	0.00	0.39	0.18	*41.06	7.39	0.39	0.26	0.00^{a}	0.00	0.22	0.12	5.17	1.71
1998	Summer	Newton	6	60.50^{a}	7.46	0.00	0.00	0.00^{a}	0.00	33.83^{a,b}	7.79	0.00^{a}	0.00	0.00^{a}	0.00	0.67^{a}	0.67	5.00^{a}	2.22
		Coffeen	7	45.14^{a}	5.58	0.00	0.00	10.29^{a}	4.28	40.36^{a}	3.17	0.00^{a}	0.00	0.00^{a}	0.00	0.64^{a}	0.64	3.57^{a}	1.12
		Egypt	13	65.65^{a}	4.53	0.04	0.04	5.31^{a}	2.84	23.85^{b}	2.97	0.12^{a}	0.12	0.42^{a}	0.42	0.65^{a}	0.30	4.96^{a}	2.06
1999	Spring	Newton	10	61.15^{a}	6.67	0.25	0.15	*1.90^{a}	1.25	27.80^{a}	6.27	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00	*8.90^{a}	2.29
		Coffeen	12	67.42^{a}	4.82	1.38	0.67	*0.79^{a}	0.36	21.29^{a}	4.30	0.00^{a}	0.00	0.29^{a}	0.22	0.04^{a}	0.04	8.79^{a}	3.58
		Egypt	9	63.89^{a}	2.32	*1.89	0.89	2.11^{a}	0.59	24.17^{a}	3.17	0.00^{a}	0.00	0.00^{a}	0.00	0.11^{a}	0.11	*7.83^{a}	1.88
1999	Summer	Newton	11	64.14^{a}	2.96	0.36^{a}	0.19	3.82^{a}	0.90	28.73^{a}	2.70	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00	2.95^{a}	0.71
		Coffeen	1	59.50	--	0.00	--	5.00^{a}	--	33.00^{a}	--	0.00^{a}	--	0.00^{a}	--	0.00^{a}	--	2.50^{a}	--
		Egypt	16	69.69^{a}	3.06	0.00^{b}	0.00	2.00^{a}	1.35	24.78^{a}	2.58	0.00^{a}	0.00	0.00^{a}	0.00	0.00^{a}	0.00	3.53^{a}	1.00

Table 9.13. Mean blood glucose concentrations (mg/dL) and standard errors for largemouth bass in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes within a year at the ∝=0.05 level.

Year	Season	Lake	N	Glucose Concentration (mg/dL)	S.E.
1998	Spring	Newton	32*	83[a]	7.10
		Coffeen	29	217[b]	14.73
		Egypt	23*	97[a]	6.85
	Summer	Newton	16	174[a,b]	18.05
		Coffeen	15	213[a]	24.47
		Egypt	13	137[b]	14.02
1999	Spring	Newton	23*	75[a]	5.61
		Coffeen	20	114[b]	7.59
		Egypt	22*	61[a]	4.79
	Summer	Newton	12	226[a]	31.94
		Coffeen	17	102[b]	10.25
		Egypt	21	105[b]	9.73
		Newton Moribund	8	156[a,b]	62-250

Table 9.14. Mean blood glucose concentrations (mg/dL) and standard errors for channel catfish in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes within a year at the α=0.05 level.

Year	Season	Lake	N	Glucose Concentration (mg/dL)	S.E.
1998	Spring	Newton	23*	36[a]	5.06
		Coffeen	25	87[b]	6.40
		Egypt	10	60[a]	11.53
	Summer	Newton	9	112[a]	17.79
		Coffeen	18	80[a]	6.86
		Egypt	17	80[a]	5.49
1999	Spring	Newton	20*	38[a]	3.27
		Coffeen	17*	36[a]	3.78
		Egypt	20*	29[a]	3.63
	Summer	Newton	16	71[a]	4.91
		Coffeen	13	68[a]	4.25
		Egypt	9	54[a]	4.69

Table 9.15. Mean blood glucose concentrations (mg/dL) and standard errors for bluegill in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes within a year at the ∝=0.05 level.

Year	Season	Lake	N	Glucose Concentration (mg/dL)	S.E.
1998	Spring	Newton	1	130[a]	--
		Coffeen		--	--
		Egypt	7*	59[b]	2.19
	Summer	Newton	6	108[a]	13.15
		Coffeen	3	89[a]	25.92
		Egypt	2	201[b]	29.5
1999	Spring	Newton	8	95[a]	22.40
		Coffeen	7	150[b]	36.46
		Egypt	9*	59[a]	7.38
	Summer	Newton	8	108[a]	5.85
		Coffeen	2	128[a]	17.38
		Egypt	10	91[a]	8.76

Table 9.16. Mean clotting times (minutes) and standard errors for largemouth bass in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Lake	N	Clotting Time (minutes)	S.E.
1998	Spring	Newton	36*	3.72^{a}	0.31
		Coffeen	30*	6.01^{b}	0.73
		Egypt	31*	$4.49^{a,b}$	0.56
	Summer	Newton	31	1.08^{a}	0.10
		Coffeen	20	$1.58^{a,b}$	0.20
		Egypt	27	1.74^{b}	0.18
1999	Spring	Newton	25*	2.97^{a}	0.22
		Coffeen	20*	5.33^{b}	0.50
		Egypt	23*	3.70^{a}	0.42
	Summer	Newton	17	1.39^{a}	0.22
		Coffeen	26	1.55^{a}	0.18
		Egypt	24	0.98^{a}	0.15

Table 9.17. Mean clotting times (minutes) and standard errors for channel catfish in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes at the α=0.05 level.

Year	Season	Lake	N	Clotting Time (minutes)	S.E.
1998	Spring	Newton	34	2.07[a]	0.17
		Coffeen	30*	11.12[b]	1.05
		Egypt	20*	5.48[b]	0.94
	Summer	Newton	19	2.00[a]	0.24
		Coffeen	20	2.26[a]	0.6
		Egypt	19	2.27[a]	0.28
1999	Spring	Newton	29*	3.21[a]	0.27
		Coffeen	19*	7.05[b]	0.26
		Egypt	20*	9.90[b]	2.03
	Summer	Newton	21	1.73[a]	0.19
		Coffeen	21	1.45[a]	0.10
		Egypt	10	1.74[a]	0.27

Table 9.18. Mean clotting times (minutes) and standard errors for bluegill in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Lake	N	Clotting Time (min)	S.E.
1998	Spring	Newton	36*	3.72[a]	0.31
		Coffeen	30*	6.01[b]	0.73
		Egypt	31*	4.49[a,b]	0.56
	Summer	Newton	31	1.08[a]	0.10
		Coffeen	20	1.58[a,b]	0.20
		Egypt	27	1.74[b]	0.18
1999	Spring	Newton	25*	2.97[a]	0.22
		Coffeen	20*	5.33[b]	0.50
		Egypt	23*	3.70[a]	0.42
	Summer	Newton	17	1.39[a,b]	0.22
		Coffeen	26	1.55[a,b]	0.18
		Egypt	24	0.98[a]	0.15
		Newton Moribund	10	1.46[a,b]	0.42
		Pooled 5 Lakes	25	1.71[b]	0.13

Table 9.19. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for largemouth bass ranging from 3.9-21.7 inches in the spring and summer of 1998. No differences in FHAI scores occurred among the lakes in the spring or the summer of 1998. Asterisks indicate differences among the lakes between the seasons for individual lakes at the α=0.05 level.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	36*	103	30.74	29.97	Summer	Lake	26	59	31.38	53.48
		3.9-9.7	2	119	8.02	6.74		3.9-9.7		--	--	--
		9.8-15.7	8	109	39.79	36.50		9.8-15.7	19	72	25.75	35.54
		15.8-21.7	28	104	32.50	31.21		15.8-21.7	7	84	20.76	24.84
Coffeen	Spring	Lake	30*	100	31.73	31.85	Summer	Lake	30	71	24.00	33.75
		3.9-9.7		--	--	--		3.9-9.7		--	--	--
		9.8-15.7	12	78	26.89	34.62		9.8-15.7	15	67	21.05	31.48
		15.8-21.7	22	96	28.59	29.71		15.8-21.7	10	67	21.36	32.12
Egypt	Spring	Lake	31*	97	26.66	27.39	Summer	Lake	30	53	30.96	57.97
		3.9-9.7		--	--	--		3.9-9.7		--	--	--
		9.8-15.7	16	99	32.78	33.01		9.8-15.7	25	51	29.71	57.88
		15.8-21.7	14	96	19.71	20.62		15.8-21.7	5	64	38.63	60.52

Table 9.20. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for largemouth bass ranging from 3.9-21.7 inches in the spring and summer of 1999. No differences in FHAI scores occurred among the lakes within a season and no seasonal differences within a lake occurred.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	32	91	48.95	53.63	Summer	Lake	17	70	26.87	38.56
		3.9-9.7		--	--	--		3.9-9.7		--	--	--
		9.8-15.7	11	80	56.07	69.80		9.8-15.7	14	62	22.80	36.56
		15.8-21.7	21	97	45.18	46.58		15.8-21.7	3	104	16.42	15.81
Coffeen	Spring	Lake	30	90	33.10	36.86	Summer	Lake	31	76	36.18	47.85
		3.9-9.7		--	--	--		3.9-9.7		--	--	--
		9.8-15.7	12	78	26.89	34.62		9.8-15.7	15	67	21.05	31.48
		15.8-21.7	17	101	33.20	32.83		15.8-21.7	13	75	37.70	50.47
Egypt	Spring	Lake	31	81	32.91	40.69	Summer	Lake	28	74	41.89	56.34
		3.9-9.7		--	--	--		3.9-9.7		--	--	--
		9.8-15.7	8	88	22.01	25.00		9.8-15.7	21	63	31.08	49.01
		15.8-21.7	23	78	36.02	45.95		15.8-21.7	7	107	54.79	51.13

Table 9.21. Mean fish health assessment index value, standard deviations and coefficient of variation for Newton Lake, Coffeen Lake, Lake of Egypt, and a pooled sample of five non-power cooling lakes. No differences in FHAI scores occurred among the lakes in the summer of 1999.

Lake	N	FHAI	S.D.	C.V.
Newton	17	70	26.87	38.56
Coffeen	31	76	36.18	47.85
Egypt	28	74	41.89	56.34
Newton Moribund	10	102	23.06	22.54
5 Lakes	23	71	27.17	38.04

Table 9.22. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for channel catfish ranging from 7.9-25.6 inches in the spring and summer of 1998. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	35*	104[a]	68.01	65.34	Summer	Lake	27	27[a]	13.14	49.20
		7.9-13.8	34	104	69.04	66.37		7.9-13.8	22	24	12.46	51.23
		13.9-19.7		--	--	--		13.9-19.7	4	35	11.62	33.64
		19.8-25.6		--	--	--		19.8-25.6		--	--	--
Coffeen	Spring	Lake	30*	58[b]	28.70	49.76	Summer	Lake	25	29[a]	21.86	74.66
		7.9-13.8	9	55	30.12	55.07		7.9-13.8	8	24	20.52	85.08
		13.9-19.7	21	59	28.74	48.74		13.9-19.7	16	33	22.71	68.78
		19.8-25.6		--	--	--		19.8-25.6		--	--	--
Egypt	Spring	Lake	20*	57[b]	27.98	48.78	Summer	Lake	18	36[a]	19.69	54.83
		7.9-13.8		--	--	--		7.9-13.8		--	--	--
		13.9-19.7	9	55	15.78	28.75		13.9-19.7	13	35	18.44	53.32
		19.8-25.6	10	60	37.48	61.95		19.8-25.6	4	43	27.23	64.08

Table 9.23. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for channel catfish ranging from 7.9-25.6 inches in the spring and summer of 1999. No differences in FHAI scores occurred among the lakes within a season and no seasonal differences within a lake occurred.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	35	61	29.52	48.69	Summer	Lake	23	48	24.52	51.28
		7.9-13.8	28	61	29.54	48.78		7.9-13.8	13	48	23.47	48.64
		13.9-19.7	5	73	20.19	27.65		13.9-19.7	8	38	18.84	49.06
		19.8-25.6		--	--	--		19.8-25.6	1	105	--	--
Coffeen	Spring	Lake	30	60	30.10	49.95	Summer	Lake	21	64	32.75	50.83
		7.9-13.8	18	63	31.01	48.93		7.9-13.8	6	61	21.54	35.50
		13.9-19.7	11	56	30.71	54.72		13.9-19.7	14	64	36.97	58.22
		19.8-25.6		--	--	--		19.8-25.6	1	100	--	--
Egypt	Spring	Lake	25	64	26.20	40.86	Summer	Lake	10	48	33.85	70.51
		7.9-13.8		--	--	--		7.9-13.8		--	--	--
		13.9-19.7	10	54	21.00	38.62		13.9-19.7	2	60	56.57	94.28
		19.8-25.6	13	70	24.27	34.58		19.8-25.6	7	47	32.90	69.78

Table 9.24. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for bluegill ranging from 3.9-8.7 inches in the spring and summer of 1998. Values with different superscripts indicate differences among the lakes within a season at the α=0.05 level. No differences in FHAI scores between the seasons occurred in 1998.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	6	66[a]	34.80	52.44	Summer	Lake	30	66[a]	32.31	49.30
		3.9-5.5	2	77	12.02	15.71		3.9-5.5	17	51	18.88	37.06
		5.6-7.1	3	46	38.12	82.33		5.6-7.1	11	82	22.86	27.75
		7.2-8.7	--	--	--			7.2-8.7		--	--	--
Coffeen	Spring	Lake		--	--	--	Summer	Lake	31	103[b]	20.20	19.61
		3.9-5.5		--	--	--		3.9-5.5	16	103	19.25	18.62
		5.6-7.1		--	--	--		5.6-7.1	11	102	23.02	22.50
		7.2-8.7		--	--	--		7.2-8.7		--	--	--
Egypt	Spring	Lake	13	82[a]	44.02	53.84	Summer	Lake	27	61[a]	30.15	49.74
		3.9-5.5		--	--	--		3.9-5.5	--	--	--	
		5.6-7.1	7	89	44.19	49.42		5.6-7.1	12	55	33.81	61.00
		7.2-8.7	6	73	46.16	63.37		7.2-8.7	13	66	26.12	39.62

Table 9.25. Mean fish health assessment index (FHAI) values, standard deviations, and coefficient of variations for bluegill ranging from 3.9-8.7 inches in the spring and summer of 1999. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Lake	Season	Size Range (in.)	N	FHAI	S.D.	C.V.	Season	Size Range (in.)	N	FHAI	S.D.	C.V.
Newton	Spring	Lake	34*	46[a]	27.67	60.69	Summer	Lake	25	89[a]	28.77	32.22
		3.9-5.5	12	45	28.17	61.97		3.9-5.5	12	84	29.17	34.65
		5.6-7.1	21	46	28.75	63.15		5.6-7.1	8	83	31.43	37.91
		7.2-8.7	1	106	--	--		7.2-8.7		--	--	--
Coffeen	Spring	Lake	19	68[b]	29.92	43.98	Summer	Lake	7	63[a,b]	15.15	23.88
		3.9-5.5	11	67	34.97	52.12		3.9-5.5	5	57	13.65	23.77
		5.6-7.1	8	69	23.50	33.89		5.6-7.1	2	78	0.00	0.00
		7.2-8.7		--	--	--		7.2-8.7		--	--	--
Egypt	Spring	Lake	32*	33[a]	17.44	52.39	Summer	Lake	31	58[b]	24.72	42.61
		3.9-5.5	1	24	--	--		3.9-5.5	9	51	24.34	47.34
		5.6-7.1	16	36	19.96	55.66		5.6-7.1	8	52	18.93	36.26
		7.2-8.7	12	34	15.53	45.86		7.2-8.7	8	76	30.24	40.03

Table 9.26. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for largemouth bass ranging from 3.9-9.7 inches in length.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	3.9-9.7	Newton	2	0.046	0.002	2	0.08	0.00	2	1.05	0.07	2	5.07	0.05	2	0.13	0.02
			Coffeen		---	--		---	--		---	--		---	--		---	--
			Egypt		---	--		---	--		---	--		---	--		---	--

Table 9.27. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for largemouth bass ranging from 9.8-15.7 inches in length. Values with different superscripts indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	9.8-15.7	Newton	6	0.037^{a}	0.001	6*	$0.13^{a,b}$	0.02	6	1.03^{a}	0.15	6	6.25^{a}	0.67	6	0.13^{a}	0.02
			Coffeen	6	0.037^{a}	0.001	6	0.09^{b}	0.01	6*	1.24^{a}	0.16	6*	7.84^{a}	1.10	6	0.13^{a}	0.02
			Egypt	16	0.046^{b}	0.001	16*	0.16^{a}	0.01	16*	1.15^{a}	0.12	16*	7.66^{a}	0.67	16*	0.14^{a}	0.01
1998	Summer	9.8-15.7	Newton	20	0.038^{a}	0.001	20	0.08^{a}	0.01	20	$0.79^{a,b}$	0.06	20	5.86^{a}	0.21	20	0.13^{a}	0.01
			Coffeen	19	0.038^{a}	0.001	19	0.11^{b}	0.01	19	0.89^{a}	0.03	19	5.66^{a}	0.25	19	0.14^{a}	0.01
			Egypt	24	0.040^{a}	0.000	24	0.07^{a}	0.00	24	0.57^{b}	0.03	24	4.09^{b}	0.11	24	0.12^{a}	0.01
1999	Spring	9.8-15.7	Newton	8	0.036^{a}	0.001	8*	0.16^{a}	0.02	8*	$1.21^{a,b}$	0.10	8*	$8.08^{a,b}$	0.84	8	0.20^{a}	0.10
			Coffeen	12	0.037^{a}	0.001	12*	0.09^{b}	0.01	12*	1.35^{a}	0.07	12	10.27^{a}	1.14	12	0.12^{a}	0.01
			Egypt	8	0.042^{b}	0.002	8*	$0.13^{a,b}$	0.02	8*	0.98^{b}	0.19	8*	6.08^{b}	0.68	8	0.12^{a}	0.01
1999	Summer	9.8-15.7	Newton	14	0.041^{a}	0.001	14	0.08^{a}	0.01	14	0.90^{b}	0.06	14	5.83^{a}	0.18	14	0.09^{b}	0.01
			Coffeen	15	0.040^{a}	0.000	15	0.06^{a}	0.01	15	0.67^{a}	0.04		--	--	15	0.13^{a}	0.01
			Egypt	22	0.040^{a}	0.08	22	0.08^{a}	0.000	22	0.63^{a}	0.03	22	4.53^{b}	0.14	22	0.13^{a}	0.01

Table 9.28. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for largemouth bass ranging from 15.8-21.7 inches in length. Values with different superscripts indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	15.8-21.7	Newton	27	0.036^{a}	0.001	27	0.16^{a}	0.01	27*	1.11^{a}	0.05	27*	8.72^{a}	0.70	27	0.11^{a}	0.01
			Coffeen	20	0.036^{a}	0.001	21	0.09^{b}	0.00	21*	1.37^{b}	0.07	21*	8.90^{a}	0.89	21	0.14^{b}	0.01
			Egypt	14	0.035^{a}	0.001	14*	0.15^{a}	0.02	14*	1.07^{a}	0.12	14*	8.97^{a}	0.96	14	0.14^{b}	0.01
	Summer	15.8-21.7	Newton	8	0.036^{a}	0.000	8	0.17^{a}	0.02	8	0.74^{a}	0.04	8	4.97^{a}	0.28	8	0.11^{a}	0.01
			Coffeen	9	0.036^{a}	0.000	9	0.08^{b}	0.01	9	0.81^{a}	0.05	9	5.53^{a}	0.24	9	0.16^{a}	0.02
			Egypt	5	0.037^{a}	0.000	5	0.08^{b}	0.02	5	0.61^{a}	0.11	5	5.14^{a}	0.29	5	0.14^{a}	0.01
1999	Spring	15.8-21.7	Newton	16	0.036^{a}	0.000	16	0.21^{a}	0.02	16*	1.17^{a}	0.08	16	8.21^{a}	0.79	16	0.11^{a}	0.01
			Coffeen	16	0.036^{a}	0.000	16*	0.10^{b}	0.01	16*	1.38^{a}	0.11	17	10.04^{a}	1.17	16	0.14^{b}	0.01
			Egypt	22	0.038^{b}	0.001	23*	0.15^{c}	0.02	23*	1.09^{a}	0.06	23*	8.68^{a}	0.53	23	0.11^{a}	0.01
	Summer	15.8-21.7	Newton	3	0.035^{a}	0.001	3	0.12^{a}	0.03	3	0.72^{a}	0.06	3	5.74^{a}	0.30	3	0.11^{a}	0.01
			Coffeen	12	0.038^{a}	0.001	12	0.07^{a}	0.01	12	0.71^{a}	0.09		--		12	0.15^{a}	0.01
			Egypt	8	0.040^{a}	0.001	8	0.08^{a}	0.01	8	0.51^{a}	0.04	8	4.32^{a}	0.45	8	0.13^{a}	0.01

Table 9.29. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for channel catfish ranging from 7.9-13.8 inches in length. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	7.9-13.8	Newton	32	0.041[a]	0.001	32*	0.16[a]	0.02	32*	1.16[a]	0.06	32	9.19[a]	0.44	32	0.10[a]	0.00
			Coffeen	7	0.035[b]	0.001	7	0.14[a]	0.02	7*	1.38[a]	0.14	8	10.75[a]	2.35	8	0.11[a]	0.02
			Egypt		--	--		--	--		--	--		--	--		--	--
1998	Summer	7.9-13.8	Newton	24	0.038[a]	0.000	24	0.07[a]	0.00	24	0.89[a]	0.06	23	9.21[a]	3.56	24	0.10[a]	0.01
			Coffeen	9	0.036[a]	0.002	9	0.10[b]	0.02	9	0.88[a]	0.06	9	7.38[a]	0.86	9	0.09[a]	0.01
			Egypt	1	0.039[a]	--		--	--	1	0.66[a]	--		--	--	1	0.13[a]	--
1999	Spring	7.9-13.8	Newton	30	0.035[a]	0.001	30*	0.15[a]	0.01	30	1.21[a]	0.06	30*	10.7[a]	0.52	30	0.11[a]	0.00
			Coffeen	18	0.036[a]	0.001	18*	0.13[a]	0.01	18*	0.77[b]	0.06	18	5.83[b]	0.67	18	0.10[a]	0.01
			Egypt		--	--		--	--		--	--		--	--		--	--
1999	Summer	7.9-13.8	Newton	12	0.034[a]	0.000	11	0.08[a]	0.01	12	1.19[a]	0.10	12	5.38	0.31	12	0.10[a]	0.01
			Coffeen	6	0.033[a]	0.001	6	0.08[a]	0.01	6	2.12[b]	0.26		--	--	6	0.10[a]	0.00
			Egypt		--	--		--	--		--	--		--	--		--	--

Table 9.30. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for channel catfish ranging from 13.9-19.7 inches in length. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	13.9-19.7	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen	20	0.032[a]	0.000	20*	0.15[a]	0.01	20*	1.31[a]	0.07	19	9.07[a]	0.51	18	0.11[a]	0.01
			Egypt	7	0.028[a]	0.000	8*	0.19[a]	0.03	8*	1.34[a]	0.16	7*	11.25[a]	1.56	8	0.09[a]	0.01
1998	Summer	13.9-19.7	Newton	4	0.030[a,b]	0.26	4	0.08[a]	0.01	4	1.02[a]	0.06	4	7.51[a]	0.96	4	0.10[a,b]	0.01
			Coffeen	18	0.031[a]	0.001	18	0.11[a]	0.01	18	1.03[a]	0.11	18	8.08[a]	0.53	18	0.10[a]	0.01
			Egypt	13	0.027[b]	0.000	13	0.11[a]	0.01	13	0.78[a]	0.09	13	7.79[a]	0.51	13	0.08[b]	0.00
1999	Spring	13.9-19.7	Newton	5	0.030[a]	0.001	5	0.13[a]	0.01	5	1.04[a]	0.12	5*	8.99[a]	1.43	5	0.10[a]	0.00
			Coffeen	11	0.031[a]	0.001	11*	0.17[a]	0.02	11*	1.24[a]	0.09	11	10.20[a]	0.57	11	0.10[a]	0.01
			Egypt	9	0.028[a]	0.002	9	0.19[a]	0.02	9	1.48[a]	0.11	9	11.49[a]	1.62	8	0.08[a]	0.01
1999	Summer	13.9-19.7	Newton	8	0.028[a]	0.001	8	0.11[a,b]	0.01	8	1.33[a]	0.31	8	5.79[a]	0.51	8	0.11[a]	0.01
			Coffeen	10	0.029[a]	0.001	10	0.08[b]	0.01	10	3.26[b]	0.13		--	--	10	0.12[a]	0.01
			Egypt	2	0.028[a]	0.001	2	0.17[a]	0.05	1	0.85[a]	--	2	8.18[a]	0.13	2	0.10[a]	0.00

Table 9.31. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for channel catfish ranging from 19.8-25.6 inches in length. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	19.8-25.6	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	9	0.027	0.001	9	0.15	0.01	10	1.11	0.15	9	8.95	1.92	9	0.10	0.01
1998	Summer	19.8-25.6	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen	1	0.021^{a}	--	1	0.17^{a}	--	1	0.93^{a}	--	1	9.74^{a}	--	1	0.13^{a}	--
			Egypt	4	0.025^{b}	0.000	4*	0.11^{b}	0.01	4	0.98^{a}	0.06	4	7.82^{a}	0.37	4	0.12^{a}	0.02
1999	Spring	19.8-25.6	Newton		--	--	--	--		--	--		--	--		--	--	
			Coffeen		--	--	--	--		--	--		--	--		--	--	
			Egypt	9	0.027	0.001	9*	0.15	0.02	10*	1.11	0.11	9*	8.95	1.08	9	0.10	0.01
1999	Summer	19.8-25.6	Newton	1	0.024^{a}	--	1	0.07^{a}	--	1	1.28^{a,b}	--	1	6.55^{a}	--	1	0.10^{a}	--
			Coffeen	1	0.028^{a}	--	1	0.09^{a}	--	1	2.13^{a}	--		--	--	1	0.08^{a}	--
			Egypt	7	0.026^{a}	0.001	7	0.13^{a}	0.01	7	0.95^{b}	0.08	7	6.49^{a}	0.64	7	0.10^{a}	0.01

Table 9.32. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for bluegill ranging from 3.9-5.5 inches in length. Values with different superscripts indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	3.9-5.5	Newton	3	0.072	0.002	3*	0.04	0.01	3*	7.20	6.79	3	3.95	0.63	3	0.11	0.02
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt		--	--		--	--		--	--		--	--		--	--
1998	Summer	3.9-5.5	Newton	16	0.077[a]	0.002	14	0.01[a]	0.00	16	0.80[a]	0.06	16	5.41[a]	0.44	13	0.20[a]	0.04
			Coffeen	16	0.077[a]	0.001	16	0.04[b]	0.01	16	0.87[a]	0.10	16	4.47[a]	0.27	16	0.25[a]	0.04
			Egypt		--	--		--	--		--	--		--	--		--	--
1999	Spring	3.9-5.5	Newton	9	0.075[a]	0.001	8*	0.07[a]	0.02	8	0.55[a]	0.10	8*	3.64[a]	0.31	10	0.15[a]	0.02
			Coffeen	11	0.075[a]	0.001	7*	0.05[a]	0.01	11*	0.95[b]	0.11	11*	4.75[a]	0.49	11	0.16[a]	0.02
			Egypt	1	0.078[a]		1	0.07[a]		1	0.65[a,b]		1	4.80[a]		1	0.09[a]	
1999	Summer	3.9-5.5	Newton	10	0.074[a]	0.002	12	0.01[a]	0.01	12	0.74[a]	0.07	12	6.50[a]	0.59	12	0.15[a]	0.02
			Coffeen	5	0.078[a]	0.002	5	0.02[a]	0.01	5	1.68[b]	0.29	5	7.54[a]	0.58	5	0.20[a]	0.04
			Egypt	8	0.070[a]	0.001	8	0.03[a]	0.01	8	0.44[c]	0.05	7	5.05[a]	0.45	8	0.08[b]	0.01

Table 9.33. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for bluegill ranging from 5.6-7.1 inches in length. Values with different superscripts indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons for individual lakes at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	5.6-7.1	Newton	5	0.069^{a}	0.001	5	0.03^{a}	0.02	5	0.48^{a}	0.13	3	3.19^{a}	0.10	5*	0.06^{a}	0.03
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	14	0.070^{a}	0.002	13	0.09^{a}	0.02	13	0.55^{a}	0.06	13	4.09^{b}	0.19	13	0.11^{b}	0.01
1998	Summer	5.6-7.1	Newton	9	0.071^{a}	0.001	8	0.02^{a}	0.01	9	0.64^{a,b}	0.06	12	3.14^{a}	0.44	9	0.17^{a}	0.02
			Coffeen	11	0.072^{a}	0.002	11	0.03^{a}	0.01	11	0.81^{a}	0.07	11	4.87^{b}	0.50	11	0.20^{a}	0.03
			Egypt	15	0.068^{a}	0.001	15	0.06^{a}	0.01	14	0.51^{b}	0.07	14	4.11^{a,b}	0.42	14	0.09^{b}	0.01
1999	Spring	5.6-7.1	Newton	21	0.068^{a}	0.001	20	0.08^{a}	0.01	20	0.60^{a}	0.05	21*	3.67^{a}	0.23	21	0.11^{a}	0.01
			Coffeen	8	0.070^{a}	0.001	8*	0.07^{a}	0.01	8*	0.67^{a}	0.10	8*	4.14^{a,b}	0.53	8	0.13^{a}	0.01
			Egypt	16	0.067^{a}	0.001	15*	0.09^{a}	0.01	16	0.54^{a}	0.03	16	4.85^{b}	0.15	16*	0.10^{a}	0.00
1999	Summer	5.6-7.1	Newton	8	0.070^{a}	0.002	8	0.03^{a}	0.01	8	0.70^{a}	0.04	8	4.88^{a}	0.49	8	0.14^{a,b}	0.03
			Coffeen	2	0.069^{a}	0.000	2	0.03^{a}	0.00	2	2.64^{b}	0.09	2	7.61^{a}	0.75	2	0.21^{a}	0.04
			Egypt	7	0.067^{a}	0.001	7	0.05^{a}	0.01	7	0.44^{c}	0.09	8	4.27^{a}	0.71	7	0.08^{b}	0.01

Table 9.34. Mean eye diameter (eye diameter in./total length of fish in.), spleenosomatic index (SSI, wt of spleen/wt of fish), liver somatic index (LSI, wt of liver/wt of fish), visceral somatic index (VSI, wt of the viscera-stomach contents/wt of the fish), and relative heart weight (HRT, wt of the heart/wt of the fish) for bluegill ranging from 7.2-8.7 inches in length. Values with different superscripts indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons for individual lakes at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	Eye Diameter (inches)	S.E.	N	SSI	S.E.	N	LSI	S.E.	N	VSI	S.E.	N	HRT	S.E.
1998	Spring	7.2-8.7	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	9	0.059	0.001	11*	0.15	0.02	11	0.48	0.06	11	3.79	0.23	11	0.10	0.01
1998	Summer	7.2-8.7	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	14	0.062	0.001	14	0.06	0.01	14	0.54	0.05	14	3.23	0.17	14	0.09	0.00
1999	Spring	7.2-8.7	Newton		--	--		--	--		--	--		--	--		--	--
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	12	0.061	0.001	11*	0.13	0.02	12	0.42	0.03	12	3.51	0.16	12*	0.08	0.01
1999	Summer	7.2-8.7	Newton	1	0.061	--	1	0.06	--	1	0.56	--	1	3.48	--	1	0.05	--
			Coffeen		--	--		--	--		--	--		--	--		--	--
			Egypt	8	0.061	0.001	7	0.06	0.01	8	0.46	0.03	8	4.22	0.56	8	0.11	0.01

Table 9.35. Mean condition factor (C) and relative weight for largemouth bass ranging from 3.9-9.7 inches in the spring of 1998. Fish of this size were not collected at any other time.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	3.9-9.7	Newton	2	4.73	0.16	2	97	2.30
			Coffeen		---	--		---	--
			Egypt		---	--		---	--

Table 9.36. Mean condition factor (C) and relative weight for largemouth bass ranging from 9.8-15.7 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	9.8-15.7	Newton	6	5.07[a]	0.18	6	96[a]	2.5
			Coffeen	8	5.48[a]	0.20	8	101[a]	3.63
			Egypt	16*	4.86[a]	0.17	16*	90[a]	3.12
1998	Summer	9.8-15.7	Newton	20	4.93[a]	0.18	20	95[a]	3.55
			Coffeen	19	5.17[a]	0.09	19	97[a]	1.57
			Egypt	25	4.35[b]	0.10	25	82[a]	1.85
1999	Spring	9.8-15.7	Newton	11	5.68[a]	0.15	11	106[a]	2.82
			Coffeen	12	5.45[a]	0.18	12	102[a]	3.03
			Egypt	8	5.34[a]	1.02	8	101[a]	20.92
1999	Summer	9.8-15.7	Newton	14	5.53[a]	0.19	14	105[a]	3.56
			Coffeen	15	5.26[a]	0.10	15	98[a]	1.89
			Egypt	22	4.41[b]	0.08	22	83[b]	1.58

Table 9.37. Mean condition factor (C) and relative weight for largemouth bass ranging from 15.8-21.7 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	15.8-21.7	Newton	28*	6.13^{a}	0.09	28*	109^{a}	1.49
			Coffeen	22*	5.81^{a}	0.11	22*	104^{a}	2.01
			Egypt	14	4.91^{b}	0.25	14	88^{b}	4.31
1998	Summer	15.8-21.7	Newton	8	5.57^{a}	0.09	8	99^{a}	1.49
			Coffeen	9	4.95^{b}	0.17	9	89^{b}	2.96
			Egypt	5	4.74^{b}	0.19	5	85^{b}	3.2
1999	Spring	15.8-21.7	Newton	21	6.13a	0.13	21	109^{a}	2.22
			Coffeen	17*	6.32^{a}	0.14	17*	113^{a}	2.46
			Egypt	23*	5.45^{b}	0.18	23*	97^{b}	3.11
1999	Summer	15.8-21.7	Newton	3	5.70^{a}	0.10	3	101^{a}	2.34
			Coffeen	13	5.09^{a}	0.07	13	92^{a}	1.37
			Egypt	8	4.24^{b}	0.25	8	76^{b}	4.54

Table 9.38. Mean condition factor (C) and relative weight for channel catfish ranging from 7.9-13.8 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	7.9-13.8	Newton	35	2.67[a]	0.24	35	92[a]	8.68
			Coffeen	9	2.84[a]	0.13	9	90[a]	4.06
			Egypt		--	--		--	--
1998	Summer	7.9-13.8	Newton	24	2.67[a]	0.16	24	93[a]	5.16
			Coffeen	10	3.83[a]	0.85	10	129[a]	31.61
			Egypt	1	2.78[a]	--	1	99[a]	--
1999	Spring	7.9-13.8	Newton	30	2.52[a]	0.04	30	83[a]	1.40
			Coffeen	18*	2.45[a]	0.09	18*	81[a]	3.40
			Egypt		--	--		--	--
1999	Summer	7.9-13.8	Newton	13	2.52[a]	0.04	13	82[a]	1.81
			Coffeen	6	3.17[a]	0.19	6	102[b]	6.78
			Egypt		--	--		--	--

Table 9.39. Mean condition factor (C) and relative weight for channel catfish ranging from 13.9-19.7 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	13.9-19.7	Newton		--	--		--	--
			Coffeen	21	2.92[a]	0.08	21	87[a]	2.35
			Egypt	9	3.35[b]	0.11	9	95[b]	3.36
1998	Summer	13.9-19.7	Newton	4	2.63[a]	0.26	4	80[a]	7.33
			Coffeen	18	2.73[a]	0.09	18	82[a]	2.78
			Egypt	13	3.33[b]	0.09	13	96[b]	2.69
1999	Spring	13.9-19.7	Newton	5	2.89[a]	0.19	5	87[a]	5.49
			Coffeen	11*	2.54[a]	0.09	11*	77[a]	2.5
			Egypt	10	4.23[a]	0.81	10	122[a]	25.33
1999	Summer	13.9-19.7	Newton	8	2.61[b]	0.08	8	78[a]	2.17
			Coffeen	14	3.15[a]	0.10	14	94[b]	3.15
			Egypt	2	3.40[a]	0.30	2	98[a,b]	6.66

Table 9.40. Mean condition factor (C) and relative weight for channel catfish ranging from 19.8-25.6 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	19.8-25.6	Newton		--	--		--	--
			Coffeen		--	--		--	--
			Egypt	10	3.9	0.24	10	106	6.2
1998	Summer	19.8-25.6	Newton		--	--		--	--
			Coffeen	1	1.31^{a}	--		--	--
			Egypt	4	3.13^{b}	0.14	4	86	3.62
1999	Spring	19.8-25.6	Newton		--	--		--	--
			Coffeen		--	--		--	--
			Egypt	10	3.9	0.14	13	97	3.69
1999	Summer	19.8-25.6	Newton	1	3.70^{a}	--	1	101^{a}	--
			Coffeen	1	3.45^{a}	--	1	95^{a}	--
			Egypt	7	3.46^{a}	0.20	7	94^{a}	5.45

Table 9.41. Mean condition factor (C) and relative weight for bluegill ranging from 3.9-5.5 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	3.9-5.5	Newton	7	6.06	0.22	7	84	3.06
			Coffeen		--	--		--	--
			Egypt		--	--		--	--
1998	Summer	3.9-5.5	Newton	17	6.12[a]	0.17	17	87[a]	2.40
			Coffeen	17	6.32[a]	0.15	17	89[a]	2.30
			Egypt		--	--		--	--
1999	Spring	3.9-5.5	Newton	12*	5.55[a]	0.16	12*	78[a]	2.33
			Coffeen	11	5.65[a]	0.18	11*	79[a]	2.72
			Egypt	1	6.32[a]	--	1	87[a]	--
1999	Summer	3.9-5.5	Newton	12	6.42[a]	0.16	12	91[a]	2.04
			Coffeen	5	6.41[a]	0.37	5	91[a]	5.31
			Egypt	9	6.01[a]	0.16	9	85[a]	2.64

Table 9.42. Mean condition factor (C) and relative weight for bluegill ranging from 5.6-7.1 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	5.6-7.1	Newton	11	6.17[a]	0.10	11	83[a]	1.26
			Coffeen		--	--		--	--
			Egypt	17	6.04[a]	0.19	17*	79[a]	2.38
1998	Summer	5.6-7.1	Newton	12	5.99[a]	0.23	12	80[a]	3.2
			Coffeen	11	6.40[a]	0.26	11	86[a]	3.61
			Egypt	15	6.42[a]	0.15	15	86[a]	1.91
1999	Spring	5.6-7.1	Newton	21	5.79[a]	0.14	21*	77[a]	1.78
			Coffeen	8*	5.81[a]	0.19	8*	78[a]	2.53
			Egypt	16	6.15[a]	0.11	16	80[a]	1.28
1999	Summer	5.6-7.1	Newton	8	6.33[a]	0.26	8	84[a]	3.27
			Coffeen	2	7.19[a]	0.01	2	96[a]	0.93
			Egypt	8	6.21[a]	0.08	8	82[a]	0.9

Table 9.43. Mean condition factor (C) and relative weight for bluegill ranging from 7.2-8.7 inches in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level. Asterisks indicate differences between seasons within a lake for an individual variable at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	C	S.E.	N	RW	S.E.
1998	Spring	7.2-8.7	Newton		--	--		--	--
			Coffeen		--	--		--	--
			Egypt	12	7.17	0.22	12	89	2.79
1998	Summer	7.2-8.7	Newton		--	--		--	--
			Coffeen		--	--		--	--
			Egypt	14	6.52	0.23	12	89	2.79
1999	Spring	7.2-8.7	Newton		--	--		--	--
			Coffeen		--	--		--	--
			Egypt	12	6.84	0.18	12*	89	2.79
1999	Summer	7.2-8.7	Newton	1	7.28	--	1	91	--
			Coffeen		--	--		--	--
			Egypt	8	6.13	0.28	8	76	3.31

Chapter 9. Appendix: Supplemental Data Tables.

Appendix 9.1. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for largemouth bass in the spring and summer of 1998 and 1999, by segment, in Newton Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
Spring	1	10	36[a]	1.43	12	0.90[a]	0.17	8	6.83[a]	0.49	12	361[a]	34.30
	2	8	35[a]	1.82	8	0.28[a,b]	0.07	6	6.26[a]	0.22	6	344[a]	22.68
	3	8	40[a]	2.45	8	0.25[b]	0.11	8	7.08[a]	0.40	8	353[a]	23.42
	4	8	36[a]	1.87	8	0.63[a,b]	0.17	8	6.36[a]	0.32	8	319[a]	2.18
Summer	1		--	--		--	--		--	--		--	--
	2	2	37[a]	1.75	2	0.00[a]	0.00	2	5.25[a]	0.05	2	324[a]	11.25
	3	5	40[a]	1.87	5	0.00[a]	0.00	2	5.45[a]	0.75	4	315[a]	12.64
	4	13	38[a]	1.24	13	0.00[a]	0.00	12	5.38[a]	0.29	13	325[a]	3.40
Spring	1	7	40[a]	3.04	7	0.10[a]	0.07	6	6.90[a]	0.45	7	317[a]	2.37
	2	6	35[a]	2.02	6	0.43[a]	0.12	6	6.35[a]	0.34	5	314[a]	2.53
	3	6	39[a]	1.56	6	0.42[a]	0.20	4	6.61[a]	0.39	4	317[a]	7.44
	4	6	35[a]	2.5	6	0.58[a]	0.14	5	7.34[a]	0.33	5	313	4.95
Summer	1		--	--		--	--		--	--		--	--
	2		--	--		--	--		--	--		--	--
	3		--	--		--	--		--	--		--	--
	4	17	42	1.2	17	0.00	0.00	11	5.69	0.28	17	318	5.58

Appendix 9.2. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for largemouth bass in the spring and summer of 1998 and 1999, by segment, in Coffeen Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	15	37[a]	1.00	15	0.02[a]	0.02	12	7.02[a]	0.3	14	325[a]	4.12
		2	15	35[a]	1.03	15	0.17[b]	0.07	10	6.91[a]	0.28	14	320[a]	2.36
	Summer	1	15	38[a]	1.18	15	0.00[a]	0.00	14	5.43[a]	0.15	14	317[a]	3.23
		2	5	43[a]	1.6	5	0.00[a]	0.00	4	5.48[a]	0.58	5	332[b]	3.41
1999	Spring	1	10	32[a]	1.34	10	0.35[a]	0.15	10	6.81[a]	0.28	10	326[a]	1.79
		2	10	31[a]	1.22	10	0.03[b]	0.02	9	6.25[a]	0.25	9	329[a]	2.68
	Summer	1		--	--		--	--		--	--		--	--
		2	27	43	0.81	27	0.00	0.00	25	6.53	0.13	25	323	4.2

Appendix 9.3. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for largemouth bass in the spring and summer of 1998 and 1999, by segment, in Lake of Egypt. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	15	33[a]	0.96	15	1.30[a]	0.31	13	6.09[a]	0.31	15	314[a]	2.54
		2	16	33[a]	0.87	16	0.56[a]	0.11	13	6.05[a]	0.25	8	311[a]	2.92
	Summer	1	25	37[a]	0.61	25	0.00[a]	0.00	21	5.63[a]	0.16	22	324[a]	1.93
		2	3	38[a]	2.01	3	0.00[a]	0.00	2	6.25[a]	0.45	2	325[a]	11.25
1999	Spring	1	11	30[a]	0.45	11	0.20[a]	0.07	11	5.89[a]	0.09	11	315[a]	2.87
		2	12	29[a]	1.19	12	0.14[a]	0.07	8	5.39[a]	0.25	11	317[a]	4.18
	Summer	1	15	37[a]	1.33	15	0.02[a]	0.02	15	5.76[a]	0.19	15	325[a]	5.62
		2	7	38[a]	0.66	7	0.00[a]	0.00	7	5.66[a]	0.17	8	305[a]	10.16

Appendix 9.4. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for channel catfish in the spring and summer of 1998 and 1999, by segment, in Newton Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
Spring	1	9	21[a]	2.32	9	1.67[a]	0.50	1	3.40[a]	--	5	277[a]	6.67
	2	11	28[a]	1.48	11	0.77[a,b]	0.15	5	3.29[a]	0.18	7	313[a]	35.05
	3	10	25[a]	1.4	10	0.28[b]	0.16	3	2.95[a]	0.49	10	272[a]	2.55
	4	1	27[a]	--	1	0.30[a,b]	--		--	--	1	266[a]	--
Summer	1		--	--		--	--		--	--		--	--
	2	20	30	1.6	20	0.50	0.08	14	4.20	0.18	15	287	3.13
	3		--	--		--	--		--	--		--	--
	4		--	--		--	--		--	--		--	--
Spring	1	7	29[a]	1.68	7	1.24[a]	0.10	7	4.27[a]	0.36	6	273[a]	5.25
	2	6	27[a]	1.15	6	0.56[a,b]	0.17	3	3.85[a]	0.37	7	267[a]	4.04
	3	7	29[a]	1.28	7	0.43[b]	0.21	3	3.85[a]	0.25	6	263[a]	3.86
	4	6	24[a]	3.23	6	1.00[a,b]	0.25	4	4.13[a]	0.11	6	269[a]	4.05
Summer	1	1	35[a]	--	1	0.33	--		--	--	1	284[a]	--
	2	11	30[a]	1.32	11	0.58[a]	0.08	2	4.58	0.98	10	277[a]	5.44
	3		--	--		--	--		--	--		--	--
	4	5	29[a]	1.06	5	1.07[b]	0.15	3	4.65	0.53	5	290[a]	3.28

Appendix 9.5. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for channel catfish in the spring and summer of 1998 and 1999, by segment, in Coffeen Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the α=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	15	34[a]	2.26	15	0.02[a]	0.02	15	4.41[a]	0.26	14	280[a]	2.93
		2	15	32[a]	1.18	15	1.18[b]	0.15	10	4.32[a]	0.27	13	275[a]	4.91
	Summer	1	20	39	1.39	20	0.48	0.06	12	4.40	0.14	17	276	1.99
		2		--	--		--	--		--	--		--	--
1999	Spring	1	9	25[a]	2.53	10	0.94[a]	0.14	8	3.31[a]	0.38	9	278[a]	3.70
		2	10	30[a]	1.58	10	0.67[a]	0.11	9	3.74[a]	0.13	10	262[b]	2.42
	Summer	1		--	--		--	--		--	--		--	--
		2	21	31	1.18	21	0.57	0.06	20	6.06	0.25	20	286	3.52

Appendix 9.6. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for channel catfish in the spring and summer of 1998 and 1999, by segment, in Lake of Egypt. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	20	31	1.53	20	1.02	0.05	17	5.99	0.42	11	277	2.66
		2		--	--		--	--					--	--
	Summer	1	18	34	0.97	18	0.56	0.10	13	4.47	0.18	14	282	2.47
		2		--	--		--	--					--	--
1999	Spring	1	11	32[a]	2.86	11	0.42[a]	0.10	9	5.53[a]	0.18	10	271[a]	3.90
		2	10	28[a]	2.35	10	0.73[a]	0.12	9	5.01[a]	0.45	9	281[a]	6.70
	Summer	1	10	36	2.48	10	1.07	0.15	10	4.62	0.36	10	287	4.23
		2		--	--		--	--		--	--		--	--

Appendix 9.7. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for bluegill in the spring and summer of 1998 and 1999, by segment, in Newton Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the α=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	3	36^{a}	3.93	3	0.67^{a}	0.67		--	--	3	289^{a}	6.37
		2		--	--		--	--		--	--		--	--
		3		--	--		--	--		--	--		--	--
		4	2	38^{a}	1.17	2	1.32^{a}	0.02		--	--	2	267^{a}	9.25
	Summer	1	7	33^{a}	2.36	7	0.00^{a}	--		--		4	290^{a}	4.71
		2	3	34^{a}	0.56	3	0.00^{a}	--	2	5.75	0.65	2	292^{a}	16.25
		3		--	--		--	--		--	--		--	--
		4		--	--		--	--		--	--		--	--
1999	Spring	1	3	33^{a}	0.51	3	0.17^{a}	0.17	2	5.75^{a}	0.45	2	284^{a}	6.5
		2	5	32^{a}	2.23	5	0.20^{a}	0.10		--	--	5	295^{a}	3.57
		3	3	32^{a}	3.86	3	0.00^{a}	0.00	2	5.60^{a}	0.20	2	297^{a}	7.25
		4	4	29^{a}	4.86	4	0.00^{a}	0.00	2	4.65^{a}	0.05	4	277^{a}	5.52
	Summer	1		--	--		--	--		--	--		--	--
		2		--	--		--	--		--	--		--	--
		3		--	--		--	--		--	--		--	--
		4	14	32	0.87	14	0.64	0.09		--		14	297	5.13

Appendix 9.8. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for bluegill in the spring and summer of 1998 and 1999, by segment, in Coffeen Lake. Values with different superscripts indicate differences among segments within a season for individual variables at the ∝=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1		--	--		--	--		--	--		--	--
		2		--	--		--	--		--	--		--	--
	Summer	1		--	--		--	--		--	--		--	--
		2	9	40	2.24	9	0.00	0.00	6	4.58	0.92	8	301	4.77
1999	Spring	1		--	--		--	--		--	--		--	--
		2	16	34	1.18	16	0.23	0.08	5	4.14	0.47	15	272	19.3
	Summer	1		--	--		--	--		--	--		--	--
		2	4	34	2.18	4	0.25	0.13	1	5.6	--	4	301	12.3

Appendix 9.9. Mean hematocrit, leucocrit, plasma proteins, plasma osmolality, and standard errors for bluegill in the spring and summer of 1998 and 1999, by segment, in Lake of Egypt. Values with different superscripts indicate differences among segments within a season for individual variables at the α=0.05 level.

Year	Season	Segment	N	Hematocrit (%)	S.E.	N	Leucocrit (%)	S.E.	N	Plasma Proteins (g/100ml)	S.E.	N	Osmolality (mmol/kg)	S.E.
1998	Spring	1	7	28^{a}	1.92	7	0.78^{a}	0.21	1	5.95^{a}	--	7	300^{a}	2.58
		2	6	33^{a}	2.85	6	0.75^{a}	0.11	2	5.05^{a}	0.8	3	290^{a}	13.36
	Summer	1	10	38	1.74	10	0.00	0.00	9	5.24	0.28	10	291	5.94
		2		--	--		--	--		--	--		--	--
1999	Spring	1	5	25^{a}	2.11	5	0.30^{a}	0.10	5	5.34^{a}	0.11	5	301^{a}	8.86
		2	5	32^{b}	1.51	5	0.00^{b}	0.00	2	5.80^{a}	0.60	5	266^{b}	6.4
	Summer	1	17	38^{a}	1.12	17	0.10^{a}	0.05	5	4.91^{a}	0.77	13	303^{a}	4.59
		2	5	36^{a}	1.25	5	0.00^{a}	0.00	3	4.83^{a}	0.34	3	295^{a}	3.77

Appendix 9.10. Mean hematocrit, leucocrit, and plasma proteins for Newton Lake, Coffeen Lake, Lake of Egypt, and five non-power cooling lakes in the summer of 1999.

Lake	N	Hematocrit (%)	N	Leucocrit (%)	N	Plasma Proteins (g/100ml)
Newton	17	42	17	0.00	11	5.69
Coffeen	27	43	27	0.00	25	6.53
Egypt	22	37	22	0.02	22	5.73
Newton Moribound	10	41	10	0.92	6	6.78
Sam Dale	5	41	5	0.20	5	6.31
East Fork	5	37	5	0.93	5	6.07
Rend	5	42	5	0.07	5	6.39
Kinkaid	5	38	5	0.00	4	5.68
Cedar	5	34	5	1.13	4	5.53

Appendix 9.11. Mean differential blood cell counts and standard errors for largemouth bass (summer 1999) in Newton Lake, Coffeen Lake, Lake of Egypt, and five non-power cooling lakes. LYM =lymphocytes, HET = heterophils, NEUT = neutrophils, THROM = thrombocytes, BASO = basophils, ESO = esonophils, MONO = monocytes, Unkown = unidentifiable white blood cell types.

Year	Season	Lake	N	%LYM	S.E.	%HET	S.E.	%NEUT	S.E.	%THROM	S.E.	%BASO	S.E.	%ESO	S.E.	%MONO	S.E.	Unknown	S.E.
1999	Summer	Newton	16	54.09	2.69	0.53	0.19	2.56	0.47	40.84	2.64	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.55
		Coffeen	25	54.32	3.54	2.06	0.89	4.66	1.63	35.28	2.80	0.02	0.02	0.00	0.00	0.02	0.02	3.64	1.10
		Egypt	20	48.00	3.81	0.55	0.29	4.00	1.00	40.58	2.85	0.05	0.05	0.00	0.00	0.63	0.63	6.20	1.10
		Newton Moribund	9.00	19.94	2.96	5.89	3.22	13.11	2.89	52.00	3.39	0.00	0.00	0.00	0.00	0.06	0.06	9.00	1.93
		Sam Dale	4.00	54.75	3.27	1.00	0.29	5.38	1.20	32.50	4.68	0.00	0.00	0.00	0.00	0.00	0.00	6.38	3.16
		East Fork	5.00	61.10	2.83	0.40	0.19	2.40	0.86	30.60	4.58	0.00	0.00	0.00	0.00	0.00	0.00	5.50	2.25
		Rend	5.00	48.30	6.24	2.40	1.37	18.30	7.19	25.40	3.57	0.00	0.00	0.00	0.00	0.20	0.20	5.40	2.00
		Kinkaid	3.00	44.17	12.66	0.17	0.17	3.67	1.76	47.17	12.37	0.00	0.00	0.00	0.00	0.33	0.33	4.50	1.26
		Cedar	3.00	65.33	5.09	0.33	0.33	1.17	0.67	30.83	5.83	0.00	0.00	0.00	0.00	0.00	0.00	2.33	1.33

Appendix 9.12. Mean blood glucose concentrations (mg/dL) and standard errors by segment for largemouth bass in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the ∝=0.05 level.

Year	Lake	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.
1998	Newton	Spring	1	9	120[a]	15.14	Summer	1		--	--
			2	8	61[b,c]	7.89		2	2	110[a]	14.75
			3	7	64[c]	9.17		3	2	181[a]	26.5
			4	8	80[a,b,c]	11.87		4	12	184[a]	22.51
1999	Newton	Spring	1	7	102[a]	9.65	Summer	1		--	--
			2	6	72[a,b,c]	6.13		2		--	--
			3	6	63[b,c]	7.43		3		--	--
			4	4	49[c]	7.61		4	12	226	31.94
1998	Coffeen	Spring	1	15	253[a]	16.97	Summer	1	12	201[a]	27.96
			2	14	178[b]	20.21		2	3	263[a]	47.2
1999	Coffeen	Spring	1	10	101[a]	7.78	Summer	1		--	--
			2	10	128[a]	11.93		2	17	102	10.25
1998	Egypt	Spring	1	11	86[a]	11.17	Summer	1	12	135[a]	15.12
			2	12	108[a]	7.38		2	1	158[a]	--
1999	Egypt	Spring	1	11	54[a]	5.76	Summer	1	15	112[a]	11.83
			2	11	68[a]	7.26		2	6	89[a]	16.55

Appendix 9.13. Mean blood glucose concentrations (mg/dL) and standard errors by segment for channel catfish in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the α=0.05 level.

Lake	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.
Newton	Spring	1	7	40^{a,b}	6.99	Summer	1		--	--
		2	8	48^{b}	10.23		2	9	112	17.79
		3	7	16^{a}	3.00		3		--	--
		4	1	60^{a,b}	--		4		--	--
Newton	Spring	1	6	37^{a}	4.25	Summer	1	1	47^{a}	--
		2	4	32^{a}	5.54		2	10	74^{a}	4.58
		3	4	58^{b}	5.92		3		--	--
		4	6	29^{a}	4.29		4	5	68^{a}	12.61
Coffeen	Spring	1	12	87^{a}	10.33	Summer	1	18	80	6.86
		2	13	87^{a}	8.21		2		--	--
Coffeen	Spring	1	7	43^{a}	4.59	Summer	1	13	68	4.25
		2	10	31^{a}	5.18		2		--	--
Egypt	Spring	1	10	60	11.53	Summer	1	17	80	5.49
		2		--	--		2		--	--
Egypt	Spring	1	10	27^{a}	3.79	Summer	1	9	54	4.69
		2	10	31^{a}	6.37		2		--	--

Appendix 9.14. Mean blood glucose concentrations (mg/dL) and standard errors by segment for bluegill in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the ∝=0.05 level.

Year	Lake	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.	Season	Segment	N	Glucose Concentration (mg/dL)	S.E.
1998	Newton	Spring	1	1	130	--	Summer	1	5	113[a]	14.53
			2		--	--		2	1	79[a]	--
			3		--	--		3		--	--
			4		--	--		4		--	--
1999	Newton	Spring	1	3	161[a]	26.3	Summer	1		--	--
			2	2	75[a]	24.66		2		--	--
			3	2	42[a]	5.18		3		--	--
			4	1	40[a]	--		4	8	108	5.85
1998	Coffeen	Spring	1		--	--	Summer	1		--	--
			2		--	--		2	3	89	25.92
1999	Coffeen	Spring	1		--	--	Summer	1		--	--
			2	7	150	36.46		2	2	128	17.38
1998	Egypt	Spring	1	7	59	2.19	Summer	1	2	201	29.50
			2		--	--		2		--	--
1999	Egypt	Spring	1	5	49[a]	8.07	Summer	1	7	92[a]	11.77
			2	4	72[a]	10.84		2	3	89[a]	13.38

Appendix 9.15. Mean blood clotting times (minutes) and standard errors by segment for largemouth bass in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the ∝=0.05 level.

Year	Lake	Season	Segment	N	Clotting Time (minutes)	S.E.	Season	Segment	N	Clotting Time (minutes)	S.E.
1998	Newton	Spring	1	12	4.26[a]	0.66	Summer	1		--	--
			2	8	4.61[a]	0.61		2	2	0.84[a]	0.09
			3	8	2.31[a]	0.42		3	5	0.83[a]	0.12
			4	8	3.44[a]	0.34		4	14	1.20[a]	0.14
1999	Newton	Spring	1	7	3.73[a]	0.55	Summer	1		--	--
			2	6	2.59[a]	0.32		2		--	--
			3	6	2.86[a]	0.26		3		--	--
			4	6	2.56[a]	0.39		4	17	1.39	0.22
1998	Coffeen	Spring	1	15	5.10[a]	1.15	Summer	1	15	1.48[a]	0.21
			2	15	6.91[a]	0.90		2	5	1.87[a]	0.51
1999	Coffeen	Spring	1	10	4.92[a]	0.76	Summer	1		--	--
			2	10	5.73[a]	0.65		2	26	1.55	0.18
1998	Egypt	Spring	1	15	6.63[a]	0.74	Summer	1	23	1.78[a]	0.20
			2	16	2.49[b]	0.44		2	4	1.50[a]	0.40
1999	Egypt	Spring	1	11	4.09[a]	0.51	Summer	1	16	0.67[a]	0.13
			2	12	3.35[a]	0.66		2	8	1.59[b]	0.24

Appendix 9.16. Mean blood clotting times (minutes) and standard errors by segment for channel catfish in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the ∝=0.05 level.

Lake	Season	Segment	N	Clotting Time (minutes)	S.E.	Season	Segment	N	Clotting Time (minutes)	S.E.
Newton	Spring	1	8	3.02[a]	0.43	Summer	1		--	--
		2	12	2.08[a,b]	0.26		2	19	2.00	0.24
		3	13	1.50[b]	0.08		3		--	--
		4	1	1.75[a,b]	0.00		4		--	--
Newton	Spring	1	8	4.14[a]	0.56	Summer	1	1	1.33[a]	0.00
		2	6	4.58[a]	0.38		2	12	1.93[a]	0.28
		3	9	2.34[b]	0.18		3		--	--
		4	6	1.91[b]	0.17		4	8	1.47[a]	0.24
Coffeen	Spring	1	15	12.84[a]	1.67	Summer	1	20	2.26	0.26
		2	15	9.39[a]	1.17		2		--	--
Coffeen	Spring	1	9	7.32[a]	1.13	Summer	1		--	--
		2	10	6.80[a]	0.59		2	21	1.45	0.10
Egypt	Spring	1	20	5.48	0.94	Summer	1	19	0.28	1.68-2.87
		2		--	--		2		--	--
Egypt	Spring	1	10	6.62[a]	0.53	Summer	1	10	0.27	1.12-2.36
		2	10	13.18[a]	3.84		2		--	--

Appendix 9.17. Mean blood clotting times (minutes) and standard errors by segment for bluegill in the spring and summer of 1998 and 1999. Superscripts with different letters indicate differences among segments within a lake and season at the ∝=0.05 level.

Year	Lake	Season	Segment	N	Clotting Time (minutes)	S.E.	Season	Segment	N	Clotting Time (minutes)	S.E.
1998	Newton	Spring	1	4	1.67[a]	0.14	Summer	1	7	1.14[a]	0.11
			2		--	--		2	3	1.29[a]	0.20
			3		--	--		3		--	--
			4	2	1.00[b]	0.00		4		--	--
1999	Newton	Spring	1	3	1.19[a]	0.08	Summer	1		--	--
			2	5	1.64[a]	0.19		2	1	0.53[a]	0.00
			3	3	1.27[a]	0.06		3		--	--
			4	5	1.60[a]	0.07		4	14	0.72[a]	0.05
1998	Coffeen	Spring	1		--	--	Summer	1		--	--
			2					2	10	0.98	0.12
1999	Coffeen	Spring	1		--	--	Summer	1		--	--
			2	16	1.64	0.18		2	6	0.69	0.33
1998	Egypt	Spring	1	7	2.20[a]	0.28	Summer	1	10	0.88	0.07
			2	6	0.94[b]	0.08		2		--	--
1999	Egypt	Spring	1	5	3.00[a]	0.40	Summer	1	16	0.49[a]	0.09
			2	5	1.43[b]	0.11		2	5	0.50[a]	0.12

Appendix 9.18. Mean fish health assessment index (FHAI) values for largemouth bass (summer of 1999) in Newton Lake, Coffeen Lake, Lake of Egypt, and five non-power cooling lakes.

Lake	N	FHAI	S.D.	C.V.
Newton	17	70	26.87	38.56
Coffeen	31	76	36.18	47.85
Egypt	28	74	41.89	56.34
Newton Moribund	10	102	23.06	22.54
Sam Dale	4	60	29.15	48.59
East Fork	5	60	30.21	50.35
Rend	4	96	14.93	15.51
Kinkaid	5	67	19.24	28.71
Cedar	5	77	31.7	41.44

Appendix 9.19. Mean condition factor (C) and standard errors for largemouth bass from Newton Lake, Coffeen Lake, Lake of Egypt, a moribund sample from Newton Lake, and a pooled sample of five non-power cooling lakes in the summer of 1999.

Lake	N	C	S.E.
Newton	17	5.56	0.16
Coffeen	31	5.20	0.06
Egypt	30	4.36	0.09
Newton Moribund	10	4.81	0.20
5 Lakes	25	4.94	0.12

Appendix 9.20. Mean gonadal somatic index (GSI, wt of the gonads/wt of the fish) for female largemouth bass ranging from 3.9-21.7 inches for the spring of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the α=0.05 level.

Year	Season	Size Range (inches)	Lake	N	GSI	S.E.
1998	Spring	3.9-9.7	Newton	2.00	0.65	0.05
			Coffeen		--	--
			Egypt		--	--
1998	Spring	9.8-15.7	Newton	3	2.27[a]	0.93302
			Coffeen	4	4.82[a]	0.10701
			Egypt	8	2.39[a]	0.82183
1999	Spring	9.8-15.7	Newton	4	4.98[a]	0.79262
			Coffeen	9	6.99[a]	0.8625
			Egypt	2	4.53[a]	0.6728
1998	Spring	15.8-21.7	Newton	16	4.16[a,b]	0.80
			Coffeen	11	6.68[a]	0.90
			Egypt	11	3.09[b]	0.61
1999	Spring	15.8-21.7	Newton	8	6.08[a]	0.60
			Coffeen	11	7.59[a]	0.62
			Egypt	17	3.96[b]	0.34

Appendix 9.21. Mean gonadal somatic index (GSI, wt of the gonads/wt of the fish) for female channel catfish ranging from 7.9-25.6 inches for the spring of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	GSI	S.E.
1998	Spring	7.9-13.8	Newton	4	0.24[a]	0.04
			Coffeen	5	3.61[a]	2.21
			Egypt		--	--
1999	Spring	7.9-13.8	Newton	15	0.98[a]	0.27
			Coffeen	10	0.47[a]	0.08
			Egypt		--	--
1998	Spring	13.9-19.7	Newton		--	--
			Coffeen	10	2.47[a]	0.80
			Egypt	5	3.91[a]	2.28
1998	Spring	13.9-19.7	Newton	2	1.04[a]	0.39
			Coffeen	10	2.17[a]	0.58
			Egypt	4	6.88[b]	1.61
1998	Spring	19.8-25.6	Newton		--	--
			Coffeen		--	--
			Egypt	4	8.06	3.06
1999	Spring	19.8-25.6	Newton		--	--
			Coffeen		--	--
			Egypt	7	4.18	1.72

Appendix 9.22. Mean gonadal somatic index (GSI, wt of the gonads/wt of the fish) for female bluegill ranging from 3.9-8.7 inches for the spring of 1998 and 1999. Superscripts with different letters indicate differences among the lakes within a season at the ∝=0.05 level.

Year	Season	Size Range (inches)	Lake	N	GSI	S.E.
1998	Spring	3.9-5.5	Newton		--	--
			Coffeen		--	--
			Egypt		--	--
1999	Spring	3.9-5.5	Newton	6	1.01	0.04
			Coffeen		--	--
			Egypt	1	0.59	--
1998	Spring	5.6-7.1	Newton		--	--
			Coffeen		--	--
			Egypt	4	0.68	0.19
1999	Spring	5.6-7.1	Newton	5	1.09[a]	0.14
			Coffeen		--	--
			Egypt	7	0.80[a]	0.03
1998	Spring	7.2-8.7	Newton		--	--
			Coffeen		--	--
			Egypt	2	0.10	0.01
1999	Spring	7.2-8.7	Newton		--	--
			Coffeen		--	--
			Egypt	2	0.86	0.03

Appendix 9.23. Variables used in the health assessment index. Variables are modified from Goede (1993) and Adams (1993)

Variable	Description	Designation	Value
Eyes:	Normal	N	0
	Exopthalmia- swollen, protruding eye	E1/E2	30
	Hemorrhagic - bleeding	H1/H2	30
	Blind - opaque eyes	B1/B2	30
	Missing	M1/M2	30
	Other	OT	30
Gills:	Normal	N	0
	Frayed - ragged appearing gills	F	30
	Clubbed - swelling of tips of gill lamellae	C	30
	Marginate - gill with a light discolored margin along the distal ends or tips of the lamellae or filaments	M	30
	Pale - very light color	P	30
	Other	OT	30
Pseudobranchs:	Normal	N	0
	Swollen - convex	S	30
	Lithic - Mineral deposits in pseudobranchs - white amorphous spots or foci	L	30
	Swollen and Lithic	SL	30
	Inflamed - redness	I	30
	Other	OT	30
Fins:	No active erosion	0	0
	Mild active erosion	1	20
	Severe active erosion	2	30
	Fins involved will be noted.		
Opercales:	Normal opercale - no shortening, gills completely covered	0	
	Slight shortening - very small portion of the gill exposed	1	
	Severe shortening - considerable portion of gills exposed	2	
Thymus:	No Hemorrhage	0	0
	Mild Hemorrhage	1	10
	Severe Hemorrhage	2	30

Visceral Fat Percentage-Channel Catfish		
0 - no fat surrounding the viscera	0	
1 - less than 50% of viscera covered in fat	1	
2 - 50% fat	2	
3 - more than 50% fat	3	
4 - viscera completely covered in fat	4	
Largemouth Bass/Bluegill:		
0 - no fat around pyloric ceca	0	
1 - slight, less than 50%	1	
2 - 50% of cecum covered with fat	2	
3 - more than 50%	3	
4 - completely covered by large amount of fat	4	
Gonads: note any abnormalities		
Spleen: Black - very dark red color, considered normal	B	0
Red - red coloration, considered normal	R	0
Granular - granular or rough	G	0
Nodular - nodules, cysts	D	30
Enlarged	E	30
Other	OT	30
Hindgut: No inflammation	0	0
Slight inflammation	1	10
Moderate inflammation	2	20
Severe inflammation	3	30
Kidney: Normal-good firm dark red color	N	0
Swollen- enlarged or swollen wholly or in part	S	30
Mottled - gray discoloration, patchy in appearance- scattered patches of gray to total gray discoloration.	M	30
Granular	G	30
Urolithiasis - deposition of white or "cream-colored " amorphous mineral material in tubules	U	30
Other	OT	30

Appendix 9.23. continued

Liver:	Normal, good, solid red color	A	0
	Lighter or less vivid red color than in A - normal	B	0
	"Fatty" liver , coffee with cream color	C	30
	Nodules	D	30
	Focal discoloration	E	30
	General discoloration	G	30
	Other	OT	30
Bile: considers fullness and degree of green of the gall bladder			
	Yellow or straw color; bladder empty or only partially full	0	
	Yellow or straw color; bladder full, distended	1	
	Light green to grass green	2	
	Dark green, dark blue-green	3	
Hemolysis in bile:			
	No hemolysis	0	
	Slight hemolysis	1	
	Moderate hemolysis	2	
	Extreme hemolysis	3	
Parasites:	No observed parasites	0	0
	Few observed parasites	1	10
	Moderated parasite infestation	2	20
	Numerous parasites	3	30
Hematocrit-Largemouth bass (Spring 1998):			
	Normal range:	29-37%	0
	Above normal range:	37-41%	15
	High above normal range	41-44%	30
	Below normal range:	26-28	15
	High below normal range	21.84	30
Hematocrit-Largemouth bass (Summer 1998):			
	Normal range:	33-41%	0
	Above normal range:	42-44%	15
	High above normal range	45-48%	30
	Below normal range:	30-33%	15
	High below normal range	26-29%	30

Appendix 9.23. continued

Hematocrit-Largemouth bass (Spring 1999):		
Normal range:	26-33%	0
Above normal range:	33-36%	15
High above normal range	36-39%	30
Below normal range:	23-25%	15
High below normal range	19-23%	30
Hematocrit-Largemouth bass (Summer 1999):		
Normal range:	32-43%	0
Above normal range:	44-49%	15
High above normal range	49-54%	30
Below normal range:	27-33%	15
High below normal range	21-27%	30
Hematocrit-Channel Catfish (Spring 1998):		
Normal range:	24-37%	0
Above normal range:	38-44%	15
High above normal range	44-51%	30
Below normal range:	18-24%	15
High below normal range	11-17%	30
Hematocrit-Channel Catfish (Summer 1998):		
Normal range:	30-38%	0
Above normal range:	38-43%	15
High above normal range	43-47%	30
Below normal range:	25-30%	15
High below normal range	21-25%	30
Hematocrit-Channel Catfish (Spring 1999):		
Normal range:	21-39%	0
Above normal range:	39-47%	15
High above normal range	47-56%	30
Below normal range:	13-20%	15
High below normal range	4-12%	30
Hematocrit-Channel Catfish (Summer 1999):		
Normal range:	29-44%	0
Above normal range:	45-52%	15
High above normal range	52-59%	30
Below normal range:	21-28%	15
High below normal range	14-20%	30

Appendix 9.23. continued

Hematocrit-Bluegill (Spring 1998)

Normal range:	24-36%	0
Above normal range:	19-23%	15
High above normal range	13-18%	30
Below normal range:	37-42%	15
High below normal range	43-48%	30

Hematocrit-Bluegill (Summer 1998)

Normal range:	33-44%	0
Above normal range:	45-50%	15
High above normal range	51-56%	30
Below normal range:	27-32%	15
High below normal range	21-28%	30

Hematocrit-Bluegill (Spring 1999)

Normal range:	23-34%	0
Above normal range:	35-40%	15
High above normal range	41-45%	30
Below normal range:	18-22%	15
High below normal range	12-17%	30

Hematocrit-Bluegill (Spring 1999)

Normal range:	23-34%	0
Above normal range:	35-40%	15
High above normal range	41-45%	30
Below normal range:	18-22%	15
High below normal range	12-17%	30

Leucocrit-Largemouth Bass (Spring 1998)

Normal range:	0-2%	0
Above normal range:	2.1-3.1%	15
High above normal range	3.2-4.2%	30
Below normal range:	--	15
High below normal range	--	30

Leucocrit-Largemouth Bass (Summer 1998)

Normal range:	0%	0
Above normal range:	--	15
High above normal range	--	30
Below normal range:	--	15
High below normal range	--	30

Appendix 9.23. continued

Leucocrit-Largemouth Bass (Spring 1999)		
Normal range:	0-0.42%	0
Above normal range:	0.43-0.67%	15
High above normal range	0.68-0.92%	30
Below normal range:	--	15
High below normal range	--	30
Leucocrit-Largemouth Bass (Summer 1999)		
Normal range:	0-1.1%	0
Above normal range:	1.2-1.8%	15
High above normal range	1.9-2.6%	30
Below normal range:	--	15
High below normal range	--	30
Leucocrit-Channel Catfish (Spring 1998)		
Normal range:	0.7-1.34%	0
Above normal range:	1.35-1.66%	15
High above normal range	1.67-1.98%	30
Below normal range:	0.38-0.69%	15
High below normal range	0.06-0.37%	30
Leucocrit-Channel Catfish (Summer 1998)		
Normal range:	0.08-1.06%	0
Above normal range:	1.07-1.55%	15
High above normal range	1.56-2.04%	30
Below normal range:	0-0.07%	15
High below normal range	--	30
Leucocrit-Channel Catfish (Spring 1999)		
Normal range:	0.17-0.97%	0
Above normal range:	0.98-1.38%	15
High above normal range	1.39-1.77%	30
Below normal range:	0-0.16%	15
High below normal range	--	30
Leucocrit-Channel Catfish (Summer 1999)		
Normal range:	0.54-1.6%	0
Above normal range:	1.7-2.1%	15
High above normal range	2.2-2.6%	30
Below normal range:	0.01-0.53%	15
High below normal range	---	30

Appendix 9.23. continued

Leucocrit-Bluegill (Spring 1998)		
Normal range:	0.2-1.3%	0
Above normal range:	1.3-1.9%	15
High above normal range	2-2.4%	30
Below normal range:	0-0.1%	15
High below normal range	---	30
Leucocrit-Bluegill (Summer 1998)		
Normal range:	0%	0
Above normal range:	--	15
High above normal range	--	30
Below normal range:	--	15
High below normal range	--	30
Leucocrit-Bluegill (Spring 1999)		
Normal range:	0-0.3%	0
Above normal range:	0.4-0.5%	15
High above normal range	0.6-0.8%	30
Below normal range:	0.9-1.1%	15
High below normal range	1.2-1.4%	30
Leucocrit-Bluegill (Summer 1999)		
Normal range:	0-0.3%	0
Above normal range:	0.4-0.6%	15
High above normal range	0.7-0.8%	30
Below normal range:	--	15
High below normal range	--	30
Plasma Proteins-Largemouth Bass (Spring 1998)		
Normal range:	5.02-7.06%	0
Above normal range:	7.06-8.08%	15
High above normal range	8.09-9.10%	30
Below normal range:	4.00-5.03%	15
High below normal range	2.98-3.99%	30
Plasma Proteins-Largemouth Bass (Summer 1998)		
Normal range:	4.90-6.36%	0
Above normal range:	6.37-7.09%	15
High above normal range	7.10-7.82%	30
Below normal range:	4.17-4.89%	15
High below normal range	3.44-4.16%	30

Plasma Proteins-Largemouth Bass (Spring 1999)

Normal range:	5.06-6.18%	0
Above normal range:	6.19-6.74%	15
High above normal range	6.75-7.30%	30
Below normal range:	4.5-5.05%	15
High below normal range	3.94-4.49%	30

Plasma Proteins-Largemouth Bass (Summer 1999)

Normal range:	5.3-6.7%	0
Above normal range:	6.71-7.4%	15
High above normal range	7.41-8.1%	30
Below normal range:	4.6-5.29%	15
High below normal range	3.9-4.59%	30

Plasma Proteins-Channel Catfish (Spring 1998)

Normal range:	4.27-7.69%	0
Above normal range:	7.70-9.40%	15
High above normal range	9.41-11.11%	30
Below normal range:	2.56-4.29%	15
High below normal range	0.85-2.55%	30

Plasma Proteins-Channel Catfish (Summer 1998)

Normal range:	3.75-4.99%	0
Above normal range:	5.00-5.61%	15
High above normal range	5.62-6.23%	30
Below normal range:	3.13-3.76%	15
High below normal range	2.51-3.12%	30

Plasma Proteins-Channel Catfish (Spring 1999)

Normal range:	4.2-6.36%	0
Above normal range:	6.37-7.44%	15
High above normal range	7.45-8.52%	30
Below normal range:	3.12-4.19%	15
High below normal range	2.04-3.11%	30

Plasma Proteins-Channel Catfish (Summer 1999)

Normal range:	3.63-5.77%	0
Above normal range:	5.78-6.84%	15
High above normal range	6.85-7.91%	30
Below normal range:	2.56-3.64%	15
High below normal range	1.49-2.55%	30

Appendix 9.23. continued

Plasma Proteins-Bluegill (Spring 1998)

Normal range:	4.55-6.15%	0
Above normal range:	6.16-6.95%	15
High above normal range	6.96-7.75%	30
Below normal range:	3.75-4.54%	15
High below normal range	2.95-3.74%	30

Plasma Proteins-Bluegill (Summer 1998)

Normal range:	4.34-5.88%	0
Above normal range:	5.89-6.65%	15
High above normal range	6.66-7.42%	30
Below normal range:	3.57-4.33%	15
High below normal range	2.8-3.56%	30

Plasma Proteins-Bluegill (Spring 1999)

Normal range:	5.18-6.24%	0
Above normal range:	6.35-6.77%	15
High above normal range	6.77-7.30%	30
Below normal range:	4.65-5.17%	15
High below normal range	4.12-4.64%	30

Plasma Proteins-Bluegill (Summer 1999)

Normal range:	3.9-6.46%	0
Above normal range:	6.45-7.74%	15
High above normal range	7.75-9.02%	30
Below normal range:	2.62-3.89%	15
High below normal range	1.34-2.61%	30

Chapter 10. Food Habits

Introduction and Methods:

In Newton Lake, food habits were determined for largemouth bass, channel catfish, and bluegill. Where possible, stomach contents were sampled from 20 specimens of each species collected by electrofishing once a month from September 1997 through December 1999 from each of the four lake segments of Newton Lake (a total of nine crew days for each segment, except segment 1 that required 11 crew days for collection). In order to draw comparisons, 14 sampling trips for food habits data were conducted on Coffeen, and 8 on the Lake of Egypt during this period.

Plastic (acrylic) tubes were inserted through the esophagus and into the stomach of larger piscivorous fishes such as largemouth bass (Van Den Avyle and Roussel 1980). The vacuum produced when an appropriate sized tube is withdrawn removes greater than 80% of the prey (Cailteux et al. 1991). A stomach gastric lavage that flushes the gut content out was used on the smaller fish and bluegill (Giles 1980). A subsample of fish were brought back to the lab to assess the efficiency of the gastric lavage technique. Stomach contents of all fishes that were sacrificed in Chapter 11 (Age and Growth) were included in the food habits study. Stomach contents were also used from the fish sacrificed for Chapter 9 (Fish Health). Stomach contents from each fish were initially fixed in 7% formalin and then transferred to 70% ethyl alcohol. Each sample jar contained an appropriate label specifying date, location, and species from which the sample was obtained. Contents of stomach samples were identified to the lowest taxon possible and wet weights determined. Data are also presented in higher taxon groups that more closely align to those of Chapter 5 (Benthos) and Chapter 6 (Phytomacrobenthos). Stomach contents are also grouped more coarsely as fish, zooplankton, other invertebrates, and miscellaneous items for ease of interpretation. Particular attention is also paid to the percentage of empty stomachs.

Results and Discussion:

During the three study years largemouth bass in Newton Lake had a mean of 60.2% empty stomachs (Table 10.1), while a mean of 51.0% of channel catfishes' stomachs were empty. The percentage of empty stomachs was higher in largemouth bass during 1999 than either 1997 or 1998 in all three lakes. Channel catfish in Newton Lake and Coffeen Lake had a higher percentage of empty stomachs during 1999 than the prior years, but, this was not the case for channel catfish from Lake of Egypt.

Over all, the number of empty stomachs in largemouth bass from month to month was higher during 1999 than 1997 or 1998 in Newton Lake (Figure 10.1). Most bluegill in Newton Lake had something in their stomach throughout the spring and summer months (Figure 10.1). The trend in empty stomachs in largemouth bass captured from Coffeen Lake was consistent from year to year (Figure 10.2). However, channel catfish from Coffeen Lake had far more empty stomachs during the spring and summer months of 1999 than during 1998. The trends in empty stomachs for both largemouth bass and channel catfish were consistent from year to year in Lake of Egypt (Figure 10.3).

It was not surprising to see that a major proportion of largemouth bass in all three lakes were feeding on fishes, and that this was the largest component of their diet, based on percent wet weight (Figures 10.4 - 10.6). Gizzard shad were of particular importance in the diet of largemouth bass in Coffeen and Newton Lakes, (See dietary breakdowns in this Chapter 10: Supplemental Figures and Data Tables). Whereas, *Lepomis* spp. (bluegill in particular) and

Pomoxis spp. were the dominant fish consumed by largemouth bass in the Lake of Egypt. For most of the sampling period gizzard shad were an important component of the diet of largemouth bass in Newton Lake (Supplemental Figures and Data Tables in this chapter); however, during late summer of 1999 and fall of 1998 and 1999, the importance of bluegill increased and surpassed gizzard shad.

Channel catfish were more omnivorous than largemouth bass, particularly in Newton Lake. Their diet during the sample period consisted of over 45 distinguishable food items during the 1998 season versus fewer than 10 in the other two lakes. Fish were important component by percentage weight of the channel catfish's diet in all three lakes (Figures 10.7 - 10.9). However, in both Newton Lake and Coffeen Lake only a very small percentage if individuals were found to have fish in their stomachs. It is this lack of fish in the diet of the majority of channel catfish sampled from Newton Lake and Coffeen Lake that could explain the slow growth they are exhibiting in these lakes (see Chapter 11: Age, Growth, and Mortality Rates). For some reason the channel catfish in these two lake are not making the switch from a primarily invertebrate diet to a primarily fish diet. This phenomenon does not appear to be a function of size since the channel catfish in Newton Lake and Coffeen Lake that are preying on fish are well distributed within the length frequency of channel catfish sampled from these lakes during 1998 and 1999 (Figure 10.10). In the Lake of Egypt a large percentage of channel catfish are on a fish diet and this is reflected in the higher growth rates seen.

Bluegill from Newton Lake had by far the greatest diversity in their diet consisting of at least 54 distinguishable food items. During 1997 the most prevalent food item by percent weight in the diet of bluegill Newton Lake were the cladocerans, particularly the non-native *Daphnia* *lumholtzi* (See Chapter 10: Supplemental Figures and Data Tables). Although *D. lumholtzi* was present in the bluegill's diet during 1998 and 1999, it was not as important an item by weight. In fact, based on percentage of weight, combined zooplankton comprised only a minor proportion of Newton Lake bluegills' diet after the fall of 1997 (Figure 10.11). The dietary profile of bluegill in Newton Lake over time is most probably driven by the availability of any given prey item in its environment. For example during the spring spawning season when eggs are plentiful, a relatively high number of fish are found with eggs in their diet. Eggs were also present in the diet of channel catfish during the spring months.

Literature Cited:

Cailteux, R.L., W.F. Porak, and S. Crawford. 1991. Reevaluating the use of acrylic tubes for collection of largemouth bass stomach contents. Proceedings of the Annual Conference of the Southwestern Association of Fish and Wildlife Agencies 44(1990):126-132.

Giles, N. 1980. A stomach sampler for use on live fish. Journal of Fish Biology 16:441-444.

Van Den Avyle, M.J., and J.E. Roussel. 1980. Evaluation of a simple method for removing food items from live black bass. The Progressive Fish-Culturist 42:222-223.

Table 10.1. Mean percentage of largemouth bass, and channel catfish with empty stomachs from the three Illinois power-cooling reservoirs (Newton Lake, Coffeen Lake, and Lake of Egypt) during 1997, 1998, and 1999.

		Newton Lake		Coffeen Lake		Lake of Egypt	
Species	Year	% Empty	Months[a]	% Empty	Months[a]	% Empty	Months[a]
Largemouth Bass	1997	49.9	4	33.6	2	36.4	1
	1998	51.7	9	29.4	5	30.4	4
	1999	70.0	12	54.6	5	55.4	2
	Mean	60.2		40.6		38.4	
Channel Catfish	1997	30.6	4	46.3	2	25.0	1
	1998	48.6	9	43.1	6	39.4	4
	1999	59.2	10	87.5	3	28.6	2
	Mean	51.0		55.8		34.3	

a/ Number of months that samples were taken.

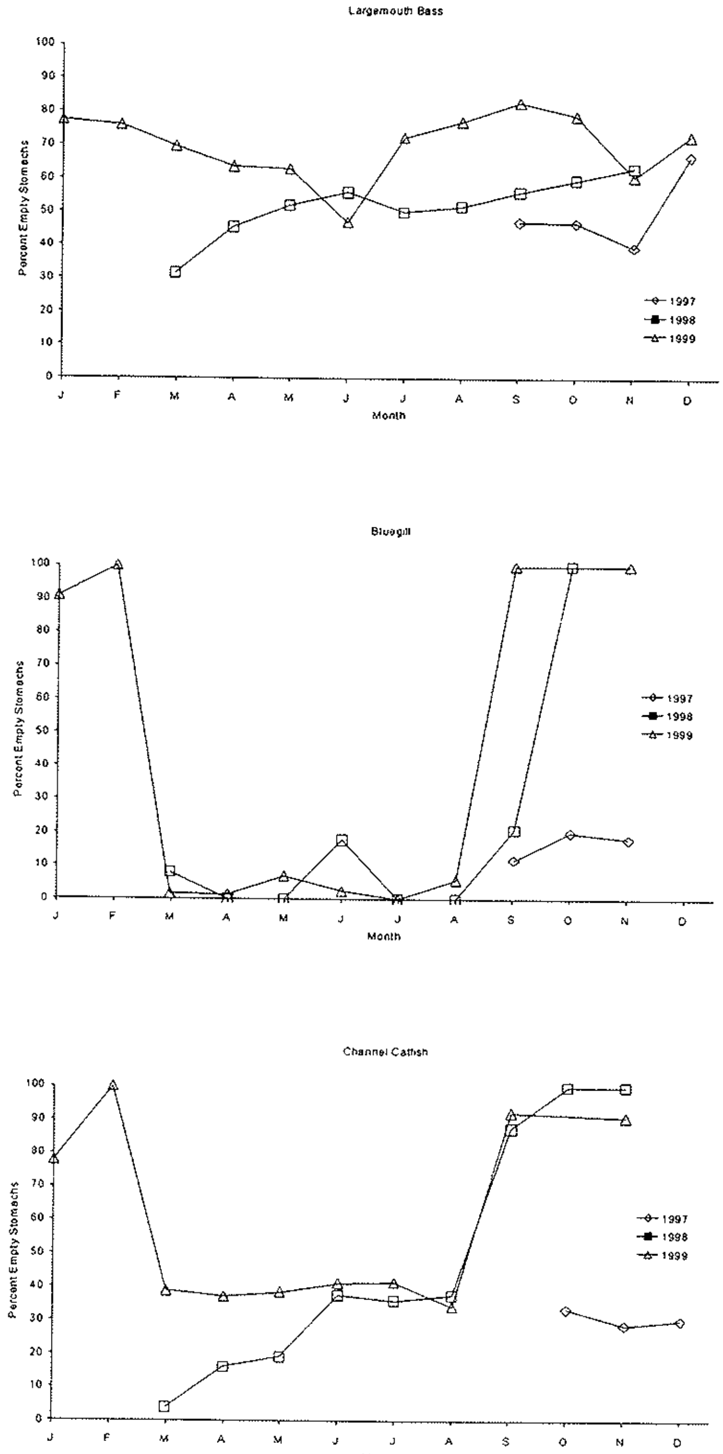
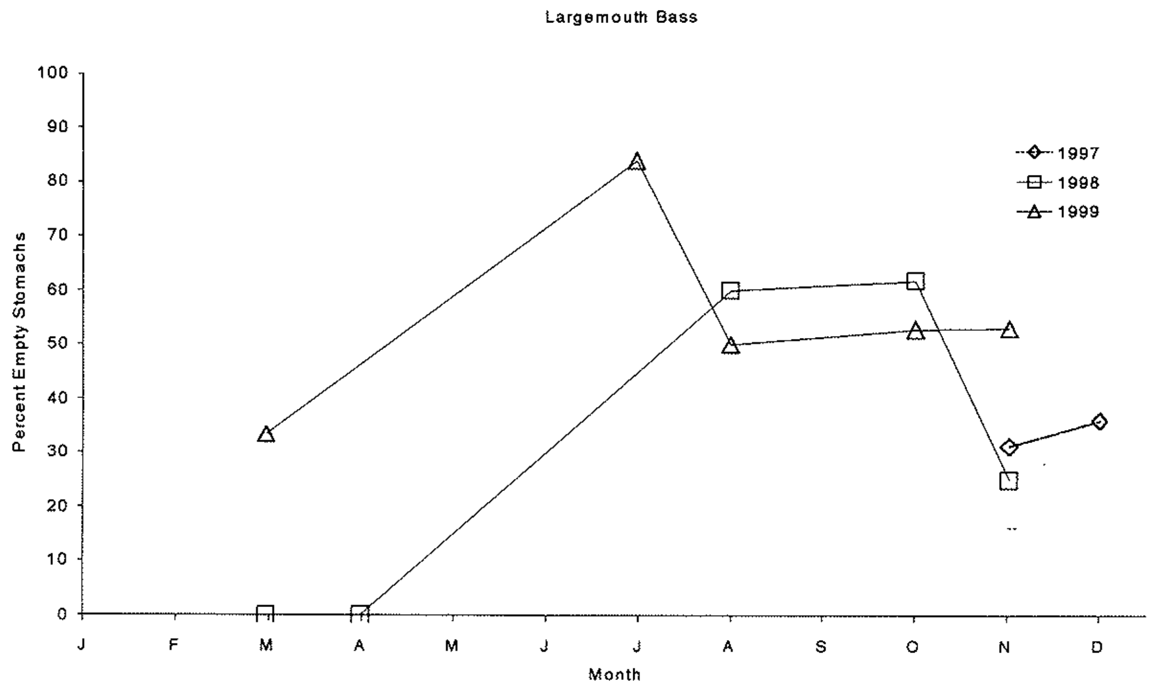


Figure 10.1. Monthly percentage of largemouth bass, bluegill, and channel catfish captured from Newton Lake during 1997, 1998, and 1999 with nothing in their stomachs.



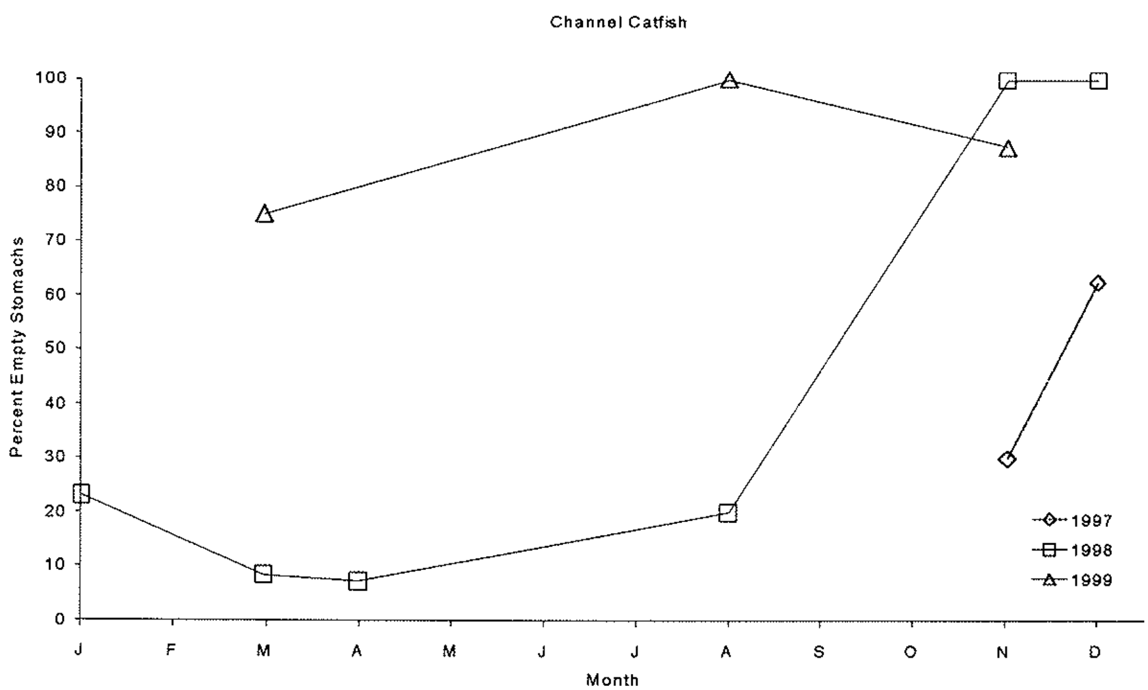


Figure 10.2. Monthly percentage of largemouth bass, and channel catfish captured from Coffeen Lake during 1997, 1998, and 1999 with nothing in their stomachs.

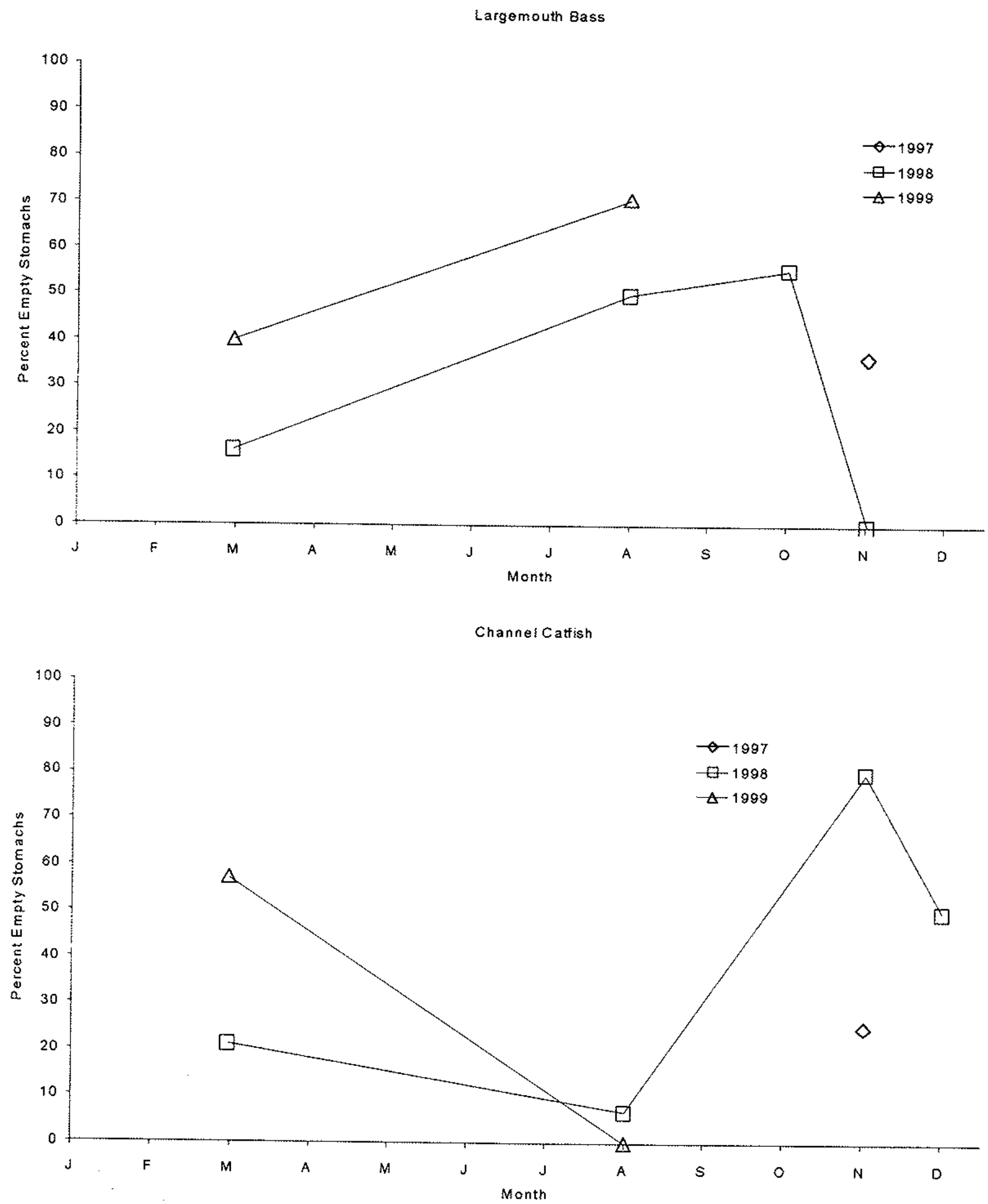


Figure 10.3. Monthly percentage of largemouth bass, and channel catfish captured from the Lake of Egypt during 1997, 1998, and 1999 with nothing in their stomachs.

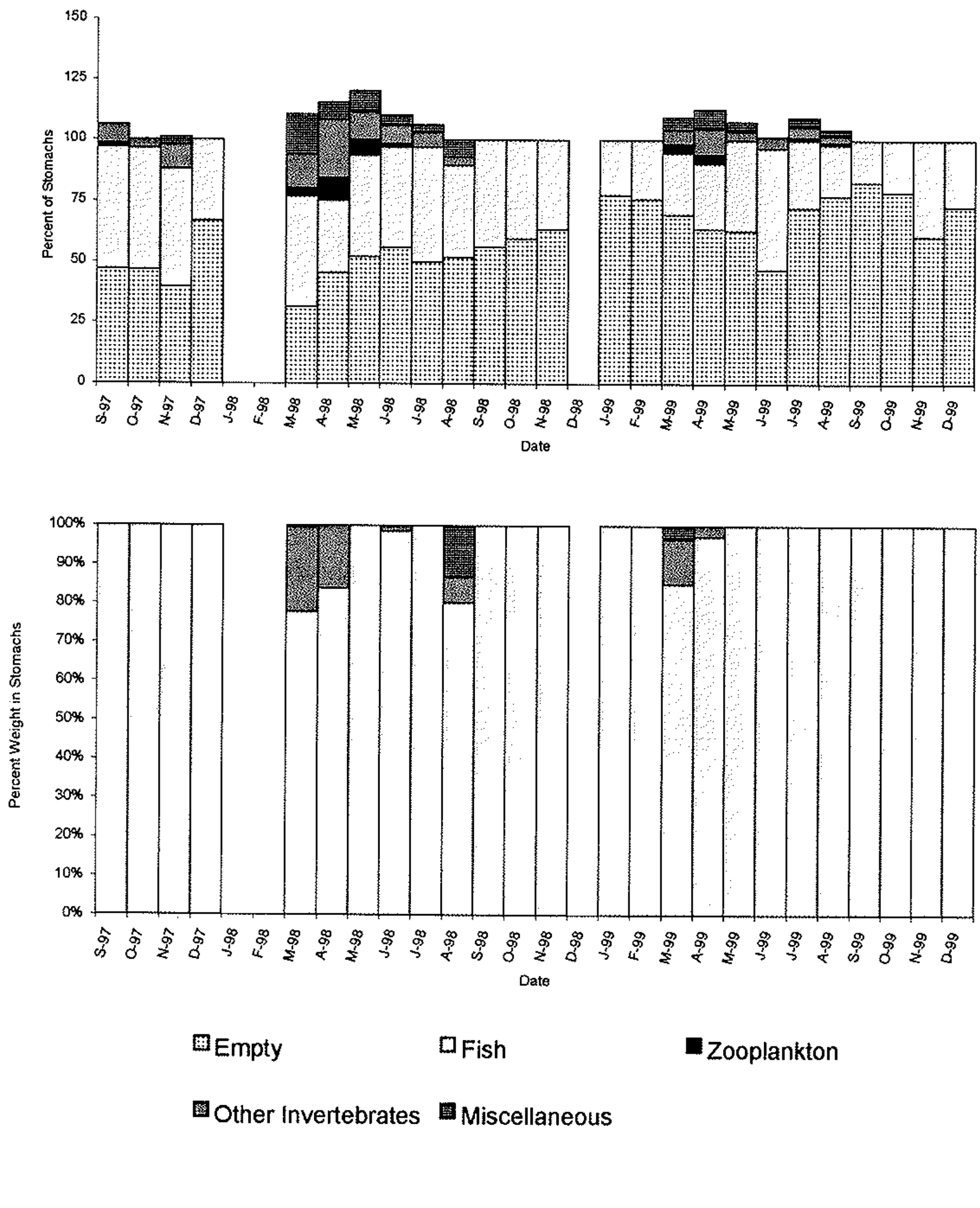


Figure 10.4. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for largemouth bass captured from Newton Lake during September 1997 through December 1999.

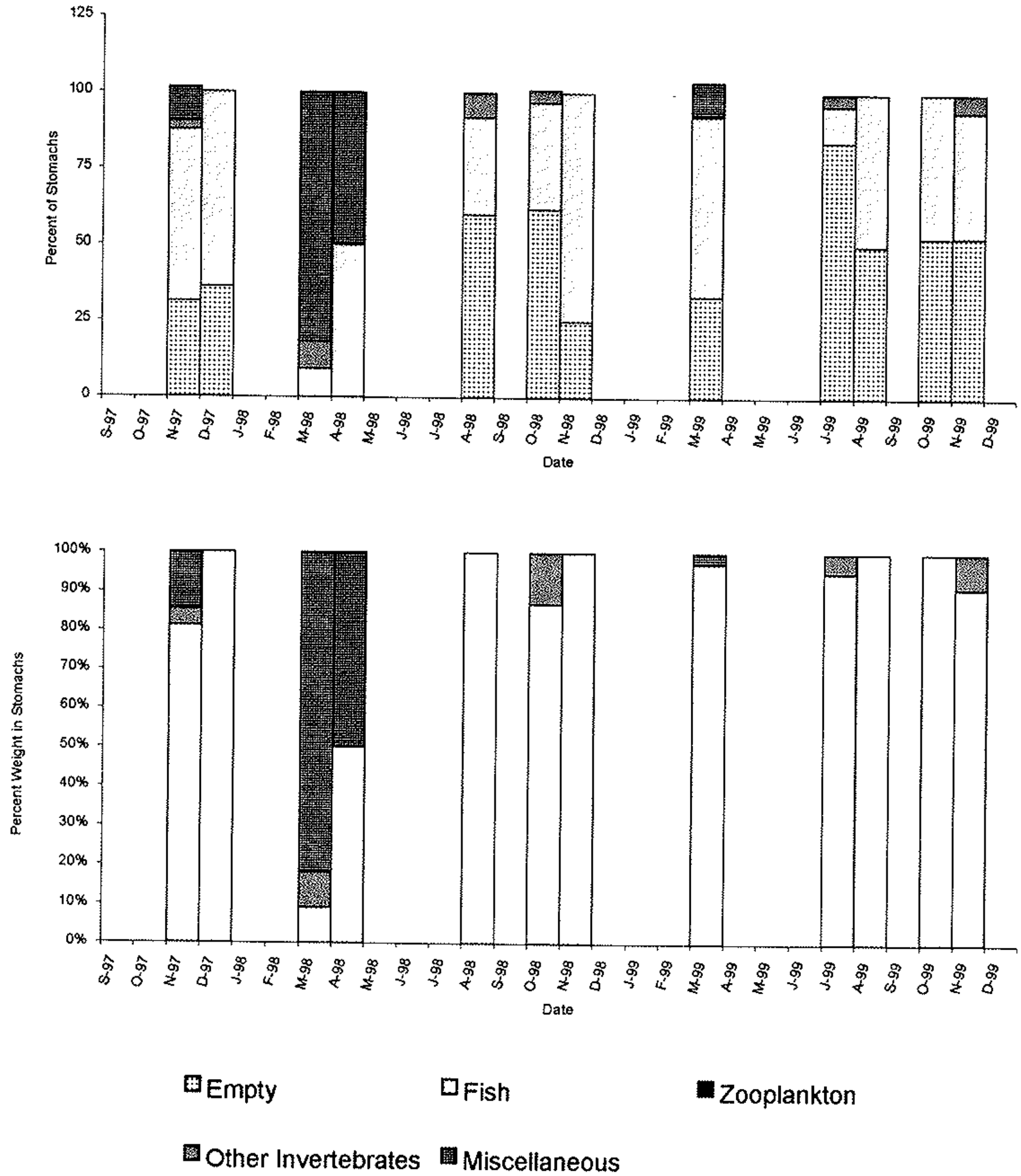


Figure 10.5. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for largemouth bass captured from Coffeen Lake during September 1997 through December 1999.

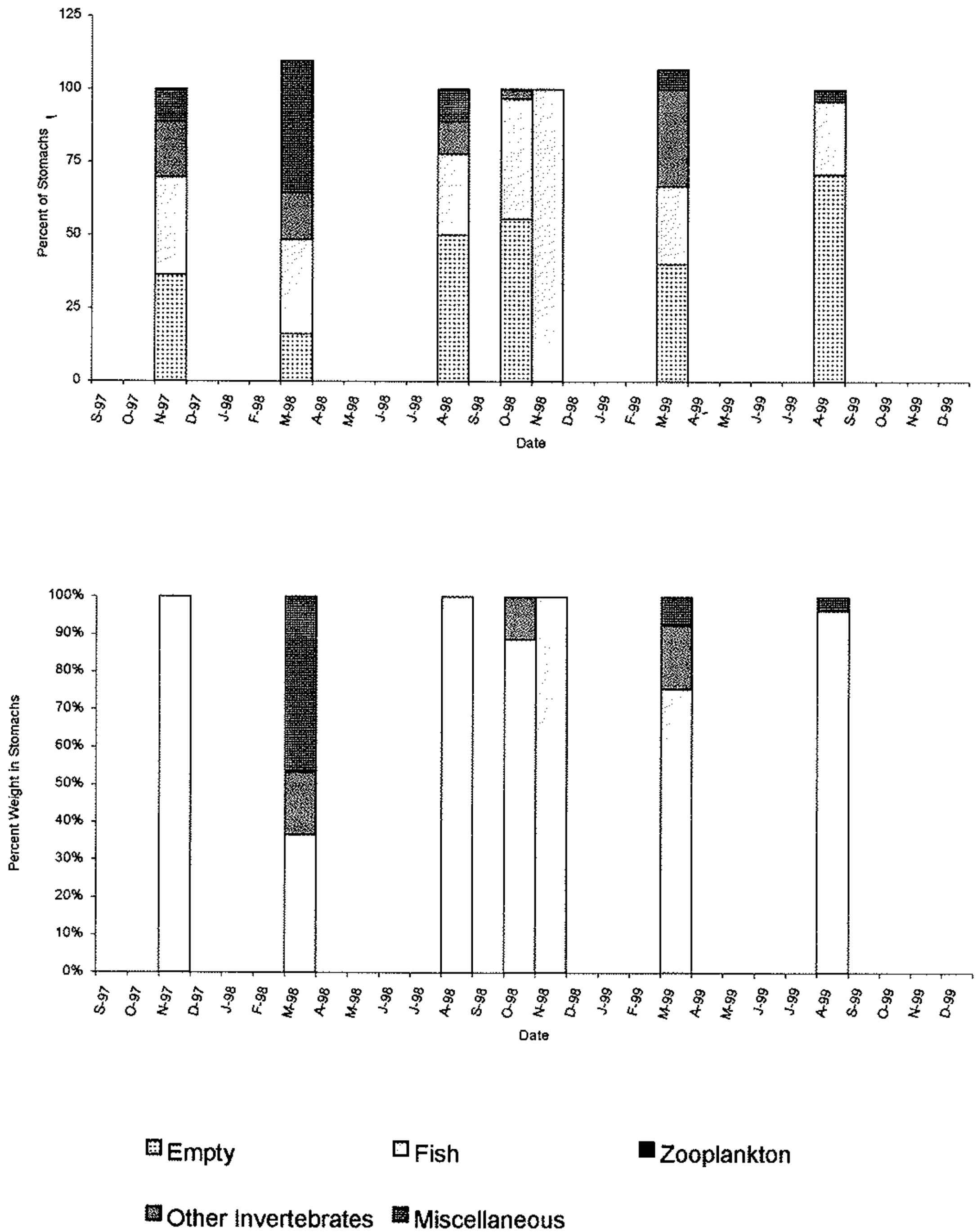


Figure 10.6. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for largemouth bass captured from Lake of Egypt during September 1997 through December 1999.

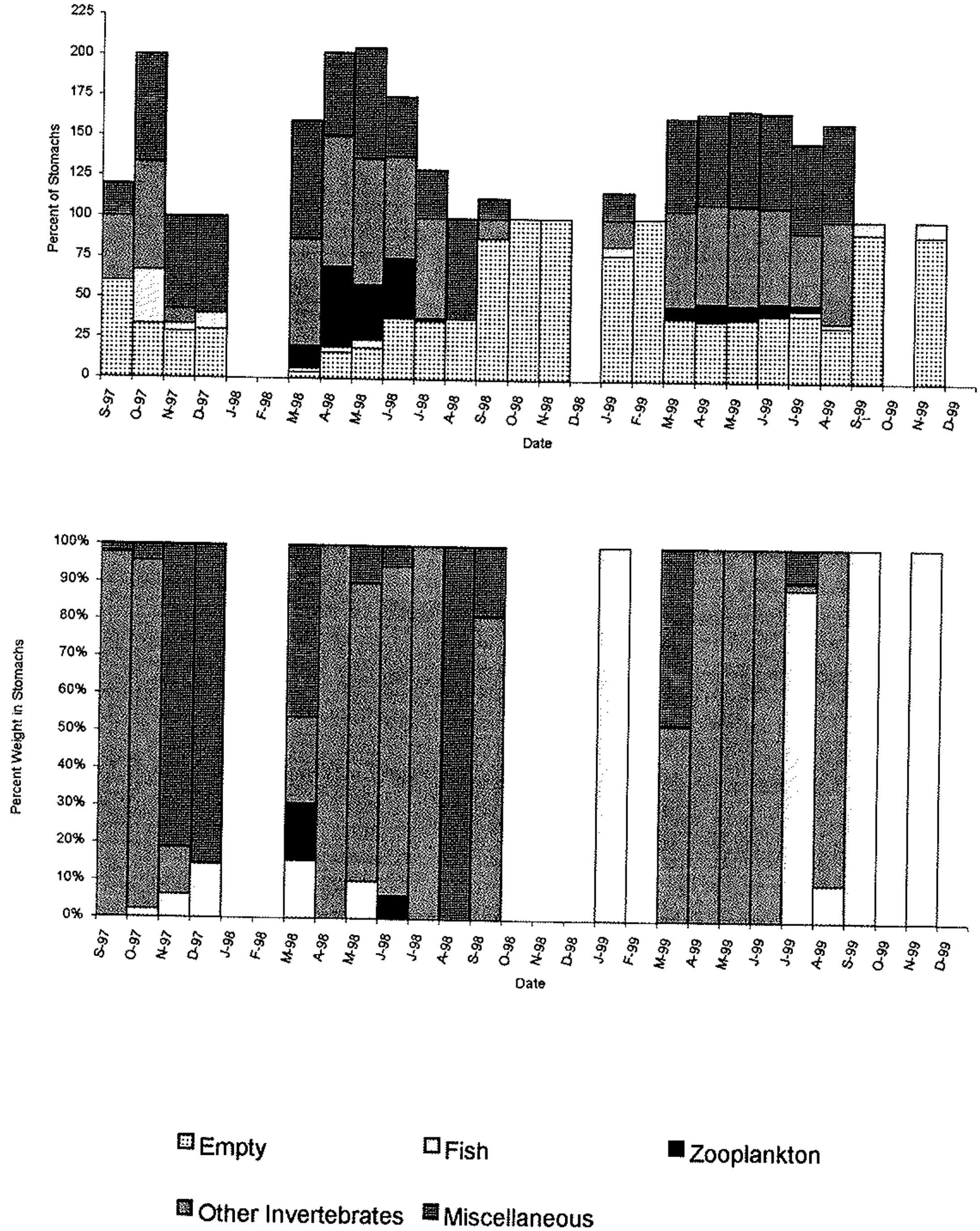


Figure 10.7. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for channel catfish captured from Newton Lake during September 1997 through December 1999.

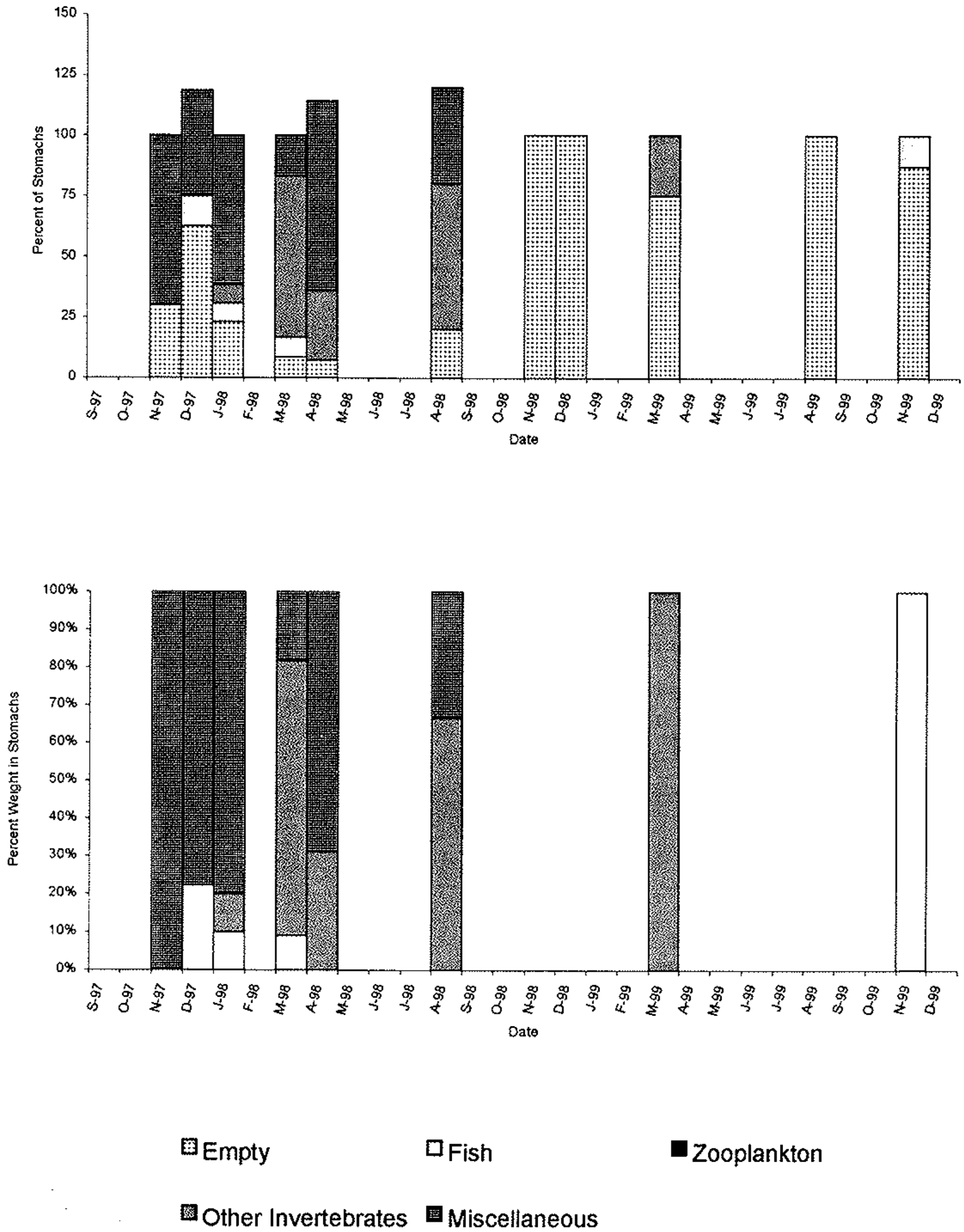


Figure 10.8. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for channel catfish captured from Coffeen Lake during September 1997 through December 1999.

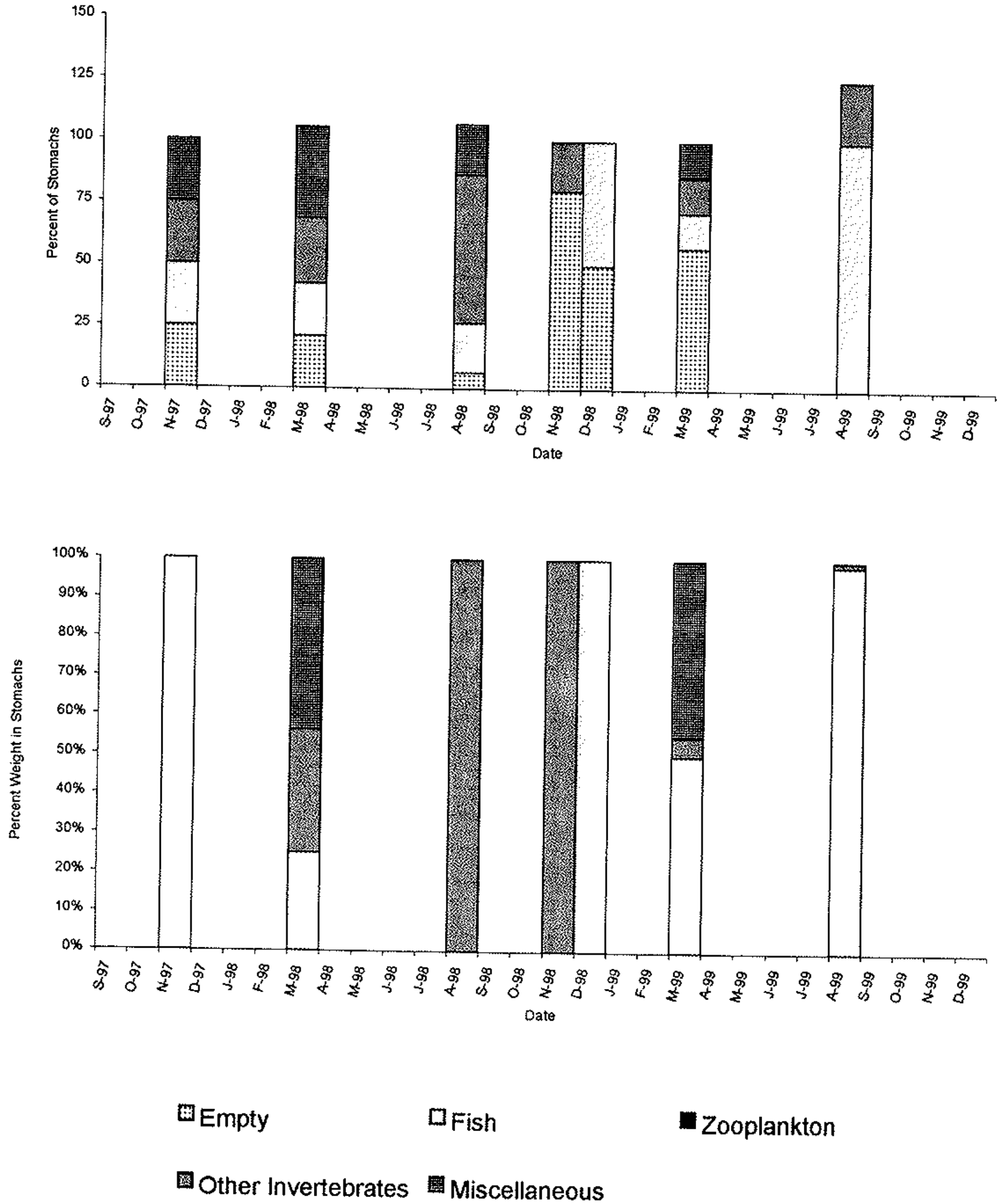


Figure 10.9. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for channel catfish captured from Lake of Egypt during September 1997 through December 1999.

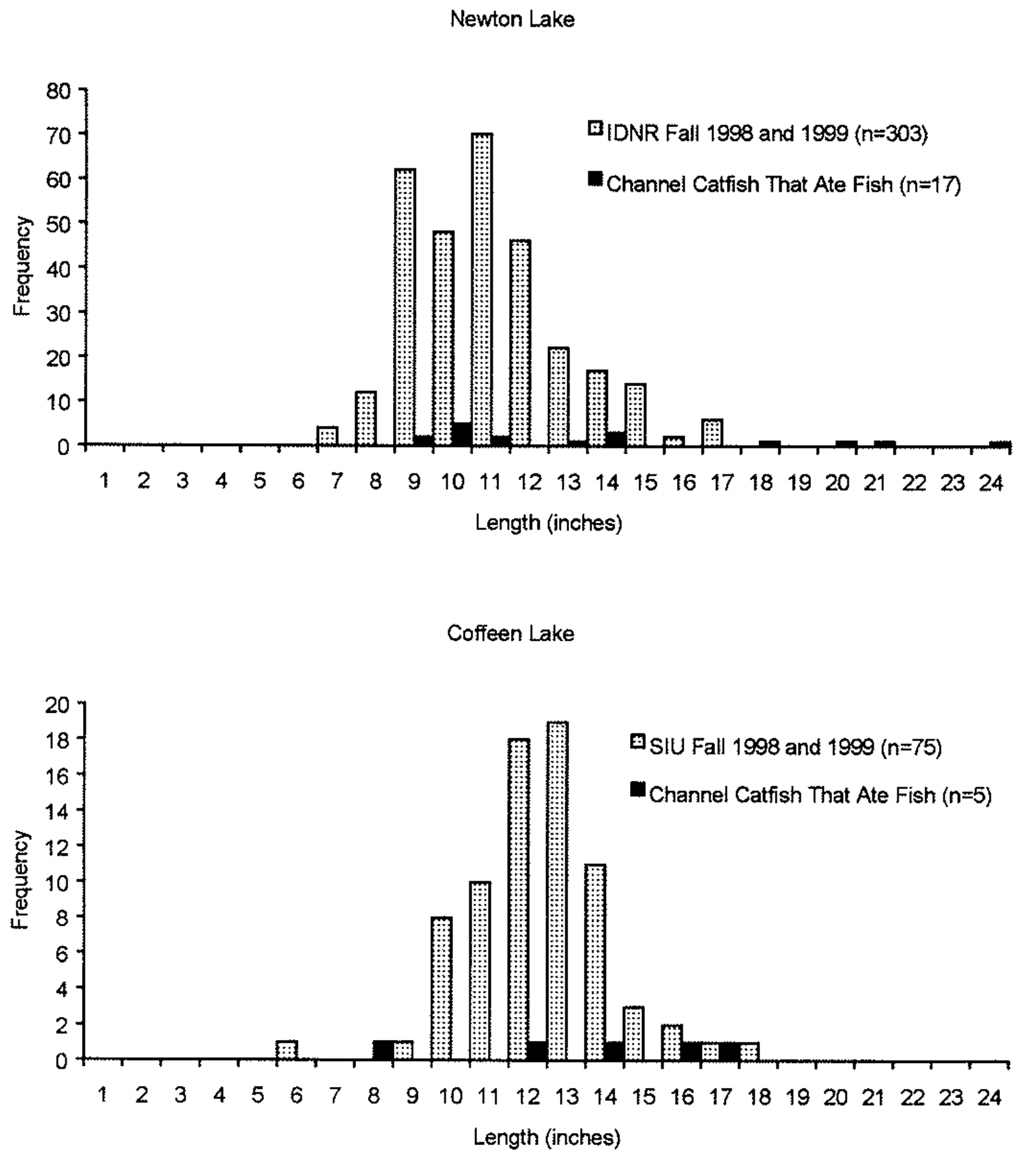


Figure 10.10. Comparison of length frequencies of channel catfish captured during 1997, 1998, and 1999 from Newton Lake and Coffeen Lake that had fish in their diet with samples taken from each lake as a whole during 1998 and 1999. The whole lake samples for Newton Lake were obtained by the Illinois Department of Natural Resources (IDNR), the Coffeen Lake Samples were obtained by SIU.

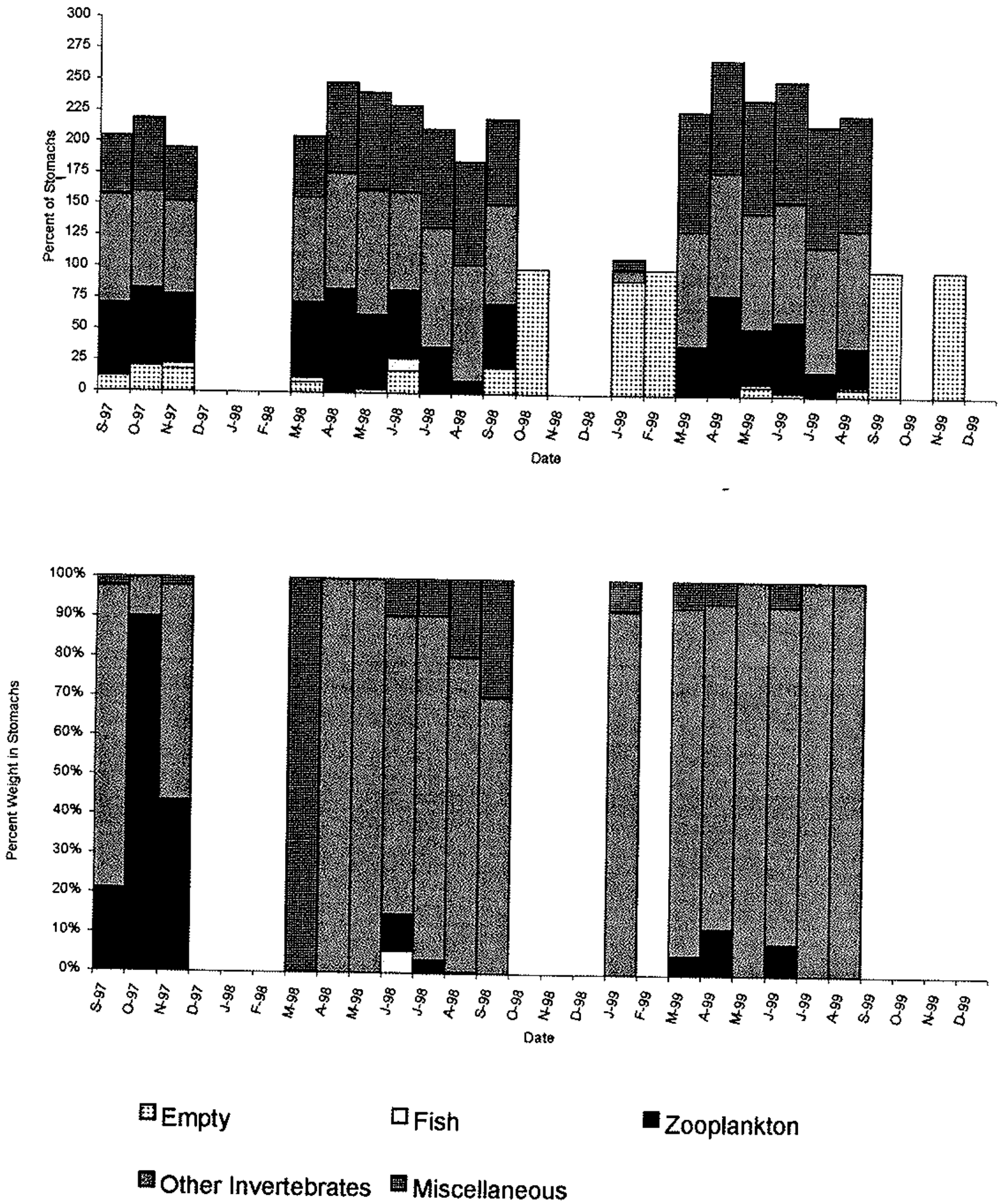
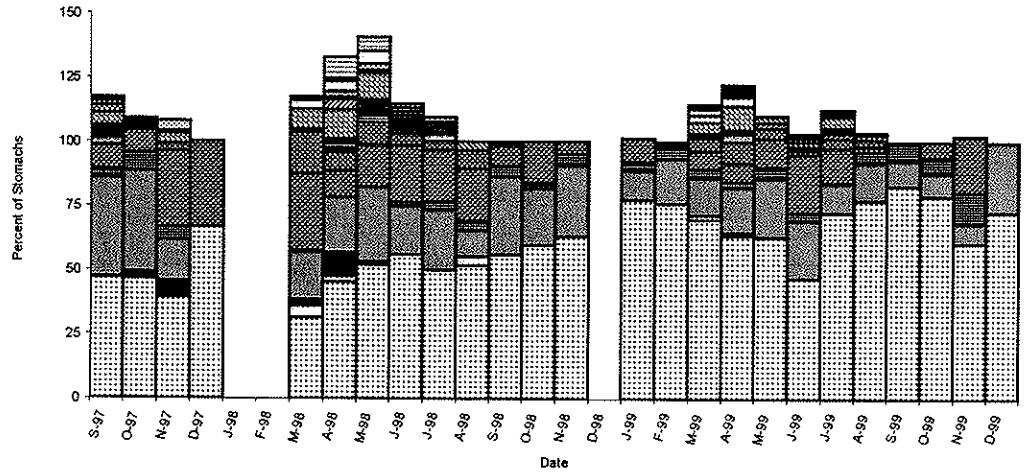


Figure 10.11. Monthly percentage of stomachs containing each food type (top), and percentage total weight of each food type in stomachs (bottom) for bluegill captured from Newton Lake during September 1997 through December 1999.

Chapter 10. Appendix: Supplemental Figures and Data Tables

Legend for Food Habits Charts

Empty	Decapoda	Unid. Invertebrate
Dorosoma	*Lepomis*	Unid. Fish
Other	Pelecypoda	*Micropterus*
Plant Material	Cyprinidae	Gastropoda
Eggs	*Pomoxis*	Ephemeroptera
Diptera	Odonata	Hemiptera
Ostracoda	Miscellaneous	Arachnida
Coleoptera	Bryozoa	Cladocera
Ichtalurus	Trichoptera	Copepoda
Orthoptera	Isopoda	Amphipoda
Hymenoptera	Collembola	Oligochaeta



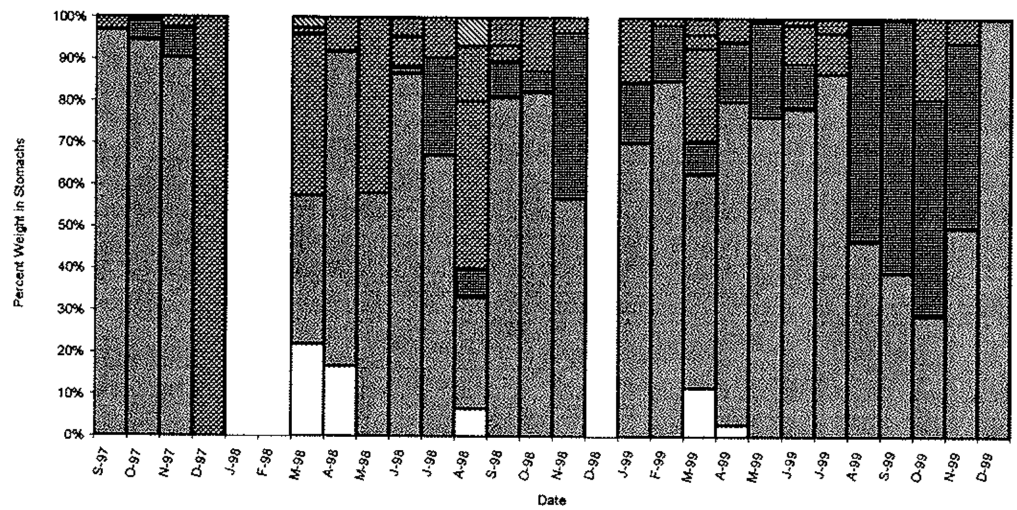
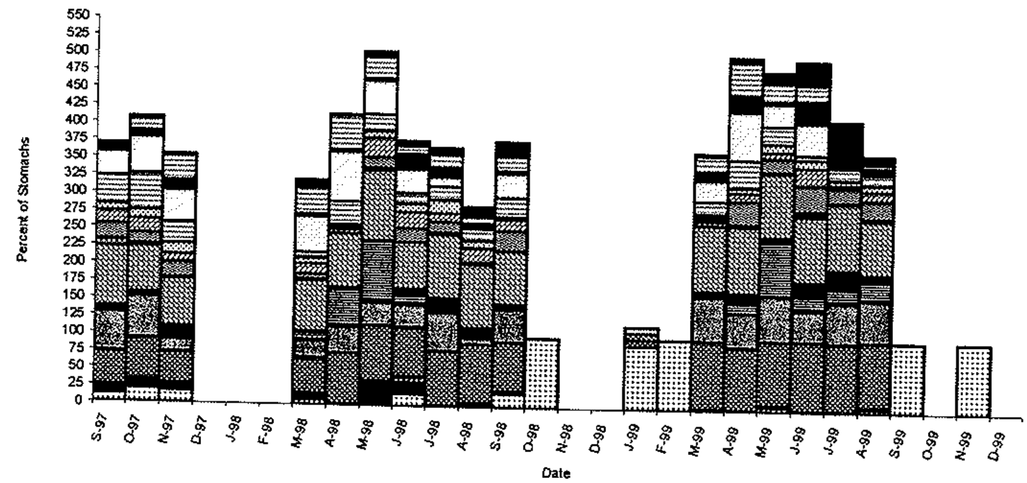


Figure 10.A1. Monthly percentage of stomachs containing each taxon grouping (top), and percentage total weight of each group in stomachs (bottom) for largemouth bass captured from Newton Lake during September 1997 through December 1999.



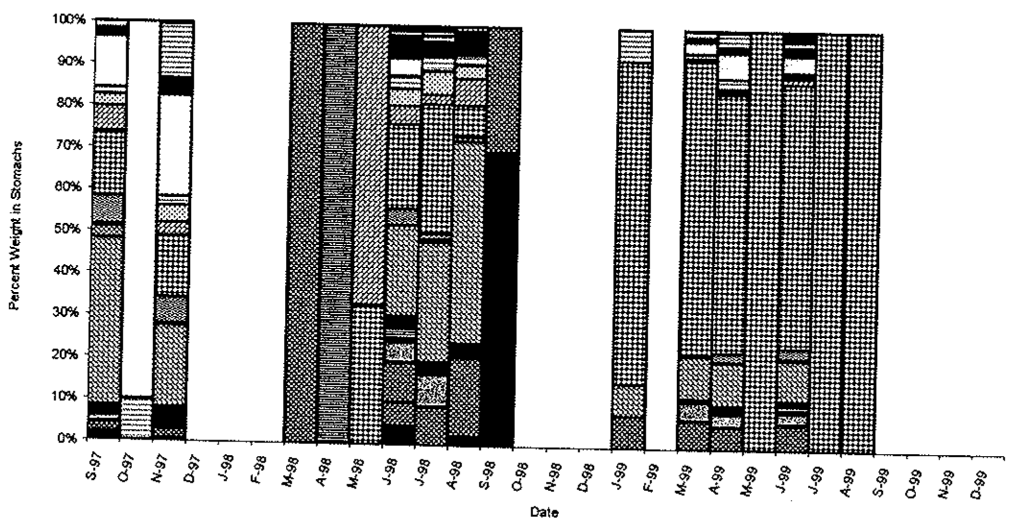
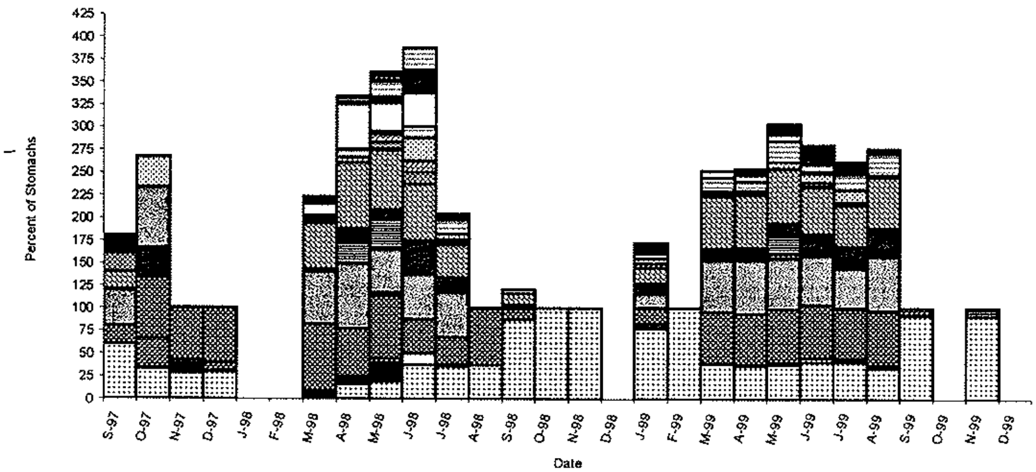


Figure 10.A2. Monthly percentage of stomachs containing each taxon grouping (top), and percentage total weight of each group in stomachs (bottom) for bluegill captured from Newton Lake during September 1997 through December 1999.



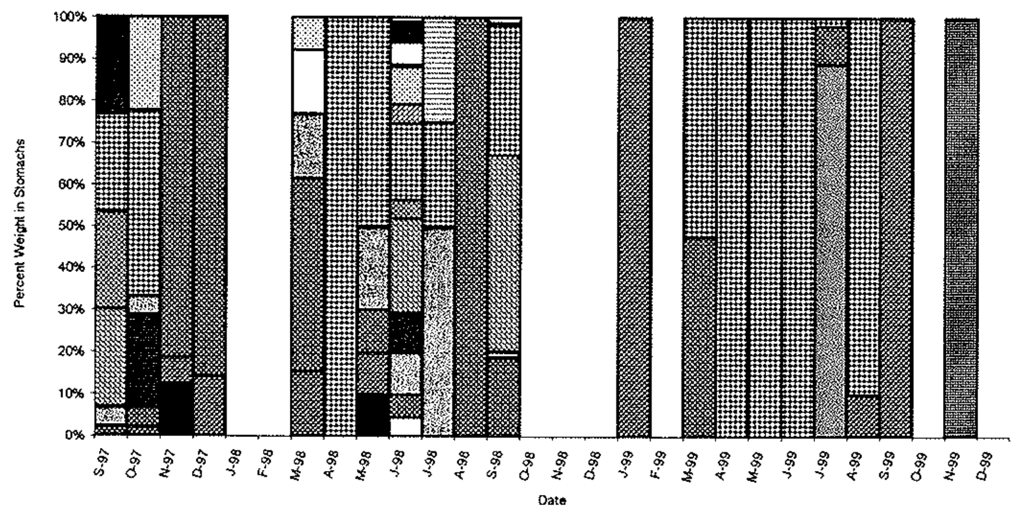
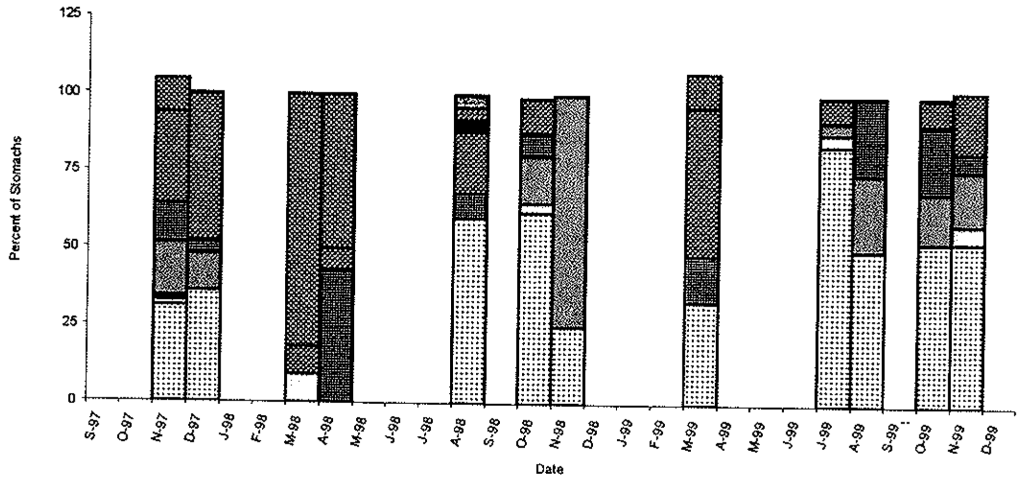


Figure 10.A3. Monthly percentage of stomachs containing each taxon grouping (top), and percentage total weight of each group in stomachs (bottom) for channel catfish captured from Newton Lake during September 1997 through December 1999.



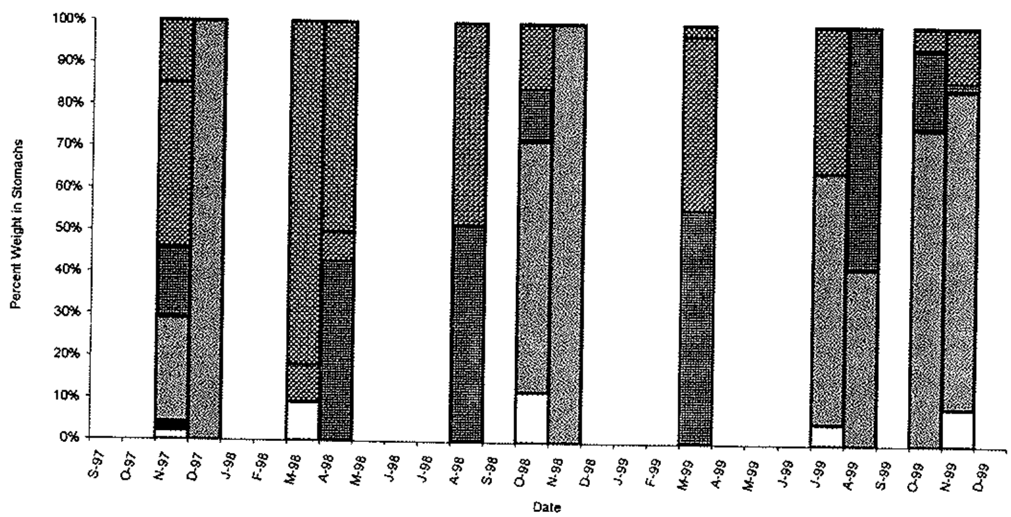
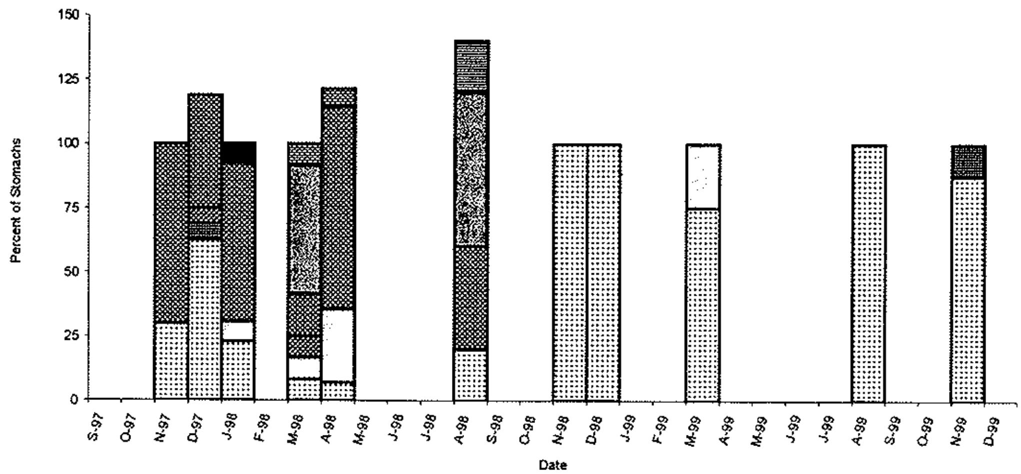


Figure 10.A4. Monthly percentage of stomachs containing each taxon grouping (top), and percentage total weight of each group in stomachs (bottom) for largemouth bass captured from Coffeen Lake during September 1997 through December 1999.



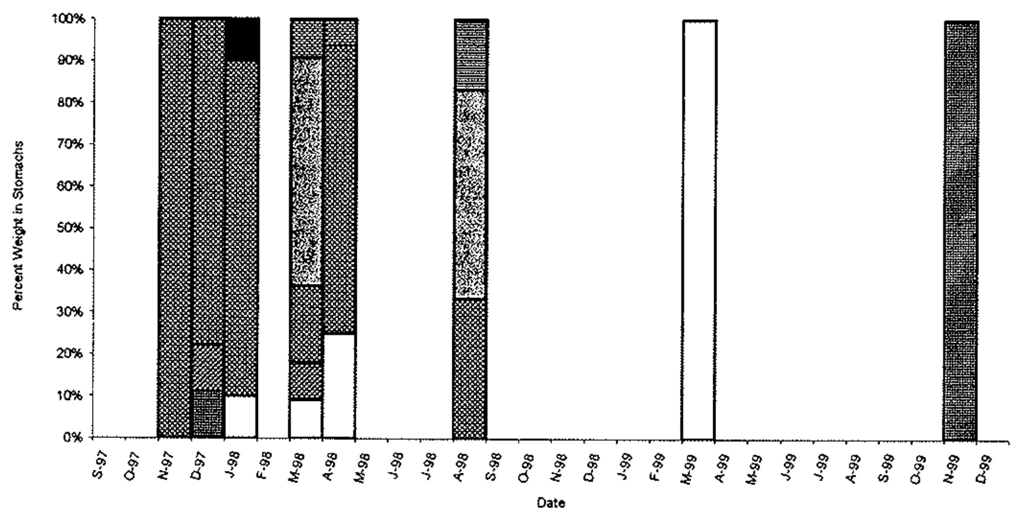


Figure 10.A5. Monthly percentage of stomachs containing each taxon grouping (top), and percentage total weight of each group in stomachs (bottom) for channel catfish captured from Coffeen Lake during September 1997 through December 1999.

Table 10.A1. Overall food habits reported at the lowest identifiable taxon, expressed as number of stomachs an item occurred in (n), percent of stomachs an item occurred in (%n), and the percentage of the total weight of items in the stomachs of fishes sampled from each of the three lakes during 1997, 1998, and 1999.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Coffeen	1997	Largemouth bass	Gizzard shad	18	20.2	100.0
			Unid. Fish	31	34.8	Trace
			Unknown	7	7.9	Trace
			Lepomis spp.	5	5.6	Trace
			Bluegill	4	4.5	Trace
			Crayfish	1	1.1	Trace
			Unid. Invertebrate	1	1.1	Trace
			Empty	29	32.6	Trace
		Channel catfish	Unknown	14	53.8	87.5
			Unid. Fish	1	3.8	6.3
			Lepomis spp.	1	3.8	6.3
			Empty	15	57.7	
	1998	Largemouth bass	Gizzard shad	20	13.2	62.4
			Lepomis spp.	16	10.6	12.7
			Unid. Fish	19	12.6	11.2
			Crayfish	4	2.6	8.6
			Largemouth bass	1	0.7	3.6
			Mussel	1	0.7	1.0
			Topminnow	1	0.7	0.5
			Unknown	16	10.6	Trace
			Plant	1	0.7	Trace
			Spheridae	1	0.7	Trace
			Empty	76	50.3	
		Bluegill	Unknown	1	5.3	100.0
			Empty	18	94.7	
		Channel catfish	Unknown	23	34.3	53.5
			Plant	9	13.4	20.9
			Crayfish	6	9.0	14.0
			Gastropoda	2	3.0	4.7
			Unid. Fish	1	1.5	2.3
			Shiner	1	1.5	2.3
			Eggs	1	1.5	2.3

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Coffeen	1998	Channel catfish	Empty	29	43.3	
	1999	Largemouth bass	Gizzard shad	31	15.7	62.2
			Lepomis spp.	29	14.6	16.0
			Unid. Fish	35	17.7	15.1
			Crayfish	4	2.0	4.3
			Bluegill	1	0.5	1.9
			Unknown	3	1.5	0.4
			Gambusia spp.	2	1.0	Trace
			Empty	107	54.0	
		Bluegill	Empty	1	100.0	
		Channel catfish	Crayfish	2	11.8	53.8
			Bluegill	2	11.8	46.2
			Empty	14	82.4	
Egypt	1997	Largemouth bass	Bluegill	2	2.0	100.0
			Unid. Fish	24	24.2	Trace
			Crayfish	19	19.2	Trace
			Unknown	11	11.1	Trace
			Lepomis spp.	6	6.1	Trace
			Minnow	1	1.0	Trace
			Empty	36	36.4	
		Channel catfish	Bluegill	1	25.0	100.0
			Crayfish	1	25.0	Trace
			Unknown	1	25.0	Trace
			Empty	1	25.0	
	1998	Largemouth bass	White crappie	1	0.7	29.0
			Lepomis spp.	12	8.5	25.5
			Black crappie	1	0.7	23.1
			Unid. Fish	31	21.8	9.2
			Gizzard shad	8	5.6	5.9
			Crayfish	11	7.7	5.0
			Largemouth bass	2	1.4	1.2
			Minnow	1	0.7	0.9
			Brook silverside	1	0.7	0.2
			Unknown	16	11.3	Trace
			Empty	64	45.1	
		Bluegill	Empty	26	100.0	
		Channel catfish	Plant	8	19.5	88.4
			Unid. Fish	3	7.3	7.2

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Egypt	1998	Channel catfish	Crayfish	8	19.5	4.3
			Unknown	10	24.4	Trace
			Gizzard shad	2	4.9	Trace
			Lepomis spp.	2	4.9	Trace
			Pomoxis spp.	1	2.4	Trace
			Empty	10	24.4	
	1999	Largemouth bass	*Lepomis* spp.	8	14.8	73.7
			Crayfish	9	16.7	14.7
			Snake	2	3.7	7.0
			Unid. Fish	5	9.3	2.7
			Annelida	1	1.9	1.3
			Unknown	2	3.7	0.3
			Gizzard shad	1	1.9	0.2
			Plant	1	1.9	0.2
			Empty	29	53.7	
		Bluegill	Empty	1	100.0	
		Channel catfish	Bluegill	7	63.6	40.9
			Gizzard shad	2	18.2	23.5
			Unid. Fish	1	9.1	17.4
			Unknown	1	9.1	15.7
			Crayfish	1	9.1	1.7
			Leech	1	9.1	0.9
			Empty	4	36.4	
Newton	1997	Largemouth bass	Gizzard shad	118	44.4	95.0
			Lepomis spp.	15	5.6	3.2
			Unid. Fish	52	19.5	1.8
			Dipteran	6	2.3	Trace
			Chironomida	5	1.9	Trace
			Coleoptera	5	1.9	Trace
			Unid. Invertebrate	8	3.0	Trace
			Ephemeroptera	3	1.1	Trace
			Other			Trace
			Anisopteran	2	0.8	Trace
			Hemiptera	2	0.8	Trace
			Ostracoda	1	0.4	Trace
			Arachnida	1	0.4	Trace
			Unknown	3	1.1	Trace
			Plant	2	0.8	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1997	Largemouth bass	Bryozoa	1	0.4	Trace
			Empty	120	45.1	
		Bluegill	*Daphnia lumholtzi*	64	20.9	90.0
			Bryozoa	113	36.9	10.0
			Chironomida	221	72.2	Trace
			Other			Trace
			Ostracoda	63	20.6	Trace
			Calanoida	54	17.6	Trace
			Dipteran	53	17.3	Trace
			Chydoridae	43	14.1	Trace
			Coleoptera	43	14.1	Trace
			Trichoptera	34	11.1	Trace
			Sididae	34	11.1	Trace
			Cyclopoida	31	10.1	Trace
			Ephemeroptera	32	10.5	Trace
			Bosmina spp.	29	9.5	Trace
			Hydracarina	26	8.5	Trace
			Unknown	151	49.3	Trace
			Arachnida	21	6.9	Trace
			Diaphanosoma spp.	18	5.9	Trace
			Unid. Invertebrate	29	9.5	Trace
			Daphnia spp.	13	4.2	Trace
			Plant	114	37.3	Trace
			Argulus spp.	9	2.9	Trace
			Bosminidae	9	2.9	Trace
			Eggs	6	2.0	Trace
			Anisopteran	5	1.6	Trace
			Heleidae	5	1.6	Trace
			Zygoptera	3	1.0	Trace
			Hemiptera	3	1.0	Trace
			Hymenoptera	2	0.7	Trace
			Leptidora	2	0.7	Trace
			Orthoptera	1	0.3	Trace
			Collembola	1	0.3	Trace
			Cladocera	1	0.3	Trace
			Argulus spp.	1	0.3	Trace
			Unid. Fish	7	2.3	Trace
			Empty	52	17.0	

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1997	Channel catfish	Other			27.0
			Unknown	22	56.4	19.8
			Chironomida	1	2.6	9.0
			Zygoptera	1	2.6	9.0
			Coleoptera	1	2.6	9.0
			Trichoptera	1	2.6	9.0
			Pelecypoda	1	2.6	9.0
			Plant	4	10.3	3.6
			Unid. Fish	3	7.7	2.7
			Unid. Invertebrate	2	5.1	1.8
			Empty	13	33.3	
	1998	Largemouth bass	Gizzard shad	193	28.2	63.8
			Unid. Fish	179	26.2	16.5
			Lepomis spp.	16	2.3	9.4
			Crayfish	9	1.3	5.6
			Hybrid sunfish	1	0.1	2.3
			Largemouth bass	3	0.4	1.2
			Bluegill	1	0.1	0.4
			Channel catfish	2	0.3	0.4
			Gambusia spp.	1	0.1	0.4
			Unknown	36	5.3	Trace
			Homoptera	1	0.1	Trace
			Other			Trace
			Dipteran	19	2.8	Trace
			Ephemeroptera	11	1.6	Trace
			Chironomida	15	2.2	Trace
			Argulus spp.	4	0.6	Trace
			Plant	4	0.6	Trace
			Coleoptera	2	0.3	Trace
			Diaphanosoma spp.	7	1.0	Trace
			Eggs	5	0.7	Trace
			Hemiptera	5	0.7	Trace
			Unid. Invertebrate	13	1.9	Trace
			Calanoida	4	0.6	Trace
			Daphnia spp.	3	0.4	Trace
			Bryozoa	3	0.4	Trace
			Orthoptera	1	0.1	Trace
			Arachnida	1	0.1	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1998	Largemouth bass	Cyclopoida	5	0.7	Trace
			Bosminidae	2	0.3	Trace
			Daphnia lumholtzi	1	0.1	Trace
			Ostracoda	1	0.1	Trace
			Trichoptera	1	0.1	Trace
			Chaoborus spp.	1	0.1	Trace
			Nematomorpha	1	0.1	Trace
			Empty	353	51.6	
		Bluegill	Unid. Invertebrate	50	10.2	66.0
			Unknown	341	69.5	30.2
			Hydracarina	38	7.7	1.9
			Other			0.9
			Eggs	132	26.9	0.9
			Chironomida	364	74.1	Trace
			Dipteran	141	28.7	Trace
			Plant	175	35.6	Trace
			Coleoptera	44	9.0	Trace
			Bryozoa	100	20.4	Trace
			Trichoptera	39	7.9	Trace
			Arachnida	23	4.7	Trace
			Ephemeroptera	32	6.5	Trace
			Ceratopogonidae	31	6.3	Trace
			Cyclopoida	102	20.8	Trace
			Unid. Fish	17	3.5	Trace
			Chaoborus spp.	31	6.3	Trace
			Diaphanosoma spp.	58	11.8	Trace
			Daphnia spp.	42	8.6	Trace
			Hymenoptera	14	2.9	Trace
			Argulus spp.	15	3.1	Trace
			Podocopa	24	4.9	Trace
			Ostracoda	39	7.9	Trace
			Sididae	57	11.6	Trace
			Daphnia lumholtzi	29	5.9	Trace
			Gastropoda	14	2.9	Trace
			Calanoida	42	8.6	Trace
			Chydoridae	45	9.2	Trace
			Acarina	17	3.5	Trace
			Bosminidae	34	6.9	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1998	Bluegill	Tipulidae	4	0.8	Trace
			Lepidoptera	4	0.8	Trace
			Zygoptera	3	0.6	Trace
			Orthoptera	2	0.4	Trace
			Odonata	2	0.4	Trace
			Argulus spp.	5	1.0	Trace
			Nematoda	4	0.8	Trace
			Oligochaeta	4	0.8	Trace
			Collembola	3	0.6	Trace
			Heleidae	2	0.4	Trace
			Hemiptera	2	0.4	Trace
			Basommatophora	2	0.4	Trace
			Choncostraca	2	0.4	Trace
			Leptidora	1	0.2	Trace
			Stratiomyidae	1	0.2	Trace
			Culicidae	1	0.2	Trace
			Trichoptera cases	1	0.2	Trace
			Bosmina spp.	3	0.6	Trace
			Nematomorpha	3	0.6	Trace
			Copepoda	2	0.4	Trace
			Decapoda	2	0.4	Trace
			Amphipoda	2	0.4	Trace
			Shiner	1	0.2	Trace
			Pelecypoda	1	0.2	Trace
			Araneae	1	0.2	Trace
			Isopoda	1	0.2	Trace
			Hirudinea	1	0.2	Trace
			Cladocera	1	0.2	Trace
			Empty	37	7.5	
		Channel catfish	Other			55.3
			Unknown	158	49.2	14.9
			Plant	145	45.2	12.8
			Unid. Fish	6	1.9	6.4
			Chydoridae	17	5.3	4.3
			Unid. Invertebrate	18	5.6	2.1
			Bryozoa	18	5.6	2.1
			Collembola	2	0.6	2.1
			Chironomida	141	43.9	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1998	Channel ctafish	Dipteran	51	15.9	Trace
			Ephemeroptera	27	8.4	Trace
			Eggs	31	9.7	Trace
			Ceratopogonidae	14	4.4	Trace
			Trichoptera	9	2.8	Trace
			Chaoborus spp.	10	3.1	Trace
			Coleoptera	11	3.4	Trace
			Sididae	26	8.1	Trace
			Arachnida	4	1.2	Trace
			Lepidoptera	3	0.9	Trace
			Anisopteran	2	0.6	Trace
			Homoptera	2	0.6	Trace
			Diaphanosoma spp.	16	5.0	Trace
			Bosminidae	13	4.0	Trace
			Cyclopoida	13	4.0	Trace
			Ostracoda	4	1.2	Trace
			Oligochaeta	4	1.2	Trace
			Argulus spp.	3	0.9	Trace
			Zygoptera	2	0.6	Trace
			Decapoda	2	0.6	Trace
			Crayfish	1	0.3	Trace
			Pelecypoda	1	0.3	Trace
			Gastropoda	1	0.3	Trace
			Spheridae	1	0.3	Trace
			Nematoda	1	0.3	Trace
			Araneae	1	0.3	Trace
			Tabinidae	1	0.3	Trace
			Hirudinea	1	0.3	Trace
			Hydracarina	2	0.6	Trace
			Calanoida	2	0.6	Trace
			Hemiptera	2	0.6	Trace
			Podocopa	2	0.6	Trace
			Cladocera	2	0.6	Trace
			Lepomis spp.	1	0.3	Trace
			Daphnia spp.	1	0.3	Trace
			Bosmina spp.	1	0.3	Trace
			Veneroida	1	0.3	Trace
			Tipulidae	1	0.3	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1998	Channel catfish	Empty	101	31.5	
	1999	Largemouth bass	Gizzard shad	170	18.8	70.5
			Lepomis spp.	51	5.6	17.0
			Unid. Fish	108	11.9	6.9
			Bluegill	4	0.4	3.4
			Crayfish	3	0.3	1.2
			Largemouth bass	8	0.9	0.6
			Unknown	22	2.4	0.3
			Other			Trace
			Dipteran	17	1.9	Trace
			Chironomida	14	1.5	Trace
			Ephemeroptera	2	0.2	Trace
			Anisopteran	1	0.1	Trace
			Sididae	6	0.7	Trace
			Plant	5	0.6	Trace
			Dipteran (Adult)	5	0.6	Trace
			Hymenoptera	4	0.4	Trace
			Cyclopoida	4	0.4	Trace
			Chaoborus spp.	2	0.2	Trace
			Channel catfish	1	0.1	Trace
			Eggs	1	0.1	Trace
			Argulus spp.	1	0.1	Trace
			Zygoptera	1	0.1	Trace
			Podocopa	1	0.1	Trace
			Lumbriculida	1	0.1	Trace
			Isopoda	1	0.1	Trace
			Amphipoda	1	0.1	Trace
			Empty	693	76.6	
		Bluegill	Other			100.0
			Unknown	299	87.9	Trace
			Chironomida	283	83.2	Trace
			Plant	183	53.8	Trace
			Dipteran	157	46.2	Trace
			Sididae	89	26.2	Trace
			Eggs	77	22.6	Trace
			Podocopa	76	22.4	Trace
			Cyclopoida	74	21.8	Trace
			Bryozoa	72	21.2	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1999	Bluegill	Trichoptera	53	15.6	Trace
			Dipteran (Adult)	45	13.2	Trace
			Ephemeroptera	38	11.2	Trace
			Hymenoptera	37	10.9	Trace
			Chydoridae	37	10.9	Trace
			Hydracarina	30	8.8	Trace
			Coleoptera	26	7.6	Trace
			Chaoborus spp.	14	4.1	Trace
			Ceratopogonidae	12	3.5	Trace
			Daphnia lumholtzi	9	2.6	Trace
			Bosminidae	9	2.6	Trace
			Arachnida	6	1.8	Trace
			Basommatophora	6	1.8	Trace
			Argulus spp.	5	1.5	Trace
			Daphnia spp.	5	1.5	Trace
			Coleopteran (Adult)	5	1.5	Trace
			Zygoptera	4	1.2	Trace
			Calanoida	4	1.2	Trace
			Hemiptera	4	1.2	Trace
			Lepidoptera	3	0.9	Trace
			Unid. Fish	2	0.6	Trace
			Gastropoda	2	0.6	Trace
			Tubificidae	2	0.6	Trace
			Nematoda	2	0.6	Trace
			Amphipoda	2	0.6	Trace
			Decapoda	1	0.3	Trace
			Lumbriculida	1	0.3	Trace
			Homoptera	1	0.3	Trace
			Megaloptera	1	0.3	Trace
			Empty	39	11.5	
		Channel catfish	Gizzard shad	1	0.3	43.2
			Other			40.8
			Unknown	188	48.5	9.2
			Unid. Fish	6	1.5	3.4
			Lepomis spp.	1	0.3	3.4
			Plant	186	47.9	Trace
			Chironomida	167	43.0	Trace
			Dipteran	96	24.7	Trace

Table 10A.1. Continued.

Lake	Year	Fish Species	Item Name[1]	n	% n	% weight[2]
Newton	1999	Channel catfish	Bryozoa	49	12.6	Trace
			Ephemeroptera	51	13.1	Trace
			Eggs	25	6.4	Trace
			Trichoptera	19	4.9	Trace
			Coleoptera	18	4.6	Trace
			Dipteran (Adult)	13	3.4	Trace
			Sididae	11	2.8	Trace
			Ceratopogonidae	11	2.8	Trace
			Hymenoptera	8	2.1	Trace
			Chydoridae	8	2.1	Trace
			Chaoborus spp.	7	1.8	Trace
			Coleopteran (Adult)	6	1.5	Trace
			Arachnida	5	1.3	Trace
			Veneroida	5	1.3	Trace
			Decapoda	3	0.8	Trace
			Gastropoda	3	0.8	Trace
			Argulus spp.	2	0.5	Trace
			Zygoptera	2	0.5	Trace
			Lepidoptera	2	0.5	Trace
			Actheres	2	0.5	Trace
			Hydracarina	1	0.3	Trace
			Bosminidae	1	0.3	Trace
			Orthoptera	1	0.3	Trace
			Hemiptera	1	0.3	Trace
			Tubificidae	1	0.3	Trace
			Podocopa	1	0.3	Trace
			Tabinidae	1	0.3	Trace
			Basommatophora	1	0.3	Trace
			Amphipoda	1	0.3	Trace
			Empty	198	51.0	

1/ "Other" Item includes *en masse* weight of "Trace" weight items.
2/ "Trace" percent weights are items that were to light to weigh individually.

Table 10.A2. Overall food habits by group, expressed as number of stomachs an item occurred in (n), percent of stomachs an item occurred in (%n), and the percentage of the total weight of items in the stomachs of fishes sampled from each of the three lakes during 1997, 1998, and 1999.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Coffeen	1997	Largemouth bass	*Dorosoma* spp.	14	15.7	100.0
			Unid. Fish	31	34.8	Trace
			Lepomis spp.	9	10.1	Trace
			Miscellaneous	7	7.9	Trace
			Decapoda	1	1.1	Trace
			Unid. Invertebrate	1	1.1	Trace
			Empty	29	32.6	
		Channel catfish	Miscellaneous	14	53.8	87.5
			Lepomis spp.	1	3.8	6.3
			Unid. Fish	1	3.8	6.3
			Empty	13	50.0	
	1998	Largemouth bass	*Dorosoma* spp.	18	11.9	62.4
			Lepomis spp.	15	9.9	12.7
			Unid. Fish	19	12.6	11.7
			Decapoda	4	2.6	8.6
			Micropterus spp.	1	0.7	3.6
			Pelecypoda	2	1.3	1.0
			Miscellaneous	16	10.6	Trace
			Plant Material	1	0.7	Trace
			Empty	76	50.3	
		Bluegill	Miscellaneous	1	5.3	100.0
			Empty	18	94.7	
		Channel catfish	Miscellaneous	23	34.3	53.5
			Plant Material	9	13.4	20.9
			Decapoda	6	9.0	14.0
			Gastropoda	2	3.0	4.7
			Unid. Fish	1	1.5	2.3
			Cyprinidae	1	1.5	2.3
			Eggs	1	1.5	2.3
			Empty	29	43.3	
	1999	Largemouth bass	*Dorosoma* spp.	26	13.1	62.2
			Lepomis spp.	28	14.1	17.9

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Coffeen	1999	Largemouth bass	Unid. Fish	34	17.2	15.1
			Decapoda	4	2.0	4.3
			Miscellaneous	3	1.5	0.4
			Empty	107	54.0	
		Bluegill	Empty	1	100.0	
		Channel catfish	Decapoda	2	11.8	53.8
			Lepomis spp.	1	5.9	46.2
			Empty	14	82.4	
Egypt	1997	Largemouth bass	*Lepomis* spp.	8	8.1	100.0
			Unid. Fish	24	24.2	Trace
			Decapoda	19	19.2	Trace
			Miscellaneous	11	11.1	Trace
			Cyprinidae	1	1.0	Trace
			Empty	36	36.4	
		Channel catfish	*Lepomis* spp.	1	25.0	100.0
			Decapoda	1	25.0	Trace
			Miscellaneous	1	25.0	Trace
			Empty	1	25.0	
	1998	Largemouth bass	*Pomoxis* spp.	2	1.4	52.1
			Lepomis spp.	11	7.7	25.5
			Unid. Fish	32	22.5	9.4
			Dorosoma spp.	7	4.9	5.9
			Decapoda	10	7.0	5.0
			Micropterus spp.	2	1.4	1.2
			Cyprinidae	1	0.7	0.9
			Miscellaneous	16	11.3	Trace
			Empty	64	45.1	
		Bluegill	Empty	26	100.0	
		Channel catfish	Plant Material	8	19.5	88.4
			Unid. Fish	3	7.3	7.2
			Decapoda	8	19.5	4.3
			Miscellaneous	10	24.4	Trace
			Dorosoma spp.	2	4.9	Trace
			Lepomis spp.	2	4.9	Trace
			Pomoxis spp.	1	2.4	Trace
			Empty	10	24.4	
	1999	Largemouth bass	*Lepomis* spp.	8	14.8	73.7
			Decapoda	8	14.8	14.7

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Egypt	1999	Largemouth bass	Miscellaneous	3	5.6	7.3
			Unid. Fish	5	9.3	2.7
			Unid. Invertebrate	1	1.9	1.3
			Dorosoma spp.	1	1.9	0.2
			Plant Material	1	1.9	0.2
			Empty	29	53.7	
		Bluegill	Empty	1	100.0	
		Channel catfish	*Lepomis* spp.	4	36.4	40.9
			Dorosoma spp.	2	18.2	23.5
			Unid. Fish	1	9.1	17.4
			Miscellaneous	1	9.1	15.7
			Decapoda	1	9.1	1.7
			Hirudinea	1	9.1	0.9
			Empty	4	36.4	
Newton	1997	Largemouth bass	*Dorosoma* spp.	76	28.6	95.0
			Lepomis spp.	13	4.9	3.2
			Unid. Fish	48	18.0	1.8
			Diptera	8	3.0	Trace
			Coleoptera	5	1.9	Trace
			Unid. Invertebrate	8	3.0	Trace
			Ephemeroptera	3	1.1	Trace
			Other			Trace
			Odonata	2	0.8	Trace
			Hemiptera	2	0.8	Trace
			Arachnida	1	0.4	Trace
			Ostracoda	1	0.4	Trace
			Miscellaneous	3	1.1	Trace
			Plant Material	2	0.8	Trace
			Bryozoa	1	0.4	Trace
			Empty	120	45.1	
		Bluegill	Cladocera	138	45.1	90.0
			Bryozoa	113	36.9	10.0
			Diptera	219	71.6	Trace
			Other			Trace
			Copepoda	77	25.2	Trace
			Ostracoda	63	20.6	Trace
			Arachnida	45	14.7	Trace
			Coleoptera	43	14.1	Trace

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Newton	1997	Bluegill	Trichoptera	33	10.8	Trace
			Ephemeroptera	32	10.5	Trace
			Miscellaneous	146	47.7	Trace
			Unid. Invertebrate	29	9.5	Trace
			Plant Material	114	37.3	Trace
			Odonata	8	2.6	Trace
			Eggs	6	2.0	Trace
			Hemiptera	3	1.0	Trace
			Hymenoptera	2	0.7	Trace
			Orthoptera	1	0.3	Trace
			Collembola	1	0.3	Trace
			Unid. Fish	7	2.3	Trace
			Empty	52	17.0	
		Channel catfish	Other			27.0
			Miscellaneous	21	53.8	19.8
			Diptera	1	2.6	9.0
			Odonata	1	2.6	9.0
			Coleoptera	1	2.6	9.0
			Trichoptera	1	2.6	9.0
			Pelecypoda	1	2.6	9.0
			Plant Material	4	10.3	3.6
			Unid. Fish	3	7.7	2.7
			Unid. Invertebrate	2	5.1	1.8
			Empty	13	33.3	
	1998	Largemouth bass	*Dorosoma* spp.	160	23.4	63.8
			Unid. Fish	110	16.1	16.8
			Lepomis spp.	14	2.0	12.1
			Decapoda	7	1.0	5.6
			Micropterus spp.	3	0.4	1.2
			Ichtalurus spp.	2	0.3	0.4
			Miscellaneous	35	5.1	Trace
			Homoptera	1	0.1	Trace
			Other			Trace
			Diptera	27	3.9	Trace
			Ephemeroptera	11	1.6	Trace
			Copepoda	12	1.8	Trace
			Cladocera	12	1.8	Trace
			Plant Material	4	0.6	Trace

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Newton	1998	Largemouth bass	Coleoptera	2	0.3	Trace
			Eggs	5	0.7	Trace
			Hemiptera	5	0.7	Trace
			Unid. Invertebrate	12	1.8	Trace
			Bryozoa	3	0.4	Trace
			Arachnida	1	0.1	Trace
			Orthoptera	1	0.1	Trace
			Trichoptera	1	0.1	Trace
			Ostracoda	1	0.1	Trace
			Nematomorpha	1	0.1	Trace
			Empty	353	51.6	
		Bluegill	Unid. Invertebrate	48	9.8	66.0
			Miscellaneous	340	69.2	30.2
			Arachnida	78	15.9	1.9
			Other			0.9
			Eggs	132	26.9	0.9
			Diptera	390	79.4	Trace
			Plant Material	175	35.6	Trace
			Cladocera	199	40.5	Trace
			Coleoptera	44	9.0	Trace
			Copepoda	140	28.5	Trace
			Bryozoa	100	20.4	Trace
			Trichoptera	39	7.9	Trace
			Ostracoda	63	12.8	Trace
			Ephemeroptera	32	6.5	Trace
			Unid. Fish	12	2.4	Trace
			Hymenoptera	14	2.9	Trace
			Gastropoda	16	3.3	Trace
			Odonata	5	1.0	Trace
			Lepidoptera	4	0.8	Trace
			Orthoptera	2	0.4	Trace
			Oligochaeta	4	0.8	Trace
			Nematoda	4	0.8	Trace
			Collembola	3	0.6	Trace
			Hemiptera	2	0.4	Trace
			Choncostraca	2	0.4	Trace
			Nematomorpha	3	0.6	Trace
			Amphipoda	2	0.4	Trace

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Newton	1998	Bluegill	Decapoda	2	0.4	Trace
			Pelecypoda	1	0.2	Trace
			Isopoda	1	0.2	Trace
			Hirudinea	1	0.2	Trace
			Cyprinidae	1	0.2	Trace
			Empty	37	7.5	
		Channel catfish	Other			55.3
			Miscellaneous	158	49.2	14.9
			Plant Material	145	45.2	12.8
			Unid. Fish	6	1.9	6.4
			Cladocera	59	18.4	4.3
			Unid. Invertebrate	16	5.0	2.1
			Bryozoa	18	5.6	2.1
			Collembola	2	0.6	2.1
			Diptera	145	45.2	Trace
			Ephemeroptera	27	8.4	Trace
			Eggs	31	9.7	Trace
			Trichoptera	9	2.8	Trace
			Coleoptera	11	3.4	Trace
			Arachnida	6	1.9	Trace
			Odonata	4	1.2	Trace
			Copepoda	18	5.6	Trace
			Pelecypoda	3	0.9	Trace
			Decapoda	3	0.9	Trace
			Lepidoptera	3	0.9	Trace
			Homoptera	2	0.6	Trace
			Ostracoda	6	1.9	Trace
			Oligochaeta	4	1.2	Trace
			Gastropoda	1	0.3	Trace
			Hirudinea	1	0.3	Trace
			Nematoda	1	0.3	Trace
			Hemiptera	2	0.6	Trace
			Lepomis spp.	1	0.3	Trace
			Empty	101	31.5	
	1999	Largemouth bass	*Dorosoma* spp.	133	14.7	70.5
			Lepomis spp.	42	4.6	20.4
			Unid. Fish	85	9.4	6.9
			Decapoda	3	0.3	1.2

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Newton	1999	Largemouth bass	*Micropterus* spp.	6	0.7	0.6
			Miscellaneous	22	2.4	0.3
			Other			Trace
			Diptera	24	2.7	Trace
			Ephemeroptera	2	0.2	Trace
			Odonata	2	0.2	Trace
			Cladocera	6	0.7	Trace
			Copepoda	5	0.6	Trace
			Plant Material	5	0.6	Trace
			Hymenoptera	4	0.4	Trace
			Isopoda	1	0.1	Trace
			Ostracoda	1	0.1	Trace
			Amphipoda	1	0.1	Trace
			Oligochaeta	1	0.1	Trace
			Ichtalurus spp.	1	0.1	Trace
			Eggs	1	0.1	Trace
			Empty	628	69.4	
		Bluegill	Other			100.0
			Diptera	293	86.2	Trace
			Miscellaneous	299	87.9	Trace
			Plant Material	183	53.8	Trace
			Cladocera	110	32.4	Trace
			Copepoda	78	22.9	Trace
			Eggs	77	22.6	Trace
			Ostracoda	76	22.4	Trace
			Bryozoa	72	21.2	Trace
			Trichoptera	53	15.6	Trace
			Ephemeroptera	38	11.2	Trace
			Hymenoptera	37	10.9	Trace
			Arachnida	35	10.3	Trace
			Coleoptera	31	9.1	Trace
			Gastropoda	8	2.4	Trace
			Odonata	4	1.2	Trace
			Hemiptera	4	1.2	Trace
			Oligochaeta	3	0.9	Trace
			Lepidoptera	3	0.9	Trace
			Amphipoda	2	0.6	Trace
			Nematoda	2	0.6	Trace

Table 10A.2. Continued.

Lake	Year	Fish Species	Group Name[1]	n	%n	% weight[2]
Newton	1999	Bluegill	Unid. Fish	2	0.6	Trace
			Decapoda	1	0.3	Trace
			Homoptera	1	0.3	Trace
			Megaloptera	1	0.3	Trace
			Empty	29	8.5	
		Channel catfish	*Dorosoma* spp.	1	0.3	43.2
			Other			40.8
			Miscellaneous	188	48.5	9.2
			Unid. Fish	5	1.3	3.4
			Lepomis spp.	1	0.3	3.4
			Diptera	181	46.6	Trace
			Plant Material	186	47.9	Trace
			Bryozoa	49	12.6	Trace
			Ephemeroptera	51	13.1	Trace
			Eggs	25	6.4	Trace
			Coleoptera	23	5.9	Trace
			Cladocera	19	4.9	Trace
			Trichoptera	19	4.9	Trace
			Hymenoptera	8	2.1	Trace
			Arachnida	6	1.5	Trace
			Pelecypoda	5	1.3	Trace
			Gastropoda	4	1.0	Trace
			Copepoda	4	1.0	Trace
			Decapoda	3	0.8	Trace
			Odonata	2	0.5	Trace
			Lepidoptera	2	0.5	Trace
			Hemiptera	1	0.3	Trace
			Ostracoda	1	0.3	Trace
			Amphipoda	1	0.3	Trace
			Oligochaeta	1	0.3	Trace
			Orthoptera	1	0.3	Trace
			Empty	184	47.4	

1/ "Other" group includes *en masse* weight of "Trace" weight items.
2/ "Trace" percent weights are items that were to light to weigh individually.

Table 10.A3. Overall food habits to the lowest identifiable taxon expressed as number of stomachs an item occurred in (n), percent of stomachs an item occurred in, and a percentage of the total weight of items in the stomachs of bluegill sampled from each of the four segments of Newton Lake during 1997, 1998 and 1999.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1997	1	*Daphnia lumholtzi*	13	15.5	90.0
1997	1	Bryozoa	35	41.7	10.0
1997	1	Chironomida	60	71.4	Trace
1997	1	Other			Trace
1997	1	Ostracoda	30	35.7	Trace
1997	1	Dipteran	20	23.8	Trace
1997	1	Chydoridae	17	20.2	Trace
1997	1	Coleoptera	17	20.2	Trace
1997	1	Calanoida	14	16.7	Trace
1997	1	*Bosmina* spp.	13	15.5	Trace
1997	1	Ephemeroptera	9	10.7	Trace
1997	1	Unknown	54	64.3	Trace
1997	1	Hydracarina	6	7.1	Trace
1997	1	Trichoptera	6	7.1	Trace
1997	1	Sididae	6	7.1	Trace
1997	1	Cyclopoida	6	7.1	Trace
1997	1	*Diaphanosoma* spp.	5	6.0	Trace
1997	1	*Daphnia* spp.	5	6.0	Trace
1997	1	Arachnida	5	6.0	Trace
1997	1	Unid. Invertebrate	8	9.5	Trace
1997	1	*Argulus* spp.	4	4.8	Trace
1997	1	Plant	34	40.5	Trace
1997	1	Eggs	3	3.6	Trace
1997	1	Heleidae	3	3.6	Trace
1997	1	Zygoptera	2	2.4	Trace
1997	1	Bosminidae	2	2.4	Trace
1997	1	Hymenoptera	1	1.2	Trace
1997	1	Unid. Fish	2	2.4	Trace
1997	1	Empty	10	11.9	
1998	1	Unknown	68	64.8	99.8
1998	1	Other			Trace
1998	1	Chironomida	65	61.9	Trace
1998	1	Eggs	34	32.4	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1998	1	Dipteran	27	25.7	Trace
1998	1	Plant	40	38.1	Trace
1998	1	Bryozoa	29	27.6	Trace
1998	1	Coleoptera	8	7.6	Trace
1998	1	Unid. Invertebrate	9	8.6	Trace
1998	1	Arachnida	5	4.8	Trace
1998	1	Ostracoda	10	9.5	Trace
1998	1	*Argulus* spp.	5	4.8	Trace
1998	1	Trichoptera	4	3.8	Trace
1998	1	Sididae	21	20.0	Trace
1998	1	Gastropoda	3	2.9	Trace
1998	1	Cyclopoida	14	13.3	Trace
1998	1	Hymenoptera	2	1.9	Trace
1998	1	Odonata	2	1.9	Trace
1998	1	Calanoida	8	7.6	Trace
1998	1	Chydoridae	14	13.3	Trace
1998	1	*Chaoborus* spp.	4	3.8	Trace
1998	1	*Daphnia* spp.	4	3.8	Trace
1998	1	Hydracarina	2	1.9	Trace
1998	1	Ceratopogonidae	2	1.9	Trace
1998	1	Basommatophora	1	1.0	Trace
1998	1	Leptidora	1	1.0	Trace
1998	1	Culicidae	1	1.0	Trace
1998	1	*Diaphanosoma* spp.	9	8.6	Trace
1998	1	Bosminidae	7	6.7	Trace
1998	1	Podocopa	3	2.9	Trace
1998	1	*Bosmina* spp.	1	1.0	Trace
1998	1	*Argulus* spp.	1	1.0	Trace
1998	1	Acarina	1	1.0	Trace
1998	1	Empty	7	6.7	
1999	1	Other			100.0
1999	1	Unknown	76	89.4	Trace
1999	1	Chironomida	72	84.7	Trace
1999	1	Plant	48	56.5	Trace
1999	1	Dipteran	38	44.7	Trace
1999	1	Bryozoa	34	40.0	Trace
1999	1	Podocopa	29	34.1	Trace
1999	1	Sididae	24	28.2	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1999	1	Eggs	20	23.5	Trace
1999	1	Cyclopoida	15	17.6	Trace
1999	1	Dipteran (Adult)	14	16.5	Trace
1999	1	Chydoridae	8	9.4	Trace
1999	1	Trichoptera	7	8.2	Trace
1999	1	*Chaoborus* spp.	7	8.2	Trace
1999	1	Coleoptera	5	5.9	Trace
1999	1	Hymenoptera	5	5.9	Trace
1999	1	Ephemeroptera	3	3.5	Trace
1999	1	Hydracarina	3	3.5	Trace
1999	1	Bosminidae	3	3.5	Trace
1999	1	Ceratopogonidae	2	2.4	Trace
1999	1	Hemiptera	1	1.2	Trace
1999	1	Decapoda	1	1.2	Trace
1999	1	Tubificidae	1	1.2	Trace
1999	1	Coleopteran (Adult)	1	1.2	Trace
1999	1	Empty	7	8.2	
1997	2	Chironomida	51	65.4	19.0
1997	2	Other			16.6
1997	2	Ostracoda	19	24.4	7.3
1997	2	Sididae	14	17.9	5.4
1997	2	Dipteran	12	15.4	4.6
1997	2	Ephemeroptera	11	14.1	4.2
1997	2	Cyclopoida	11	14.1	4.2
1997	2	Calanoida	11	14.1	4.2
1997	2	Hydracarina	11	14.1	3.9
1997	2	Trichoptera	9	11.5	3.5
1997	2	*Daphnia lumholtzi*	8	10.3	3.1
1997	2	Chydoridae	8	10.3	3.1
1997	2	*Bosmina* spp.	7	9.0	2.7
1997	2	Coleoptera	7	9.0	2.4
1997	2	Unknown	30	38.5	2.2
1997	2	Bryozoa	20	25.6	1.8
1997	2	*Diaphanosoma* spp.	4	5.1	1.5
1997	2	Bosminidae	4	5.1	1.5
1997	2	Plant	40	51.3	1.5
1997	2	Unid. Invertebrate	4	5.1	1.2
1997	2	*Daphnia* spp.	3	3.8	1.2

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1997	2	Anisopteran	3	3.8	1.2
1997	2	Arachnida	3	3.8	1.2
1997	2	Hemiptera	2	2.6	0.8
1997	2	*Argulus* spp.	1	1.3	0.4
1997	2	Zygoptera	1	1.3	0.4
1997	2	Collembola	1	1.3	0.4
1997	2	Cladocera	1	1.3	0.4
1997	2	Empty	18	23.1	
1998	2	Hydracarina	14	10.9	66.6
1998	2	Other			33.3
1998	2	Chironomida	95	73.6	Trace
1998	2	Unknown	96	74.4	Trace
1998	2	Eggs	42	32.6	Trace
1998	2	Dipteran	21	16.3	Trace
1998	2	Plant	60	46.5	Trace
1998	2	Podocopa	12	9.3	Trace
1998	2	Bryozoa	35	27.1	Trace
1998	2	Trichoptera	11	8.5	Trace
1998	2	Ephemeroptera	8	6.2	Trace
1998	2	Unid. Invertebrate	10	7.8	Trace
1998	2	Coleoptera	6	4.7	Trace
1998	2	*Chaoborus* spp.	5	3.9	Trace
1998	2	Hymenoptera	4	3.1	Trace
1998	2	*Argulus* spp.	3	2.3	Trace
1998	2	Ostracoda	17	13.2	Trace
1998	2	Sididae	16	12.4	Trace
1998	2	Cyclopoida	25	19.4	Trace
1998	2	Ceratopogonidae	4	3.1	Trace
1998	2	Calanoida	15	11.6	Trace
1998	2	*Diaphanosoma* spp.	12	9.3	Trace
1998	2	*Daphnia lumholtzi*	3	2.3	Trace
1998	2	Chydoridae	11	8.5	Trace
1998	2	Arachnida	2	1.6	Trace
1998	2	*Daphnia* spp.	10	7.8	Trace
1998	2	Hemiptera	1	0.8	Trace
1998	2	Gastropoda	1	0.8	Trace
1998	2	Tipulidae	1	0.8	Trace
1998	2	Bosminidae	9	7.0	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1998	2	*Argulus* spp.	3	2.3	Trace
1998	2	Shiner	1	0.8	Trace
1998	2	*Bosmina* spp.	1	0.8	Trace
1998	2	Nematoda	1	0.8	Trace
1998	2	Acarina	1	0.8	Trace
1998	2	Choncostraca	1	0.8	Trace
1998	2	Lepidoptera	1	0.8	Trace
1998	2	Empty	12	9.3	
1999	2	Other			62.9
1999	2	Unknown	72	84.7	6.0
1999	2	Chironomida	69	81.2	5.8
1999	2	Plant	51	60.0	4.3
1999	2	Dipteran	36	42.4	3.0
1999	2	Sididae	32	37.6	2.7
1999	2	Cyclopoida	25	29.4	2.1
1999	2	Bryozoa	22	25.9	1.8
1999	2	Podocopa	22	25.9	1.8
1999	2	Trichoptera	16	18.8	1.3
1999	2	Chydoridae	16	18.8	1.3
1999	2	Eggs	14	16.5	1.2
1999	2	Ephemeroptera	13	15.3	1.1
1999	2	Hymenoptera	11	12.9	0.9
1999	2	Hydracarina	8	9.4	0.7
1999	2	Dipteran (Adult)	8	9.4	0.7
1999	2	Zygoptera	4	4.7	0.3
1999	2	Coleoptera	4	4.7	0.3
1999	2	Arachnida	4	4.7	0.3
1999	2	*Chaoborus* spp.	2	2.4	0.2
1999	2	Ceratopogonidae	2	2.4	0.2
1999	2	Basommatophora	2	2.4	0.2
1999	2	Lepidoptera	2	2.4	0.2
1999	2	*Argulus* spp.	1	1.2	Trace
1999	2	*Daphnia* spp.	1	1.2	Trace
1999	2	Bosminidae	1	1.2	Trace
1999	2	Calanoida	1	1.2	Trace
1999	2	Gastropoda	1	1.2	Trace
1999	2	Homoptera	1	1.2	Trace
1999	2	Coleopteran (Adult)	1	1.2	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1999	2	Empty	13	15.3	
1997	3	Chironomida	65	80.2	18.5
1997	3	Other			17.6
1997	3	*Daphnia lumholtzi*	27	33.3	8.5
1997	3	Dipteran	19	23.5	6.0
1997	3	Calanoida	16	19.8	5.0
1997	3	Chydoridae	15	18.5	4.7
1997	3	Coleoptera	15	18.5	3.9
1997	3	Ostracoda	12	14.8	3.5
1997	3	Sididae	11	13.6	3.5
1997	3	Arachnida	10	12.3	3.1
1997	3	Cyclopoida	9	11.1	2.8
1997	3	*Bosmina* spp.	9	11.1	2.8
1997	3	Ephemeroptera	8	9.9	2.5
1997	3	Trichoptera	7	8.6	2.2
1997	3	Unknown	36	44.4	2.0
1997	3	*Diaphanosoma* spp.	6	7.4	1.9
1997	3	Bryozoa	38	46.9	1.8
1997	3	Hydracarina	5	6.2	1.3
1997	3	*Daphnia* spp.	4	4.9	1.3
1997	3	Unid. Invertebrate	12	14.8	1.2
1997	3	Eggs	3	3.7	0.9
1997	3	*Argulus* spp.	3	3.7	0.9
1997	3	Bosminidae	3	3.7	0.9
1997	3	Plant	29	35.8	0.9
1997	3	Anisopteran	2	2.5	0.6
1997	3	Heleidae	2	2.5	0.6
1997	3	Leptidora	2	2.5	0.6
1997	3	Hymenoptera	1	1.2	0.3
1997	3	Unid. Fish	2	2.5	Trace
1997	3	Empty	11	13.6	
1998	3	Unknown	72	62.1	99.7
1998	3	Other			Trace
1998	3	Chironomida	88	75.9	Trace
1998	3	Dipteran	42	36.2	Trace
1998	3	Plant	33	28.4	Trace
1998	3	Coleoptera	19	16.4	Trace
1998	3	Eggs	27	23.3	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1998	3	Unid. Invertebrate	13	11.2	Trace
1998	3	*Diaphanosoma* spp.	19	16.4	Trace
1998	3	*Daphnia* spp.	15	12.9	Trace
1998	3	Unid. Fish	8	6.9	Trace
1998	3	Trichoptera	9	7.8	Trace
1998	3	Ephemeroptera	6	5.2	Trace
1998	3	Cyclopoida	27	23.3	Trace
1998	3	Arachnida	4	3.4	Trace
1998	3	*Daphnia lumholtzi*	12	10.3	Trace
1998	3	*Argulus* spp.	3	2.6	Trace
1998	3	Hydracarina	10	8.6	Trace
1998	3	Ostracoda	9	7.8	Trace
1998	3	Acarina	9	7.8	Trace
1998	3	*Chaoborus* spp.	7	6.0	Trace
1998	3	Calanoida	14	12.1	Trace
1998	3	Gastropoda	5	4.3	Trace
1998	3	Hymenoptera	3	2.6	Trace
1998	3	Ceratopogonidae	3	2.6	Trace
1998	3	Orthoptera	2	1.7	Trace
1998	3	Lepidoptera	2	1.7	Trace
1998	3	Bryozoa	7	6.0	Trace
1998	3	Bosminidae	11	9.5	Trace
1998	3	Sididae	11	9.5	Trace
1998	3	Chydoridae	10	8.6	Trace
1998	3	*Argulus* spp.	1	0.9	Trace
1998	3	Tipulidae	1	0.9	Trace
1998	3	Choncostraca	1	0.9	Trace
1998	3	Pelecypoda	1	0.9	Trace
1998	3	Collembola	1	0.9	Trace
1998	3	Hemiptera	1	0.9	Trace
1998	3	Decapoda	1	0.9	Trace
1998	3	*Bosmina* spp.	1	0.9	Trace
1998	3	Podocopa	1	0.9	Trace
1998	3	Oligochaeta	1	0.9	Trace
1998	3	Amphipoda	1	0.9	Trace
1998	3	Empty	7	6.0	
1999	3	Other			100.0
1999	3	Unknown	76	86.4	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1999	3	Chironomida	66	75.0	Trace
1999	3	Dipteran	42	47.7	Trace
1999	3	Plant	40	45.5	Trace
1999	3	Eggs	23	26.1	Trace
1999	3	Podocopa	16	18.2	Trace
1999	3	Trichoptera	15	17.0	Trace
1999	3	Sididae	14	15.9	Trace
1999	3	Cyclopoida	14	15.9	Trace
1999	3	Ephemeroptera	11	12.5	Trace
1999	3	Hymenoptera	10	11.4	Trace
1999	3	Dipteran (Adult)	8	9.1	Trace
1999	3	Hydracarina	6	6.8	Trace
1999	3	*Daphnia lumholtzi*	6	6.8	Trace
1999	3	Coleoptera	6	6.8	Trace
1999	3	Bryozoa	6	6.8	Trace
1999	3	Chydoridae	5	5.7	Trace
1999	3	Ceratopogonidae	5	5.7	Trace
1999	3	*Daphnia* spp.	4	4.5	Trace
1999	3	*Argulus* spp.	3	3.4	Trace
1999	3	*Chaoborus* spp.	3	3.4	Trace
1999	3	Bosminidae	2	2.3	Trace
1999	3	Basommatophora	2	2.3	Trace
1999	3	Arachnida	1	1.1	Trace
1999	3	Empty	16	18.2	
1997	4	Chironomida	45	71.4	23.8
1997	4	Other			19.0
1997	4	*Daphnia lumholtzi*	16	25.4	9.8
1997	4	Calanoida	13	20.6	7.4
1997	4	Trichoptera	12	19.0	7.4
1997	4	Cyclopoida	5	7.9	3.1
1997	4	Unknown	31	49.2	3.0
1997	4	Bryozoa	20	31.7	2.9
1997	4	Unid. Invertebrate	5	7.9	2.5
1997	4	Ephemeroptera	4	6.3	2.5
1997	4	Hydracarina	4	6.3	2.5
1997	4	Coleoptera	4	6.3	2.5
1997	4	*Diaphanosoma* spp.	3	4.8	1.8
1997	4	Sididae	3	4.8	1.8

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1997	4	Chydoridae	3	4.8	1.8
1997	4	Arachnida	3	4.8	1.8
1997	4	Dipteran	2	3.2	1.2
1997	4	Ostracoda	2	3.2	1.2
1997	4	Plant	11	17.5	0.7
1997	4	*Argulus* spp.	1	1.6	0.6
1997	4	*Daphnia* spp.	1	1.6	0.6
1997	4	Orthoptera	1	1.6	0.6
1997	4	Hemiptera	1	1.6	0.6
1997	4	*Argulus* spp.	1	1.6	0.6
1997	4	Unid. Fish	3	4.8	0.2
1997	4	Empty	13	20.6	
1998	4	Unid. Invertebrate	16	14.3	69.3
1998	4	Unknown	81	72.3	29.7
1998	4	Eggs	29	25.9	1.0
1998	4	Other			Trace
1998	4	Chironomida	92	82.1	Trace
1998	4	Dipteran	35	31.3	Trace
1998	4	Plant	39	34.8	Trace
1998	4	Bryozoa	24	21.4	Trace
1998	4	Ceratopogonidae	19	17.0	Trace
1998	4	Unid. Fish	9	8.0	Trace
1998	4	Coleoptera	8	7.1	Trace
1998	4	Arachnida	7	6.3	Trace
1998	4	Trichoptera	13	11.6	Trace
1998	4	Cyclopoida	34	30.4	Trace
1998	4	Ephemeroptera	14	12.5	Trace
1998	4	*Daphnia lumholtzi*	14	12.5	Trace
1998	4	*Chaoborus* spp.	10	8.9	Trace
1998	4	*Diaphanosoma* spp.	18	16.1	Trace
1998	4	Sididae	9	8.0	Trace
1998	4	*Daphnia* spp.	13	11.6	Trace
1998	4	*Argulus* spp.	4	3.6	Trace
1998	4	Hydracarina	11	9.8	Trace
1998	4	Zygoptera	2	1.8	Trace
1998	4	Hymenoptera	2	1.8	Trace
1998	4	Chydoridae	10	8.9	Trace
1998	4	Acarina	6	5.4	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1998	4	Gastropoda	5	4.5	Trace
1998	4	Oligochaeta	3	2.7	Trace
1998	4	Nematoda	3	2.7	Trace
1998	4	Heleidae	2	1.8	Trace
1998	4	Tipulidae	2	1.8	Trace
1998	4	Stratiomyidae	1	0.9	Trace
1998	4	Lepidoptera	1	0.9	Trace
1998	4	Podocopa	8	7.1	Trace
1998	4	Bosminidae	7	6.3	Trace
1998	4	Ostracoda	3	2.7	Trace
1998	4	Calanoida	3	2.7	Trace
1998	4	Nematomorpha	3	2.7	Trace
1998	4	Copepoda	2	1.8	Trace
1998	4	Collembola	1	0.9	Trace
1998	4	Decapoda	1	0.9	Trace
1998	4	Araneae	1	0.9	Trace
1998	4	Isopoda	1	0.9	Trace
1998	4	Basommatophora	1	0.9	Trace
1998	4	Amphipoda	1	0.9	Trace
1998	4	Hirudinea	1	0.9	Trace
1998	4	Cladocera	1	0.9	Trace
1998	4	Empty	11	9.8	
1999	4	Other			100.0
1999	4	Chironomida	76	92.7	Trace
1999	4	Unknown	75	91.5	Trace
1999	4	Plant	44	53.7	Trace
1999	4	Dipteran	41	50.0	Trace
1999	4	Eggs	20	24.4	Trace
1999	4	Cyclopoida	20	24.4	Trace
1999	4	Sididae	19	23.2	Trace
1999	4	Trichoptera	15	18.3	Trace
1999	4	Dipteran (Adult)	15	18.3	Trace
1999	4	Hydracarina	13	15.9	Trace
1999	4	Ephemeroptera	11	13.4	Trace
1999	4	Coleoptera	11	13.4	Trace
1999	4	Hymenoptera	11	13.4	Trace
1999	4	Bryozoa	10	12.2	Trace
1999	4	Podocopa	9	11.0	Trace

Table 10.A3. Continued.

Year	Segment	Item Name[1]	n	% n	% weight[2]
1999	4	Chydoridae	8	9.8	Trace
1999	4	*Daphnia lumholtzi*	3	3.7	Trace
1999	4	Bosminidae	3	3.7	Trace
1999	4	Calanoida	3	3.7	Trace
1999	4	Hemiptera	3	3.7	Trace
1999	4	Ceratopogonidae	3	3.7	Trace
1999	4	Coleopteran (Adult)	3	3.7	Trace
1999	4	Unid. Fish	2	2.4	Trace
1999	4	*Chaoborus* spp.	2	2.4	Trace
1999	4	Nematoda	2	2.4	Trace
1999	4	Basommatophora	2	2.4	Trace
1999	4	Amphipoda	2	2.4	Trace
1999	4	*Argulus* spp.	1	1.2	Trace
1999	4	Gastropoda	1	1.2	Trace
1999	4	Arachnida	1	1.2	Trace
1999	4	Tubificidae	1	1.2	Trace
1999	4	Lumbriculida	1	1.2	Trace
1999	4	Lepidoptera	1	1.2	Trace
1999	4	Megaloptera	1	1.2	Trace
1999	4	Empty	3	3.7	

1/ "Other" items includes *en masse* weight of "Trace" weight items.

2/ "Trace" percent weights are items that were to light to weigh individually.

Table 10.A4. Overall Food habits by grouping expressed as number of stomachs an item occurred in (n), percent of stomachs an item occurred in, and a percentage of the total weight of items in the stomachs of bluegill sampled from each of the four segments of Newton Lake during 1997, 1998 and 1999.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1997	1	Cladocera	40	47.6	90.0
1997	1	Bryozoa	35	41.7	10.0
1997	1	Diptera	61	72.6	Trace
1997	1	Other			Trace
1997	1	Ostracoda	30	35.7	Trace
1997	1	Copepoda	20	23.8	Trace
1997	1	Coleoptera	17	20.2	Trace
1997	1	Arachnida	10	11.9	Trace
1997	1	Ephemeroptera	9	10.7	Trace
1997	1	Miscellaneous	54	64.3	Trace
1997	1	Trichoptera	5	6.0	Trace
1997	1	Unid. Invertebrate	8	9.5	Trace
1997	1	Plant Material	34	40.5	Trace
1997	1	Eggs	3	3.6	Trace
1997	1	Odonata	2	2.4	Trace
1997	1	Hymenoptera	1	1.2	Trace
1997	1	Unid. Fish	2	2.4	Trace
1997	1	Empty	10	11.9	
1998	1	Miscellaneous	68	64.8	99.8
1998	1	Diptera	77	73.3	Trace
1998	1	Other			Trace
1998	1	Eggs	34	32.4	Trace
1998	1	Plant Material	40	38.1	Trace
1998	1	Bryozoa	29	27.6	Trace
1998	1	Cladocera	37	35.2	Trace
1998	1	Coleoptera	8	7.6	Trace
1998	1	Copepoda	26	24.8	Trace
1998	1	Unid. Invertebrate	9	8.6	Trace
1998	1	Arachnida	8	7.6	Trace
1998	1	Gastropoda	4	3.8	Trace
1998	1	Ostracoda	13	12.4	Trace
1998	1	Trichoptera	4	3.8	Trace
1998	1	Odonata	2	1.9	Trace

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1998	1	Hymenoptera	2	1.9	Trace
1998	1	Empty	7	6.7	
1999	1	Other			100.0
1999	1	Diptera	77	90.6	Trace
1999	1	Miscellaneous	76	89.4	Trace
1999	1	Plant Material	48	56.5	Trace
1999	1	Cladocera	27	31.8	Trace
1999	1	Bryozoa	34	40.0	Trace
1999	1	Ostracoda	29	34.1	Trace
1999	1	Eggs	20	23.5	Trace
1999	1	Copepoda	15	17.6	Trace
1999	1	Trichoptera	7	8.2	Trace
1999	1	Coleoptera	6	7.1	Trace
1999	1	Hymenoptera	5	5.9	Trace
1999	1	Ephemeroptera	3	3.5	Trace
1999	1	Arachnida	3	3.5	Trace
1999	1	Hemiptera	1	1.2	Trace
1999	1	Oligochaeta	1	1.2	Trace
1999	1	Decapoda	1	1.2	Trace
1999	1	Empty	5	5.9	
1997	2	Diptera	50	64.1	23.6
1997	2	Cladocera	30	38.5	18.9
1997	2	Other			16.6
1997	2	Copepoda	17	21.8	8.9
1997	2	Ostracoda	19	24.4	7.3
1997	2	Arachnida	13	16.7	5.1
1997	2	Ephemeroptera	11	14.1	4.2
1997	2	Trichoptera	9	11.5	3.5
1997	2	Coleoptera	7	9.0	2.4
1997	2	Miscellaneous	29	37.2	2.2
1997	2	Bryozoa	20	25.6	1.8
1997	2	Odonata	4	5.1	1.5
1997	2	Plant Material	40	51.3	1.5
1997	2	Unid. Invertebrate	4	5.1	1.2
1997	2	Hemiptera	2	2.6	0.8
1997	2	Collembola	1	1.3	0.4
1997	2	Empty	18	23.1	
1998	2	Arachnida	17	13.2	66.6

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1998	2	Other			33.3
1998	2	Diptera	96	74.4	Trace
1998	2	Miscellaneous	95	73.6	Trace
1998	2	Eggs	42	32.6	Trace
1998	2	Plant Material	60	46.5	Trace
1998	2	Ostracoda	29	22.5	Trace
1998	2	Bryozoa	35	27.1	Trace
1998	2	Cladocera	50	38.8	Trace
1998	2	Trichoptera	11	8.5	Trace
1998	2	Copepoda	39	30.2	Trace
1998	2	Ephemeroptera	8	6.2	Trace
1998	2	Unid. Invertebrate	9	7.0	Trace
1998	2	Coleoptera	6	4.7	Trace
1998	2	Hymenoptera	4	3.1	Trace
1998	2	Hemiptera	1	0.8	Trace
1998	2	Gastropoda	1	0.8	Trace
1998	2	Choncostraca	1	0.8	Trace
1998	2	Lepidoptera	1	0.8	Trace
1998	2	Nematoda	1	0.8	Trace
1998	2	Cyprinidae	1	0.8	Trace
1998	2	Empty	12	9.3	
1999	2	Other			62.9
1999	2	Diptera	71	83.5	9.8
1999	2	Miscellaneous	72	84.7	6.0
1999	2	Plant Material	51	60.0	4.3
1999	2	Cladocera	36	42.4	4.2
1999	2	Copepoda	26	30.6	2.3
1999	2	Bryozoa	22	25.9	1.8
1999	2	Ostracoda	22	25.9	1.8
1999	2	Trichoptera	16	18.8	1.3
1999	2	Eggs	14	16.5	1.2
1999	2	Ephemeroptera	13	15.3	1.1
1999	2	Arachnida	12	14.1	1.0
1999	2	Hymenoptera	11	12.9	0.9
1999	2	Coleoptera	5	5.9	0.4
1999	2	Odonata	4	4.7	0.3
1999	2	Gastropoda	3	3.5	0.3
1999	2	Lepidoptera	2	2.4	0.2

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1999	2	Homoptera	1	1.2	Trace
1999	2	Empty	10	11.8	
1997	3	Diptera	64	79.0	25.1
1997	3	Cladocera	45	55.6	24.2
1997	3	Other			17.6
1997	3	Copepoda	22	27.2	8.8
1997	3	Arachnida	15	18.5	4.4
1997	3	Coleoptera	15	18.5	3.9
1997	3	Ostracoda	12	14.8	3.5
1997	3	Ephemeroptera	8	9.9	2.5
1997	3	Trichoptera	7	8.6	2.2
1997	3	Miscellaneous	36	44.4	2.0
1997	3	Bryozoa	38	46.9	1.8
1997	3	Unid. Invertebrate	12	14.8	1.2
1997	3	Eggs	3	3.7	0.9
1997	3	Plant Material	29	35.8	0.9
1997	3	Odonata	2	2.5	0.6
1997	3	Hymenoptera	1	1.2	0.3
1997	3	Unid. Fish	2	2.5	Trace
1997	3	Empty	11	13.6	
1998	3	Miscellaneous	72	62.1	99.7
1998	3	Diptera	96	82.8	Trace
1998	3	Other			Trace
1998	3	Cladocera	60	51.7	Trace
1998	3	Plant Material	33	28.4	Trace
1998	3	Coleoptera	19	16.4	Trace
1998	3	Eggs	27	23.3	Trace
1998	3	Copepoda	35	30.2	Trace
1998	3	Arachnida	23	19.8	Trace
1998	3	Unid. Invertebrate	13	11.2	Trace
1998	3	Unid. Fish	5	4.3	Trace
1998	3	Trichoptera	9	7.8	Trace
1998	3	Ephemeroptera	6	5.2	Trace
1998	3	Ostracoda	10	8.6	Trace
1998	3	Gastropoda	5	4.3	Trace
1998	3	Hymenoptera	3	2.6	Trace
1998	3	Orthoptera	2	1.7	Trace
1998	3	Lepidoptera	2	1.7	Trace

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1998	3	Bryozoa	7	6.0	Trace
1998	3	Choncostraca	1	0.9	Trace
1998	3	Pelecypoda	1	0.9	Trace
1998	3	Hemiptera	1	0.9	Trace
1998	3	Amphipoda	1	0.9	Trace
1998	3	Oligochaeta	1	0.9	Trace
1998	3	Collembola	1	0.9	Trace
1998	3	Decapoda	1	0.9	Trace
1998	3	Empty	7	6.0	
1999	3	Other			100.0
1999	3	Diptera	68	77.3	Trace
1999	3	Miscellaneous	76	86.4	Trace
1999	3	Plant Material	40	45.5	Trace
1999	3	Cladocera	22	25.0	Trace
1999	3	Eggs	23	26.1	Trace
1999	3	Copepoda	16	18.2	Trace
1999	3	Ostracoda	16	18.2	Trace
1999	3	Trichoptera	15	17.0	Trace
1999	3	Ephemeroptera	11	12.5	Trace
1999	3	Hymenoptera	10	11.4	Trace
1999	3	Arachnida	7	8.0	Trace
1999	3	Coleoptera	6	6.8	Trace
1999	3	Bryozoa	6	6.8	Trace
1999	3	Gastropoda	2	2.3	Trace
1999	3	Empty	11	12.5	
1997	4	Diptera	44	69.8	25.0
1997	4	Other			19.0
1997	4	Cladocera	23	36.5	16.0
1997	4	Copepoda	18	28.6	11.7
1997	4	Trichoptera	12	19.0	7.4
1997	4	Arachnida	7	11.1	4.3
1997	4	Miscellaneous	27	42.9	3.0
1997	4	Bryozoa	20	31.7	2.9
1997	4	Unid. Invertebrate	5	7.9	2.5
1997	4	Ephemeroptera	4	6.3	2.5
1997	4	Coleoptera	4	6.3	2.5
1997	4	Ostracoda	2	3.2	1.2
1997	4	Plant Material	11	17.5	0.7

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1997	4	Hemiptera	1	1.6	0.6
1997	4	Orthoptera	1	1.6	0.6
1997	4	Unid. Fish	3	4.8	0.2
1997	4	Empty	13	20.6	
1998	4	Unid. Invertebrate	15	13.4	69.3
1998	4	Miscellaneous	81	72.3	29.7
1998	4	Eggs	29	25.9	1.0
1998	4	Diptera	95	84.8	Trace
1998	4	Other			Trace
1998	4	Cladocera	52	46.4	Trace
1998	4	Plant Material	39	34.8	Trace
1998	4	Arachnida	24	21.4	Trace
1998	4	Copepoda	37	33.0	Trace
1998	4	Bryozoa	24	21.4	Trace
1998	4	Unid. Fish	7	6.3	Trace
1998	4	Coleoptera	8	7.1	Trace
1998	4	Trichoptera	13	11.6	Trace
1998	4	Ephemeroptera	14	12.5	Trace
1998	4	Odonata	2	1.8	Trace
1998	4	Hymenoptera	2	1.8	Trace
1998	4	Gastropoda	6	5.4	Trace
1998	4	Oligochaeta	3	2.7	Trace
1998	4	Nematoda	3	2.7	Trace
1998	4	Ostracoda	11	9.8	Trace
1998	4	Lepidoptera	1	0.9	Trace
1998	4	Nematomorpha	3	2.7	Trace
1998	4	Isopoda	1	0.9	Trace
1998	4	Amphipoda	1	0.9	Trace
1998	4	Hirudinea	1	0.9	Trace
1998	4	Collembola	1	0.9	Trace
1998	4	Decapoda	1	0.9	Trace
1998	4	Empty	11	9.8	
1999	4	Other			100.0
1999	4	Diptera	77	93.9	Trace
1999	4	Miscellaneous	75	91.5	Trace
1999	4	Plant Material	44	53.7	Trace
1999	4	Cladocera	25	30.5	Trace
1999	4	Copepoda	21	25.6	Trace

Table 10.A4. Continued.

Year	Segment	Group Name[1]	n	% n	% weight[2]
1999	4	Eggs	20	24.4	Trace
1999	4	Trichoptera	15	18.3	Trace
1999	4	Arachnida	13	15.9	Trace
1999	4	Coleoptera	14	17.1	Trace
1999	4	Ephemeroptera	11	13.4	Trace
1999	4	Hymenoptera	11	13.4	Trace
1999	4	Bryozoa	10	12.2	Trace
1999	4	Ostracoda	9	11.0	Trace
1999	4	Hemiptera	3	3.7	Trace
1999	4	Gastropoda	3	3.7	Trace
1999	4	Amphipoda	2	2.4	Trace
1999	4	Oligochaeta	2	2.4	Trace
1999	4	Nematoda	2	2.4	Trace
1999	4	Unid. Fish	2	2.4	Trace
1999	4	Lepidoptera	1	1.2	Trace
1999	4	Megaloptera	1	1.2	Trace
1999	4	Empty	3	3.7	

1/ "Other" group includes *en masse* weight of "Trace" weight items.
2/ "Trace" percent weights are items that were to light to weigh individually.

No

Volume II

AmerenCIPS Newton Lake Project

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Chapter 12. Young-of-the-Year Fish and Recruitment

Introduction:

Documentation of young-of-the-year fish (age-0+) and recruitment (age-1+) is necessary to determine the status of a fish community in terms of sustaining adequate numbers. Depending on the rates of recruitment, exploitation, and natural mortality, failure of only two or three consecutive year-classes could result in a significant reduction in a fishery.

The purpose of this chapter was to monitor reproduction and recruitment of largemouth bass and bluegill in order to determine the future status of those species in each of the three power-cooling lakes.

Methods:

The occurrence of young-of-the-year (y-o-y) fish was documented by shoreline seining once in August 1997 and twice a month during April through August 1998 and 1999. Samples were taken with a 30-ft. long, 6 ft. deep, 0.25-inch bar mesh bag seine. In order to quantify the effort, each seine haul was approximately 200 ft^2 of shore area. Ten seine hauls were made in each of the four lake segments in Newton Lake and each of two segments in Coffeen Lake and Lake of Egypt. Small fish not identifiable at the lakes were fixed in 10% formalin and returned to the laboratory where they were identified to the lowest possible taxa and counted. When large numbers were present, a random subsample of 100 specimens of each target taxa from each lake segment on each sampling date was measured for total length, and the rest of the fish were enumerated.

The three lakes were initially seined in August 1997 to estimate species abundance (catch per seine haul or CPU) and diversity of all fish vulnerable to seining which included age-0+

largemouth bass (*Micropterus salmoides*) and from age-0+ through age-1+ bluegill (*Lepomis macrochirus*). Age-1+ largemouth bass abundance (CPUE) was determined for each lake and year from fall electrofishing samples. Age-1+ largemouth bass were collected by Southern Illinois University personnel during periods when fish were collected for mortality and/or age and growth estimates. Ages were determined by examining saggittae otoliths.

Results:

Age-1+ largemouth bass abundance in Newton Lake was highest in 1998 (9.84 CPUE) and lowest in 1997 (1.94 CPUE, Table 12.1). Both Newton and Coffeen lakes had fall electrofishing CPUEs for age-1+ bass that were higher than Lake of Egypt during 1997 and 1998 when all three lakes were sampled. CPUE for age-1+ bass in Newton Lake was higher in 1998 than 1999, but there were more age-1+ bass collected per hour in Coffeen Lake during 1999 than 1998.

In Newton Lake, the lowest seining CPU for age-0+ bass (1.58) was in 1997 (Table 12.2), and the electrofishing CPUE for age-1+ bass the following year (1998) was 9.84. Age-0+ bass were collected at 5.78 CPU in 1998 or 3.6 times the number of age-0+ fish collected in 1997. Thus, we expected a higher CPUE of age-1+ bass to be collected in 1999 than in 1998. However, the fall electrofishing CPUE for age-1+ bass was only 3.11 in 1999 - or roughly one third the number of the age-1+ bass collected in the previous year. In contrast, age-0+ bass abundance in Coffeen Lake decreased from 1997 (1.50 CPU) to 1998 (0.39 CPU), but age-1+ abundance increased slightly from 1998 to 1999.

Abundance of age-0+ bluegills was highest in Lake of Egypt and lowest in Newton Lake in each of the three years (Table 12.2). Seining CPUs for age-1+ bluegills were variable among the lakes and years within lakes. Trends of bluegill abundance from age-0+ to age-1+ were dependent on the lake sampled. Newton Lake bluegill abundance trends were similar to largemouth bass in the lake. A CPU of 0.23 for age-0+ bluegill in 1997 precluded a 3.45 CPU of age-1+ bluegill in 1998. Age-0+ bluegill abundance was slightly higher in 1998 (0.58 CPU) than 1997, but age-1+ fish numbers decreased to 0.38 CPU in 1999 – a 9-fold decrease from 1998 to 1999. In Coffeen Lake, abundance of age-0+ bluegill was 29% less in 1998 than 1997, and age-1+ bluegill numbers fell in close proportion (35%) from 3.37 CPU in 1998 to 1.18 CPU in 1999. Lake of Egypt age-0+ numbers were 46% lower in 1998 than 1997, but numbers of age-1+ fish collected were similar in 1998 (2.17 CPU) and 1999 (2.14 CPU).

Seining CPUs for all largemouth bass and bluegill in Newton Lake and Coffeen Lake were usually highest in segment 2 (Tables 12.3 and 12.4), but the differences among the segments were not statistically significant in either lake. In both lakes, there were generally fewer bass collected in segment 1 (discharge area) than in the remaining segments following early June of each year (Figures 12.1 and 12.2). There were usually more age-0+ and age-1+ bluegills collected in the cooler segments of Newton Lake during the warmest periods of summer (Figures 12.3 and 12.4). In Coffeen Lake, most age-0+ bluegills were collected from the cooler segment 2 in August 1998 and throughout the 1999 sampling season (Figure 12.5). Age-1+ bluegills in Coffeen Lake were collected at higher CPUs in segment 2 (intake area) than segment 1 (discharge area) on every sampling date except in early April 1999 (Figure 12.6). Seining CPUs in Lake of Egypt were variable between segments for age-0+ largemouth bass and bluegill (Table 12.3). Age-1+ bluegills were collected in higher numbers in segment 2, but there were no significant differences in abundance between segments (Table 12.4). In Lake of Egypt, age-0+ largemouth bass were generally collected at higher CPUs in the cooler portion (segment 2) of the lakes than in the warmer, discharge (segment 1) areas during April through August (Figure 12.7). The opposite was true for age-0+ bluegills in Lake of Egypt (Figure 12.8). Segment collected was not a factor for the age-1+ bluegills in Lake of Egypt (Figure 12.9).

In Newton Lake, there was a 51% decrease in the number of total fish (all species) collected per seine haul from 1998 (16.38 CPU) to 1999 (7.89 CPU, Table 12.5). The number of fish collected in Coffeen Lake decreased by 26% during the same period. In contrast, Lake of Egypt seining CPU increased from 12.44 CPU in 1998 to 30.56 CPU in 1999. There were no statistically significant differences in CPUs among or between segments for all years.

Diversity of species collected in seine hauls was not adversely affected by water conditions in any of the lakes. In Newton Lake, eight fish species were collected in August 1997 (Table 12.6), 11 species in 1998, and 12 species in 1999. Largemouth bass were most abundant in each year. Gizzard shad (*Dorosoma cepedianum*) was the second most abundant species collected in each year, and *Lepomis* spp. was the third.

Fish species in Coffeen Lake were similar to those in Newton Lake, but the highest relative abundance was from bluegill in each year (Table 12.7). In 1998, with the exception of bluegill, gizzard shad (2.01 CPU), and mosquito fish (*Gambusia affinis*) (1.19 CPU) contributed most to the fish collected in Coffeen Lake. No single fish species, other than bluegill, contributed significantly in 1999.

The highest diversity of fish species was collected in Lake of Egypt. Ten fish species were present in August 1997, 16 species were collected during 1998, and 20 in 1999 (Table 12.8). The black-striped topminnow (*Fundulus notatus*) was the most abundant species in the 1997 seine hauls. Bluegills were collected at a higher CPU (6.29) than all other species in Lake of Egypt during 1998. In 1999, silversides were collected at the highest CPU (12.25) of any other fish species, and bluegills were second (8.59 CPU).

Discussion:

Largemouth bass and bluegill cohort abundance at age-1+ is dependent on age-0+ production in the previous year and overwintering survival. Perhaps the most important indicator of a fish population's ability to proliferate is its survival through age-1. After only two years of data, the results of this study are incomplete since probably the most important season of sampling would occur in 2000 – the first year following summer water temperatures that were within range of the new variance. Preliminary indications are that largemouth bass and bluegill abundance trends declined from 1998 to 1999 when compared to the same annual period from 1997 to 1998.

It is worth noting that the numbers most important are the trends of abundance and not the precise numbers reported. For instance, it is impossible to have more age-1+ fish than age-0+ fish of the same species in the following year. Obviously, relatively more bluegills were susceptible to seining at age-1+ than at age-0+. However, it is reasonable to assume that the same proportion of age-0+ bluegill is susceptible in each year. Therefore, seining can be a viable index of age-0+ numbers among years and lakes, and analysis of abundance trends of fish from age-0+ to age-1+ can be made. Trend analysis in Newton Lake indicated that the age-1+ largemouth bass and bluegill were disproportionately lower in 1999 than in 1998. This was not the case for largemouth bass and bluegill in Coffeen Lake. Although age-1+ bluegill abundance was lower in 1999, the decrease was in proportion to the decrease in age-0+ abundance from 1997 to 1998. Thus, the decrease in abundance of bluegill in Coffeen Lake was most likely due to a decrease in reproduction. In Newton Lake, other factors caused the disproportionate shifts in bluegill and bass abundance from age-0+ to age-1+.

Comparisons of seining CPU were biased for 1997 because only late-August sampling was conducted in that year. In Newton Lake, largemouth bass were collected at 1.58 CPU in 1997 and 1.30 CPU in August 1999 (40 seine hauls). However, 400 seine hauls throughout spring and summer in 1998 and 1999 resulted in 41% fewer largemouth bass in 1999 (3.49 CPU) than in 1998 (5.90 CPU, Table 12.6).

The mean number of bass collected in Newton Lake was higher in both years than in Coffeen Lake (Table 12.7) or Lake of Egypt (Table 12.8). In Coffeen Lake, bass were collected at 1.50 CPU in August 1997 (20 seine hauls) and only 0.03 CPU in August 1999 (36 seine hauls). Two hundred seine hauls per year collected less than one half the number of largemouth bass in 1999 (0.17 CPU) than in 1998 (0.40 CPU, Table 12.7). Despite the percentage disparity between the years of collection, it should be pointed out that the CPUs in Coffeen Lake were very low throughout the study.

The number of largemouth bass collected during August in Lake of Egypt was similar in 1997 (2.35 CPU) and 1999 (2.53 CPU). In contrast to Newton and Coffeen lakes, over twice as many largemouth bass were collected per haul (200 hauls per year) in Lake of Egypt during 1999 (2.64 CPU) than in 1998 (1.29 CPU, Table 12.8). However, the CPUs in Lake of Egypt were also very low. An increase of 1.35 CPUs is probably not an indication of a major increase in largemouth bass production in Lake of Egypt during 1999. More important is the fact that the CPU did not decrease substantially in 1999 from 1998.

Seining throughout the spring and summer in Newton Lake resulted in a CPU of bluegill that decreased almost four fold in 1999 (1.06 CPU) as compared to 1998 (4.19 CPU, Table 12.6).

However, bluegills were collected at only 0.43 CPU in August 1997 as compared to 2.75 CPU in August 1999.

Bluegills in Coffeen Lake were less affected by the temperature and water level extremes in 1999. Seining CPUs for bluegill throughout spring and summer were similar in 1998 (6.47) and 1999 (5.81, Table 12.7). August CPUs were 2.90 in 1997 and 6.65 in 1999. In Lake of Egypt, bluegill CPUs increased each year (Table 12.8). The largest bluegill CPU increase occurred with August CPUs from 1997 (1.60) to 1999 (24.38).

In most cases, the use of August samples for comparison was less biased to bluegill CPUs than largemouth bass CPUs. Part of the reason is that age-0+ bluegills do not begin to contribute to the CPUs until June or July. One would expect to see lower CPUs for the entire season because there were at least two months when age-0+ bluegills were not contributing. However, largemouth bass may be negatively affected by August samples. Given the growth rates of largemouth bass young-of-the-year in Newton and Coffeen lakes, they are usually less susceptible to seining by July or August when the fish approach four inches in length. Examinations of length frequencies (Figures 12.10 - 12.21) support the discussion of abundance and trends apparent in Figures 12.1 - 12.9. Most of the contributions to the seining CPUs consisted of age-0+ bass that appear in late April or May and continued to be at least somewhat susceptible until at least late August. However, depending on their rate of growth and propensity to search for deeper water during the warmer months, their susceptibility may have decreased during the latter months of their first growing season. Sufficient largemouth bass reproduction occurred in Newton Lake (Figure 12.13) and Lake of Egypt (Figure 12.14) to further examine the trends described. The decline in largemouth bass numbers throughout the months in Newton

Lake is quite apparent in 1998 and 1999. Growth (thus susceptibility to seining), mortality, and a combination of the factors could account for the decreases over time.

Table 12.1. Electrofishing catch per hour for age-1+ largemouth bass collected by Southern Illinois University personnel during fall of each year. Largemouth bass ages were determined by examining their saggittae otoliths.

	1997		1998		1999	
Lake	Effort (hrs)	Catch per hour	Effort (hrs)	Catch per hour	Effort (hrs)	Catch per hour
Newton	9.3	1.94	6.3	9.84	9	3.11
Coffeen	4.8	3.33	7.3	6.03	5.1	7.06
Lake of Egypt	12.6	1.83	10.2	2.25	---	---

Table 12.2. Largemouth bass and bluegill collected by seining in three Illinois power-cooling lakes during August 1997 and April through August 1998 and 1999. The lakes were seined twice per month. Ten seine hauls were made in each of four segments in Newton Lake and in two segments in the remaining lakes. The number of age-0+ bluegill was extrapolated in relation to relative abundance of identifiable *Lepomis* species collected at each station.

Species	Lake	Year	Age-0 Number per seine	Age-0 Range		Age-0 Standard deviation	Age-1 Number per seine	Age-1 Range		Age-1 Standard deviation	Number of seine hauls
Micropterus salmoides	Coffeen	1997	1.50	0	15	3.35	0.00	0	0	0.00	20
	Coffeen	1998	0.39	0	8	1.11	0.01	0	1	0.10	200
	Coffeen	1999	0.15	0	15	1.12	0.01	0	1	0.07	196
	Egypt	1997	1.20	0	9	2.63	0.05	0	1	0.22	20
	Egypt	1998	1.26	0	12	2.12	0.03	0	2	0.20	200
	Egypt	1999	2.62	0	25	4.24	0.03	0	1	0.16	200
	Newton	1997	1.58	0	29	4.68	0.00	0	0	0.00	40
	Newton	1998	5.88	0	1,001	50.73	0.01	0	1	0.10	400
	Newton	1999	3.49	0	500	26.31	0.00	0	1	0.05	400
Lepomis macrochirus	Coffeen	1997	3.00	0	25	6.22	0.75	0	13	2.90	20
	Coffeen	1998	2.13	0	103	9.46	3.37	0	45	6.02	200
	Coffeen	1999	4.67	0	427	31.71	1.18	0	15	2.55	196
	Egypt	1997	8.00	0	73	17.45	0.50	0	4	1.24	20
	Egypt	1998	3.98	0	118	13.52	2.17	0	25	4.17	200
	Egypt	1999	8.59	0	150	23.82	2.14	0	25	3.93	200
	Newton	1997	0.23	0	4	0.73	0.03	0	1	0.16	40
	Newton	1998	0.58	0	27	2.09	3.45	0	89	9.81	400
	Newton	1999	0.15	0	9	0.68	0.38	0	21	1.41	400

Table 12.3. Age-0+ largemouth bass and bluegill collected by seining in three Illinois power cooling reservoirs. Ten stations were sampled in each segment in each lake twice monthly during August 1997 and April through August 1999.

Species	Lake	Year	Segment 1	Standard deviation	Segment 2	Standard deviation	Segment 3	Standard deviation	Segment 4	Standard deviation
Micropterus salmoides	Newton	1997	0.30	0.48	0.70	1.57	3.40	9.06	1.90	1.91
		1998	3.31	12.35	13.59	100.30	3.88	7.78	2.73	4.34
		1999	1.20	3.63	6.63	49.94	1.72	3.55	4.39	15.85
	Weighted mean		**2.16**	**8.93**	**9.66**	**77.21**	**2.83**	**6.27**	**3.48**	**11.35**
	Coffeen	1997	0.60	0.84	2.40	4.60				
		1998	0.09	0.32	0.68	1.48				
		1999	0.10	0.40	0.20	1.52				
	Weighted mean		**2.29**	**3.70**	**2.94**	**4.72**				
	Egypt	1997	1.60	3.06	0.80	2.20				
		1998	1.26	1.85	1.25	2.36				
		1999	1.77	2.96	2.03	3.76				
	Weighted mean		**0.12**	**0.41**	**0.53**	**1.81**				
Lepomis macrochirus	Newton	1997	0.10	0.32	0.50	1.27	0.30	0.67	0.00	0.00
		1998	0.53	2.23	0.85	3.18	0.39	1.02	0.57	1.21
		1999	0.08	0.27	0.10	0.39	0.17	0.78	0.23	1.00
	Weighted mean		**0.30**	**1.56**	**0.48**	**2.25**	**0.28**	**0.90**	**0.38**	**1.10**
	Coffeen	1997	2.80	4.52	3.20	7.81				
		1998	1.28	4.02	2.97	12.74				
		1999	0.84	2.98	8.34	44.10				
	Weighted mean		**1.15**	**3.60**	**5.54**	**31.75**				
	Egypt	1997	3.80	8.47	12.20	23.07				
		1998	5.59	17.49	2.38	7.49				
		1999	11.00	27.42	6.18	19.41				
	Weighted mean		**8.08**	**22.63**	**4.66**	**15.31**				

Table 12.4. Age-1 bluegill collected by seining in three Illinois power cooling reservoirs. Ten stations were sampled in each segment in each lake twice monthly during August 1997 and April through August 1999.

Species	Lake	Year	Segment 1	Standard deviation	Segment 2	Standard deviation	Segment 3	Standard deviation	Segment 4	Standard deviation
Lepomis macrochirus	Newton	1997	0.00	0.00	0.00	0.00	0.10	0.32	0.00	0.00
		1998	4.12	10.79	6.14	15.17	1.56	3.12	1.96	4.26
		1999	0.68	2.37	0.55	1.31	0.18	0.56	0.11	0.35
	Weighted mean		**2.29**	**7.80**	**3.19**	**10.85**	**0.83**	**2.29**	**0.99**	**3.08**
	Coffeen	1997	0.00	0.00	1.50	4.06				
		1998	2.25	4.66	4.48	6.97				
		1999	0.71	1.91	1.63	2.98				
	Weighted mean		**1.42**	**3.59**	**2.98**	**5.47**				
	Egypt	1997	0.10	0.32	0.90	1.66				
		1998	1.70	3.67	2.63	4.58				
		1999	1.54	2.94	2.73	4.66				
	Weighted mean		**1.55**	**3.25**	**2.60**	**4.53**				

Table 12.5. Fish collected by seining in three power cooling lakes in Illinois during August 1997 and April through August 1998 and 1999.

Segment	Mean number per seine	Range		Standard deviation	Number of seine hauls
		Newton 1997			
1	1.90	0	8	2.56	10
2	1.70	0	9	2.87	10
3	4.00	0	34	10.61	10
4	4.30	0	18	5.12	10
Weighted mean	**2.98**	**0**	**34**	**6.07**	**40**
		Newton 1998			
1	20.44	0	551	57.78	100
2	23.59	0	1,007	101.49	100
3	8.07	0	51	10.22	100
4	13.40	0	347	36.43	100
Weighted mean	**16.38**	**0**	**1,007**	**61.45**	**400**
		Newton 1999			
1	8.78	0	89	14.76	100
2	9.37	0	501	50.01	100
3	5.22	0	76	9.95	100
4	8.18	0	125	17.30	100
Weighted mean	**7.89**	**0**	**501**	**27.86**	**400**
		Coffeen 1997			
1	6.30	0	19	7.13	10
2	11.30	0	50	19.50	10
Weighted mean	**8.80**	**0**	**50**	**14.52**	**20**
		Coffeen 1998			
1	6.68	0	55	10.35	100
2	17.23	0	365	41.40	100
Weighted mean	**11.96**	**0**	**365**	**30.56**	**200**
		Coffeen 1999			
1	3.65	0	40	5.81	96
2	13.80	0	464	47.80	100
Weighted mean	**8.83**	**0**	**464**	**34.67**	**196**

Table 12.5. Continued.

Segment	Mean number per seine	Range		Standard deviation	Number of seine hauls
		Egypt 1997			
1	19.90	0	51	16.32	10
2	37.80	1	176	55.97	10
Weighted mean	**28.85**	**0**	**176**	**41.16**	**20**
		Egypt 1998			
1	13.16	0	130	22.50	100
2	11.72	0	105	18.63	100
Weighted mean	**12.44**	**0**	**130**	**20.61**	**200**
		Egypt 1999			
1	43.15	0	1,355	153.56	100
2	17.96	0	159	28.26	100
Weighted mean	**30.56**	**0**	**1,355**	**110.85**	**200**

Table 12.6 Fish taxa collected by seining in Newton Lake during August 1997 and April through August 1998 and 1999.

Family	Species	Number per seine	Range		Standard deviation	Number of seine hauls
		1997				
Centrarchidae	*Micropterus salmoides*	1.58	0	29	4.68	40
	Lepomis gulosus	0.05	0	2	0.32	40
	Lepomis macrochirus	0.43	0	7	1.34	40
	Lepomis humilus	0.08	0	1	0.27	40
	Lepomis spp.	0.03	0	1	0.16	40
	Subtotal for *Lepomis* spp.	0.58	0	7	1.57	40
Clupeidae	*Dorosoma cepedianum*	0.65	0	16	2.58	40
Cyprinidae	*Cyprinus carpio*	0.03	0	1	0.16	40
Fundulidae	*Fundulus notatus*	0.23	0	3	0.62	40
		1998				
Centrarchidae	*Micropterus salmoides*	5.90	0	1,001	50.73	400
	Lepomis macrochirus	4.19	0	90	10.36	400
	Lepomis megalotis	0.03	0	2	0.18	400
	Lepomis cyanellus	0.03	0	2	0.19	400
	Lepomis microlophus	0.00	0	1	0.05	400
	Lepomis humilis	0.04	0	2	0.24	400
	Lepomis spp.	0.37	0	21	1.31	400
	Subtotal for *Lepomis* spp.	4.66	0	90	10.46	400
Cyprinidae	*Cyprinus carpio*	0.03	0	1	0.17	400
Ictaluridae	*Ictalurus punctatus*	0.04	0	3	0.23	400
Clupeidae	*Dorosoma cepedianum*	5.49	0	549	33.90	400
Fundulidae	*Fundulus notatus*	0.25	0	27	1.52	400
Moronidae	*Morone chrysops*	0.00	0	1	0.05	400

Table 12.6 Continued.

Family	Species	Number per seine	Range		Standard deviation	Number of seine hauls
		1999				
Centrarchidae	*Micropterus salmoides*	3.49	0	500	26.31	400
	Lepomis macrochirus	1.06	0	23	2.44	400
	Lepomis megalotis	0.12	0	7	0.53	400
	Lepomis cyanellus	0.04	0	4	0.26	400
	Lepomis humilis	0.01	0	1	0.07	400
	Lepomis spp.	0.41	0	89	4.68	400
	Subtotal for *Lepomis* spp.	1.62	0	89	5.27	400
Moronidae	*Morone chrysops*	0.00	0	1	0.05	400
Fundulidae	*Fundulus notatus*	0.22	0	12	1.03	400
Clupeidae	*Dorosoma cepedianum*	2.45	0	76	8.39	400
Cyprinidae	*Cyprinus carpio*	0.02	0	1	0.13	400
	Notemigonus crysoleucas	0.07	0	8	0.61	400
Ictaluridae	*Ictalurus punctatus*	0.01	0	1	0.11	400

Table 12.7. Fish taxa collected by seining in Coffeen Lake during August 1997 and April through August 1998 and 1999.

Family	Species	Number per seine	Range	Standard deviation	Number of seine hauls
		1997			
Centrarchidae	*Micropterus salmoides*	1.50	0 15	3.35	20
	Lepomis macrochirus	2.90	0 21	5.51	20
	Lepomis megalotis	0.05	0 1	0.22	20
	Lepomis spp.	2.30	0 25	7.11	20
	Subtotal for *Lepomis* spp.	5.25	0 47	11.24	20
Ictaluridae	*Noturus* spp.	0.25	0 5	1.12	20
Clupeidae	*Dorosoma cepedianum*	1.05	0 18	4.02	20
Poeciliidae	*Gambusia affinis*	0.30	0 3	0.92	20
Fundulidae	*Fundulus notatus*	0.45	0 5	1.23	20
		1998			
Centrarchidae	*Micropterus salmoides*	0.40	0 8	1.11	200
	Lepomis macrochirus	6.47	0 92	10.20	200
	Lepomis megalotis	0.08	0 4	0.37	200
	Lepomis cyanellus	0.05	0 4	0.34	200
	Lepomis microlophus	0.16	0 4	0.55	200
	Lepomis spp.	1.23	0 71	6.38	200
	Subtotal for *Lepomis* spp.	7.98	0 112	13.52	200
Cyprinidae	*Notemigonus crysoleucas*	0.01	0 1	0.10	200
Ictaluridae	*Ictalurus punctatus*	0.02	0 3	0.22	200
Clupeidae	*Dorosoma cepedianum*	2.01	0 300	21.33	200
Poeciliidae	*Gambusia affinis*	1.19	0 105	8.34	200
	Fundulus notatus	0.36	0 11	1.54	200

Table 12.7. Continued.

Family	Species	Number per seine	Range		Standard deviation	Number of seine hauls
		1999				
Centrarchidae	*Micropterus salmoides*	0.17	0	15	1.13	196
	Lepomis macrochirus	5.81	0	385	28.32	196
	Lepomis megalotis	0.09	0	3	0.38	196
	Lepomis cyanellus	0.02	0	2	0.16	196
	Lepomis microlophus	0.22	0	7	0.75	196
	Lepomis spp.	1.35	0	88	7.77	196
	Subtotal for *Lepomis* spp.	7.48	0	456	33.86	196
Moronidae	*Morone mississippiensis*	0.01	0	1	0.07	196
Atherinidae	*Menidia beryllina*	0.30	0	39	3.12	196
Ictaluridae	*Noturus* spp.	0.01	0	1	0.07	196
	Ictalurus punctatus	0.02	0	1	0.12	196
	Subtotal for Ictaluridae	0.02	0	1.00	0.07	196
Fundulidae	*Fundulus notatus*	0.08	0	5	0.49	196
Poeciliidae	*Gambusia affinis*	0.51	0	30	2.88	196
Clupeidae	*Dorosoma cepedianum*	0.23	0	8	1.06	196

Table 12.8. Fish taxa collected by seining in Lake of Egypt during August 1997 and April through August 1998.

Family	Species	Number per seine	Range		Standard deviation	Number of seine hauls
		1997				
Centrarchidae	*Micropterus salmoides*	1.25	0	9	2.65	20
	Micropterus punctulatus	1.10	0	8	2.22	20
	Subtotal for *Micropterus* spp.	2.35	0	17	4.18	20
	Lepomis macrochirus	1.60	0	5	1.90	20
	Lepomis microlophus	0.10	0	1	0.31	20
	Lepomis spp.	9.40	0	73	17.65	20
	Subtotal for *Lepomis* spp.	11.10	0	75	17.82	20
	Pomoxis nigromacula	0.80	0	13	2.91	20
Cyprinidae	*Pimephales notatus*	0.65	0	11	2.48	20
	Notemigonus crysoleucas	0.15	0	2	0.49	20
	Subtotal for Cyprinidae	0.80	0	12	2.71	20
Ictaluridae	*Noturus* spp.	0.05	0	1	0.22	20
Fundulidae	*Fundulus notatus*	11.00	0	69	19.32	20
Atherinidae	*Menidia beryllina*	2.75	0	49	10.97	20
		1998				
Centrarchidae	*Micropterus salmoides*	1.29	0	13	2.14	200
	Lepomis macrochirus	6.29	0	125	15.14	200
	Lepomis megalotis	0.07	0	4	0.38	200
	Lepomis microlophus	0.58	0	21	1.98	200
	Lepomis humilis	0.02	0	1	0.14	200
	Lepomis spp.	0.37	0	15	1.41	200
	Subtotal for *Lepomis* spp.	7.32	0	126	16.81	200
	Pomoxis nigromaculatus	0.03	0	2	0.20	200
	Pomoxis annularis	0.01	0	1	0.07	200
	Subtotal *Pomoxis* spp.	0.04	0	2	0.21	200
Percidae	*Percina* spp.	0.01	0	1	0.07	200
Clupeidae	*Dorosoma petenense*	0.02	0	3	0.22	200
	Dorosoma cepedianum	0.03	0	2	0.19	200
	Subtotal for Clupeidae	0.05	0	3	0.29	200
Poeciliidae	*Gambusia affinis*	0.01	0	1	0.10	200

Table 12.8 Continued.

Family	Species	Number per seine	Range		Standard deviation	Number of seine hauls
Fundulidae	*Fundulus notatus*	1.08	0	27	3.45	200
Atherinidae	*Menidia beryllina*	2.46	0	59	7.47	200
Cyprinidae	*Pimephales notatus*	0.17	0	7	0.80	200
	Notemigonus crysoleucas	0.03	0	3	0.25	200
	Subtotal for Cyprinidae	0.20	0	7	0.86	200
Esocidae	*Esox niger*	0.01	0	1	0.10	200
		1999				
Centrarchidae	*Micropterus salmoides*	2.64	0	25	4.25	200
	Lepomis macrochirus	8.59	0	151	20.66	200
	Lepomis gulosus	0.03	0	1	0.16	200
	Lepomis megalotis	0.38	0	7	1.02	200
	Lepomis cyanellus	0.01	0	1	0.10	200
	Lepomis microlophus	0.88	0	14	1.98	200
	Lepomis spp.	2.87	0	127	13.91	200
	Subtotal for *Lepomis* spp.	12.75	0	154	25.84	200
	Pomoxis nigromaculatus	0.03	0	4	0.30	200
	Pomoxis annularis	0.02	0	1	0.12	200
	Subtotal *Pomoxis* spp.	0.05	0	4	0.32	200
Clupeidae	*Dorosoma cepedianum*	1.64	0	320	22.63	200
	Dorosoma petenense	0.06	0	5	0.46	200
Atherinidae	*Menidia beryllina*	12.25	0	1020	88.74	200
Fundulidae	*Fundulus notatus*	0.60	0	12	1.51	200
Poeciliidae	*Gambusia affinis*	0.15	0	21	1.51	200
Esocidae	*Esox niger*	0.02	0	1	0.12	200
Ictaluridae	*Ictalurus punctatus*	0.01	0	1	0.07	200
Cyprinidae	*Cyprinus carpio*	0.01	0	1	0.07	200
	Pimephales notatus	0.01	0	1	0.07	200
	Notemigonus crysoleucas	0.05	0	4	0.34	200
	Pimephales notatus	0.32	0	13	1.50	200
Percidae	*Percina* spp.	0.01	0	1	0.07	200

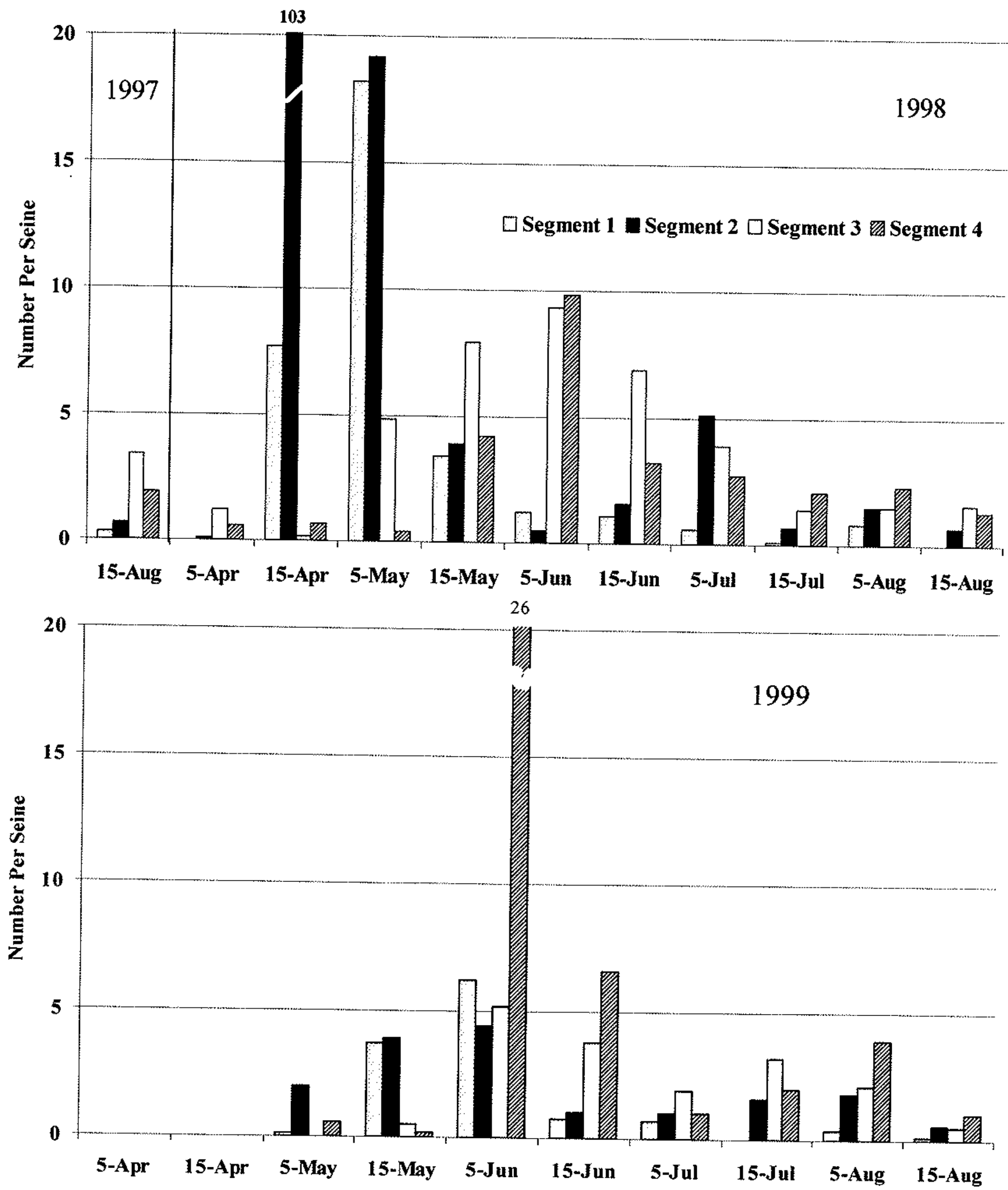


Figure 12.1. Mean number of age-0+ largemouth bass collected by seining in Newton Lake during August 1997, and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

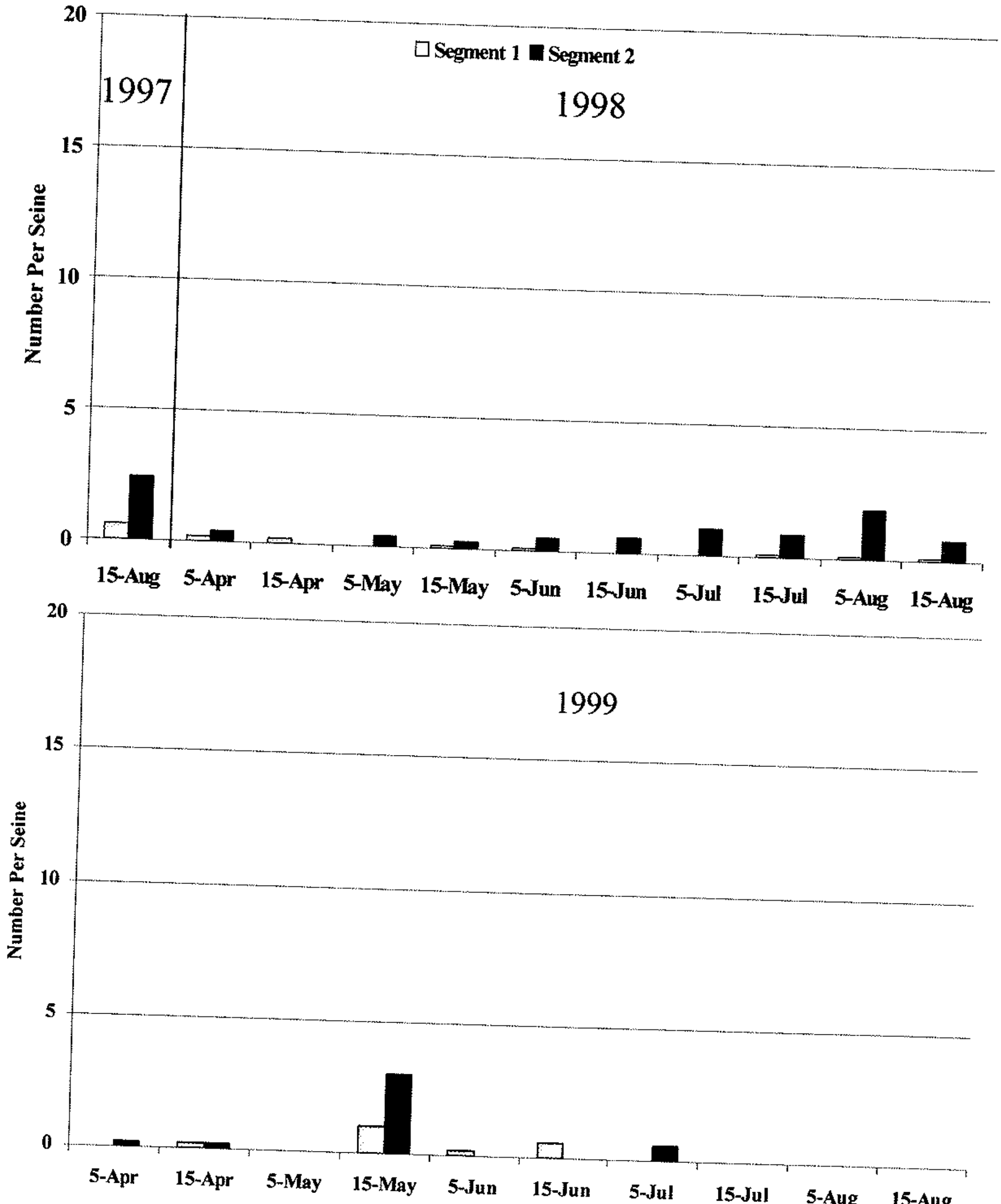


Figure 12.2. Mean number of age-0+ largemouth bass collected by seining in Coffeen Lake during August 1997, and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

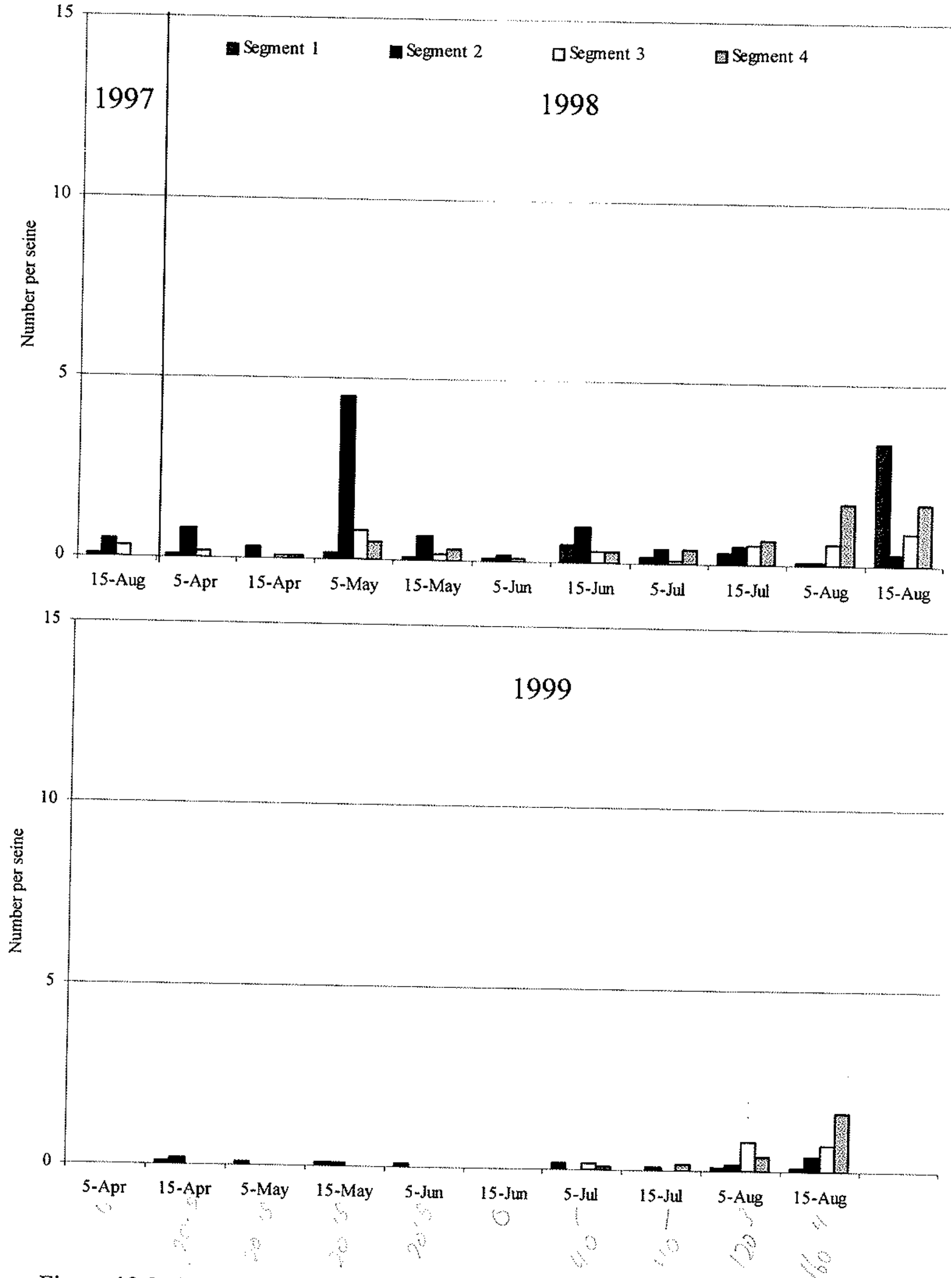


Figure 12.3. Mean number of age-0+ bluegill collected by seining in Newton Lake during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

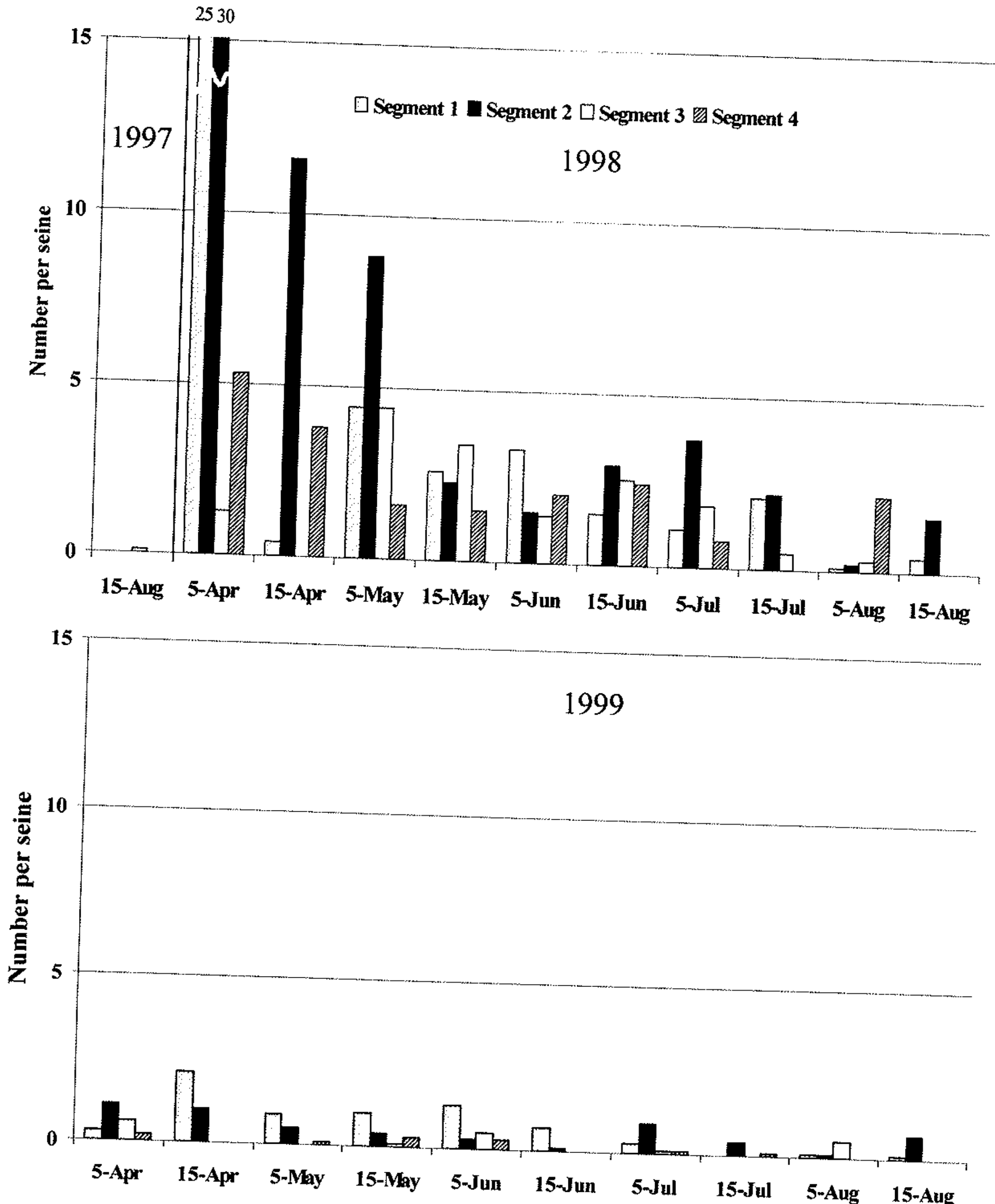


Figure 12.4. Mean number of age-1+ bluegill collected by seining in Newton Lake during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

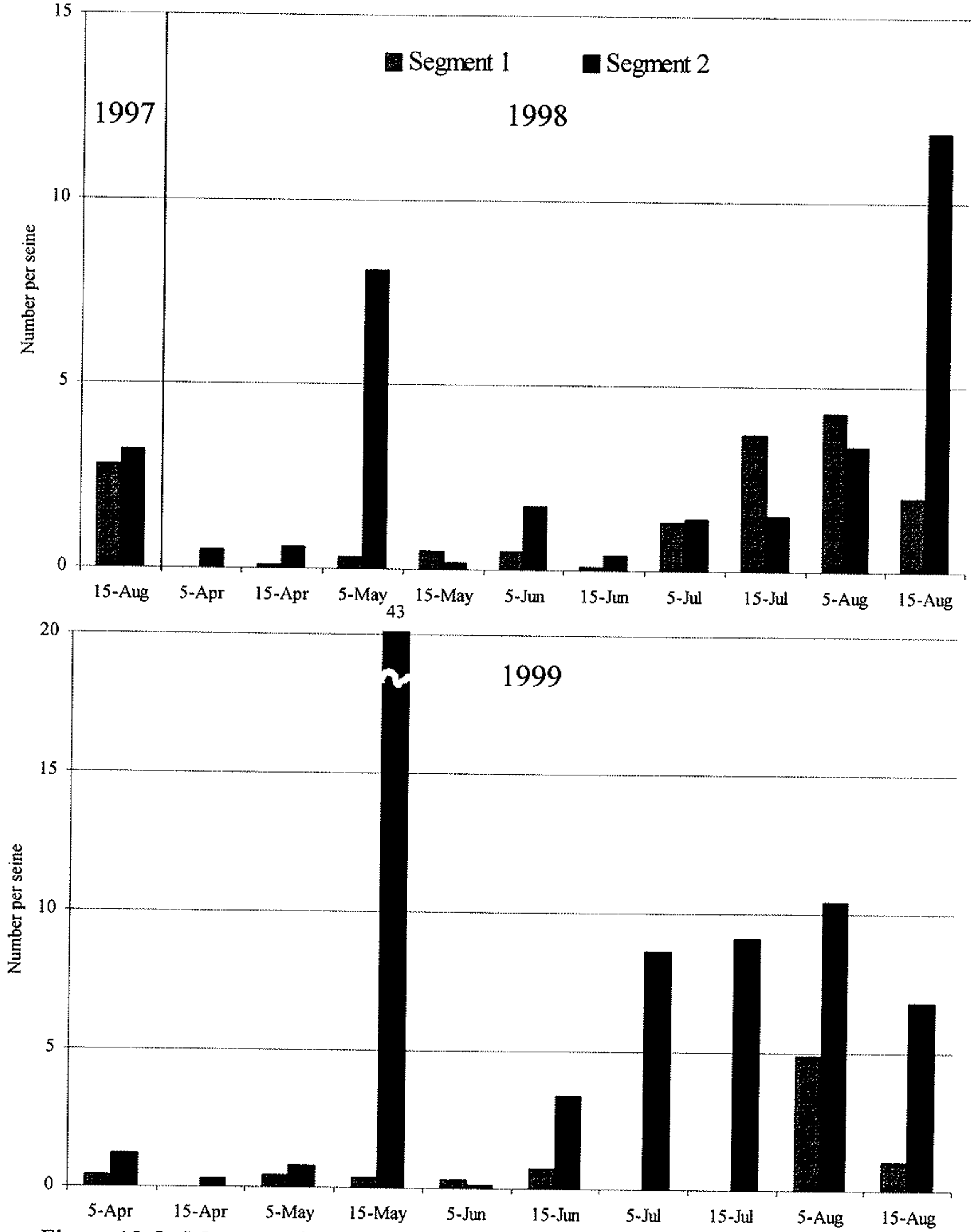


Figure 12.5. Mean number of age-0+ bluegill collected by seining in Coffeen Lake during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

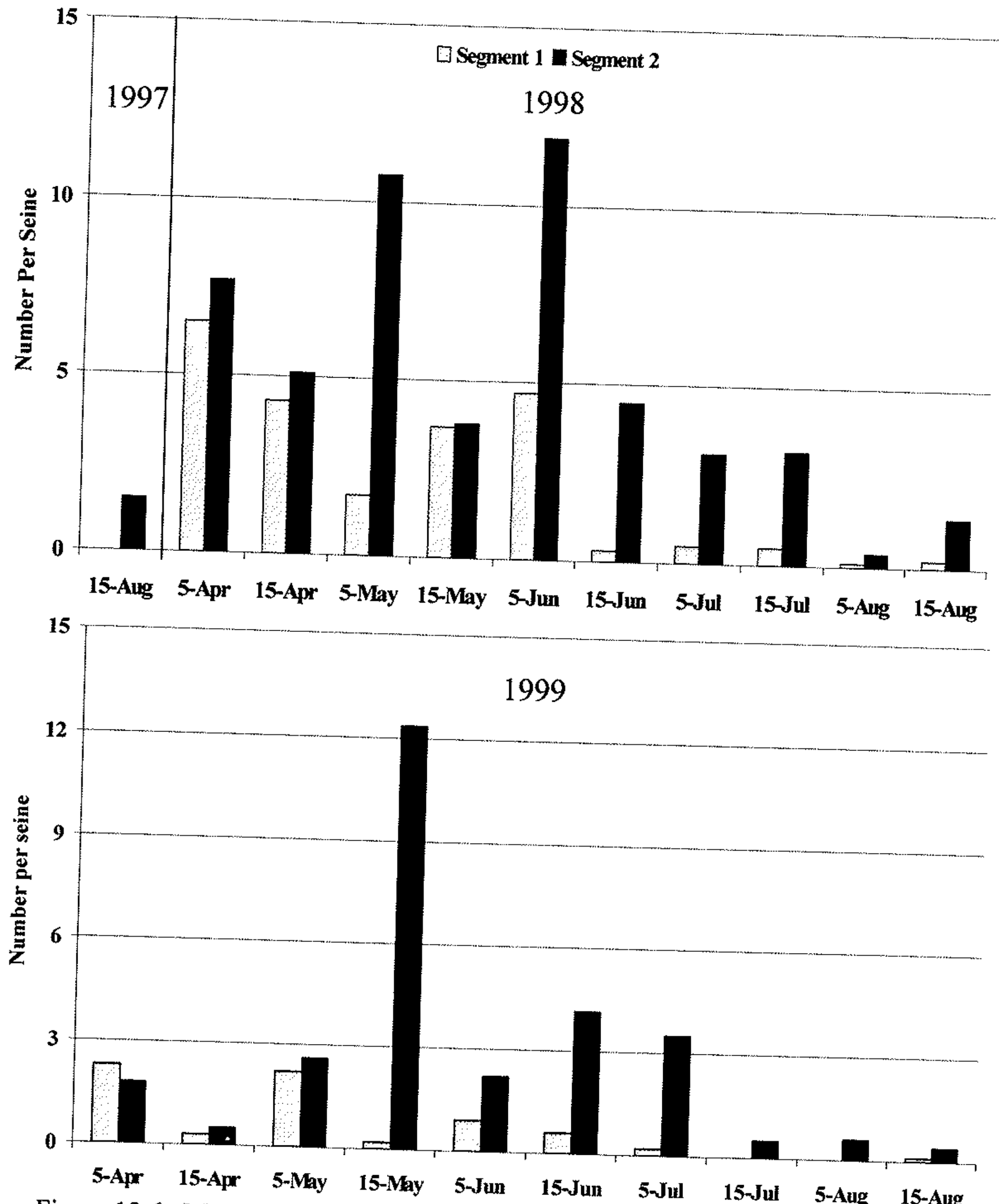


Figure 12.6. Mean number of age-1+ bluegill collected by seining in Coffeen Lake during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

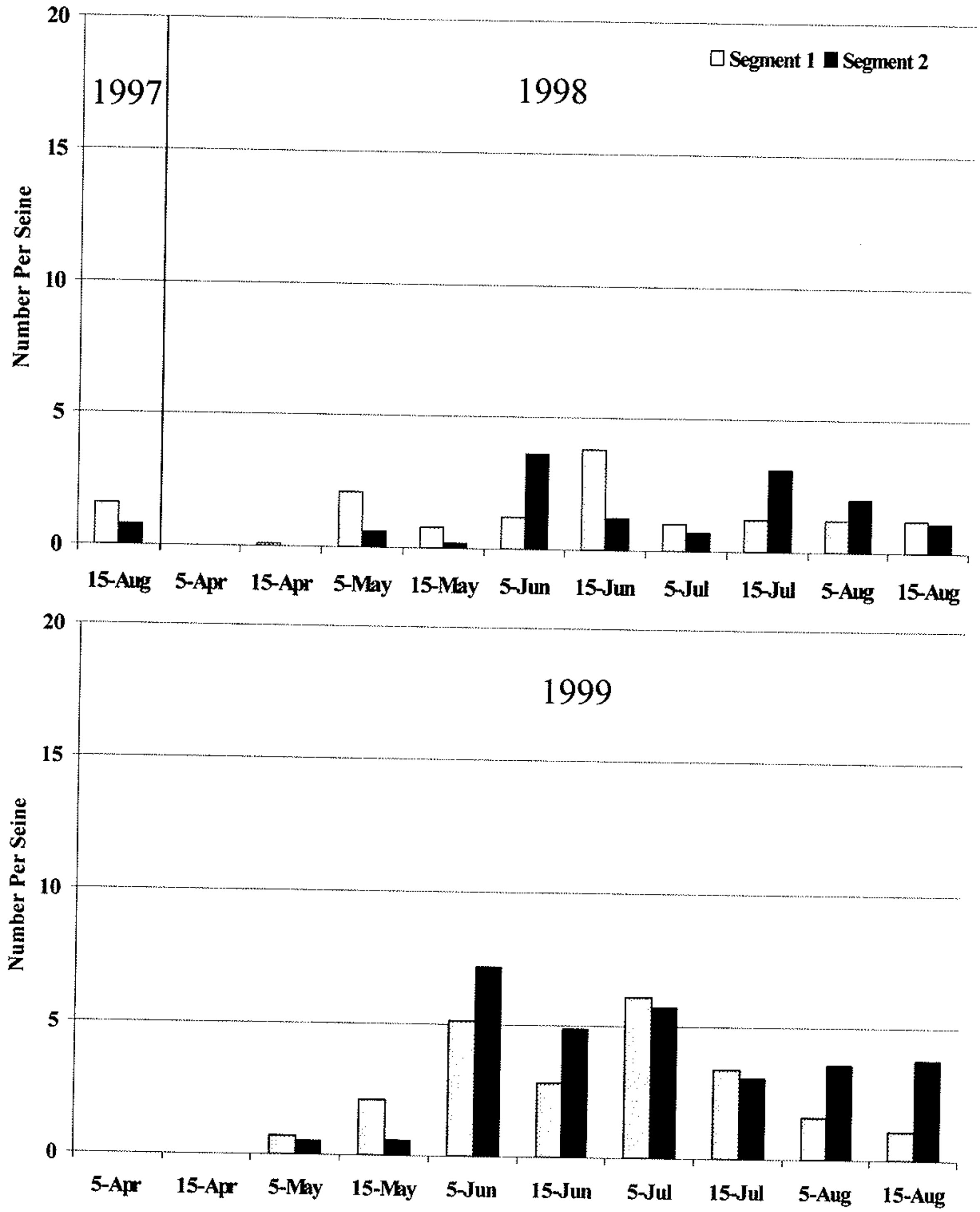


Figure 12.7. Mean number of age-0+ largemouth bass collected by seining in Lake of Egypt during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

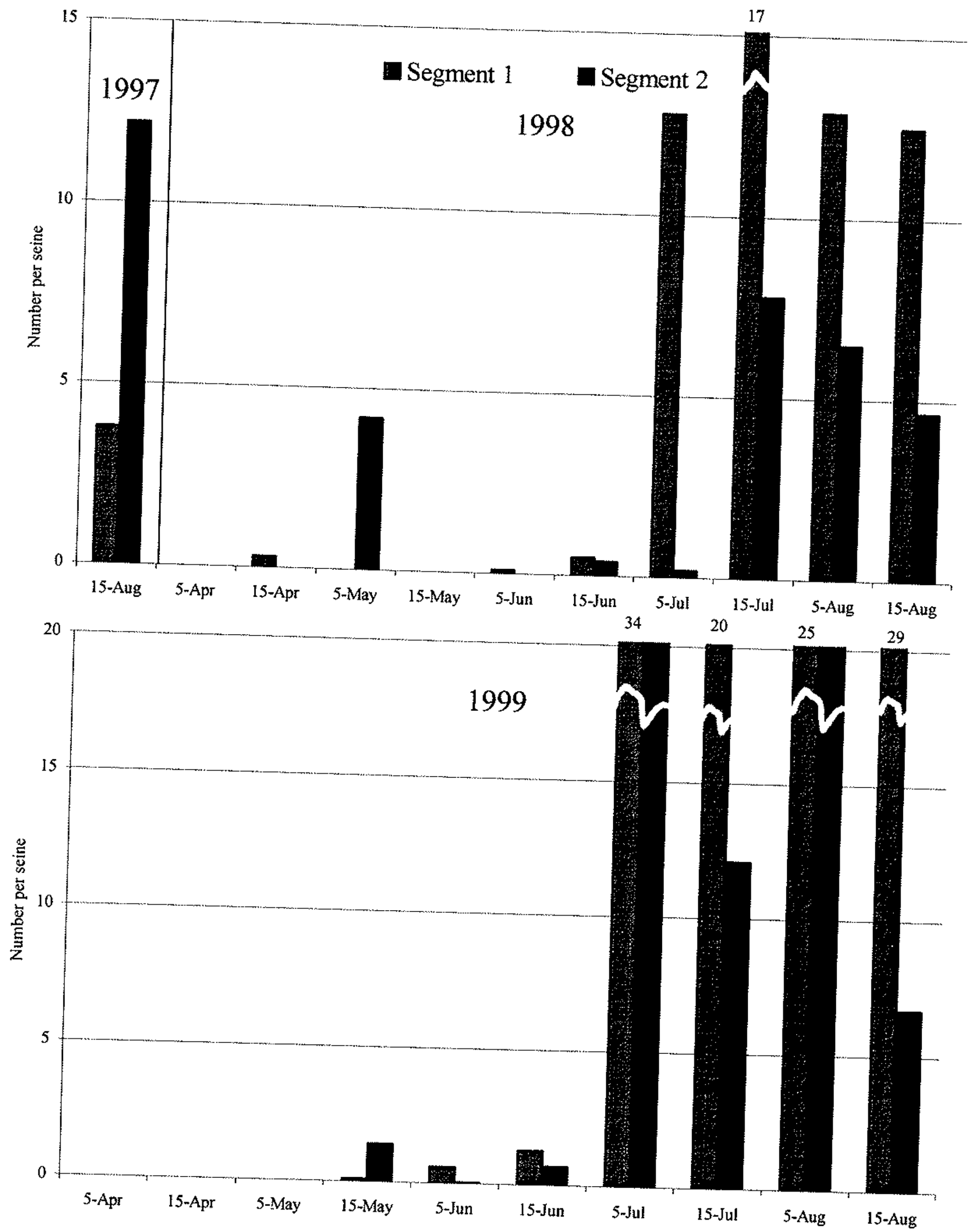


Figure 12.8. Mean number of age-0+ bluegill collected by seining in Lake of Egypt during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

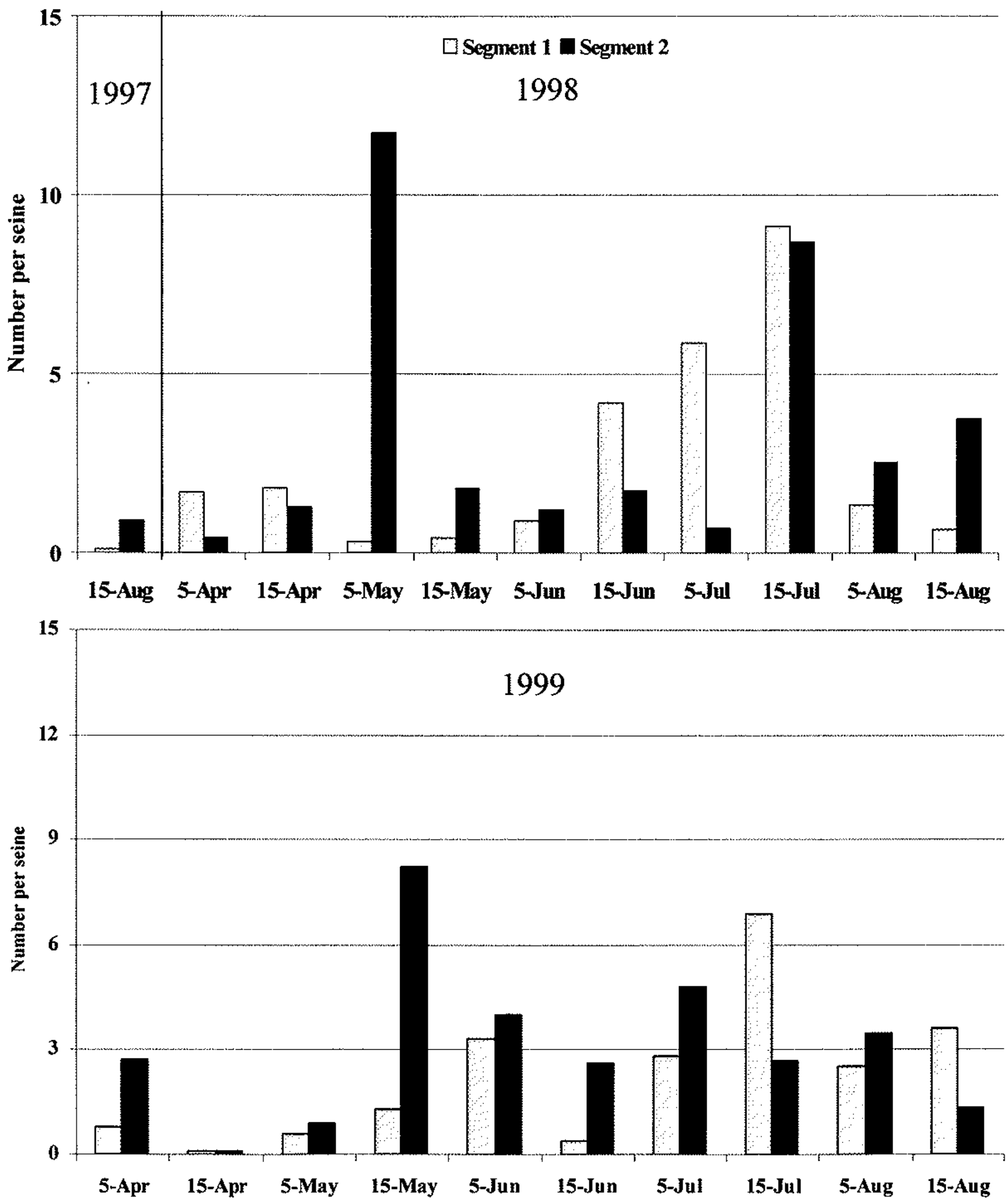


Figure 12.9. Mean number of age-1+ bluegill collected by seining in Lake of Egypt during August 1997 and April through August 1998 and 1999. Ten stations were sampled twice monthly in each segment.

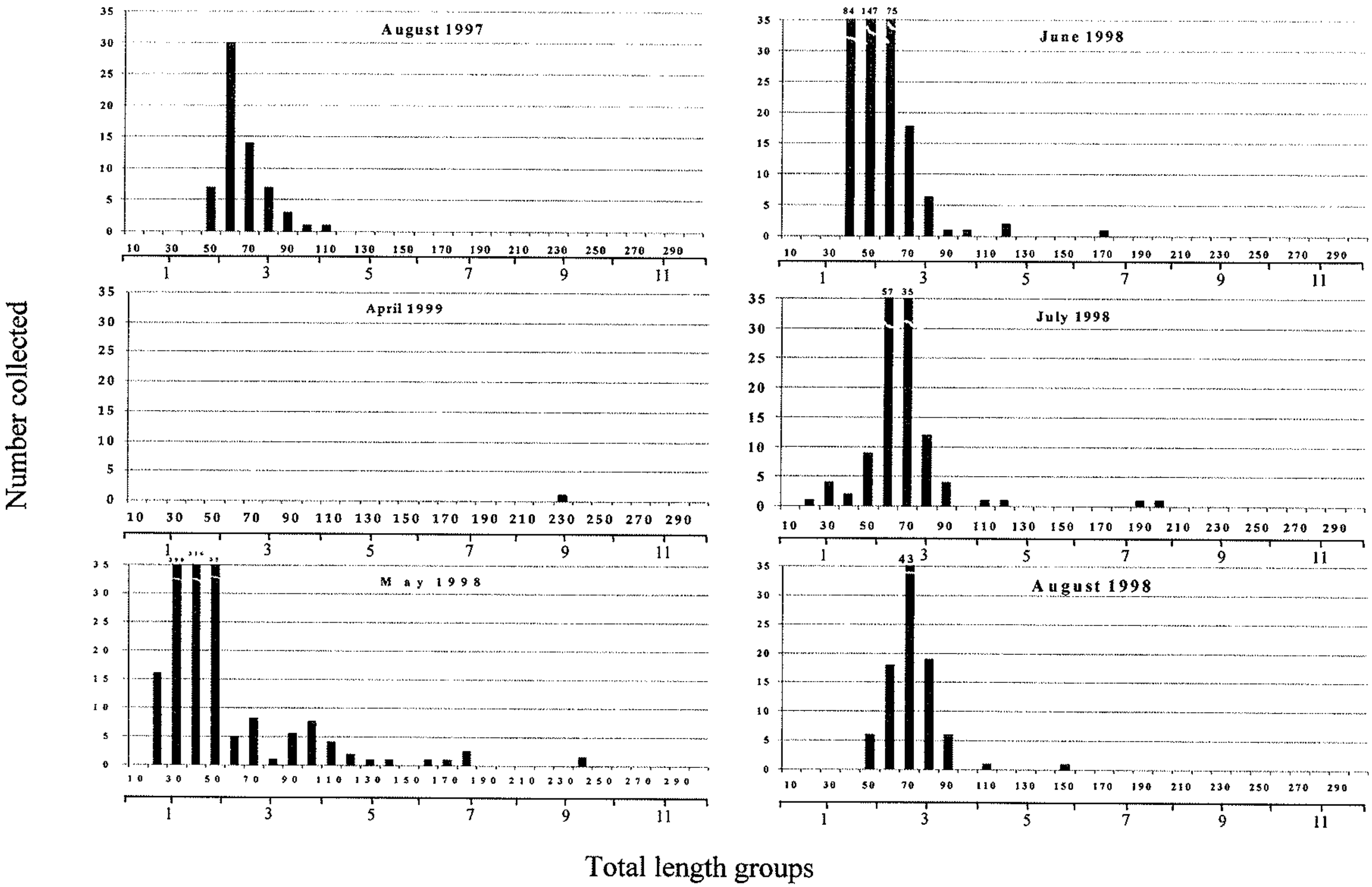


Figure 12.10. Length frequencies of all largemouth bass collected using seine hauls in Newton Lake during August 1997 and April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

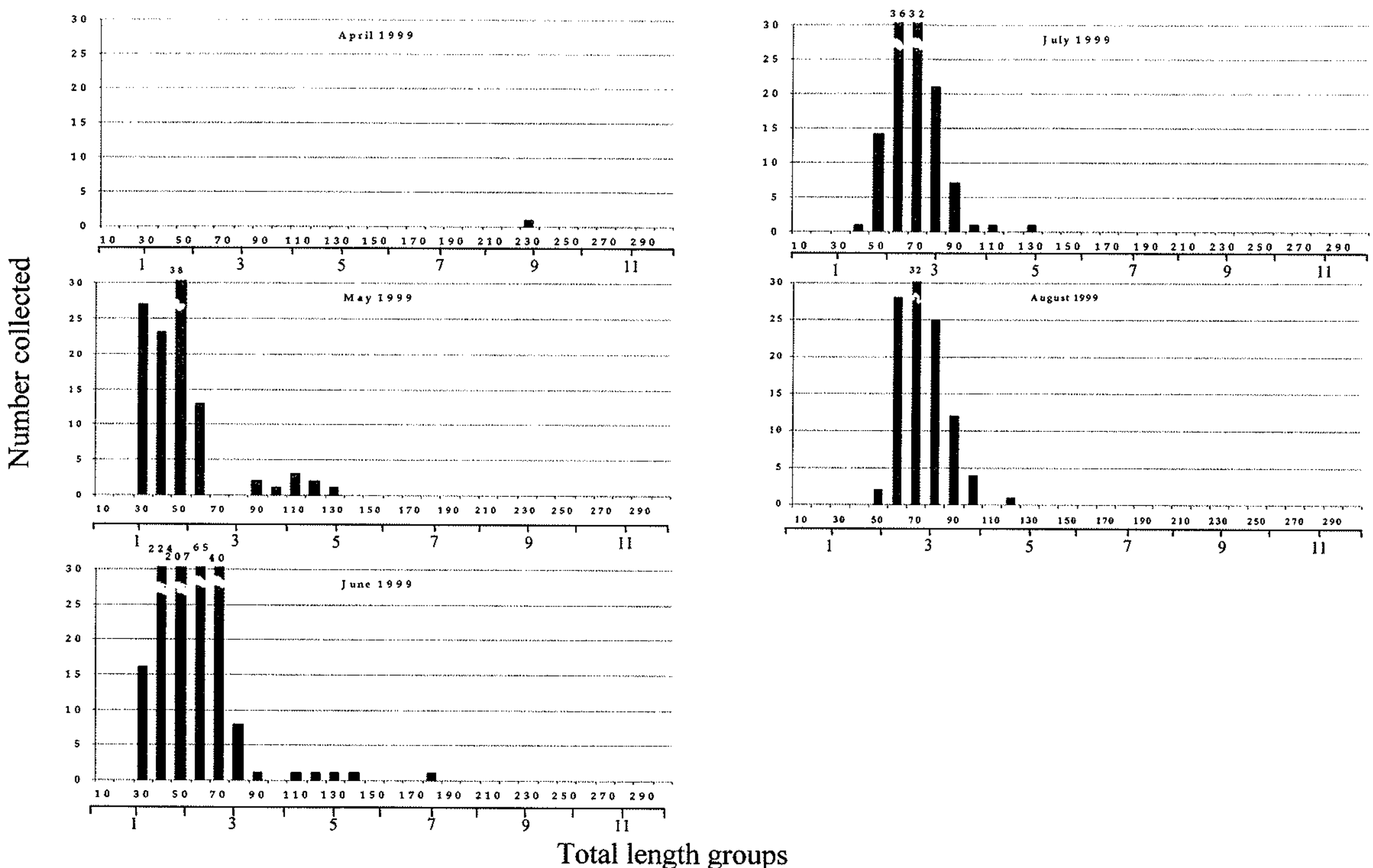


Figure 12.11. Length frequencies of all largemouth bass collected using seine hauls in Newton Lake during April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

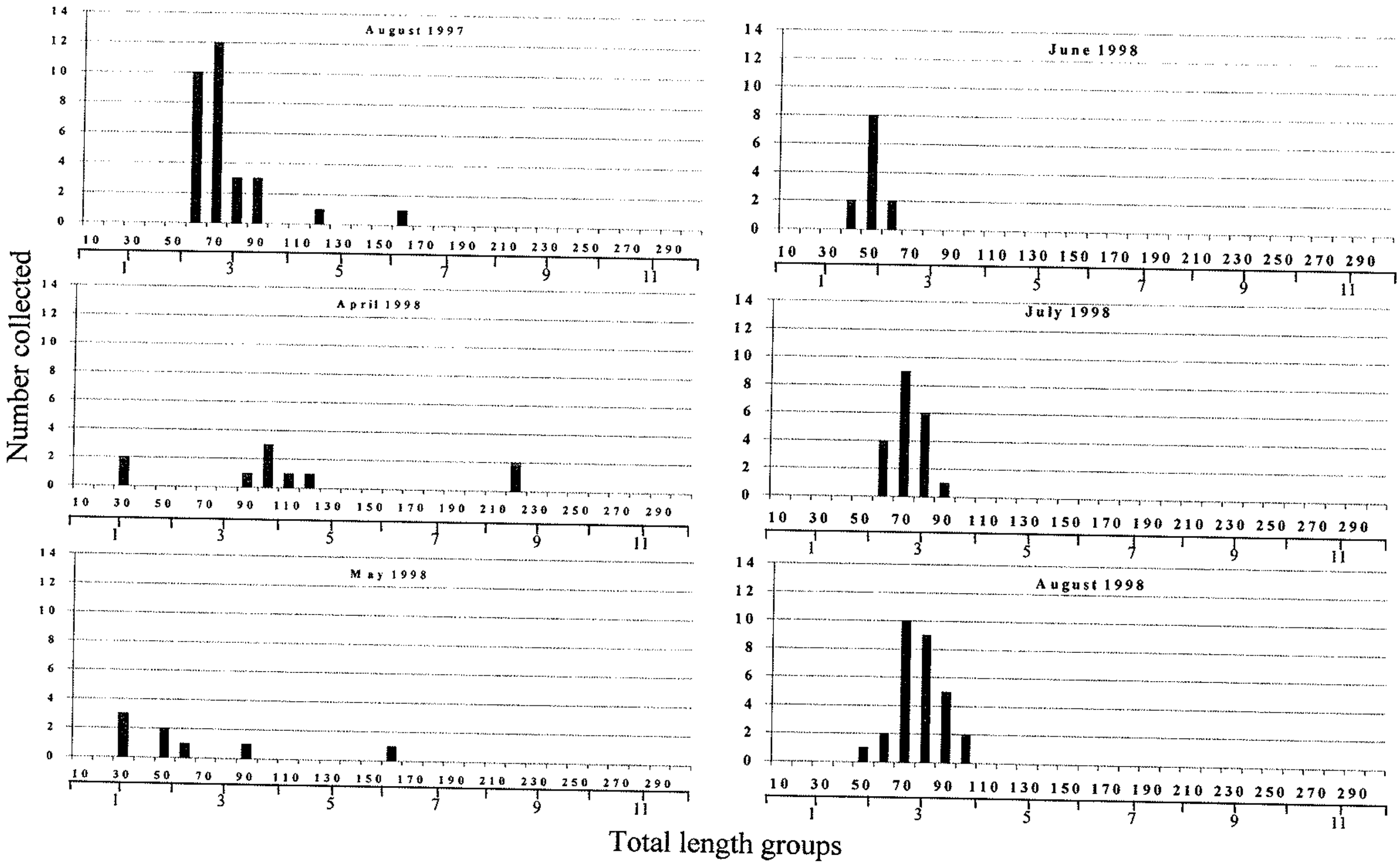


Figure 12.12. Length frequencies of all largemouth bass collected using seine hauls in Coffeen Lake during August 1997 and April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

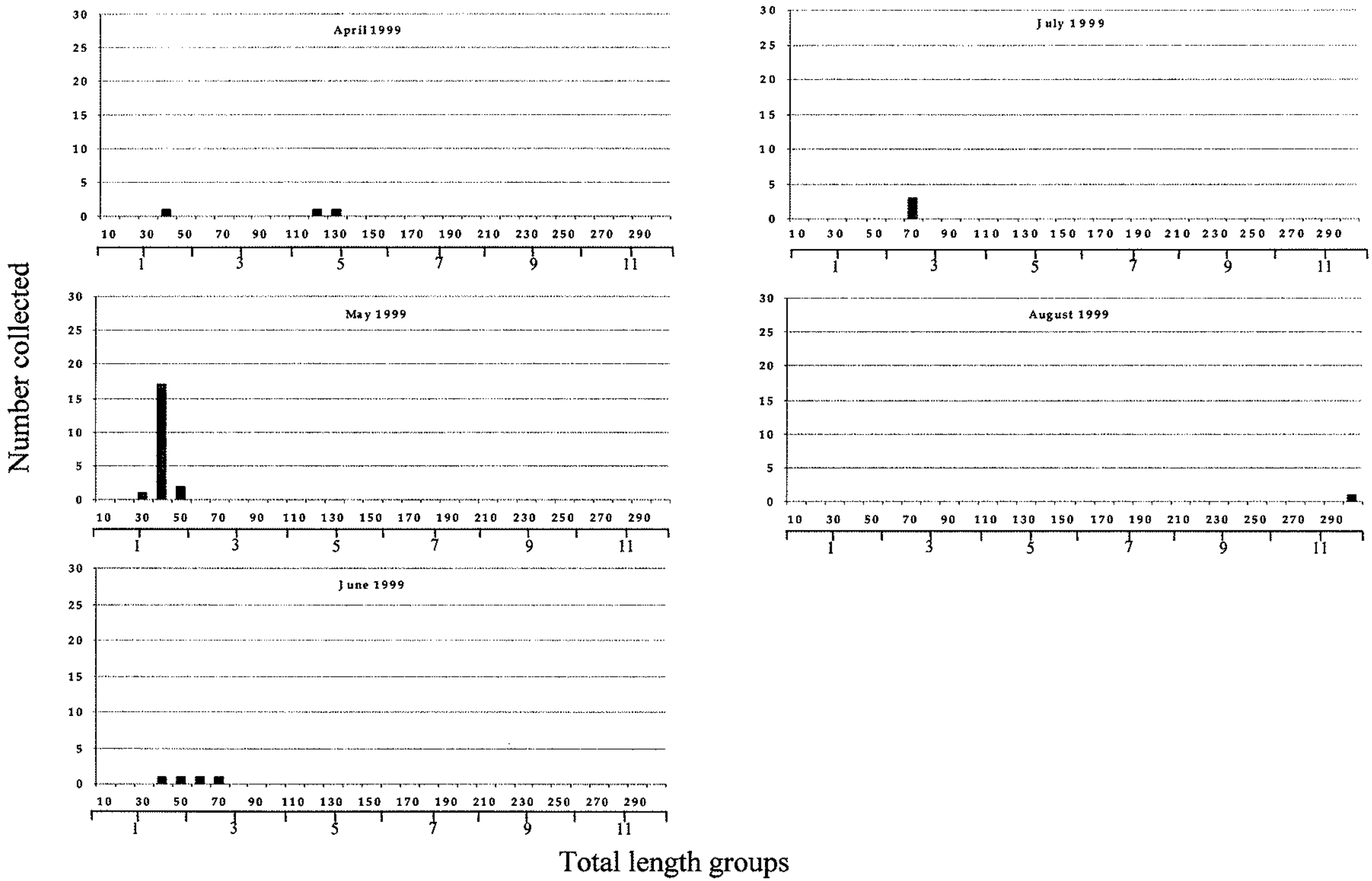


Figure 12.13. Length frequencies of all largemouth bass collected using seine hauls in Coffeen Lake during April through August 1999. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

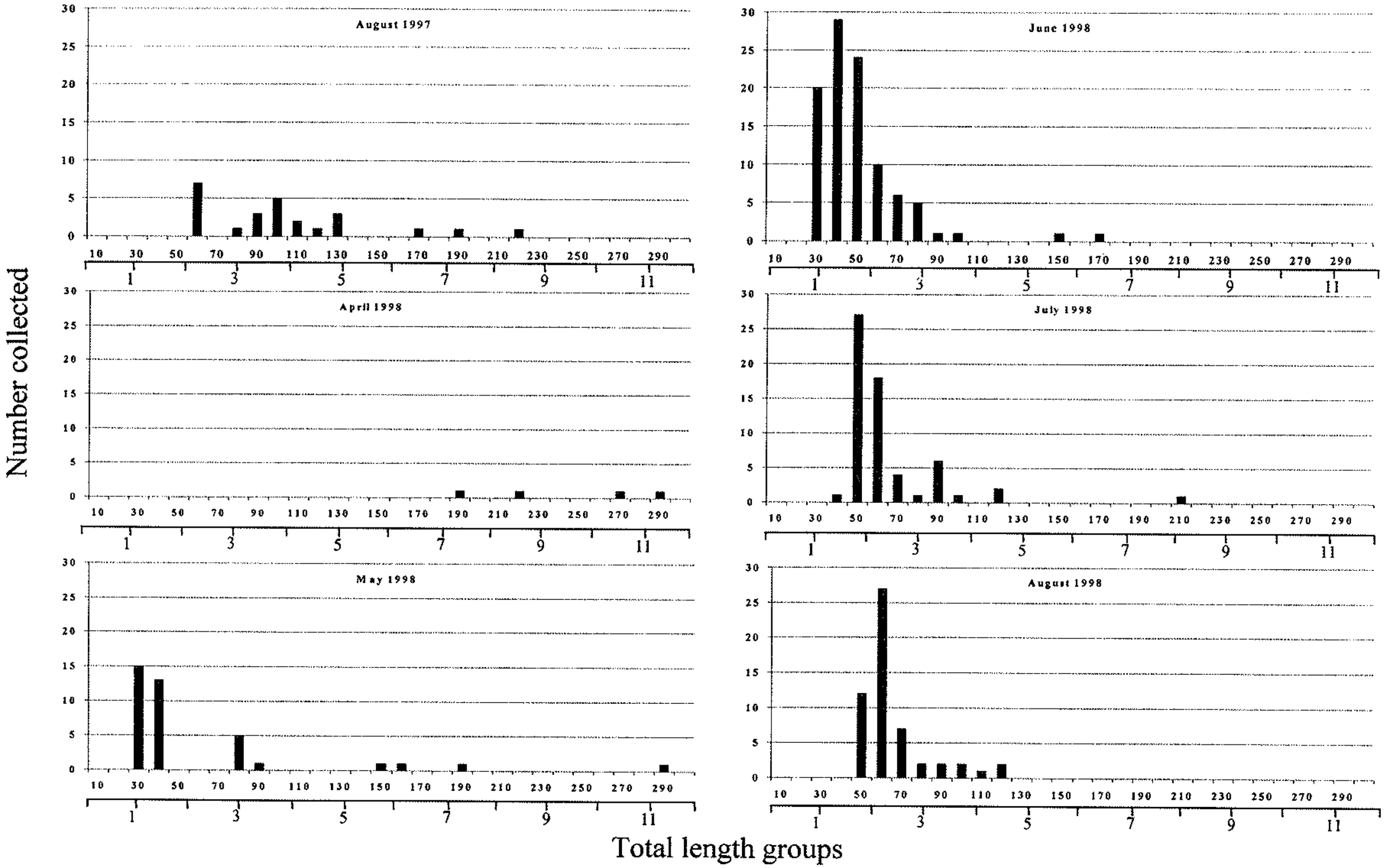


Figure 12.14. Length frequencies of all largemouth bass collected using seine hauls in Lake of Egypt during August 1997 and April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

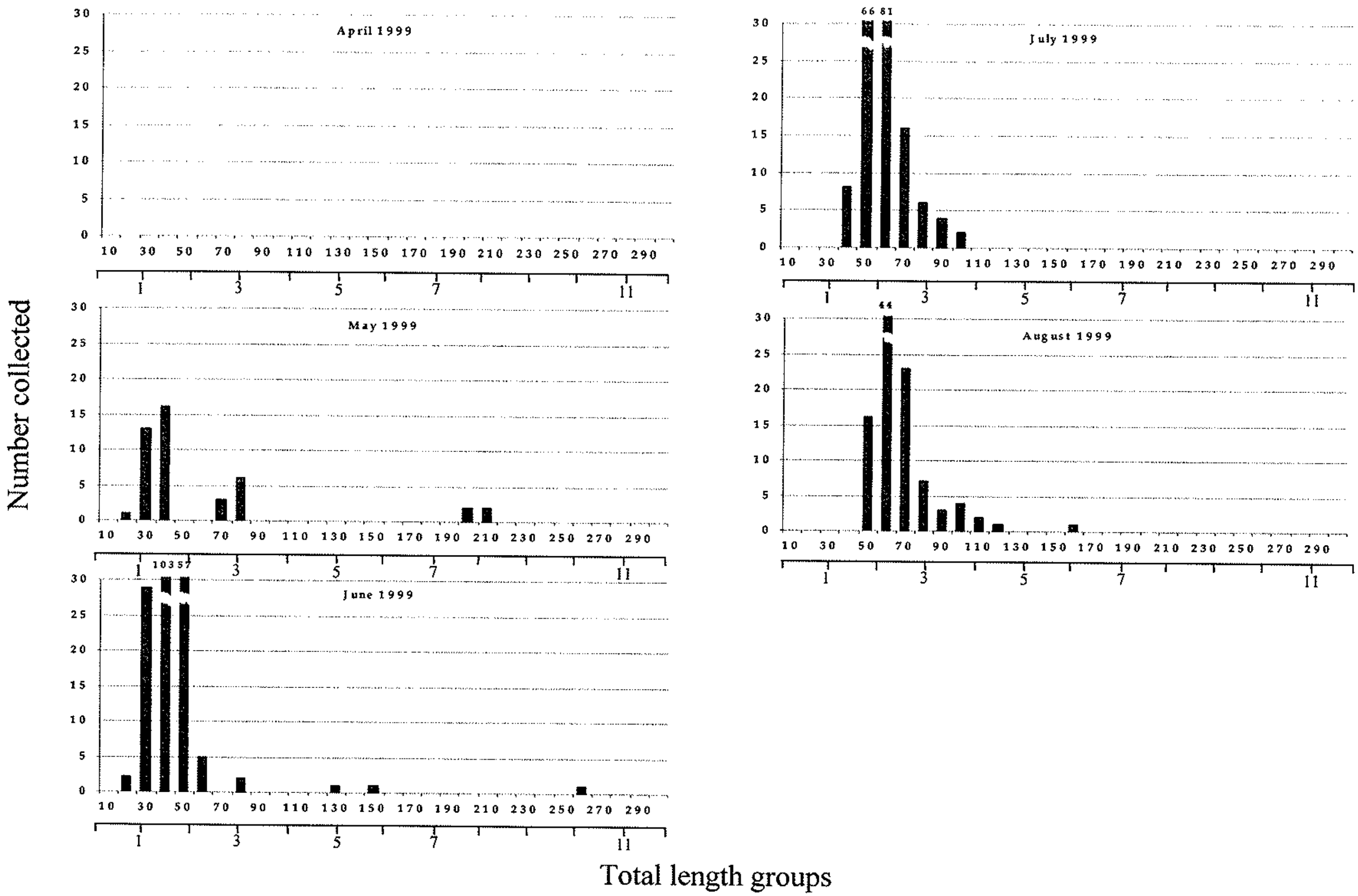


Figure 12.15. Length frequencies of all largemouth bass collected using seine hauls in Lake of Egypt during April through August 1999. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

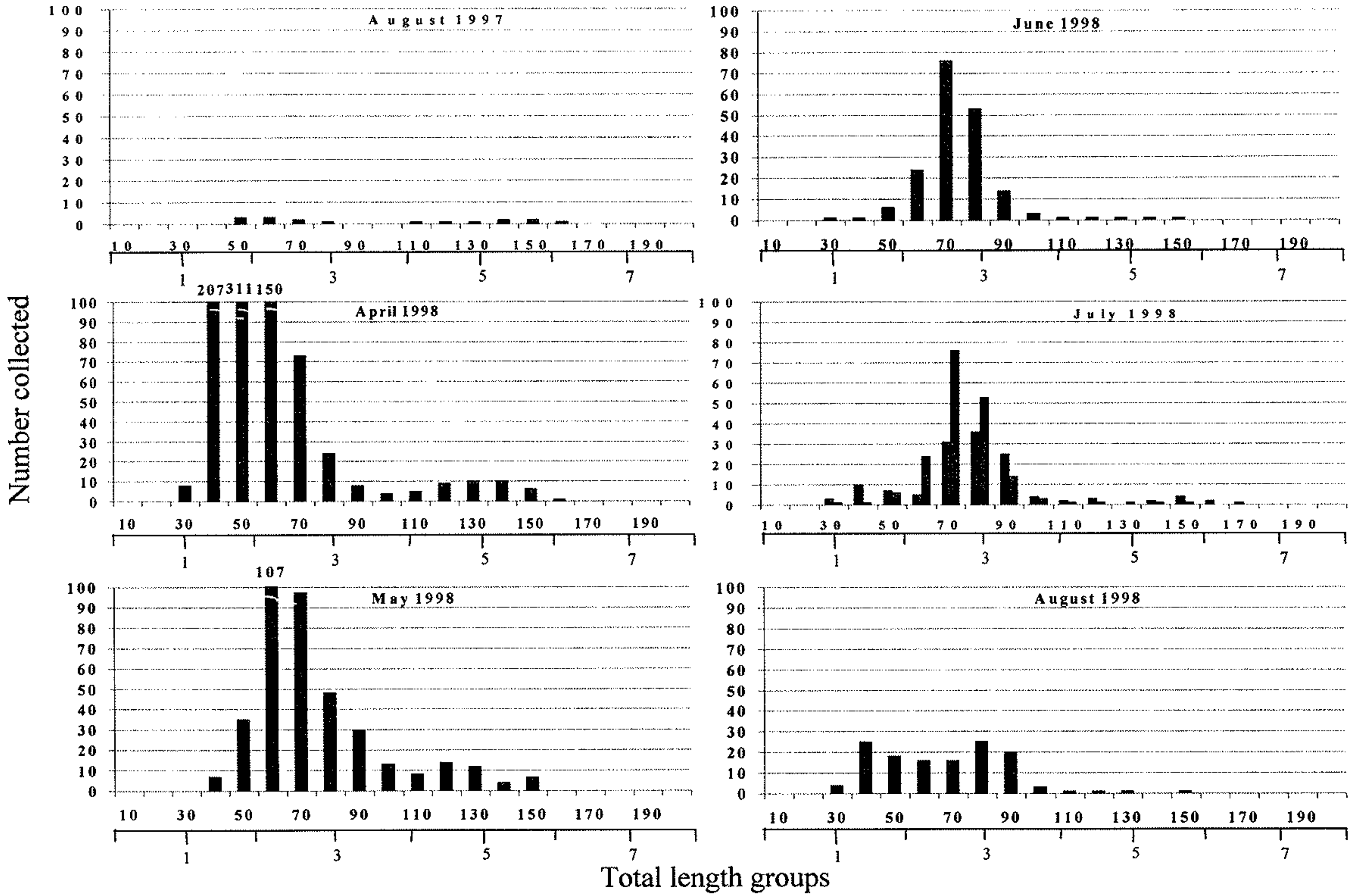


Figure 12.16. Length frequencies of all bluegill collected using seine hauls in Newton Lake during August 1997 and April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

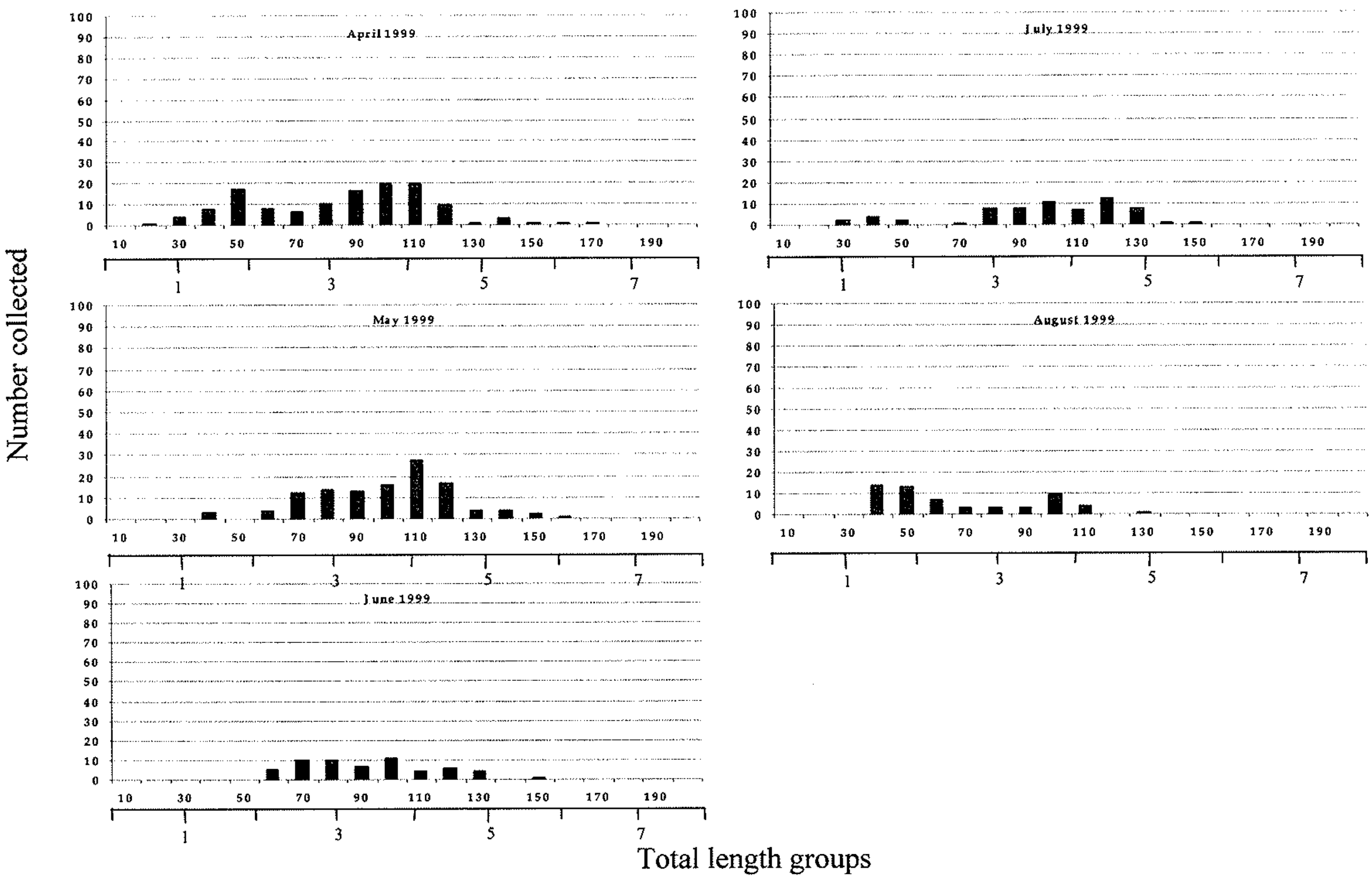


Figure 12.17. Length frequencies of all bluegill collected using seine hauls in Newton Lake during April through August 1999. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

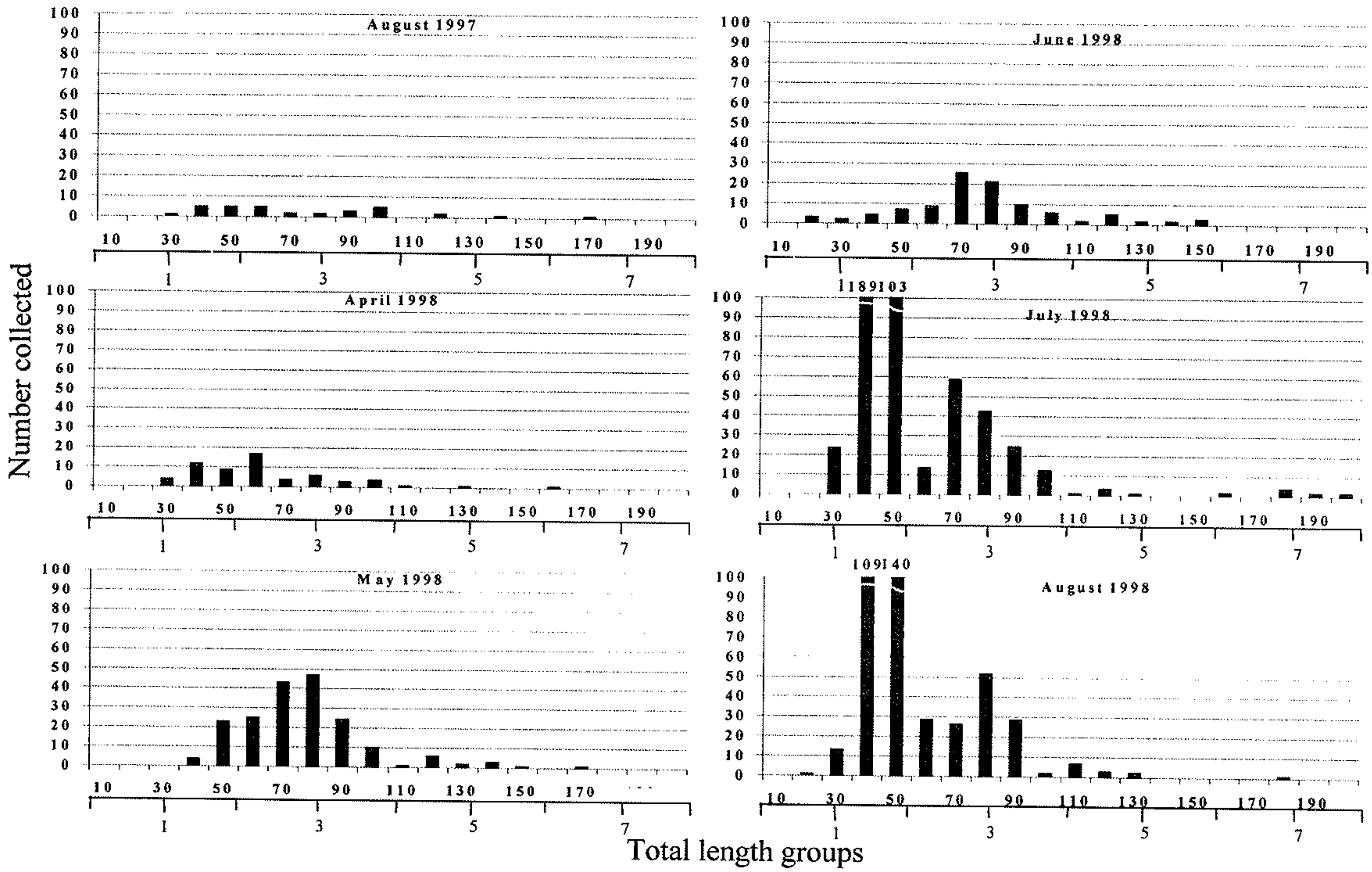


Figure 12.18. Length frequencies of all bluegill collected using seine hauls in Lake of Egypt during August 1997 and April through August 1998.Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

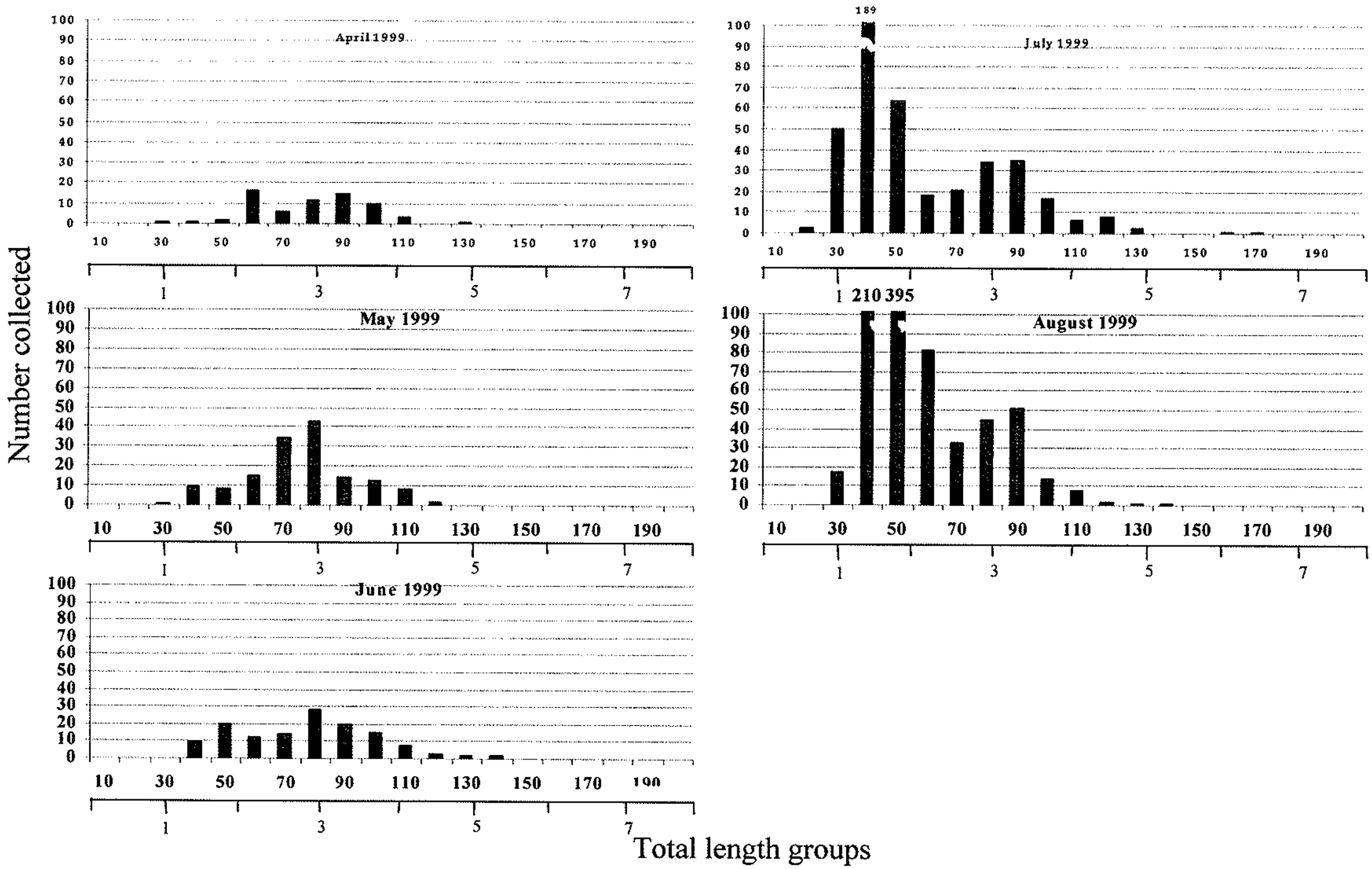


Figure 12.19. Length frequencies of all bluegill collected using seine hauls in Lake of Egypt during April through August 1999. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

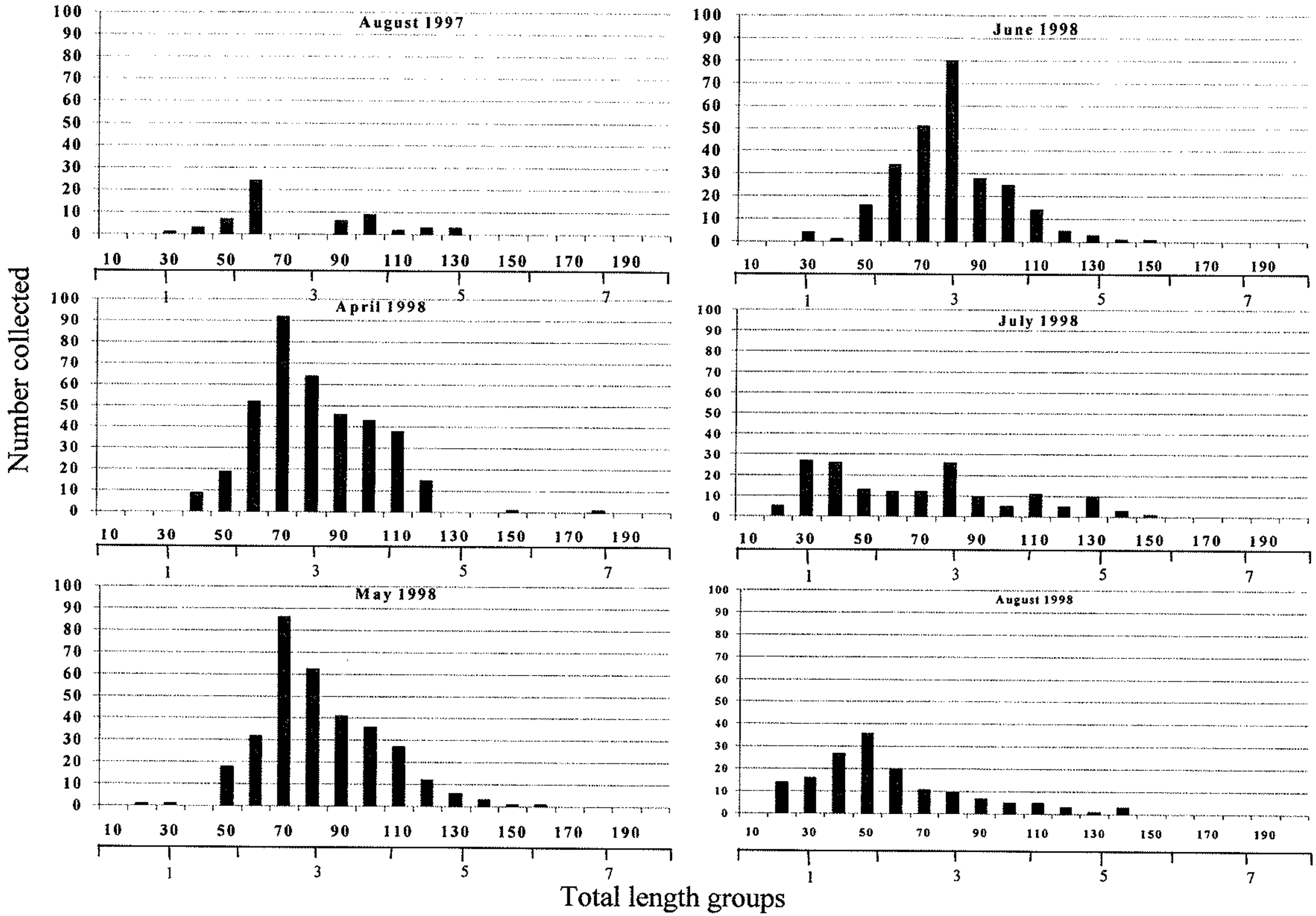


Figure 12.20. Length frequencies of all bluegill collected using seine hauls in Coffeen Lake during August 1997 and April through August 1998. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

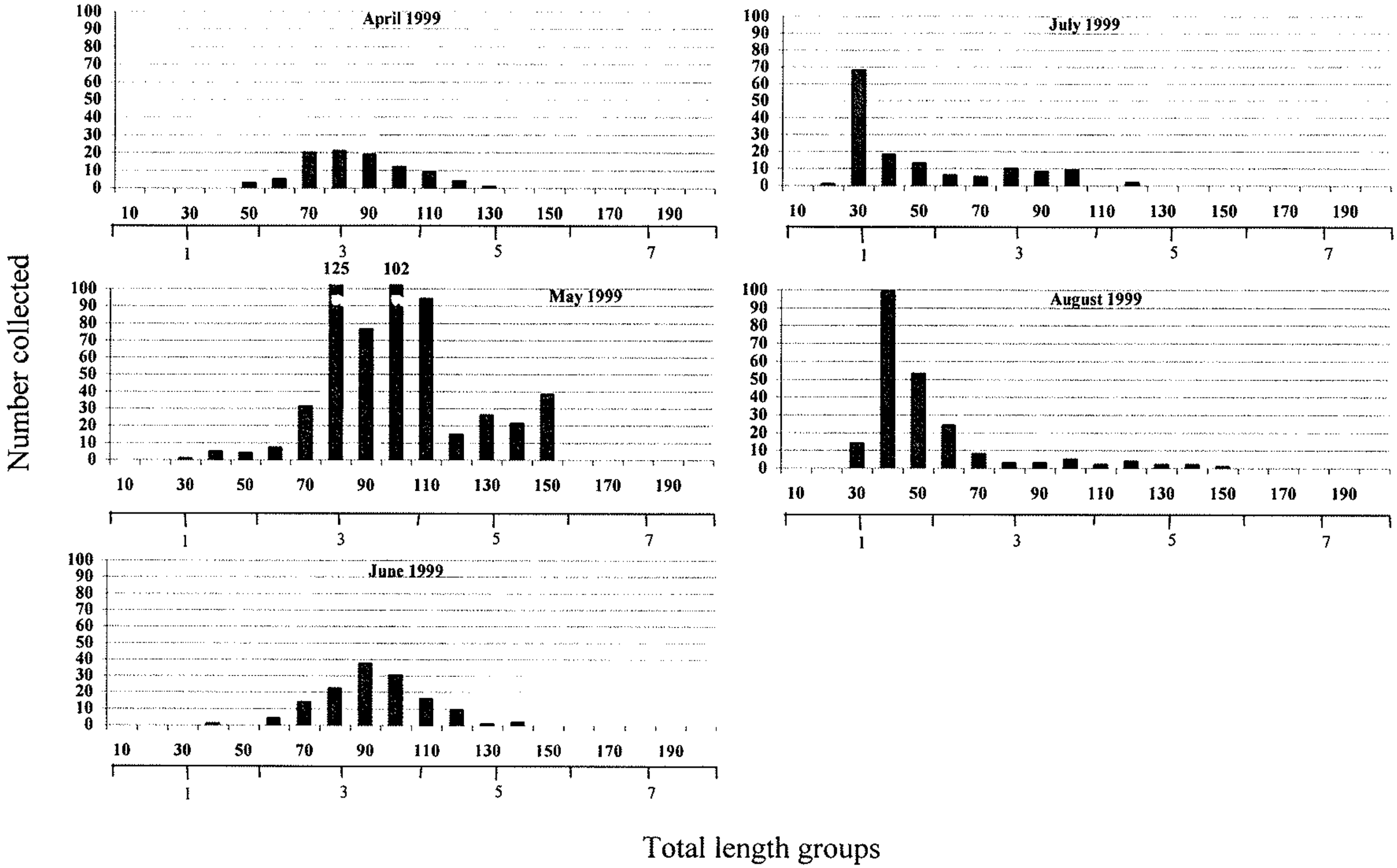


Figure 12.21. Length frequencies of all bluegill collected using seine hauls in Coffeen Lake during April through August 1999. Total length groups are given in inches (lower x-axis) and millimeters (upper x-axis).

Chapter 13. Electrofishing Catch Per Unit Effort and Relative Abundance

Introduction and 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). All electrofishing data collected by IDNR will be used to compare pre- and post-Variance catch-per-hour (CPUE) by species, relative weight, relative abundance and structural indices. Fish collected by Southern Illinois University Fisheries Lab personnel (SIUC) for Job 10 (Food Habits) and Job 11 (Age and Growth) during September, October, November and December of each year were also used to calculate these parameters. In addition to the above effort, we attempted to electrofish each segment of Newton Lake for four hours in August of 1998, and 1999, and, although not required, August 1997 with a 5000 watt, boat-mounted, pulsed-DC unit. One person dipped fish while another maneuvered the boat. All fish were collected, identified, counted, and (except for gizzard shad) weighed and measured. CPUE and relative abundance, etc., results were compared to the 1995 Environmental Science and Engineering, Inc. (ESE) summer study. The ESE (1995) study used a pulsed-DC electrofishing unit. Different types of electrofishing systems tend to yield different CPUE values (Heidinger et al. 1983); thus we used the same type of unit.

Data from historic IDNR fall electrofishing samples from Coffeen Lake were used to compare trends in CPUE and relative abundance. IDNR has agreed to collect fall data each year of this study from Coffeen Lake. SIUC obtained fall CPUE and relative abundance data on the fish populations from Lake of Egypt. A three-phase, AC, boat-mounted electrofishing unit was used for this sample.

Results and Discussion:

CPUE

The trends in electrofishing catch-per-unit-effort, expressed as number of fish captured per hour of active electrofishing, for largemouth bass were similar for samples collected in Newton Lake by the Illinois Department of Natural Resources (IDNR) and for these studies during the years 1997, 1998, and 1999 (Table 13.1). The IDNR sampling has tended to show a general decline in CPUE over the years between 1995 and 1999. In our sampling, bluegill were captured at a greater rate than other species from all three study lakes. Largemouth bass were second most frequently caught in all lakes.

Differences in our AC electrofishing CPUE data among years, lakes, and segments within lakes were only analyzed for bluegill since the sonic tracking study results show that largemouth bass and channel catfish both move freely throughout the lakes (see Job 13: Supplemental Data Tables: for lake and segment breakdowns of AC electrofishing CPUE for all species captured). There were significant differences found in AC electrofishing CPUE of bluegill between Newton Lake and the Lake of Egypt, and Lake of Egypt and Coffeen Lake but not between Coffeen Lake and Newton Lake (Tukey; alpha=0.05). There was no significant interaction effect across years among the three lakes (i.e., the trends in CPUE were consistent across years among the lakes for bluegill)(GLM; p=0.3942). CPUEs were significantly higher for bluegill in segment 1 of Lake of Egypt than in segment 2 (GLM; p=0.0116). There was no significant difference between the segments of Coffeen Lake (GLM; p=0.5304) or Newton Lake (GLM; p=0.2247). In Newton Lake, there were no significant differences in AC electrofishing CPUEs between segments 1, 3, and 4. However, segment 2 was significantly different from the other three segments (Tukey;

alpha=0.05) (Table 13.2). There was no significant segment by year interaction effect for AC CPUEs from Newton Lake (GLM; p=0.5584).

Environmental Science and Engineering, Inc. sampled eight zones of Newton Lake in August of 1995 (Figure 13.1). We used similar equipment to sample these zones in August 1997, 1998, and 1999 (Table 13.3) Zones 1, 2 and 3 are in our segment 1, zone 4 is in segment 2, zone 5 is in segment 3, and zones 6, 7 and 8 are in our segment 4.

Length frequencies

Based on the fall 1997, 1998, and 1999 length-frequency data for bluegill in the four segments of Newton Lake, there didn't appear to be any clear trends in size structure related to the "instream" position of the segments (Figure 13.2). However, the spring 1998 and 1999 data suggests that the bluegill were somewhat segregated by size with smaller fish being more abundant in segments 1 and 2 (Figure 13.3). The length-frequency distributions of largemouth bass collected during the spring of 1998 and 1999 appear to show two reasonably strong cohorts (one in the 3-6 inch range, and one in the 7 to 10 inch range) which possibly moved to the7 to 10 inch and 11 to 14 inch range, respectively (Figure 13.4). The cohort in the 16 to 20 inch range during spring of 1999 was likely a year older than the 11 to 14 inch cohort (See Job 11: Age, Growth, and Mortality). As in the segment data, there was no clear overall trend in the spring length frequencies of bluegill across the years 1998 and 1999. This was probably indicative of stunting in the bluegill population. The spring length frequencies of channel catfish, though, show a similar pattern to the largemouth bass with a predominate cohort of 8 to 11 inch fish apparent during 1998 that had moved to the 11 to 14 inch range during the spring of 1999. There was a lack of the smaller fish during spring 1999 but this probably didn't relate to recruitment failure since fish that would have been at these smaller sizes were represented in the samples taken during the fall of 1998 in a proportion similar to the fall samples taken during 1997 (Figure 13.5). Based on the age-frequency data obtained for calculating mortality (See Job 11: Age, Growth, and Mortality) these recruits may have represented age-3 or older individuals. The back-calculated length-at-age data for channel catfish taken from Newton Lake indicate very slow growth with 10 to 12 year old fish reaching lengths of only 12 to 14 inches and 0.5 to 0.8 lbs. The fall length-frequency data for largemouth bass captured from Newton Lake is not particularly informative, except to note that there appeared to be a strong cohort that probably represented young-of-the-year individuals. The fall 1997-1999 length-frequency data for bluegill, however, is similar to that seen during spring 1998-1999 sampling.

The fall length frequency data for largemouth bass collected from Coffeen Lake doesn't show any outstanding trends (Figure 13.6). However, the bluegill length frequencies seem to show a pattern of only relatively small fish being present from year to year similar to that seen in Newton Lake. The low numbers of fish appearing in the length-frequency data taken during fall of 1997 and 1998 make the assessment of trends for channel catfish problematical. However, from the fall 1999 data, it is apparent that there were more of the larger size classes than were found in Newton Lake.

Again, the fall length-frequency data for largemouth bass collected from the Lake of Egypt doesn't show any outstanding trends (Figure 13.7). However, the bluegill length frequencies indicate that larger individuals were present in the population with some individuals in the 8 to 9 inch range being present. There were so few fish in the length-frequency data set for Lake of Egypt during 1997 and 1998 that one would be remiss to draw any conclusions except to note that the individuals present were larger than those seen during the same two years in Newton Lake or Coffeen Lake.

It is apparent, from the Newton Lake length-frequency data for largemouth bass and channel catfish collected during 1998 and 1999 provided to us by the IDNR, that dead and dying fish of both species collected by us during routine sampling from 1 June 1999 through 31 August 1999, were disproportionately large as compared with the populations of these two species as a whole (Figures 13.8-13.11). The larger size classes, though, do not seem to be under-represented in the 1999 data as compared with the 1998 data for either species.

IDNR provided considerable data on length-frequency distribution obtained from fall of 1976 through fall of 1999. Based on this data, the population of largemouth bass appeared to be in decent shape, showing good recruitment and a good distribution of size classes (Table 13.4). The bluegill population, on the other hand, has been dominated by small fish during the entire period of this record (Table 13.5). Despite their slow growth, the bluegill have shown consistently good recruitment during the 23 years.

Between the years of 1976 and 1986, white crappie in Newton Lake apparently had decent recruitment and showed a good distribution of size classes (Table 13.6). However, around 1986, their population crashed. Based on the lack of smaller size classes in the sample, there was apparently a problem with recruitment to the population. In 1988, a 10 inch size limit and 10 fish-per-day creel limit was imposed on white crappie in the lake. Despite decent growth of white crappie in Newton Lake, this creel limit failed to prevent the populations decline and failed to reestablish recruitment of strong year-classes.

The channel catfish population in Newton Lake during this period showed a trend similar to that exhibited by white crappie. The exception being that the demise of the channel catfish population was more protracted, becoming evident after 1992 when the majority of large fish had disappeared. The delay of the manifestation of size distribution problems in this population is likely due to the relative longevity of channel catfish as compared with white crappie. Recruitment, to this date, does not appear to be a problem. However, the population is dominated by smaller size classes of fish. This points to a population that is experiencing slow growth of individuals. This observation is borne out, as discussed earlier, in the small size of very old fish (See Job 11: Age, Growth, and Mortality).

Literature Cited:

ESE. 1995. Newton Lake 1995 aquatic biota and water quality surveys. ESE Project No. 5195-125-0400. Environmental Science and Engineering, Inc., St. Louis, Missouri.

Heidinger, R.C., D.R. Helms, T.I. Heibert, and P.H. Howe. 1983. Operational comparison of three electrofishing systems. North American Journal of Fisheries Management 3:254-257.

Table 13.1. Summary of fall and spring electrofishing catch per hour (CPUE) obtained by the Illinois Department of Natural Resources (IDNR) from 1995 through 1999 for Newton Lake, and Lake Coffeen. The 1997 and 1998 electrofishing CPUE data for Lake of Egypt were obtained during the months of November and December by Southern Illinois University Fisheries Research Lab (SIU) for this study.

	Newton Lake		Coffeen		Lake of Egypt	
Year	Hours of Electrofishing	Catch per Hour	Hours of Electrofishing	Catch per Hour	Hours of Electrofishing	Catch per Hour
			Largemouth Bass			
1995	12	70	7.5	111	-	-
1996	12	83	7.5	82	-	-
1997	12	30	7.5	79	13	41
1998	12	59	7.5	43	10	41
1999	12	43	-	-	-	-
			Bluegill			
1995	12	103	-	-	-	-
1996	12	52	-	-	-	-
1997	12	45	7.5	196	10	129
1998	12	44	7.5	99	9	92
1999	12	69	-	-	-	-
			Channel Catfish			
1995	12	44	-	-	-	-
1996	12	12	-	-	-	-
1997	12	4	7.5	9	13	0.5
1998	12	13	7.5	12	11	0.8
1999	12	12	-	-	-	-

Table 13.2. Summary of AC electrofishing catch-per-unit-effort for bluegill captured within the four segments of Newton Lake during the months September through December of 1997, 1998, and 1999.

	Segment 1		Segment 2		Segment 3		Segment 4	
Year	Effort (hrs)	Catch/hr	Effort (hrs)	Catch/hr	Effort (hrs)	Catch/hr	Effort (hrs)	Catch/hr
1997	3.0	144	2.4	154	3.2	139	2.7	83
1998	2.6	42	1.2	161	1.8	68	1.6	91
1999	1.6	71	0.5	186	1.6	84	1.6	77

Table 13.3. Catch-per-unit-effort of fish collected in August with pulsed DC electrofishing within eight zones of Newton Lake. ESE collected the 1995 data.

Station	Species	1995		1997		1998		1999	
		Temp. (°F)	Catch/hr.	Temp (°F)	Catch/hr.	Temp (°F)	Catch/hr.	Temp (°F)	Catch/hr.
Zone 1	Gizzard shad	102.2	3.8	95.0	-	96.5	-	100.1	283.0
	Carp		-		-		3.0		13.6
	Bluegill		3.8		-		15.0		61.4
	Longear sunfish		22.5		-		-		3.4
	Hybrid sunfish		11.2		-		-		-
	Largemouth bass		30.0		-		15.0		-
			71.3		-		33.0		361.4
Zone 2	Gizzard shad	102.2	20.00	95.0	3.0	96.5	48.0	100.1	-
	Bluegill		-		-		6.0		-
	Hybrid sunfish		-		-		6.0		-
			20.00		3.0		60.0		
Zone 3	Gizzard shad	95.0	96.00	90.5	12.0	96.0	-	95.2	-
	Carp		-		2.4		-		-
	Green sunfish		-		2.4		-		-
	Bluegill		68.00		16.8		-		-
	Longear sunfish		28.00		4.8		-		-
	Hybrid sunfish		4.00		2.4		-		-
	Largemouth bass		60.00		-		-		-
			256.00		40.8				

Table 13.3. Continued

Station	Species	1995 Temp. (°F)	1995 Catch/hr.	1997 Temp (°F)	1997 Catch/hr.	1998 Temp (°F)	1998 Catch/hr.	1999 Temp (°F)	1999 Catch/hr.
Zone 4	Gizzard shad	93.2	728.00	90.5	-	92.6	15.0	91.4	67.9
	Carp		4.00		-		-		-
	Orange spotted sunfish		-		-		9.0		-
	Bluegill		36.00		6.0		-		319.3
	Longear sunfish		4.00		-		-		-
	Hybrid sunfish		4.90		3.0		12.0		4.5
	Largemouth bass		8.00		-		-		4.5
			784.00		9.0		36.0		396.2
Zone 5	Gizzard shad	93.2	33.0	85.3	-	88.1	27.5	90.6	55.8
	Channel catfish		4.0		-		-		4.7
	Bluegill		88.0		3.0		10.0		14.0
	Green sunfish		12.0		-		-		-
	Longear sunfish		16.0		3.0		5.0		4.7
	Hybrid sunfish		16.0		-		-		-
	Largemouth bass		-		-		2.5		-
			268.0		6.0		55.0		79.2
Zone 6	Gizzard shad	90.5	76.0	85.3	-	96.5	32.4	87.1	17.2
	Channel catfish		4.0		-		-		-
	Bluegill		244.0		-		-		58.6
	Green Sunfish		-		-		-		10.3
	Longear sunfish		76.0		-		-		31.0
	Hybrid sunfish		8.0		-		22.7		3.5
	Largemouth bass		-		-		3.2		17.2
			408.0		-		58.3		137.8

Table 13.3. Continued

Station	Species	1995 Temp. (°F)	1995 Catch/hr.	1997 Temp (°F)	1997 Catch/hr.	1998 Temp (°F)	1998 Catch/hr.	1999 Temp (°F)	1999 Catch/hr.
Zone 7	Gizzard shad	89.6	124.0	85.3	-	96.5	26.9	86.7	-
	Carp		4.0		3.0		-		-
	Channel catfish		4.0		-		-		-
	Bluegill		76.0		3.0		-		-
	Longear		24.0		-		-		-
	Hybrid sunfish		4.0		-		11.9		-
	Largemouth bass		8.0		3.0		3.0		-
			244.0		9.0		51.8		
Zone 8	Gizzard shad	87.8	475.0	85.3	12.0	96.5	45.6	86.7	582.9
	Carp		8.0		3.0		-		-
	Channel catfish		8.0		3.0		-		-
	Green sunfish		4.0		3.0		3.3		34.3
	Bluegill		72.0		3.0		16.3		114.3
	Longear sunfish		4.0		6.0		-		34.3
	Hybrid sunfish		-		-		3.3		-
	Largemouth bass		36.0		3.0		26.1		62.9
	White bass		-		-		-		5.7
			572.0		33.0		94.6		834.4

Table 13.4. Changes in the size-frequency distribution of largemouth bass in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

		Length (inches)			
Year	Sample Size	12	14	16	18
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	1622	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	1006	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

Table 13.4. Continued

Year	Sample Size	Length (inches)			
		12	14	16	18
1993 Spring	509	69	60	21	8
1993 Fall	637	69	56	11	6
1994 Spring	809	52	50	0	0
1994 Fall	1126	79	53	6	2
1995 Spring	548	53	50	0	0
1995 Fall	840	44	32	14	2
1996 Spring	592	85	73	43	9
1996 Fall	1000	58	47	27	7
1997 Spring	718	84	70	46	14
1997 Fall	357	24	19	12	5
1998 Spring	691	63	53	41	15
1998 Fall	705	53	41	31	6
1999 Spring	--	--	--	--	--
1999 Fall	514	50	38	13	4

Table 13.5. Changes in the size frequency distribution of bluegill in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

Year	Sample Size	Length (inches)		
		6	7	8
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	0.8	0
1980 Spring	113	15	0	0
1980 Fall	262	13	0.8	0
1981 Spring	379	15	2	0
1981 Fall	264	20	0	0
1982 Spring	1026	13	0.2	0
1982 Fall	363	3	0.3	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	0.5	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	0.7	0
1988 Fall	376	3	0	0
1989 Spring	120	9	0.8	0
1989 Fall	628	5	0	0
1990 Spring	95	17	4	2
1990 Fall	107	5	2	2
1991 Spring	512	5	0.8	0
1991 Fall	108	4	0	0
1992 Spring	108	14	1	0
1992 Fall	78	15	0	0

Table 13.5. Continued

Year	Sample Size	Length (inches)		
		6	7	8
1993 Spring	112	21	3	0.9
1993 Fall	620	14	3	0
1994 Spring	106	0	0	0
1994 Fall	289	0	0	0
1995 Spring	133	0	0	0
1995 Fall	1236	<1	0	0
1996 Spring	434	5	2	0.5
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	--	--	--	--
1999 Fall	832	1	0	0

Table 13.6. Changes in the size frequency distribution of white crappie in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

		Length (inches)		
Year	Sample Size	6	7	10
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

Table 13.6. Continued

Year	Sample Size	Length (inches)		
		6	7	10
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
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	--	--	--	--
1999 Fall	22	100	100	5

Table 13.7. Changes in the size frequency distribution of channel catfish in Newton Lake based on IDNR fall and spring electrofishing samples from fall 1976 to fall 1999.

		Length (inches)		
Year	Sample Size	12	16	20
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

Table 13.7. Continued

Year	Sample Size	Length (inches) 12	16	20
1993 Spring	73	36	15	1
1993 Fall	193	4	0	0
1994 Spring	72	42	19	0
1994 Fall	137	28	8	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	--	--	--	--
1999 Fall	142	37	1	0

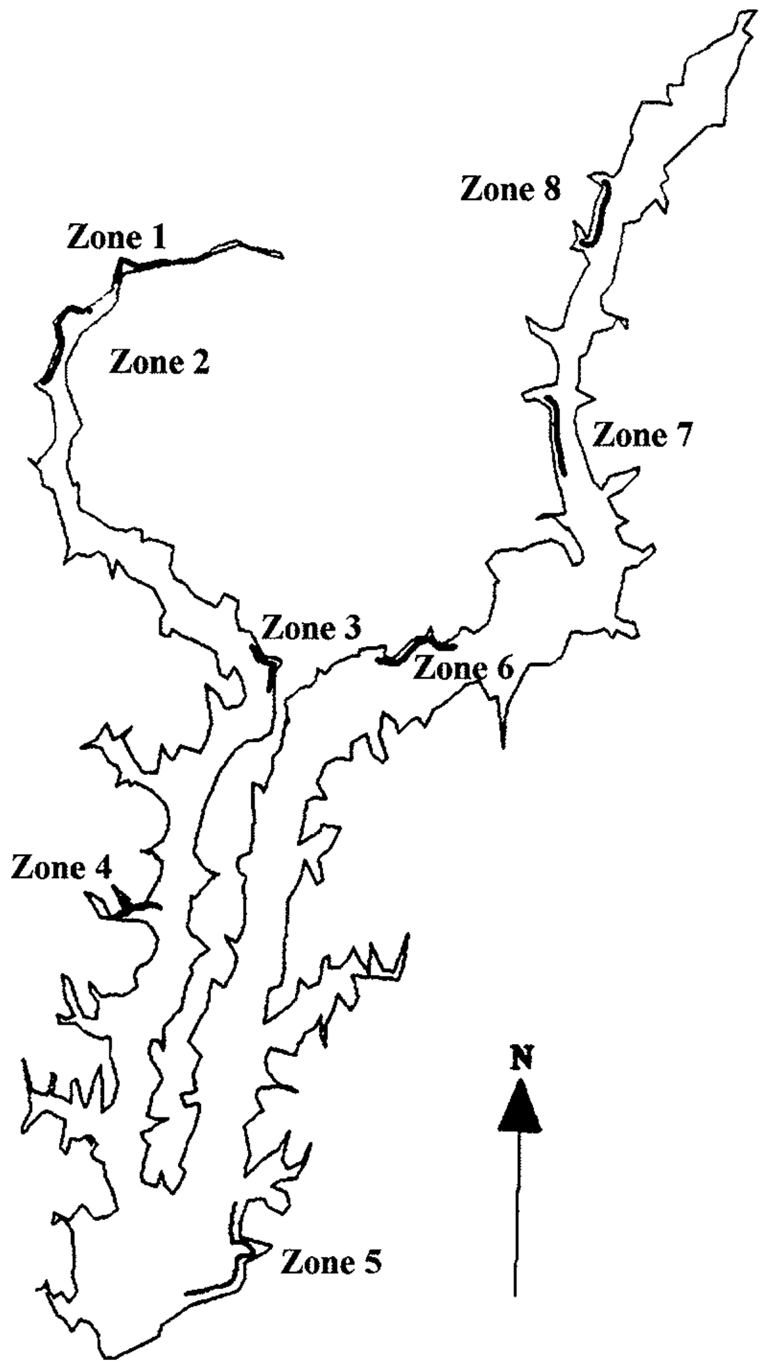


Figure 13.1. Environmental Science and Engineering Inc. sampling zones used for DC electrofishing in Newton Lake, Illinois.

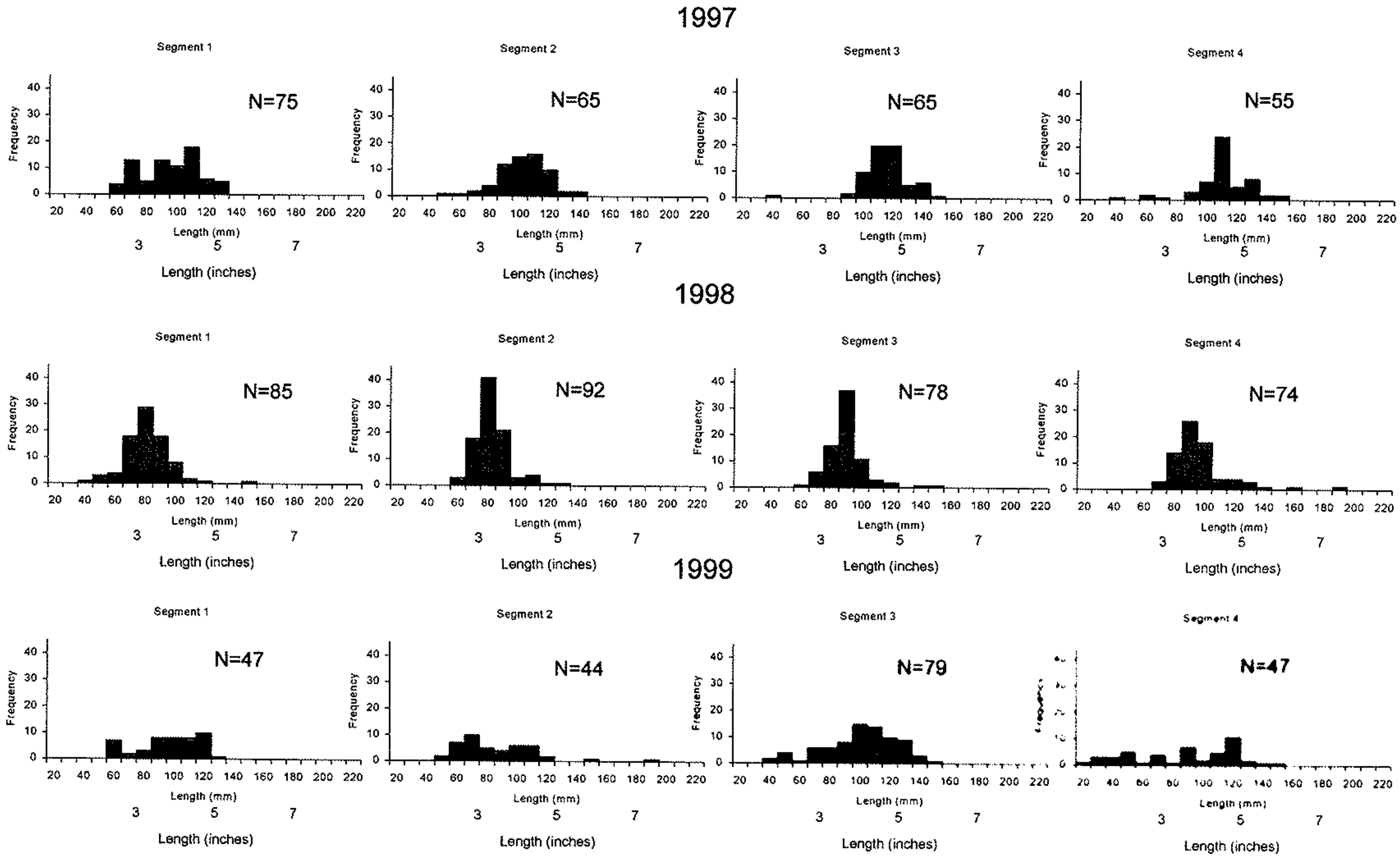


Figure 13.2. Length-frequency histograms of bluegill captured in each segment of Newton Lake during October and November 1997, 1998, and 1999. Lengths are combined into 10-mm groups.

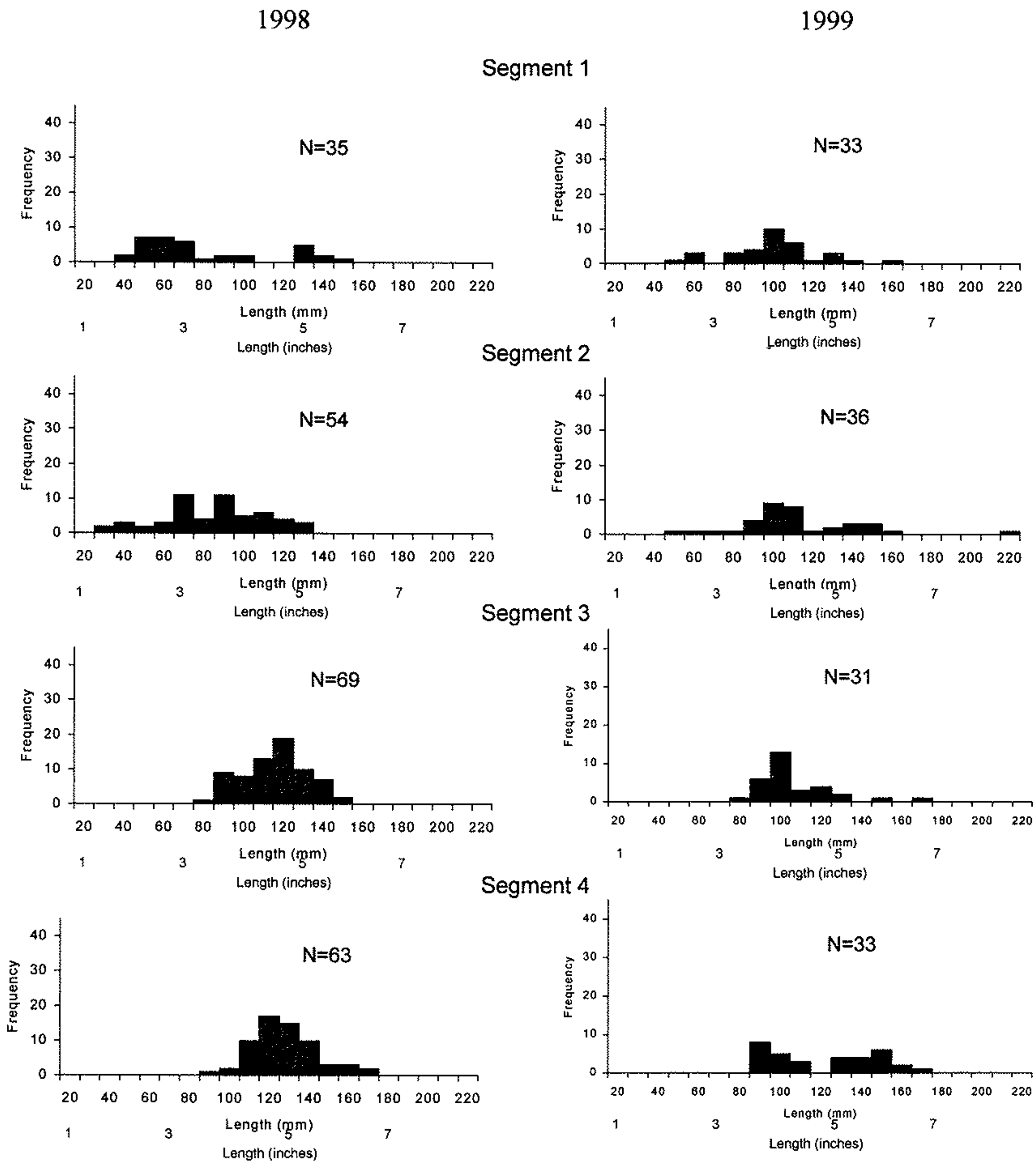


Figure 13.3. Length-frequency histograms of bluegill captured in each segment of Newton Lake during the months of March and April 1998, and 1999. Lengths are combined into 10-mm groups.

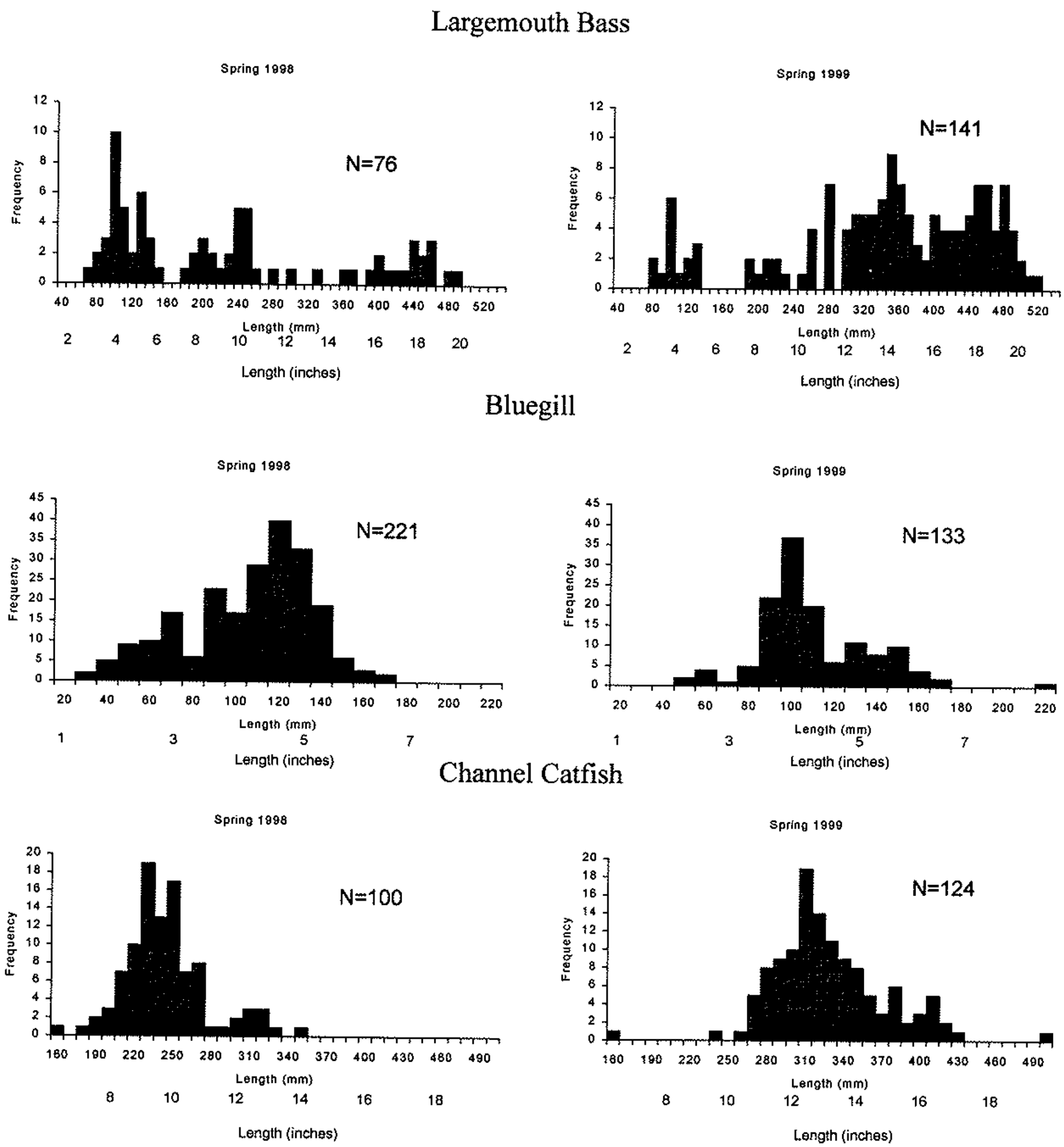
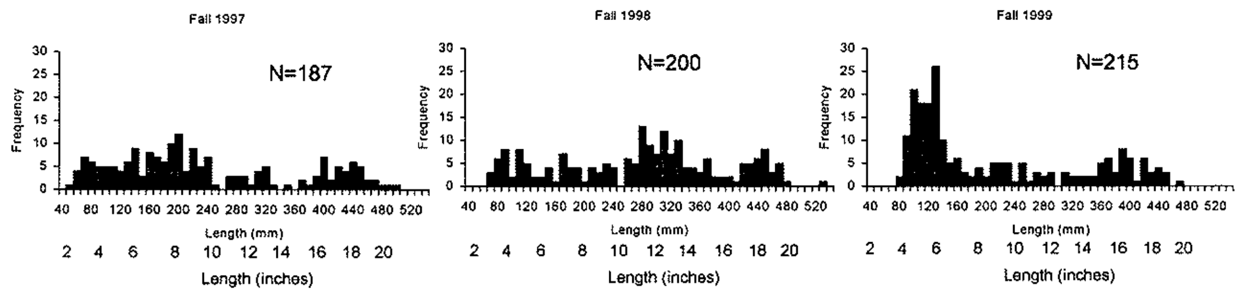
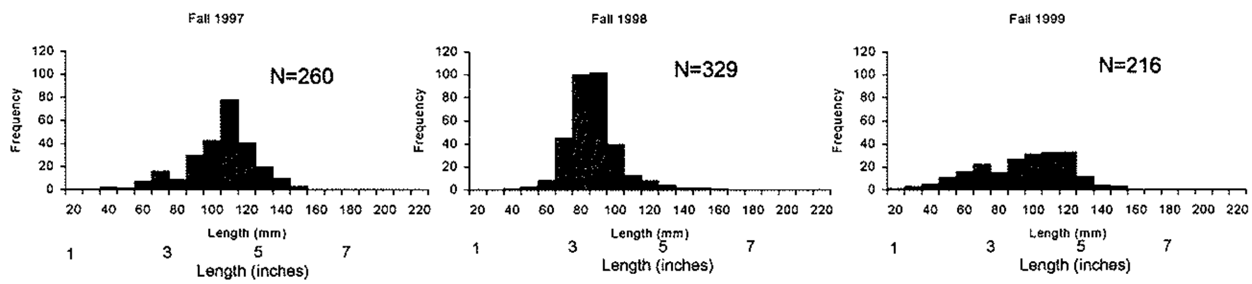


Figure 13.4. Length-frequency histograms of largemouth bass, bluegill, and channel catfish captured in Newton Lake during the months of March and April 1998, and 1999. Lengths are combined into 10-mm groups.

Largemouth Bass



Bluegill



Channel Catfish

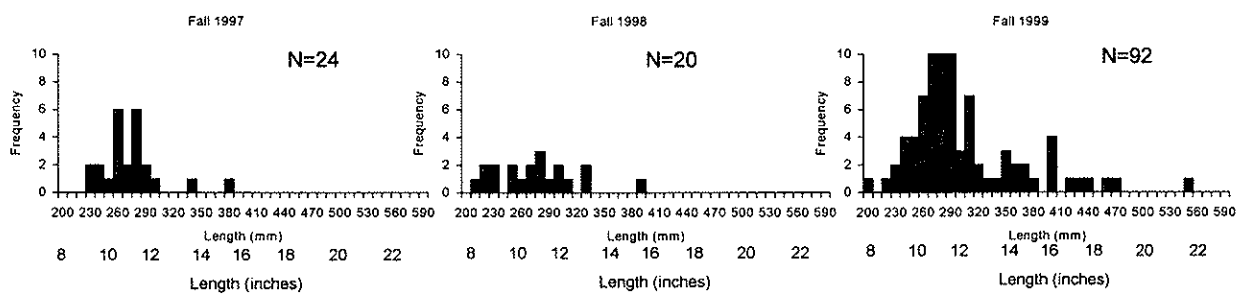


Figure 13.5. Length-frequency histograms of largemouth bass, bluegill, and channel catfish captured in Newton Lake during the months of October and November 1997, 1998, and 1999. Lengths are combined into 10-mm groups

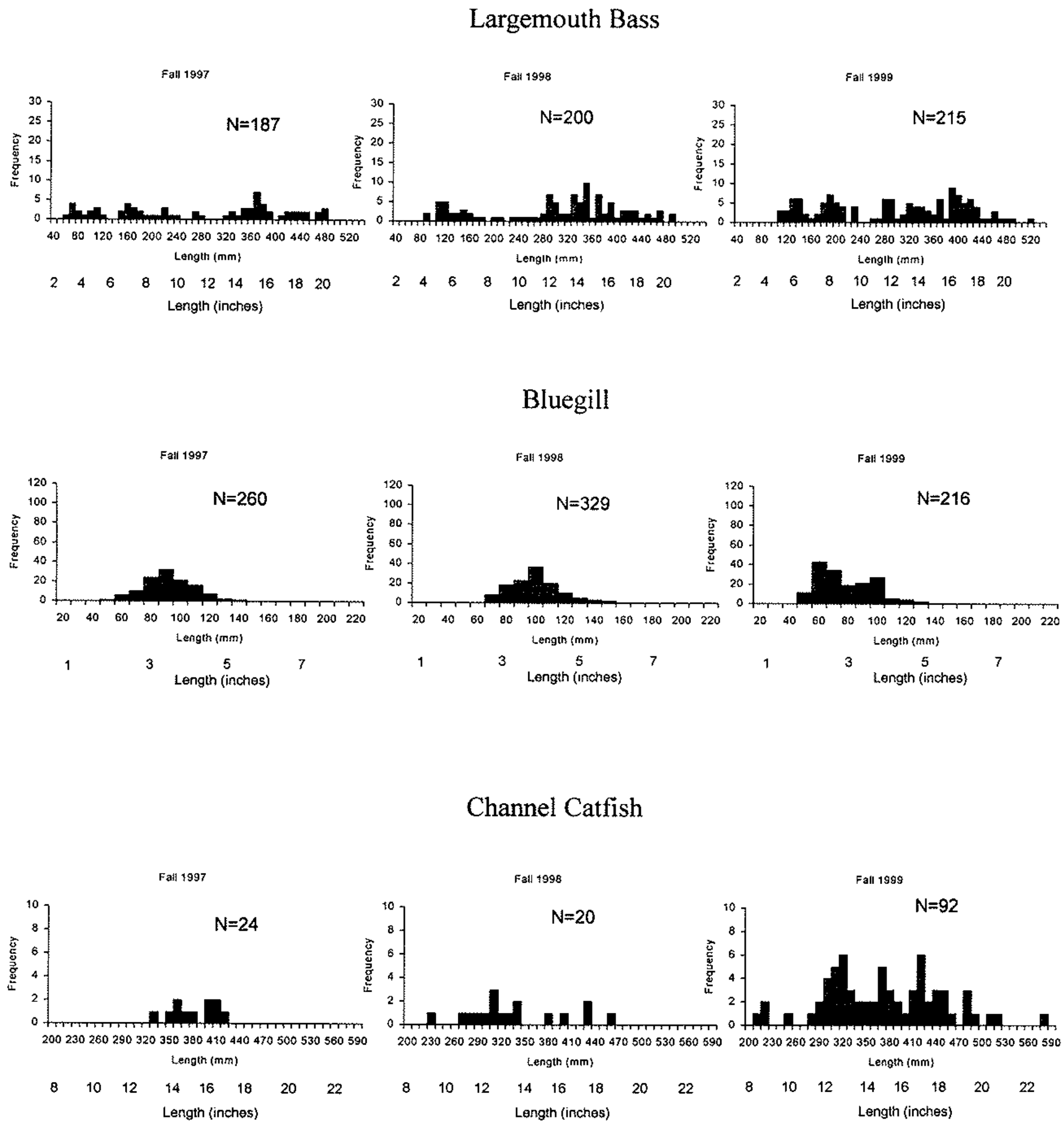


Figure 13.6. Length-frequency histograms of largemouth bass, bluegill, and channel catfish captured in Coffeen Lake during the months of October and November 1997, 1998, and 1999. Lengths are combined into 10-mm groups.

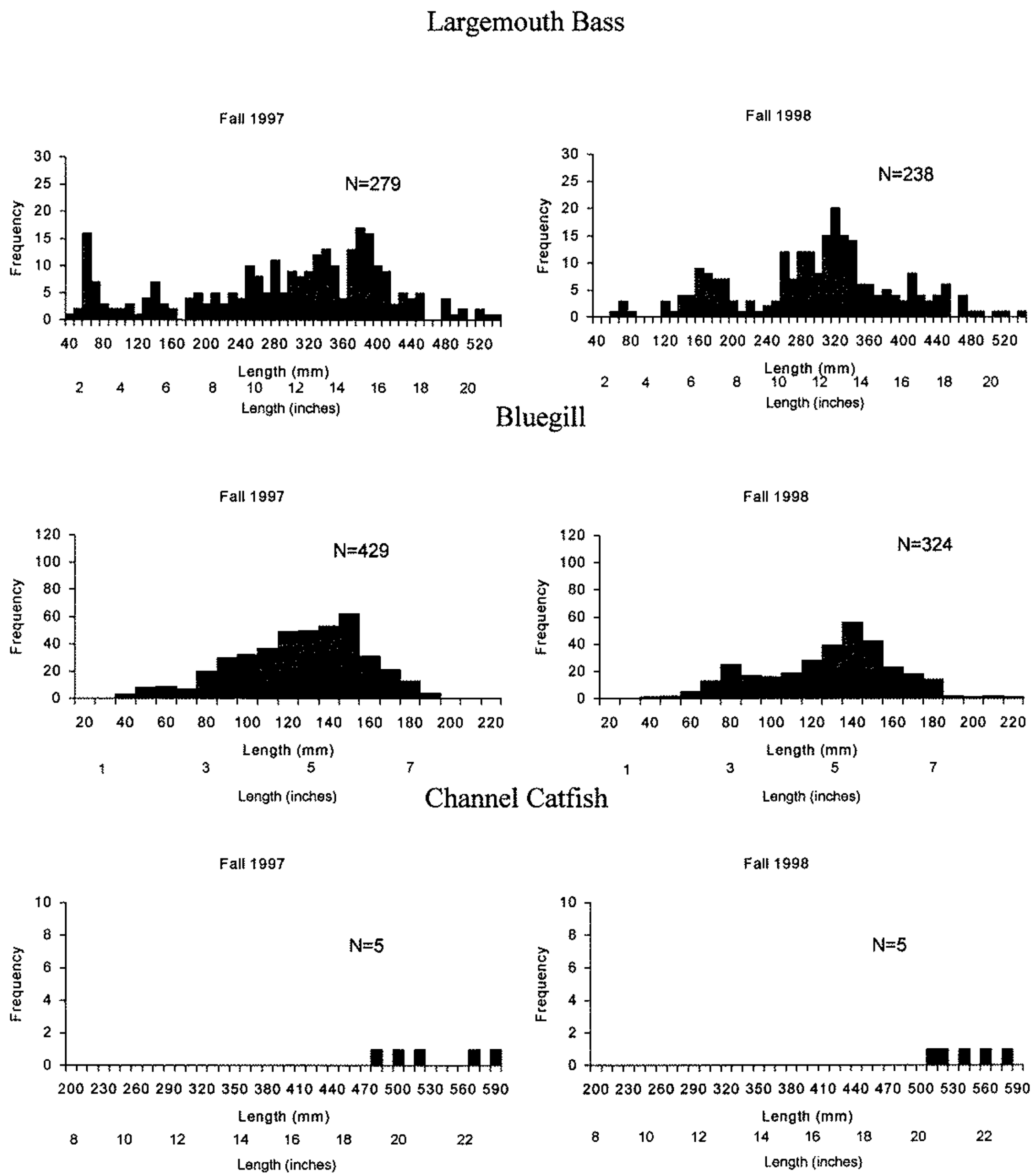


Figure 13.7. Length-frequency histograms of largemouth bass, bluegill, and channel catfish captured in Lake of Egypt during the months of October and November 1998, and 1999. Lengths are combined into 10-mm groups.

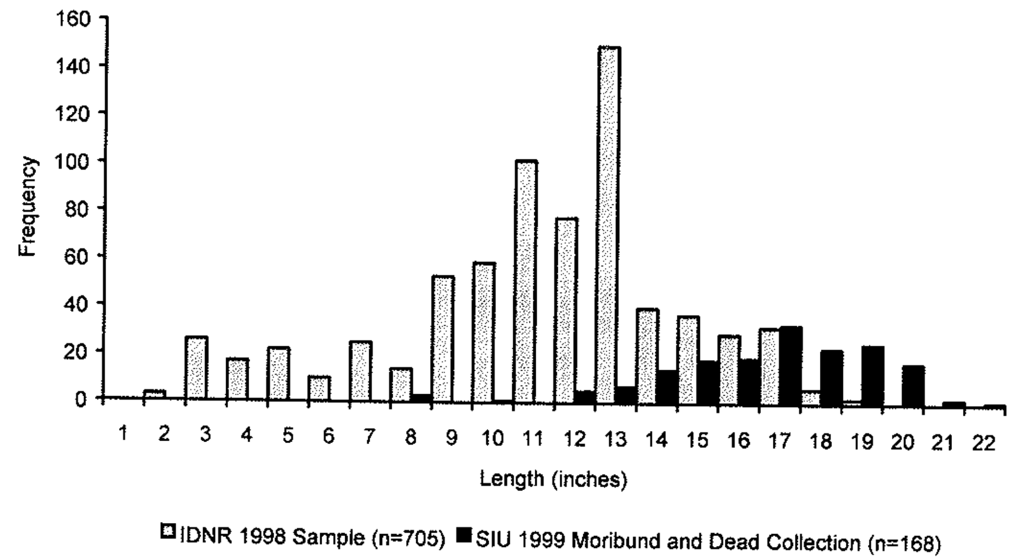


Figure 13.8. Comparison of the length-frequency histograms of largemouth bass obtained by 12 hours of electrofishing during fall 1998 on Newton Lake by the Illinois Department of Natural Resources (IDNR)(N=705), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by Southern Illinois University Fisheries Research Lab (SIU) during routine sampling trips (N=168).

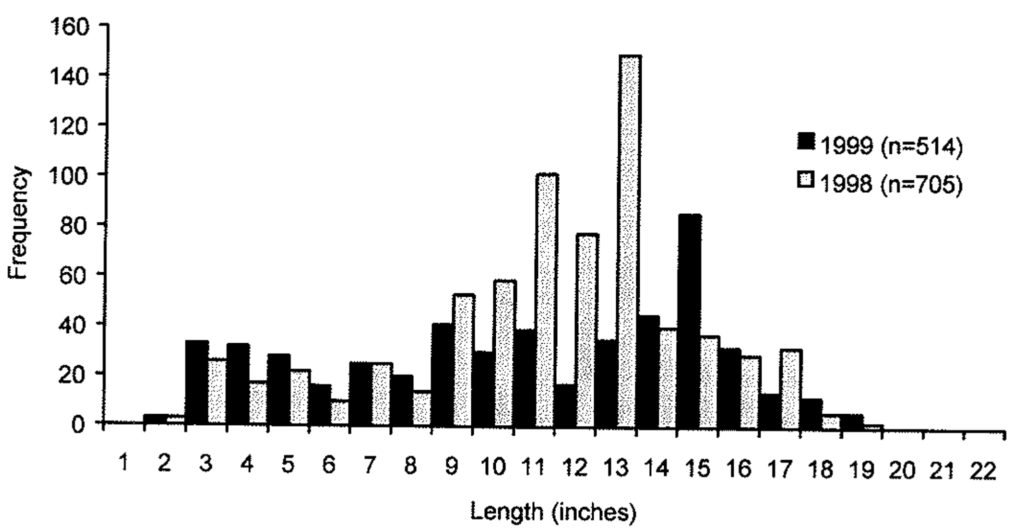


Figure 13.9. Comparison of the length-frequency histograms of largemouth bass obtained in fall of 1998 (N=705) and 1999 (N=514) from 12 hours of electrofishing on Newton Lake, data provided by the Illinois Department of Natural Resources.

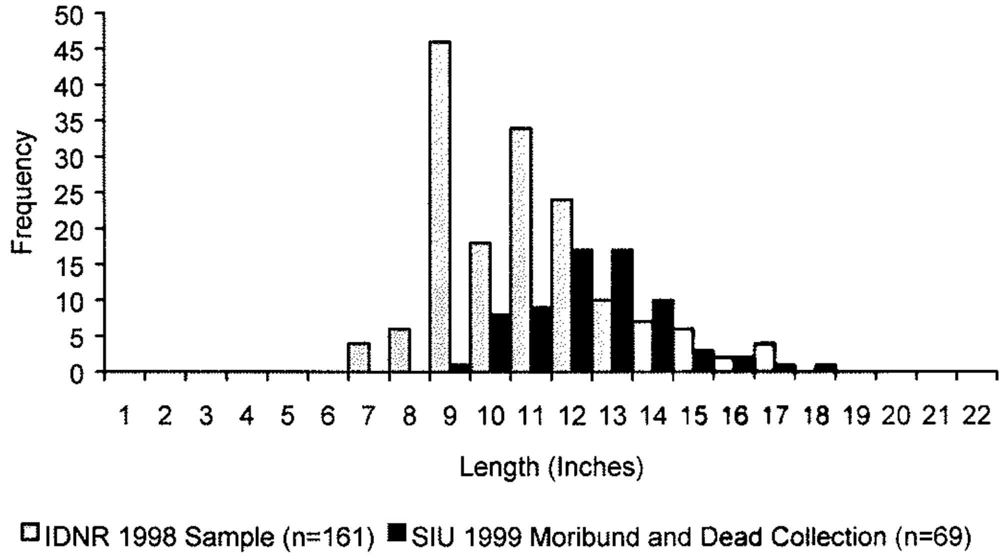


Figure 13.10. Comparison of the length-frequency histograms of channel catfish obtained by 12 hours of electrofishing during fall 1998 from Newton Lake by the Illinois Department of Natural Resources (IDNR)(N=161), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by Southern Illinois University Fisheries Research Lab (SIU) during routine sampling trips (N=69).

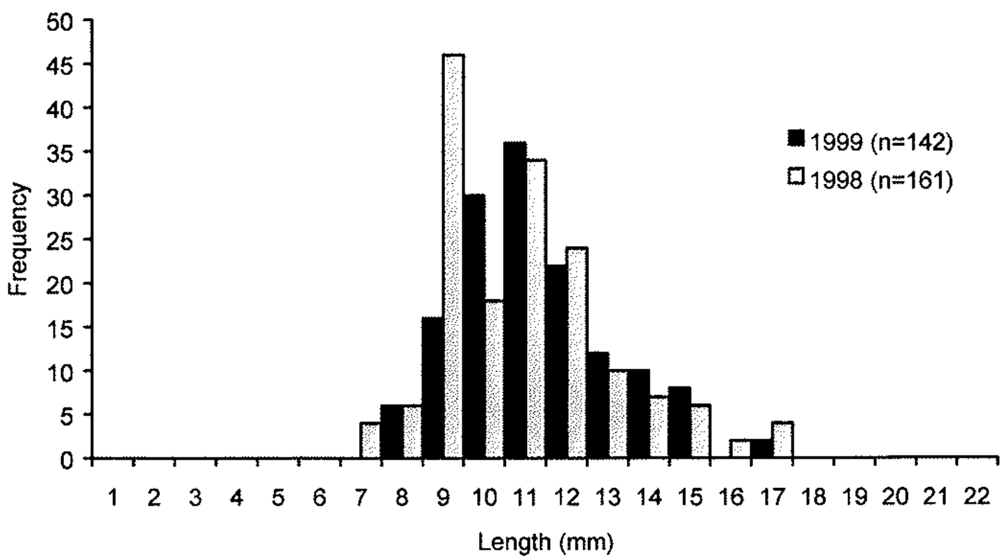


Figure 13.11. Comparison of the length-frequency histograms of channel catfish obtained in 1998 (N=161) and 1999 (N=142) from 12 hours of electrofishing during fall on Newton Lake, data provided by the Illinois Department of Natural Resources.

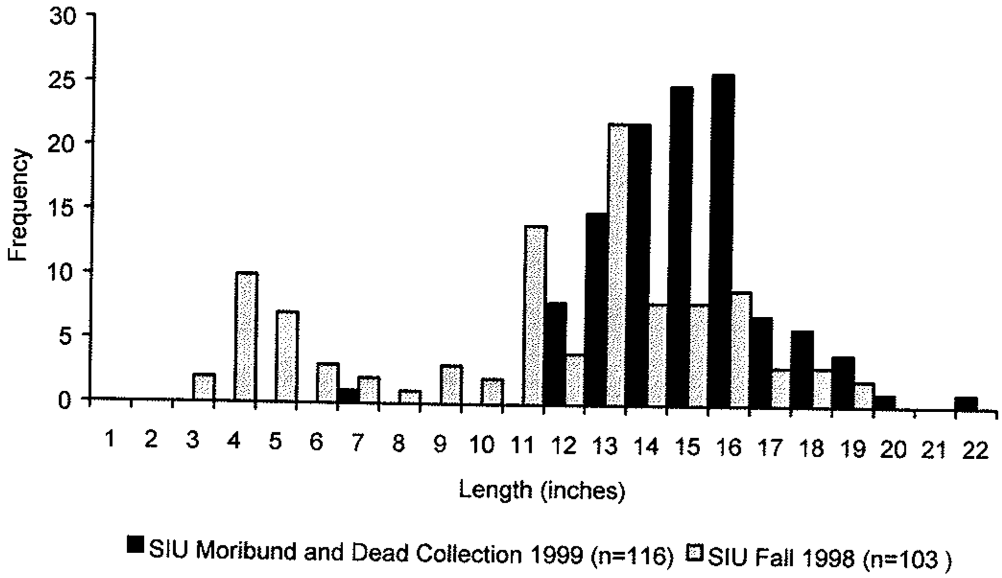


Figure 13.12. Comparison of the length-frequency histograms of largemouth bass obtained by electrofishing during fall 1998 on Coffeen Lake by Southern Illinois University Fisheries Research Lab (N=103), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by SIU during routine sampling trips (N=116).

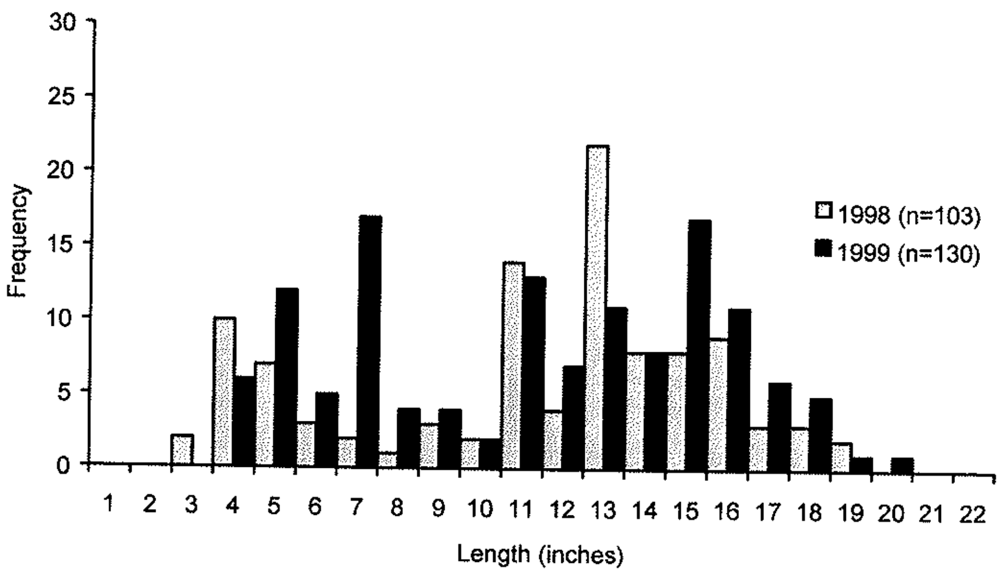


Figure 13.13. Comparison of the length-frequency histograms of largemouth bass obtained in fall of 1998 (N=103) and 1999 (N=130) by electrofishing on Coffeen Lake by Southern Illinois University Fisheries Research Lab.

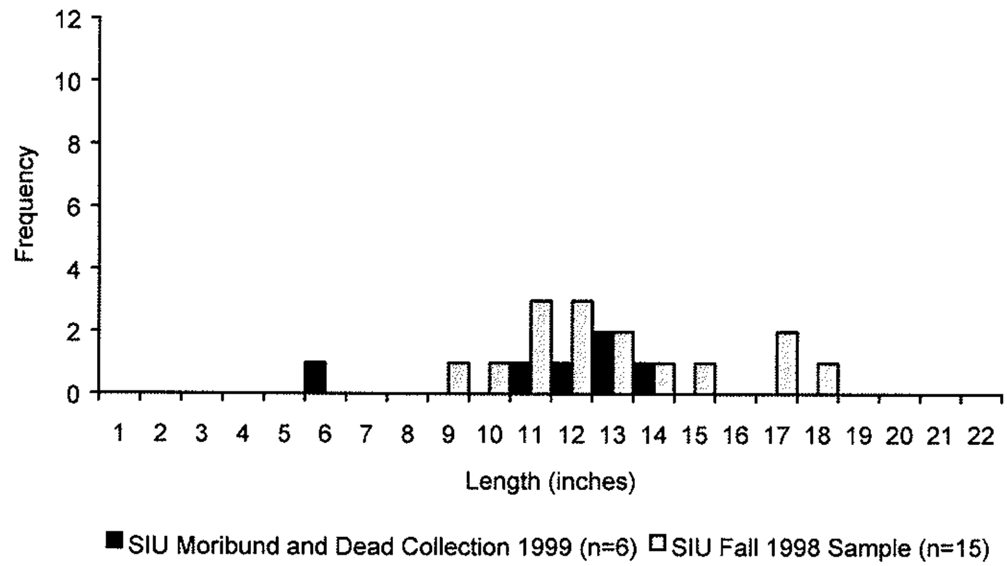


Figure 13.14. Comparison of the length-frequency histograms of channel catfish obtained by electrofishing during fall 1998 on Coffeen Lake by Southern Illinois University Fisheries Research Lab (N=15), and dead and moribund fish collected between 1 June 1999 and 31 August 1999 by SIU during routine sampling trips (N=6).

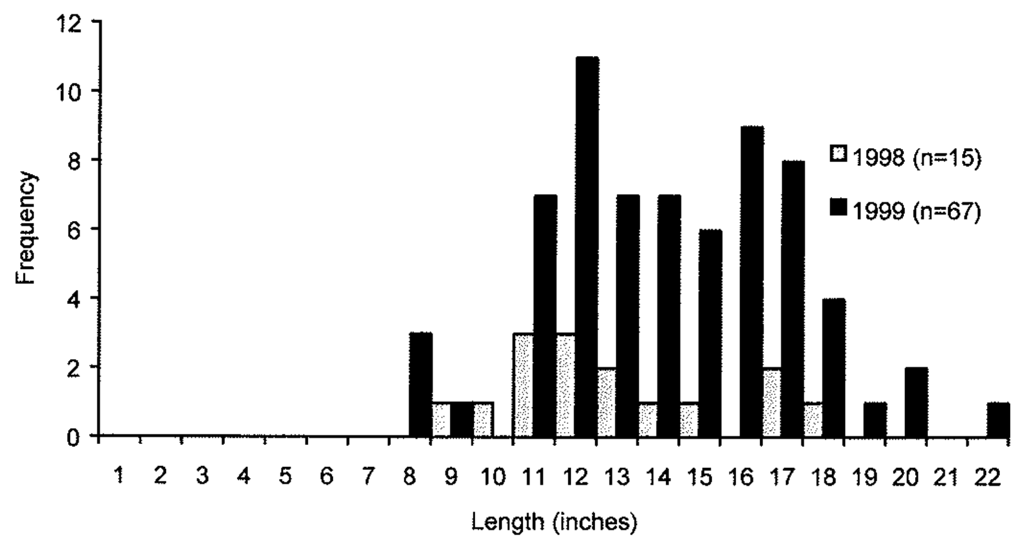


Figure 13.15. Comparison of the length-frequency histograms of channel catfish obtained in fall of 1998 (N=15) and 1999 (N=67) by electrofishing on Coffeen Lake by Southern Illinois University Fisheries Research Lab.

Chapter 13. Appendix: Supplemental Data Tables.

Table 13.A1. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in Coffeen Lake during November through December of 1997 through 1999.

Year	Species	Catch (N)	Effort (hrs)	CPUE
1997	largemouth bass	116	4.8	24.4
	bluegill	274	4.0	69.1
	redear sunfish	5	6.0	0.8
	green sunfish	7	6.0	1.2
	white crappie	31	6.0	5.2
	channel catfish	34	6.0	5.7
	yellow bass	17	6.0	2.8
	Orange-spotted sunfish	10	6.0	1.7
1998	largemouth bass	109	7.3	15.0
	bluegill	126	2.1	58.7
	white crappie	8	7.9	1.0
	channel catfish	17	7.9	2.2
1999	largemouth bass	141	5.1	27.9
	bluegill	166	1.0	163.3
	white crappie	52	10.2	5.1
	channel catfish	68	10.2	6.6

Table 13.A2. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in Lake of Egypt during the months November through December of 1997 and 1998.

Year	Species	Catch (N)	Effort (hrs)	CPUE
1997	largemouth bass	518	12.6	41.0
	bluegill	1337	10.4	129.0
	redear sunfish	489	12.9	38.0
	green sunfish	131	12.9	10.2
	warmouth	12	12.9	0.9
	longear sunfish	227	12.9	17.6
	white crappie	36	12.9	2.8
	black crappie	26	12.9	2.0
	channel catfish	6	12.9	0.5
	yellow bullhead	3	12.9	0.2
	common carp	14	12.9	1.1
	white bass	2	12.9	0.2
	grass pickerel	1	12.9	0.1
	golden shiner	11	12.9	0.9
	white x striper	1	12.9	0.1
	gizzard shad	290	12.9	22.5
	threadfin shad	4	12.9	0.3
	bluntnose minnow	1	12.9	0.1
	topminnow	4	12.9	0.3
	brook silverside	1	12.9	0.1
	Orange-spotted sunfish	13	12.9	1.0
	spotted sucker	2	12.9	0.2
1998	largemouth bass	419	10.2	41.2
	bluegill	839	9.1	92.0
	redear sunfish	274	11.2	24.5
	green sunfish	22	11.2	2.0
	warmouth	8	11.2	0.7
	longear sunfish	125	11.2	11.2
	white crappie	4	11.2	0.4
	black crappie	34	11.2	3.0
	channel catfish	9	11.2	0.8
	yellow bullhead	6	11.2	0.5
	common carp	13	11.2	1.2

Table 13.A2. Continued

Year	Species	Catch (N)	Effort (hrs)	CPUE
1998	golden shiner	7	11.2	0.6
	white x striper	8	11.2	0.7
	gizzard shad	155	11.2	13.9
	threadfin shad	34	11.2	3.0
	brook silverside	17	11.2	1.5
	hybrid sunfish	10	11.2	0.9
	spotted sucker	12	11.2	1.1

Table 13.A3. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in Newton Lake during the months November through December of 1997 through 1999.

Year	Species	Catch (N)	Effort (hrs)	CPUE
1997	largemouth bass	344	9.3	37.1
	bluegill	1468	11.3	130.1
	channel catfish	52	16.6	3.1
1998	largemouth bass	318	6.3	50.6
	bluegill	565	7.2	78.8
	green sunfish	43	10.0	4.3
	longear sunfish	93	10.0	9.3
	channel catfish	73	10.0	7.3
	common carp	5	10.0	0.5
	gizzard shad	230	10.0	23.1
	hybrid sunfish	23	10.0	2.3
1999	largemouth bass	330	9.0	36.7
	bluegill	472	4.8	97.6
	white crappie	23	17.6	1.3
	channel catfish	130	17.8	7.3
	white bass	1	17.8	0.1

Table 13.A4. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in each segment of Coffeen Lake during the months November through December of 1997 through 1999.

Year	Segment	Species	Catch (N)	Effort (hrs)	CPUE
1997	1	largemouth bass	30	1.4	21.4
		bluegill	16	0.7	22.9
		white crappie	31	1.4	22.1
		channel catfish	23	1.4	16.4
	2	largemouth bass	86	3.4	25.7
		bluegill	258	3.3	79.0
		redear sunfish	5	4.6	1.1
		green sunfish	7	4.6	1.5
		channel catfish	11	4.6	2.4
		yellow bass	17	4.6	3.7
		Orange-spotted sunfish	10	4.6	2.2
1998	1	largemouth bass	54	3.4	16.0
		bluegill	57	1.0	55.1
		channel catfish	17	3.4	5.0
	2	largemouth bass	55	3.9	14.1
		bluegill	69	1.1	62.0
		white crappie	8	4.5	1.8
1999	1	largemouth bass	47	3.1	15.4
		bluegill	116	0.9	133.8
		white crappie	4	4.5	0.9
		channel catfish	19	4.5	4.2
	2	largemouth bass	94	2.0	46.7
		bluegill	50	0.2	333.3
		white crappie	48	5.8	8.3
		channel catfish	49	5.8	8.5

Table 13.A5. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in each segment of Lake of Egypt during the months November through December of 1997 and 1998.

Year	Segment	Species	Catch (N)	Effort (hrs)	CPUE
1997	1	largemouth bass	383	5.8	65.7
		bluegill	633	4.9	130.1
		redear sunfish	341	6.1	56.1
		green sunfish	68	6.1	11.2
		warmouth	6	6.1	1.0
		longear sunfish	140	6.1	23.0
		white crappie	29	6.1	4.8
		black crappie	15	6.1	2.5
		channel catfish	6	6.1	1.0
		yellow bullhead	3	6.1	0.5
		common carp	7	6.1	1.2
		white bass	2	6.1	0.3
		golden shiner	7	6.1	1.2
		white x striper	1	6.1	0.2
		gizzard shad	117	6.1	19.2
		threadfin shad	1	6.1	0.2
		bluntnose minnow	1	6.1	0.2
		brook silverside	1	6.1	0.2
		Orange-spotted sunfish	7	6.1	1.2
		spotted sucker	1	6.1	0.2
	2	largemouth bass	135	6.8	19.9
		bluegill	704	5.5	128.0
		redear sunfish	148	6.8	21.8
		green sunfish	63	6.8	9.3
		warmouth	6	6.8	0.9
		longear sunfish	87	6.8	12.8
		white crappie	7	6.8	1.0
		black crappie	11	6.8	1.6
		common carp	7	6.8	1.0
		grass pickerel	1	6.8	0.1
		golden shiner	4	6.8	0.6
		gizzard shad	173	6.8	25.4
		threadfin shad	3	6.8	0.4

Table 13.A5. Continued

Year	Segment	Species	Catch (N)	Effort (hrs)	CPUE
1997	2	topminnow	4	6.8	0.6
		Orange-spotted sunfish	6	6.8	0.9
		spotted sucker	1	6.8	0.1
1998	1	largemouth bass	274	4.9	56.1
		bluegill	420	4.5	93.0
		redear sunfish	221	5.6	39.8
		green sunfish	7	5.6	1.3
		warmouth	6	5.6	1.1
		longear sunfish	53	5.6	9.5
		white crappie	3	5.6	0.5
		black crappie	21	5.6	3.8
		channel catfish	4	5.6	0.7
		yellow bullhead	6	5.6	1.1
		common carp	8	5.6	1.4
		golden shiner	3	5.6	0.5
		white x striper	8	5.6	1.4
		gizzard shad	88	5.6	15.9
		threadfin shad	7	5.6	1.3
		brook silverside	8	5.6	1.4
		hybrid sunfish	7	5.6	1.3
		spotted sucker	4	5.6	0.7
	2	largemouth bass	145	5.3	27.4
		bluegill	419	4.6	91.1
		redear sunfish	53	5.6	9.4
		green sunfish	15	5.6	2.7
		warmouth	2	5.6	0.4
		longear sunfish	72	5.6	12.8
		white crappie	1	5.6	0.2
		black crappie	13	5.6	2.3
		channel catfish	5	5.6	0.9
		common carp	5	5.6	0.9
		golden shiner	4	5.6	0.7
		gizzard shad	67	5.6	11.9
		threadfin shad	27	5.6	4.8
		brook silverside	9	5.6	1.6
		hybrid sunfish	3	5.6	0.5
		spotted sucker	8	5.6	1.4

Table 13.A6. AC electrofishing catch-per-unit-effort (CPUE) of all species captured in each segment of Newton Lake during the months November through December of 1997 through 1999.

Year	Segment	Species	Catch (N)	Effort (hrs)	CPUE
1997	1	largemouth bass	80	1.3	60.0
		bluegill	437	3.0	144.1
		channel catfish	9	5.7	1.6
	2	largemouth bass	75	2.7	28.0
		bluegill	365	2.4	154.2
		channel catfish	20	3.8	5.3
	3	largemouth bass	113	3.3	34.2
		bluegill	442	3.2	138.8
		channel catfish	9	4.4	2.0
	4	largemouth bass	76	1.9	39.1
		bluegill	224	2.7	83.0
		channel catfish	14	2.7	5.2
1998	1	largemouth bass	81	1.5	53.4
		bluegill	110	2.6	41.7
		green sunfish	7	3.2	2.2
		longear sunfish	9	3.2	2.8
		channel catfish	11	3.2	3.4
		gizzard shad	37	3.2	11.4
		hybrid sunfish	1	3.2	0.3
	2	largemouth bass	76	1.0	80.0
		bluegill	191	1.2	161.1
		green sunfish	8	2.3	3.5
		longear sunfish	26	2.3	11.5
		channel catfish	15	2.3	6.6
		common carp	3	2.3	1.3
		gizzard shad	9	2.3	4.0
		hybrid sunfish	4	2.3	1.8
1998	3	largemouth bass	77	2.1	37.3
		bluegill	121	1.8	68.0

Table 13.A6. Continued

Year	Segment	Species	Catch (N)	Effort (hrs)	CPUE
1998	3	green sunfish	13	2.3	5.7
		longear sunfish	32	2.3	13.9
		channel catfish	20	2.3	8.7
		common carp	1	2.3	0.4
		gizzard shad	55	2.3	23.9
		hybrid sunfish	13	2.3	5.7
	4	largemouth bass	84	1.8	48.0
		bluegill	143	1.6	91.1
		green sunfish	15	2.2	6.9
		longear sunfish	26	2.2	12.0
		channel catfish	27	2.2	12.5
		common carp	1	2.2	0.5
		gizzard shad	129	2.2	59.5
		hybrid sunfish	5	2.2	2.3
1999	1	largemouth bass	70	3.4	20.5
		bluegill	115	1.6	71.1
		white crappie	4	4.6	0.9
		channel catfish	15	4.9	3.1
	2	largemouth bass	75	2.2	34.6
		bluegill	99	0.5	185.6
		white crappie	4	4.3	0.9
		channel catfish	36	4.3	8.3
	3	largemouth bass	95	2.1	44.9
		bluegill	131	1.6	84.2
		white crappie	1	4.2	0.2
		channel catfish	59	4.2	13.9
		white bass	1	4.2	0.2
	4	largemouth bass	90	1.8	49.5
		bluegill	127	1.6	77.1
		white crappie	14	4.9	2.8
		channel catfish	20	4.9	4.1

Chapter 14: Movement of Largemouth Bass and Channel Catfish
(Primary Responsibility-Joseph L. Rush)

Introduction:

The goal of this phase of the study was to determine seasonal, three-dimensional movement of largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*) in three Illinois power cooling lakes. Sonic-telemetry studies were conducted to assess whether habitat utilization by largemouth bass and channel catfish differs among Newton Lake, Lake of Egypt, and Coffeen Lake. Observing fish movement is of great importance because it provides insight into the habitat being utilized and therefore may indicate if habitat is being lost. The water column is separated into three layers; an upper warm, lighter layer - the epilimnion; a cool denser layer – the hypolimnion; and a transitional zone between them - the metalimnion. If utilization of the epilimnion decreases during summer for these species, and the epilimnion expands in depth, then there may be a loss of fish habitat. On the other hand, the habitat utilization information may indicate that the elevated temperatures provide more habitat for these species during other seasons in Newton Lake. Attempts were also made to ascertain diel movement to determine if differences occurred due to seasonal changes in photoperiod and temperature.

Materials and Methods:

Due to thermal stratification and water conductivity, temperature sensitive (± 0.5 °C [0.9 °F]) sonic transmitters (Sonotronics Model CTT-83-3) were used to track the fish instead of radio wave frequency transmitters. The transmitters were approximately 17 mm in diameter and mm long and transmitted at a frequency of 75 khz. Each transmitter weighed approximately 8 g in water and thus, should not have affected the movement of study fish due to the fishes' relatively large size (> 537 g for channel catfish and > 552 g for largemouth bass). Each transmitter was pulse-coded to allow differentiation between specific fish and has an estimated life expectancy of approximately 36 months. DH-2 directional hydrophones, and a Sonotronics narrow band receiver (Model USR-96) were used to track largemouth bass and channel catfish in all three lakes. Once detected, the fishes' locations were determined with a Garmin Model 45XL hand held Global Positioning System (G.P.S). In addition, locations were marked on a map of the lake. The G.P.S. coordinates were imported into ArcView Geographic Information System for observed linear distance analysis.

A Model-50B Yellow Springs Instrument unit was used to determine temperature, dissolved oxygen, and depth. Using a certified thermometer, the temperature sensors were calibrated at three temperatures that bracketed the temperatures recorded in the field. Field measurements were adjusted as required by the calibration curve. The oxygen probe was calibrated each time it was used following the manufacturers recommended method. In addition, the oxygen probe was calibrated once a month using the method recommended in APHA (1995).

Transmitter Calibration

The sonic transmitters were individually calibrated in the laboratory prior to use. Calibration was accomplished by recording pulse intervals (PI) at two different measured temperatures: room temperature and freezing. Measurements were taken after the transmitters had time to stabilize to the surrounding temperature (approximately two hours). The measurements were labeled as PI_1 and T_1. A second set of measurements was taken after letting the transmitters equilibrate overnight in a styrofoam cup filled with water and ice and placed in a refrigerator. This measurement was labeled as PI_2. The resultant temperature factor was obtained as follows: $T_f = T_1 / (PI_2 - PI_1)$.

The pulse interval in the field was used to determine the ambient temperature of the surrounding environment. Ambient temperature was derived as follows: $(PI_2\text{-}PI)T_f$

Collection and Surgical Procedure

Largemouth bass and channel catfish were obtained by electroshocking using a three-phase, AC, boat-mounted electrofishing system. Attempts were also made to collect channel catfish using a low pulse, DC electroshocking unit. In addition, hoop nets were set in Newton Lake's warm water discharge in attempt to obtain channel catfish. Length distributions of largemouth bass used for transmitter implantation on all three lakes ranged from 362 mm (14.25 in.) to 522 mm (20.55 in.) total length. Total lengths for channel catfish ranged from 412 mm (16.22 in.) to 635 mm (25.00 in.).

Once obtained, fish were placed into a holding tank that was two-thirds full of fresh lake water oxygenated to super saturation. After fish were recovered from the initial electroshock, they were relocated to a second tank containing buffered water used for anesthetization. Carbon dioxide gas was diffused into the anesthetization tank until the fish were anesthetized. This was determined by visually observing the fishes' voluntary muscle response (i.e., lack of buoyancy control and dorso-ventral orientation). Carbon dioxide was used in order to avoid the FDA requirement of holding the fish for a prescribed time before release. For example, FDA requires that MS-222 anesthetized fish be held for 21 days before release. This methodology is well documented for walleye (*Stizostedium vitrieum*), sauger (*S. canadense*), largemouth bass, and pallid sturgeon (*Scaphirhynchus albus*) (Heidinger et al. 1988, Heidinger et al. 1991, Heidinger et al. 1996).

After anesthetization, fish were removed from the holding tank, weighed, measured, and placed on an operating table for surgery. For largemouth bass, the incision location was prepared by removing approximately three rows of scales roughly 25 mm (0.98 in.) in length at 25-30 mm (0.98 –1.18 in.) anterior of the anal opening, at the location where ventral coloration converts to dorsal coloration. For channel catfish, the incision location was slightly more anterior and ventral. Prior to making the incision, an anti-bacterial solution (betadine) was used to disinfect the body surfaces. All utensils used in the surgical procedures were sterilized in 70% ethanol prior to surgery. A scalpel and hemostat were used to make incisions large enough to insert the sonic transmitters. The hemostat was used to lift muscle tissue away from the internal organs which ensured no organs were incised. Once the surgical openings were created, attempts were made to visually sex the fish with minimal amounts of probing to prevent damage to internal organs and tissues. Sonic transmitters were inserted into the incisions using a slight rotation to prevent binding of internal organs. Following insertion, the transmitters were pulled back until they were past the posterior end of the incision to minimize internal pressure on the sutures. This technique should decrease chances of transmitter expulsion and should relieve any pressure on organs that might have occurred during insertion. The incisions were closed with simple interrupted sutures using Ethilon® monofilament nylon sutures attached to FS-1 curved cutting needles. The incisions and sutures were sealed with cyanoacrylate resin to prevent contamination and suture knot failure. The fish were placed in a recovery tank supplemented with oxygen and monitored. After the fish attained control of buoyancy and orientation, they were released at the capture sites. The fish were not released unless they were able to swim under their own power.

Weekly and Monthly Sampling Regime

Initial sonic transmitter implantation began in October 1997. Once the transmitters were implanted, attempts were made to determine locations of individual fish in each lake beginning in November 1997 and ending during the last week of August 1999. In each lake, tracking was conducted once a month from October to March and weekly from April to September. A DH-2 directional hydrophone was used to detect signals from the sonic transmitters. An USR-96 narrow band receiver was used to convert signals to audible pulses, which were then counted to determine transmitter sequences. The transmitter sequences determined which fish was located. After triangulating the location, an anchor was dropped, and the location was recorded on a map. Latitude and longitude coordinates were then recorded using the Garmin 45XL handheld G.P.S. The pulse intervals were also recorded. As previously described, pulse intervals determined the ambient temperatures of the transmitters, which were a direct reflection of internal body temperatures and the surrounding environment. Depth, temperature, and dissolved oxygen profiles were taken at 0.5-m (1.6 ft) intervals using a Yellow Springs Instrument unit. The entire lake was covered on each sampling trip, when possible.

Diel Sampling Regime

An attempt was made to track diel movements of four fish in each lake twice during a two-week period, and the sampling was repeated during several seasons. Sampling schedules consisted of two weeks between May and June, two weeks in August, and two weeks between December and January. The first sampling began in May 1998 and ended in mid-August 1999.

Each sampling date consisted of tracking two largemouth bass and two channel catfish over a 24-hour period. If two channel catfish were not available, then largemouth bass were substituted. Attempts were made to locate each fish every three hours. Once the fish were located, data were collected in the same manner as the weekly and monthly collections.

Transmitter Recovery

Attempts were also made to recover sonic transmitters that had been "lost" by the fish due to trans-intestinal expulsion by channel catfish (Summerfelt 1984) or by natural mortality of both species. When a fish did not move over an extended period of time, an attempt was made to recover that sonic transmitter. If the transmitter could not be recovered, it was deemed "un-recoverable." If the water was shallow, the transmitter was recovered by wading or snorkeling using a mask, fins, and snorkel. In water over 2-m in depth, a recovery team consisting of two certified SCUBA divers and one signal person were used. The signal person stayed in the boat listening to the receiver while the divers, descended with the hydrophone. When a signal was detected, the person in the boat would signal the divers with a tugging motion on the coaxial cable of the hydrophone. The tugging would become more erratic with the stronger signal, which would let the divers know they were on a "hot" signal. This method proved invaluable in the recovery of these transmitters. Length of the coaxial cable limited recovery of some transmitters located in water deeper than 30 feet.

Results:

Considerable effort was made to surgically implant and track largemouth bass and channel catfish. Sonic transmitters were inserted into 100 largemouth bass and 42 channel catfish from October 1997 through May 1999 (Table 14.1) and a total of 31 days were spent tagging (Table 14.2). Efforts were made to distribute transmitters throughout the lake with 27 sites in Newton Lake (Table 14.3, Figure 14.1), 26 sites in Coffeen Lake (Table 14.4, Figure 14.2), and 23 sites in Lake of Egypt (Table 14.5, Figure 14.3). Implanted largemouth bass lengths ranged from 362 mm (14.25 in.) to 522 mm (20.55 in.) and they weighed from 552 g (1.22 lbs.) to 2,440 g (5.38 lbs.). Channel catfish lengths ranged from 412 mm (16.22 in.) to 635 mm (25.00 in.) and weighed from 537 g (1.18 lbs.) to 3,012 g (6.64 lbs.)(Tables 14.3-14.5). Tracking was conducted a total of 190 days on the three lakes from October 1997 through August 1999 (Table 14.2). Total transmitter loss of at least 64% for largemouth bass and 93% to 100% for channel catfish occurred on all three lakes throughout the course of this study (Table 14.6). The history of transmitter usage and the dates transmitters were active in each lake are shown in Tables 14.7-14.9 along with the number of contacts made for each individual transmitter throughout the study. Most fish had been located on several occasions prior to tag loss.

Mean Internal Body Temperature

Mean internal body temperatures of largemouth bass during 1998 in Newton Lake ranged from 8.0 °C (46.4 °F) in December to 29.0 °C (84.2 °F) in July. The 1999 results were similar in that the lowest mean internal temperature (7.9 °C [46.2 °F]) was in January and the highest (30.3 °C [86.5 °F]) was in July (Figure 14.4). Largemouth bass in Coffeen Lake during 1998 reached their minimum mean internal body temperatures of 9.6 °C (49.3 °F) in March and their maximum of 31.4 °C (88.5 °F) in July. The 1999 data for Coffeen Lake largemouth bass shows the minimum of 13.8 °C (56.8 °F) and maximum of 32.0 °C (89.6 °F) mean temperatures being attained in January and July (Figure 14.5). During 1998, largemouth bass in Lake of Egypt were located in temperature extremes in February (5.8 °C [42.4 °F]) and July (30.0 °C [86.0 °F]).

Data from 1999 was consistent with Coffeen Lake largemouth bass since coolest mean internal body temperatures were attained in January (7.7 °C [45.9 °F]) and warmest (29.5 °C [85.0 °F]) in July (Figure 14.6). Minimum and maximum recorded internal body temperatures for largemouth bass in Newton Lake for 1998 and 1999 were attained in January and July. The 1998 minimum was 6.2 °C (43.2 °F), and the maximum was 32.3 °C (90.1 °F). During 1999, the temperature minimum was 6.4 °C (43.5 °F), and the maximum was 35.0 °C (95.0 °F) (Table 14.10). Coffeen Lake largemouth bass internal temperatures ranged from 6.3 °C (43.3 °F) to 35.3 °C (95.5 °F) during 1998. The minimum temperature was recorded in March and the maximum in July. During 1999, the temperature ranged from 8.4 °C (47.1 °F) in February and March to 36.3 °C (97.3 °F) in July (Table 14.11). Minimum and maximum ranges were consistent with means for Lake of Egypt largemouth bass, and the minimum occurred in February and the maximum in July 1998. The 1998 internal body temperatures ranged from 3.5 °C (38.3 °F) to 33.5 °C (92.3 °F), and the 1999 internal body temperature ranged from 4.1 °C (39.4 °F) in January to 34.1 °C (93.4 °F) in July (Table 14.12).

Laboratory Study

Internal body temperatures were not always within the range of the water temperature, depth, and dissolved oxygen profiles taken where the fish were located. This is possibly due to the fish changing locations. When fish move, they may be moving from cooler water to warmer water or vice versa, and therefore, internal body temperatures may not have coincided with the external temperatures. In such cases, depth and dissolved oxygen where fish were located could not be determined. Since internal transmitters were used, there is an initial latency in temperature equilibration for the transmitters (Weller et al. 1984, Reynolds 1977, and Kubb et al.1980).

Internal lag time was investigated in a laboratory study conducted in October 1999 at Southern Illinois University Carbondale. This study was designed to establish temperature lag time between internal body temperature and external environmental temperature for largemouth bass implanted with ultrasonic transmitters. Transmitter implanted largemouth bass were acclimated to room temperature in a holding tank and transmitter temperatures were recorded. The acclimated fish were individually placed in a test tank chilled 10 °C (18 °F) cooler than the holding tank. Transmitter temperatures and tank temperatures were recorded every 30 seconds until the transmitter equilibrated to the test-tank temperature. Equilibration times ranged from 38.5 minutes to 68.5 minutes for largemouth bass ranging in size from 362 mm (14.3 in.) to 520 mm (20.5 in.), weighing 606 g (1.3 lbs.) to 2,376 g (5.2 lbs.), and with body wall thickness' of 5.5 mm (0.22 in.) to 8.9 mm (0.35 in.)(Table 14.13). Weller et al. (1984) reported that largemouth bass exchanged heat (k) at a faster rate (ratio for $k_h/k_c = 1.31$) when warming (k_h) than when cooling (k_c), but they also reported that the lag when warming (L_h) was significantly greater than the cooling lag (L_c)(ratio for $L_h/L_c = 1.59$). This apparent inconsistency was thought to be due to the initial time required for the largemouth bass to start dissipating heat.

Depth, Dissolved Oxygen, and Internal Body Temperature Relationships

A separate data set was established to determine depth, dissolved oxygen, and internal body temperature relationships. Only those contacts that were within a depth, dissolved oxygen, and temperature profile were utilized in this data set. Depth and dissolved oxygen at the point of contact were determined by correlating the internal body temperature to that of the profile. If the correlating body temperature was between the 0.5-meter (1.6 ft) profile readings, then the deeper of the two were used. If a range of profile readings matched the internal body temperature, then the mean of the range was utilized. June, July, and August data will be discussed since the summer month temperatures are of greatest concern due to a possible reduction in available habitat. During the summer of 1998 in Newton Lake, mean internal body temperatures for largemouth bass ranged from 24.1 °C (75.4 °F) to 31.7 °C (89.1 °F) and a maximum of 32.3 °C (90.1 °F) was recorded. During 1999, summer internal body temperatures ranged from 26.3 °C (79.3 °F) to 33.0 °C (91.4 °F), and a maximum of 35.0 °C (95.0 °F) was recorded (Table 14.14, Figure 14.7). Largemouth bass in Coffeen Lake had mean internal body temperatures ranging from 26.6 °C (79.9 °F) to 33.1 °C (91.6 °F) and a maximum of 35.3 °C (95.5 °F) was recorded for the summer of 1998. The 1999 means ranged from 26.4 °C (79.5 °F) to 35.9 °C (96.6 °F), and the maximum was 36.3 °C (97.3 °F)(Table 14.15, Figure 14.8). Largemouth bass located in Lake of Egypt had mean internal body temperatures that ranged between 27.4 °C (81.3 °F) and 32.0 °C (89.6 °F). A maximum of 33.4 °C (92.1 °F) was recorded for the summer of 1998. Mean for Lake of Egypt during summer of 1999 ranged from 26.4 °C (79.5 °F) to 32.1 °C (89.8 °F) and a maximum of 34.1 °C (93.4 °F) was recorded (Table 14.16, Figure 14.9). Mean dissolved oxygen where the fish were located (within the water column) ranged from 1.4 mg/L to 13.5 mg/L and a minimum of 0.1 mg/L and a maximum of 17.2 mg/L was recorded in Newton Lake during 1998. Mean dissolved oxygen during 1999 ranged from 1.7 mg/L to 7.1 mg/L. A minimum of 0.8 mg/L and a maximum of 6.4 mg/L were recorded (Table 14.14, Figure 14.10). Fish in Coffeen Lake were located in water with mean dissolved oxygen ranging from 2.8 mg/L to 7.1 mg/L for 1998. A minimum of 1.1 mg/L and a maximum of 9.2 mg/L were recorded. During 1999, fish were located in water with mean dissolved oxygen ranging between 3.1 mg/L and 7.4 mg/L, and a minimum of 1.1 mg/L and a maximum of 12.5 mg/L were recorded (Table 14.15, Figure 14.11). Mean dissolved oxygen levels for fish in Lake of Egypt ranged from 1.8 mg/L to 11.1 mg/L in 1998, and a minimum of 1.2 mg/L and a maximum of 12.3 mg/L were recorded. Dissolved oxygen ranges during 1999 were from 2.9 mg/L to 6.8 mg/L, and a minimum of 0.2 mg/L and a maximum of 10.3 mg/L were recorded (Table 14.16, Figure 14.12).

The relationships among temperature, depth, and dissolved oxygen all followed a basic trend: As summer progressed, internal body temperature increased, fish then moved deeper in the water column, and dissolved oxygen in the areas where fish were located decreased (Figures 14.13-14.18). This trend was seen for fish in all lakes during both years, with the exception of Coffeen Lake in the summer of 1999 (Figure 14.16). As internal body temperatures increased, fish moved shallower and dissolved oxygen increased. This may have been due to lower dissolved oxygen in late July. As dissolved oxygen decreased at greater depths, fish migrated up in the water column and endured higher body temperatures for higher dissolved oxygen levels.

Largemouth bass, in all three lakes, utilized areas with higher dissolved oxygen at shallower depths during winter than during summer. Mean dissolved oxygen did not drop below 8 mg/L during winter or spring for largemouth bass located in Newton Lake, and fish did not occupy depths greater than 11 feet during winter (Table 14.17, Figure 14.19). Similarly, largemouth bass in Coffeen Lake and Lake of Egypt utilized shallower depths during winter, however; mean dissolved oxygen was sporadic during fall, and winter (Table 14.18, 14.19, Figure 14.20, 14.21).

Observed Linear Distance

Extensive linear movements were observed in Newton and Coffeen Lakes between individual contacts. Individual transmitter-implanted largemouth bass mean movement between contacts ranged from 58.0 m (0.04 miles) to 3,799.5 m (2.36 miles) in Newton Lake, and channel catfish mean movements ranged from 78.0 m (0.05 miles) to 5,880.1 m (3.65 miles) (Table 14.20). Largemouth bass in Coffeen Lake had mean individual movements that ranged from 63.7 m (0.04 miles) to 3,509.7 m (2.18 miles) and channel catfish mean movement ranged from 62.9 m (0.04 miles) to 1,786.3 m (1.11 miles) (Table 14.21). Lake of Egypt largemouth bass mean individual movements ranged from 82.6 m (0.05 miles) to 1,903.9 m (1.18 miles), and channel catfish ranged from 52.2 m (0.03 miles) to 537.3 m (0.33 miles) (Table 14.22). Scatter plots show the observed movements between contacts throughout the study (Figures 14.22 – 14.27). In Newton Lake, 18.2% of largemouth bass observed movements between contacts were over 1,613.3 m (1 mile), and 2.8% of contacts were over 4,990.4 m (3.10 miles) apart. Over 20% of observed channel catfish movements in Newton Lake were greater than 1,662.4 m (1.03 miles) and 9.6% of observed movements were greater than 4,884.3 m (3.04 miles). In Coffeen Lake, 15.9% of largemouth bass had observed movements that were greater than 1,620.4 m (1.01 miles), and 1.5% of the observations were greater than 4,988.5 m (3.10 miles). Channel catfish observed movements in Coffeen Lake resulted in 13.8% of the observations being greater than 1,701.0 m (1.06 miles). Largemouth bass observed movements in Lake of Egypt were much less extensive. Only 1.5% of the observed movements were greater than 1,625.8 m (1.01 miles), and only 0.5% were greater than 3,260.6 m (2.03 miles). Observed movements of channel catfish in Lake of Egypt were much less than those in Coffeen and Newton lakes. Only 0.5% (one individual movement) of the observations were greater than 2,469.7 m (1.53 miles). Thus, extensive linear movement was exhibited for largemouth bass and channel catfish in Newton and Coffeen Lakes, and comparatively less movement was observed in Lake of Egypt.

Twenty-four Hour Diel Movement

This extensive linear movement was also supported by the 24-hour diel movement data. Movements greater than two miles were observed for 11.5% of implanted largemouth bass in Newton Lake, and 9.1% of bass in Coffeen Lake. While movements over two miles were not observed in Lake of Egypt, 3.3% of the movement observations were between 1.0 and 2.0 miles, and the majority of observations were less than one-half mile (Table 14.23). The range for largemouth bass in Newton Lake was 415.2 m (0.26 miles) to 5,558.0 m (3.45 miles), and Coffeen Lake largemouth bass movement ranged from 273.3 m (0.17 miles) to 4,850.7 m (3.01 miles) (Tables 14.24, 14.25). Largemouth bass movement in Lake of Egypt ranged from 421.4 m (0.26 miles) to 2,203.0 m (1.37 miles) (Table 14.26). Channel catfish observed 24-hour diel movements in Newton Lake were limited to one individual that moved 11,762.2 m (7.31 miles). Coffeen Lake catfish ranged from 543.6 m (0.34 miles) to 5,054.1 m (3.14 miles). Diel movement observations of channel catfish in Lake of Egypt had a range of 335.9 m (0.21 miles) to 1,804.0 m (1.12 miles). These extreme diel movements are shown in Figures 14.25 - 14.29. When comparing the mean seasonal movements, the greatest observed movements were made during summer sampling periods in all three lakes, and observed movements in Newton and Coffeen lakes were much greater than those observed in Lake of Egypt (Figure 14.30).

Seasonal Migrations

Migrations away from the discharge were observed for largemouth bass in Newton Lake for summer months and towards the discharge throughout the remaining seasons (Figure 14.31). Segment one and two were rarely utilized in the summer. Similar migrations were also observed for largemouth bass in Coffeen Lake. However, they were less extreme (Figure 14.32). Migrations towards the discharge in summer months were observed for largemouth bass in Lake of Egypt in segment one (Figure 14.33). Largemouth bass implanted in segment two showed no migratory behavior.

Discussion:

Considerable effort was expended to study channel catfish (AC electroshocking, DC electroshocking, and hoop nets), however, due to the severe problems associated with obtaining useable size channel catfish and retaining transmitters in those fish (>93% transmitter loss), limited data was obtained for this species. For the purpose of discussion, the focus will be on largemouth bass, but channel catfish will be addressed where appropriate.

Mean Internal Body Temperature

Largemouth bass have a preferred laboratory temperature of 29.0 °C (84.2 °F) (Venables et al. 1978). Mean internal body temperatures exceeded the preferred temperature in Newton Lake in July and August 1999, and the upper internal body temperature ranges exceeded the preference temperature from May through September 1998 and May through August 1999. Similarly, Coffeen Lake mean internal body temperatures exceeded the preferred temperature in July and August of 1998 and 1999. The maximum internal body temperatures exceeded the preference temperature from April through September 1998 and April through August 1999.

Mean internal body temperatures of largemouth bass in Lake of Egypt also exceeded the preferred temperature in July and August 1998 and 1999. Maximum internal body temperatures exceeded the preference temperature in June through September 1998 and June through August 1999. This suggests that the preferred temperatures in these lakes are higher than those found in the literature.

Largemouth bass in Coffeen Lake had consistently higher mean internal body temperatures than those in Newton Lake and Lake of Egypt. Largemouth bass in Coffeen Lake also utilized warmer temperatures throughout the winter months than did largemouth bass in Newton Lake and Lake of Egypt.

Depth, Dissolved Oxygen, and Internal Body Temperature Relationships

Only conditions found during summer months are discussed here since they are of greatest biological concern. The general trend for largemouth bass in this study was to go deeper as temperatures increased; however, as the fish went deeper, less dissolved oxygen was available to them. Largemouth bass in Newton Lake consistently utilized areas with dissolved oxygen less than 3 mg/L in the summer of 1999. Also, in 1999, largemouth bass in Coffeen Lake had higher internal body temperatures; however, dissolved oxygen levels utilized were consistently higher than those utilized in Newton Lake. Largemouth bass in Lake of Egypt also consistently utilized areas with higher dissolved oxygen. This suggests that largemouth bass in Newton Lake are forced into higher temperatures and lower dissolved oxygen areas. It also implies loss of available habitat to the bass. The differences observed in Coffeen Lake and Newton Lake can be explained by the morphology and thermodynamics of the reservoirs' basins. Coffeen Lake has a deeper basin with much more vegetation. These factors allow for a larger temperature and dissolved oxygen gradient in Coffeen Lake (See Chapter 15: Temperature and Dissolved Oxygen).

The trend for internal body temperatures of largemouth bass was consistent in the summer of 1998 and 1999. Largemouth bass attained higher internal body temperatures earlier in 1998, but internal body temperature peaked much higher in late July 1999. Similar results were seen for largemouth bass in Coffeen Lake. Data for largemouth bass in Lake of Egypt show similar results in that the bass attained higher internal temperatures earlier in the summer, but the peak in 1998 (mid July) was similar in magnitude to the 1999 peak (early August). Dissolved oxygen in areas utilized by largemouth bass in summer 1998 were higher than those areas utilized in summer 1999 in Newton Lake. Dissolved oxygen in areas utilized by largemouth bass in Coffeen Lake were higher in summer 1999 than 1998, and the dissolved oxygen was fairly consistent in areas of Lake of Egypt where study fish were located. Fish were found at greater depths in summer 1999 than in summer 1998 in Newton Lake. The depth ranges utilized by largemouth bass were consistent between years in Coffeen Lake, but they were inverse when compared to Newton Lake. As the summer progressed, largemouth bass utilized shallower water in 1999 than in 1998. As internal body temperature increased, fish moved shallower, and dissolved oxygen increased. This may have been due to lower dissolved oxygen in late July. As dissolved oxygen decreased at greater depths, fish migrated up in the water column exchanging higher body temperatures for higher dissolved oxygen levels. Largemouth bass in Lake of Egypt were found at shallower depths in summer 1999 than in summer 1998. Temperature, depth, and dissolved oxygen were more variable in summer 1999 in Lake of Egypt where study fish were located. Newton Lake largemouth bass were utilizing areas of lower temperature than those in Coffeen Lake, but they were also utilizing areas of lower dissolved oxygen.

As established earlier, largemouth bass have internal temperature lag times as compared to the surrounding water temperature. The data in this report show that largemouth bass may be utilizing areas of low dissolved oxygen as a thermoregulatory process. As Weller et al. (1984) established, the internal body cavity of largemouth bass has a longer initial temperature lag when warming than when cooling, and they retain their cooler temperatures for a longer period of time. This means that largemouth bass can cool faster, and retain cooler temperatures for a longer time period. Thus, largemouth bass may be utilizing areas of lower dissolved oxygen as a thermoregulatory process. It is possible that the largemouth bass are moving into the lower metalimnion or upper hypolimnion for temperature relief and then going back up to utilize available dissolved oxygen.

Observed Linear Distance, Diel Movement, and Seasonal Migrations

Largemouth bass in Newton Lake and Coffeen Lake were observed moving consistently more than those in Lake of Egypt. Observed movements between contacts exceeding one mile were common in Newton and Coffeen lakes, and observed movements over one-half mile were uncommon for largemouth bass in Lake of Egypt. When comparing this data to the literature, largemouth bass in Newton and Coffeen lakes are moving more than those described elsewhere. Comparisons of mean observed movement between contacts in this study and mean observed movement between contacts for the Sangchris Lake study (Tranquilli et al 1981) show that largemouth bass in Newton and Coffeen lakes were usually moving much greater distances than largemouth bass in the Sangchris study (Table 14.27). Lewis and Flickinger (1967) reported that

96% of the recaptures in their largemouth bass tagging study were found within 91 m (300 ft) of the point of initial capture. Funk (1957) reported that Missouri streams have "mobile" and "sedentary" individuals within the population. Our data show it is possible that there are mobile and sedentary individuals in Newton Lake and Coffeen Lake populations as well.

Largemouth bass and channel catfish are capable of extensive long-range movements in a relatively short period of time in Newton and Coffeen Lakes. The diel data show that largemouth bass were usually moving more in the summer months than in the spring or winter. Mean observed 24-hour movements in excess of one mile were common for largemouth bass in the summer months in Coffeen Lake, and observed movements in excess of 1.5 miles were common in Newton Lake.

Migrations observed for largemouth bass in Newton and Coffeen Lakes were similar in that there were summer migrations away from the discharge, however, the migrations in Newton Lake were more extensive than those in Coffeen Lake. Morphology and thermodynamics of the reservoir basins may explain these migrations. Segment one in Newton Lake is fairly shallow, approximately 3 m (9.8 feet) deep. This shallow area spans a distance of approximately two miles. Segment one in Coffeen Lake has much greater depths (>7 m (23 feet)) within one-half mile from the discharge. These deeper areas allow largemouth bass to utilize areas closer to the discharge due to available dissolved oxygen. Also, Coffeen Lake has a larger temperature and dissolved oxygen gradient than Newton Lake (See Chapter 15: Temperature and Dissolved Oxygen). Migrations in Lake of Egypt may be explained by the forage base. Gizzard shad migrate into the discharge during summer months, and the largemouth bass were consistently observed schooling and feeding in the discharge area in Lake of Egypt.

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Table 14.1. History of sonic transmitter disposition from October 1997 through May 1999 in three Illinois power cooling reservoirs.

	Total tagged	Largemouth bass tagged	Channel catfish tagged
Newton	55	39	16
Coffeen	43	31	12
Lake of Egypt	44	30	14
Total	142	100	42

Table 14.2. Effort (days) in determining movement of largemouth bass and channel catfish from October 1997 through August 1999 in three Illinois power cooling reservoirs.

	Tracking	Tagging	Recovery dives	24-hour tracking
Newton	67	11	1	20
Coffeen	61	11	1	20
Lake of Egypt	62	9	2	20
Total:	190	31	4	60
Total Effort:	285			

Table 14.3. Release sites, total length, and weight of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Newton Lake, Jasper Co. Illinois from October 1997 through April 1999.

Release sites	Date	Transmitter number	Species	Total length mm (inches)	Weight grams (pounds)
21	21-Oct-97	285	LMB	404 (15.91)	1010 (2.23)
14	21-Oct-97	447	LMB	433 (17.05)	1280 (2.82)
12	21-Oct-97	456	LMB	396 (15.59)	1020 (2.25)
15	21-Oct-97	2524	LMB	430 (16.93)	1360 (3.00)
17	21-Oct-97	2633	LMB	427 (16.81)	1200 (2.65)
24	22-Oct-97	88	LMB	463 (18.23)	1760 (3.88)
8	22-Oct-97	97	LMB	441 (17.36)	1475 (3.25)
22	22-Oct-97	249	LMB	456 (17.95)	1630 (3.59)
3	22-Oct-97	258	LMB	453 (17.83)	1420 (3.13)
20	22-Oct-97	375	LMB	415 (16.34)	1090 (2.40)
4	22-Oct-97	555	LMB	446 (17.56)	1410 (3.11)
26	22-Oct-97	2345	LMB	475 (18.70)	1800 (3.97)
11	22-Oct-97	2533	LMB	431 (16.97)	1410 (3.11)
2	22-Oct-97	3334	LMB	445 (17.52)	1200 (2.65)
6	22-Oct-97	3335	LMB	487 (19.17)	1580 (3.48)
8	13-Apr-98	335	CCAT	430 (16.93)	674 (1.49)
5	13-Apr-98	9-11	CCAT	415 (16.34)	537 (1.18)
1	12-May-98	275	CCAT	630 (24.80)	3012 (6.64)
1	12-May-98	338	CCAT	530 (20.87)	1564 (3.45)
1	12-May-98	374	CCAT	526 (20.71)	1368 (3.02)
1	12-May-98	2543	CCAT	528 (20.79)	1236 (2.73)
1	12-May-98	3337	CCAT	592 (23.31)	1837 (4.05)
1	12-May-98	4444	CCAT	628 (24.72)	2146 (4.73)
1	12-May-98	12-4	CCAT	511 (20.12)	1120 (2.47)
5	12-May-98	13-3	LMB	468 (18.43)	1503 (3.31)
1	12-May-98	5-8-10	CCAT	520 (20.47)	1393 (3.07)
25	21-Jul-98	248	CCAT	412 (16.22)	624 (1.38)
25	21-Jul-98	284	CCAT	458 (18.03)	921 (2.03)
25	21-Jul-98	293	CCAT	424 (16.69)	603 (1.33)
25	21-Jul-98	446	CCAT	475 (18.70)	892 (1.97)
25	21-Jul-98	2443	LMB	522 (20.55)	1872 (4.13)

Table 14.3. Continued

Release sites	Date	Transmitter number	Species	Total length mm (inches)	Weight grams (pounds)
23	22-Jul-98	246	LMB	474 (18.66)	1637 (3.61)
23	22-Jul-98	365	LMB	432 (17.01)	1434 (3.16)
25	22-Jul-98	368	CCAT	454 (17.87)	779 (1.72)
25	22-Jul-98	557	CCAT	494 (19.45)	1084 (2.39)
25	22-Jul-98	2246	LMB	444 (17.48)	1230 (2.71)
21	22-Jul-98	3434	LMB	416 (16.38)	1144 (2.52)
27	19-Nov-98	248	LMB	454 (17.87)	1651 (3.64)
3	19-Nov-98	356	LMB	453 (17.83)	1520 (3.35)
8	19-Nov-98	456	LMB	416 (16.38)	1248 (2.75)
27	19-Nov-98	689	LMB	467 (18.39)	2058 (4.54)
18	19-Nov-98	2237	LMB	501 (19.72)	2038 (4.49)
3	19-Nov-98	2273	LMB	426 (16.77)	1222 (2.69)
5	19-Nov-98	2435	LMB	461 (18.15)	1636 (3.61)
4	19-Nov-98	2452	LMB	418 (16.46)	1155 (2.55)
2	19-Nov-98	2633	LMB	511 (20.12)	2440 (5.38)
17	19-Nov-98	3343	LMB	395 (15.55)	988 (2.18)
14	19-Nov-98	12-4	LMB	445 (17.52)	1387 (3.06)
7	19-Nov-98	6-11-13	LMB	470 (18.50)	1585 (3.49)
13	16-Apr-99	257	LMB	482 (18.98)	1682 (3.71)
9	16-Apr-99	444	LMB	417 (16.42)	1078 (2.38)
16	16-Apr-99	2362	LMB	474 (18.66)	1788 (3.94)
19	16-Apr-99	14-2	LMB	454 (17.87)	1692 (3.73)
10	16-Apr-99	9-11	LMB	438 (17.24)	1430 (3.15)

Table 14.4. Release sites, total length, and weight of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Coffeen Lake, Montgomery Co. Illinois from October 1997 through May 1999.

Release sites	Date	Transmitter number	Species	Total length mm (inches)	Weight grams (pounds)
18	28-Oct-97	339	LMB	453 (17.83)	1337 (2.95)
12	28-Oct-97	348	LMB	470 (18.50)	1663 (3.67)
8	28-Oct-97	384	LMB	506 (19.92)	2033 (4.48)
26	28-Oct-97	2336	LMB	401 (15.79)	1087 (2.40)
16	28-Oct-97	2363	LMB	437 (17.20)	1259 (2.78)
10	28-Oct-97	2425	LMB	425 (16.73)	1134 (2.50)
25	28-Oct-97	2542	LMB	460 (18.11)	1576 (3.48)
9	28-Oct-97	11-5	LMB	450 (17.72)	1426 (3.14)
3	29-Oct-97	267	LMB	405 (15.94)	1041 (2.30)
6	29-Oct-97	2228	LMB	382 (15.04)	764 (1.68)
14	29-Oct-97	2246	LMB	485 (19.09)	2017 (4.45)
4	29-Oct-97	2327	LMB	398 (15.67)	1031 (2.27)
7	29-Oct-97	2426	LMB	413 (16.26)	1123 (2.48)
13	29-Oct-97	2435	LMB	432 (17.01)	1283 (2.83)
1	29-Oct-97	2444	LMB	410 (16.14)	1155 (2.55)
22	05-Nov-97	347	CCAT	470 (18.50)	1038 (2.29)
12	05-Nov-97	455	CCAT	465 (18.31)	927 (2.04)
1	03-Dec-97	7777	CCAT	540 (21.26)	1260 (2.78)
1	07-Jan-98	224	CCAT	463 (18.23)	910 (2.01)
1	07-Jan-98	268	CCAT	500 (19.69)	1245 (2.75)
1	07-Jan-98	468	CCAT	489 (19.25)	811 (1.79)
1	07-Jan-98	2632	CCAT	635 (25.00)	2364 (5.21)
1	07-Jan-98	3343	CCAT	456 (17.95)	897 (1.98)
17	31-Mar-98	379	CCAT	436 (17.17)	819 (1.81)
24	27-Jul-98	239	CCAT	426 (16.77)	658 (1.45)
19	27-Jul-98	266	LMB	465 (18.31)	1134 (2.50)
22	27-Jul-98	568	CCAT	491 (19.33)	932 (2.06)
20	27-Jul-98	2353	LMB	366 (14.41)	837 (1.85)
23	27-Jul-98	3335	LMB	451 (17.76)	1059 (2.34)
20	27-Jul-98	4444	LMB	404 (15.91)	1013 (2.23)
26	27-Jul-98	5-12-14	CCAT	447 (17.60)	848 (1.87)
19	27-Jul-98	6-11-13	LMB	382 (15.04)	838 (1.85)

Table 14.4. Continued

Release sites	Date	Transmitter number	Species	Total length mm (inches)		Weight grams (pounds)	
24	27-Jul-98	6-12-14	LMB	394	(15.51)	924	(2.04)
2	23-Nov-98	239	LMB	422	(16.61)	1230	(2.71)
1	23-Nov-98	246	LMB	461	(18.15)	1830	(4.04)
4	23-Nov-98	557	LMB	390	(15.35)	965	(2.13)
7	23-Nov-98	568	LMB	405	(15.94)	1179	(2.60)
4	23-Nov-98	2227	LMB	490	(19.29)	1930	(4.26)
5	23-Nov-98	3434	LMB	455	(17.91)	1626	(3.59)
21	28-May-99	379	LMB	407	(16.02)	929	(2.05)
11	28-May-99	2335	LMB	369	(14.53)	630	(1.39)
15	28-May-99	2363	LMB	396	(15.59)	818	(1.80)
19	28-May-99	2534	LMB	409	(16.10)	989	(2.18)

Table 14.5. Release sites, total length, and weight of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Lake of Egypt, Williamson / Johnson Co. Illinois from October 1997 through March 1999.

Release sites	Date	Transmitter number	Species	Total length mm	(inches)	Weight grams	(pounds)
16	14-Oct-97	366	LMB	362	(14.25)	618	(1.36)
5	14-Oct-97	2255	LMB	414	(16.30)	957	(2.11)
18	14-Oct-97	2264	LMB	409	(16.10)	836	(1.84)
1	14-Oct-97	2273	LMB	364	(14.33)	552	(1.22)
3	14-Oct-97	2434	LMB	384	(15.12)	695	(1.53)
18	14-Oct-97	2453	LMB	393	(15.47)	756	(1.67)
2	14-Oct-97	2525	LMB	396	(15.59)	887	(1.96)
8	14-Oct-97	10-6	LMB	395	(15.55)	745	(1.64)
7	16-Oct-97	294	LMB	412	(16.22)	721	(1.59)
12	16-Oct-97	2237	CCAT	438	(17.24)	905	(2.00)
12	16-Oct-97	2443	LMB	441	(17.36)	1188	(2.62)
1	16-Oct-97	2534	CCAT	452	(17.80)	957	(2.11)
20	17-Oct-97	276	LMB	375	(14.76)	610	(1.35)
23	17-Oct-97	357	LMB	410	(16.14)	795	(1.75)
21	17-Oct-97	465	LMB	405	(15.94)	847	(1.87)
22	17-Oct-97	2452	LMB	401	(15.79)	680	(1.50)
19	17-Oct-97	3344	LMB	460	(18.11)	1204	(2.65)
3	11-Nov-97	235	CCAT	598	(23.54)	2068	(4.56)
3	11-Nov-97	356	CCAT	596	(23.46)	2325	(5.13)
3	11-Nov-97	479	CCAT	580	(22.83)	2056	(4.53)
2	17-Nov-97	266	CCAT	564	(22.20)	1708	(3.77)
1	17-Nov-97	457	CCAT	498	(19.61)	1433	(3.16)
1	17-Nov-97	689	CCAT	520	(20.47)	1370	(3.02)
2	17-Nov-97	2263	CCAT	498	(19.61)	983	(2.17)
2	17-Nov-97	14-2	CCAT	514	(20.24)	1215	(2.68)
13	27-Mar-98	2222	CCAT	544	(21.42)	1434	(3.16)
4	25-Jul-98	346	CCAT	473	(18.62)	901	(1.99)
4	25-Jul-98	347	LMB	401	(15.79)	824	(1.82)
2	25-Jul-98	2227	CCAT	495	(19.49)	1055	(2.33)
10	25-Jul-98	2263	LMB	410	(16.14)	943	(2.08)
17	25-Jul-98	2326	LMB	399	(15.71)	780	(1.72)
4	25-Jul-98	2344	CCAT	494	(19.45)	910	(2.01)

Table 14.5. Continued

Release sites	Date	Transmitter number	Species	Total length mm (inches)		Weight grams (pounds)	
4	25-Jul-98	2534	LMB	413	(16.26)	894	(1.97)
5	25-Jul-98	2543	LMB	400	(15.75)	746	(1.64)
8	09-Nov-98	224	LMB	397	(15.63)	727	(1.60)
11	09-Nov-98	275	LMB	405	(15.94)	817	(1.80)
3	09-Nov-98	338	LMB	382	(15.04)	805	(1.78)
1	09-Nov-98	375	LMB	492	(19.37)	1669	(3.68)
5	09-Nov-98	455	LMB	385	(15.16)	653	(1.44)
15	09-Nov-98	2246	LMB	459	(18.07)	1406	(3.10)
11	09-Nov-98	2327	LMB	441	(17.36)	1220	(2.69)
6	09-Nov-98	3335	LMB	456	(17.95)	1273	(2.81)
14	26-Mar-99	455	LMB	407	(16.02)	940	(2.07)
9	26-Mar-99	2534	LMB	397	(15.63)	724	(1.60)

Table 14.6. Total sonic transmitter losses from October 1997 through August 1999 in three Illinois power cooling reservoirs.

Lake	Largemouth bass (%)	Channel catfish (%)	Total (%)
Newton	64	100	75
Coffeen	74	100	81
Lake of Egypt	70	93	77

Table 14.7. History of contacts and time period sonic transmitters were active for largemouth bass (LMB) and channel catfish (CCAT) in Newton Lake, Jasper Co. Illinois.

Transmitter sequence	Species	Number of locations	Dates active	Last date found
248	CCAT	9	7/98-10/98	
275	CCAT	16	5/98-10/98	
284	CCAT	8	7/98-10/98	Un-recoverable
293	CCAT	34	7/98-8/99	
335	CCAT	2	4/98-missing	23-Apr-98
338	CCAT	15	5/98-10/98	
368	CCAT	1	7/98-missing	28-Jul-98
374	CCAT	8	5/98-missing	07-Jul-98
446	CCAT	6	7/98-missing	09-Jun-99
557	CCAT	10	7/98-10/98	
2543	CCAT	4	5/98-6/98	
3337	CCAT	1	5/98-missing	21-May-98
4444	CCAT	3	5/98-6/98	
12-4	CCAT	18	5/98-10/98	
5-8-10	CCAT	8	5/98-missing	07-Jul-98
9-11	CCAT	1	4/98-missing	23-Apr-98
88	LMB	38	10/97-missing	12-May-99
97	LMB	31	10/97-missing	25-Nov-98
246	LMB	6	7/98-10/98	
248	LMB	20	11/98-7/99	
249	LMB	41	10/97-8/99	Transmitter failure
257	LMB	18	4/98-8/99	
258	LMB	19	10/97-missing	28-Dec-98
285	LMB	6	10/97-missing	28-Jul-98
356	LMB	25	11/98-8/99	
365	LMB	30	7/98-missing	27-Jul-99
375	LMB	24	10/97-8/98	

Table 14.7. Continued

Transmitter sequence	Species	Number of locations	Dates active	Last date found
444	LMB	20	4/99-8/99	
447	LMB	24	10/97-missing	18-Aug-98
455	LMB	1	7/98-7/98	
456	LMB	26	10/97-9/98	
456	LMB	20	11/98-8/99	
555	LMB	56	10/97-8/99	
689	LMB	22	11/98-8/99	
2237	LMB	23	11/98-8/99	
2246	LMB	10	7/98-10/98	
2273	LMB	23	11/98-8/99	
2345	LMB	4	10/97-missing	12-Feb-98
2362	LMB	19	4/99-8/99	
2435	LMB	0	11/98-missing	28-Dec-99
2443	LMB	0	7/98-missing	Never found
2452	LMB	0	11/98-4/99	Transmitter failure
2524	LMB	47	10/97-7/99	
2533	LMB	57	10/97-8/99	
2633	LMB	24	10/97-8/98	
2633	LMB	13	11/98-missing	28-Jan-99
3334	LMB	53	10/97-8/99	
3335	LMB	2	10/97-2/98	
3343	LMB	25	11/98-8/99	
3434	LMB	4	7/98-8/98	
12-4	LMB	1	5/98-10/98	
13-3	LMB	1	5/98-missing	13-May-98
14-2	LMB	18	4/99-8/99	
6-11-13	LMB	26	11/98-7/99	
9-11	LMB	19	4/99-8/99	

Table 14.8. History of contacts and time period sonic transmitters were active for largemouth bass (LMB) and channel catfish (CCAT) in Coffeen Lake, Montgomery Co. Illinois.

Transmitter sequence	Species	Number of locations	Dates active	Last date found
224	CCAT	22	1/98-10/98	
239	CCAT	4	7/98-8/98	
268	CCAT	17	1/98-10/98	
347	CCAT	17	11/97-7/98	
379	CCAT	23	3/98-1/99	
455	CCAT	18	11/97-7/98	
468	CCAT	10	1/98-missing	10-Jul-98
568	CCAT	3	7/98-8/98	
2632	CCAT	22	1/98-8/98	
3343	CCAT	22	1/98-10/98	
7777	CCAT	12	12/97-missing	16-Jun-98
5-12-14	CCAT	2	7/98-missing	08-Aug-98
239	LMB	24	11/98-8/99	
246	LMB	2	11/98-3/99	
266	LMB	29	7/98-7/99	
267	LMB	46	10/97-7/99	
339	LMB	35	10/97-missing	06-May-99
348	LMB	37	10/97-missing	20-May-99
379	LMB	13	5/99-8/99	
384	LMB	17	10/97-missing	10-Jul-98
557	LMB	19	11/98-missing	16-Jul-99
568	LMB	25	11/98-8/99	
2227	LMB	21	11/98-8/99	
2228	LMB	39	10/97-missing	14-May-99
2246	LMB	16	10/97-7/98	
2327	LMB	22	10/97-8/98	
2335	LMB	13	5/99-8/99	

Table 14.8. Continued

Transmitter sequence	Species	Number of locations	Dates active	Last date found
2336	LMB	32	10/97-missing	06-Apr-99
2353	LMB	34	7/98-8/99	
2363	LMB	42	10/97-5/99	
2363	LMB	12	5/99-8/99	
2425	LMB	49	10/97-missing	21-Jul-99
2426	LMB	30	10/97-missing	08-Oct-98
2435	LMB	23	10/97-8/98	
2444	LMB	49	10/97-missing	21-Jul-99
2534	LMB	13	5/99-8/99	
2542	LMB	10	10/97-missing	22-May-98
3335	LMB	4	7/98-8/98	
3434	LMB	24	11/98-8/99	
4444	LMB	9	7/98-missing	25-Sep-98
11-5	LMB	33	10/97-missing	01-Dec-98
6-11-13	LMB	28	7/98-8/98	
6-12-14	LMB	12	7/98-6/99	

Table 14.9. History of contacts and time period sonic transmitters were active for largemouth bass (LMB) and channel catfish (CCAT) in Lake of Egypt, Williamson / Johnson Co. Illinois.

Transmitter sequence	Species	Number of locations	Dates active	Last date found
235	CCAT	21	11/97-present	Un-recoverable
266	CCAT	16	11/97-7/98	
346	CCAT	9	7/98-9/98	Un-recoverable
356	CCAT	22	11/97-9/98	
457	CCAT	4	11/97-missing	19-May-98
479	CCAT	23	11/97-9/98	Un-recoverable
689	CCAT	24	11/97-9/98	
2222	CCAT	22	3/98-9/98	Un-recoverable
2227	CCAT	8	7/98-9/98	
2237	CCAT	27	10/97-9/98	
2263	CCAT	12	11/97-7/98	
2344	CCAT	28	7/98-8/99	
2534	CCAT	18	10/97-7/98	
14-2	CCAT	1	11/97-3/98	
224	LMB	13	11/98-7/99	
275	LMB	2	11/98-missing	03-Dec-98
276	LMB	57	10/97-8/99	
294	LMB	13	10/97-5/99	14-Apr-98
338	LMB	25	11/98-8/99	
347	LMB	3	7/98-present	11-Aug-98
357	LMB	48	10/97-8/99	
366	LMB	36	10/97-6/99	Transmitter Failure
375	LMB	26	11/98-8/99	
455	LMB	3	11/98-1/99	
455	LMB	21	3/99-8/99	
465	LMB	35	10/97-missing	04-Feb-99
2246	LMB	24	11/98-8/99	

Table 14.9. Continued

Transmitter sequence	Species	Number of locations	Dates active	Last date found
2255	LMB	53	10/97-8/99	
2263	LMB	32	7/98-8/99	
2264	LMB	16	10/97-missing	12-Jun-98
2273	LMB	26	10/97-9/98	
2326	LMB	35	7/98-8/99	
2327	LMB	10	11/98-5/99	
2434	LMB	24	10/97-8/98	Un-recoverable
2443	LMB	17	10/97-7/98	
2452	LMB	14	10/97-9/98	
2453	LMB	44	10/97-8/99	
2525	LMB	27	10/97-9/98	Un-recoverable
2534	LMB	14	7/98-2/99	
2534	LMB	3	4/99-missing	20-Apr-99
2543	LMB	9	7/98-missing	24-Sep-98
3335	LMB	23	11/98-8/99	
3344	LMB	36	10/97-missing	25-May-99
10-6	LMB	51	10/97-8/99	

Table 14.10. Largemouth bass internal body temperature, as determined by temperature sensitive ultrasonic telemetry, in Newton Lake, Jasper Co. Illinois.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max.temp. C (F)	Standard deviation C (F)
Aug-97	--	--	--	--	--
Sep-97	--	--	--	--	--
Oct-97	--	--	--	--	--
Nov-97	12	15.2 (59.4)	9.7 (49.5)	19.9 (67.8)	6.6 (11.9)
Dec-97	10	10.7 (51.3)	6.7 (44.1)	19.7 (67.5)	3.5 (6.2)
Jan-98	12	9.4 (48.9)	6.2 (43.2)	16.7 (62.1)	2.8 (5.1)
Feb-98	12	11.5 (52.7)	6.4 (43.5)	16.7 (62.1)	4.0 (7.3)
Mar-98	9	10.7 (51.3)	7.7 (45.9)	13.8 (56.8)	1.9 (3.4)
Apr-98	34	17.1 (62.8)	12.4 (54.3)	22.8 (73.0)	3.0 (5.3)
May-98	38	24.6 (76.3)	16.1 (61.0)	30.2 (86.4)	3.1 (5.6)
Jun-98	44	26.6 (79.9)	20.6 (69.1)	31.5 (88.7)	3.1 (5.6)
Jul-98	36	29.0 (84.2)	24.7 (76.5)	32.3 (90.1)	2.3 (4.1)
Aug-98	41	28.9 (84.0)	23.6 (74.5)	32.0 (89.6)	2.2 (3.9)
Sep-98	35	26.2 (79.2)	21.7 (71.1)	30.6 (87.1)	2.3 (4.2)
Oct-98	5	21.5 (70.7)	18.4 (65.1)	22.7 (72.9)	1.8 (3.2)
Nov-98	16	15.8 (60.4)	12.2 (54.0)	22.4 (72.3)	2.6 (4.7)
Dec-98	10	8.0 (46.4)	6.9 (44.4)	11.3 (52.3)	1.4 (2.6)
Jan-99	12	7.9 (46.2)	6.4 (43.5)	10.5 (50.9)	1.3 (2.3)
Feb-99	11	11.2 (52.2)	7.1 (44.8)	15.8 (60.4)	2.4 (4.3)
Mar-99	6	15.1 (59.2)	12.0 (53.6)	19.4 (66.9)	2.9 (5.3)
Apr-99	65	16.9 (62.4)	9.7 (49.5)	24.5 (76.1)	2.8 (5.1)
May-99	72	23.2 (73.8)	15.9 (60.6)	29.8 (85.6)	3.0 (5.3)
Jun-99	82	27.7 (81.9)	14.9 (58.8)	34.4 (93.9)	2.9 (5.2)
Jul-99	62	30.3 (86.5)	25.2 (77.4)	35.0 (95.0)	2.3 (4.1)
Aug-99	54	29.3 (84.7)	24.4 (75.9)	33.8 (92.8)	2.0 (3.6)

Table 14.11. Largemouth bass internal body temperature, as determined by temperature sensitive ultrasonic telemetry, in Coffeen Lake, Montgomery Co. Illinois.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max.temp. C (F)	Standard deviation C (F)
Aug-97	--	--	--	--	--
Sep-97	--	--	--	--	--
Oct-97	--	--	--	--	--
Nov-97	9	15.2 (59.4)	11.9 (53.4)	21.4 (70.5)	2.7 (4.9)
Dec-97	12	17.2 (63.0)	12.8 (55.0)	23.6 (74.5)	4.0 (7.2)
Jan-98	14	13.1 (55.6)	7.8 (46.0)	22.9 (73.2)	4.7 (8.4)
Feb-98	15	14.1 (57.4)	10.1 (50.2)	19.2 (66.6)	2.5 (4.5)
Mar-98	12	9.6 (49.3)	6.3 (43.3)	16.9 (62.4)	3.6 (6.4)
Apr-98	57	19.8 (67.6)	13.6 (56.5)	29.3 (84.7)	3.7 (6.7)
May-98	52	25.8 (78.4)	18.0 (64.4)	34.3 (93.7)	3.6 (6.4)
Jun-98	46	27.4 (81.3)	18.5 (65.3)	34.4 (93.9)	2.8 (5.0)
Jul-98	58	31.4 (88.5)	26.7 (80.1)	35.3 (95.5)	1.8 (3.3)
Aug-98	52	30.9 (87.6)	25.2 (77.4)	33.3 (91.9)	1.8 (3.2)
Sep-98	53	28.9 (84.0)	23.1 (73.6)	32.9 (91.2)	2.1 (3.7)
Oct-98	11	21.4 (70.5)	19.4 (66.9)	22.4 (72.3)	0.9 (1.7)
Nov-98	11	18.1 (64.6)	13.9 (57.0)	25.2 (77.4)	3.3 (5.9)
Dec-98	16	16.0 (60.8)	10.5 (50.9)	23.3 (73.9)	3.9 (7.0)
Jan-99	14	13.8 (56.8)	9.7 (49.5)	19.4 (66.9)	3.2 (5.8)
Feb-99	14	14.2 (57.6)	8.4 (47.1)	22.7 (72.9)	5.1 (9.2)
Mar-99	15	15.7 (60.3)	8.4 (47.1)	23.2 (73.8)	5.6 (10.1)
Apr-99	56	21.7 (71.1)	17.3 (63.1)	30.3 (86.5)	2.8 (5.1)
May-99	46	25.3 (77.5)	19.3 (66.7)	31.5 (88.7)	2.9 (5.2)
Jun-99	61	27.8 (82.0)	19.9 (67.8)	32.7 (90.9)	1.9 (3.5)
Jul-99	42	32.0 (89.6)	29.5 (85.1)	36.3 (97.3)	1.6 (2.8)
Aug-99	33	31.3 (88.3)	28.6 (83.5)	34.5 (94.1)	1.4 (2.6)

Table 14.12. Largemouth bass internal body temperature, as determined by temperature sensitive ultrasonic telemetry, in Lake of Egypt, Williamson / Johnson Co. Illinois.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max.temp. C (F)	Standard deviation C (F)
Aug-97	--	--	--	--	--
Sep-97	--	--	--	--	--
Oct-97	--	--	--	--	--
Nov-97	14	11.9 (53.4)	10.8 (51.4)	13.8 (56.8)	0.9 (1.5)
Dec-97	11	10.1 (50.2)	8.1 (46.6)	13.9 (57.0)	1.8 (3.3)
Jan-98	11	8.7 (47.7)	5.7 (42.3)	13.8 (56.8)	2.6 (4.7)
Feb-98	10	5.8 (42.4)	3.5 (38.3)	8.6 (47.5)	1.4 (2.5)
Mar-98	10	9.4 (48.9)	5.9 (42.6)	14.3 (57.7)	2.7 (4.9)
Apr-98	42	15.0 (59.0)	12.2 (54.0)	18.1 (64.6)	1.5 (2.8)
May-98	30	23.3 (73.9)	18.7 (65.7)	28.3 (82.9)	3.1 (5.5)
Jun-98	35	28.0 (82.4)	25.5 (77.9)	33.3 (91.9)	1.8 (3.3)
Jul-98	43	30.0 (86.0)	27.4 (81.3)	33.5 (92.3)	1.7 (3.0)
Aug-98	50	29.6 (85.3)	27.3 (81.1)	33.0 (91.4)	1.3 (2.4)
Sep-98	40	28.1 (82.6)	25.6 (78.1)	31.2 (88.2)	1.4 (2.6)
Oct-98	11	19.6 (67.2)	18.3 (64.9)	22.5 (72.5)	1.1 (2.0)
Nov-98	15	15.5 (59.9)	13.1 (55.6)	22.1 (71.8)	2.7 (4.9)
Dec-98	17	15.1 (59.1)	12.5 (54.5)	20.6 (69.1)	2.3 (4.1)
Jan-99	19	7.7 (45.9)	4.1 (39.4)	16.1 (61.0)	3.0 (5.3)
Feb-99	16	8.2 (46.8)	5.2 (41.4)	15.9 (60.6)	3.2 (5.7)
Mar-99	16	9.3 (48.7)	7.6 (45.7)	13.0 (55.4)	1.5 (2.7)
Apr-99	63	16.9 (62.5)	12.9 (55.2)	22.8 (73.0)	2.0 (3.5)
May-99	53	22.8 (73.0)	18.5 (65.3)	27.4 (81.3)	2.0 (3.6)
Jun-99	64	26.9 (80.3)	22.5 (72.5)	33.4 (92.1)	2.1 (3.7)
Jul-99	44	29.5 (85.0)	23.0 (73.4)	34.1 (93.4)	1.9 (3.3)
Aug-99	39	29.1 (84.4)	26.0 (78.8)	33.1 (91.6)	1.5 (2.8)

Table 14.13. Equilibration times and morphometrics of largemouth bass utilized in a sonic telemetry study to determine internal body temperature lag times.

Number	Length mm (inches)	Weight grams (pounds)	Wall thickness mm (inches)	Equilibration time minutes
569	483 (19.0)	1499 (3.3)	7.4 (0.29)	59.0
2237	385 (15.2)	777 (1.7)	5.5 (0.22)	49.0
668	480 (18.9)	1485 (3.3)	8.0 (0.31)	65.5
479	419 (16.5)	1037 (2.3)	5.5 (0.22)	53.0
2227	389 (15.3)	736 (1.6)	6.0 (0.24)	41.0
578	503 (19.8)	1720 (3.8)	7.6 (0.30)	58.5
379	362 (14.3)	606 (1.3)	5.5 (0.22)	39.5
299	505 (19.9)	1773 (3.9)	7.5 (0.30)	63.0
61214	419 (16.5)	822 (1.8)	5.0 (0.20)	38.5
2354	520 (20.5)	2376 (5.2)	8.9 (0.35)	63.5
246	476 (18.7)	1412 (3.1)	6.8 (0.27)	58.0
389	444 (17.5)	1230 (2.7)	8.0 (0.31)	68.5

Table 14.14. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Newton Lake, Jasper Co. Illinois for summer months in 1998 and 1999. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
03-Jun-98	2	27.1 (80.8)	27.0 (80.6)	27.1 (80.8)	3.0 (9.84)	2.5 (8.20)	3.5 (11.48)	6.80	4.13	9.47
10-Jun-98	3	24.1 (75.4)	23.5 (74.3)	24.5 (76.1)	2.3 (7.54)	1.0 (3.28)	4.0 (13.12)	13.45	8.21	17.24
19-Jun-98	4	27.7 (81.9)	23.6 (74.5)	30.0 (86.0)	1.9 (6.23)	1.5 (4.92)	2.5 (8.20)	9.29	6.84	11.67
23-Jun-98	4	28.2 (82.8)	27.2 (81.0)	29.9 (85.8)	3.5 (11.48)	1.5 (4.92)	5.0 (16.40)	5.61	4.08	8.30
30-Jun-98	4	31.0 (87.8)	29.5 (85.1)	31.5 (88.7)	2.3 (7.54)	0.0 (0.00)	4.5 (14.76)	5.30	0.90	8.51
07-Jul-98	6	29.9 (85.8)	26.4 (79.5)	31.3 (88.3)	3.8 (12.46)	2.0 (6.56)	5.5 (18.04)	3.89	0.19	7.74
13-Jul-98	4	30.7 (87.3)	29.7 (85.5)	31.9 (89.4)	4.1 (13.45)	3.5 (11.48)	5.0 (16.40)	4.13	1.24	9.04
21-Jul-98	4	31.7 (89.1)	31.2 (88.2)	32.3 (90.1)	3.5 (11.48)	2.5 (8.20)	4.0 (13.12)	1.37	0.76	2.99
28-Jul-98	3	30.3 (86.5)	29.5 (85.1)	31.3 (88.3)	4.0 (13.12)	3.0 (9.84)	4.5 (14.76)	3.90	2.86	5.00
07-Aug-98	3	29.9 (85.8)	28.8 (83.8)	30.8 (87.4)	3.2 (10.50)	0.0 (0.00)	6.0 (19.68)	4.54	0.30	7.46
12-Aug-98	4	29.9 (85.8)	29.4 (84.9)	30.3 (86.5)	2.8 (9.18)	0.5 (1.64)	5.0 (16.40)	6.37	4.42	8.39
18-Aug-98	5	29.6 (85.3)	25.9 (78.6)	31.2 (88.2)	4.6 (15.09)	2.5 (8.20)	6.5 (21.32)	2.52	0.40	8.01
27-Aug-98	5	29.9 (85.8)	28.2 (82.8)	30.8 (87.4)	4.2 (13.78)	1.5 (4.92)	6.0 (19.68)	3.02	0.12	6.44

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
03-Jun-99	10	26.3 (79.3)	24.8 (76.6)	29.1 (84.4)	3.7 (12.14)	1.0 (3.28)	5.0 (16.40)	5.02	3.06	4.18
09-Jun-99	13	28.6 (83.5)	24.2 (75.6)	34.4 (93.9)	4.0 (13.12)	1.0 (3.28)	6.0 (19.68)	4.13	4.12	6.41
14-Jun-99	11	29.5 (85.1)	26.1 (79.0)	31.7 (89.1)	3.9 (12.79)	2.0 (6.56)	5.0 (16.40)	2.99	2.94	5.71
22-Jun-99	13	28.2 (82.8)	27.2 (81.0)	31.7 (89.1)	3.2 (10.50)	1.0 (3.28)	5.5 (18.04)	7.13	4.50	5.74
29-Jun-99	5	28.4 (83.1)	27.3 (81.1)	30.9 (87.6)	4.1 (13.45)	2.5 (8.20)	5.5 (18.04)	1.69	1.69	2.88
07-Jul-99	10	30.3 (86.5)	26.4 (79.5)	31.7 (89.1)	4.3 (14.10)	3.5 (11.48)	5.5 (18.04)	1.87	1.86	2.61
15-Jul-99	10	29.2 (84.6)	27.7 (81.9)	31.7 (89.1)	4.2 (13.78)	1.5 (4.92)	6.0 (19.68)	2.91	2.60	3.95
20-Jul-99	12	30.8 (87.4)	27.6 (81.7)	32.8 (91.0)	4.0 (13.12)	1.5 (4.92)	6.0 (19.68)	2.40	2.12	6.30
27-Jul-99	10	33.0 (91.4)	29.7 (85.5)	35.0 (95.0)	4.0 (13.12)	3.0 (9.84)	5.0 (16.40)	2.27	2.04	2.67
05-Aug-99	8	31.2 (88.2)	29.7 (85.5)	32.3 (90.1)	4.6 (15.09)	1.5 (4.92)	6.0 (19.68)	3.21	3.05	4.31
09-Aug-99	6	29.5 (85.1)	28.4 (83.1)	30.3 (86.5)	5.6 (18.37)	4.5 (14.76)	6.5 (21.32)	2.06	1.92	3.62
18-Aug-99	12	29.3 (84.7)	27.0 (80.6)	31.0 (87.8)	4.8 (15.74)	3.5 (11.48)	7.0 (22.96)	2.80	2.74	2.43
26-Aug-99	6	30.0 (86.0)	29.8 (85.6)	30.3 (86.5)	4.3 (14.10)	3.5 (11.48)	5.0 (16.40)	2.57	0.78	2.12

Table 14.15. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Coffeen Lake, Montgomery Co. Illinois for summer months in 1998 and 1999. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
05-Jun-98	4	28.0 (82.4)	25.5 (77.9)	31.5 (88.7)	2.9 (9.51)	0.0 (0.00)	8.5 (27.88)	7.11	5.52	8.72
11-Jun-98	8	26.6 (79.9)	24.9 (76.8)	28.5 (83.3)	2.4 (7.87)	0.0 (0.00)	5.0 (16.40)	5.91	4.88	7.64
16-Jun-98	4	27.7 (81.9)	26.6 (79.9)	28.8 (83.8)	2.0 (6.56)	1.0 (3.28)	4.5 (14.76)	4.38	3.48	4.84
26-Jun-98	4	28.1 (82.6)	23.9 (75.0)	31.7 (89.1)	5.3 (17.38)	1.0 (3.28)	9.0 (29.52)	4.50	2.29	7.33
03-Jul-98	6	31.5 (88.7)	29.5 (85.1)	34.6 (94.3)	5.0 (16.40)	0.5 (1.64)	7.5 (24.60)	2.91	1.38	6.29
10-Jul-98	8	33.1 (91.6)	31.6 (88.9)	35.3 (95.5)	2.9 (9.51)	1.5 (4.92)	4.0 (13.12)	3.72	1.89	5.67
14-Jul-98	4	31.9 (89.4)	30.7 (87.3)	32.8 (91.0)	3.8 (12.46)	1.0 (3.28)	5.5 (18.04)	4.25	1.65	9.21
24-Jul-98	3	33.0 (91.4)	32.3 (90.1)	33.9 (93.0)	5.3 (17.38)	3.5 (11.48)	6.5 (21.32)	2.76	1.64	3.76
31-Jul-98	7	31.3 (88.3)	30.8 (87.4)	31.9 (89.4)	2.6 (8.53)	0.5 (1.64)	5.5 (18.04)	6.10	1.22	7.70
08-Aug-98	6	30.7 (87.3)	28.7 (83.7)	32.8 (91.0)	3.6 (11.81)	1.5 (4.92)	8.0 (26.24)	4.17	1.08	6.13
13-Aug-98	6	31.1 (88.0)	28.7 (83.7)	32.9 (91.2)	4.3 (14.10)	2.5 (8.20)	8.0 (26.24)	4.53	3.02	5.23
19-Aug-98	8	31.1 (88.0)	29.0 (84.2)	32.3 (90.1)	5.0 (16.40)	3.0 (9.84)	8.5 (27.88)	4.94	1.63	6.93
28-Aug-98	6	31.7 (89.1)	29.7 (85.5)	32.9 (91.2)	2.8 (9.18)	0.0 (0.00)	8.5 (27.88)	5.74	1.92	7.56

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
02-Jun-99	6	26.4 (79.5)	19.9 (67.8)	29.1 (84.4)	4.4 (14.43)	1.0 (3.28)	9.5 (31.16)	5.58	2.47	7.34
08-Jun-99	10	28.1 (82.6)	24.7 (76.5)	32.7 (90.9)	4.6 (15.09)	0.5 (1.64)	8.0 (26.24)	6.85	3.33	12.52
15-Jun-99	8	28.6 (83.5)	24.7 (76.5)	31.1 (88.0)	3.7 (12.14)	0.0 (0.00)	9.0 (29.52)	6.84	1.52	9.73
23-Jun-99	6	27.3 (81.1)	26.1 (79.0)	28.5 (83.3)	5.1 (16.73)	1.0 (3.28)	7.5 (24.60)	5.38	2.11	8.08
30-Jun-99	5	29.3 (84.7)	28.6 (83.5)	30.0 (86.0)	3.6 (11.81)	0.5 (1.64)	5.5 (18.04)	6.81	4.85	7.98
08-Jul-99	9	31.0 (87.8)	29.5 (85.1)	33.2 (91.8)	5.2 (17.06)	1.5 (4.92)	7.0 (22.96)	5.32	2.89	9.35
16-Jul-99	5	31.9 (89.4)	31.4 (88.5)	32.6 (90.7)	3.9 (12.79)	2.5 (8.20)	5.5 (18.04)	6.45	5.70	7.30
21-Jul-99	7	32.8 (91.0)	31.4 (88.5)	34.1 (93.4)	5.1 (16.73)	4.0 (13.12)	6.0 (19.68)	4.22	2.77	5.30
28-Jul-99	2	35.9 (96.6)	35.5 (95.9)	36.3 (97.3)	4.3 (14.10)	3.5 (11.48)	5.0 (16.40)	3.07	2.68	3.45
06-Aug-99	2	30.5 (86.9)	28.7 (83.7)	32.3 (90.1)	1.5 (4.92)	0.5 (1.64)	2.5 (8.20)	5.93	5.90	5.95
10-Aug-99	6	32.3 (90.1)	31.4 (88.5)	33.1 (91.6)	3.1 (10.17)	1.0 (3.28)	6.5 (21.32)	7.36	5.25	11.58
19-Aug-99	5	31.2 (88.2)	29.8 (85.6)	32.1 (89.8)	3.6 (11.81)	1.0 (3.28)	8.0 (26.24)	5.42	1.10	7.55
27-Aug-99	5	30.9 (87.6)	30.3 (86.5)	31.1 (88.0)	3.7 (12.14)	2.5 (8.20)	5.0 (16.40)	7.00	5.42	8.02

Table 14.16. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Lake of Egypt, Williamson / Johnson Co. Illinois for summer months in 1998 and 1999. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
04-Jun-98	3	27.6 (81.7)	26.9 (80.4)	28.1 (82.6)	2.8 (9.18)	1.0 (3.28)	4.5 (14.76)	6.49	4.60	8.37
12-Jun-98	5	27.4 (81.3)	25.7 (78.3)	28.6 (83.5)	1.7 (5.58)	0.5 (1.64)	3.5 (11.48)	11.12	9.86	12.34
18-Jun-98	1	29.4 (84.9)	--	--	0.0 (0.00)	--	--	6.55	--	--
25-Jun-98	4	31.2 (88.2)	29.5 (85.1)	33.3 (91.9)	1.5 (4.92)	0.0 (0.00)	2.5 (8.20)	6.05	5.34	6.64
02-Jul-98	2	29.7 (85.5)	29.4 (84.9)	30.0 (86.0)	2.8 (9.18)	2.5 (8.20)	3.0 (9.84)	5.31	5.27	5.34
09-Jul-98	6	31.4 (88.5)	30.0 (86.0)	32.7 (90.9)	2.4 (7.87)	0.0 (0.00)	4.5 (14.76)	6.10	3.30	8.00
16-Jul-98	6	29.7 (85.5)	28.3 (82.9)	33.4 (92.1)	1.4 (4.59)	0.0 (0.00)	3.5 (11.48)	6.19	3.33	7.50
23-Jul-98	4	32.0 (89.6)	30.3 (86.5)	33.4 (92.1)	2.5 (8.20)	0.5 (1.64)	3.5 (11.48)	5.92	4.86	7.52
30-Jul-98	8	29.1 (84.4)	28.1 (82.6)	30.7 (87.3)	2.0 (6.56)	1.0 (3.28)	4.0 (13.12)	1.80	1.23	2.15
04-Aug-98	3	29.5 (85.1)	28.6 (83.5)	30.0 (86.0)	1.7 (5.58)	1.0 (3.28)	2.5 (8.20)	6.68	5.60	7.79
10-Aug-98	11	29.4 (84.9)	27.5 (81.5)	31.7 (89.1)	2.0 (6.56)	0.0 (0.00)	4.5 (14.76)	6.14	2.50	8.72
16-Aug-98	8	29.6 (85.3)	28.5 (83.3)	30.8 (87.4)	2.1 (6.89)	0.5 (1.64)	4.0 (13.12)	9.05	5.28	12.04
25-Aug-98	5	30.7 (87.3)	29.8 (85.6)	31.7 (89.1)	1.8 (5.90)	0.5 (1.64)	2.5 (8.20)	2.97	2.19	3.75

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
01-Jun-99	6	26.4 (79.5)	24.5 (76.1)	29.0 (84.2)	1.3 (4.26)	0.0 (0.00)	4.0 (13.12)	6.20	4.54	8.60
06-Jun-99	8	27.1 (80.8)	24.1 (75.4)	30.2 (86.4)	2.7 (8.86)	0.0 (0.00)	5.5 (18.04)	6.77	2.00	10.34
18-Jun-99	6	27.4 (81.3)	25.6 (78.1)	30.9 (87.6)	2.4 (7.87)	0.5 (1.64)	6.0 (19.68)	5.93	4.00	7.90
25-Jun-99	9	27.3 (81.1)	25.6 (78.1)	28.9 (84.0)	2.9 (9.51)	0.0 (0.00)	5.5 (18.04)	6.38	2.01	8.93
28-Jun-99	8	28.3 (82.9)	26.9 (80.4)	30.9 (87.6)	3.0 (9.84)	0.5 (1.64)	4.0 (13.12)	6.41	4.88	7.79
09-Jul-99	7	29.6 (85.3)	27.6 (81.7)	31.0 (87.8)	4.0 (13.1)	1.5 (4.92)	5.5 (18.04)	5.21	3.32	7.98
13-Jul-99	10	28.2 (82.8)	23.0 (73.4)	30.1 (86.2)	3.0 (9.84)	0.5 (1.64)	6.0 (19.68)	6.13	4.43	7.15
22-Jul-99	3	30.3 (86.5)	28.8 (83.8)	32.8 (91.0)	4.0 (13.1)	1.5 (4.92)	5.5 (18.04)	3.51	1.82	6.28
29-Jul-99	6	31.4 (88.5)	29.5 (85.1)	34.1 (93.4)	3.8 (12.4)	1.5 (4.92)	5.5 (18.04)	2.86	0.22	5.75
03-Aug-99	3	32.1 (89.8)	31.4 (88.5)	33.1 (91.6)	2.0 (6.56)	1.5 (4.92)	2.5 (8.20)	3.73	3.24	4.13
12-Aug-99	6	30.3 (86.5)	29.5 (85.1)	31.7 (89.1)	2.9 (9.51)	1.5 (4.92)	5.5 (18.04)	5.00	3.23	6.62
16-Aug-99	6	28.5 (83.3)	26.5 (79.7)	29.3 (84.7)	3.0 (9.84)	1.5 (4.92)	4.5 (14.76)	4.61	4.00	5.75
25-Aug-99	2	28.4 (83.1)	28.3 (82.9)	28.5 (83.3)	2.8 (9.18)	2.5 (8.20)	3.0 (9.84)	4.12	2.67	5.56

Table 14.17. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
Sept	11	27.8 (82.0)	24.8 (76.6)	30.6 (87.1)	2.8 (9.18)	0.5 (1.64)	6.0 (19.68)	5.42	3.10	7.63
Oct	2	21.9 (71.4)	21.3 (70.3)	22.4 (72.3)	1.3 (4.26)	1.0 (3.28)	1.5 (4.92)	8.42	8.39	8.45
Nov	3	15.4 (59.7)	13.1 (55.6)	18.7 (65.7)	3.2 (10.50)	1.5 (4.92)	4.0 (13.12)	10.33	9.74	11.03
Dec	5	8.3 (46.9)	6.9 (44.4)	11.3 (52.3)	3.5 (11.48)	2.0 (6.56)	4.5 (14.76)	9.84	9.60	10.35
Jan	6	7.6 (45.7)	6.7 (44.1)	8.4 (47.1)	2.9 (9.51)	0.0 (0.00)	4.5 (14.76)	10.42	9.55	11.44
Feb	2	10.5 (50.9)	10.5 (50.9)	10.5 (50.9)	1.5 (4.92)	1.5 (4.92)	1.5 (4.92)	10.78	10.60	10.95
Mar	7	16.6 (61.9)	12.0 (53.6)	19.6 (67.3)	1.9 (6.23)	0.5 (1.64)	3.0 (9.84)	12.06	8.65	14.99
Apr	28	18.0 (64.4)	14.1 (57.4)	22.1 (71.8)	1.5 (4.92)	0.0 (0.00)	3.5 (11.48)	10.26	5.06	14.62
May	43	23.6 (74.5)	18.1 (64.6)	29.8 (85.6)	2.7 (8.86)	0.0 (0.00)	7.0 (22.96)	8.33	1.25	14.64
Jun	52	28.2 (82.8)	24.2 (75.6)	34.4 (93.9)	3.7 (12.14)	1.0 (3.28)	6.0 (19.68)	4.58	0.00	12.87
Jul	42	30.8 (87.4)	26.4 (79.5)	35.0 (95.0)	4.1 (13.45)	1.5 (4.92)	6.0 (19.68)	2.37	0.01	8.70
Aug	32	29.9 (85.8)	27.0 (80.6)	32.3 (90.1)	4.8 (15.74)	1.5 (4.92)	7.0 (22.96)	2.72	0.06	7.52

Table 14.18. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
Sept	14	30.2 (86.4)	27.0 (80.6)	32.9 (91.2)	3.9 (12.79)	0.5 (1.64)	9.5 (31.16)	5.48	2.95	7.38
Oct	2	21.6 (70.9)	21.0 (69.8)	22.2 (72.0)	1.3 (4.26)	1.0 (3.28)	1.5 (4.92)	6.76	5.73	7.79
Nov	1	25.2 (77.4)	--	--	1.0 (3.28)	--	--	4.00	--	--
Dec	6	17.3 (63.1)	13.7 (56.7)	23.3 (73.9)	2.2 (7.22)	1.0 (3.28)	4.5 (14.76)	10.09	9.07	10.88
Jan	6	15.6 (60.1)	12.0 (53.6)	17.9 (64.2)	2.0 (6.56)	1.0 (3.28)	5.0 (16.40)	4.40	4.13	4.69
Feb	3	18.7 (65.7)	12.1 (53.8)	22.7 (72.9)	1.2 (3.94)	1.0 (3.28)	1.5 (4.92)	8.22	7.64	9.29
Mar	6	19.8 (67.6)	10.0 (50.0)	23.2 (73.8)	1.3 (4.26)	0.0 (0.00)	2.5 (8.20)	9.33	8.84	11.00
Apr	28	21.8 (71.2)	17.8 (64.0)	28.2 (82.8)	2.6 (8.53)	0.0 (0.00)	8.0 (26.24)	7.77	5.83	9.01
May	25	25.8 (78.4)	19.3 (66.7)	30.2 (86.4)	3.8 (12.46)	0.0 (0.00)	9.0 (29.52)	7.20	3.59	9.51
Jun	34	27.9 (82.2)	19.9 (67.8)	32.7 (90.9)	4.3 (14.10)	0.0 (0.00)	9.5 (31.16)	6.36	1.51	12.52
Jul	23	32.2 (90.0)	29.5 (85.1)	36.3 (97.3)	4.8 (15.74)	1.5 (4.92)	7.0 (22.96)	5.04	2.68	9.35
Aug	18	31.4 (88.5)	28.7 (83.7)	33.1 (91.6)	3.2 (10.50)	0.5 (1.64)	8.0 (26.24)	6.56	1.10	11.58

Table 14.19. Largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where located in Lake of Egypt, Williamson / Johnson Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

Date	Number of locations	Mean temp. C (F)	Min. temp. C (F)	Max. temp. C (F)	Mean depth Meters (Feet)	Min. depth Meters (Feet)	Max. depth Meters (Feet)	Mean DO mg/L	Min. DO mg/L	Max. DO mg/L
Sept	14	28.6 (83.5)	26.6 (79.9)	30.6 (87.1)	1.7 (5.58)	0.0 (0.00)	5.0 (16.40)	4.89	1.50	7.44
Oct	1	19.2 (66.6)	--	--	3.0 (9.84)	--	--	7.90	--	--
Nov	1	15.2 (59.4)	--	--	3.0 (9.84)	--	--	2.27	--	--
Dec	7	16.4 (61.5)	13.2 (55.8)	20.6 (69.1)	2.1 (6.89)	0.5 (1.64)	3.5 (11.48)	7.91	7.24	8.51
Jan	8	7.2 (45.0)	5.4 (41.7)	8.7 (47.7)	1.5 (4.92)	0.0 (0.00)	6.0 (19.68)	5.89	5.69	6.20
Feb	4	11.2 (52.2)	6.8 (44.2)	15.9 (60.6)	0.6 (1.97)	0.5 (1.64)	1.0 (3.28)	11.00	10.32	11.93
Mar	7	10.3 (50.5)	8.5 (47.3)	13.0 (55.4)	1.1 (3.61)	0.0 (0.00)	2.5 (8.20)	4.26	3.43	5.73
Apr	27	17.6 (63.7)	14.3 (57.7)	22.8 (73.0)	1.3 (4.26)	0.0 (0.00)	3.5 (11.48)	9.40	6.64	12.09
May	27	23.3 (73.9)	19.6 (67.3)	25.7 (78.3)	2.3 (7.54)	0.5 (1.64)	5.0 (16.40)	8.50	5.38	11.73
Jun	37	27.3 (81.1)	24.1 (75.4)	30.9 (87.6)	2.5 (8.20)	0.0 (0.00)	6.0 (19.68)	6.37	2.00	10.34
Jul	26	29.6 (85.3)	23.0 (73.4)	34.1 (93.4)	3.6 (11.81)	0.5 (1.64)	6.0 (19.68)	4.82	0.22	7.98
Aug	17	29.7 (85.5)	26.5 (79.7)	33.1 (91.6)	2.8 (9.18)	1.5 (4.92)	5.5 (18.04)	4.53	2.67	6.62

Table 14.20. Observed movements of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Newton Lake, Jasper Co. Illinois.

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
CCAT	275	10	36802.39 (22.87)	3680.24 (2.29)
CCAT	284	8	624.20 (0.39)	78.03 (0.05)
CCAT	293	34	7987.30 (4.96)	234.92 (0.15)
CCAT	335	2	4666.90 (2.90)	2333.45 (1.45)
CCAT	338	1	5841.26 (3.63)	5841.26 (3.63)
CCAT	368	1	415.52 (0.26)	415.52 (0.26)
CCAT	374	3	16788.76 (10.43)	5596.25 (3.48)
CCAT	446	14	12932.20 (8.04)	923.73 (0.57)
CCAT	557	10	2920.22 (1.81)	292.02 (0.18)
CCAT	12-4	4	11887.09 (7.39)	2971.77 (1.85)
CCAT	248	9	922.29 (0.57)	102.48 (0.06)
CCAT	2543	2	11760.26 (7.31)	5880.13 (3.65)
CCAT	3337	1	4884.33 (3.04)	4884.33 (3.04)
CCAT	4444	3	17363.86 (10.79)	5787.95 (3.60)
CCAT	5-8-10	8	18379.68 (11.42)	2297.46 (1.43)
LMB	88	38	28312.57 (17.59)	745.07 (0.46)
LMB	97	31	30230.22 (18.79)	975.17 (0.61)
LMB	13-3	1	121.34 (0.08)	121.34 (0.08)
LMB	14-2	18	17619.71 (10.95)	978.87 (0.61)
LMB	246	6	3972.07 (2.47)	662.01 (0.41)
LMB	249	42	63843.03 (39.67)	1520.07 (0.94)
LMB	257	18	28752.22 (17.87)	1597.35 (0.99)
LMB	258	19	29609.45 (18.40)	1558.39 (0.97)
LMB	285	6	22796.82 (14.17)	3799.47 (2.36)
LMB	356	25	23944.84 (14.88)	957.79 (0.60)
LMB	365	30	26392.22 (16.40)	879.74 (0.55)
LMB	375	1	2027.69 (1.26)	2027.69 (1.26)
LMB	444	20	16981.99 (10.55)	849.10 (0.53)
LMB	447	5	3643.68 (2.26)	728.74 (0.45)

Table 14.20. Continued

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
LMB	555	56	68899.55 (42.81)	1230.35 (0.76)
LMB	689	22	41640.13 (25.88)	1892.73 (1.18)
LMB	12-4	4	1683.95 (1.05)	420.99 (0.26)
LMB	2237	23	15295.27 (9.50)	665.01 (0.41)
LMB	2246	10	579.61 (0.36)	57.96 (0.04)
LMB	2273	23	41664.37 (25.89)	1811.49 (1.13)
LMB	2345	4	2929.51 (1.82)	732.38 (0.46)
LMB	2362	19	16369.60 (10.17)	861.56 (0.54)
LMB	2435	2	2386.50 (1.48)	1193.25 (0.74)
LMB	2482	20	14739.43 (9.16)	736.97 (0.46)
LMB	2524	47	26421.10 (16.42)	562.15 (0.35)
LMB	2533	57	16496.13 (10.25)	289.41 (0.18)
LMB	3334	53	23075.24 (14.34)	435.38 (0.27)
LMB	3335	2	2628.62 (1.63)	1314.31 (0.82)
LMB	3343	25	9407.95 (5.85)	376.32 (0.23)
LMB	3434	1	1591.82 (0.99)	1591.82 (0.99)
LMB	456 (1)	25	31793.18 (19.76)	1271.73 (0.79)
LMB	456 (2)	20	17225.51 (10.70)	861.28 (0.54)
LMB	9-11	19	14950.79 (9.29)	786.88 (0.49)
LMB	2633	8	4400.59 (2.73)	550.07 (0.34)
LMB	6-11-13	26	26933.56 (16.74)	1035.91 (0.64)

Table 14.21. Observed movements of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Coffeen Lake, Montgomery Co. Illinois.

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
CCAT	224	1	177.23 (0.11)	177.23 (0.11)
CCAT	268	1	169.68 (0.11)	169.68 (0.11)
CCAT	347	13	8304.91 (5.16)	638.84 (0.40)
CCAT	455	15	16554.46 (10.29)	1103.63 (0.69)
CCAT	468	10	7011.44 (4.36)	701.14 (0.44)
CCAT	239	2	1713.54 (1.06)	856.77 (0.53)
CCAT	2632	1	1255.16 (0.78)	1255.16 (0.78)
CCAT	3343	1	235.94 (0.15)	235.94 (0.15)
CCAT	379	23	11101.31 (6.90)	482.67 (0.30)
CCAT	568	1	220.96 (0.14)	220.96 (0.14)
CCAT	7777	12	754.55 (0.47)	62.88 (0.04)
CCAT	5-12-14	2	3572.64 (2.22)	1786.32 (1.11)
LMB	11-5	33	26858.89 (16.69)	813.91 (0.51)
LMB	246	2	2918.45 (1.81)	1459.23 (0.91)
LMB	266	6	6634.16 (4.12)	1105.69 (0.69)
LMB	267	46	39186.58 (24.35)	851.88 (0.53)
LMB	339	35	11601.36 (7.21)	331.47 (0.21)
LMB	348	37	13158.89 (8.18)	355.65 (0.22)
LMB	384	17	4960.32 (3.08)	291.78 (0.18)
LMB	557	19	7285.62 (4.53)	383.45 (0.24)
LMB	2227	21	23402.83 (14.54)	1114.42 (0.69)
LMB	2228	39	34125.72 (21.21)	875.02 (0.54)
LMB	2246	14	5207.03 (3.24)	371.93 (0.23)
LMB	2327	15	17980.26 (11.17)	1198.68 (0.74)
LMB	2335	14	11198.84 (6.96)	799.92 (0.50)
LMB	2336	32	32034.81 (19.91)	1001.09 (0.62)
LMB	2353	34	36928.88 (22.95)	1086.14 (0.67)
LMB	239	24	30808.78 (19.14)	1283.70 (0.80)
LMB	2425	49	27609.15 (17.16)	563.45 (0.35)

Table 14.21. Continued

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
LMB	2426	30	36595.23 (22.74)	1219.84 (0.76)
LMB	2435	8	28077.47 (17.45)	3509.68 (2.18)
LMB	2444	49	52364.98 (32.54)	1068.67 (0.66)
LMB	2534	13	6284.04 (3.90)	483.39 (0.30)
LMB	2542	10	2311.55 (1.44)	231.16 (0.14)
LMB	3335	4	254.89 (0.16)	63.72 (0.04)
LMB	3434	24	31537.05 (19.60)	1314.04 (0.82)
LMB	379	13	8278.19 (5.14)	636.78 (0.40)
LMB	4444	9	7594.84 (4.72)	843.87 (0.52)
LMB	568	25	24899.64 (15.47)	995.99 (0.62)
LMB	2363 (1)	42	18741.79 (11.65)	446.23 (0.28)
LMB	2363 (2)	12	941.74 (0.59)	78.48 (0.05)
LMB	6-11-13	2	697.05 (0.43)	348.53 (0.22)
LMB	6-12-14	23	6131.34 (3.81)	266.58 (0.17)

Table 14.22. Observed movements of sonic transmitter implanted largemouth bass (LMB) and channel catfish (CCAT) in Lake of Egypt, Williamson / Johnson Co. Illinois.

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
CCAT	14-2	1	98.42 (0.06)	98.42 (0.06)
CCAT	235	21	9584.94 (5.96)	456.43 (0.28)
CCAT	266	15	965.62 (0.60)	64.37 (0.04)
CCAT	346	9	531.77 (0.33)	59.09 (0.04)
CCAT	356	22	4569.55 (2.84)	207.71 (0.13)
CCAT	457	4	1359.70 (0.84)	339.93 (0.21)
CCAT	479	15	4269.90 (2.65)	284.66 (0.18)
CCAT	689	23	2827.98 (1.76)	122.96 (0.08)
CCAT	2222	11	1461.71 (0.9)1	132.88 (0.08)
CCAT	2227	8	502.05 (0.31)	62.76 (0.04)
CCAT	2237	8	1068.76 (0.66)	133.60 (0.08)
CCAT	2344	28	8664.01 (5.38)	309.43 (0.19)
CCAT	2263	9	4835.99 (3.01)	537.33 (0.33)
CCAT	2534	10	521.58 (0.32)	52.16 (0.03)
LMB	2273	1	88.31 (0.05)	88.31 (0.05)
LMB	2525	1	171.86 (0.11)	171.86 (0.11)
LMB	2452	2	3807.81 (2.37)	1903.91 (1.18)
LMB	275	2	325.37 (0.20)	162.69 (0.10)
LMB	2534 (1)	3	647.71 (0.40)	215.90 (0.13)
LMB	347	3	542.41 (0.34)	180.80 (0.11)
LMB	455 (1)	3	505.19 (0.31)	168.40 (0.10)
LMB	2543	9	1388.37 (0.86)	154.26 (0.10)
LMB	2327	10	2873.52 (1.79)	287.35 (0.18)
LMB	224	13	4428.27 (2.75)	340.64 (0.21)
LMB	294	13	3799.81 (2.36)	292.29 (0.18)
LMB	2434	14	3585.23 (2.23)	256.09 (0.16)
LMB	2443	14	1156.50 (0.72)	82.61 (0.05)
LMB	2534 (2)	14	2225.01 (1.38)	158.93 (0.10)
LMB	2264	16	6620.41 (4.11)	413.78 (0.26)

Table 14.22. Continued

Species	Transmitter sequence	Number of locations	Total movement meters (miles)	Average movement meters (miles)
LMB	455 (2)	21	2089.06 (1.30)	99.48 (0.06)
LMB	3335	23	4952.34 (3.08)	215.32 (0.13)
LMB	2246	24	7120.27 (4.42)	296.68 (0.18)
LMB	338	25	6900.51 (4.29)	276.02 (0.17)
LMB	375	26	7120.81 (4.42)	273.88 (0.17)
LMB	2263	32	2857.76 (1.78)	89.31 (0.06)
LMB	2326	35	8931.27 (5.55)	255.18 (0.16)
LMB	465	35	5039.96 (3.13)	144.00 (0.09)
LMB	3344	36	7712.99 (4.79)	214.25 (0.13)
LMB	366	36	9020.57 (5.61)	250.57 (0.16)
LMB	2453	44	4529.46 (2.81)	102.94 (0.06)
LMB	357	48	15795.67 (9.82)	329.08 (0.20)
LMB	10-6	51	11757.64 (7.31)	230.54 (0.14)
LMB	2255	53	9788.20 (6.08)	184.68 (0.11)
LMB	276	57	10351.35 (6.43)	181.60 (0.11)

Table 14.23. Classification of 24-hour diel movements of largemouth bass (LMB) and channel catfish (CCAT) in three Illinois power cooling reservoirs.

Lake (species)	Number of fish observed	0.0-0.5 miles %	0.5-1.0 miles %	1.0-2.0 miles %	2.0-3.0 miles %	> 3 miles %
Newton (LMB)	35	22.9	28.6	37.1	8.6	2.9
Coffeen (LMB)	33	33.3	45.5	12.1	3.0	6.1
Lake of Egypt (LMB)	30	50.0	46.7	3.3	--	--
Newton (CCAT)	1	--	--	--	--	100.0
Coffeen (CCAT)	4	50.0	--	25.0	--	25.0
Lake of Egypt (CCAT)	6	50.0	16.7	33.3	--	--

Table 14.24. Total observed 24-hour diel movement of largemouth bass (LMB) and channel catfish (CCAT) in Newton Lake, Jasper Co. Illinois, as described by ultrasonic telemetry.

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
26-27 May-98	5-8-10	CCAT	7	11762.22 (7.31)
26-27 May-98	2633	LMB	8	415.22 (0.26)
26-27 May-98	555	LMB	8	1238.03 (0.77)
9-10 Jun-98	2524	LMB	9	561.35 (0.35)
9-10 Jun-98	97	LMB	9	1485.27 (0.92)
12-13 Aug-98	555	LMB	9	2537.00 (1.58)
12-13 Aug-98	97	LMB	9	2931.76 (1.82)
12-13 Aug-98	2533	LMB	9	3502.82 (2.18)
18-19 Aug-98	3334	LMB	9	1800.22 (1.12)
18-19 Aug-98	555	LMB	9	2395.06 (1.49)
18-19 Aug-98	2533	LMB	9	2576.51 (1.60)
18-19 Aug-98	456	LMB	9	2699.31 (1.68)
10-11 Jan-99	12-4	LMB	9	638.59 (0.40)
10-11 Jan-99	2533	LMB	9	838.22 (0.52)
10-11 Jan-99	6-11-13	LMB	9	1088.53 (0.68)
10-11 Jan-99	356	LMB	9	3179.19 (1.98)
15-16 Jan-99	365	LMB	9	540.19 (0.34)
15-16 Jan-99	689	LMB	9	575.20 (0.36)
15-16 Jan-99	456	LMB	9	947.64 (0.59)
15-16 Jan-99	555	LMB	9	1082.63 (0.67)
3-4 Jun-99	2237	LMB	9	481.81 (0.30)
3-4 Jun-99	2533	LMB	9	561.67 (0.35)
3-4 Jun-99	555	LMB	9	1581.22 (0.98)
3-4 Jun-99	356	LMB	9	3412.06 (2.12)
14-15 Jun-99	3343	LMB	9	537.93 (0.33)
14-15 Jun-99	2362	LMB	9	1862.08 (1.16)
14-15 Jun-99	456	LMB	6	2009.85 (1.25)
14-15 Jun-99	444	LMB	9	2357.20 (1.46)

Table 14.24. Continued

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
9-10 Aug-99	9-11	LMB	9	1302.94 (0.81)
9-10 Aug-99	2362	LMB	9	2471.85 (1.54)
9-10 Aug-99	555	LMB	8	4370.76 (2.72)
9-10 Aug-99	2273	LMB	9	5558.03 (3.45)
17-18 Aug-99	2533	LMB	9	1294.70 (0.80)
17-18 Aug-99	14-2	LMB	9	1306.82 (0.81)
17-18 Aug-99	257	LMB	7	1802.49 (1.12)
17-18 Aug-99	444	LMB	9	2117.11 (1.32)

Table 14.25. Total observed 24-hour diel movement of largemouth bass (LMB) and channel catfish (CCAT) in Coffeen Lake, Montgomery Co. Illinois, as described by ultrasonic telemetry.

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
28-29 May-98	379	CCAT	9	5054.25 (3.14)
11-12 Jun-98	468	CCAT	9	1813.56 (1.13)
13-14 Aug-98	379	CCAT	9	600.08 (0.37)
19-20 Aug-98	379	CCAT	9	543.64 (0.34)
28-29 May-98	348	LMB	8	273.28 (0.17)
28-29 May-98	2444	LMB	9	1881.08 (1.17)
11-12 Jun-98	267	LMB	8	1010.06 (0.63)
11-12 Jun-98	2363	LMB	9	1347.68 (0.84)
13-14 Aug-98	339	LMB	9	1063.35 (0.66)
13-14 Aug-98	2426	LMB	9	4850.67 (3.01)
13-14 Aug-98	2444	LMB	9	4587.32 (2.85)
19-20 Aug-98	11-5	LMB	9	1022.97 (0.64)
19-20 Aug-98	6-12-14	LMB	9	559.00 (0.35)
11-12 Jan-99	246	LMB	9	708.79 (0.44)
11-12 Jan-99	267	LMB	9	1553.13 (0.97)
11-12 Jan-99	348	LMB	9	585.42 (0.36)
11-12 Jan-99	557	LMB	9	1357.70 (0.84)
16-17 Jan-99	267	LMB	9	2054.64 (1.28)
16-17 Jan-99	557	LMB	9	894.26 (0.56)
16-17 Jan-99	2353	LMB	9	316.98 (0.20)
16-17 Jan-99	2363	LMB	9	802.56 (0.50)
2-3 Jun-99	267	LMB	9	995.88 (0.62)
2-3 Jun-99	379	LMB	9	874.65 (0.54)
2-3 Jun-99	2227	LMB	9	1135.00 (0.71)
2-3 Jun-99	2534	LMB	9	605.23 (0.38)
15-16 Jun-99	557	LMB	9	1000.34 (0.62)
15-16 Jun-99	2335	LMB	9	825.29 (0.51)
15-16 Jun-99	2363	LMB	9	602.79 (0.37)

Table 14.25. Continued

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
15-16 Jun-99	2444	LMB	9	1423.91 (0.88)
10-11 Aug-99	568	LMB	7	4843.40 (3.01)
10-11 Aug-99	2335	LMB	9	2514.83 (1.56)
10-11 Aug-99	2363	LMB	9	623.53 (0.39)
10-11 Aug-99	2534	LMB	9	341.09 (0.21)
19-20 Aug-99	239	LMB	9	1120.21 (0.70)
19-20 Aug-99	379	LMB	9	906.98 (0.56)
19-20 Aug-99	2353	LMB	9	2148.58 (1.34)
19-20 Aug-99	3434	LMB	9	766.25 (0.48)

Table 14.26. Total observed 24-hour diel movement of largemouth bass (LMB) and channel catfish (CCAT) in Lake of Egypt, Williamson / Johnson Co. Illinois, as described by ultrasonic telemetry.

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
19-20 May-98	2222	CCAT	9	1803.96 (1.12)
19-20 May-98	2263	CCAT	9	1660.31 (1.03)
7-8 Jun-98	2222	CCAT	9	335.89 (0.21)
7-8 Jun-98	235	CCAT	9	709.09 (0.44)
7-8 Jun-98	479	CCAT	9	516.78 (0.32)
16-17 Aug-98	2344	CCAT	6	1152.43 (0.72)
19-20 May-98	10-6	LMB	9	421.35 (0.26)
19-20 May-98	3344	LMB	9	464.27 (0.29)
7-8 Jun-98	366	LMB	9	947.42 (0.59)
10-11 Aug-98	2326	LMB	9	580.83 (0.36)
10-11 Aug-98	2543	LMB	9	967.99 (0.60)
16-17 Aug-98	2263	LMB	9	748.10 (0.46)
16-17 Aug-98	357	LMB	9	873.06 (0.54)
16-17 Aug-98	465	LMB	9	1356.90 (0.84)
7-8 Jan-99	2246	LMB	9	953.16 (0.59)
7-8 Jan-99	2255	LMB	9	727.73 (0.45)
7-8 Jan-99	2534	LMB	9	573.99 (0.36)
7-8 Jan-99	366	LMB	9	488.92 (0.30)
13-14 Jan-99	2246	LMB	9	904.83 (0.56)
13-14 Jan-99	2326	LMB	9	605.75 (0.38)
13-14 Jan-99	275	LMB	9	512.40 (0.32)
13-14 Jan-99	3335	LMB	9	954.78 (0.59)
6-7 Jun-99	224	LMB	8	425.08 (0.26)
6-7 Jun-99	2255	LMB	9	949.50 (0.59)
6-7 Jun-99	276	LMB	9	514.95 (0.32)
6-7 Jun-99	357	LMB	9	938.77 (0.58)
18-19 Jun-99	10-6	LMB	9	551.06 (0.34)

Table 14.26. Continued

Date	Transmitter number	Species	Observations	Total observed distance meters (miles)
18-19 Jun-99	2246	LMB	9	1065.05 (0.66)
18-19 Jun-99	2326	LMB	9	443.14 (0.28)
18-19 Jun-99	375	LMB	9	2203.03 (1.37)
12-13 Aug-99	10-6	LMB	9	752.67 (0.47)
12-13 Aug-99	2255	LMB	9	704.95 (0.44)
12-13 Aug-99	2326	LMB	9	1217.33 (0.76)
16-17 Aug-99	276	LMB	9	865.21 (0.54)
16-17 Aug-99	338	LMB	9	1461.24 (0.91)
16-17 Aug-99	375	LMB	9	1555.24 (0.97)

Table 14.27. Comparison of mean movements between contacts for largemouth bass in three Illinois power cooling reservoirs as described by ultrasonic telemetry with observed movements of largemouth bass in Lake Sangchris and Lake Shelbyville as described by radio telemetry (Tranquilli 1981).

Lake Sites	Average movement [a] meters (miles)	Standard deviation meters (miles)	Minimum average movements [b] meters (miles)	Maximum average movements [b] meters (miles)
Heated zone: Sangchris	561 (0.35)	336 (0.21)	259 (0.16)	1507 (0.94)
Transition zone: Sangchris	269 (0.17)	149 (0.09)	93 (0.06)	626 (0.39)
Unheated zone: Sangchris	291 (0.18)	195 (0.12)	31 (0.02)	694 (0.43)
Shelbyville	387 (0.24)	307 (0.19)	28 (0.02)	1440 (0.89)
Newton	1031 (0.64)	688 (0.43)	58 (0.04)	3799 (2.36)
Coffeen	819 (0.51)	639 (0.40)	64 (0.04)	3510 (2.18)
Egypt	267 (0.17)	320 (0.20)	83 (0.05)	1904 (1.18)

[a] This is the average of the averages. Total movement for each individual was divided by the number of contacts to yield mean individual movements.
These values for individuals were summed and the means were used to yield the Average Movement

[b] These are the average minimum and maximum observed movements of individual fish throughout the studies.

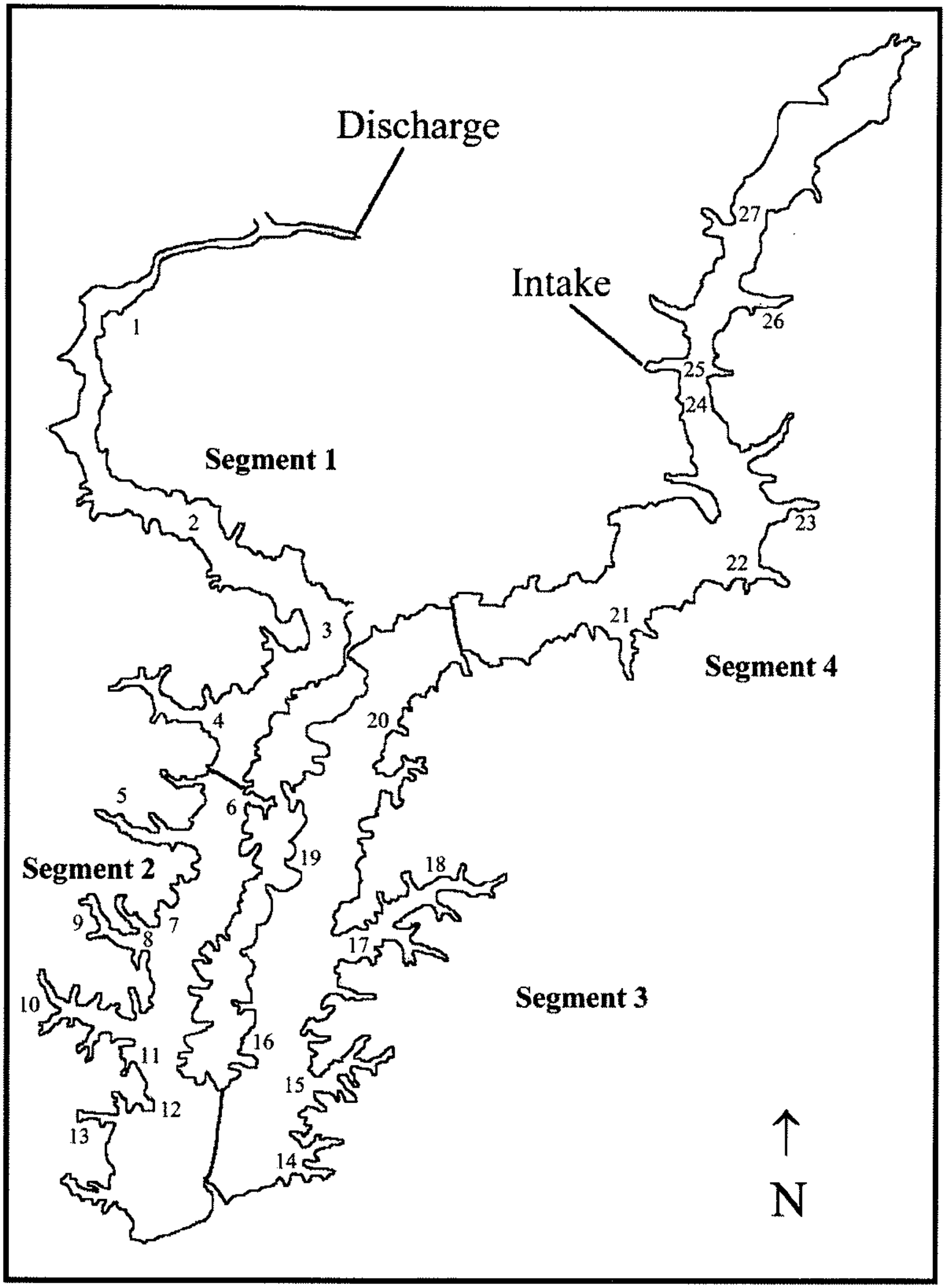

Figure 14.1. Initial release sites for largemouth bass and channel catfish surgically implanted with ultrasonic transmitters in Newton Lake, Jasper Co., Illinois.

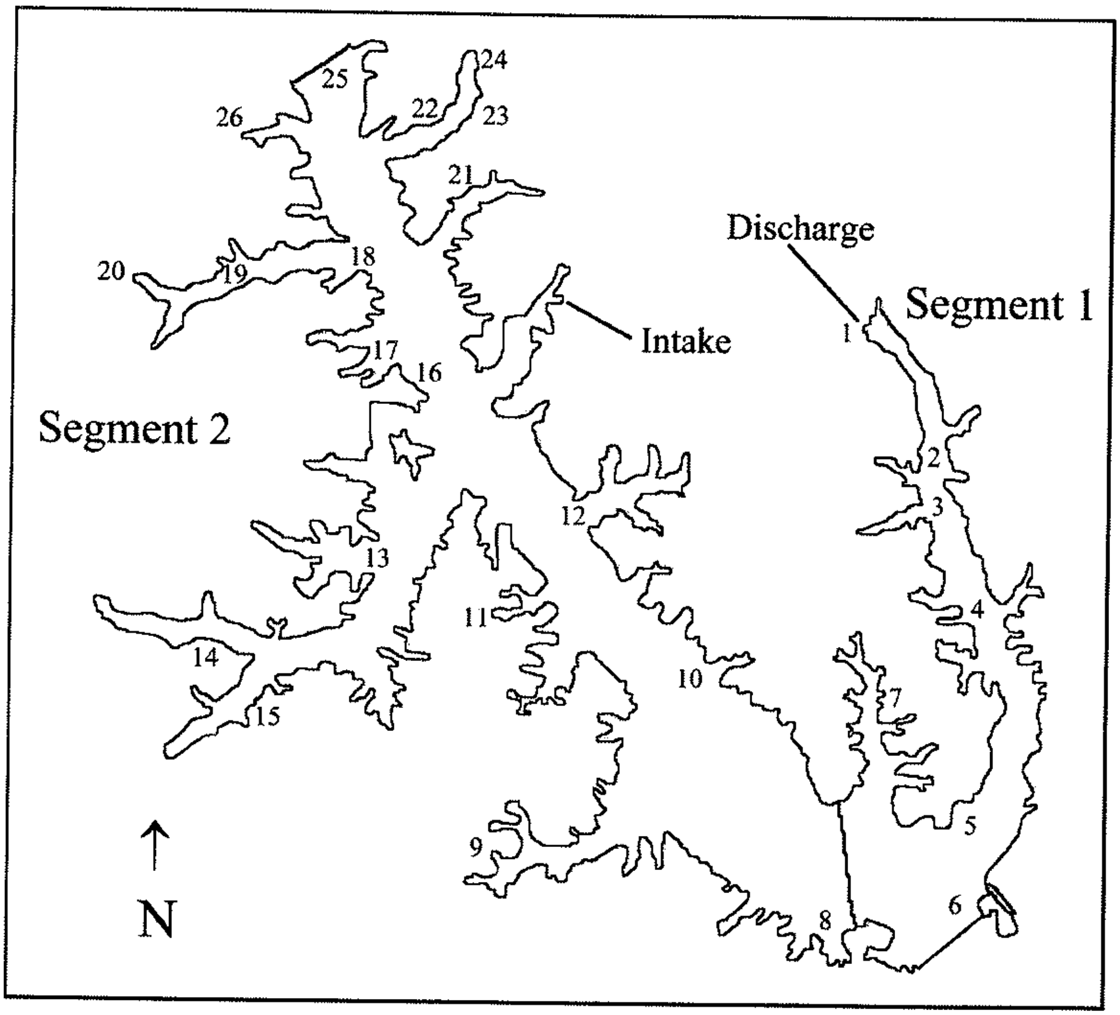

Figure 14.2. Initial release sites for largemouth bass and channel catfish surgically implanted with ultrasonic transmitters in Coffeen Lake, Montgomery Co., Illinois.

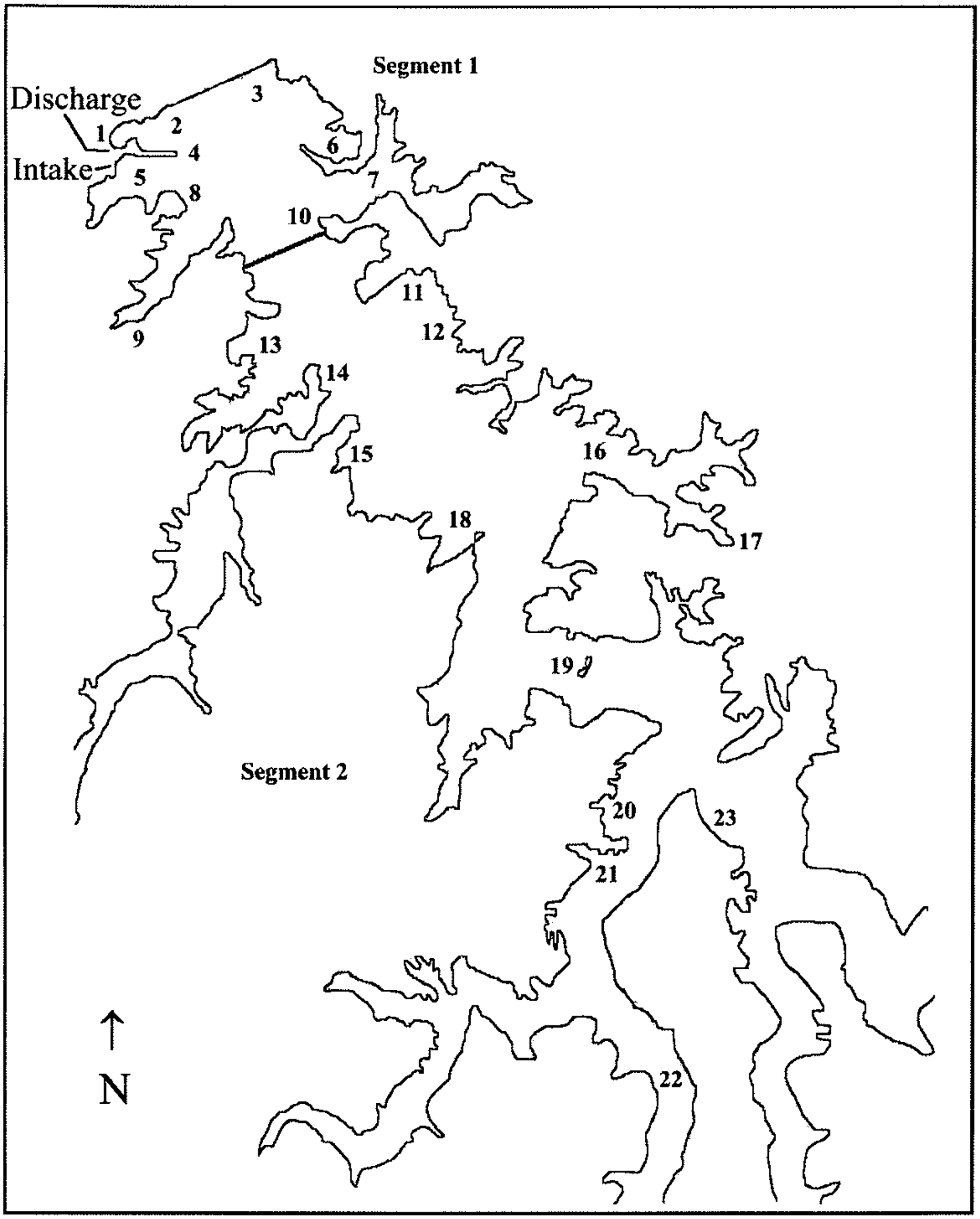

Figure 14.3. Initial release sites for largemouth bass and channel catfish surgically implanted with ultrasonic transmitters in Lake of Egypt, Williamson / Johnson Co., Illinois.

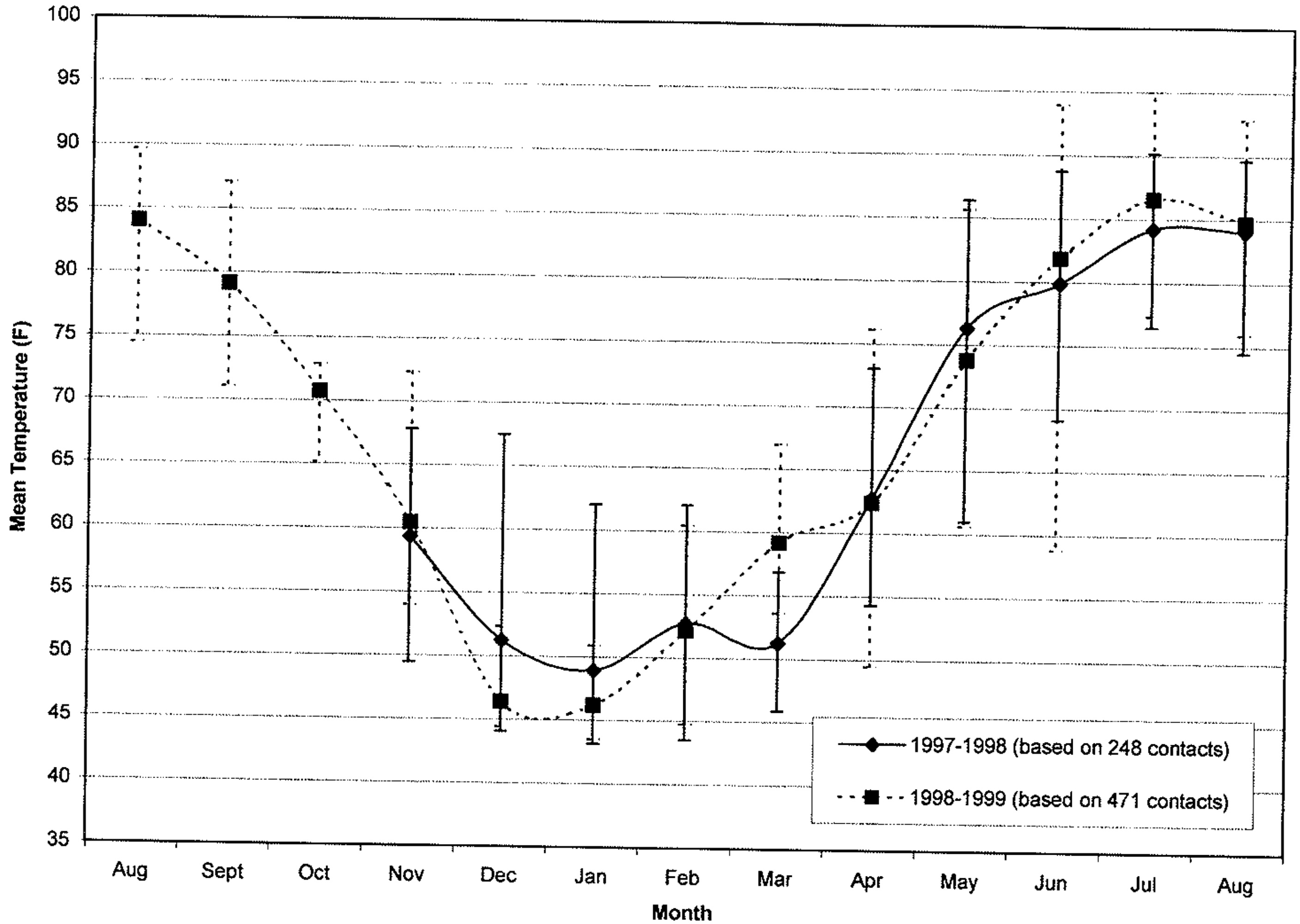

Figure 14.4. Largemouth bass mean temperature preference in Newton Lake, Jasper Co. Illinois, as determined by temperature sensitive ultrasonic transmitters. (Bars represent the range)

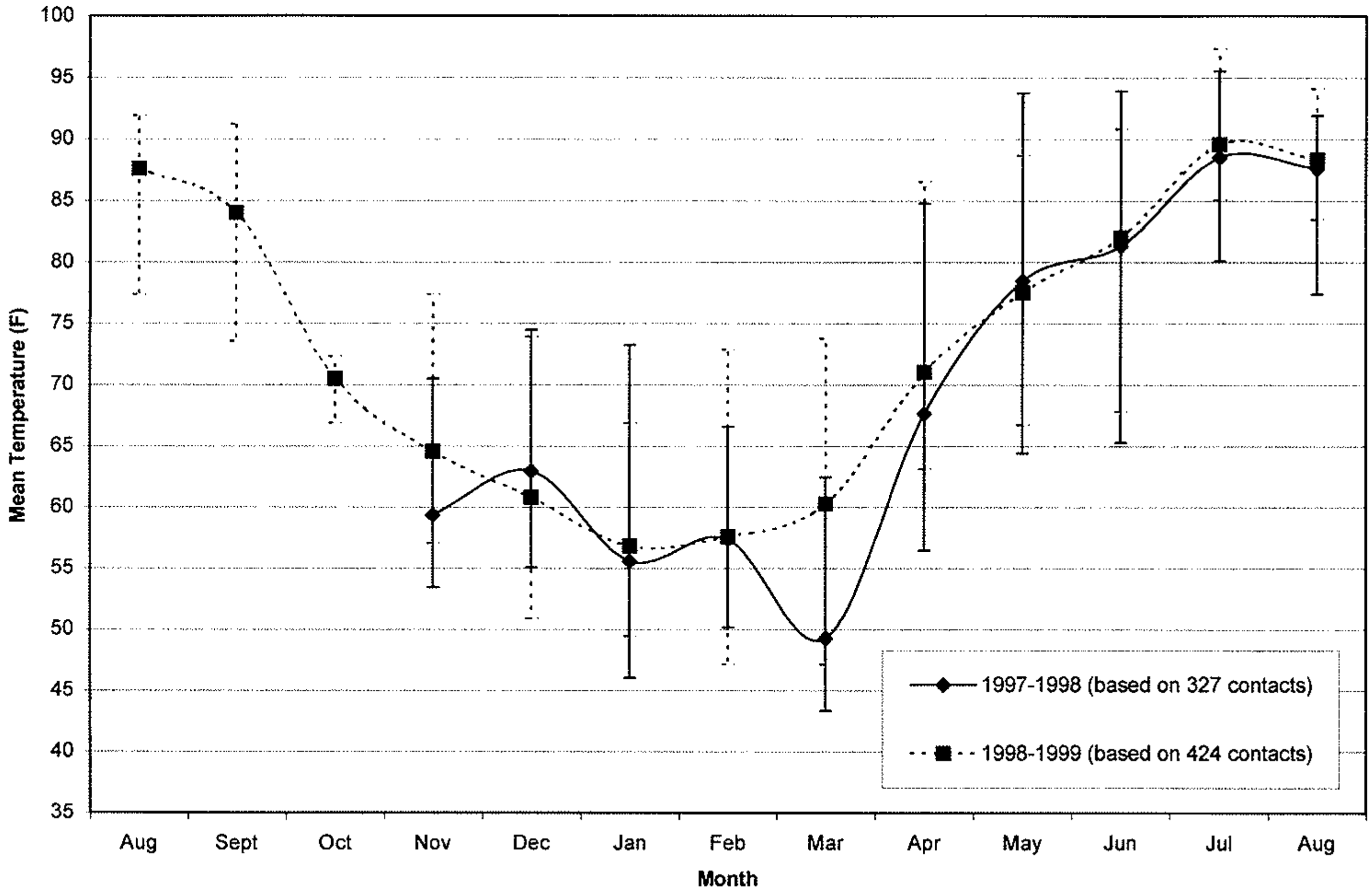

Figure 14.5. Largemouth bass mean temperature preference in Coffeen Lake, Montgomery Co. Illinois, as determined by temperature sensitive ultrasonic transmitters. (Bars represent the range)

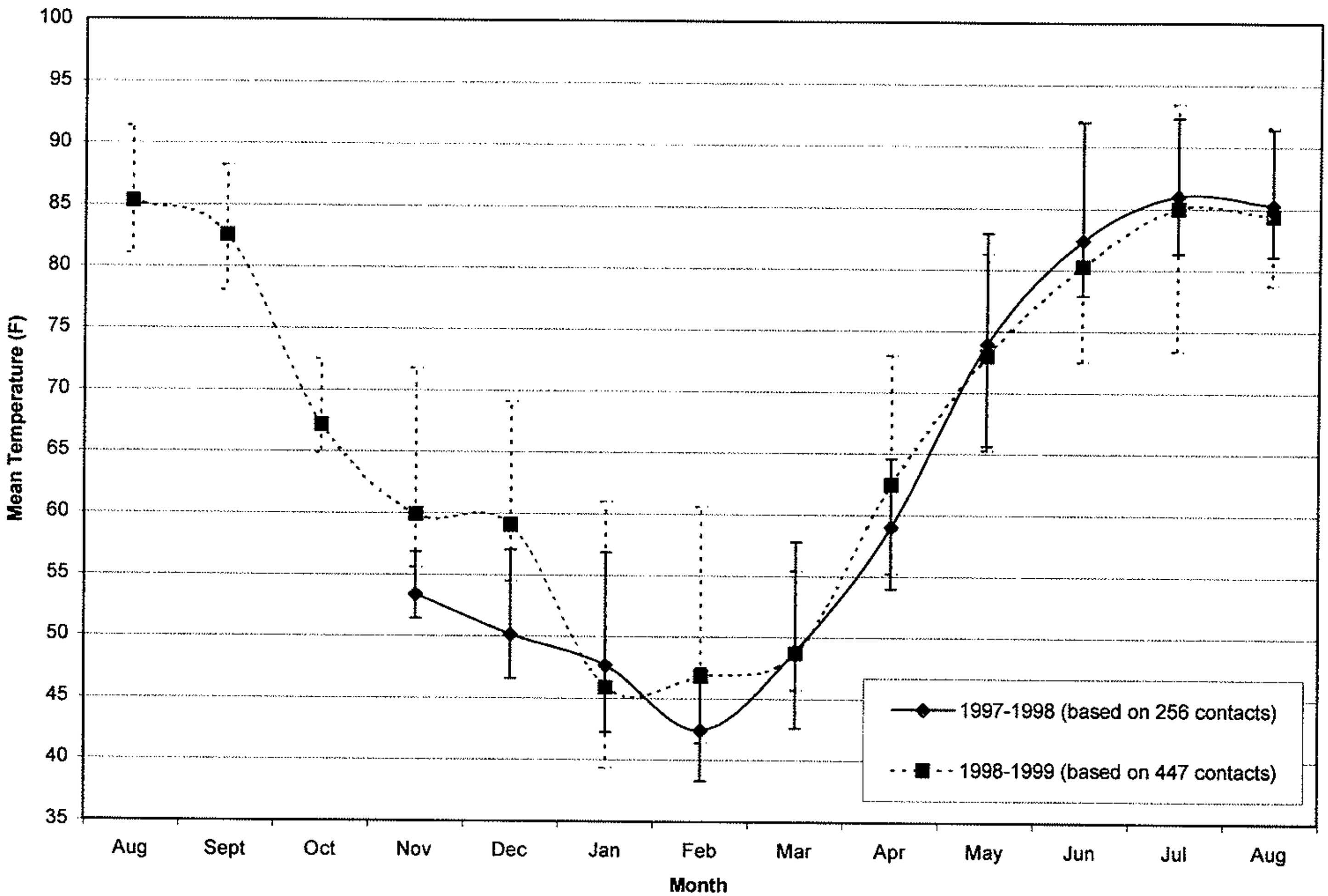

Figure 14.6. Largemouth bass mean temperature preference in Lake of Egypt, Williamson / Johnson Co. Illinois, as determined by temperature sensitive ultrasonic transmitters. (Bars represent the range)

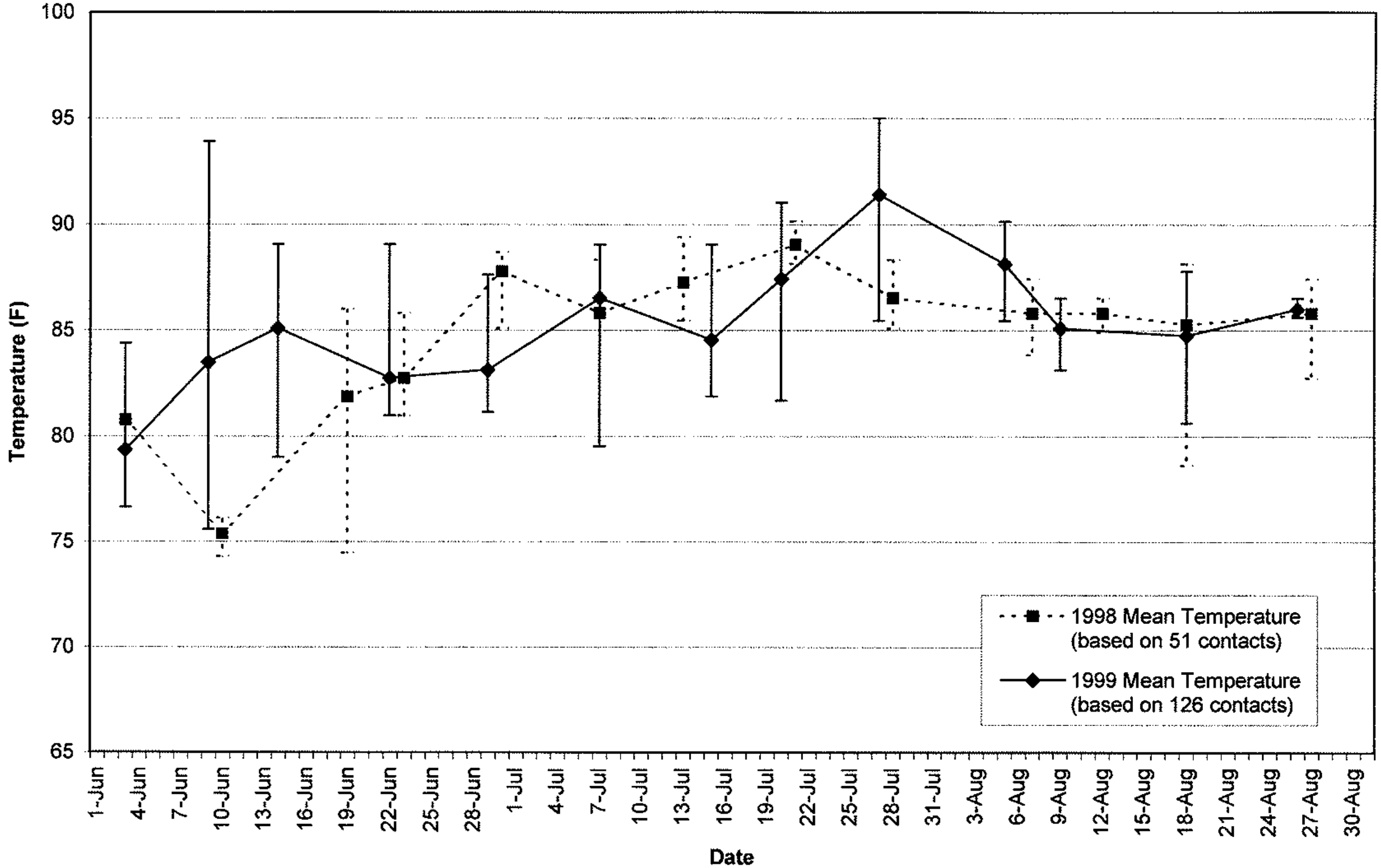

Figure 14.7. Internal body temperatures of largemouth bass in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

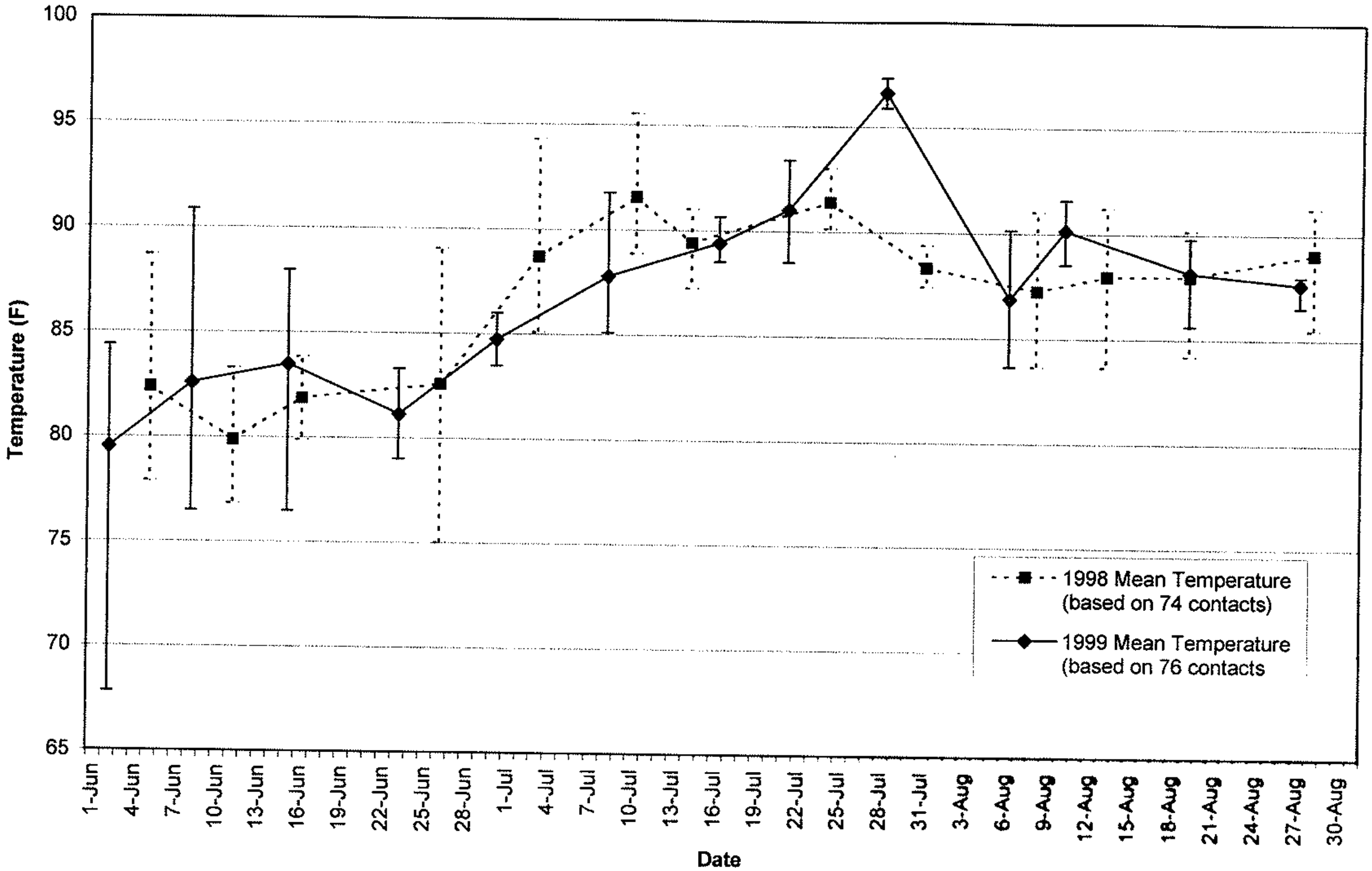

Figure 14.8. Internal body temperatures of largemouth bass in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

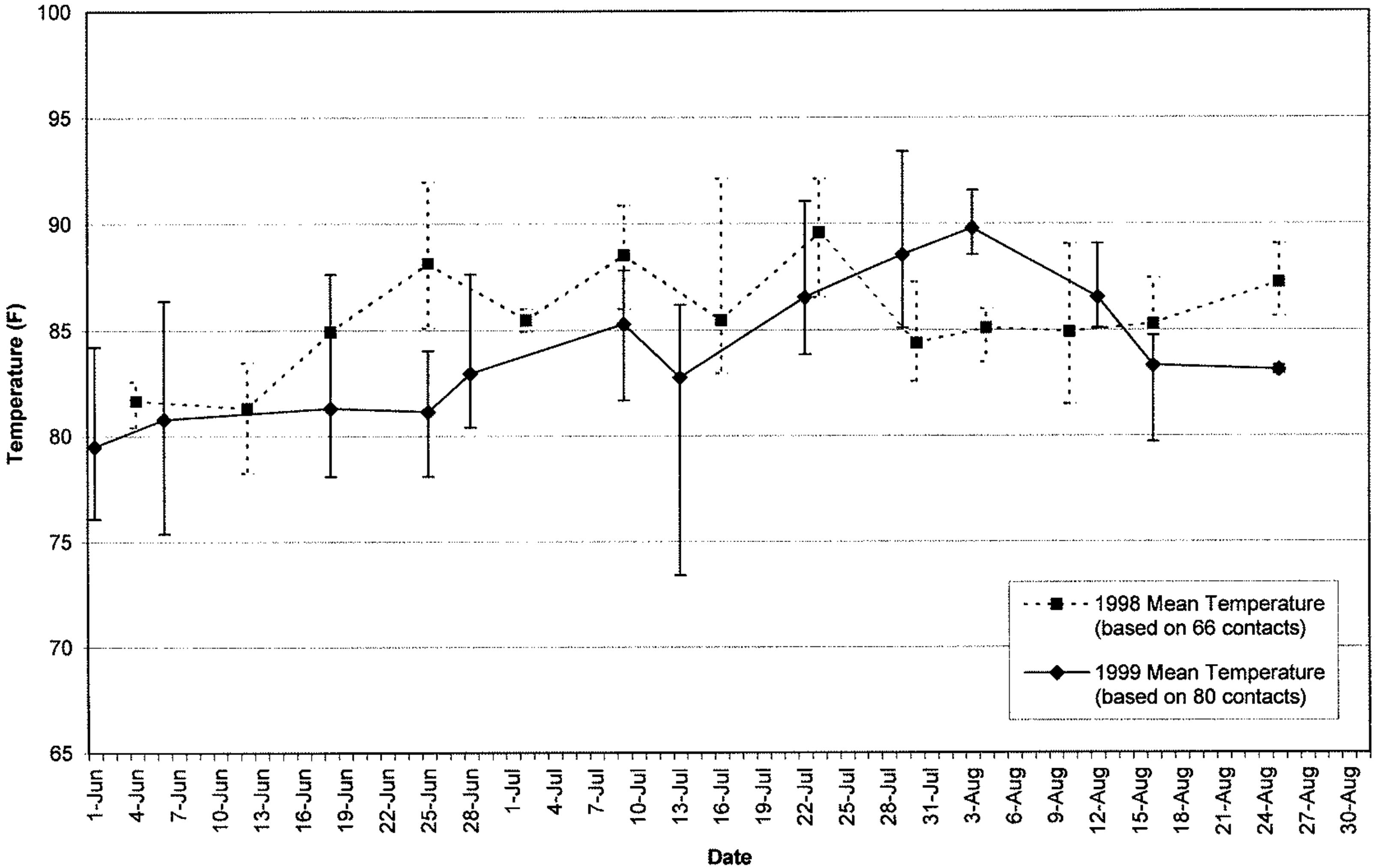

Figure 14.9. Internal body temperatures of largemouth bass in Lake of Egypt, Williamson / Johnson Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

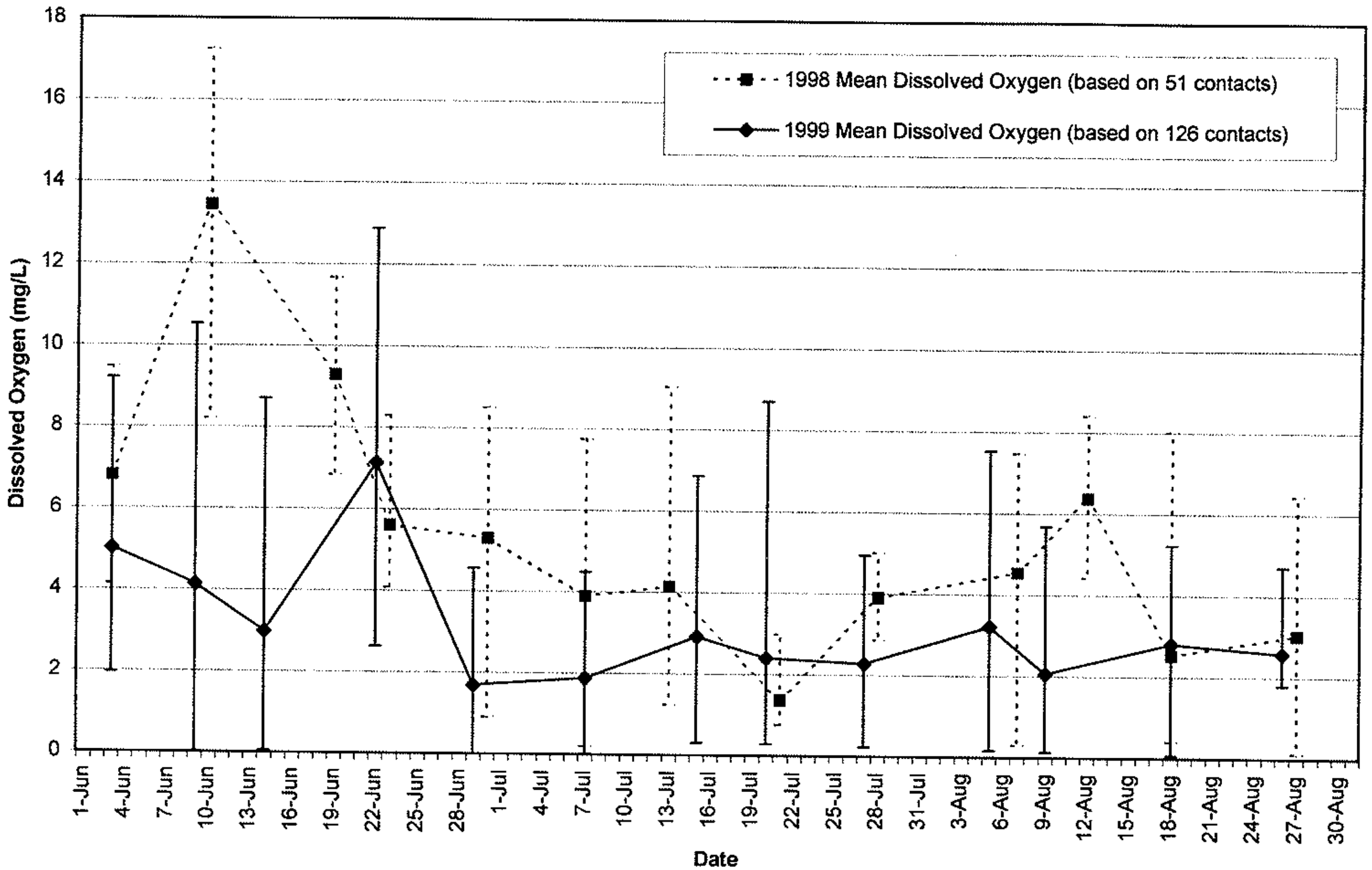

Figure 14.10. Dissolved oxygen levels at the depth where largemouth bass where located in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

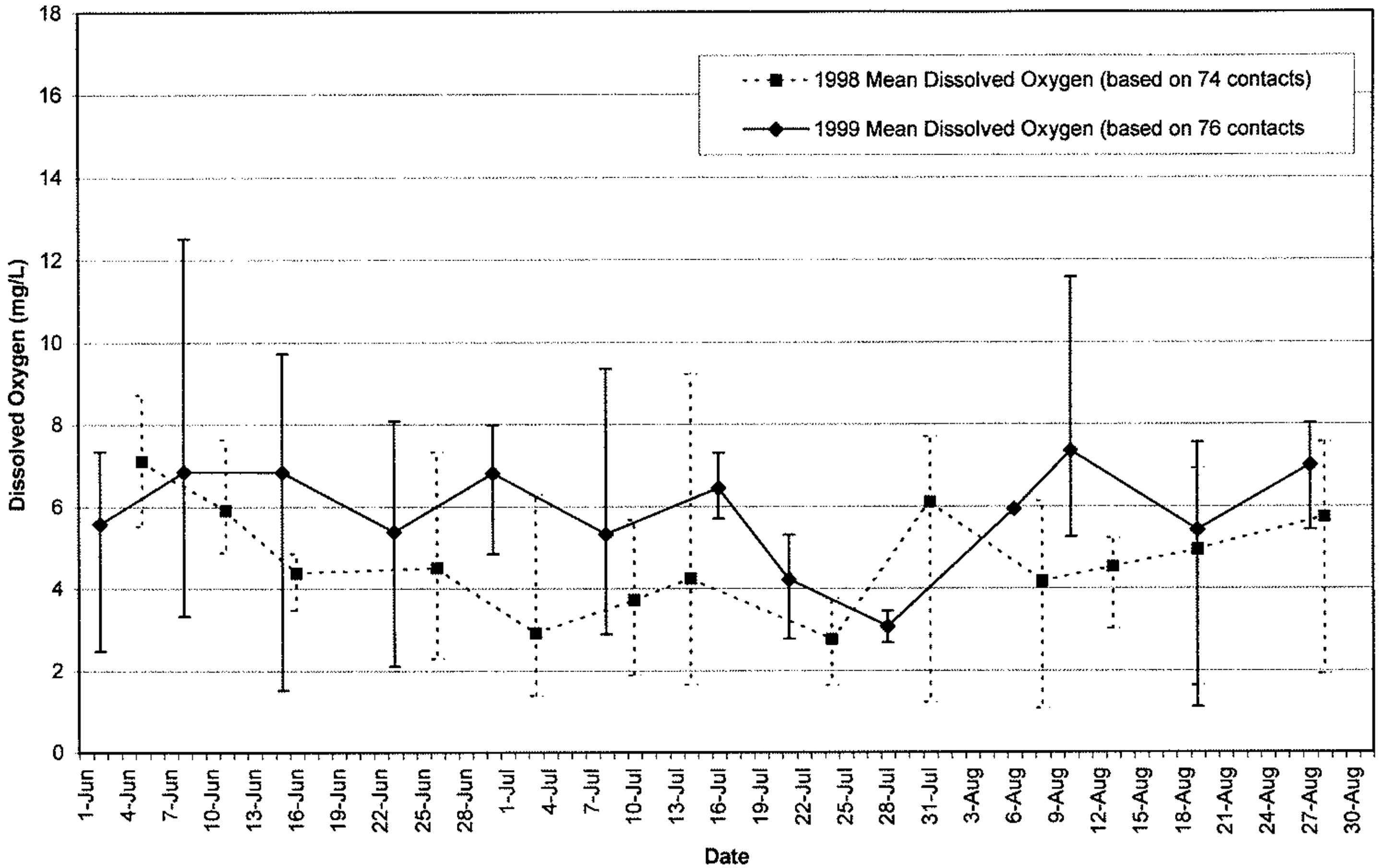

Figure 14.11. Dissolved oxygen levels at the depth where largemouth bass where located in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

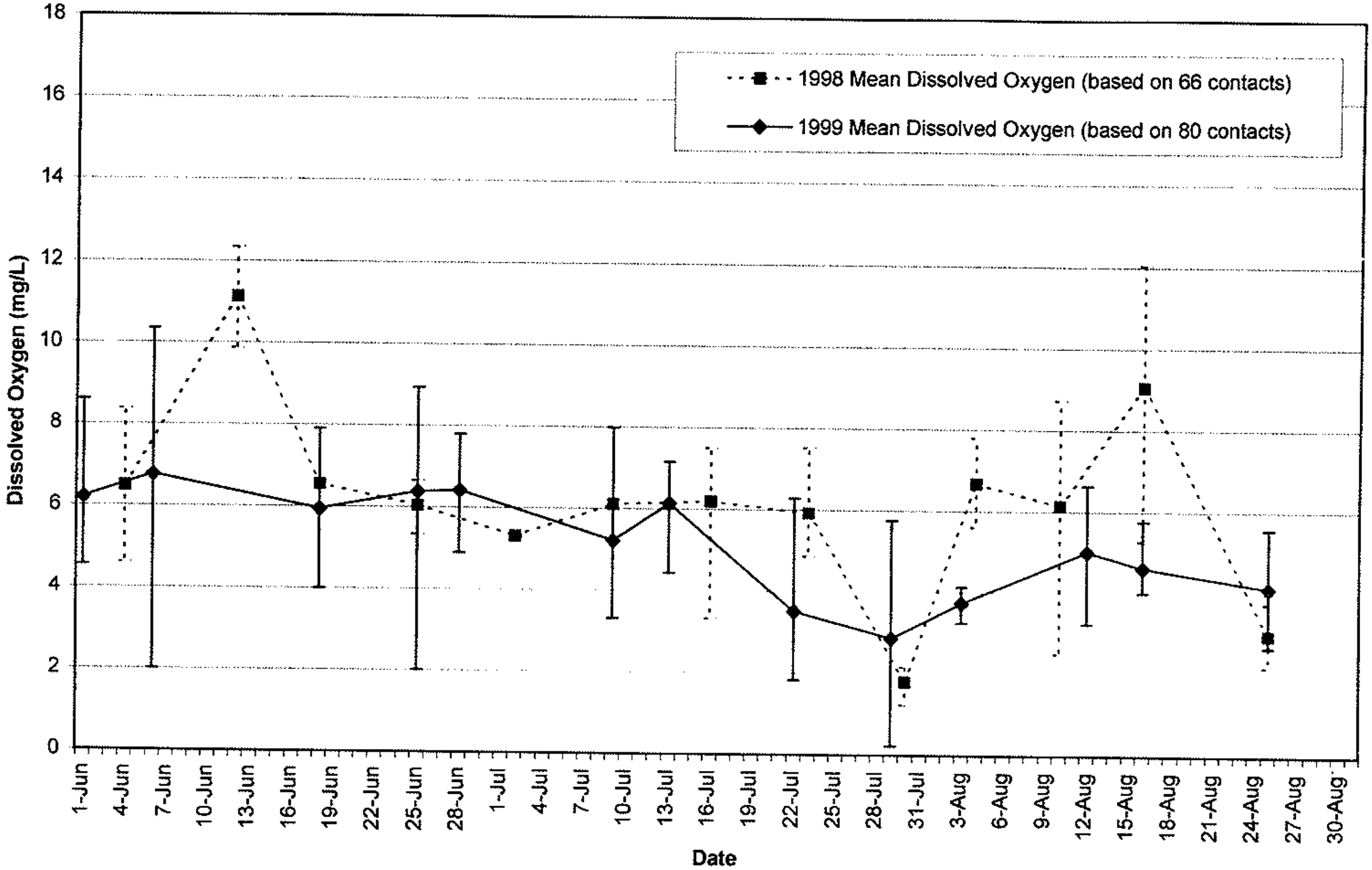

Figure 14.12. Dissolved oxygen levels at the depth where largemouth bass where located in Lake of Egypt, Williamson / Johnson Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish. The bars represent ranges.

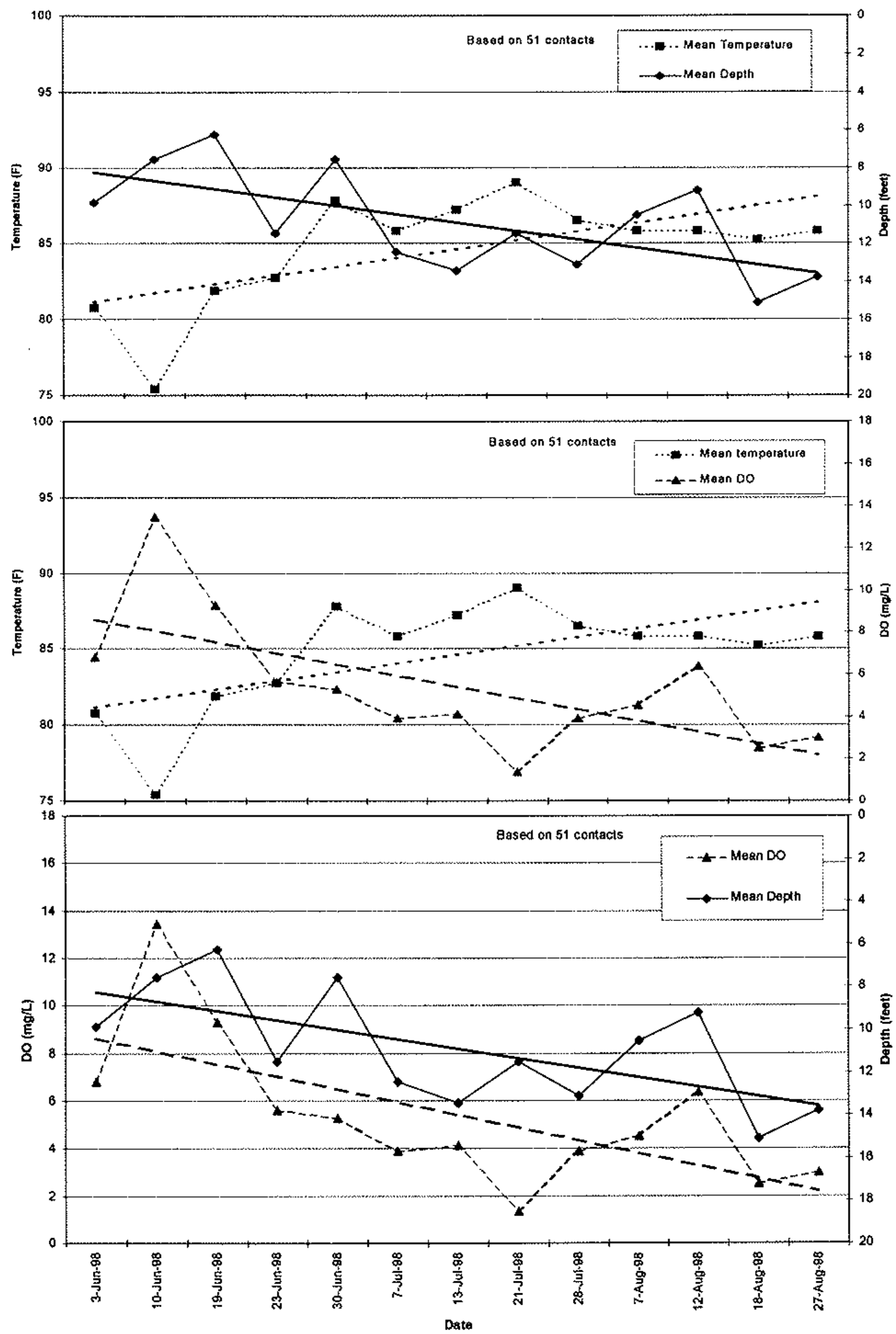

Figure 14.13. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1998 summer sampling dates in Newton Lake, Jasper Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

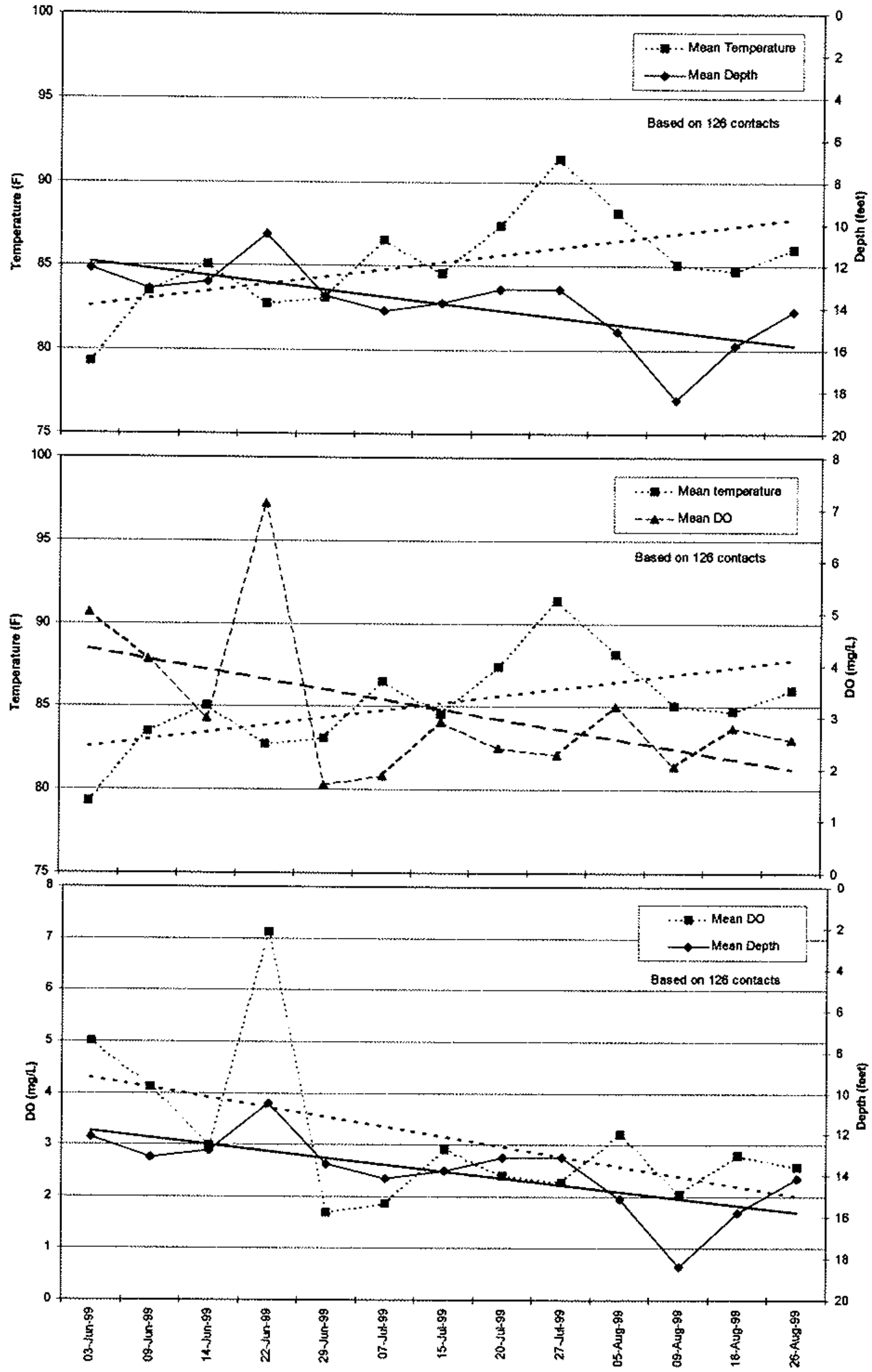

Figure 14.14. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1999 summer sampling dates in Newton Lake, Jasper Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

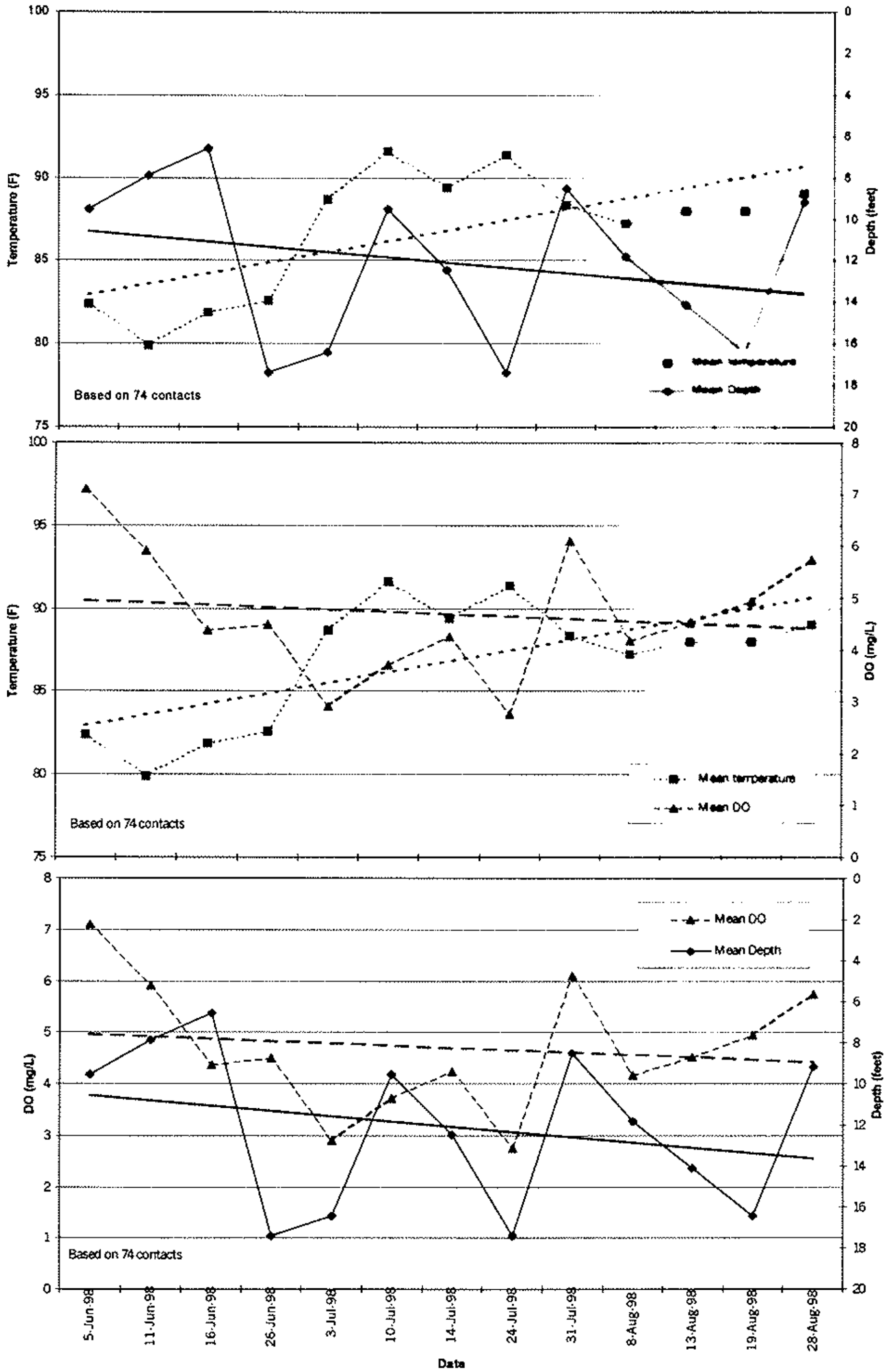

Figure 14.15. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1998 summer sampling dates in Coffeen Lake, Montgomery Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

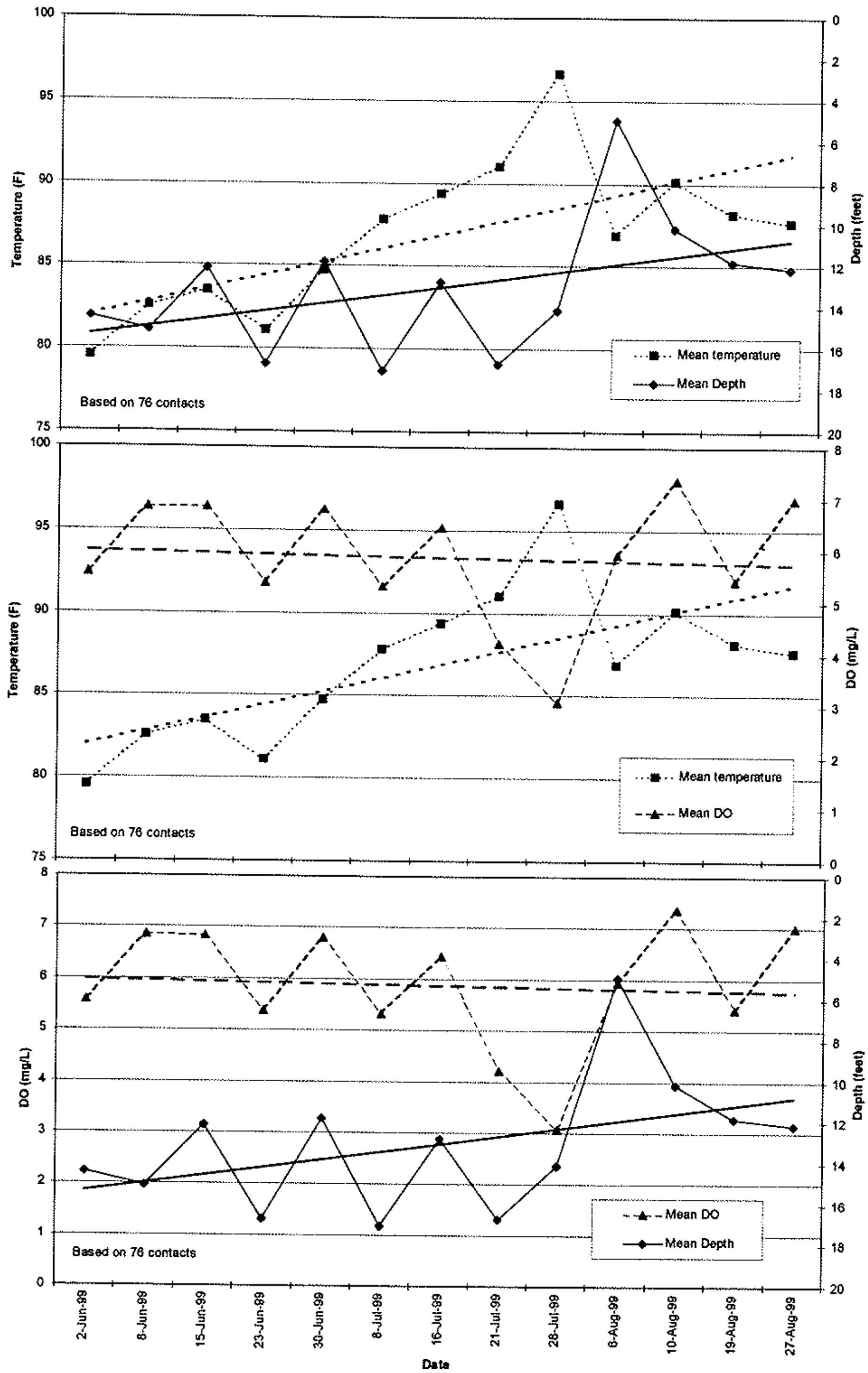

Figure 14.16. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1999 summer sampling dates in Coffeen Lake, Montgomery Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

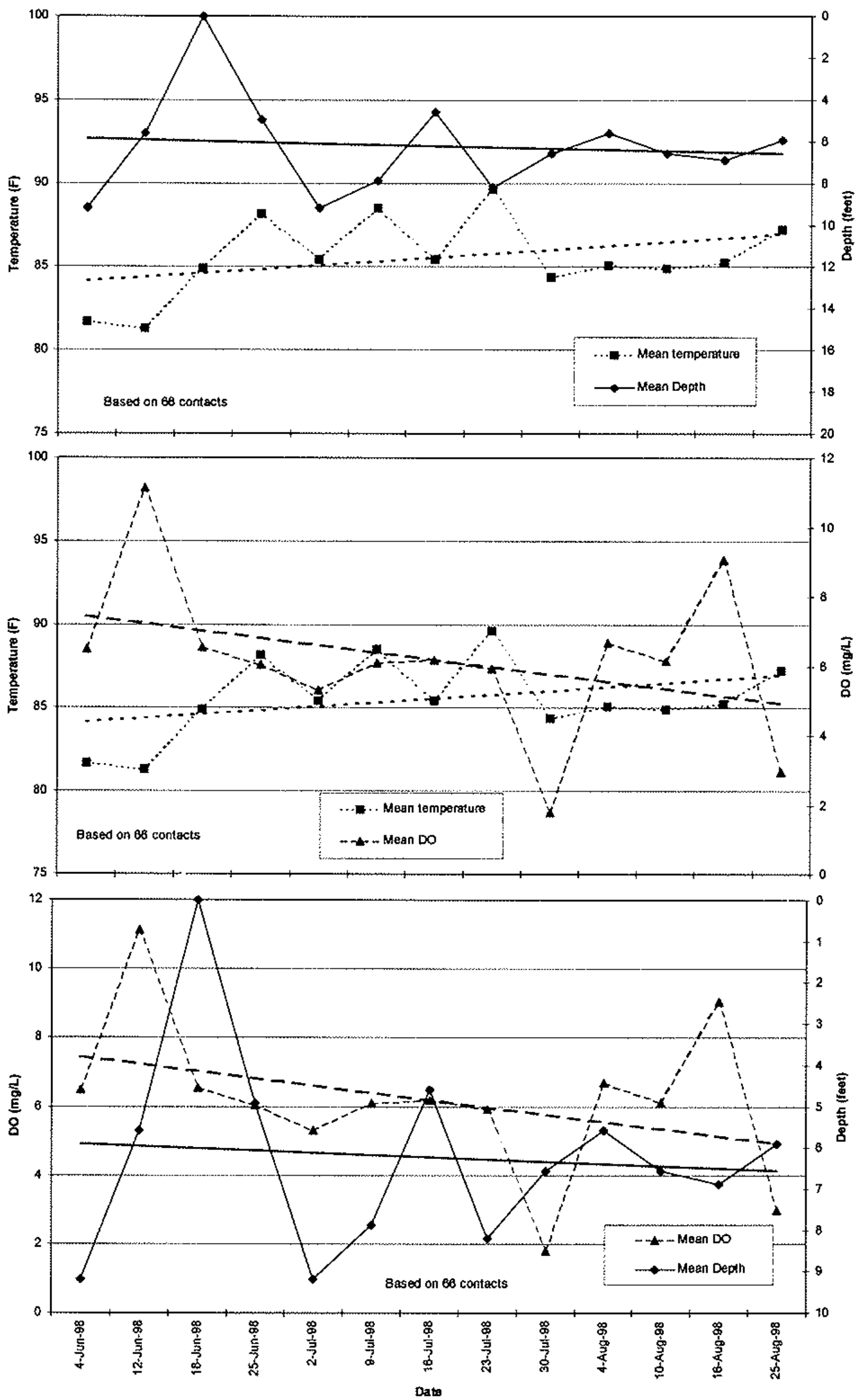

Figure 14.17. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1998 summer sampling dates in Lake of Egypt, Williamson / Johnson Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

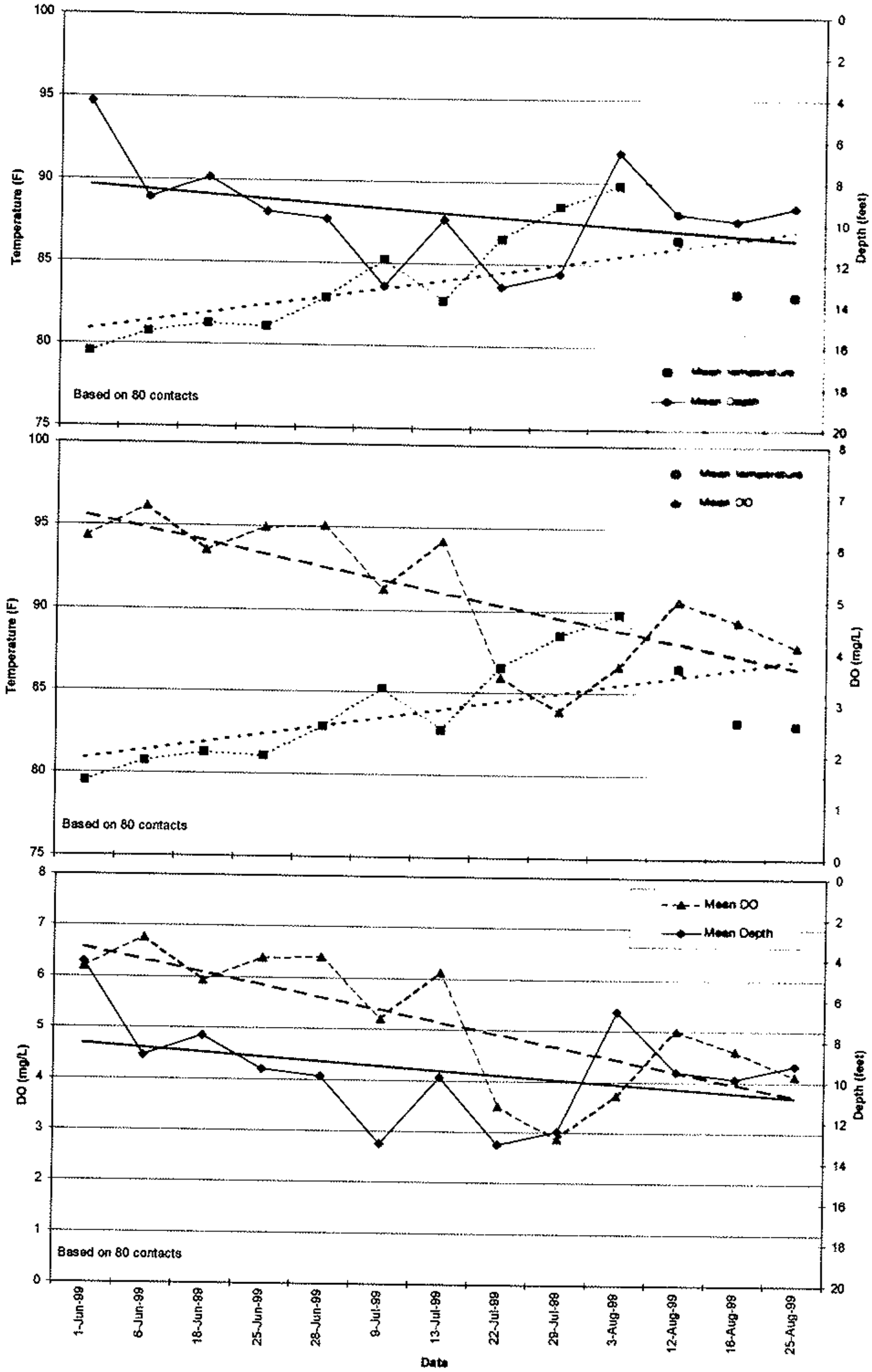

Figure 14.18. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for 1999 summer sampling dates in Lake of Egypt, Williamson / Johnson Co. Illinois (straight lines represent trends). Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

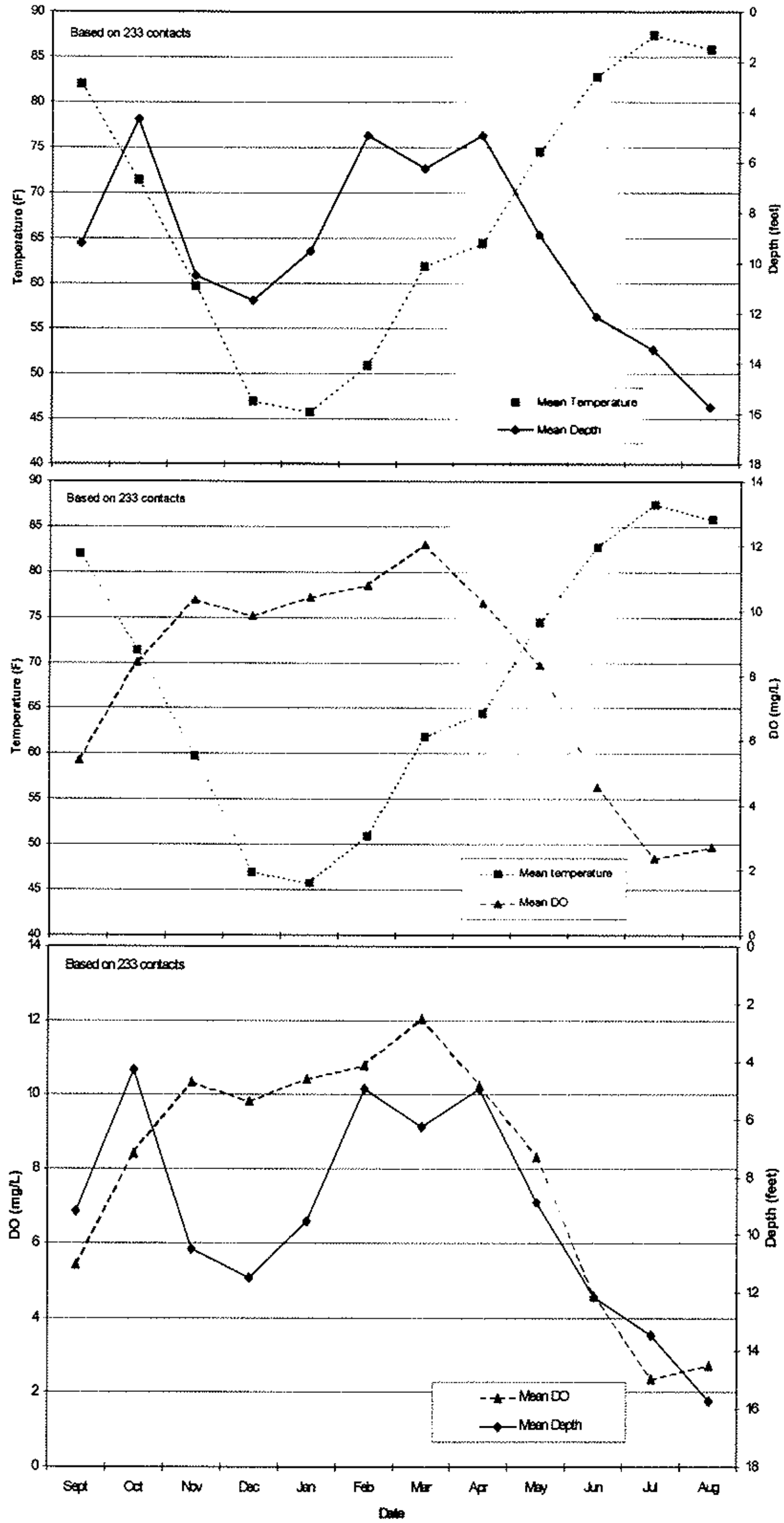

Figure 14.19. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for sampling months in Newton Lake, Jasper Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

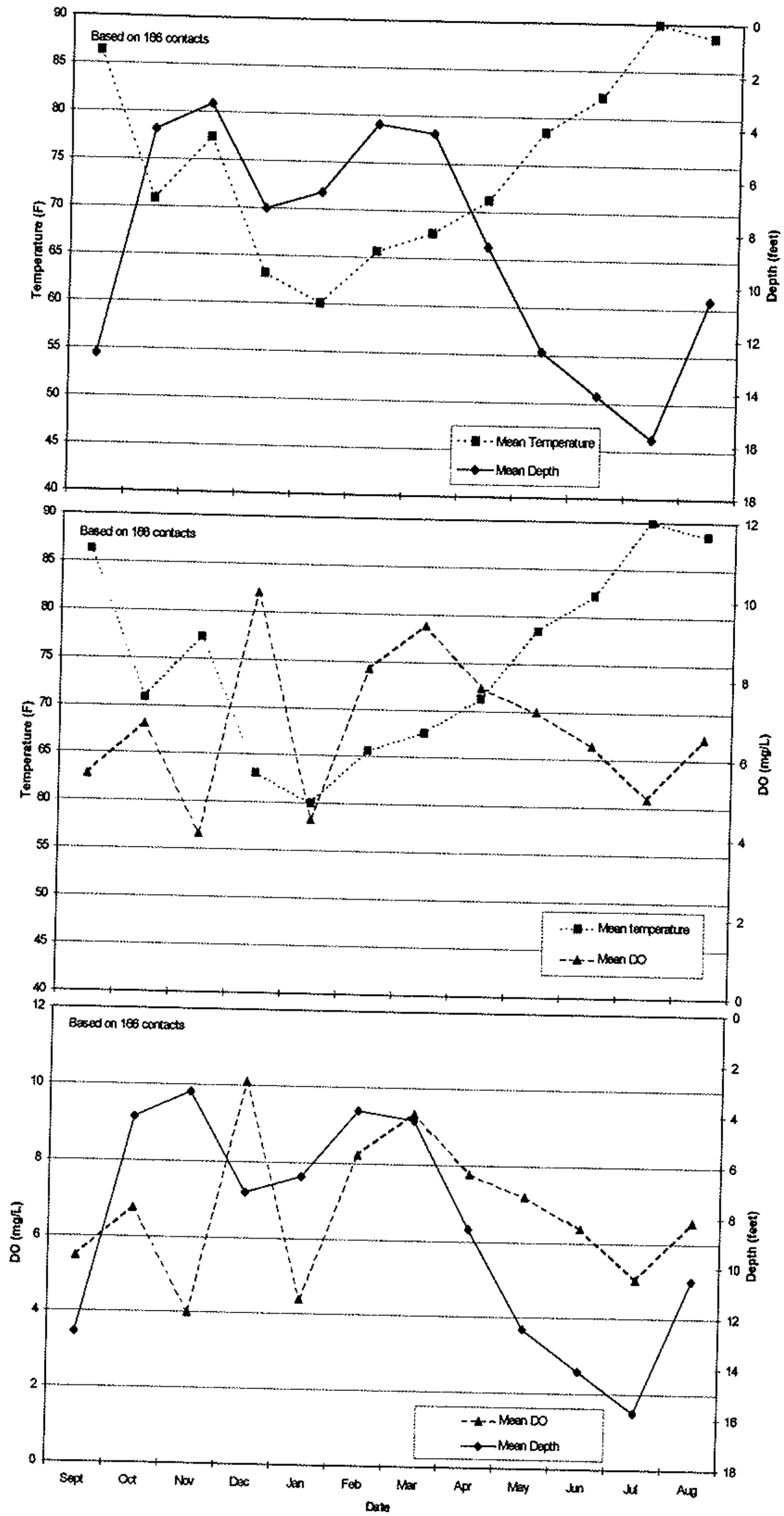

Figure 14.20. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for sampling months in Coffeen Lake, Montgomery Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

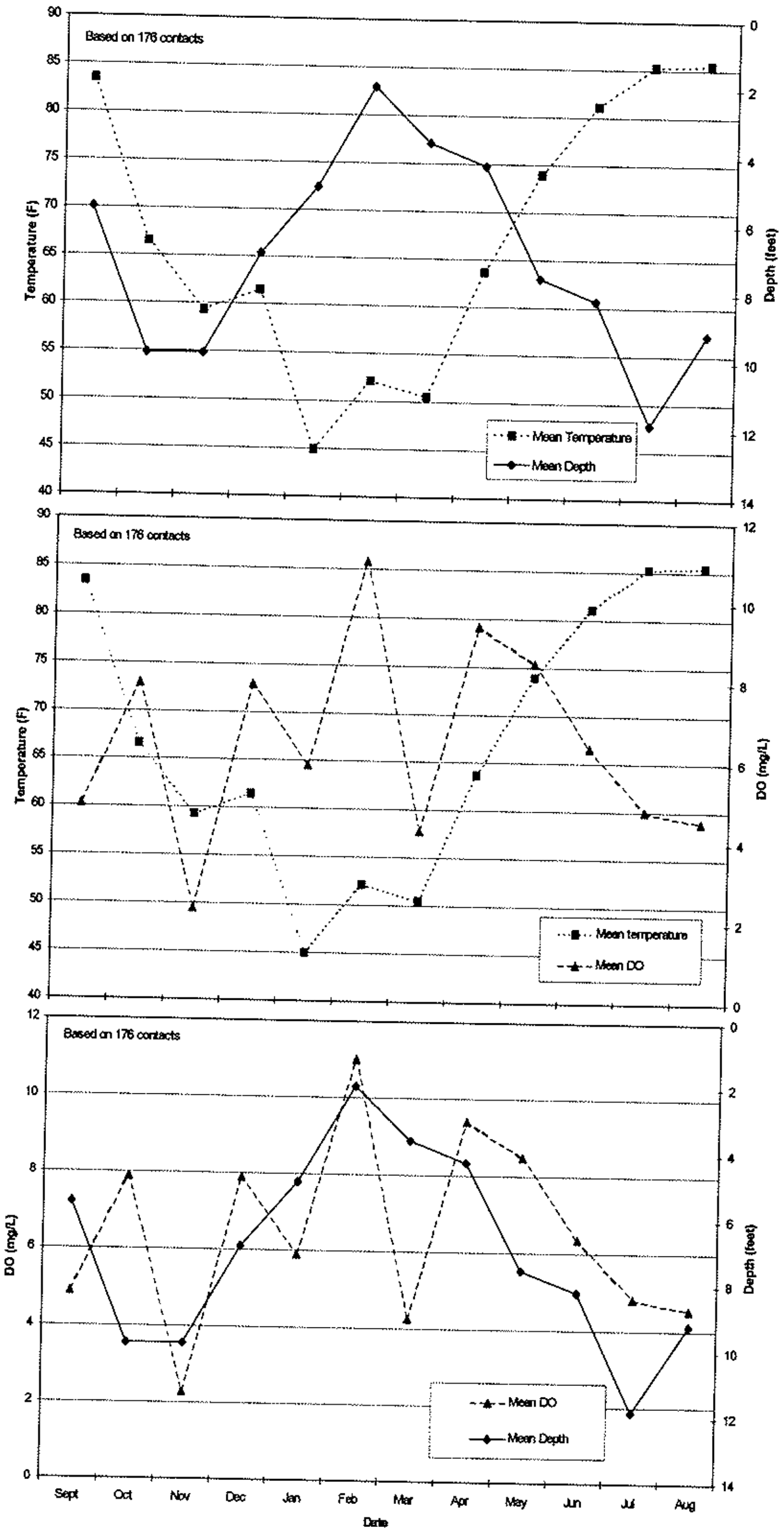

Figure 14.21. Comparison between largemouth bass internal body temperature, depth, and dissolved oxygen (DO) where found for sampling months in Lake of Egypt, Williamson / Johngosn Co. Illinois. Only contacts with largemouth bass were used when their internal body temperatures, determined by the temperature sensitive ultrasonic transmitters, corresponded with a water temperature on the temperature-depth-oxygen profile that was taken at the location of each fish.

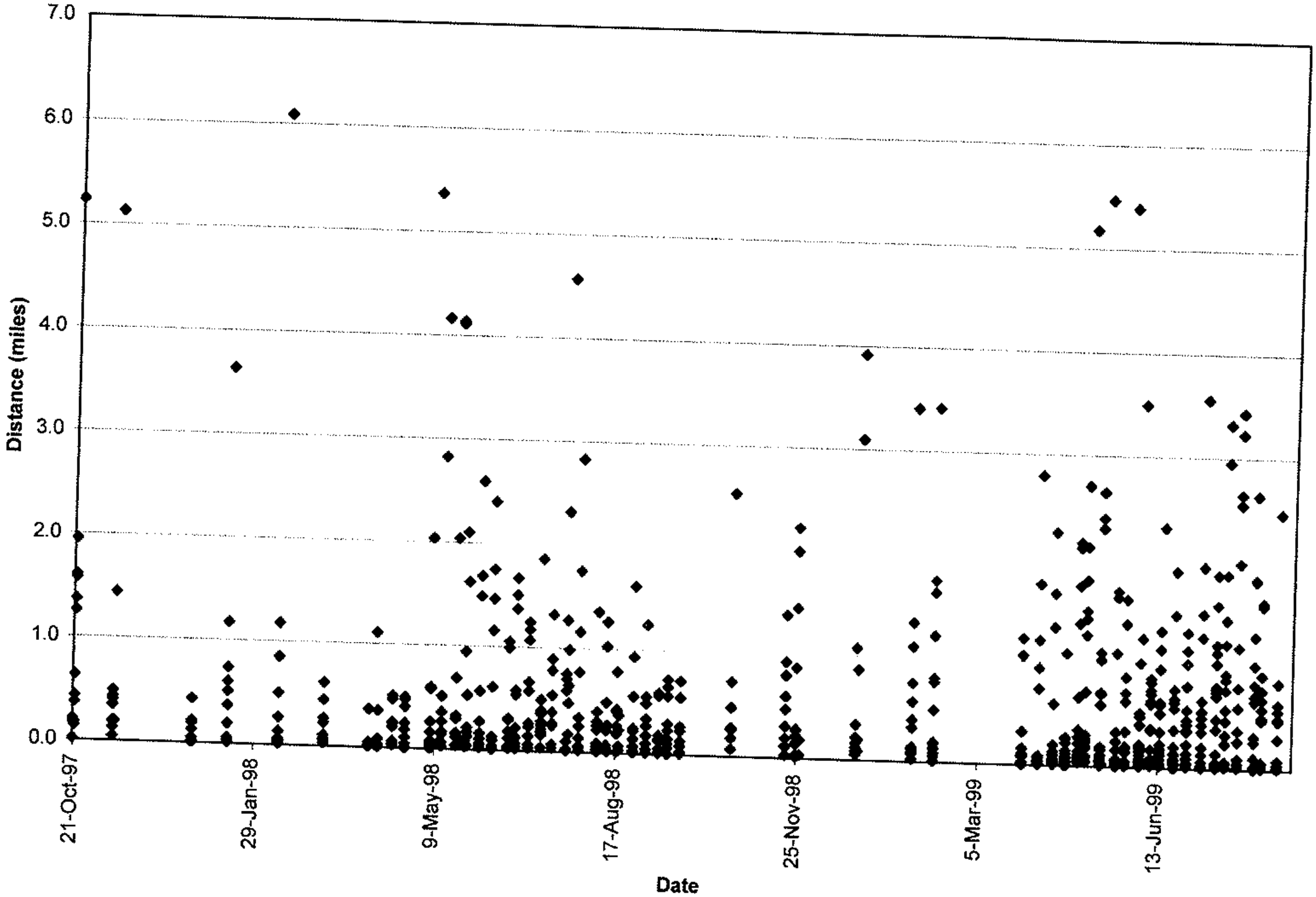

Figure 14.22. Observed largemouth bass movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Newton Lake, Jasper Co. Illinois.

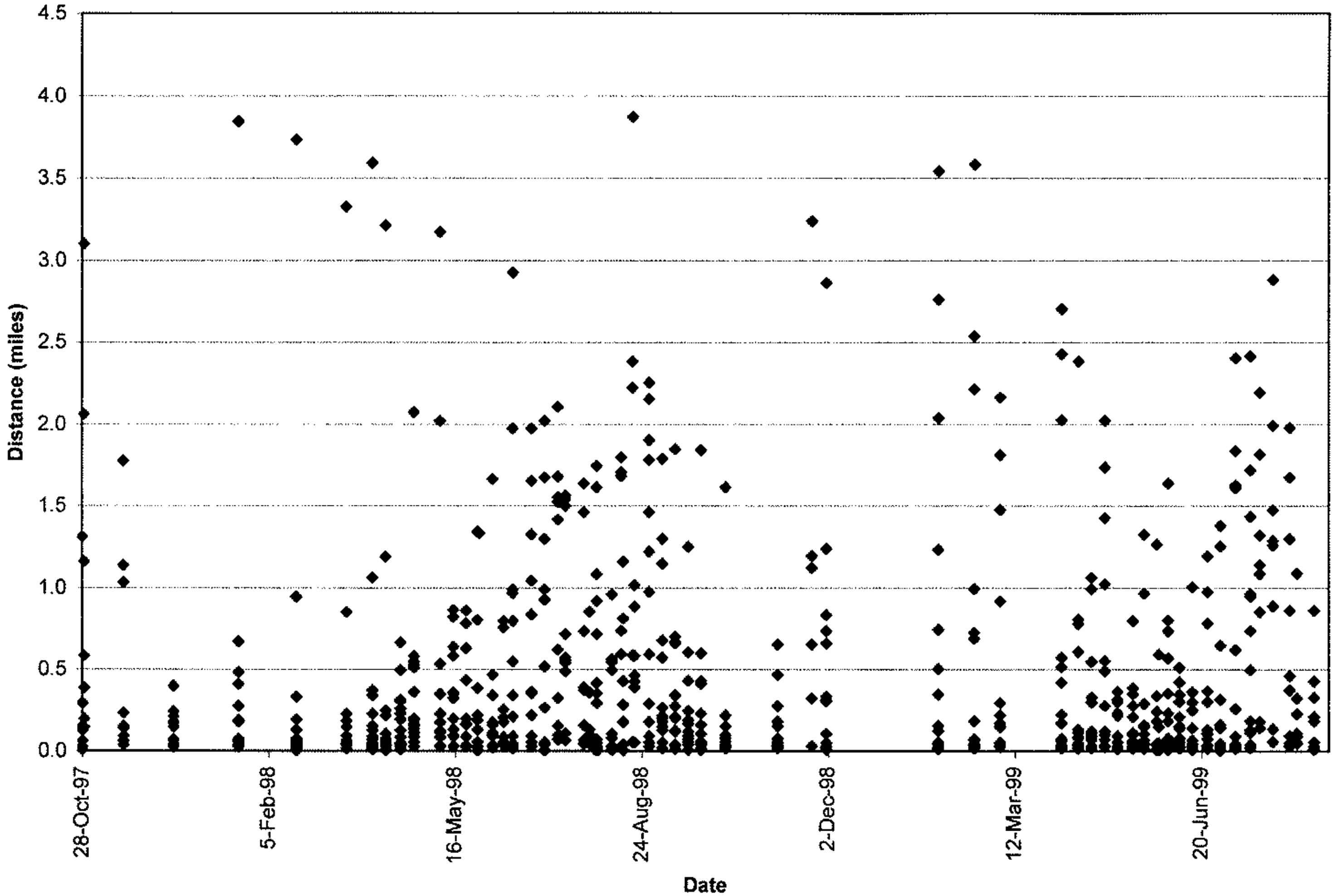

Figure 14.23. Observed largemouth bass movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Coffeen Lake, Montgomery Co. Illinois.

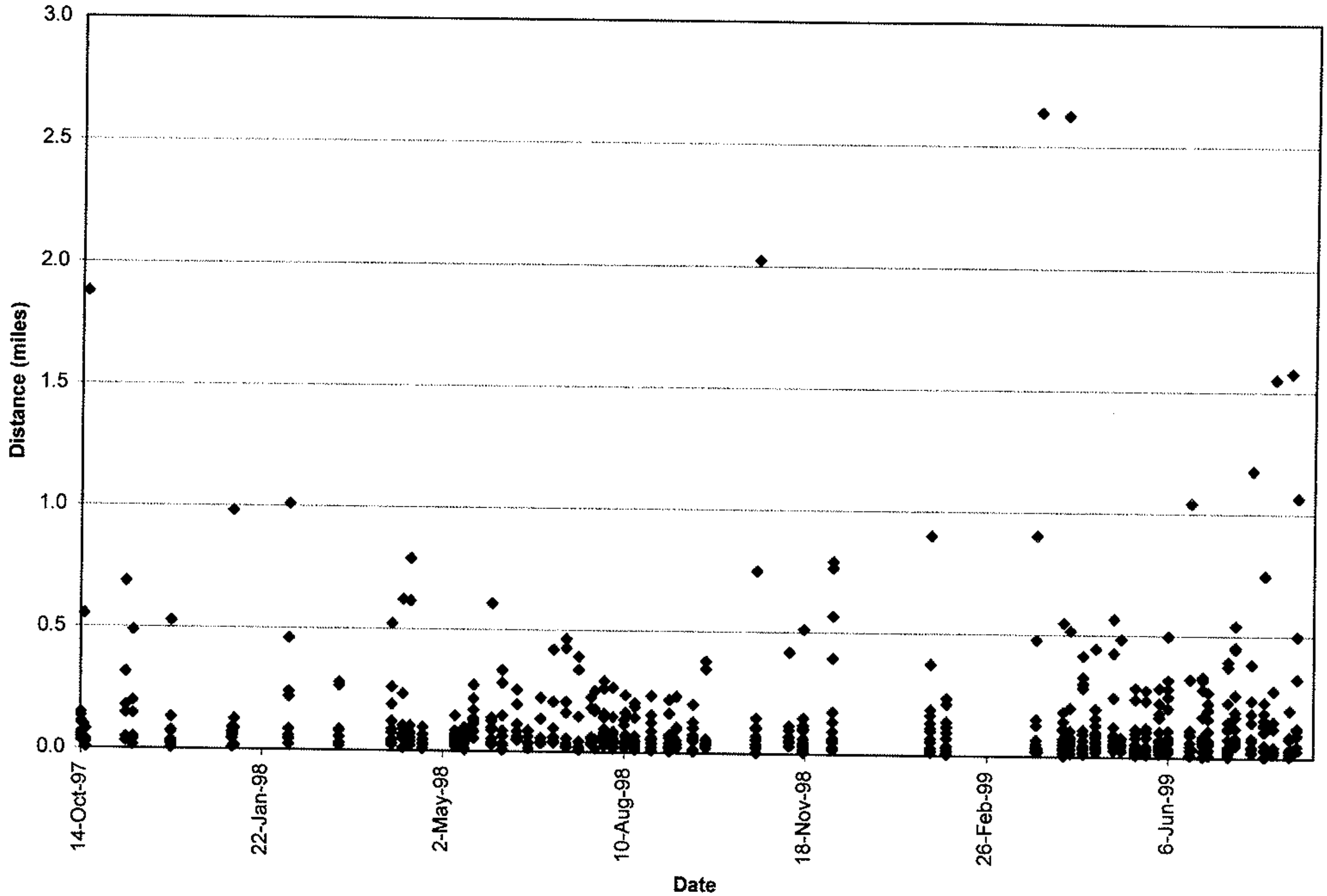

Figure 14.24. Observed largemouth bass movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Lake of Egypt, Williamson / Johnson Co Illinois.

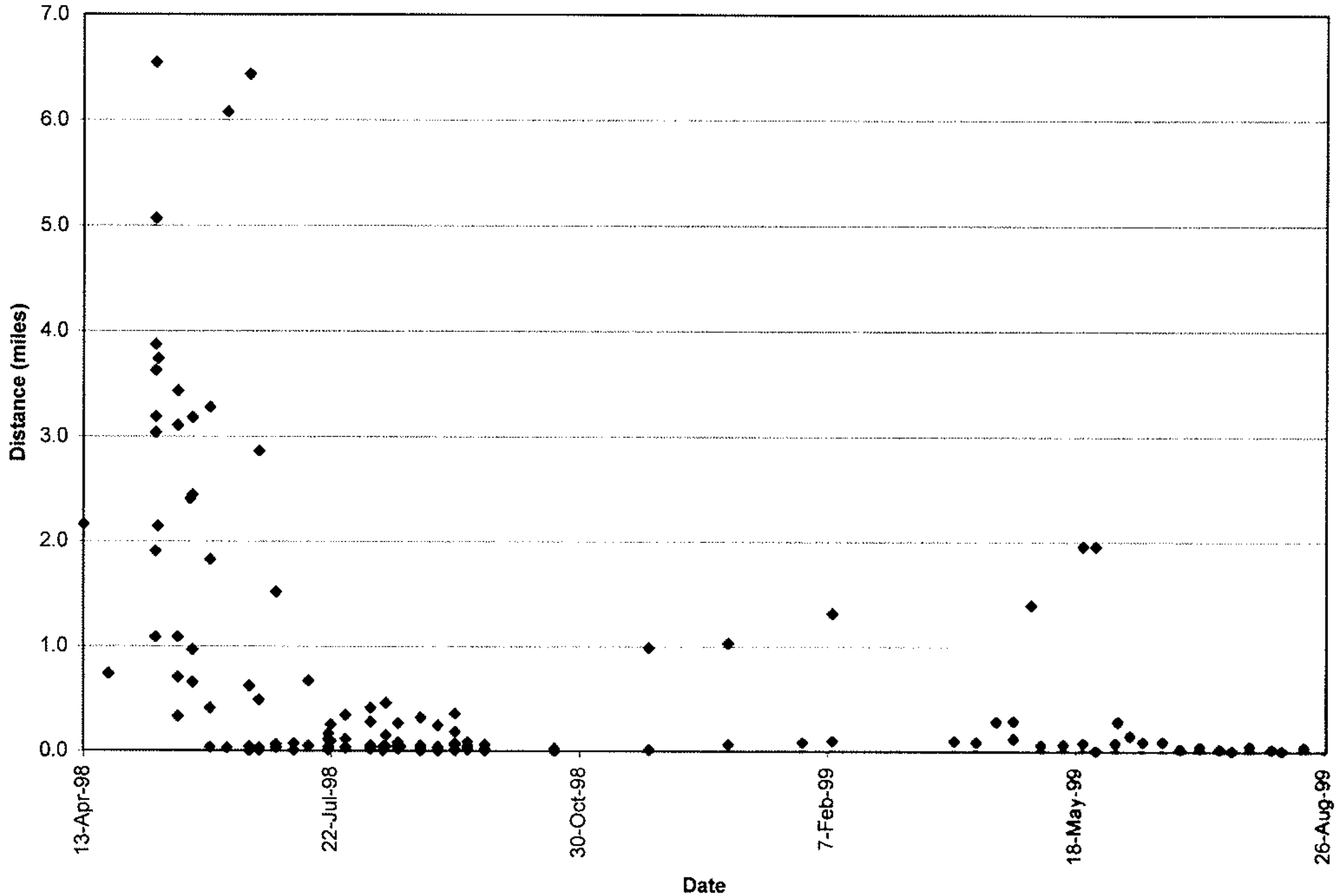

Figure 14.25. Observed channel catfish movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Newton Lake, Jasper Co. Illinois.

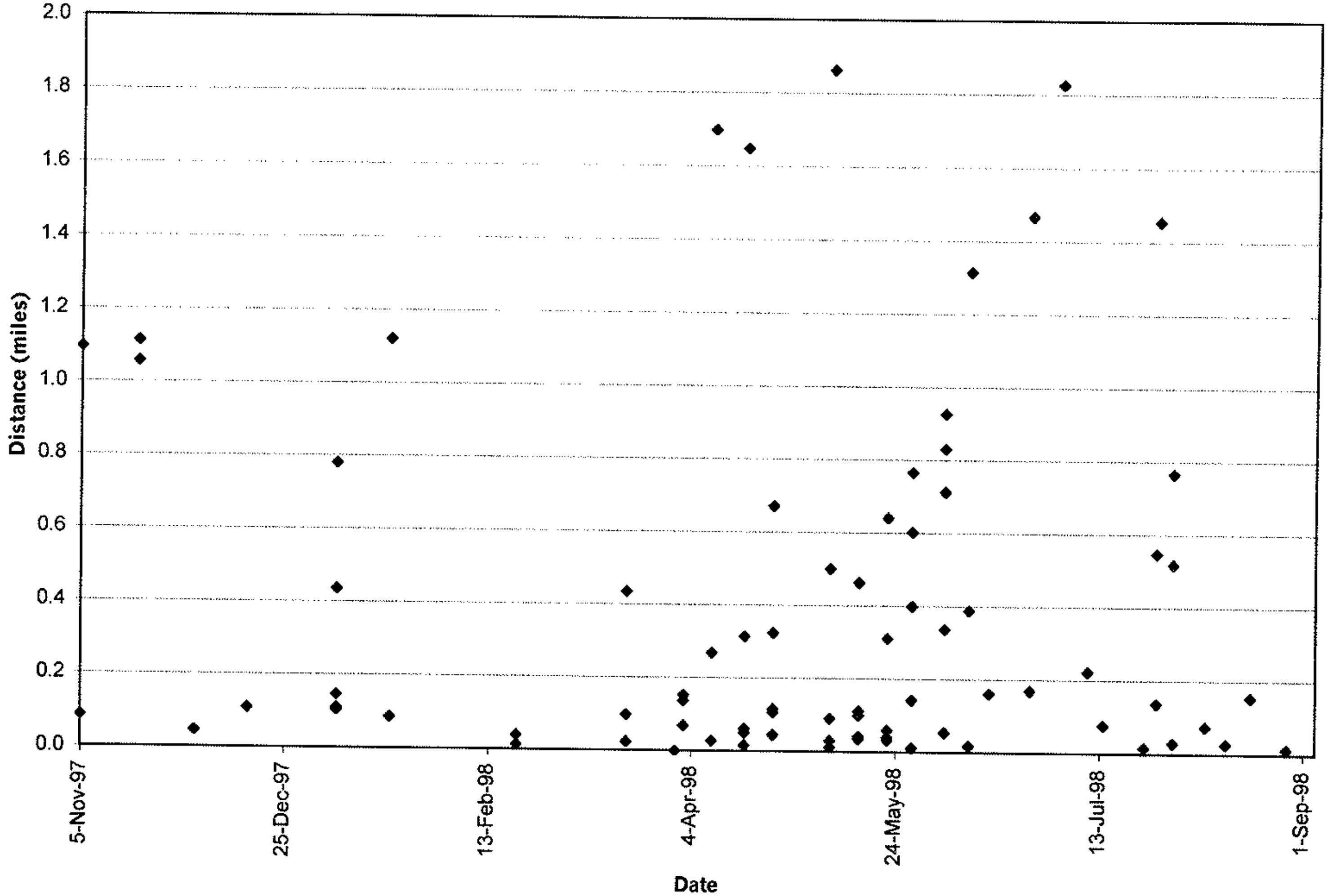

Figure 14.26. Observed channel catfish movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Coffeen Lake, Montgomery Co. Illinois.

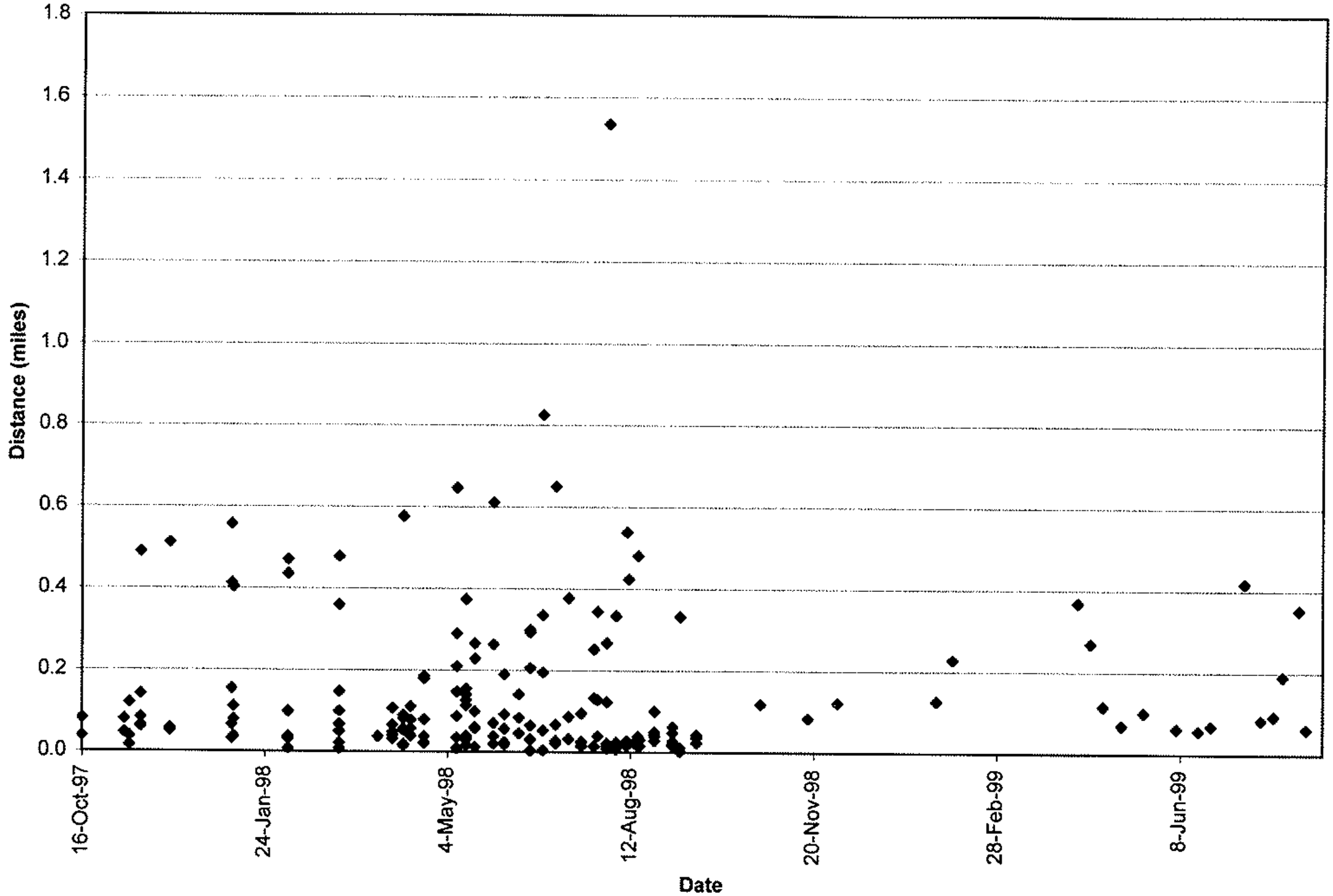

Figure 14.27. Observed channel catfish movement between contacts from October 1997 through August 1999, determined by ultrasonic telemetry in Lake of Egypt, Williamson / Johnson Co. Illinois.

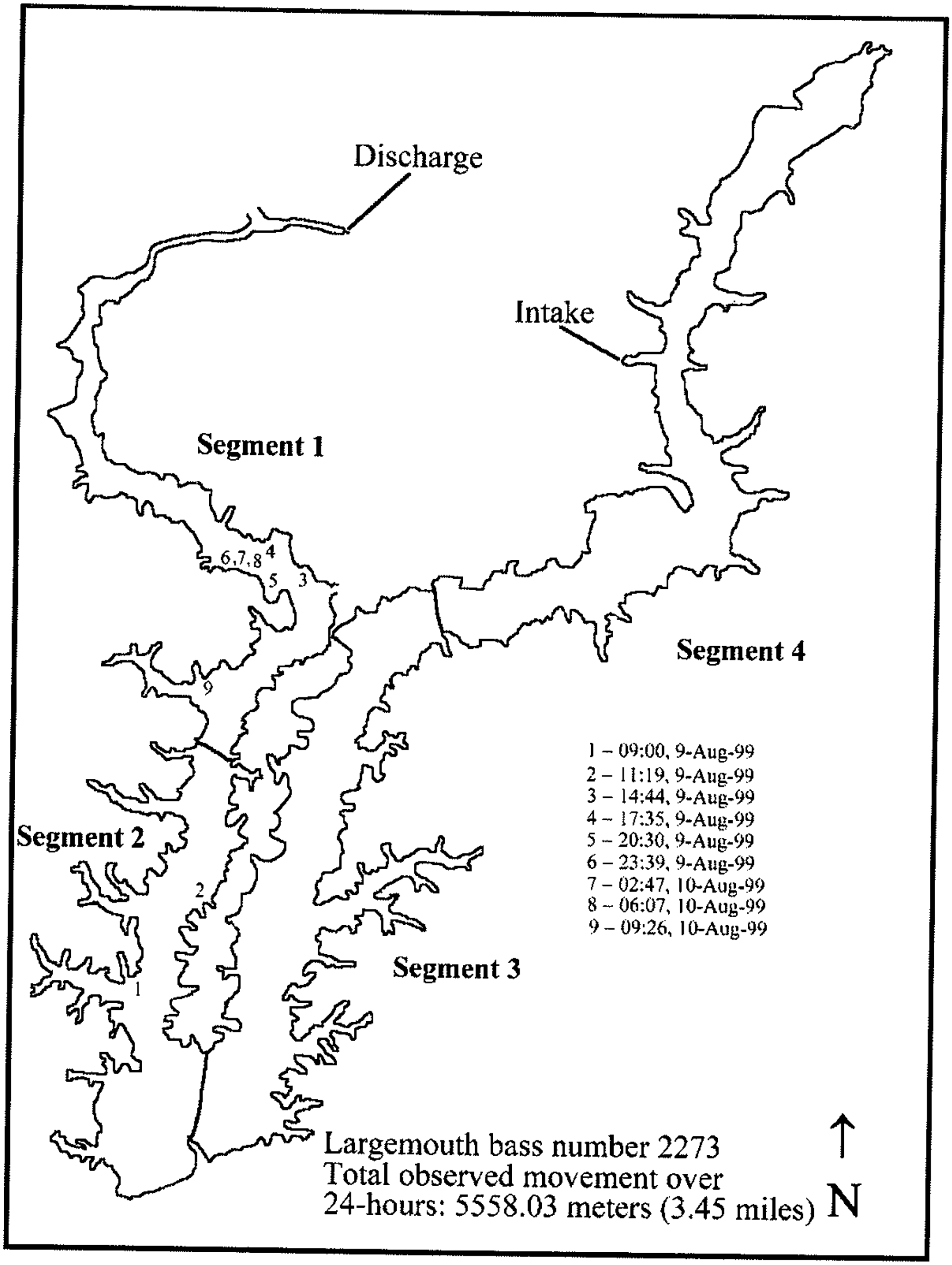

Figure 14.28. Extreme 24-hour diel movement observations of an ultrasonic transmitter implanted largemouth bass in Newton Lake, Jasper Co. Illinois.

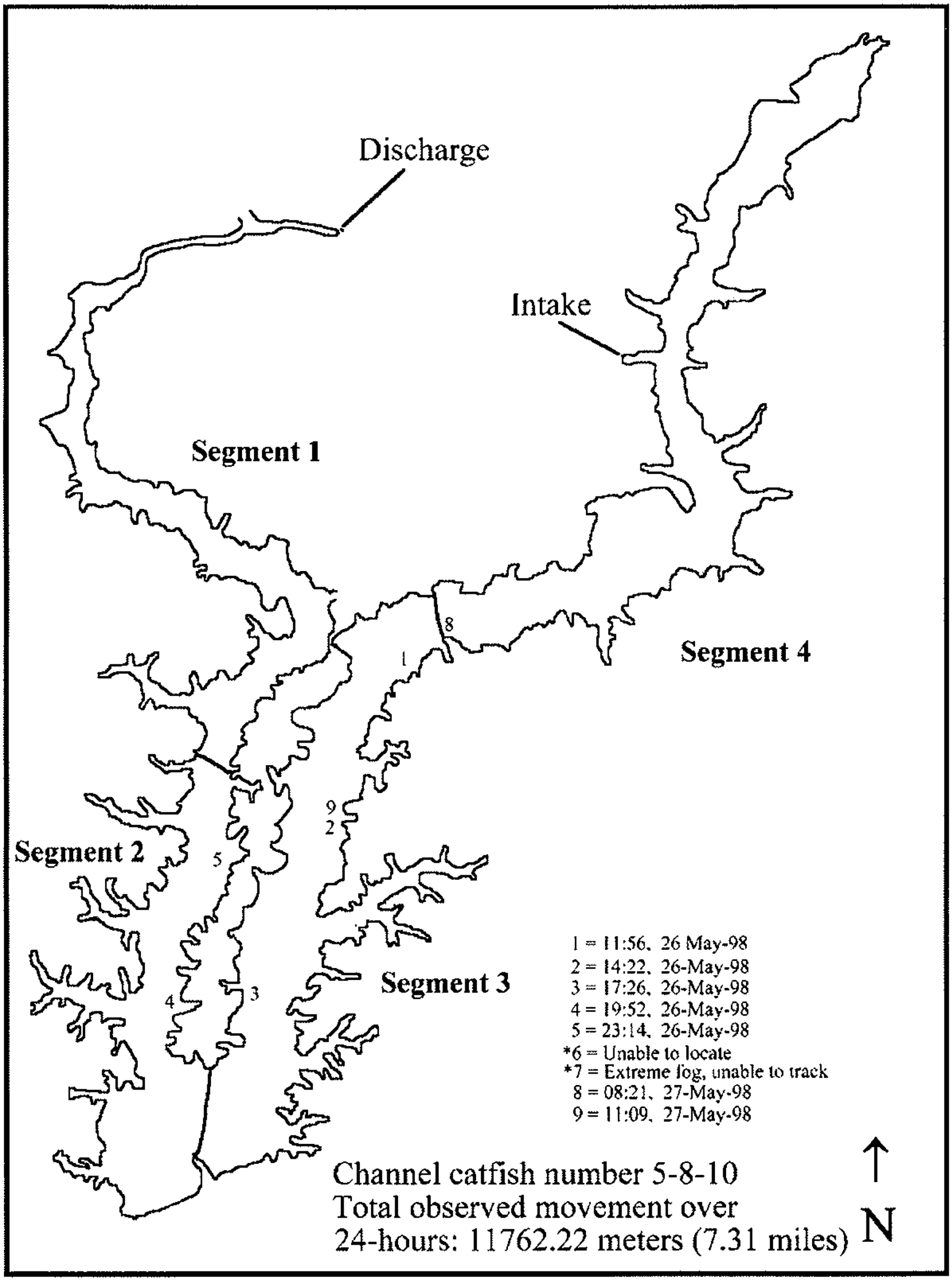

Figure 14.29. Extreme 24-hour diel movement observations of an ultrasonic transmitter implanted channel catfish in Newton Lake, Jasper Co. Illinois.

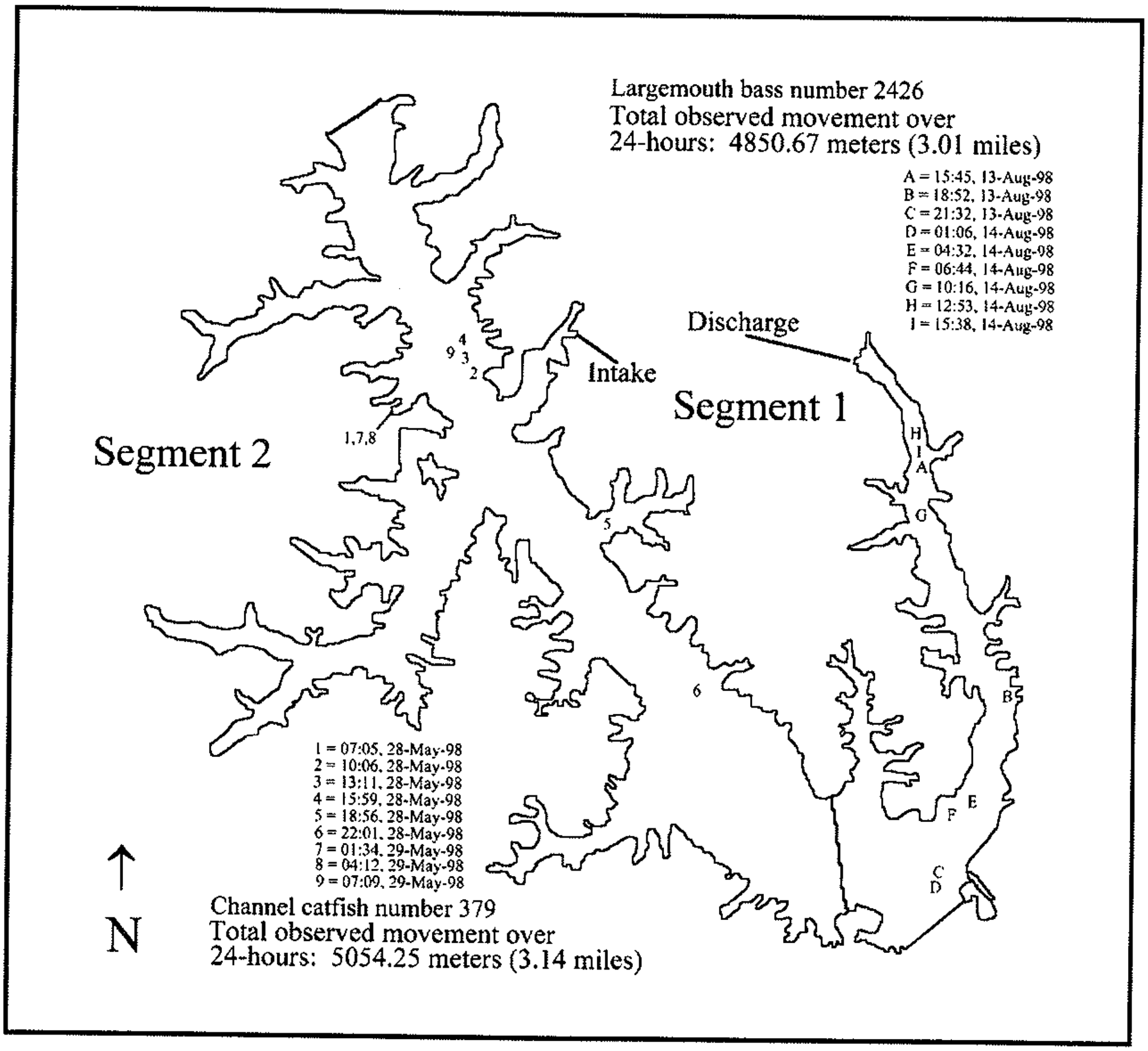

Figure 14.30. Extreme 24-hour diel movement observations of an ultrasonic transmitter implanted largemouth bass and channel catfish in Coffeen Lake, Montgomery Co. Illinois.

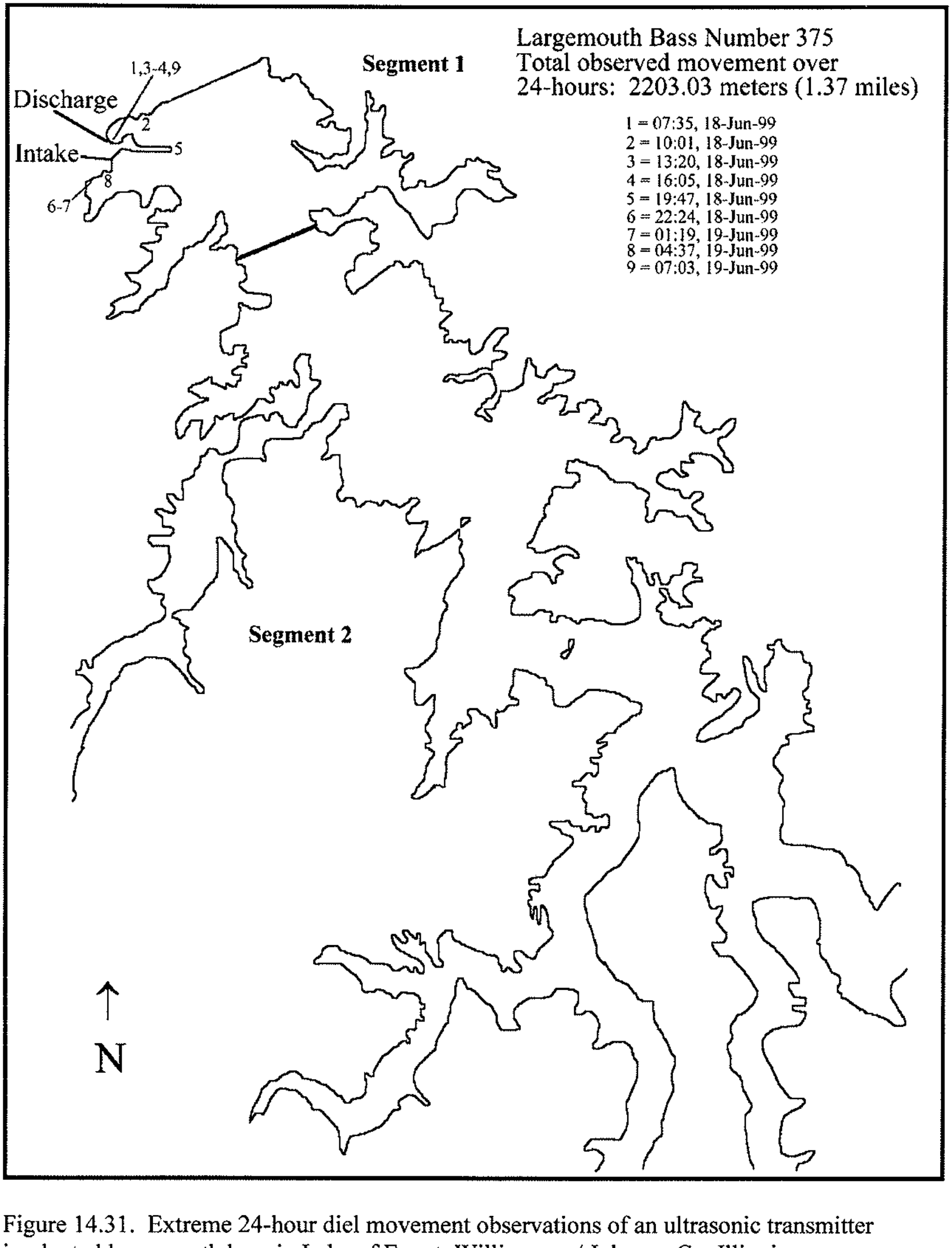

Figure 14.31. Extreme 24-hour diel movement observations of an ultrasonic transmitter implanted largemouth bass in Lake of Egypt, Williamson / Johnson Co. Illinois.

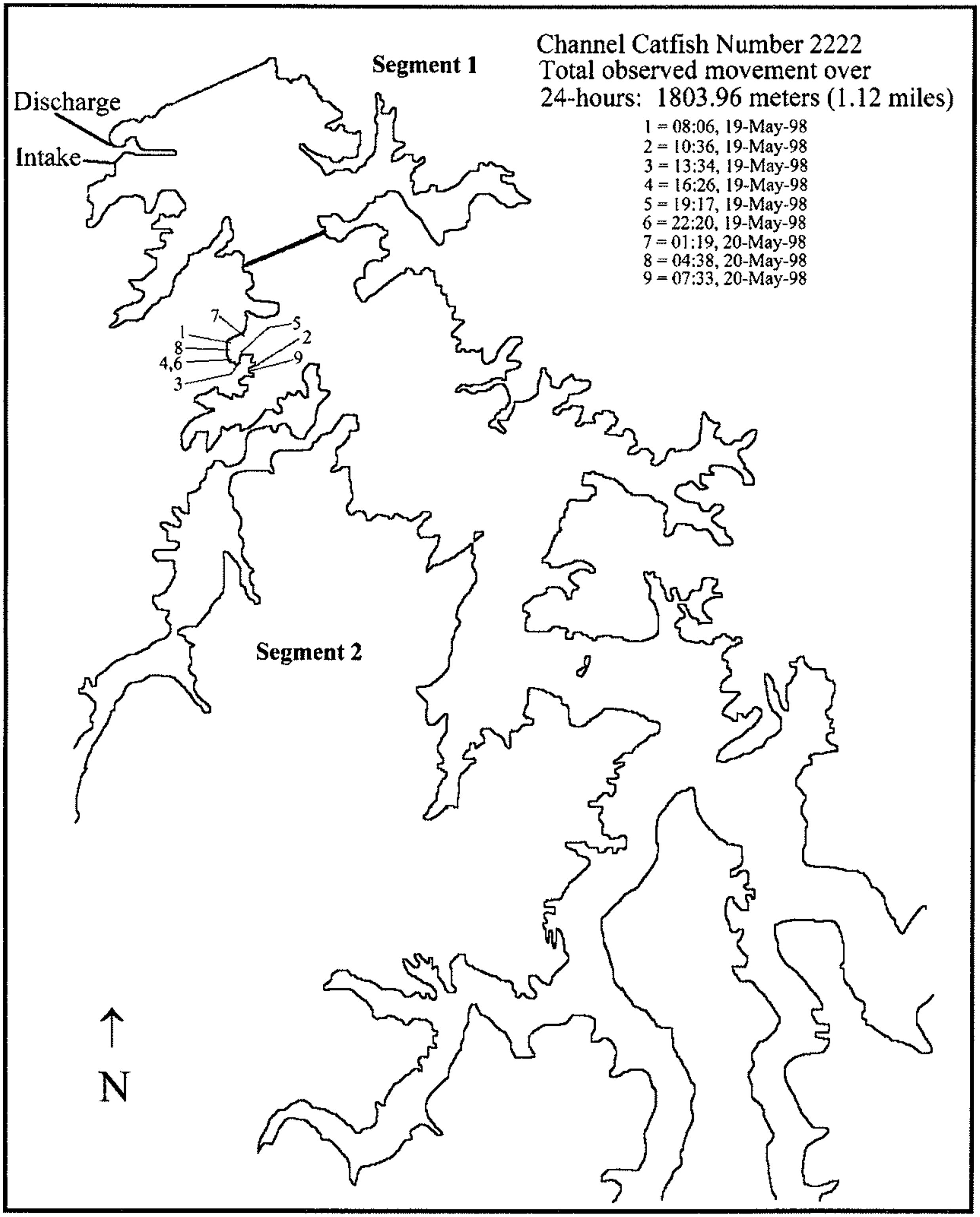

Figure 14.32. Extreme 24-hour diel movement observations of an ultrasonic transmitter implanted channel catfish in Lake of Egypt, Williamson / Johnson Co. Illinois.

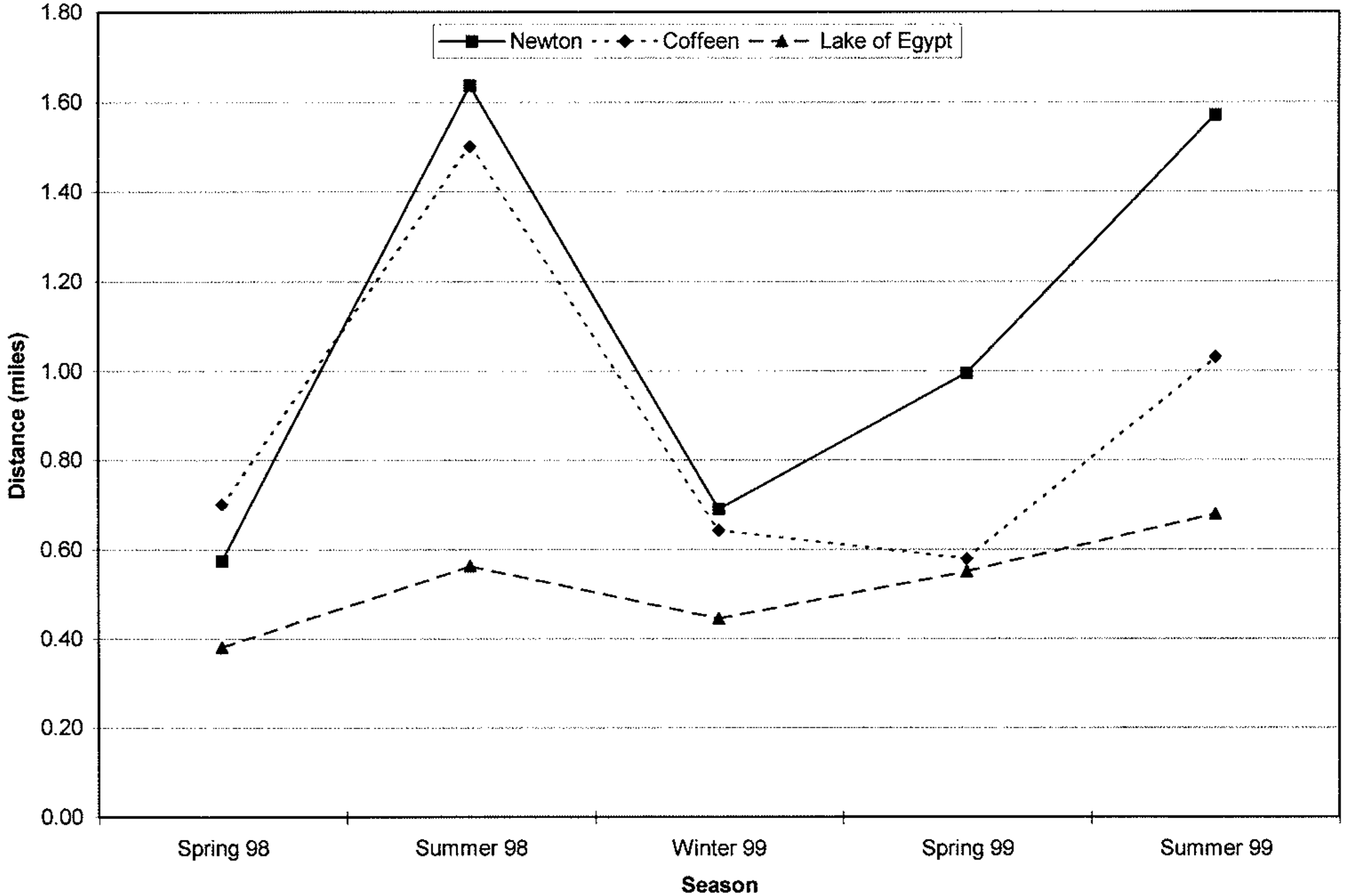

Figure 14.33. Comparison among sampling seasons for largemouth bass mean observed diel movements in three Illinois power cooling reservoirs.

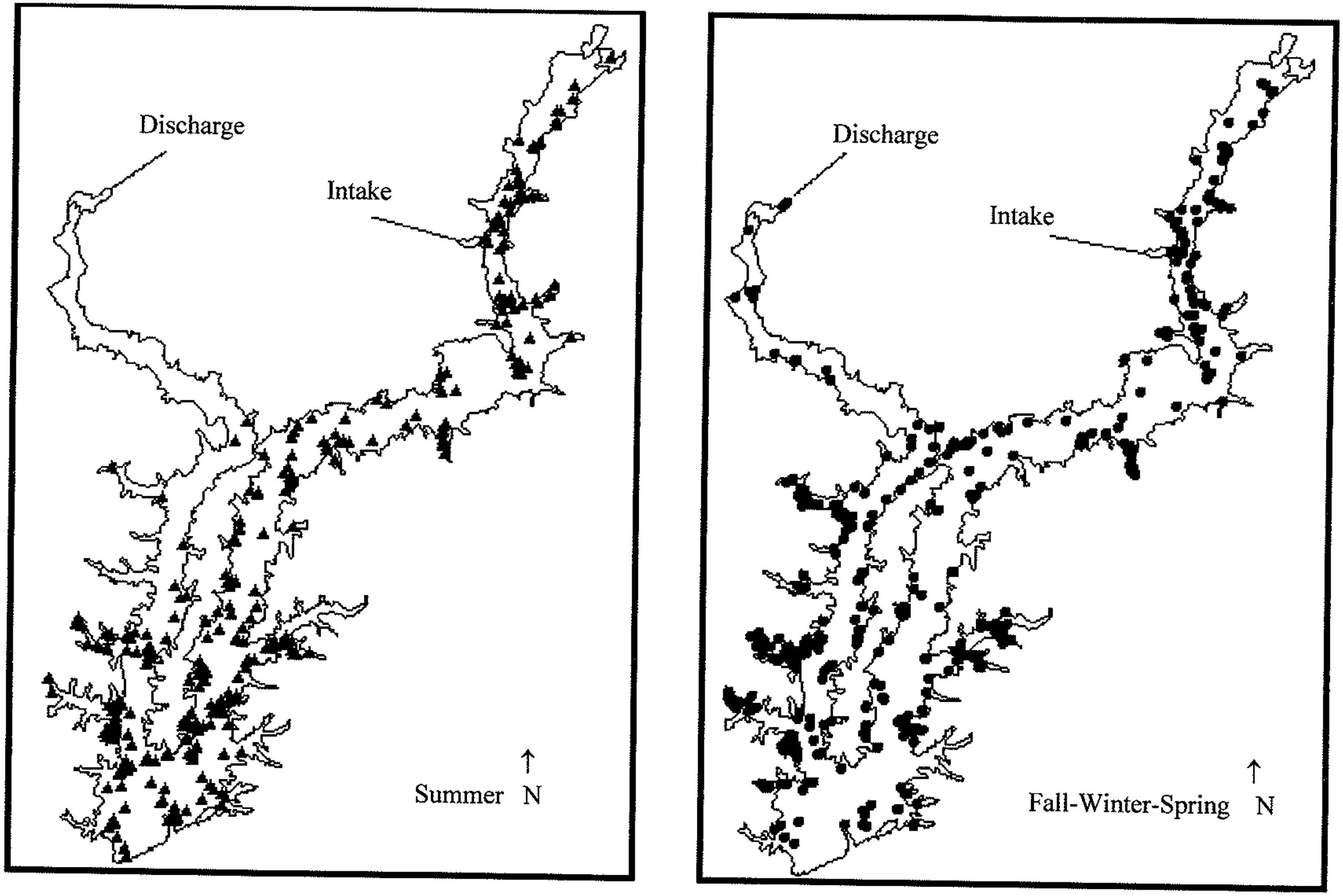

Figure 14.34. Seasonal largemouth bass locations in Newton Lake, Jasper Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

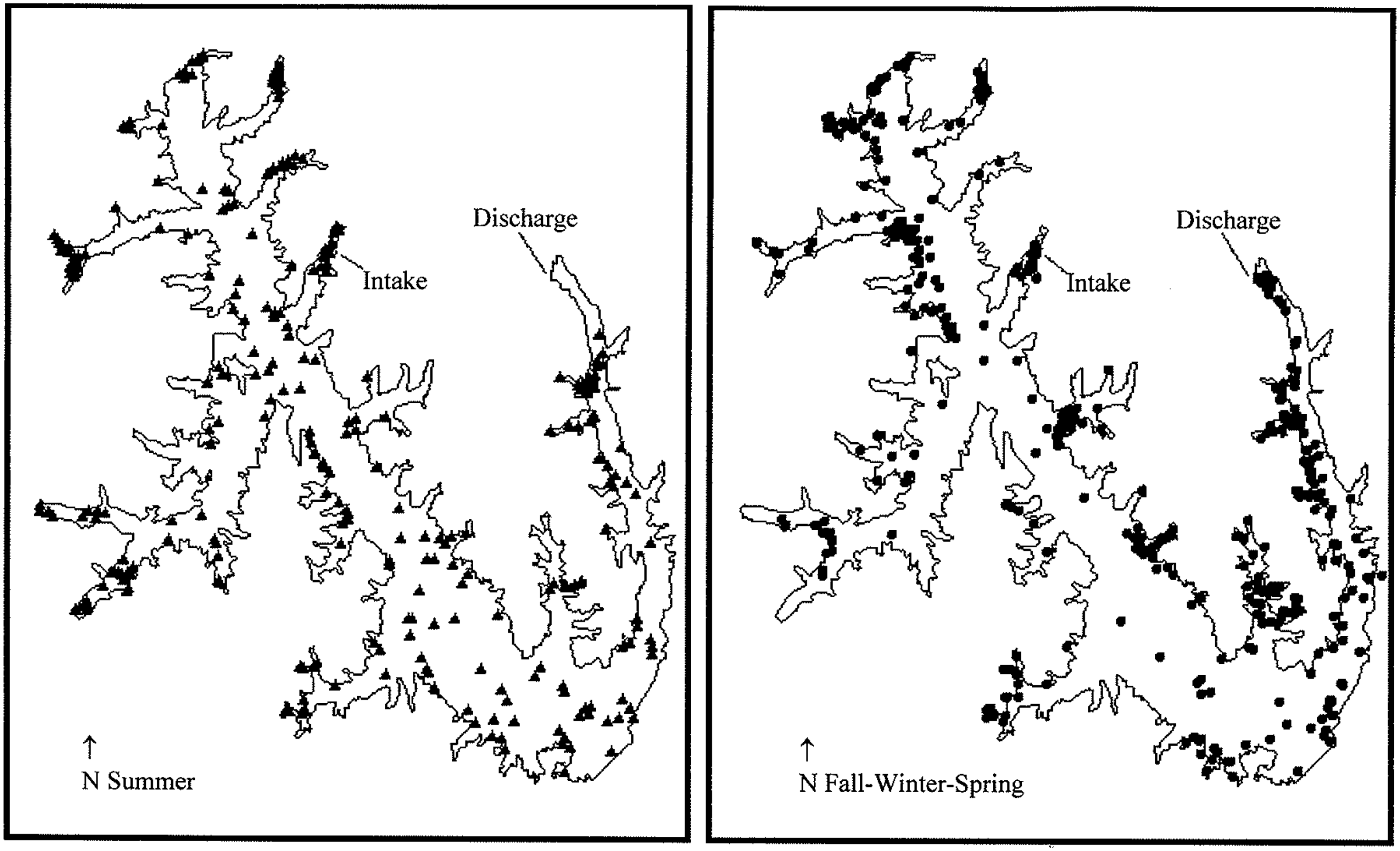

Figure 14.35. Seasonal largemouth bass locations in Coffeen Lake, Montgomery Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

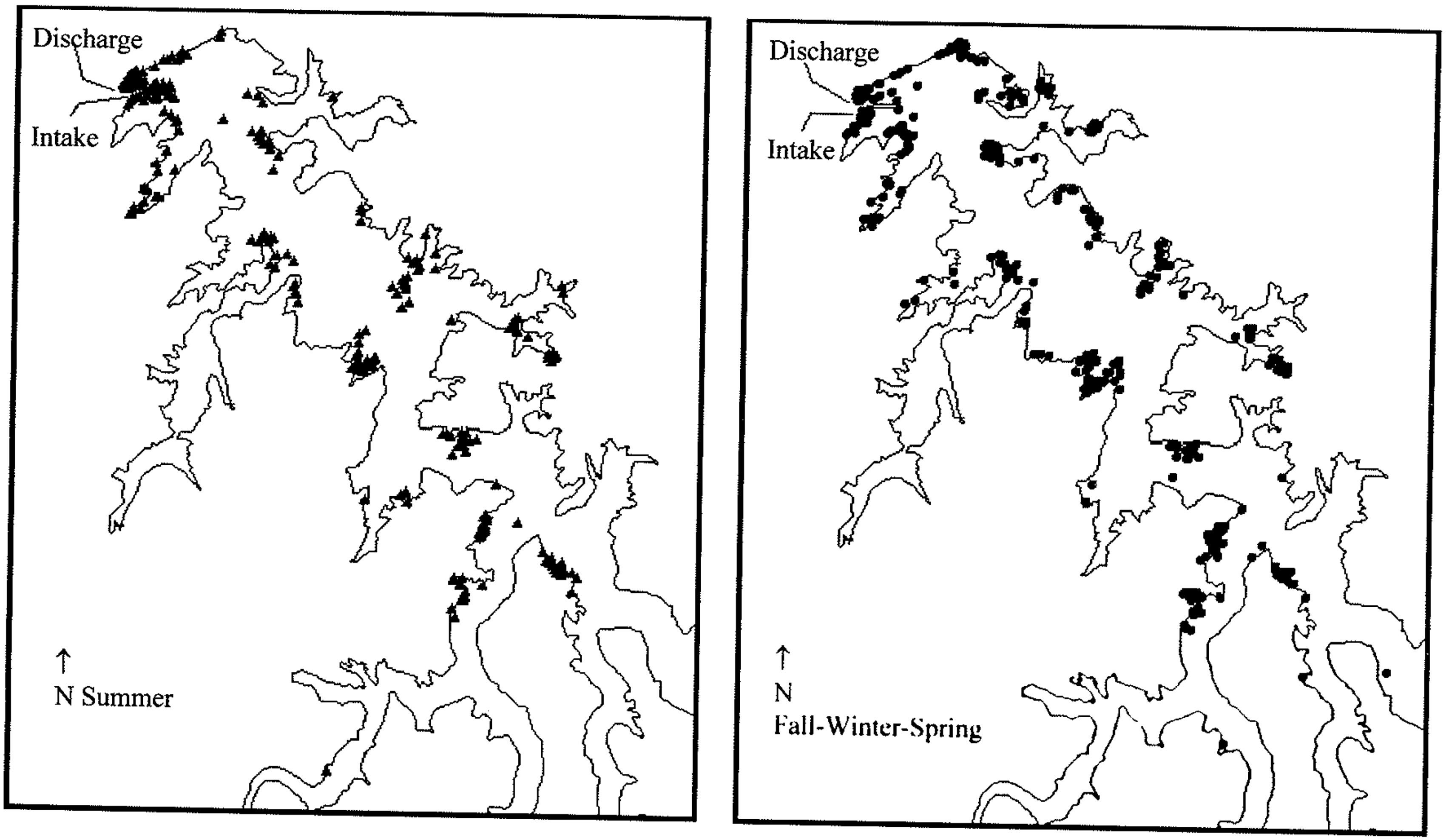

Figure 14.36. Seasonal largemouth bass locations in Lake of Egypt, Williamson / Johnson Co. Illinois, as determined by ultrasonic telemetry. June, July, and August represent summer months.

Chapter 15. Depth, Temperature, Oxygen Profile (Primary responsibility - Timothy Spier)

Introduction:

Much effort was directed toward measuring temperature within Newton Lake, Coffeen Lake, and Lake of Egypt in order to reflect the importance of thermal loading to this study. Temperature and oxygen profiles were measured bimonthly in each segment of each lake. Temperature and oxygen profiles were also obtained during fish tracking and at various other times throughout the study. Continuous temperature data was recorded from temperature loggers stationed at various depths throughout Newton Lake, Coffeen Lake, and Lake of Egypt.

Materials and Methods:

Temperature and oxygen were measured bimonthly in each lake by lowering the probe from a YSI Model 50B temperature – oxygen meter. Measurements were taken at 0.5 m intervals from the surface to the bottom at the midpoint of each segment of each lake; therefore, the final reading taken each sample date is within 0.5 – m of the bottom of the lake. The YSI meters were calibrated approximately every 4 weeks using a standard thermometer. Oxygen membranes were changed frequently. Oxygen meters were calibrated each time they were used following the method outlined by the manufacturer.

Temperature loggers were stationed 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 – 3 of Newton Lake. Loggers were placed at 0, 1.5, and 3.0 m in Segment 4; on August 8, 1999 the surface logger in Segment 4 was moved down to 4.5 m. Loggers were also stationed at the surface near the intake and at the surface in the discharge of the Newton Lake Generating Station; data from the latter was used to evaluate adherence to the thermal variance (Figure 15.1).

Temperature loggers were stationed at the surface, 1.5 m, 3.0 m, and 4.5 m in the discharge, near the dam, and near the intake of Coffeen Lake (Figure 15.2). Temperature loggers were stationed at the surface, 1.5 m, 3.0 m, and 4.5 m in Segments 1 and 2 of Lake of Egypt (Figure 15.3). Note that data from all surface loggers of Newton Lake, except the surface logger in Segment 4, and all surface loggers in Coffeen Lake were operated by Ameren CIPS. Data from the Ameren CIPS surface loggers in Newton Lake begin in early June 1997, while data from surface loggers for all segments of Coffeen Lake begin in September of 1996. Loggers for the deeper water in Newton Lake and Coffeen Lake, as well as all loggers for Lake of Egypt, were purchased and installed in September 1997.

Temperature loggers were programmed to measure temperature every 2 minutes, and the mean of these measurements was recorded every 1 or 2 hours to determine the hourly temperature. 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.

Preliminary analysis of temperature logger data suggested that some loggers gave erratic data at various times throughout the study. This erratic data often manifested itself as temperature readings for loggers near the surface that were much lower than temperature readings from loggers that were deeper in the water column. Readings from each logger were compared to readings from all deeper loggers, and any upper reading which was more than 5 degrees F cooler than a deeper reading was scrutinized. Comparison of the scrutinized readings to other data, such as temperature profile data or other logger data, indicated which logger was malfunctioning. Data from the malfunctioning logger were then discarded.

Regular biweekly temperature and oxygen profiles were used to estimate the amount of habitat available to the fish during the summer months (June, July, and August) of 1998 and 1999. 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 or oxygen levels lower than the given oxygen. 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, then the percent habitat available would have been 25%. Thus, on June 5, 1998 in Newton Lake Segment 1, 69% of the habitat had oxygen levels greater than 4 ppm and temperatures less than 87 F, and 94% of the habitat had oxygen levels greater than 1 ppm and temperatures less than 97 F (Table 15A.5).

Percent habitat available for Newton Lake on July 29 and 30, 1999 (Tables 15A.18 and 15A.19), and Coffeen Lake on July 31 and August 1, 1999 (Tables 15A.49 and 15A.50) were calculated from temperature and oxygen profiles obtained during fish health sampling (Chapter 9) performed during the fish kill.

Interspersed throughout the Coffeen Lake summer available habitat tables are similar tables calculated from data recorded by Ameren CIPS. These tables were created using temperature / dissolved oxygen profiles taken at locations F1, F2, and G and thus represent estimated percent available habitat in areas of Coffeen Lake which are outside of the cooling loop.

Habitat calculations were also determined for the winter months (December, January, and February) of each year. Estimated habitat values for the winter months provided insight concerning the creation of available habitat due to thermal loading during the coldest months, in contrast to the summer estimated habitat values which were concerned with the loss of habitat during the warmest months. For winter estimated habitat calculations, a stratum of the lake was considered to provide available habitat if it contained temperatures that were greater than the evaluation temperature and oxygen levels that were higher than the evaluation oxygen level. Because oxygen is rarely limiting during cooler months, habitat was only estimated at 1 level of oxygen (4 ppm), while available habitat was estimated at 1 degree increments over the range 50 – 60 ° F.

Since all segments were nearly equal in size in Newton Lake, a mean value of percent available habitat was calculated for this lake. Irregularity of segment sizes for Coffeen Lake and Lake of Egypt precluded calculation of mean percent available habitat.

The above method is calculated in two dimensions and provides an estimate of percent available habitat. Future work will involve using a contour map of each lake to determine percent available habitat on a volume basis. Also, the current method was based upon assumptions of rectangular basin shape and might be inaccurate due to changes in lake morphology. However, preliminary investigations suggested that even extreme changes in basin shape has little effect on the value calculated for percent available habitat.

Results and Discussion:

Temperature – Oxygen Profiles

Temperature and dissolved oxygen profiles are summarized in Appendix 15A, Figures 15A.1 – 15A.185. Time of measurement (when available) is also indicated on each graph. Figures 15A.1 – 15A.185 contain not only the regular biweekly temperature profiles but also profiles obtained from fish tracking (Chapter 14), profiles obtained by Ameren CIPS (Chapter 17), and profiles obtained during fish health sampling (Chapter 9). Reported profiles from fish tracking are for June – September of 1998 and 1999 in warm segments only (Segments 1 and 2 from Newton Lake, Segment 1 from Coffeen Lake, and Segment 1 from Lake of Egypt). Note that each profile obtained during fish tracking represents the location of at least one tracked fish. Also note that tracking profiles were taken at various points within the given segment, not at the midpoint of each segment as with the biweekly samples. Profiles obtained from Ameren CIPS were recorded during normal water quality sampling. Sites for these profiles are given in Figures 15.4 and 15.5. Profiles obtained during fish health sampling are given for July 30 – August 1. These dates coincided with the final days of the 1999 fish kill. Fish tracking, Ameren CIPS, and fish health – obtained profiles are interspersed throughout the regular biweekly profiles in Figures 15A.1 – 15A.185 to allow for comparison of proximate dates; origin of profile data is clearly indicated in the caption for each individual figure.

Temperature Loggers

Temperature logger data is summarized in Figures 15A.186 – 15A.218. Although mean daily temperature was recorded at several depths for each segment of each lake, to simplify interpretation only mean temperature for the surface and the deepest temperature logger is given. Tables 15A.1 – 15A.4 give data which were used to evaluate thermal variance compliance for both Newton Lake and Coffeen Lake. In Newton Lake, discharge temperatures never exceeded 111° F during 1998, while in 1999 discharge temperatures exceeded 111° F a total of 100 hours (maximum allowable number of hours exceeding 111° F = 110) (Table 15A.1). In Coffeen Lake, discharge temperatures never exceeded 112° F during 1998, while in 1999 discharge temperatures exceeded 112° F a total of 83 hours (maximum allowable number of hours exceeding 112° F = 132) (Table 15A.2). Mean monthly temperatures are given for Newton Lake (Table 15A.3) and Coffeen Lake (Table 15A.4).

Percent Habitat Available

High temperature and low oxygen, either individually or in combination, can adversely impact the fish community of a lake. Largemouth bass show reduced growth at oxygen levels below 4 mg L^{-1} (Stewart et al. 1967), and levels below 1 mg L^{-1} are considered lethal (Moss and Scott 1961). Suitable largemouth habitat decreases as midsummer oxygen levels fall below 5 mg L^{-1} and average growing season temperatures increase above 30° C (86° F) (Stuber et al. 1982b). Bluegill avoid oxygen levels from 1.5 to 3.0 mg L^{-1} (Whitmore et al. 1960), and optimal oxygen levels are 5.0 mg L^{-1} and above (Petit 1973). No growth of adult bluegill occurs above 30° C (86° F) (Anderson 1959), and the upper incipient lethal temperature for bluegill is 35° C (95° F) (Reynolds and Casterlin 1976, Stuber et al. 1982a).

Percent habitat available during the summer months (June, July, and August) of 1998 and 1999 is given for all 3 lakes in Tables 15A.5 – 15A.72. Low values for Lake of Egypt on July 30, 1998 (Table 15A.62) were likely due to a malfunctioning oxygen probe.

Percent habitat available for the winter months (December, January, and February) of 1997, 1998, and 1999 is given for all 3 lakes in Tables 15A.73 – 15A.107.

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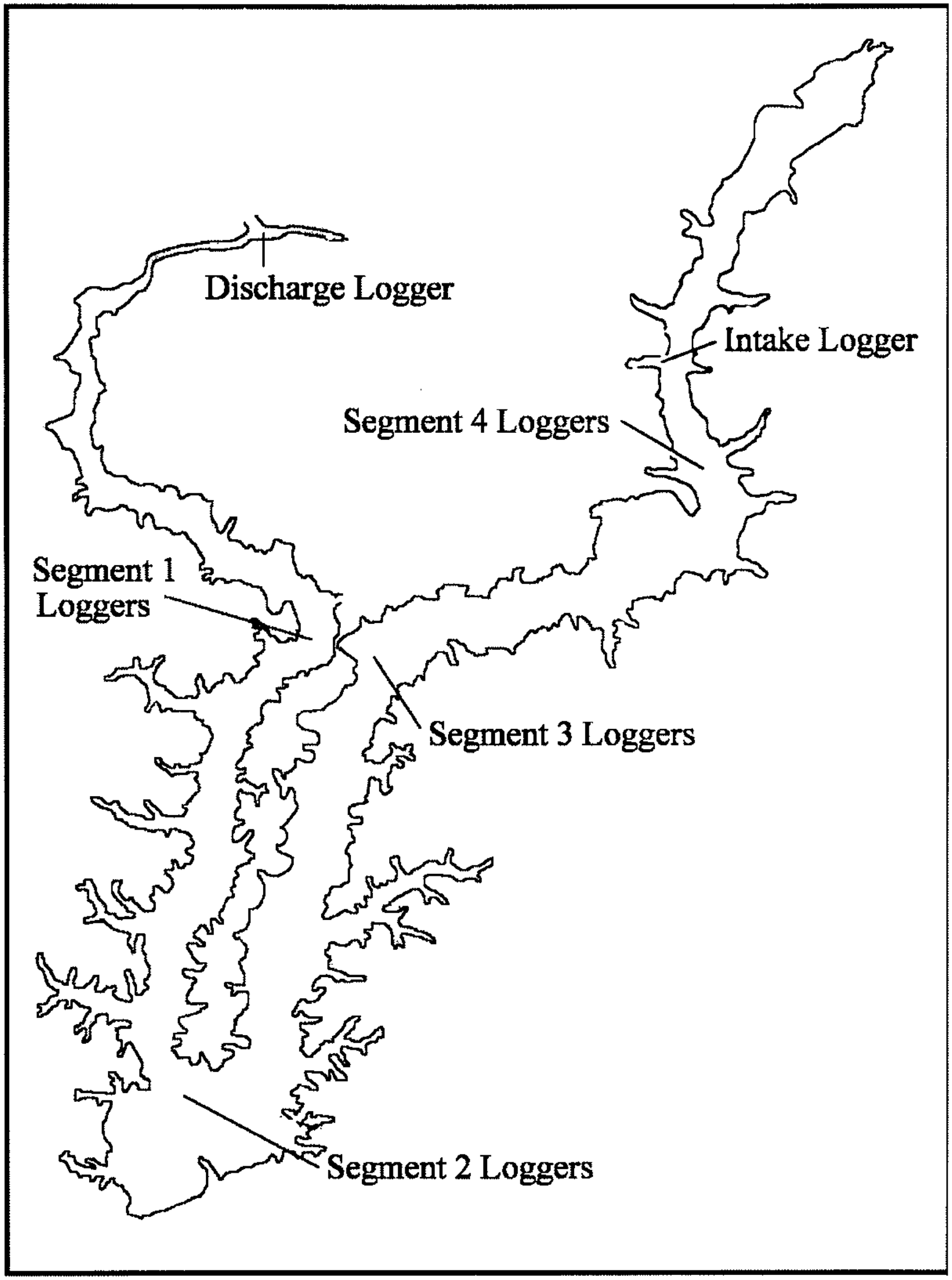


Figure 15.1. Location of temperature loggers in Newton Lake.

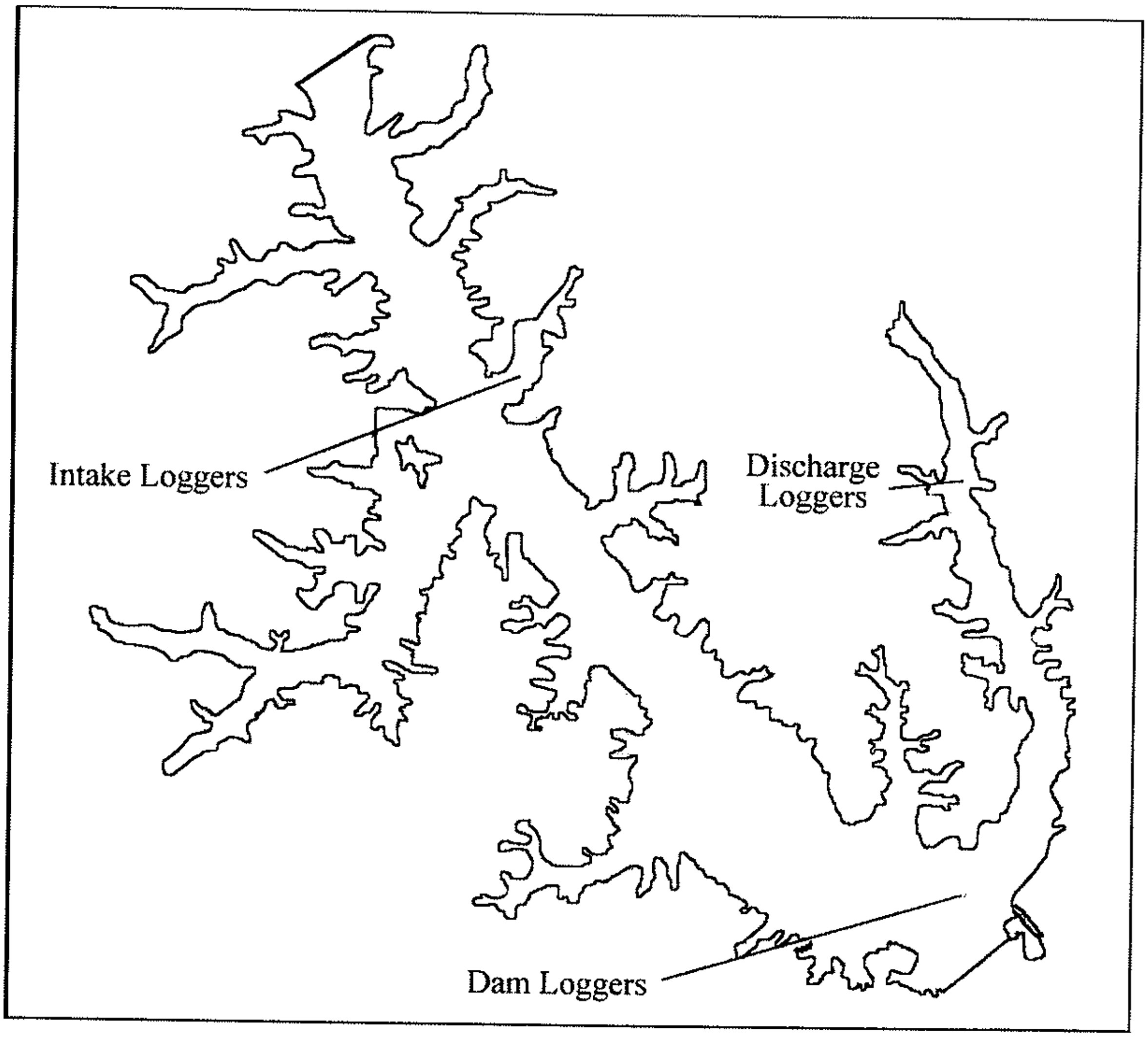


Figure 15.2. Location of temperature loggers in Coffeen Lake.

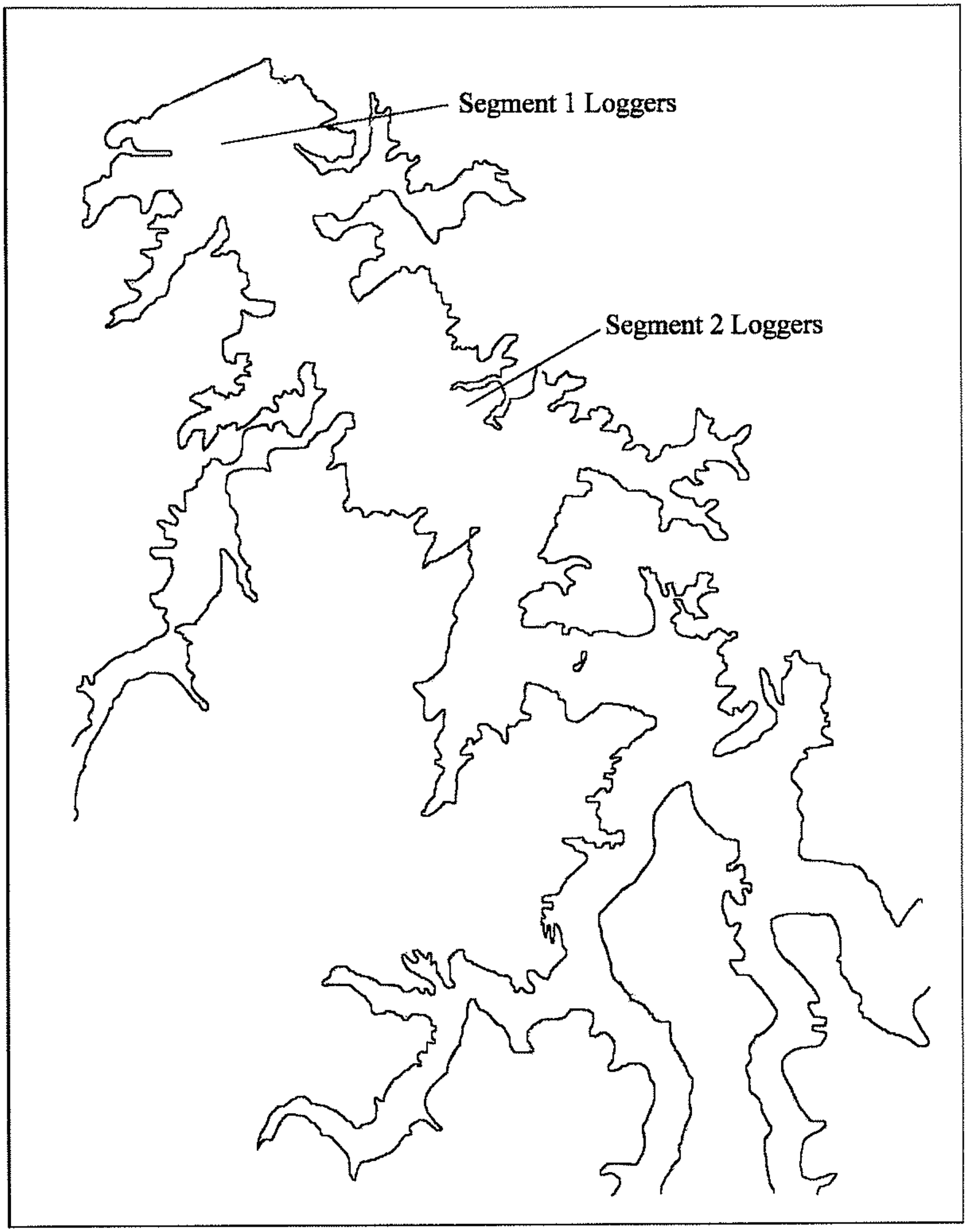


Figure 15.3. Location of temperature loggers in Lake of Egypt.

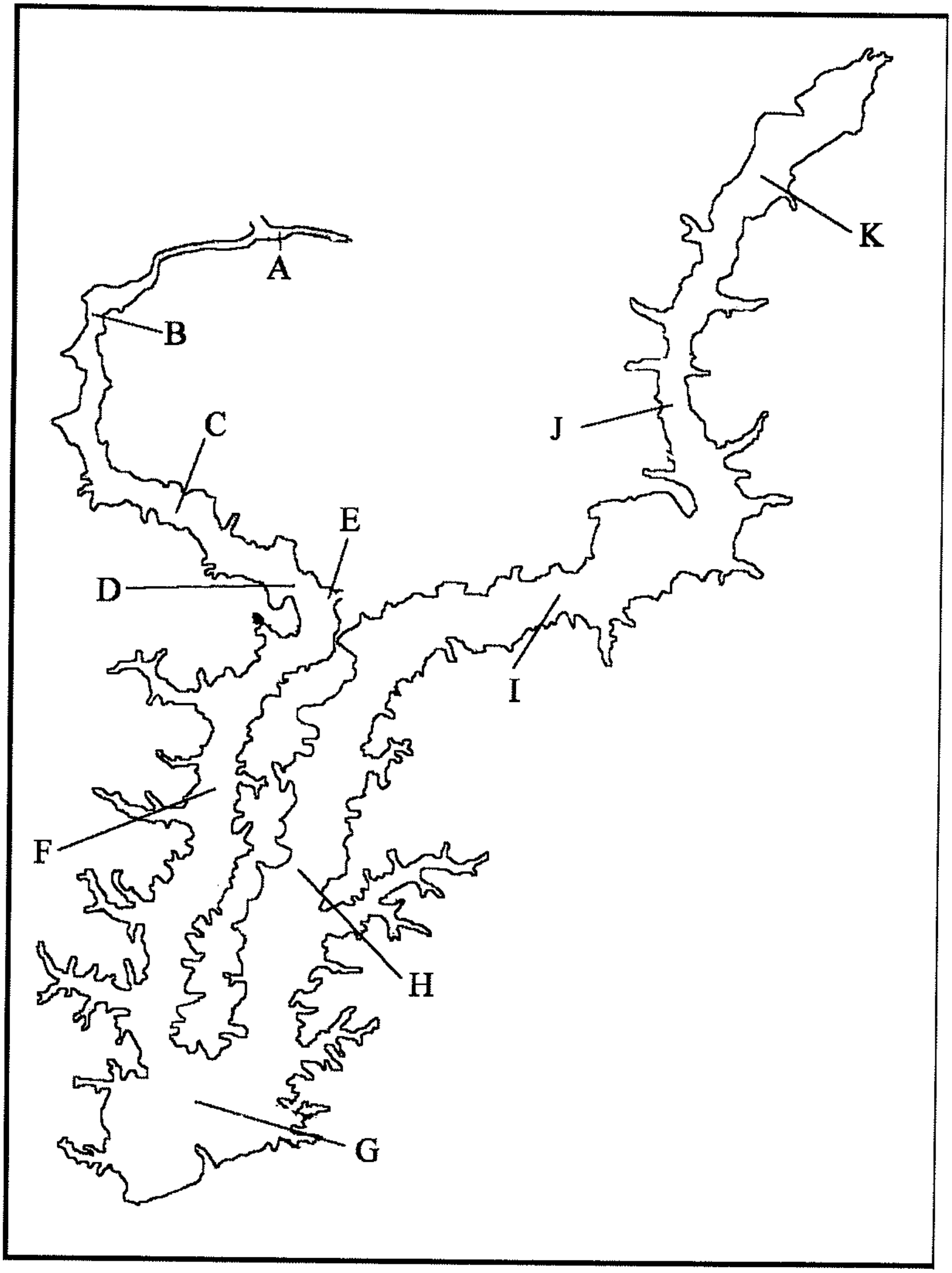


Figure 15.4. Location of Ameren CIPS water quality sampling sites, Newton Lake.

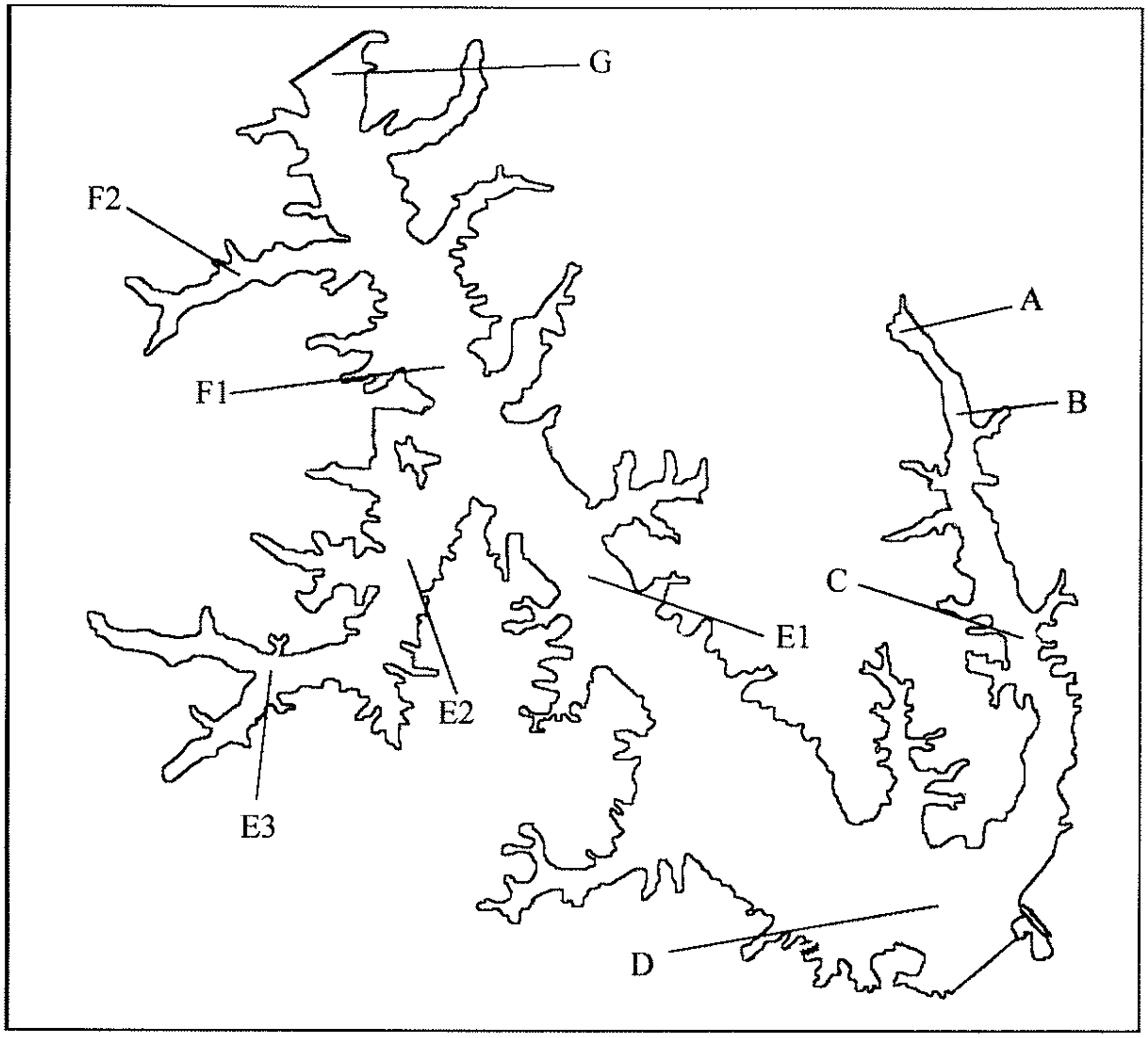


Figure 15.5. Location of Ameren CIPS water quality sampling sites, Coffeen Lake. Sites H and I (not shown) lie north of the railroad bridge.

Chapter 15 Appendix: Supplemental data tables and figures.

Table 15A.1. Hourly readings which exceeded 111° F, Newton Lake discharge, 1998 – 1999. Within a year, total hours above 111° F were not to exceed 110 (3% of total number of hours during the period June – October, 3672 hours).

Date	Time	Surface Temp.	Date	Time	Surface Temp.	Date	Time	Surface Temp.
07/22/1999	13:34:28	111.22	07/24/1999	20:34:28	111.47	07/28/1999	0:34:28	111.36
07/22/1999	14:34:28	111.39	07/24/1999	21:34:28	111.18	07/29/1999	12:34:28	111.33
07/22/1999	15:34:28	111.48	07/24/1999	22:34:28	111.01	07/29/1999	13:34:28	111.79
07/22/1999	16:34:28	111.65	07/25/1999	13:34:28	111.53	07/29/1999	14:34:28	111.99
07/22/1999	17:34:28	111.84	07/25/1999	14:34:28	111.5	07/29/1999	15:34:28	111.87
07/22/1999	18:34:28	112.03	07/25/1999	15:34:28	111.71	07/29/1999	16:34:28	111.99
07/22/1999	19:34:28	112.09	07/25/1999	16:34:28	111.77	07/29/1999	17:34:28	112.31
07/22/1999	20:34:29	112.06	07/25/1999	17:34:28	112.03	07/29/1999	18:34:28	111.43
07/22/1999	21:34:28	111.93	07/25/1999	18:34:28	112.13	07/29/1999	19:34:28	112.61
07/22/1999	22:34:28	111.85	07/25/1999	19:34:28	112.06	07/29/1999	20:34:28	112.85
07/22/1999	23:34:28	111.74	07/25/1999	20:34:28	112.11	07/29/1999	21:34:28	113
07/23/1999	0:34:28	111.48	07/25/1999	21:34:28	112.44	07/29/1999	22:34:28	112.39
07/23/1999	10:34:28	111.59	07/25/1999	22:34:28	112.53	07/29/1999	23:34:28	112.85
07/23/1999	11:34:29	112.01	07/25/1999	23:34:28	112.32	07/30/1999	0:34:28	112.79
07/23/1999	12:34:28	112.32	07/26/1999	11:34:28	111.15	07/30/1999	11:34:28	111.81
07/23/1999	13:34:28	112.53	07/26/1999	12:18:32	111.28	07/30/1999	12:34:28	111.85
07/23/1999	14:34:28	111.93	07/26/1999	16:34:28	111.35	07/30/1999	14:34:28	112.99
07/23/1999	15:34:28	112.06	07/26/1999	17:34:28	112.57	07/30/1999	15:34:28	113.31
07/23/1999	16:34:28	112.05	07/26/1999	18:34:28	112.46	07/30/1999	16:34:28	113.27
07/23/1999	17:34:28	111.98	07/26/1999	19:34:28	112.47	07/30/1999	17:34:28	113.35
07/23/1999	18:34:28	111.84	07/26/1999	20:34:28	112.34	07/30/1999	18:34:28	113.37
07/23/1999	19:34:28	111.77	07/26/1999	21:34:28	112.31	07/30/1999	19:34:28	113.51
07/23/1999	20:34:28	111.73	07/26/1999	22:34:28	112.33	07/30/1999	20:34:28	113.56
07/23/1999	21:34:28	111.79	07/26/1999	23:34:29	112.29	07/30/1999	21:34:28	113.63
07/23/1999	22:34:28	111.75	07/27/1999	0:34:28	112.23	07/30/1999	22:34:28	113.66
07/23/1999	23:34:28	111.49	07/27/1999	14:34:28	111.37	07/30/1999	23:34:28	113.64
07/24/1999	11:34:28	111.54	07/27/1999	15:34:28	111.54	07/31/1999	0:34:28	113.48
07/24/1999	12:34:28	111.96	07/27/1999	16:34:28	111.71	07/31/1999	1:34:28	111.98
07/24/1999	13:34:28	112.18	07/27/1999	17:34:28	111.82	07/31/1999	2:34:28	112.8
07/24/1999	14:34:28	112.27	07/27/1999	18:34:28	111.78	07/31/1999	3:34:28	112.67
07/24/1999	15:34:28	112.09	07/27/1999	19:34:28	111.57			
07/24/1999	16:34:28	112.05	07/27/1999	20:34:29	111.59	TOTAL HOURS	100	
07/24/1999	17:34:28	111.77	07/27/1999	21:34:28	111.7			
07/24/1999	18:34:28	111.7	07/27/1999	22:34:28	111.71			
07/24/1999	19:34:28	111.75	07/27/1999	23:34:28	111.6			

Table 15A.2. Hourly readings which exceeded 112° F, Coffeen Lake discharge, 1998 – 1999. Within a year, total hours above 112° F were not to exceed 132 (3% of total number of hours during the period May – October, 4416 hours).

Date	Time	Surface Temp.	Date	Time	Surface Temp.
07/23/1999	16:00:00	112	07/29/1999	13:00:00	112.89
07/23/1999	17:00:00	112.5	07/29/1999	14:00:00	114.24
07/23/1999	18:00:00	112.21	07/29/1999	15:00:00	114.02
07/23/1999	19:00:00	112.59	07/29/1999	16:00:00	114.14
07/23/1999	20:00:00	112.16	07/29/1999	17:00:00	114.56
07/25/1999	14:00:00	112.09	07/29/1999	18:00:00	114.67
07/25/1999	15:00:00	112.72	07/29/1999	19:00:00	114.19
07/25/1999	16:00:00	112.72	07/29/1999	20:00:00	114.21
07/25/1999	17:00:00	112.43	07/29/1999	21:00:00	113.6
07/25/1999	18:00:00	113.34	07/29/1999	22:00:00	114
07/25/1999	19:00:00	112.95	07/29/1999	23:00:00	113.89
07/25/1999	20:00:00	112.2	07/30/1999	1:00:00	113.24
07/25/1999	23:00:00	112.8	07/30/1999	2:00:00	113.9
07/26/1999	12:00:00	113.01	07/30/1999	3:00:00	113.11
07/26/1999	13:00:00	113.48	07/30/1999	4:00:00	112.34
07/26/1999	14:00:00	113.75	07/30/1999	12:00:00	112.74
07/26/1999	15:00:00	113.87	07/30/1999	13:00:00	114.2
07/26/1999	16:00:00	112.19	07/30/1999	14:00:00	114.3
07/26/1999	18:00:00	112.36	07/30/1999	15:00:00	114.65
07/26/1999	19:00:00	113.4	07/30/1999	16:00:00	114.88
07/26/1999	20:00:00	114.35	07/30/1999	17:00:00	115.05
07/26/1999	21:00:00	112.96	07/30/1999	18:00:00	115.39
07/26/1999	22:00:00	114.17	07/30/1999	19:00:00	114.06
07/26/1999	23:00:00	113.93	07/30/1999	20:00:00	113.44
07/27/1999	0:00:00	112.9	07/30/1999	21:00:00	113.52
07/27/1999	14:00:00	113.62	07/30/1999	22:00:00	112.95
07/27/1999	15:00:00	113.22	07/30/1999	23:00:00	113.64
07/27/1999	16:00:00	113.81	07/31/1999	1:00:00	112.54
07/27/1999	17:00:00	113.31	07/31/1999	2:00:00	112.31
07/27/1999	18:00:00	113.68	07/31/1999	14:00:00	113.02
07/27/1999	19:00:00	113.43	07/31/1999	15:00:00	112.88
07/27/1999	20:00:00	113.81	07/31/1999	18:00:00	113.29
07/27/1999	21:00:00	114	07/31/1999	19:00:00	113.83
07/27/1999	22:00:00	113.29	07/31/1999	20:00:00	114.09
07/27/1999	23:00:00	112.91	07/31/1999	21:00:00	114.2
07/28/1999	15:00:00	112.41	07/31/1999	22:00:00	113.68
07/28/1999	16:00:00	112.95	07/31/1999	23:00:00	112.83
07/28/1999	17:00:00	113.17	09/07/1999	14:00:00	120.27
07/28/1999	18:00:00	113.86	09/07/1999	15:00:00	120.08
07/28/1999	19:00:00	113.91	09/07/1999	16:00:00	122.49
07/28/1999	20:00:00	113.58			
07/28/1999	21:00:00	113.37	TOTAL HOURS	83	
07/28/1999	22:00:00	112.17			

Table 15A.3. Mean monthly surface temperature, Newton Lake discharge.

Year	Month	n	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	67.0
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	54.0
1999	February	28	67.0
1999	March	31	72.3
1999	April	30	77.3
1999	May	31	88.4
1999	June	30	97.0
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

Table 15A.4. Mean monthly surface temperature, Coffeen Lake discharge.

Year	Month	n	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	76.0
1997	December	31	73.3
1998	January	23	68.2
1998	February	0	
1998	March	0	
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 15A.5. Estimated percent habitat available in Newton Lake, June 5, 1998 (Segment 1 = 11:30 AM, Segment 2 = 1:10 PM, Segment 3 = 10:40 AM, Segment 4 = 10:20 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	Segment 3	Segment 4	mean
4	87	69	62	72	94	74
4	88	69	62	72	94	74
4	89	69	62	72	94	74
4	90	69	62	72	94	74
4	91	69	62	72	94	74
4	92	69	62	72	94	74
4	93	69	62	72	94	74
4	94	69	62	72	94	74
4	95	69	62	72	94	74
4	96	69	62	72	94	74
4	97	69	62	72	94	74
3	87	69	62	72	94	74
3	88	69	62	72	94	74
3	89	69	62	72	94	74
3	90	69	62	72	94	74
3	91	69	62	72	94	74
3	92	69	62	72	94	74
3	93	69	62	72	94	74
3	94	69	62	72	94	74
3	95	69	62	72	94	74
3	96	69	62	72	94	74
3	97	69	62	72	94	74
2	87	69	62	72	100	76
2	88	69	62	72	100	76
2	89	69	62	72	100	76
2	90	69	62	72	100	76
2	91	69	62	72	100	76
2	92	69	62	72	100	76
2	93	69	62	72	100	76
2	94	69	62	72	100	76
2	95	69	62	72	100	76
2	96	69	62	72	100	76
2	97	69	62	72	100	76
1	87	94	68	72	100	84
1	88	94	68	72	100	84
1	89	94	68	72	100	84
1	90	94	68	72	100	84
1	91	94	68	72	100	84
1	92	94	68	72	100	84
1	93	94	68	72	100	84
1	94	94	68	72	100	84
1	95	94	68	72	100	84
1	96	94	68	72	100	84
1	97	94	68	72	100	84

Table 15A.6. Estimated percent habitat available in Newton Lake, June 10, 1998 (Segment 1 = 4:53 PM, Segment 2 = 4:35 PM, Segment 3 = 4:11 PM, Segment 4 = 3:53 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	22	60	79	100	65
4	88	22	60	79	100	65
4	89	22	60	79	100	65
4	90	22	67	79	100	67
4	91	22	73	79	100	69
4	92	33	77	79	100	72
4	93	33	77	79	100	72
4	94	44	77	79	100	75
4	95	44	77	79	100	75
4	96	56	77	79	100	78
4	97	61	77	79	100	79
3	87	56	60	79	100	74
3	88	56	60	79	100	74
3	89	56	60	79	100	74
3	90	56	67	79	100	76
3	91	56	73	79	100	77
3	92	67	77	79	100	81
3	93	67	77	79	100	81
3	94	78	77	79	100	84
3	95	78	77	79	100	84
3	96	89	77	79	100	86
3	97	94	77	79	100	88
2	87	61	60	85	100	77
2	88	61	60	85	100	77
2	89	61	60	85	100	77
2	90	61	67	85	100	78
2	91	61	73	85	100	80
2	92	72	77	85	100	84
2	93	72	77	85	100	84
2	94	83	77	85	100	86
2	95	83	77	85	100	86
2	96	94	77	85	100	89
2	97	100	77	85	100	91
1	87	61	83	94	100	85
1	88	61	83	94	100	85
1	89	61	83	94	100	85
1	90	61	90	94	100	86
1	91	61	97	94	100	88
1	92	72	100	94	100	92
1	93	72	100	94	100	92
1	94	83	100	94	100	94
1	95	83	100	94	100	94
1	96	94	100	94	100	97
1	97	100	100	94	100	99

Table 15A.7. Estimated percent habitat available in Newton Lake, June 26, 1998 (Segment 1 = 2:51 PM, Segment 2 = 2:20 PM, Segment 3 = 2:00 PM, Segment 4 = 1:40 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	0	0
4	88	0	0	0	0	0
4	89	0	0	0	55	14
4	90	0	0	6	64	18
4	91	0	0	12	77	22
4	92	0	0	24	77	25
4	93	0	0	24	77	25
4	94	0	0	38	77	29
4	95	0	0	38	77	29
4	96	0	0	38	77	29
4	97	0	0	38	77	29
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	55	14
3	90	0	0	6	64	18
3	91	0	0	18	86	26
3	92	0	0	29	86	29
3	93	0	0	29	86	29
3	94	0	0	44	86	33
3	95	0	0	44	86	33
3	96	0	0	44	86	33
3	97	0	0	44	86	33
2	87	0	6	0	0	2
2	88	0	6	0	0	2
2	89	0	6	0	55	15
2	90	0	13	6	64	21
2	91	0	13	18	95	32
2	92	0	13	29	95	34
2	93	0	13	29	95	34
2	94	0	13	44	95	38
2	95	0	13	44	95	38
2	96	0	13	44	95	38
2	97	0	13	44	95	38
1	87	0	19	0	0	5
1	88	0	19	0	0	5
1	89	0	19	0	55	19
1	90	0	25	6	64	24
1	91	0	25	18	95	35
1	92	0	25	29	95	37
1	93	0	25	29	95	37
1	94	0	25	44	95	41
1	95	0	25	44	95	41
1	96	0	25	44	95	41
1	97	0	25	44	95	41

Table 15A.8. Estimated percent habitat available in Newton Lake, July 11, 1998 (Segment 1 = 8:44 AM, Segment 2 = 9:04 AM, Segment 3 = 9:31 AM, Segment 4 = 10:00 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	Segment 3	Segment 4	mean
4	87	0	0	0	0	0
4	88	0	0	0	65	16
4	89	0	0	6	65	18
4	90	0	0	24	65	22
4	91	0	0	50	65	29
4	92	0	0	50	65	29
4	93	0	0	50	65	29
4	94	0	0	50	65	29
4	95	0	0	50	65	29
4	96	0	0	50	65	29
4	97	0	42	50	65	39
3	87	0	0	0	0	0
3	88	0	0	0	65	16
3	89	0	0	6	65	18
3	90	0	0	24	65	22
3	91	0	0	50	65	29
3	92	0	0	50	65	29
3	93	0	0	50	65	29
3	94	0	0	50	65	29
3	95	0	0	50	65	29
3	96	0	0	50	65	29
3	97	0	42	50	65	39
2	87	0	0	0	0	0
2	88	0	0	0	65	16
2	89	0	0	6	65	18
2	90	0	0	24	65	22
2	91	0	8	50	65	31
2	92	0	8	50	65	31
2	93	0	8	50	65	31
2	94	13	8	50	65	34
2	95	13	8	50	65	34
2	96	13	8	50	65	34
2	97	13	50	50	65	45
1	87	0	0	6	10	4
1	88	0	15	6	75	24
1	89	0	15	12	75	26
1	90	0	15	29	75	30
1	91	13	23	56	75	42
1	92	13	23	56	75	42
1	93	13	23	56	75	42
1	94	25	23	56	75	45
1	95	25	23	56	75	45
1	96	25	23	56	75	45
1	97	25	65	56	75	55

Table 15A.9 Estimated percent habitat available in Newton Lake, July 18, 1998 (Segment 1 = 7:07 PM, Segment 2 = 6:41 PM, Segment 3 = 6:15 PM, Segment 4 = 5:54 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	6	0	2
4	88	0	0	18	10	7
4	89	0	0	18	30	12
4	90	0	0	24	40	16
4	91	0	0	29	80	27
4	92	0	0	41	95	34
4	93	0	6	47	95	37
4	94	0	6	56	95	39
4	95	0	18	56	95	42
4	96	0	24	56	95	44
4	97	0	24	56	95	44
3	87	0	0	6	0	2
3	88	0	0	18	10	7
3	89	0	0	18	30	12
3	90	0	0	24	40	16
3	91	0	0	29	80	27
3	92	0	6	41	95	36
3	93	0	12	47	95	39
3	94	0	12	56	95	41
3	95	11	24	56	95	47
3	96	11	29	56	95	48
3	97	11	29	56	95	48
2	87	0	0	6	0	2
2	88	0	0	18	10	7
2	89	0	0	18	30	12
2	90	0	0	24	40	16
2	91	0	0	29	80	27
2	92	0	6	41	95	36
2	93	0	12	47	95	39
2	94	0	12	56	95	41
2	95	11	24	56	95	47
2	96	11	29	56	95	48
2	97	11	29	56	95	48
1	87	0	12	12	0	6
1	88	0	18	24	10	13
1	89	0	18	24	30	18
1	90	0	18	29	40	22
1	91	0	18	35	80	33
1	92	0	24	47	95	42
1	93	0	29	53	95	44
1	94	0	29	62	95	47
1	95	11	41	62	95	52
1	96	11	47	62	95	54
1	97	11	47	62	95	54

Table 15A.10. Estimated percent habitat available in Newton Lake, July 30, 1998 (Time unknown). 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	11	77	22
4	88	0	0	53	77	33
4	89	0	0	53	77	33
4	90	0	0	53	77	33
4	91	0	0	53	77	33
4	92	0	0	53	77	33
4	93	0	0	53	77	33
4	94	0	38	53	77	42
4	95	0	38	53	77	42
4	96	6	38	53	77	44
4	97	19	38	53	77	47
3	87	0	0	17	77	24
3	88	0	6	58	77	35
3	89	0	6	58	77	35
3	90	0	6	58	77	35
3	91	0	6	58	77	35
3	92	0	6	58	77	35
3	93	0	6	58	77	35
3	94	0	44	58	77	45
3	95	0	44	58	77	45
3	96	19	44	58	77	50
3	97	56	44	58	77	59
2	87	0	12	17	77	27
2	88	0	18	58	77	38
2	89	0	18	58	77	38
2	90	0	18	58	77	38
2	91	0	18	58	77	38
2	92	0	18	58	77	38
2	93	0	18	58	77	38
2	94	0	56	58	77	48
2	95	0	56	58	77	48
2	96	19	56	58	77	53
2	97	56	56	58	77	62
1	87	0	18	17	95	33
1	88	0	24	58	95	44
1	89	0	24	58	95	44
1	90	0	24	58	95	44
1	91	0	24	58	95	44
1	92	13	24	58	95	48
1	93	13	24	58	95	48
1	94	13	62	58	95	57
1	95	13	62	58	95	57
1	96	31	62	58	95	62
1	97	69	62	58	95	71

Table 15A.11. Estimated percent habitat available in Newton Lake, August 4, 1998 (Time unknown). 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	
4	87	0	0	15	30	11
4	88	0	0	30	70	25
4	89	0	0	53	95	37
4	90	0	0	53	95	37
4	91	0	0	53	95	37
4	92	0	10	53	95	40
4	93	0	15	53	95	41
4	94	0	20	53	95	42
4	95	0	28	53	95	44
4	96	0	28	53	95	44
4	97	11	28	53	95	47
3	87	0	0	15	30	11
3	88	0	0	30	70	25
3	89	0	0	53	95	37
3	90	0	0	53	95	37
3	91	0	0	53	95	37
3	92	0	10	53	95	40
3	93	0	15	53	95	41
3	94	0	20	53	95	42
3	95	0	28	53	95	44
3	96	0	28	53	95	44
3	97	11	28	53	95	47
2	87	0	0	15	35	13
2	88	0	0	30	75	26
2	89	0	0	53	100	38
2	90	0	0	53	100	38
2	91	0	0	53	100	38
2	92	0	10	53	100	41
2	93	0	15	53	100	42
2	94	0	20	53	100	43
2	95	0	28	53	100	45
2	96	0	28	53	100	45
2	97	11	28	53	100	48
1	87	0	25	20	35	20
1	88	0	25	35	75	34
1	89	0	25	58	100	46
1	90	0	25	58	100	46
1	91	0	25	58	100	46
1	92	11	35	58	100	51
1	93	11	40	58	100	52
1	94	11	45	58	100	54
1	95	11	53	58	100	56
1	96	11	53	58	100	56
1	97	22	53	58	100	58

Table 15A.12. Estimated percent habitat available in Newton Lake, August 24, 1998 (Segment 1 = 5:26 PM, Segment 2 = 5:03 PM, Segment 3 = 4:36 PM, Segment 4 = 4:14 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	0	0
4	88	0	0	0	0	0
4	89	0	0	6	0	2
4	90	0	0	11	100	28
4	91	0	0	17	100	29
4	92	0	0	53	100	38
4	93	0	0	53	100	38
4	94	0	0	53	100	38
4	95	0	0	53	100	38
4	96	0	13	53	100	42
4	97	7	20	53	100	45
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	17	100	29
3	91	0	0	22	100	31
3	92	0	0	58	100	40
3	93	0	0	58	100	40
3	94	0	0	58	100	40
3	95	0	0	58	100	40
3	96	0	13	58	100	43
3	97	7	20	58	100	46
2	87	0	0	0	0	0
2	88	0	0	6	0	2
2	89	0	0	11	0	3
2	90	0	0	17	100	29
2	91	0	0	22	100	31
2	92	0	0	58	100	40
2	93	0	0	58	100	40
2	94	0	0	58	100	40
2	95	0	0	58	100	40
2	96	0	13	58	100	43
2	97	7	20	58	100	46
1	87	0	0	0	0	0
1	88	0	7	6	0	3
1	89	0	7	11	0	5
1	90	0	7	17	100	31
1	91	0	13	22	100	34
1	92	0	13	58	100	43
1	93	0	13	58	100	43
1	94	0	13	58	100	43
1	95	0	13	58	100	43
1	96	0	27	58	100	46
1	97	7	33	58	100	50

Table 15A.13. Estimated percent habitat available in Newton Lake, June 2, 1999 (Segment 1 = 4:54 PM, Segment 2 = 4:15 PM, Segment 3 = 3:47 PM, Segment 4 = 3:25 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	17	62	100	45
4	88	22	22	62	100	52
4	89	44	22	62	100	57
4	90	72	42	62	100	69
4	91	72	42	62	100	69
4	92	72	42	62	100	69
4	93	72	42	62	100	69
4	94	72	42	62	100	69
4	95	72	42	62	100	69
4	96	72	42	62	100	69
4	97	72	42	62	100	69
3	87	0	17	62	100	45
3	88	22	22	62	100	52
3	89	44	22	62	100	57
3	90	72	42	62	100	69
3	91	72	42	62	100	69
3	92	72	42	62	100	69
3	93	72	42	62	100	69
3	94	72	42	62	100	69
3	95	72	42	62	100	69
3	96	72	42	62	100	69
3	97	72	42	62	100	69
2	87	0	28	68	100	49
2	88	22	33	68	100	56
2	89	44	33	68	100	61
2	90	72	53	68	100	73
2	91	72	53	68	100	73
2	92	72	53	68	100	73
2	93	72	53	68	100	73
2	94	72	53	68	100	73
2	95	72	53	68	100	73
2	96	72	53	68	100	73
2	97	72	53	68	100	73
1	87	0	33	68	100	50
1	88	22	39	68	100	57
1	89	44	39	68	100	63
1	90	72	58	68	100	75
1	91	72	58	68	100	75
1	92	72	58	68	100	75
1	93	72	58	68	100	75
1	94	72	58	68	100	75
1	95	72	58	68	100	75
1	96	72	58	68	100	75
1	97	72	58	68	100	75

Table 15A.14. Estimated percent habitat available in Newton Lake, June 18, 1999 (Segment 1 = 5:25 PM, Segment 2 = 5:42 PM, Segment 3 = 5:00 PM, Segment 4 = 4:41 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	33	68	86	47
4	88	11	33	68	86	50
4	89	22	50	68	86	57
4	90	22	50	68	86	57
4	91	33	50	68	86	59
4	92	33	50	68	86	59
4	93	44	50	68	86	62
4	94	72	50	68	86	69
4	95	72	50	68	86	69
4	96	72	50	68	86	69
4	97	72	50	68	86	69
3	87	11	47	74	86	55
3	88	22	47	74	86	57
3	89	33	63	74	86	64
3	90	33	63	74	86	64
3	91	44	63	74	86	67
3	92	44	63	74	86	67
3	93	56	63	74	86	70
3	94	83	63	74	86	77
3	95	83	63	74	86	77
3	96	83	63	74	86	77
3	97	83	63	74	86	77
2	87	11	53	74	95	58
2	88	22	53	74	95	61
2	89	33	70	74	95	68
2	90	33	70	74	95	68
2	91	44	70	74	95	71
2	92	44	70	74	95	71
2	93	56	70	74	95	74
2	94	83	70	74	95	81
2	95	83	70	74	95	81
2	96	83	70	74	95	81
2	97	83	70	74	95	81
1	87	11	60	74	95	60
1	88	22	60	74	95	63
1	89	33	77	74	95	70
1	90	33	77	74	95	70
1	91	44	77	74	95	73
1	92	44	77	74	95	73
1	93	56	77	74	95	76
1	94	83	77	74	95	82
1	95	83	77	74	95	82
1	96	83	77	74	95	82
1	97	83	77	74	95	82

Table 15A.15. Estimated percent habitat available in Newton Lake, July 2, 1999 (Segment 1 = 4:35 PM, Segment 2 = 4:00 PM, Segment 3 = 3:21 PM, Segment 4 = 2:45 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	39	95	34
4	88	0	0	44	95	35
4	89	11	0	50	95	39
4	90	11	0	53	95	40
4	91	33	6	53	95	47
4	92	33	12	53	95	48
4	93	44	18	53	95	53
4	94	56	26	53	95	58
4	95	56	26	53	95	58
4	96	78	26	53	95	63
4	97	83	26	53	95	64
3	87	0	18	39	100	39
3	88	0	18	44	100	41
3	89	11	18	50	100	45
3	90	11	18	53	100	46
3	91	33	24	53	100	53
3	92	33	29	53	100	54
3	93	44	35	53	100	58
3	94	56	44	53	100	63
3	95	56	44	53	100	63
3	96	78	44	53	100	69
3	97	83	44	53	100	70
2	87	11	24	44	100	45
2	88	11	24	50	100	46
2	89	22	24	56	100	51
2	90	22	24	58	100	51
2	91	44	29	58	100	58
2	92	44	35	58	100	59
2	93	56	41	58	100	64
2	94	67	50	58	100	69
2	95	67	50	58	100	69
2	96	89	50	58	100	74
2	97	94	50	58	100	76
1	87	11	29	44	100	46
1	88	11	29	50	100	48
1	89	22	29	56	100	52
1	90	22	29	58	100	52
1	91	44	35	58	100	59
1	92	44	41	58	100	61
1	93	56	47	58	100	65
1	94	67	56	58	100	70
1	95	67	56	58	100	70
1	96	89	56	58	100	76
1	97	94	56	58	100	77

Table 15A.16. Estimated percent habitat available in Newton Lake, July 13, 1999 (Segment 1 = 10:00 AM, Segment 2 = 11:15 AM, Segment 3 = 12:20 PM, Segment 4 = 1:25 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	18	47	95	40
4	88	0	41	59	100	50
4	89	22	47	62	100	58
4	90	22	56	62	100	60
4	91	22	56	62	100	60
4	92	61	56	62	100	70
4	93	61	56	62	100	70
4	94	61	56	62	100	70
4	95	61	56	62	100	70
4	96	61	56	62	100	70
4	97	61	56	62	100	70
3	87	0	18	53	95	42
3	88	0	41	65	100	52
3	89	22	47	68	100	59
3	90	22	56	68	100	62
3	91	22	56	68	100	62
3	92	61	56	68	100	71
3	93	61	56	68	100	71
3	94	61	56	68	100	71
3	95	61	56	68	100	71
3	96	61	56	68	100	71
3	97	61	56	68	100	71
2	87	0	18	53	95	42
2	88	22	41	65	100	57
2	89	44	47	68	100	65
2	90	44	56	68	100	67
2	91	44	56	68	100	67
2	92	83	56	68	100	77
2	93	83	56	68	100	77
2	94	83	56	68	100	77
2	95	83	56	68	100	77
2	96	83	56	68	100	77
2	97	83	56	68	100	77
1	87	11	24	53	95	46
1	88	33	47	65	100	61
1	89	56	53	68	100	69
1	90	56	62	68	100	72
1	91	56	62	68	100	72
1	92	94	62	68	100	81
1	93	94	62	68	100	81
1	94	94	62	68	100	81
1	95	94	62	68	100	81
1	96	94	62	68	100	81
1	97	94	62	68	100	81

Table 15A.17. 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	Maximum	% Habitat Available				
Oxygen (ppm)	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	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 15A.18. 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 15A.19. 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	Maximum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	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 15A.20. 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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available 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 15A.21. 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 15A.22. 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 15A.23. Estimated percent habitat available in Coffeen Lake, June 5, 1998 (Segment 1 = 3:54 PM, Segment 2 = 3:20 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	58	100
4	88	58	100
4	89	58	100
4	90	58	100
4	91	58	100
4	92	58	100
4	93	58	100
4	94	58	100
4	95	58	100
4	96	58	100
4	97	58	100
3	87	85	100
3	88	85	100
3	89	85	100
3	90	85	100
3	91	85	100
3	92	85	100
3	93	85	100
3	94	85	100
3	95	85	100
3	96	85	100
3	97	85	100
2	87	100	100
2	88	100	100
2	89	100	100
2	90	100	100
2	91	100	100
2	92	100	100
2	93	100	100
2	94	100	100
2	95	100	100
2	96	100	100
2	97	100	100
1	87	100	100
1	88	100	100
1	89	100	100
1	90	100	100
1	91	100	100
1	92	100	100
1	93	100	100
1	94	100	100
1	95	100	100
1	96	100	100
1	97	100	100

Table 15A.24. Estimated percent habitat available outside of Coffeen Lake cooling loop, June 9, 1998 (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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
4	87		100	100
4	88		100	100
4	89		100	100
4	90		100	100
4	91		100	100
4	92		100	100
4	93		100	100
4	94		100	100
4	95		100	100
4	96		100	100
4	97		100	100
3	87		100	100
3	88		100	100
3	89		100	100
3	90		100	100
3	91		100	100
3	92		100	100
3	93		100	100
3	94		100	100
3	95		100	100
3	96		100	100
3	97		100	100
2	87		100	100
2	88		100	100
2	89		100	100
2	90		100	100
2	91		100	100
2	92		100	100
2	93		100	100
2	94		100	100
2	95		100	100
2	96		100	100
2	97		100	100
1	87		100	100
1	88		100	100
1	89		100	100
1	90		100	100
1	91		100	100
1	92		100	100
1	93		100	100
1	94		100	100
1	95		100	100
1	96		100	100
1	97		100	100

Table 15A.25. Estimated percent habitat available in Coffeen Lake, June 16, 1998 (Segment 1 = 3:23 PM, Segment 2 = 3:50 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	21	31
4	88	21	31
4	89	32	31
4	90	37	31
4	91	37	31
4	92	42	31
4	93	55	31
4	94	55	31
4	95	55	31
4	96	55	31
4	97	55	31
3	87	37	48
3	88	37	48
3	89	47	48
3	90	53	48
3	91	53	48
3	92	58	48
3	93	71	48
3	94	71	48
3	95	71	48
3	96	71	48
3	97	71	48
2	87	47	77
2	88	47	77
2	89	58	77
2	90	63	77
2	91	63	77
2	92	68	77
2	93	82	77
2	94	82	77
2	95	82	77
2	96	82	77
2	97	82	77
1	87	66	94
1	88	66	94
1	89	76	94
1	90	82	94
1	91	82	94
1	92	87	94
1	93	100	94
1	94	100	94
1	95	100	94
1	96	100	94
1	97	100	94

Table 15A.26. Estimated percent habitat available outside of Coffeen Lake cooling loop, June 23, 1998 (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	18	6	31
4	88	35	61	69
4	89	41	83	77
4	90	47	94	96
4	91	59	100	96
4	92	68	100	96
4	93	68	100	96
4	94	68	100	96
4	95	68	100	96
4	96	68	100	96
4	97	68	100	96
3	87	29	6	35
3	88	47	61	73
3	89	53	83	81
3	90	59	94	100
3	91	71	100	100
3	92	79	100	100
3	93	79	100	100
3	94	79	100	100
3	95	79	100	100
3	96	79	100	100
3	97	79	100	100
2	87	41	6	35
2	88	59	61	73
2	89	65	83	81
2	90	71	94	100
2	91	82	100	100
2	92	91	100	100
2	93	91	100	100
2	94	91	100	100
2	95	91	100	100
2	96	91	100	100
2	97	91	100	100
1	87	50	6	35
1	88	68	61	73
1	89	74	83	81
1	90	79	94	100
1	91	91	100	100
1	92	100	100	100
1	93	100	100	100
1	94	100	100	100
1	95	100	100	100
1	96	100	100	100
1	97	100	100	100

Table 15A.27. Estimated percent habitat available in Coffeen Lake, June 26, 1998 (Segment 1 = 5:03 PM, Segment 2 = 5:29 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	17	8
4	88	17	12
4	89	22	20
4	90	28	20
4	91	33	24
4	92	33	28
4	93	33	36
4	94	39	40
4	95	39	44
4	96	39	44
4	97	39	54
3	87	22	20
3	88	22	24
3	89	28	32
3	90	33	32
3	91	39	36
3	92	39	40
3	93	39	48
3	94	44	52
3	95	44	56
3	96	44	56
3	97	44	66
2	87	33	28
2	88	33	32
2	89	39	40
2	90	44	40
2	91	50	44
2	92	50	48
2	93	50	56
2	94	56	60
2	95	56	64
2	96	56	64
2	97	56	74
1	87	39	32
1	88	39	36
1	89	44	44
1	90	50	44
1	91	56	48
1	92	56	52
1	93	56	60
1	94	61	64
1	95	61	68
1	96	61	68
1	97	61	78

Table 15A.28. Estimated percent habitat available in Coffeen Lake, July 3, 1998 (Segment 1 = 3:02 PM, Segment 2 = 3:32 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	0	4
4	94	0	4
4	95	0	13
4	96	0	28
4	97	0	28
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	4
3	91	5	9
3	92	11	9
3	93	11	17
3	94	11	22
3	95	11	30
3	96	21	46
3	97	26	46
2	87	0	0
2	88	0	0
2	89	0	13
2	90	11	17
2	91	21	22
2	92	26	22
2	93	26	30
2	94	26	35
2	95	26	43
2	96	37	59
2	97	42	59
1	87	5	9
1	88	5	9
1	89	11	22
1	90	21	26
1	91	32	30
1	92	37	30
1	93	37	39
1	94	37	43
1	95	37	52
1	96	47	67
1	97	53	67

Table 15A.29. Estimated percent habitat available outside of Coffeen Lake cooling loop, July 7, 1998 (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	0
4	88	0	0	0
4	89	0	0	14
4	90	11	6	21
4	91	47	100	96
4	92	58	100	96
4	93	76	100	96
4	94	76	100	96
4	95	76	100	96
4	96	76	100	96
4	97	76	100	96
3	87	0	0	4
3	88	5	0	4
3	89	5	0	18
3	90	16	6	25
3	91	53	100	100
3	92	63	100	100
3	93	82	100	100
3	94	82	100	100
3	95	82	100	100
3	96	82	100	100
3	97	82	100	100
2	87	5	0	4
2	88	16	0	4
2	89	16	0	18
2	90	26	6	25
2	91	63	100	100
2	92	74	100	100
2	93	92	100	100
2	94	92	100	100
2	95	92	100	100
2	96	92	100	100
2	97	92	100	100
1	87	5	0	4
1	88	16	0	4
1	89	16	0	18
1	90	26	6	25
1	91	63	100	100
1	92	74	100	100
1	93	92	100	100
1	94	92	100	100
1	95	92	100	100
1	96	92	100	100
1	97	92	100	100

Table 15A.30. Estimated percent habitat available in Coffeen Lake, July 10, 1998 (Segment 1 = 2:01 PM, Segment 2 = 2:26 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	5
4	91	0	9
4	92	0	18
4	93	0	23
4	94	0	27
4	95	0	27
4	96	0	27
4	97	0	43
3	87	0	0
3	88	0	0
3	89	0	5
3	90	0	18
3	91	5	23
3	92	5	32
3	93	10	36
3	94	10	41
3	95	10	41
3	96	10	41
3	97	10	57
2	87	0	0
2	88	0	0
2	89	5	5
2	90	14	18
2	91	19	23
2	92	19	32
2	93	24	36
2	94	24	41
2	95	24	41
2	96	24	41
2	97	24	57
1	87	0	5
1	88	0	9
1	89	14	18
1	90	24	32
1	91	29	36
1	92	29	45
1	93	33	50
1	94	33	55
1	95	33	55
1	96	33	55
1	97	33	70

Table 15A.31. Estimated percent habitat available in Coffeen Lake, July 14, 1998 (Segment 1 = 1:27 PM, Segment 2 = 2:02 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	5	4
4	92	10	54
4	93	10	54
4	94	10	54
4	95	14	54
4	96	24	54
4	97	24	54
3	87	0	0
3	88	0	0
3	89	0	0
3	90	5	0
3	91	10	4
3	92	14	54
3	93	14	54
3	94	14	54
3	95	19	54
3	96	29	54
3	97	29	54
2	87	0	0
2	88	0	8
2	89	0	12
2	90	5	12
2	91	10	16
2	92	14	66
2	93	14	66
2	94	14	66
2	95	19	66
2	96	29	66
2	97	29	66
1	87	0	4
1	88	0	12
1	89	5	16
1	90	10	16
1	91	14	20
1	92	19	70
1	93	19	70
1	94	19	70
1	95	24	70
1	96	33	70
1	97	33	70

Table 15A.32. Estimated percent habitat available outside of Coffeen Lake cooling loop, July 21, 1998 (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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
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	6	0	0
4	93	6	0	0
4	94	6	6	0
4	95	12	28	75
4	96	56	100	75
4	97	56	100	75
3	87	0	0	0
3	88	0	0	4
3	89	0	0	11
3	90	6	0	25
3	91	6	0	25
3	92	12	0	25
3	93	12	0	25
3	94	12	6	25
3	95	18	28	100
3	96	62	100	100
3	97	62	100	100
2	87	0	0	0
2	88	12	0	4
2	89	24	0	11
2	90	35	0	25
2	91	35	0	25
2	92	41	0	25
2	93	41	0	25
2	94	41	6	25
2	95	47	28	100
2	96	91	100	100
2	97	91	100	100
1	87	0	0	0
1	88	12	0	4
1	89	24	0	11
1	90	35	0	25
1	91	35	0	25
1	92	41	0	25
1	93	41	0	25
1	94	41	6	25
1	95	47	28	100
1	96	91	100	100
1	97	91	100	100

Table 15A.33. Estimated percent habitat available in Coffeen Lake, July 24, 1998 (Segment 1 = 11:04 AM, Segment 2 = 11:29 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)	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	22
4	94	11	39
4	95	17	54
4	96	17	54
4	97	22	54
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	4
3	92	0	13
3	93	6	26
3	94	17	43
3	95	22	59
3	96	22	59
3	97	28	59
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	4
2	91	0	9
2	92	6	17
2	93	11	30
2	94	22	48
2	95	28	63
2	96	28	63
2	97	33	63
1	87	0	9
1	88	0	9
1	89	0	9
1	90	0	17
1	91	6	22
1	92	11	30
1	93	17	43
1	94	28	61
1	95	33	76
1	96	33	76
1	97	39	76

Table 15A.34. Estimated percent habitat available in Coffeen Lake, July 31, 1998 (Segment 1 = 3:45 PM, Segment 2 = 1:22 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	5
4	88	0	9
4	89	0	23
4	90	0	45
4	91	0	55
4	92	5	59
4	93	5	68
4	94	5	75
4	95	5	75
4	96	10	75
4	97	10	75
3	87	0	5
3	88	0	9
3	89	0	23
3	90	0	45
3	91	5	55
3	92	10	59
3	93	10	68
3	94	10	75
3	95	10	75
3	96	15	75
3	97	15	75
2	87	0	9
2	88	0	14
2	89	0	27
2	90	15	50
2	91	20	59
2	92	25	64
2	93	25	73
2	94	25	80
2	95	25	80
2	96	30	80
2	97	30	80
1	87	0	14
1	88	0	18
1	89	5	32
1	90	25	55
1	91	30	64
1	92	35	68
1	93	35	77
1	94	35	84
1	95	35	84
1	96	40	84
1	97	40	84

Table 15A.35. Estimated percent habitat available outside of Coffeen Lake cooling loop, August 4, 1998 (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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
4	87	0	0	0
4	88	6	0	4
4	89	17	15	4
4	90	33	75	77
4	91	44	100	100
4	92	81	100	100
4	93	81	100	100
4	94	81	100	100
4	95	81	100	100
4	96	81	100	100
4	97	81	100	100
3	87	6	0	0
3	88	11	0	4
3	89	22	15	4
3	90	39	75	77
3	91	50	100	100
3	92	86	100	100
3	93	86	100	100
3	94	86	100	100
3	95	86	100	100
3	96	86	100	100
3	97	86	100	100
2	87	17	0	0
2	88	22	0	4
2	89	33	15	4
2	90	50	75	77
2	91	61	100	100
2	92	97	100	100
2	93	97	100	100
2	94	97	100	100
2	95	97	100	100
2	96	97	100	100
2	97	97	100	100
1	87	17	0	0
1	88	22	0	4
1	89	33	15	4
1	90	50	75	77
1	91	61	100	100
1	92	97	100	100
1	93	97	100	100
1	94	97	100	100
1	95	97	100	100
1	96	97	100	100
1	97	97	100	100

Table 15A.36. Estimated percent habitat available in Coffeen Lake, August 8, 1998 (Segment 1 = 4:06 PM, Segment 2 = 4:29 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	4
4	89	0	13
4	90	5	26
4	91	10	54
4	92	10	54
4	93	20	54
4	94	25	54
4	95	30	54
4	96	43	54
4	97	43	54
3	87	0	0
3	88	0	9
3	89	0	17
3	90	10	30
3	91	15	59
3	92	15	59
3	93	25	59
3	94	30	59
3	95	35	59
3	96	48	59
3	97	48	59
2	87	0	9
2	88	0	22
2	89	5	30
2	90	15	43
2	91	20	72
2	92	20	72
2	93	30	72
2	94	35	72
2	95	40	72
2	96	53	72
2	97	53	72
1	87	0	13
1	88	0	26
1	89	10	35
1	90	20	48
1	91	25	76
1	92	25	76
1	93	35	76
1	94	40	76
1	95	45	76
1	96	58	76
1	97	58	76

Table 15A.37. Estimated percent habitat available in Coffeen Lake, August 13, 1998 (Segment 1 = 7:48 AM, Segment 2 = 8:12 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	4
4	88	0	22
4	89	0	59
4	90	0	59
4	91	0	59
4	92	0	59
4	93	6	59
4	94	21	59
4	95	21	59
4	96	21	59
4	97	21	59
3	87	0	9
3	88	0	26
3	89	6	63
3	90	12	63
3	91	12	63
3	92	12	63
3	93	18	63
3	94	32	63
3	95	32	63
3	96	32	63
3	97	32	63
2	87	0	13
2	88	12	30
2	89	24	67
2	90	29	67
2	91	29	67
2	92	29	67
2	93	35	67
2	94	50	67
2	95	50	67
2	96	50	67
2	97	50	67
1	87	0	13
1	88	24	30
1	89	35	67
1	90	41	67
1	91	41	67
1	92	41	67
1	93	47	67
1	94	62	67
1	95	62	67
1	96	62	67
1	97	62	67

Table 15A.38. Estimated percent habitat available outside of Coffeen Lake cooling loop, August 18, 1998 (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	18
4	88	17	11	32
4	89	17	94	46
4	90	64	94	100
4	91	64	94	100
4	92	64	94	100
4	93	64	94	100
4	94	64	94	100
4	95	64	94	100
4	96	64	94	100
4	97	64	94	100
3	87	0	6	18
3	88	17	17	32
3	89	17	100	46
3	90	64	100	100
3	91	64	100	100
3	92	64	100	100
3	93	64	100	100
3	94	64	100	100
3	95	64	100	100
3	96	64	100	100
3	97	64	100	100
2	87	0	6	18
2	88	22	17	32
2	89	22	100	46
2	90	69	100	100
2	91	69	100	100
2	92	69	100	100
2	93	69	100	100
2	94	69	100	100
2	95	69	100	100
2	96	69	100	100
2	97	69	100	100
1	87	17	6	18
1	88	39	17	32
1	89	39	100	46
1	90	86	100	100
1	91	86	100	100
1	92	86	100	100
1	93	86	100	100
1	94	86	100	100
1	95	86	100	100
1	96	86	100	100
1	97	86	100	100

Table 15A.39. Estimated percent habitat available in Coffeen Lake, August 20, 1998 (Segment 1 = 10:47 AM, Segment 2 =11:14 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	5	8
4	89	18	12
4	90	18	12
4	91	23	20
4	92	23	46
4	93	23	46
4	94	23	46
4	95	32	46
4	96	32	46
4	97	48	46
3	87	0	4
3	88	9	12
3	89	23	16
3	90	23	16
3	91	27	24
3	92	27	50
3	93	27	50
3	94	27	50
3	95	36	50
3	96	36	50
3	97	52	50
2	87	5	8
2	88	14	16
2	89	27	20
2	90	27	20
2	91	32	28
2	92	32	54
2	93	32	54
2	94	32	54
2	95	41	54
2	96	41	54
2	97	57	54
1	87	9	16
1	88	18	24
1	89	32	28
1	90	32	28
1	91	36	36
1	92	36	62
1	93	36	62
1	94	36	62
1	95	45	62
1	96	45	62
1	97	61	62

Table 15A.40. Estimated percent habitat available in Coffeen Lake, August 28, 1998 (Segment 1 = 1:23 PM, Segment 2 = 1:42 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	0	4
4	94	0	15
4	95	0	24
4	96	0	24
4	97	0	24
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	9
3	91	11	17
3	92	17	26
3	93	17	30
3	94	17	41
3	95	22	50
3	96	22	50
3	97	22	50
2	87	0	0
2	88	0	0
2	89	0	4
2	90	17	17
2	91	33	26
2	92	39	35
2	93	39	39
2	94	39	50
2	95	44	59
2	96	44	59
2	97	44	59
1	87	0	0
1	88	0	4
1	89	0	13
1	90	22	26
1	91	39	35
1	92	44	43
1	93	44	48
1	94	44	59
1	95	50	67
1	96	50	67
1	97	50	67

Table 15A.41. Estimated percent habitat available in Coffeen Lake, June 2, 1999 (Segment 1 = 3:05 PM, Segment 2 = 3:35 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	71	60
4	88	71	60
4	89	71	60
4	90	71	60
4	91	71	60
4	92	71	60
4	93	71	60
4	94	71	60
4	95	71	60
4	96	71	60
4	97	71	60
3	87	82	69
3	88	82	69
3	89	82	69
3	90	82	69
3	91	82	69
3	92	82	69
3	93	82	69
3	94	82	69
3	95	82	69
3	96	82	69
3	97	82	69
2	87	87	81
2	88	87	81
2	89	87	81
2	90	87	81
2	91	87	81
2	92	87	81
2	93	87	81
2	94	87	81
2	95	87	81
2	96	87	81
2	97	87	81
1	87	100	90
1	88	100	90
1	89	100	90
1	90	100	90
1	91	100	90
1	92	100	90
1	93	100	90
1	94	100	90
1	95	100	90
1	96	100	90
1	97	100	90

Table 15A.42. Estimated percent habitat available outside of Coffeen Lake cooling loop, June 9, 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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
4	87	28	5	39
4	88	56	55	68
4	89	75	95	89
4	90	75	100	100
4	91	75	100	100
4	92	75	100	100
4	93	75	100	100
4	94	75	100	100
4	95	75	100	100
4	96	75	100	100
4	97	75	100	100
3	87	39	5	39
3	88	67	55	68
3	89	86	95	89
3	90	86	100	100
3	91	86	100	100
3	92	86	100	100
3	93	86	100	100
3	94	86	100	100
3	95	86	100	100
3	96	86	100	100
3	97	86	100	100
2	87	50	5	39
2	88	78	55	68
2	89	97	95	89
2	90	97	100	100
2	91	97	100	100
2	92	97	100	100
2	93	97	100	100
2	94	97	100	100
2	95	97	100	100
2	96	97	100	100
2	97	97	100	100
1	87	53	5	39
1	88	81	55	68
1	89	100	95	89
1	90	100	100	100
1	91	100	100	100
1	92	100	100	100
1	93	100	100	100
1	94	100	100	100
1	95	100	100	100
1	96	100	100	100
1	97	100	100	100

Table 15A.43. Estimated percent habitat available in Coffeen Lake, June 16, 1999 (Segment 1 = 9:31 AM, Segment 2 = 9:58 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)	Segment 1	Segment 2
4	87	37	66
4	88	47	66
4	89	53	66
4	90	71	66
4	91	71	66
4	92	71	66
4	93	71	66
4	94	71	66
4	95	71	66
4	96	71	66
4	97	71	66
3	87	42	75
3	88	53	75
3	89	58	75
3	90	76	75
3	91	76	75
3	92	76	75
3	93	76	75
3	94	76	75
3	95	76	75
3	96	76	75
3	97	76	75
2	87	47	75
2	88	58	75
2	89	63	75
2	90	82	75
2	91	82	75
2	92	82	75
2	93	82	75
2	94	82	75
2	95	82	75
2	96	82	75
2	97	82	75
1	87	53	84
1	88	63	84
1	89	68	84
1	90	87	84
1	91	87	84
1	92	87	84
1	93	87	84
1	94	87	84
1	95	87	84
1	96	87	84
1	97	87	84

Table 15A.44. Estimated percent habitat available outside of Coffeen Lake cooling loop, June 23, 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	93	100	100
4	88	93	100	100
4	89	93	100	100
4	90	93	100	100
4	91	93	100	100
4	92	93	100	100
4	93	93	100	100
4	94	93	100	100
4	95	93	100	100
4	96	93	100	100
4	97	93	100	100
3	87	100	100	100
3	88	100	100	100
3	89	100	100	100
3	90	100	100	100
3	91	100	100	100
3	92	100	100	100
3	93	100	100	100
3	94	100	100	100
3	95	100	100	100
3	96	100	100	100
3	97	100	100	100
2	87	100	100	100
2	88	100	100	100
2	89	100	100	100
2	90	100	100	100
2	91	100	100	100
2	92	100	100	100
2	93	100	100	100
2	94	100	100	100
2	95	100	100	100
2	96	100	100	100
2	97	100	100	100
1	87	100	100	100
1	88	100	100	100
1	89	100	100	100
1	90	100	100	100
1	91	100	100	100
1	92	100	100	100
1	93	100	100	100
1	94	100	100	100
1	95	100	100	100
1	96	100	100	100
1	97	100	100	100

Table 15A.45. Estimated percent habitat available outside of Coffeen Lake cooling loop, July 7, 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	0
4	88	5	0	0
4	89	11	0	7
4	90	16	28	50
4	91	26	72	79
4	92	37	100	89
4	93	47	100	89
4	94	66	100	89
4	95	66	100	89
4	96	66	100	89
4	97	66	100	89
3	87	0	0	0
3	88	5	0	7
3	89	11	0	14
3	90	16	28	57
3	91	26	72	86
3	92	37	100	96
3	93	47	100	96
3	94	66	100	96
3	95	66	100	96
3	96	66	100	96
3	97	66	100	96
2	87	11	0	4
2	88	16	0	11
2	89	21	0	18
2	90	26	28	61
2	91	37	72	89
2	92	47	100	100
2	93	58	100	100
2	94	76	100	100
2	95	76	100	100
2	96	76	100	100
2	97	76	100	100
1	87	21	0	4
1	88	26	0	11
1	89	32	0	18
1	90	37	28	61
1	91	47	72	89
1	92	58	100	100
1	93	68	100	100
1	94	87	100	100
1	95	87	100	100
1	96	87	100	100
1	97	87	100	100

Table 15A.46. Estimated percent habitat available in Coffeen Lake, July 8, 1999 (Segment 1 = 1:15 PM, Segment 2 = 2:10 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	5	5
4	88	11	9
4	89	16	9
4	90	26	18
4	91	32	23
4	92	32	32
4	93	32	32
4	94	32	36
4	95	37	50
4	96	37	57
4	97	42	57
3	87	5	14
3	88	11	18
3	89	16	18
3	90	26	27
3	91	32	32
3	92	32	41
3	93	32	41
3	94	32	45
3	95	37	59
3	96	37	66
3	97	42	66
2	87	21	23
2	88	26	27
2	89	32	27
2	90	42	36
2	91	47	41
2	92	47	50
2	93	47	50
2	94	47	55
2	95	53	68
2	96	53	75
2	97	58	75
1	87	26	27
1	88	32	32
1	89	37	32
1	90	47	41
1	91	53	45
1	92	53	55
1	93	53	55
1	94	53	59
1	95	58	73
1	96	58	80
1	97	63	80

Table 15A.47. 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 15A.48. 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	Maximum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	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 15A.49. 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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available 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 15A.50. 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 15A.51. 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

Table 15A.52. Estimated percent habitat available outside of Coffeen Lake cooling loop, August 11, 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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
4	87	0	0	0
4	88	0	0	0
4	89	12	31	58
4	90	59	81	81
4	91	71	100	100
4	92	97	100	100
4	93	97	100	100
4	94	97	100	100
4	95	97	100	100
4	96	97	100	100
4	97	97	100	100
3	87	0	0	0
3	88	0	0	0
3	89	15	31	58
3	90	62	81	81
3	91	74	100	100
3	92	100	100	100
3	93	100	100	100
3	94	100	100	100
3	95	100	100	100
3	96	100	100	100
3	97	100	100	100
2	87	0	0	0
2	88	0	0	0
2	89	15	31	58
2	90	62	81	81
2	91	74	100	100
2	92	100	100	100
2	93	100	100	100
2	94	100	100	100
2	95	100	100	100
2	96	100	100	100
2	97	100	100	100
1	87	0	0	0
1	88	0	0	0
1	89	15	31	58
1	90	62	81	81
1	91	74	100	100
1	92	100	100	100
1	93	100	100	100
1	94	100	100	100
1	95	100	100	100
1	96	100	100	100
1	97	100	100	100

Table 15A.53. Estimated percent habitat available in Coffeen Lake, August 19, 1999 (Segment 1 = 2:00 PM, Segment 2 =1:00 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 1	Segment 2
4	87	0	0
4	88	6	18
4	89	11	27
4	90	11	39
4	91	17	52
4	92	17	52
4	93	17	52
4	94	22	52
4	95	22	52
4	96	28	52
4	97	33	52
3	87	0	0
3	88	11	27
3	89	17	36
3	90	17	48
3	91	22	61
3	92	22	61
3	93	22	61
3	94	28	61
3	95	28	61
3	96	33	61
3	97	39	61
2	87	0	5
2	88	33	32
2	89	39	41
2	90	39	52
2	91	44	66
2	92	44	66
2	93	44	66
2	94	50	66
2	95	50	66
2	96	56	66
2	97	61	66
1	87	6	14
1	88	39	41
1	89	44	50
1	90	44	61
1	91	50	75
1	92	50	75
1	93	50	75
1	94	56	75
1	95	56	75
1	96	61	75
1	97	67	75

Table 15A.54. Estimated percent habitat available outside of Coffeen Lake cooling loop, August 25, 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 Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Location F1	Location F2	Location G
4	87	10	100	100
4	88	100	100	100
4	89	100	100	100
4	90	100	100	100
4	91	100	100	100
4	92	100	100	100
4	93	100	100	100
4	94	100	100	100
4	95	100	100	100
4	96	100	100	100
4	97	100	100	100
3	87	10	100	100
3	88	100	100	100
3	89	100	100	100
3	90	100	100	100
3	91	100	100	100
3	92	100	100	100
3	93	100	100	100
3	94	100	100	100
3	95	100	100	100
3	96	100	100	100
3	97	100	100	100
2	87	10	100	100
2	88	100	100	100
2	89	100	100	100
2	90	100	100	100
2	91	100	100	100
2	92	100	100	100
2	93	100	100	100
2	94	100	100	100
2	95	100	100	100
2	96	100	100	100
2	97	100	100	100
1	87	10	100	100
1	88	100	100	100
1	89	100	100	100
1	90	100	100	100
1	91	100	100	100
1	92	100	100	100
1	93	100	100	100
1	94	100	100	100
1	95	100	100	100
1	96	100	100	100
1	97	100	100	100

Table 15A.55. Estimated percent habitat available in Lake of Egypt, June 4, 1998 (Segment 1 = 2:28 PM, Segment 2 = 10:30 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)	Segment 1	Segment 2
4	87	50	47
4	88	50	47
4	89	50	47
4	90	50	47
4	91	50	47
4	92	50	47
4	93	50	47
4	94	50	47
4	95	50	47
4	96	50	47
4	97	50	47
3	87	61	94
3	88	61	94
3	89	61	94
3	90	61	94
3	91	61	94
3	92	61	94
3	93	61	94
3	94	61	94
3	95	61	94
3	96	61	94
3	97	61	94
2	87	70	100
2	88	70	100
2	89	70	100
2	90	70	100
2	91	70	100
2	92	70	100
2	93	70	100
2	94	70	100
2	95	70	100
2	96	70	100
2	97	70	100
1	87	74	100
1	88	74	100
1	89	74	100
1	90	74	100
1	91	74	100
1	92	74	100
1	93	74	100
1	94	74	100
1	95	74	100
1	96	74	100
1	97	74	100

Table 15A.56. Estimated percent habitat available in Lake of Egypt, June 12, 1998 (Segment 1 = 10:23 AM, Segment 2 = 8:00 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 1	Segment 2
4	87	92	88
4	88	92	88
4	89	92	88
4	90	92	88
4	91	92	88
4	92	92	88
4	93	92	88
4	94	92	88
4	95	92	88
4	96	92	88
4	97	92	88
3	87	92	96
3	88	92	96
3	89	92	96
3	90	92	96
3	91	92	96
3	92	92	96
3	93	92	96
3	94	92	96
3	95	92	96
3	96	92	96
3	97	92	96
2	87	92	96
2	88	92	96
2	89	92	96
2	90	92	96
2	91	92	96
2	92	92	96
2	93	92	96
2	94	92	96
2	95	92	96
2	96	92	96
2	97	92	96
1	87	92	100
1	88	92	100
1	89	92	100
1	90	92	100
1	91	92	100
1	92	92	100
1	93	92	100
1	94	92	100
1	95	92	100
1	96	92	100
1	97	92	100

Table 15A.57. Estimated percent habitat available in Lake of Egypt, June 25, 1998 (Segment 1 = 10:40 AM, Segment 2 = 9:20 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)	Segment 1	Segment 2
4	87	4	53
4	88	4	53
4	89	4	53
4	90	13	53
4	91	13	53
4	92	13	53
4	93	13	53
4	94	13	53
4	95	13	53
4	96	13	53
4	97	13	53
3	87	13	58
3	88	13	58
3	89	13	58
3	90	29	58
3	91	40	58
3	92	40	58
3	93	40	58
3	94	40	58
3	95	40	58
3	96	40	58
3	97	40	58
2	87	17	64
2	88	17	64
2	89	17	64
2	90	33	64
2	91	44	64
2	92	44	64
2	93	44	64
2	94	44	64
2	95	44	64
2	96	44	64
2	97	44	64
1	87	29	64
1	88	29	64
1	89	29	64
1	90	46	64
1	91	56	64
1	92	56	64
1	93	56	64
1	94	56	64
1	95	56	64
1	96	56	64
1	97	56	64

Table 15A.58. Estimated percent habitat available in Lake of Egypt, July 2, 1998 (Segment 1 = 2:42 PM, Segment 2 = 10:12 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	47
4	88	8	47
4	89	8	47
4	90	8	47
4	91	8	47
4	92	8	47
4	93	8	47
4	94	8	47
4	95	8	47
4	96	8	47
4	97	8	47
3	87	17	53
3	88	25	53
3	89	29	53
3	90	29	53
3	91	29	53
3	92	29	53
3	93	29	53
3	94	29	53
3	95	29	53
3	96	29	53
3	97	29	53
2	87	21	53
2	88	29	53
2	89	33	53
2	90	33	53
2	91	38	53
2	92	40	53
2	93	40	53
2	94	40	53
2	95	40	53
2	96	40	53
2	97	40	53
1	87	25	58
1	88	33	58
1	89	38	58
1	90	38	58
1	91	42	58
1	92	44	58
1	93	44	58
1	94	44	58
1	95	44	58
1	96	44	58
1	97	44	58

Table 15A.59. Estimated percent habitat available in Lake of Egypt, July 9, 1998 (Segment 1 = 8:06 AM, Segment 2 = 2:21 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	4	0
4	88	22	17
4	89	30	22
4	90	30	22
4	91	35	39
4	92	35	47
4	93	35	47
4	94	35	47
4	95	35	47
4	96	35	47
4	97	35	47
3	87	9	0
3	88	26	17
3	89	35	22
3	90	35	22
3	91	39	39
3	92	39	47
3	93	39	47
3	94	39	47
3	95	39	47
3	96	39	47
3	97	39	47
2	87	24	11
2	88	41	28
2	89	50	33
2	90	50	33
2	91	54	50
2	92	54	58
2	93	61	58
2	94	61	58
2	95	61	58
2	96	61	58
2	97	61	58
1	87	24	25
1	88	41	42
1	89	50	47
1	90	50	47
1	91	54	64
1	92	54	72
1	93	61	72
1	94	61	72
1	95	61	72
1	96	61	72
1	97	61	72

Table 15A.60. Estimated percent habitat available in Lake of Egypt, July 16, 1998 (Segment 1 = 8:16 AM, Segment 2 = 11:18 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	57	75
4	88	57	75
4	89	63	75
4	90	63	75
4	91	63	75
4	92	63	75
4	93	63	75
4	94	63	75
4	95	63	75
4	96	63	75
4	97	63	75
3	87	57	75
3	88	57	75
3	89	63	75
3	90	63	75
3	91	63	75
3	92	63	75
3	93	63	75
3	94	63	75
3	95	63	75
3	96	63	75
3	97	63	75
2	87	57	75
2	88	57	75
2	89	63	75
2	90	63	75
2	91	63	75
2	92	63	75
2	93	63	75
2	94	63	75
2	95	63	75
2	96	63	75
2	97	63	75
1	87	57	81
1	88	57	81
1	89	63	81
1	90	63	81
1	91	63	81
1	92	63	81
1	93	63	81
1	94	63	81
1	95	63	81
1	96	63	81
1	97	63	81

Table 15A.61. Estimated percent habitat available in Lake of Egypt, July 23, 1998 (Segment 1 = 8:20 AM, Segment 2 = 12:45 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
4	87	0	6
4	88	0	6
4	89	5	35
4	90	14	50
4	91	18	50
4	92	23	50
4	93	27	50
4	94	27	50
4	95	32	50
4	96	36	50
4	97	36	50
3	87	5	18
3	88	5	18
3	89	9	47
3	90	18	62
3	91	23	62
3	92	27	62
3	93	32	62
3	94	32	62
3	95	36	62
3	96	43	62
3	97	43	62
2	87	18	18
2	88	18	18
2	89	23	47
2	90	32	62
2	91	36	62
2	92	41	62
2	93	45	62
2	94	45	62
2	95	50	62
2	96	57	62
2	97	57	62
1	87	18	24
1	88	18	24
1	89	23	53
1	90	32	68
1	91	36	68
1	92	41	68
1	93	45	68
1	94	45	68
1	95	50	68
1	96	57	68
1	97	57	68

Table 15A.62. Estimated percent habitat available in Lake of Egypt, July 30, 1998 (Segment 1 = 11:57 AM, Segment 2 = 9:07 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	2
4	88	0	2
4	89	0	2
4	90	0	2
4	91	0	2
4	92	0	2
4	93	0	2
4	94	0	2
4	95	0	2
4	96	0	2
4	97	0	2
3	87	0	2
3	88	0	2
3	89	0	2
3	90	0	2
3	91	0	2
3	92	0	2
3	93	0	2
3	94	0	2
3	95	0	2
3	96	0	2
3	97	0	2
2	87	0	52
2	88	0	52
2	89	0	52
2	90	0	52
2	91	0	52
2	92	0	52
2	93	0	52
2	94	0	52
2	95	0	52
2	96	0	52
2	97	0	52
1	87	35	57
1	88	35	57
1	89	35	57
1	90	39	57
1	91	39	57
1	92	39	57
1	93	43	57
1	94	46	57
1	95	46	57
1	96	46	57
1	97	46	57

Table 15A.63. Estimated percent habitat available in Lake of Egypt, August 4, 1998 (Segment 1 = 8:20 AM, Segment 2 = 11:28 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	17	68
4	88	26	68
4	89	26	68
4	90	26	68
4	91	30	68
4	92	37	68
4	93	37	68
4	94	37	68
4	95	37	68
4	96	37	68
4	97	37	68
3	87	22	74
3	88	30	74
3	89	30	74
3	90	30	74
3	91	35	74
3	92	41	74
3	93	41	74
3	94	41	74
3	95	41	74
3	96	41	74
3	97	41	74
2	87	30	74
2	88	39	74
2	89	39	74
2	90	39	74
2	91	43	74
2	92	50	74
2	93	50	74
2	94	50	74
2	95	50	74
2	96	50	74
2	97	50	74
1	87	43	79
1	88	52	79
1	89	52	79
1	90	52	79
1	91	57	79
1	92	63	79
1	93	63	79
1	94	63	79
1	95	63	79
1	96	63	79
1	97	63	79

Table 15A.64. Estimated percent habitat available in Lake of Egypt, August 11, 1998 (Segment 1 = 10:03 AM, Segment 2 = 9:27 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	26	61
4	88	26	64
4	89	26	64
4	90	30	64
4	91	30	64
4	92	30	64
4	93	35	64
4	94	35	64
4	95	35	64
4	96	35	64
4	97	35	64
3	87	39	67
3	88	39	69
3	89	39	69
3	90	43	69
3	91	43	69
3	92	43	69
3	93	48	69
3	94	50	69
3	95	50	69
3	96	50	69
3	97	50	69
2	87	39	83
2	88	39	86
2	89	39	86
2	90	43	86
2	91	43	86
2	92	43	86
2	93	48	86
2	94	50	86
2	95	50	86
2	96	50	86
2	97	50	86
1	87	48	83
1	88	48	86
1	89	48	86
1	90	52	86
1	91	52	86
1	92	52	86
1	93	57	86
1	94	59	86
1	95	59	86
1	96	59	86
1	97	59	86

Table 15A.65. Estimated percent habitat available in Lake of Egypt, August 17, 1998 (Segment 1 = 9:24 AM, Segment 2 =8:57 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	26	64
4	88	26	64
4	89	30	64
4	90	35	64
4	91	35	64
4	92	41	64
4	93	41	64
4	94	41	64
4	95	41	64
4	96	41	64
4	97	41	64
3	87	30	64
3	88	30	64
3	89	35	64
3	90	39	64
3	91	39	64
3	92	46	64
3	93	46	64
3	94	46	64
3	95	46	64
3	96	46	64
3	97	46	64
2	87	35	69
2	88	35	69
2	89	39	69
2	90	43	69
2	91	43	69
2	92	50	69
2	93	50	69
2	94	50	69
2	95	50	69
2	96	50	69
2	97	50	69
1	87	43	69
1	88	43	69
1	89	48	69
1	90	52	69
1	91	52	69
1	92	59	69
1	93	59	69
1	94	59	69
1	95	59	69
1	96	59	69
1	97	59	69

Table 15A.66. Estimated percent habitat available in Lake of Egypt, August 25, 1998 (Segment 1 = 3:36 PM, Segment 2 = 3:00 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 1	Segment 2
4	87	0	0
4	88	0	0
4	89	0	9
4	90	0	9
4	91	0	9
4	92	0	9
4	93	0	9
4	94	0	9
4	95	0	9
4	96	0	9
4	97	0	9
3	87	0	6
3	88	0	6
3	89	0	15
3	90	0	15
3	91	4	15
3	92	4	15
3	93	4	15
3	94	4	15
3	95	11	15
3	96	11	15
3	97	11	15
2	87	4	41
2	88	9	47
2	89	13	56
2	90	17	56
2	91	22	56
2	92	22	56
2	93	22	56
2	94	22	56
2	95	33	56
2	96	33	56
2	97	33	56
1	87	22	53
1	88	26	59
1	89	30	68
1	90	35	68
1	91	39	68
1	92	39	68
1	93	39	68
1	94	39	68
1	95	50	68
1	96	50	68
1	97	50	68

Table 15A.67. Estimated percent habitat available in Lake of Egypt, June 1, 1999 (Segment 1 = 2:05 PM, Segment 2 = 1:20 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	% Habitat Available Segment 2
4	87	52	62
4	88	52	62
4	89	52	62
4	90	52	62
4	91	52	62
4	92	52	62
4	93	52	62
4	94	52	62
4	95	52	62
4	96	52	62
4	97	52	62
3	87	56	68
3	88	56	68
3	89	56	68
3	90	56	68
3	91	56	68
3	92	56	68
3	93	56	68
3	94	56	68
3	95	56	68
3	96	56	68
3	97	56	68
2	87	60	68
2	88	60	68
2	89	60	68
2	90	60	68
2	91	60	68
2	92	60	68
2	93	60	68
2	94	60	68
2	95	60	68
2	96	60	68
2	97	60	68
1	87	65	79
1	88	65	79
1	89	65	79
1	90	65	79
1	91	65	79
1	92	65	79
1	93	65	79
1	94	65	79
1	95	65	79
1	96	65	79
1	97	65	79

Table 15A.68. Estimated percent habitat available in Lake of Egypt, June 18, 1999 (Segment 1 = 12:30 PM, Segment 2 = 12:00 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 1	Segment 2
4	87	48	74
4	88	48	74
4	89	48	74
4	90	48	74
4	91	48	74
4	92	48	74
4	93	48	74
4	94	48	74
4	95	48	74
4	96	48	74
4	97	48	74
3	87	48	74
3	88	48	74
3	89	48	74
3	90	48	74
3	91	48	74
3	92	48	74
3	93	48	74
3	94	48	74
3	95	48	74
3	96	48	74
3	97	48	74
2	87	52	74
2	88	52	74
2	89	52	74
2	90	52	74
2	91	52	74
2	92	52	74
2	93	52	74
2	94	52	74
2	95	52	74
2	96	52	74
2	97	52	74
1	87	52	74
1	88	52	74
1	89	52	74
1	90	52	74
1	91	52	74
1	92	52	74
1	93	52	74
1	94	52	74
1	95	52	74
1	96	52	74
1	97	52	74

Table 15A.69. Estimated percent habitat available in Lake of Egypt, July 9, 1999 (Segment 1 = 2:00 PM, Segment 2 = 1:30 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
4	87	0	22
4	88	12	22
4	89	12	44
4	90	15	58
4	91	15	58
4	92	23	58
4	93	33	58
4	94	33	58
4	95	33	58
4	96	33	58
4	97	33	58
3	87	12	22
3	88	23	22
3	89	23	44
3	90	27	58
3	91	27	58
3	92	35	58
3	93	44	58
3	94	44	58
3	95	44	58
3	96	44	58
3	97	44	58
2	87	15	28
2	88	27	28
2	89	27	50
2	90	31	64
2	91	31	64
2	92	38	64
2	93	48	64
2	94	48	64
2	95	48	64
2	96	48	64
2	97	48	64
1	87	19	28
1	88	31	28
1	89	31	50
1	90	35	64
1	91	35	64
1	92	42	64
1	93	52	64
1	94	52	64
1	95	52	64
1	96	52	64
1	97	52	64

Table 15A.70. Estimated percent habitat available in Lake of Egypt, July 22, 1999 (Segment 1 = 5:26 PM, Segment 2 = 4:20 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	5	29
4	88	14	43
4	89	18	43
4	90	18	50
4	91	23	61
4	92	23	61
4	93	23	61
4	94	23	61
4	95	23	61
4	96	23	61
4	97	23	61
3	87	14	36
3	88	23	50
3	89	27	50
3	90	27	57
3	91	32	68
3	92	32	68
3	93	32	68
3	94	36	68
3	95	36	68
3	96	36	68
3	97	36	68
2	87	18	36
2	88	27	50
2	89	32	50
2	90	32	57
2	91	36	68
2	92	36	68
2	93	36	68
2	94	41	68
2	95	45	68
2	96	45	68
2	97	45	68
1	87	23	50
1	88	32	64
1	89	36	64
1	90	36	71
1	91	41	82
1	92	41	82
1	93	41	82
1	94	45	82
1	95	50	82
1	96	52	82
1	97	52	82

Table 15A.71. Estimated percent habitat available in Lake of Egypt, August 3, 1999 (Segment 1 = 12:51 PM, Segment 2 =10:58 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)	Segment 1	Segment 2
4	87	0	6
4	88	0	64
4	89	0	64
4	90	4	64
4	91	9	64
4	92	9	64
4	93	15	64
4	94	15	64
4	95	15	64
4	96	15	64
4	97	15	64
3	87	0	6
3	88	0	64
3	89	17	64
3	90	22	64
3	91	26	64
3	92	26	64
3	93	33	64
3	94	33	64
3	95	33	64
3	96	33	64
3	97	33	64
2	87	0	6
2	88	4	64
2	89	22	64
2	90	26	64
2	91	30	64
2	92	30	64
2	93	37	64
2	94	37	64
2	95	37	64
2	96	37	64
2	97	37	64
1	87	4	6
1	88	13	64
1	89	30	64
1	90	35	64
1	91	39	64
1	92	39	64
1	93	46	64
1	94	46	64
1	95	46	64
1	96	46	64
1	97	46	64

Table 15A.72. Estimated percent habitat available in Lake of Egypt, August 16, 1999 (Segment 1 = 2:40 PM, Segment 2 = 3:10 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	14	82
4	88	14	85
4	89	18	85
4	90	18	85
4	91	18	85
4	92	23	85
4	93	23	85
4	94	23	85
4	95	25	85
4	96	25	85
4	97	25	85
3	87	45	88
3	88	45	91
3	89	50	91
3	90	50	91
3	91	50	91
3	92	55	91
3	93	55	91
3	94	55	91
3	95	57	91
3	96	57	91
3	97	57	91
2	87	45	88
2	88	45	91
2	89	50	91
2	90	50	91
2	91	50	91
2	92	55	91
2	93	55	91
2	94	55	91
2	95	57	91
2	96	57	91
2	97	57	91
1	87	59	94
1	88	59	97
1	89	64	97
1	90	64	97
1	91	64	97
1	92	68	97
1	93	68	97
1	94	68	97
1	95	70	97
1	96	70	97
1	97	70	97

Table 15A.73. Estimated percent habitat available in Newton Lake, December 17, 1997 (Times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	100	64	91
4	51	100	100	96	0	74
4	52	100	75	96	0	68
4	53	100	54	89	0	61
4	54	100	46	68	0	54
4	55	100	39	0	0	35
4	56	100	39	0	0	35
4	57	100	39	0	0	35
4	58	100	39	0	0	35
4	59	100	32	0	0	33
4	60	100	32	0	0	33

Table 15A.74. Estimated percent habitat available in Newton Lake, December 26, 1997 (Times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	100	0	75
4	51	100	100	100	0	75
4	52	100	100	79	0	70
4	53	100	100	56	0	64
4	54	100	63	0	0	41
4	55	100	43	0	0	36
4	56	100	43	0	0	36
4	57	100	37	0	0	34
4	58	100	30	0	0	33
4	59	100	0	0	0	25
4	60	100	0	0	0	25

Table 15A.75. Estimated percent habitat available in Newton Lake, January 15, 1998 (Segment 1 = 2:35 PM, Segment 2 = 1:55 PM, Segment 3 = 1:07 PM, Segment 4 = 12:45 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	0	0	0	0	0
4	51	0	0	0	0	0
4	52	0	0	0	0	0
4	53	0	0	0	0	0
4	54	0	0	0	0	0
4	55	0	0	0	0	0
4	56	0	0	0	0	0
4	57	0	0	0	0	0
4	58	0	0	0	0	0
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.76. Estimated percent habitat available in Newton Lake, January 31, 1998 (Times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	63	43	0	52
4	51	100	50	0	0	38
4	52	100	43	0	0	36
4	53	100	17	0	0	29
4	54	93	0	0	0	23
4	55	0	0	0	0	0
4	56	0	0	0	0	0
4	57	0	0	0	0	0
4	58	0	0	0	0	0
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.77. Estimated percent habitat available in Newton Lake, February 12, 1998 (Segment 1 = 2:50 PM, Segment 2 = 12:26 PM, Segment 3 = 10:50 AM, Segment 4 = 10:30 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	92	62	0	0	38
4	51	92	50	0	0	35
4	52	92	44	0	0	34
4	53	92	44	0	0	34
4	54	75	38	0	0	28
4	55	75	38	0	0	28
4	56	75	38	0	0	28
4	57	75	32	0	0	27
4	58	75	26	0	0	25
4	59	58	26	0	0	21
4	60	58	26	0	0	21

Table 15A.78. Estimated percent habitat available in Newton Lake, February 26, 1998 (Segment 1 = 2:21 PM, Segment 2 = 3:55 PM, Segment 3 = 3:25 PM, Segment 4 = 2:50 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	100	100	100
4	51	100	100	100	100	100
4	52	100	97	84	100	95
4	53	100	84	84	100	92
4	54	100	84	84	0	67
4	55	100	84	47	0	58
4	56	100	84	0	0	46
4	57	100	84	0	0	46
4	58	100	78	0	0	45
4	59	100	47	0	0	37
4	60	100	28	0	0	32

Table 15A.79. Estimated percent habitat available in Newton Lake, December 9, 1998 (Segment 1 = 10:48 AM, Segment 2 = 11:04 AM, Segment 3 = 11:54 AM, Segment 4 = 12:23 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	100	100	100
4	51	100	100	100	100	100
4	52	100	100	100	100	100
4	53	100	100	100	100	100
4	54	100	100	100	100	100
4	55	100	100	100	100	100
4	56	100	100	100	100	100
4	57	100	100	100	0	75
4	58	100	100	100	0	75
4	59	100	100	75	0	69
4	60	100	50	0	0	38

Table 15A.80. Estimated percent habitat available in Newton Lake, December 29, 1998 (Segment 1 = 11:32 AM, Segment 2 =11:50 AM, Segment 3 = 12:11 PM, Segment 4 = 12:35 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	0	0	50
4	51	100	0	0	0	25
4	52	100	0	0	0	25
4	53	100	0	0	0	25
4	54	93	0	0	0	23
4	55	93	0	0	0	23
4	56	93	0	0	0	23
4	57	93	0	0	0	23
4	58	64	0	0	0	16
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.81. Estimated percent habitat available in Newton Lake, January 11, 1999 (Segment 1 = 3:25 AM, Segment 2 = 3:55 AM, Segment 3 = 5:01 AM, Segment 4 = 5:30 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	93	0	0	0	23
4	51	93	0	0	0	23
4	52	93	0	0	0	23
4	53	71	0	0	0	18
4	54	0	0	0	0	0
4	55	0	0	0	0	0
4	56	0	0	0	0	0
4	57	0	0	0	0	0
4	58	0	0	0	0	0
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.82. Estimated percent habitat available in Newton Lake, January 22, 1999 (Segment 1 = 1:27 PM, Segment 2 = 1:55 PM, Segment 3 = 12:12 PM, Segment 4 = 12:45 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	0	0	0	0	0
4	51	0	0	0	0	0
4	52	0	0	0	0	0
4	53	0	0	0	0	0
4	54	0	0	0	0	0
4	55	0	0	0	0	0
4	56	0	0	0	0	0
4	57	0	0	0	0	0
4	58	0	0	0	0	0
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.83. Estimated percent habitat available in Newton Lake, February 10, 1999 (Segment 1 = 6:10 PM, Segment 2 = 5:45 PM, Segment 3 = 5:18 PM, Segment 4 = 4:59 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	79	69	0	62
4	51	94	74	58	0	57
4	52	94	62	31	0	47
4	53	83	56	0	0	35
4	54	83	50	0	0	33
4	55	83	26	0	0	27
4	56	83	0	0	0	21
4	57	83	0	0	0	21
4	58	83	0	0	0	21
4	59	83	0	0	0	21
4	60	72	0	0	0	18

Table 15A.84. Estimated percent habitat available in Newton Lake, February 24, 1999 (Segment 1 = 2:10 PM, Segment 2 = 1:51 PM, Segment 3 = 1:32 PM, Segment 4 = 1:15 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	0	0	50
4	51	100	59	0	0	40
4	52	100	47	0	0	37
4	53	100	41	0	0	35
4	54	72	34	0	0	27
4	55	61	34	0	0	24
4	56	50	28	0	0	20
4	57	50	28	0	0	20
4	58	50	22	0	0	18
4	59	50	22	0	0	18
4	60	50	0	0	0	13

Table 15A.85. Estimated percent habitat available in Newton Lake, December 15, 1999 (Segment 1 = 12:22 PM, Segment 2 = 12:50 PM, Segment 3 = 1:40 PM, Segment 4 = 2:00 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	100	100	100
4	51	100	100	100	100	100
4	52	100	100	100	0	75
4	53	100	100	100	0	75
4	54	100	100	100	0	75
4	55	100	100	100	0	75
4	56	100	100	0	0	50
4	57	100	100	0	0	50
4	58	100	100	0	0	50
4	59	100	100	0	0	50
4	60	100	0	0	0	25

Table 15A.86. Estimated percent habitat available in Newton Lake, December 27, 1999 (Segment 1 = 10:24 AM, Segment 2 = 10:38 AM, Segment 3 = 10:58 AM, Segment 4 = 11:18 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	50	100	100	0	0	50
4	51	100	65	0	0	41
4	52	100	50	0	0	38
4	53	100	0	0	0	25
4	54	100	0	0	0	25
4	55	100	0	0	0	25
4	56	100	0	0	0	25
4	57	92	0	0	0	23
4	58	0	0	0	0	0
4	59	0	0	0	0	0
4	60	0	0	0	0	0

Table 15A.87. Estimated percent habitat available in Coffeen Lake, December 3, 1997 (times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	100
4	53	100	100
4	54	100	100
4	55	100	100
4	56	84	100
4	57	66	95
4	58	47	50
4	59	47	41
4	60	13	41

Table 15A.88. Estimated percent habitat available in Coffeen Lake, January 7, 1998 (times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	83
4	53	100	73
4	54	100	58
4	55	100	38
4	56	100	33
4	57	100	33
4	58	100	33
4	59	100	33
4	60	60	28

Table 15A.89. Estimated percent habitat available in Coffeen Lake, February 6, 1998 (Segment 1 = 3:46 PM, Segment 2 = 4:26 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	68
4	51	100	63
4	52	50	43
4	53	30	0
4	54	30	0
4	55	23	0
4	56	23	0
4	57	23	0
4	58	23	0
4	59	23	0
4	60	23	0

Table 15A.90. Estimated percent habitat available in Coffeen Lake, December 1, 1998 (Segment 1 = 3:10 PM, Segment 2 = 3:40 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	100
4	53	100	100
4	54	100	100
4	55	97	80
4	56	58	25
4	57	42	25
4	58	31	20
4	59	31	20
4	60	25	20

Table 15A.91. Estimated percent habitat available in Coffeen Lake, December 17, 1998 (Segment 1 = 12:27 PM, Segment 2 = 11:47 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	100
4	53	100	100
4	54	100	80
4	55	100	0
4	56	44	0
4	57	32	0
4	58	32	0
4	59	26	0
4	60	26	0

Table 15A.92. Estimated percent habitat available in Coffeen Lake, January 7, 1999 (Segment 1 = 2:30 PM, Segment 2 = 3:30 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	26	24
4	51	26	0
4	52	26	0
4	53	26	0
4	54	26	0
4	55	26	0
4	56	26	0
4	57	26	0
4	58	21	0
4	59	21	0
4	60	21	0

Table 15A.93. Estimated percent habitat available in Coffeen Lake, January 21, 1999 (Segment 1 = 1:55 PM, Segment 2 = 2:32 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available	
		Segment 1	Segment 2
4	50	25	23
4	51	25	23
4	52	19	15
4	53	19	15
4	54	19	15
4	55	19	15
4	56	19	10
4	57	19	0
4	58	19	0
4	59	14	0
4	60	14	0

Table 15A.94. Estimated percent habitat available in Coffeen Lake, February 3, 1999 (Segment 1 = 1:10 PM, Segment 2 = 12:25 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available	
		Segment 1	Segment 2
4	50	100	90
4	51	88	90
4	52	68	0
4	53	53	0
4	54	53	0
4	55	53	0
4	56	53	0
4	57	48	0
4	58	43	0
4	59	33	0
4	60	23	0

Table 15A.95. Estimated percent habitat available in Coffeen Lake, February 18, 1999 (Segment 1 = 2:30 PM, Segment 2 = 2:50 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	45	28
4	51	21	24
4	52	21	24
4	53	17	24
4	54	17	24
4	55	17	20
4	56	17	15
4	57	17	0
4	58	17	0
4	59	17	0
4	60	17	0

Table 15A.96. Estimated percent habitat available in Coffeen Lake, December 1, 1999 (Segment 1 = 11:54 AM, Segment 2 = 1:00 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	100
4	53	100	100
4	54	100	98
4	55	100	57
4	56	80	0
4	57	25	0
4	58	0	0
4	59	0	0
4	60	0	0

Table 15A.97. Estimated percent habitat available in Coffeen Lake, December 14, 1999 (Segment 1 = 12:30 PM, Segment 2 = 11:40 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	100
4	53	100	0
4	54	95	0
4	55	86	0
4	56	77	0
4	57	68	0
4	58	59	0
4	59	59	0
4	60	59	0

Table 15A.98. Estimated percent habitat available in Coffeen Lake, December 29, 1999 (Segment 1 = 12:09 PM, Segment 2 = 12:48 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	50	21
4	51	45	17
4	52	45	0
4	53	45	0
4	54	40	0
4	55	40	0
4	56	31	0
4	57	21	0
4	58	2	0
4	59	0	0
4	60	0	0

Table 15A.99. Estimated percent habitat available in Lake of Egypt, December 3, 1997 (times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	100	41
4	51	93	0
4	52	48	0
4	53	38	0
4	54	38	0
4	55	28	0
4	56	13	0
4	57	8	0
4	58	8	0
4	59	8	0
4	60	8	0

Table 15A.100. Estimated percent habitat available in Lake of Egypt, January 5, 1998 (times unknown). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	0	0
4	51	0	0
4	52	0	0
4	53	0	0
4	54	0	0
4	55	0	0
4	56	0	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

Table 15A.101. Estimated percent habitat available in Lake of Egypt, February 19, 1998 (Segment 1 = 4:13 PM, Segment 2 = 3:36 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	19	0
4	51	10	0
4	52	10	0
4	53	6	0
4	54	6	0
4	55	2	0
4	56	0	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

Table 15A.102. Estimated percent habitat available in Lake of Egypt, December 3, 1998 (Segment 1 = 9:00 AM, Segment 2 = 2:10 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	93	100
4	51	93	100
4	52	93	100
4	53	93	100
4	54	93	100
4	55	93	84
4	56	72	72
4	57	54	16
4	58	50	0
4	59	41	0
4	60	37	0

Table 15A.103. Estimated percent habitat available in Lake of Egypt, December 15, 1998 (Segment 1 = 10:19 AM, Segment 2 = 10:49 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	100	100
4	51	100	100
4	52	100	32
4	53	100	0
4	54	100	0
4	55	93	0
4	56	11	0
4	57	7	0
4	58	7	0
4	59	7	0
4	60	7	0

Table 15A.104. Estimated percent habitat available in Lake of Egypt, January 7, 1999 (Segment 1 = 10:50 AM, Segment 2 = 8:30 AM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	0	0
4	51	0	0
4	52	0	0
4	53	0	0
4	54	0	0
4	55	0	0
4	56	0	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

Table 15A.105. Estimated percent habitat available in Lake of Egypt, January 20, 1999 (Segment 1 = 12:55 PM, Segment 2 = 1:54 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	2	0
4	51	2	0
4	52	2	0
4	53	2	0
4	54	2	0
4	55	2	0
4	56	0	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

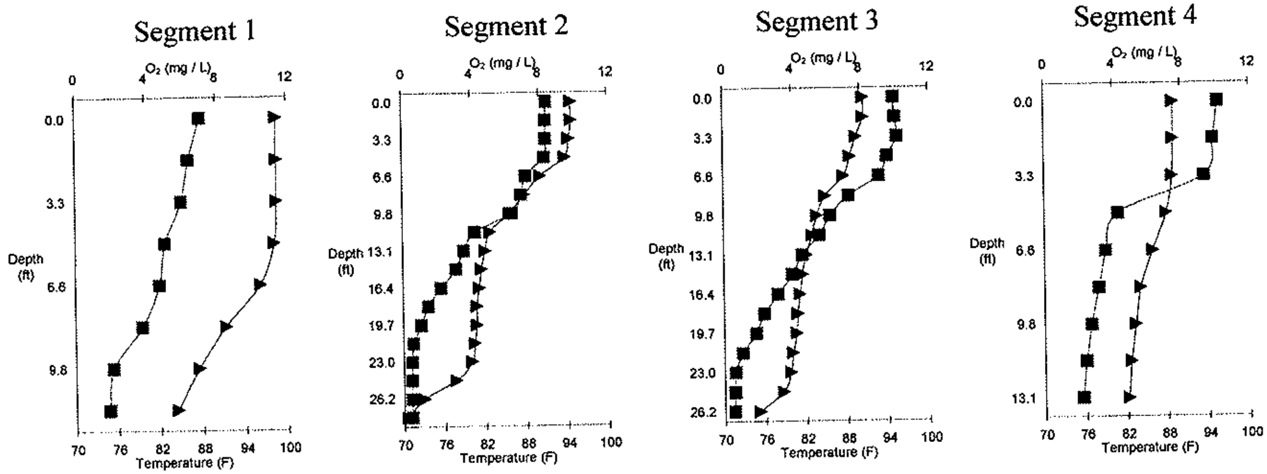
Table 15A.106. Estimated percent habitat available in Lake of Egypt, February 4, 1999 (Segment 1 = 3:00 PM, Segment 2 = 2:40 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum Oxygen (ppm)	Minimum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	50	25	0
4	51	20	0
4	52	0	0
4	53	0	0
4	54	0	0
4	55	0	0
4	56	0	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

Table 15A.107. Estimated percent habitat available in Lake of Egypt, February 17, 1999 (Segment 1 = 2:35 PM, Segment 2 = 1:55 PM). Habitat was considered available if it contained no less than the minimum oxygen or minimum temperature indicated.

Minimum	Minimum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2
4	50	16	0
4	51	11	0
4	52	11	0
4	53	11	0
4	54	7	0
4	55	2	0
4	56	2	0
4	57	0	0
4	58	0	0
4	59	0	0
4	60	0	0

Newton Lake – August 28, 1997



Newton Lake - September 12, 1997

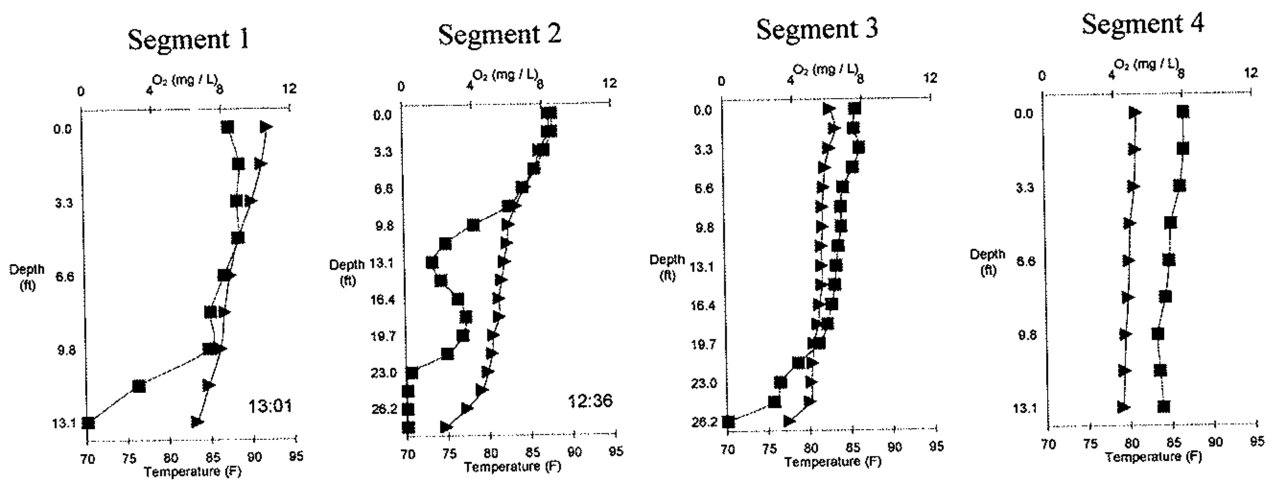


Figure 15A.1. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

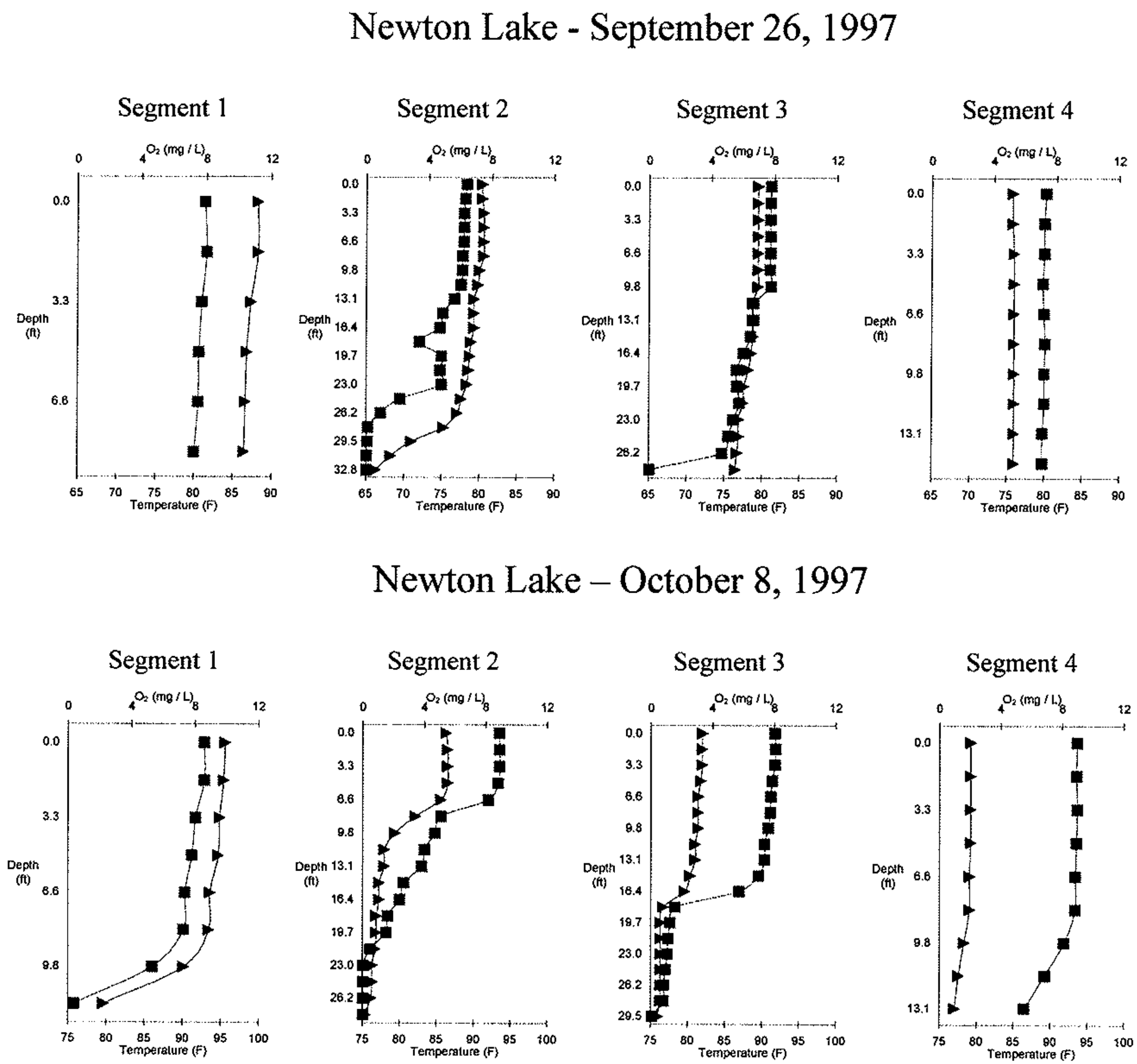


Figure 15A.2. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

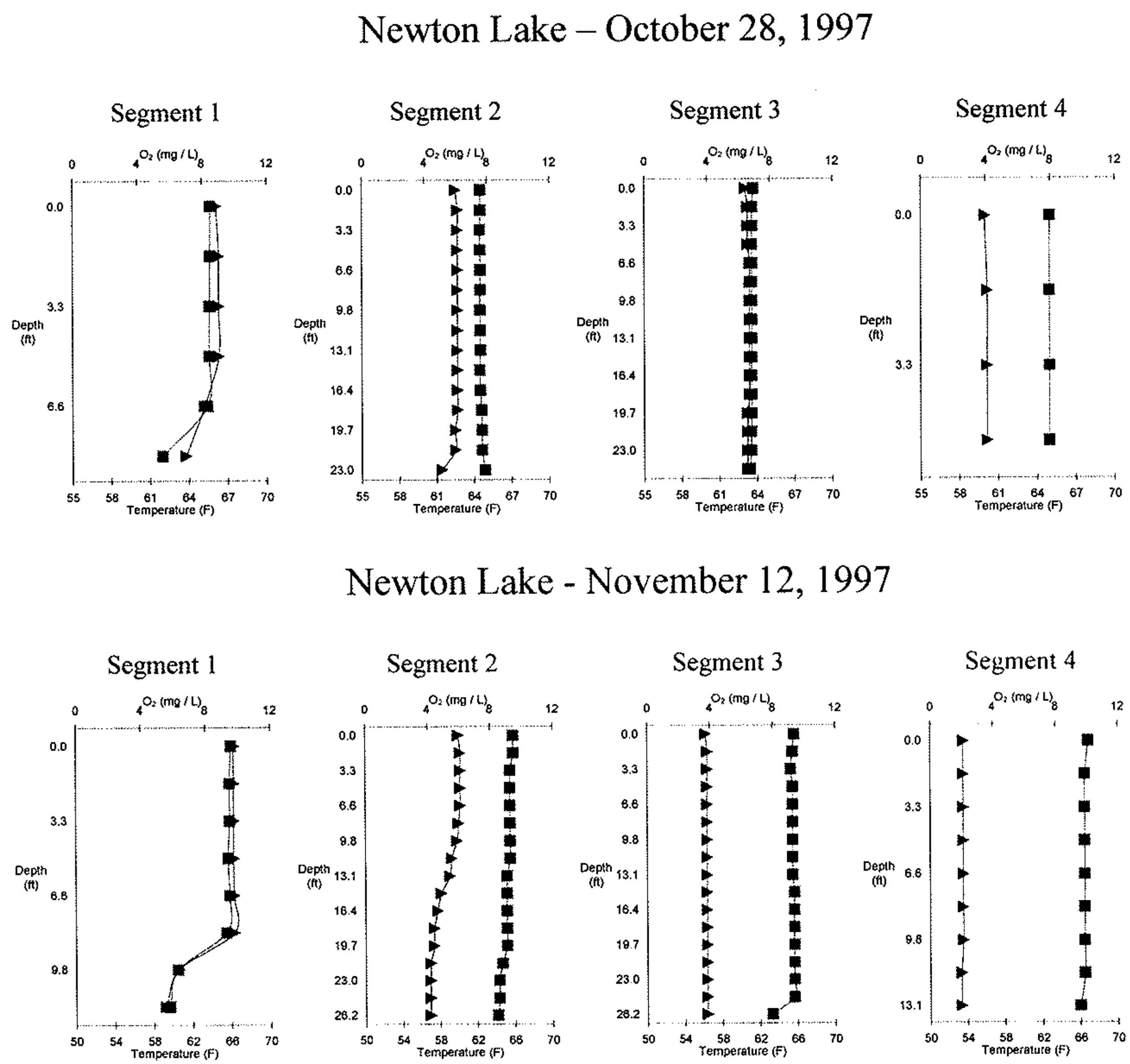
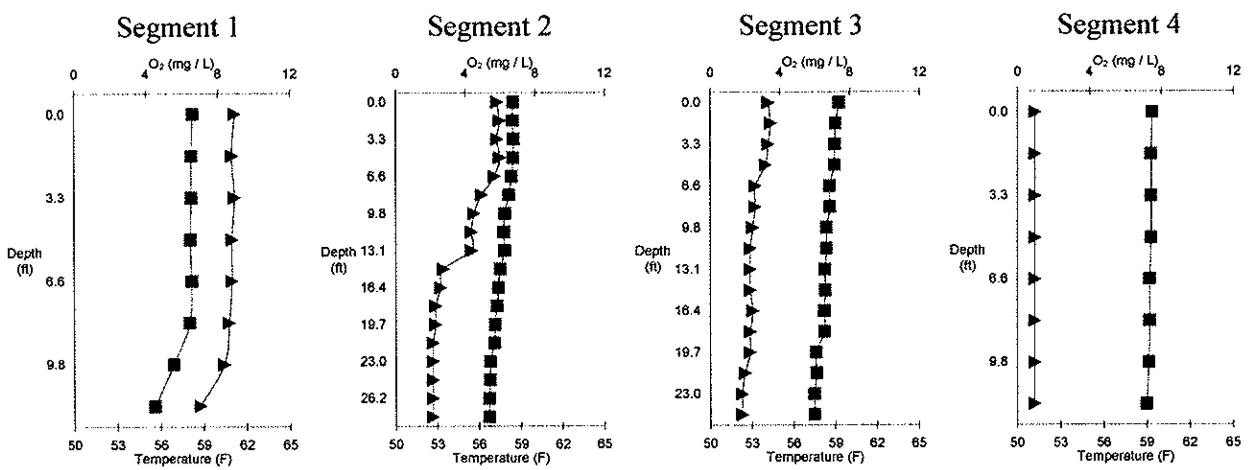


Figure 15A.3. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – November 24, 1997



Newton Lake – December 17, 1997

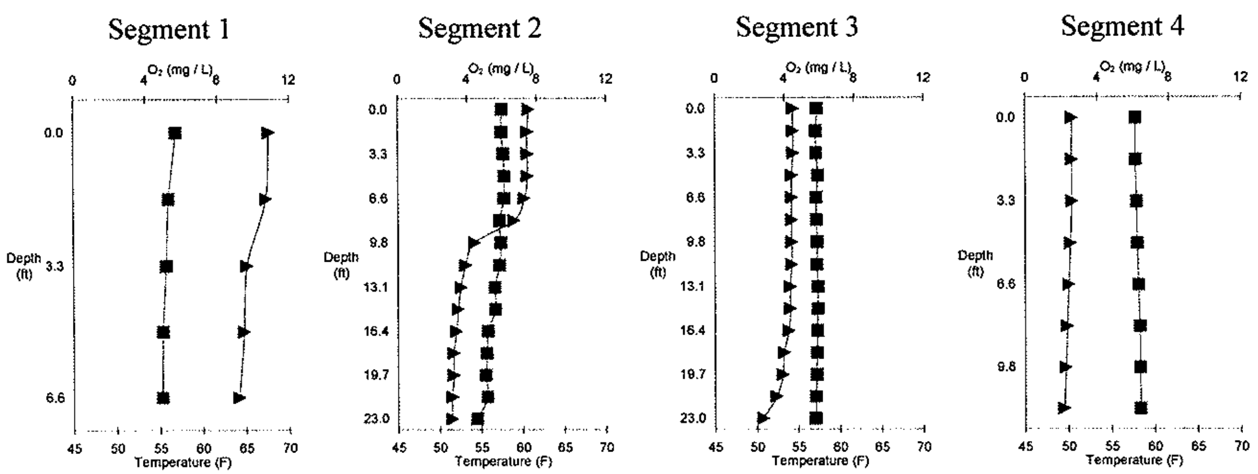


Figure 15A.4. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

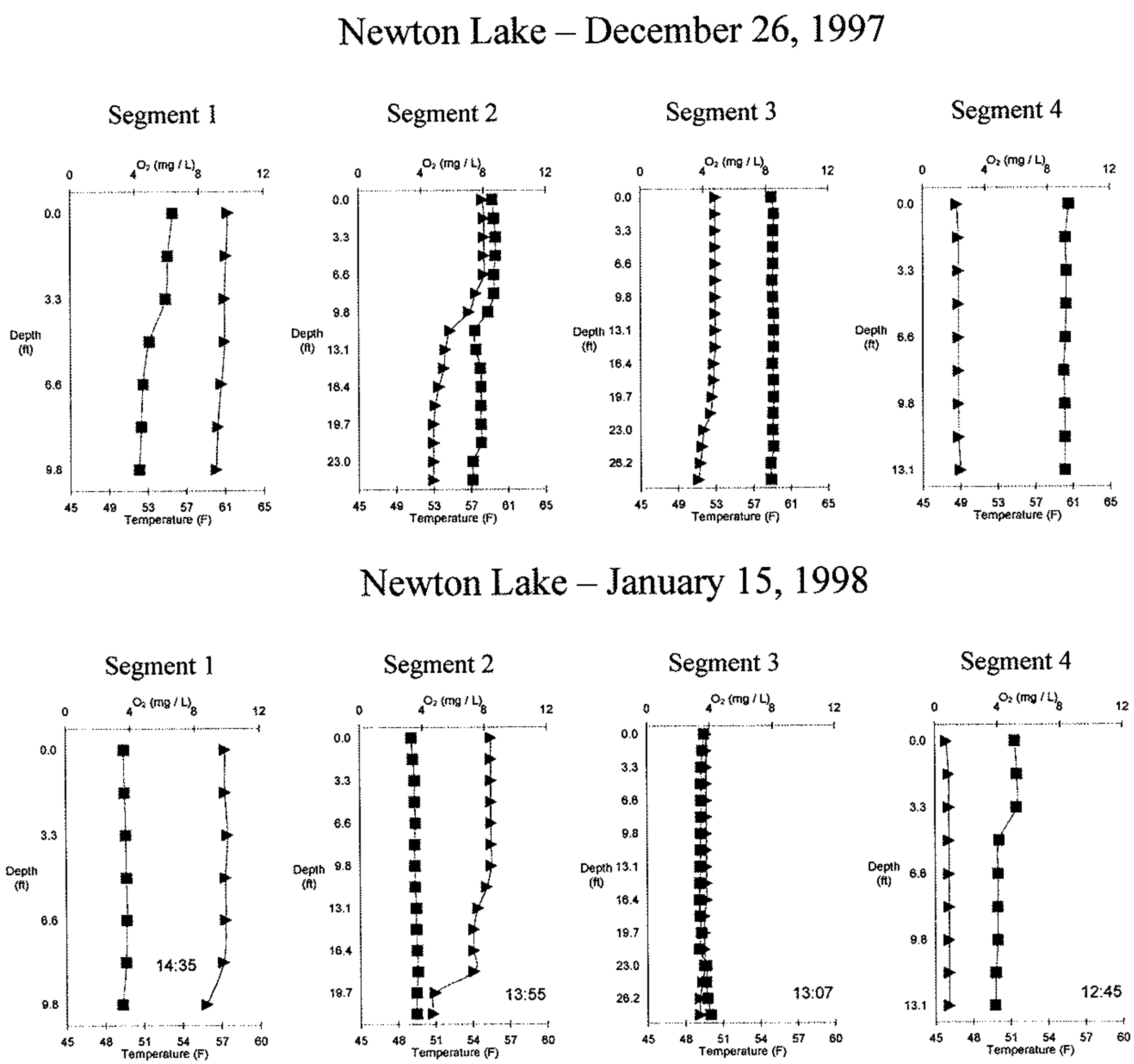
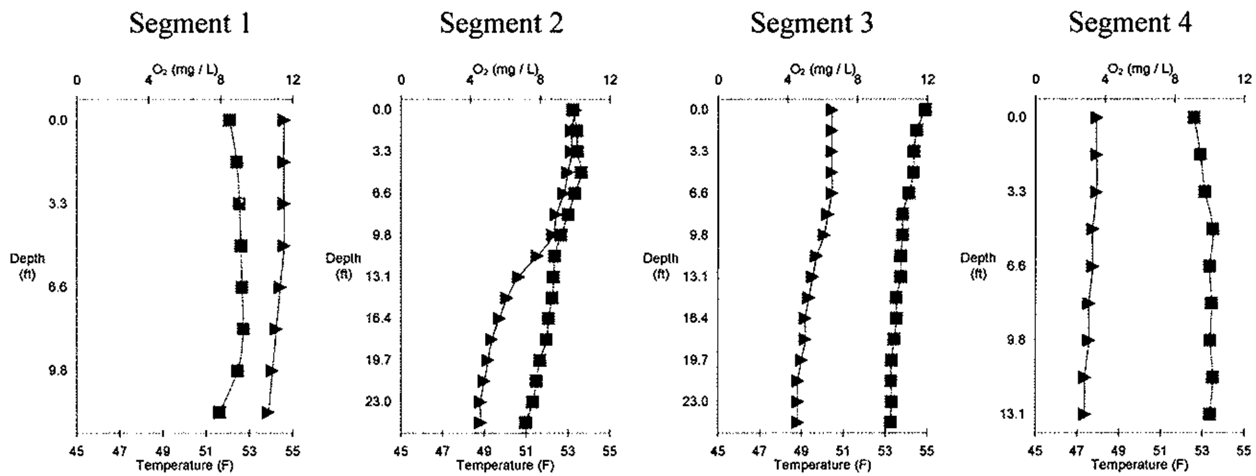


Figure 15A.5. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – January 31, 1998



Newton Lake - February 12, 1998

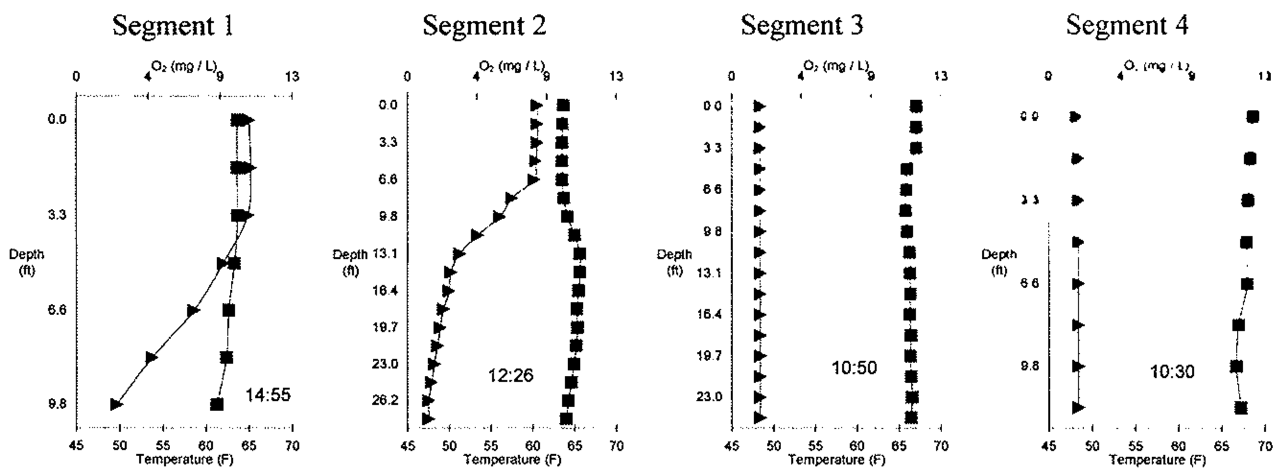
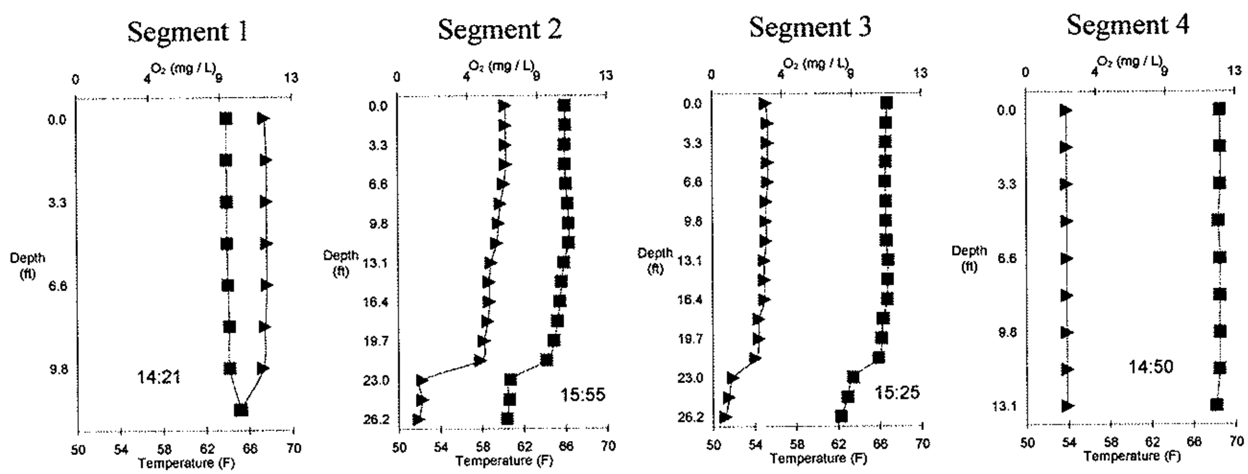


Figure 15A.6. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – February 26, 1998



Newton Lake – March 29, 1998

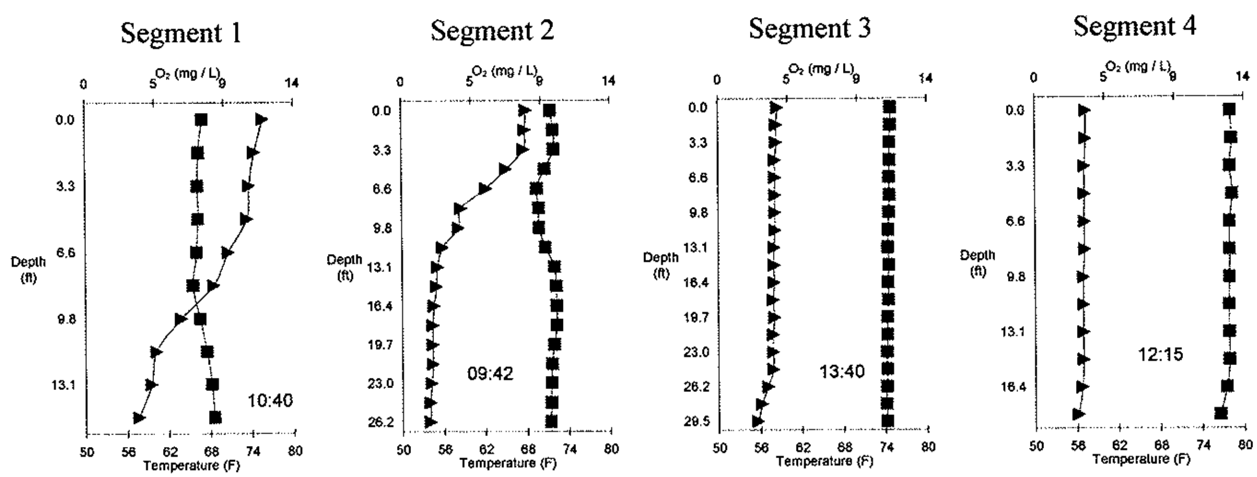
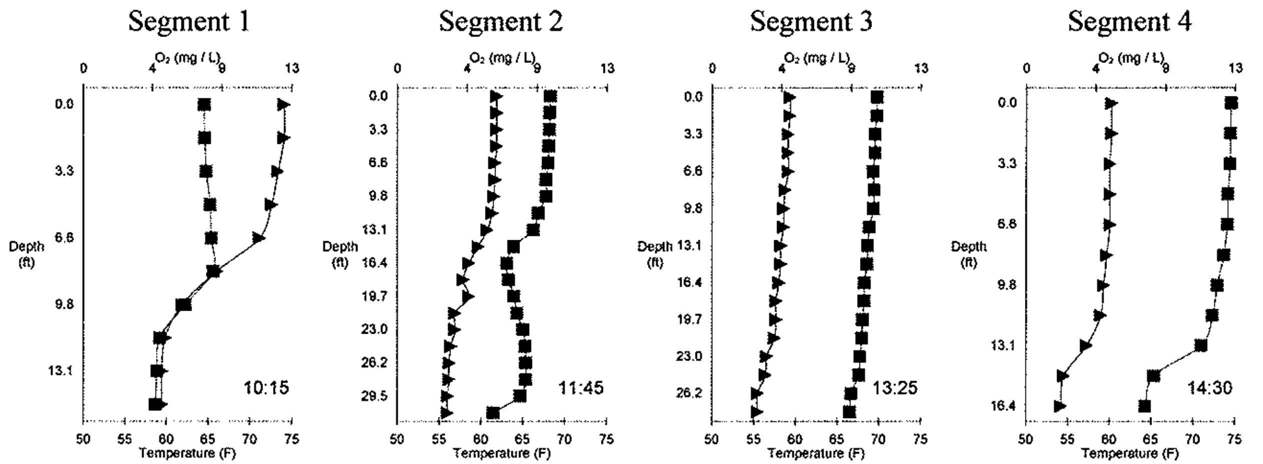


Figure 15A.7. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – April 7, 1998



Newton Lake – April 16, 1998

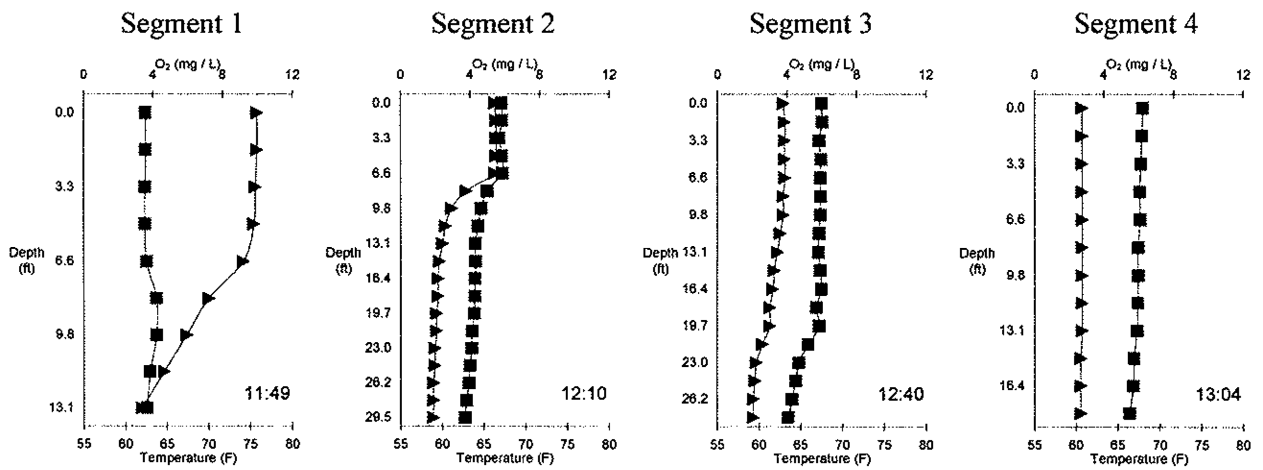
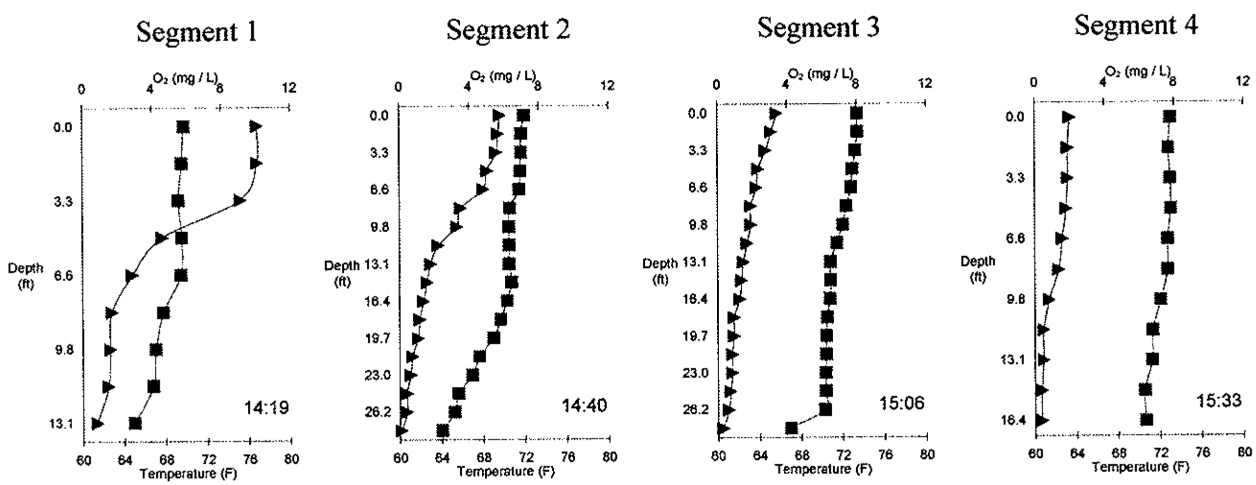


Figure 15A.8 Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – April 23, 1998



Newton Lake – May 7, 1998

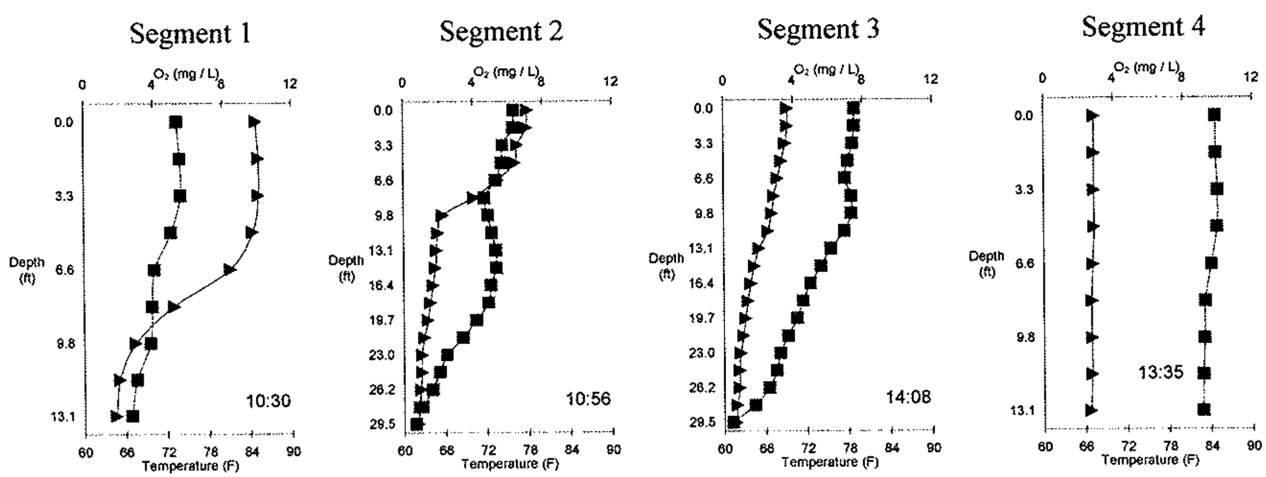
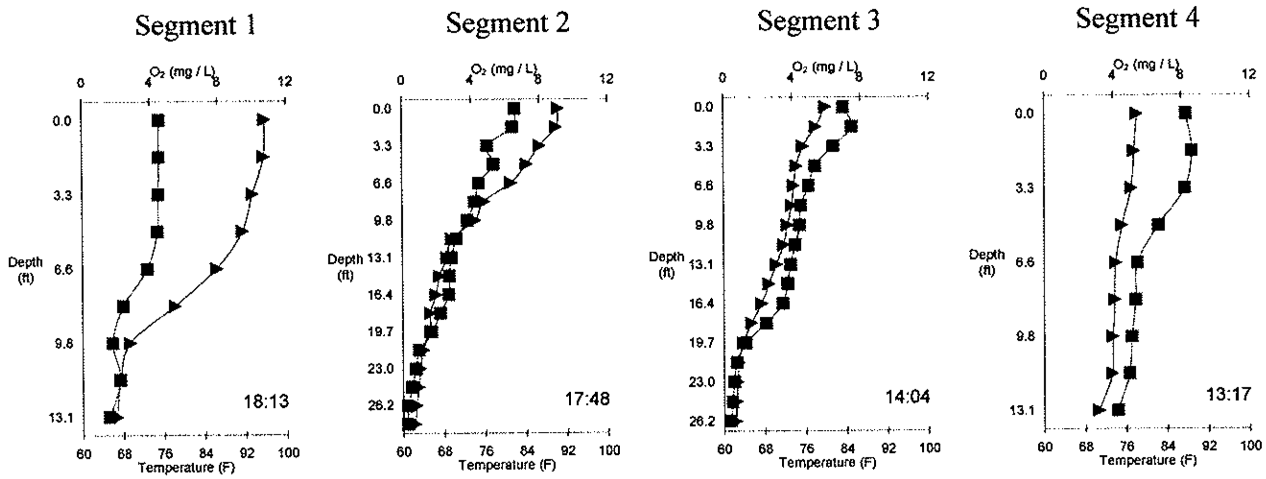


Figure 15A.9. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – May 13, 1998



Newton Lake – May 20, 1998

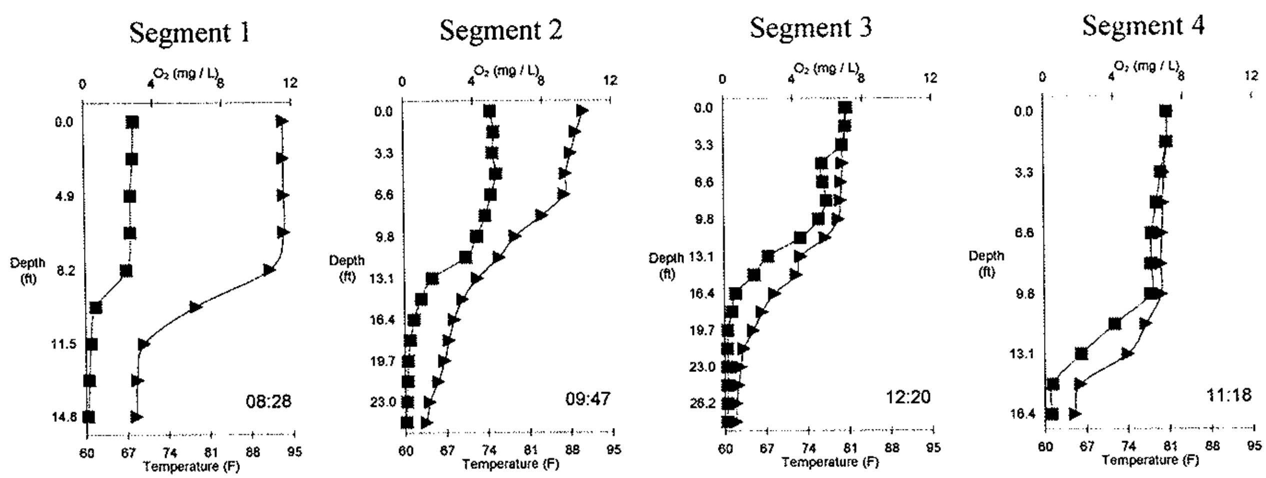


Figure 15A.10 Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – May 26, 1998

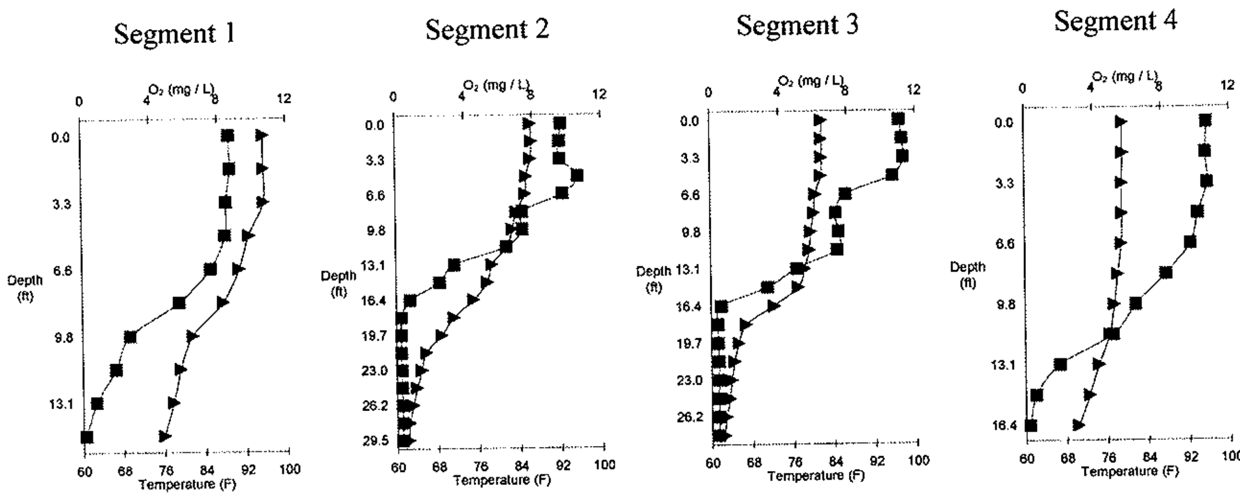
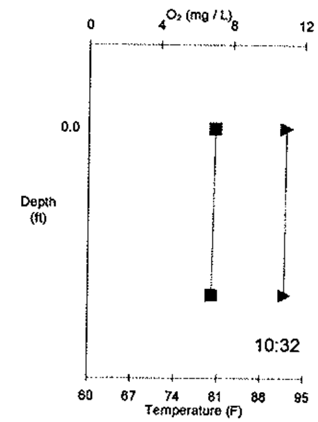


Figure 15A.11. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 3, 1998

Segment 1



Segment 2

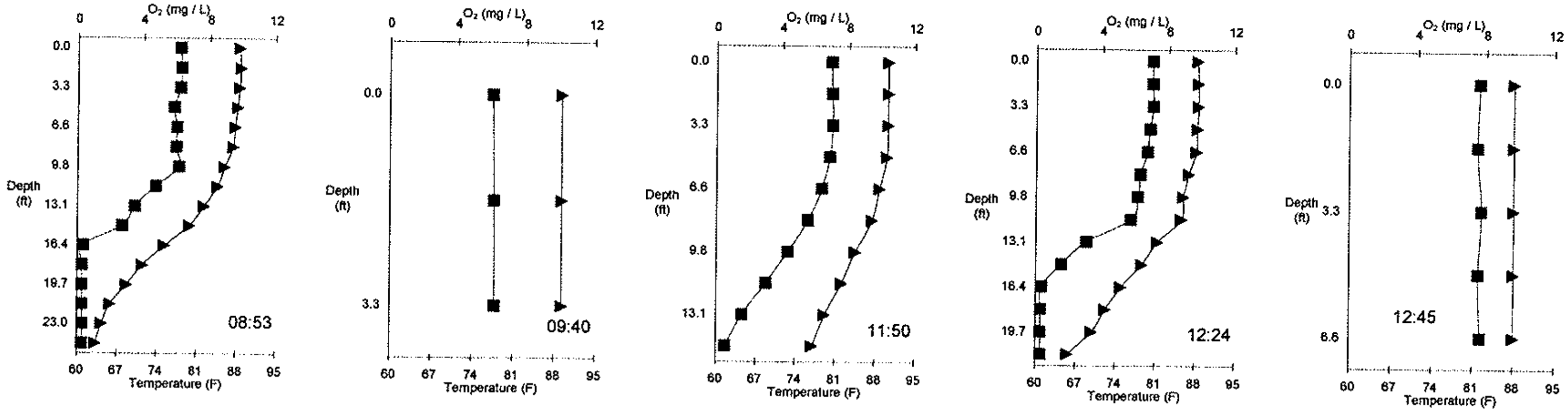


Figure 15A.12. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 5, 1998

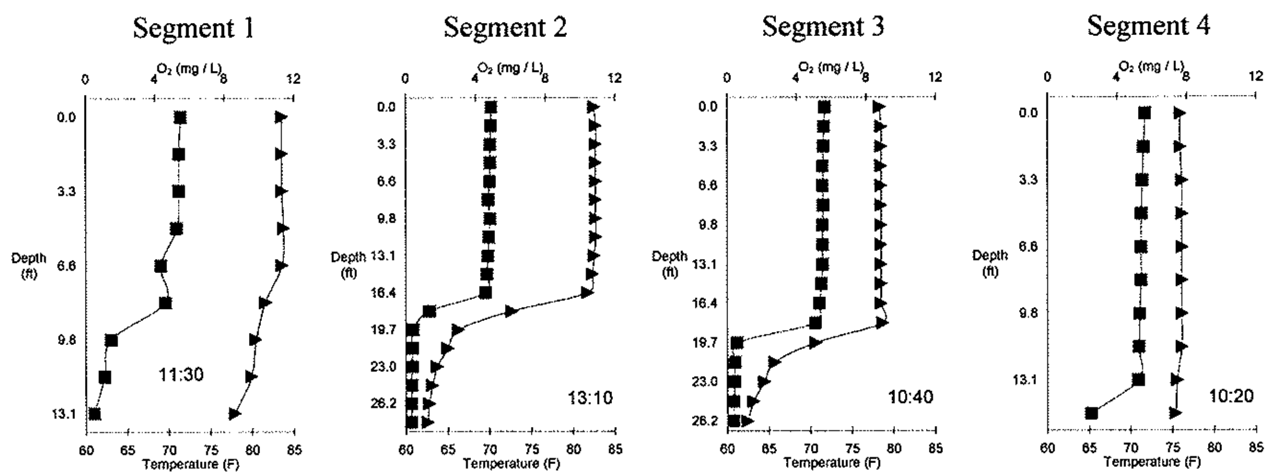
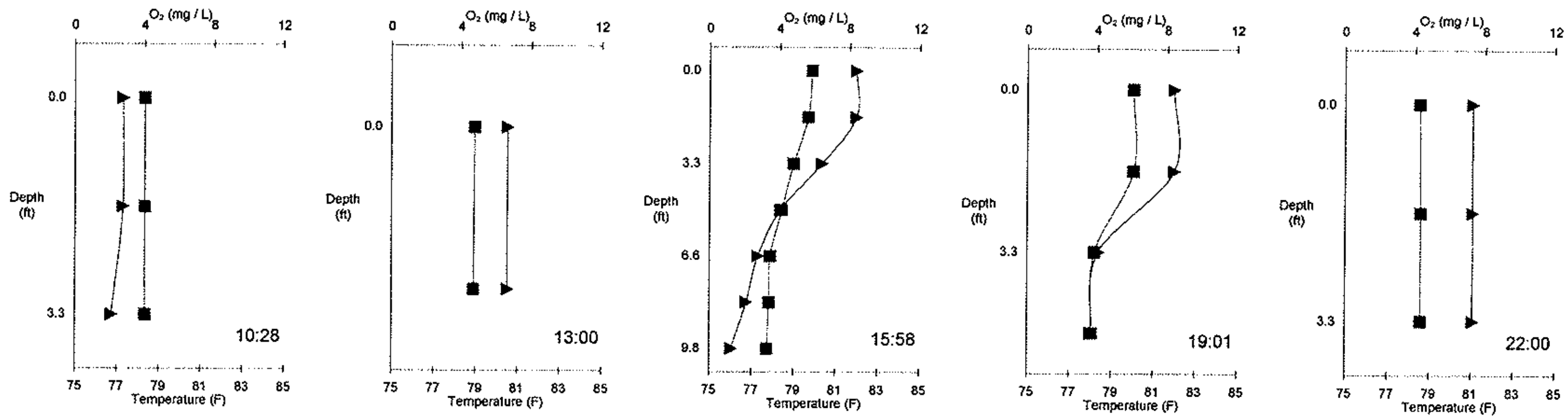


Figure 15A.13. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 9, 1998

Segment 2



Newton Lake – June 10, 1998

Segment 1

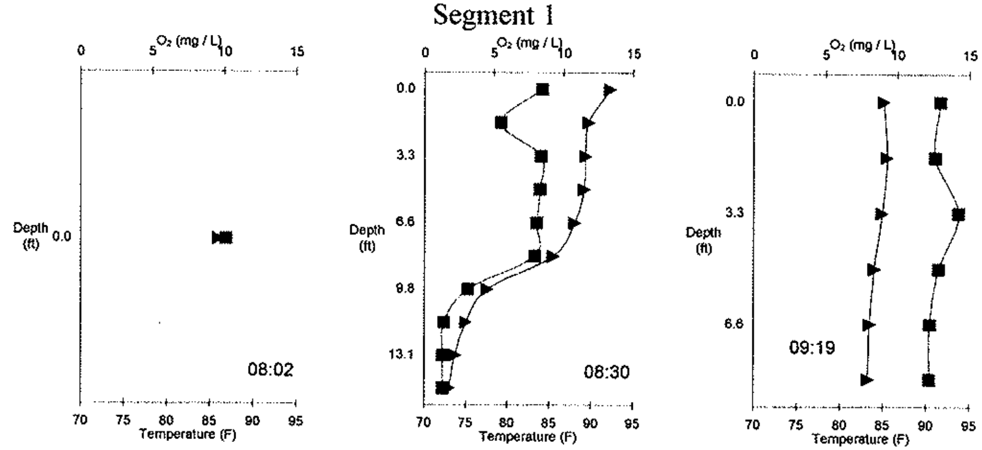


Figure 15A.14. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 10, 1998

Segment 2

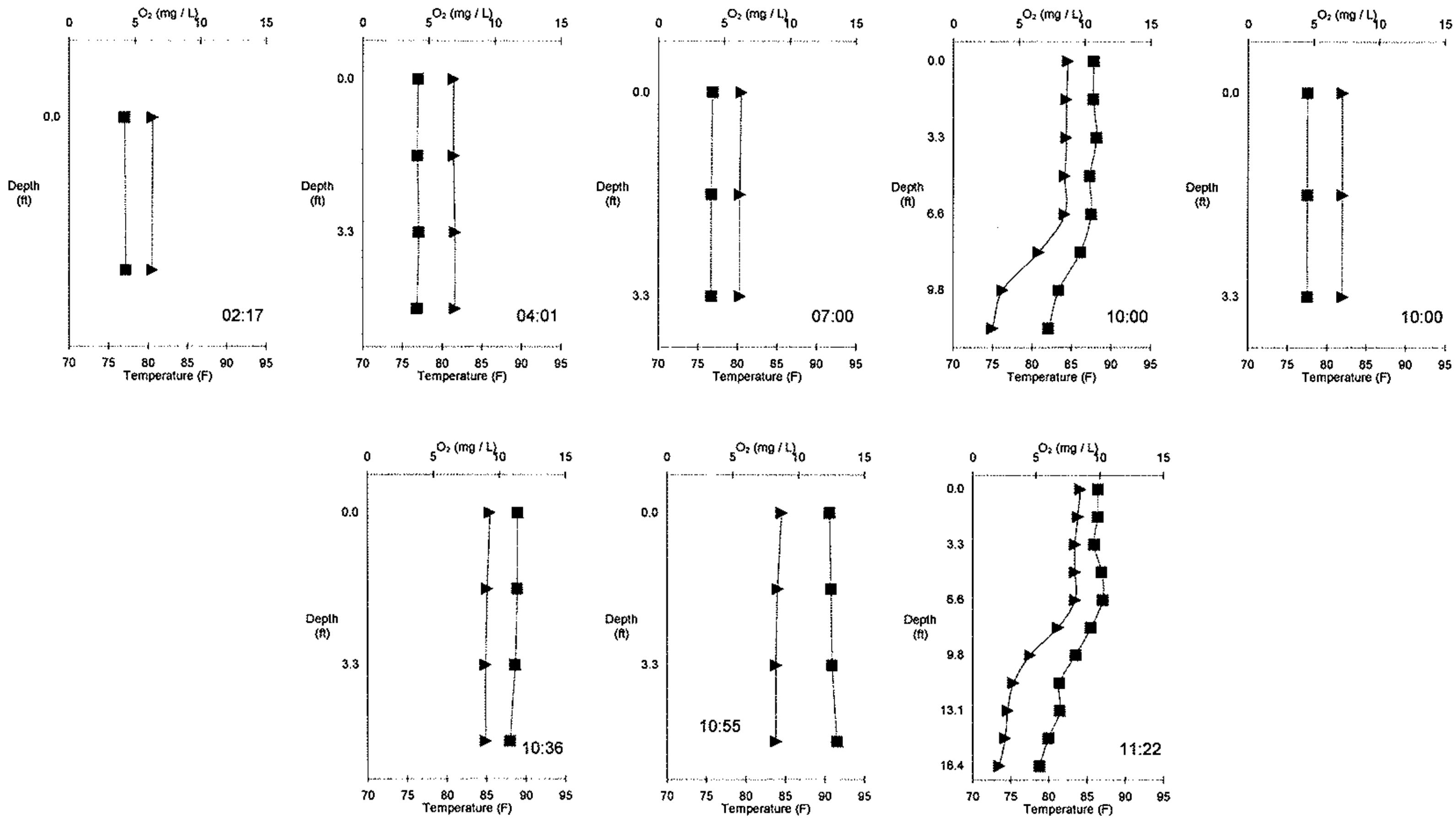


Figure 15A.15 Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 10, 1998

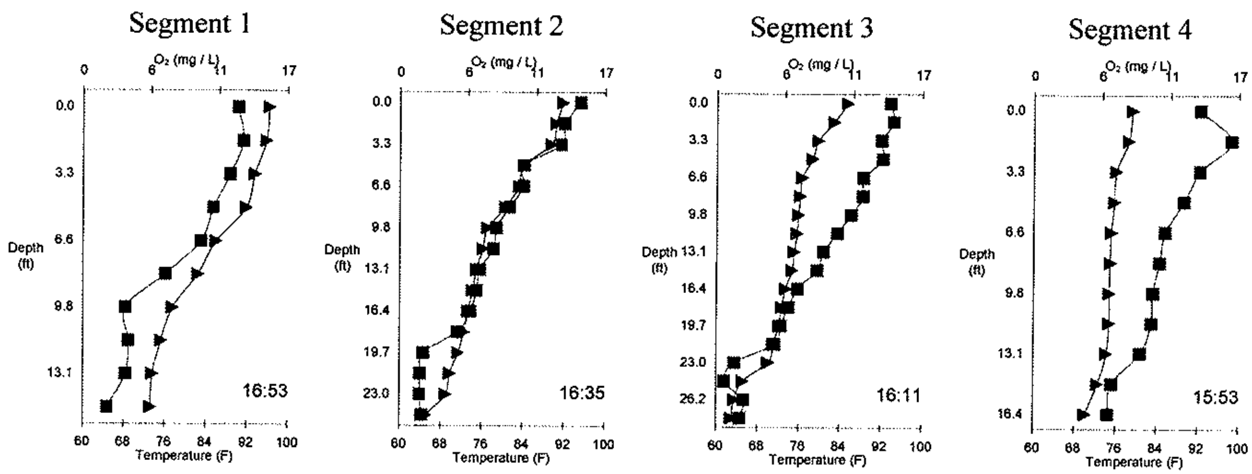
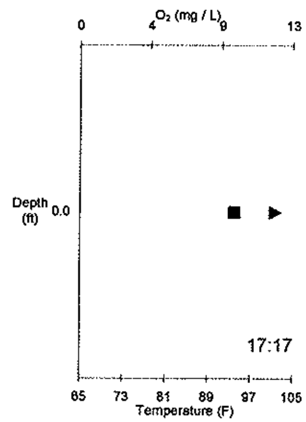


Figure 15A.16. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 19, 1998

Segment 1



Segment 2

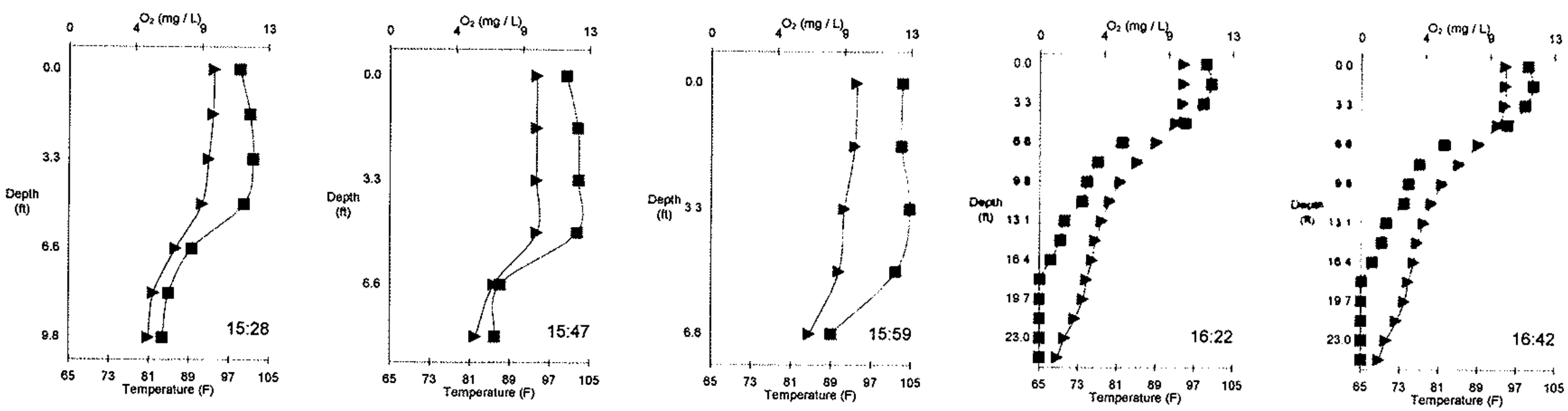
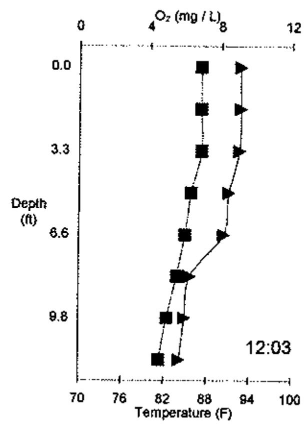
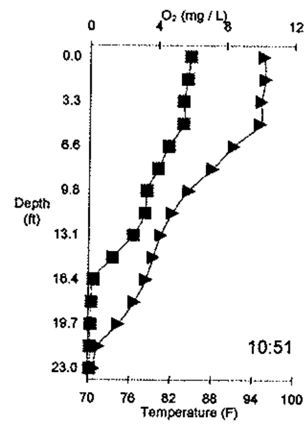


Figure 15A.17. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

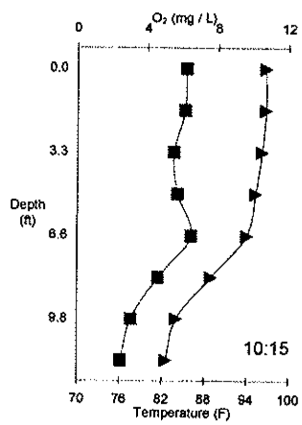
Newton Lake – June 23, 1998

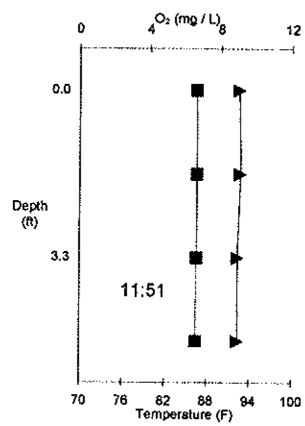
Segment 1





Segment 2





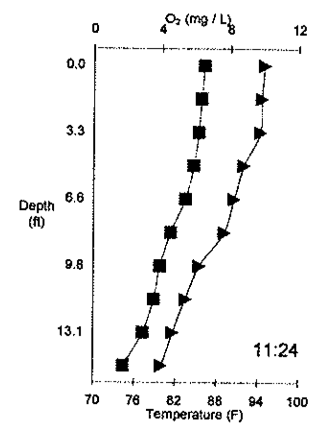


Figure 15A.18. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 26, 1998

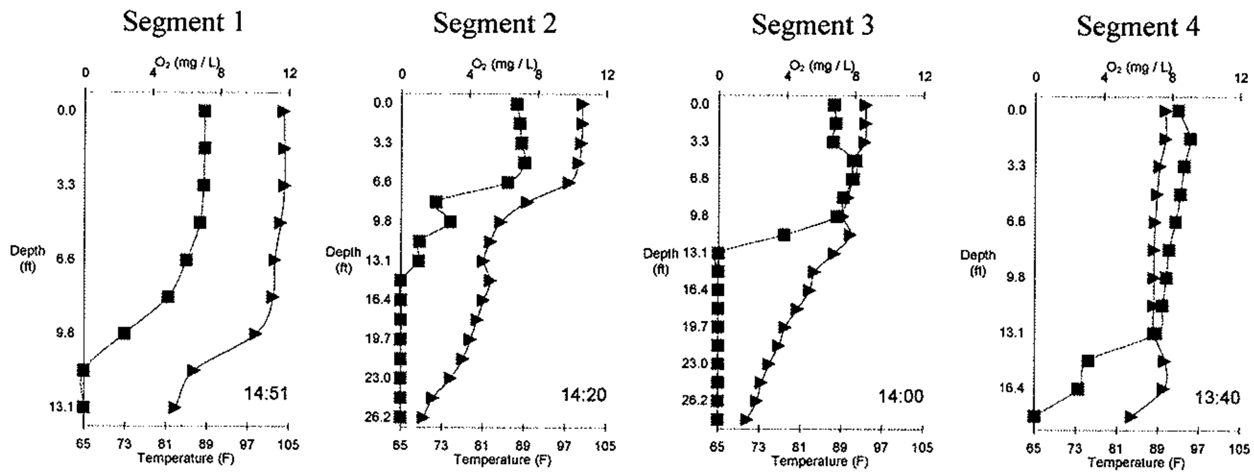
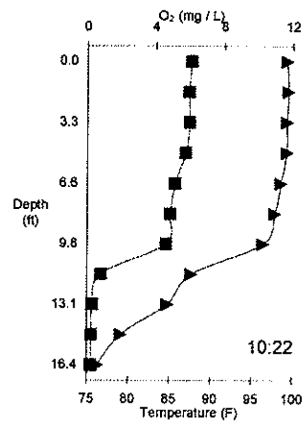


Figure 15A.19. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 30, 1998

Segment 1



Segment 2

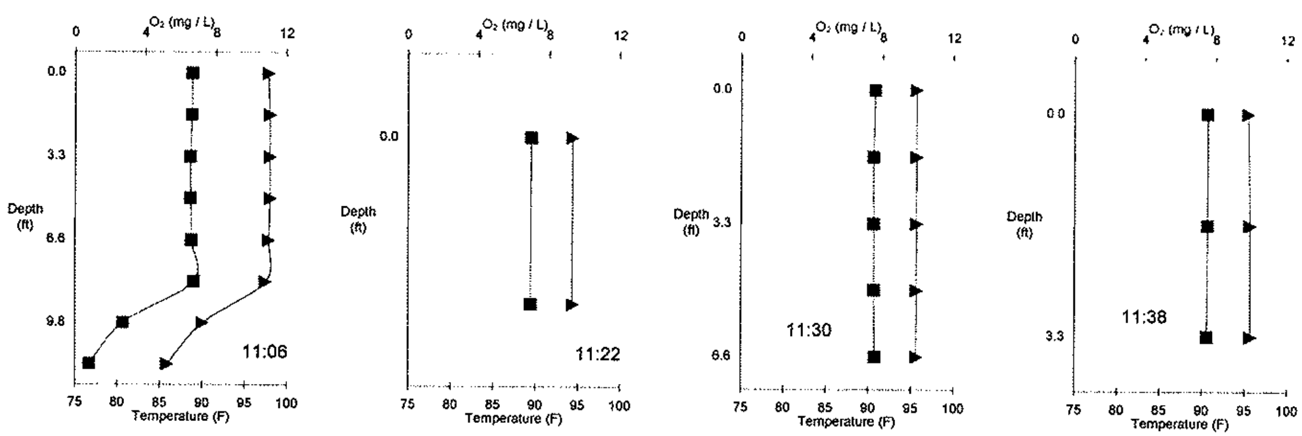


Figure 15A.20. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –July 7, 1998

Segment 2

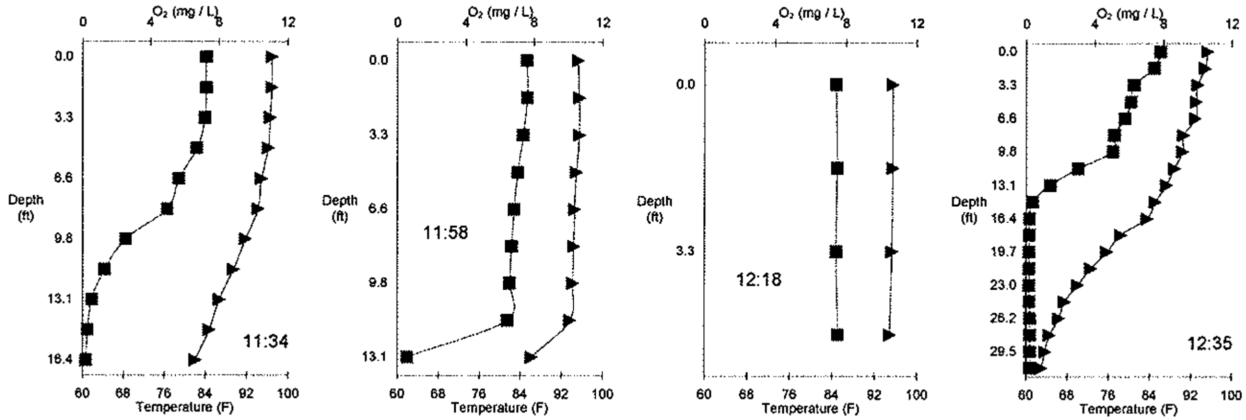


Figure 15A.21. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 11, 1998

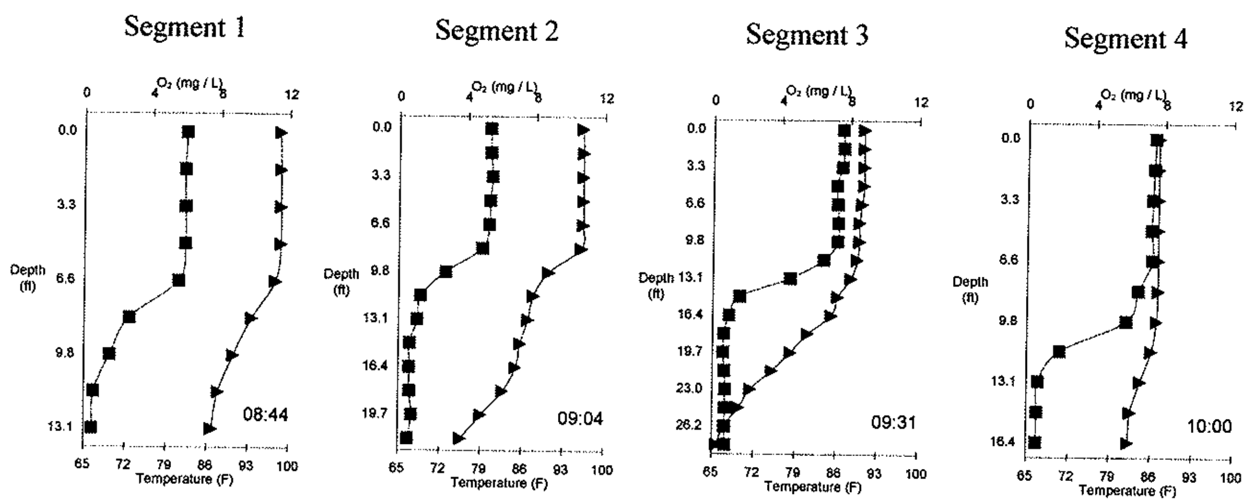


Figure 15A.22. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –July 13, 1998

Segment 2

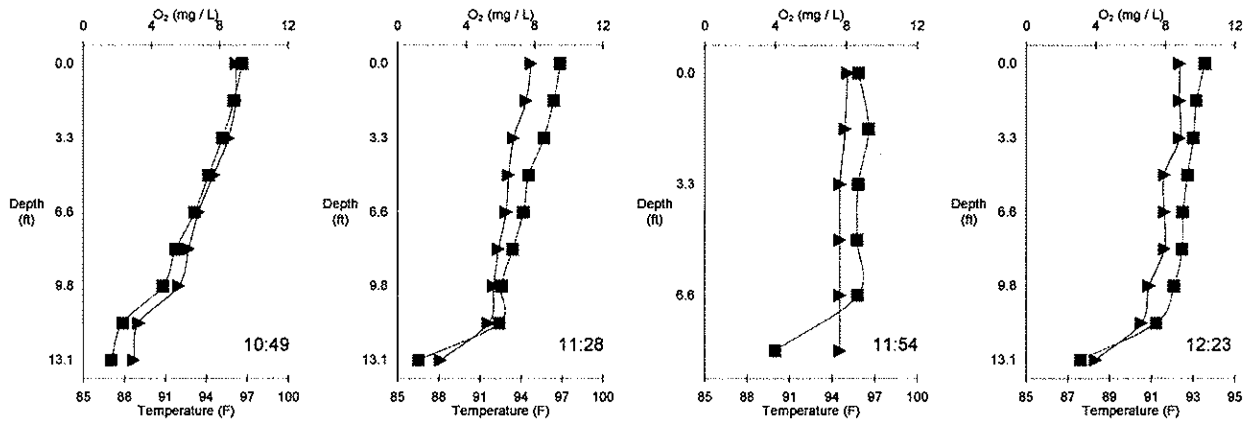


Figure 15A.23. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 18, 1998

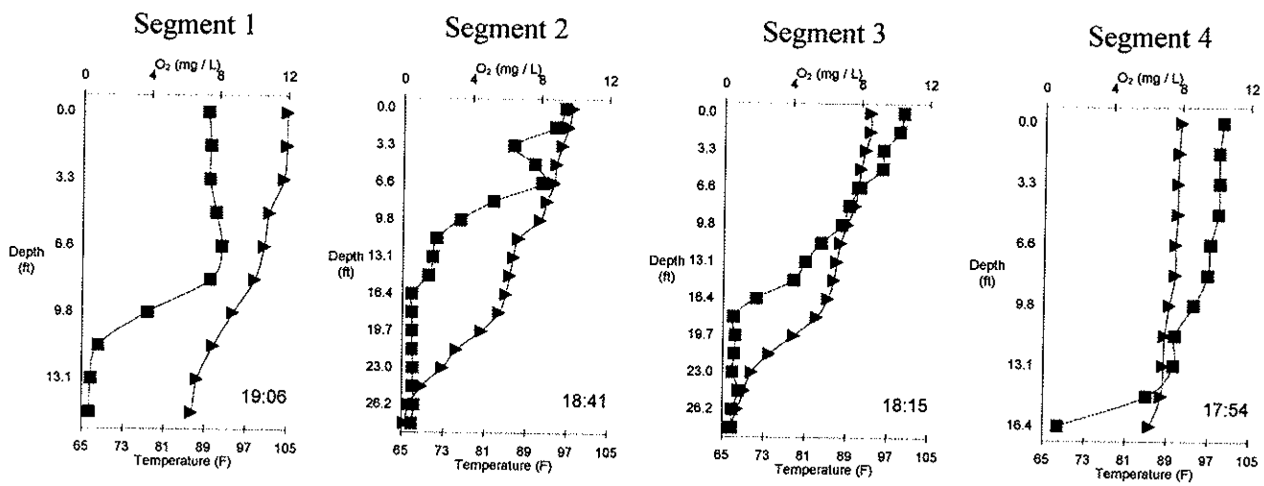
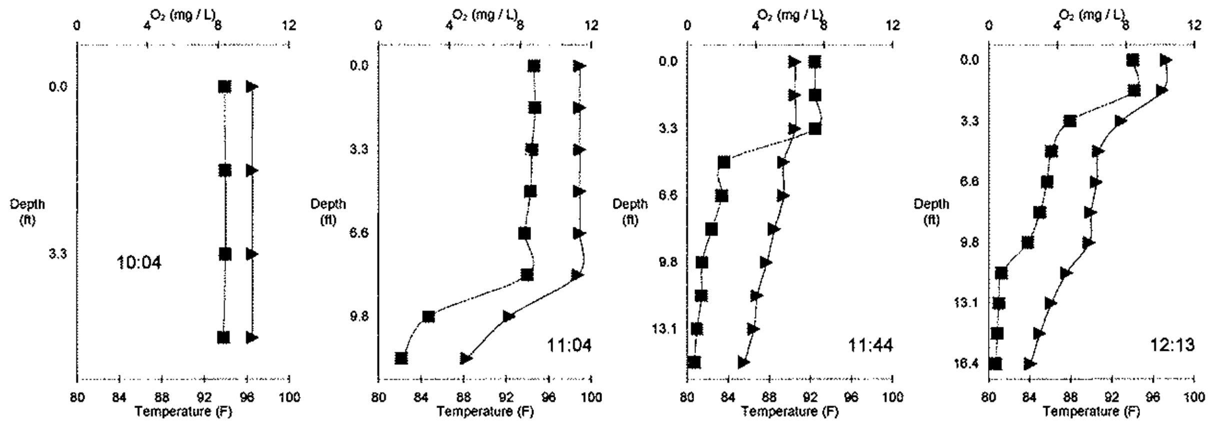


Figure 15A.24 Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 21, 1998

Segment 2



Newton Lake – July 28, 1998

Segment 1

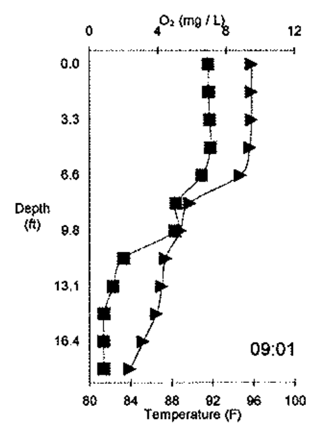


Figure 15A.25. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 28, 1998

Segment 2

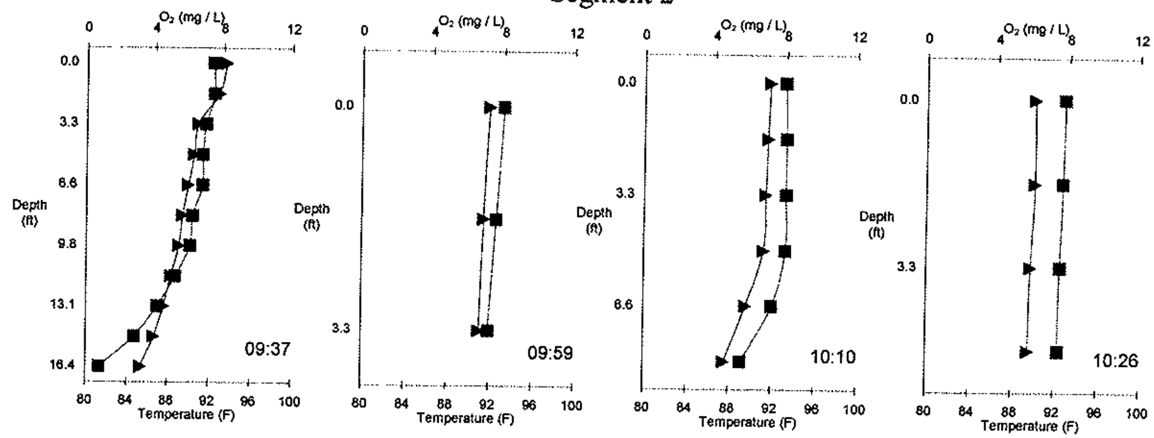


Figure 15A.26. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

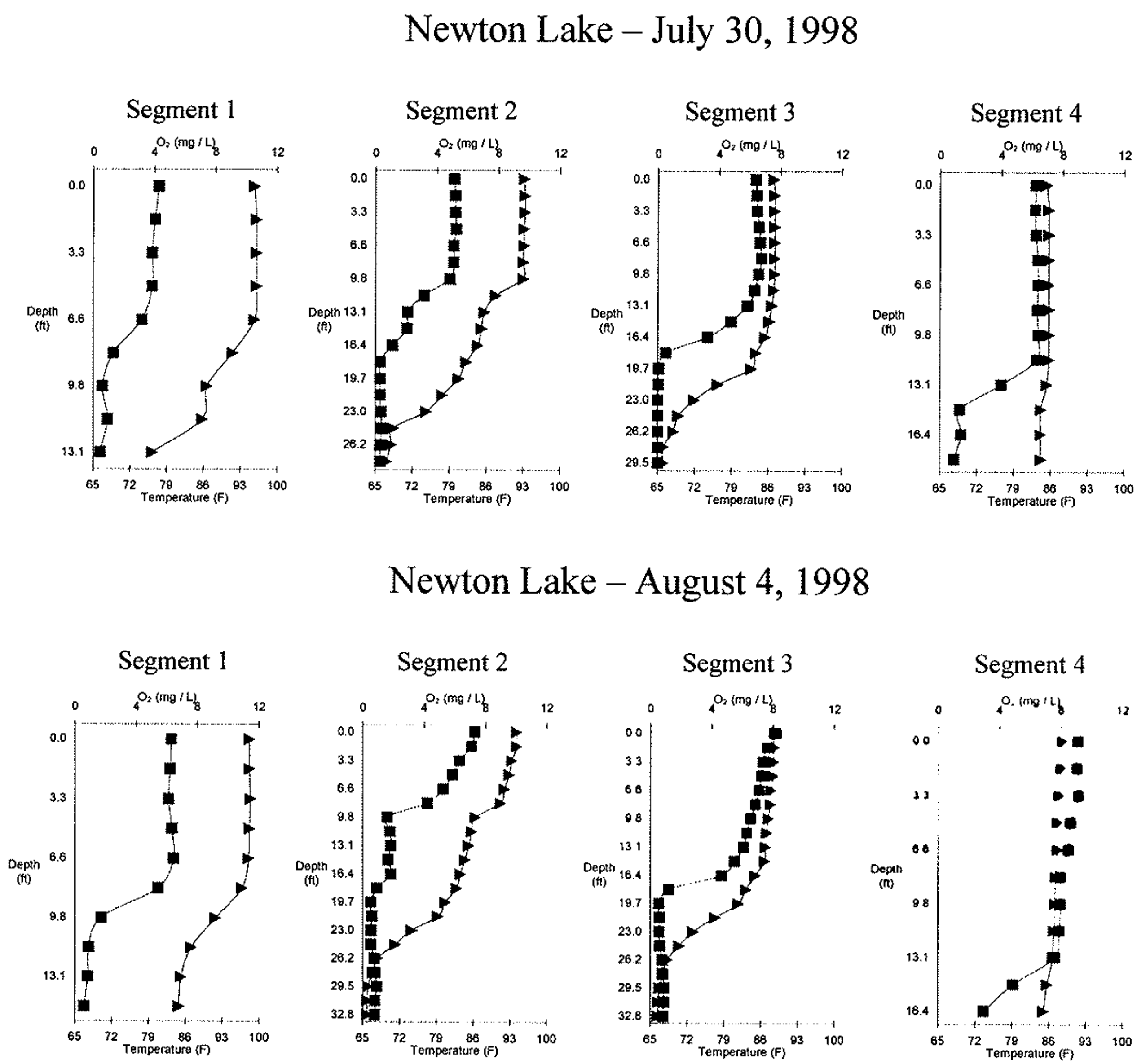


Figure 15A.27. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 7, 1998

Segment 2

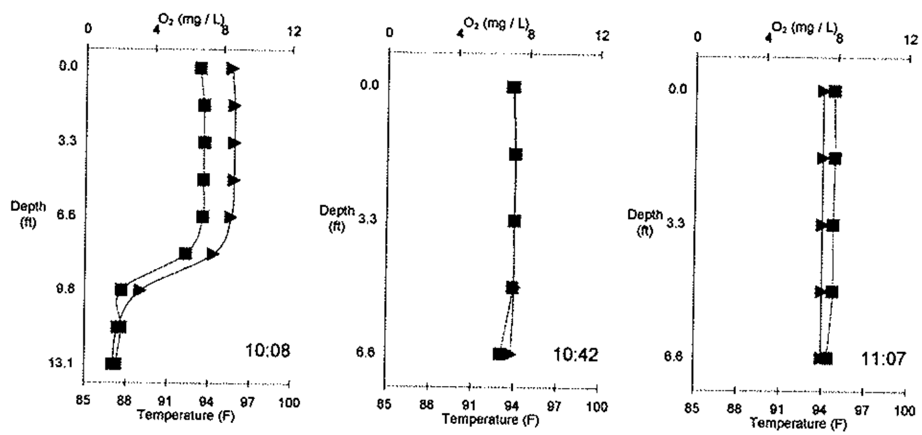


Figure 15A.28. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –August 12, 1998

Segment 2

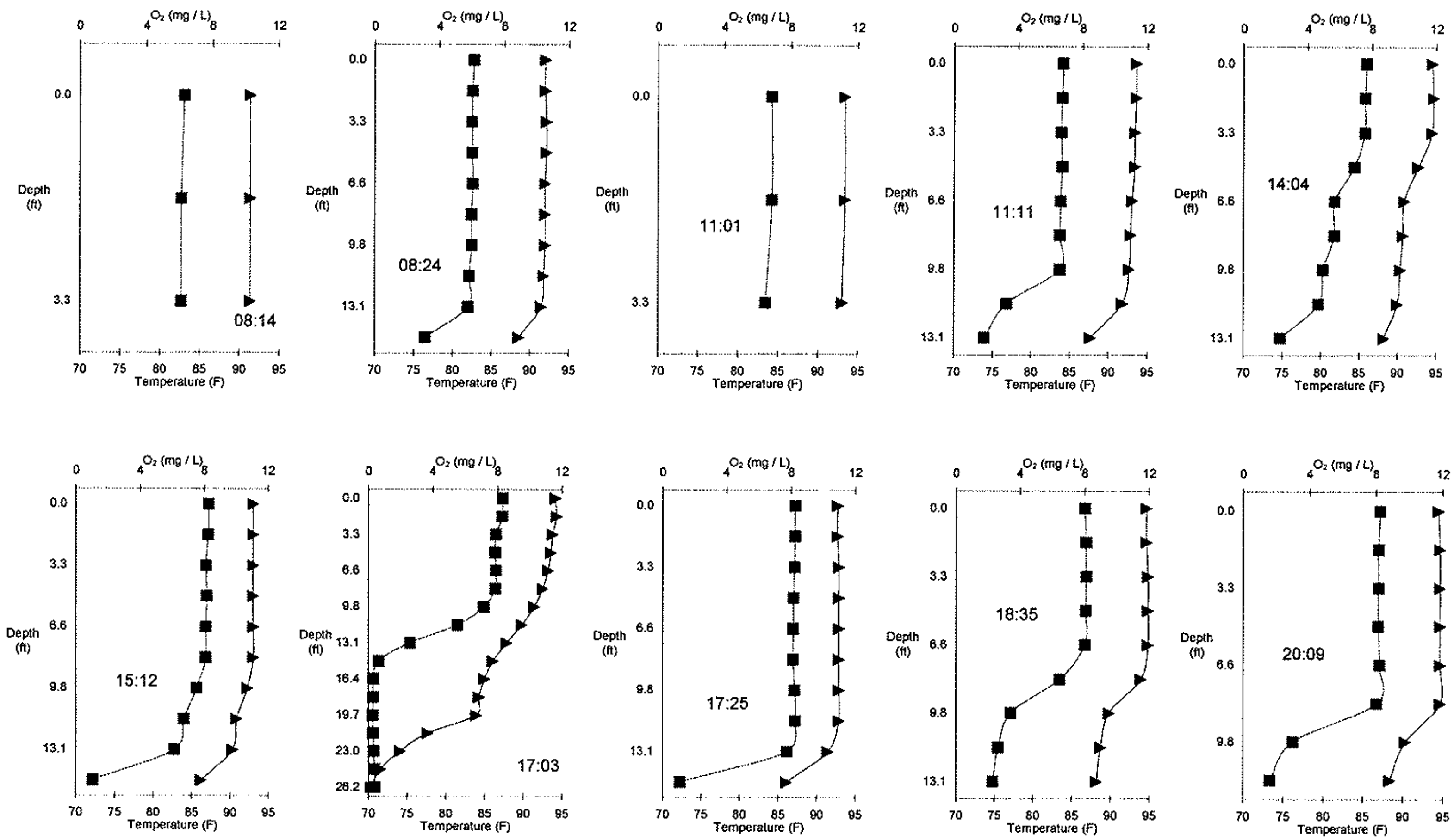
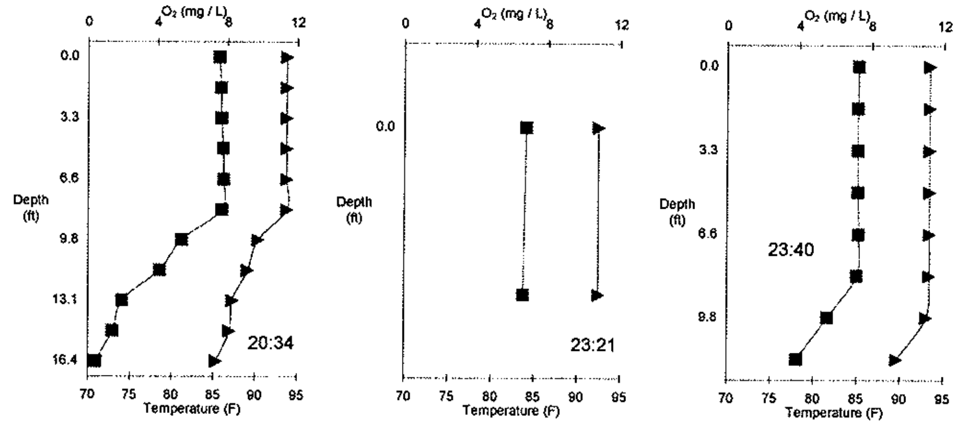


Figure 15A.29. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 12, 1998

Segment 2



Newton Lake – August 13, 1998

Segment 2

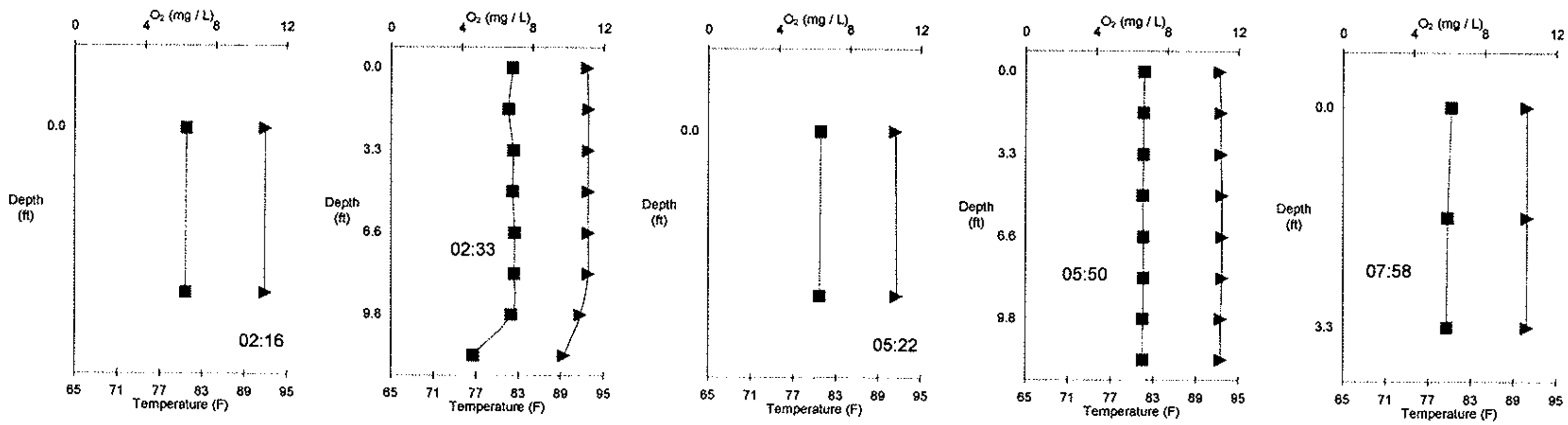
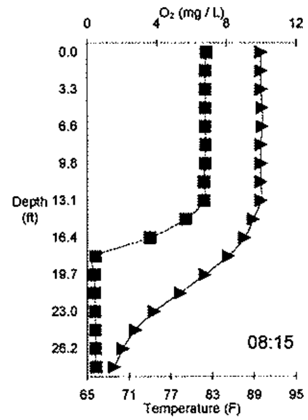


Figure 15A.30. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 13, 1998

Segment 2



Newton Lake – August 18, 1998

Segment 2

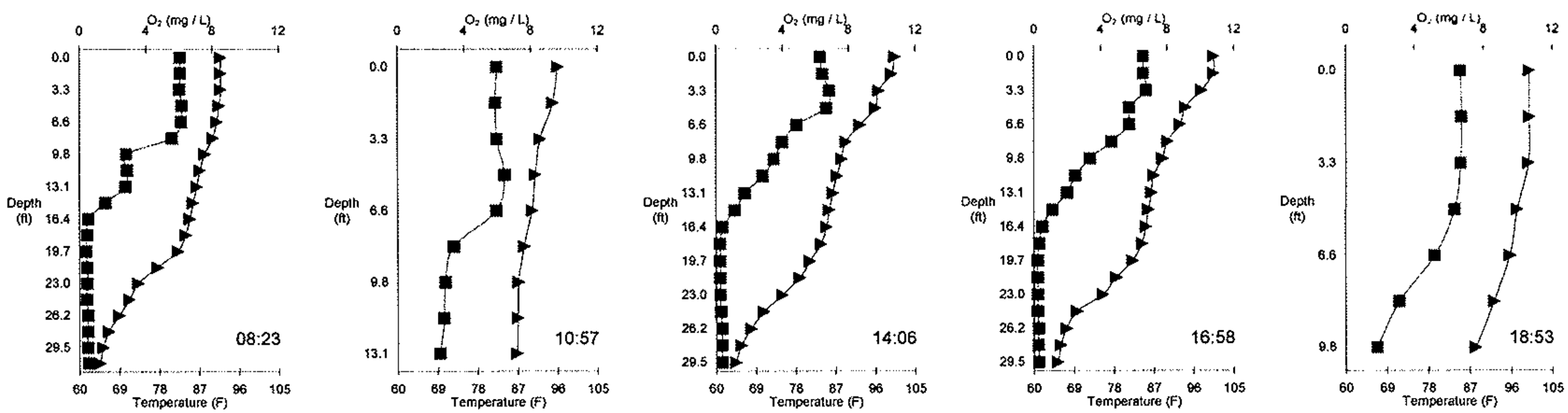
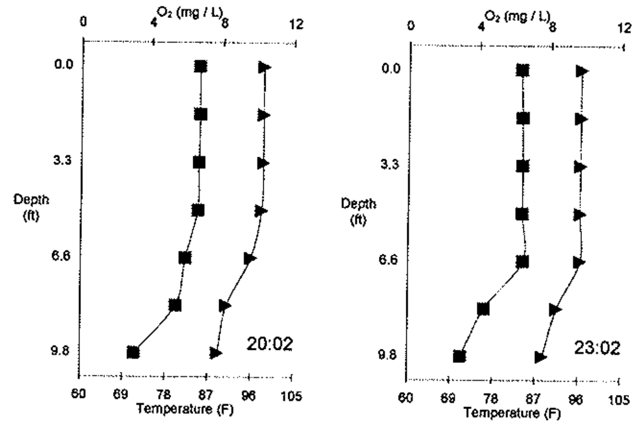


Figure 15A.31. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –August 18, 1998

Segment 2



Newton Lake –August 19, 1998

Segment 2

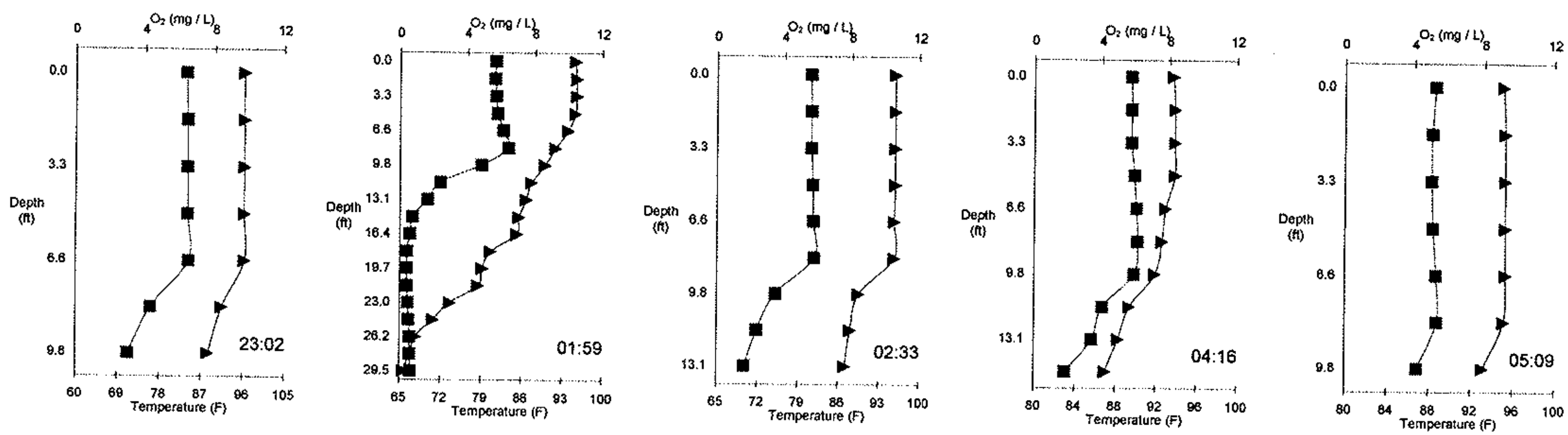


Figure 15A.32. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 19, 1998

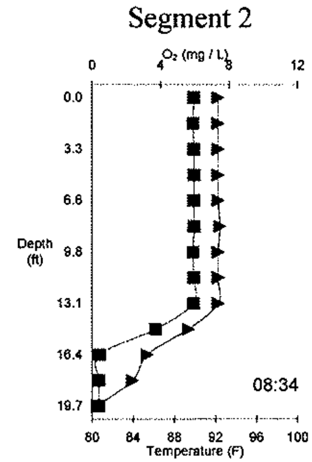


Figure 15A.33. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 24, 1998

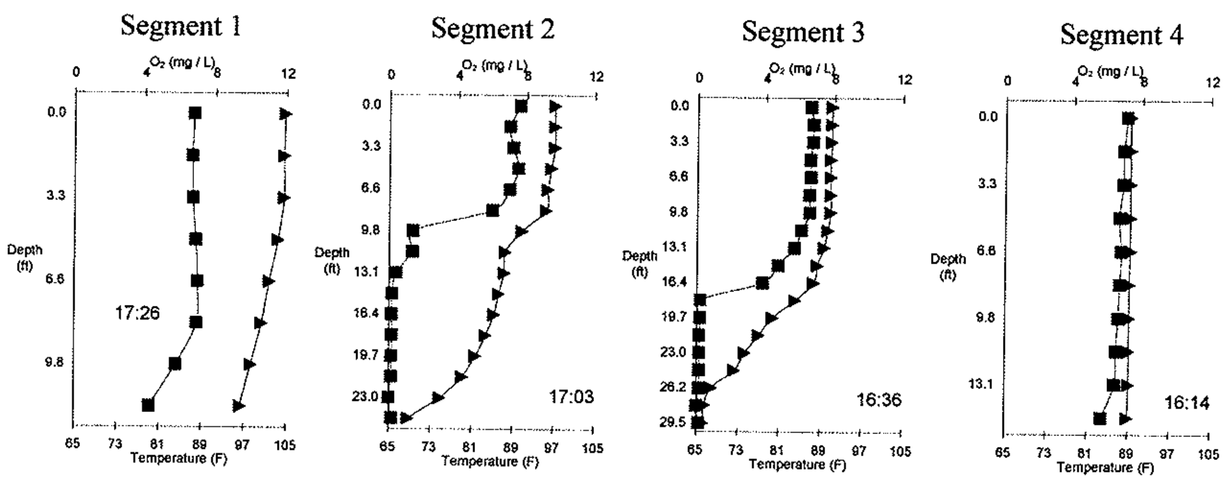
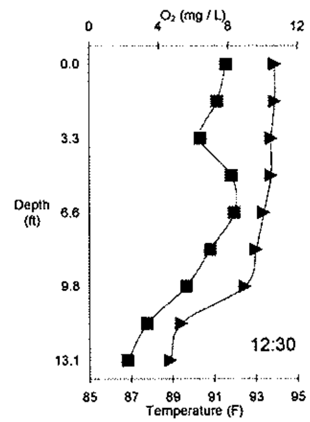


Figure 15A.34. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 27, 1998

Segment 2



Newton Lake – September 3, 1998

Segment 2

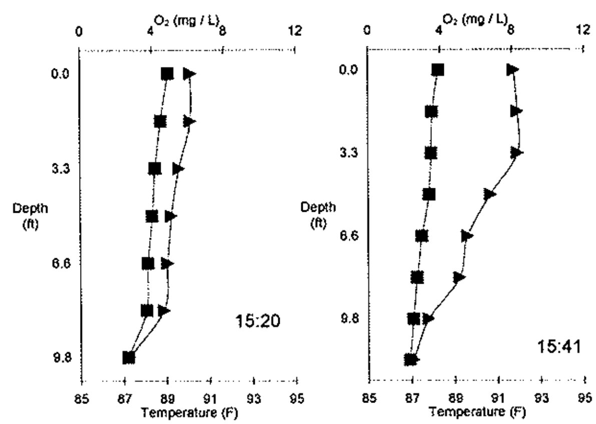


Figure 15A.35. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - September 8, 1998

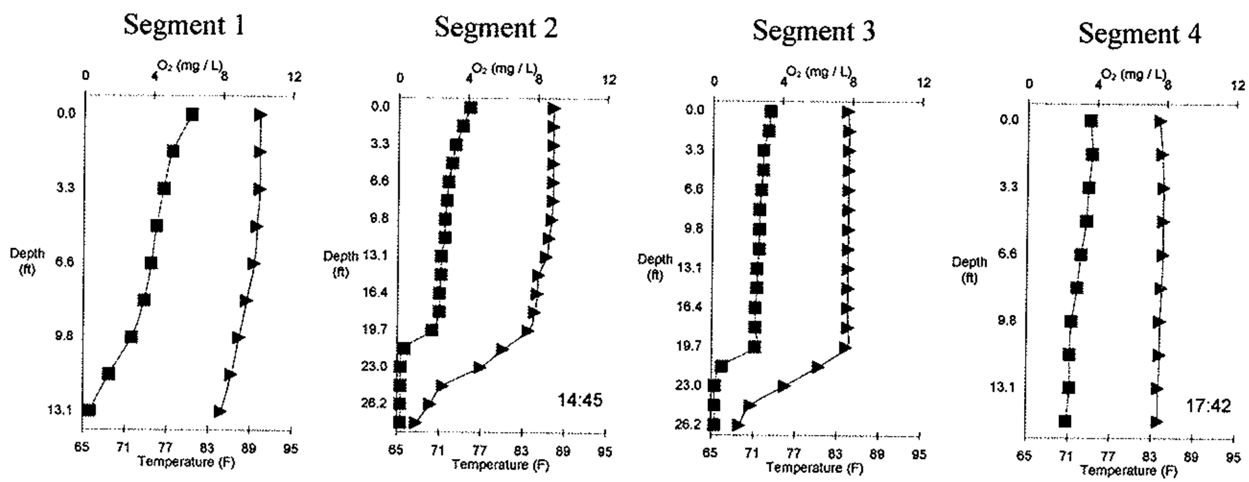
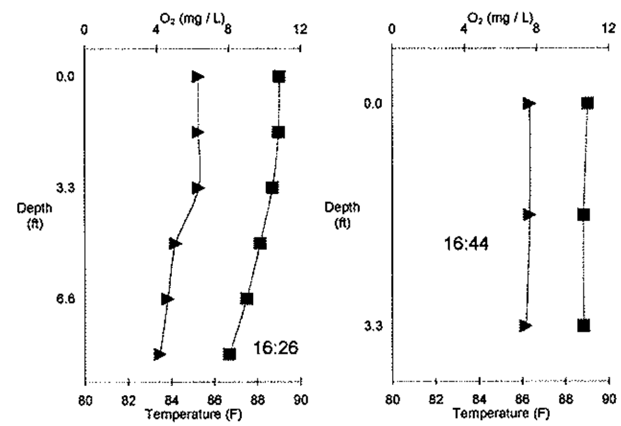


Figure 15A.36. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – September 10, 1998

Segment 2



Newton Lake - September 12, 1998

Segment 3

Segment 4

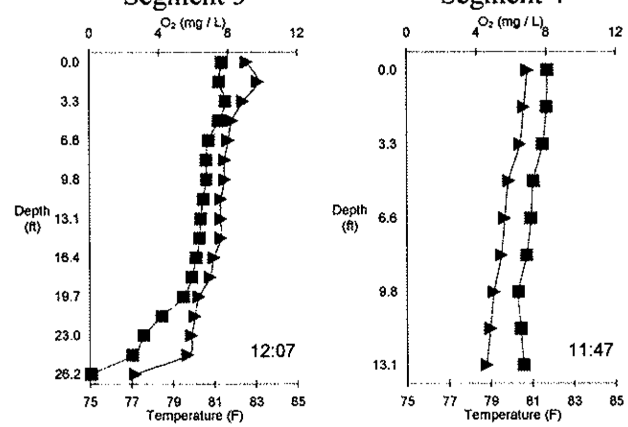


Figure 15A.37.Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –September 15, 1998

Segment 2

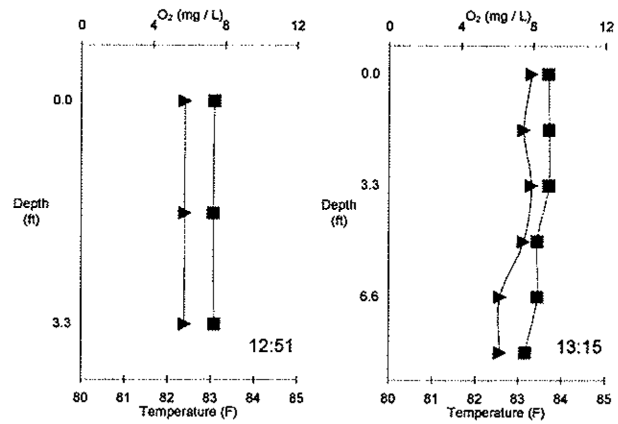


Figure 15A.38. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - September 21, 1998

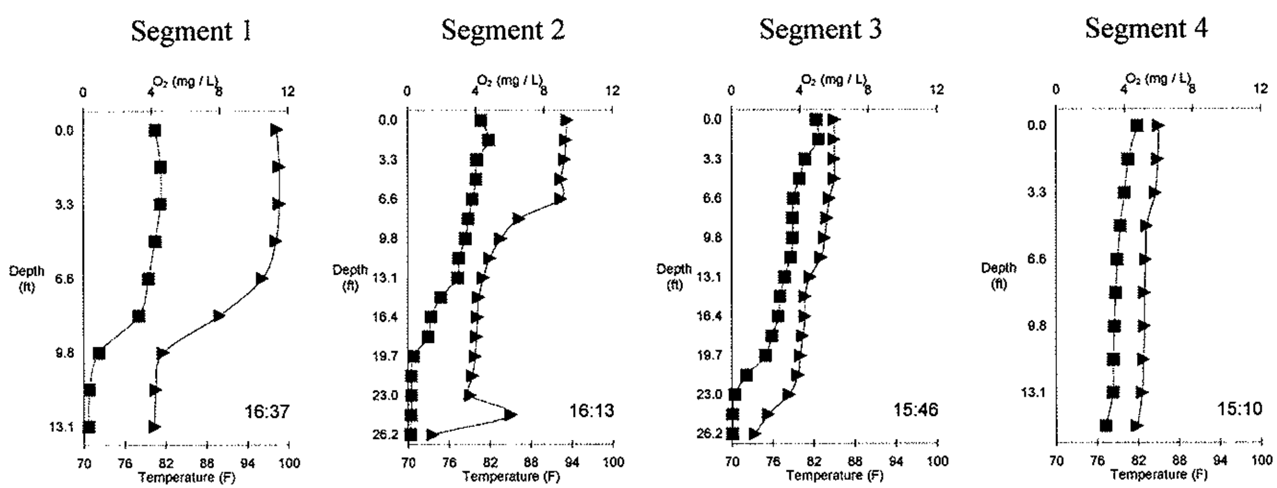
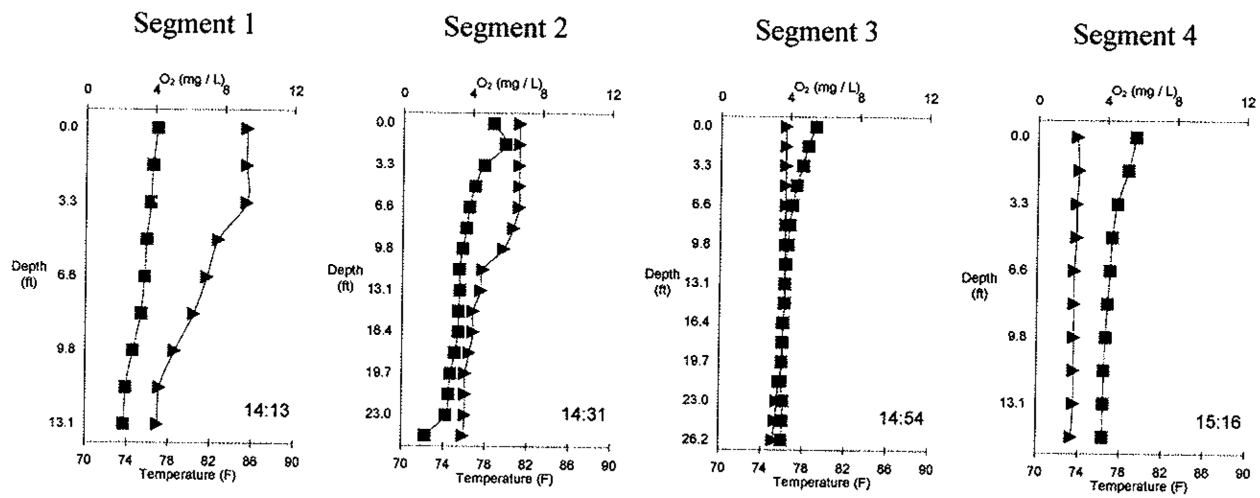


Figure 15A.39. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - October 8, 1998



Newton Lake – October 21, 1998

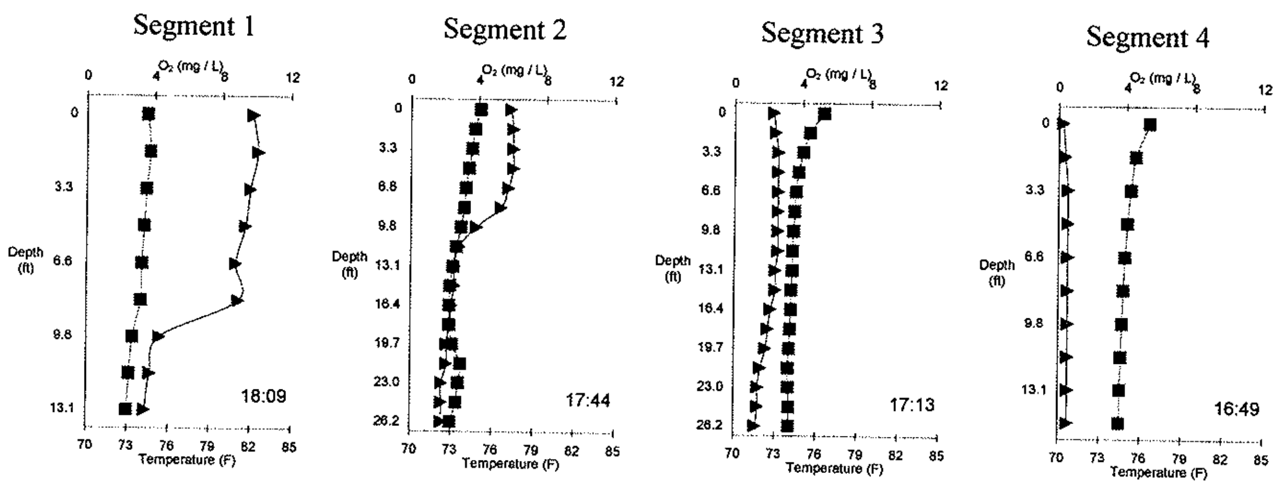
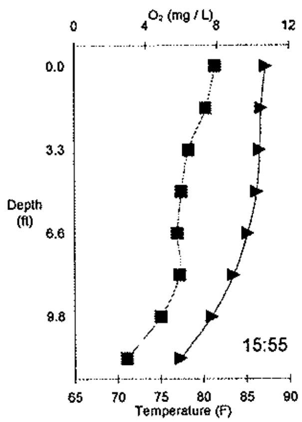


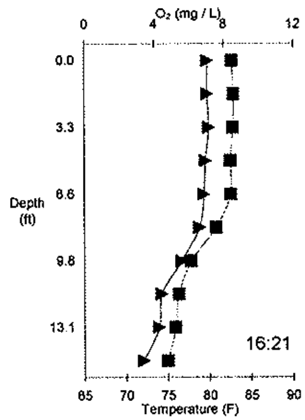
Figure 15A.40. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – October 29, 1998

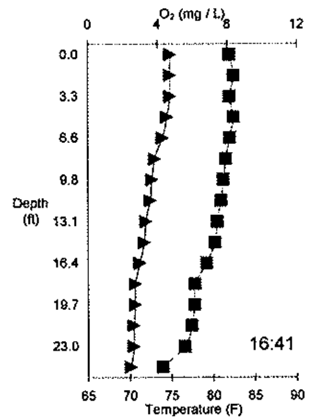
Segment 1



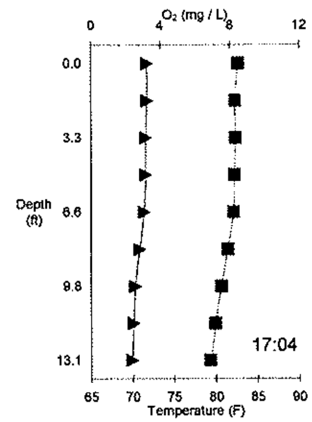
Segment 2



Segment 3

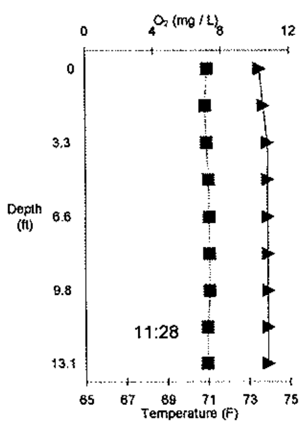


Segment 4

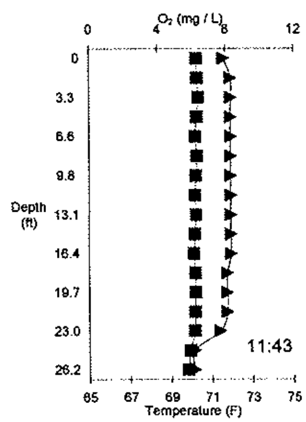


Newton Lake – November 3, 1998

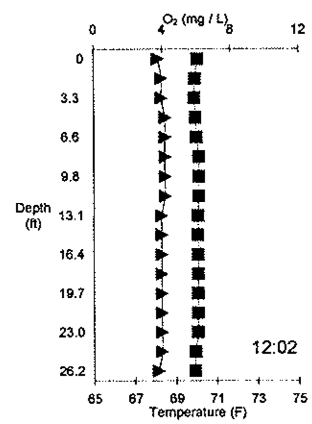
Segment 1



Segment 2



Segment 3



Segment 4

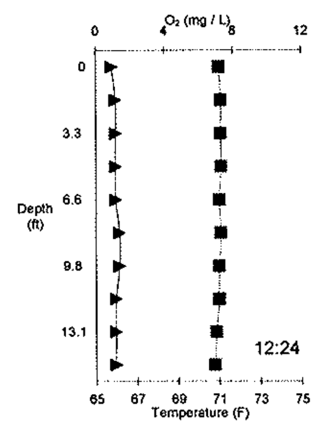
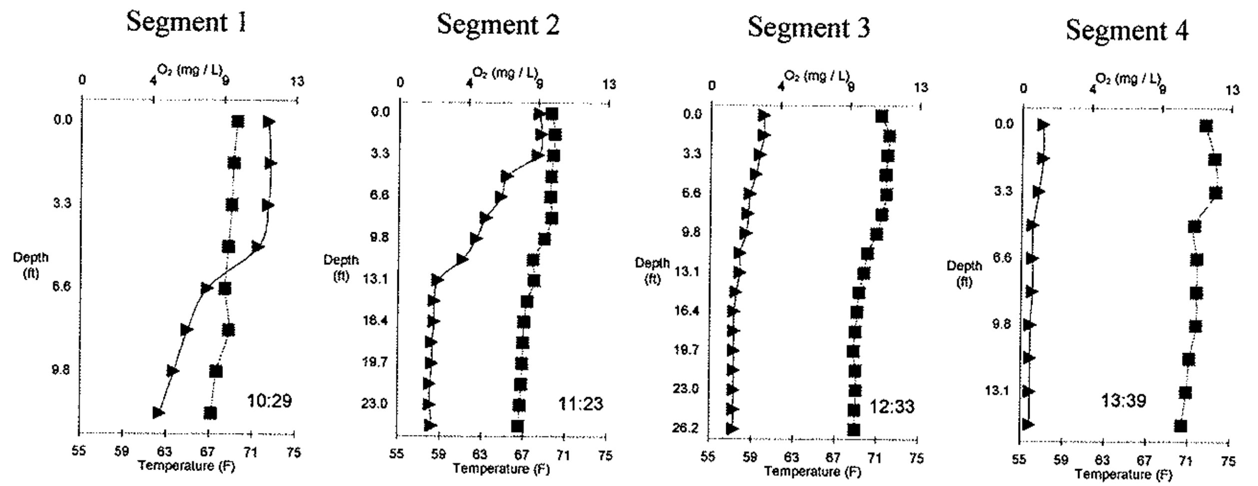


Figure 15A.41. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – November 24, 1998



Newton Lake – December 9, 1998

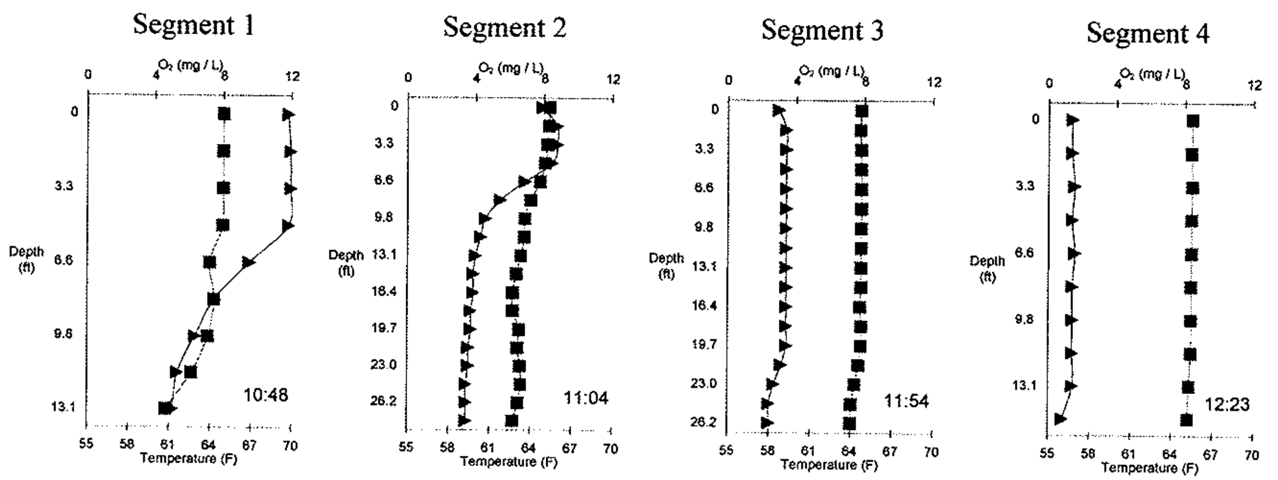


Figure 15A.42. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

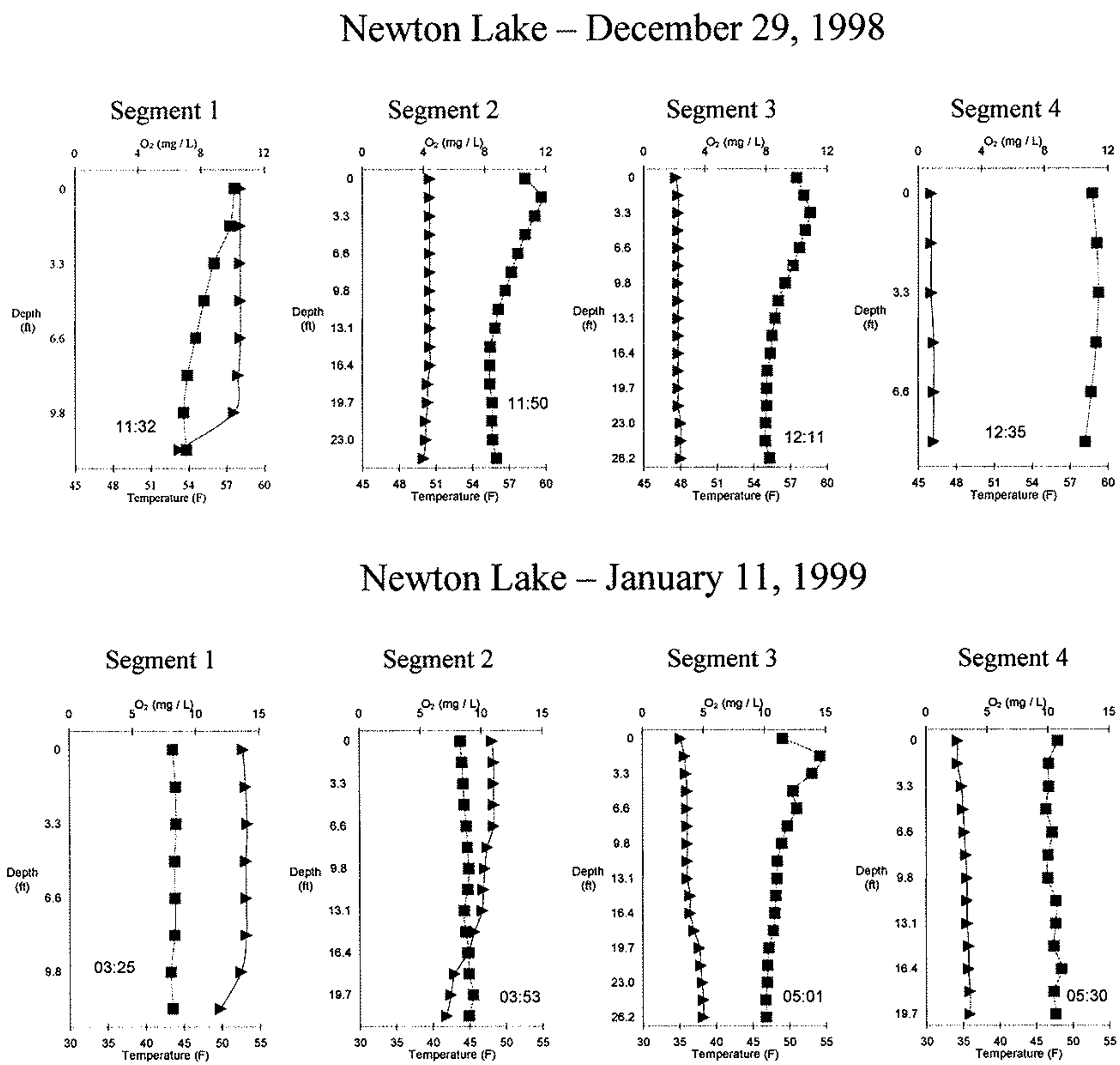
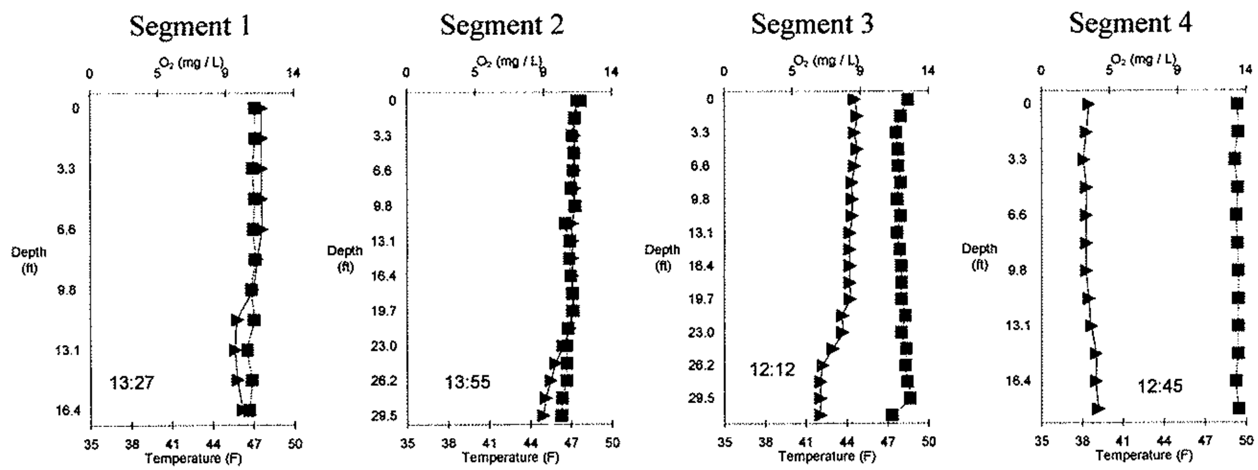


Figure 15A.43. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – January 22, 1999



Newton Lake – February 10, 1999

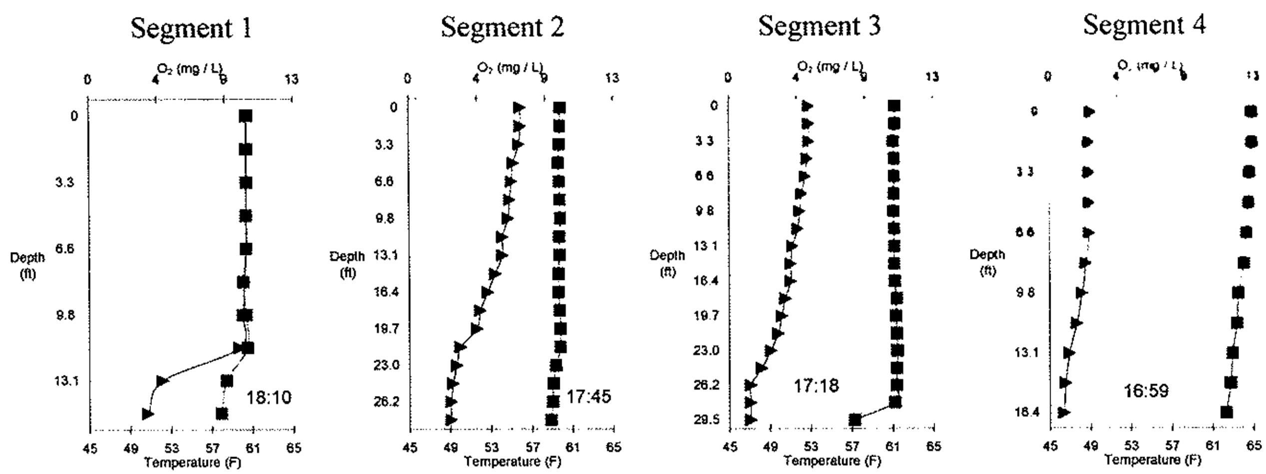


Figure 15A.44. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

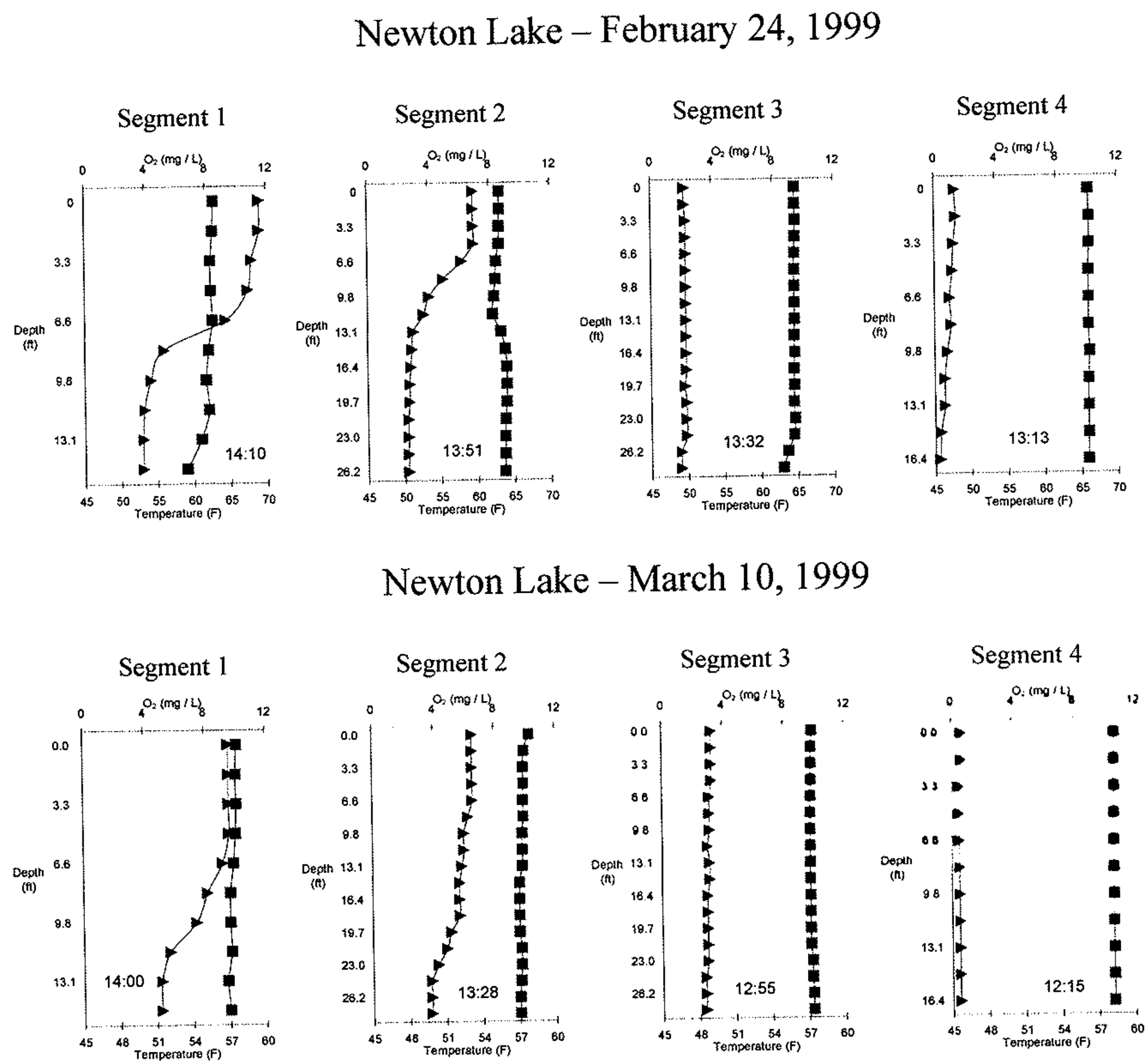
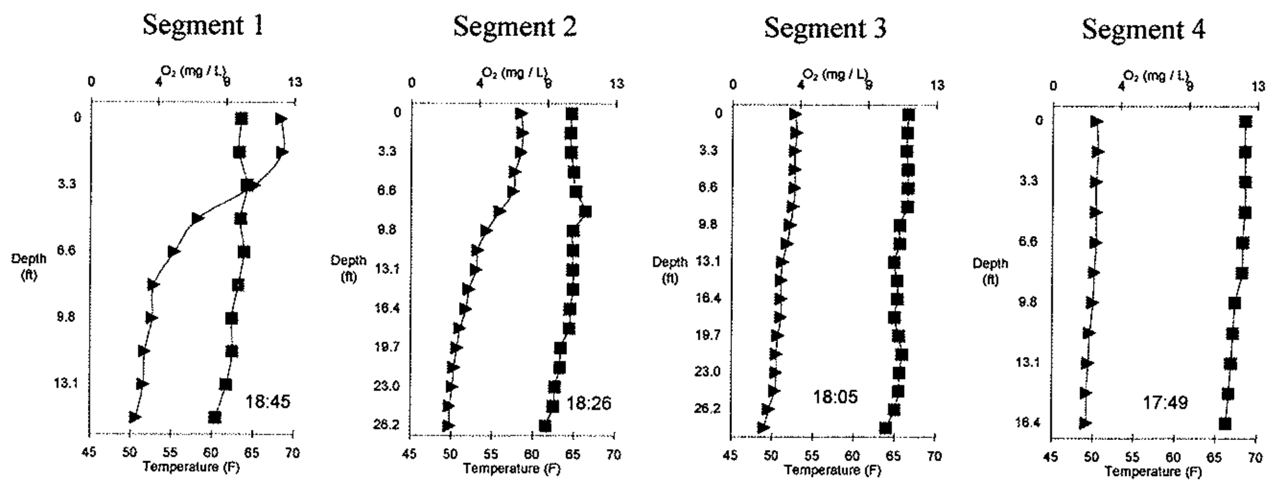


Figure 15A.45. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – March 22, 1999



Newton Lake – April 7, 1999

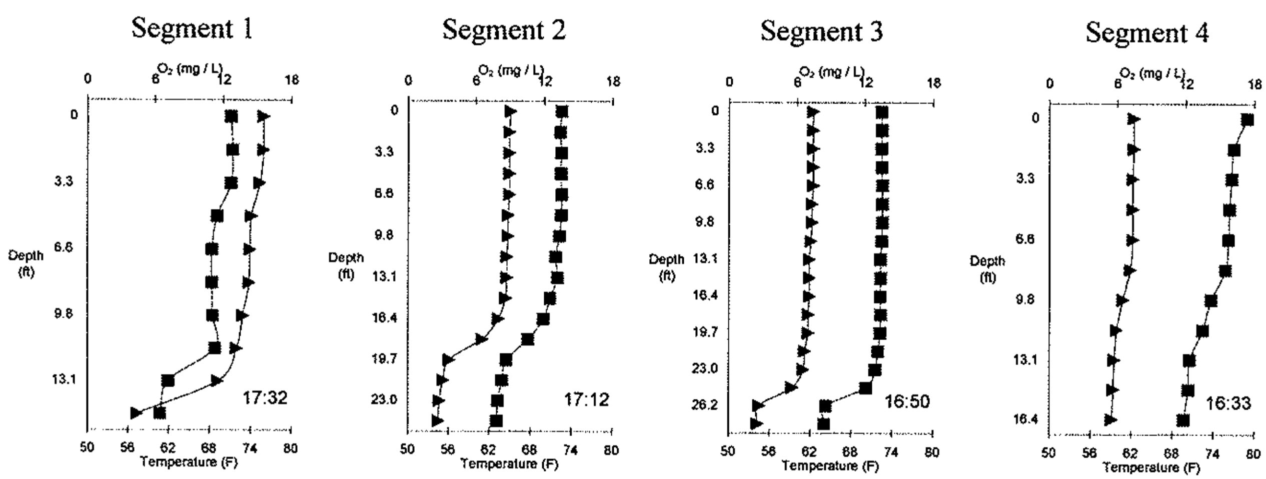
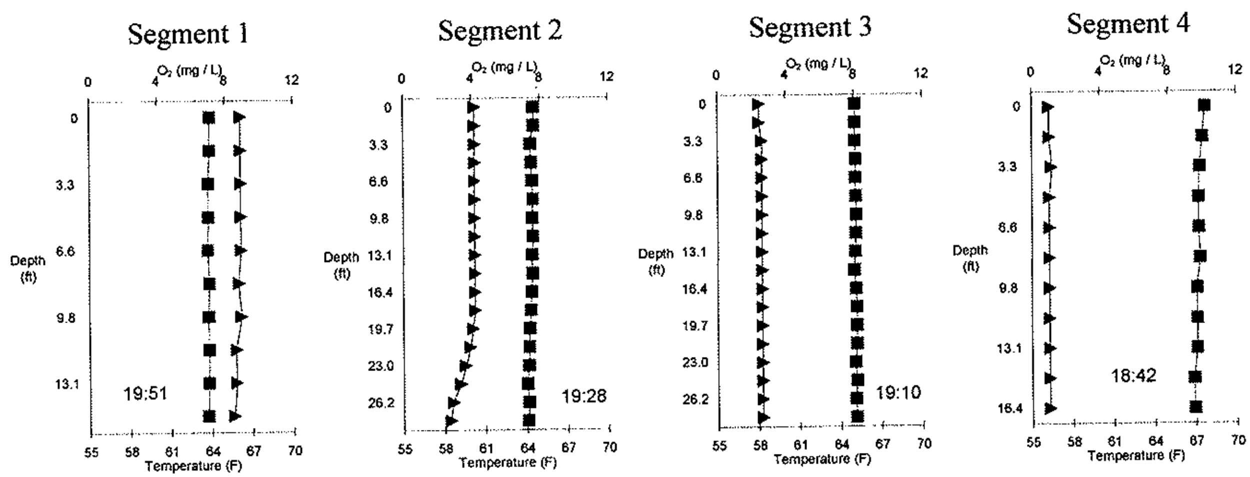


Figure 15A.46. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – April 16, 1999



Newton Lake – April 23, 1999

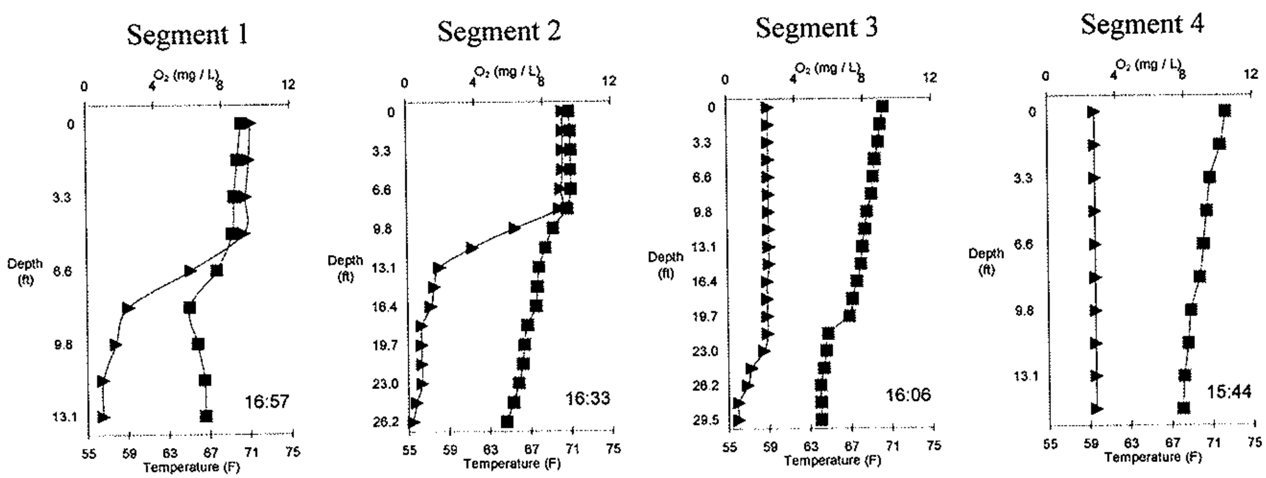


Figure 15A.47. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

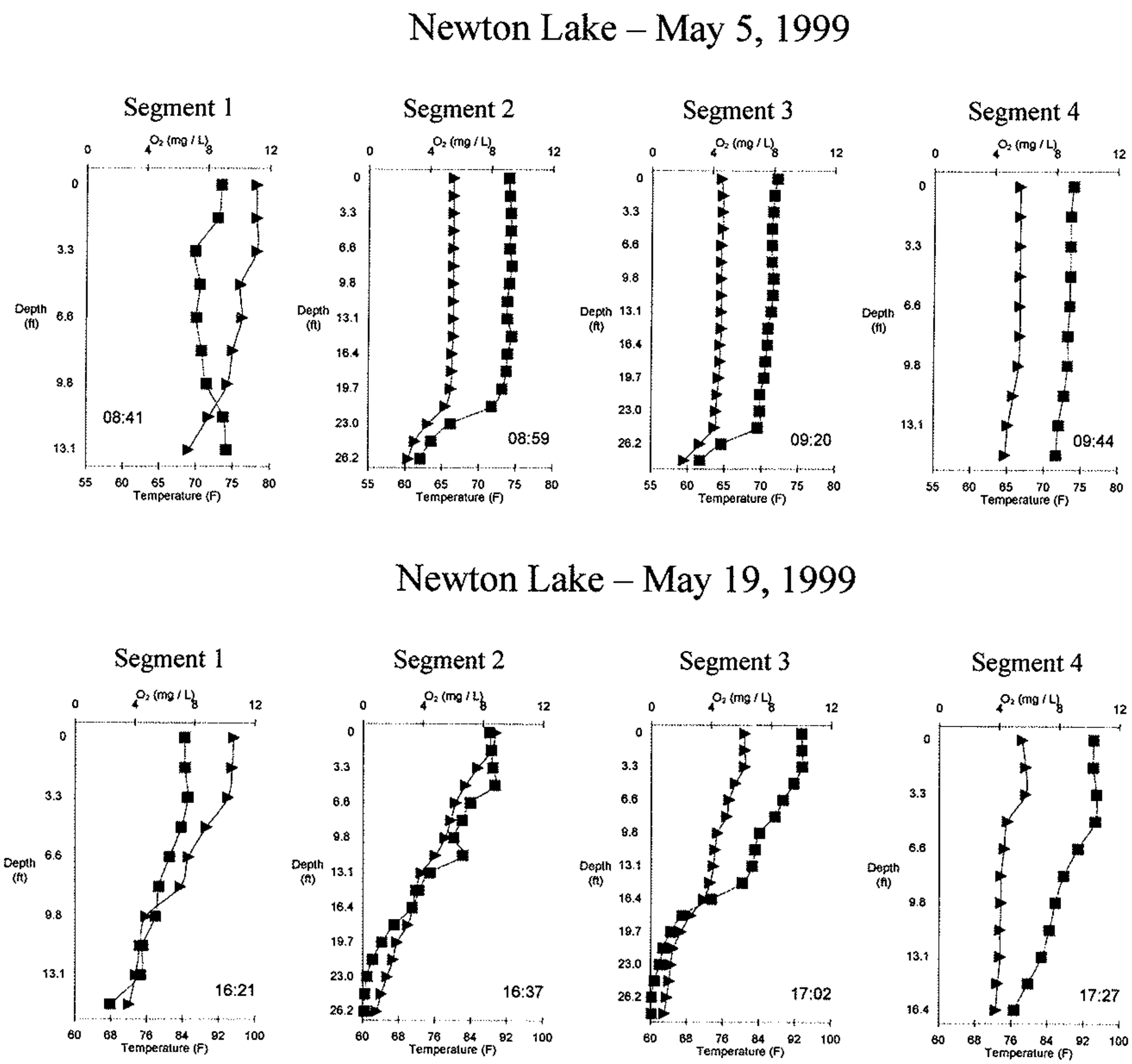


Figure 15A.48. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 2, 1999

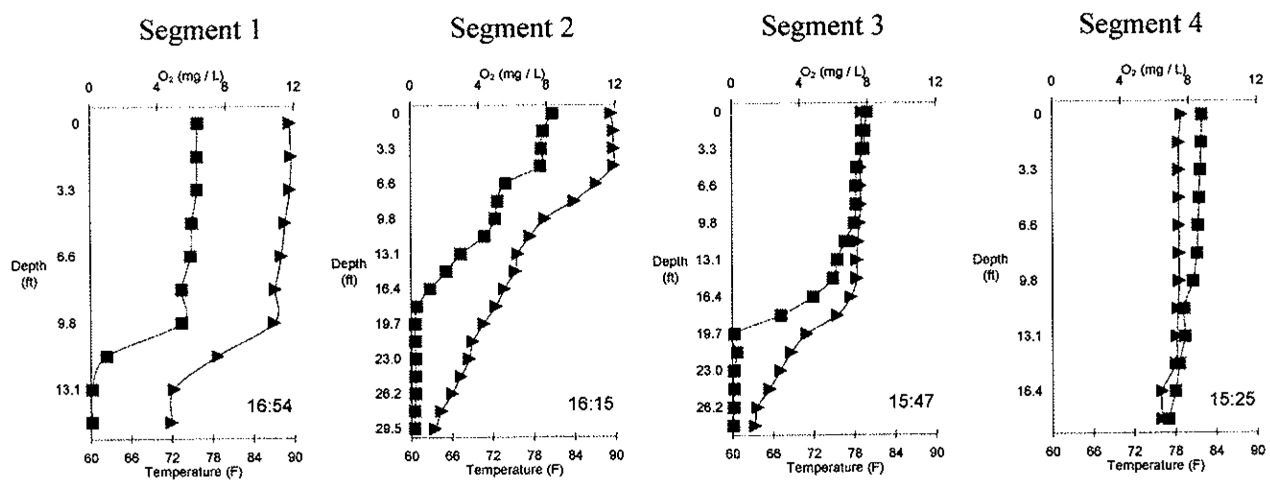


Figure 15A.49. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 3, 1999

Segment 2

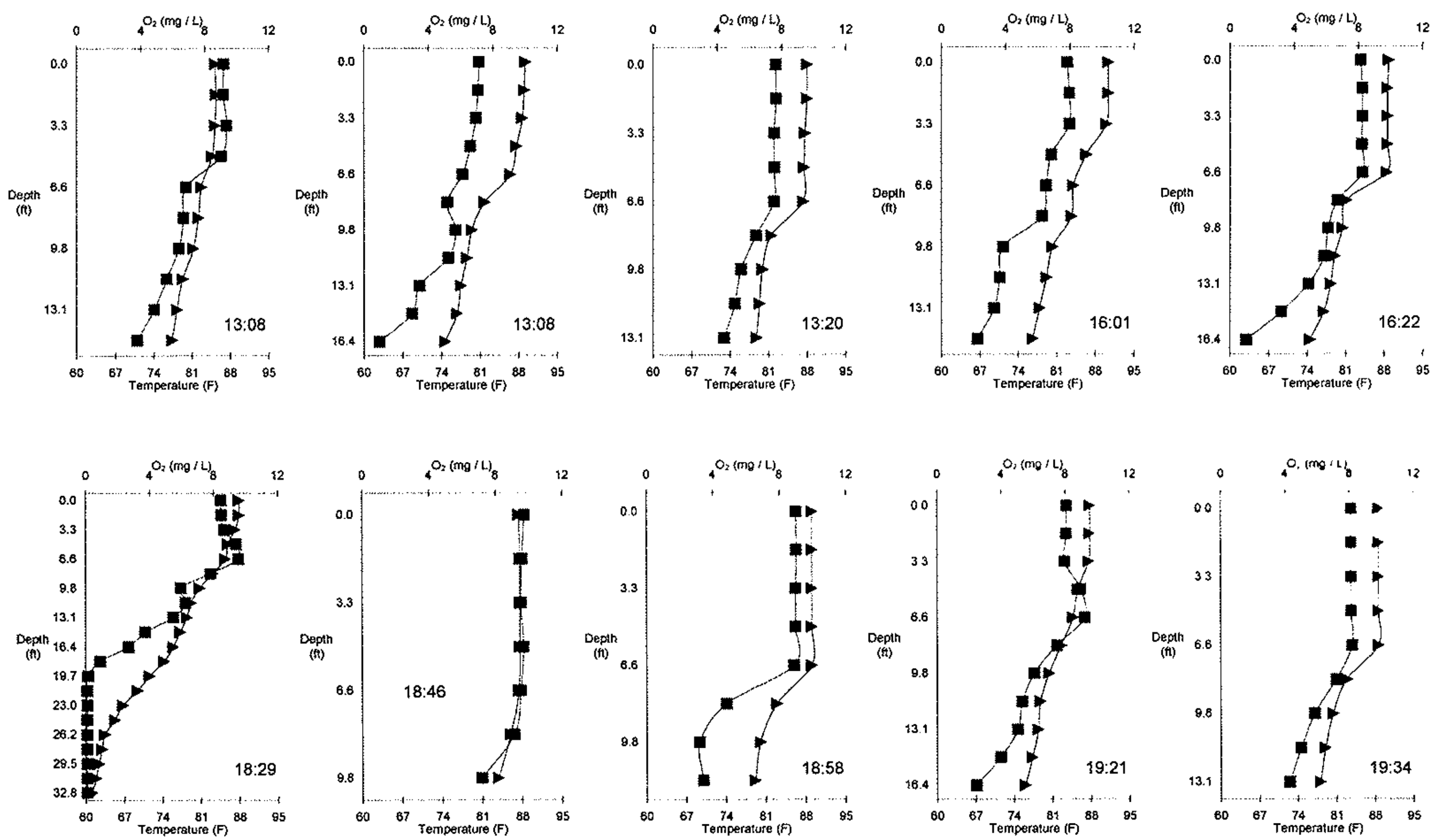
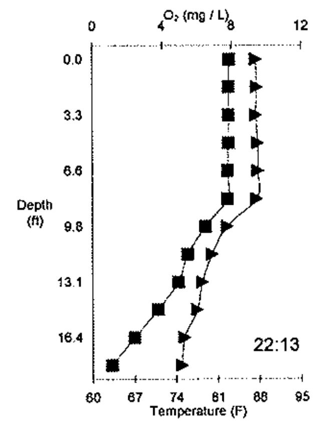


Figure 15A.50. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 3, 1999

Segment 2



Newton Lake – June 4, 1999

Segment 1

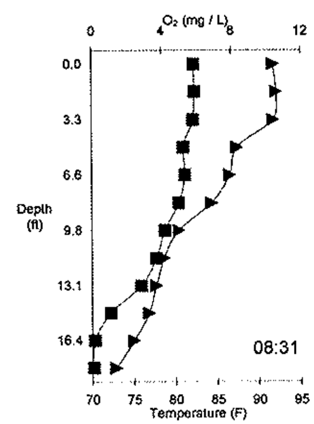


Figure 15A.51. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 4, 1999

Segment 2

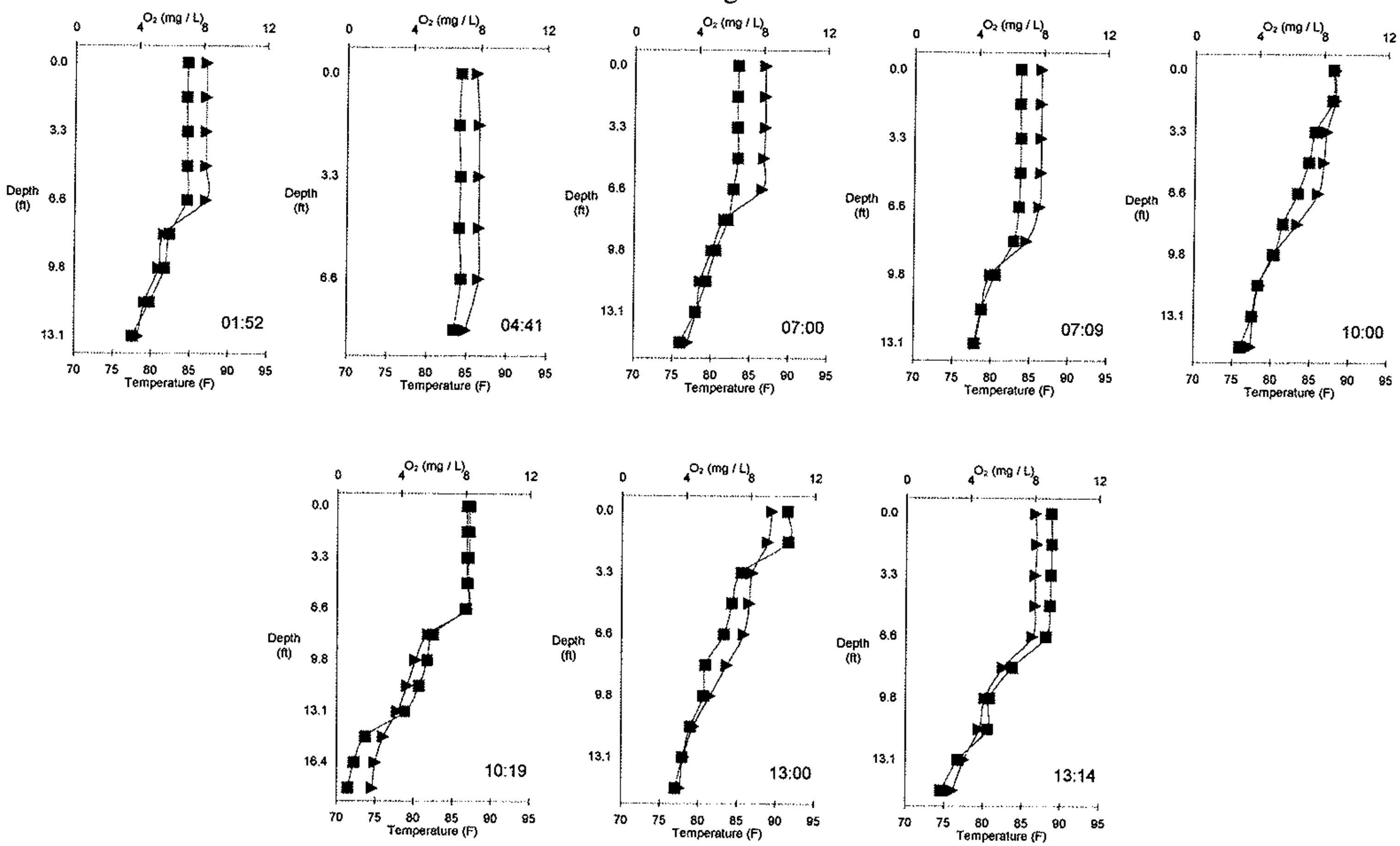


Figure 15A.52. – Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - June 8, 1999

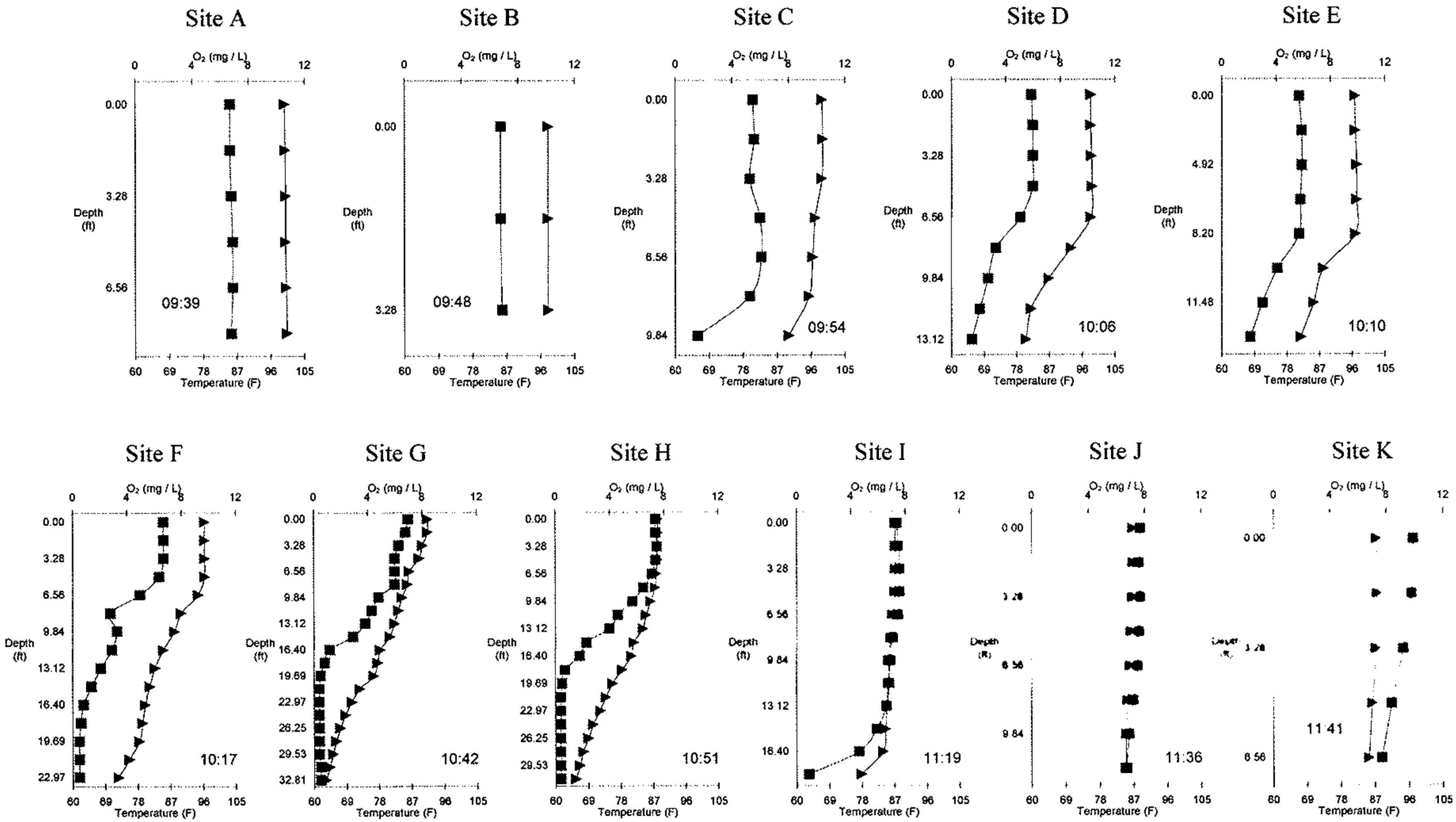
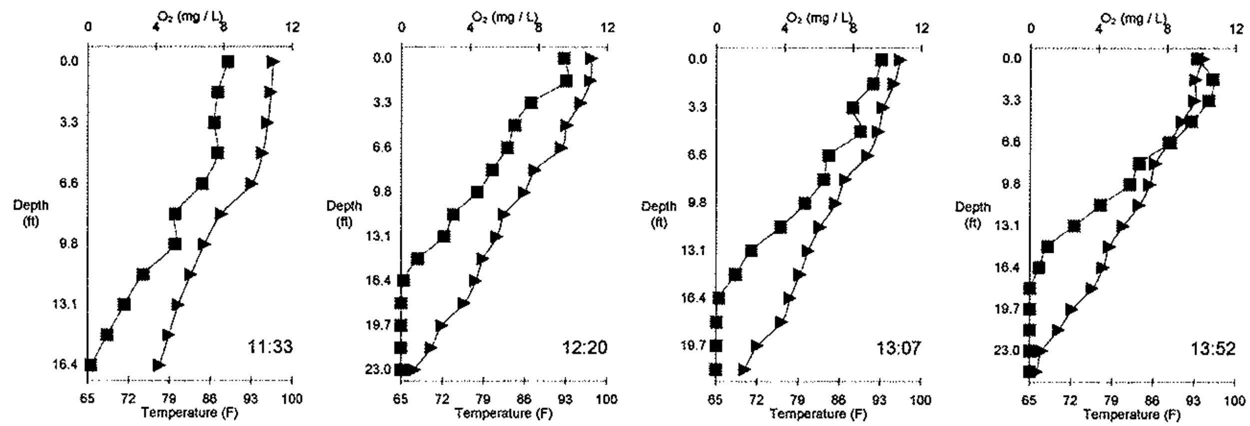


Figure 15A.53. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 9, 1999

Segment 2



Newton Lake – June 14 , 1999

Segment 2

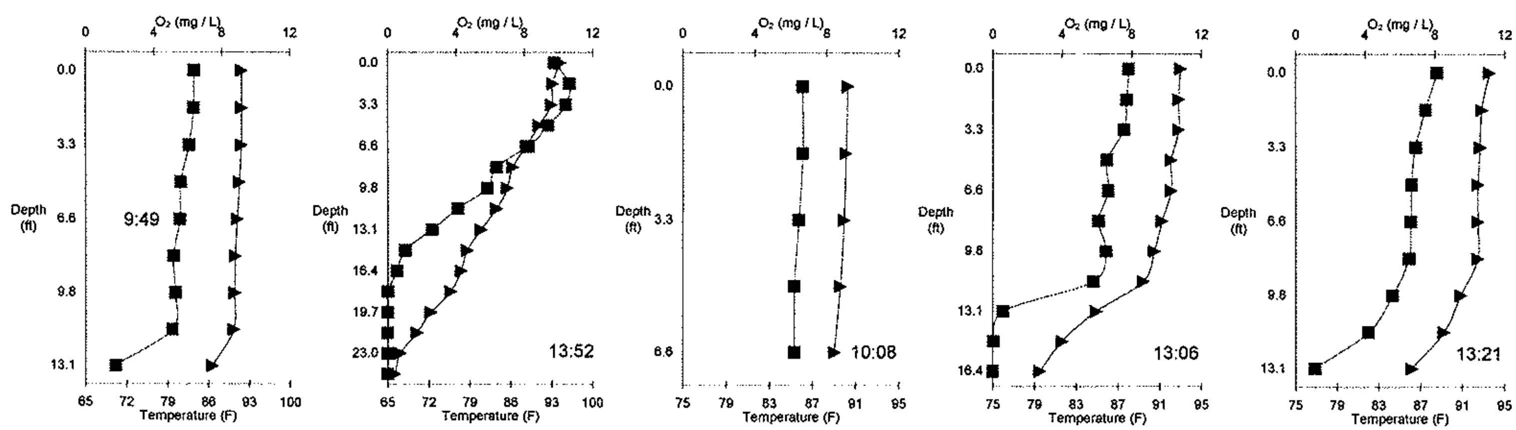


Figure 15A.54. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 14, 1999

Segment 2

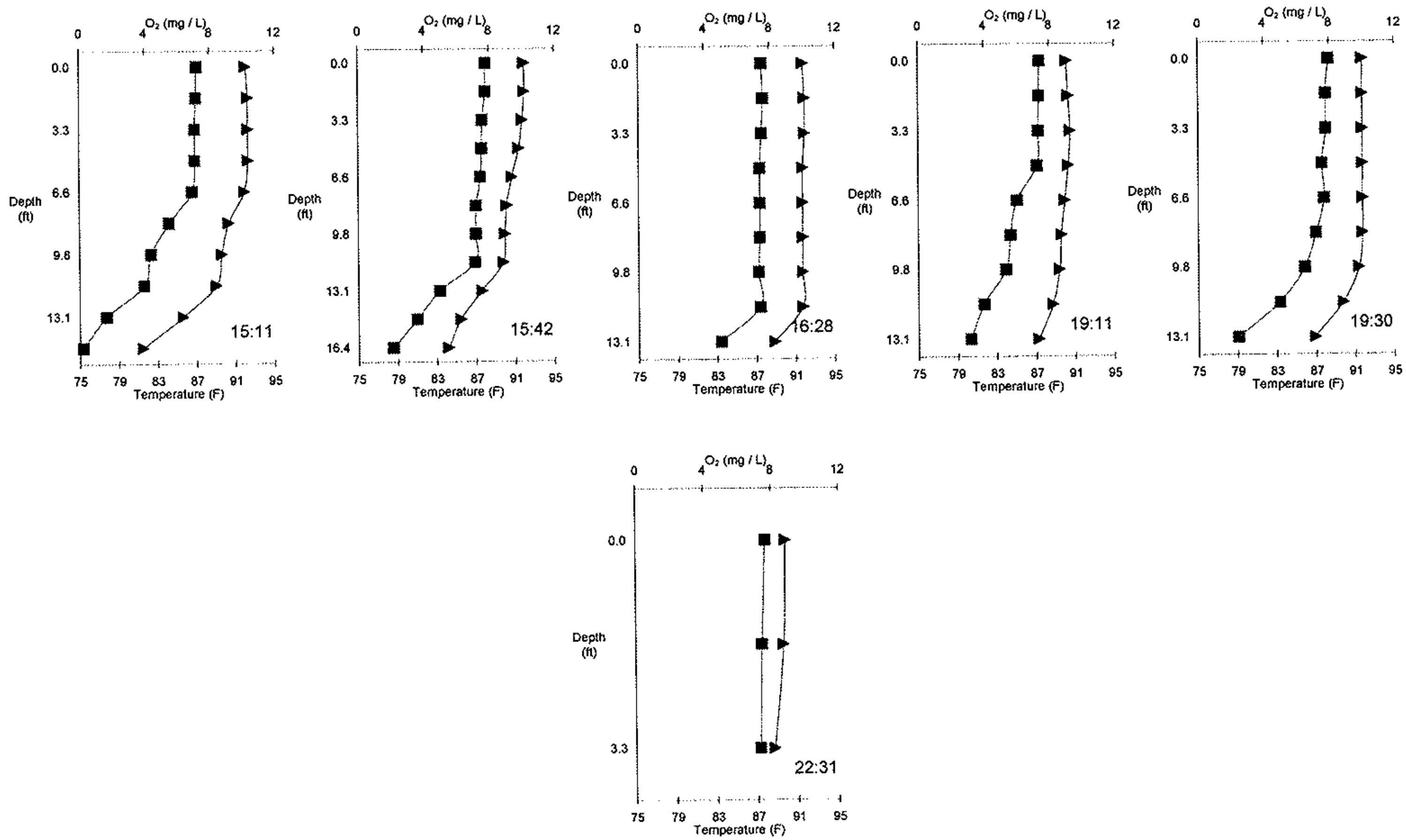


Figure 15A.55. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 15, 1999

Segment 2

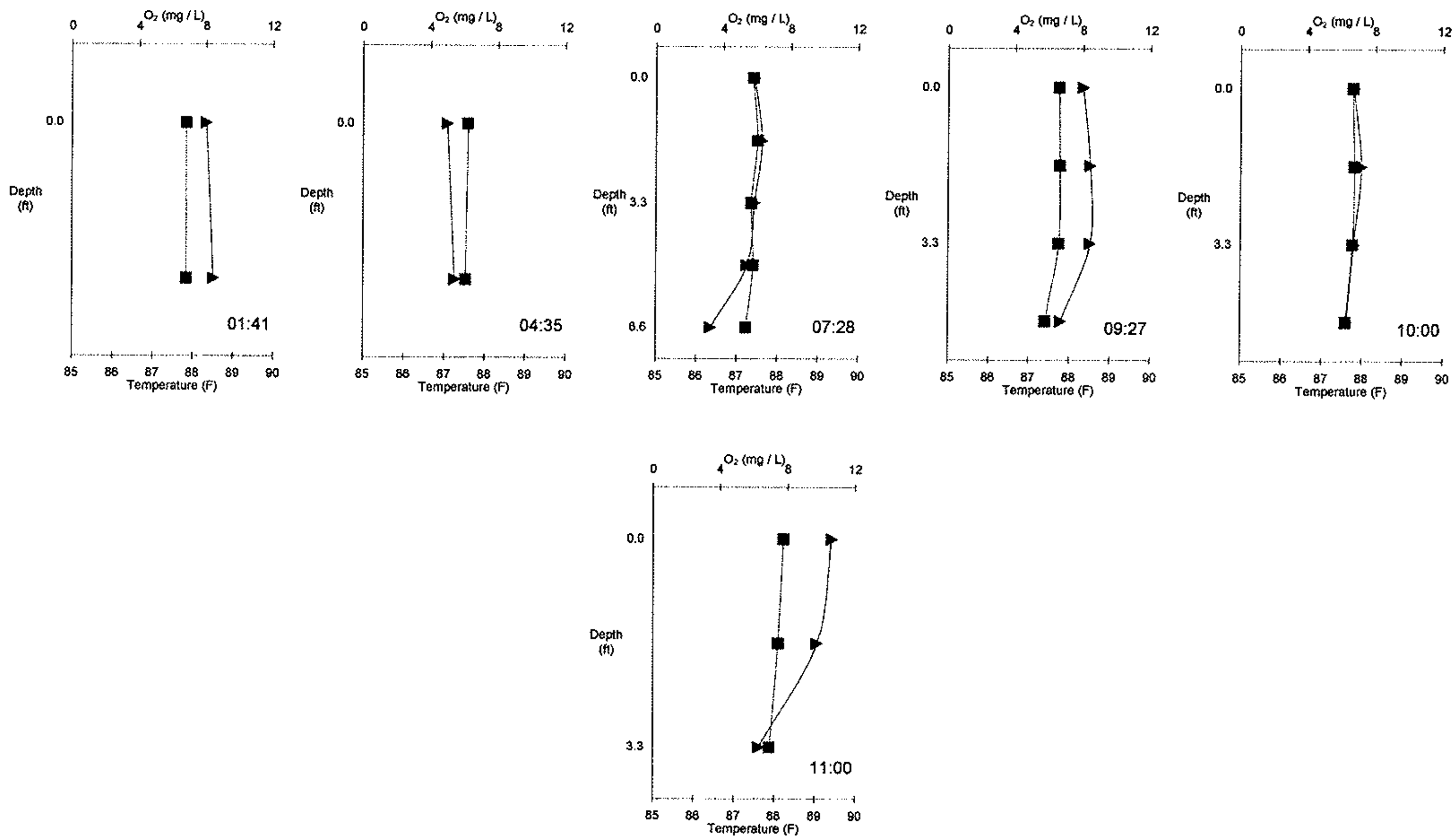


Figure 15A.56. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 18, 1999

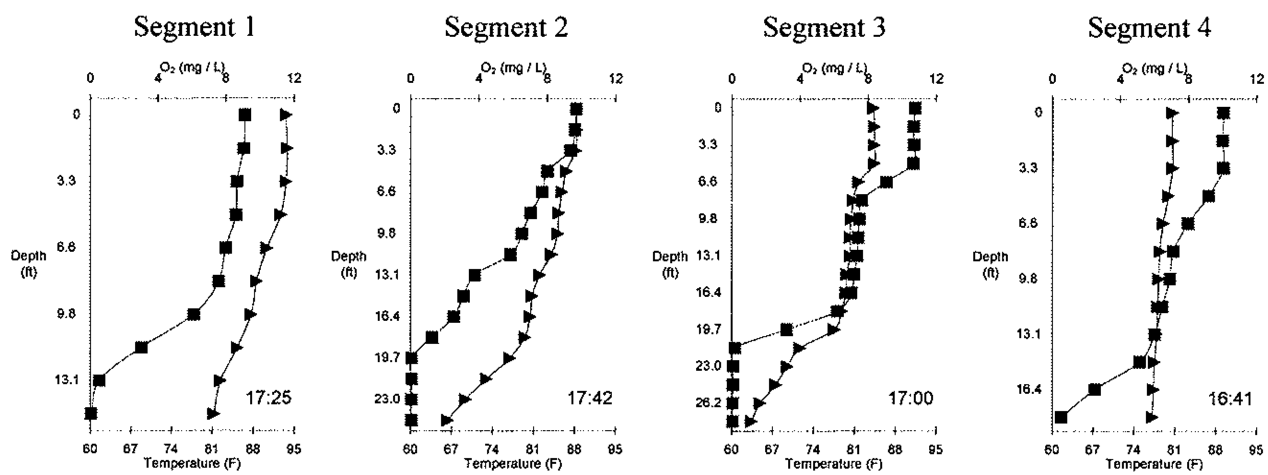


Figure 15A.57. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - June 22, 1999

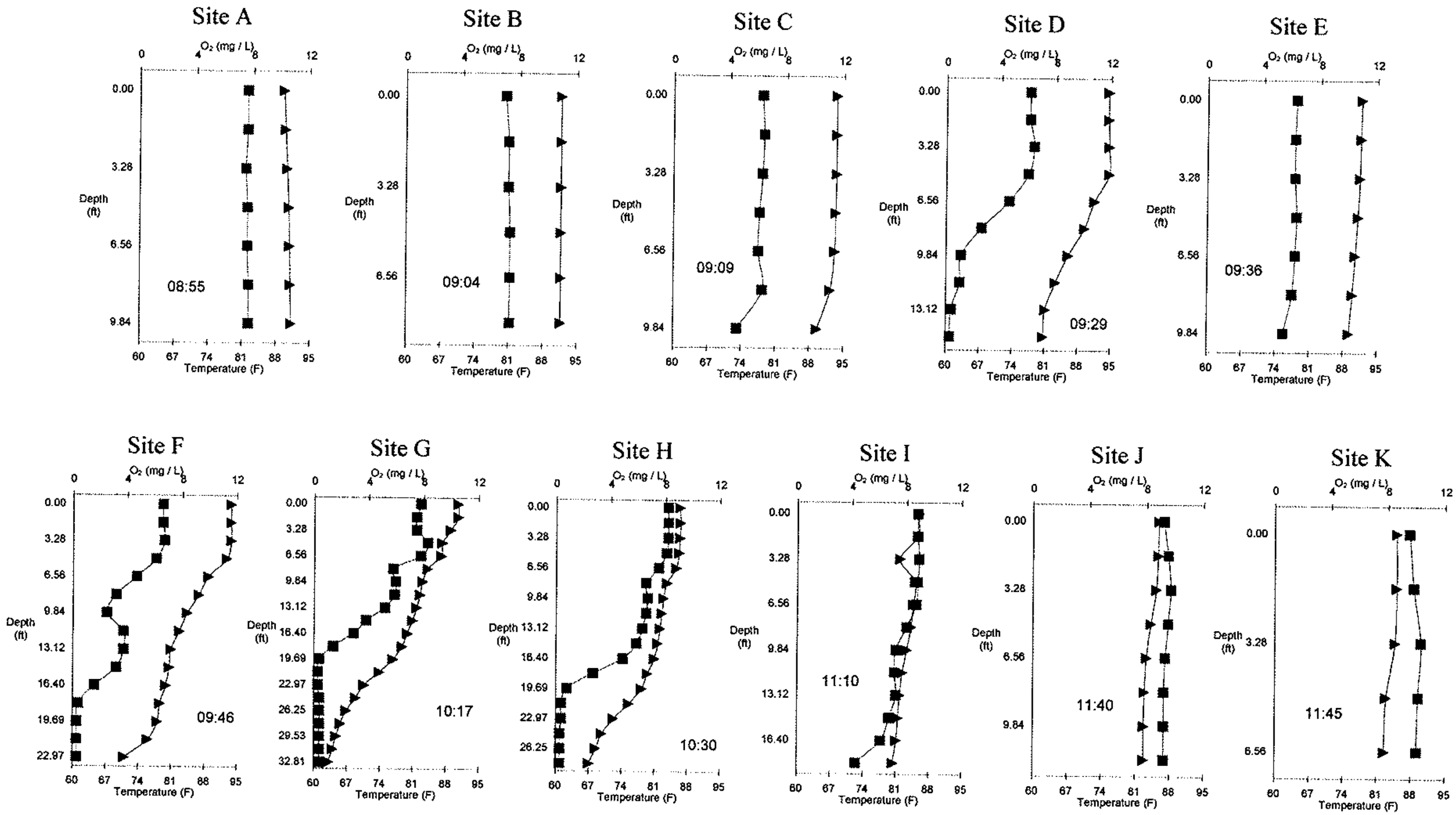
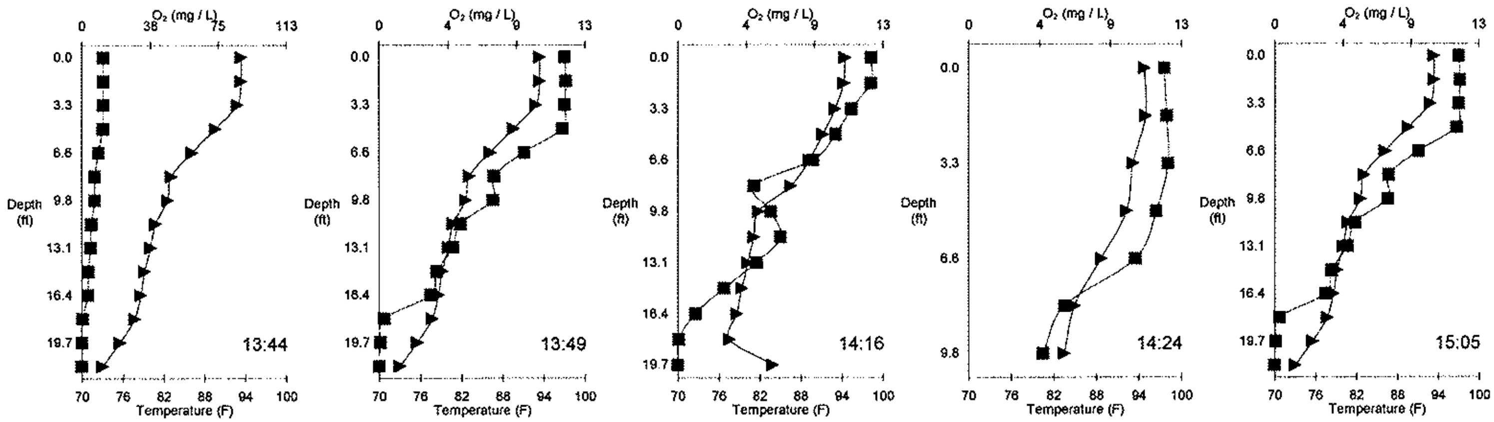


Figure 15A.58. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – June 22, 1999

Segment 2



Newton Lake – June 29 , 1999

Segment 2

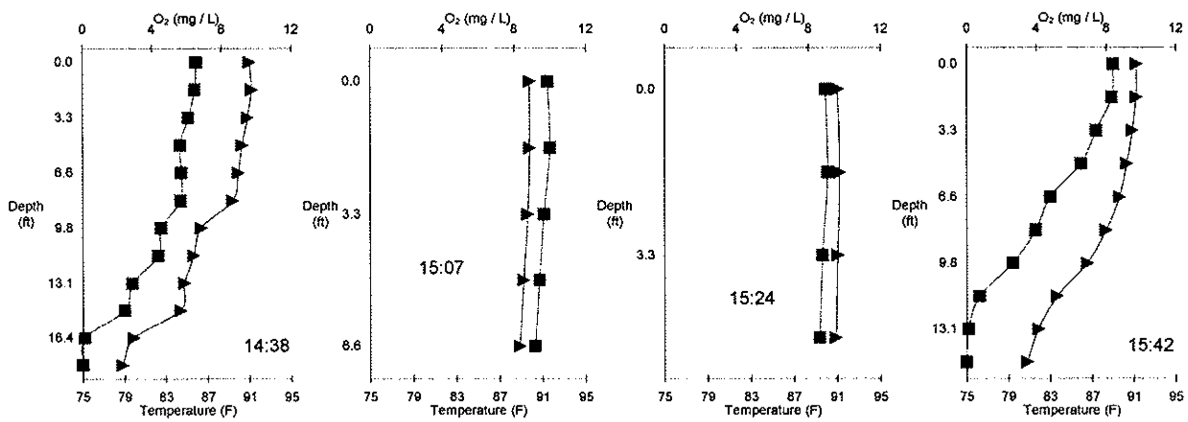


Figure 15A.59. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 2, 1999

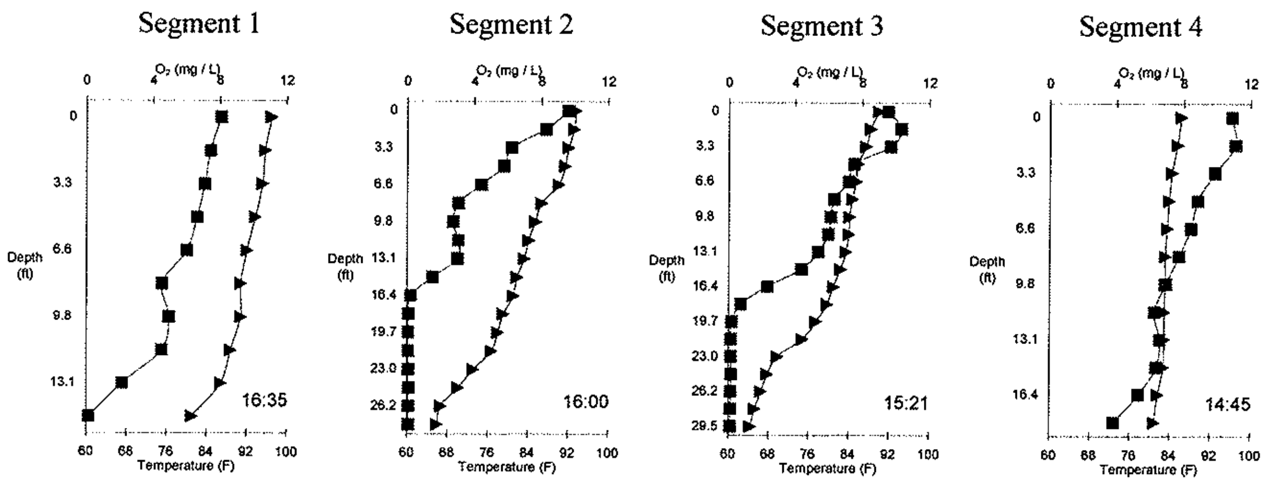


Figure 15A.60. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - July 6, 1999

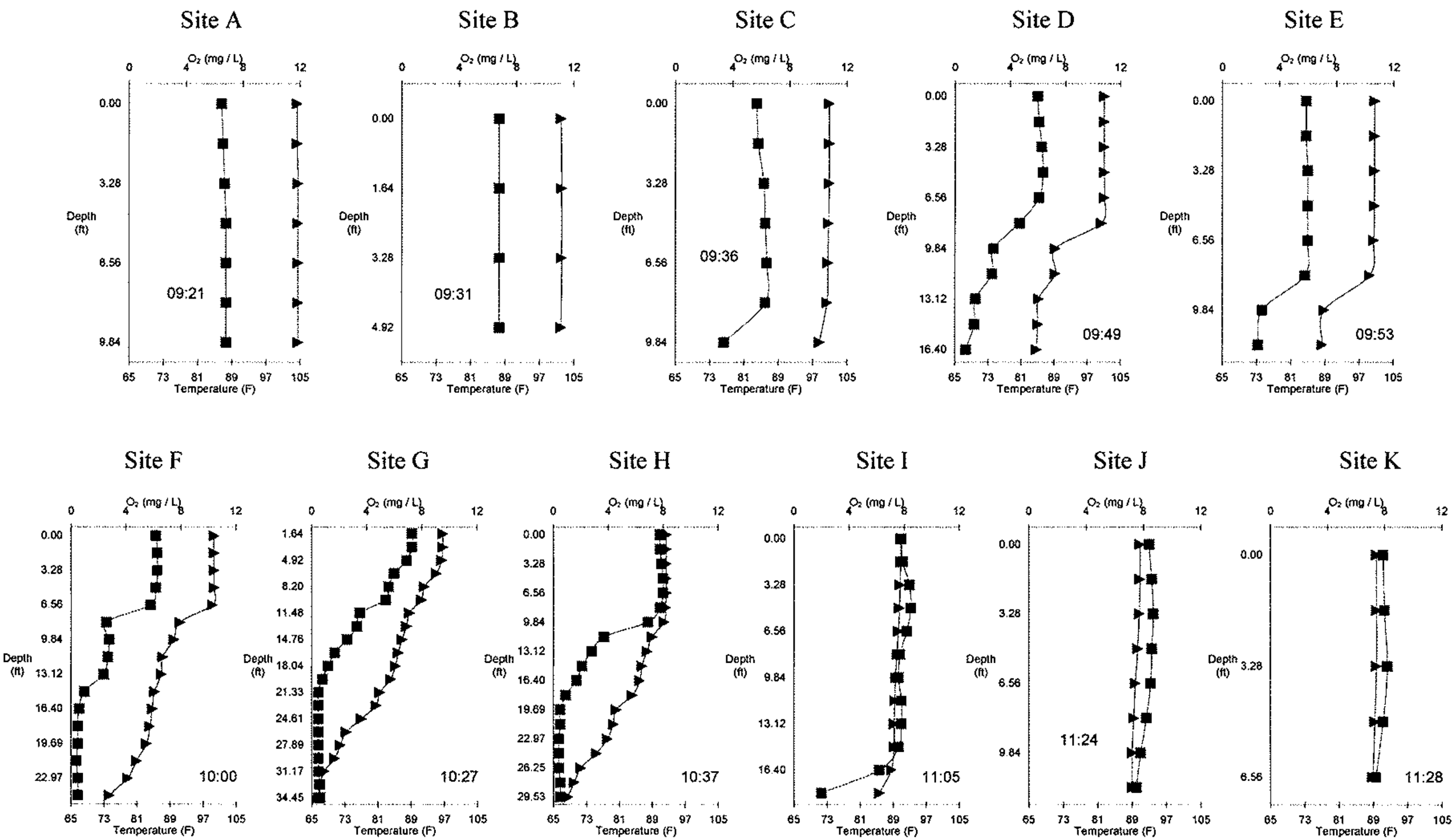
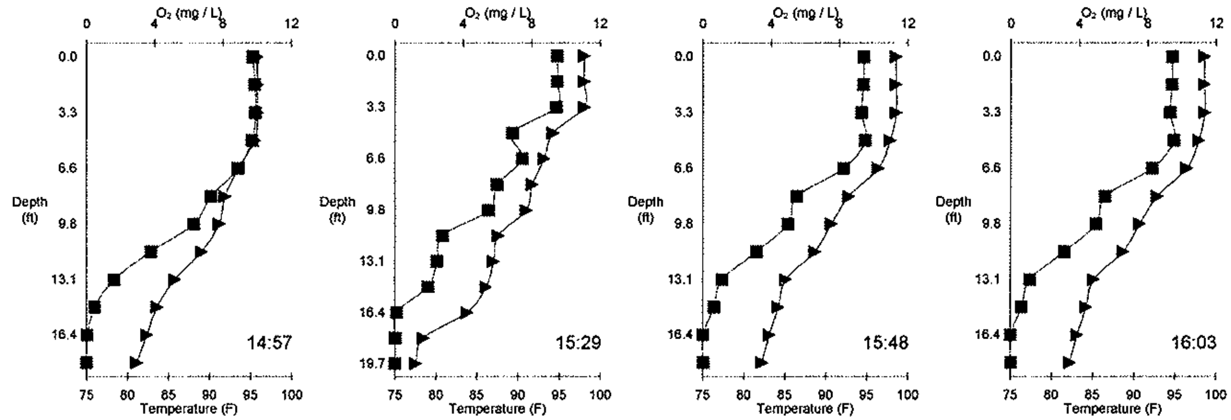


Figure 15A.61. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 7, 1999

Segment 2



Newton Lake – July 13, 1999

Segment 1 | Segment 2 | Segment 3 | Segment 4

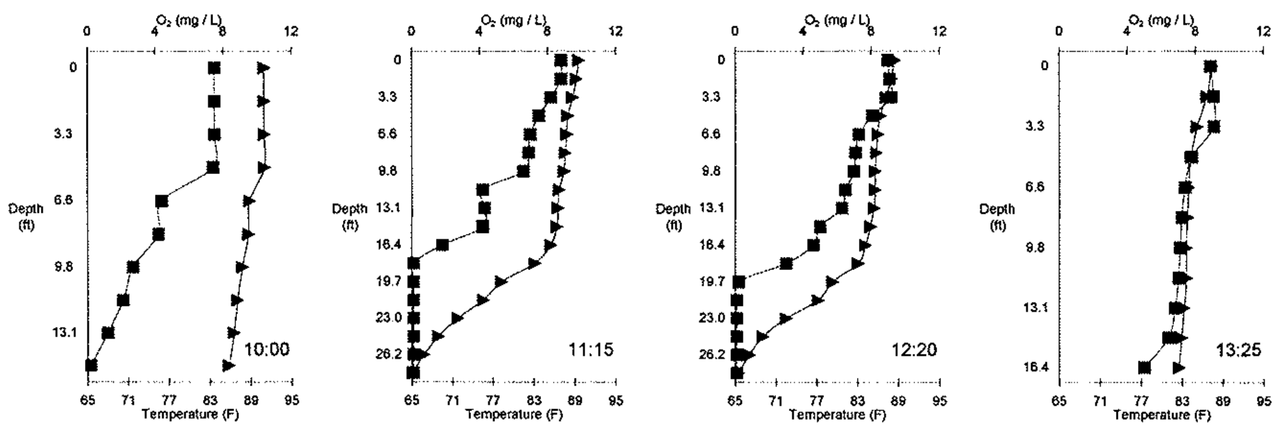


Figure 15A.62. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 15, 1999

Segment 2

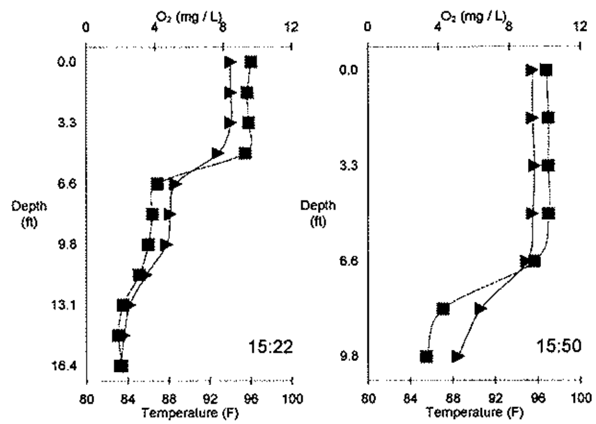


Figure 15A.63. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - July 19, 1999

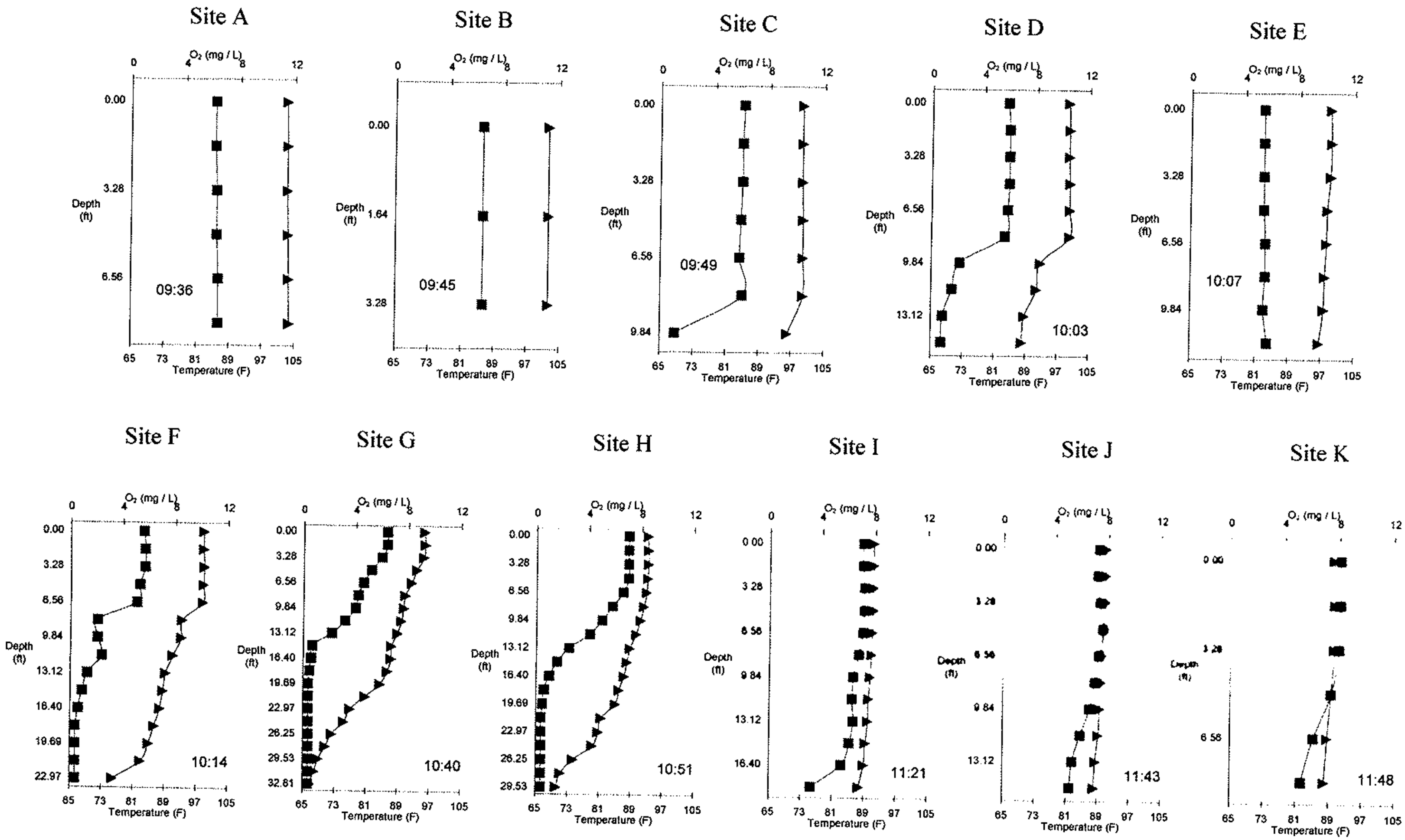
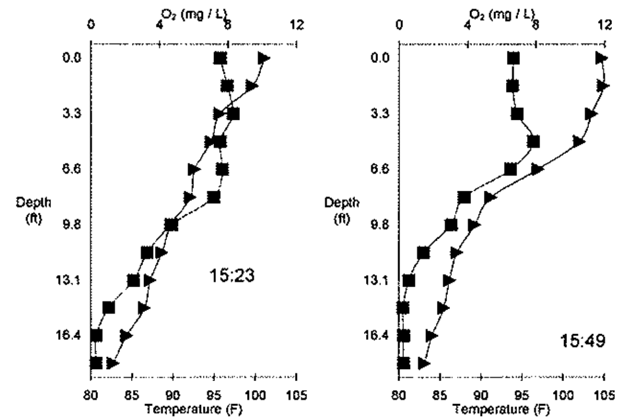


Figure 15A.64. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 20, 1999

Segment 2



Newton Lake – July 20, 1999

Segment 2

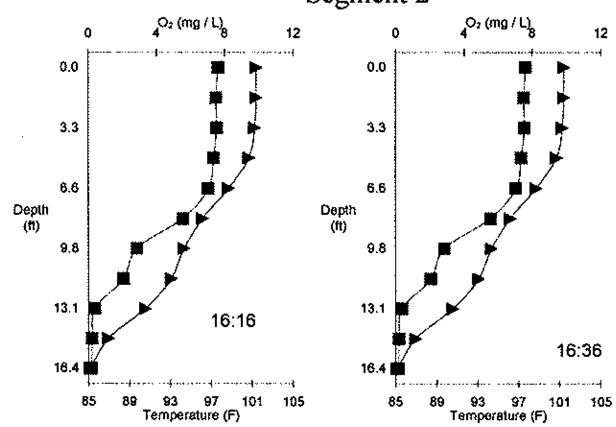


Figure 15A.65. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 24, 1999

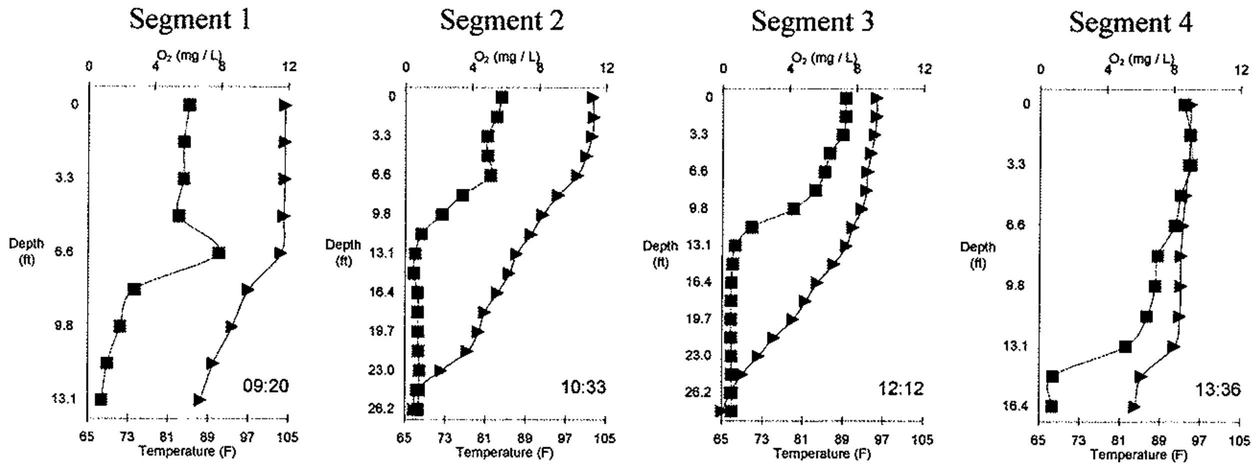
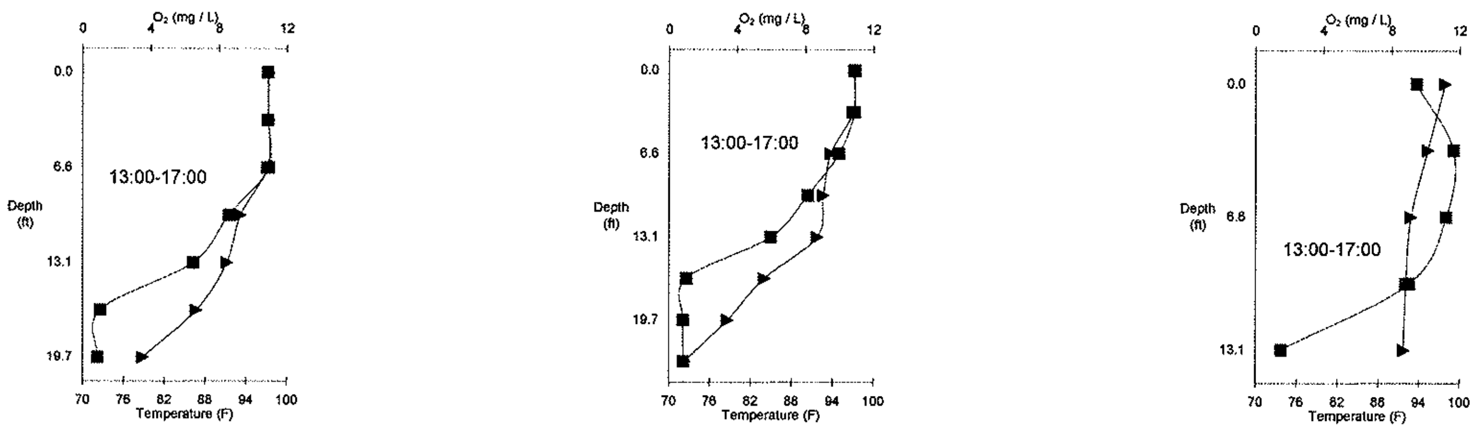


Figure 15A.66. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – July 29, 1999

Segment 3 | Segment 3-4 border | Segment 4



Newton Lake – July 30, 1999

Segment 4

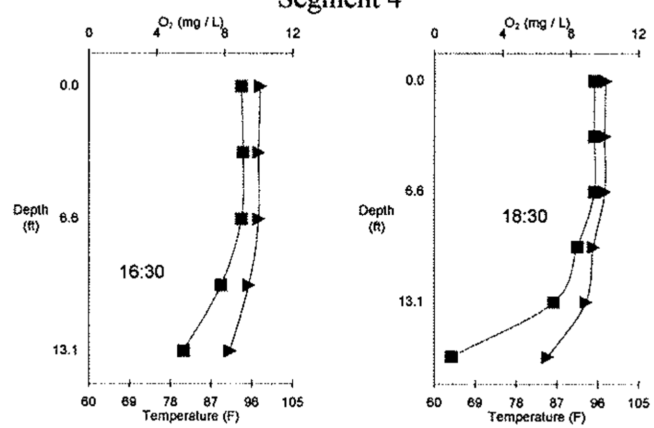


Figure 15A.67. Temperature and dissolved oxygen obtained during fish health sampling, Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 5, 1999

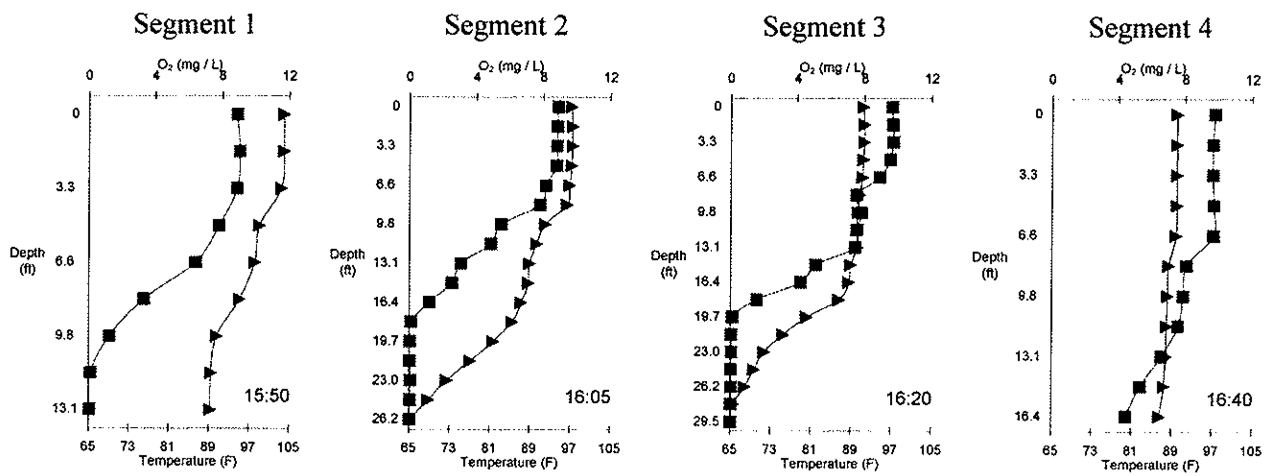
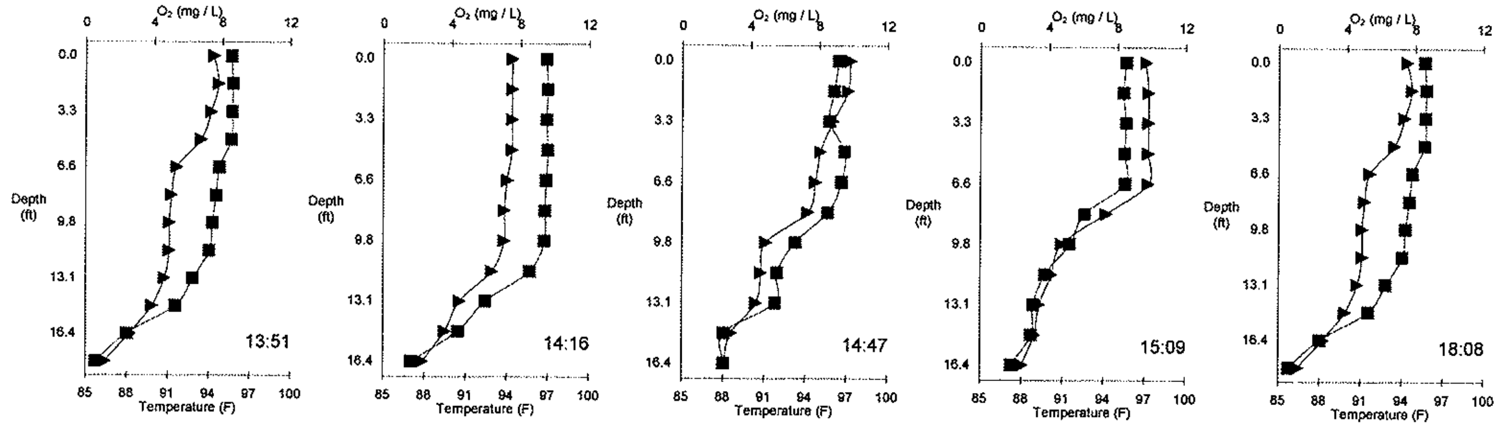


Figure 15A.68. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 5, 1999

Segment 2



Newton Lake – August 9 , 1999

Segment 2

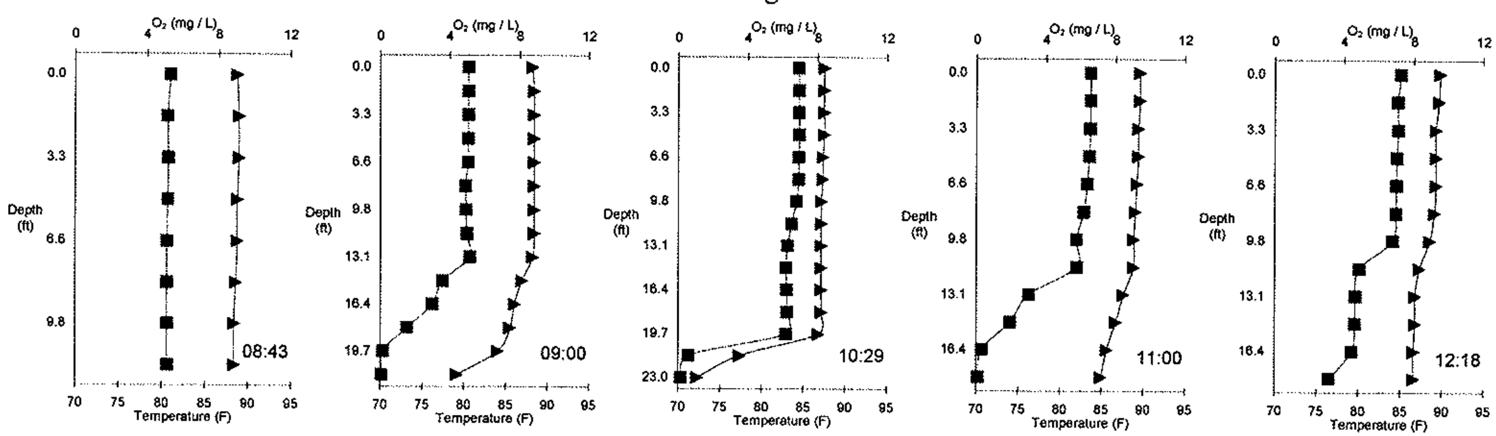
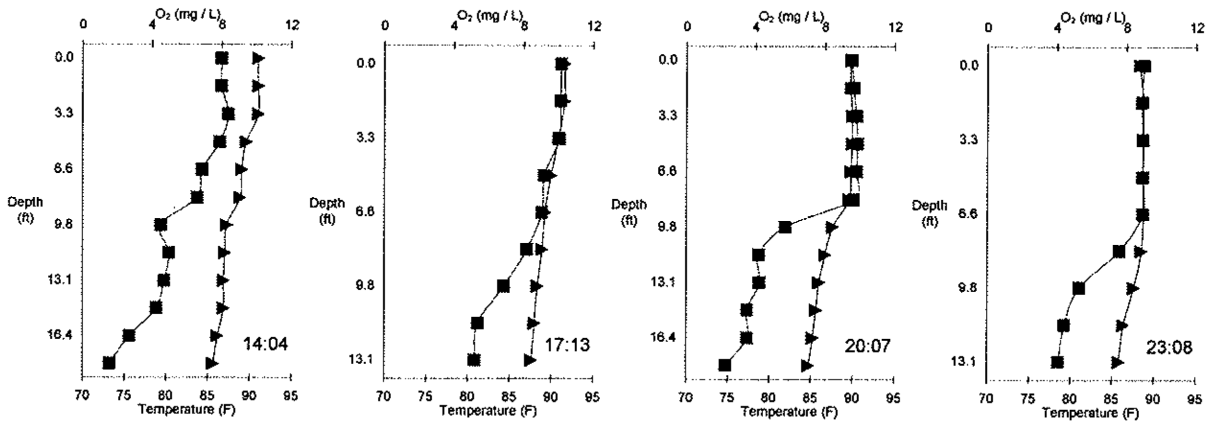


Figure 15A.69. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake –August 9, 1999

Segment 2



Newton Lake –August 10, 1999

Segment 2

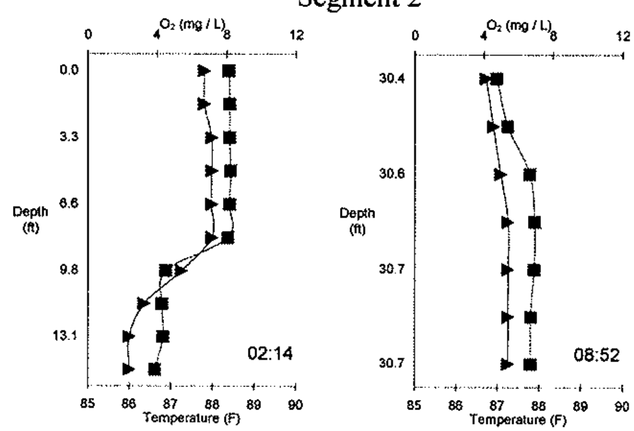


Figure 15A.70. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 10, 1999

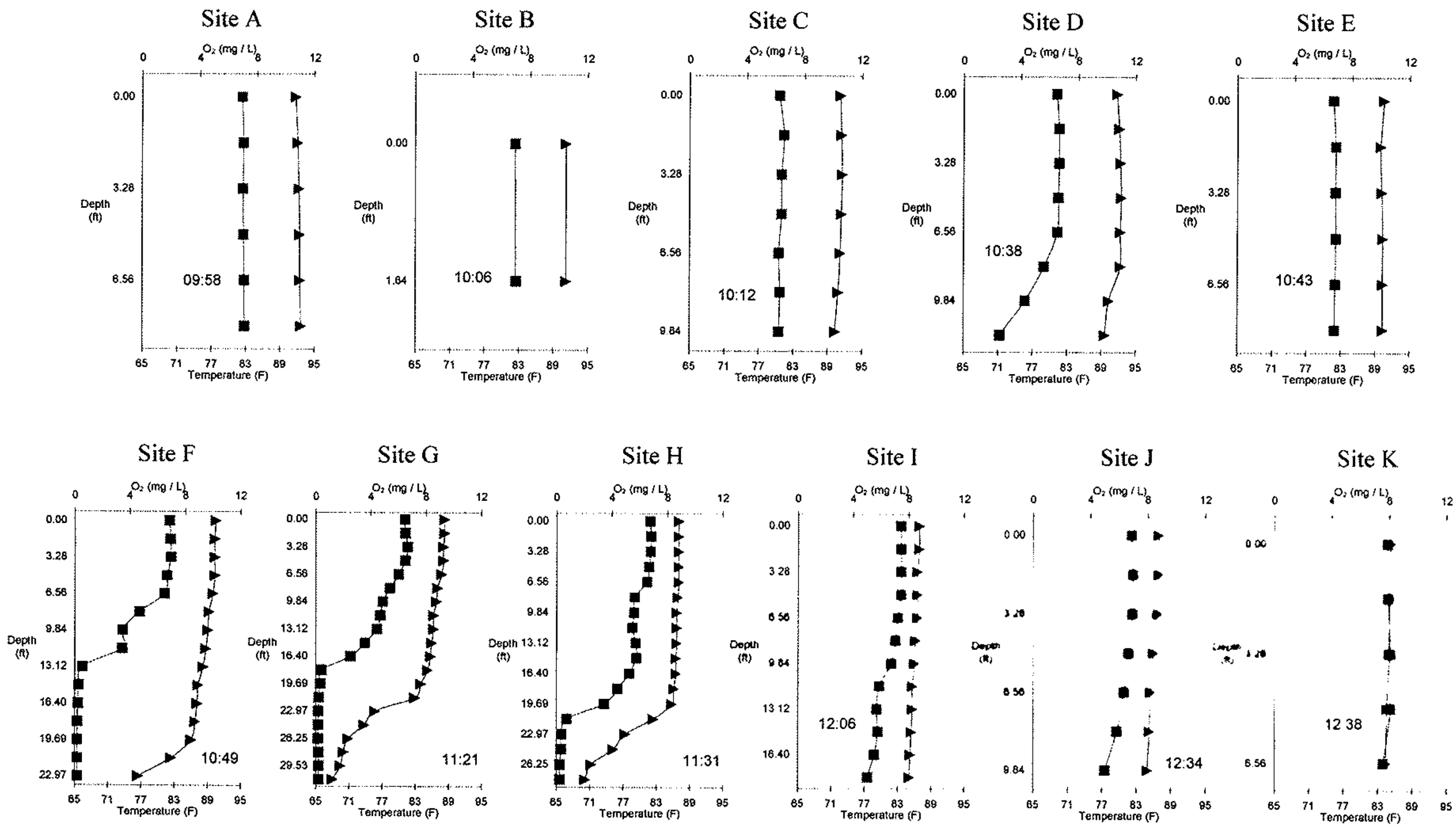


Figure 15A.71. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 18, 1999

Segment 2

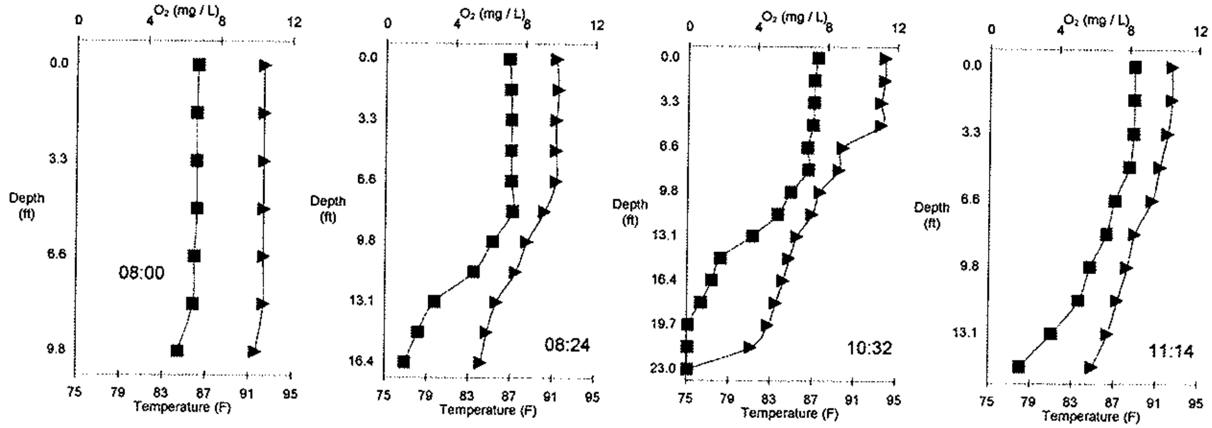


Figure 15A.72. – Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 18, 1999

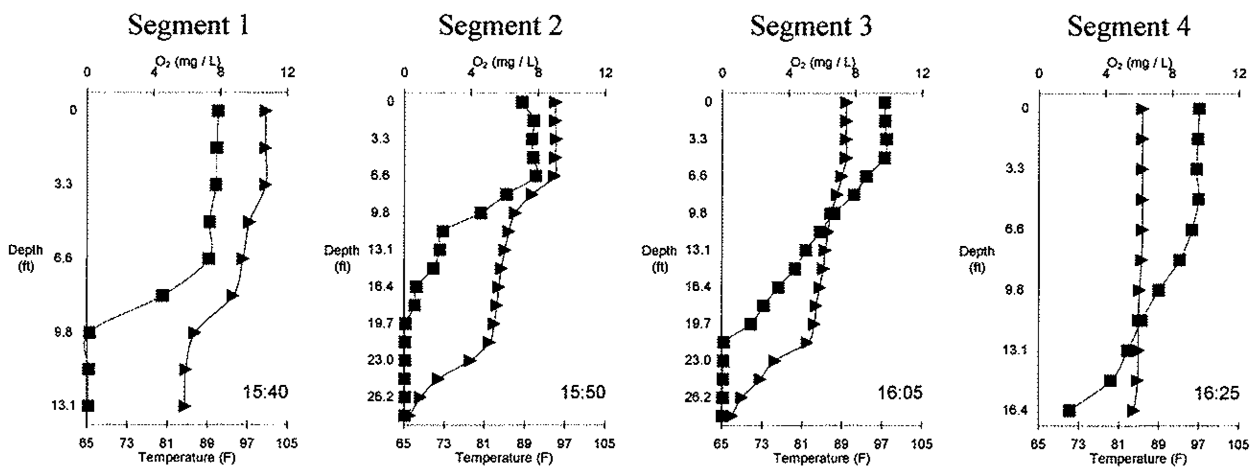


Figure 15A.73. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 24, 1999

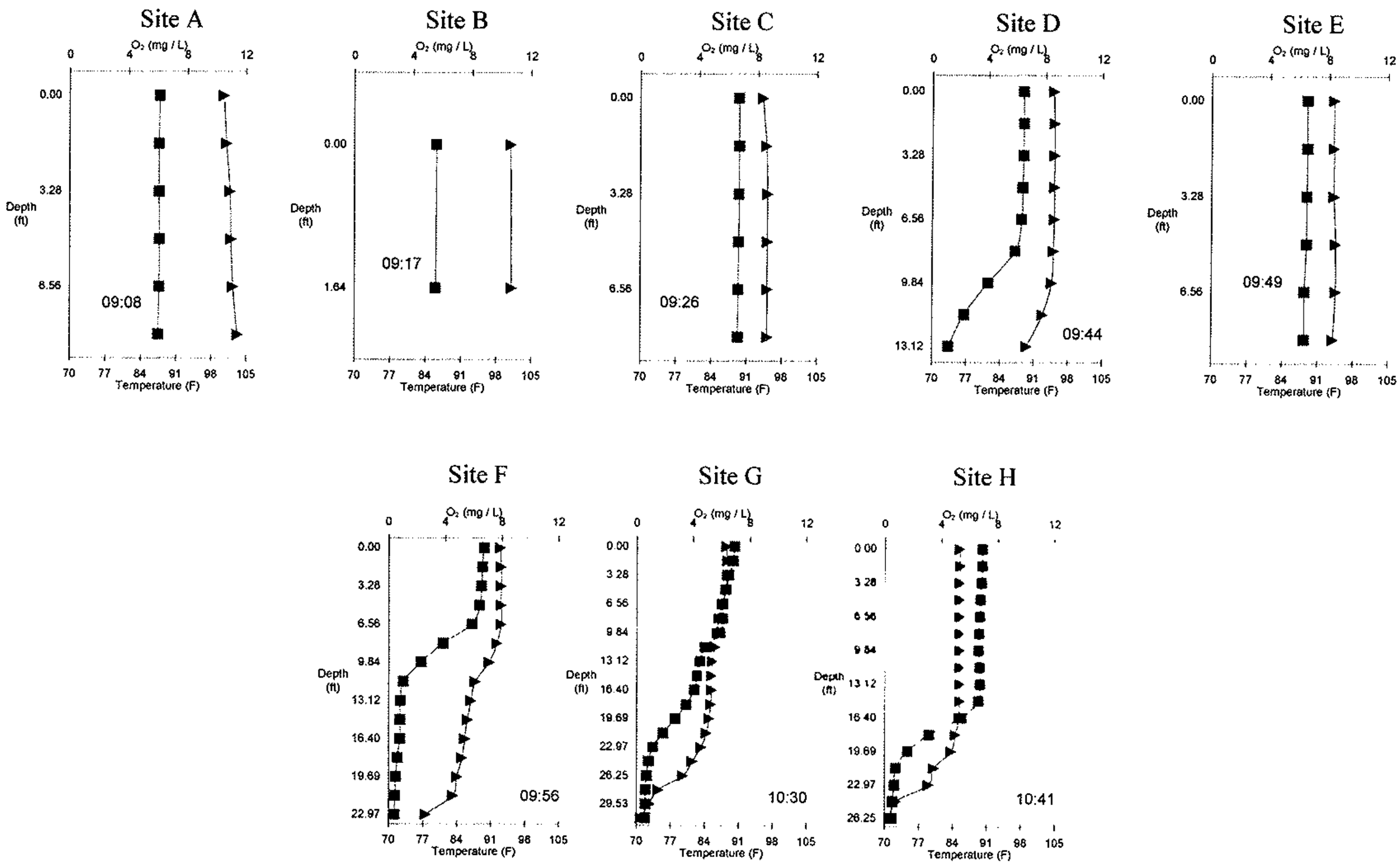
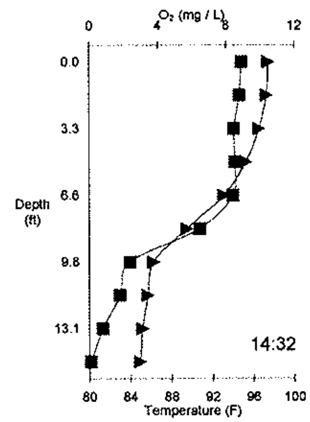


Figure 15A.74. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 26, 1999

Segment 1



Segment 2

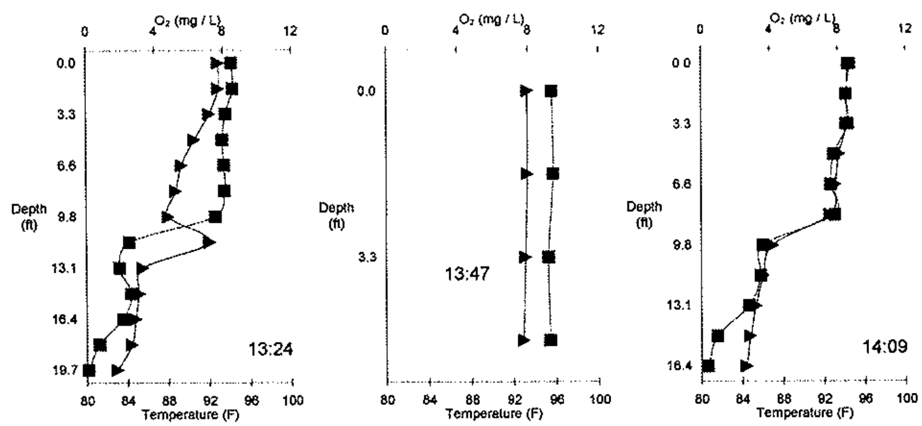


Figure 15A.75. Temperature and dissolved oxygen measured during fish tracking in Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – August 31, 1999

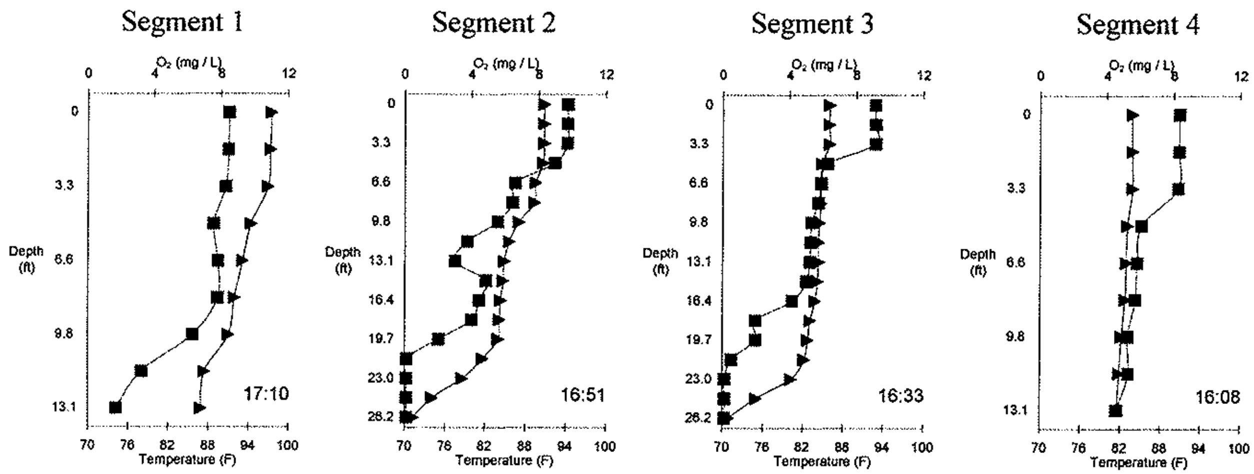


Figure 15A.76. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – September 7, 1999

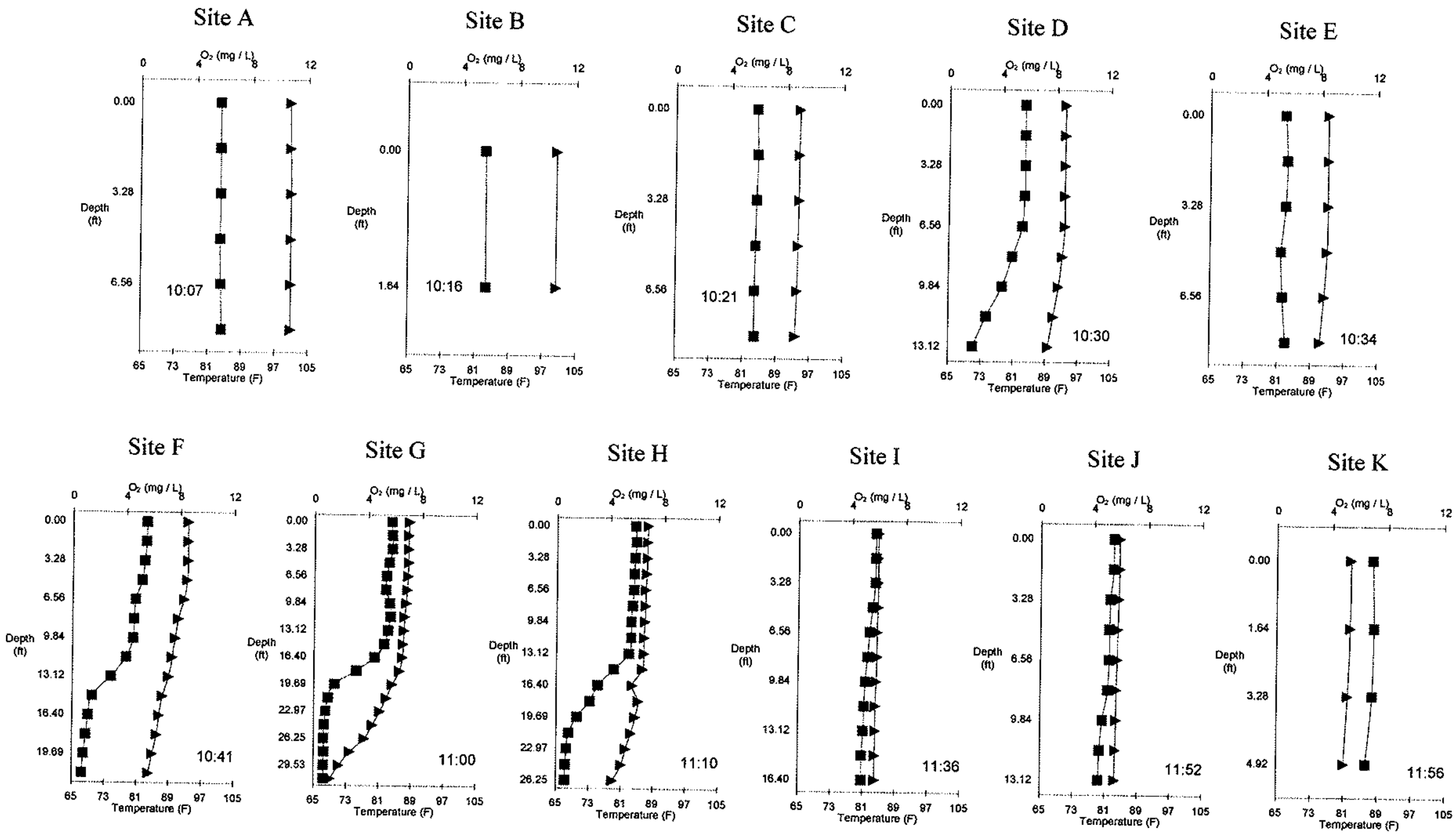
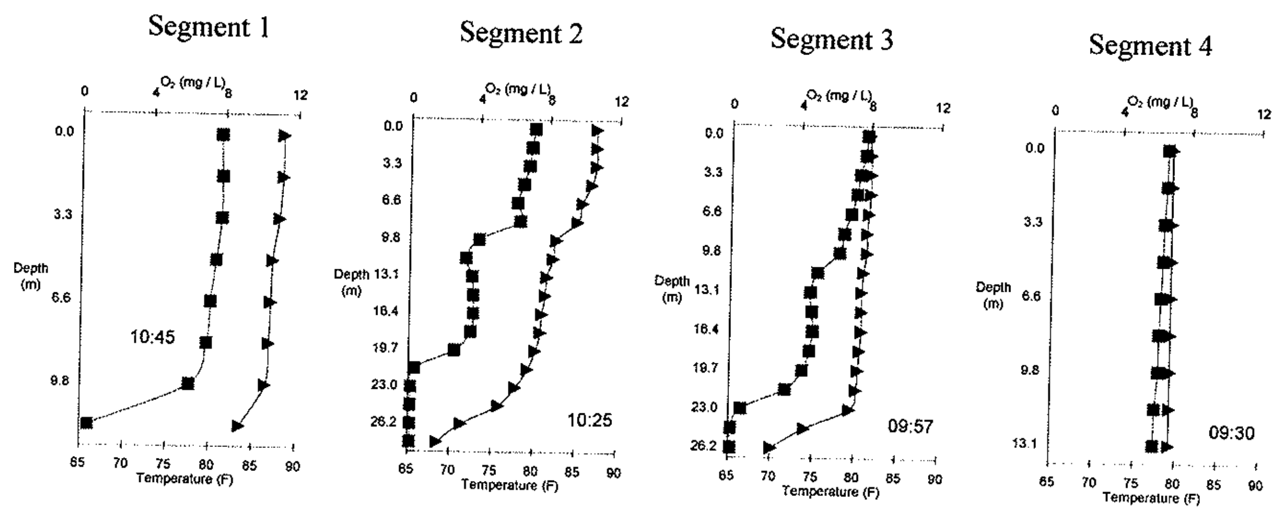


Figure 15A.77. Temperature and dissolved oxygen at Newton Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake - September 15, 1999



Newton Lake – October 13, 1999

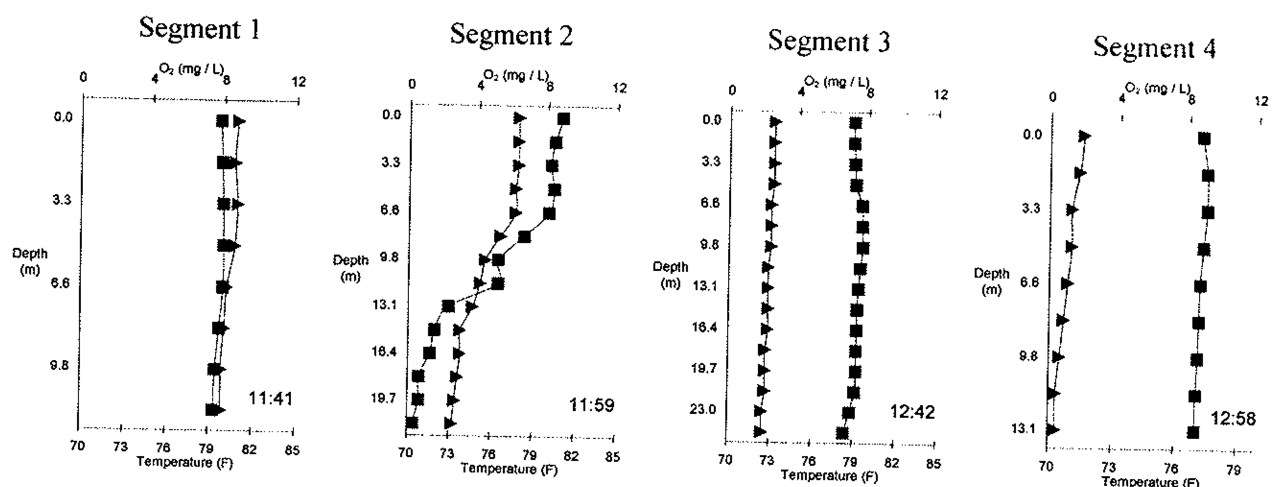


Figure 15A.78. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

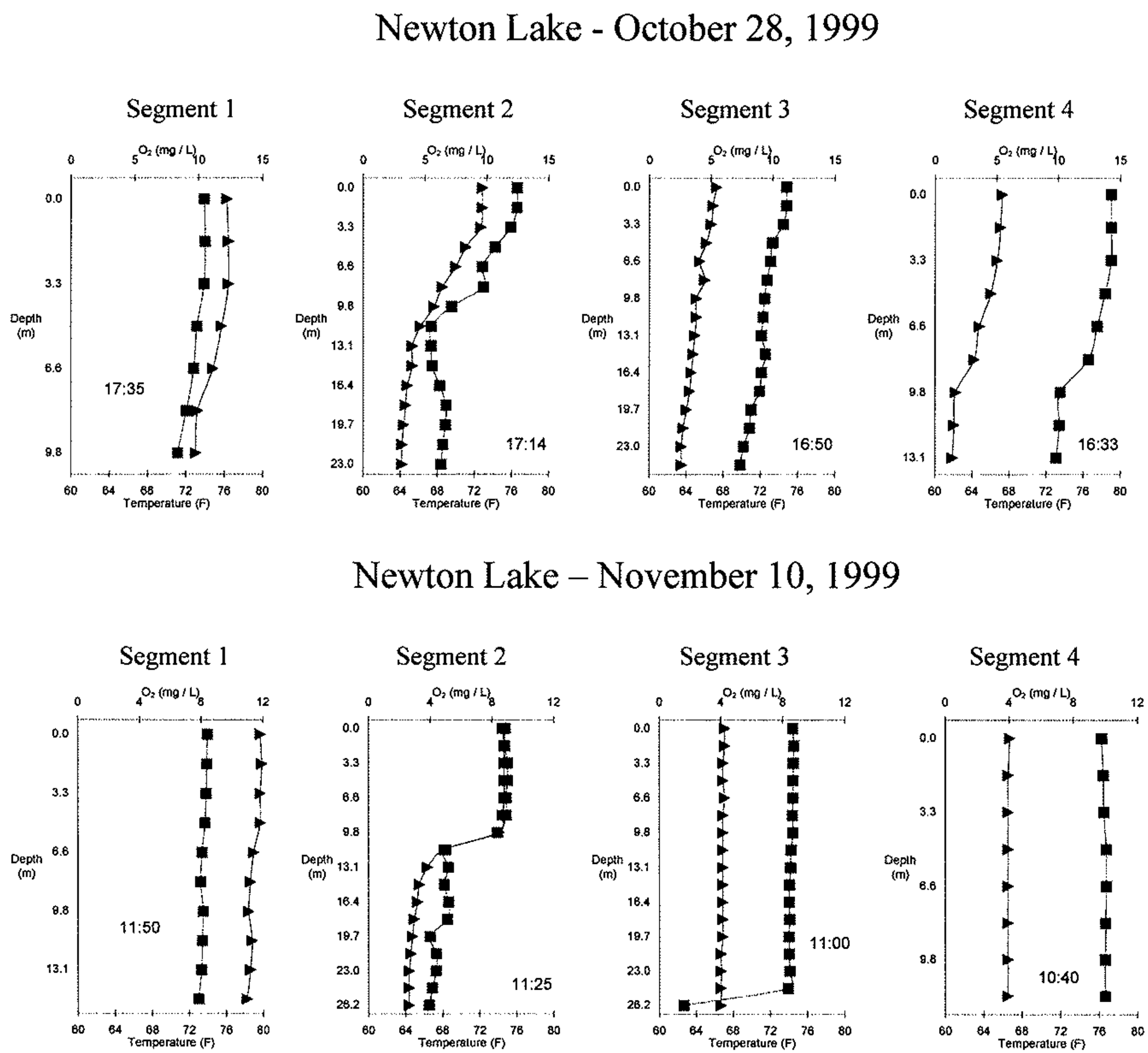
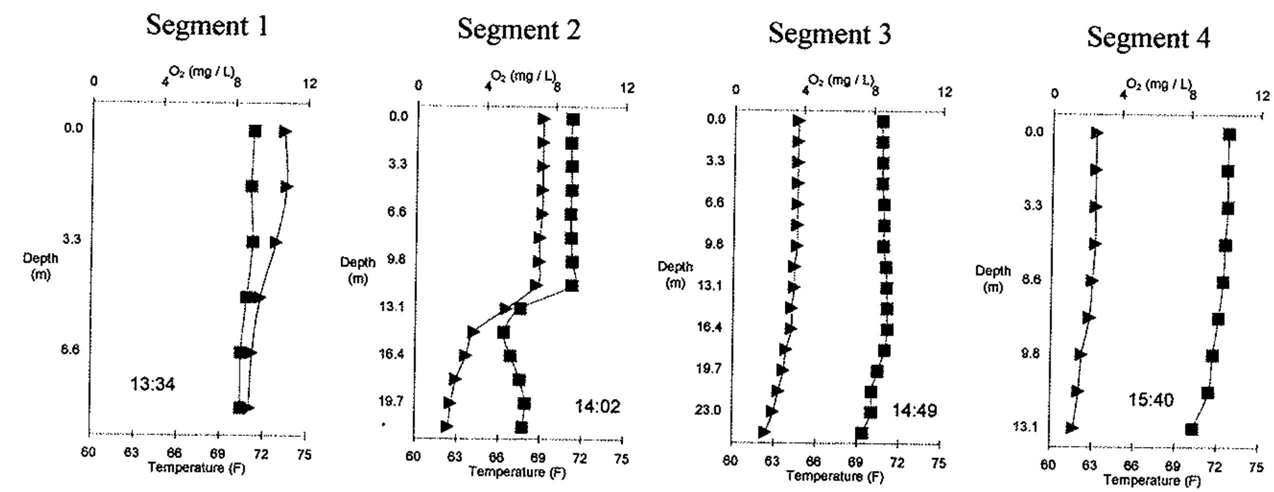


Figure 15A.79. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – November 22, 1999



Newton Lake – December 15, 1999

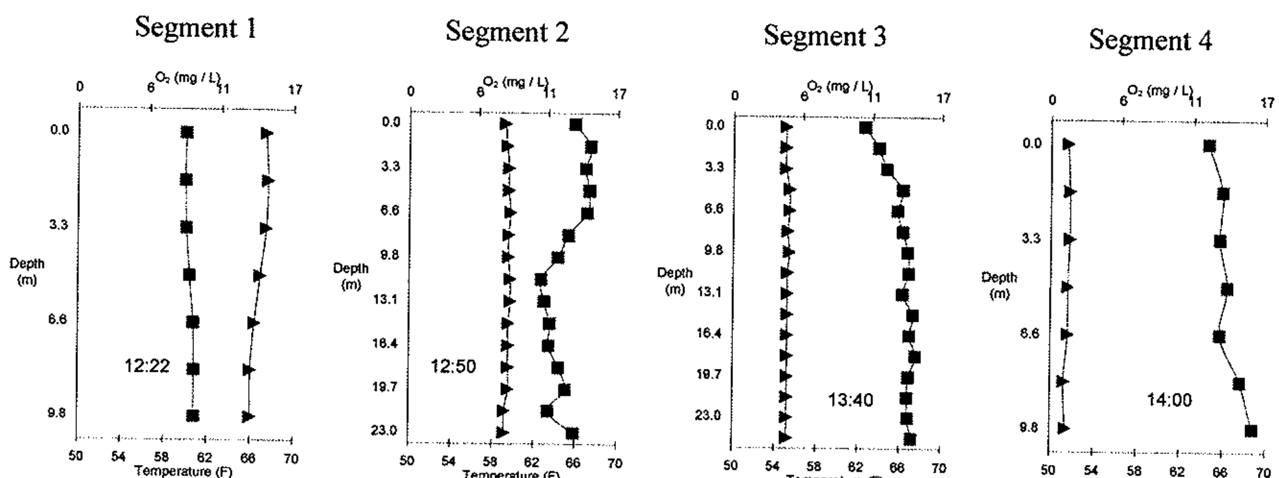
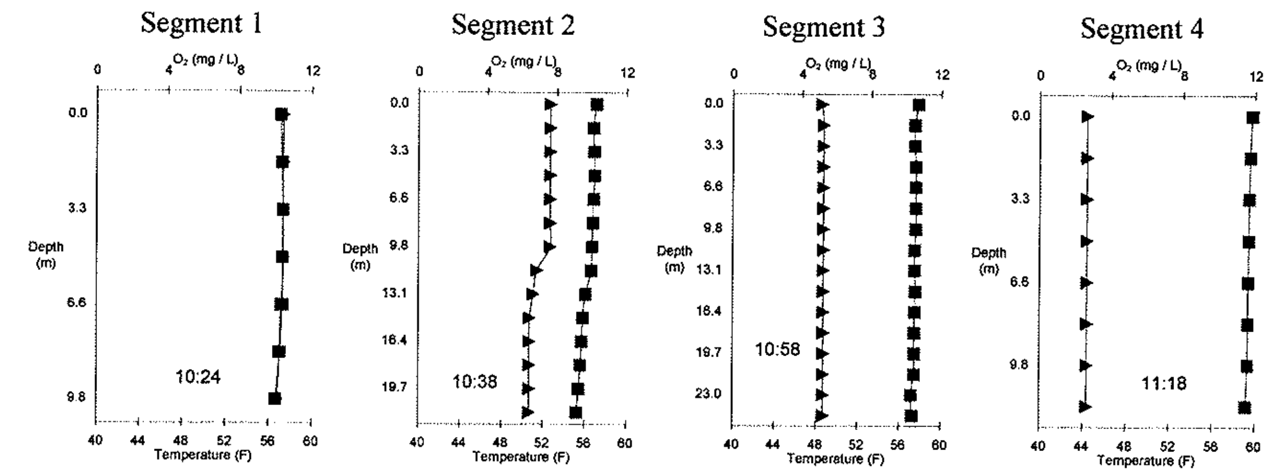


Figure 15A.80. Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Newton Lake – December 27, 1999



Newton Lake – January 6, 2000

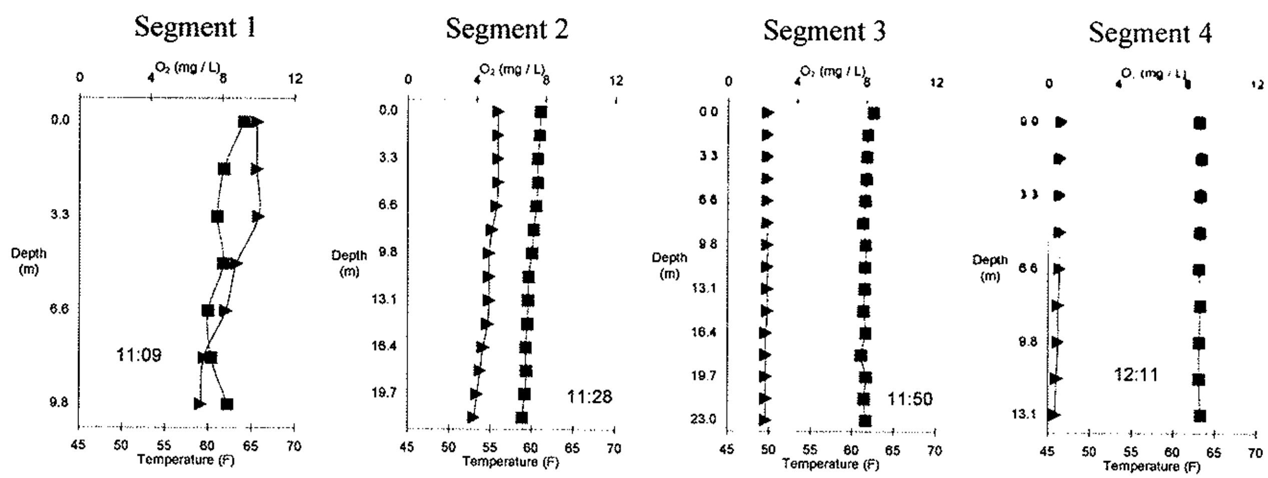


Figure 15A.81. – Temperature and dissolved oxygen by date within 4 segments of Newton Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

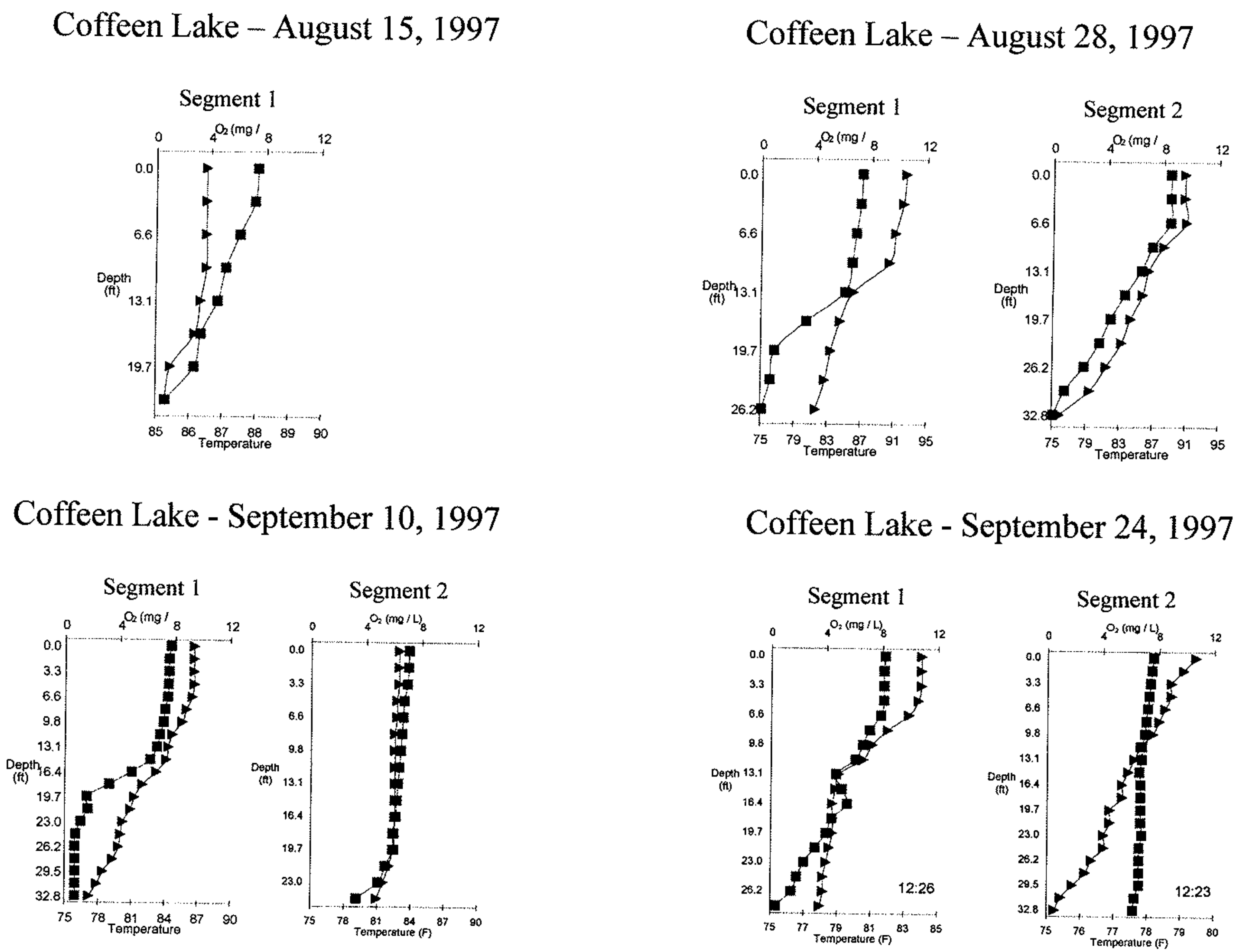
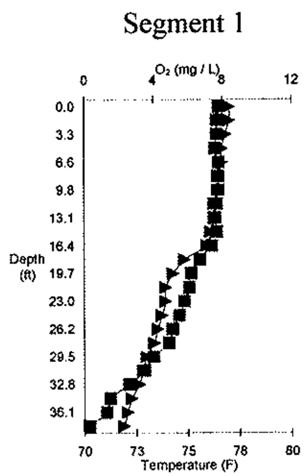
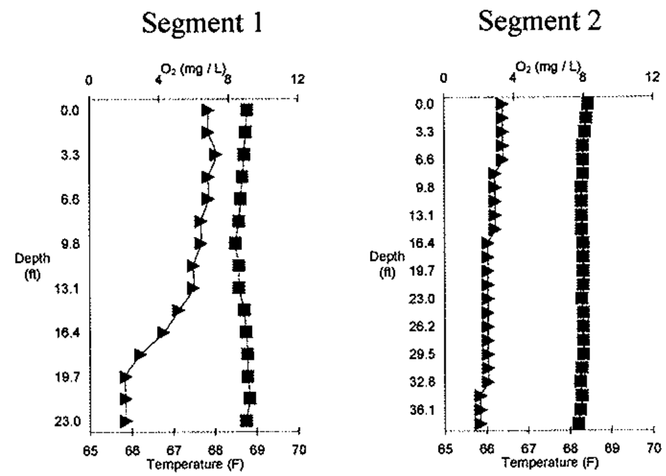


Figure 15A.82. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

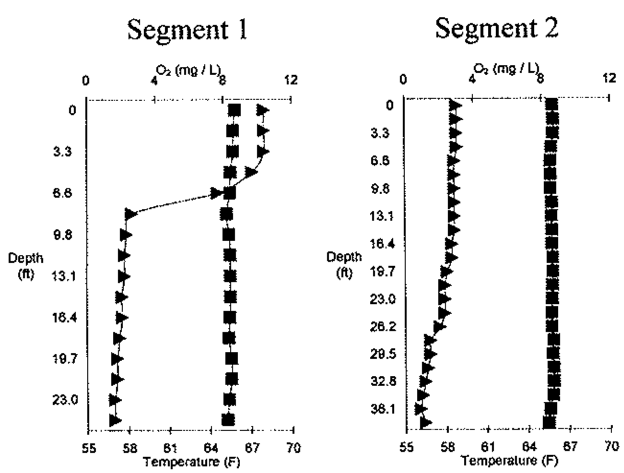
Coffeen Lake – October 10, 1997



Coffeen Lake – October 22, 1997



Coffeen Lake – November 6, 1997



Coffeen Lake – November 19, 1997

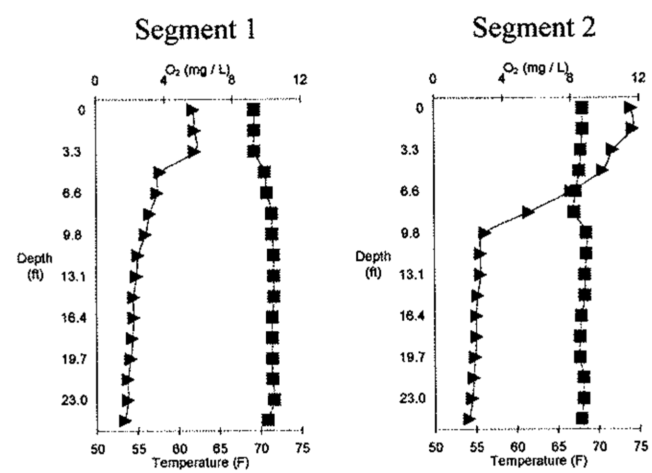


Figure 15A.83. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

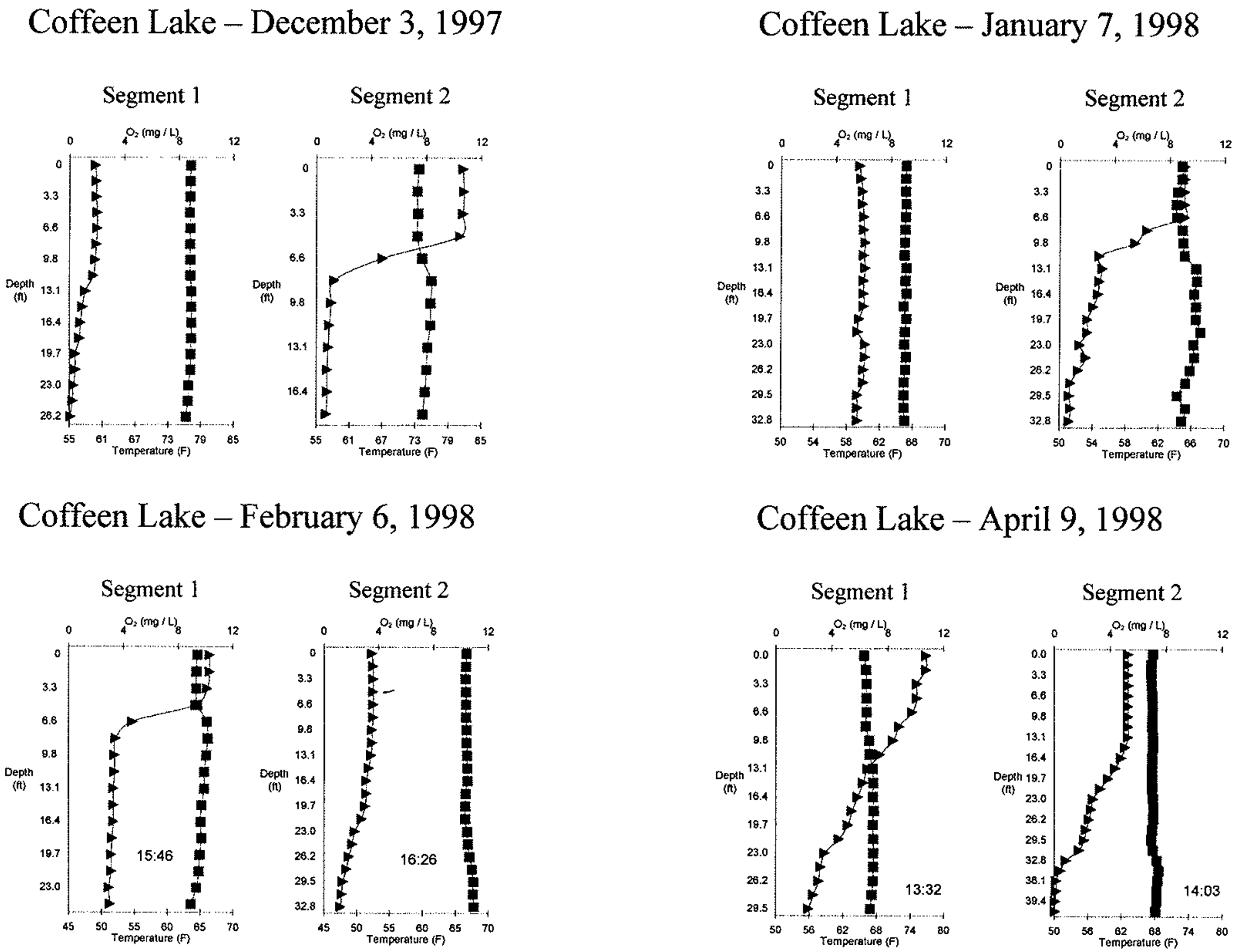


Figure 15A.84. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

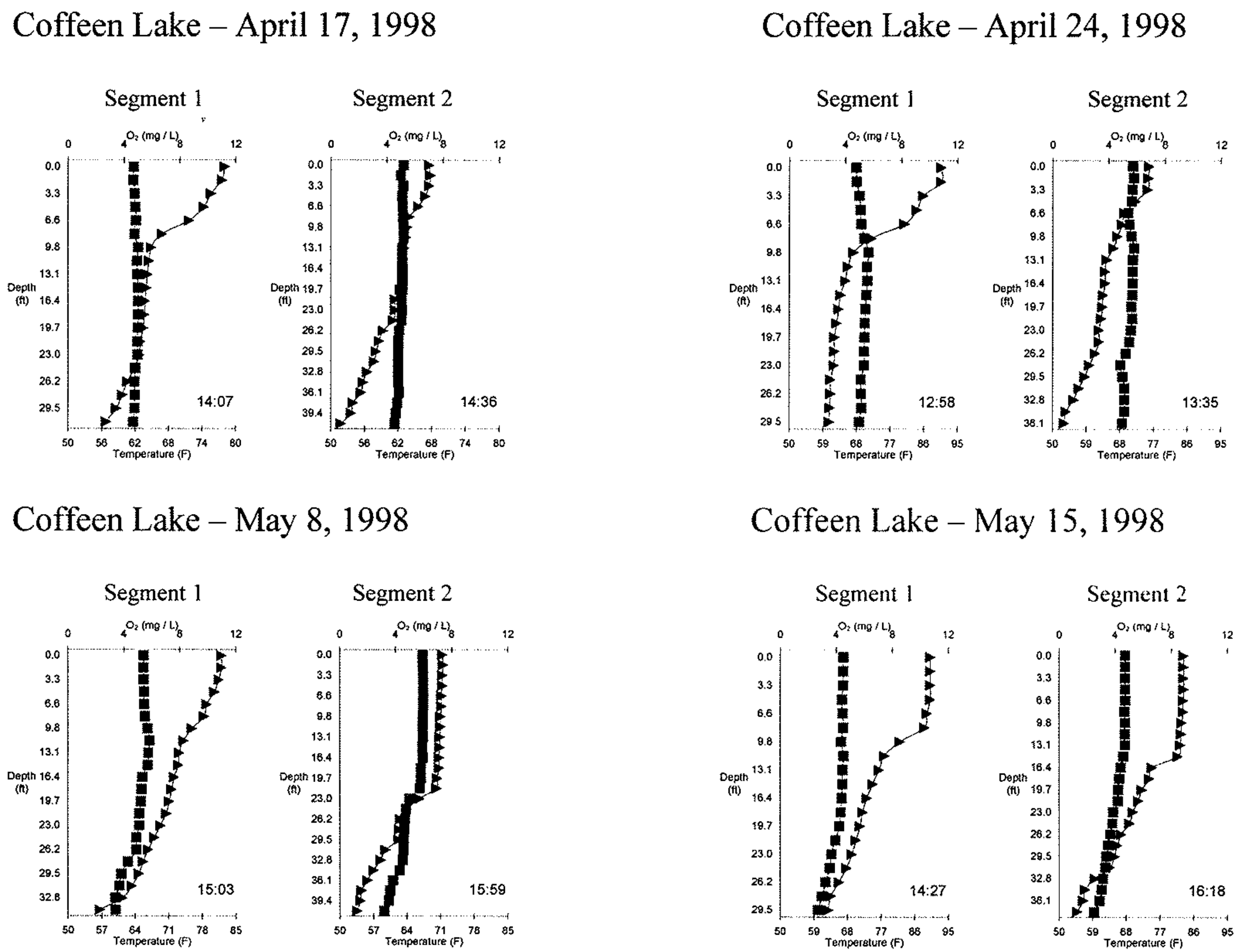


Figure 15A.85. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

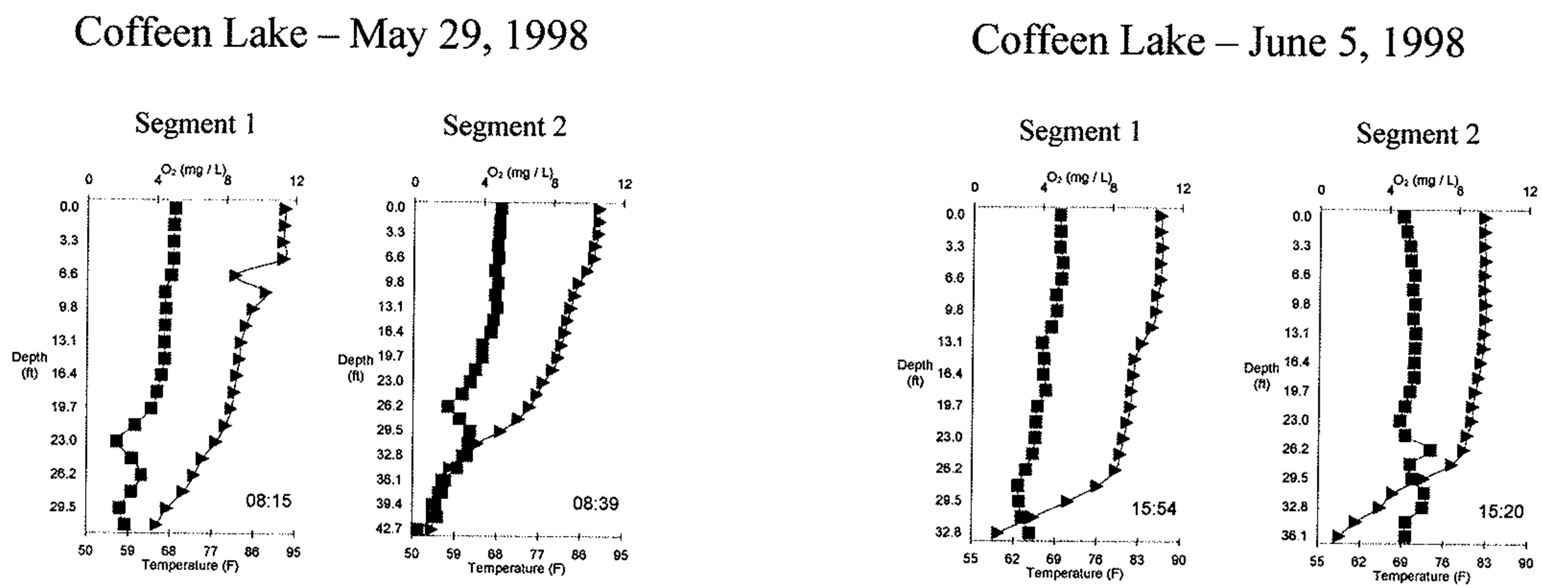


Figure 15A.86. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 5, 1998

Segment 1

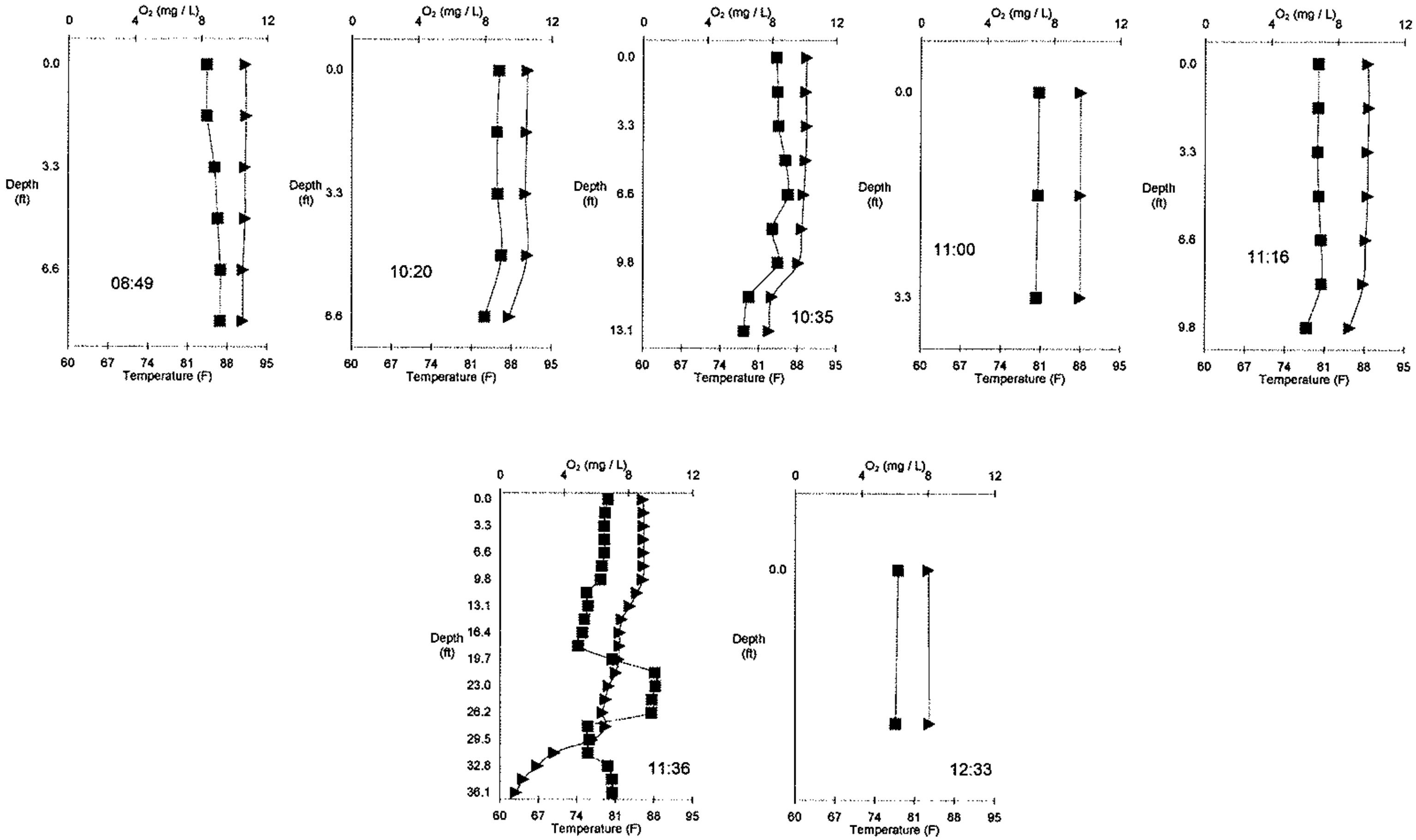


Figure 15A.87. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 11, 1998

Segment 1

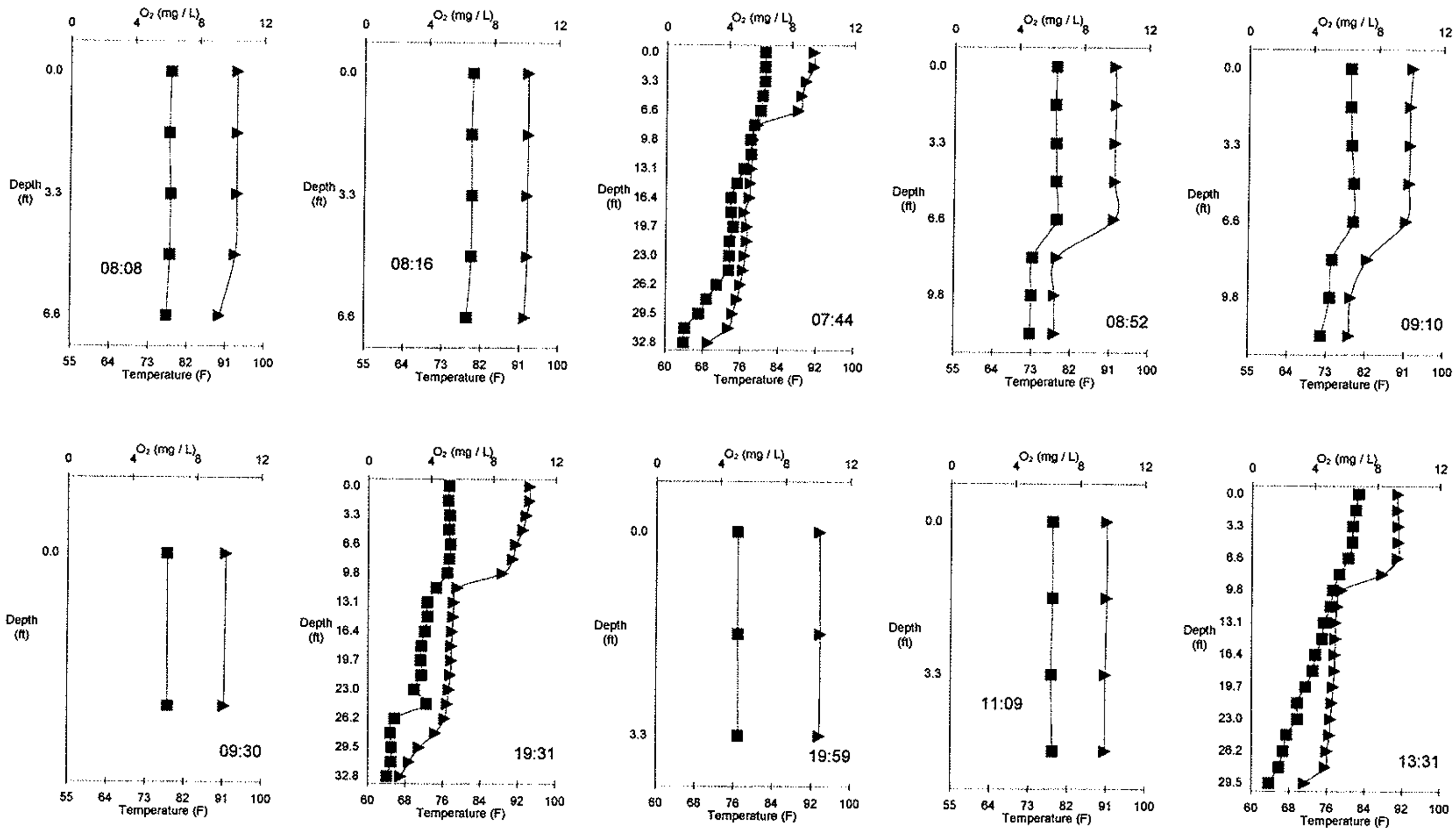


Figure 15A.88. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 11, 1998

Segment 1

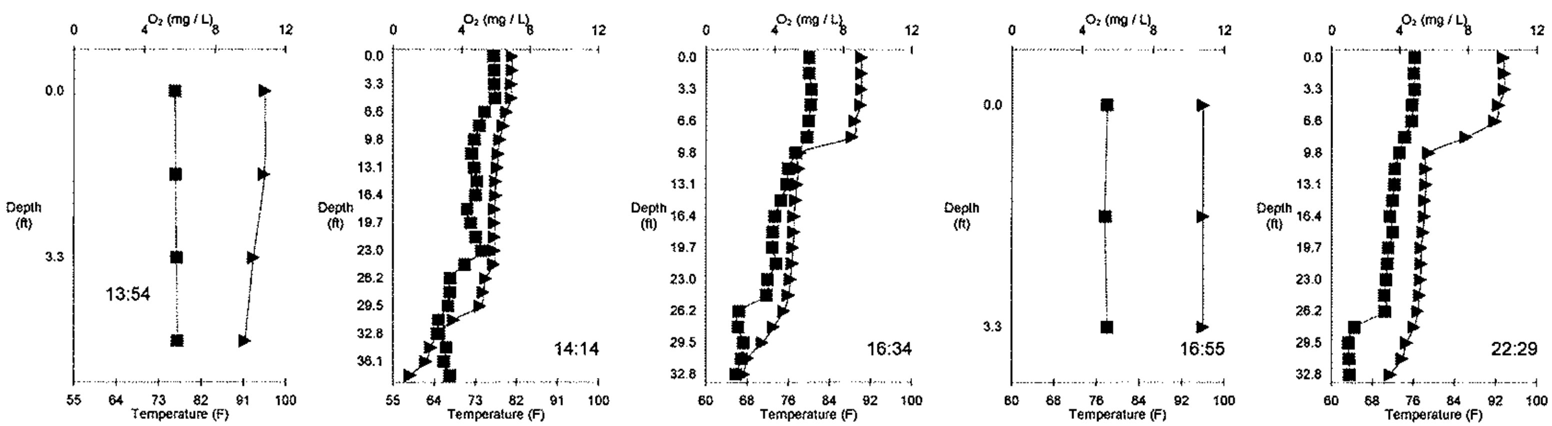


Figure 15A.89. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 12, 1998

Segment 1

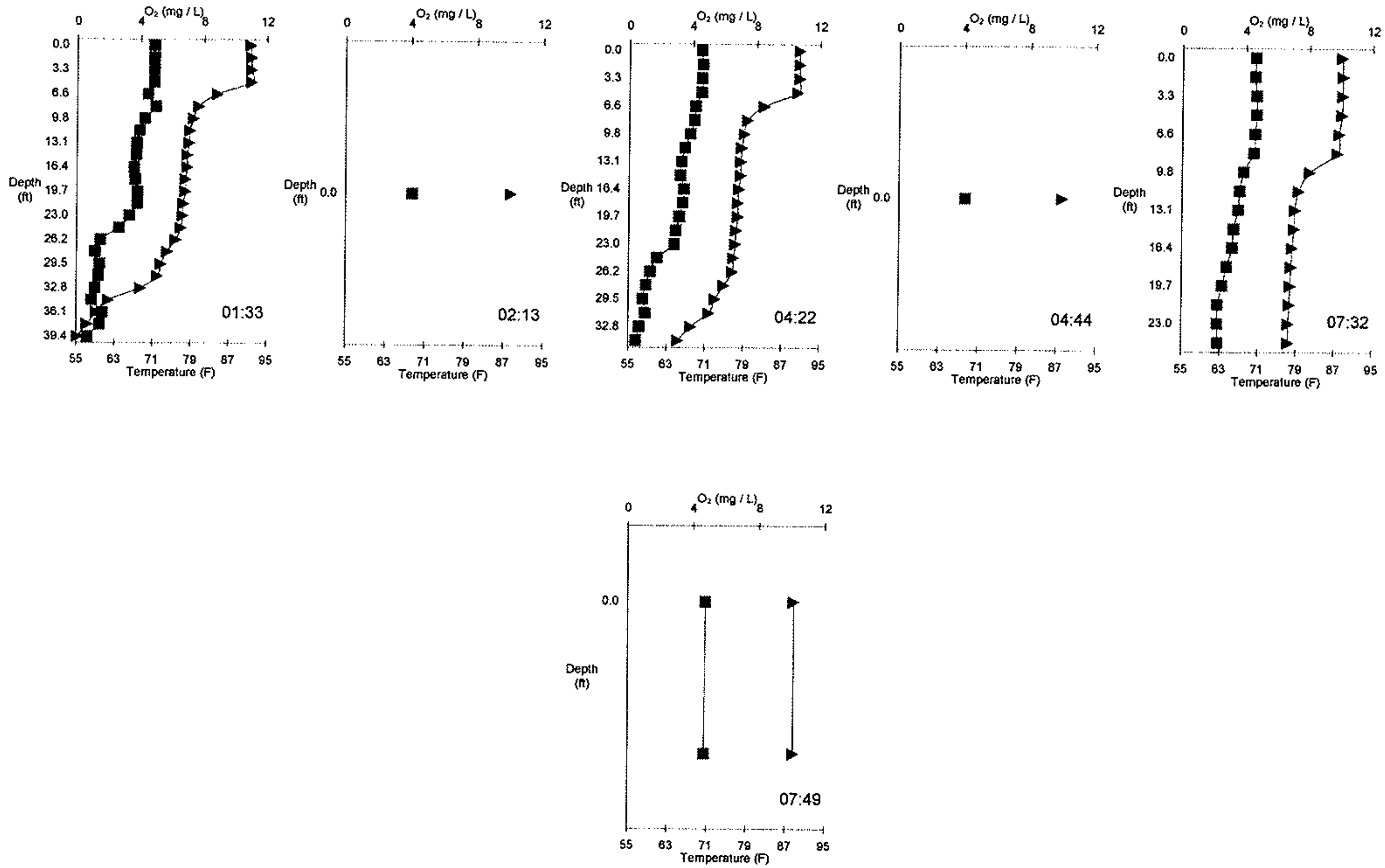


Figure 15A.90. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 16, 1998

Segment 1

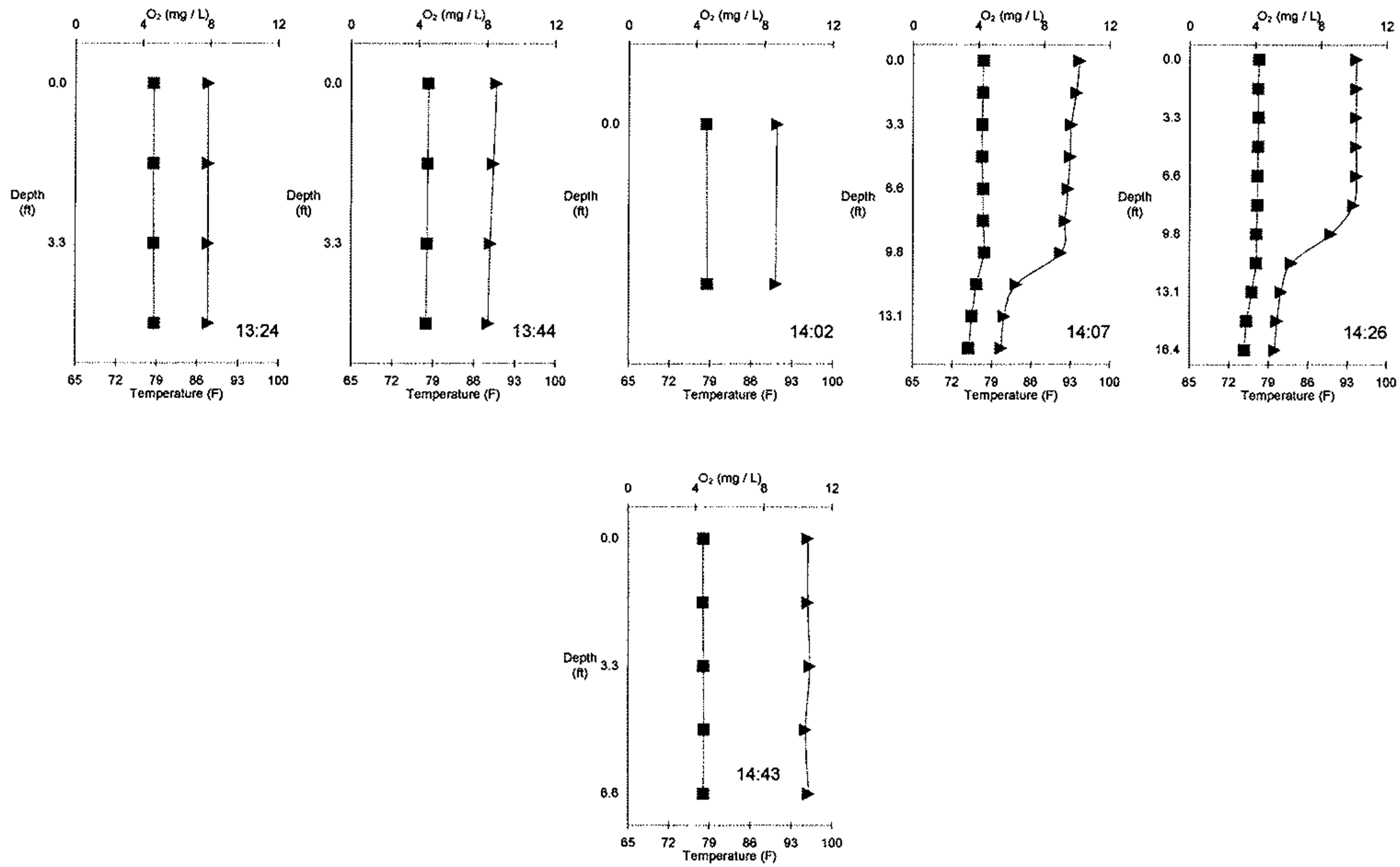
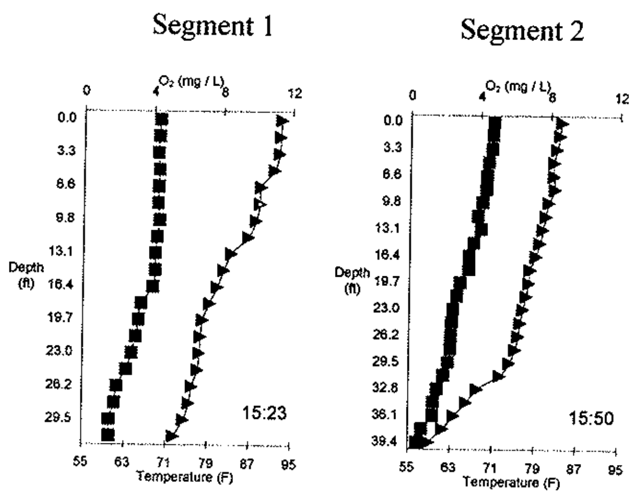


Figure 15A.91. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 16, 1998



Coffeen Lake – June 26, 1998

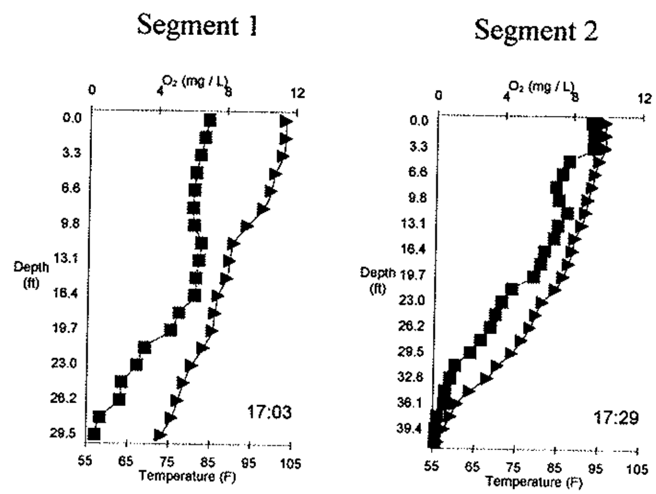
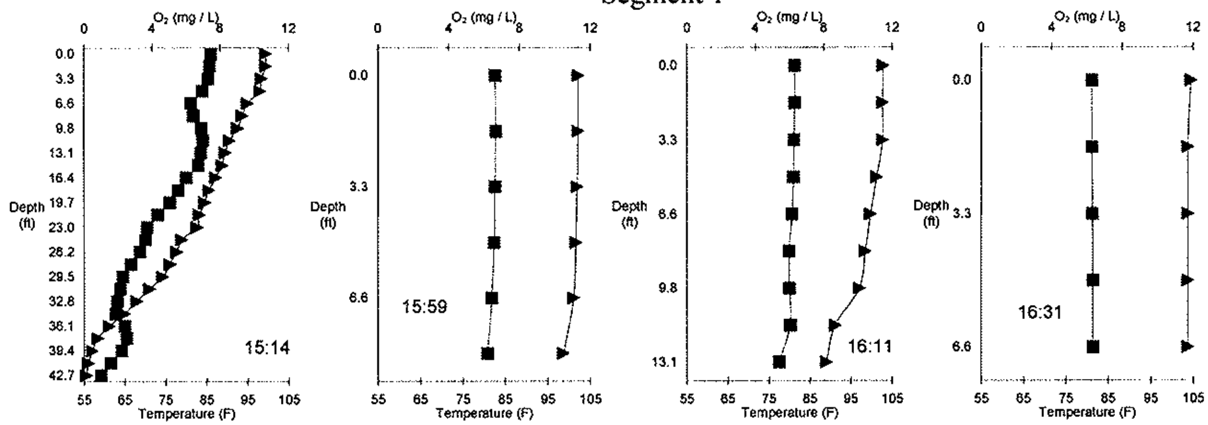


Figure 15A.92. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 26, 1998

Segment 1



Coffeen Lake – July 3, 1998

Segment 1

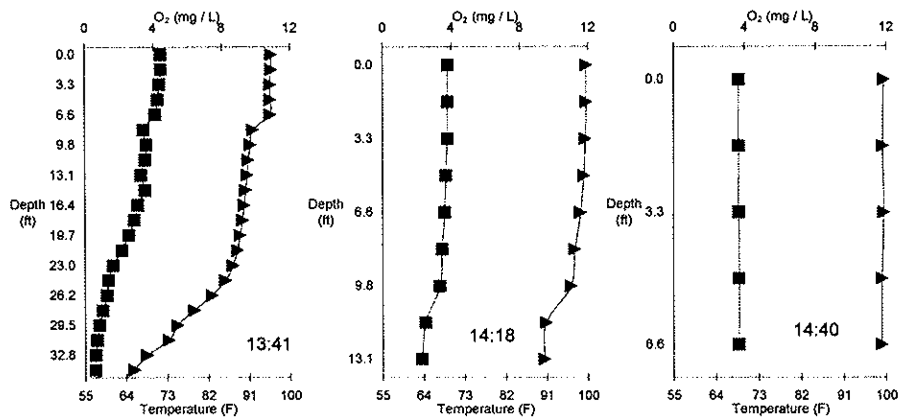
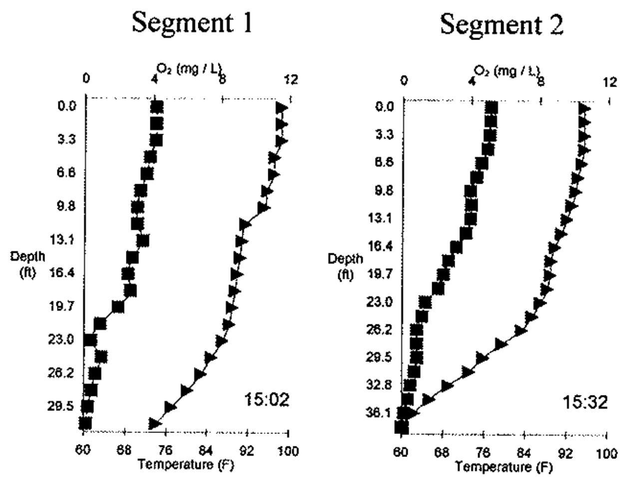


Figure 15A.93. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 3, 1998



Coffeen Lake – July 10, 1998

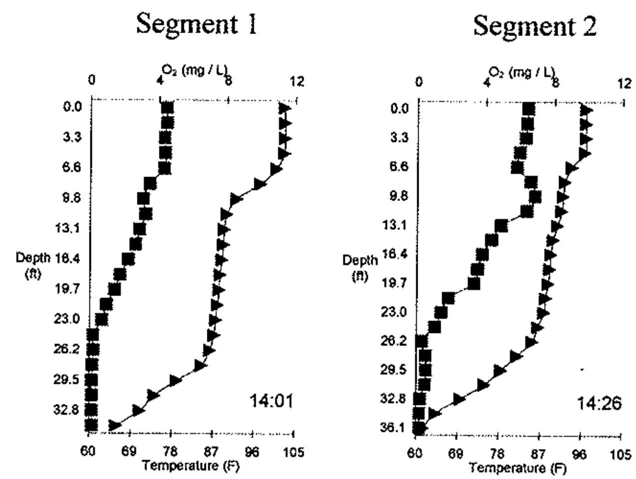
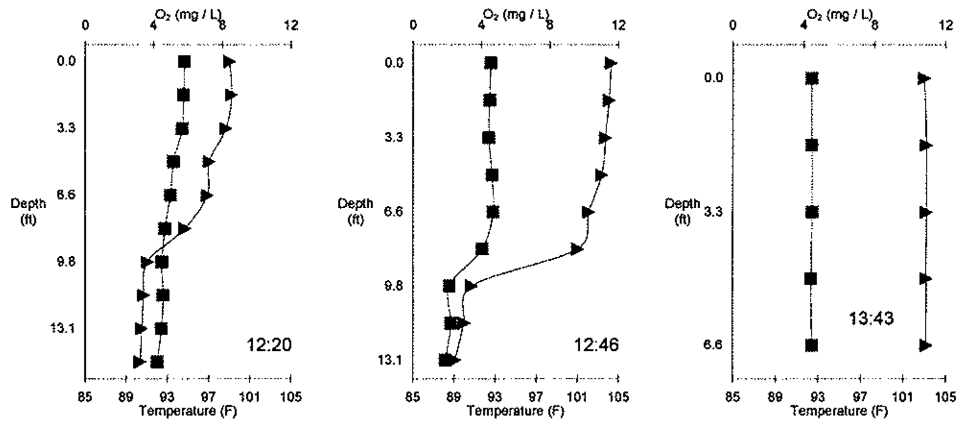


Figure 15A.94. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 10, 1998

Segment 1



Coffeen Lake – July 14, 1998

Segment 1

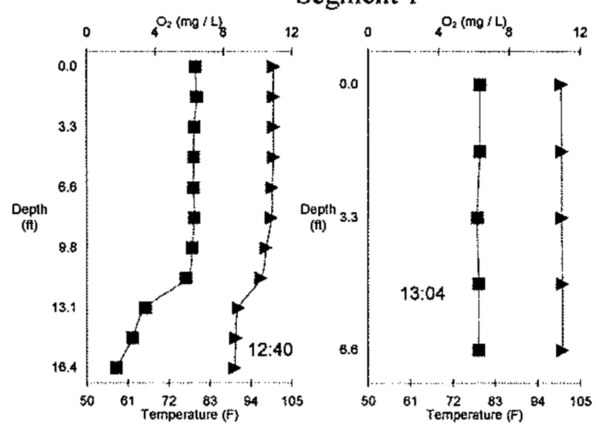
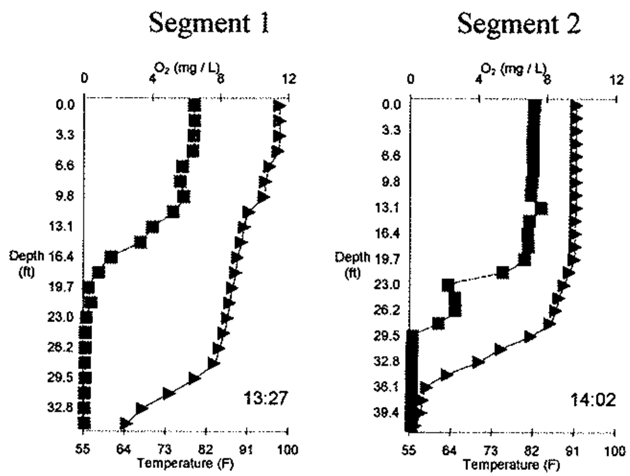


Figure 15A.95. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 14, 1998



Coffeen Lake – July 24, 1998

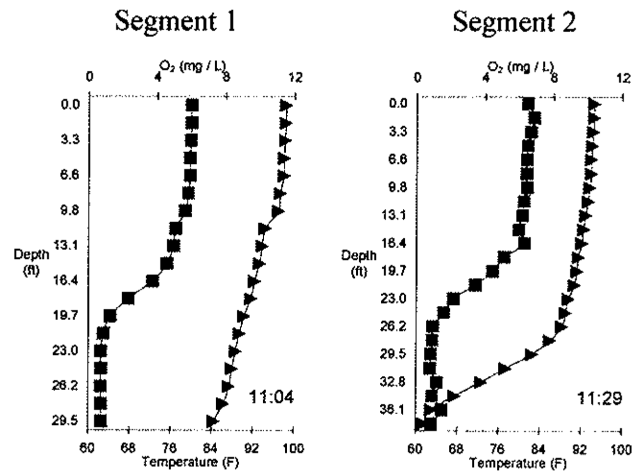
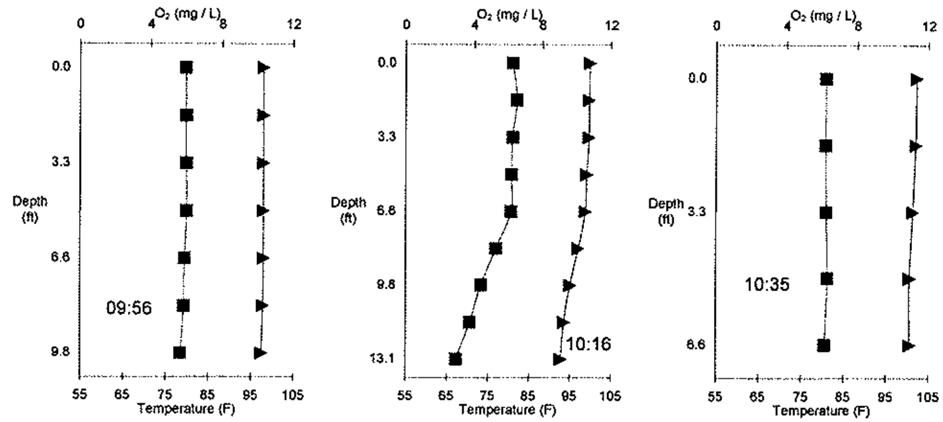


Figure 15A.96. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 24, 1998

Segment 1



Coffeen Lake – July 31, 1998

Segment 1

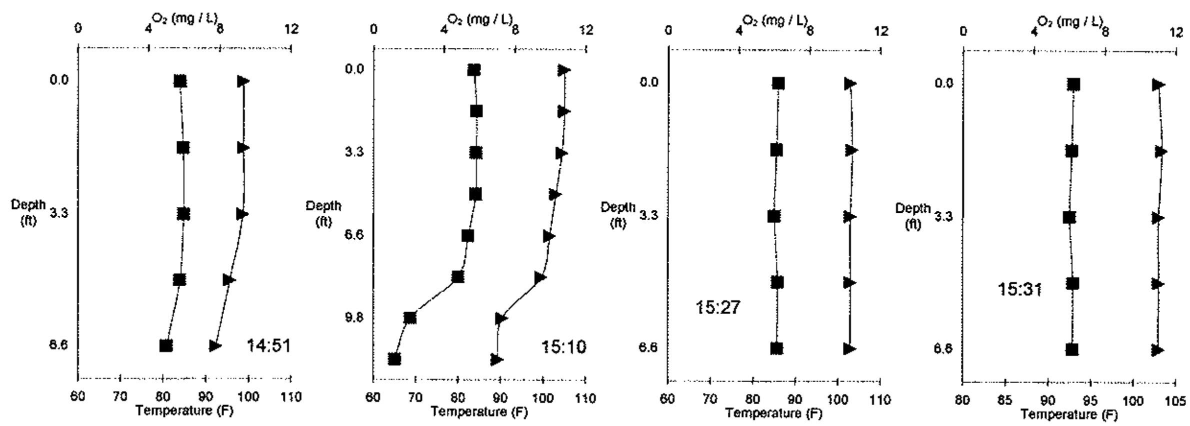
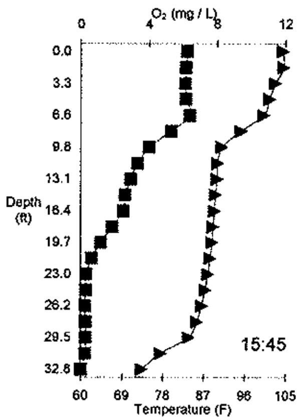


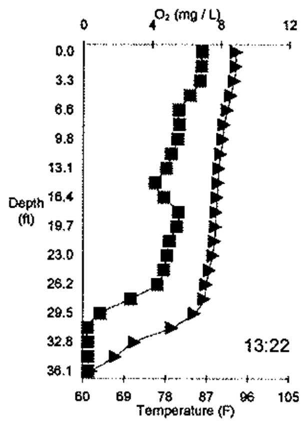
Figure 15A.97. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 31, 1998

Segment 1

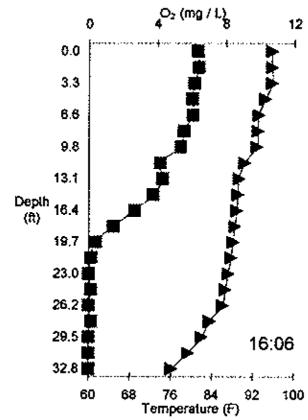


Segment 2



Coffeen Lake – August 8, 1998

Segment 1



Segment 2

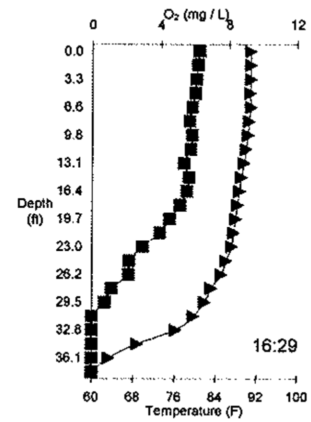
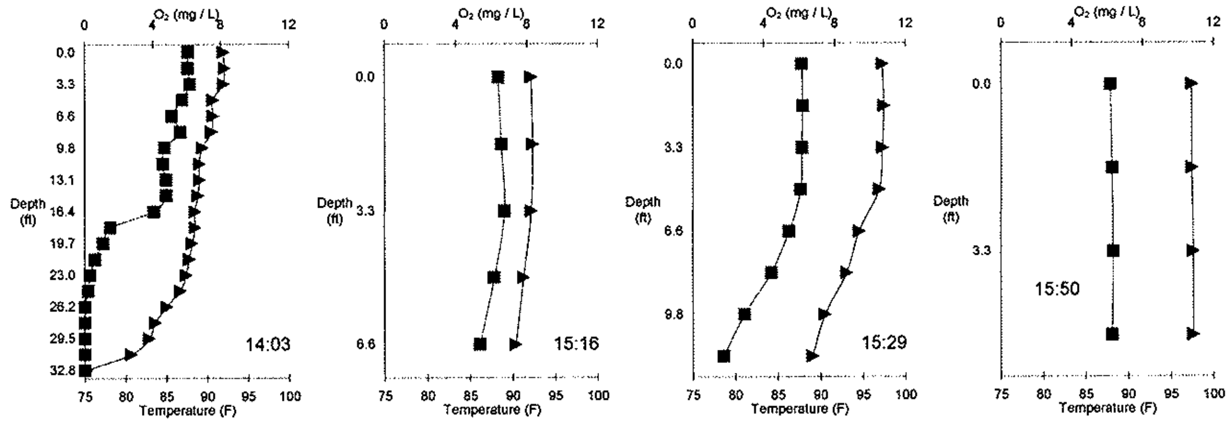


Figure 15A.98. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake –August 8, 1998

Segment 1



Coffeen Lake – August 13, 1998

Segment 1

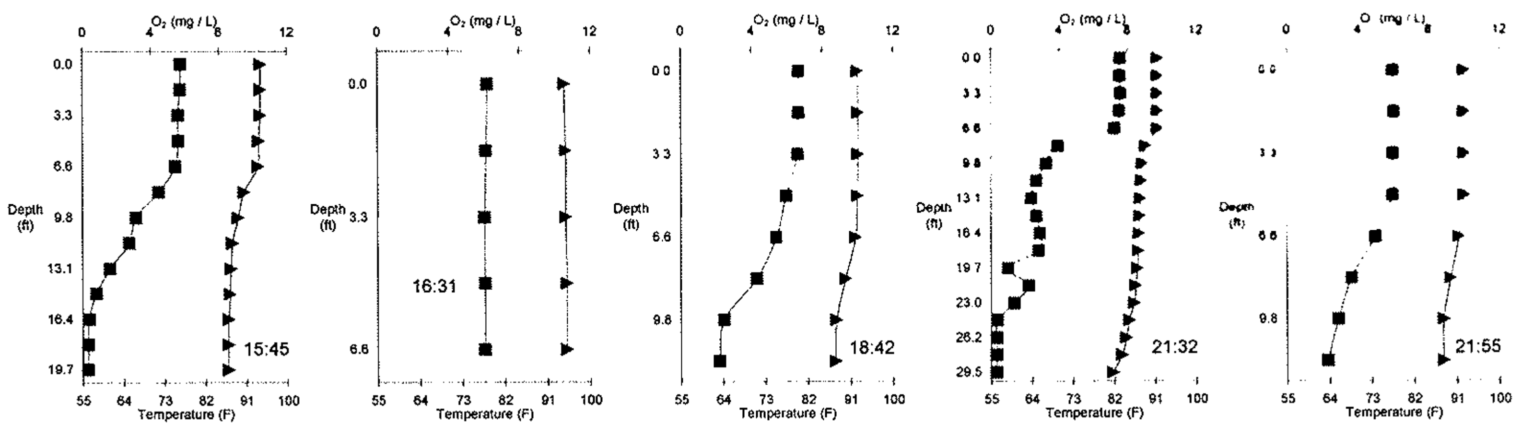


Figure 15A.99. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 13, 1998

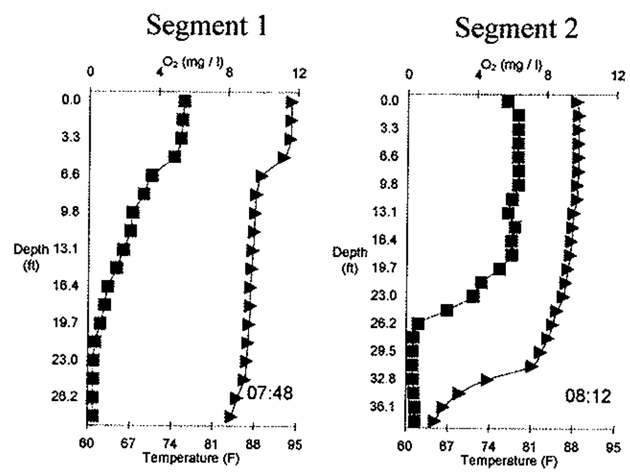


Figure 15A.100. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 14, 1998

Segment 1

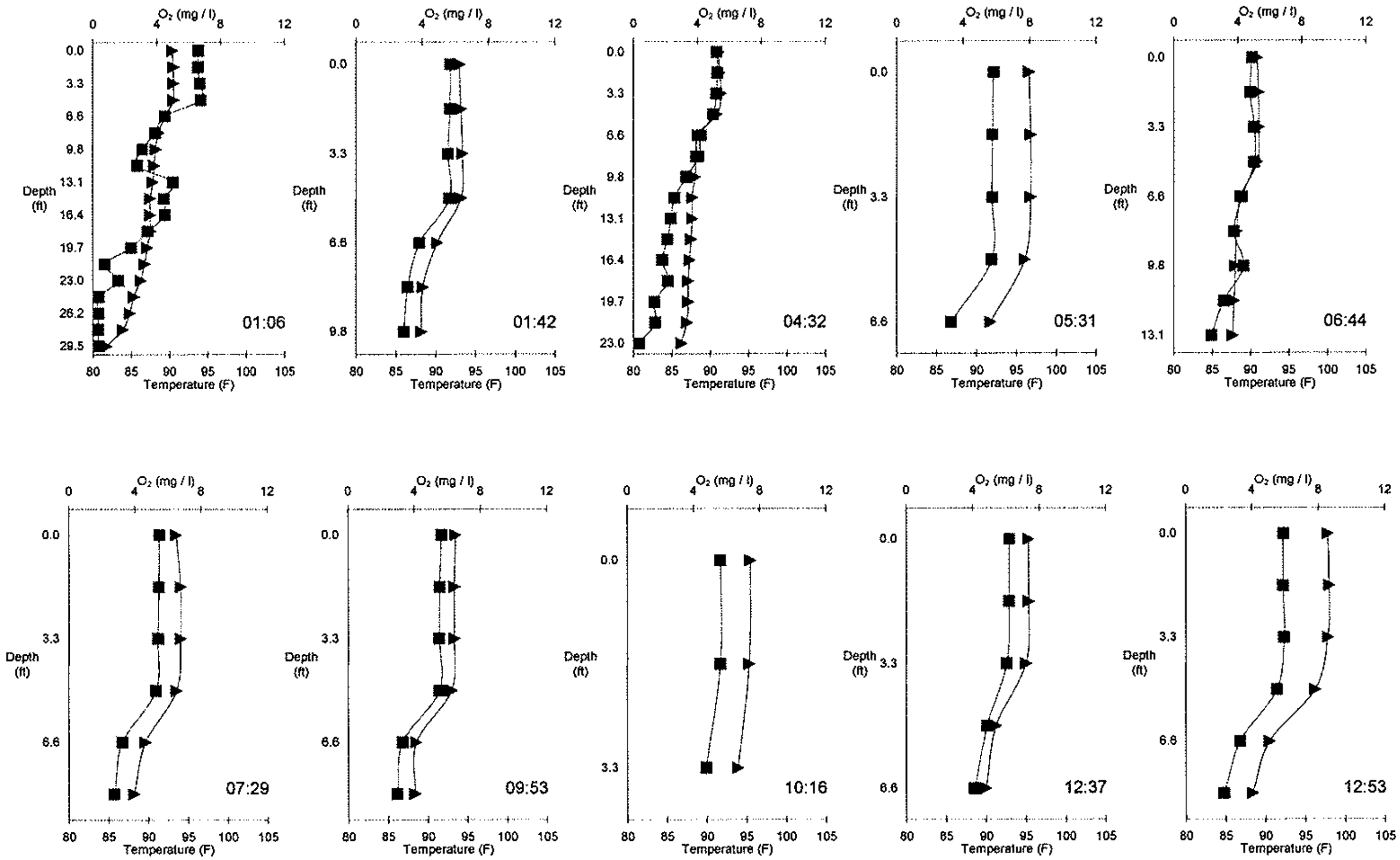
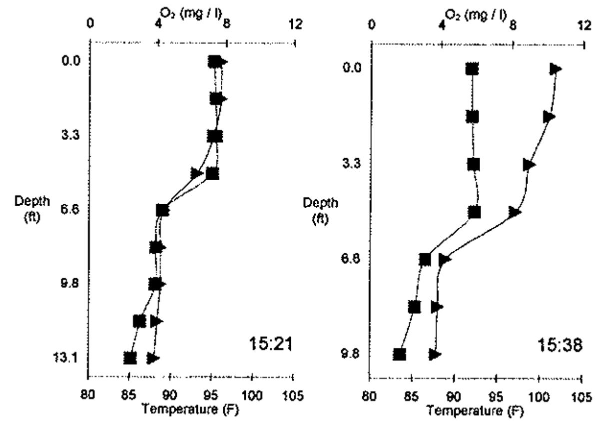


Figure 15A.101. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 14, 1998

Segment 1



Coffeen Lake – August 19, 1998

Segment 1

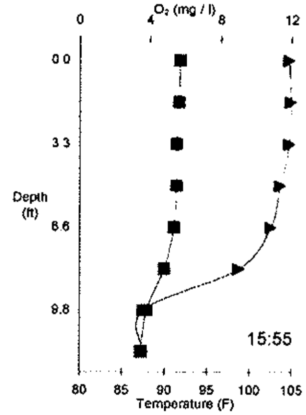


Figure 15A.102. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake –August 20, 1998

Segment 1

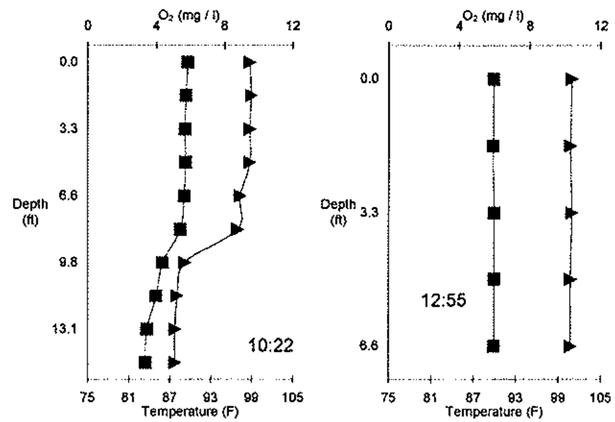


Figure 15A.103. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 20, 1998

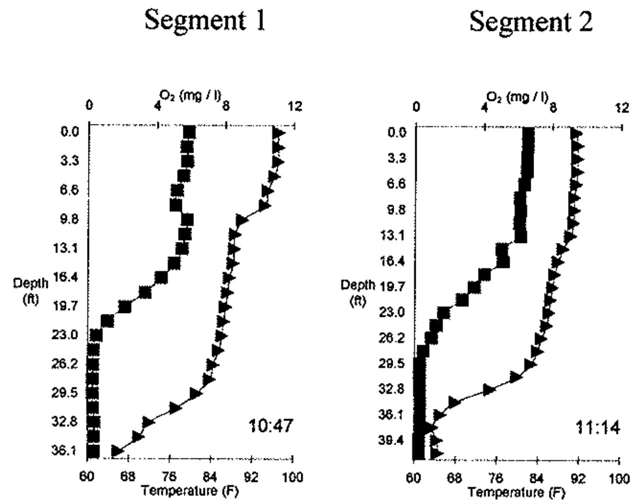


Figure 15A.104. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 28, 1998

Segment 1

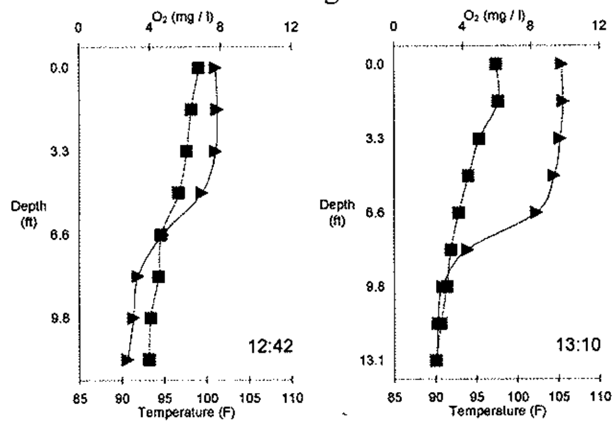
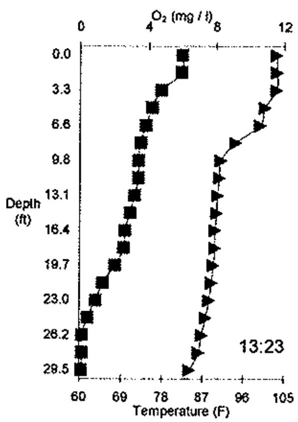


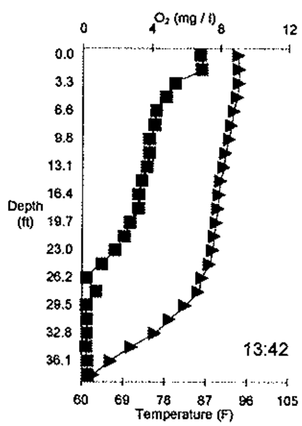
Figure 15A.105. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 28, 1998

Segment 1

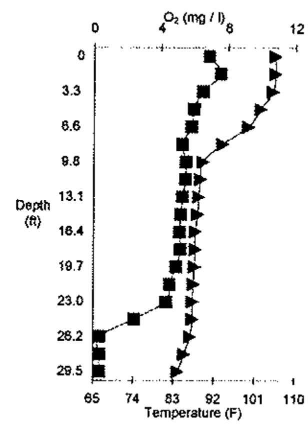


Segment 2



Coffeen Lake - September 4, 1998

Segment 1



Segment 2

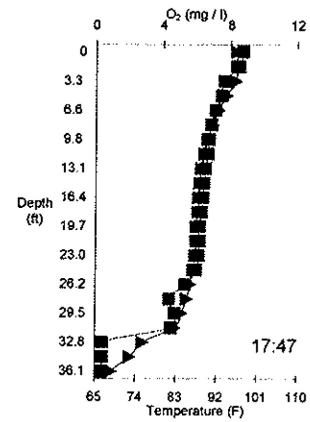
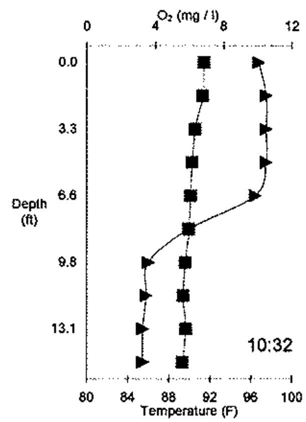


Figure 15A.106. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – September 4, 1998

Segment 1



Coffeen Lake – September 11, 1998

Segment 1

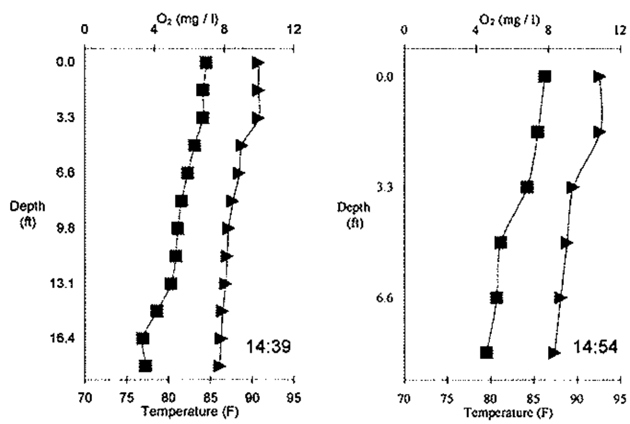
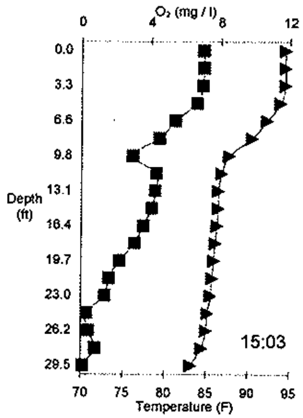


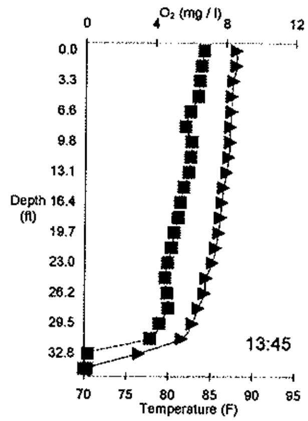
Figure 15A.107. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake - September 11, 1998

Segment 1

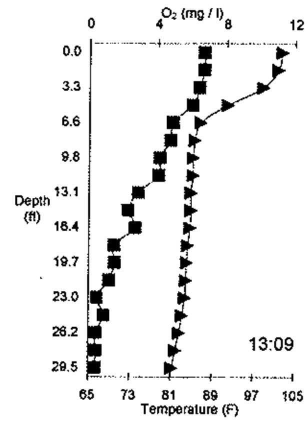


Segment 2



Coffeen Lake - September 18, 1998

Segment 1



Segment 2

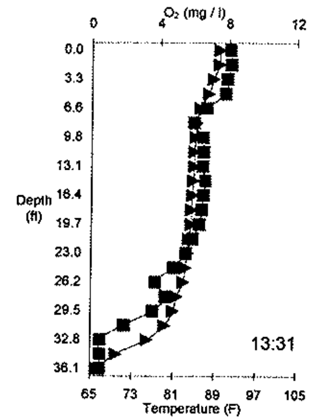


Figure 15A.108. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

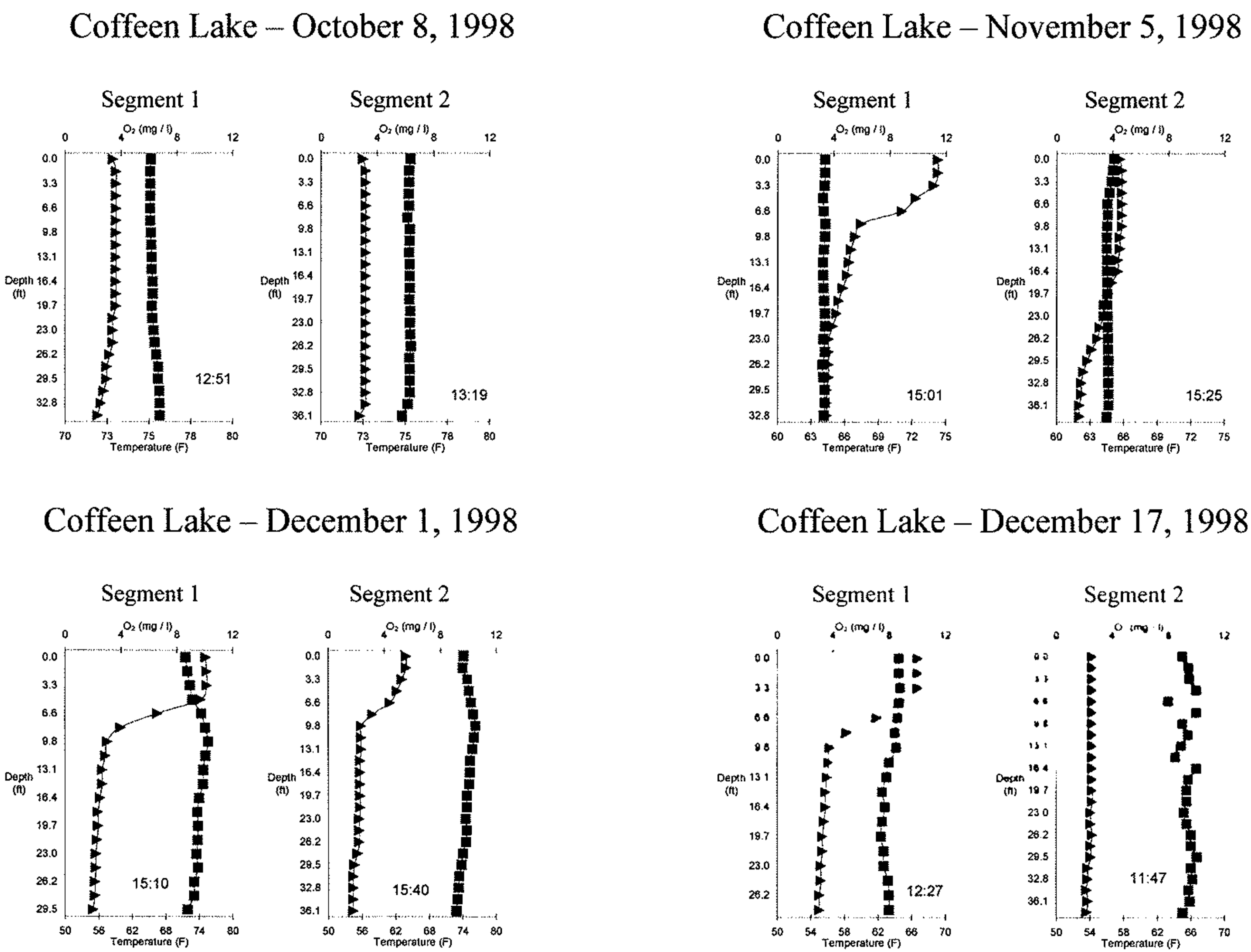
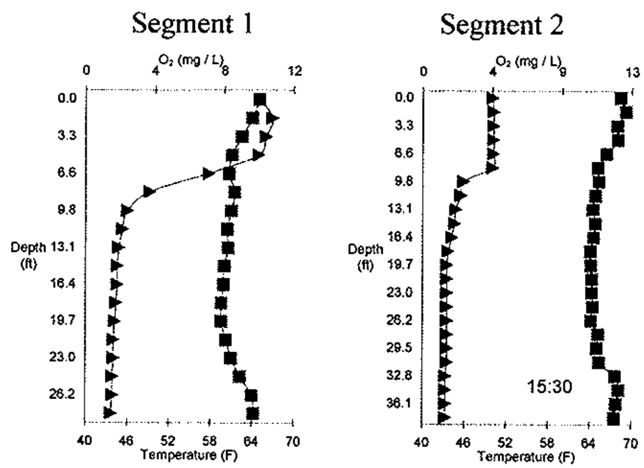
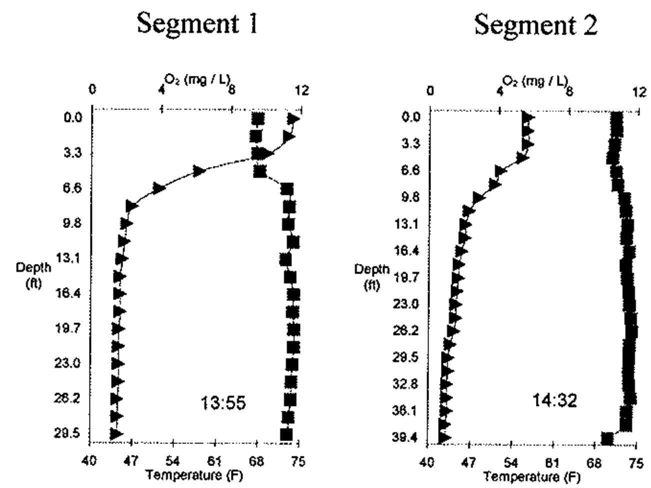


Figure 15A.109. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

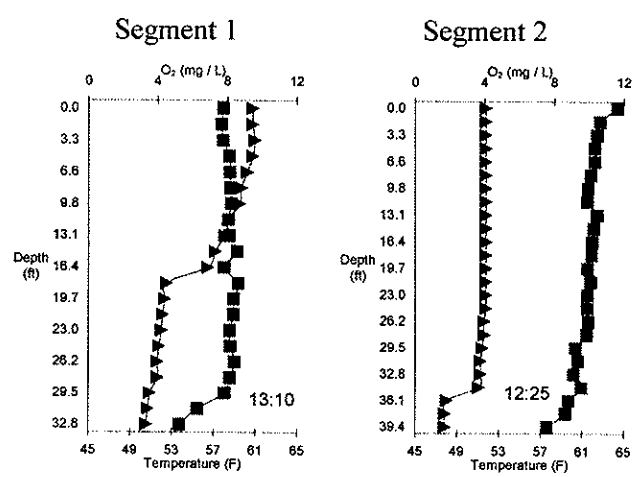
Coffeen Lake – January 7, 1999



Coffeen Lake – January 21, 1999



Coffeen Lake – February 3, 1999



Coffeen Lake – February 18, 1999

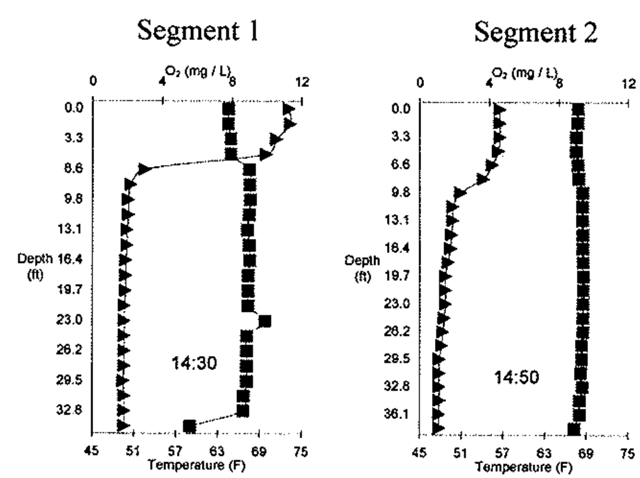


Figure 15A.110. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

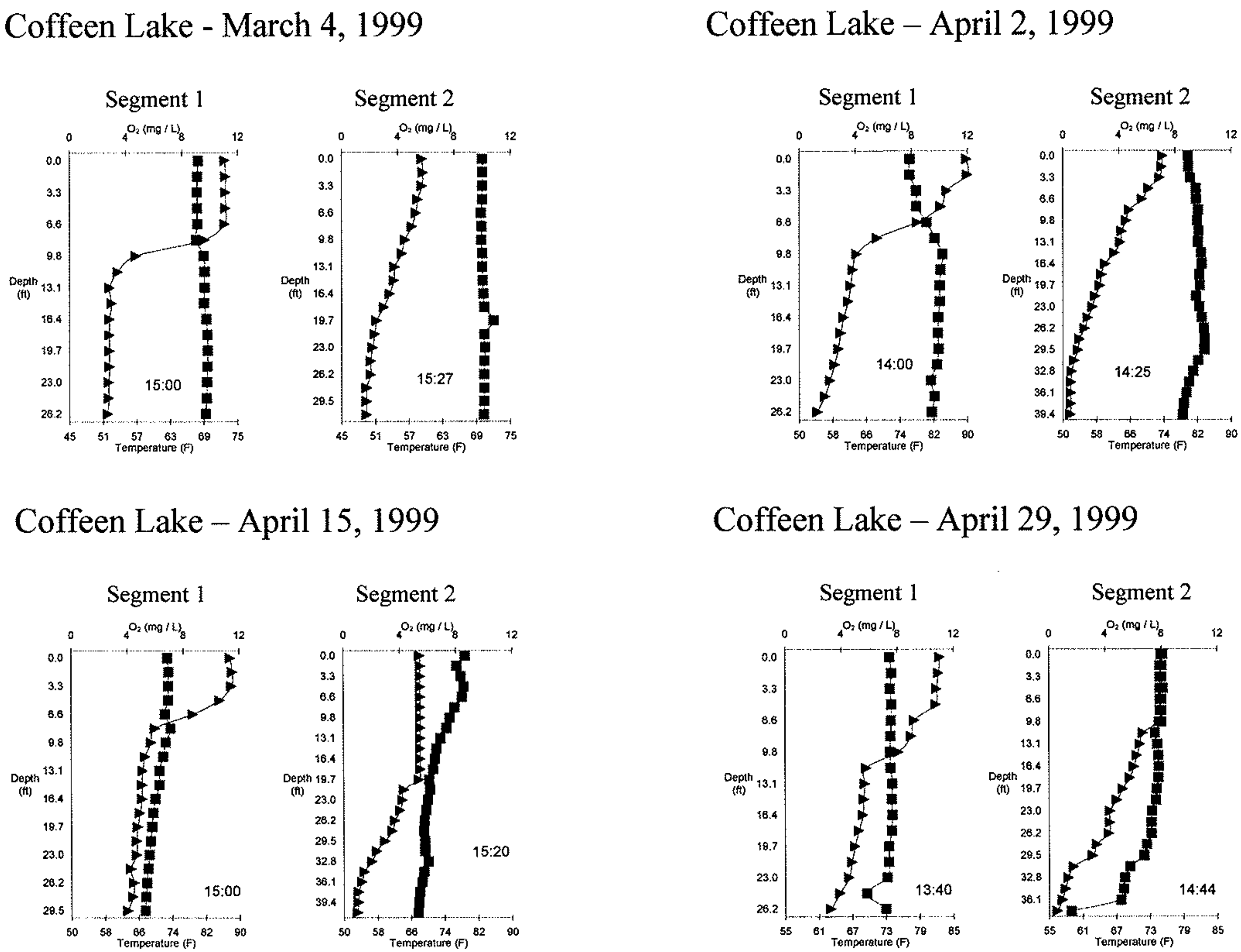
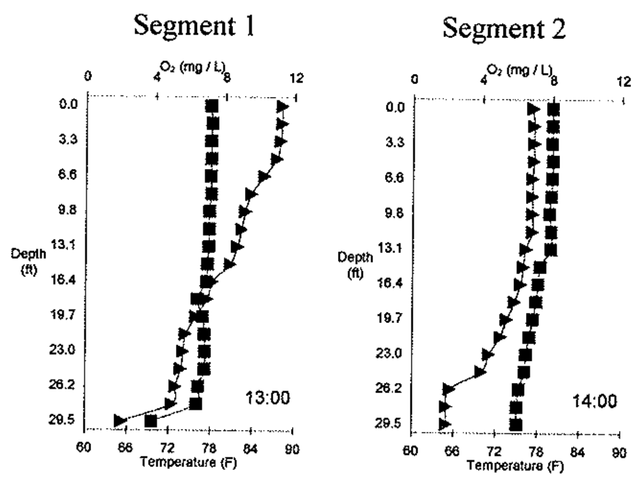
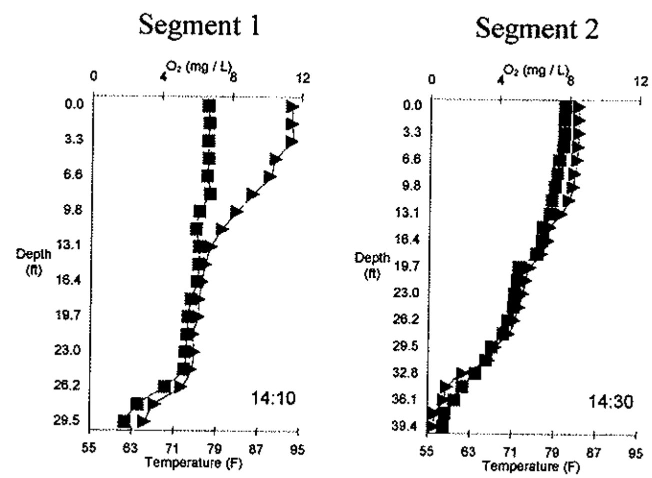


Figure 15A.111. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – May 6, 1999



Coffeen Lake – May 20, 1999



Coffeen Lake – June 2, 1999

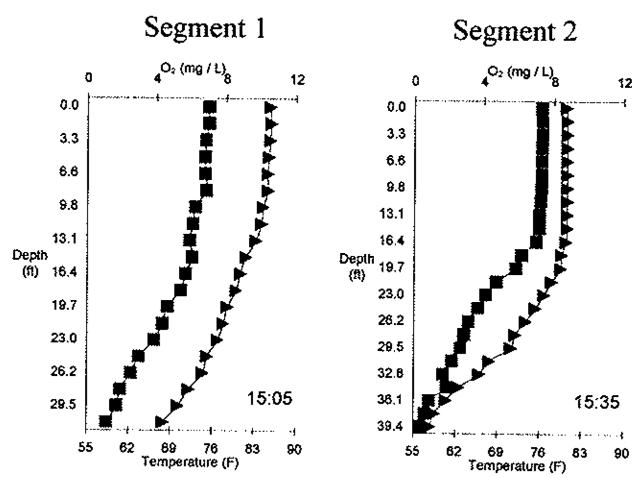


Figure 15A.112. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 2, 1999

Segment 1

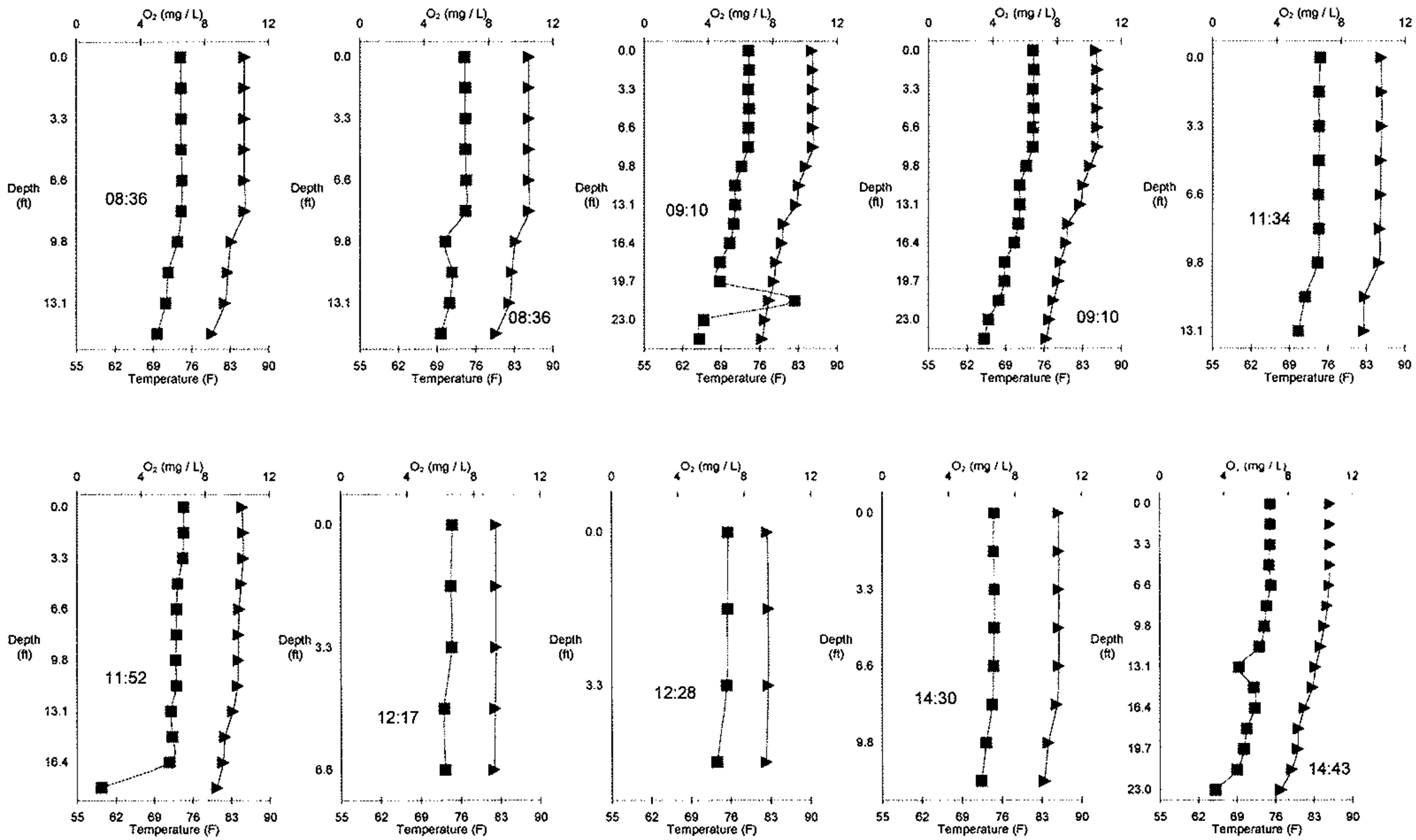
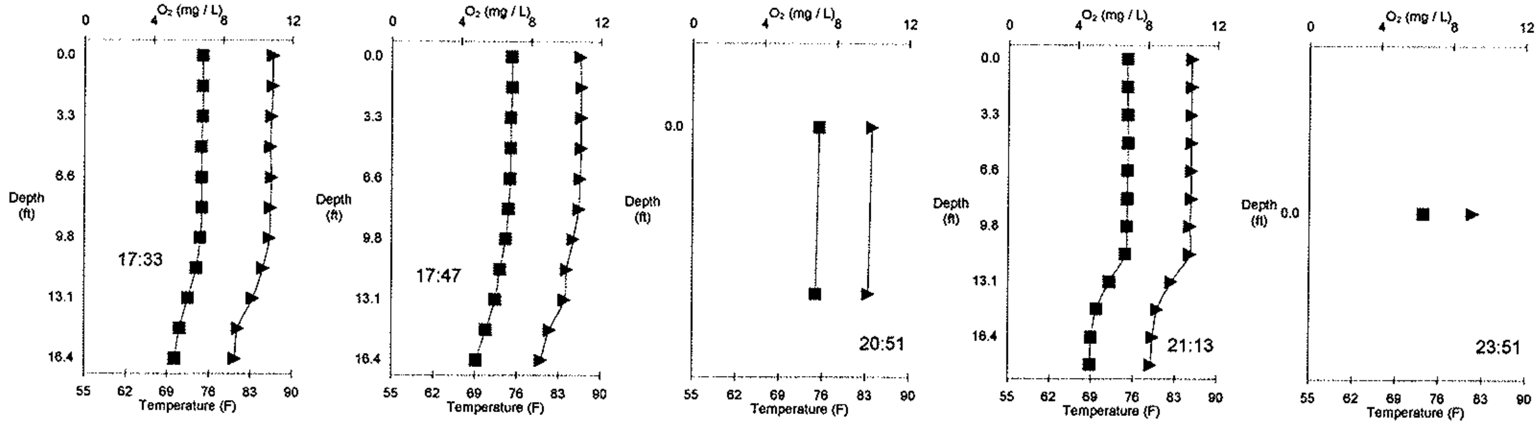


Figure 15A.113. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 2, 1999

Segment 1



Coffeen Lake – June 3, 1999

Segment 1

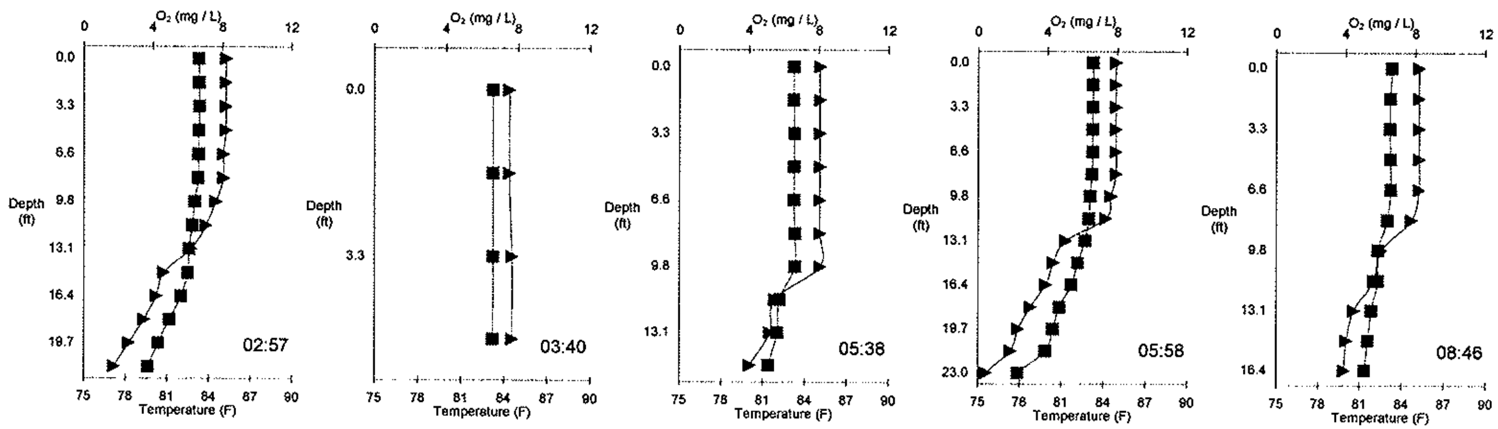
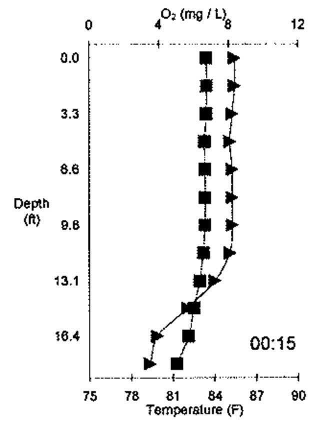


Figure 15A.114. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 3, 1999

Segment 1



Coffeen Lake – June 8, 1999

Segment 1

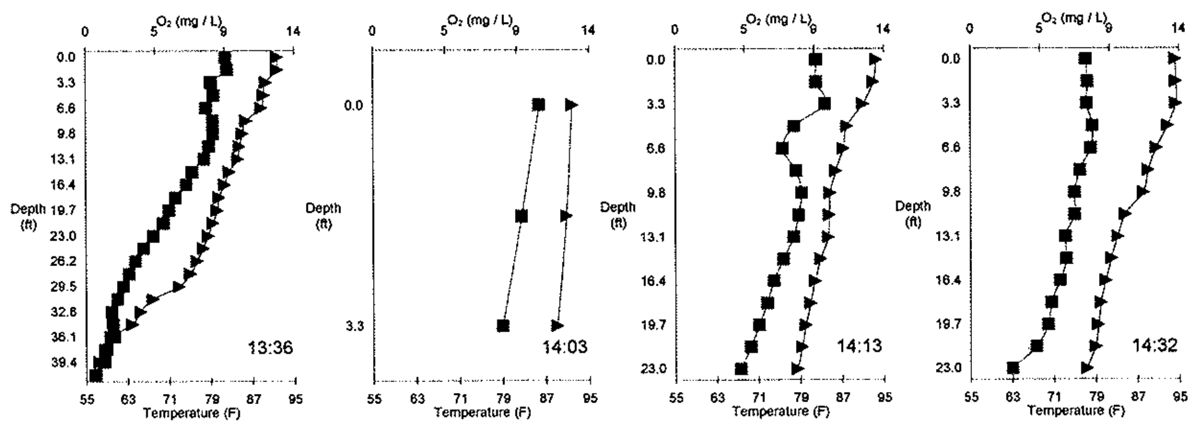


Figure 15A.115. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 15, 1999

Segment 1

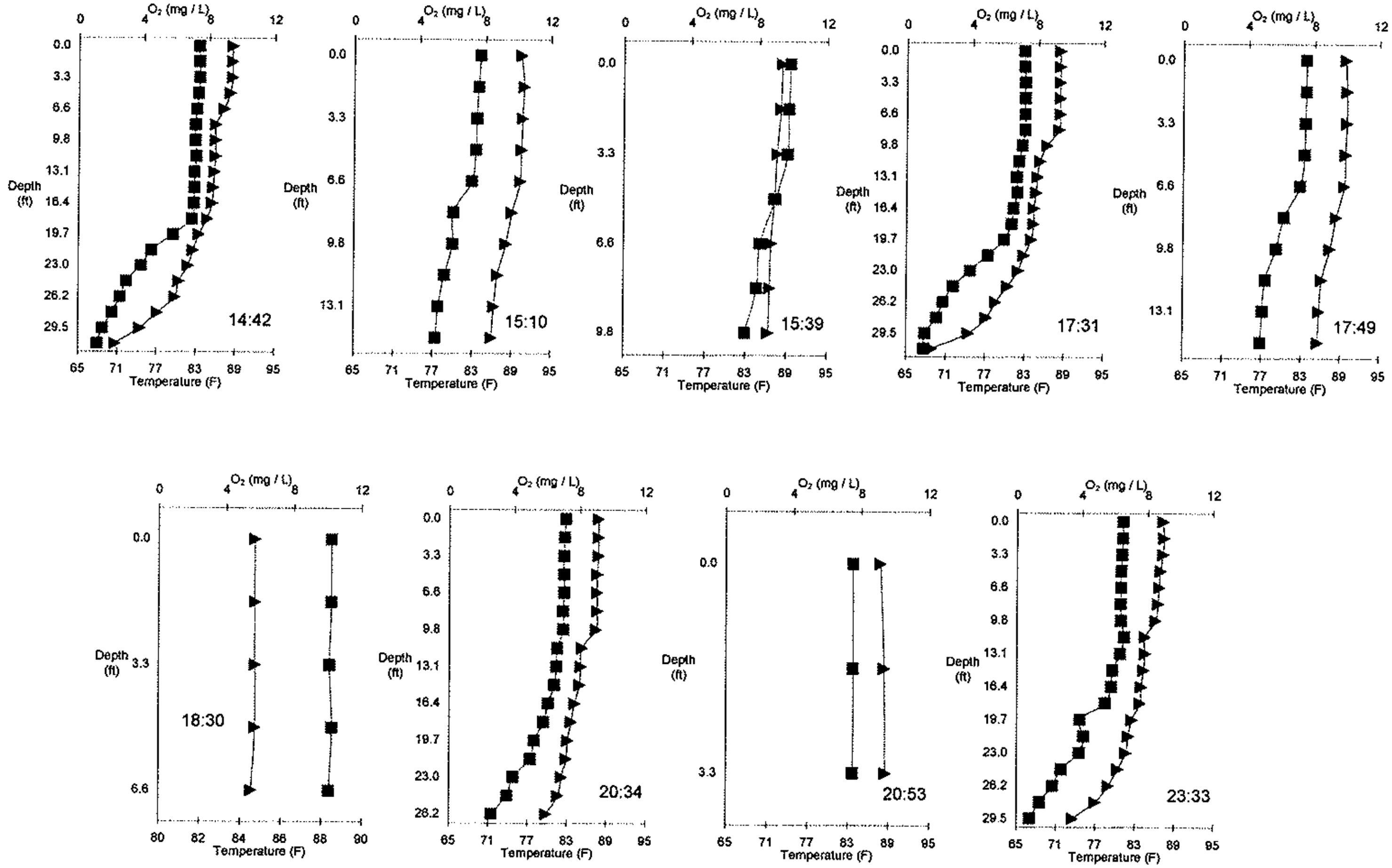


Figure 15A.116. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 16, 1999

Segment 1

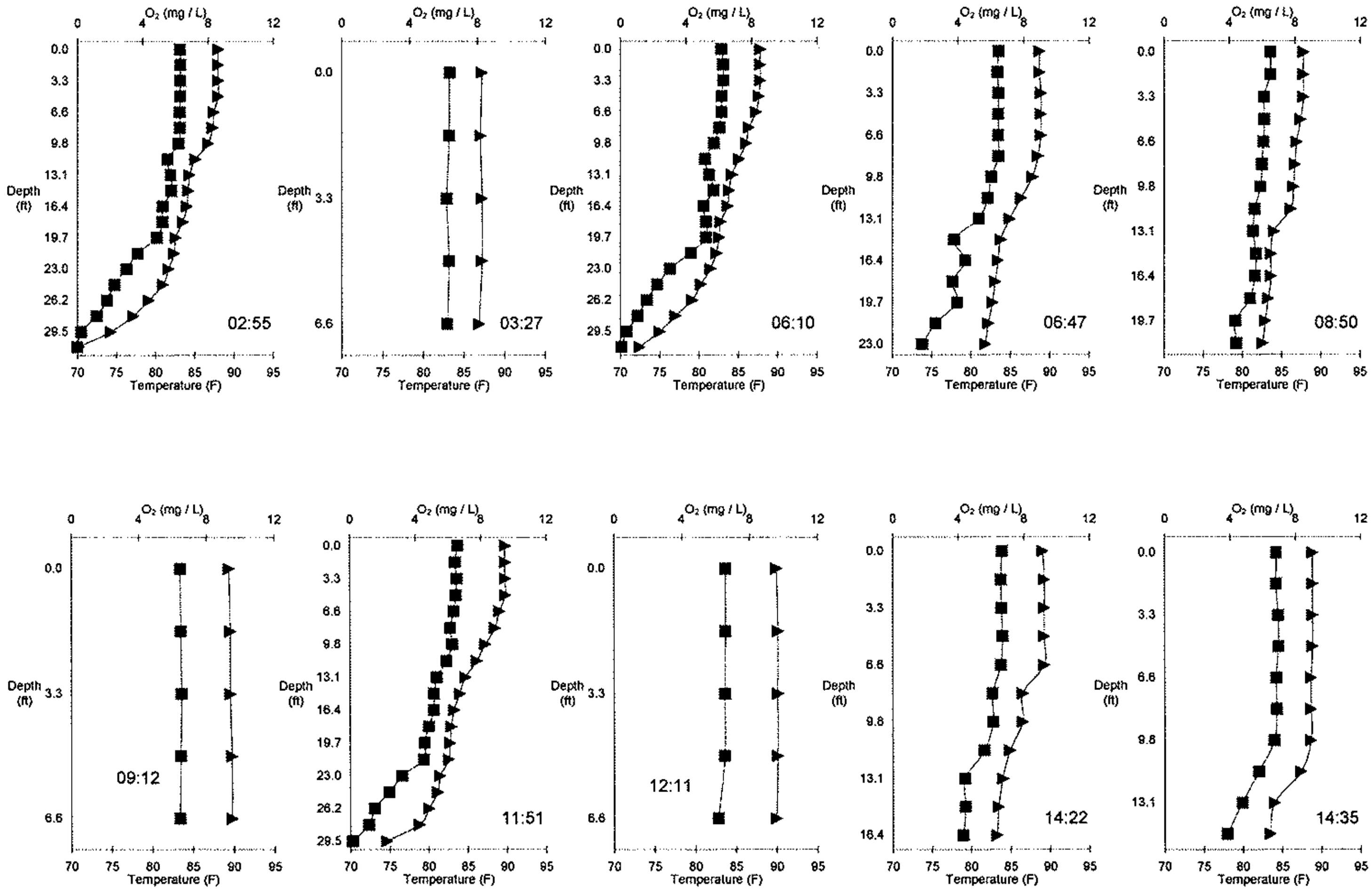


Figure 15A.117. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 16, 1999

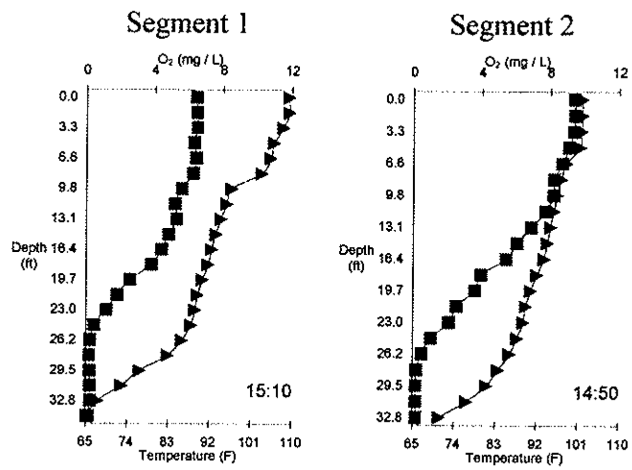
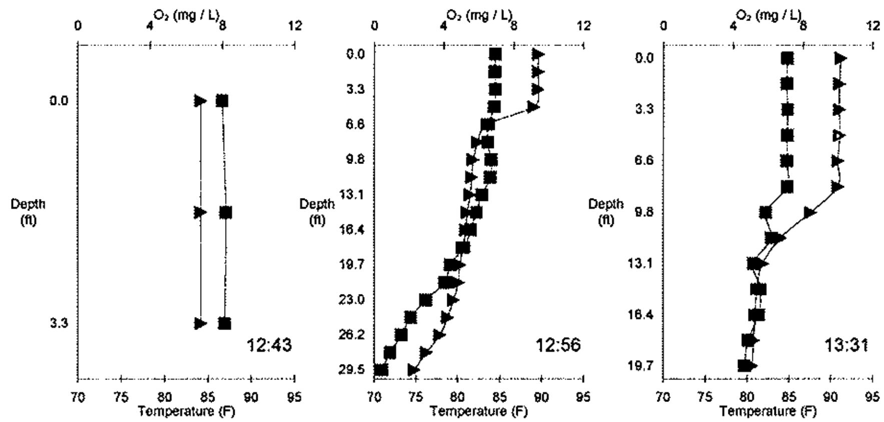


Figure 15A.118. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – June 23, 1999

Segment 1



Coffeen Lake – June 30, 1999

Segment 1

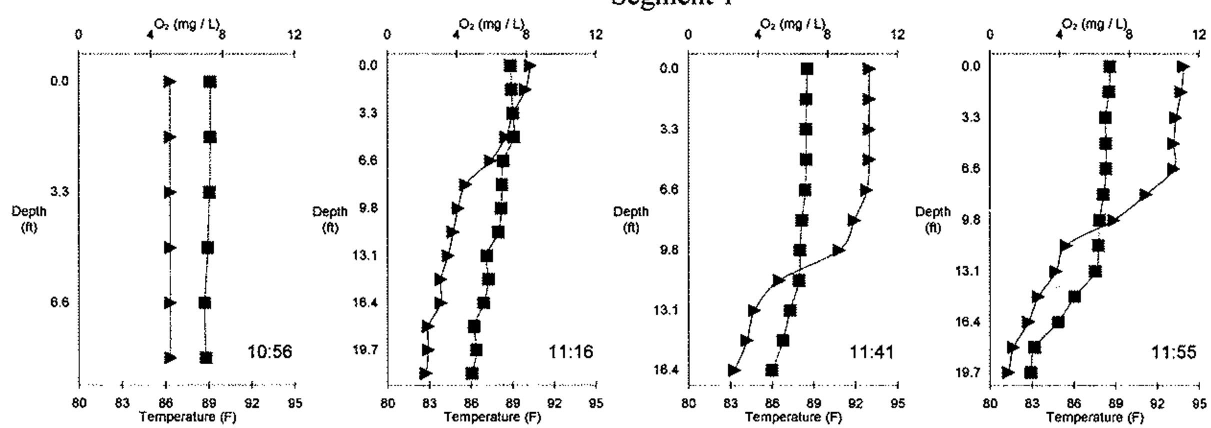


Figure 15A.119. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 8, 1999

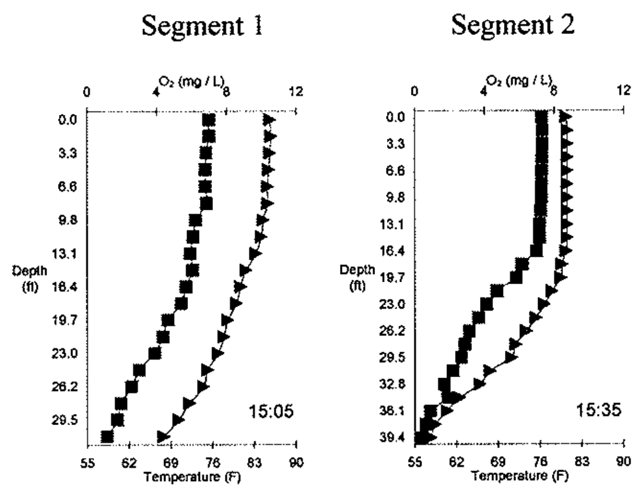
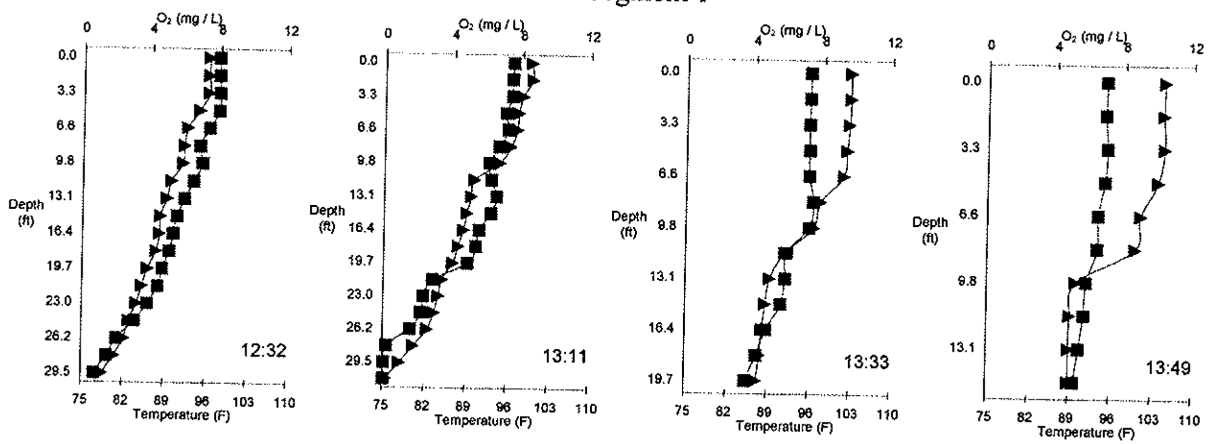


Figure 15A.120. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 8, 1999

Segment 1



Coffeen Lake – July 21, 1999

Segment 1

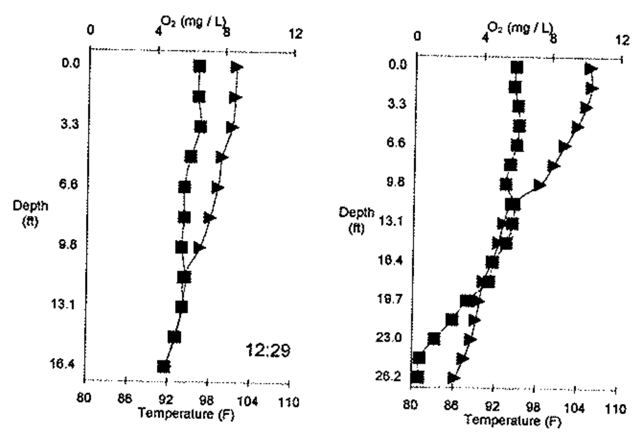


Figure 15A.121. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 21, 1999

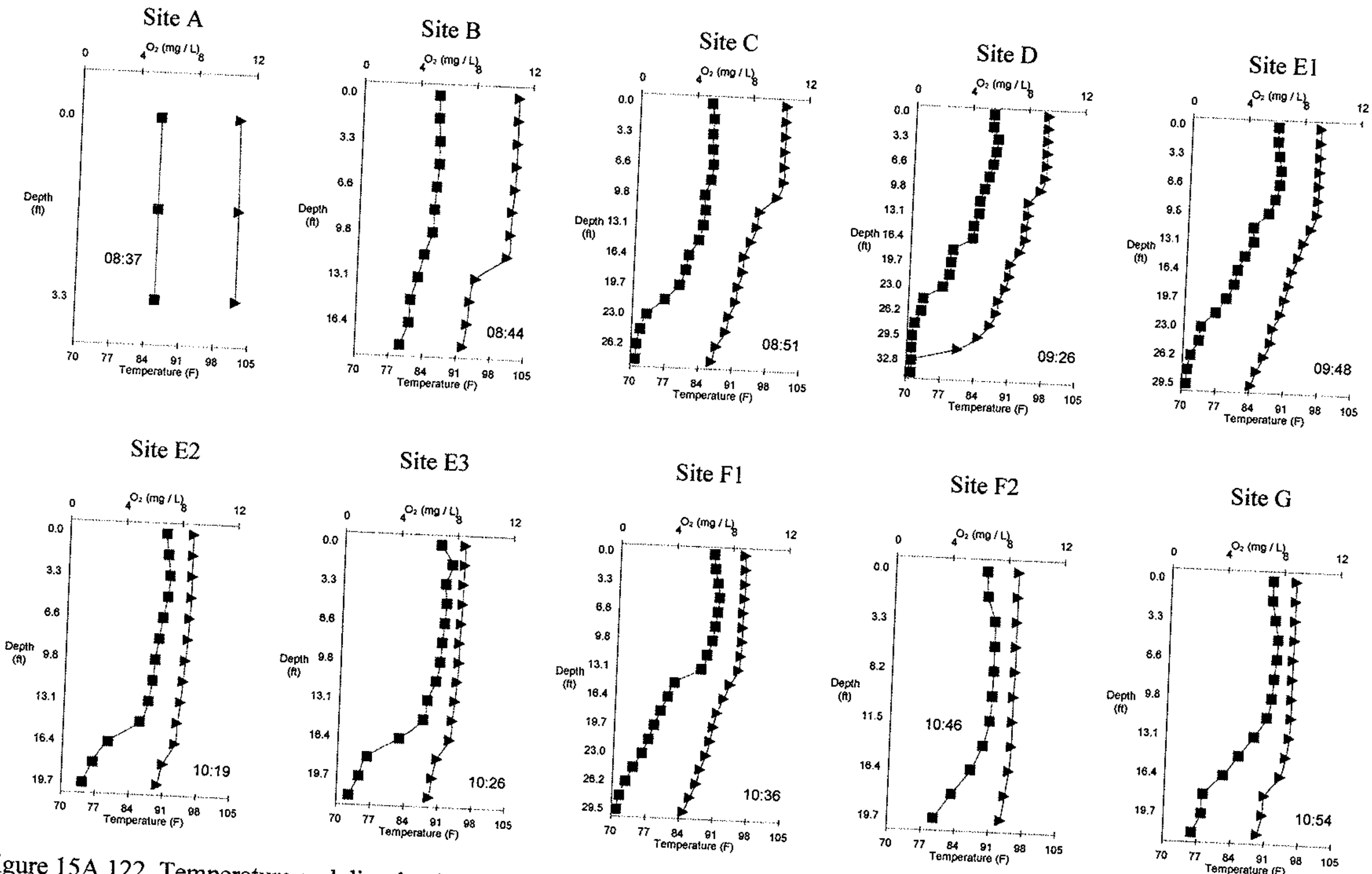


Figure 15A.122. Temperature and dissolved oxygen at Coffeen Lake, IL, as measured by Ameren CIPS. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 23, 1999

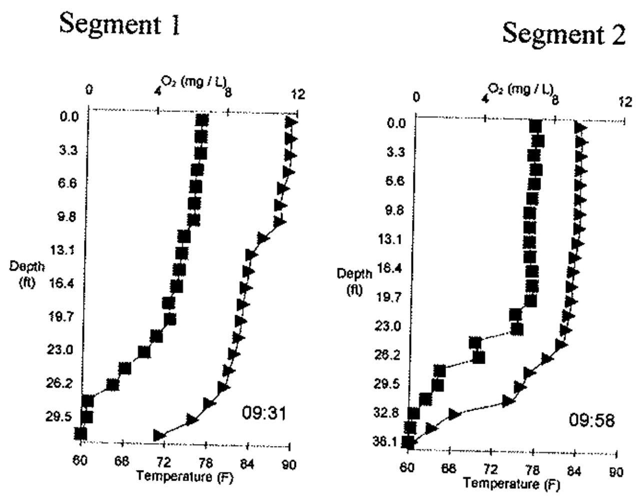


Figure 15A.123. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 28, 1999

Segment 1

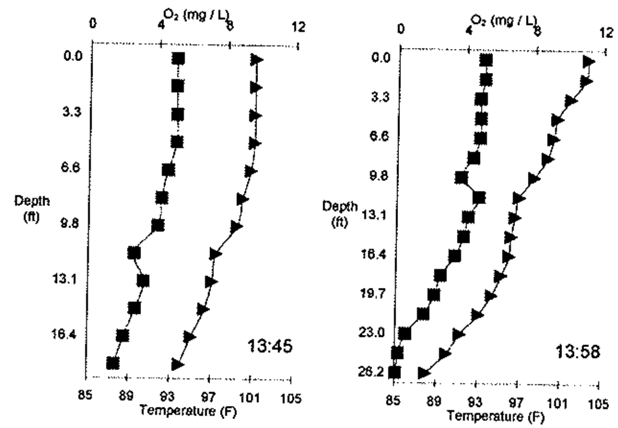
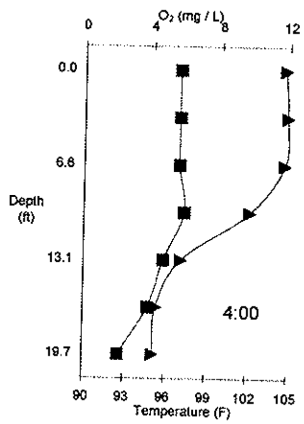


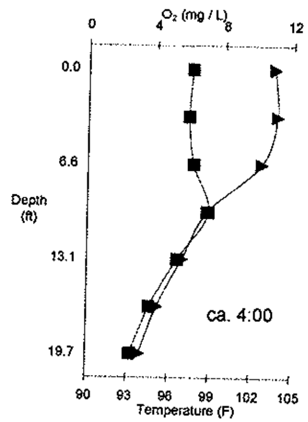
Figure 15A.124. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – July 31, 1999

Segment 1 (Discharge) Buoy

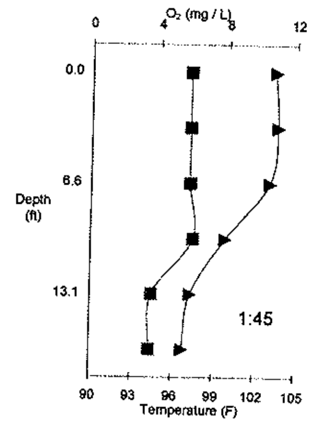


Dam Buoy



Coffeen Lake – August 1, 1999

Segment 1 (Discharge) Buoy



Dam Buoy

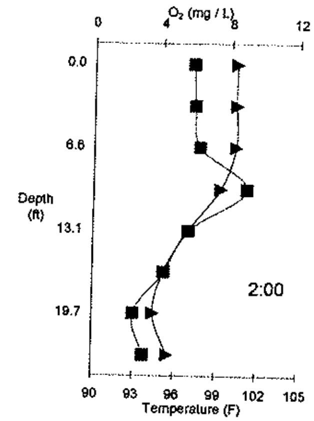


Figure 15A.125. Temperature and dissolved oxygen obtained during fish health sampling, Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 6, 1999

Segment 1 | Segment 2

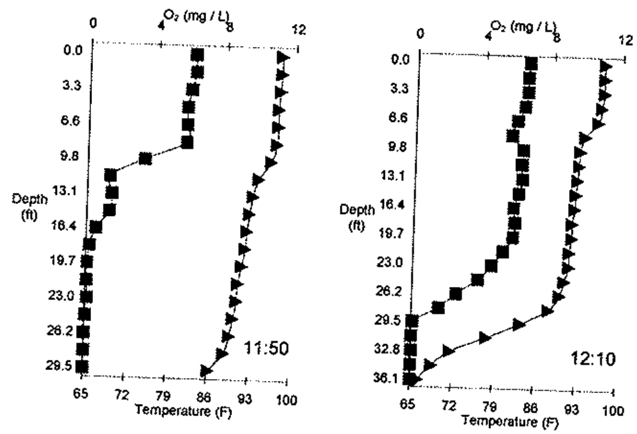


Figure 15A.126. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 11, 1999

Segment 1

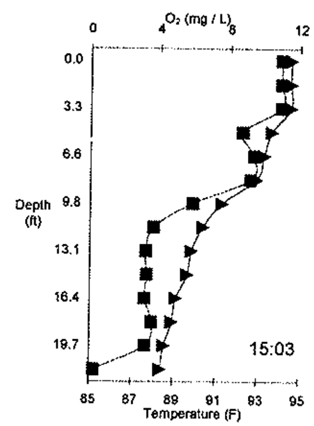


Figure 15A.127. Temperature and dissolved oxygen measured during fish tracking in Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – August 19, 1999

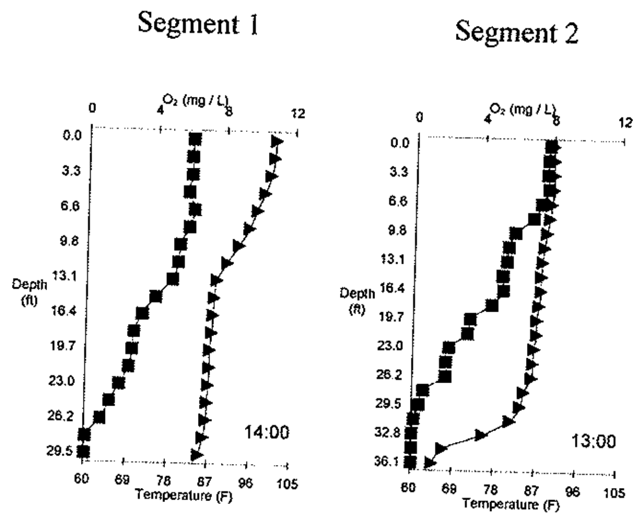


Figure 15A.128. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

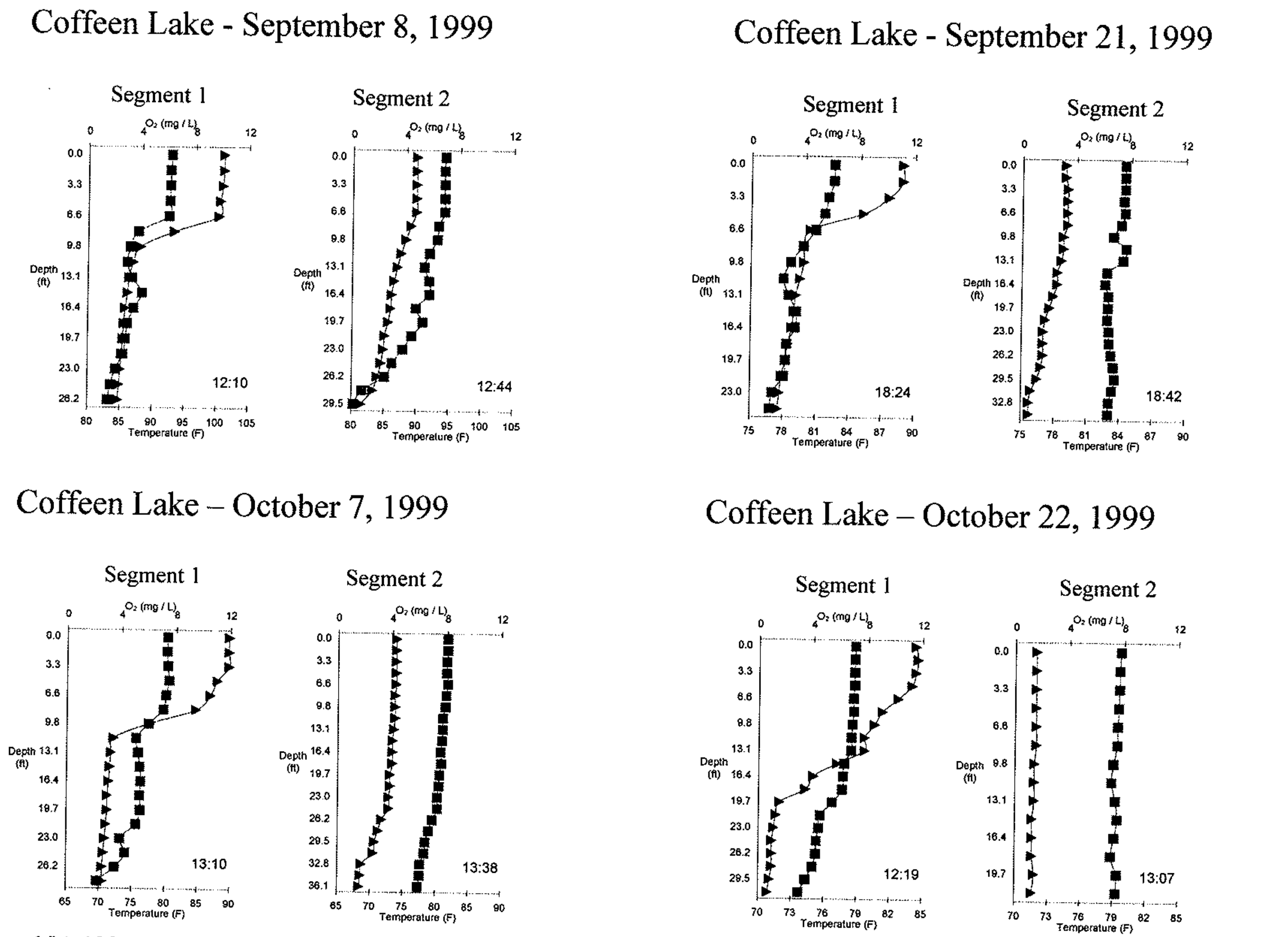


Figure 15A.129. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

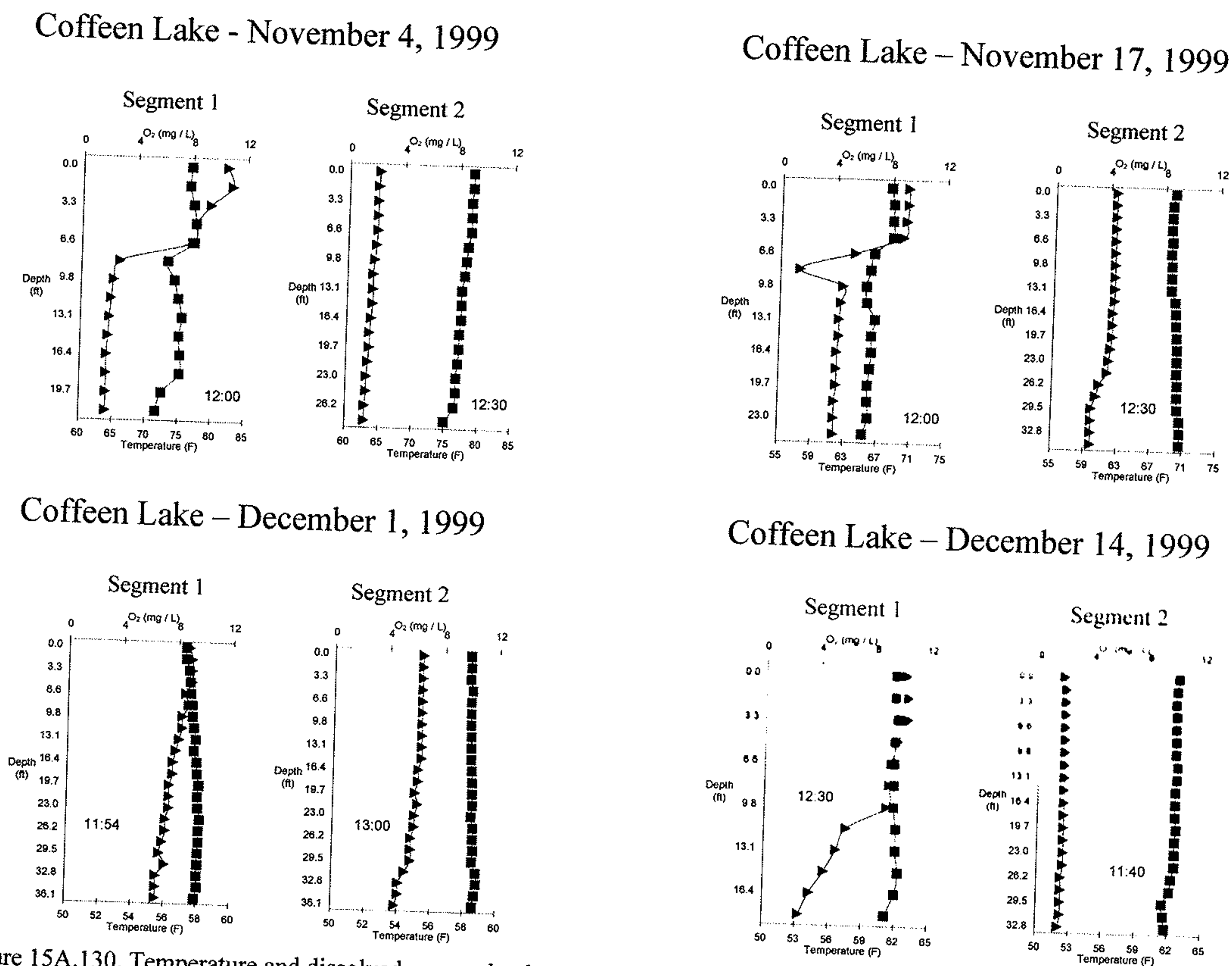


Figure 15A.130. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Coffeen Lake – December 29, 1999

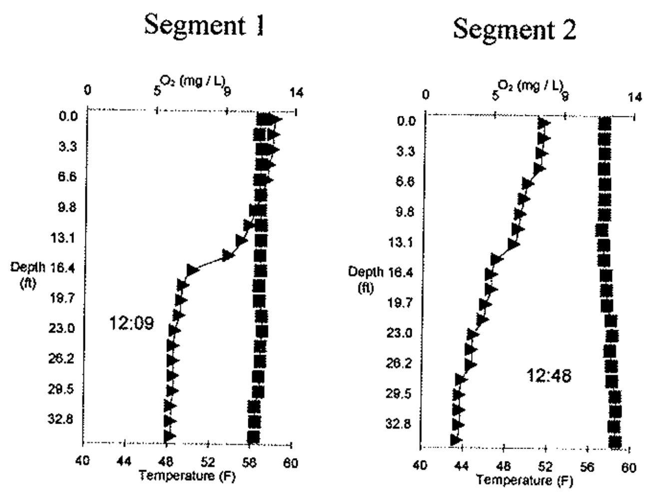


Figure 15A.131. Temperature and dissolved oxygen by date within 2 segments of Coffeen Lake, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

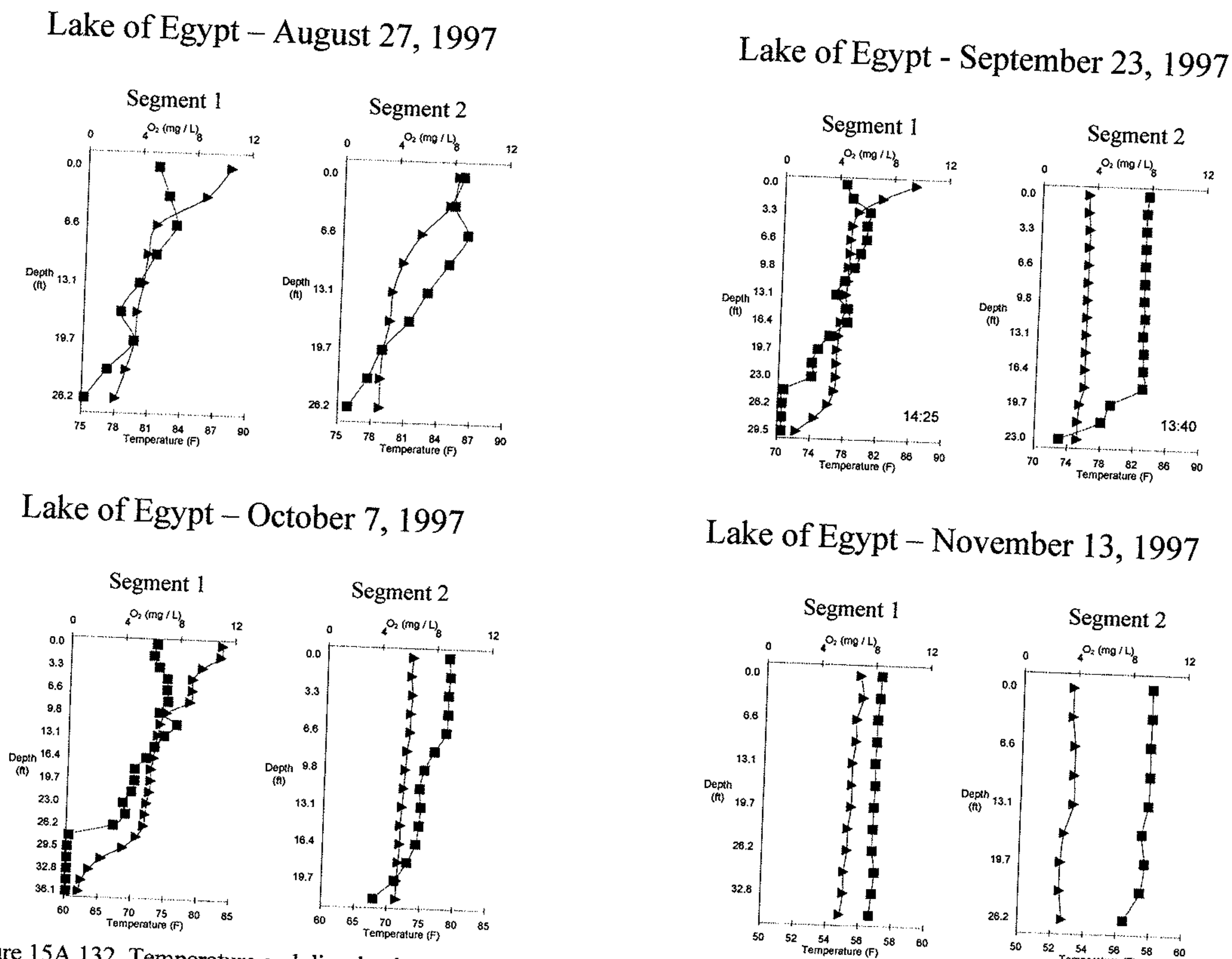
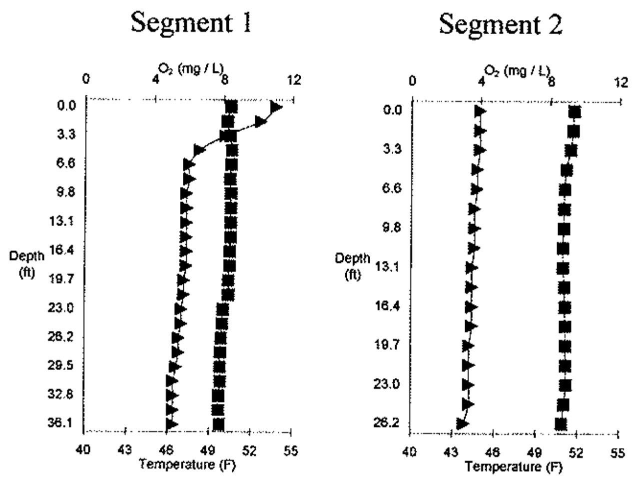
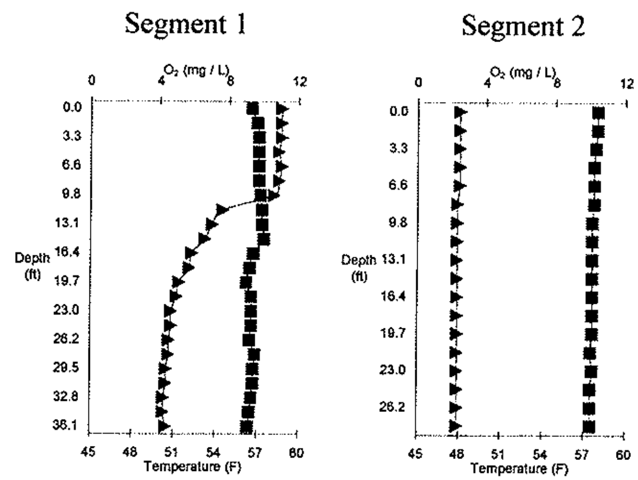


Figure 15A.132. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

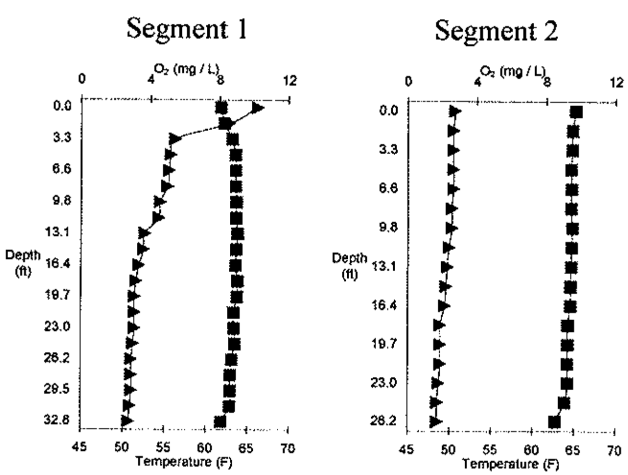
Lake of Egypt – November 17, 1997



Lake of Egypt – November 20, 1997



Lake of Egypt – December 3, 1997



Lake of Egypt – January 5, 1998

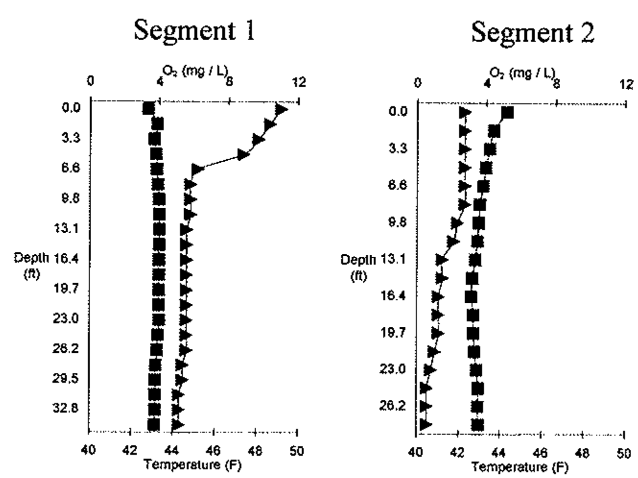
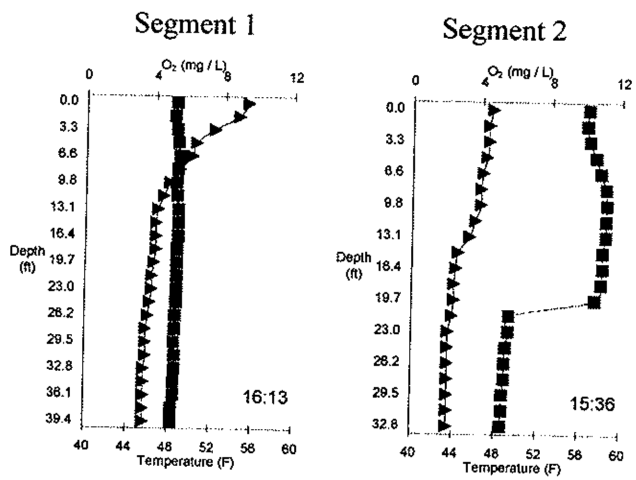
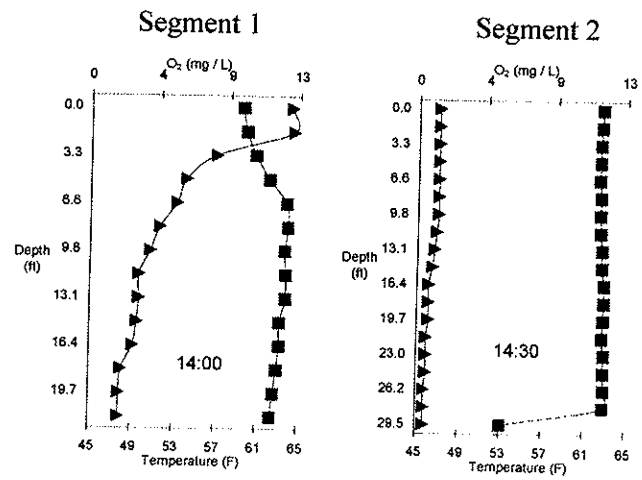


Figure 15A.133. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

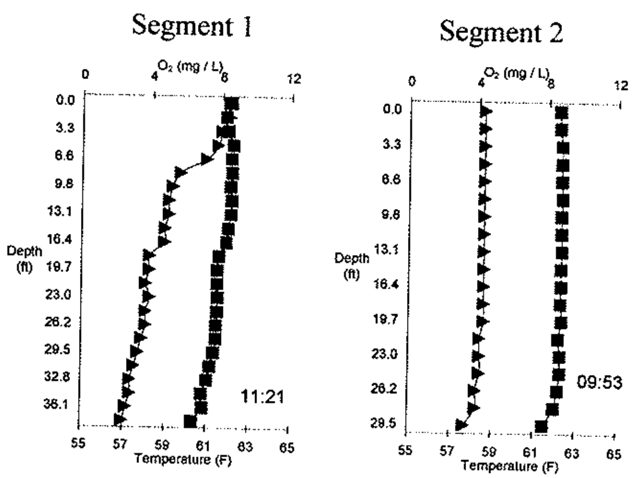
Lake of Egypt – February 19, 1998



Lake of Egypt – March 16, 1998



Lake of Egypt – April 10, 1998



Lake of Egypt – April 14, 1998

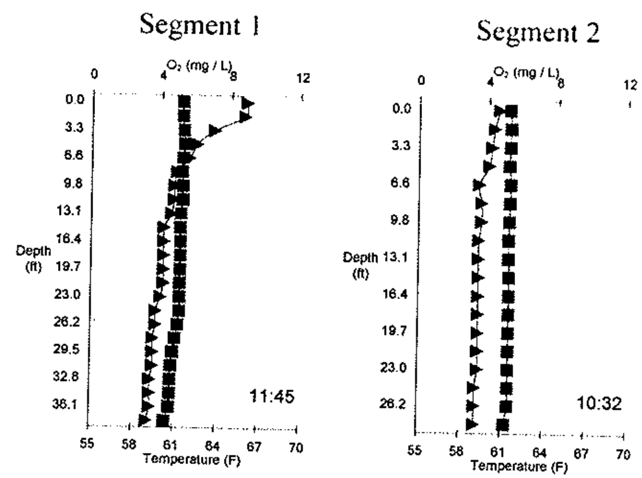
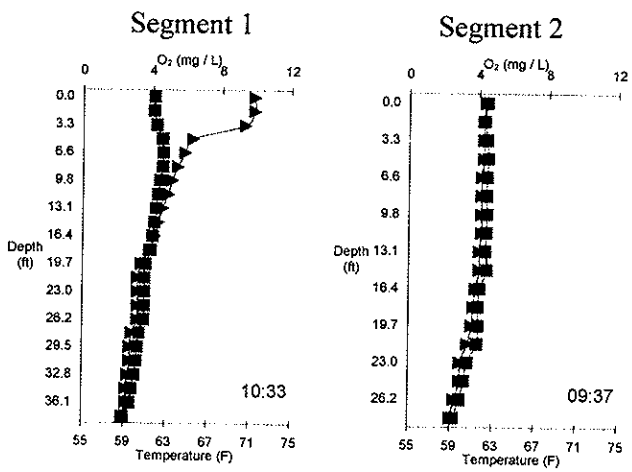
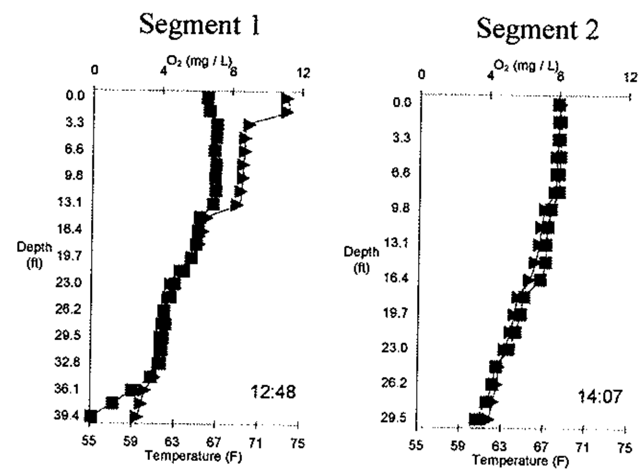


Figure 15A.134. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – April 21, 1998



Lake of Egypt – May 9, 1998



Lake of Egypt – May 14, 1998

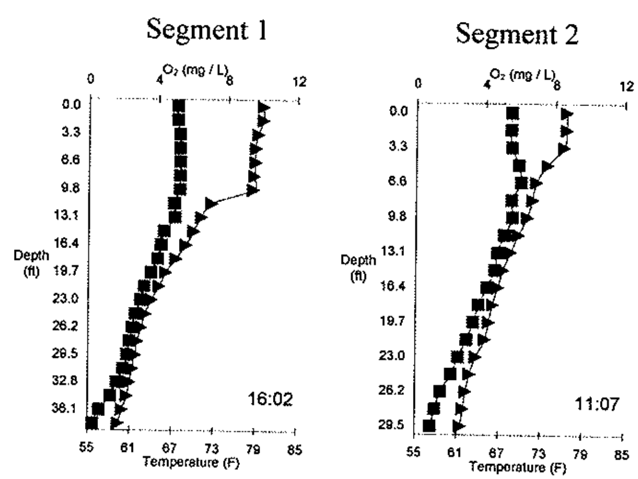


Figure 15A.135. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 3, 1998

Segment 1

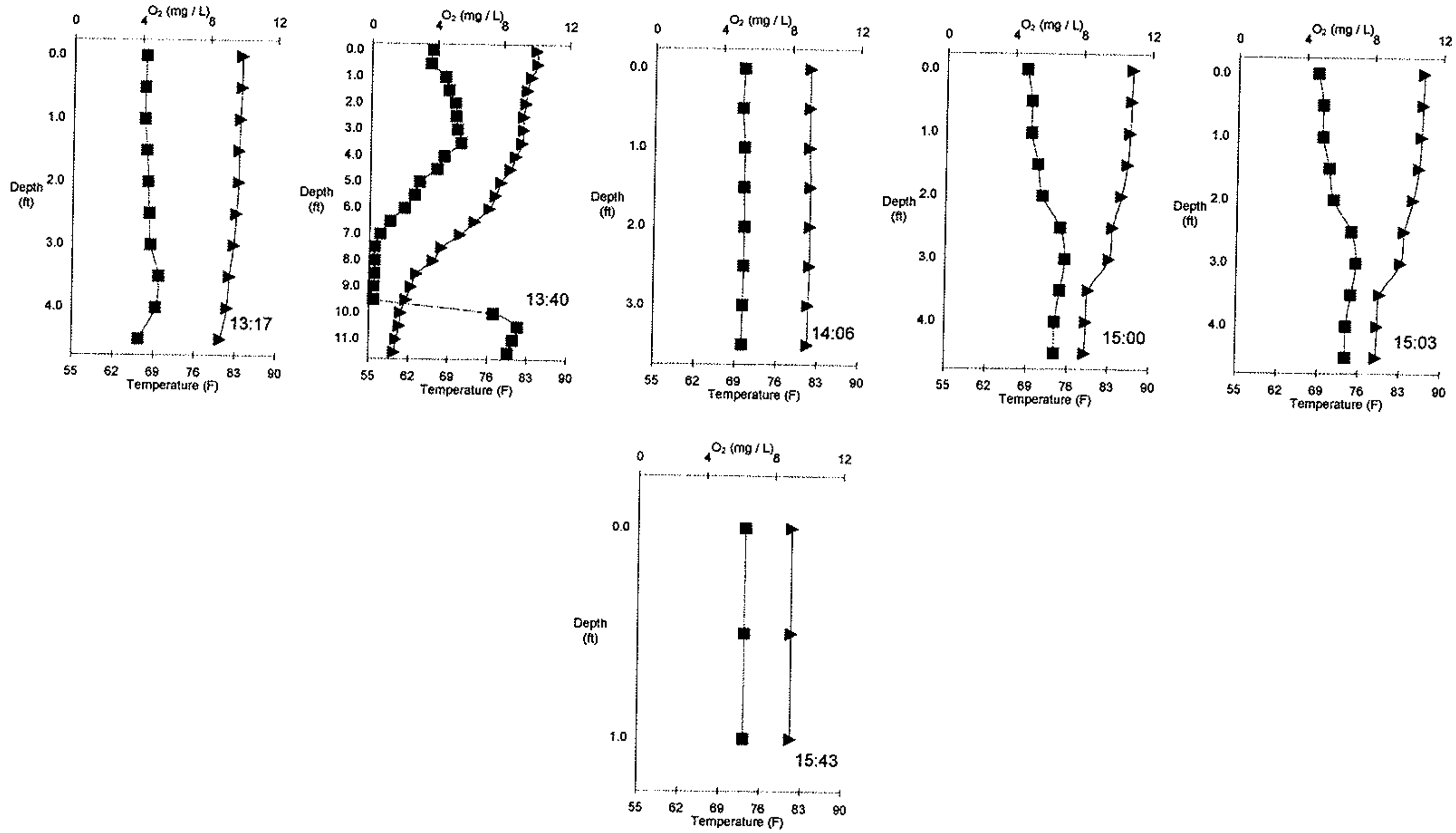


Figure 15A.136. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 4, 1998

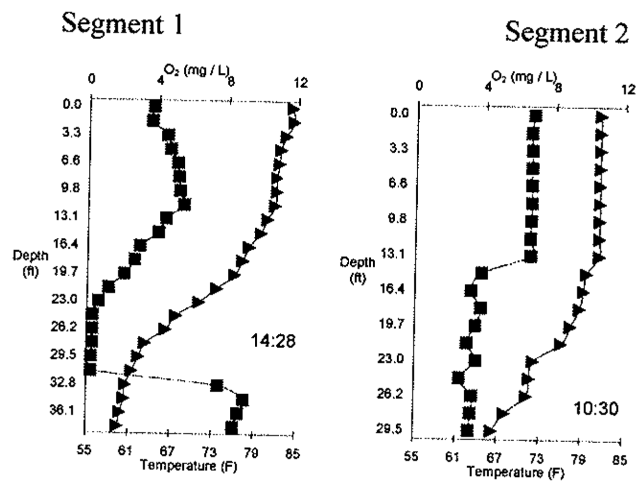


Figure 15A.137. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 7, 1998

Segment 1

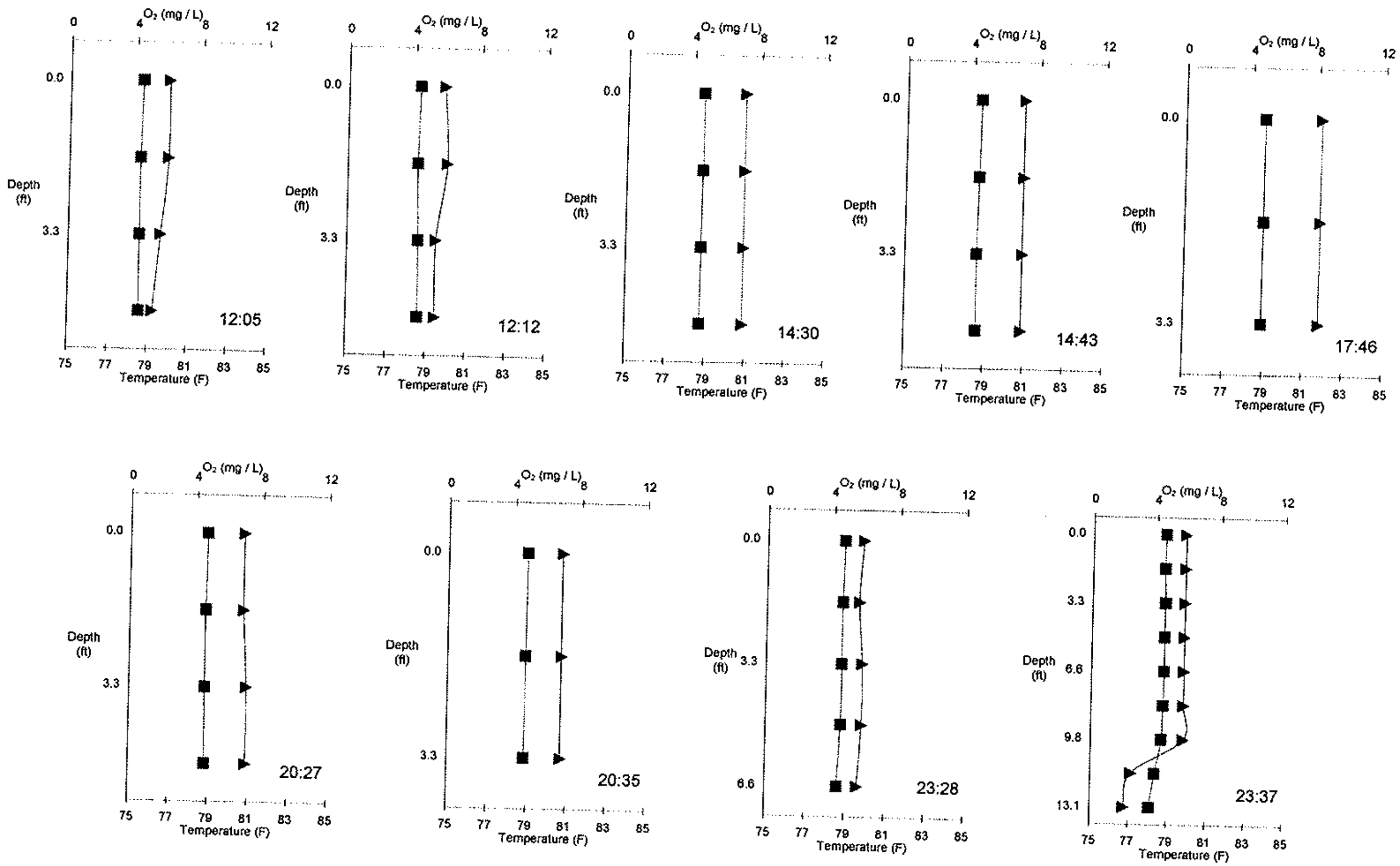


Figure 15A.138. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 12, 1998

Segment 1

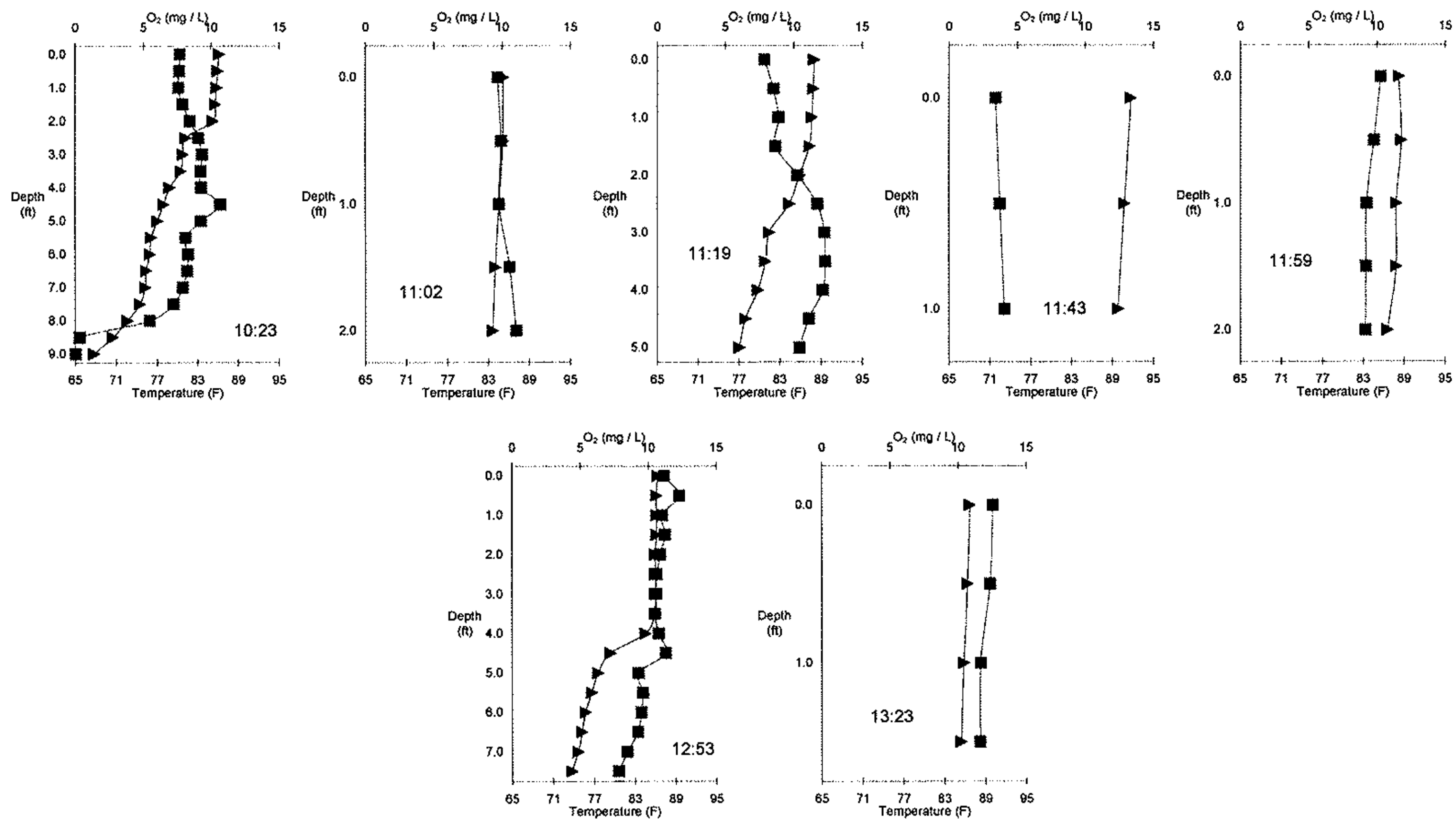


Figure 15A.140. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 8, 1998

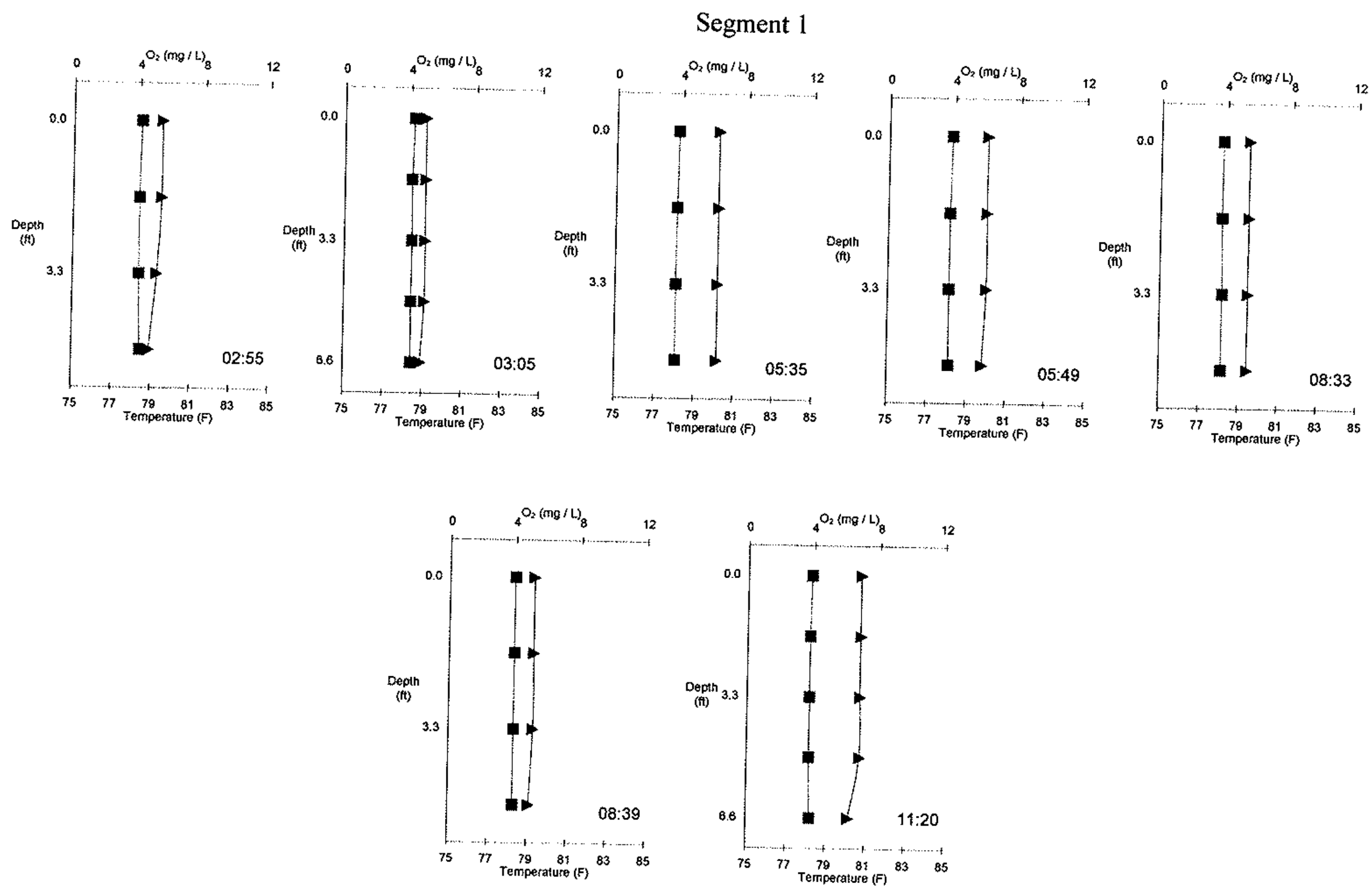
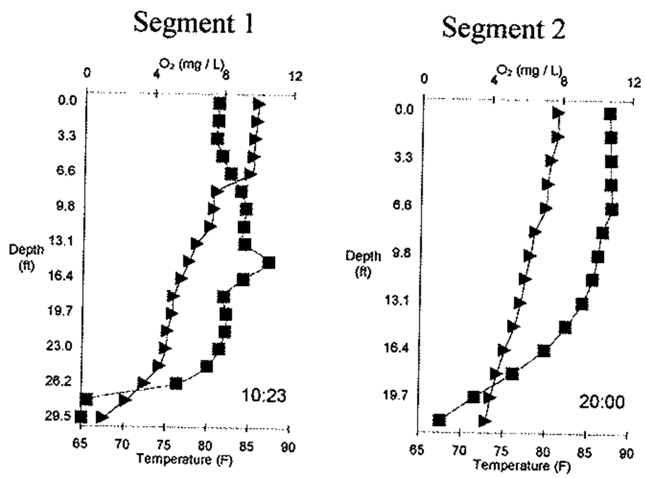


Figure 15A.139. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 12, 1998



Lake of Egypt – June 18, 1998

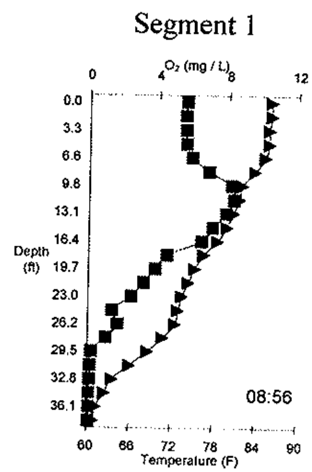
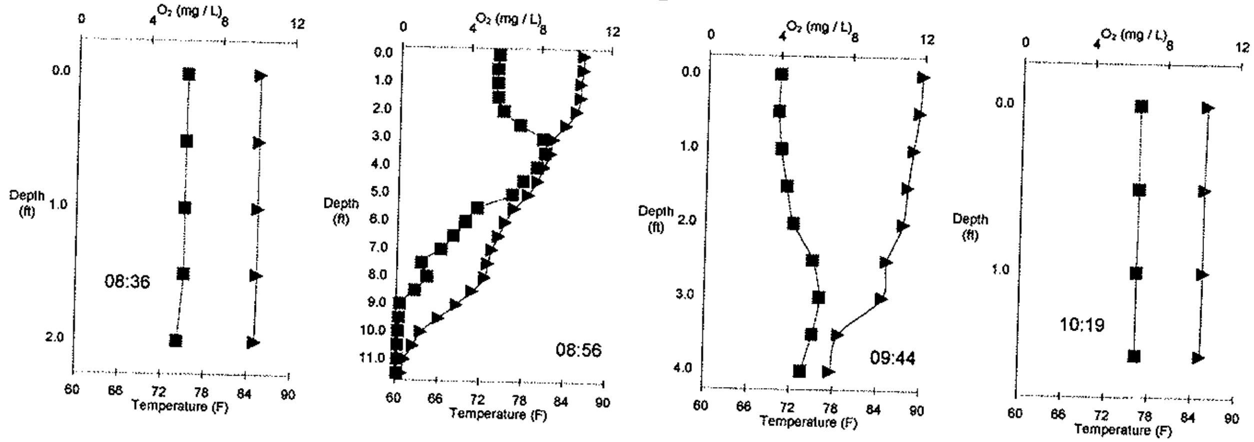


Figure 15A.141. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 18, 1998

Segment 1



Lake of Egypt – June 25, 1998

Segment 1

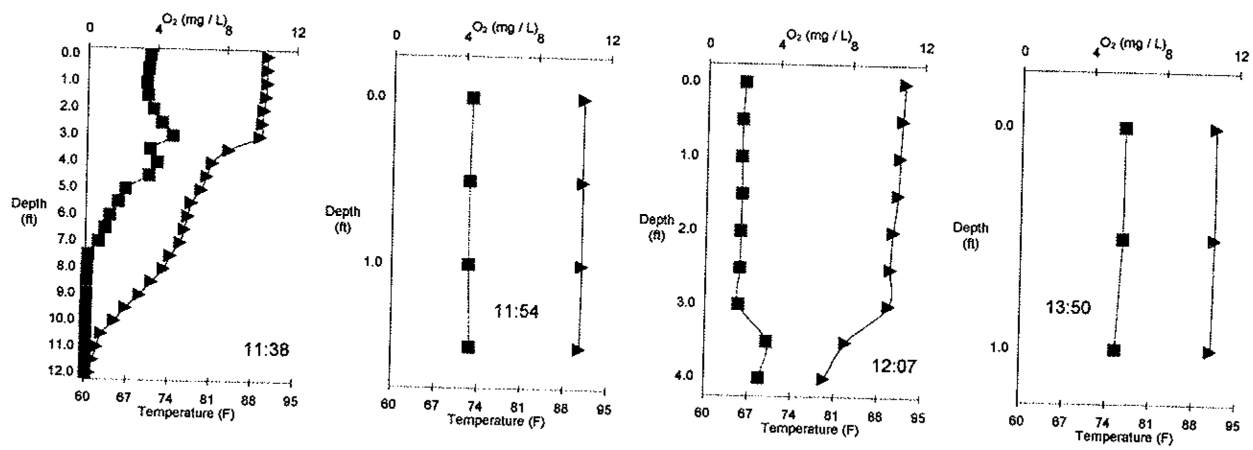
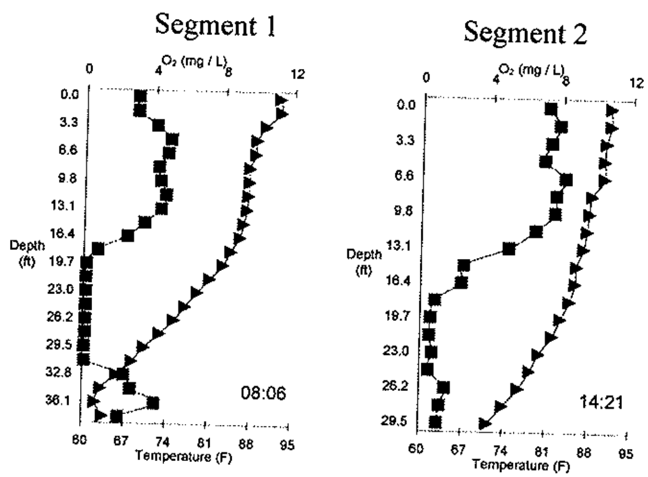


Figure 15A.142. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 25, 1998



Lake of Egypt – July 2, 1998

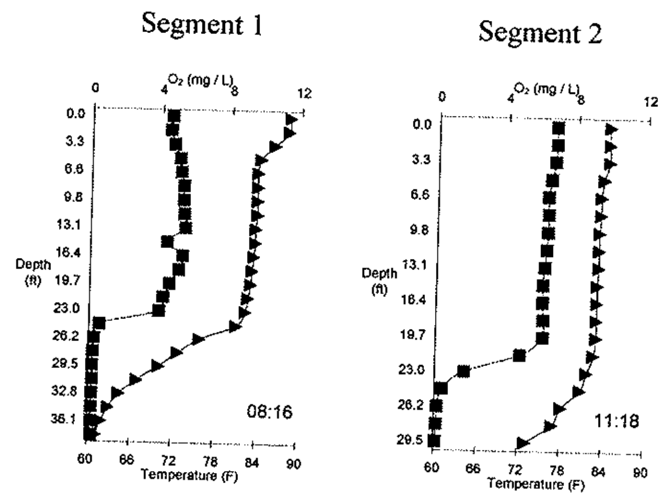


Figure 15A.143. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt –July 2, 1998

Segment 1

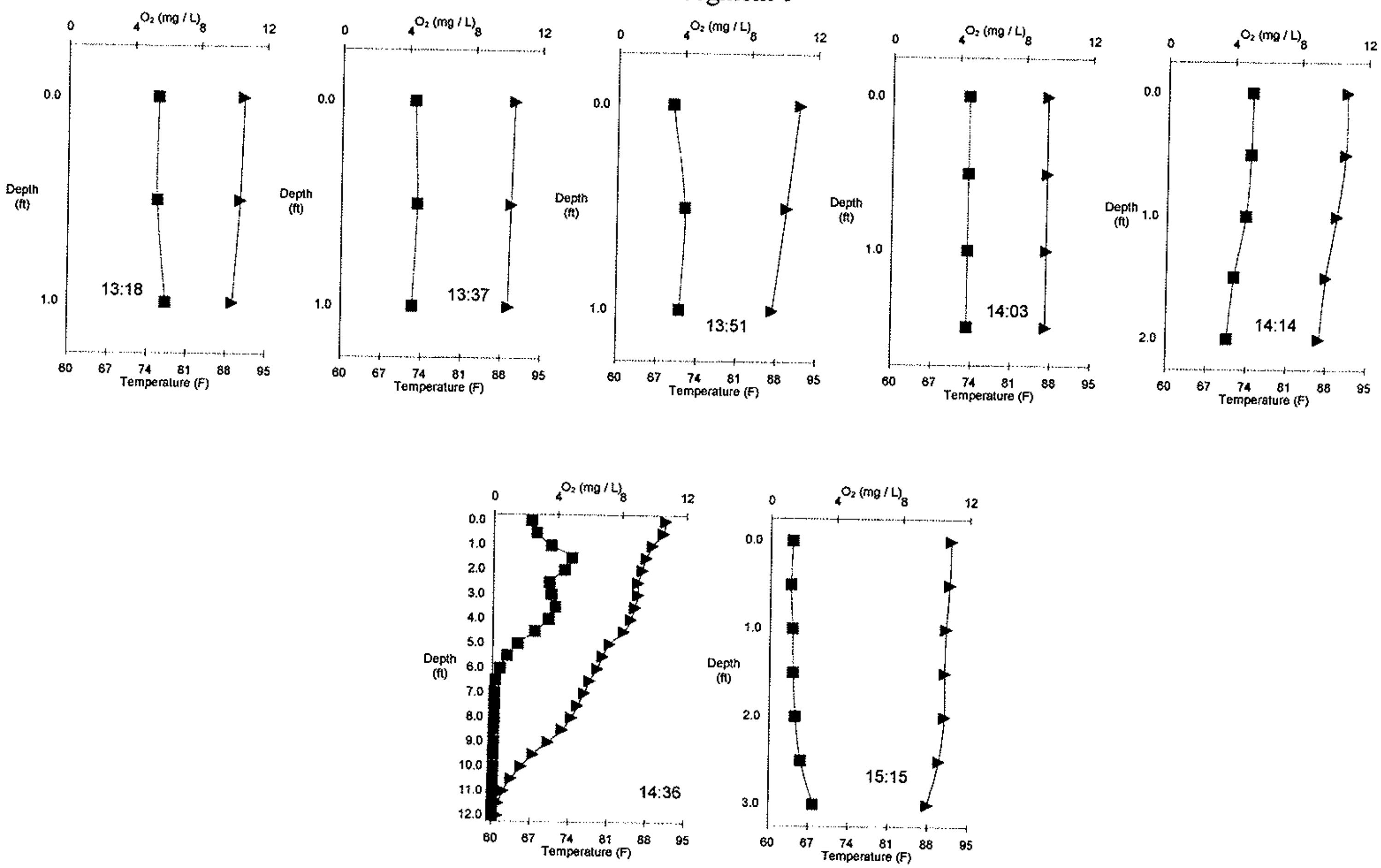


Figure 15A.144. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 9, 1998

Segment 1

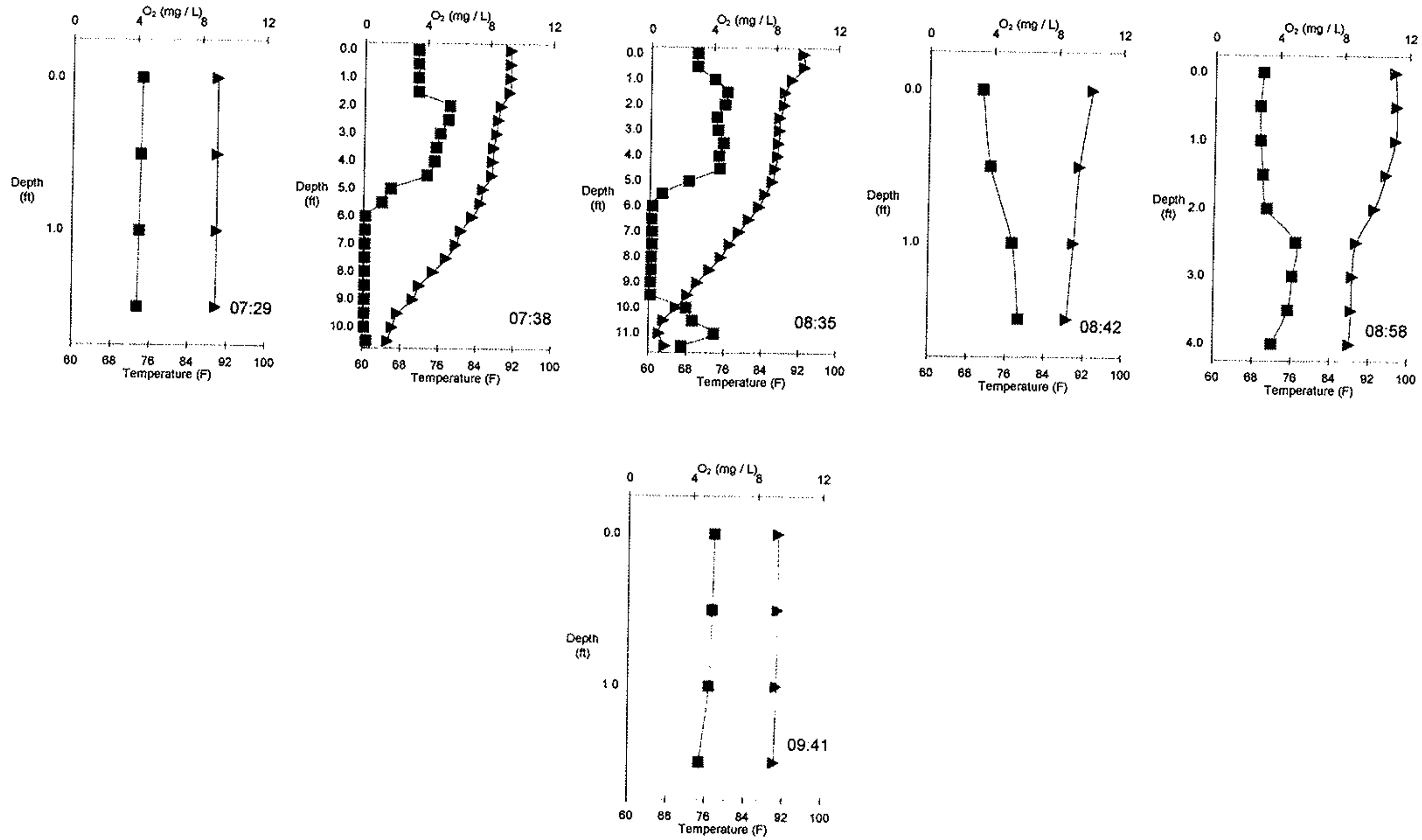


Figure 15A.145. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

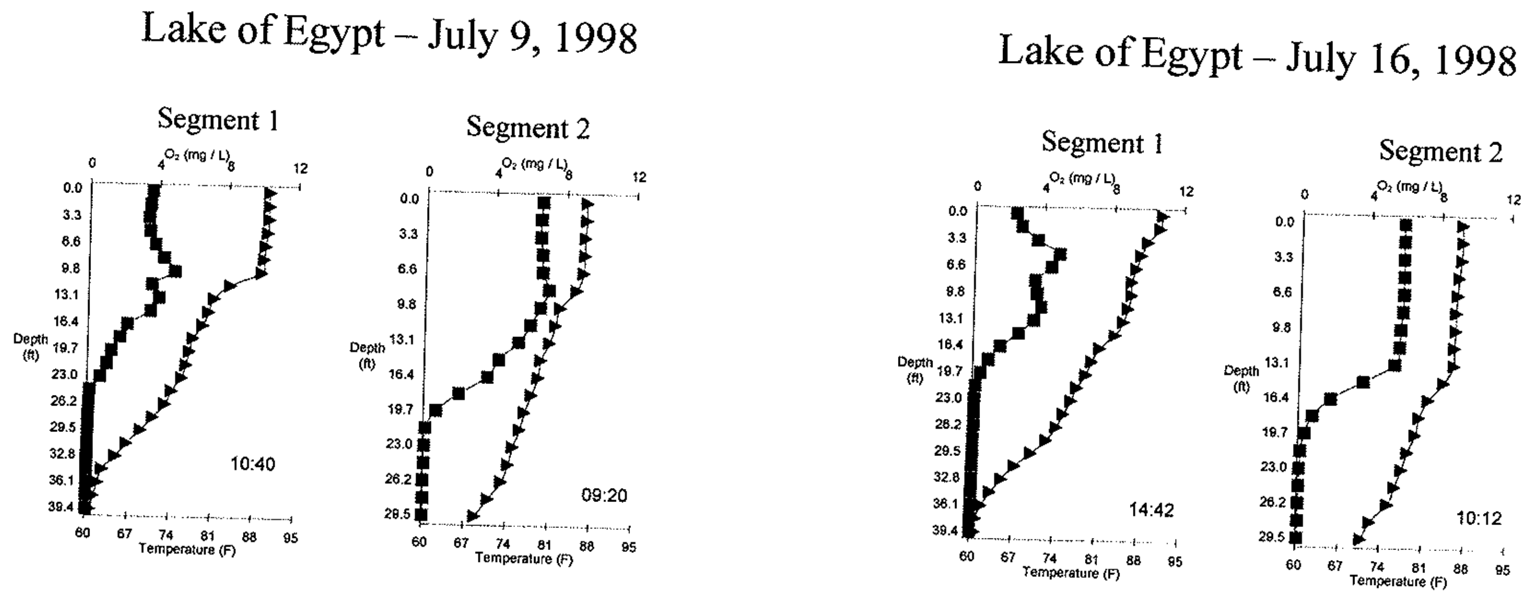


Figure 15A.146. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 16, 1998

Segment 1

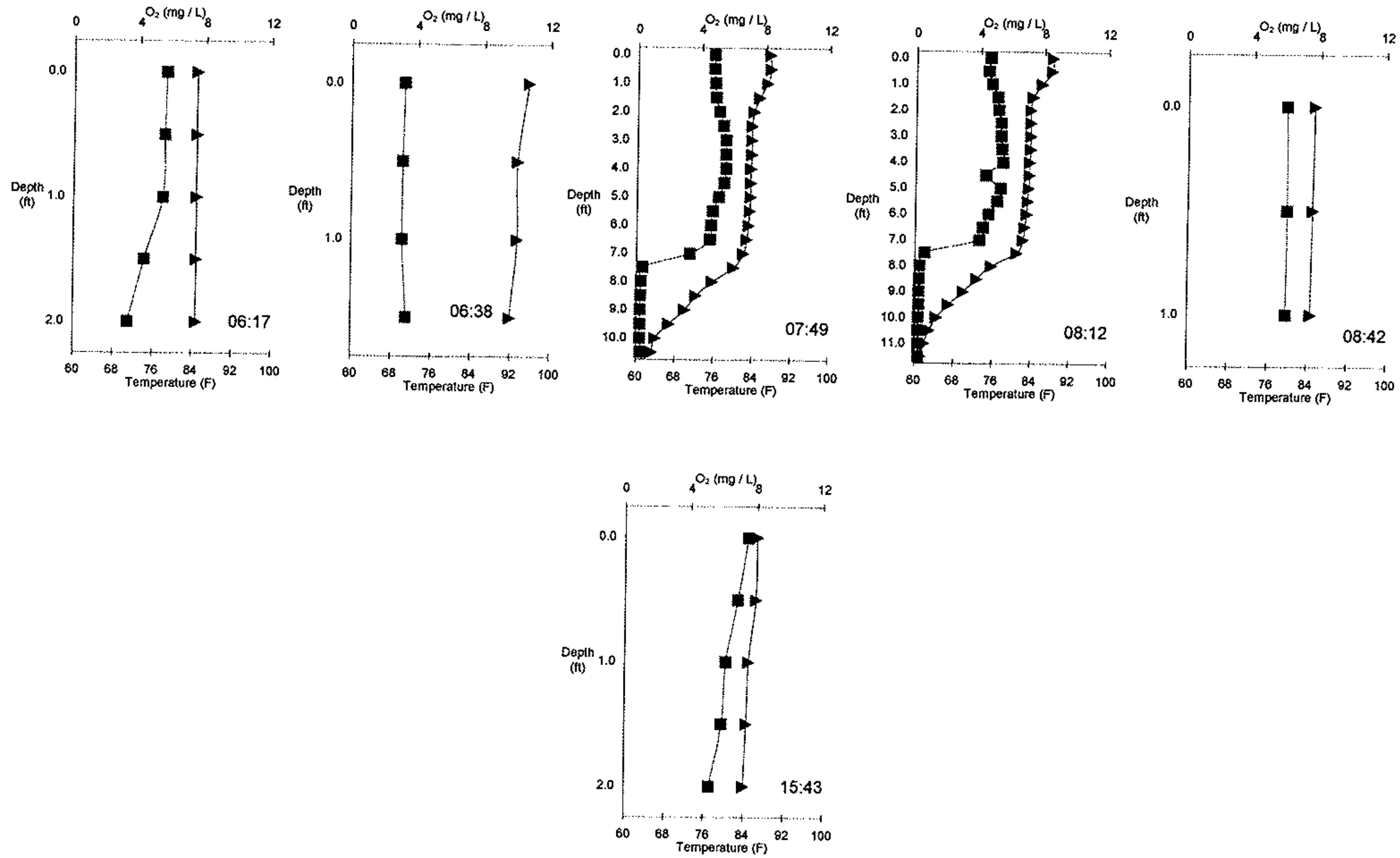
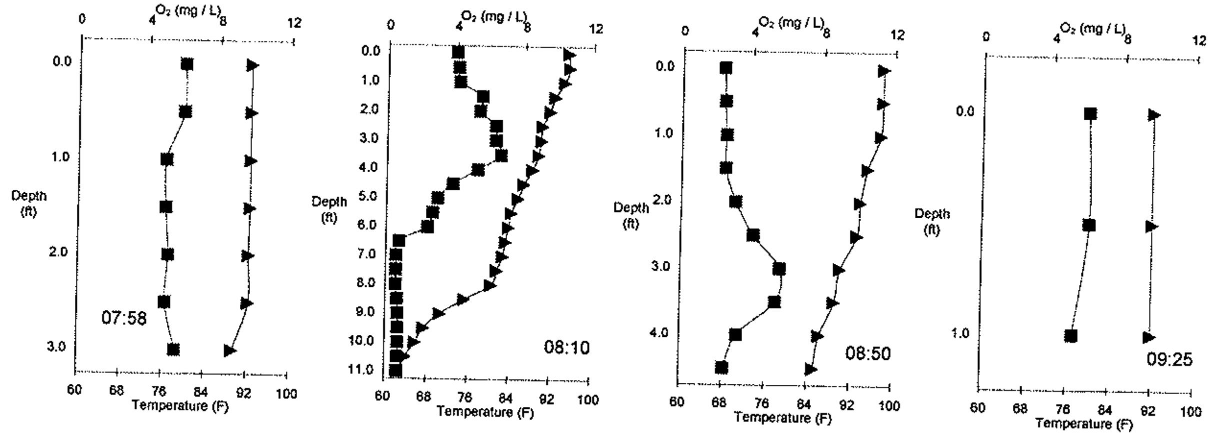


Figure 15A.147. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt –July 23, 1998

Segment 1



Lake of Egypt –July 30, 1998

Segment 1

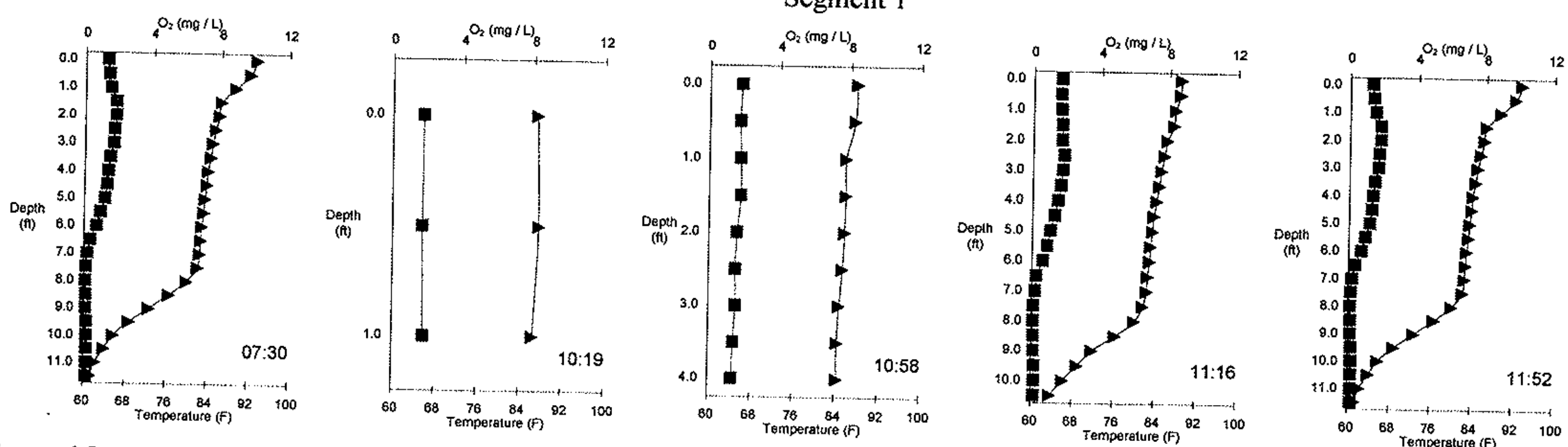


Figure 15A.148. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

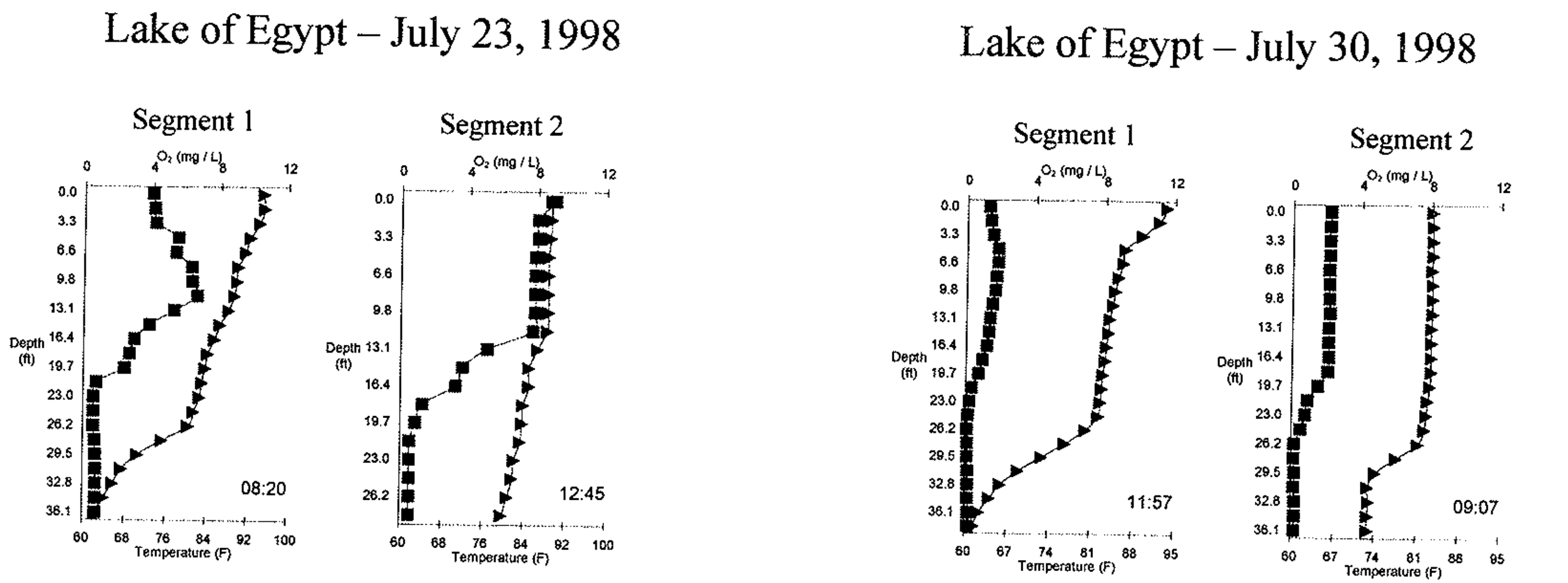
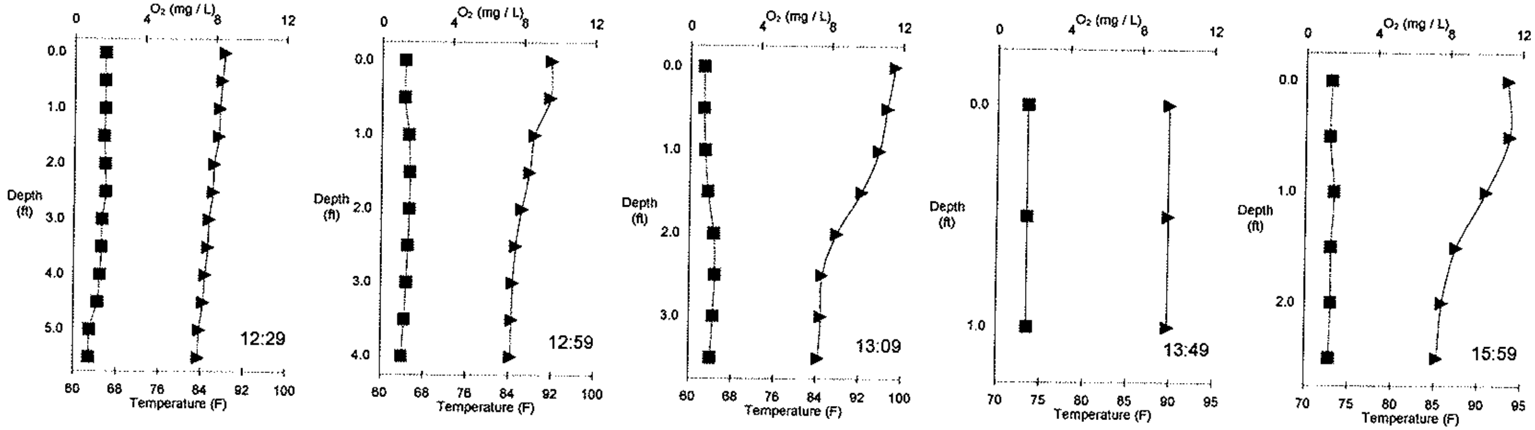


Figure 15A.149. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 30, 1998

Segment 1



Lake of Egypt – August 4, 1998

Segment 1

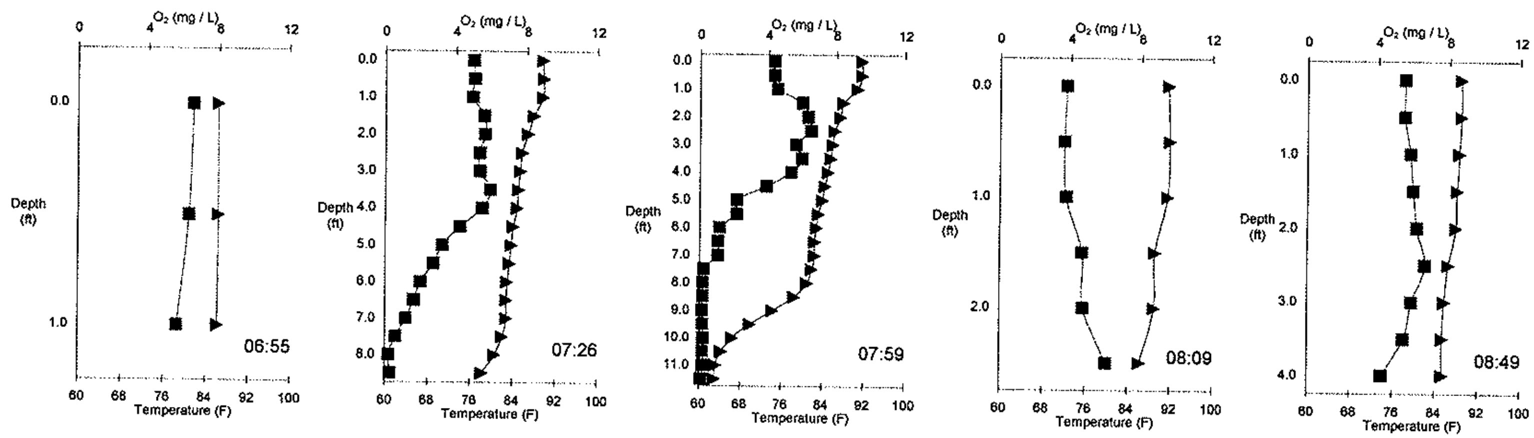


Figure 15A.150. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 4, 1998

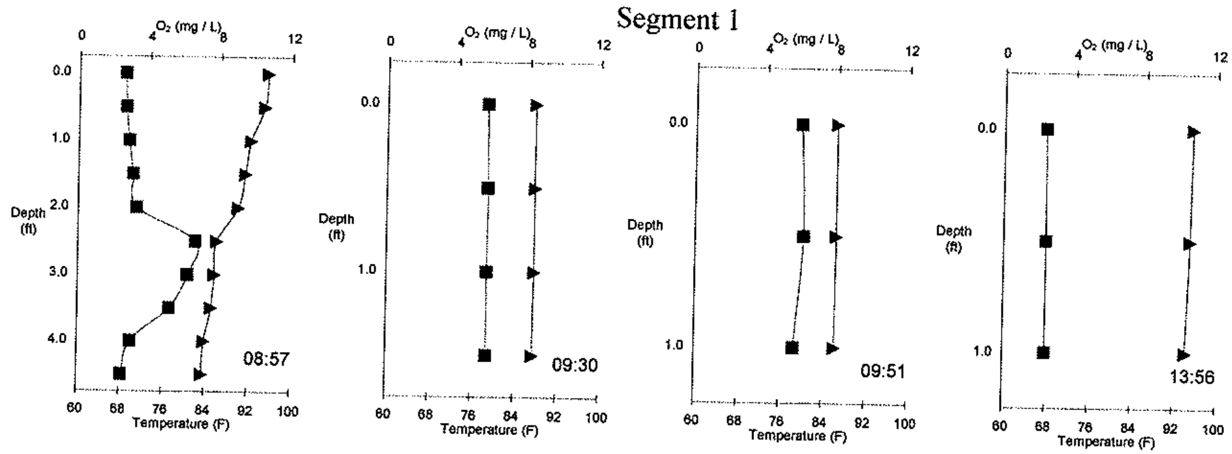


Figure 15A.151. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 4, 1998

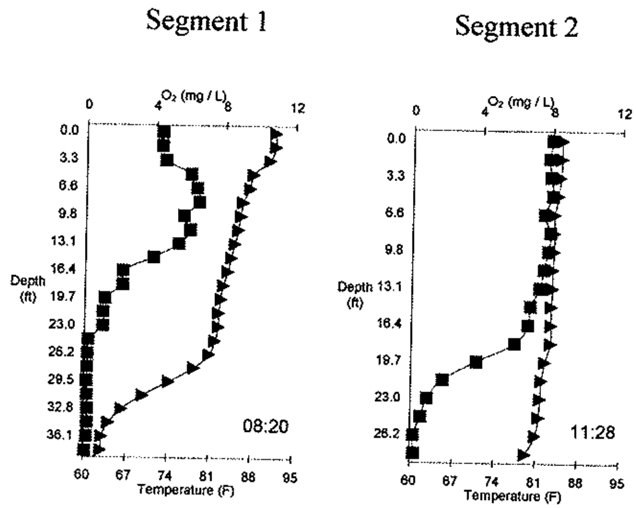


Figure 15A.152. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 10, 1998

Segment 1

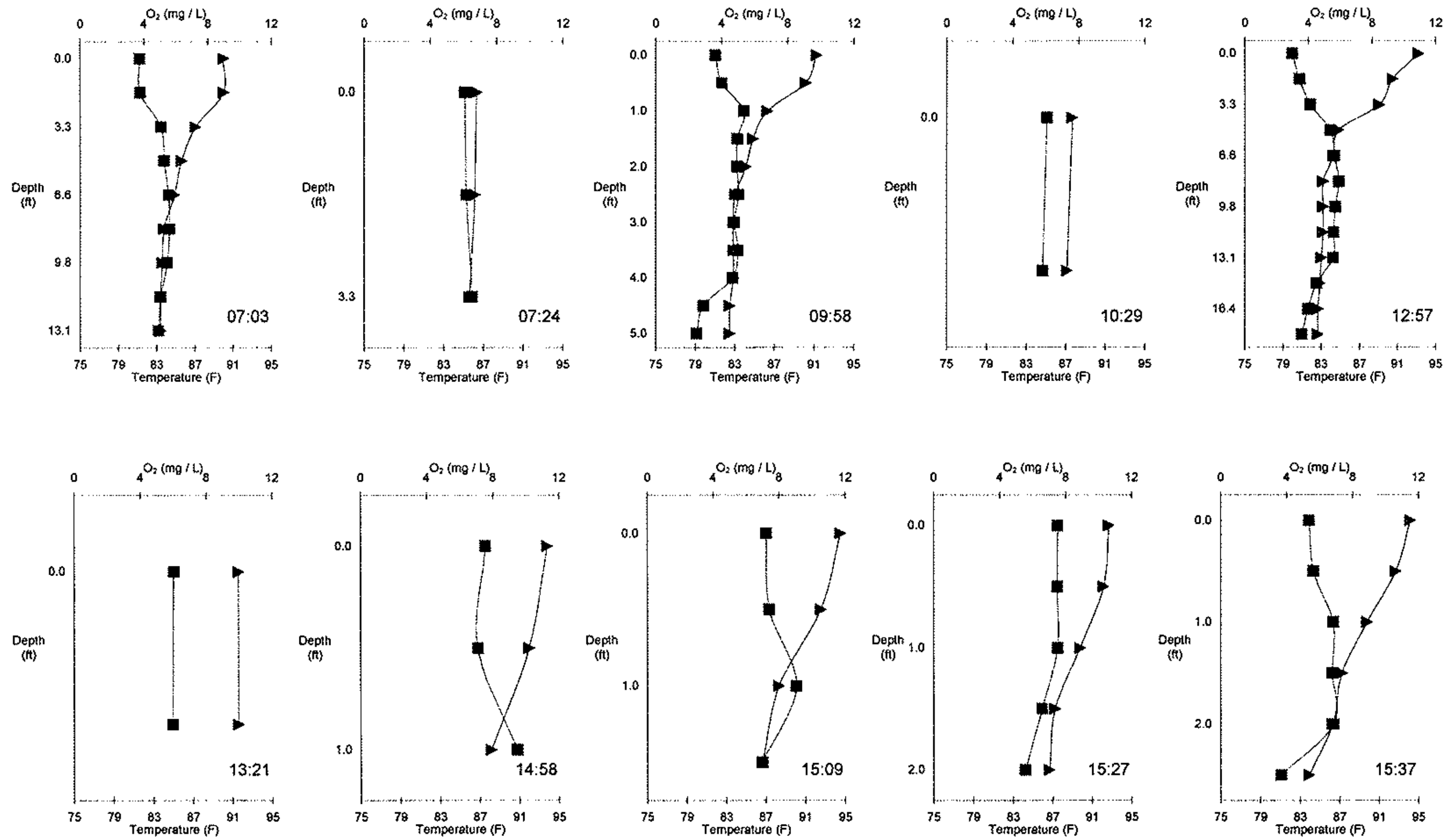


Figure 15A.153. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 10, 1998

Segment 1

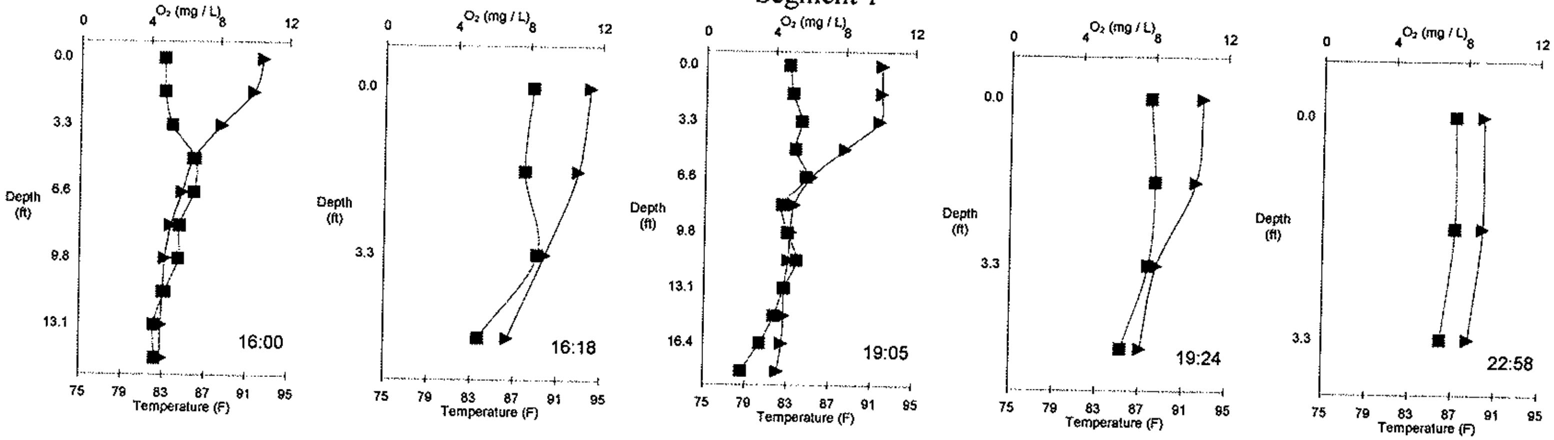


Figure 15A.154. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt –August 11, 1998

Segment 1

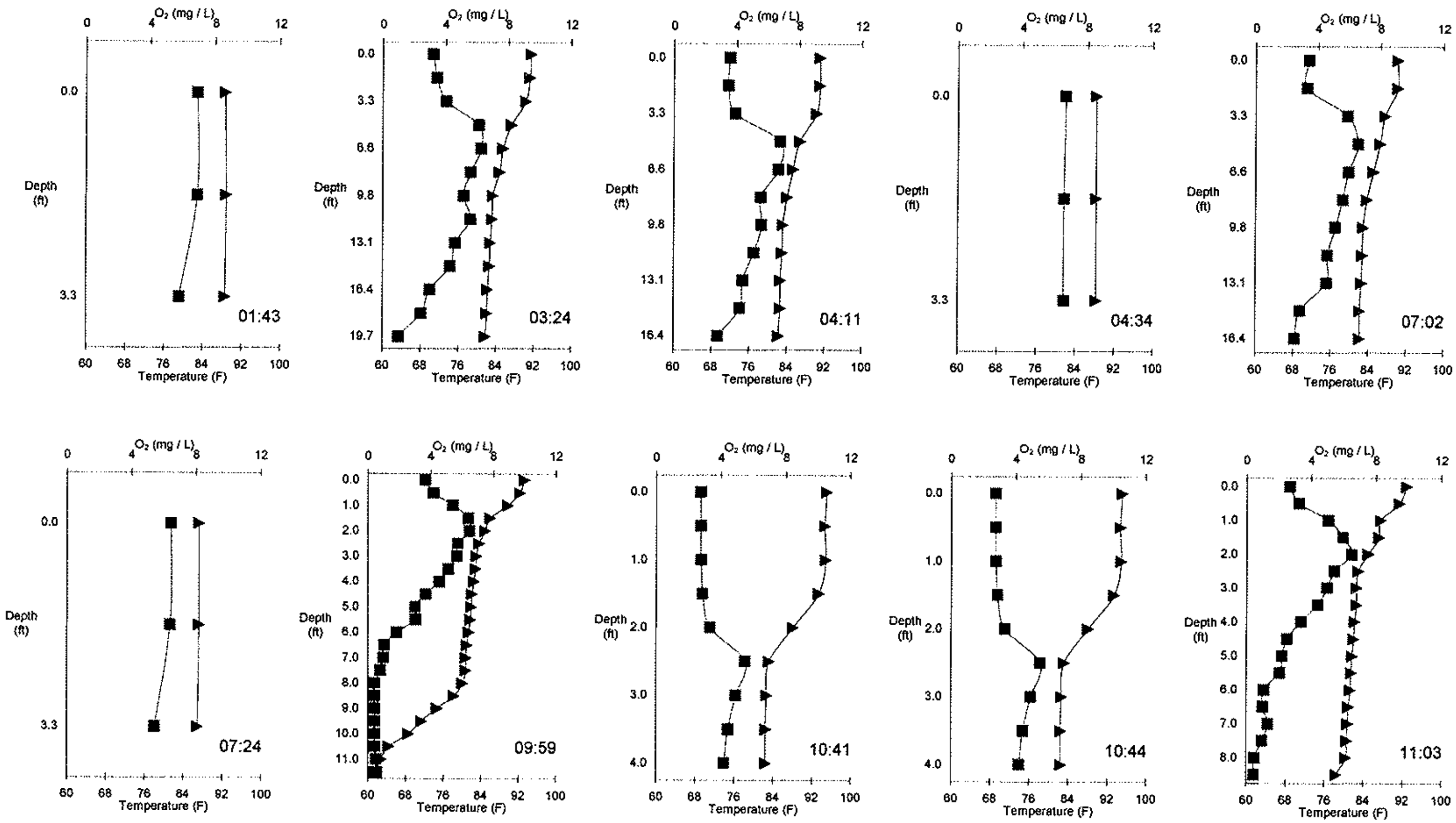
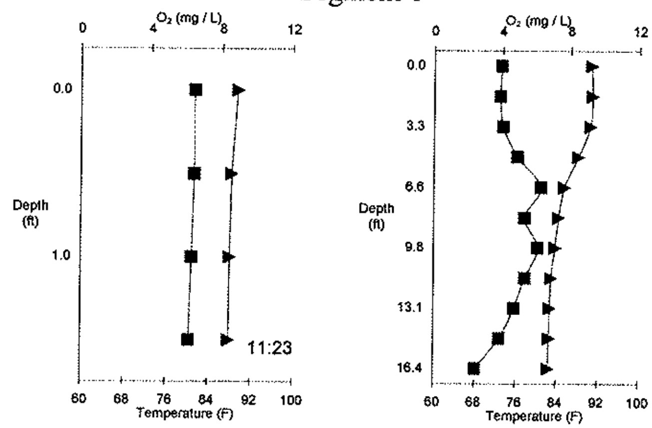


Figure 15A.155. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 11, 1998

Segment 1



Lake of Egypt – August 16, 1998

Segment 1

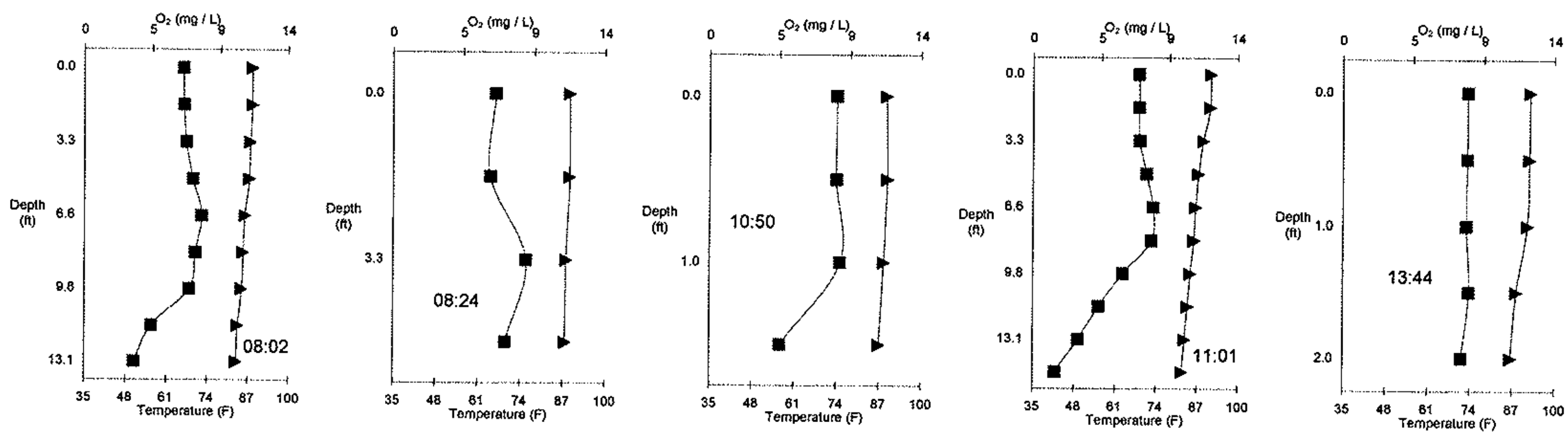


Figure 15A.156. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 16, 1998

Segment 1

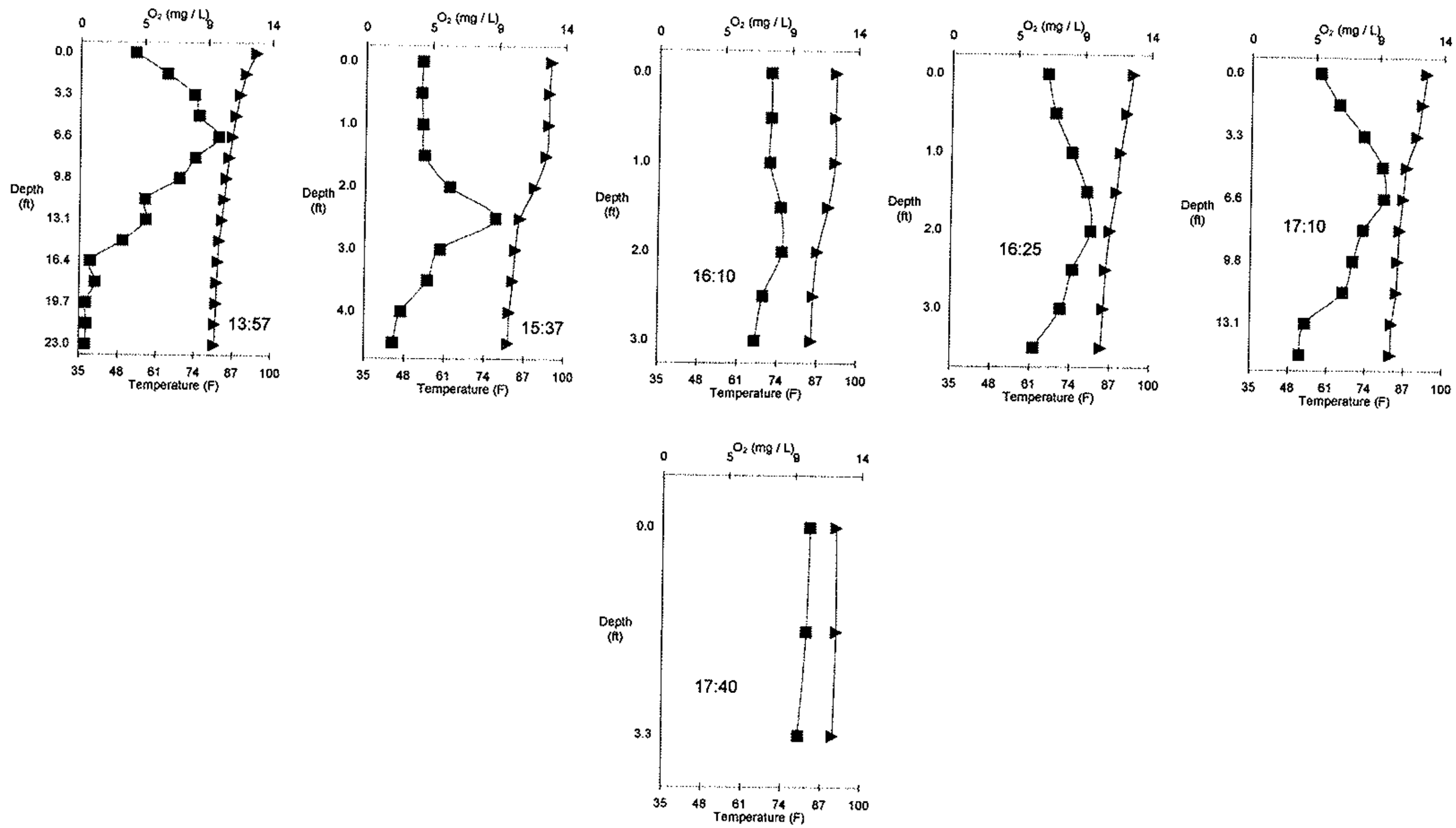


Figure 15A.157. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt –August 17, 1998

Segment 1

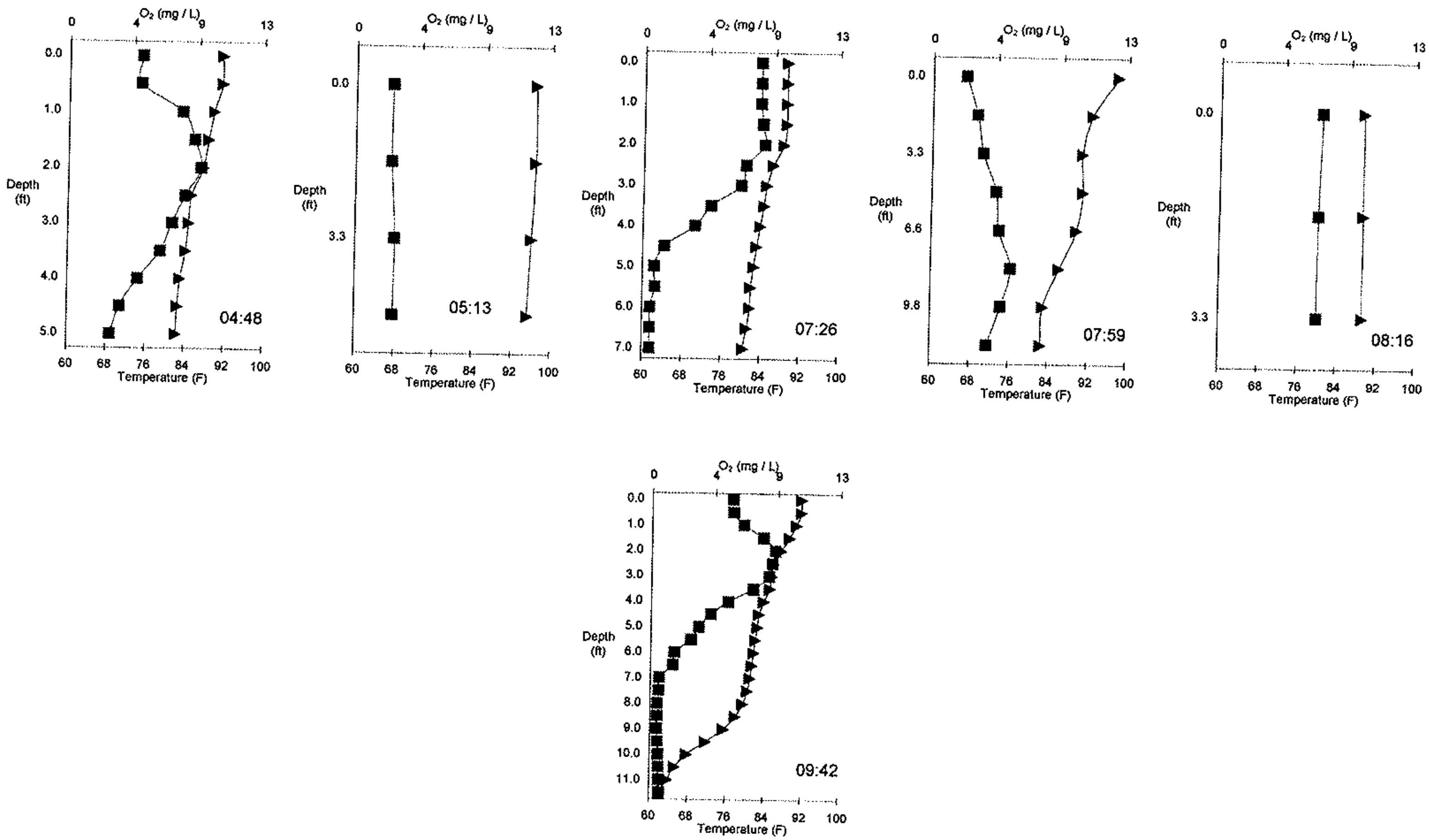


Figure 15A.158. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

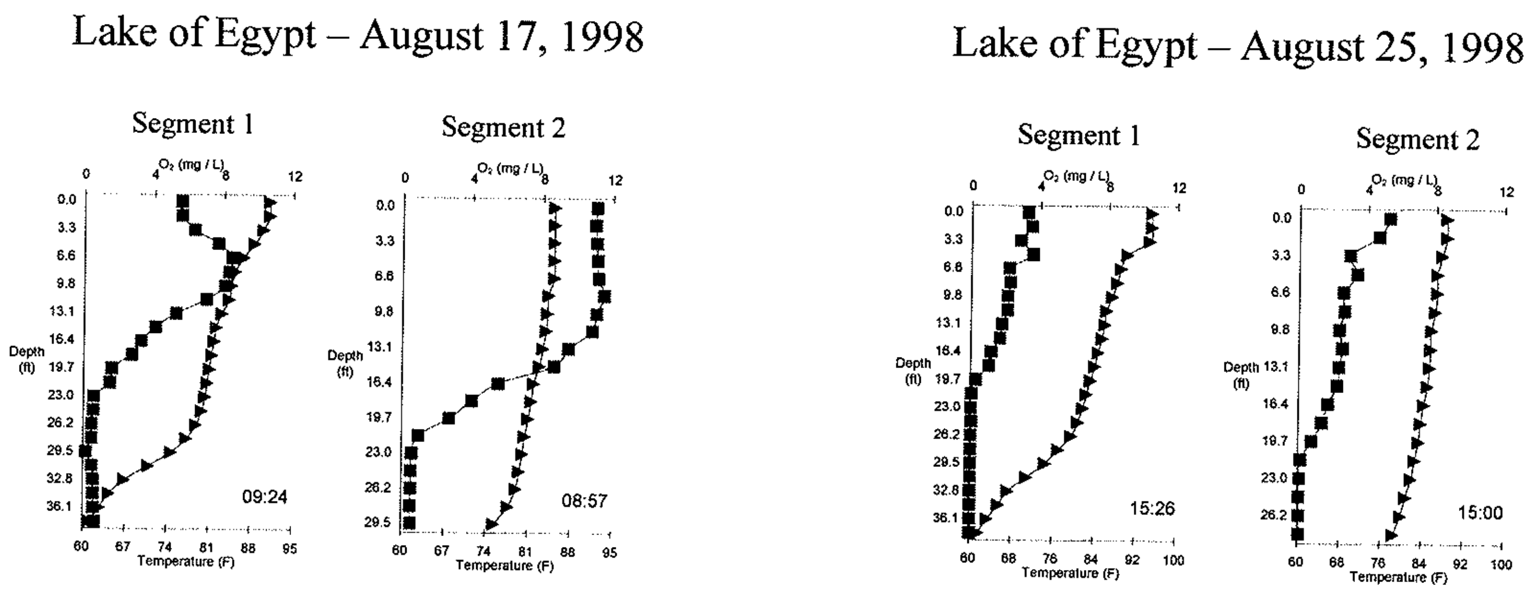


Figure 15A.159. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 25, 1998

Segment 1

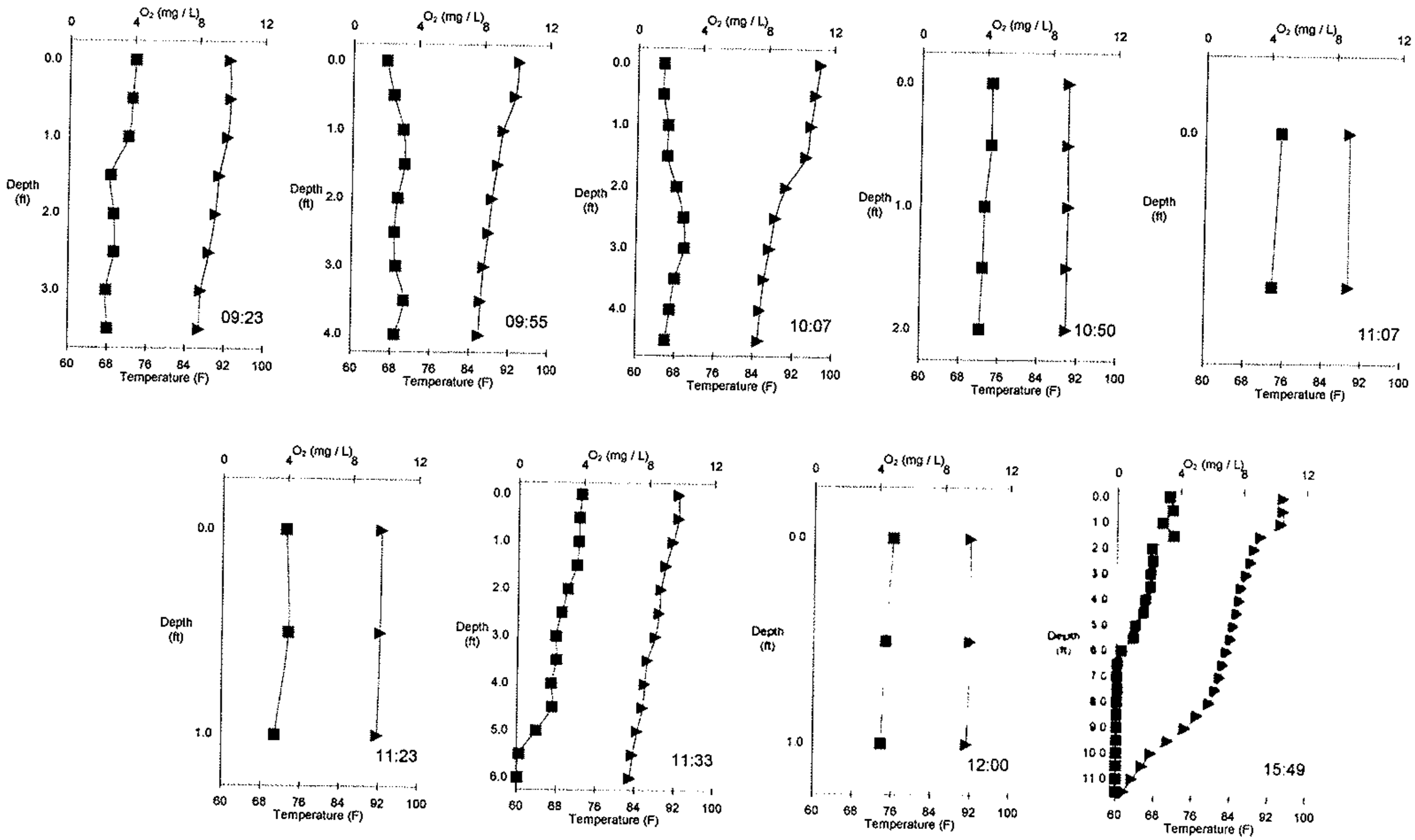
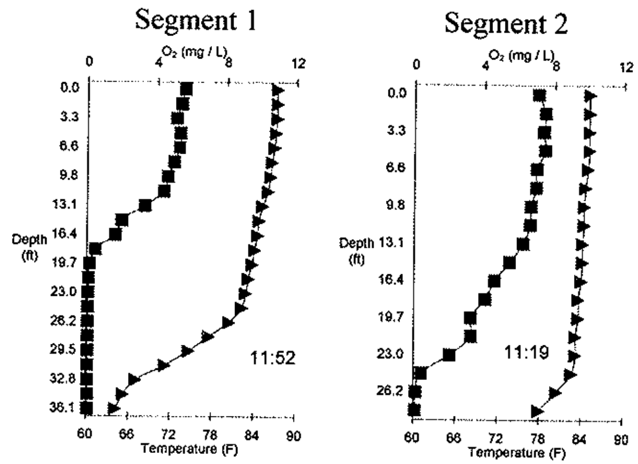
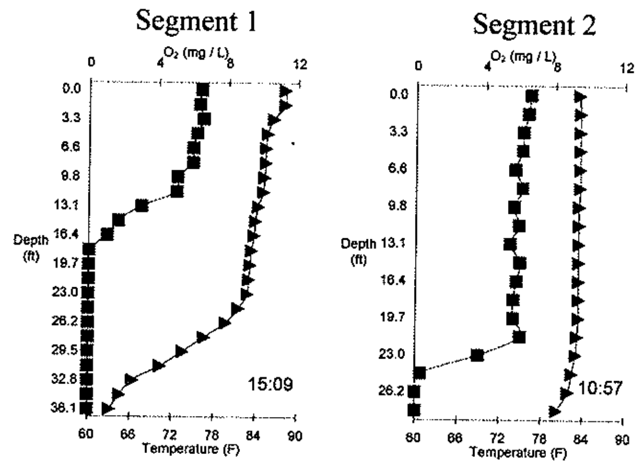


Figure 15A.160. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

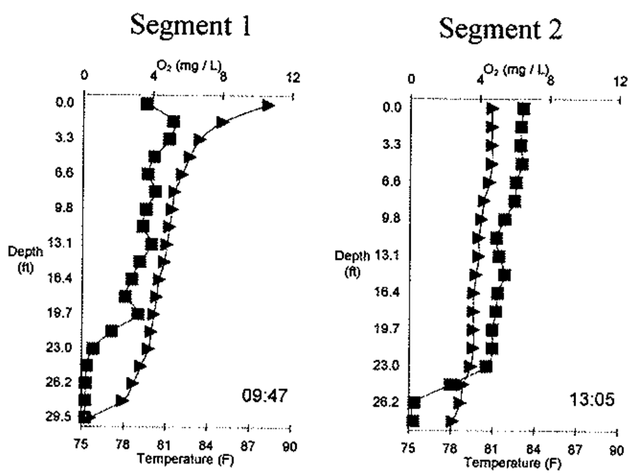
Lake of Egypt - September 4, 1998



Lake of Egypt - September 8, 1998



Lake of Egypt - September 17, 1998



Lake of Egypt - September 24, 1998

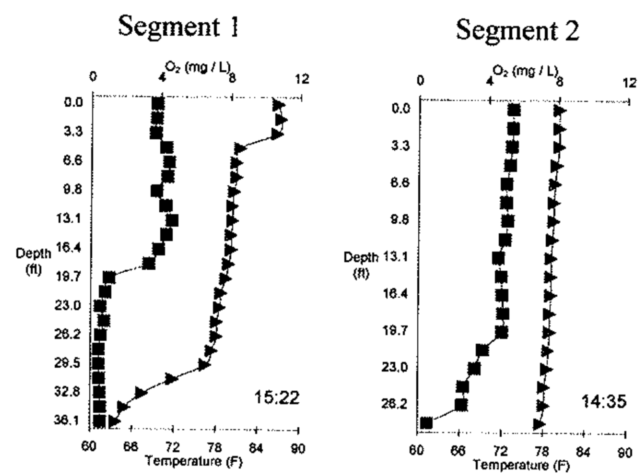
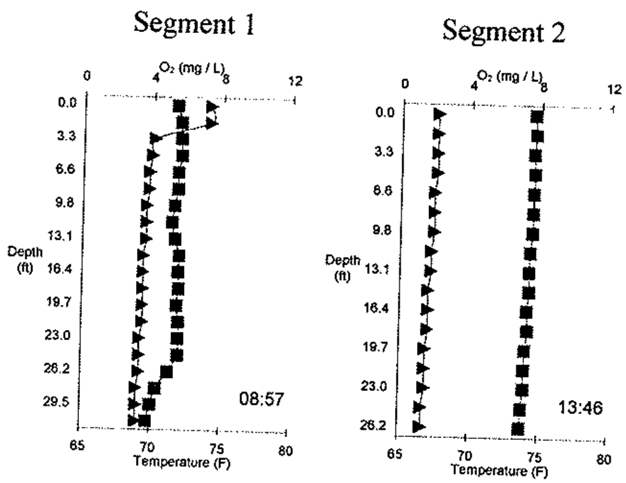
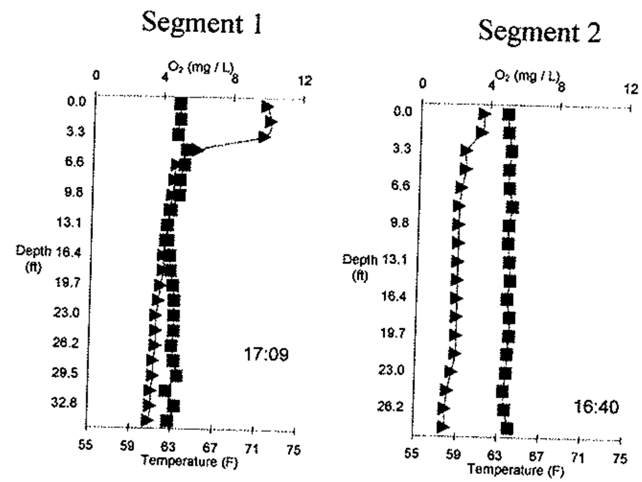


Figure 15A.161. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

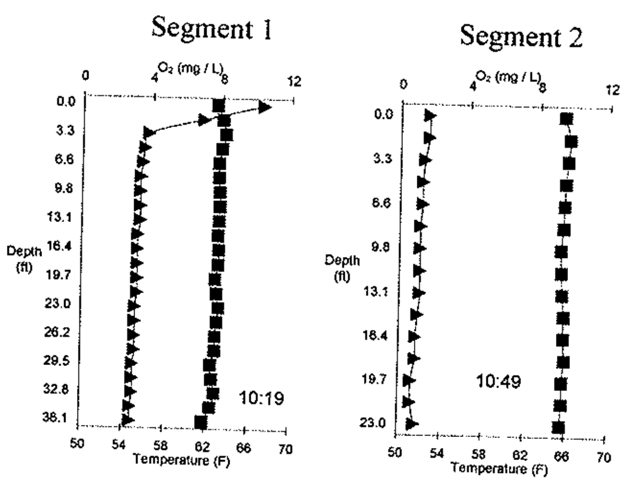
Lake of Egypt – October 22, 1998



Lake of Egypt – November 9, 1998



Lake of Egypt – November 17, 1998



Lake of Egypt – December 3, 1998

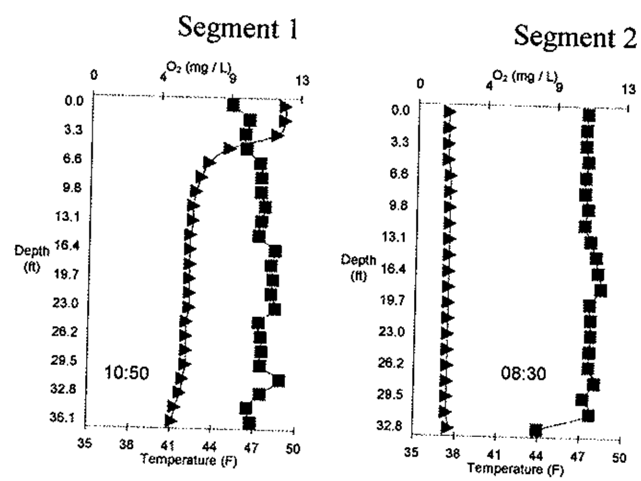


Figure 15A.162. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

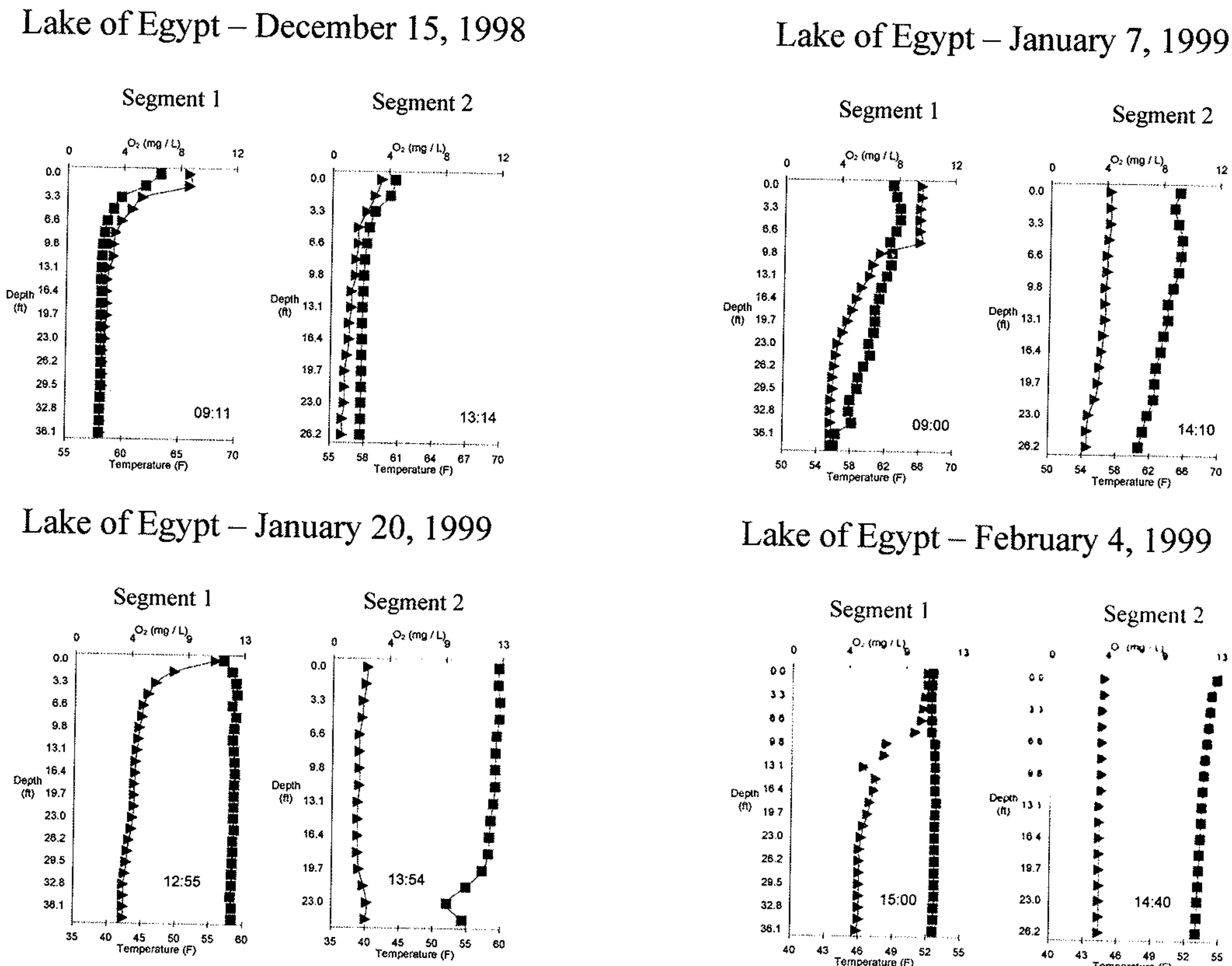
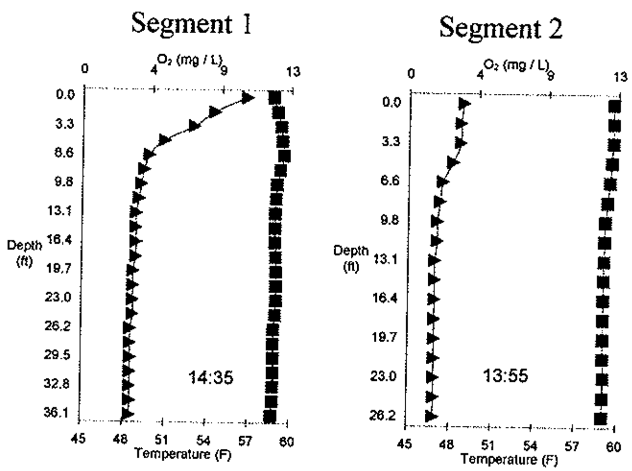
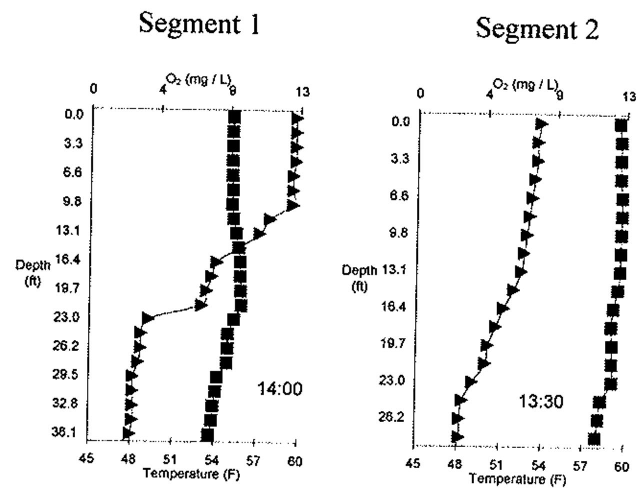


Figure 15.163. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

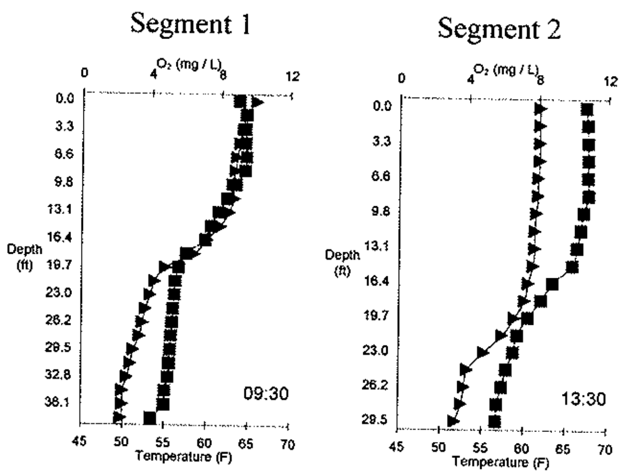
Lake of Egypt – February 17, 1999



Lake of Egypt – April 1, 1999



Lake of Egypt – April 13, 1999



Lake of Egypt – April 27, 1999

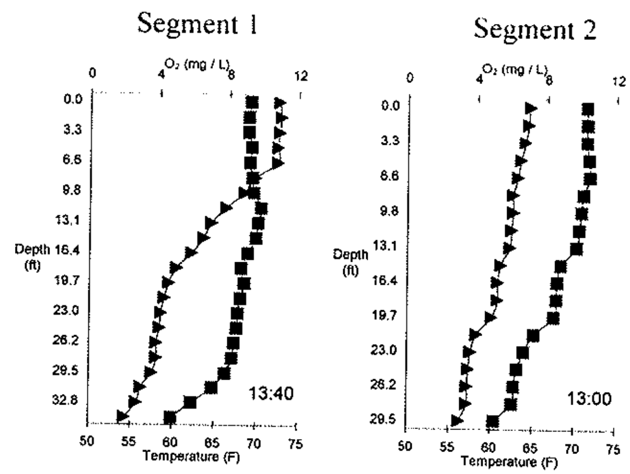


Figure 15A.164. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

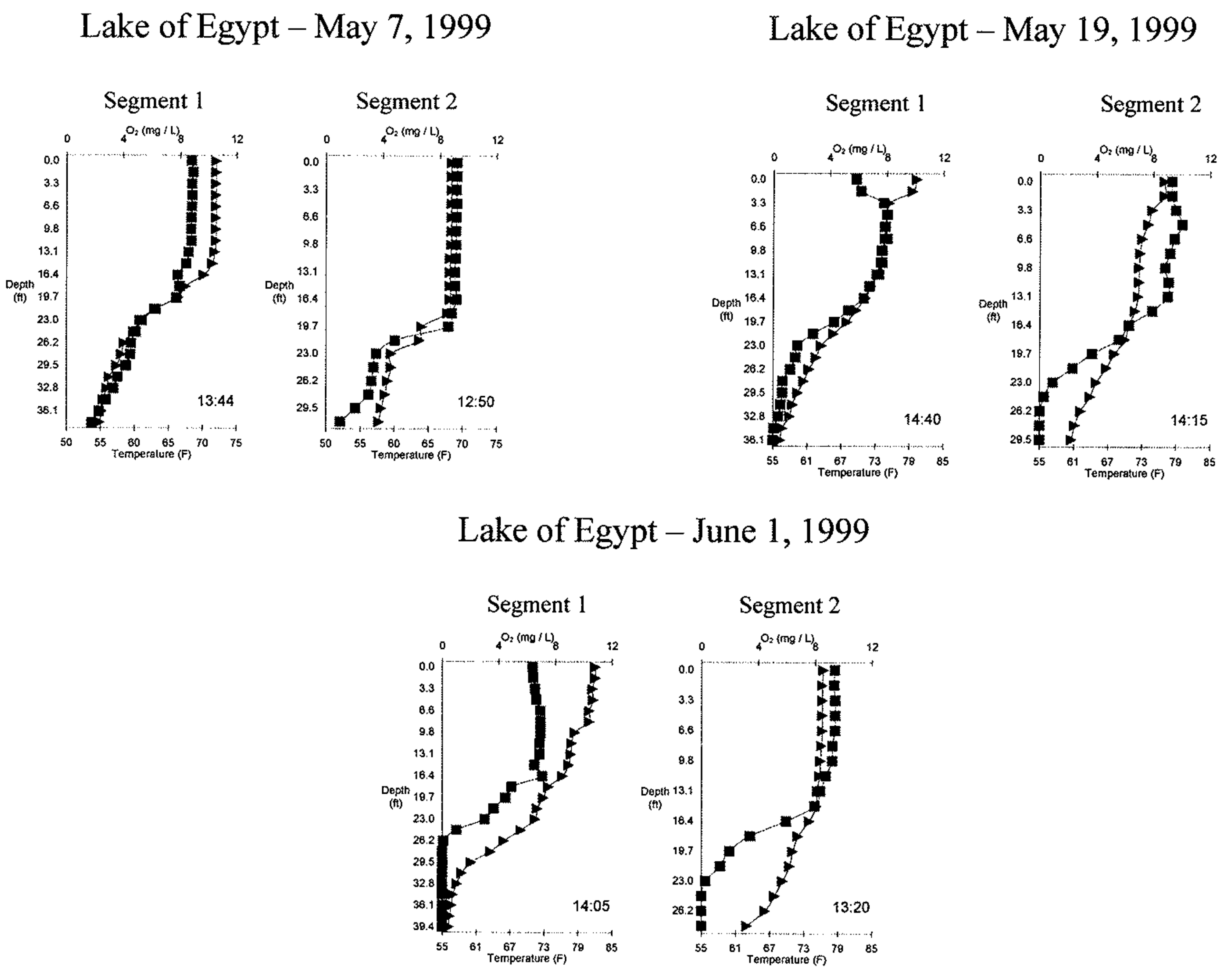


Figure 15A.165. – Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 1, 1999

Segment 1

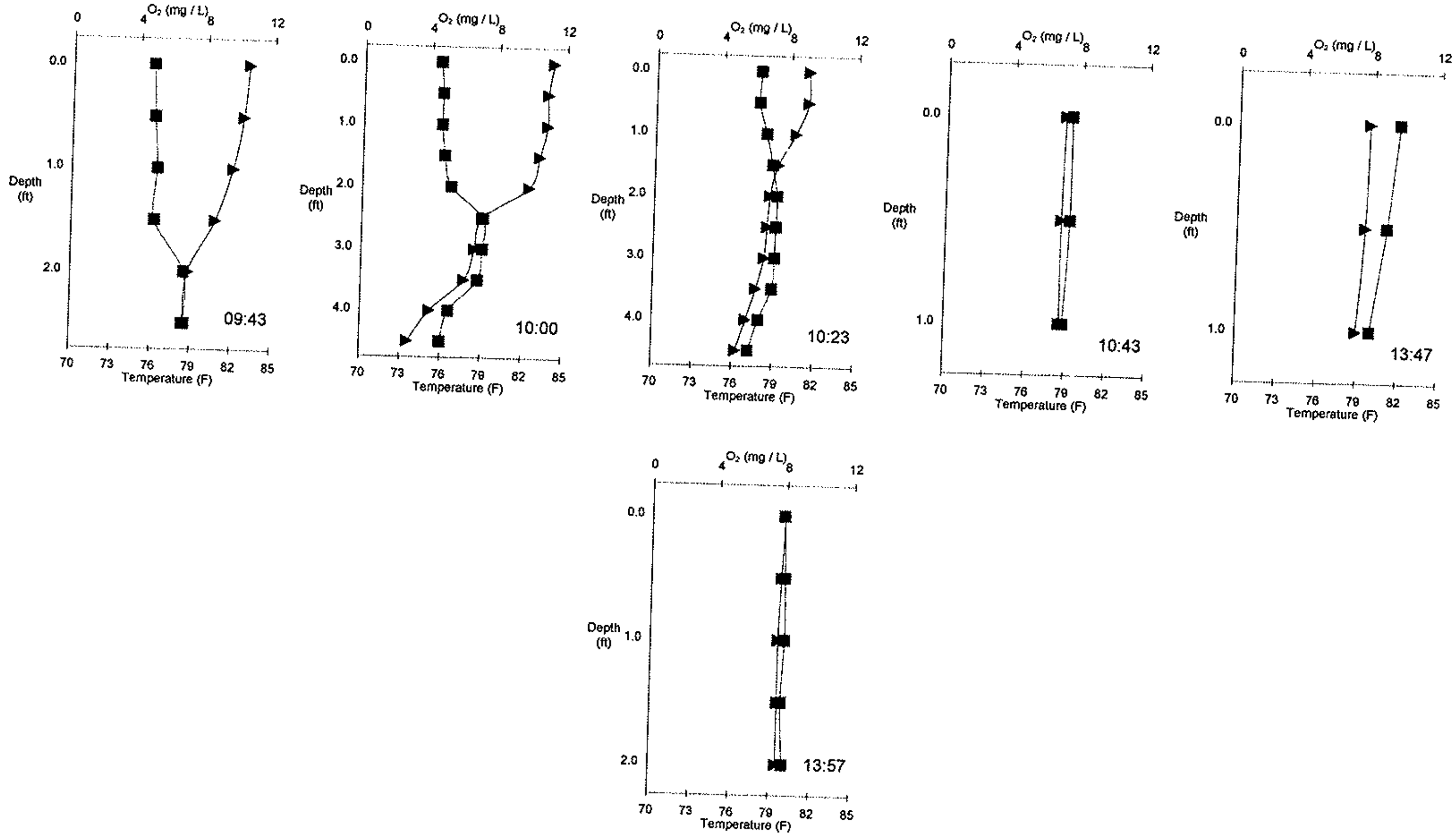


Figure 15A.166. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 6, 1999

Segment 1

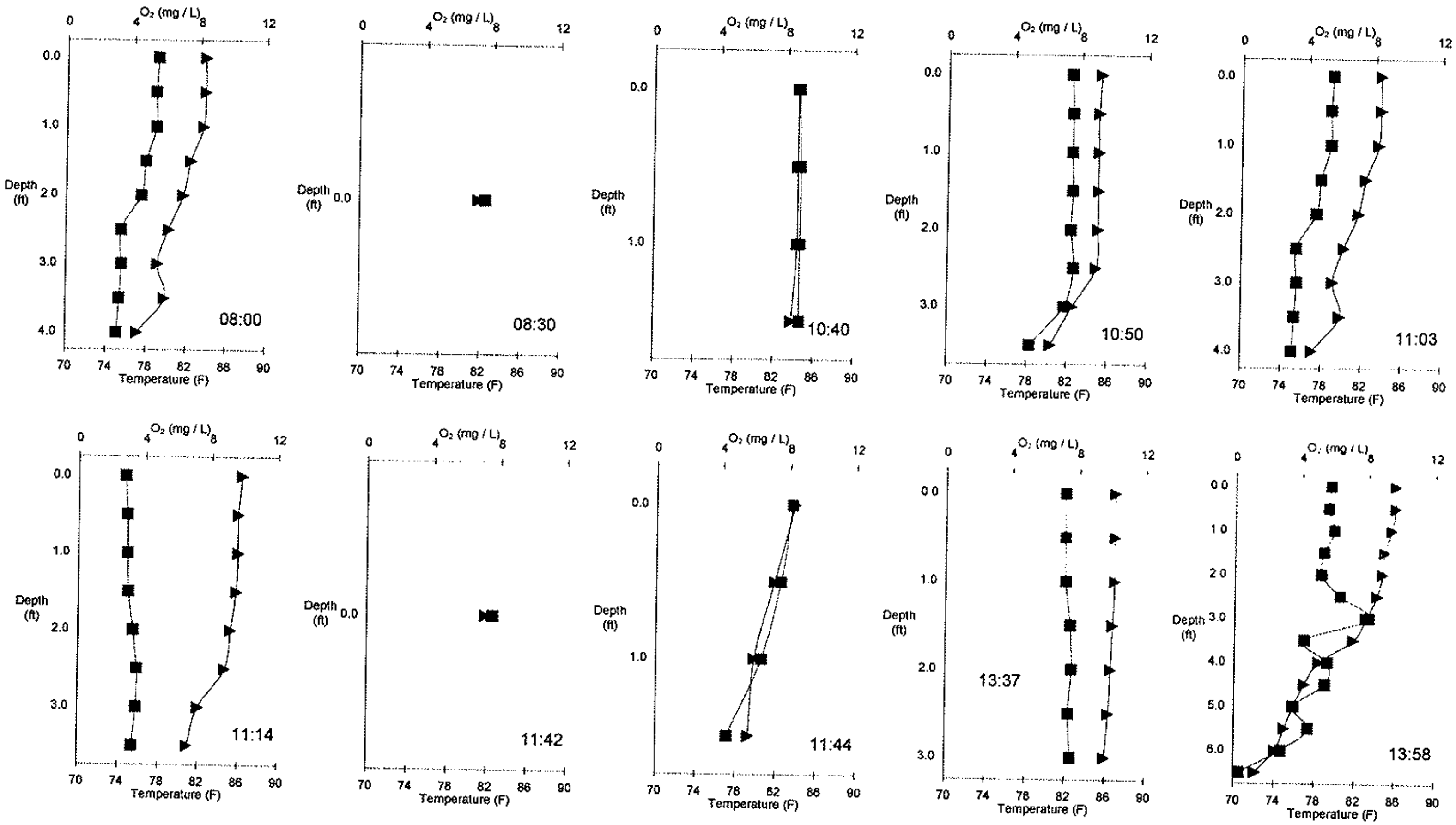


Figure 15A.167. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 6, 1999

Segment 1

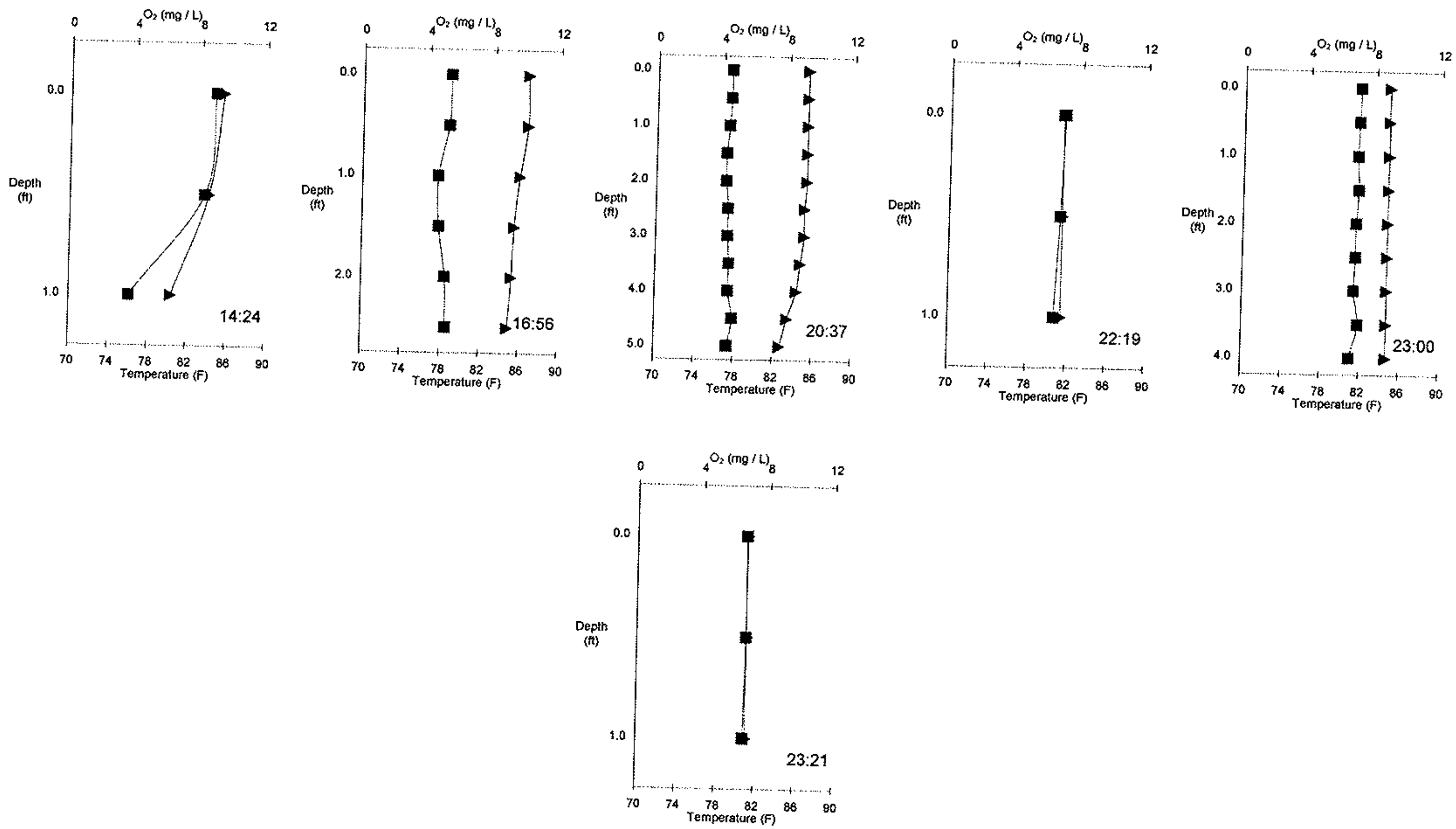


Figure 15A.168. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 7, 1999

Segment 1

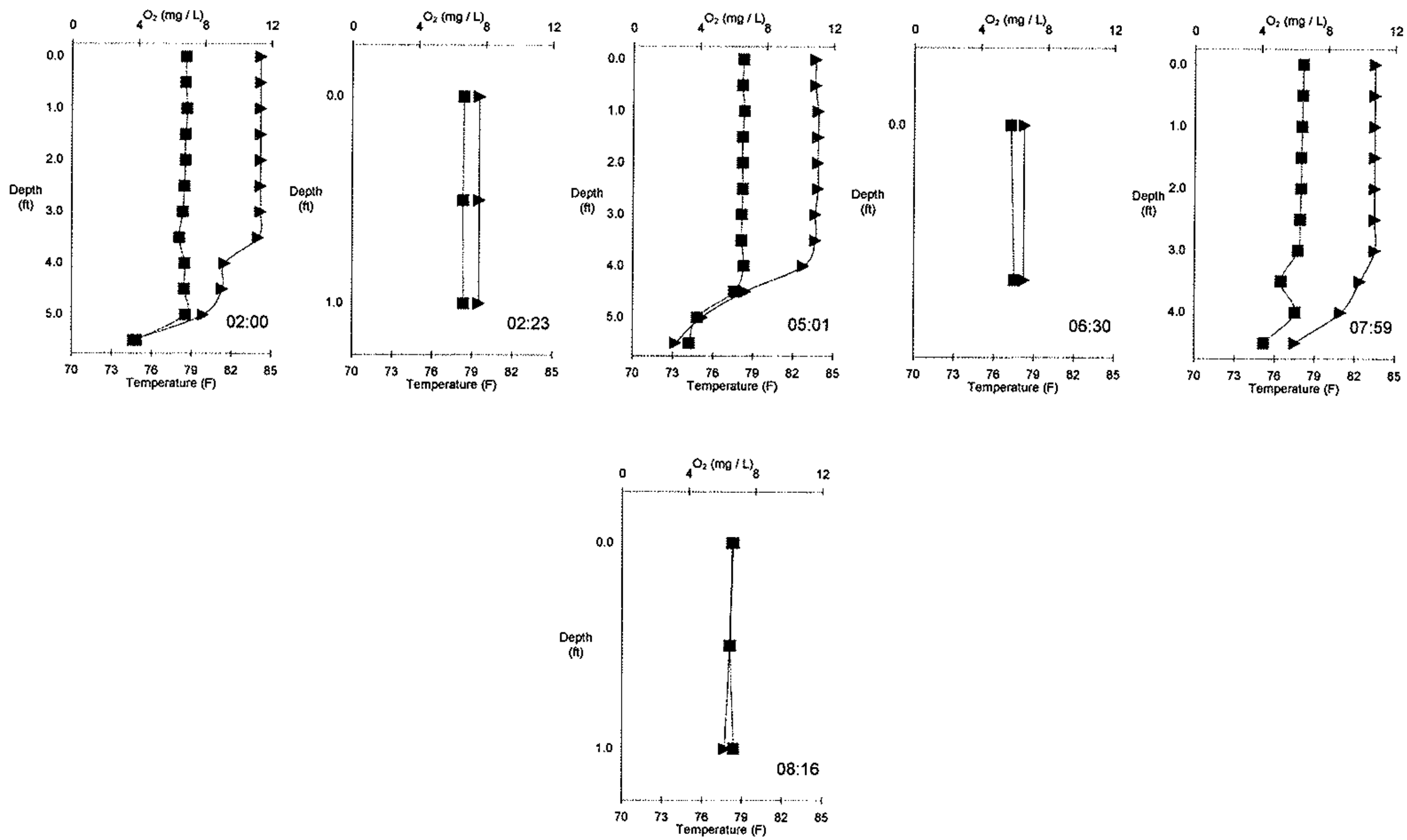


Figure 15A.169. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 18, 1999

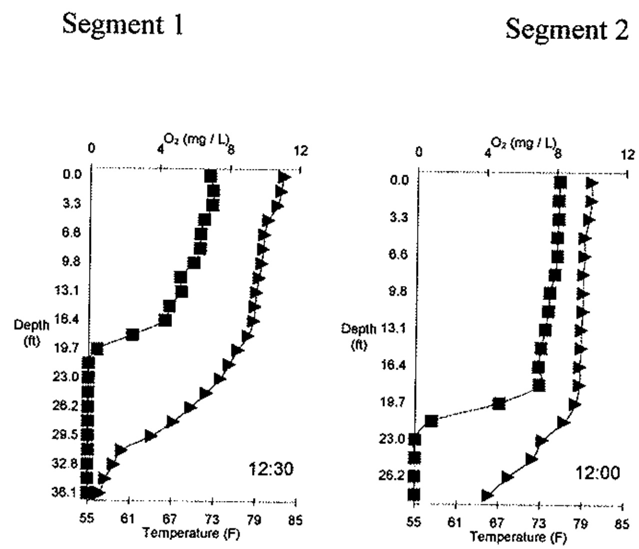


Figure 15A.170. – Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 18, 1999

Segment 1

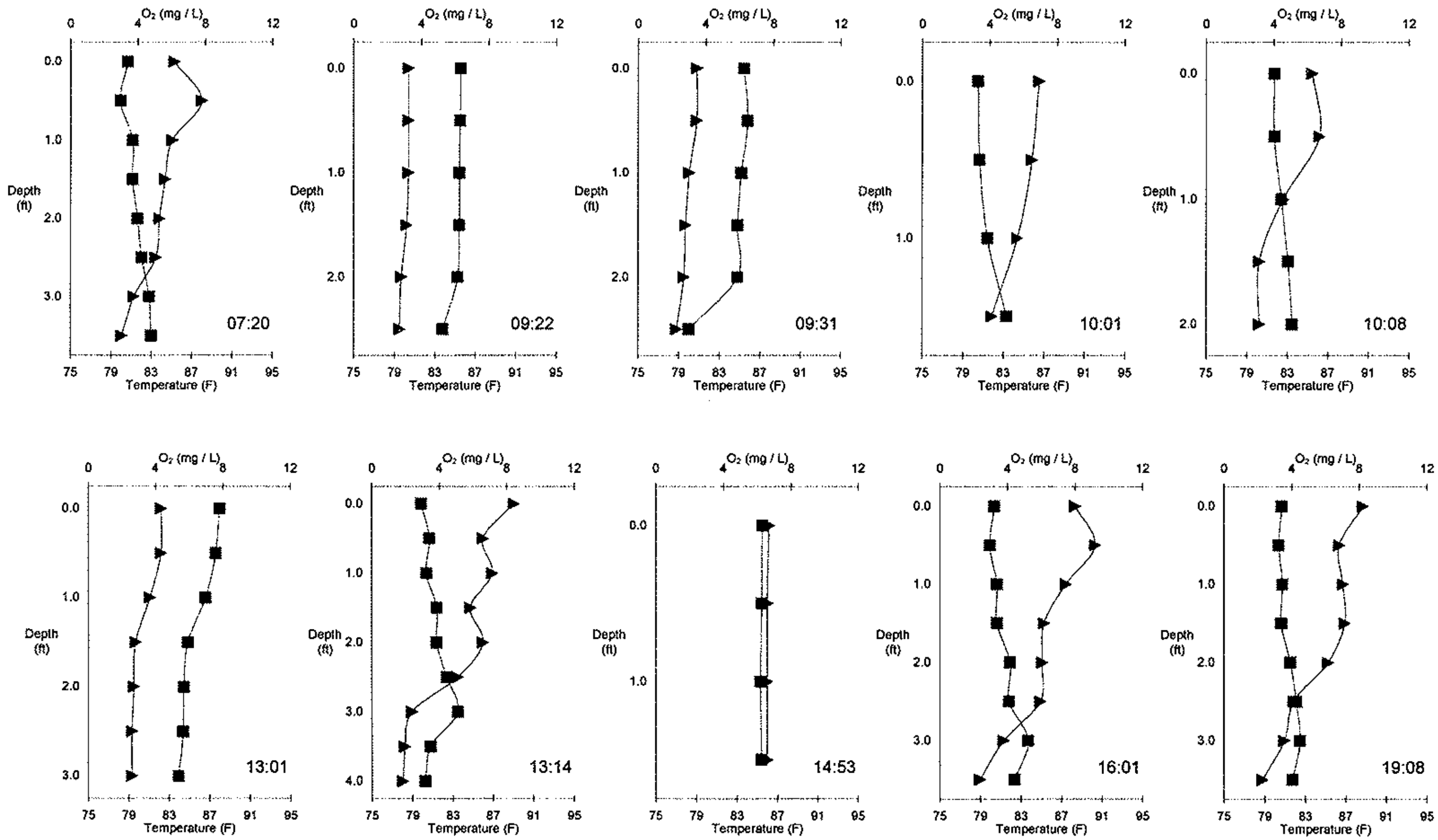
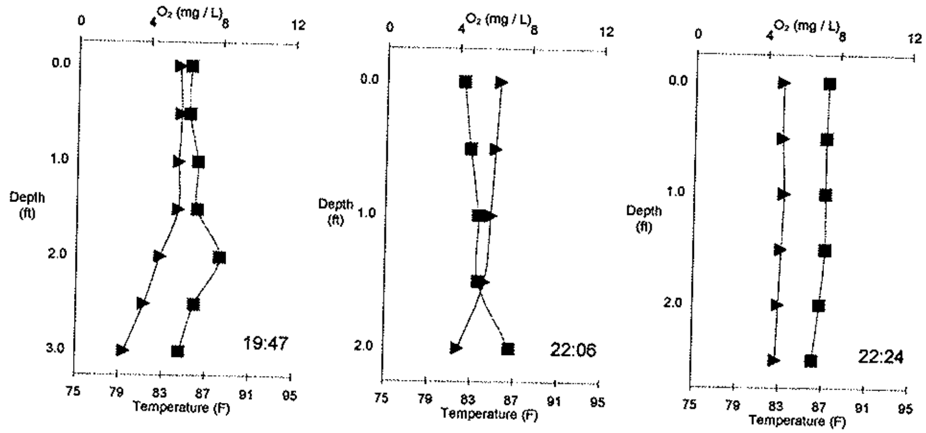


Figure 15A.171. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 18, 1999

Segment 1



Lake of Egypt – June 19, 1999

Segment 1

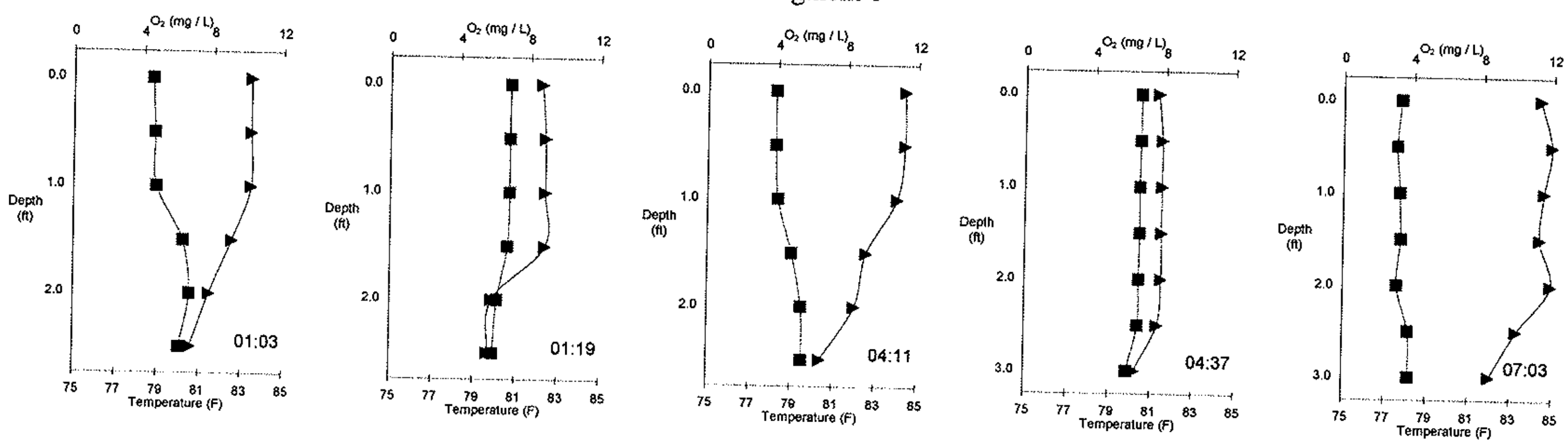
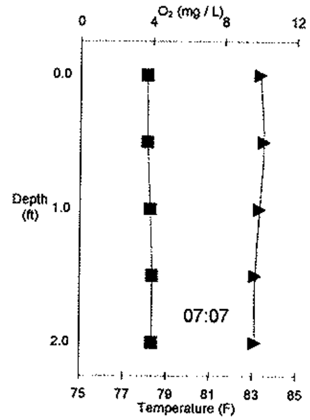


Figure 15A.172. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 19, 1999

Segment 1



Lake of Egypt – June 25, 1999

Segment 1

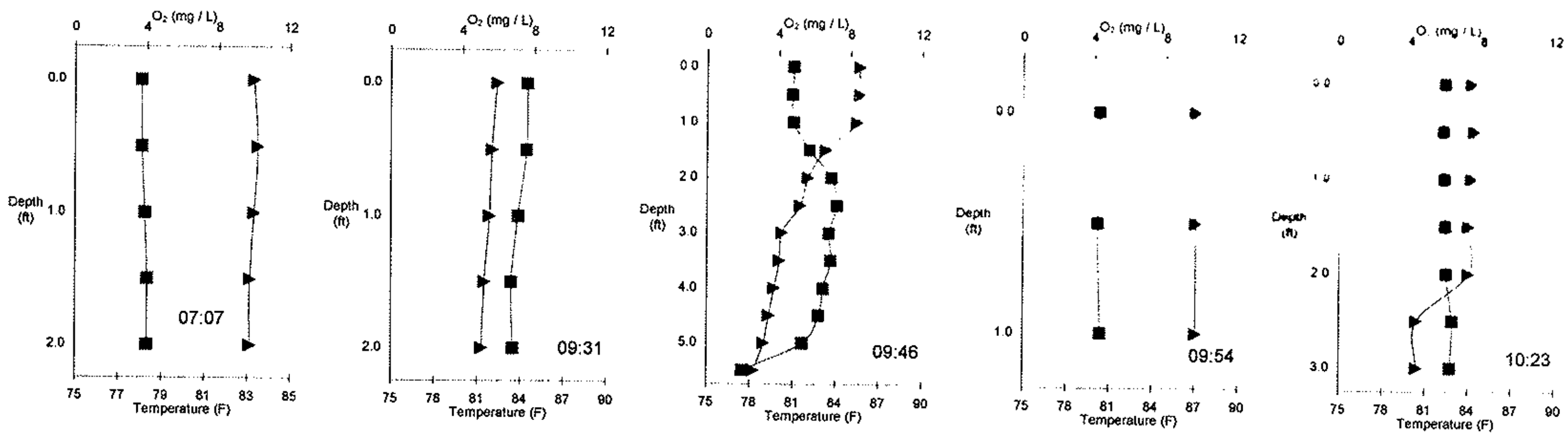
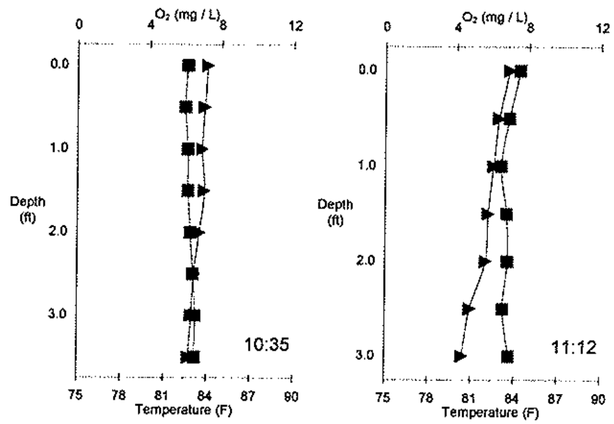


Figure 15A.173. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – June 25, 1999

Segment 1



Lake of Egypt – June 28, 1999

Segment 1

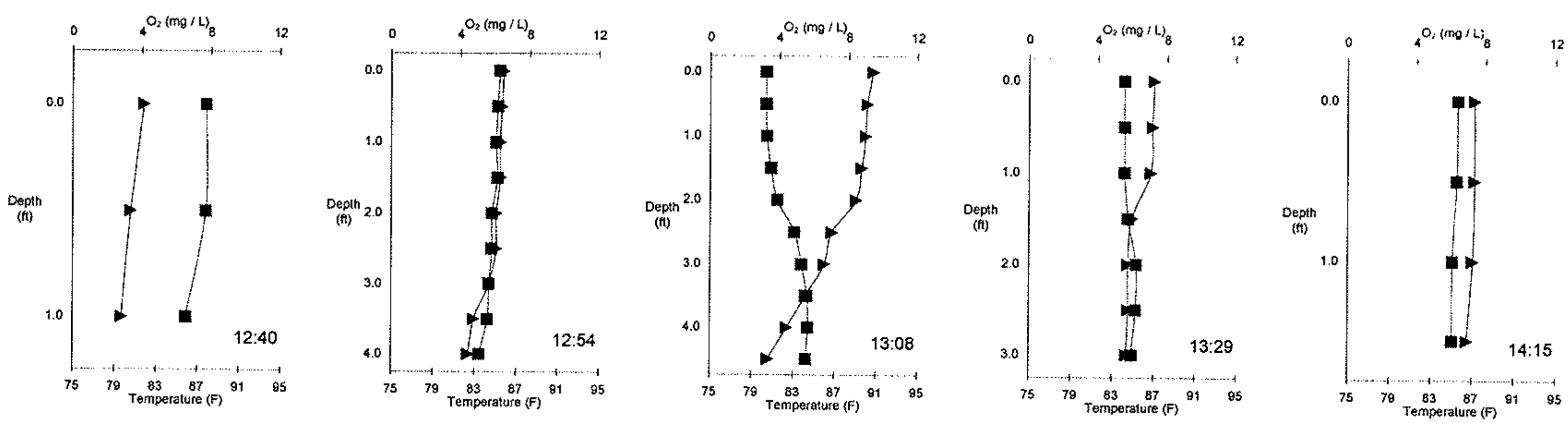


Figure 15A.174. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 9, 1999

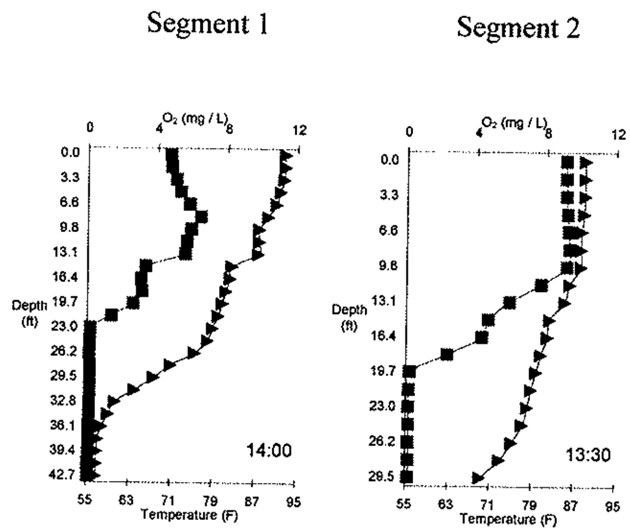
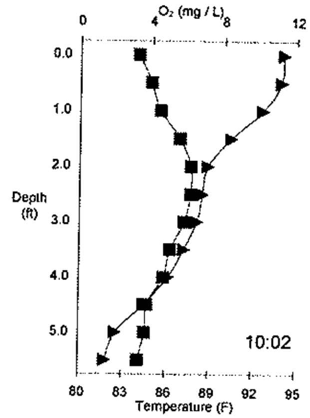


Figure 15A.175. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 9, 1999

Segment 1



Lake of Egypt – July 13, 1999

Segment 1

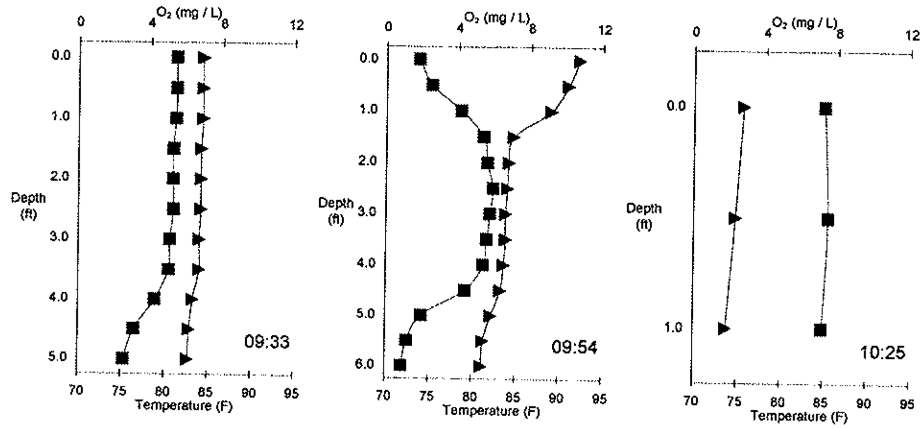


Figure 15A.176. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 22, 1999

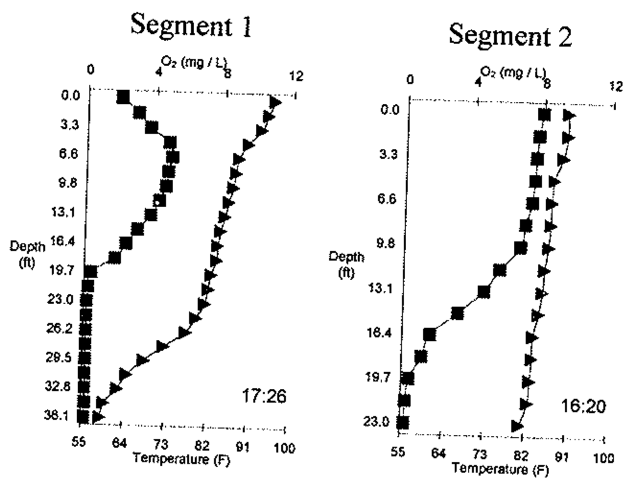
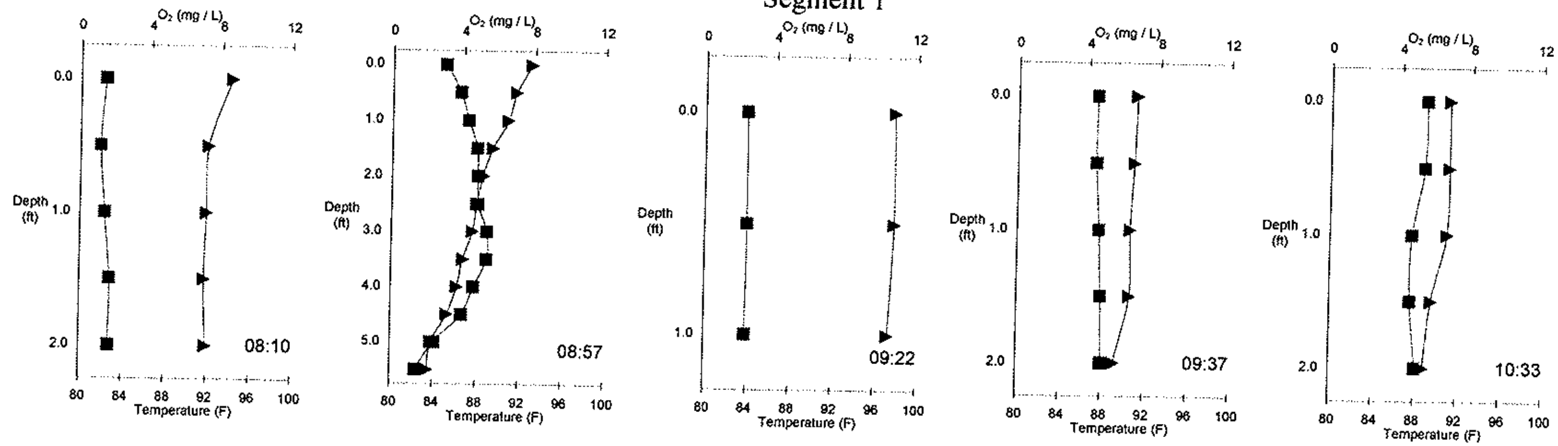


Figure 15A.177. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 22, 1999

Segment 1



Lake of Egypt – July 29, 1999

Segment 1

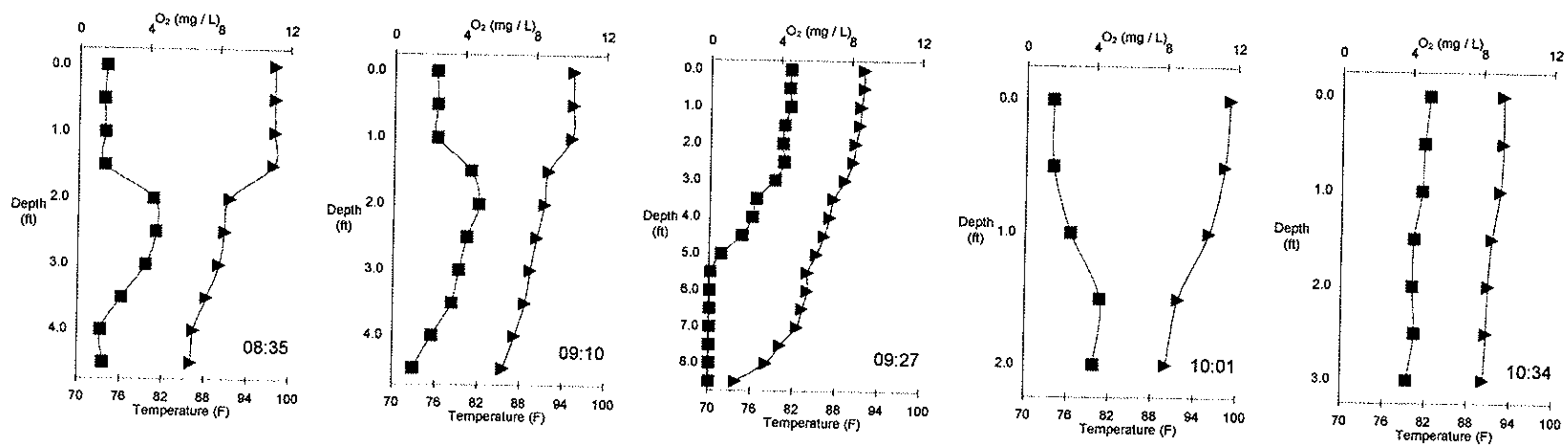
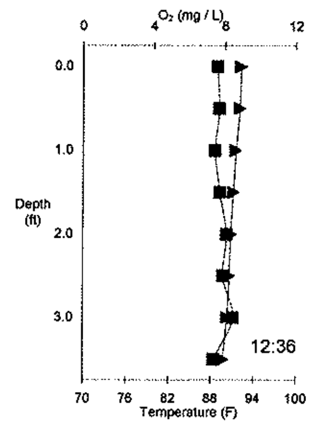


Figure 15A.178. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – July 29, 1999

Segment 1



Lake of Egypt –August 3, 1999

Segment 1

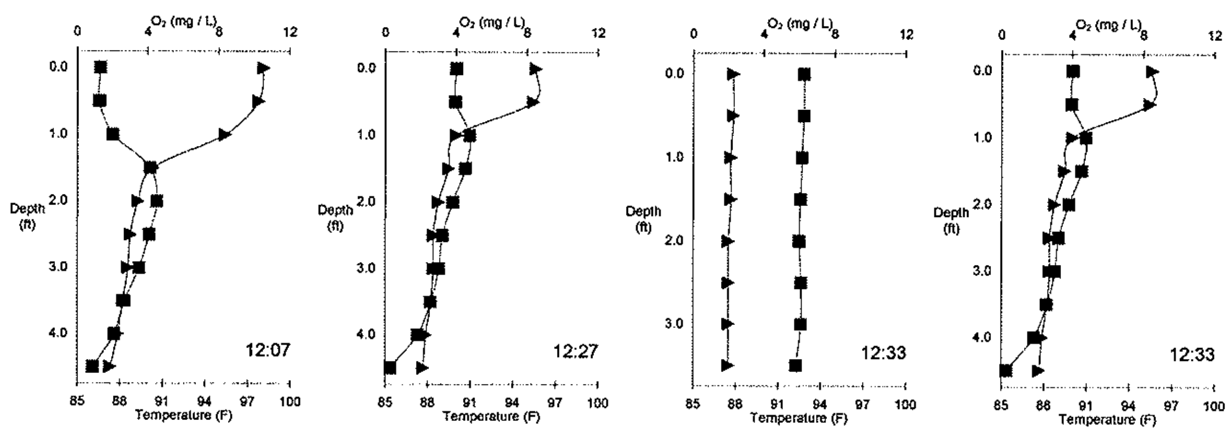


Figure 15A.179. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 3, 1999

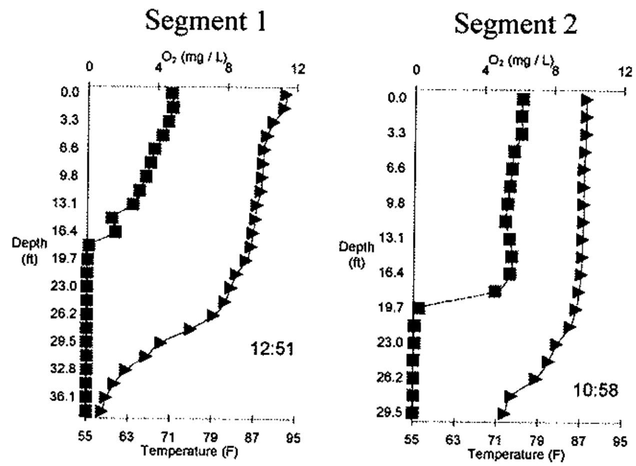


Figure 15A.180. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 12, 1999

Segment 1

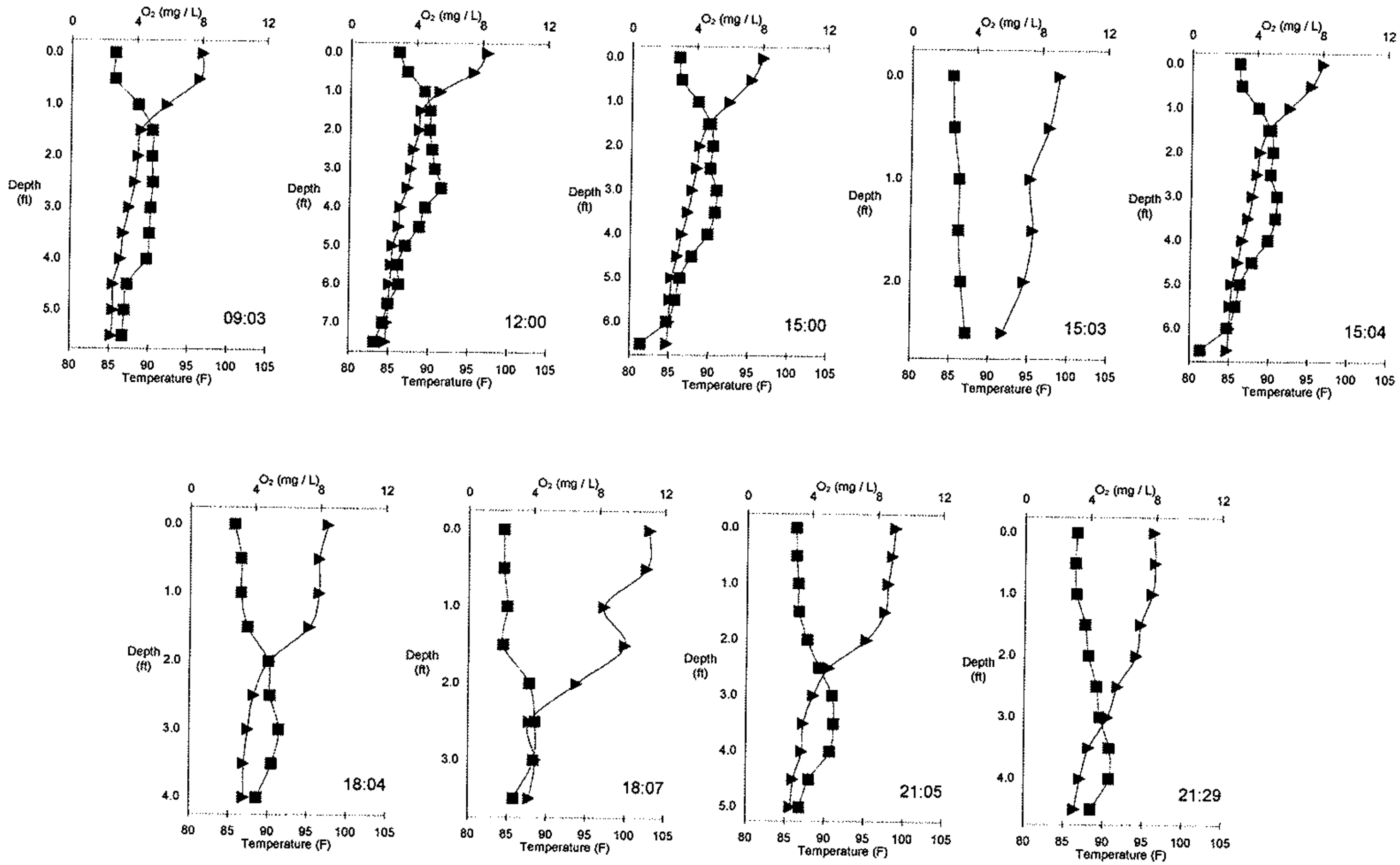


Figure 15A.181. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 13, 1999

Segment 1

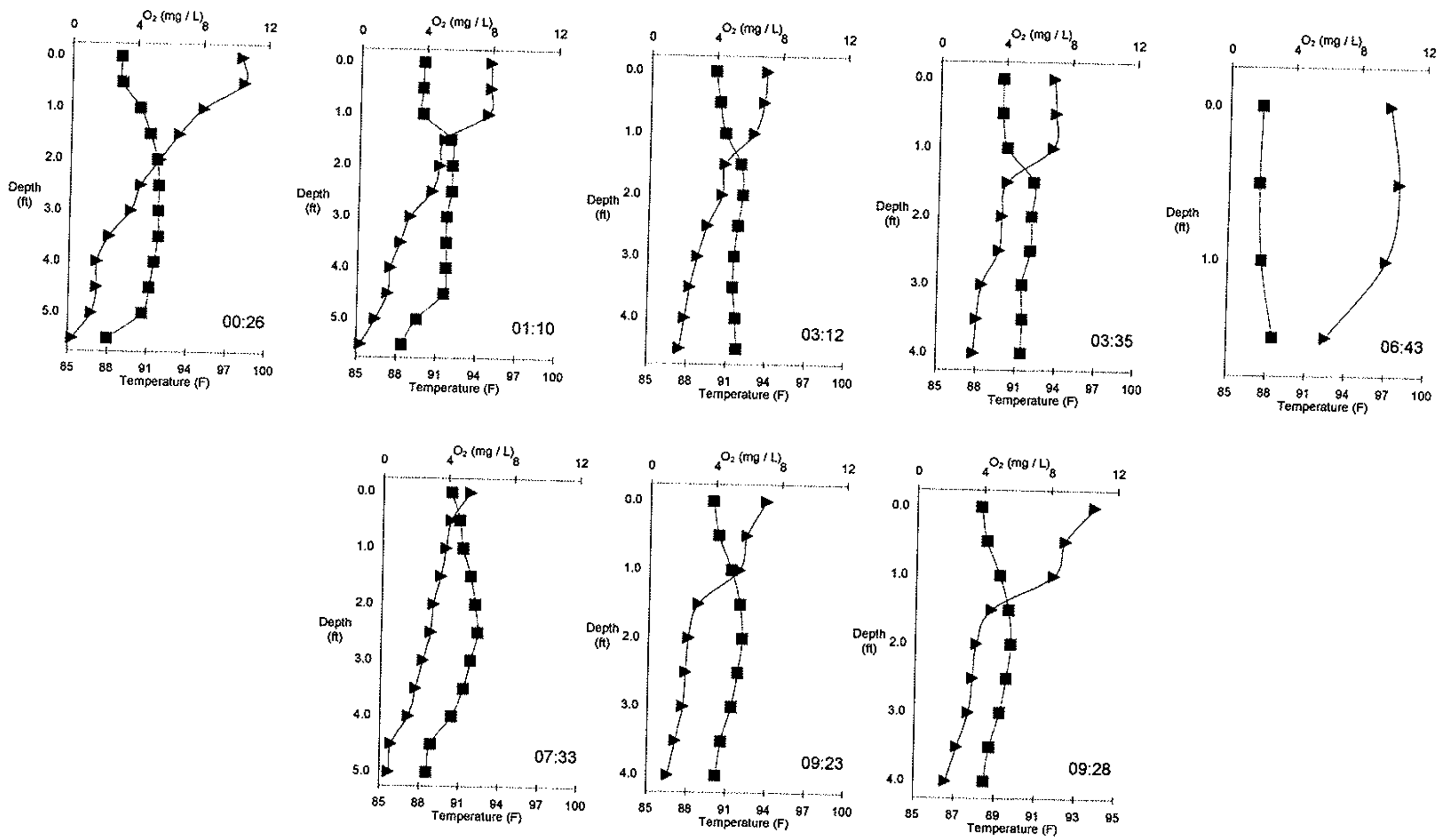


Figure 15A.182. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 16, 1999

Segment 1

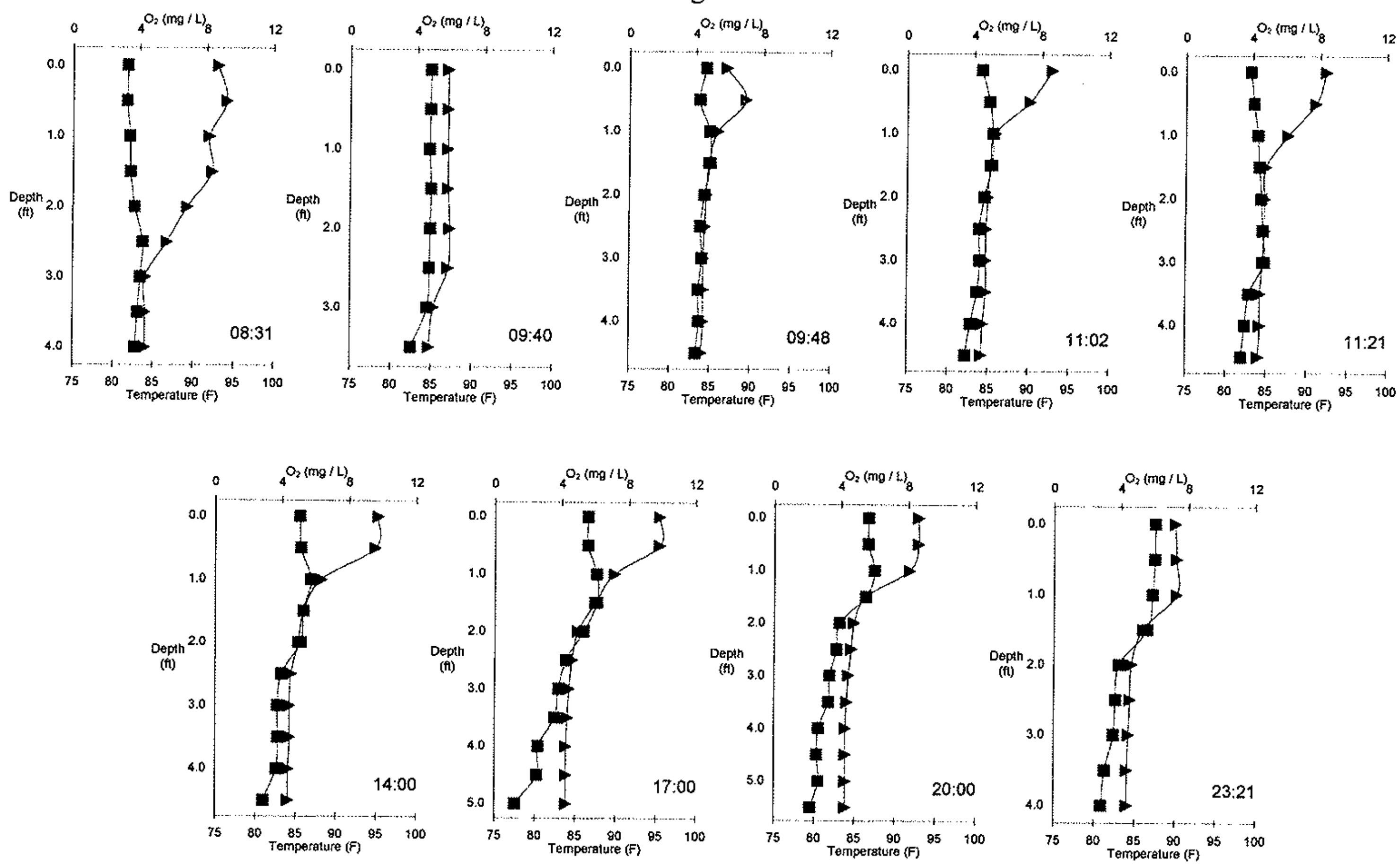


Figure 15A.183. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 16, 1999

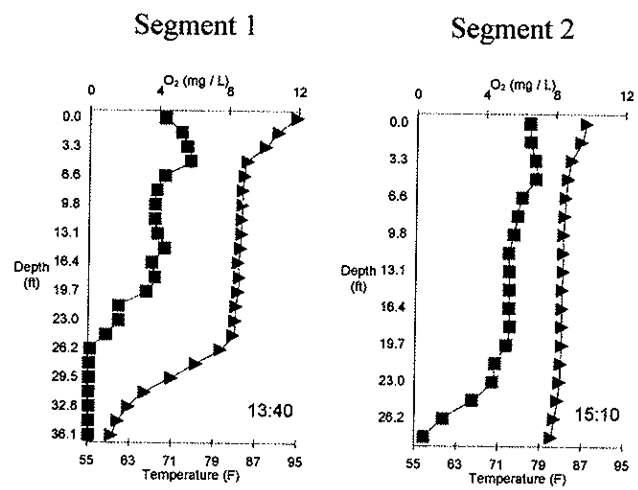
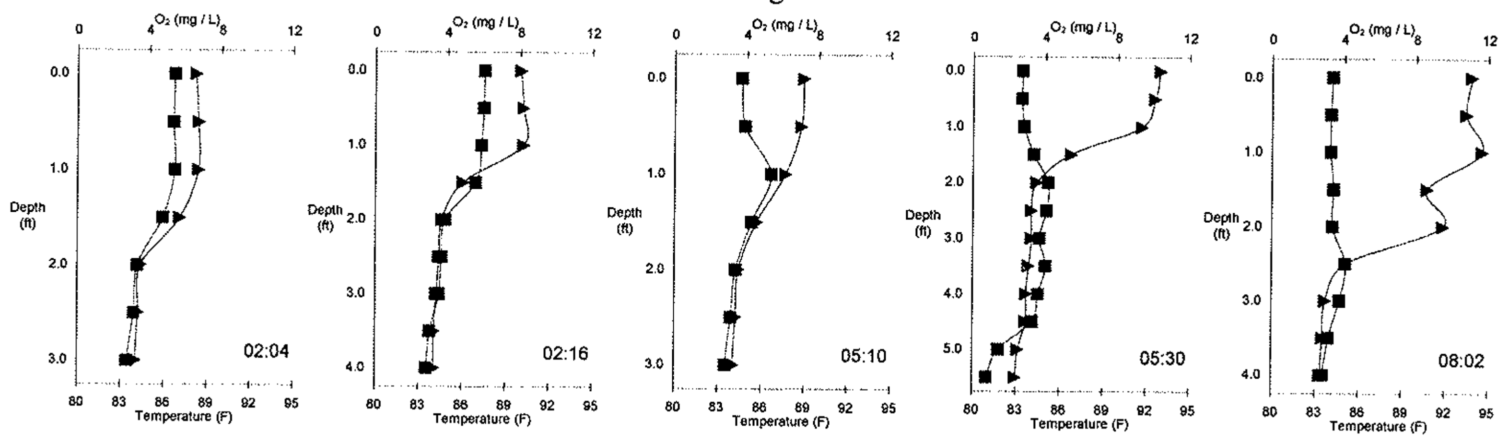


Figure 15A.184. Temperature and dissolved oxygen by date within 2 segments of Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

Lake of Egypt – August 17, 1999

Segment 1



Lake of Egypt – August 25, 1999

Segment 1

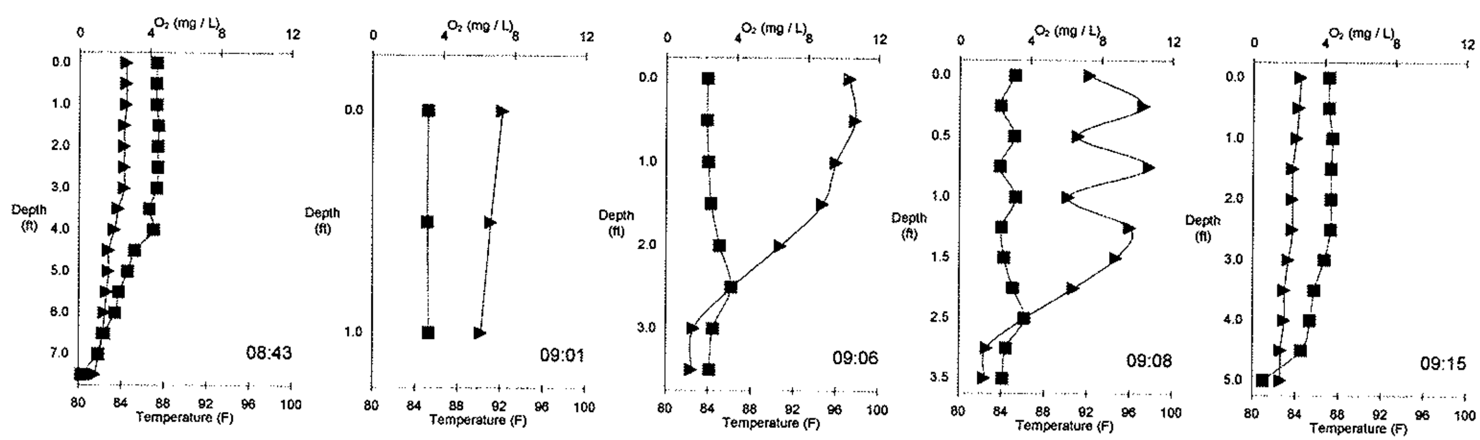


Figure 15A.185. Temperature and dissolved oxygen measured during fish tracking in Lake of Egypt, IL. Triangles represent temperature (F) and squares represent oxygen (mg / l). Time of measurement is indicated on each graph.

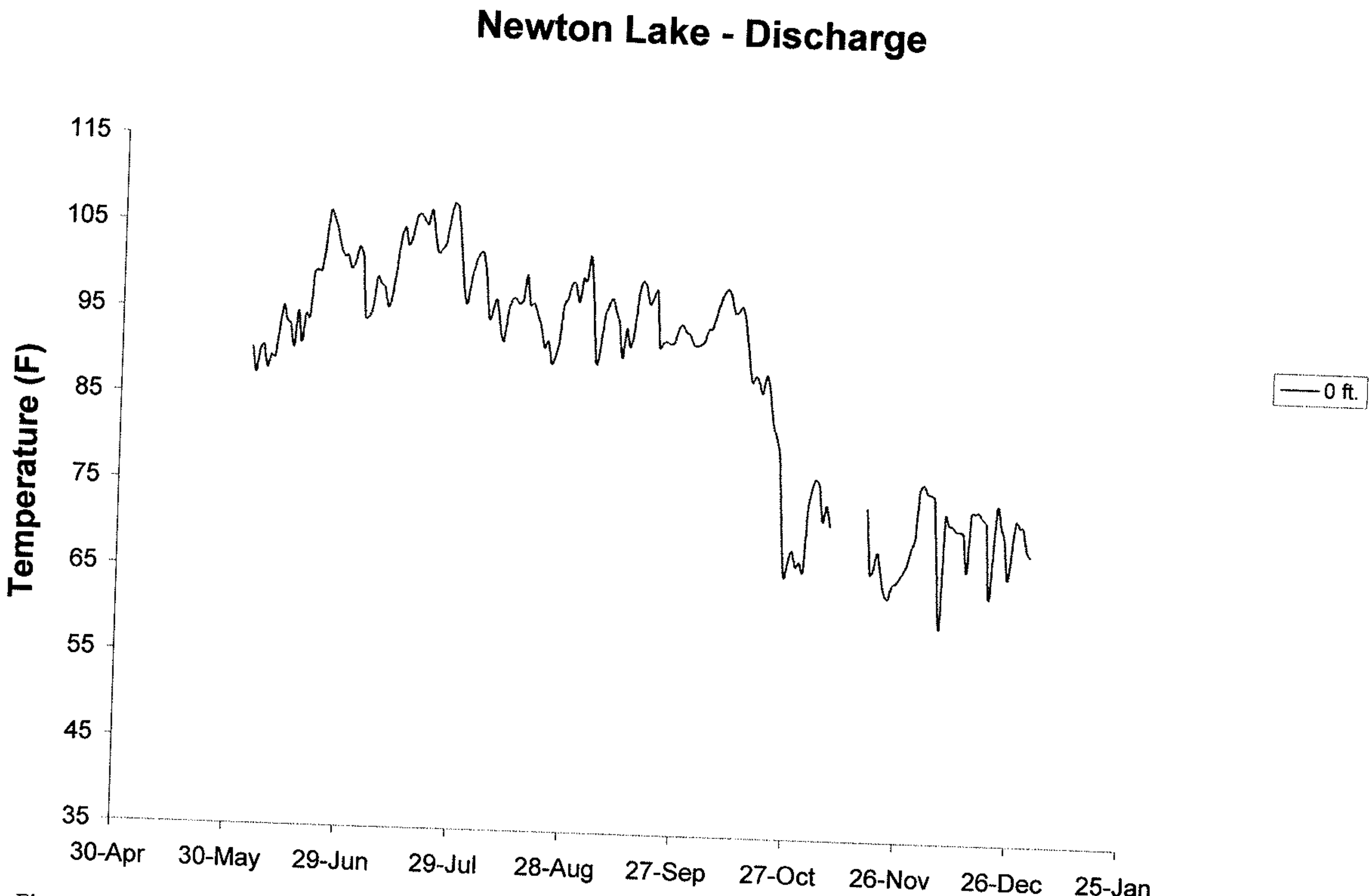


Figure 15A.186. Mean daily temperature during 1997, Newton Lake discharge.

Newton Lake - Discharge

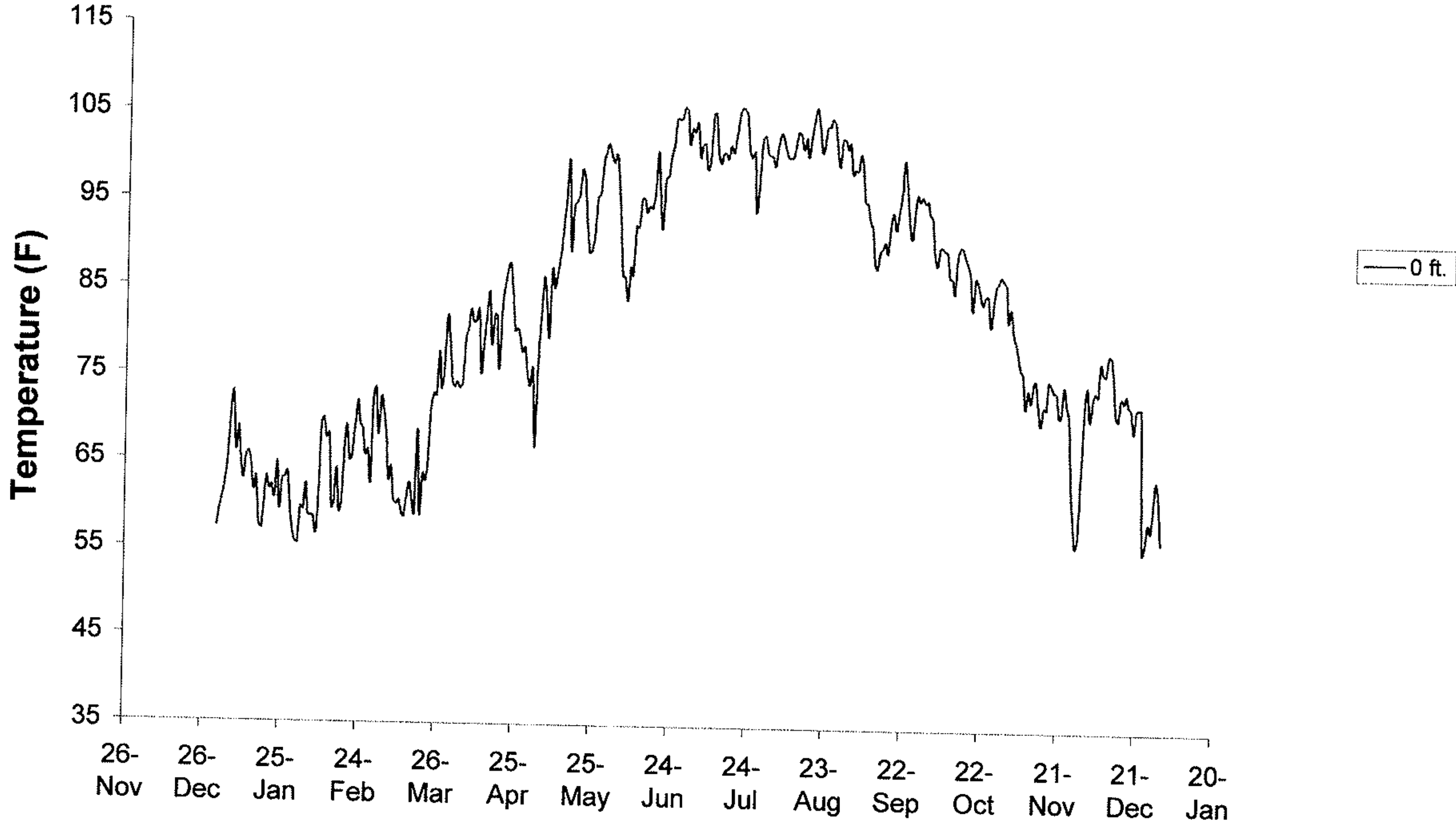


Figure 15A.187. Mean daily temperature during 1998, Newton Lake discharge.

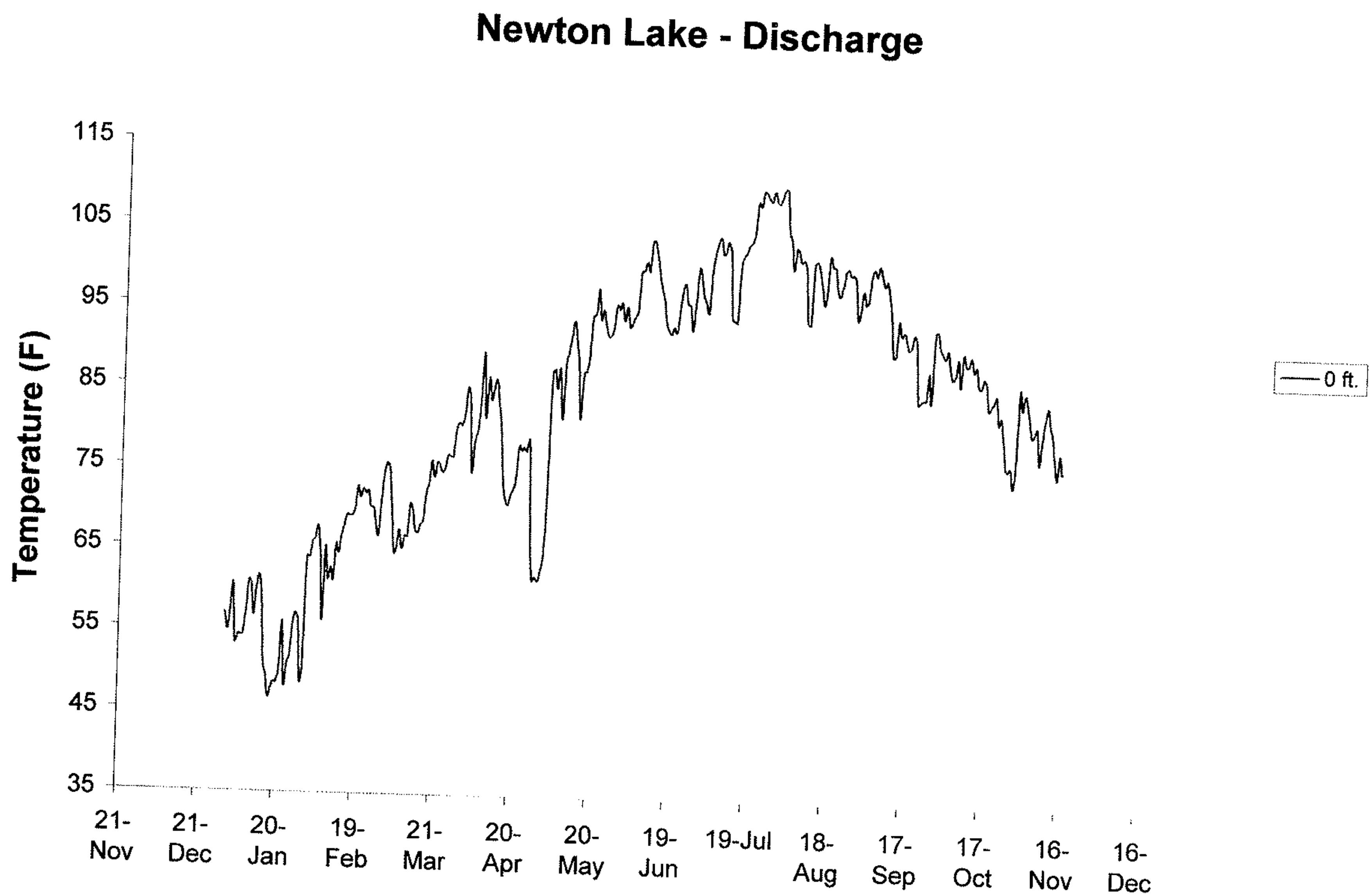


Figure 15A.188. Mean daily temperature during 1999, Newton Lake discharge.

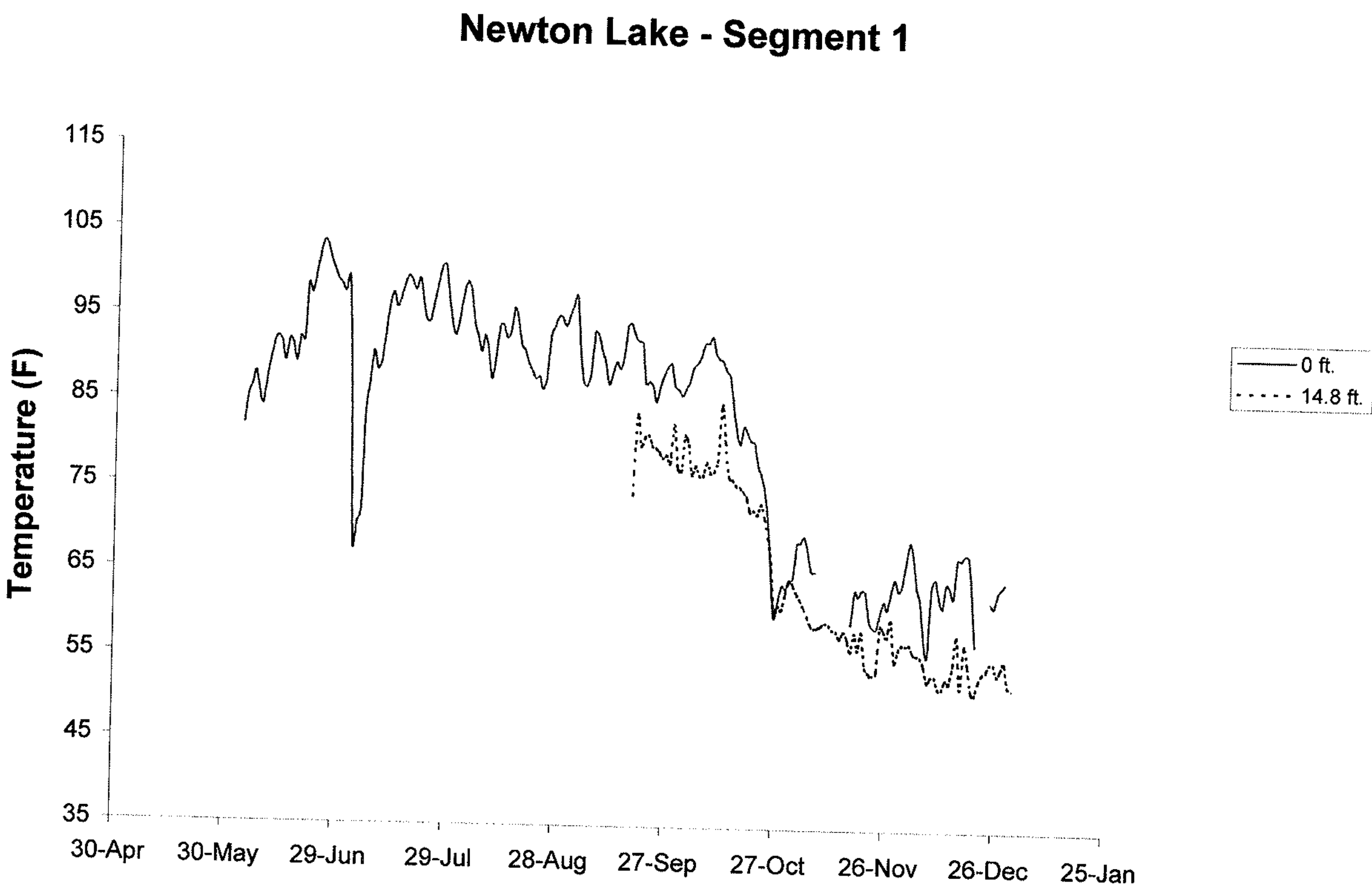


Figure 15A.189. Mean daily temperature during 1997, Newton Lake Segment 1. Lake bottom is approximately 16.4 ft.

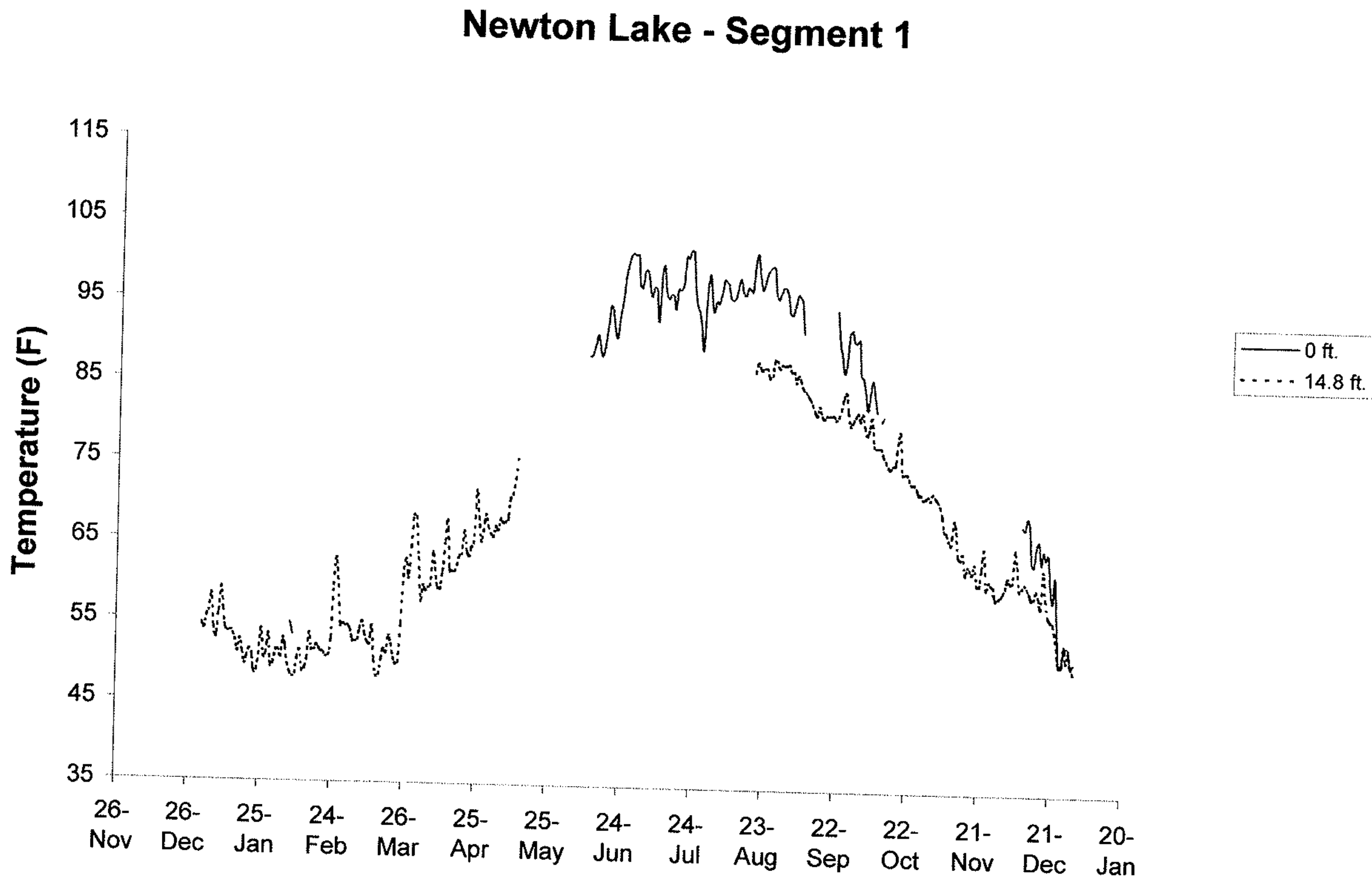


Figure 15A.190. Mean daily temperature during 1998, Newton Lake Segment 1. Lake bottom is approximately 16.4 ft.

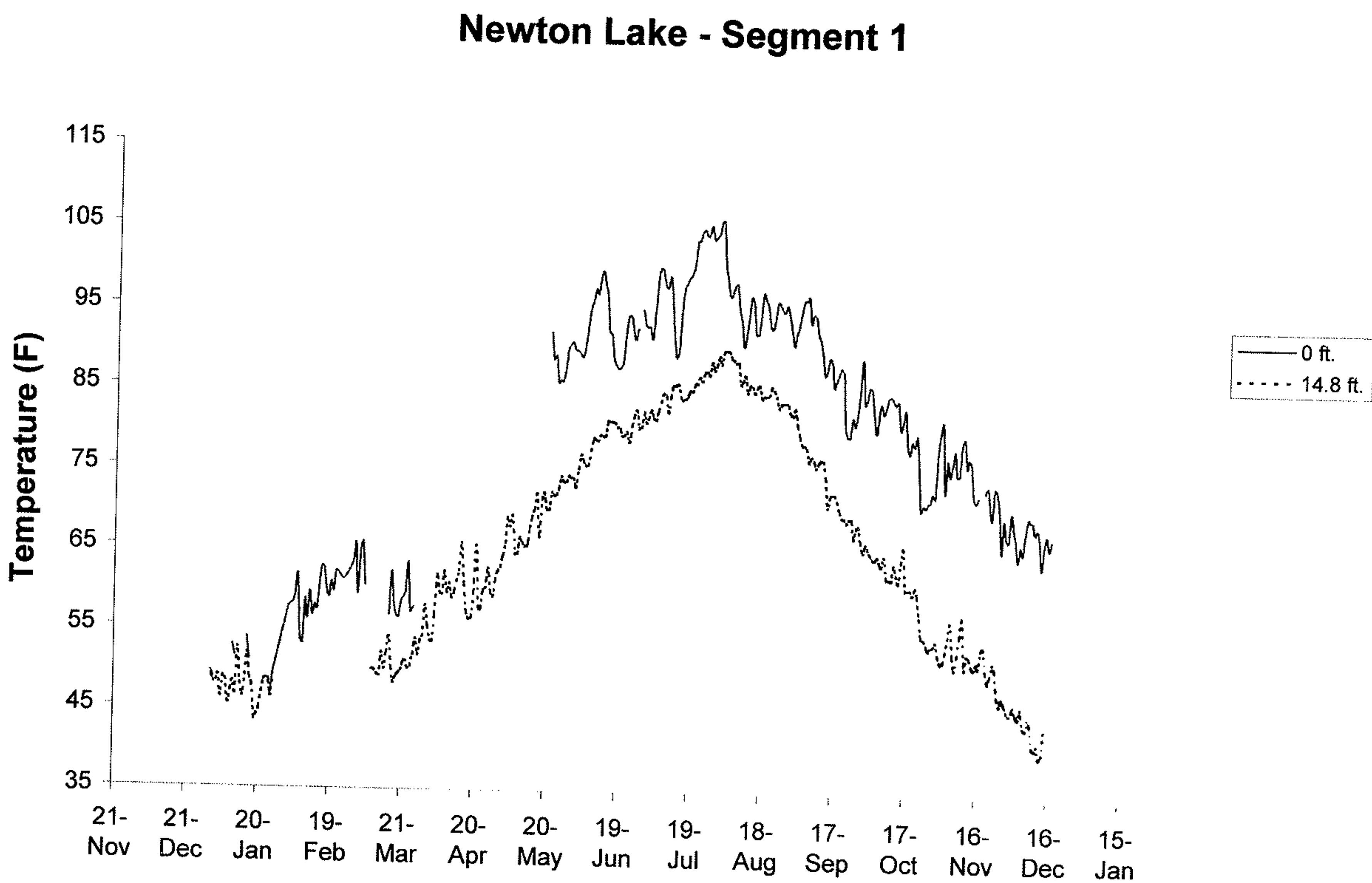


Figure 15A.191. Mean daily temperature during 1999, Newton Lake Segment 1. Lake bottom is approximately 16.4 ft.

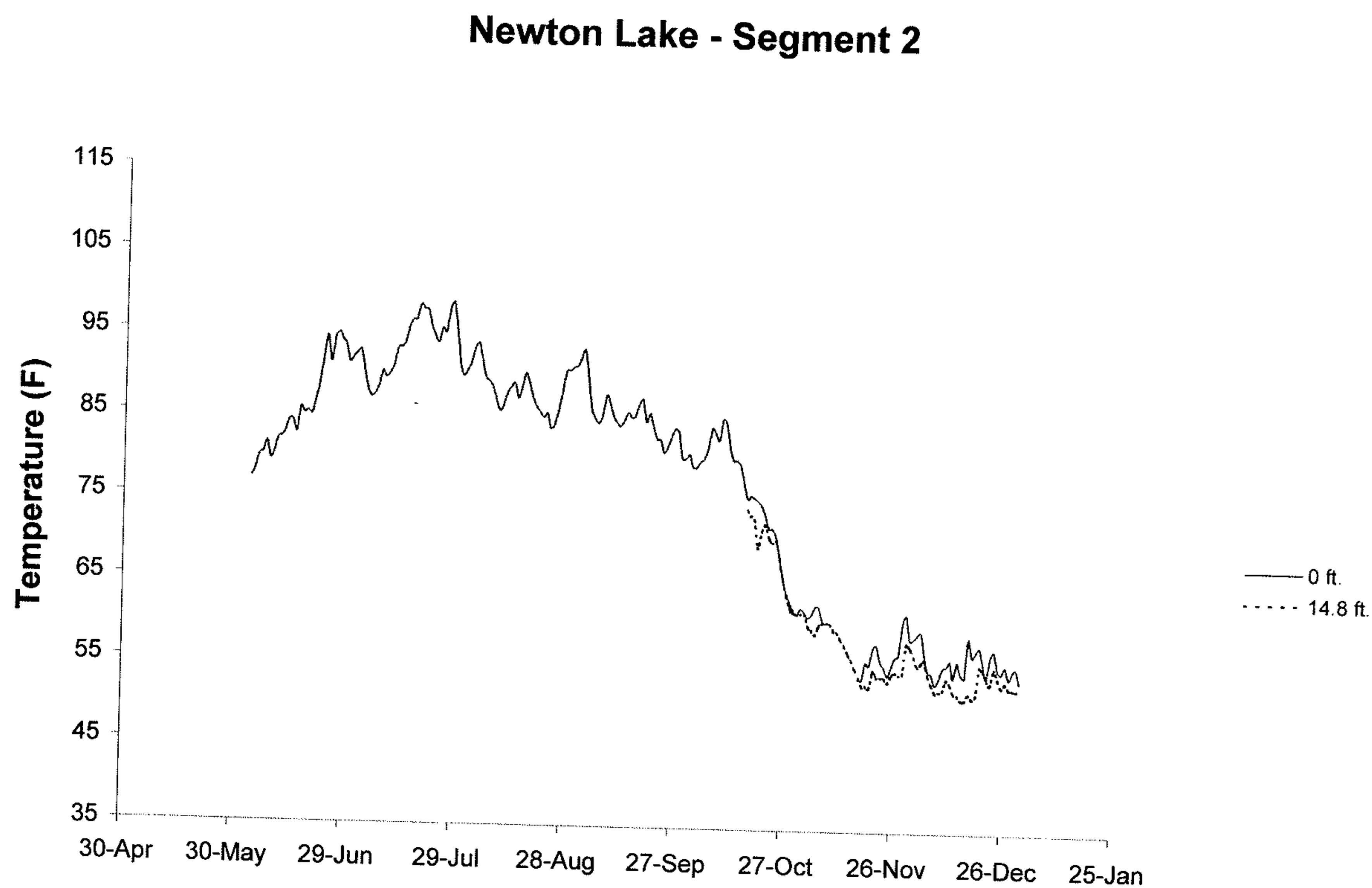


Figure 15A.192. Mean daily temperature during 1997, Newton Lake Segment 2. Lake bottom is approximately 32.8 ft.

Newton Lake - Segment 2

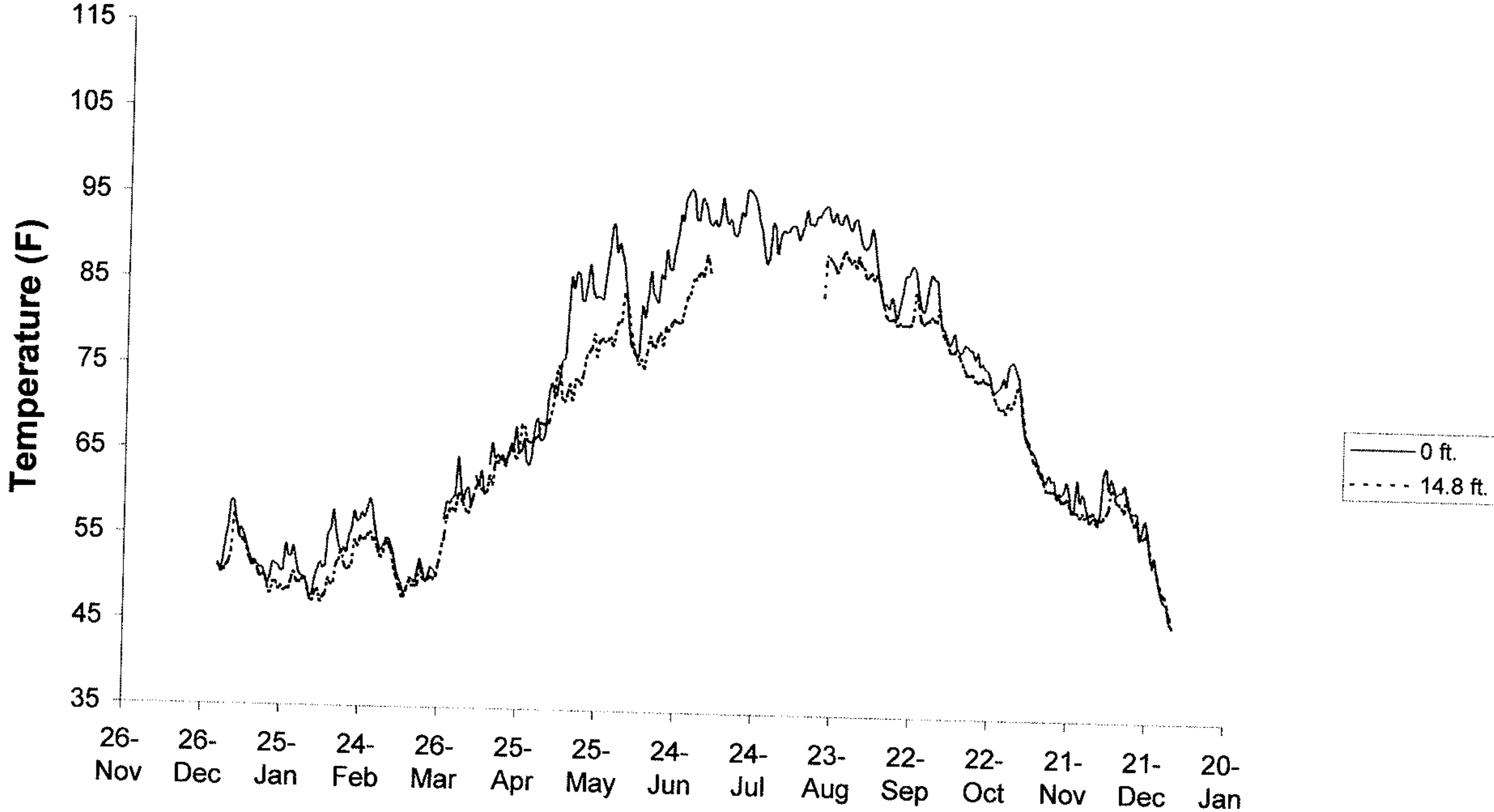


Figure 15A.193. Mean daily temperature during 1998, Newton Lake Segment 2. Lake bottom is approximately 32.8 ft.

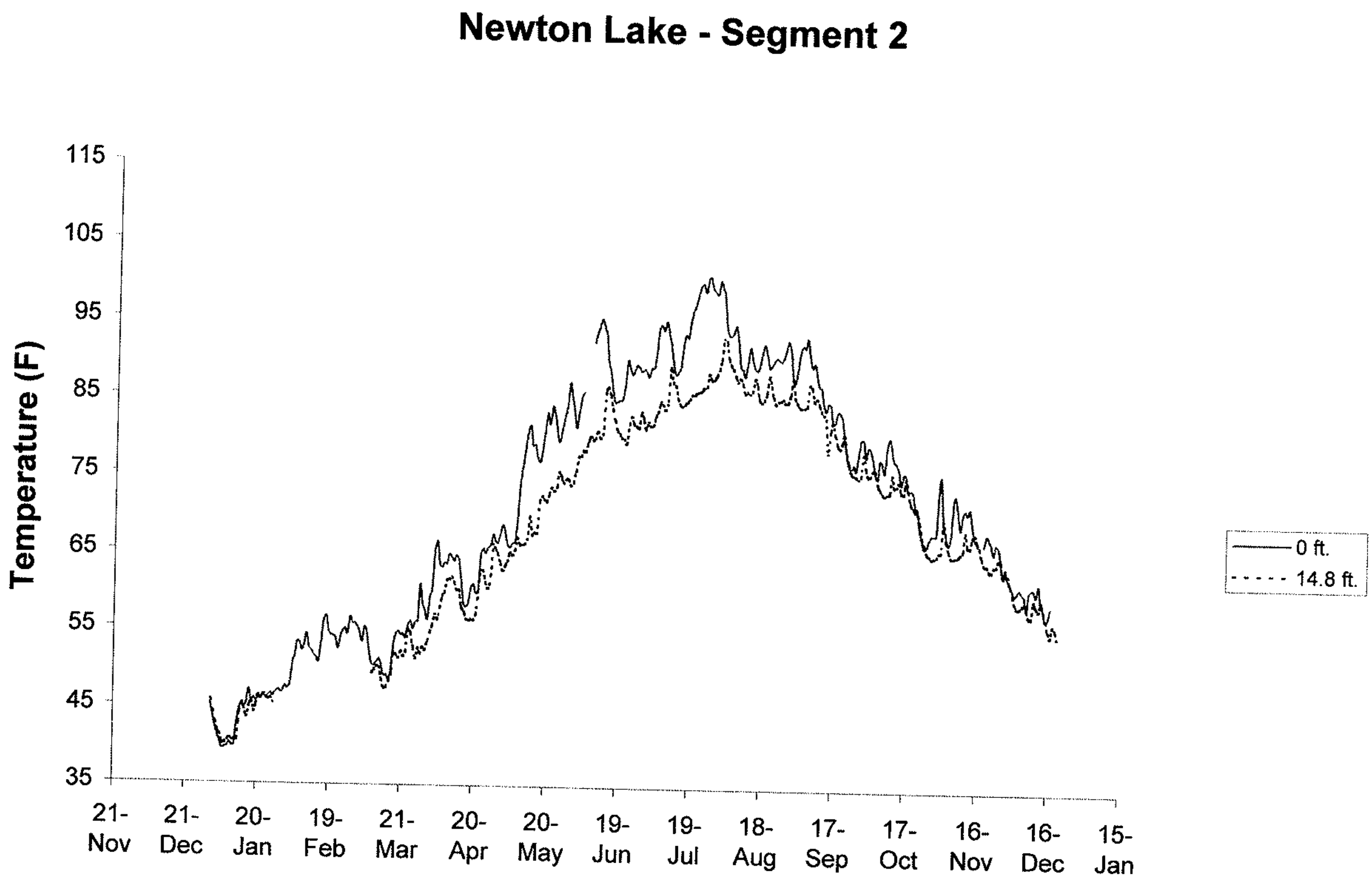


Figure 15A.194. Mean daily temperature during 1999, Newton Lake Segment 2. Lake bottom is approximately 32.8 ft.

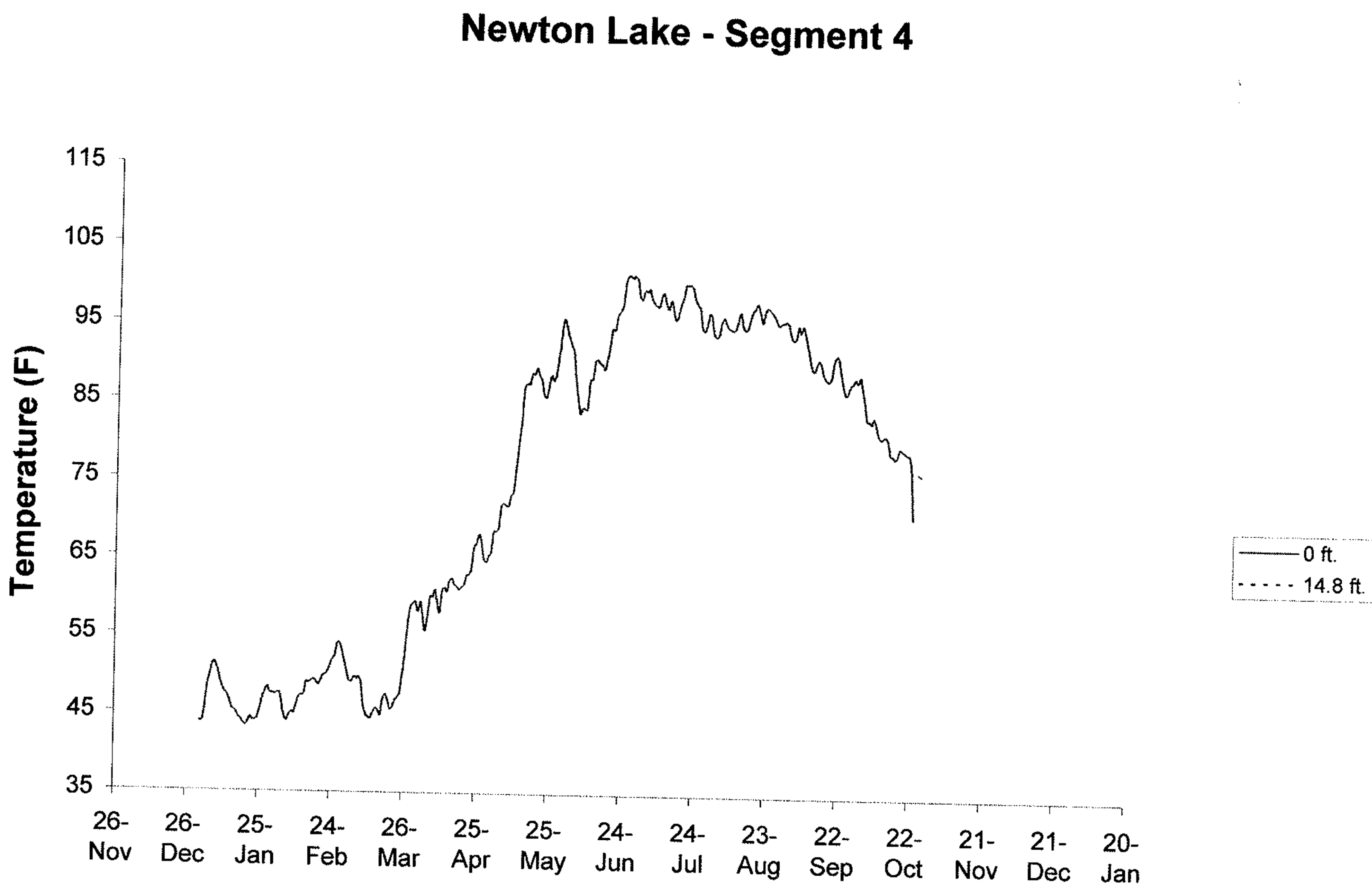


Figure 15A.199. Mean daily temperature during 1998, Newton Lake Segment 4. Lake bottom is approximately15.0 ft.

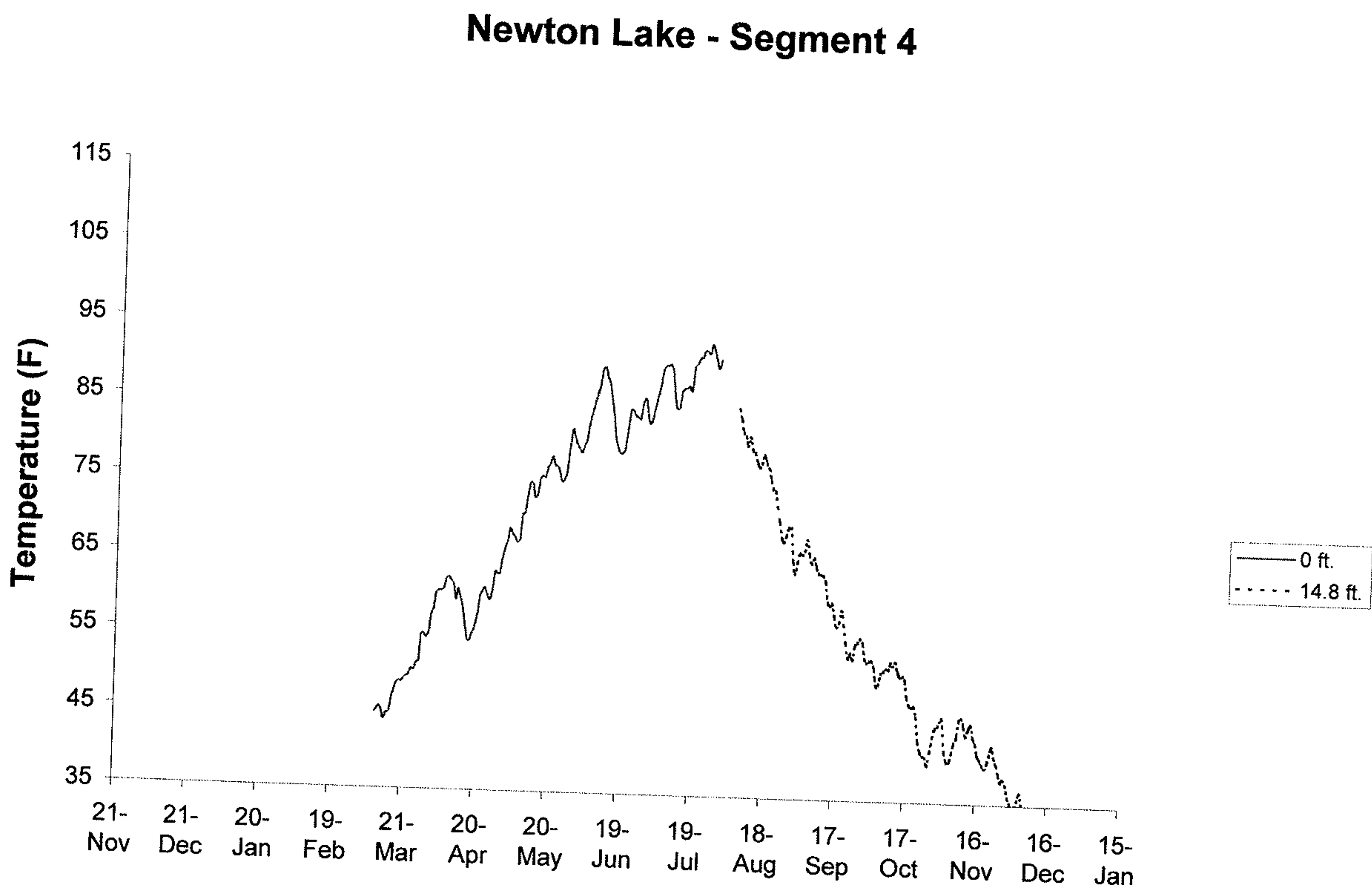


Figure 15A.200. Mean daily temperature during 1999, Newton Lake Segment 4. Lake bottom is approximately15.0 ft.

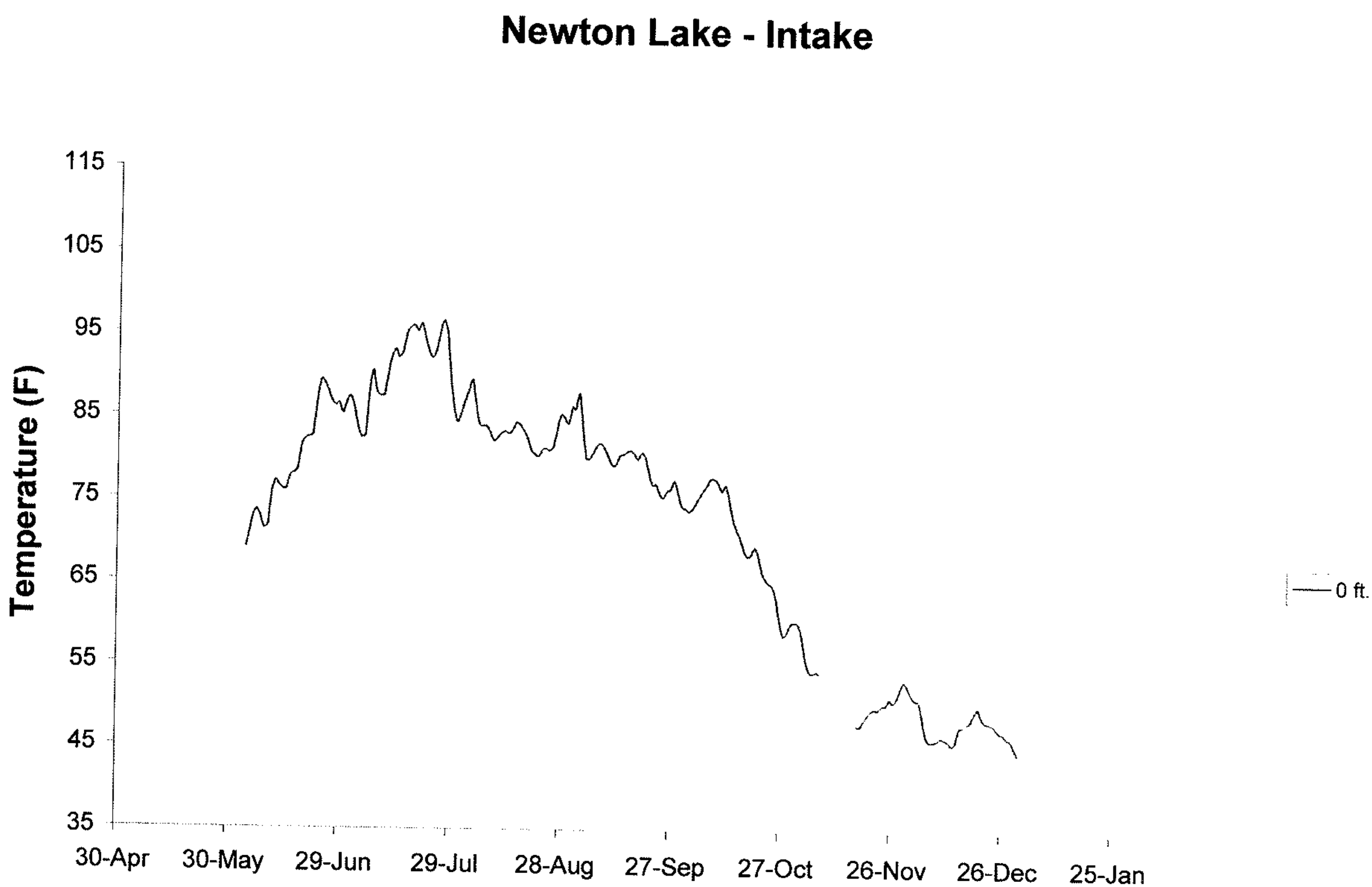


Figure 15A.201. Mean daily temperature during 1997, Newton Lake intake.

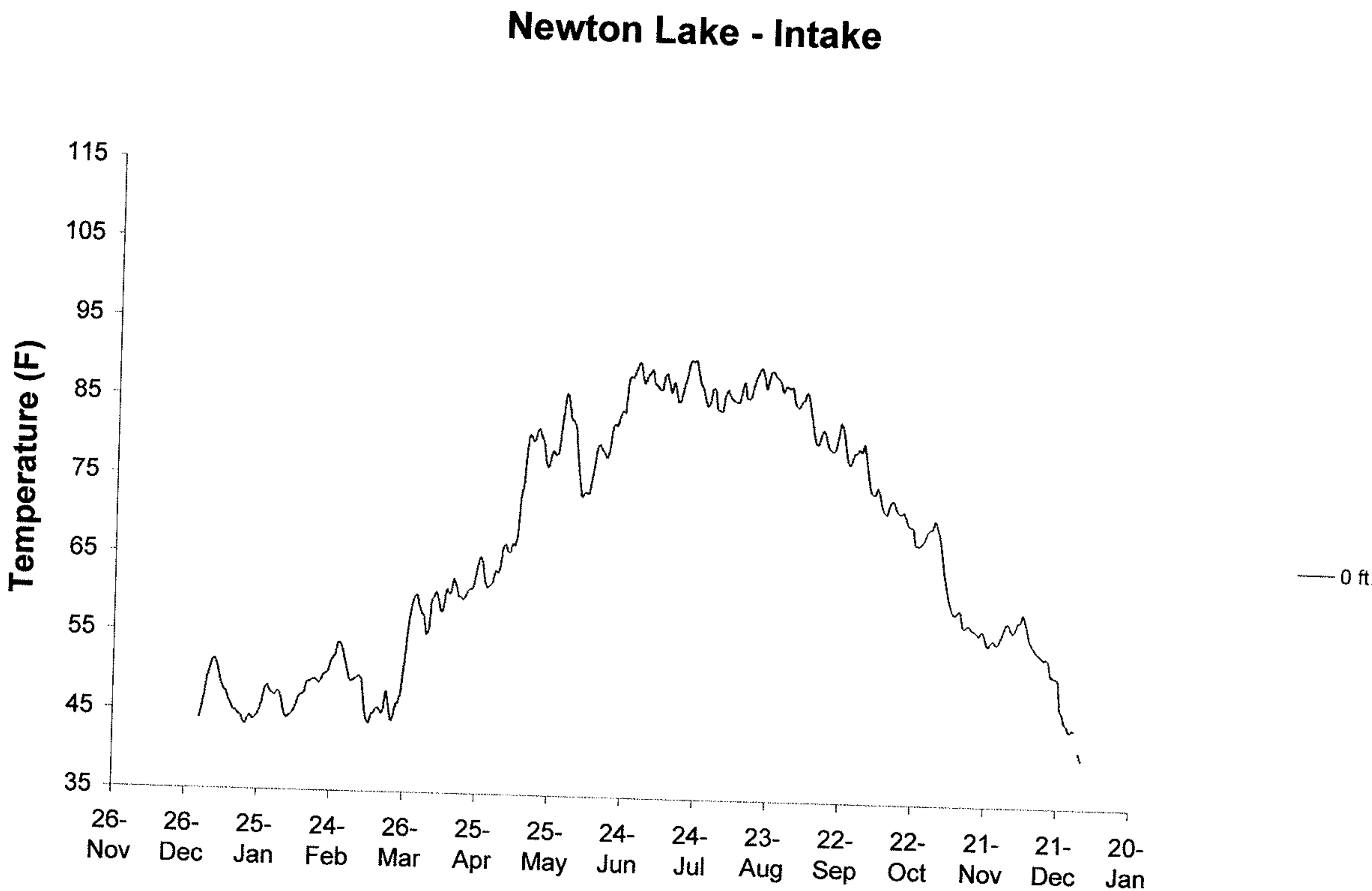


Figure 15A.202. Mean daily temperature during 1998, Newton Lake intake.

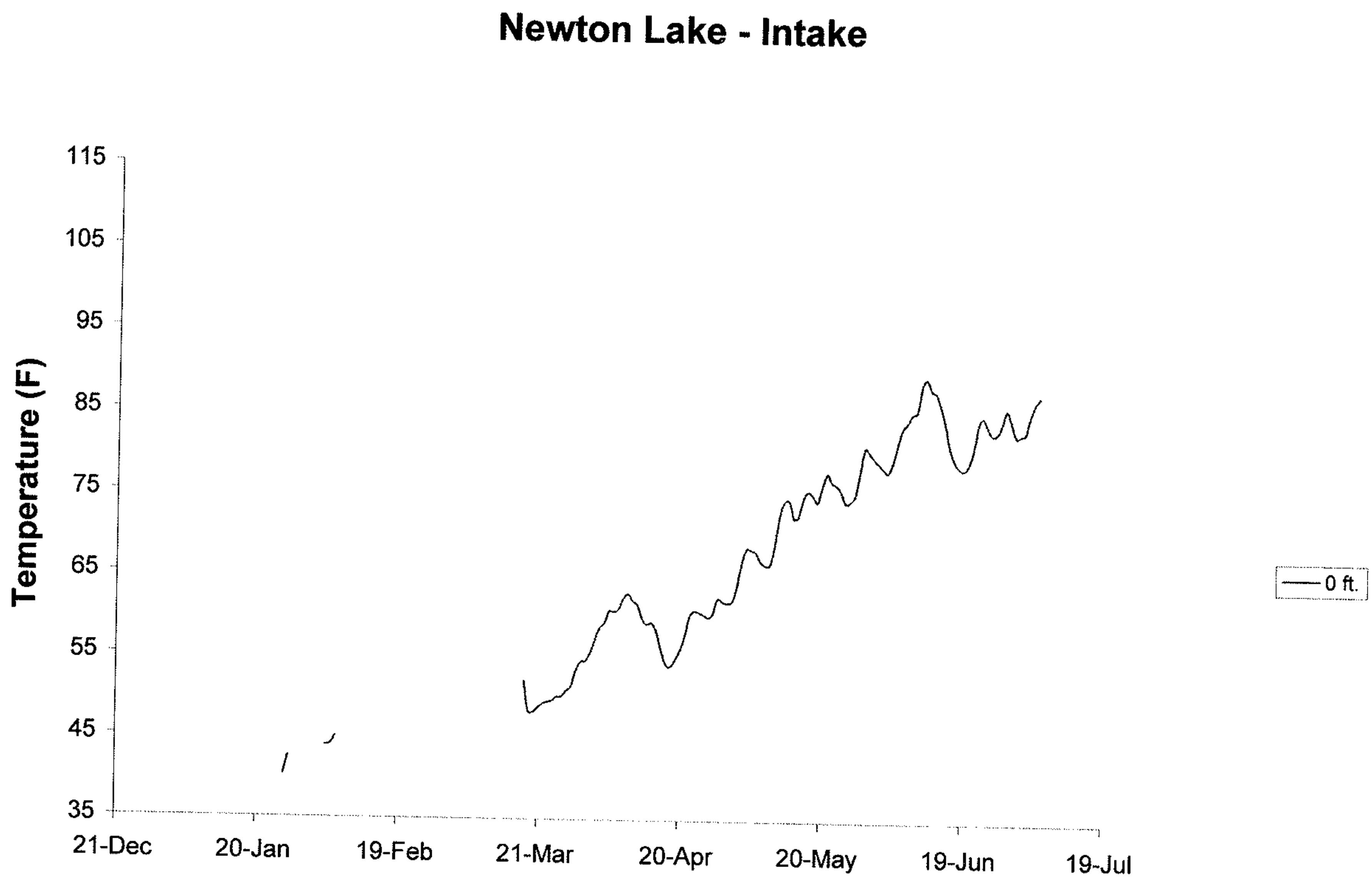


Figure 15A.203. Mean daily temperature during 1999, Newton Lake intake.

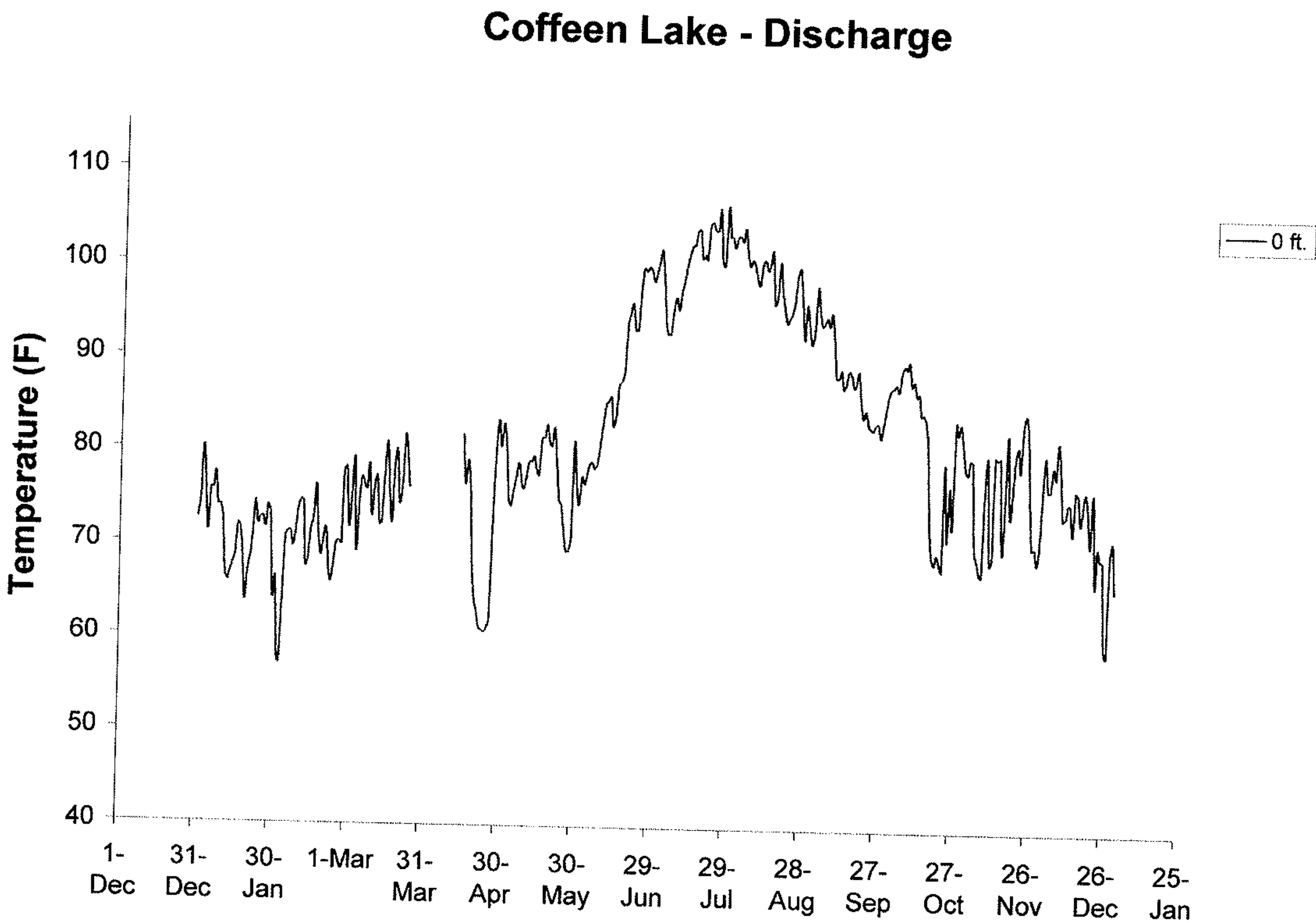


Figure 15A.204. Mean daily temperature during 1997, Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

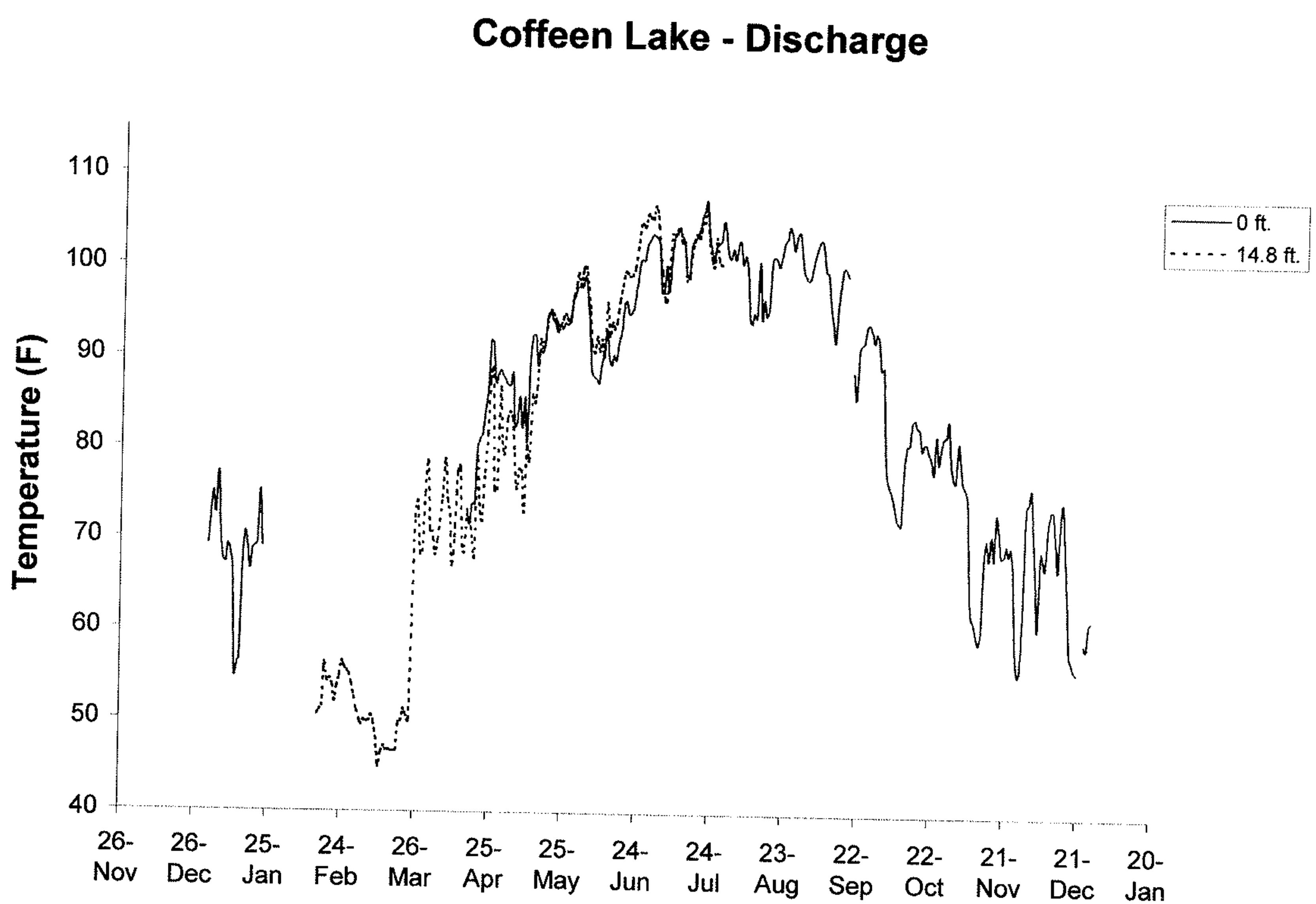


Figure 15A.205. Mean daily temperature during 1997, Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

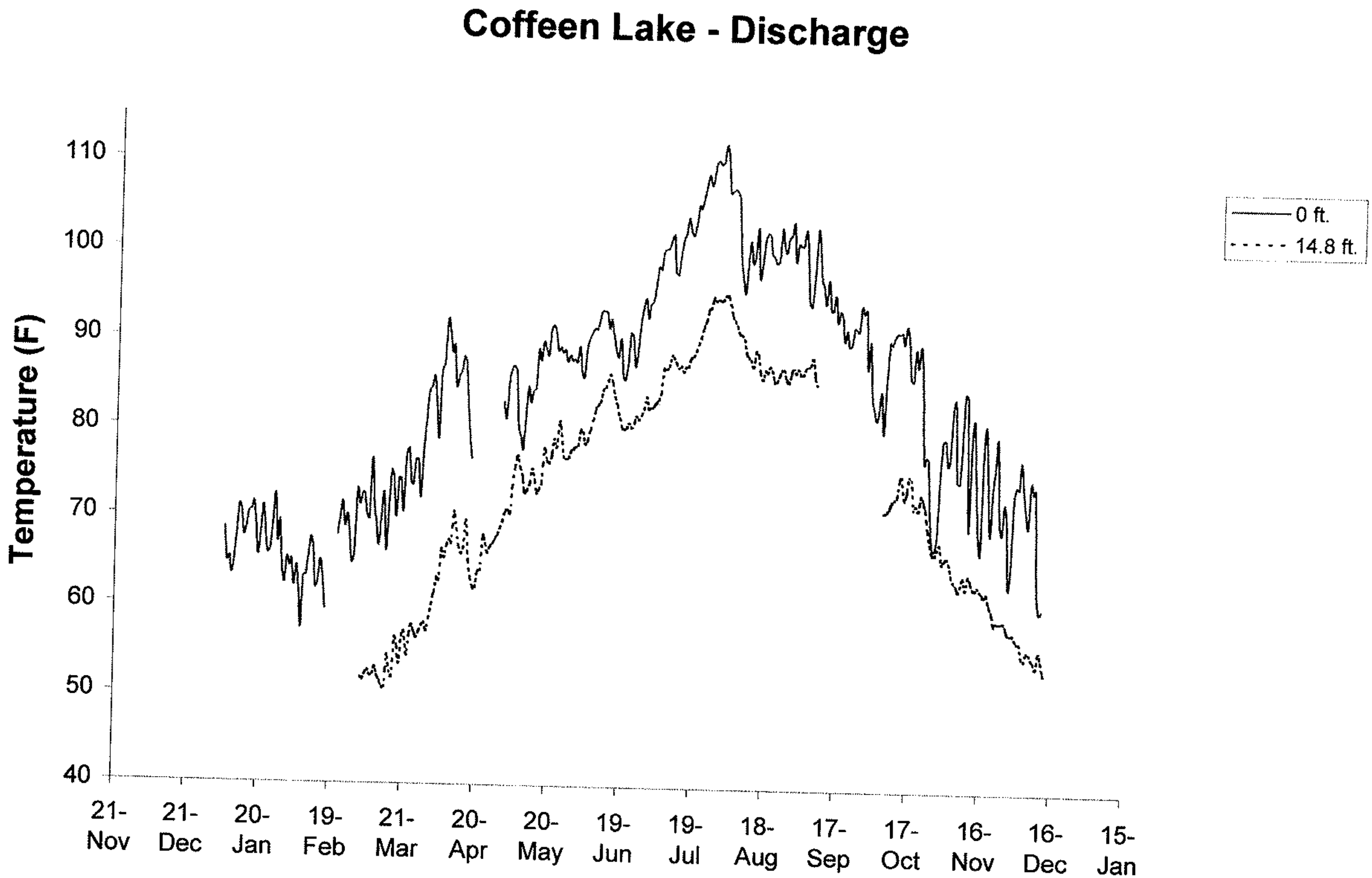


Figure 15A.206. Mean daily temperature during 1997, Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

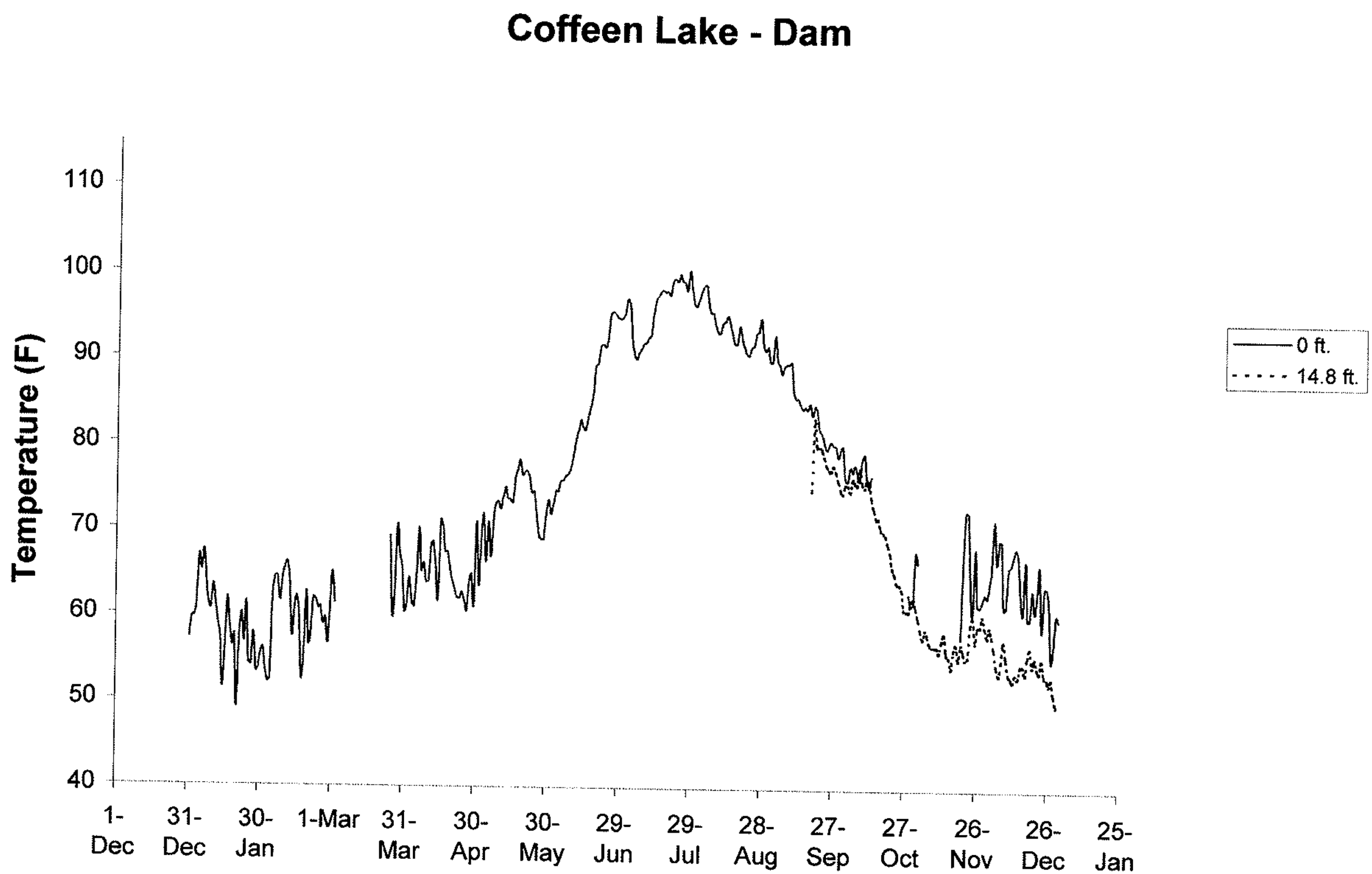


Figure 15A.207. Mean daily temperature during 1997, Coffeen Lake dam. Lake bottom is approximately 42.6 feet.

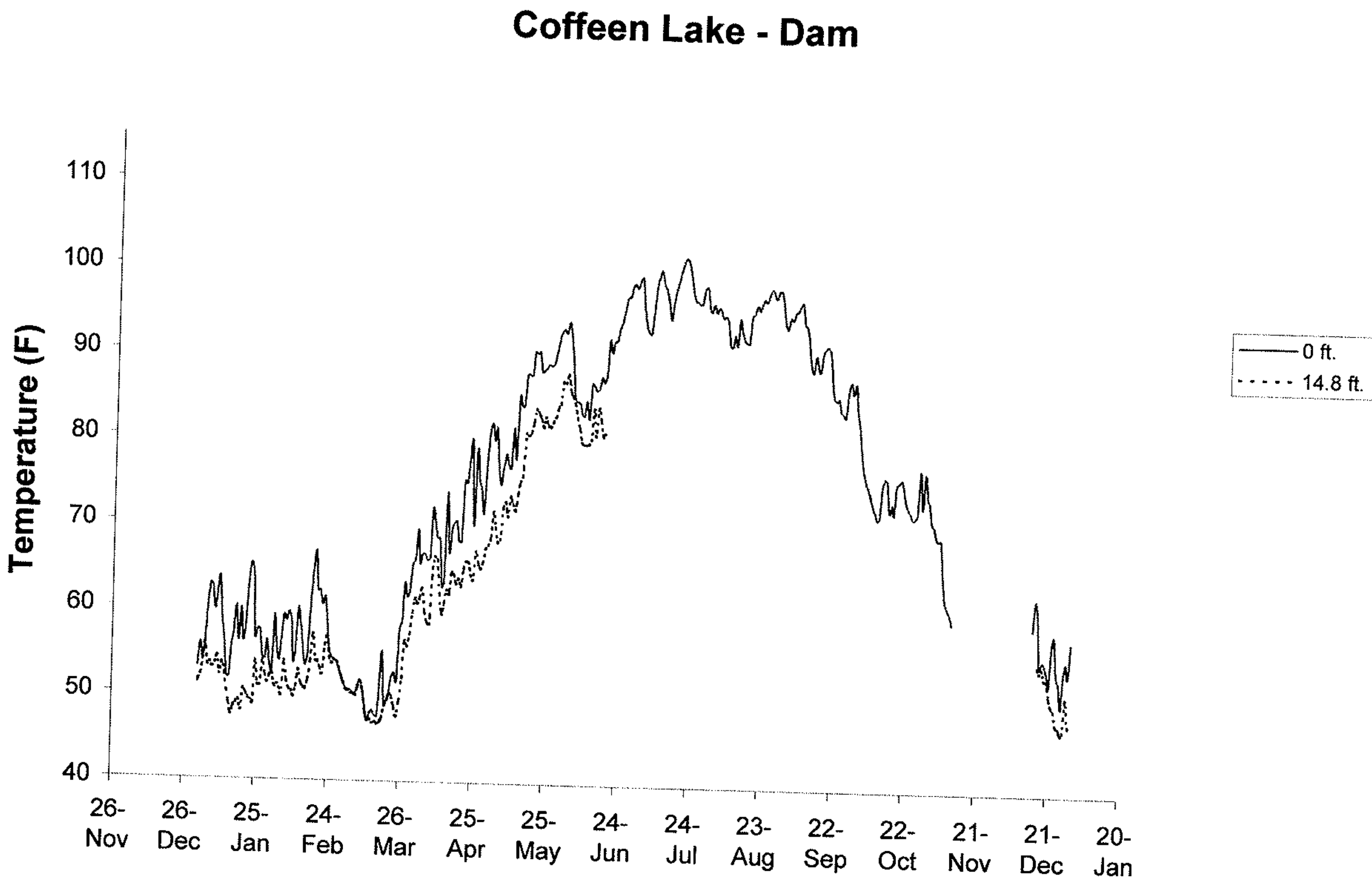


Figure 15A.208. Mean daily temperature during 1997, Coffeen Lake dam. Lake bottom is approximately 42.6 feet.

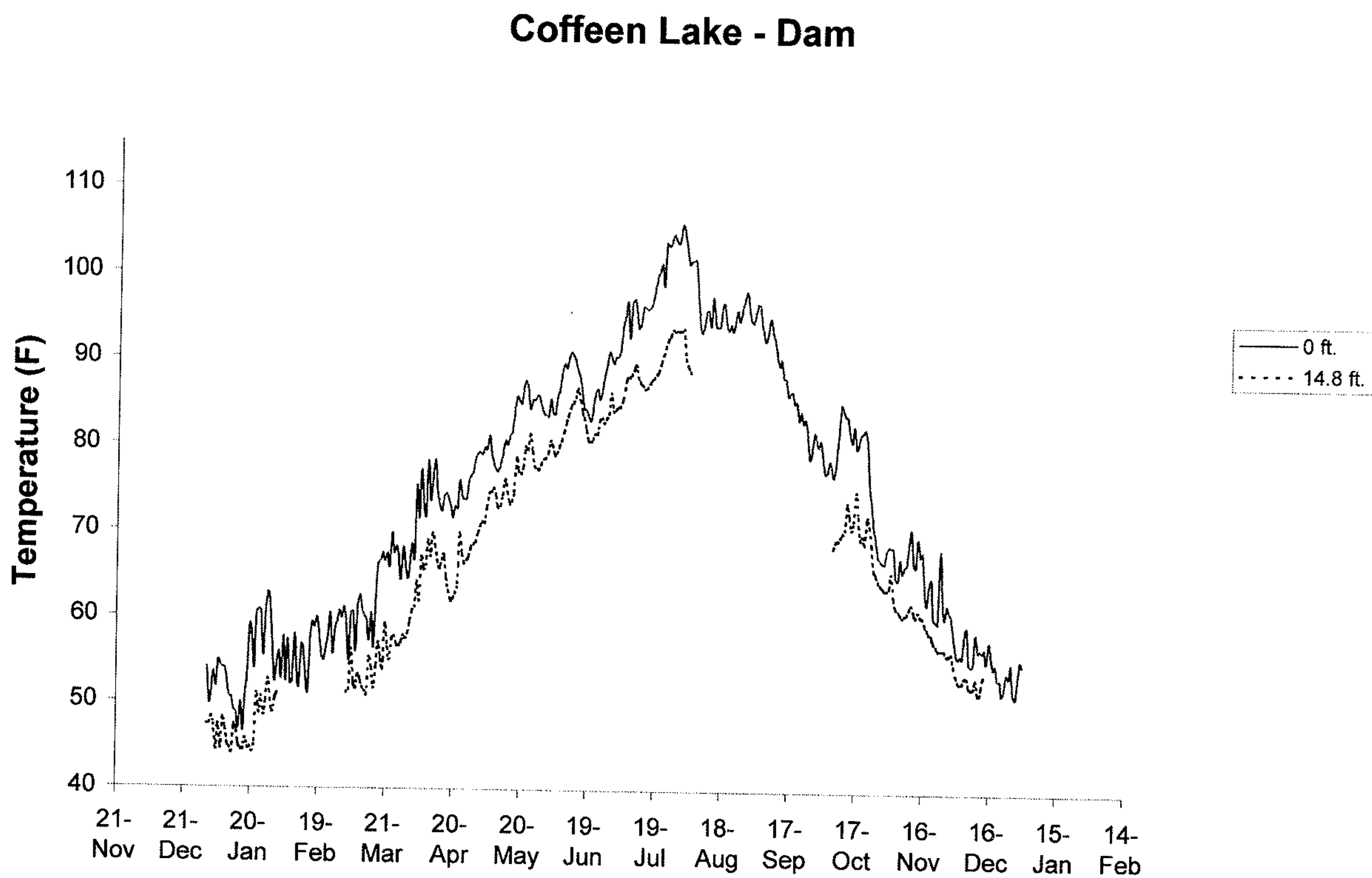


Figure 15A.209. Mean daily temperature during 1997, Coffeen Lake dam. Lake bottom is approximately 42.6 feet.

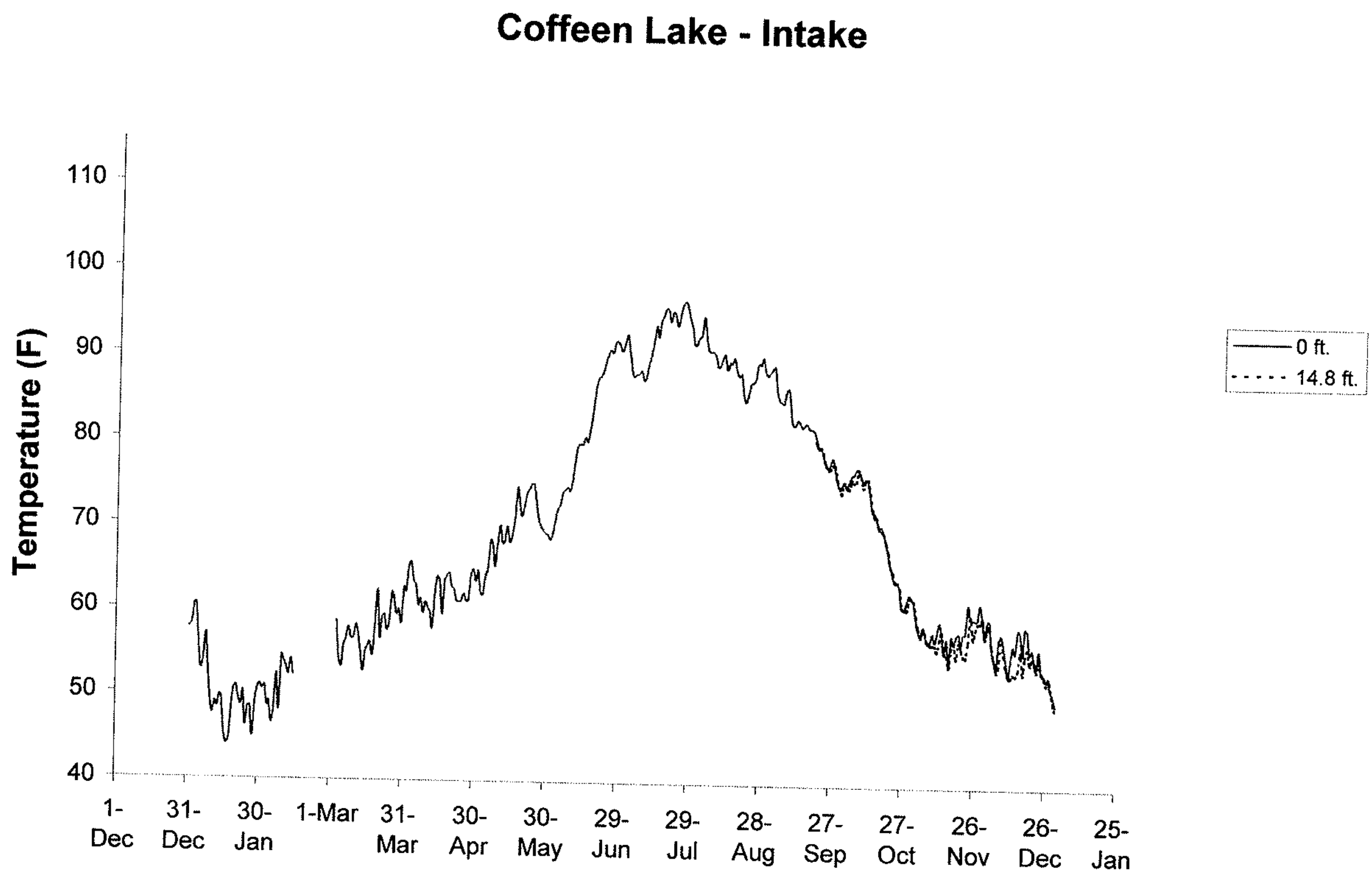


Figure 15A.210. Mean daily temperature during 1997, Coffeen Lake intake. Lake bottom is approximately 26.2 feet.

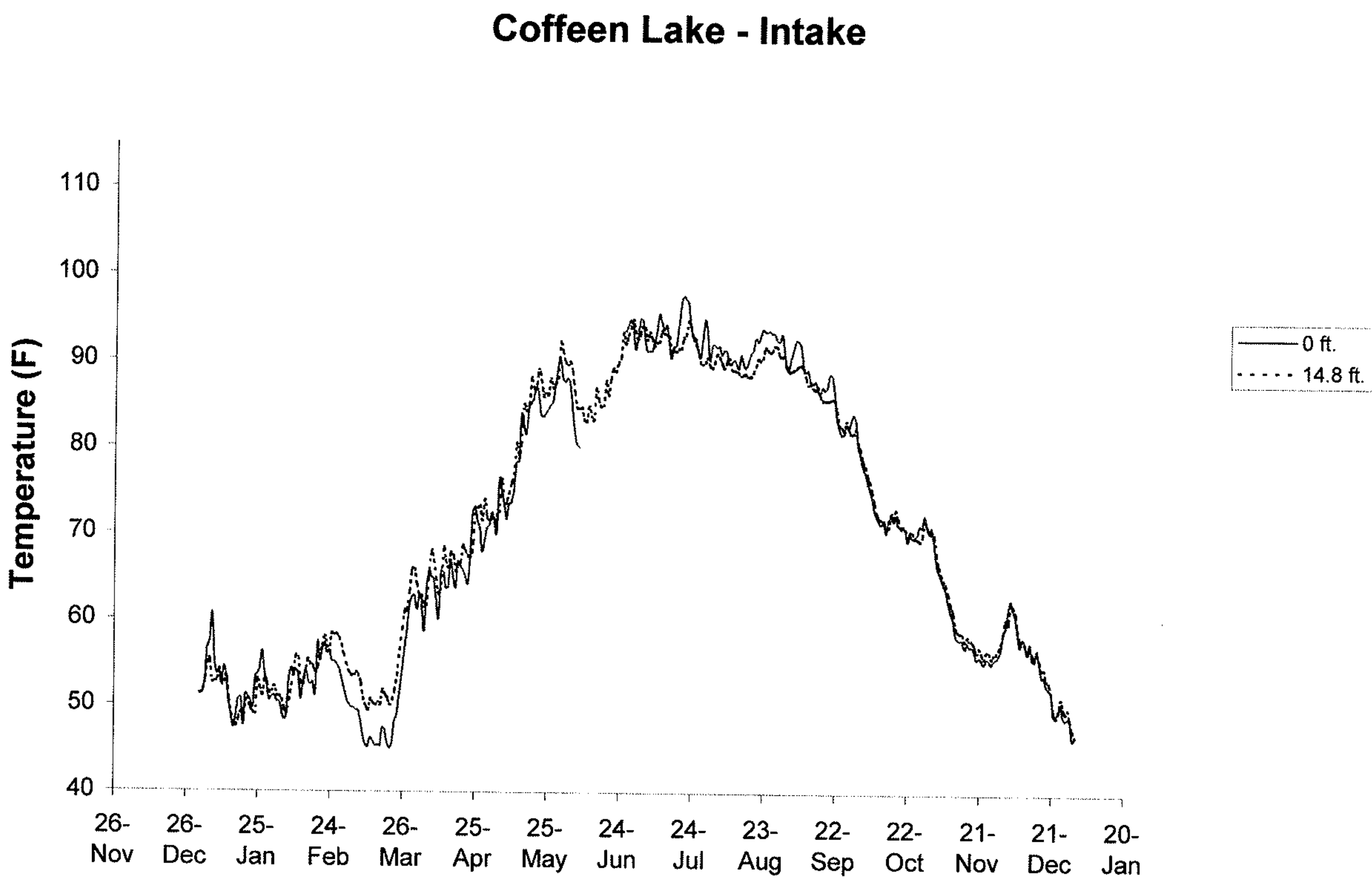


Figure 15A.211. Mean daily temperature during 1997, Coffeen Lake intake. Lake bottom is approximately 26.2 feet.

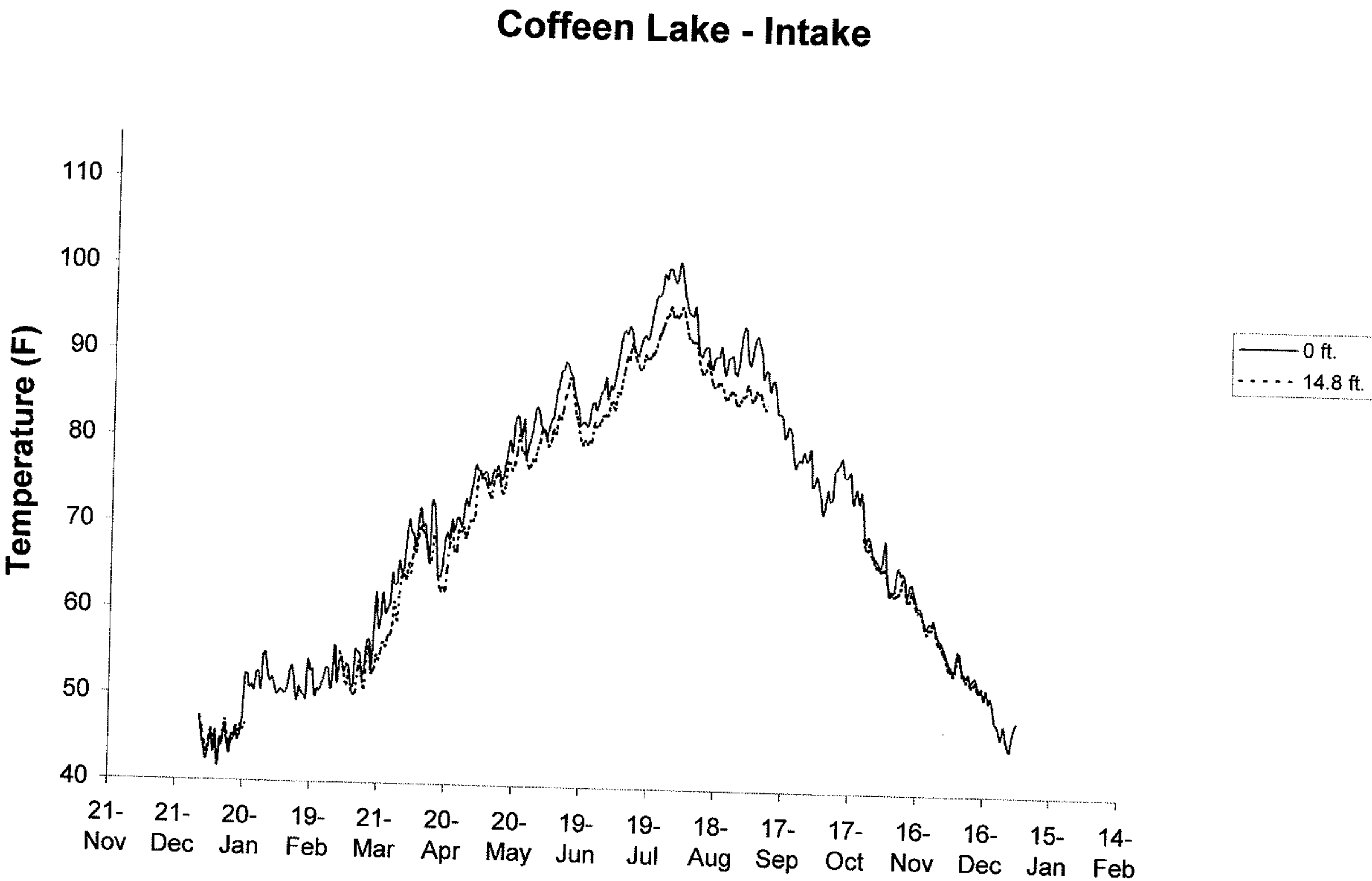


Figure 15A.212. Mean daily temperature during 1997, Coffeen Lake intake. Lake bottom is approximately 26.2 feet.

Figure 15A.213. Mean daily temperature during 1997, Lake of Egypt Segment 1. Lake bottom is approximately 36.1 feet.

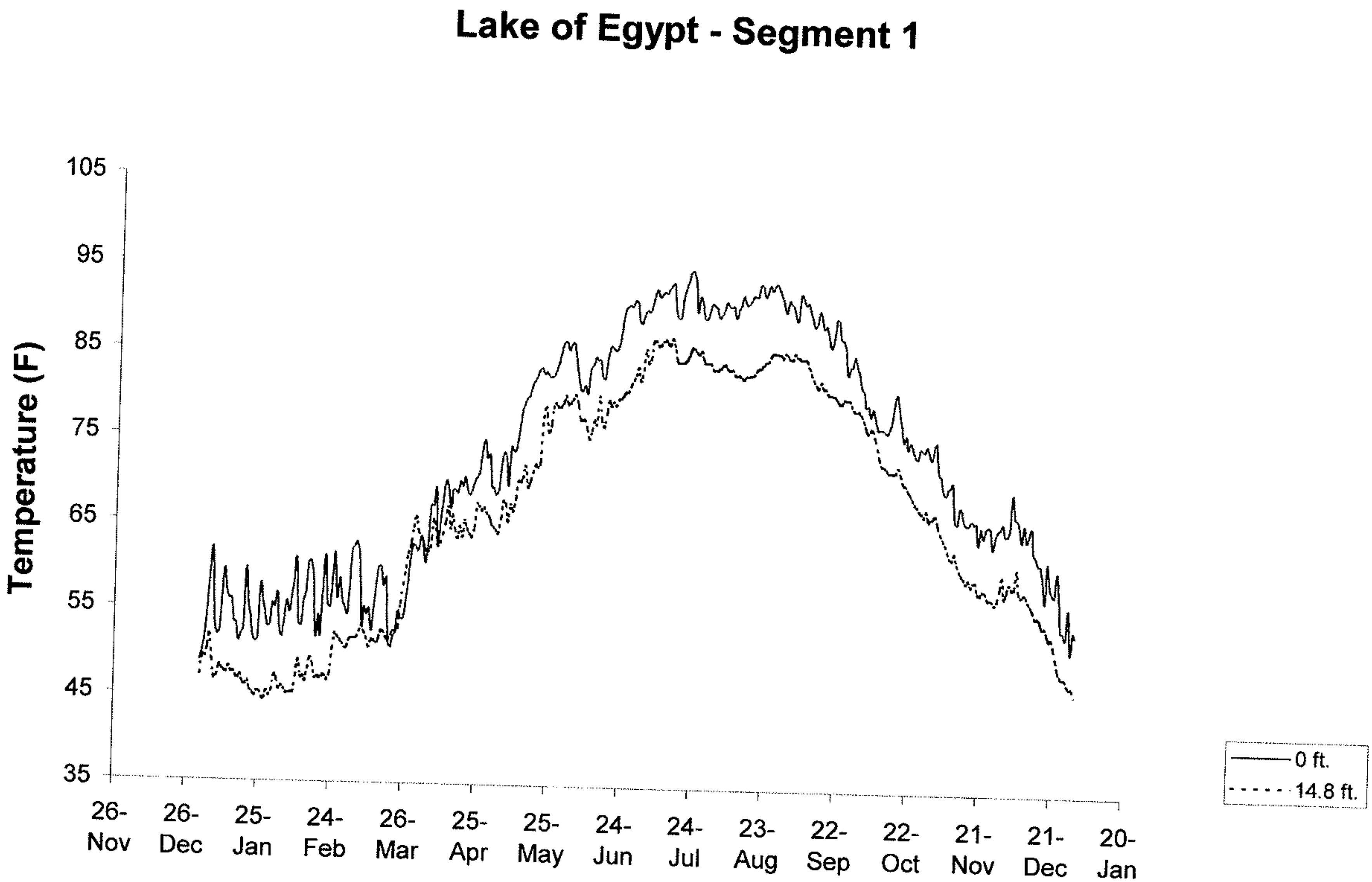


Figure 15A.214. Mean daily temperature during 1998, Lake of Egypt Segment 1. Lake bottom is approximately 36.1 feet.

Figure 15A.215. Mean daily temperature during 1999, Lake of Egypt Segment 1. Lake bottom is approximately 36.1 feet.

Lake of Egypt - Segment 2

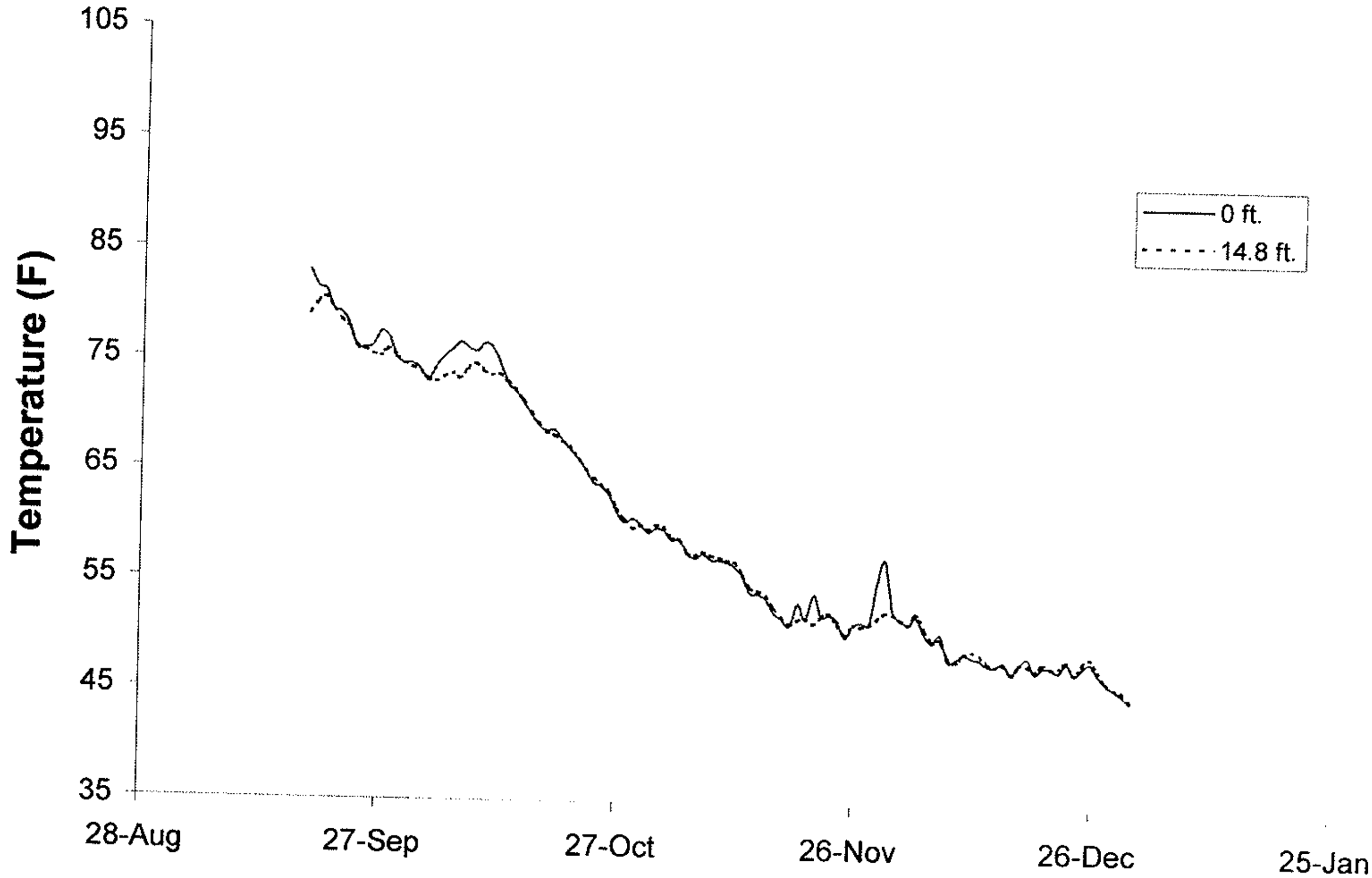


Figure 15A.216. Mean daily temperature during 1997, Lake of Egypt Segment 2. Lake bottom is approximately 13.1 feet.

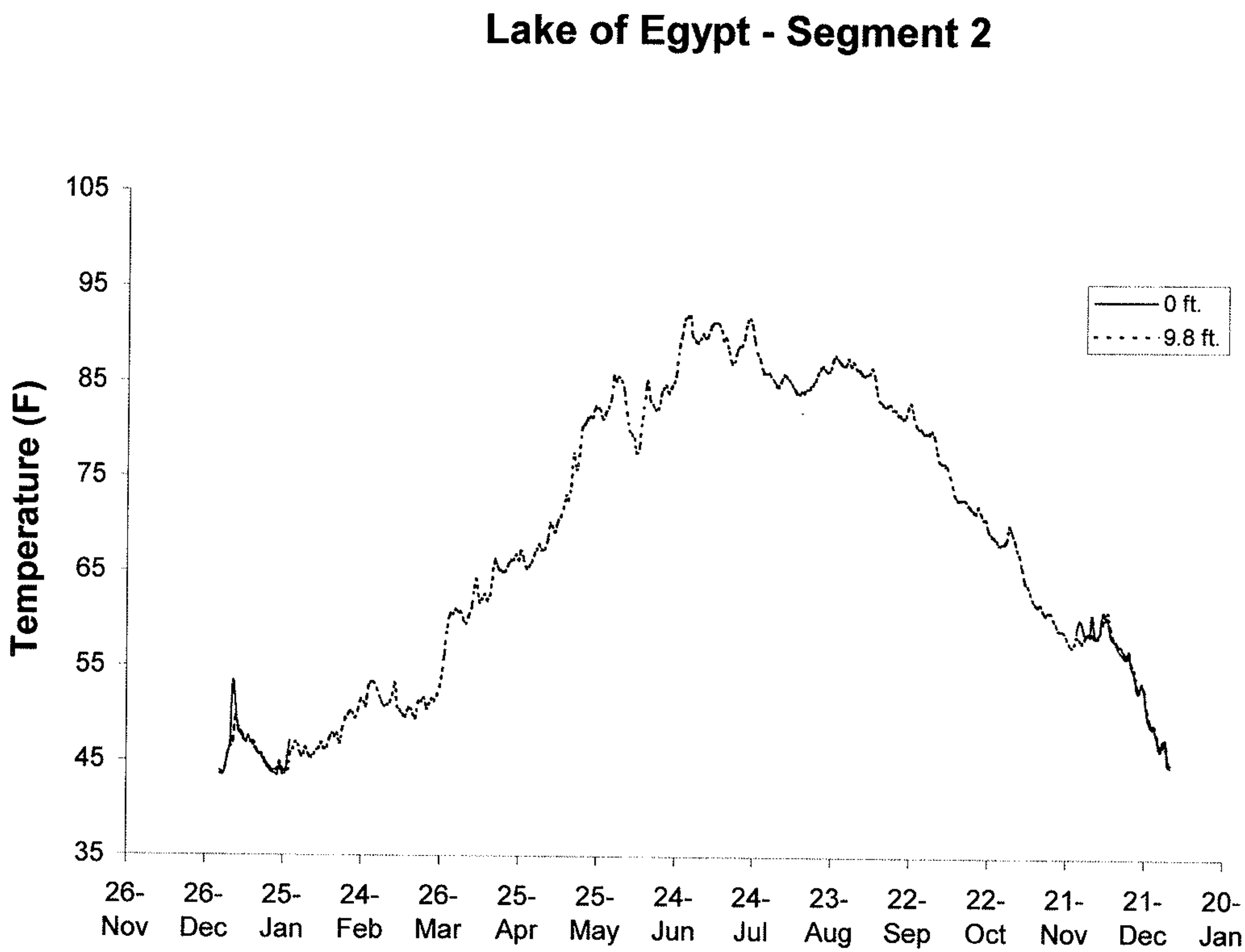


Figure 15A.217. Mean daily temperature during 1998, Lake of Egypt Segment 2. Lake bottom is approximately 13.1 feet.

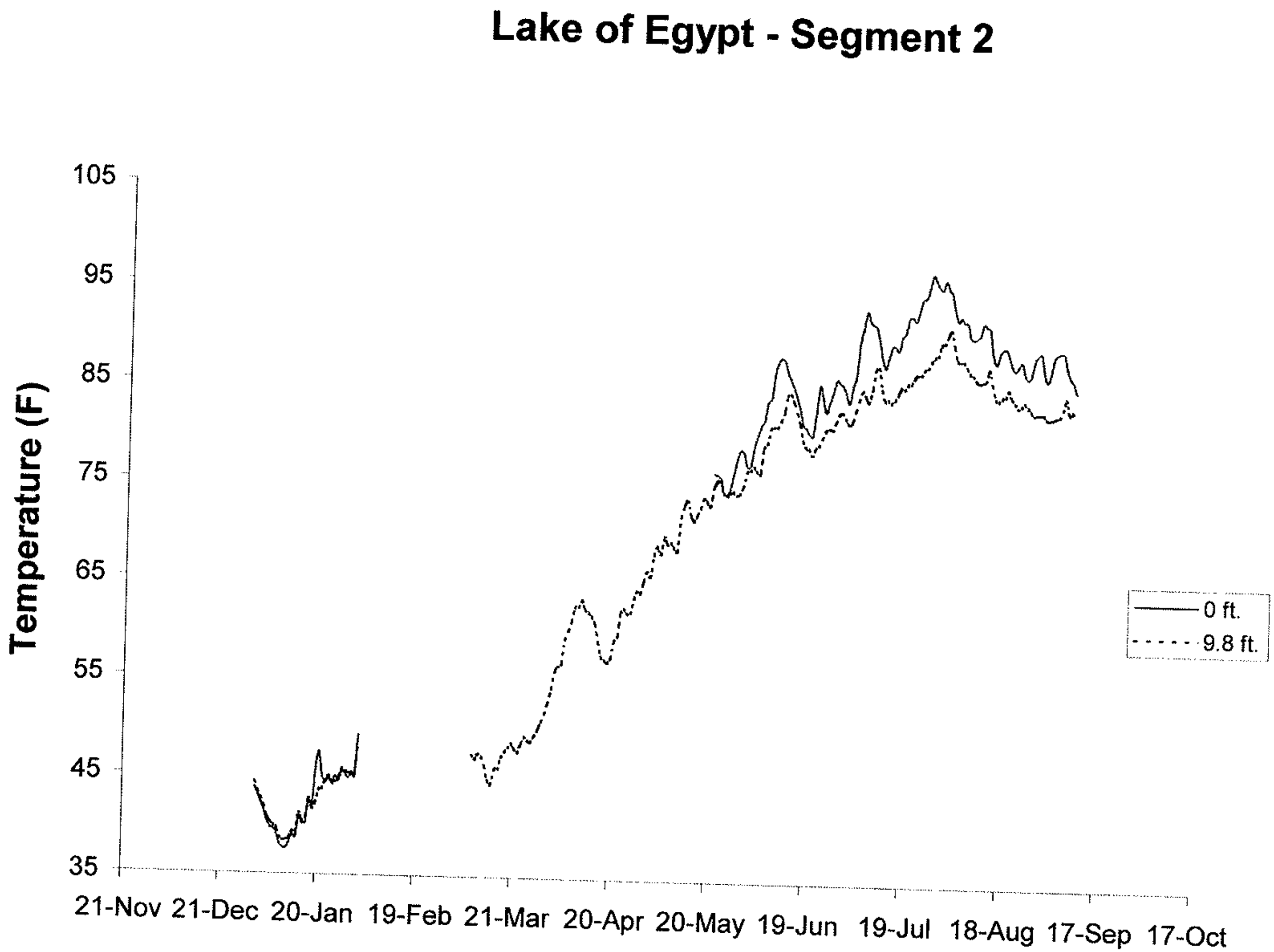


Figure 15A.218. Mean daily temperature during 1999, Lake of Egypt Segment 2. Lake bottom is approximately 13.1 feet.

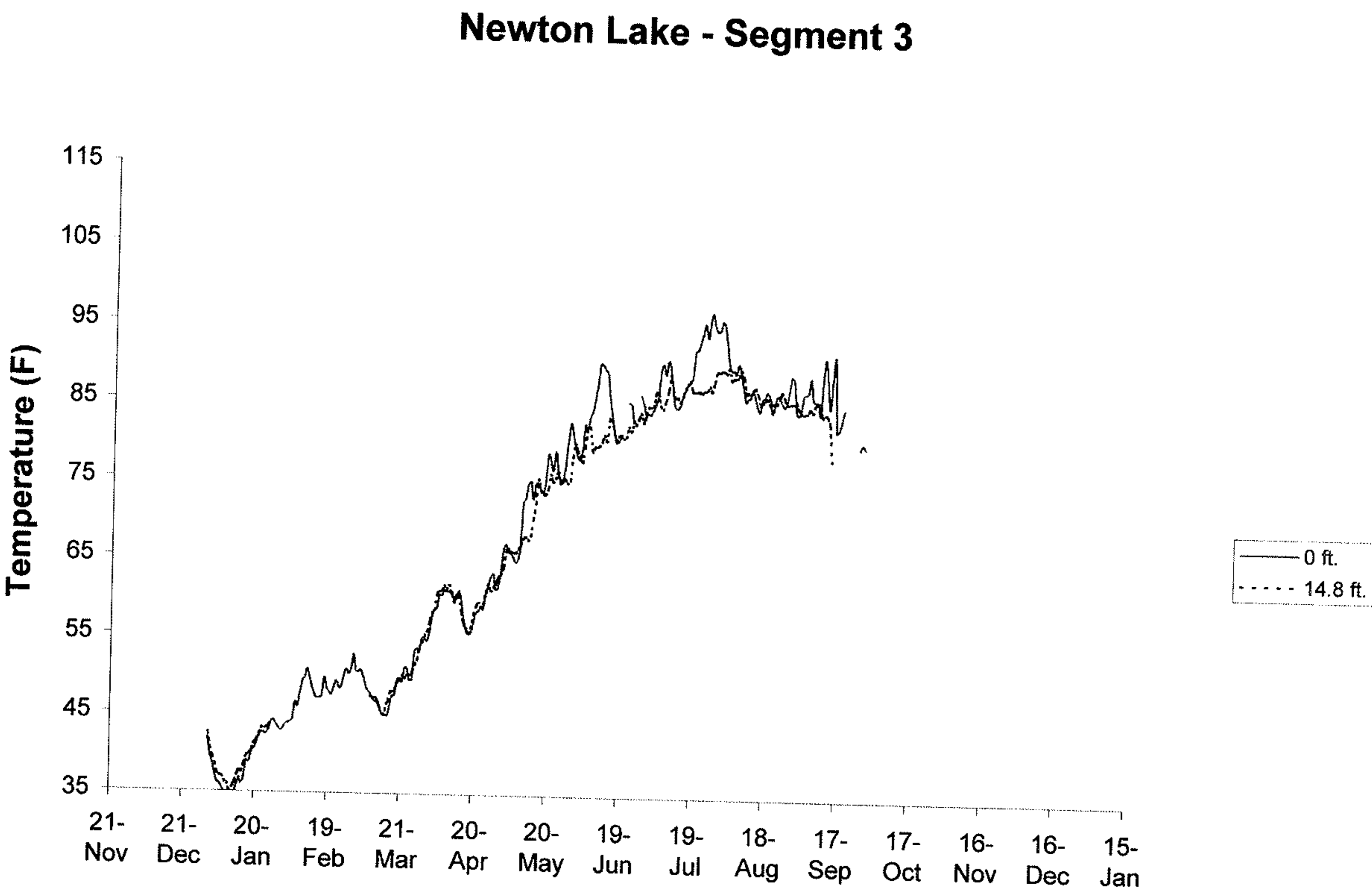


Figure 15A.197. Mean daily temperature during 1999, Newton Lake Segment 3. Lake bottom is approximately 29.5 ft.

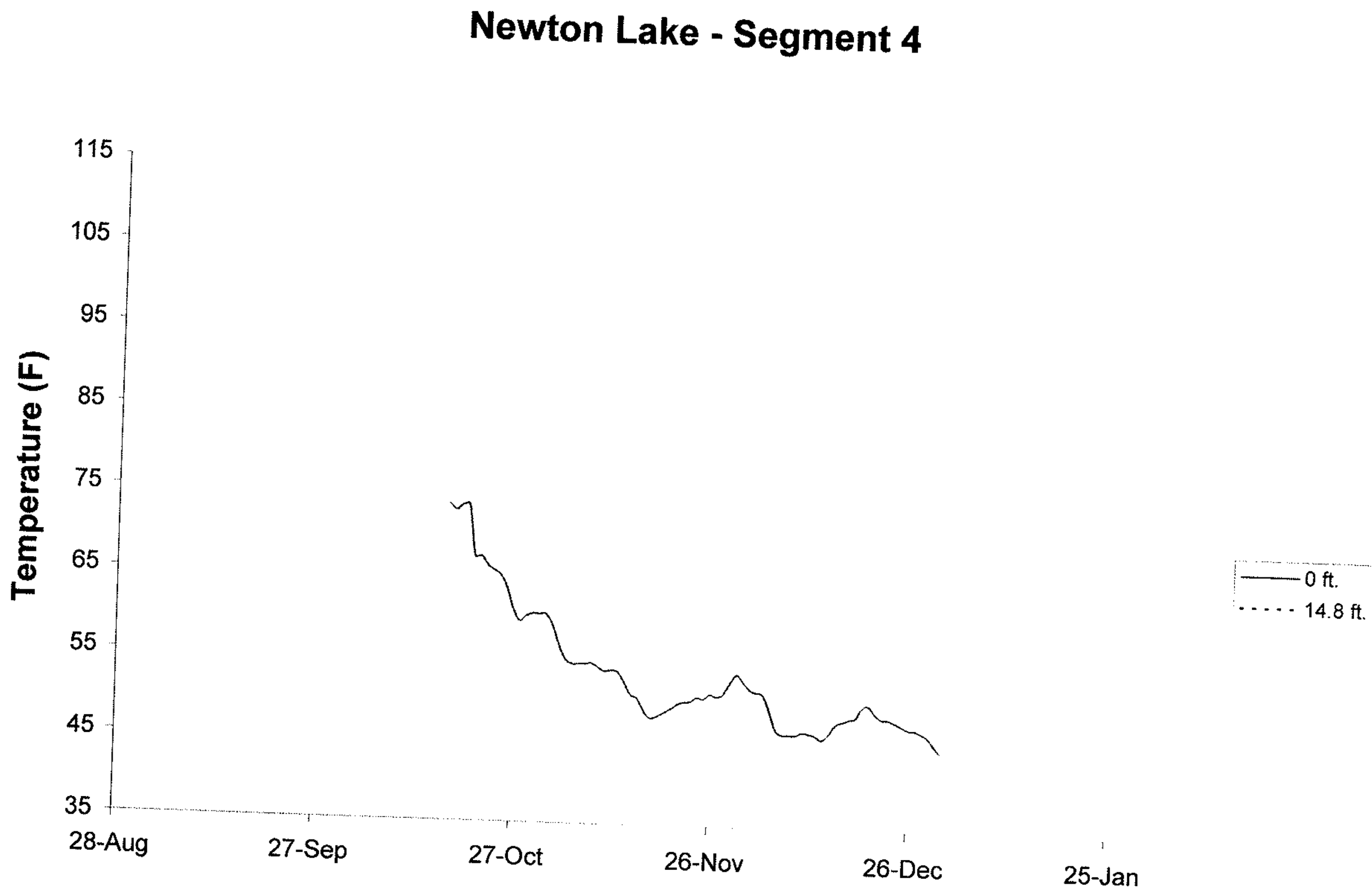


Figure 15A.198. Mean daily temperature during 1997, Newton Lake Segment 4. Lake bottom is approximately15.0 ft.

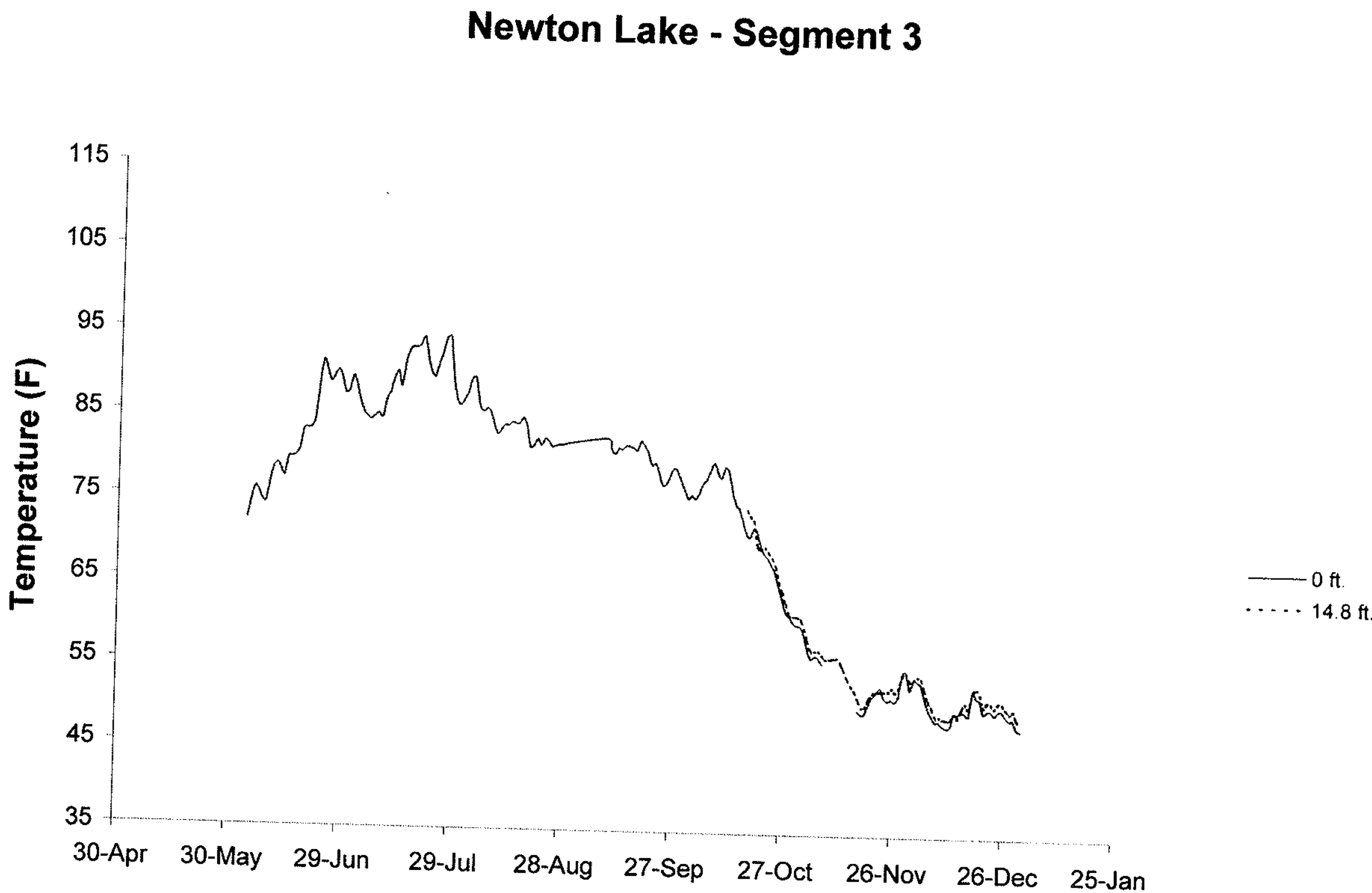


Figure 15A.195. Mean daily temperature during 1997, Newton Lake Segment 3. Lake bottom is approximately 29.5 ft.

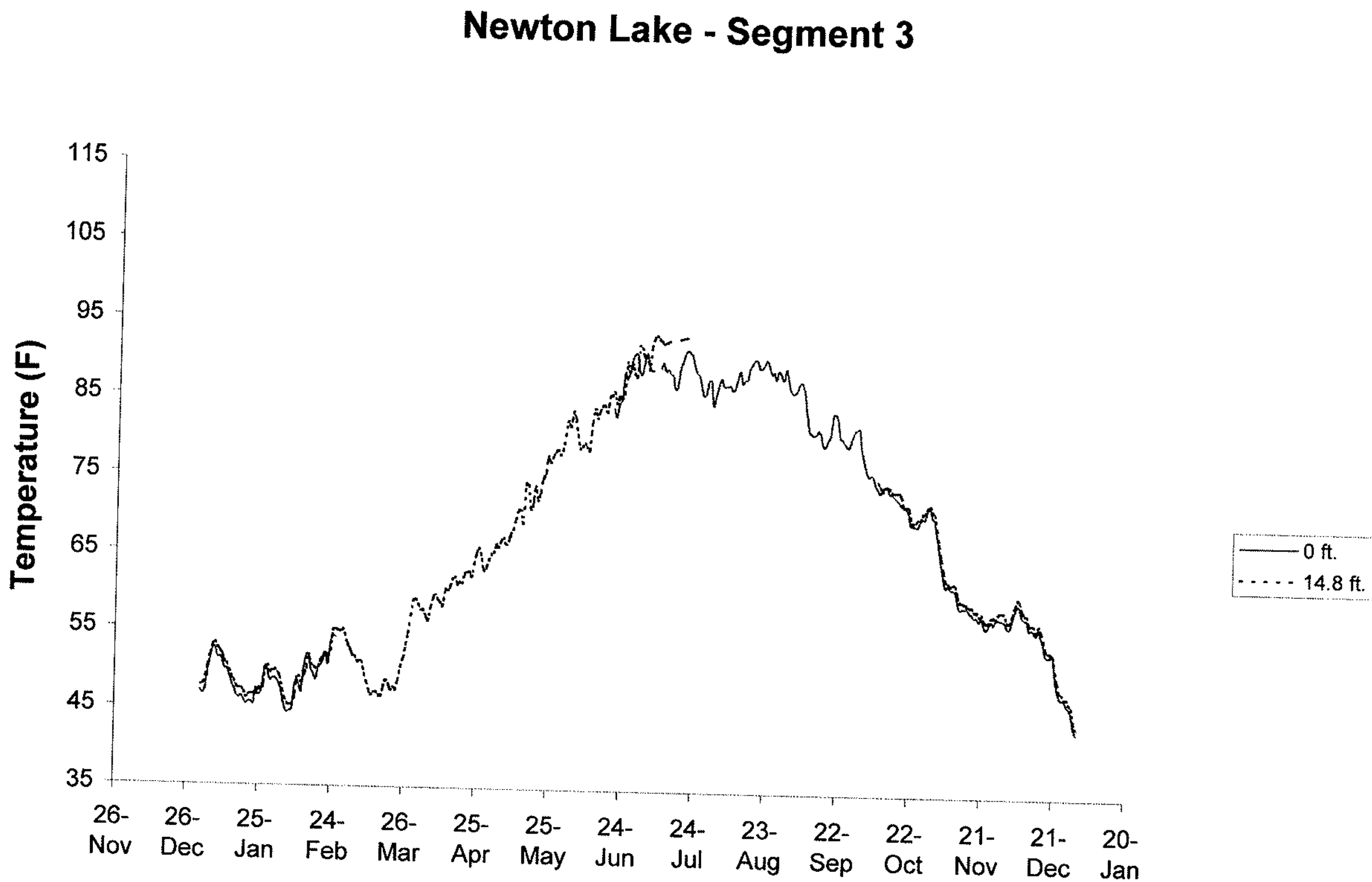


Figure 15A.196. Mean daily temperature during 1998, Newton Lake Segment 3. Lake bottom is approximately 29.5 ft.

CHAPTER 16. CREEL

Creels were not run on either Coffeen Lake or Lake of Egypt in 1997-1999. Historical 12-month creel data for Newton Lake was provided by AmerenCIPS. These creels were designed to yield harvest, but not catch data. AmerenCIPS contracted with the Illinois Natural History Survey to conduct a creel survey on Newton Lake in 1998 and 1999. The 1998 creel survey, April 12, 1999 report covered only nine months. The heavily fished November, December, and January months were included.

Angling effort dropped from a high of 150,814 hours in 1986 (12 months) to a 12 month low level of 70,330 hours in 1991 (Table 16.1). In 1998, fishing pressure was back up to 105,931 hours for the nine months of creel. Harvest of largemouth bass has remained remarkably consistent since 1986 (Table 16.2). In 1998, a total of 1,287 largemouth bass was harvested. A size limit of 18 inches total length and three fish per day has been in place since Newton Lake was open to fishing in 1980.

The harvest of 947 bluegill in 1998 approaches the 1986 high of 1,009 fish (Table 16.3). Bluegill harvest has been very low throughout all creel years. The harvest of crappie fell from 89,499 in 1986 and 66,971 in 1987 to 69 in 1988. This drastic decrease in harvest reflects a significant reduction in recruitment of crappie which is well documented in power cooling lakes but not understood. Since angler harvest of crappie tend to be dominated by three and four year old fish, the reduction in recruitment probably started in 1985.

Channel catfish harvest in Newton Lake during 1998 was approximately one-half that of previous years (Table 16.4). The harvested fish averaged approximately one pound in weight which reflects the relatively slow growth rate of channel catfish in Newton Lake. Since a 10-

year old catfish averages approximately 0.6 pounds, the harvested fish were probably the faster growing portion of the population.

Table 16.1. Summary of fishing and harvest effort on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 was taken from Merle Price's report to AmerenCIPS (Table 50). Creel data for 1998 was taken from INHS April 12, 1999, report to AmerenCIPS.

	Angling	Total no. Fish		Fish/acre		Fish/hr.	Total pounds		Pounds/acre		Pounds/hr	
Year	hours	Caught	Harvested	Caught	Harvested	caught	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986	150,814		125,746		72			76,368		43.6		0.51
1987	119,609		90,018		51			64,448		36.8		0.54
1988	73,395		25,537		15			26,630		15.2		0.36
1989	84,022		24,942		14			29,146		16.6		0.35
1990	82,351		32,102		18			44,356		25.3		0.34
1991	70,330		21,029		12			23,142		16.1		0.33
1992	78,531		24,320		14			30,514		17.4		0.39
1993	51,152		10,495		6			14,991		8.6		0.29
1998	105,931	89,726	12,432	127	7	1	114,902	11,937	66	6.8	0.68	0.08

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Table 16.2. Summary of largemouth bass catch and harvest on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 was taken from Merle Price's report to AmerenCIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to AmerenCIPS.

	Total no. fish		Fish/acre		No. fish/hr.		Total pounds		Pounds/acre		Pounds/hr.	
Year	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986		1,743		1.0		0.01		7,033		4.0		0.05
1987		1,278		0.7		0.01		5,409		3.0		0.04
1988		1,231		0.7		0.02		5,322		3.0		0.07
1989		1,141		0.6		0.01		5,160		3.0		0.06
1990		1,216		0.7		0.01		5,248		3.0		0.06
1991		1,143		0.7		0.02		4,883		2.8		0.07
1992		1,441		0.8		0.02		6,351		3.6		0.08
1993		731		0.4		0.01		3,465		2.0		0.07
1998	56,339	1,287	32	0.7	0.35	0.01	103,364	4,752	59	2.7	0.60	0.03

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Table 16.3. Summary of bluegill and white crappie harvest, on Newton Lake (1,750 acres), from 1986-1993 and 1998. Creel data for 1986-1993 was taken from Merle Price's report to AmerenCIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to AmerenCIPS.

	Number of bluegill		
Year	Harvested	Caught	Number of harvested white crappie
1986	1,009		89,499
1987	619		66,971
1988	90		69
1989	283		141
1990	281		199
1991	112		3
1992	29		0
1993[a]	91		0
1998[b]	947	4,482	?[c]

a Lake was closed 5/20/93 - 8/31/93

b In 1998 creel was only run from 2/01/98 through 10/31/98 (9 months).

c Some of the miscellaneous category that contains 61 fish may be crappie.

Table 16.4. Summary of channel catfish catch and harvest on Newton Lake (1,750 acres) from 1986-1993 and 1998. Creel data for 1986-1993 was taken from Merle Price's report to AmerenCIPS (Table 50). Creel data for 1998 was summarized from INHS April 12, 1999 report to AmerenCIPS.

	Total no. fish		Fish/acre		No. fish/hr.		Total pounds		Pounds/acre		Pounds/hr.	
Year	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested	Caught	Harvested
1986		32,280		18.0		0.21		35,231		20.0		0.23
1987		20,691		12.0		0.17		21,398		12.0		0.18
1988		23,939		14.0		0.33		21,070		12.0		0.29
1989		22,887		13.0		0.27		23,605		13.0		0.28
1990		30,133		17.0		0.37		38,824		22.0		0.47
1991		19,500		11.0		0.28		23,154		13.0		0.33
1992		22,755		13.0		0.29		24,058		14.0		0.31
1993		9,642		6.0		0.19		11,486		7.0		0.22
1998		9,720		5.6		0.19		6,984		4.0		0.05

[a] Lake was closed 5/20/93 – 8/31/93.

[b] Creel was only run from 2/01/98 through 10/31/98 (9 months).

Chapter 17. AmerenCIPS Water Quality Data Summary

Introduction:

During the course of this study, several water quality parameters were measured in both Newton Lake and Coffeen Lake by individuals from AmerenCIPS. The sampling frequency and location, as well as the subsequent analysis, differed from that from SIU and thus no attempt will be made to synthesize the AmerenCIPS data with the SIU data.

Methods:

Both Coffeen Lake and Newton lake were sampled monthly from October to March and semimonthly from April to September. Sampling sites are given in Figures 17.1 and 17.2. To distinguish AmerenCIPS sampling sites from SIU sampling sites, the former will be referred to as "locations" while the latter will be referred to as "segments." Thus, for Newton Lake, Location F and Location H correspond exactly with sampling sites in Segment 2 and Segment 3, respectively. Location C is near the sampling site for Segment 1, while Location I is near the sampling site for Segment 4. Since no water quality analysis was performed by SIU on Coffeen Lake, there are no corresponding segments between AmerenCIPS and SIU on this lake.

Temperature and dissolved oxygen was measured at 1 m intervals in all locations. Secchi depth was measured to the nearest 0.25 m in each location.

All other water quality parameters were measured in Locations C, F, H, and I only on Newton Lake, and Locations C and E1 only in Coffeen Lake. Each parameter was measured at 1-m intervals as well. Analyses were performed by PDC Labs or by AmerenCIPS laboratories. Methods used by both laboratories were not available for all parameters.

Parameters measured at 1-m intervals included pH, carbon dioxide (mg/L CO_2), alkalinity (mg/L $CaCO_3$), phenolphthalein alkalinity (mg/L $CaCO_3$), total hardness (mg/L $CaCO_3$), calcium hardness (mg/L $CaCO_3$), total ammonia (mg/L NH_3), nitrate (mg/L NO_3 and mg/L $NO_3 - N$), nitrite (mg/L $NO_2 - N$), total Kjeldahl nitrogen (TKN) (mg/L $NH_3 - N$), orthophosphate (mg/L PO_4 and mg/L $PO_4 - P$), total inductively coupled plasma mass spectroscopy (ICPMS) phosphorus (mg/L $PO_4 - P$), total dissolved solids (TDS) (mg/L TDS), sulfate (mg/L SO_4), and chloride (mg/L Cl^-). Note that digestions were only performed sporadically before ICPMS analysis of total phosphorus. Prior to April 1998, values for nitrate were given in mg/L NO_3 and values for orthophosphate were given in mg/L PO_4, while after April 1998, values for nitrate were given in mg/L $NO_3 - N$ and values for orthophosphate were given in mg/L $PO_4 - P$. Although these units can be easily converted from one to the other, they were kept separate to reflect possible changes in analytical procedure.

Daily mean values were calculated over all depths within a location for all parameters except secchi depth and pH. Only 1 secchi depth was determined at each segment each date, so calculation of a mean secchi depth was impossible. Since it is not appropriate to calculate a mean value for a series of pH measurements, the minimum and maximum pH was determined for each location on each date.

Results and Discussion

Temperature and dissolved oxygen profiles obtained during the summer months are given in Chapter 15. For all other parameters, means with 95% confidence intervals are given in Tables 4.1 – 4.36. Note that larger samples sizes within certain locations were the result of deeper water in those locations. None of the parameters measured by AmerenCIPS had values outside the acceptable range for fish.

Many of the analyses performed were not able to detect the low levels of some parameters found in Newton Lake. Any sample in which the parameter was not detected was recorded as having 0 value; the high number of these 0 values likely led to underestimation of the parameters. Consequently, analysis of AmerenCIPS samples consistently demonstrated lower values for some parameter than did the samples taken by SIU. For example, on September 28, 1999 samples were taken by both AmerenCIPS and SIU. AmerenCIPS data showed no ammonia, nitrate, or total phosphorus for Segment 2, while SIU data showed mean values of 0.28 mg/L ammonia, 1.20 mg/L nitrate, and 0.20 mg/L total phosphorus.

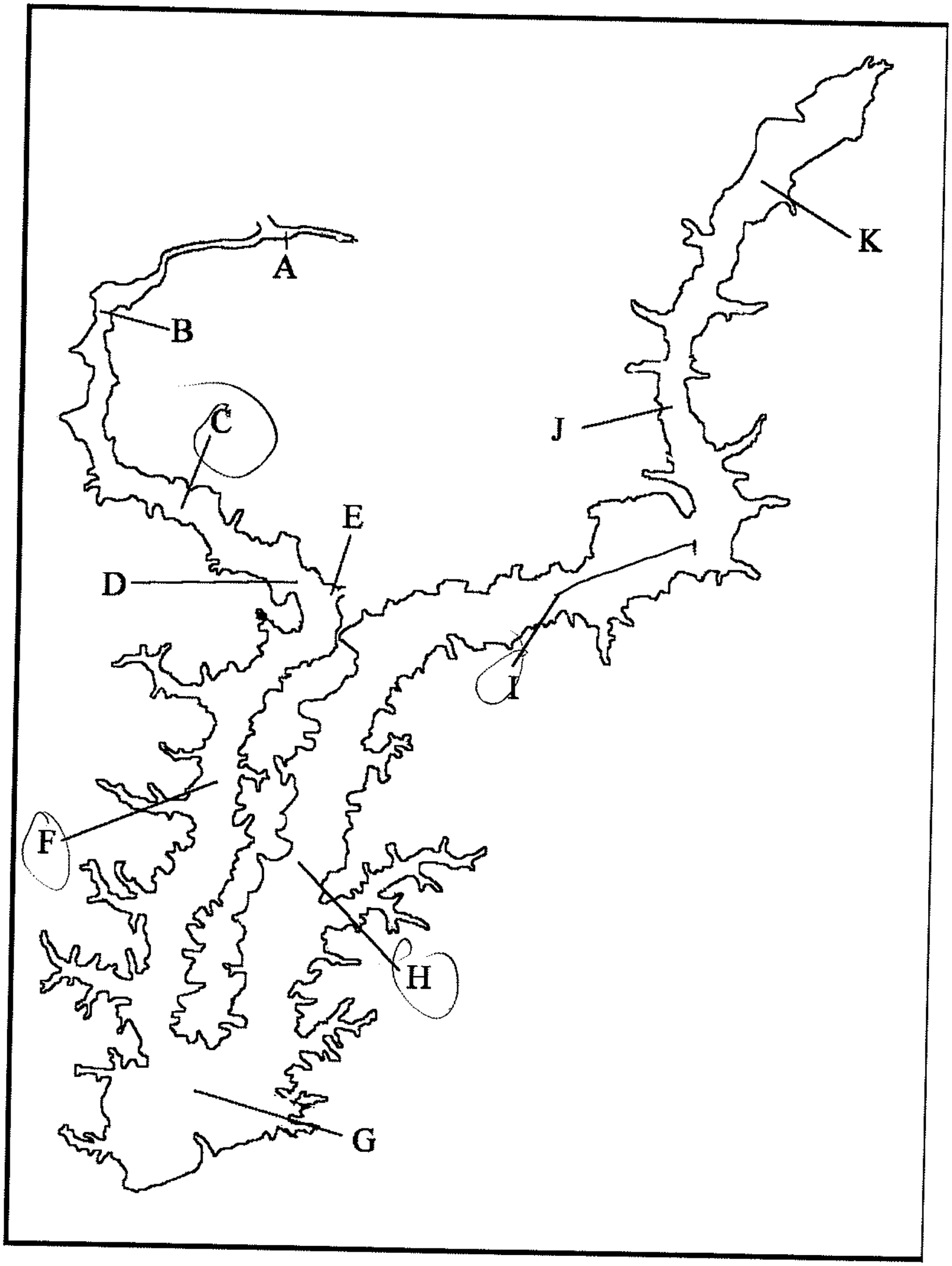


Figure 17.1. Location of AmerenCIPS water quality sampling sites, Newton Lake.

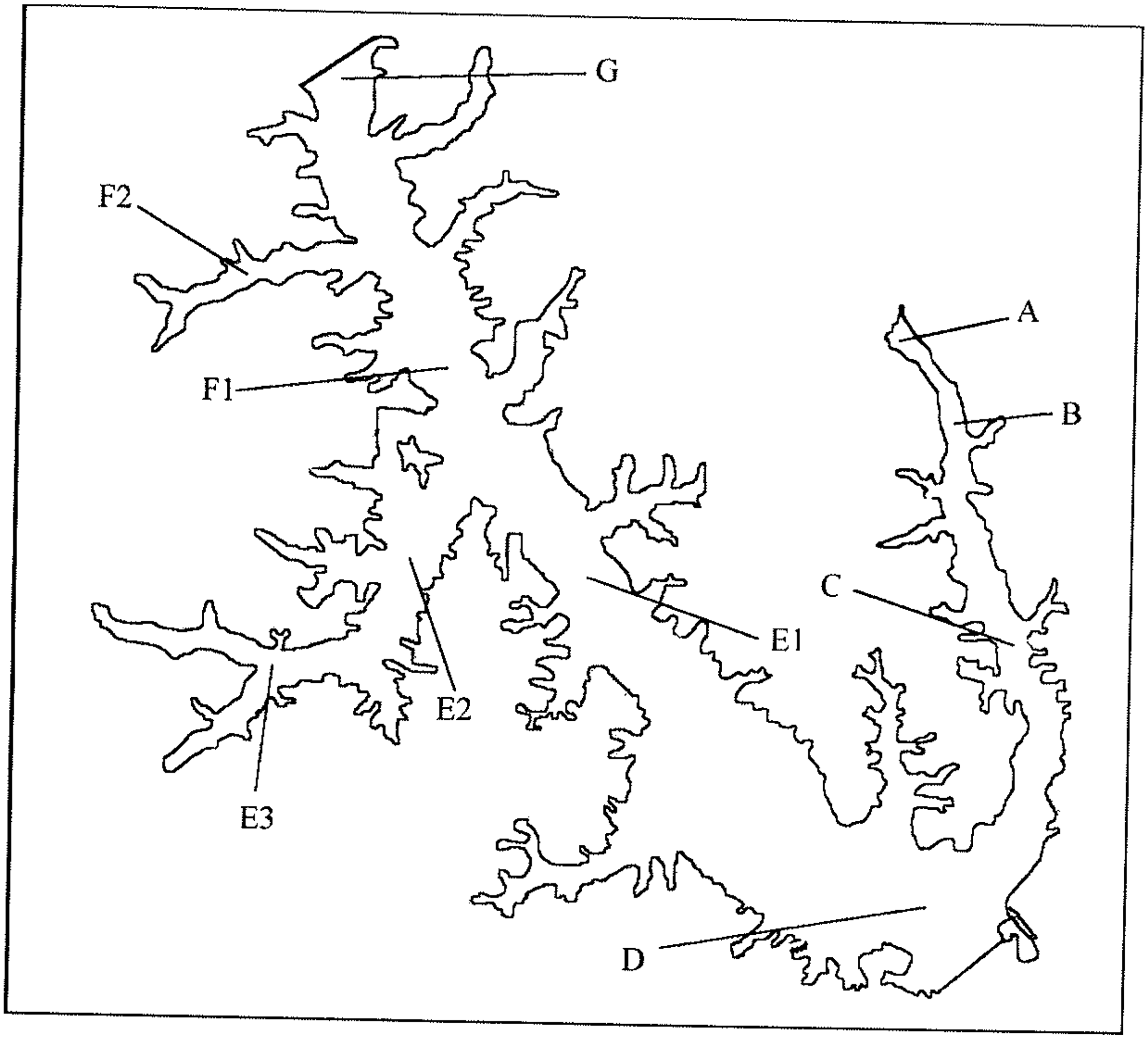


Figure 17.2. Location of AmerenCIPS water quality sampling sites, Coffeen Lake. Sites H and I (not shown) lie north of the railroad bridge.

Table 17.1. Mean CO_2 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L CO_2.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	25.63 ± 19.73	2	10.50 ± 3.92	7	8.00 ± 2.40	9	6.00 ± 2.75	6
09/17/1997	3.75 ± 0.00	3	7.14 ± 1.15	7	7.08 ± 0.95	9	6.46 ± 0.42	6
10/15/1997	8.67 ± 5.15	3	9.43 ± 1.11	7	9.33 ± 1.07	9	9.33 ± 0.85	6
11/12/1997	15.00 ± 7.60	3	12.96 ± 2.92	7	7.00 ± 0.72	8	6.67 ± 0.85	6
12/17/1997	8.00 ± 0.00	3	8.86 ± 0.79	7	8.00 ± 0.00	8	6.40 ± 0.85	5
01/22/1998	6.00 ± 0.00	3	6.00 ± 0.00	7	5.40 ± 0.56	10	4.40 ± 0.85	5
02/11/1998	5.42 ± 1.22	3	6.25 ± 0.92	7	3.44 ± 0.74	8	2.50 ± 0.00	6
03/18/1998	5.00 ± 0.00	4	5.00 ± 0.63	8	4.17 ± 0.39	9	4.64 ± 0.45	7
04/08/1998	5.63 ± 0.85	4	6.53 ± 0.52	9	7.38 ± 0.41	10	4.46 ± 0.49	7
04/22/1998	6.56 ± 0.74	4	5.78 ± 0.62	8	4.63 ± 0.60	10	1.61 ± 0.45	7
05/06/1998	6.88 ± 0.85	4	10.63 ± 2.28	8	8.00 ± 1.19	10	6.61 ± 0.87	7
05/20/1998	5.00 ± 0.00	4	7.50 ± 1.42	8	7.88 ± 2.90	10	2.50 ± 0.00	2
06/15/1998	7.50 ± 1.20	4	7.78 ± 1.33	9	6.67 ± 1.23	9	5.00 ± 0.00	4
06/24/1998	6.88 ± 0.85	4	7.19 ± 1.32	8	7.75 ± 2.83	10	3.21 ± 1.58	7
07/06/1998	8.44 ± 0.74	4	7.19 ± 1.16	8	6.25 ± 0.68	10	5.00 ± 0.53	7
07/22/1998	3.75 ± 0.00	3	7.97 ± 3.41	8	7.25 ± 4.33	10	2.50 ± 0.00	4
08/05/1998	3.75 ± 1.20	4	5.47 ± 1.90	8	6.57 ± 3.11	10	2.71 ± 0.42	6
08/17/1998	3.13 ± 0.85	4	6.56 ± 2.52	8	6.11 ± 3.21	9	3.33 ± 1.25	6
09/09/1998	5.83 ± 1.22	3	6.56 ± 1.40	8	5.56 ± 0.41	9	6.46 ± 1.01	6
09/23/1998	6.67 ± 1.22	3	5.18 ± 0.63	7	4.17 ± 0.55	9	5.63 ± 0.86	6
10/14/1998	5.42 ± 1.22	3	4.38 ± 0.63	8	4.17 ± 0.95	9	4.38 ± 0.56	6
11/18/1998	8.75 ± 0.00	3	9.17 ± 0.53	6	9.58 ± 0.55	9	7.92 ± 0.84	6
12/17/1998	5.83 ± 1.22	3	5.16 ± 0.30	8	4.32 ± 0.36	11	4.38 ± 0.85	4
01/20/1999	4.06 ± 0.74	4	5.78 ± 0.43	8	5.38 ± 0.35	10	5.00 ± 0.00	4
02/16/1999	3.75 ± 0.00	4	4.69 ± 0.39	8	4.75 ± 0.31	10	5.00 ± 0.00	6
03/23/1999	5.00 ± 0.00	4	5.47 ± 0.43	8	5.00 ± 0.39	9	5.00 ± 0.00	7
04/06/1999	5.00 ± 0.00	4	3.59 ± 1.14	8	4.03 ± 0.34	9	4.29 ± 0.72	7
04/20/1999	5.94 ± 0.74	4	6.88 ± 0.78	8	6.67 ± 0.39	9	6.25 ± 0.92	6
05/03/1999	3.44 ± 0.74	4	4.22 ± 1.61	8	5.13 ± 1.54	10	4.17 ± 1.55	6
05/19/1999	5.00 ± 0.00	4	6.41 ± 1.14	8	6.25 ± 1.08	10	5.18 ± 0.35	7
06/08/1999	5.94 ± 0.74	4	6.38 ± 1.21	8	0.00 ± 0.00	0	4.38 ± 0.86	6
06/22/1999	3.75 ± 0.00	4	5.00 ± 1.48	8	4.72 ± 1.44	9	2.71 ± 0.42	6
07/06/1999	4.38 ± 0.85	4	5.47 ± 1.09	8	5.70 ± 1.25	10	3.75 ± 0.00	6
07/19/1999	5.00 ± 0.00	4	6.25 ± 0.90	8	7.38 ± 2.00	10	4.38 ± 0.56	6
08/10/1999	5.94 ± 0.74	4	7.66 ± 2.21	8	6.53 ± 1.01	9	6.04 ± 0.42	6
08/24/1999	4.38 ± 0.85	4	7.34 ± 2.26	8	5.97 ± 0.93	9	5.00 ± 0.92	6
09/07/1999	6.25 ± 0.00	3	6.43 ± 0.35	7	7.36 ± 1.25	9	5.83 ± 0.53	6
09/28/1999	6.25 ± 0.00	3			6.13 ± 0.23	10	6.04 ± 0.42	6
10/13/1999	13.75 ± 4.21	3	8.38 ± 2.07	6	7.64 ± 2.03	9	7.92 ± 2.02	6
11/22/1999	11.67 ± 1.22	3	10.83 ± 0.53	6	13.75 ± 1.27	8	15.50 ± 1.36	5
12/13/1999	12.50 ± 3.65	3	9.64 ± 0.69	7	7.86 ± 0.69	7	5.42 ± 0.53	6

Table 17.2. Mean alkalinity levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	71 ± 2	3	73 ± 1	7	72 ± 1	9	72 ± 2	6
09/17/1997	74 ± 3	3	75 ± 1	7	75 ± 1	9	77 ± 3	6
10/15/1997	78 ± 3	3	82 ± 1	7	81 ± 1	9	81 ± 1	6
11/12/1997	80 ± 0	3	81 ± 1	7	73 ± 4	8	72 ± 7	6
12/17/1997	82 ± 0	3	82 ± 0	7	81 ± 3	8	81 ± 1	5
01/22/1998	78 ± 3	3	77 ± 1	7	77 ± 1	10	77 ± 2	5
02/11/1998	79 ± 2	3	79 ± 1	7	78 ± 3	8	79 ± 1	6
03/18/1998	75 ± 2	4	80 ± 2	8	80 ± 1	9	81 ± 2	7
04/08/1998	73 ± 2	4	72 ± 0	9	75 ± 1	10	75 ± 1	7
04/22/1998	72 ± 0	4	74 ± 1	8	73 ± 1	10	75 ± 1	7
05/06/1998	79 ± 5	4	75 ± 4	8	79 ± 1	10	77 ± 6	6
05/20/1998	80 ± 1	4	79 ± 1	8	78 ± 2	10	74 ± 16	2
06/15/1998	76 ± 1	4	78 ± 4	9	76 ± 2	9	76 ± 2	4
06/24/1998	76 ± 2	4	77 ± 2	8	81 ± 6	10	73 ± 4	7
07/06/1998	61 ± 2	4	69 ± 7	8	80 ± 4	10	76 ± 1	6
07/22/1998	76 ± 1	3	79 ± 5	8	82 ± 7	10	76 ± 4	4
08/05/1998	76 ± 3	4	78 ± 3	8	82 ± 7	10	76 ± 2	4
08/17/1998	79 ± 1	4	82 ± 7	8	85 ± 8	9	80 ± 1	6
09/09/1998	84 ± 1	3	87 ± 2	8	85 ± 1	9	84 ± 1	6
09/23/1998	85 ± 2	3	85 ± 1	7	84 ± 1	9	85 ± 1	6
10/14/1998	88 ± 3	3	88 ± 1	8	87 ± 1	9	86 ± 2	6
11/18/1998	80 ± 1	3	80 ± 2	6	79 ± 1	9	80 ± 1	6
12/17/1998	80 ± 2	3	80 ± 0	8	80 ± 1	10	80 ± 0	4
01/20/1999	63 ± 2	4	66 ± 5	8	85 ± 0	9	76 ± 11	4
02/16/1999	62 ± 2	4	63 ± 2	8	58 ± 1	10	60 ± 1	6
03/23/1999	58 ± 1	4	59 ± 1	8	59 ± 0	9	59 ± 1	7
04/06/1999	59 ± 1	4	61 ± 1	8	61 ± 1	9	62 ± 1	7
04/20/1999	64 ± 1	4	61 ± 1	8	62 ± 1	9	62 ± 1	5
05/03/1999	65 ± 1	4	65 ± 1	8	63 ± 1	10	63 ± 1	6
05/19/1999	68 ± 1	4	66 ± 1	8	68 ± 1	10	67 ± 1	7
06/08/1999	68 ± 1	4	68 ± 1	8	70 ± 2	10	70 ± 1	6
06/22/1999	67 ± 1	4	68 ± 1	8	68 ± 1	9	67 ± 1	6
07/06/1999	63 ± 1	4	64 ± 2	8	64 ± 3	10	60 ± 2	6
07/19/1999	66 ± 1	4	66 ± 1	8	66 ± 1	8	66 ± 1	6
08/10/1999	72 ± 1	4	72 ± 1	8	71 ± 1	9	71 ± 1	6
08/24/1999	73 ± 1	3	72 ± 1	8	73 ± 3	9	72 ± 1	6
09/07/1999	75 ± 1	3	76 ± 1	7	76 ± 3	9	75 ± 0	6
09/28/1999	79 ± 4	3	78 ± 2	7	76 ± 1	10	76 ± 0	6
10/13/1999	81 ± 4	3	79 ± 1	7	79 ± 1	9	80 ± 0	6
11/22/1999	79 ± 1	3	78 ± 1	6	78 ± 1	8	78 ± 1	5
12/13/1999	76 ± 2	3	76 ± 1	7	77 ± 1	7	76 ± 1	6

Table 17.3. Mean phenolphthalein alkalinity levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	3 ± 2	3	1 ± 1	7	2 ± 2	9	4 ± 2	6
09/17/1997	0 ± 0	3	0 ± 0	7	0 ± 0	9	0 ± 0	6
10/15/1997	0 ± 0	3	0 ± 0	7	0 ± 0	9	0 ± 0	6
11/12/1997	0 ± 0	3	0 ± 0	7	0 ± 0	8	0 ± 0	6
12/17/1997	2 ± 0	3	1 ± 1	7	0 ± 0	8	2 ± 1	5
01/22/1998	0 ± 0	3	0 ± 0	7	0 ± 0	10	0 ± 0	5
02/11/1998	0 ± 0	3	0 ± 0	7	0 ± 0	8	0 ± 0	6
03/18/1998	0 ± 0	4	3 ± 1	8	3 ± 1	9	4 ± 0	7
04/08/1998	0 ± 0	4	0 ± 0	9	0 ± 0	10	0 ± 0	7
04/22/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	7
05/06/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	6
05/20/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	2
06/15/1998	0 ± 0	4	0 ± 0	9	0 ± 0	9	0 ± 0	4
06/24/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	2 ± 2	7
07/06/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	6
07/22/1998	0 ± 0	3	0 ± 0	8	1 ± 1	8	3 ± 2	4
08/05/1998	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	4
08/17/1998	3 ± 0	4	1 ± 1	8	1 ± 1	9	6 ± 2	6
09/09/1998	0 ± 0	1	0 ± 0	8	0 ± 0	9	0 ± 0	6
09/23/1998	0 ± 0	3	0 ± 0	7	0 ± 0	9	0 ± 0	6
10/14/1998	0 ± 0	3	0 ± 0	8	0 ± 0	9	0 ± 0	6
11/18/1998	0 ± 0	3	0 ± 0	6	0 ± 0	9	0 ± 0	6
12/17/1998	0 ± 0	3	0 ± 0	8	0 ± 0	10	0 ± 0	4
01/20/1999	0 ± 0	4	0 ± 0	8	0 ± 0	9	0 ± 0	4
02/16/1999	0 ± 0	4	0 ± 0	8	0 ± 0	10	0 ± 0	6
03/23/1999	0 ± 0	4	0 ± 0	8	0 ± 0	9	0 ± 0	7
04/06/1999	0 ± 0	4	0 ± 0	8	2 ± 1	9	4 ± 1	7
04/20/1999	0 ± 0	4	0 ± 0	8	0 ± 0	9	0 ± 0	5
05/03/1999	4 ± 1	4	3 ± 2	8	2 ± 1	10	2 ± 2	6
05/19/1999	0 ± 0	4	0 ± 0	8	1 ± 1	10	1 ± 1	7
06/08/1999	0 ± 0	4	0 ± 0	8	1 ± 1	10	0 ± 0	6
06/22/1999	3 ± 1	4	1 ± 1	8	2 ± 2	9	5 ± 1	6
07/06/1999	2 ± 1	4	1 ± 1	8	1 ± 1	10	3 ± 1	6
07/19/1999	0 ± 0	4	0 ± 0	8	1 ± 1	8	2 ± 1	6
08/10/1999	1 ± 1	4	1 ± 1	8	0 ± 1	9	1 ± 1	6
08/24/1999	2 ± 1	3	1 ± 1	8	0 ± 0	9	1 ± 1	6
09/07/1999	0 ± 0	3	0 ± 1	7	1 ± 1	9	0 ± 0	6
09/28/1999	1 ± 2	3	1 ± 1	7	1 ± 1	10	1 ± 1	6
10/13/1999	0 ± 0	3	2 ± 2	7	4 ± 0	9	4 ± 0	6
11/22/1999	0 ± 0	3	0 ± 0	6	0 ± 0	8	0 ± 0	5
12/13/1999	0 ± 0	3	0 ± 0	7	0 ± 0	7	0 ± 0	6

Table 17.4. Mean NH_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L NH_3.

	Location C		Location F		Location H		Location I	
Date	95% C. I.	n	95% C. I.	n	95% C. I.	n	95% C. I.	n
08/28/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
09/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/15/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/12/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
12/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	5
01/22/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	5
02/11/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
03/18/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/08/1998	0.00 ± 0.00	4	0.00 ± 0.00	9	0.00 ± 0.00	10	0.00 ± 0.00	7
04/22/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
05/06/1998	0.15 ± 0.35	4	0.16 ± 0.20	8	0.08 ± 0.15	10	0.00 ± 0.00	6
05/20/1998	1.17 ± 0.42	4	0.45 ± 0.34	8	0.17 ± 0.16	10	0.25 ± 1.58	2
06/15/1998	0.63 ± 0.63	4	0.79 ± 0.24	9	0.14 ± 0.18	9	0.15 ± 0.35	4
06/24/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.42 ± 0.29	10	0.13 ± 0.25	7
07/06/1998	0.25 ± 0.59	4	0.32 ± 0.33	8	0.31 ± 0.24	10	0.15 ± 0.30	6
07/22/1998	0.00 ± 0.00	3	0.21 ± 0.26	8	0.37 ± 0.29	10	0.00 ± 0.00	4
08/05/1998	0.00 ± 0.00	4	0.24 ± 0.30	8	0.46 ± 0.37	10	0.17 ± 0.41	4
08/17/1998	0.00 ± 0.00	4	0.56 ± 0.79	8	0.30 ± 0.44	9	0.00 ± 0.00	6
09/09/1998	0.40 ± 2.53	2	0.14 ± 0.17	8	0.08 ± 0.14	9	0.00 ± 0.00	6
09/23/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/14/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
11/18/1998	0.00 ± 0.00	3	0.10 ± 0.20	6	0.07 ± 0.12	9	0.13 ± 0.27	6
12/17/1998	0.27 ± 0.78	3	0.06 ± 0.12	8	0.14 ± 0.17	10	0.00 ± 0.00	4
01/20/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	4
02/16/1999	0.00 ± 0.00	4	0.30 ± 0.21	8	0.28 ± 0.21	10	0.00 ± 0.00	6
03/23/1999	0.00 ± 0.00	4	0.06 ± 0.12	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.06 ± 0.10	9	0.00 ± 0.00	7
04/20/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	5
05/03/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
05/19/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
06/08/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.05 ± 0.09	10	0.00 ± 0.00	6
06/22/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
07/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.06 ± 0.11	10	0.00 ± 0.00	6
07/19/1999	0.00 ± 0.00	4	0.08 ± 0.14	8	0.00 ± 0.00	8	0.00 ± 0.00	6
08/10/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.06 ± 0.10	9	0.00 ± 0.00	6
08/24/1999	0.00 ± 0.00	3	0.00 ± 0.00	8	0.20 ± 0.25	9	0.25 ± 0.50	6
09/07/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.16 ± 0.29	9	0.00 ± 0.00	6
09/28/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.15 ± 0.27	10	0.00 ± 0.00	6
10/13/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/22/1999	0.00 ± 0.00	3	0.00 ± 0.00	6	0.00 ± 0.00	8	0.00 ± 0.00	5
12/13/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	6	0.00 ± 0.00	6

Table 17.5. Mean Cl^- levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L Cl^-.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	27 ± 0	3	28 ± 0	7	26 ± 0	9	27 ± 0	6
09/17/1997	24 ± 0	3	26 ± 1	7	26 ± 0	9	26 ± 0	6
10/15/1997	26 ± 2	3	26 ± 1	7	26 ± 0	9	27 ± 0	6
11/12/1997	26 ± 5	3	27 ± 1	7	28 ± 0	8	28 ± 0	6
12/17/1997	26 ± 0	3	27 ± 0	7	27 ± 0	8	26 ± 1	5
01/22/1998	31 ± 0	3	31 ± 1	7	31 ± 0	10	31 ± 0	5
02/11/1998	28 ± 3	3	22 ± 2	7	25 ± 3	8	29 ± 1	6
03/18/1998	24 ± 2	4	28 ± 1	8	28 ± 0	9	28 ± 0	7
04/08/1998	21 ± 2	4	20 ± 1	9	21 ± 1	10	20 ± 1	7
04/22/1998	22 ± 1	4	22 ± 0	8	22 ± 0	10	22 ± 1	7
05/06/1998	21 ± 2	4	20 ± 2	8	23 ± 0	10	22 ± 2	6
05/20/1998	21 ± 0	4	21 ± 1	8	22 ± 1	10	22 ± 3	2
06/15/1998	20 ± 0	4	21 ± 1	9	20 ± 0	9	20 ± 0	4
06/24/1998	20 ± 1	4	20 ± 0	8	21 ± 1	10	20 ± 0	7
07/06/1998	14 ± 0	4	18 ± 1	8	20 ± 0	10	20 ± 0	6
07/22/1998	21 ± 1	3	20 ± 0	8	20 ± 0	10	21 ± 1	4
08/05/1998	19 ± 1	4	19 ± 0	8	19 ± 0	10	18 ± 1	4
08/17/1998	19 ± 1	4	20 ± 1	8	19 ± 1	9	19 ± 0	6
09/09/1998	22 ± 2	3	21 ± 0	8	21 ± 0	9	21 ± 0	6
09/23/1998	22 ± 1	3	22 ± 0	7	22 ± 0	9	22 ± 0	6
10/14/1998	22 ± 0	3	22 ± 2	8	22 ± 0	9	22 ± 0	6
11/18/1998	22 ± 3	3	22 ± 1	6	22 ± 1	9	22 ± 0	6
12/17/1998	23 ± 1	3	22 ± 0	8	22 ± 0	10	22 ± 0	4
01/20/1999	16 ± 1	4	17 ± 2	8	22 ± 0	9	20 ± 3	4
02/16/1999	14 ± 0	4	14 ± 0	8	13 ± 0	10	14 ± 0	6
03/23/1999	14 ± 1	4	14 ± 0	8	13 ± 2	9	14 ± 0	7
04/06/1999	13 ± 0	4	13 ± 0	8	13 ± 0	9	13 ± 0	7
04/20/1999	14 ± 1	4	14 ± 0	8	14 ± 0	9	14 ± 0	5
05/03/1999	14 ± 0	4	14 ± 0	8	13 ± 1	10	13 ± 1	6
05/19/1999	14 ± 0	4	14 ± 0	8	14 ± 0	10	14 ± 0	7
06/08/1999	15 ± 0	4	15 ± 0	8	15 ± 0	10	15 ± 0	6
06/22/1999	15 ± 1	4	14 ± 1	8	13 ± 0	9	14 ± 1	6
07/06/1999	14 ± 1	4	14 ± 0	8	14 ± 0	10	13 ± 0	6
07/19/1999	14 ± 0	4	14 ± 0	8	14 ± 0	8	14 ± 1	6
08/10/1999	15 ± 1	4	15 ± 1	8	15 ± 0	9	15 ± 0	6
08/24/1999	15 ± 0	3	15 ± 0	8	15 ± 0	9	15 ± 1	6
09/07/1999	15 ± 1	3	15 ± 1	7	16 ± 0	9	16 ± 0	6
09/28/1999	15 ± 1	3	16 ± 0	7	16 ± 0	10	17 ± 0	6
10/13/1999	18 ± 1	3	19 ± 1	7	19 ± 0	9	19 ± 0	6
11/22/1999	20 ± 0	3	20 ± 0	6	20 ± 0	8	20 ± 0	5
12/13/1999	21 ± 1	3	21 ± 0	7	21 ± 0	7	21 ± 0	6

Table 17.6. Mean water hardness levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	136 ± 3	3	135 ± 2	7	135 ± 1	9	134 ± 1	6
09/17/1997	139 ± 4	3	140 ± 3	7	139 ± 1	9	139 ± 1	6
10/15/1997	145 ± 2	3	144 ± 2	7	144 ± 1	9	145 ± 2	6
11/12/1997	154 ± 3	3	154 ± 1	7	154 ± 2	8	155 ± 1	6
12/17/1997	152 ± 3	3	152 ± 1	7	152 ± 1	8	152 ± 1	5
01/22/1998	151 ± 2	3	151 ± 1	7	151 ± 1	10	152 ± 2	5
02/11/1998	176 ± 0	3	171 ± 4	7	169 ± 4	8	166 ± 4	6
03/18/1998	155 ± 12	4	163 ± 3	8	160 ± 0	9	160 ± 0	7
04/08/1998	143 ± 6	4	142 ± 3	9	140 ± 0	10	141 ± 3	7
04/22/1998	145 ± 7	4	143 ± 3	8	140 ± 0	10	146 ± 4	7
05/06/1998	125 ± 7	4	119 ± 9	8	131 ± 2	10	125 ± 10	6
05/20/1998	140 ± 0	4	140 ± 0	8	144 ± 3	10	140 ± 0	2
06/15/1998	130 ± 0	4	132 ± 3	9	132 ± 3	9	130 ± 0	4
06/24/1998	130 ± 0	4	131 ± 2	8	135 ± 5	10	130 ± 0	7
07/06/1998	108 ± 6	4	123 ± 9	8	132 ± 2	10	130 ± 0	6
07/22/1998	120 ± 0	3	126 ± 3	8	127 ± 5	10	125 ± 7	4
08/05/1998	120 ± 0	4	120 ± 0	8	124 ± 5	10	120 ± 0	4
08/17/1998	125 ± 7	4	126 ± 3	8	123 ± 4	9	122 ± 3	6
09/09/1998	127 ± 10	3	130 ± 0	8	130 ± 0	9	130 ± 0	6
09/23/1998	137 ± 10	3	140 ± 0	7	139 ± 2	9	135 ± 7	6
10/14/1998	140 ± 0	3	140 ± 0	8	140 ± 0	9	140 ± 0	6
11/18/1998	130 ± 0	3	130 ± 0	6	130 ± 0	9	130 ± 0	6
12/17/1998	130 ± 0	3	136 ± 3	8	133 ± 3	10	133 ± 6	4
01/20/1999	108 ± 11	4	113 ± 6	8	141 ± 2	9	128 ± 18	4
02/16/1999	110 ± 10	4	113 ± 10	8	102 ± 4	10	100 ± 5	6
03/23/1999	98 ± 3	4	97 ± 2	8	97 ± 1	9	99 ± 1	7
04/06/1999	103 ± 6	4	103 ± 3	8	101 ± 2	9	101 ± 3	7
04/20/1999	120 ± 17	4	114 ± 9	8	110 ± 0	9	108 ± 8	5
05/03/1999	110 ± 0	4	111 ± 2	8	110 ± 0	10	112 ± 3	6
05/19/1999	110 ± 0	4	110 ± 0	8	110 ± 0	10	110 ± 0	7
06/08/1999	123 ± 6	4	121 ± 2	8	121 ± 3	10	123 ± 4	6
06/22/1999	110 ± 0	4	113 ± 3	8	117 ± 3	9	118 ± 3	6
07/06/1999	100 ± 1	4	101 ± 2	8	104 ± 3	10	100 ± 0	6
07/19/1999	110 ± 0	4	110 ± 0	8	111 ± 2	8	112 ± 3	6
08/10/1999	110 ± 0	4	113 ± 3	8	113 ± 3	9	117 ± 4	6
08/24/1999	113 ± 10	3	110 ± 0	8	110 ± 3	9	110 ± 0	6
09/07/1999	103 ± 10	3	104 ± 4	7	104 ± 3	9	100 ± 0	6
09/28/1999	140 ± 17	3	139 ± 10	7	138 ± 7	10	148 ± 12	6
10/13/1999	153 ± 10	3	147 ± 7	7	149 ± 4	9	150 ± 5	6
11/22/1999	129 ± 1	3	129 ± 0	6	128 ± 0	8	129 ± 1	5
12/13/1999	130 ± 1	3	129 ± 0	7	129 ± 0	7	129 ± 0	6

Table 17.7. Mean calcium water hardness levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	103 ± 4	3	102 ± 2	7	101 ± 1	9	100 ± 1	6
09/17/1997	103 ± 4	3	103 ± 2	7	101 ± 1	9	102 ± 2	6
10/15/1997	107 ± 2	3	108 ± 2	7	108 ± 1	9	108 ± 1	6
11/12/1997	115 ± 4	3	114 ± 1	7	114 ± 1	8	115 ± 1	6
12/17/1997	111 ± 4	3	112 ± 2	7	113 ± 2	8	112 ± 2	5
01/22/1998	111 ± 2	3	112 ± 1	7	112 ± 1	10	114 ± 2	5
02/11/1998	125 ± 4	3	121 ± 6	7	126 ± 3	8	120 ± 0	6
03/18/1998	108 ± 6	4	118 ± 3	8	117 ± 3	9	120 ± 0	7
04/08/1998	110 ± 0	4	109 ± 2	9	105 ± 3	10	107 ± 4	7
04/22/1998	103 ± 6	4	103 ± 3	8	101 ± 2	10	104 ± 4	7
05/06/1998	88 ± 6	4	89 ± 5	8	98 ± 1	10	93 ± 6	6
05/20/1998	101 ± 24	4	103 ± 13	8	115 ± 3	10	115 ± 32	2
06/15/1998	96 ± 2	4	98 ± 1	9	96 ± 1	9	97 ± 2	4
06/24/1998	97 ± 0	4	99 ± 2	8	98 ± 2	10	96 ± 3	7
07/06/1998	70 ± 3	4	84 ± 4	8	95 ± 1	10	95 ± 1	6
07/22/1998	92 ± 0	3	95 ± 1	8	95 ± 2	10	94 ± 3	4
08/05/1998	96 ± 3	4	94 ± 1	8	93 ± 2	10	92 ± 0	4
08/17/1998	97 ± 4	4	96 ± 2	8	97 ± 1	9	96 ± 3	6
09/09/1998	100 ± 0	3	105 ± 4	8	104 ± 3	9	103 ± 4	6
09/23/1998	107 ± 10	3	104 ± 4	7	101 ± 2	9	102 ± 3	6
10/14/1998	110 ± 0	3	110 ± 0	8	110 ± 0	9	110 ± 0	6
11/18/1998	97 ± 3	3	97 ± 2	6	98 ± 1	9	98 ± 1	6
12/17/1998	97 ± 3	3	101 ± 0	8	100 ± 1	10	100 ± 2	4
01/20/1999	78 ± 3	4	83 ± 7	8	101 ± 2	9	94 ± 15	4
02/16/1999	30 ± 3	4	31 ± 4	8	28 ± 1	10	30 ± 3	6
03/23/1999	27 ± 1	4	28 ± 1	8	29 ± 1	9	28 ± 1	7
04/06/1999	31 ± 1	4	31 ± 1	8	29 ± 2	9	30 ± 1	7
04/20/1999	33 ± 2	4	30 ± 0	8	32 ± 0	9	30 ± 1	5
05/03/1999	31 ± 0	4	31 ± 0	8	31 ± 0	10	31 ± 0	6
05/19/1999	31 ± 1	4	31 ± 0	8	31 ± 0	10	31 ± 0	7
06/08/1999	82 ± 2	4	84 ± 1	8	83 ± 1	10	82 ± 2	6
06/22/1999	84 ± 3	4	81 ± 1	8	81 ± 1	9	81 ± 1	6
07/06/1999	77 ± 1	4	73 ± 2	8	80 ± 5	10	70 ± 2	6
07/19/1999	72 ± 0	4	72 ± 0	8	74 ± 1	8	72 ± 3	6
08/10/1999	79 ± 5	4	75 ± 0	8	77 ± 3	9	79 ± 2	6
08/24/1999	77 ± 0	3	78 ± 2	8	76 ± 3	9	72 ± 1	6
09/07/1999	68 ± 6	3	67 ± 1	7	70 ± 2	9	71 ± 1	6
09/28/1999	90 ± 0	3	93 ± 4	7	94 ± 6	10	93 ± 7	6
10/13/1999	80 ± 45	3	96 ± 4	7	94 ± 3	9	103 ± 7	6
11/22/1999	90 ± 1	3	88 ± 3	6	89 ± 1	8	89 ± 1	5
12/13/1999	91 ± 1	3	90 ± 0	7	90 ± 1	7	90 ± 1	6

Table 17.8. Mean NO_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L NO_3.

	Location C	n	Location F	n	Location H	n	Location I	n
Date	95% C. I.		95% C. I.		95% C. I.		95% C. I.	
08/28/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.01 ± 0.02	9	0.00 ± 0.00	6
09/17/1997	0.13 ± 0.19	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/15/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/12/1997	1.00 ± 0.00	3	1.00 ± 0.00	7	1.00 ± 0.00	8	1.00 ± 0.00	6
12/17/1997	0.57 ± 0.10	3	0.70 ± 0.10	7	0.66 ± 0.03	8	0.60 ± 0.00	5
01/22/1998	1.27 ± 0.10	3	1.21 ± 0.08	7	1.18 ± 0.04	10	1.16 ± 0.05	5
02/11/1998	0.80 ± 0.00	3	0.76 ± 0.04	7	0.75 ± 0.09	8	0.58 ± 0.03	6
03/18/1998	1.50 ± 0.68	4			0.00 ± 0.00	9	0.00 ± 0.00	7
04/08/1998	0.15 ± 0.23	4	0.19 ± 0.09	9	0.45 ± 0.13	10	0.06 ± 0.07	7
04/22/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7

Table 17.9. Mean NO_2 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L NO_2 - N.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
09/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/15/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/12/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
12/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
01/22/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	5
02/11/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	5
03/18/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	8	0.00 ± 0.00	6
04/08/1998	0.00 ± 0.00	4	0.00 ± 0.00	9	0.00 ± 0.00	9	0.00 ± 0.00	7
04/22/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
05/06/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
05/20/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
06/15/1998	0.00 ± 0.00	4	0.00 ± 0.00	9	0.00 ± 0.00	10	0.00 ± 0.00	2
06/24/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	4
07/06/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
07/22/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
08/05/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	8	0.00 ± 0.00	4
08/17/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	4
09/09/1998	0.00	1	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/23/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/14/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
11/18/1998	0.00 ± 0.00	3	0.00 ± 0.00	6	0.00 ± 0.00	9	0.00 ± 0.00	6
12/17/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
01/20/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	4
02/16/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	4
03/23/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
04/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/20/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	7
05/03/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	5
05/19/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
06/08/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
06/22/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
07/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
07/19/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	8	0.00 ± 0.00	6
08/10/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
08/24/1999	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/07/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
09/28/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	6
10/13/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/22/1999	0.00 ± 0.00	3	0.00 ± 0.00	6	0.00 ± 0.00	8	0.00 ± 0.00	5
12/13/1999	0.00 ± 0.00	3	0.02 ± 0.04	7	0.00 ± 0.00	7	0.00 ± 0.00	6

Table 17.10. Mean NO_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L NO_3 - N.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
05/06/1998	0.07 ± 0.02	4	0.16 ± 0.03	8	0.03 ± 0.01	10	0.04 ± 0.06	6
05/20/1998	0.03 ± 0.01	4	0.11 ± 0.06	8	0.11 ± 0.06	10	0.00 ± 0.00	2
06/15/1998	0.13 ± 0.02	4	0.14 ± 0.03	9	0.14 ± 0.03	9	0.07 ± 0.00	4
06/24/1998	0.11 ± 0.00	4	0.10 ± 0.02	8	0.05 ± 0.02	10	0.02 ± 0.02	7
07/06/1998	0.21 ± 0.01	4	0.10 ± 0.04	8	0.01 ± 0.01	10	0.00 ± 0.00	6
07/22/1998	0.01 ± 0.03	3	0.00 ± 0.01	8	0.00 ± 0.00	8	0.00 ± 0.00	4
08/05/1998	0.01 ± 0.02	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	4
08/17/1998	0.01 ± 0.02	4	0.00 ± 0.00	8	0.01 ± 0.01	9	0.01 ± 0.01	6
09/09/1998	0.00	1	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/23/1998	0.02 ± 0.00	3	0.02 ± 0.01	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/14/1998	0.00 ± 0.00	3	0.02 ± 0.01	8	0.00 ± 0.00	9	0.00 ± 0.00	6
11/18/1998	0.30 ± 0.00	3	0.27 ± 0.04	6	0.30 ± 0.03	9	0.31 ± 0.00	6
12/17/1998	0.36 ± 0.20	3	0.31 ± 0.01	8	0.30 ± 0.00	10	0.29 ± 0.01	4
01/20/1999	0.46 ± 0.01	4	0.43 ± 0.02	8	0.36 ± 0.00	9	0.38 ± 0.04	4
02/16/1999	0.58 ± 0.15	4	0.51 ± 0.02	8	0.50 ± 0.00	10	0.51 ± 0.00	6
03/23/1999	0.56 ± 0.03	4	0.55 ± 0.00	8	0.54 ± 0.01	9	0.55 ± 0.00	7
04/06/1999	0.29 ± 0.01	4	0.30 ± 0.04	8	0.26 ± 0.01	9	0.24 ± 0.00	7
04/20/1999	0.23 ± 0.01	4	0.23 ± 0.01	8	0.25 ± 0.00	9	0.26 ± 0.00	5
05/03/1999	0.01 ± 0.02	4	0.05 ± 0.04	8	0.09 ± 0.03	10	0.08 ± 0.02	6
05/19/1999	0.05 ± 0.01	4	0.09 ± 0.05	8	0.10 ± 0.08	9	0.01 ± 0.01	7
06/08/1999	0.05 ± 0.01	4	0.05 ± 0.01	8	0.02 ± 0.01	10	0.00 ± 0.00	6
06/22/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
07/06/1999	0.00 ± 0.00	4	0.02 ± 0.01	8	0.02 ± 0.01	10	0.00 ± 0.00	6
07/19/1999	0.00 ± 0.01	4	0.00 ± 0.00	8	0.00 ± 0.00	8	0.00 ± 0.00	6
08/10/1999	0.20 ± 0.46	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
08/24/1999	0.00 ± 0.00	3	0.00 ± 0.01	8	0.02 ± 0.01	9	0.01 ± 0.01	6
09/07/1999	0.00 ± 0.00	3	0.01 ± 0.01	7	0.01 ± 0.01	9	0.00 ± 0.01	6
09/28/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	6
10/13/1999	0.05 ± 0.01	3	0.08 ± 0.06	7	0.02 ± 0.01	9	0.00 ± 0.00	6
11/22/1999	0.13 ± 0.00	3	0.12 ± 0.00	6	0.12 ± 0.00	8	0.10 ± 0.00	5
12/13/1999	0.22 ± 0.00	3	0.21 ± 0.01	7	0.21 ± 0.00	7	0.20 ± 0.00	6

Table 17.11. Mean Total Kjeldahl Nitrogen levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L NH_3 - N.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	0.41 ± 0.16	3	0.67 ± 0.10	7	0.69 ± 0.17	9	0.63 ± 0.20	6
09/17/1997	0.11 ± 0.17	3	0.15 ± 0.17	7	0.23 ± 0.15	9	0.20 ± 0.14	6
10/15/1997	0.77 ± 0.18	3	1.10 ± 0.19	7	0.80 ± 0.11	9	0.76 ± 0.09	6
11/12/1997	0.52 ± 0.52	3	0.49 ± 0.22	7	0.63 ± 0.37	8	0.43 ± 0.10	6
12/17/1997	0.28 ± 0.21	3	0.45 ± 0.40	7	0.40 ± 0.07	8	1.40 ± 1.64	5
01/22/1998	0.48 ± 0.05	3	0.44 ± 0.05	7	0.44 ± 0.05	10	0.41 ± 0.07	5
02/11/1998	0.80 ± 0.10	3	0.68 ± 0.07	7	0.79 ± 0.10	8	0.74 ± 0.05	6
03/18/1998	0.69 ± 0.14	4	0.57 ± 0.14	8	0.76 ± 0.15	9	0.56 ± 0.11	7
04/08/1998	1.32 ± 1.43	4	0.81 ± 0.06	9	0.72 ± 0.06	10	0.97 ± 0.29	7
04/22/1998	0.91 ± 0.20	4	0.74 ± 0.15	8	0.81 ± 0.15	10	0.87 ± 0.14	7
05/06/1998	1.42 ± 0.31	4	1.51 ± 0.17	8	1.37 ± 0.17	10	1.70 ± 0.14	6
05/20/1998	1.65 ± 0.07	4	1.89 ± 0.19	8	1.50 ± 0.39	10	1.05 ± 0.32	2
06/15/1998	2.10 ± 0.76	4	1.44 ± 0.20	9	1.06 ± 0.08	9	1.30 ± 0.21	4
06/24/1998	1.40 ± 0.10	4	1.33 ± 0.07	8	1.24 ± 0.15	10	1.11 ± 0.18	7
07/06/1998	1.35 ± 0.39	4	1.51 ± 0.28	8	1.15 ± 0.21	10	1.03 ± 0.24	6
07/22/1998	0.80 ± 0.34	3	0.84 ± 0.14	8	1.07 ± 0.20	10	0.63 ± 0.10	3
08/05/1998	0.88 ± 0.15	4	0.81 ± 0.14	8	0.90 ± 0.20	10	0.80 ± 0.10	4
08/17/1998	1.35 ± 0.07	4	1.48 ± 0.53	8	1.71 ± 0.49	9	1.28 ± 0.10	6
09/09/1998	0.83 ± 0.10	3	0.95 ± 0.09	8	0.77 ± 0.06	9	0.75 ± 0.11	6
09/23/1998	0.80 ± 0.00	3	0.76 ± 0.06	7	0.71 ± 0.05	9	0.78 ± 0.03	6
10/14/1998	1.17 ± 0.26	3	1.01 ± 0.10	8	1.21 ± 0.21	9	1.25 ± 0.14	6
11/18/1998	0.90 ± 0.17	3	0.78 ± 0.10	6	0.92 ± 0.04	9	0.85 ± 0.07	6
12/17/1998	0.77 ± 0.10	3	0.85 ± 0.11	8	0.95 ± 0.11	10	0.57 ± 0.11	4
01/20/1999	0.68 ± 0.06	4	1.25 ± 0.21	8	1.38 ± 0.28	9	0.98 ± 0.15	4
02/16/1999	1.15 ± 0.60	4	1.05 ± 0.11	8	1.00 ± 0.26	10	1.05 ± 0.19	6
03/23/1999	0.88 ± 0.06	4	0.80 ± 0.11	8	0.96 ± 0.05	9	1.06 ± 0.16	7
04/06/1999	0.60 ± 0.47	4	0.89 ± 0.06	8	1.02 ± 0.10	9	0.71 ± 0.05	7
04/20/1999	0.98 ± 0.15	4	1.08 ± 0.14	8	0.86 ± 0.08	9	1.12 ± 0.12	5
05/03/1999	1.15 ± 0.15	4	1.14 ± 0.07	8	1.00 ± 0.06	10	1.63 ± 0.35	6
05/19/1999	1.02 ± 0.18	4	0.90 ± 0.11	8	1.05 ± 0.13	10	1.29 ± 0.08	7
06/08/1999	1.70 ± 0.25	4	1.26 ± 0.12	8	1.31 ± 0.09	10	0.82 ± 0.36	6
06/22/1999	1.38 ± 0.24	4	1.17 ± 0.17	8	1.06 ± 0.11	9	1.08 ± 0.06	6
07/06/1999	1.15 ± 0.24	4	1.13 ± 0.29	8	1.12 ± 0.06	10	1.03 ± 0.13	6
07/19/1999	0.75 ± 0.68	4	1.04 ± 0.26	8	0.70 ± 0.95	8	2.07 ± 0.99	6
08/10/1999	1.42 ± 0.31	4	1.00 ± 0.12	8	1.09 ± 0.14	9	0.80 ± 0.10	6
08/24/1999	1.50 ± 0.88	3	1.16 ± 0.07	8	0.94 ± 0.26	9	0.95 ± 0.23	6
09/07/1999	1.23 ± 0.87	3	1.26 ± 0.11	7	1.04 ± 0.17	9	1.05 ± 0.23	6
09/28/1999	1.47 ± 0.19	3	1.40 ± 0.06	7	1.14 ± 0.24	10	1.35 ± 0.05	6
10/13/1999	1.30 ± 0.00	3	0.60 ± 0.56	7	0.11 ± 0.21	9	1.37 ± 0.08	6
11/22/1999	1.35 ± 0.32	2	1.68 ± 0.53	6	1.25 ± 0.06	8	1.86 ± 0.13	5
12/13/1999	1.36 ± 1.38	3	1.69 ± 0.77	7	0.90 ± 0.13	7	0.98 ± 0.27	6

Table 17.12. Mean orthophosphate levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L PO_4.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.17 ± 0.22	6
09/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/15/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9		
11/12/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
12/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	5
01/22/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	5
02/11/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
03/18/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/08/1998	0.00 ± 0.00	4	0.00 ± 0.00	9	0.00 ± 0.00	10	0.00 ± 0.00	7
04/22/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7

Table 17.13. Mean orthophosphate levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L PO_4 - P.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
05/06/1998	0.00 ± 0.00	4	0.03 ± 0.03	8	0.00 ± 0.00	10	0.01 ± 0.03	6
05/20/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	2
06/15/1998	0.00 ± 0.00	4	0.00 ± 0.00	9	0.00 ± 0.00	9	0.00 ± 0.00	4
06/24/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
07/06/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
07/22/1998	0.00 ± 0.00	3	0.02 ± 0.04	8	0.03 ± 0.03	10	0.00 ± 0.00	4
08/05/1998	0.00 ± 0.00	4	0.02 ± 0.04	8	0.05 ± 0.06	10	0.00 ± 0.00	4
08/17/1998	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/09/1998	0.00	1	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/23/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
10/14/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
11/18/1998	0.00 ± 0.00	3	0.00 ± 0.00	6	0.00 ± 0.00	9	0.00 ± 0.00	6
12/17/1998	0.00 ± 0.00	3	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	4
01/20/1999	0.13 ± 0.00	4	0.10 ± 0.04	8	0.00 ± 0.00	9	0.02 ± 0.05	4
02/16/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
03/23/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.02 ± 0.03	7
04/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/20/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	5
05/03/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
05/19/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
06/08/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
06/22/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
07/06/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
07/19/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	8	0.00 ± 0.00	6
08/10/1999	0.00 ± 0.00	4	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
08/24/1999	0.03 ± 0.10	3	0.00 ± 0.00	8	0.00 ± 0.00	9	0.00 ± 0.00	6
09/07/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
09/28/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	6
10/13/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	9	0.00 ± 0.00	6
11/22/1999	0.07 ± 0.21	3	0.00 ± 0.00	6	0.00 ± 0.00	8	0.00 ± 0.00	5
12/13/1999	0.05 ± 0.14	3	0.00 ± 0.00	7	0.00 ± 0.00	7	0.00 ± 0.00	6

Table 17.14. Mean total phosphorus levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L PO_4 - P.

	Location C		Location F		Location H		Location I	
Date	95% C. I.	n	95% C. I.	n	95% C. I.	n	95% C. I.	n
08/28/1997	0.03 ± 0.01	3	0.02 ± 0.01	7	0.03 ± 0.01	9	0.02 ± 0.01	6
09/17/1997	0.00	1	0.04 ± 0.06	3	0.03 ± 0.04	5	0.00 ± 0.00	5
10/15/1997	0.00 ± 0.00	3	0.04 ± 0.07	7	0.01 ± 0.02	9	0.00 ± 0.00	6
11/12/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
12/17/1997	0.00 ± 0.00	3	0.00 ± 0.00	7	0.02 ± 0.04	8	0.00 ± 0.00	5
01/22/1998	0.04 ± 0.11	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	5
02/11/1998	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	8	0.00 ± 0.00	6
03/18/1998	0.27 ± 0.10	4	0.02 ± 0.02	8	0.00 ± 0.00	9	0.00 ± 0.00	7
04/08/1998	0.07 ± 0.04	4	0.08 ± 0.01	9	0.06 ± 0.00	10	0.07 ± 0.00	7
04/22/1998	0.04 ± 0.03	4	0.01 ± 0.02	8	0.01 ± 0.01	10	0.00 ± 0.00	7
05/06/1998	0.16 ± 0.03	4	0.18 ± 0.04	8	0.08 ± 0.02	10	0.14 ± 0.06	6
05/20/1998	0.08 ± 0.01	4	0.09 ± 0.01	8	0.09 ± 0.02	10	0.09 ± 0.02	2
06/15/1998	0.12 ± 0.02	4	0.10 ± 0.03	9	0.09 ± 0.01	9	0.07 ± 0.02	4
06/24/1998	0.09 ± 0.01	4	0.04 ± 0.03	8	0.10 ± 0.11	10	0.03 ± 0.03	7
07/06/1998	0.24 ± 0.02	4	0.16 ± 0.06	8	0.06 ± 0.06	10	0.00 ± 0.00	6
07/22/1998	0.00 ± 0.00	3	0.04 ± 0.08	8	0.09 ± 0.10	10	0.00 ± 0.00	4
08/05/1998	0.03 ± 0.04	4	0.01 ± 0.02	8	0.10 ± 0.11	10	0.00 ± 0.00	4
08/17/1998	0.02 ± 0.05	4	0.01 ± 0.01	8	0.08 ± 0.13	9	0.00 ± 0.00	6
09/09/1998	0.07 ± 0.02	3	0.09 ± 0.03	8	0.07 ± 0.02	9	0.09 ± 0.01	6
09/23/1998	0.06 ± 0.02	3	0.04 ± 0.03	7	0.03 ± 0.03	9	0.05 ± 0.02	6
10/14/1998	0.04 ± 0.06	3	0.00 ± 0.00	8	0.01 ± 0.02	9	0.01 ± 0.02	6
11/18/1998	0.12 ± 0.04	3	0.11 ± 0.02	6	0.11 ± 0.01	9	0.12 ± 0.01	6
12/17/1998	0.08 ± 0.01	3	0.07 ± 0.01	8	0.07 ± 0.01	10	0.06 ± 0.05	4
01/20/1999	0.19 ± 0.03	4	0.18 ± 0.05	8	0.05 ± 0.02	9	0.09 ± 0.09	4
02/16/1999	0.18 ± 0.05	4	0.17 ± 0.01	8	0.17 ± 0.04	10	0.15 ± 0.03	6
03/23/1999	0.09 ± 0.01	4	0.09 ± 0.01	8	0.09 ± 0.00	9	0.09 ± 0.01	7
04/06/1999	0.11 ± 0.01	4	0.10 ± 0.02	8	0.01 ± 0.01	9	0.02 ± 0.02	7
04/20/1999	0.03 ± 0.04	4	0.01 ± 0.01	8	0.00 ± 0.00	9	0.00 ± 0.00	5
05/03/1999	0.03 ± 0.04	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	6
05/19/1999	0.01 ± 0.04	4	0.00 ± 0.00	8	0.00 ± 0.00	10	0.00 ± 0.00	7
06/08/1999	0.08 ± 0.02	4	0.06 ± 0.00	8	0.07 ± 0.02	10	0.00 ± 0.00	6
06/22/1999	0.07 ± 0.01	4	0.07 ± 0.01	8	0.05 ± 0.02	9	0.04 ± 0.03	6
07/06/1999	0.06 ± 0.01	4	0.03 ± 0.02	8	0.02 ± 0.02	10	0.00 ± 0.00	6
07/19/1999	0.08 ± 0.01	4	0.06 ± 0.04	8	0.10 ± 0.01	8	0.11 ± 0.02	6
08/10/1999	0.05 ± 0.04	4	0.06 ± 0.02	8	0.09 ± 0.03	9	0.01 ± 0.02	6
08/24/1999	0.09 ± 0.01	3	0.07 ± 0.01	8	0.06 ± 0.02	9	0.03 ± 0.02	6
09/07/1999	0.05 ± 0.08	3	0.07 ± 0.01	7	0.09 ± 0.03	9	0.07 ± 0.01	6
09/28/1999	0.00 ± 0.00	3	0.00 ± 0.00	7	0.00 ± 0.00	10	0.00 ± 0.00	6
10/13/1999	0.02 ± 0.05	3	0.01 ± 0.01	7	0.00 ± 0.00	9	0.01 ± 0.02	6
11/22/1999	0.06 ± 0.01	3	0.06 ± 0.01	6	0.08 ± 0.01	8	0.07 ± 0.01	5
12/13/1999	0.02 ± 0.05	3	0.04 ± 0.02	7	0.01 ± 0.01	7	0.01 ± 0.02	6

Table 17.15. Mean SO_4 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L SO_4.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	121 ± 1	3	121 ± 1	7	123 ± 8	9	120 ± 2	6
09/17/1997	125 ± 5	3	129 ± 7	7	111 ± 1	9	111 ± 2	6
10/15/1997	132 ± 4	3	126 ± 2	7	127 ± 0	9	129 ± 2	6
11/12/1997	135 ± 14	3	135 ± 4	7	140 ± 6	8	143 ± 13	6
12/17/1997	140 ± 0	3	142 ± 1	7	142 ± 1	8	141 ± 1	5
01/22/1998	150 ± 9	3	150 ± 2	7	152 ± 1	10	152 ± 4	5
02/11/1998	144 ± 14	3	146 ± 2	7	151 ± 4	8	154 ± 4	6
03/18/1998	135 ± 10	4	148 ± 2	8	150 ± 1	9	148 ± 2	7
04/08/1998	137 ± 7	4	141 ± 2	9	142 ± 2	10	141 ± 2	7
04/22/1998	146 ± 6	4	147 ± 3	8	148 ± 2	10	147 ± 1	7
05/06/1998	108 ± 6	4	100 ± 12	8	118 ± 5	10	113 ± 13	6
05/20/1998	102 ± 2	4	101 ± 3	8	103 ± 3	10	99 ± 9	2
06/15/1998	93 ± 2	4	97 ± 1	9	99 ± 3	9	96 ± 4	4
06/24/1998	87 ± 2	4	90 ± 3	8	93 ± 3	10	92 ± 1	7
07/06/1998	63 ± 1	4	84 ± 3	8	95 ± 1	10	95 ± 0	6
07/22/1998	94 ± 1	3	92 ± 2	8	95 ± 1	10	95 ± 1	4
08/05/1998	95 ± 2	4	93 ± 2	8	93 ± 2	10	94 ± 2	4
08/17/1998	92 ± 1	4	91 ± 4	8	105 ± 18	9	97 ± 10	6
09/09/1998	95 ± 4	3	93 ± 1	8	95 ± 1	9	93 ± 3	6
09/23/1998	97 ± 3	3	99 ± 1	7	100 ± 1	9	97 ± 2	6
10/14/1998	98 ± 5	3	97 ± 1	8	96 ± 1	9	99 ± 0	6
11/18/1998	100 ± 0	3	100 ± 0	6	100 ± 3	9	99 ± 1	6
12/17/1998	110 ± 0	3	110 ± 0	8	109 ± 2	10	110 ± 0	4
01/20/1999	73 ± 2	4	83 ± 9	8	110 ± 0	9	98 ± 17	4
02/16/1999	64 ± 1	4	65 ± 2	8	61 ± 1	10	66 ± 3	6
03/23/1999	69 ± 2	4	70 ± 1	8	69 ± 1	9	69 ± 1	7
04/06/1999	66 ± 2	4	71 ± 1	8	70 ± 1	9	69 ± 1	7
04/20/1999	72 ± 1	4	72 ± 1	8	75 ± 2	9	74 ± 1	5
05/03/1999	70 ± 1	4	75 ± 1	8	72 ± 1	10	73 ± 1	6
05/19/1999	75 ± 2	4	74 ± 2	8	72 ± 1	10	72 ± 1	7
06/08/1999	74 ± 1	4	74 ± 1	8	73 ± 1	10	75 ± 2	6
06/22/1999	75 ± 2	4	73 ± 2	8	74 ± 7	9	71 ± 3	6
07/06/1999	63 ± 1	4	65 ± 1	8	65 ± 1	10	65 ± 2	6
07/19/1999	66 ± 1	4	67 ± 1	8	64 ± 2	8	67 ± 1	6
08/10/1999	71 ± 6	4	71 ± 2	8	72 ± 2	9	74 ± 3	6
08/24/1999	67 ± 1	3	67 ± 1	8	66 ± 2	9	71 ± 7	6
09/07/1999	71 ± 3	3	69 ± 1	7	70 ± 2	9	71 ± 1	6
09/28/1999	77 ± 0	3	78 ± 1	7	79 ± 0	10	79 ± 0	6
10/13/1999	79 ± 7	3	76 ± 2	7	75 ± 1	9	75 ± 1	6
11/22/1999	88 ± 0	3	88 ± 0	6	88 ± 0	8	88 ± 0	5
12/13/1999	94 ± 2	3	95 ± 0	7	95 ± 0	7	97 ± 1	6

Table 17.16. Mean total dissolved solids (TDS) levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in mg/L TDS.

Date	Location C 95% C. I.	n	Location F 95% C. I.	n	Location H 95% C. I.	n	Location I 95% C. I.	n
08/28/1997	311 ± 27	3	313 ± 8	7	305 ± 5	9	318 ± 11	6
09/17/1997	337 ± 52	3	347 ± 23	7	339 ± 35	9	340 ± 17	6
10/15/1997	338 ± 27	3	333 ± 10	7	336 ± 19	9	353 ± 19	6
11/12/1997	377 ± 51	3	366 ± 16	7	380 ± 23	8	363 ± 16	6
12/17/1997	365 ± 19	3	360 ± 21	7	369 ± 12	8	363 ± 9	5
01/22/1998	379 ± 15	3	369 ± 11	7	367 ± 20	10	379 ± 11	5
02/11/1998	489 ± 108	3	374 ± 24	7	376 ± 15	8	446 ± 98	6
03/18/1998	355 ± 29	4	401 ± 11	8	404 ± 6	9	397 ± 3	7
04/08/1998	329 ± 27	4	321 ± 8	9	347 ± 24	10	322 ± 17	7
04/22/1998	336 ± 10	4	338 ± 4	8	340 ± 5	10	342 ± 9	7
05/06/1998	305 ± 12	4	293 ± 20	8	336 ± 21	10	327 ± 30	6
05/20/1998	300 ± 14	4	308 ± 12	8	304 ± 11	10	285 ± 32	2
06/15/1998	318 ± 6	4	327 ± 14	9	320 ± 32	9	290 ± 10	4
06/24/1998	275 ± 7	4	286 ± 11	8	289 ± 10	10	276 ± 6	7
07/06/1998	210 ± 10	4	244 ± 14	8	272 ± 8	10	267 ± 4	6
07/22/1998	260 ± 0	3	288 ± 28	8	299 ± 22	10	273 ± 22	4
08/05/1998	265 ± 7	4	275 ± 6	8	272 ± 8	10	260 ± 10	4
08/17/1998	278 ± 11	4	274 ± 3	8	333 ± 61	9	283 ± 21	6
09/09/1998	297 ± 10	3	298 ± 28	8	287 ± 4	9	280 ± 5	6
09/23/1998	280 ± 29	3	284 ± 10	7	284 ± 9	9	282 ± 27	6
10/14/1998	290 ± 0	3	305 ± 6	8	298 ± 4	9	292 ± 8	6
11/18/1998	303 ± 10	3	295 ± 5	6	314 ± 22	9	315 ± 23	6
12/17/1998	310 ± 0	3	304 ± 3	8	308 ± 6	10	300 ± 17	4
01/20/1999	243 ± 22	4	265 ± 25	8	316 ± 26	9	285 ± 41	4
02/16/1999	313 ± 162	4	280 ± 64	8	194 ± 11	10	207 ± 13	6
03/23/1999	323 ± 120	4	343 ± 83	8	304 ± 81	9	380 ± 78	7
04/06/1999	188 ± 6	4	218 ± 23	8	201 ± 16	9	259 ± 92	7
04/20/1999	238 ± 11	4	256 ± 20	8	217 ± 20	9	242 ± 25	5
05/03/1999	288 ± 83	4	253 ± 28	8	257 ± 22	10	253 ± 50	6
05/19/1999	205 ± 15	4	218 ± 46	8	415 ± 148	10	277 ± 60	7
06/08/1999	300 ± 66	4	340 ± 63	8	252 ± 27	10	267 ± 54	6
06/22/1999	225 ± 12	4	218 ± 6	8	210 ± 14	9	213 ± 34	6
07/06/1999	198 ± 11	4	203 ± 8	8	193 ± 12	10	157 ± 11	6
07/19/1999	223 ± 22	4	263 ± 40	8	250 ± 66	8	210 ± 13	6
08/10/1999	203 ± 6	4	273 ± 127	8	280 ± 66	9	207 ± 14	6
08/24/1999	213 ± 10	3	240 ± 18	8	269 ± 53	9	230 ± 16	6
09/07/1999	217 ± 10	3	267 ± 48	7	252 ± 36	9	283 ± 80	6
09/28/1999	237 ± 2	3	219 ± 12	7	236 ± 6	10	225 ± 11	6
10/13/1999	247 ± 7	3	253 ± 15	7	245 ± 9	9	242 ± 6	6
11/22/1999	245 ± 26	3	249 ± 13	6	246 ± 3	8	271 ± 58	5
12/13/1999	271 ± 8	3	269 ± 3	7	267 ± 3	7	271 ± 3	6

Table 17.17. Secchi depths measured by AmerenCIPS in Newton Lake, 1997 – 1999. Values are in meters.

Date	Location										
	A	B	C	D	E	F	G	H	I	J	K
08/28/97	0.75	1.00	0.75	0.75	1.00	1.00	1.00	1.25	1.25	1.25	1.00
09/17/97	1.00		1.00	1.00	1.00	1.00	1.00	1.25	1.25	0.75	0.50
10/15/97	0.75		1.00	0.75	1.00	1.00	1.25	1.25	1.00	1.00	0.75
11/12/97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.75
12/17/97	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.25	1.00
01/22/98		0.75	1.25	1.25	1.25	1.25	1.25	1.50	1.50	1.50	0.50
02/11/98		0.75	1.00	1.00	1.00	1.00	1.25	1.25	1.00	1.00	0.50
03/18/98	0.25	0.25	0.50	0.50	0.50	0.75	0.75	0.75	0.75	0.75	0.25
04/08/98	0.50	0.50	0.50	0.50	0.50	0.50	0.75	0.75	0.75	0.75	0.25
04/22/98	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	0.75	0.25
05/06/98	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.75	0.75	0.75	0.25
05/20/98	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00		
06/15/98	0.50	0.50	0.50	0.50	0.50	0.50	0.75	1.00	1.00	0.75	0.25
06/24/98	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	0.75
07/06/98	0.25	0.25	0.25	0.25	0.25	0.25	0.75	1.00	1.00	0.75	0.50
07/22/98	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.25	1.25	1.00	0.50
08/05/98	0.50	0.75	0.75	0.75	0.75	1.00	1.00	1.00	1.25	1.00	0.25
08/17/98	0.75	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.25	1.25	0.50
09/09/98	0.50	0.50	0.75	0.75	0.75	1.00	1.25	1.25	1.00	0.75	0.50
09/23/98	0.75	0.75	0.75	0.75	1.00	0.75	1.25	1.50	1.00	0.75	0.50
10/14/98	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	0.75	0.75	0.75
11/18/98	0.75	0.75	0.75	0.75	0.75	1.00	0.75	1.00	1.00	1.00	0.50
12/17/98	0.75	0.75	0.75	1.00	1.00	1.00	1.25	1.25	1.25	1.00	0.75
01/20/99	0.50	0.50	0.50	0.50	0.50	0.50	1.00	0.75	0.50		
02/16/99	0.25	0.25	0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.25
03/23/99	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.25
04/06/99	0.25	0.25	0.50	0.50	0.50	0.50	0.75	0.75	0.75	0.50	0.25
04/20/99	0.75	0.75	0.50	0.75	0.50	0.50	0.75	0.75	0.75	1.00	
05/03/99	0.75	0.75	0.75	0.75	0.75	1.25	1.25	1.50	1.50	1.00	0.50
05/19/99	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	1.00	1.00	0.25
06/08/99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.25	1.25	0.50
06/22/99	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
07/06/99	0.75	0.75	0.75	0.75	0.75	0.75		1.00	1.00	1.00	0.50
07/19/99	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	1.25	0.50
08/10/99	0.50	0.50		0.75	0.75	0.75	0.75	0.75	1.00	0.75	0.50
08/24/99	0.75	0.75	0.75	0.75		0.75	0.75	1.00	1.00	0.75	0.50
09/07/99	0.50	0.50	0.50	0.75	0.75	0.75	0.75	1.00	1.25	0.75	0.50
09/28/99	0.75		0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	0.50
10/13/99	0.75		0.75	0.75	0.75	0.75	1.00	1.00	1.00	0.75	0.50
11/22/99			0.75	0.75	0.75	1.00	1.00	1.00	1.00	0.75	0.50
12/13/99			0.75	1.00	1.00	1.00	1.25	1.25	1.00	1.00	0.75

Table 17.18. Range of pH determined by AmerenCIPS in Newton Lake, 1997 – 1999.

Date	Location C		Location F		Location H		Location I	
	Minimum pH	Maximum pH	Minimum pH	Maximum pH	Minimum pH	Maximum pH	Minimum pH	Maximum pH
10/15/97	7.52	8.12	7.37	8.09	7.85	8.35	7.89	8.20
11/12/97	8.10	8.30	7.81	8.07	7.53	8.01	7.62	8.00
12/17/97	8.23	8.49	7.80	8.20	7.95	7.98	8.11	8.14
01/22/98	7.84	7.88	7.57	7.84	7.70	7.75	7.77	7.79
02/11/98	7.91	8.05	7.83	8.05	8.08	8.20	8.36	8.40
03/18/98	7.87	8.19	8.07	8.29	8.24	8.35	8.20	8.43
04/08/98	8.25	8.58	7.69	8.45	7.95	8.02	8.11	8.66
04/22/98	7.82	8.12	7.57	8.36	7.58	8.50	8.49	8.66
05/06/98	7.95	8.16	7.39	7.80	7.27	8.40	7.86	8.36
05/20/98	7.95	7.98	7.03	7.96	7.12	8.40	8.22	8.43
06/15/98	7.66	7.79	7.01	7.79	7.13	7.79	8.06	8.07
06/24/98	7.75	7.98	7.13	8.03	7.03	8.19	7.29	8.47
07/06/98	7.57	7.60	7.23	7.66	7.27	8.04	7.93	8.05
07/22/98	8.22	8.27	7.00	8.21	6.94	8.37	8.29	8.33
08/05/98	7.82	8.29	7.04	8.21	6.95	8.20	7.90	8.17
08/17/98	7.93	8.19	6.86	8.24	6.94	8.27	8.24	8.40
09/09/98	7.79	7.95	7.29	7.83	7.06	7.71	7.21	7.73
09/23/98	7.80	7.83	7.19	7.85	7.31	8.15	7.46	7.68
10/14/98	8.14	8.25	7.33	8.15	7.78	8.23	8.09	8.17
11/18/98	7.36	7.42	7.30	7.61	7.41	7.46	7.48	7.52
12/17/98	7.30	7.47	7.52	7.60	7.63	7.68	7.68	7.73
01/20/99	7.16	7.19	6.99	7.18	7.09	7.68	7.52	7.70
02/16/99	7.15	7.17	7.12	7.27	7.08	7.12	7.10	7.12
03/23/99	7.29	7.29	7.12	7.52	7.30	7.48	7.12	7.35
04/06/99	7.20	7.57	7.05	8.03	7.76	8.17	8.01	8.20
04/20/99	7.39	7.53	7.12	7.77	7.31	7.49	7.65	7.75
05/03/99	8.44	8.49	7.64	8.64	7.38	8.53	8.19	8.52
05/19/99	7.51	7.77	7.00	7.70	6.85	8.23	7.79	8.18
06/08/99	7.64	7.83	6.85	7.97			7.90	8.20
06/22/99	8.05	8.21	6.85	8.34	7.06	8.42	8.27	8.45
07/06/99	7.25	7.92	6.75	7.98	6.65	8.23	8.12	8.25
07/19/99	8.00	8.02	6.95	8.10	6.91	8.36	8.28	8.43
08/10/99	8.08	8.21	7.11	8.43	7.46	8.29	8.18	8.42
08/24/99	7.94	8.12	6.96	8.29	7.10	8.13	8.16	8.29
09/07/99	8.01	8.13	7.24	8.19	7.05	8.22	7.90	8.19
09/28/99	7.84	7.92			7.35	8.04	7.80	8.13
10/13/99	7.65	7.68	7.50	7.90	7.93	7.96	7.91	8.02
11/22/99	7.34	7.50	7.38	7.74	7.51	7.62	7.67	7.74
12/13/99	7.25	7.40	7.16	7.41	7.30	7.66	7.41	7.52

Table 17.19. Mean CO_2 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L CO_2.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	10.17 ± 1.78	9	7.79 ± 0.72	13
09/16/97	7.19 ± 0.59	8	7.41 ± 0.66	11
10/14/97	9.16 ± 0.87	8	7.23 ± 0.80	10
11/13/97	4.00 ± 0.00	9	4.00 ± 0.00	11
12/16/97	4.50 ± 0.62	8	4.00 ± 0.00	12
01/28/98	4.00 ± 0.00	8	4.00 ± 0.00	11
02/12/98	4.17 ± 0.39	9	3.96 ± 0.25	12
03/25/98	5.00 ± 0.00	9	5.10 ± 0.19	12
04/07/98	5.14 ± 0.26	9	6.04 ± 0.47	12
04/23/98	4.58 ± 0.39	9	5.10 ± 0.75	12
05/05/98	6.53 ± 0.34	9	6.25 ± 0.68	11
05/19/98	6.67 ± 0.87	9	6.25 ± 0.53	11
06/09/98	6.39 ± 0.47	9	4.66 ± 0.62	11
06/23/98	6.63 ± 0.69	10	6.36 ± 0.98	11
07/07/98	5.56 ± 0.41	9	5.23 ± 0.41	11
07/21/98	6.53 ± 2.00	9	6.38 ± 1.54	10
08/04/98	8.19 ± 1.55	9	6.88 ± 1.04	10
08/18/98	5.00 ± 0.34	10	3.82 ± 1.22	11
09/10/98	5.69 ± 0.88	9	4.77 ± 0.28	11
09/22/98	5.42 ± 0.39	9	5.57 ± 0.83	11
10/13/98	5.28 ± 0.34	9	4.20 ± 0.34	11
11/19/98	5.28 ± 0.34	9	5.13 ± 0.23	10
12/29/98	3.75 ± 0.00	9	3.75 ± 0.00	10
01/19/99	3.75 ± 0.00	9	3.75 ± 0.00	10
02/17/99	3.75 ± 0.00	10	3.75 ± 0.00	11
03/17/99	4.13 ± 0.35	10	4.03 ± 0.34	9
04/07/99	5.07 ± 0.49	10	6.70 ± 0.98	11
04/21/99	6.00 ± 0.67	10	4.88 ± 0.53	10
05/06/99	5.69 ± 0.41	9	5.75 ± 0.51	10
05/20/99	6.11 ± 0.82	9	6.14 ± 0.37	11
06/09/99	5.97 ± 0.52	9	5.75 ± 0.70	10
06/23/99	6.25 ± 0.00	9	5.75 ± 0.37	10
07/07/99	6.53 ± 0.85	9	5.91 ± 0.54	11
07/21/99	5.97 ± 0.34	9	5.43 ± 0.34	10
08/11/99	6.11 ± 0.47	9	6.14 ± 0.48	11
08/25/99	6.53 ± 0.52	9	5.45 ± 0.34	11
09/08/99	6.81 ± 0.41	9	6.75 ± 0.37	10
09/29/99	6.28 ± 0.65	9	6.36 ± 0.37	11
10/12/99	7.13 ± 0.86	8	7.34 ± 0.94	8
11/23/99	11.39 ± 1.25	9	12.39 ± 0.83	11
12/14/99	3.75 ± 0.00	8	4.00 ± 0.31	10

Table 17.20. Mean alkalinity levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	54 ± 1	9	56 ± 4	13
09/16/97	51 ± 1	8	49 ± 1	11
10/14/97	48 ± 1	8	47 ± 1	11
11/13/97	46 ± 3	9	47 ± 1	11
12/16/97	48 ± 1	8	46 ± 4	12
01/28/98	47 ± 1	8	49 ± 1	11
02/12/98	51 ± 1	9	50 ± 1	12
03/25/98	52 ± 0	9	52 ± 0	12
04/07/98	48 ± 1	9	50 ± 1	12
04/23/98	48 ± 1	9	48 ± 1	12
05/05/98	56 ± 1	9	58 ± 1	11
05/19/98	60 ± 1	9	60 ± 1	11
06/09/98	59 ± 1	9	58 ± 1	11
06/23/98	58 ± 1	10	59 ± 1	11
07/07/98	58 ± 1	9	59 ± 1	11
07/21/98	58 ± 1	9	59 ± 1	10
08/04/98	59 ± 1	9	58 ± 1	10
08/18/98	54 ± 1	10	54 ± 2	11
09/10/98	49 ± 1	9	48 ± 0	11
09/22/98	47 ± 1	9	48 ± 1	11
10/13/98	48 ± 0	9	48 ± 1	11
11/19/98	43 ± 3	9	44 ± 1	10
12/29/98	44 ± 1	9	44 ± 1	10
01/19/99	49 ± 1	9	48 ± 2	10
02/17/99	50 ± 1	10	50 ± 0	11
03/17/99	47 ± 1	10	46 ± 1	9
04/07/99	48 ± 1	10	47 ± 0	11
04/21/99	48 ± 0	10	49 ± 1	10
05/06/99	50 ± 1	9	50 ± 0	10
05/20/99	54 ± 1	9	54 ± 1	11
06/09/99	53 ± 1	9	53 ± 1	10
06/23/99	51 ± 1	9	51 ± 0	10
07/07/99	49 ± 1	8	49 ± 1	11
07/21/99	50 ± 1	9	50 ± 0	10
08/11/99	54 ± 1	9	55 ± 1	11
08/25/99	57 ± 1	9	57 ± 1	11
09/08/99	56 ± 0	9	56 ± 1	10
09/29/99	54 ± 1	9	54 ± 1	11
10/12/99	55 ± 1	8	55 ± 1	8
11/23/99	55 ± 1	9	55 ± 1	11
12/14/99	53 ± 1	8	53 ± 1	10

Table 17.21. Mean phenolphthalein alkalinity levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0 ± 0	9	0 ± 0	13
09/16/97	0 ± 0	8	0 ± 0	11
10/14/97	0 ± 0	8	0 ± 0	11
11/13/97	0 ± 0	9	0 ± 0	11
12/16/97	0 ± 0	8	0 ± 0	12
01/28/98	0 ± 0	8	0 ± 0	11
02/12/98	0 ± 0	9	0 ± 0	12
03/25/98	0 ± 0	9	0 ± 0	12
04/07/98	0 ± 0	9	0 ± 0	12
04/23/98	0 ± 0	9	0 ± 0	12
05/05/98	0 ± 0	9	0 ± 0	11
05/19/98	0 ± 0	9	0 ± 0	11
06/09/98	0 ± 0	9	0 ± 0	11
06/23/98	0 ± 0	10	0 ± 0	11
07/07/98	0 ± 0	9	0 ± 0	11
07/21/98	0 ± 0	9	0 ± 0	10
08/04/98	0 ± 0	9	0 ± 0	10
08/18/98	0 ± 0	10	0 ± 0	11
09/10/98	0 ± 0	9	0 ± 0	11
09/22/98	0 ± 0	9	0 ± 0	11
10/13/98	0 ± 0	9	0 ± 0	11
11/19/98	0 ± 0	9	0 ± 0	10
12/29/98	0 ± 0	9	0 ± 0	10
01/19/99	0 ± 0	9	0 ± 0	10
02/17/99	0 ± 0	10	0 ± 0	11
03/17/99	0 ± 0	10	0 ± 0	9
04/07/99	0 ± 0	10	0 ± 0	11
04/21/99	0 ± 0	10	0 ± 0	10
05/06/99	0 ± 0	9	0 ± 0	10
05/20/99	0 ± 0	9	0 ± 0	11
06/09/99	0 ± 0	9	0 ± 0	10
06/23/99	0 ± 0	9	0 ± 0	10
07/07/99	0 ± 0	8	0 ± 0	11
07/21/99	2 ± 0	9	2 ± 0	10
08/11/99	2 ± 0	9	2 ± 0	11
08/25/99	0 ± 0	9	0 ± 0	11
09/08/99	2 ± 0	9	2 ± 0	10
09/29/99	2 ± 0	9	2 ± 0	11
10/12/99	0 ± 0	8	0 ± 0	8
11/23/99	0 ± 0	9	0 ± 0	11
12/14/99	0 ± 0	8	0 ± 0	10

Table 17.22. Mean NH_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L NH_3.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.00 ± 0.00	9	0.11 ± 0.19	13
09/16/97	0.00 ± 0.00	8	0.00 ± 0.00	11
10/14/97	0.00 ± 0.00	8	0.00 ± 0.00	11
11/13/97	0.00 ± 0.00	9	0.00 ± 0.00	11
12/16/97	0.00 ± 0.00	8	0.00 ± 0.00	12
01/28/98	0.00 ± 0.00	8	0.00 ± 0.00	11
02/12/98	0.00 ± 0.00	9	0.00 ± 0.00	12
03/25/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/07/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/23/98	0.00 ± 0.00	9	0.00 ± 0.00	12
05/05/98	0.28 ± 0.26	9	0.06 ± 0.12	11
05/19/98	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/98	0.32 ± 0.24	9	0.11 ± 0.13	11
06/23/98	0.32 ± 0.21	10	0.31 ± 0.20	11
07/07/98	0.20 ± 0.19	9	0.13 ± 0.15	11
07/21/98	0.08 ± 0.14	9	0.06 ± 0.11	10
08/04/98	0.16 ± 0.19	9	0.21 ± 0.20	10
08/18/98	0.00 ± 0.00	10	0.00 ± 0.00	11
09/10/98	0.00 ± 0.00	9	0.00 ± 0.00	11
09/22/98	0.00 ± 0.00	9	0.00 ± 0.00	11
10/13/98	0.00 ± 0.00	9	0.00 ± 0.00	11
11/19/98	0.00 ± 0.00	9	0.00 ± 0.00	10
12/29/98	0.33 ± 0.25	9	0.06 ± 0.11	10
01/19/99	0.21 ± 0.20	9	0.24 ± 0.23	10
02/17/99	0.05 ± 0.09	10	0.12 ± 0.14	11
03/17/99	0.00 ± 0.00	10	0.13 ± 0.16	9
04/07/99	0.00 ± 0.00	10	0.00 ± 0.00	11
04/21/99	0.00 ± 0.00	10	0.00 ± 0.00	10
05/06/99	0.00 ± 0.00	9	0.00 ± 0.00	10
05/20/99	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/99	0.00 ± 0.00	9	0.00 ± 0.00	10
06/23/99	0.00 ± 0.00	9	0.00 ± 0.00	10
07/07/99	0.00 ± 0.00	8	0.00 ± 0.00	11
07/21/99	0.00 ± 0.00	9	0.00 ± 0.00	10
08/11/99	0.00 ± 0.00	9	0.00 ± 0.00	11
08/25/99	0.19 ± 0.23	9	0.00 ± 0.00	11
09/08/99	0.00 ± 0.00	9	0.00 ± 0.00	10
09/29/99	0.00 ± 0.00	9	0.00 ± 0.00	11
10/12/99	0.00 ± 0.00	8	0.00 ± 0.00	8
11/23/99	0.00 ± 0.00	9	0.00 ± 0.00	11
12/14/99	0.00 ± 0.00	8	0.00 ± 0.00	10

Table 17.23. Mean Cl^- levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L Cl^-.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	24 ± 1	9	24 ± 0	13
09/16/97	27 ± 0	8	24 ± 1	11
10/14/97	24 ± 0	8	23 ± 0	11
11/13/97	23 ± 1	9	24 ± 0	11
12/16/97	24 ± 1	8	23 ± 0	12
01/28/98	25 ± 0	8	20 ± 0	11
02/12/98	21 ± 0	9	22 ± 2	12
03/25/98	19 ± 0	9	19 ± 0	13
04/07/98	19 ± 1	9	17 ± 1	12
04/23/98	20 ± 1	9	20 ± 1	12
05/05/98	20 ± 0	9	20 ± 0	11
05/19/98	19 ± 0	9	19 ± 0	11
06/09/98	18 ± 0	9	18 ± 0	11
06/23/98	18 ± 0	10	18 ± 0	11
07/07/98	18 ± 0	9	18 ± 0	11
07/21/98	17 ± 0	9	17 ± 0	10
08/04/98	19 ± 0	9	19 ± 0	10
08/18/98	20 ± 2	10	17 ± 0	11
09/10/98	19 ± 0	9	19 ± 0	11
09/22/98	20 ± 0	9	20 ± 0	11
10/13/98	20 ± 0	9	19 ± 0	11
11/19/98	20 ± 1	9	19 ± 1	10
12/29/98	20 ± 0	9	19 ± 0	10
01/19/99	18 ± 0	9	19 ± 0	10
02/17/99	18 ± 0	10	18 ± 0	11
03/17/99	17 ± 0	10	18 ± 0	9
04/07/99	18 ± 0	10	17 ± 0	11
04/21/99	19 ± 1	10	20 ± 0	10
05/06/99	18 ± 0	9	19 ± 0	10
05/20/99	19 ± 1	9	18 ± 1	11
06/09/99	19 ± 0	9	19 ± 0	10
06/23/99	19 ± 0	9	19 ± 0	10
07/07/99	20 ± 0	8	19 ± 0	11
07/21/99	21 ± 0	9	21 ± 0	10
08/11/99	22 ± 0	9	21 ± 0	11
08/25/99	22 ± 0	9	22 ± 0	11
09/08/99	23 ± 0	9	24 ± 1	10
09/29/99	26 ± 0	9	26 ± 0	11
10/12/99	28 ± 1	8	27 ± 1	8
11/23/99	29 ± 0	9	29 ± 0	11
12/14/99	27 ± 0	8	27 ± 0	10

Table 17.24. Mean water hardness levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

	Location C		Location E1	
Date	95% C. I.	n	95% C. I.	n
08/29/97	124 ± 1	9	123 ± 2	13
09/16/97	118 ± 2	8	116 ± 2	11
10/14/97	111 ± 4	8	110 ± 2	11
11/13/97	117 ± 2	9	118 ± 1	11
12/16/97	118 ± 1	8	118 ± 1	12
01/28/98	126 ± 2	8	127 ± 1	11
02/12/98	134 ± 2	9	132 ± 2	12
03/25/98	127 ± 2	9	129 ± 1	12
04/07/98	118 ± 3	9	118 ± 2	12
04/23/98	120 ± 0	9	120 ± 0	12
05/05/98	121 ± 2	9	120 ± 0	11
05/19/98	139 ± 2	9	137 ± 3	11
06/09/98	132 ± 3	9	130 ± 0	11
06/23/98	122 ± 2	10	121 ± 3	11
07/07/98	121 ± 2	9	120 ± 0	11
07/21/98	120 ± 0	9	120 ± 0	10
08/04/98	120 ± 0	9	120 ± 0	10
08/18/98	111 ± 2	10	113 ± 3	11
09/10/98	111 ± 2	9	110 ± 0	11
09/22/98	117 ± 3	9	111 ± 2	11
10/13/98	117 ± 3	9	110 ± 0	11
11/19/98	102 ± 3	9	100 ± 0	10
12/29/98	108 ± 3	9	109 ± 2	10
01/19/99	127 ± 3	9	118 ± 2	10
02/17/99	110 ± 0	10	110 ± 0	11
03/17/99	110 ± 0	10	110 ± 0	9
04/07/99	110 ± 0	10	110 ± 0	11
04/21/99	119 ± 2	10	120 ± 0	10
05/06/99	119 ± 2	9	120 ± 0	10
05/20/99	120 ± 0	9	120 ± 0	11
06/09/99	131 ± 2	9	129 ± 2	10
06/23/99	121 ± 2	9	122 ± 2	10
07/07/99	125 ± 4	8	127 ± 3	11
07/21/99	120 ± 0	9	121 ± 2	10
08/11/99	128 ± 3	9	128 ± 2	11
08/25/99	112 ± 3	9	117 ± 3	11
09/08/99	119 ± 2	9	119 ± 2	10
09/29/99	149 ± 6	9	152 ± 5	11
10/12/99	156 ± 8	8	153 ± 5	8
11/23/99	130 ± 0	9	130 ± 0	11
12/14/99	130 ± 0	8	130 ± 0	10

Table 17.25. Mean calcium water hardness levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L $CaCO_3$.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	56 ± 1	9	58 ± 2	13
09/16/97	49 ± 3	8	49 ± 1	11
10/14/97	49 ± 2	8	47 ± 2	11
11/13/97	48 ± 1	9	46 ± 2	11
12/16/97	46 ± 2	8	47 ± 2	12
01/28/98	52 ± 1	8	52 ± 2	11
02/12/98	55 ± 1	9	55 ± 1	12
03/25/98	56 ± 2	9	57 ± 1	12
04/07/98	51 ± 2	9	53 ± 3	12
04/23/98	52 ± 3	9	52 ± 2	12
05/05/98	55 ± 1	9	55 ± 1	11
05/19/98	68 ± 3	9	67 ± 3	11
06/09/98	64 ± 1	9	63 ± 1	11
06/23/98	67 ± 1	10	65 ± 1	11
07/07/98	63 ± 3	9	62 ± 1	11
07/21/98	66 ± 3	9	63 ± 2	10
08/04/98	59 ± 1	9	58 ± 2	10
08/18/98	56 ± 1	10	58 ± 2	11
09/10/98	52 ± 1	9	52 ± 1	11
09/22/98	48 ± 0	9	48 ± 1	11
10/13/98	48 ± 1	9	49 ± 1	11
11/19/98	44 ± 1	9	45 ± 1	10
12/29/98	44 ± 0	9	45 ± 1	10
01/19/99	49 ± 1	9	48 ± 0	10
02/17/99	20 ± 1	10	19 ± 1	11
03/17/99	19 ± 1	10	19 ± 1	9
04/07/99	21 ± 1	10	22 ± 0	11
04/21/99	24 ± 2	10	23 ± 1	10
05/06/99	23 ± 0	9	22 ± 1	10
05/20/99	23 ± 0	9	23 ± 0	11
06/09/99	56 ± 12	9	62 ± 1	10
06/23/99	58 ± 4	9	56 ± 1	10
07/07/99	53 ± 2	8	50 ± 2	11
07/21/99	50 ± 2	9	48 ± 1	10
08/11/99	58 ± 2	9	57 ± 2	11
08/25/99	63 ± 2	9	62 ± 1	11
09/08/99	48 ± 2	9	49 ± 1	10
09/29/99	68 ± 3	9	65 ± 4	11
10/12/99	66 ± 3	8	66 ± 3	8
11/23/99	49 ± 1	9	49 ± 0	11
12/14/99	52 ± 3	8	54 ± 3	10

Table 17.26. Mean NO_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L NO_3.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.00 ± 0.00	9	0.00 ± 0.00	13
09/16/97	0.23 ± 0.16	8	0.18 ± 0.33	11
10/14/97	0.13 ± 0.24	8	0.00 ± 0.00	10
11/13/97	1.00 ± 0.00	9	1.00 ± 0.00	11
12/16/97	1.05 ± 0.05	8	0.96 ± 0.04	12
01/28/98	1.44 ± 0.05	8	1.31 ± 0.08	11
02/12/98	1.41 ± 0.08	9	1.65 ± 0.13	12
03/25/98	2.56 ± 0.33	9	2.50 ± 0.27	12
04/07/98	2.47 ± 0.03	9	3.03 ± 0.27	12
04/23/98	3.00 ± 0.00	9	3.00 ± 0.00	12

Table 17.27. Mean NO_2 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L NO_2 - N.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.00 ± 0.00	9	0.00 ± 0.00	13
09/16/97	0.00 ± 0.00	8	0.00 ± 0.00	11
10/14/97	0.00 ± 0.00	8	0.00 ± 0.00	11
11/13/97	0.00 ± 0.00	9	0.00 ± 0.00	11
12/16/97	0.00 ± 0.00	8	0.00 ± 0.00	12
01/28/98	0.00 ± 0.00	8	0.00 ± 0.00	11
02/12/98	0.00 ± 0.00	9	0.00 ± 0.00	12
03/25/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/07/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/23/98	0.00 ± 0.00	9	0.00 ± 0.00	12
05/05/98	0.00 ± 0.00	9	0.00 ± 0.00	11
05/19/98	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/98	0.00 ± 0.00	9	0.00 ± 0.00	11
06/23/98	0.00 ± 0.00	10	0.00 ± 0.00	11
07/07/98	0.00 ± 0.00	9	0.00 ± 0.00	11
07/21/98	0.00 ± 0.00	9	0.00 ± 0.00	10
08/04/98	0.00 ± 0.00	9	0.00 ± 0.00	10
08/18/98	0.00 ± 0.00	10	0.00 ± 0.00	11
09/10/98	0.00 ± 0.00	9	0.00 ± 0.00	11
09/22/98	0.02 ± 0.03	9	0.01 ± 0.02	11
10/13/98	0.00 ± 0.00	9	0.00 ± 0.00	11
11/19/98	0.00 ± 0.00	9	0.00 ± 0.00	10
12/29/98	0.00 ± 0.00	9	0.00 ± 0.00	10
01/19/99	0.00 ± 0.00	9	0.00 ± 0.00	10
02/17/99	0.00 ± 0.00	10	0.00 ± 0.00	11
03/17/99	0.00 ± 0.00	10	0.00 ± 0.00	9
04/07/99	0.00 ± 0.00	10	0.00 ± 0.00	11
04/21/99	0.00 ± 0.00	10	0.00 ± 0.00	10
05/06/99	0.00 ± 0.00	9	0.00 ± 0.00	10
05/20/99	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/99	0.00 ± 0.00	9	0.00 ± 0.00	10
06/23/99	0.00 ± 0.00	9	0.00 ± 0.00	10
07/07/99	0.00 ± 0.00	8	0.00 ± 0.00	11
07/21/99	0.00 ± 0.00	9	0.00 ± 0.00	10
08/11/99	0.00 ± 0.00	9	0.00 ± 0.00	11
08/25/99	0.00 ± 0.00	9	0.00 ± 0.00	11
09/08/99	0.00 ± 0.00	9	0.00 ± 0.00	10
09/29/99	0.00 ± 0.00	9	0.00 ± 0.00	11
10/12/99	0.00 ± 0.00	8	0.00 ± 0.00	8
11/23/99	0.00 ± 0.00	9	0.00 ± 0.00	11
12/14/99	0.00 ± 0.00	8	0.00 ± 0.00	10

Table 17.28. Mean NO_3 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L NO_3 - N.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
05/05/98	0.75 ± 0.01	9	0.73 ± 0.01	11
05/19/98	0.70 ± 0.01	9	0.70 ± 0.02	11
06/09/98	0.85 ± 0.01	9	0.85 ± 0.01	11
06/23/98	0.74 ± 0.03	10	0.73 ± 0.06	11
07/07/98	0.50 ± 0.05	9	0.50 ± 0.08	11
07/21/98	0.20 ± 0.08	9	0.19 ± 0.08	10
08/04/98	0.19 ± 0.07	9	0.14 ± 0.04	10
08/18/98	0.08 ± 0.04	10	0.12 ± 0.03	11
09/10/98	0.09 ± 0.03	9	0.03 ± 0.00	11
09/22/98	0.07 ± 0.00	9	0.07 ± 0.02	11
10/13/98	0.15 ± 0.01	9	0.14 ± 0.00	11
11/19/98	0.18 ± 0.01	9	0.18 ± 0.00	10
12/29/98	0.09 ± 0.00	9	0.09 ± 0.00	10
01/19/99	0.13 ± 0.01	9	0.12 ± 0.03	10
02/17/99	0.41 ± 0.01	10	0.41 ± 0.00	11
03/17/99	0.52 ± 0.00	10	0.52 ± 0.00	9
04/07/99	0.52 ± 0.00	10	0.52 ± 0.00	11
04/21/99	0.59 ± 0.01	10	0.57 ± 0.00	10
05/06/99	0.54 ± 0.00	9	0.52 ± 0.00	10
05/20/99	0.59 ± 0.01	9	0.59 ± 0.01	11
06/09/99	0.36 ± 0.03	9	0.36 ± 0.05	10
06/23/99	0.21 ± 0.02	9	0.18 ± 0.02	10
07/07/99	0.12 ± 0.05	8	0.14 ± 0.06	11
07/21/99	0.06 ± 0.01	9	0.06 ± 0.03	10
08/11/99	0.11 ± 0.03	9	0.03 ± 0.01	11
08/25/99	0.03 ± 0.04	9	0.02 ± 0.02	11
09/08/99	0.04 ± 0.02	9	0.00 ± 0.00	10
09/29/99	0.00 ± 0.00	9	0.00 ± 0.00	11
10/12/99	0.02 ± 0.04	8	0.00 ± 0.00	8
11/23/99	0.00 ± 0.01	9	0.00 ± 0.00	11
12/14/99	0.00 ± 0.00	8	0.00 ± 0.00	10

Table 17.29. Mean Total Kjeldahl Nitrogen levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L NH_3 - N.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.47 ± 0.09	9	0.78 ± 0.25	13
09/16/97	0.02 ± 0.03	8	0.01 ± 0.02	11
10/14/97	0.86 ± 0.55	8	0.69 ± 0.12	11
11/13/97	0.32 ± 0.07	9	0.32 ± 0.07	11
12/16/97	0.61 ± 0.16	8	0.27 ± 0.12	11
01/28/98	0.69 ± 0.10	8	0.66 ± 0.06	11
02/12/98	0.68 ± 0.15	9	0.70 ± 0.05	12
03/25/98	0.63 ± 0.07	9	0.62 ± 0.06	12
04/07/98	0.65 ± 0.10	9	0.62 ± 0.07	12
04/23/98	0.49 ± 0.12	9	0.48 ± 0.05	12
05/05/98	1.63 ± 0.44	9	1.27 ± 0.16	11
05/19/98	1.11 ± 0.07	9	1.62 ± 0.24	11
06/09/98	1.38 ± 0.21	9	1.58 ± 0.30	11
06/23/98	1.20 ± 0.14	10	1.10 ± 0.06	11
07/07/98	0.81 ± 0.09	9	0.93 ± 0.16	11
07/21/98	1.21 ± 0.20	9	0.80 ± 0.19	10
08/04/98	0.94 ± 0.11	9	0.80 ± 0.11	10
08/18/98	1.24 ± 0.14	10	1.09 ± 0.08	11
09/10/98	0.66 ± 0.07	9	0.64 ± 0.08	11
09/22/98	0.88 ± 0.09	9	0.68 ± 0.02	11
10/13/98	0.74 ± 0.06	9	0.78 ± 0.06	11
11/19/98	0.88 ± 0.03	9	0.55 ± 0.12	10
12/29/98	1.51 ± 0.27	9	0.92 ± 0.10	10
01/19/99	1.06 ± 0.15	9	0.98 ± 0.15	10
02/17/99	1.13 ± 0.15	10	0.96 ± 0.10	11
03/17/99	0.58 ± 0.21	10	0.56 ± 0.41	9
04/07/99	0.90 ± 0.09	10	0.84 ± 0.11	11
04/21/99	0.73 ± 0.23	10	0.87 ± 0.05	10
05/06/99	1.03 ± 0.17	9	1.02 ± 0.07	10
05/20/99	0.94 ± 0.07	9	0.53 ± 0.23	11
06/09/99	0.79 ± 0.02	9	0.80 ± 0.05	10
06/23/99	0.80 ± 0.22	9	0.86 ± 0.06	10
07/07/99	0.81 ± 0.02	8	0.66 ± 0.20	11
07/21/99	0.98 ± 0.14	9	0.71 ± 0.04	10
08/11/99	1.54 ± 0.31	9	0.73 ± 0.05	11
08/25/99	1.02 ± 0.23	9	0.66 ± 0.05	11
09/08/99	0.81 ± 0.06	9	0.74 ± 0.04	10
09/29/99	1.04 ± 0.05	9	1.11 ± 0.11	11
10/12/99	1.15 ± 0.14	8	0.94 ± 0.12	8
11/23/99	1.08 ± 0.28	9	1.21 ± 0.19	11
12/14/99	0.74 ± 0.08	8	0.66 ± 0.25	10

Table 17.30. Mean orthophosphate levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L PO_4.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.34 ± 0.30	9	0.28 ± 0.18	13
09/16/97	0.00 ± 0.00	8	0.00 ± 0.00	11
10/14/97	0.00 ± 0.00	8	0.00 ± 0.00	11
11/13/97	0.00 ± 0.00	9	0.00 ± 0.00	11
12/16/97	0.10 ± 0.13	8	0.00 ± 0.00	12
01/28/98	0.00 ± 0.00	8	0.00 ± 0.00	11
02/12/98	0.00 ± 0.00	9	0.00 ± 0.00	12
03/25/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/07/98	0.00 ± 0.00	9	0.00 ± 0.00	12
04/23/98	0.00 ± 0.00	9	0.00 ± 0.00	12

Table 17.31. Mean orthophosphate levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L PO_4 - P.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
05/05/98	0.00 ± 0.00	9	0.00 ± 0.00	11
05/19/98	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/98	0.00 ± 0.00	9	0.00 ± 0.00	11
06/23/98	0.00 ± 0.00	10	0.00 ± 0.00	11
07/07/98	0.00 ± 0.00	9	0.00 ± 0.00	11
07/21/98	0.00 ± 0.00	9	0.00 ± 0.00	10
08/04/98	0.02 ± 0.03	9	0.01 ± 0.02	10
08/18/98	0.00 ± 0.00	10	0.00 ± 0.00	11
09/10/98	0.00 ± 0.00	9	0.00 ± 0.00	11
09/22/98	0.00 ± 0.00	9	0.00 ± 0.00	11
10/13/98	0.00 ± 0.00	9	0.00 ± 0.00	11
11/19/98	0.00 ± 0.00	9	0.00 ± 0.00	10
12/29/98	0.00 ± 0.00	9	0.00 ± 0.00	10
01/19/99	0.00 ± 0.00	9	0.00 ± 0.00	10
02/17/99	0.00 ± 0.00	10	0.00 ± 0.00	11
03/17/99	0.09 ± 0.02	10	0.10 ± 0.00	9
04/07/99	0.01 ± 0.02	10	0.01 ± 0.02	11
04/21/99	0.00 ± 0.00	10	0.00 ± 0.00	10
05/06/99	0.00 ± 0.00	9	0.00 ± 0.00	10
05/20/99	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/99	0.00 ± 0.00	9	0.00 ± 0.00	10
06/23/99	0.00 ± 0.00	9	0.00 ± 0.00	10
07/07/99	0.00 ± 0.00	8	0.01 ± 0.02	11
07/21/99	0.00 ± 0.00	9	0.00 ± 0.00	10
08/11/99	0.00 ± 0.00	9	0.00 ± 0.00	11
08/25/99	0.01 ± 0.02	9	0.00 ± 0.00	11
09/08/99	0.00 ± 0.00	9	0.00 ± 0.00	10
09/29/99	0.05 ± 0.00	9	0.00 ± 0.00	11
10/12/99	0.00 ± 0.00	8	0.01 ± 0.02	8
11/23/99	0.00 ± 0.00	9	0.00 ± 0.00	11
12/14/99	0.00 ± 0.00	8	0.00 ± 0.00	10

Table 17.32. Mean total phosphorus levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L PO_4 - P.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	0.04 ± 0.01	9	0.04 ± 0.01	12
09/16/97	0.00 ± 0.00	8	0.01 ± 0.02	11
10/14/97	0.02 ± 0.02	8	0.01 ± 0.01	11
11/13/97	0.00 ± 0.00	9	0.04 ± 0.04	11
12/16/97	0.00 ± 0.00	8	0.01 ± 0.01	12
01/28/98	0.00 ± 0.00	8	0.01 ± 0.02	11
02/12/98	0.00 ± 0.00	9	0.00 ± 0.01	12
03/25/98	0.03 ± 0.02	9	0.06 ± 0.01	12
04/07/98	0.09 ± 0.00	9	0.11 ± 0.01	12
04/23/98	0.08 ± 0.02	9	0.10 ± 0.01	12
05/05/98	0.09 ± 0.01	9	0.08 ± 0.00	11
05/19/98	0.09 ± 0.01	9	0.10 ± 0.03	11
06/09/98	0.09 ± 0.01	9	0.08 ± 0.01	11
06/23/98	0.11 ± 0.01	10	0.13 ± 0.01	11
07/07/98	0.09 ± 0.01	9	0.10 ± 0.01	11
07/21/98	0.06 ± 0.02	9	0.05 ± 0.02	10
08/04/98	0.08 ± 0.01	9	0.07 ± 0.01	10
08/18/98	0.04 ± 0.02	10	0.07 ± 0.02	11
09/10/98	0.10 ± 0.01	9	0.09 ± 0.01	11
09/22/98	0.08 ± 0.01	9	0.08 ± 0.01	11
10/13/98	0.05 ± 0.01	9	0.06 ± 0.01	11
11/19/98	0.13 ± 0.01	9	0.14 ± 0.01	10
12/29/98	0.09 ± 0.01	8	0.09 ± 0.01	10
01/19/99	0.12 ± 0.06	9	0.05 ± 0.02	10
02/17/99	0.17 ± 0.02	10	0.24 ± 0.02	11
03/17/99	0.12 ± 0.02	10	0.09 ± 0.01	9
04/07/99	0.09 ± 0.00	10	0.08 ± 0.00	11
04/21/99	0.06 ± 0.00	10	0.06 ± 0.00	10
05/06/99	0.07 ± 0.00	9	0.06 ± 0.00	10
05/20/99	0.00 ± 0.00	9	0.00 ± 0.00	11
06/09/99	0.10 ± 0.01	9	0.07 ± 0.02	10
06/23/99	0.10 ± 0.01	9	0.09 ± 0.00	10
07/07/99	0.01 ± 0.02	8	0.00 ± 0.00	11
07/21/99	0.11 ± 0.01	9	0.08 ± 0.02	10
08/11/99	0.08 ± 0.00	9	0.08 ± 0.00	11
08/25/99	0.09 ± 0.01	9	0.07 ± 0.01	11
09/08/99	0.12 ± 0.01	9	0.09 ± 0.00	10
09/29/99	0.00 ± 0.00	9	0.05 ± 0.00	11
10/12/99	0.07 ± 0.01	8	0.06 ± 0.02	8
11/23/99	0.27 ± 0.22	9	0.31 ± 0.21	11
12/14/99	0.03 ± 0.02	8	0.06 ± 0.00	10

Table 17.33. Mean SO_4 levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L SO_4.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	133 ± 1	9	135 ± 3	13
09/16/97	139 ± 2	8	135 ± 2	11
10/14/97	145 ± 2	8	143 ± 1	11
11/13/97	138 ± 5	9	138 ± 3	11
12/16/97	152 ± 1	8	150 ± 2	12
01/28/98	155 ± 1	8	144 ± 3	11
02/12/98	154 ± 1	9	153 ± 2	12
03/25/98	153 ± 2	9	154 ± 2	12
04/07/98	152 ± 2	9	150 ± 2	12
04/23/98	148 ± 2	9	145 ± 2	12
05/05/98	142 ± 3	9	139 ± 3	11
05/19/98	141 ± 2	9	143 ± 4	11
06/09/98	140 ± 11	9	130 ± 0	11
06/23/98	121 ± 2	10	118 ± 2	11
07/07/98	120 ± 0	9	121 ± 2	11
07/21/98	120 ± 0	9	120 ± 0	10
08/04/98	131 ± 2	9	130 ± 0	10
08/18/98	123 ± 3	10	125 ± 5	11
09/10/98	124 ± 3	9	125 ± 3	11
09/22/98	129 ± 2	9	129 ± 2	11
10/13/98	128 ± 3	9	128 ± 2	11
11/19/98	132 ± 3	9	130 ± 0	10
12/29/98	139 ± 2	9	141 ± 2	10
01/19/99	132 ± 3	9	137 ± 3	10
02/17/99	120 ± 0	10	119 ± 2	11
03/17/99	124 ± 3	10	124 ± 3	9
04/07/99	120 ± 0	10	120 ± 0	11
04/21/99	129 ± 2	10	125 ± 3	10
05/06/99	123 ± 3	9	121 ± 2	10
05/20/99	130 ± 0	9	129 ± 2	11
06/09/99	130 ± 0	9	130 ± 0	10
06/23/99	131 ± 6	9	133 ± 3	10
07/07/99	134 ± 6	8	120 ± 0	11
07/21/99	137 ± 3	9	137 ± 3	10
08/11/99	140 ± 0	9	141 ± 2	11
08/25/99	141 ± 2	9	140 ± 0	11
09/08/99	150 ± 3	9	151 ± 2	10
09/29/99	148 ± 1	9	143 ± 1	11
10/12/99	168 ± 5	8	165 ± 5	8
11/23/99	170 ± 1	9	172 ± 0	11
12/14/99	174 ± 1	8	175 ± 1	10

Table 17.34. Mean total dissolved solids (TDS) levels with 95% confidence intervals (C. I.) measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in mg/L TDS.

Date	Location C 95% C. I.	n	Location E1 95% C. I.	n
08/29/97	332 ± 8	9	330 ± 6	13
09/16/97	316 ± 8	8	319 ± 12	11
10/14/97	305 ± 14	8	303 ± 11	11
11/13/97	313 ± 4	9	329 ± 8	11
12/16/97	330 ± 9	8	322 ± 8	12
01/28/98	348 ± 17	8	348 ± 10	11
02/12/98	375 ± 19	9	386 ± 20	12
03/25/98	332 ± 4	9	324 ± 3	12
04/07/98	312 ± 13	9	312 ± 13	12
04/23/98	310 ± 5	9	302 ± 2	12
05/05/98	344 ± 11	9	346 ± 17	11
05/19/98	336 ± 5	9	329 ± 9	11
06/09/98	351 ± 18	9	347 ± 17	11
06/23/98	315 ± 7	10	312 ± 4	11
07/07/98	311 ± 14	9	310 ± 10	11
07/21/98	301 ± 8	9	372 ± 56	10
08/04/98	323 ± 20	9	299 ± 7	10
08/18/98	285 ± 3	10	284 ± 5	11
09/10/98	323 ± 65	9	290 ± 16	11
09/22/98	310 ± 24	9	285 ± 8	11
10/13/98	289 ± 8	9	306 ± 4	11
11/19/98	336 ± 18	9	318 ± 9	10
12/29/98	326 ± 12	9	303 ± 12	10
01/19/99	326 ± 10	9	317 ± 18	10
02/17/99	322 ± 20	10	282 ± 13	11
03/17/99	346 ± 36	10	316 ± 25	9
04/07/99	293 ± 10	10	276 ± 15	11
04/21/99	276 ± 13	10	268 ± 6	10
05/06/99	303 ± 13	9	296 ± 12	10
05/20/99	327 ± 56	9	318 ± 11	11
06/09/99	302 ± 11	9	258 ± 12	10
06/23/99	300 ± 14	9	286 ± 7	10
07/07/99	295 ± 4	8	302 ± 3	11
07/21/99	408 ± 33	9	384 ± 18	10
08/11/99	302 ± 7	9	293 ± 7	11
08/25/99	312 ± 10	9	296 ± 15	11
09/08/99	306 ± 8	9	347 ± 20	10
09/29/99	316 ± 9	9	295 ± 21	11
10/12/99	335 ± 6	8	335 ± 3	8
11/23/99	344 ± 6	9	349 ± 4	11
12/14/99	351 ± 7	8	351 ± 8	10

Table 17.35. Secchi depths measured by AmerenCIPS in Coffeen Lake, 1997 – 1999. Values are in meters.

Date	Location									
	A	B	C	D	E1	E2	E3	F1	F2	G
08/29/97	1.00		1.00	1.25	1.50	1.50	1.50	1.50	1.50	1.75
09/16/97	1.25	1.25	1.25	1.50	1.75	1.75	1.75	1.50	1.75	1.75
10/14/97	1.00	1.25	1.50	1.50	2.00	2.00	1.50	1.50	1.25	1.50
09/16/97		1.75	1.75	1.75	1.75	2.00	2.00	1.75	2.00	2.00
12/16/97	1.00	1.50	1.50	2.00	2.00	2.00	2.00	2.00	2.00	1.75
01/28/98	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.25	2.25
02/12/98	1.00	2.00	2.00		2.00	2.00	2.00	2.00	2.50	2.50
03/25/98	0.75	0.75	0.75	0.75	0.75	0.75	0.50	0.75	0.75	0.50
04/07/98	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	1.00	1.00
04/23/98	0.75	0.75	0.75	0.75	1.00	1.00	1.00		1.00	0.75
05/05/98	0.75	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75
05/19/98	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
06/09/98	0.50	0.50	0.50	0.50	0.50	0.75	0.75		0.75	0.50
06/23/98	0.50	0.50	0.50	0.50		0.75	0.75	1.00	0.75	0.75
07/07/98	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.00	1.00
07/21/98	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.25	1.50	1.50
08/04/98	1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.25	1.25	1.50
08/18/98	1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.25	1.50	1.50
09/10/98	1.25	1.25	1.25	1.25	1.50	1.50	1.50	1.75	1.75	2.00
09/22/98	1.25	1.25	1.25	1.50	1.50	1.50	1.25	1.50	1.25	
10/13/98	1.25	1.25	1.50	1.50	2.00	1.50	1.50	1.75	2.00	
11/19/98	1.50	1.75	1.50	1.50	1.75	1.75	1.50	2.25	2.00	2.00
12/29/98	1.75	2.25	2.25	2.25	2.25	2.25	2.25	1.75	2.25	2.25
01/19/99	1.25	1.75	1.50	1.75	1.50	1.75	1.25	0.75	1.75	2.00
02/17/99	0.75	0.75	0.75	0.75	1.00	0.75	0.75	1.25	0.75	0.50
03/17/99	1.25	1.25	1.00	1.50	1.25	1.25	1.25	1.25	1.25	1.25
04/07/99	1.00	1.25	1.25	1.50	1.50	1.50	1.25	1.25		1.50
04/21/99	1.00	1.00	1.00	1.25	1.25	1.25	1.00	1.00	1.25	1.50
05/06/99	0.75	0.75	1.00	1.00	1.00	1.00	1.00		1.25	1.25
05/20/99	0.75	0.75	0.75	1.00	1.00	1.00	1.00		1.00	1.00
06/09/99	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
06/23/99	0.75	0.75	0.75	1.00	1.00	1.00	1.25	1.00	1.25	1.25
07/07/99	0.75	1.00	1.00	1.25	1.25	1.50	1.50	1.50	1.50	1.50
07/21/99	1.00	1.00	1.00	1.25	1.25	0.75	1.25	1.25	1.50	
08/11/99	1.00	1.00	1.25	1.25	1.25	1.50	1.50	1.50	1.50	1.50
08/25/99	1.00	1.00	1.00	1.25	1.50	1.25	1.25	1.25	1.25	1.50
09/08/99	1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.50	1.50	1.50
09/29/99	1.00	1.25	1.25	1.25	0.75	1.25	1.50	1.50	1.00	1.00
10/12/99	1.00	1.00	1.00	1.25	1.50	1.50	1.50	1.50	1.50	
11/23/99	1.50	1.50	1.50	1.75	1.75	1.75	2.00	2.00	2.00	1.75
12/14/99	1.50	1.50	1.50	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Table 17.36. Range of pH determined by AmerenCIPS in Coffeen Lake, 1997 – 1999.

	Location C		Location E1	
Date	Minimum pH	Maximum pH	Minimum pH	Maximum pH
09/16/97	7.13	7.60	7.56	7.62
10/14/97	7.08	7.53	7.20	7.27
11/13/97	7.56	7.86	7.48	7.81
12/16/97	7.63	8.01	7.62	7.88
01/28/98	7.63	7.80	7.52	7.82
02/12/98	7.79	8.01	7.81	7.90
03/25/98	7.57	7.70	7.50	7.63
04/07/98	7.48	7.74	7.31	7.56
04/23/98	7.66	7.70		
05/05/98	7.00	7.45	7.22	7.55
05/19/98	7.18	7.54	7.17	7.60
06/09/98	7.08	7.28	7.26	7.37
06/23/98	6.97	7.42	6.84	7.69
07/07/98	7.01	7.58	6.54	7.68
07/21/98	7.19	7.91	7.14	8.30
08/04/98	6.94	7.54	7.18	7.78
08/18/98	6.92	7.33	6.93	7.95
09/10/98	7.00	7.67	7.09	7.38
09/22/98	6.66	7.06	6.99	7.33
10/13/98	6.71	7.13	7.24	7.31
11/19/98	5.79	6.15	5.98	6.08
12/29/98	6.90	8.61		
01/19/99	6.90	7.12	7.10	7.14
02/17/99	7.08	7.45	7.05	7.16
03/17/99	6.92	7.25	7.15	7.27
04/07/99	6.95	7.13	6.90	7.15
04/21/99	6.85	7.01	7.05	7.25
05/06/99	7.06	7.25	7.17	7.47
05/20/99	7.03	7.14	6.90	7.23
06/09/99	6.95	7.57	6.70	7.79
06/23/99	6.87	7.03	7.10	7.45
07/07/99	6.92	7.48	6.85	7.72
07/21/99	7.12	7.94	7.00	7.73
08/11/99	7.00	7.57	7.43	8.28
08/25/99	6.90	7.67	7.16	7.86
09/08/99	6.96	7.45	7.14	7.54
09/29/99	7.20	7.59	7.37	7.47
10/12/99	7.11	7.46	6.90	7.74
11/23/99	7.15	7.43	7.24	7.52
12/14/99	7.03	7.30	7.10	7.36