BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

AMEREN ENERGY GENERATING COMPANY,	)	
Petitioner,	)	
v.	)	PCB 09-38 (Thermal Demonstration)
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY,	)	
Respondent.	)	

NOTICE OF FILING

TO:

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PLEASE TAKE NOTICE that I have electronically filed with the Office of the Clerk of the Pollution Control Board, **AMEREN'S RESPONSE TO THE RECOMMENDATION OF THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, ANSWERS TO HEARING OFFICER QUESTIONS, PREFILED TESTIMONY OF JAMES B. McLAREN, Ph.D., ANNE SHORTELLE, Ph.D., AND JAMES L. WILLIAMS, JR., AND APPEARANCE OF GABRIEL M. RODRIGUEZ,** copies of which are herewith served upon you.

Ameren Energy Generating Company

By: Amy Antoniolli

Dated: May 12, 2009

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CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 12th day of May, 2009, I have served electronically the attached **AMEREN'S RESPONSE TO THE RECOMMENDATION OF THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, ANSWERS TO HEARING OFFICER QUESTIONS, PREFILED TESTIMONY OF JAMES B. McLAREN, Ph.D., ANNE SHORTELLE, Ph.D., AND JAMES L. WILLIAMS, JR., AND APPEARANCE OF GABRIEL M. RODRIGUEZ,** upon the following persons:

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AMEREN'S RESPONSE TO THE RECOMMENDATION OF THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

NOW COMES AMEREN ENERGY GENERATING COMPANY ("Ameren" or "the Petitioner"), by and through its attorneys, SCHIFF HARDIN, LLP, and pursuant to Section 106.208 of the Illinois Pollution Control Board's ("Board") procedural rules (35 Ill. Adm. Code 106.208), and presents its response to the Illinois Environmental Protection Agency's ("the Agency") recommendation ("Agency Recommendation"). For the reasons provided herein, Ameren disagrees with the recommendation and reasserts its petition to modify the specific thermal standard applicable to Ameren's heated effluent discharge to Coffeen Lake.

On December 15, 2008, Ameren filed its Petition to Modify Specific Thermal Standard ("Petition"). Pursuant to 35 Ill. Adm. Code 106.208, a recommendation was due to be filed on February 13, 2009. On April 8, 2009, the Board Hearing Officer issued an order granting the Agency until April 17, 2009 to file the recommendation. The Agency filed the recommendation on April 24, 2009.

I. INTRODUCTION

Coffeen Station's discharge to Coffeen Lake is currently subject to a specific thermal standard established by the Board in CIPS v. IEPA, PCB 77-158, PCB 78-100 (consolidated)

(March 18, 1982). The thermal standard establishes monthly average and maximum thermal limits in Coffeen Lake for specific monthly periods. Ameren has and currently operates under these limits, which require that the lake temperature not exceed a monthly average of 105 degrees Fahrenheit ("F") and a maximum of 112 F (for more than three percent of the hours) during the calendar months of June through September, and a lower monthly average of 89 F and a lower maximum of 94 F (for more than two percent of the hours) during the calendar months of October through May.

In its Petition, Ameren seeks to modify *only* the thermal limits of the calendar months May and October. Ameren's proposed modification does not seek revision of thermal limits during the summer months of June through September. The months of May and October are transitional months, insomuch as the ambient temperatures affecting lake temperature often reflect summer temperatures rather than cooler winter temperatures. Ameren seeks to modify the thermal limits during these transitional months to provide for a more gradual change in lake temperature like would otherwise naturally occur in a water-body not impacted by thermal discharge. Ameren does not anticipate that lake temperatures will even reach the limits requested on a regular basis. Under anticipated operating conditions, Ameren only expects to exceed current temperature limits during unusually warm May or October months. Accordingly, the proposed modified thermal limits for May and October provide for transitional thermal limits, requiring that Coffeen Lake not exceed a monthly average of 96 F and a maximum of 102 F (for more than two percent of the hours).

According to the Agency Recommendation, Ameren is not entitled to relief in the form of revised May and October limits. It appears to make three principal arguments. First, selectively quoting from the SIUC Reports so as to highlight fish kills reported since 2000, the Agency argues that the Petition does not address the potential impact of the proposed May/October limits on fish habitat, specifically focusing on impacts to summer lake temperatures and dissolved oxygen concentrations. The Agency acknowledges that the historic fish kills occurred in the middle of summer, but argues that increasing thermal loading in May may have a cumulative or carry-over effect into summer months making summer conditions worse than have been seen in the past. Second, noting that Coffeen Lake is impaired for phosphorous, the Agency asserts that Ameren has not assessed whether increased thermal loading in May will result in greater "internal loading" of phosphorous. Third, it notes that the lake is subject to a mercury advisory and that the Petition failed to address whether increased thermal loading would result in an increase in methyl mercury through the process of methylation of mercury found in the lake.

The Agency Recommendation of denial is flawed and should be disregarded. As noted below, the Agency's assertion that the Petition fails to address the impact of the proposed relief on lake temperatures and habitat is simply wrong. The ASA Report and the SIUC studies focus intently on the question of the thermal regime and the health of the aquatic community. Both ASA and SIUC concluded that RIS are propagating and thriving. Second, the assertion that granting the proposed relief for May and October will have some sort of carry-over or cumulative adverse effect on lake temperature and dissolved oxygen is unsupported by the data. There is no evidence that sustained thermal temperatures will lead to an increase in summer lake temperatures or dissolved oxygen depletion over time. *See* Pre-filed Testimony of Dr. McLaren, at par. 9, 10. Finally, the assertions that increasing the thermal limits in May and October will lead to greater internal loading of phosphorous or an increase in methylation of mercury in this lake are also not supported by the data. *See* Pre-filed Testimony of Dr. Shortelle, at par. 3, 5, 8. The Petition and supporting testimony and reports do, in fact, address the impact that the proposed limits will have on the aquatic community and demonstrate that the modification to the May and October limits will be environmentally acceptable to the lake.

II. STATUTORY AND REGULATORY REQUIREMENTS DO NOT REQUIRE A SHOWING OF NO ENVIRONMENTAL IMPACT

At the outset, Ameren wishes to address the question of the appropriate standard in this proceeding. The Agency makes much of the fact that fish kills have occurred over the years in Coffeen Lake. It selectively quotes from the SIUC reports to create the impression that fish kills occur frequently and that the conditions in the lake are not capable of sustaining fish, shellfish and wildlife. The Agency's selective quotation of the SIUC studies distorts the overall conclusions of the SIUC studies as well as the ultimate issue in this case: Whether environmentally acceptable conditions will persist at Coffeen Lake with the discharge as proposed under the Petition.

Ameren is not requesting a new thermal standard. The Petition requests a modification of thermal limits at Coffeen Lake for the two transitional months, May and October. Section 28.1 of the Act permits the Board to grant an adjusted standard to persons who provide the required justification. Accordingly, while Ameren is not seeking that the Board establish a specific new standard, it has the burden of demonstrating that it has satisfied the required justification for thermal discharges to an artificial cooling lake.

Pursuant to 35 Ill. Adm. Code 106.200(a)(2)(A), Ameren must demonstrate that Coffeen Lake will remain "environmentally acceptable and within the intent of the Act" upon receiving the heated effluent from Coffeen Station consistent with Ameren's proposed thermal limits in May and October. Illinois regulations define "environmentally acceptable and within the intent of the Act" to mean that Coffeen Lake must remain "*capable of supporting* shellfish, fish and wildlife, and recreational uses consistent with good management practices." *See* 35 Ill. Adm.

Code 106.202(b)(1)(A); 35 Ill. Adm. Code 302.211(j)(3)(A) (emphasis added).[1] The Board itself has noted that the lake need not have an acceptable fishery, but need only provide conditions *capable of supporting* a fishery and recreational uses. In the Matter of: Water Quality and Effluent Standards Amendments, R75-2 slip op. at 40 (Sept. 29, 1975).

Notably absent from the federal and state thermal demonstration requirements is a duty to demonstrate an absence of environmental impact on the waterbody receiving the heated effluent. Rather, the thermal limit must maintain conditions in the waterbody such that it remains capable of supporting shellfish, fish and wildlife and a diverse biotic community capable of sustaining itself through cyclic seasonal changes. Ameren's proposed modification to the thermal limits in May and October do not impact Coffeen Lake's capacity to maintain a sustainable biotic community. In fact, the proposed thermal limits allow for water temperatures that are lower than those which are already permitted during the summer months of June through September. As such, the record is clear that the proposed temperatures for May and October will be well tolerated by the lake and will not have any appreciable adverse impacts in May and October.

III. THE AGENCY MISREPRESENTS THE EXTENT AND NATURE OF THE HISTORIC IMPACT ON FISH AT COFFEEN LAKE

[1] Further, any such demonstration may be undertaken consistent with Section 316(a) of the Clean Water Act ("CWA") (33 USC § 1326(a)). *See* 35 Ill. Adm. Code 106.202(b)(2)(C). Section 316(a) authorizes alternate thermal conditions in NPDES permits where the effluent limitation is "more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made." *See also* 40 CFR § 125.73. Federal regulations provide further clarity to this requirement, defining a balanced, indigenous population to mean "a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species." *See* 40 CFR § 125.71(c). That is, the structure, function and cyclical patterns typical of the waterbody's aquatic community should be maintained in the presence of the thermal discharge.

A. The Amount and Nature of Historic Fish Kills are Misrepresented

The Agency's selective quotation of the SIUC reports does not provide a fair representation of the decade-long SIUC studies. SIUC identified three, possibly four, thermally-induced fish kills during the 10 years it studied the impact of the discharge on the lake. According to SIUC, two, possibly three, of these instances occurred in situations where sudden changes in water temperature resulted in entrapment of fish in coves near the discharge point. These occurred in 2001 and 2002. SIUC indicated a third instance may have occurred in 2005.[2] SIUC noted that a sudden increase in water temperature in the mixing zone main channel can lead to entrapment of small numbers of fish in coves in near the mixing zone. If high temperatures persist in the main channel long enough, water temperatures in these coves will increase until they are similar to those in the main channel leading to what SIUC called "eroded fish habitat." Again, SIUC identified two (2001, 2002) and possibly a third such event (2005) in the 10 years of its study of the lake. *See* Pre-filed Testimony of Dr. McLaren, at par. 12.

SIUC linked the 2001, 2002 and 2005 incidents to fish becoming trapped in coves near the discharge because the fish kills were short-lived events that did not continue even where extreme conditions persisted for prolonged periods. When temperatures increase in the eastern arm of the lake, fish move away from the eastern arm toward the western arm where temperatures are typically 10 to 15 degrees cooler. Only those few fish trapped within the coves by sudden temperature changes in the discharge become trapped.[3] *See* Pre-filed Testimony of Dr. McLaren at par. 12.

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[2] The most recent of these events – in 2005 -- involved a total of 19 channel catfish.

[3] As Dr. McLaren has indicated, the proposed modification to the thermal limit would eliminate abrupt changes in water temperatures in the area near the discharge, and would more realistically reflect the natural thermal environment where temperatures would change more gradually. Moderating the thermal limit for May to provide a less abrupt change in the thermal discharge would likely result in even fewer incidents of entrapment.

Apart from entrapment, SIUC did identify one other instance of a thermally-induced fish kill. In July 1999, abnormal meteorological conditions (*e.g.*, prolonged heat and humidity, reduced wind/waves, and overcast sky), coupled with unusually warm water temperatures, led to a limited fish kill (*e.g.*, approximately 200 or fewer fish recovered). With respect to this event, however, SIUC also specifically noted that fish kills arising from extreme weather conditions are to be expected in this region of the country, whether in cooling or in ambient lakes. In the case of the July 1999 incident, for example, similar fish kills were reported at other southern Illinois lakes, including at least one ambient lake, according to the SIUC investigators. More important, these kinds of extreme weather conditions are not typical in May and October. Indeed, of the three or four thermally-induced incidents described in the 10 years of studies done by SIUC, all occurred in July or August. *See* Pre-filed Testimony of Dr. McLaren at par. 13.

Since 1999, the Station has adopted several measures to avoid thermal conditions similar to those that might have led to the 1999 fish event. These measures include installation of a 70-acre supplemental cooling basin in 2000 and a 48-cell helper cooling tower structure in 2002, as well as intensive monitoring of water temperatures at several locations within the cooling loop. Since the installation of these enhancements, SIUC reported no cases of thermally-induced fish kills, other than the possible 2005 event, and none in those years that did not involve entrapment. The SIUC studies thus indicate that thermally-induced fish mortality is a rather infrequent phenomenon.

Lastly, the Agency's suggestion that historic fish kills are prima facie evidence of environmentally unacceptable conditions is wrong. In the original 1977 proceeding for a specific thermal standard for Coffeen Lake, the Board found Coffeen Lake environmentally acceptable despite prior fish kills. The Board granted Central Illinois Public Service Co., ("CIPS") the requested specific thermal limit even though there had been three prior fish kills reported, the worst of which concerned 80-100 of one species of fish. Central Illinois Public Service Co. (CIPS) v. IEPA, PCB 77-158, slip op. at 6 (Apr. 27, 1978). The Board emphasized that it was not necessary to "create and sustain a fishery in Coffeen Lake but rather that Coffeen Lake be in such a condition as to allow the presence of a fishery." *Id.* at 7.

As noted above, Coffeen Lake is supporting a healthy and propagating biotic system primarily free of thermally-induced fish kills even when lake temperatures exceed those temperatures that might occur under Ameren's proposed thermal limits. Moreover, historic fish kills have not resulted in significant long-term impacts to Coffeen Lake or the fish populations.[4] SIUC has noted that it found no significant difference in the health or condition of fish before and after a fish kill. *See* Agency Recommendation, Exhibit 2, SIUC Draft Report February 2004 at 27. In fact, the March 2007 Annual Report noted that "[t]he number of largemouth bass that died in Coffeen Lake and Newton Lake in 1999, relative to their abundance in the two lakes, indicated no significant long-term negative effects on the two bass populations were likely." *See* Agency Recommendation, Exhibit 1, SIUC Draft Annual Report March 2007 at 9. This indicates that fish kills have not had a long-term detrimental effect on the fish population in Coffeen Lake.

B. Fish Population and Relative Weight Indicate Environmentally Acceptable Conditions at Coffeen Lake

[4] As previously identified in Ameren's Petition, the ASA Report reached the same conclusion, and noted that it was even less likely that detrimental effects on fish could result from the proposed May and October thermal limits. *See* Petition, Exhibit 11, ASA Report at p. 5-2. In fact, the ASA report was overly conservative on the impacts to the fishery because the report made conclusions based on current lake levels in Coffeen Lake. Ameren anticipates raising water levels in Coffeen Lake which will, in effect, further lessen any potential detrimental effect on fish under Ameren's proposed thermal limits. *See* Answers to Hearing Officer Order, Attachment A.

IEPA briefly cited passages from IDNR's March 23, 2007 Lake Management Status Report ("IDNR Report") that address the status of the largemouth bass population and other species in 2006 with regard to relative weight (fish condition) and abundance (catch per unit effort, or "CPUE"). The Agency's assertion that the IDNR Report suggests that Coffeen Lake will not be able to support Ameren's proposed thermal limits is not supported by the data.

A relative weight index ("Wr") of 100 implies ecological and physiological optimality for a population. While the 2006 Wr for largemouth bass declined from 102 in 2004 to 95 in 2006, there was no sustained trend of declining Wr during the seven-year period from 2000 through 2006. *See* Petition, Exhibit 12, IDNR Report at 1. In fact, all reported values (range 95-101) fell within the Lake Management Program ("LMP") objective range of 90-110. The annual variability in Wr observed for largemouth bass since 2000 is typical for any fish population.

Additionally, a sustained decline in Wr has not been observed for any other species, as would be expected if there were continual thermal stress. As recently as 2003 and 2004, the Wr for bluegill and redear sunfish was 88-89, i.e., very close to achieving the LMP objective of 90-110 for this species, while white crappie consistently have achieved the LMP objective of 90-110 for Wr. *See* Petition, Exhibit 12, IDNR Report at 2. Channel catfish in 2004 and 2006 did not quite achieve the LMP objective for Wr. However, during these two most recent years of data, channel catfish abundance (CPUE) has doubled or tripled and the proportion of "quality-size fish" ("PSD") in the population has approximately doubled or tripled. *See* Petition, Exhibit 12, IDNR Report at 2.

IV. HIGHER THERMAL LIMITS IN MAY AND OCTOBER WILL NOT RESULT IN HABITAT EROSION DURING SUMMER MONTHS

While the Agency acknowledges that the proposed limits for May and October are lower than temperatures the lake has experienced in the past, it asserts that increased thermal loading in May and October under Ameren's proposed thermal limits could have a cumulative impact on water temperatures or dissolved oxygen concentrations in the latter parts of the summer season leading to habitat erosion. The Agency states that Ameren has failed to adequately address the environmental impacts of increased heat loading in May on lower dissolved oxygen levels and prolonged periods of lake stratification throughout the remaining summer months.

The Agency's assertion is incorrect. As noted below, Ameren has in fact assessed whether there is any carry-over or cumulative effect from increasing the thermal limits in May and October on temperature and dissolved oxygen concentrations in later months and found no such effect. There is no evidence demonstrating a cumulative impact on thermal loading from higher May and October thermal limits, in the form of higher lake temperatures or lower dissolved oxygen concentrations during later summer months or other months in the year.

A. Higher Thermal Limits in May and October Do Not Result in Higher Lake Temperatures during Summer Months

As more thoroughly described in Ameren's Petition, Ameren relied upon a March 2008 evaluation of the potential impacts of the proposed thermal limits conducted by ASA. ASA examined data from the SIUC studies conducted from 1997 through 2006. It found no statistically significant relationship between higher water temperatures in May with warmer temperatures throughout the remainder of the season. *See* Petition, Exhibit 11, ASA Report at p. 2-4. In fact, the ASA Report noted that annual variability in metrological conditions appeared to dictate historic monthly water temperatures. *See* Petition, Exhibit 11, ASA Report at p. 5-1.

Sargent & Lundy corroborated that there was no such cumulative impact through thermal modeling. Sargent & Lundy evaluated the potential impacts of the proposed thermal limits under near worse-case conditions in terms of temperature increases and maximum station operation in the lake during the months of May and October. *See* Petition, Exhibit 11, ASA Report at p. 4-2. It compared mean daily temperatures in the lake for the May to October period for 1987 – a particularly warm summer – with the predicted temperatures under the same conditions but with higher thermal loading in May and October. The modeling showed that the mean daily lake temperatures for the months of June through September would be unaffected by thermal loading in May, as mean lake temperatures would rapidly converge by early June. *See* Petition, Exhibit 11, ASA Report at p. 4-3. The modeling indicates that increasing thermal loading in May, consistent with Ameren's proposal, will not carryover to impact water temperature during the summer months of June through September.

The Agency questions the reliability of the ASA Report in assessing the potential cumulative impacts of the proposed thermal limits. The Agency criticizes ASA's use of "degree-days" to evaluate potential cumulative thermal impacts as opposed to an evaluation of temperature and dissolved oxygen related to depth. The use of degree-days, according to the Agency, does not take into account varying temperatures and levels of dissolved oxygen at depth and therefore cannot accurately assess whether higher thermal limits in May and October will have an impact on the critical summer months of June through September.

The Agency's criticism, however, lacks merit. If anything, ASA reliance on degree-days resulted in an assessment that was overly-conservative. Degree-days, as calculated by ASA, are the cumulative daily mean near-surface water temperatures recorded at the boundary of the mixing zone. Temperatures at the edge of the mixing zone represent the warmest exposure temperatures in an artificial cooling lake, as temperatures decrease with distance from the effluent discharge point. Thus, ASA's reliance on degree-days measured at the edge of the mix zone represents a near worst-case assessment on the question whether increasing thermal loading in May would have a lasting or persistent carry-over affect into succeeding summer months.

In addition, degree-days are an appropriate mechanism and reliable index to assess cumulative thermal impact because it accounts for annual variation in heat loading and meteorological conditions. *See* Petition, Exhibit 11, ASA Report at p. 2-4. The SIUC studies repeatedly highlight the significant impact that meteorological conditions have on lake biological conditions, independent of water temperature. *See* Agency Recommendation, Exhibit 1, SIUC Draft Annual Report March 2007 at 8; Attachment 2, March 2006 Annual Report at 8 (attached as Attachment 1), March 2005 Annual Report at 5 (attached as Attachment 2). By taking into consideration meteorological and heat loading variability and worse-case water temperature, the use of degree-days represents a stringent evaluation of the potential environmental impacts of the proposed thermal limits. The Agency's assertion that the use of degree-days is insufficient to evaluate cumulative impact is therefore meritless. Ameren has demonstrated that thermal loading in May and October will not have a cumulative impact on lake conditions during the summer months of June through September.

B. Higher Thermal Limits in May and October Will Not Have a Cumulative Impact on Dissolved Oxygen Levels in Succeeding Summer Months

The Agency argues that increased heat loading in May and October may have an adverse affect on dissolved oxygen levels and therefore lead to erosion of habitat, and ultimately fish kills. It offers no evidence – it simply asserts that the Petition failed to address this issue. However, this concern is also unfounded.

First, years worth of data show that temperatures warmer than those being proposed for May and October have not adversely affected the aquatic community. Thus, the evidence demonstrates that dissolved oxygen concentrations will be sufficient to sustain the aquatic community even under the proposed May and October limits.

As it did with temperature, however, the Agency argues that increased loading in May could have a cumulative effect on dissolved oxygen levels in June through September. ASA has examined the SIUC data to determine whether the temperature and dissolved oxygen profiling SIUC performed showed any such effect. It looked at the SIUC data with respect to dissolved oxygen at depth in segments 1 and 2 of the lake to determine whether thermal loading from the heated discharge exhibited any carry-over effect on oxygen concentrations as the summer wears on. It plotted the depth at which 5mg/l dissolved oxygen was first encountered in each week during the summer months for the years 2001 through 2006. It plotted the data for both segments 1 and 2. While the depth at which dissolved oxygen concentrations reached 5 mg/l varied from week to week throughout the summer; the data plots show no discernable pattern that oxygen depletion is increasing as summers progress. This pattern (or lack thereof) is evident in every year SIUC performed dissolved oxygen and temperature profiling. *See* Pre-filed Testimony of Dr. McLaren, at par. 10. The data simply do not support the premise advanced by the Agency.

In sum, the data do not indicate that the proposed modifications to thermal limits in May and October will have a cumulative impact and result in warmer lake temperatures or decreased dissolved oxygen levels in summer months or other months throughout the year. Absent cumulative impact, the evaluation of the potential impact of Ameren's proposed thermal limits must focus on the impact in May and October. As explained below, the Agency's concerns are unwarranted and contrary to the available evidence.

V. AN INCREASE IN LAKE TEMPERATURES IN MAY AND OCTOBER FROM AMEREN'S PROPOSED THERMAL LIMITS WILL NOT

IMPACT TOTAL PHOSPHOROUS AND MERCURY LOADING IN THE LAKE

The Agency notes that Coffeen Lake is impaired for phosphorous, and asserts that Ameren has not assessed whether increased thermal loading in May and October will result in greater "internal loading" of phosphorous, i.e., phosphorous released from sediments. The stated concern is that higher temperatures in May and October may result in prolonged stratification which, according to the Agency, can increase phosphorus releases from sediments. It makes a similar argument for mercury. These concerns are unwarranted.

Ameren retained Dr. Ann B. Shortelle to perform an evaluation of potential impacts associated with modified thermal discharge during the months of May and October, and to quantify the potential for additional phosphorus release and anticipated impacts to surface water quality due to the increase in thermal loading. She also assessed conditions associated with the lake and mercury. The evaluation is provided as a report entitled "Evaluation of Effects of Revised Thermal Standards on Phosphorus and Mercury Cycling in Coffeen Lake," attached as Attachment 1 to the Pre-Filed Testimony of Ann B. Shortelle.

With respect to phosphorous, Dr. Shortelle's analysis showed that any phosphorus released from the sediment is not expected to reach the epilimnion, and is therefore unavailable for biological production within Coffeen Lake. Moreover, even if phosphorous releases from the hypolimnion to the epilimnion, the total loading attributable to internal loading from sediment release is so minute compared to loading from external sources as to be unobservable. She compared seasonal water quality data and saw no evidence that phosphorus released from sediments was or is an important component of surface water phosphorus loading within Coffeen Lake. She concluded that future modifications to thermal discharge limits from Coffeen Station are unlikely to present significant phosphorus loads from sediment release to the epilimnion in the future, and therefore are not a threat to the existing water quality of Coffeen Lake.

With respect to mercury, the Agency states that periods of stratification and low dissolved oxygen in the lake will produce more methylmercury. Noting that methylmercury bioaccumulates and is typically found in predatory fish, the Agency goes on to state that if the temperature of the lake is higher in May and October, and the period of stratification is lengthened, the levels of mercury in the fish may also increase.

Dr. Shortelle considered this hypothesis in light of the current understanding of mercury and mercury dynamics in Coffeen Lake, and the incremental effect of the change in the thermal standard for May and October on mercury cycling in the lake. Based on the available Coffeen Lake data, she concluded that mercury concentrations appear to be generally low in the lake relative to other lakes in Montgomery County, in the State of Illinois or across the nation. She also notes that conditions in the lake do not appear to be favorable for methylation. She concludes by noting that the proposed change in the thermal standard affecting May and October conditions does not substantially change lake conditions, although thermal stratification may persist for more days, on average, annually. That change, she noted, is minor and does not represent a change that could or would significantly increase hypolimnetic mercury methylation rates. It is anticipated that the change, if any, would be so small, that it would not result in increased mercury in the biota.

Additionally, as the Board is well aware, Illinois has taken the lead in reducing the levels of atmospheric deposition of mercury from electric generating utilities. In accordance with Illinois mercury regulations, Ameren has and continues to install pollution control equipment that substantially curtails the release of mercury from its facilities. Ameren's activities will likely result in a noticeable reduction in mercury levels in fish in Illinois lakes. During the 2006 Illinois mercury rulemaking proceedings, the Agency testified that a substantial reduction in the atmospheric deposition of mercury was expected to result in a similar reduction in mercury levels in fish tissue within a period of a few years. *See* In the Matter of: Proposed New 35 Ill. Adm. Code 225 Control of Emissions From Large Combustion Sources (Mercury), R06-25, Testimony of Marcia Willhite, at 162-172 (June 14, 2006). The Agency cited to mercury studies done in Florida and Massachusetts which found a direct correlation between a reduction in mercury emissions into the atmosphere and a reduction in mercury levels in fish tissue.

V. THE ALTERNATIVES TO THE REQUESTED RELIEF ARE ECONOMICALLY UNREASONABLE

In its recommendation, the Agency states Ameren has not met its burden to show that the alternatives investigated are not technically feasible and economically reasonable. The Agency Recommendation supposes that based on the Sargent & Lundy Report, attached to the Petition as Exhibit 15, the 175,000 gallon-per-minute ("gpm") helper cooling tower would be an economically reasonable alternative for Ameren. Ameren explained in the Petition that considering capital and operating and maintenance costs as well as time for commissioning, Ameren would not recover its costs from this option until 2022. Petition at 30-32. More recent analyses have confirmed that this option is economically prohibitive because Ameren would not recoup costs expended to realize this project during the operating life of the helper tower.

Since the original analyses in the Sargent & Lundy Report were performed in 2007, market prices for electric capacity and energy have fallen considerably. Accordingly, Ameren prepared an updated analysis utilizing May 2009 capacity and energy prices. While conducting this economic analysis, Ameren also refined and updated certain assumptions utilized in the August 2007 analysis regarding the capital expenditures and revenue impacts associated with the installation of enhanced cooling technologies. The result was a conclusion that the 2007 analysis overstated the economic viability of an $18 million investment required to potentially increase the availability of the Coffeen plant during two months of the year. The updated economic analysis demonstrates that the additional capacity revenues and energy margins realized from this increased availability do not recover the high up-front cost. The installation of such technology is, therefore, economically unreasonable.

VI. CONCLUSION

Contrary to the Agency's assertions, Ameren has met its burden and sufficiently demonstrated that the proposed modification to the thermal limits in May and October will not impact the capability of Coffeen Lake to support a diverse fish and biotic community capable of sustaining itself through cyclic seasonal changes. Accordingly, Ameren's proposed modification is consistent with applicable regulatory requirements and its Petition should be granted.

Respectfully submitted,

AMEREN ENERGY GENERATING COMPANY,

by: Amy Antoniolli
One of Its Attorneys

Dated: May 12, 2009

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Attachment 1

Ameren Newton and Coffeen Lakes Research and Monitoring Project

Annual Report

Principal Investigators
Ronald C. Brooks
Roy C. Heidinger

Researcher
Patrick Beck

Fisheries & Illinois Aquaculture Center
Southern Illinois University at Carbondale

March 2006
DRAFT

Table of Contents

List of Tables

List of Figures

ABSTRACT

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

Another type of fish kill that likely occurred was habitat erosion, and we believe it accounted for three smaller fish kills since 1997. In 2001 there was a temperature related fish kill on July 10 in Coffeen Lake and August 24 in Newton Lake. A small fish kill (124 fish) was observed by SIU personnel and estimated by IDNR between 24 June and 4 July, 2002 in Coffeen Lake. In these cases, the small fish were probably trapped in a thermal refuge near or in the discharge mixing zones. Prolonged periods of heated discharge eventually eroded away the refuge. The third type of fish kill is angler related. During 2003 and 2004, few dead fish were observed either lake, and the deaths appeared to be angler related, it accounted for the most frequent occurrences, but the least number of deaths. In Newton Lake, no fish kills were observed during 2005. In Coffeen Lake, 19 channel catfish were observed on 2 August, 2005, and habitat conditions were the most critcal we observed throught the eight years of this study. In each year

of the study, a few largemouth bass and channel catfish are found dead or dying in both lakes. The dead or moribund fish are often in proximity of boat ramps or popular fishing areas. The bass probably succumbed to angling related stress. Such events were occasionally witnessed by SIU personnel during the warmest periods. The deaths are usually delayed, and most anglers are not aware of the problem. The preponderance of the data collected during 2000 through 2005 suggests that there were no long-term negative effects of the fish kills in either of these lakes.

INTRODUCTION

This report includes 2005 water temperature and dissolved oxygen data collected in Newton Lake and Coffeen Lake in Illinois. The data was collected using the same methods employed annually since fall 1997 to facilitate comparison among years. Habitat availability was determined by combining water temperature, dissolved oxygen, and depth; the limiting factors being water temperature tolerances in conjunction with dissolved oxygen available to the fish.

The original project, which encompassed fall 1997 through fall 1999, monitored biotic communities ranging from phytoplankton through major sportfish. The goal was to determine conditions of the biotic communities prior to a water temperature "Variance" initiated in 1999 and compare those evaluations to the same parameters during and after the "Variance". A fish kill occurred during July, 1999 in both lakes (Appendix B) while the power plants were operating under the new "Variance" (Heidinger et al. 2000). As a result of the fish kills and other economic considerations, the corporate decision was made to add additional cooling capacity to the Newton Lake and Coffeen Lake electrical generating stations. After summer 1999, the impetus of the study was to determine if the 1999 fish kill and subsequent smaller fish kills in either lake adversely affected three major sportfish populations in the lakes - channel catfish, largemouth bass, and bluegill. Data presented in this 2005 report will be used in conjunction with the previous years' water quality data primarily to examine trends of the abiotic parameters during potentially stressful summer periods.

For sampling purposes, Newton Lake was divided into four segments (Figure 1). From 1997 to 1999, Coffeen Lake was divided into two sampling segments. Beginning in 2000, temperature/oxygen/depth profiles were taken in two additional Segments (3 and 4) in Coffeen Lake (Figure 2). The basic sampling regime for data collected concurrently from 1997-2005 is outlined in

Table 1. A full description of the methods can be found in Appendix A. The 2005 study was approved and initiated at Newton Lake and Coffeen Lake during June. An additional component was added to this year's report which included a bathymetry map of Newton Lake from data collected in previous years (Appendix C).

PLANT OPERATION IN RELATION TO DISCHARGE STANDARDS

Four months (June-September) potentially encompass the critical period when extremely warm water temperatures may be lethal to fish species, and extremely warm ambient temperatures were prevalent throughout summer 2005. Water temperatures were correspondingly high in both lakes. In Newton Lake, the June average water discharge temperature was 99.0°F and higher than in any previous study year (Table 2). However, hourly water discharge temperatures throughout the study period were greater than 106.0°F on only 19 occasions (7-8 June) and were never higher than 106.5. These water discharge temperatures were not conducive of critical consequences to the biota present in Newton lake. In fact, since 1999, neither mean monthly nor hourly temperatures have approached the old "Variance" levels of 102°F and 111°F, respectively. The highest monthly average temperature (104.1°F) during this study was recorded during July 1999, and hourly temperatures were consistently the highest recorded during this study exceeding 111°F on 100 occasions (Table 3). Therefore, despite the higher mean discharge temperature for June 2005, hourly temperatures were not consistently high enough to cause excessive stress to the biota. Due to extended periods of warm weather that persisted through September, the 2005 discharge water temperatures (97.7°F) were also higher than in any previous year (Table 2). They were, however, lower than the prior three months and not considered to be critical.

Water temperatures typically cool considerably from the discharge mixing zone to our Segment 4 station located near the intake (Figure 1), but in Newton Lake, the most pronounced differences occurred from the Segment 1 station to our Segment 2 station (Figure 3). In Segment 1, the temperatures were usually much cooler at 3.0 m than near the surface or at 1.5 m (Figure 4). The water temperature discrepancies among water depths were most pronounced in Segment 1 and gradually decreased as the water flowed towards the water intake (Appendix A, Figures 22 - 25).

Coffeen Lake mixing zone water temperatures were recorded hourly at the edge of the mixing zone in Segment 1 (Figure 2) either by Ameren or SIU-C for the past eight years. SIU-C's temperature logger placement was located in direct proximity to the station used by Ameren for measuring surface water temperatures in the mixing zone. However, the SIU-C temperature loggers were within 6 inches of the surface, and the biostations used by AMEREN have sensors located near the bottom of the buoys (approximately 28 inches below the surface). Therefore, mean monthly mixing zone water temperatures determined from SIU-C temperature loggers for 2001, July 2003, and July-August 2004 are higher than would have been indicated for the deeper sensors on the biostations. This is especially true in Coffeen Lake where there can be a distinct drop in temperature throughout the upper three meters of water in that area of the lake (Figure 5). Hence, the discharge water temperatures reported for July 2003 (104.3°F) and July-August 2004 (105.0°F and 105.6°F) were the highest among the eight years studied in Coffeen Lake (Table 2), but they were also slightly elevated from the levels that would have been recorded at approximately one meter.

Given the slight corrections likely required for the previous two-years' data, it is likely that June - September 2005 water discharge temperatures (99.9 - 104.2°) averaged higher than any previous year, and they were certainly higher than in 1999 - year of the fish kill (Table 2). However, the maximum water discharge temperature recorded in 2005 was 111.3°F, and there were only 24 records where hourly temperatures exceeded 111°F. Those temperatures occurred during 27 and 29 June and on 31 July. Although these water temperatures were high, they were apparently infrequent enough that the biota in Coffeen Lake did not succumb enmass to excessive thermal stress. When fish kills occurred in 1999, the maximum hourly surface water temperatures were higher (115.4°F) and more frequent than in 2005 (Table 4). Additional weather-related factors in 1999 prolonged conditions that limited the cooling capacity of the lake water and resulted in temperatures that were elevated at all depths and in all segments of the lake (Appendix B). In 2005, water temperatures cooled considerably as the distance increased from the discharge (Figure 6).

HABITAT

Temperature/Oxygen/Depth Profiles

Seasonal temperature/oxygen /depth profiles were taken in Newton Lake and Coffeen Lake from 1997 through 2005 (Appendix A). Exact periods of data collection varied somewhat by grant time lines, but the historically, most stressful periods for the fish were usually encompassed. We estimated how much of the lake or lake segments were available to the fish as a percentage of the depth of the water that was below various temperatures (87-96° F) and above various dissolved oxygen levels (1-4ppm) (Heidinger et al. 2000). The mean percentage difference in habitat was calculated at 1.0° F intervals from 87-97° F at dissolved oxygen levels from 1-4ppm at 1ppm intervals.

During 2000-2005, we added two additional lake segments (Segments 3 and 4) to our original two segments (Segments 1 and 2) in Coffeen Lake. Segment 3 is the large arm on the west side of Coffeen Lake known as cemetery bay, and segment 4 is the area between the intake canal and the railroad bridge. Both segment 3 and segment 4 are outside of the normal cooling loop.

Habitat availability was recorded year around during the initial three years of study. The results indicated that potentially critical periods for fish existed in the power-cooling lakes between

June and mid-September. Therefore, since 2000, water temperature, dissolved oxygen, and depth profiles were monitored only during the summer periods when the grant time lines permitted.

Initially in the study period, habitat availability was compared between morning and afternoon samples. It appeared that afternoon temperature/oxygen/depth profiles gave a reasonable estimate of when the amounts of habitat available to the fish at various temperature and oxygen levels were at a minimum (Heidinger et al. 2001). Therefore, the afternoon samples would likely best indicate times when fish would likely be exposed to maximum stress periods, and habitat profiles used in this report were taken from the latest possible times recorded within a date for each year..

Habitat data (2005) complete with all temperature ranges (87 - 96°F), dissolved oxygen levels (1 - 4), segments (1 - 4) and sample dates are presented in Appendix A. Ancillary versions of that appendix are given in Table 5 (Coffeen Lake) and Table 6 (Newton Lake). We also determined the three days per year that had the smallest amount of habitat from our samples from 1998 through 2005 for Coffeen Lake (Table 7) and Newton Lake (Table 8). In 2002, because of the contract time line, habitat monitoring formally started August 1. However, since there was a particularly warm period in July, we took temperature, oxygen, and depth profiles in Coffeen Lake on 6 and 8 July. For Chapter 1, habitat tables (2005) were condensed to include only four temperatures (87, 90, 93, and 96°F), and tables with data providing dates with the most critical habitat conditions during 1998-2005 were compiled using 3-ppm dissolved oxygen as a minimum criterion for the biotic communities at the same four temperatures. Habitat percentages represent means across all four segments in Newton Lake (Figure 1) and only segments one and two in Coffeen Lake (Figure 2).

During 2005 in Coffeen Lake, 28 June, 27 July, and 2 August were the three days when water quality was measured and conditions appeared to be extremely critical (Table 7). Those were days when habitat availability in the cooling loop (segments 1 and 2) was 0-3% at even 93°F. Even in segments 3 and 4 (located outside the cooling loop) habitat availability only ranged from 0% to 7% on 28 June and 22 August. On 27 July, available habitat (at 93°F and 3 ppm dissolved oxygen) in Segements 3 and 4 was at 25% and 29%, respectively. At 93°F and 3 ppm dissolved oxygen, fish would be compelled to locate some type of thermal refugia to avoid short-term thermal stress. Each of those three days in 2005 represented the most critical conditions determined for the entire eight-year period; however, dead or moribund fish were located only on 2 August, 2005 when 19 channel catfish were found in Segment 2 (across the lake from the water intake area). The fish had been dead for a period of time that was indicative of mortality occurring more than several hours previous to their detection. Given the water flow in Coffeen Lake , it is likely that the fish did not die in the immediate vicinity, but somewhere in Segment 1. It is possible that the fish had been trapped in a cove near the warm-water discharge area and succumbed to excessive temperature erosion.

Similar critical habitat conditions have been apparent on seven other dates during the eight years of data collection (Table 7). Two of the seven dates occurred in 2005. No significant fish kills occurred on any of the other dates following the 1999 fish kill despite the fact that suitable habitat was extremely limited. It is possible that in 1999, habitat conditions were worst after the sample dates when fish kills were reported. Habitat conditions were as critical on 8 August, 2001, 6 July and 8 July, 2001, 20 August, 2003 and in all three of the dates in 2005 as they were on 23 July, 1999 - just four days before the major portion of the fish kill occurred.

Average, lake wide habitat values do not necessarily give a complete indication of how stressful the habitat really is to fish in specific sections of the lake. For example, most habitat values in Coffeen Lake indicate more limited quality habitat in Segment 1 than when both segments are averaged. Extremely limited habitat was available to fish in Coffeen Lake on the eight dates previously indicated (Table 7). Interestingly, and perhaps indicating more serious conditions, these low levels usually occurred in both the cooling loop (Segments 1 and 2) and outside of the cooling loop (Segments 3 and 4) in 2005 (Table 5).

In Newton Lake, the most critical periods prior to 2005 occurred on 24 July, 1999, 25 July and 7 August 2001, and 2 August 2002 (Tables 8). On two of the 2005 dates (28 June and 26 July), water quality was worst than all other dates sampled during the eight-year sampling period except 24 July, 1999. At 90° F, 0% habitat with 3-ppm oxygen occurred on 24 July 1999 and on 26 July 2005; but on 25 July 2001 and 28 June 2005, only 2% habitat was available to fish (Table 8). To put this in perspective, if the lake depth averaged 5 m, 2% of that depth would mean only 0.1 m of water was available to the fish on that date. Fish kills occurred within three days of the 1999 and 2001 sampling dates. All four segments are in the cooling loop in Newton Lake. Segments 1 and 2 (discharge arm) tend to have less desirable habitat during the summer months than Segments 3 and 4 (intake arm) (Table 6). It is likely that most of the fish killed during the periods of critical habitat were located well inside the discharge arm when the potentially fatal conditions began. If this were not true, then the fish kills would have involved much higher numbers of fish within and among species. Despite the very critical conditions prevalent in summer 2005, no fish kills were detected in Newton Lake.

Water Levels

Water levels in power-cooling reservoirs are typically lower than pool. Effects of lower water levels on fish species are dependent on the extent of aquatic macrophyte habitats lost. In Newton Lake, six of the seven worst habitat conditions occurred when water levels were at least 1.5 feet below pool level (Figures 7 - 9). The seventh occurred in 1999, just prior to the water levels dropping to 2.0 feet below pool. However, since there have been several summer periods when water levels were similar to the aforementioned dates (including 2005), effects of low water levels on fish stress are unclear at this time. Water levels occasionally are greater than pool over extended periods. No attempt has been made to determine the extent of spillway mortality in Newton or Coffeen lakes. Given the amount of movement of largemouth bass exhibit throughout all seasons, it is likely that some do escape over the spillway.

In Coffeen Lake, water levels fluctuate more than in Newton Lake. The levels have dipped to over 3 feet below pool during four extended periods over the last eight years (Figures 10-12). Examination of the most severe habitat conditions does not show any indication that low water levels promote the poor habitat conditions. As one would expect, those periods when water levels were over pool level often occurred during late spring or early summer. Since the higher water levels were infrequent, spillway mortality was not considered to be a threat to sport species in the lake.

FACTORS ASSOCIATED WITH FISH KILLS

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

(Table 9). In Newton Lake, 227 largemouth bass and 70 channel catfish were observed dead or dying (Table 10).

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

The number of largemouth bass that died in Coffeen Lake and Newton Lake in 1999, relative to their abundance in the two lakes, indicated no significant long-term negative effects on the two bass populations were likely. In Coffeen Lake, assuming that only 50% of the largemouth bass that died were counted, then 242 bass died (0.22 per acre). If there were 20 bass per acre in Coffeen Lake (1100 acres), then the death of 242 bass represented only 1% of the population. Although we have no recent creel data for Coffeen Lake, 242 bass is probably well below what is removed by anglers each year. Also, to place the 1% mortality due to the fish kill in perspective, the average total annual mortality rate for largemouth bass in Coffeen Lake from 1997-2004 is approximately 42% (Brooks 2005). In Newton Lake, assuming 20 largemouth bass per acre (1,750 acres), there were 35,000 bass in the lake before the kill. If anything, this was an underestimate, considering that from 02/16/98 through 12/31/98 the creel indicated that 60,187 bass were caught (Heidinger et al. 2002). In other words, if there were 35,000 bass in the lake, each bass on average was caught 1.7 times. Based on an estimate of 454 bass killed during the 1999 event and a population of 35,000 bass, the death of 454 (0.26 per acre) bass in Newton Lake would equal only 1% of the population.

Again, to place the 1% of dead bass in perspective, average total annual mortality for bass in Newton Lake from 1997-2004 is approximately 57% .

The 1999 fish kills were likely induced by a combination of elevated, discharge water temperatures, prolonged periods of relatively hot air temperatures (which reduced the cooling capacity of the lakes and increased water temperatures at most depths throughout the lakes), and low levels of dissolved oxygen due to atmospheric conditions (which also induced fish kills in local ambient lakes). Habitat availability was extremely low for extended periods during late July 1999 in both lakes (Heidinger et al. 2000). A combination of factors caused the 1999 fish kills; but the kills were relatively insignificant to the sportfish populations.

Fish kills of smaller magnitudes also occurred in the two reservoirs during the study. Those kills were likely more directly associated with water mixing zone temperatures. Water currents associated with power-cooling discharges cause the biota behavior to be more characteristic of slow-moving rivers than of reservoirs. As a result, fish movement increases over that of ambient reservoirs. The movement is, in large part, dictated by forage abundance and locality. In power-cooling reservoirs, forage species often inhabits water temperatures near their thermal maximums because their food supply is more abundant there. If a sudden pulse of lethally hot water is pushed through, and some fish happen to be located in a cove away from the main water flow, the fish can be forced to stay in the cove until the slug of hot water passes. If lethally hot water temperatures persist in the main channel long enough, water temperatures in the coves will increase until they are similar to those in the main channel. This phenomenon, described as eroded fish habitats, results in smaller but more frequent fish kills such as occurred in 2001, 2002, and perhaps in Coffeen Lake in August 2005.

On July 10, 2001, in Coffeen Lake, 546 channel catfish (2-7 in TL), 513 Lepomis spp. (2-6 in TL) and 65 largemouth bass (2-7 in TL) were estimated to have died (Table 11). Mixing zone surface water temperatures began a prolonged increase where mean temperatures were at least 100°F on July 7 in 2001 (Heidinger and Brooks 2002). Prior to that date, although maximum water temperatures had increased to over 100°F, minimum temperatures were low enough to provide the fish with relief within a several-hour period. Minimum water temperatures increased to nearly 100°F after July 7 and did not decrease until mid-August. As postulated earlier, the prolonged nature of the high water temperatures after July 7 likely caused an eroding of cove habitat in the discharge mixing zone which resulted in the July 10 fish kill. Mean water temperatures were also high to a depth of 3 m which was the depth at which dissolved oxygen was limiting at that time.

In Newton Lake on August 28, 2001, we estimated that 10,765 three-inch gizzard shad were killed (Table 11). Again, maximum temperatures in the mixing zone prior to that time had been at least as high as on the day of the fish kill; but as in Coffeen Lake, Newton Lake mid-August water temperatures were increasing from summer lows, and by August 28, the temperatures stabilized at mean at over 100°F for several days. The prolonged high temperatures most likely caused fish mortality in a relatively small cove where the fish's thermal refuge was broken down..

Two additional fish kills detected during this study; that were likely a result of eroding habitat. One occurred in Coffeen Lake during late June and early July 2002, and the other just prior to 2 August 2005. In 2002, Forty two largemouth bass, 64 striped bass, and small amounts of five other species were found dead by SIU-C Personnel during the period (Table 12). In 2005, 19 channel catfish were discovered near the water intake. The fish were too decomposed to takes measurements, but were estimated to be about 12 to 15 inches TL. The abiotic circumstances in both years were very similar to the previous two fish kills in that water temperatures were increasing from summer lows, and the temperatures increased until late June (Heidinger and Brooks 2003).

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

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

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

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

SUMMARY

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

Mean monthly water temperatures in Newton Lake during the annual study periods were , for the most part, cooler following 1999. In Coffeen Lake, the temperatures were actually warmer in 2003, 2004, and 2005 than in 1999. However, in both Newton Lake and Coffeen Lake, maximum hourly water temperatures at the outer edge of the mixing zone in June, July and August were cooler in every year since 1999. Weather patterns (and not water temperatures) in 2000 - 2005 likely were responsible the lack of fish kills versus 1999. In 1999, temperatures remained very hot for a number of weeks. In 2000 - 2004, very hot weather was followed for a few days by cooler weather, and in some cases, heavy rain events. These rain events are reflected in the summer water levels of Newton Lake through 2004. Weather patterns were mild through most of summer 2003 and 2004, and at least in Newton Lake, water temperatures were somewhat indicative of the weather. During 2005, the lack of extended periods of cloud cover most likely spared the lakes of fish kills despite the high water temperatures. It is likely that an extended period of cloud cover would have reduced the already critically limited habitat and caused fish kill as was witnessed in 1999.

The higher 2003 - 2004 mean mixing zone, surface water temperatures in Coffeen Lake reflected the stable increase in power production in that power plant. During 2005, the same habitat quality that persisted in Newton Lake due to ambient conditions were present in Coffeen Lake, except water temperatures were warmer in Coffeen Lake. Based on the water quality and the fact that a few fish succumbed to the water conditions, it is likely that adequate habitat in Coffeen Lake was very nearly exhausted during several periods in 2005. Based on water quality data, a timely period of cloud cover would most likely have induced one or more fish kills. However, given the very warm summer ambient temperatures, It is just as likely that the same could have been reported for unheated lakes in the region since there was very little precipitation. In Coffeen Lake, temperature /oxygen profiles have indicated that cemetery cove and the area between the railroad bridge and the intake canal could serve as refuges for at least part of the fish community during heavy thermal loading and/or low oxygen events. However, during extremely critical periods, even those areas would likely have critically low quality habitat.

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

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

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Table 1. Ameren Project's basic sampling schedule for data collected concurrently from 1997 through 2005.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Newton Lake													
Temp/DO	0	0	0	0	0	4	4	4	4	0	0	0	**4 samples per date:** midway between segment borders; 1/2 meter intervals to bottom.
Coffeen Lake													
Temp/DO	0	0	0	0	0	4	4	4	4	0	0	0	**4 samples per date:** midway between segment borders; 1/2 meter intervals to bottom

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

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

Month	1997	1998	1999	2000	2001[a]	2002	2003	2004	2005
					Newton Lake				
May	---	89.8	88.4	82.5	91.7	84.8	84.6	93.2	91.4
June	95.9	96.3	97.0	94.2	94.5	97.4	90.8	96.7	99.0
July	101.7	101.7	104.1	98.0	100.1	99.1	96.9	96.8	99.3
August	96.2	102.3	99.7	97.5	99.4	96.6	98.3	95.3	99.3
September	94.9	94.6	93.1	92.8	92.9	94.0	92.7	93.3	97.7
October	86.3	87.5	85.4	84.9	84.8	86.3	84.8	84.2	86.9
					Coffeen Lake				
May	77.7	90.8	86.4	88.0	84.7	83.5	86.3	88.4	83.7
June	87.9	94.9	90.5	93.9	86.6	82.2	96.7	100.8	99.9
July	100.8	102.4	103.9	99.2	101.3	96.9	104.3[a]	105.0[a]	104.2
August	98.7	100.1	101.5	99.2	102.4	100.4	102.2	105.6[a]	102.6
September	88.7	96.1	94.8	93.5	93.2	100.4	97.2	102.9	100.5
October	81.6	79.9	83.6	83.4	64.2	99.1	81.8	85.3	84.2

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

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

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

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

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

Total Hours 83

Table 5. Percent habitat among segments at various temperatures and oxygen ranges in Coffeen Lake during June-September 2005. Profiles were taken from 2:00 p.m. to 7:00 p.m.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
06/03/05	87	14	18	29	27	11	14	29	25	10	13	27	23	8	12	21	23
06/03/05	90	17	18	29	27	15	14	29	25	13	13	27	23	12	12	21	23
06/03/05	93	17	18	29	27	15	14	29	25	13	13	27	23	12	12	21	23
06/03/05	96	17	18	29	27	15	14	29	25	13	13	27	23	12	12	21	23
06/08/05	87	10	9	8	15	10	8	6	10	9	7	4	10	9	7	2	8
06/08/05	90	10	11	25	26	10	9	23	20	9	8	21	20	9	8	19	18
06/08/05	93	10	17	25	26	10	15	23	20	9	14	21	20	9	14	19	18
06/08/05	96	10	17	25	26	10	15	23	20	9	14	21	20	9	14	19	18
06/16/05	87	8	16	30	28	6	15	30	28	2	13	29	28	2	13	29	28
06/16/05	90	12	21	30	30	11	19	30	30	6	18	29	30	6	18	29	30
06/16/05	93	18	21	30	30	16	19	30	30	11	18	29	30	11	18	29	30
06/16/05	96	18	21	30	30	16	19	30	30	11	18	29	30	11	18	29	30
06/21/05	87	5	8	14	12	4	7	14	12	4	5	14	12	2	4	10	9
06/21/05	90	7	11	20	21	6	9	20	21	6	8	20	21	5	7	16	19
06/21/05	93	8	13	27	23	7	12	27	23	7	11	27	23	6	9	23	21
06/21/05	96	8	18	27	29	7	17	27	29	7	15	27	29	6	14	23	27
06/28/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06/28/05	90	0	3	4	0	0	1	4	0	0	0	4	0	0	0	2	0
06/28/05	93	4	6	4	2	4	4	4	2	3	3	4	0	1	3	2	0
06/28/05	96	12	12	17	16	12	10	17	16	10	9	17	14	9	9	15	14

Table 5. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
07/07/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/07/05	90	3	6	7	2	0	6	7	2	0	4	7	2	0	1	7	0
07/07/05	93	6	13	29	23	2	13	29	23	0	12	29	23	0	9	29	21
07/07/05	96	10	21	29	29	5	21	29	29	3	20	29	29	2	17	29	27
07/13/05	87	0	3	4	0	0	0	2	0	0	0	2	0	0		0	0
07/13/05	90	0	12	29	30	0	9	27	30	0	4	27	26	0		17	15
07/13/05	93	3	24	29	30	0	21	27	30	0	15	27	26	0		17	15
07/13/05	96	7	24	29	30	4	21	27	30	4	15	27	26	2		17	15
07/20/05	87	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
07/20/05	90	3	6	8	2	3	4	7	2	2	3	2	0	0	1	2	0
07/20/05	93	9	9	10	14	9	7	9	14	8	6	4	12	5	4	4	12
07/20/05	96	11	13	30	27	11	12	29	27	9	10	25	25	6	9	25	25
07/27/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/27/05	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/27/05	93	0	3	29	29	0	1	25	29	0	1	25	29	0	1	23	29
07/27/05	96	10	21	29	29	10	20	25	29	6	20	25	29	5	20	23	29
08/02/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/02/05	90	0	0	4	0	0	0	4	0	0	0	4	0	0	0	0	0
08/02/05	93	2	3	7	4	0	3	7	2	0	0	7	2	0	0	0	2
08/02/05	96	8	8	29	17	6	8	29	15	5	6	29	15	2	6	23	15

Table 5. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
08/09/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/09/05	90	0	3	3	0	0	0	2	0	0	0	2	0	0	0	2	0
08/09/05	93	10	10	10	12	6	6	9	12	5	6	9	9	2	4	9	9
08/09/05	96	11	15	30	29	8	10	29	29	6	10	29	27	3	9	29	27
08/18/05	87	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0
08/18/05	90	8	14	8	13	5	12	8	13	0	11	8	13	0	8	8	13
08/18/05	93	11	25	29	29	8	24	29	29	0	22	29	29	0	19	29	29
08/18/05	96	11	25	29	29	8	24	29	29	0	22	29	29	0	19	29	29
08/23/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/23/05	90	0	6	1	1	0	5	1	1	0	3	1	1	0	2	1	1
08/23/05	93	7	12	30	30	5	11	30	30	3	9	30	30	2	8	30	30
08/23/05	96	8	22	30	30	7	21	30	30	5	19	30	30	3	18	30	30
08/31/05	87	0	12	30	19	0	11	30	19	0	9	30	19	0	9	29	19
08/31/05	90	9	26	30	30	9	24	30	30	7	23	30	30	5	23	29	30
08/31/05	93	9	26	30	30	9	24	30	30	7	23	30	30	5	23	29	30
08/31/05	96	13	26	30	30	13	24	30	30	11	23	30	30	9	23	29	30
09/08/05	87	3	9	8	4	2	8	7	4	0	3	7	3	0	2	7	3
09/08/05	90	11	15	20	22	9	14	19	22	8	9	19	20	8	8	19	20
09/08/05	93	12	22	30	30	11	21	29	30	9	16	29	29	9	14	29	29
09/08/05	96	14	25	30	30	12	24	29	30	11	19	29	29	11	18	29	29

Table 5. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
09/14/05	87	8	9	5	3	3	7	4	2	1	0	2	0	1	0	2	0
09/14/05	90	18	20	30	30	9	18	29	29	4	11	27	27	1	10	27	27
09/14/05	93	23	30	30	30	14	29	29	29	9	22	27	27	6	20	27	27
09/14/05	96	25	30	30	30	16	29	29	29	11	22	27	27	8	20	27	27
09/21/05	87	10	17	8	15	5	17	8	15	0	17	8	15	0	14	8	13
09/21/05	90	11	23	30	29	6	23	30	29	2	23	30	29	0	20	30	27
09/21/05	93	11	25	30	29	6	25	30	29	2	25	30	29	0	22	30	27
09/21/05	96	13	25	30	29	8	25	30	29	3	25	30	29	2	22	30	27
09/29/05	87	18	26	30	30	13	26	30	30	6	26	30	30	0	24	30	30
09/29/05	90	19	30	30	30	14	30	30	30	8	30	30	30	2	28	30	30
09/29/05	93	21	30	30	30	16	30	30	30	10	30	30	30	3	28	30	30
09/29/05	96	23	30	30	30	18	30	30	30	12	30	30	30	6	28	30	30

Table 6. Percent habitat among segments at various temperatures and oxygen ranges in Newton Lake during June-September 2005. Profiles were taken from 12:00 p.m. to 6:30 p.m.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
06/02/05	87	15	11	19	27	15	10	19	24	11	10	18	22	11	8	18	19
06/02/05	90	29	18	19	27	29	16	19	24	25	16	18	22	25	14	18	19
06/02/05	93	29	18	19	27	29	16	19	24	25	16	18	22	25	14	18	19
06/02/05	96	29	18	19	27	29	16	19	24	25	16	18	22	25	14	18	19
06/07/05	87	8	8	13	30	8	8	11	30	0	4	11	30	0	4	9	30
06/07/05	90	8	8	19	30	8	8	17	30	0	4	17	30	0	4	15	30
06/07/05	93	8	10	19	30	8	10	17	30	0	6	17	30	0	6	15	30
06/07/05	96	19	17	19	30	19	17	17	30	11	13	17	30	11	13	15	30
06/14/05	87	0	6	16	30	0	2	14	30	0	0	14	30	0	0	13	30
06/14/05	90	0	6	16	30	0	2	14	30	0	0	14	30	0	0	13	30
06/14/05	93	4	10	16	30	4	6	14	30	4	4	14	30	0	4	13	30
06/14/05	96	8	19	16	30	8	15	14	30	8	13	14	30	4	13	13	30
06/21/05	87	0	6	11	27	0	4	9	27	0	4	9	27	0	2	7	27
06/21/05	90	4	8	21	27	0	6	19	27	0	6	19	27	0	4	17	27
06/21/05	93	11	12	21	27	8	10	19	27	8	10	19	27	8	8	17	27
06/21/05	96	25	17	21	27	21	15	19	27	21	15	19	27	21	13	17	27
06/28/05	87	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
06/28/05	90	4	2	4	9	4	2	2	6	0	0	0	6	0	0	0	3
06/28/05	93	8	2	14	29	8	2	12	26	4	0	10	26	4	0	10	23
06/28/05	96	8	10	14	29	8	10	12	26	4	8	10	26	4	8	10	23

Table 6. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
07/05/05	87	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
07/05/05	90	0	2	20	30	0	0	18	29	0	0	18	29	0	0	18	29
07/05/05	93	3	9	20	30	0	7	18	29	0	7	18	29	0	5	18	29
07/05/05	96	22	18	20	30	19	15	18	29	19	15	18	29	19	13	18	29
07/12/05	87	0	2	22	30	0	0	22	29	0	0	20	22	0	0	18	12
07/12/05	90	0	14	22	30	0	9	22	29	0	5	20	22	0	0	18	12
07/12/05	93	0	25	22	30	0	20	22	29	0	15	20	22	0	6	18	12
07/12/05	96	20	25	22	30	20	20	22	29	20	15	20	22	9	6	18	12
07/19/05	87	0	4	4	0	0	2	2	0	0	0	2	0	0	0	2	0
07/19/05	90	0	7	15	25	0	4	13	25	0	2	13	25	0	2	13	25
07/19/05	93	4	9	19	30	4	7	17	30	4	4	17	30	0	4	17	30
07/19/05	96	4	15	22	30	4	13	20	30	4	11	20	30	0	11	20	30
07/26/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/26/05	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/26/05	93	0	0	30	29	0	0	30	29	0	0	30	26	0	0	30	24
07/26/05	96	0	2	30	29	0	0	30	29	0	0	30	26	0	0	30	24
08/02/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/02/05	90	0	0	6	17	0	0	6	15	0	0	4	15	0	0	4	15
08/02/05	93	0	5	11	30	0	2	11	29	0	2	10	29	0	2	10	29
08/02/05	96	5	12	18	30	5	9	18	29	5	9	16	29	5	9	16	29

Table 6. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
08/09/05	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/09/05	90	0	0	8	13	0	0	8	13	0	0	4	13	0	0	2	11
08/09/05	93	0	5	16	30	0	2	16	30	0	2	12	30	0	0	10	29
08/09/05	96	4	14	21	30	4	12	21	30	4	12	17	30	0	9	15	29
08/16/05	87	0	0	4	15	0	0	0	15	0	0	0	15	0	0	0	15
08/16/05	90	0	9	52	59	0	9	49	59	0	4	49	59	0	0	45	59
08/16/05	93	9	42	52	59	9	42	49	59	9	38	49	59	9	34	45	59
08/16/05	96	35	42	52	59	35	42	49	59	35	38	49	59	35	34	45	59
08/23/05	87	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0	20
08/23/05	90	0	5	25	30	0	5	23	30	0	0	23	30	0	0	23	29
08/23/05	93	0	22	25	30	0	22	23	30	0	18	23	30	0	18	23	29
08/23/05	96	28	22	25	30	28	22	23	30	28	18	23	30	28	18	23	29
08/31/05	87	0	2	17	30	0	2	16	30	0	0	16	30	0	0	14	29
08/31/05	90	0	6	30	30	0	4	29	30	0	2	29	30	0	0	27	29
08/31/05	93	3	12	30	30	3	10	29	30	3	8	29	30	3	6	27	29
08/31/05	96	8	19	30	30	8	17	29	30	8	15	29	30	8	13	27	29
09/08/05	87	0	9	11	8	0	4	8	8	0	0	6	7	0	0	4	7
09/08/05	90	0	11	19	30	0	7	15	30	0	0	13	29	0	0	11	29
09/08/05	93	7	13	26	30	7	9	22	30	4	2	20	29	0	2	18	29
09/08/05	96	7	23	26	30	7	19	22	30	4	12	20	29	0	12	18	29

Table 6. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
09/14/05	87	0	13	29	30	0	2	28	29	0	0	24	29	0	0	24	29
09/14/05	90	0	15	30	30	0	5	29	29	0	2	25	29	0	0	25	29
09/14/05	93	0	20	30	30	0	9	29	29	0	7	25	29	0	5	25	29
09/14/05	96	30	30	30	30	30	20	29	29	28	18	25	29	28	15	25	29
09/22/05	87	0	0	30	30	0	0	28	28	0	0	24	28	0	0	24	28
09/22/05	90	0	2	30	30	0	2	28	28	0	2	24	28	0	0	24	28
09/22/05	93	3	5	30	30	3	5	28	28	3	5	24	28	0	3	24	28
09/22/05	96	20	14	30	30	20	14	28	28	20	14	24	28	17	12	24	28
09/29/05	87	0	22	30	30	0	20	30	30	0	20	30	30	0	18	30	30
09/29/05	90	30	22	30	30	30	20	30	30	30	20	30	30	30	18	30	30
09/29/05	93	30	22	30	30	30	20	30	30	30	20	30	30	30	18	30	30
09/29/05	96	30	22	30	30	30	20	30	30	30	20	30	30	30	18	30	30

Table 7. Comparison of the three days in Coffeen Lake during 1998 through 2005 that had the worst habitat conditions. Comparisons are made at 3 ppm dissolved for 4 temperatures. Percent habitats were averaged for Segments 1and 2. Percentages for Segments 3 and 4 are given in parentheses when the segments were sampled from 2000 through 2005.

Temperature	1998			1999			2000		
(°F)	3-Jul	24-Jul	28-Aug	23-Jul	6-Aug	19-Aug	18-Jul	15-Aug	4-Sep
87	0	0	0	0	0	0	0 (0)	3 (9)	0 (0)
90	2	0	5	0	0	33	5 (15)	39 (78)	3 (4)
93	14	16	24	10	21	42	30 (100)	44 (99)	24 (83)
96	34	41	36	27	25	47	42 (100)	50 (99)	43 (83)
	2001			2002[a]			2003		
	10-Jul	24-Jul	8-Aug	6-Jul	8-Jul	1-Aug	8-Jul	20-Aug	27-Aug
87	0 (14)	0 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (4)
90	17 (21)	2 (20)	0 (0)	0 (0)	0 (0)	3 (13)	0 (4)	0 (11)	3 (15)
93	29 (59)	18 (44)	0 (7)	3 (10)	0 (24)	24 (52)	12 (54)	7 (84)	21 (54)
96	33 (62)	25 (90)	21 (40)	42 (83)	17 (80)	31 (82)	25 (88)	30 (96)	29 (96)

Table 7. Continued.

Temperature	2004			2005		
(°F)	16-Jun	30-Jun	7-Jul	28-Jun	27-Jul	2-Aug
87	0 (4)	2 (11)	0 (24)	0 (0)	0 (0)	0 (0)
90	9 (69)	10 (38)	33 (85)	0 (2)	0 (0)	0 (2)
93	27 (87)	14 (77)	35 (85)	3 (2)	0 (27)	0 (5)
96	31 (87)	21 (87)	42 (85)	10 (16)	13 (27)	6 (22)

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

Table 8. Comparison of the three days in Newton Lake during 1998 through 2005 that had the worst habitat conditions. Comparisons are made at 3 ppm dissolved for 4 temperatures. Percent habitats were averaged in all four segments.

Temperature	1998			1999			2000		
(°F)	26-Jun	11-Jul	24-Aug	24-Jul	5-Aug	18-Aug	13-Jul	28-Jul	1-Sep
87	0	0	0	0	1	31	2	31	4
90	18	22	29	0	21	41	15	41	21
93	29	29	40	7	44	42	30	46	35
96	33	29	43	32	48	52	40	57	44

Temperature (°F)	2001			2002[a]			2003		
	18-Jun	25-Jul	7-Aug	2-Aug	21-Aug	29-Aug	2-Jul	9-Jul	28-Aug
87	3	0	0	0	34	47	15	0	2
90	37	2	9	9	53	57	26	31	28
93	44	24	26	27	72	69	39	41	40
96	56	32	39	34	79	85	50	53	45

Table 8. Continued.

Temperature (°F)	2004 15-Jun	2004 13-Jul	2004 3-Aug	2005 28-Jun	2005 26-Jul	2005 2-Aug
87	11	0	9	0	0	0
90	34	7	22	2	0	5
93	34	26	32	10	14	10
96	42	30	39	12	14	15

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

Table 9. Numbers of dead and morbid fishes observed by SIU personnel in Coffeen Lake in 1999.

Date	Largemouth bass	*Lepomis*	Channel catfish	*Morone*	Crappie	Carp	Shad
4/9/1999	0	0	2	0	0	1	0
6/2/1999	0	0	0	0	0	0	0
6/3/1999	0	0	0	0	0	0	0
6/8/1999	0	0	0	0	0	0	0
6/15/1999	0	0	0	0	0	0	0
6/16/1999	0	0	0	0	0	0	0
6/29/1999	0	0	0	0	0	0	0
6/29/1999	0	0	0	0	0	0	0
6/30/1999	0	0	0	0	0	0	0
7/8/1999	1	0	0	0	0	0	0
7/9/1999	0	0	0	0	0	0	0
7/13/1999	0	0	0	0	0	0	0
7/16/1999	0	0	0	0	0	0	0
7/21/1999	0	0	0	1	1	0	0
7/23/1999	0	0	0	0	0	0	0
7/27/1999	15	31	0	0	0	0	5
7/28/1999	105	0	5	11	0	0	7
8/1/1999	0	0	0	0	0	0	0
8/2/1999	0	0	0	0	0	0	0
8/6/1999	0	0	0	0	0	0	0
8/10/1999	0	0	1	0	1	0	0
8/11/1999	0	0	0	0	0	0	0
8/19/1999	0	0	0	0	0	0	0
8/20/1999	0	0	0	0	0	0	0
8/24/1999	0	0	0	0	0	0	0
8/25/1999	0	0	0	0	0	0	0
8/26/1999	0	0	0	0	0	0	0
8/27/1999	0	0	0	0	0	0	0
Total	121	31	8	12	2	1	12

Table 10. Number of dead and morbid fishes observed by SIU personnel in Newton Lake in 1999.

Date	Largemouth bass	*Lepomis*	Channel catfish	*Morone*	Carp	Shad
3/23/1999	1	0	0	0	0	0
5/20/1999	1	0	0	0	0	1
6/1/1999	0	0	0	0	0	0
6/2/1999	0	0	0	0	0	0
6/3/1999	0	0	0	0	0	0
6/4/1999	0	0	0	0	0	0
6/8/1999	0	0	0	0	0	0
6/9/1999	27	0	0	0	0	0
6/14/1999	0	0	0	0	0	0
6/15/1999	0	0	0	0	0	0
6/19/1999	0	0	0	0	0	0
6/22/1999	4	0	0	0	0	0
6/23/1999	0	0	0	0	0	0
6/24/1999	0	0	0	0	0	0
6/29/1999	0	0	0	0	0	0
7/6/1999	0	0	0	0	0	0
7/7/1999	1	0	0	0	0	0
7/8/1999	0	0	0	0	0	0
7/14/1999	0	0	0	0	0	0
7/15/1999	0	0	0	0	0	0
7/16/1999	0	0	0	0	0	0
7/20/1999	1	0	0	1	0	0
7/21/1999	0	0	0	0	0	0
7/23/1999	0	0	0	0	0	0
7/24/1999	0	0	0	0	0	0
7/27/1999	18	1	22	1	1	8
7/29/1999	60	4	36	1	0	15
7/30/1999	5	0	0	0	0	0
7/31/1999	0	0	0	0	0	0
8/5/1999	3	0	9	0	0	2
8/9/1999	3	0	2	0	0	0
8/10/1999	0	0	0	0	0	0
8/11/1999	20	0	0	0	0	35
8/18/1999	24	0	1	2	0	0
8/19/1999	18	0	0	0	0	0
8/24/1999	6	0	0	0	0	0
8/25/1999	9	0	0	0	0	0
8/26/1999	14	0	0	0	0	0
8/27/1999	11	0	0	0	0	0
8/31/1999	1	0	0	0	0	0
Total	227	5	70	5	1	59

Table 11. Number and total length of dead and morbid fish observed by SIU personnel in Coffeen Lake and Newton Lake in 2000 and 2001.

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

Table 11. Continued.

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

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

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

Table12. Number and total length of dead and moribund fish estimated by IDNR personnel in Coffeen Lake from 24 June through 4 July, 2002.

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

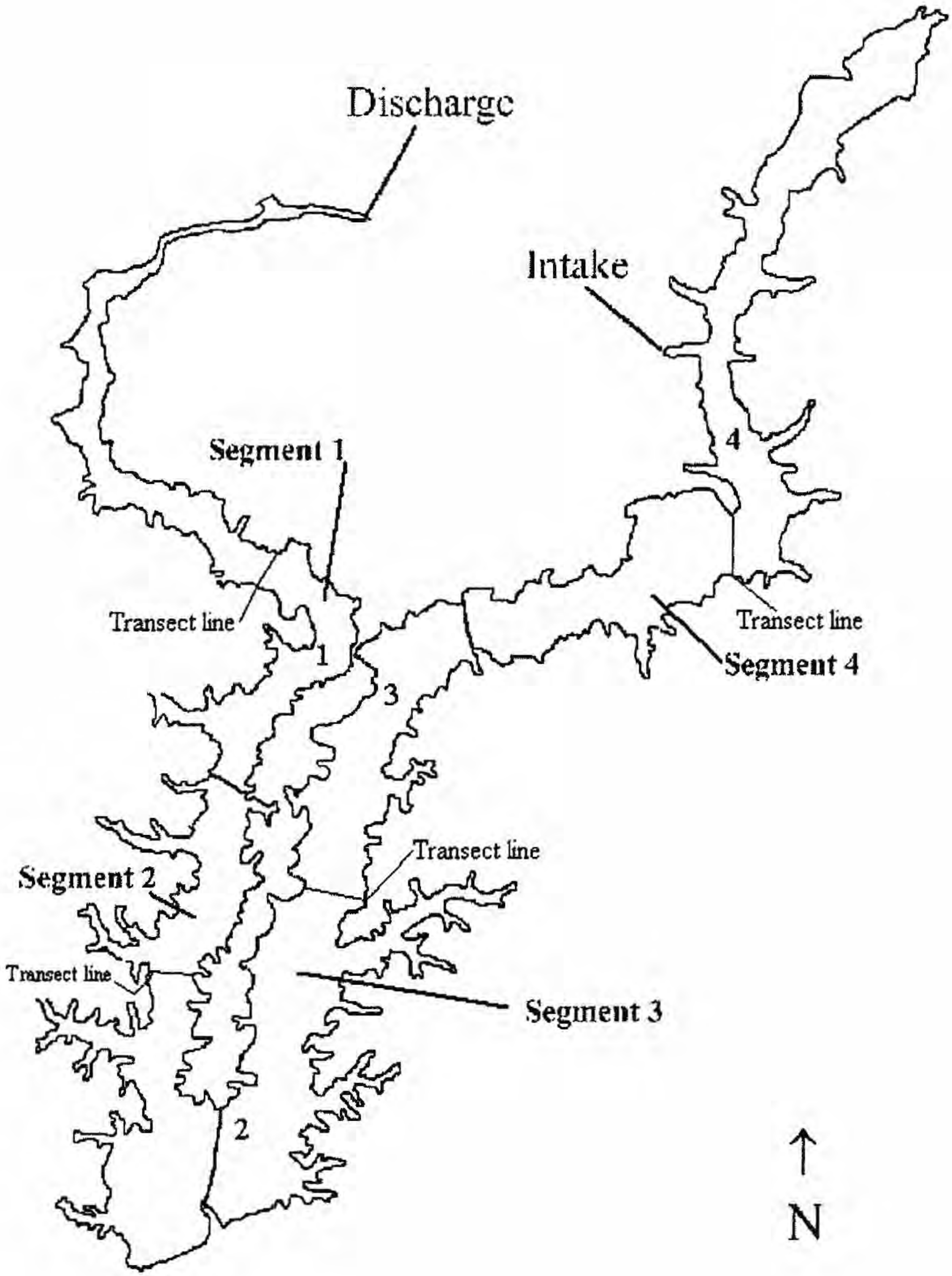


Figure 1. Newton Lake with four segments where sampling was conducted. Water temperature and dissolved oxygen were sampled at each transect line from August 1997 through 2005. Numbers represent locations of continuous temperature recorders.

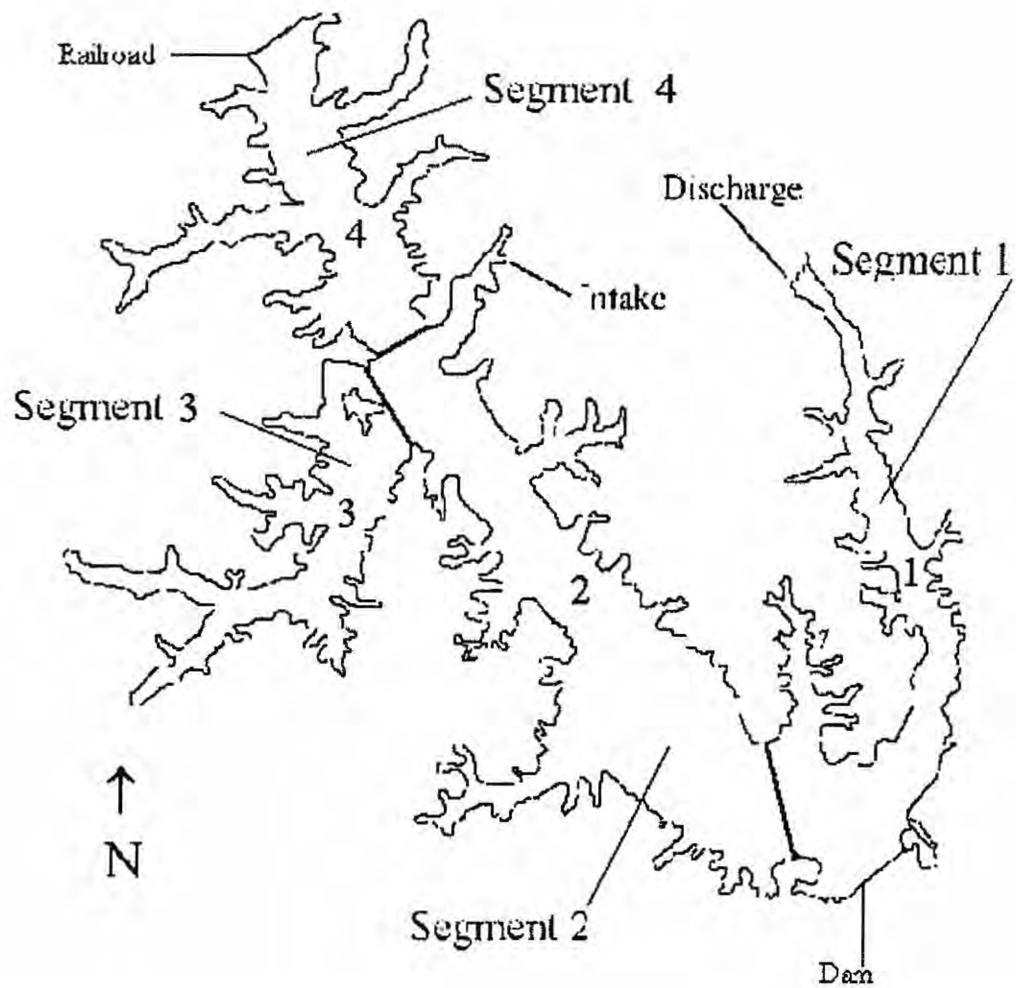


Figure 2. Coffeen Lake with two segments where sampling was conducted for water temperature and dissolved oxygen from August 1997 through 2005. Segments 3 and 4 were added in 2000. Sampling sites are represented by numbers inside lake borders.

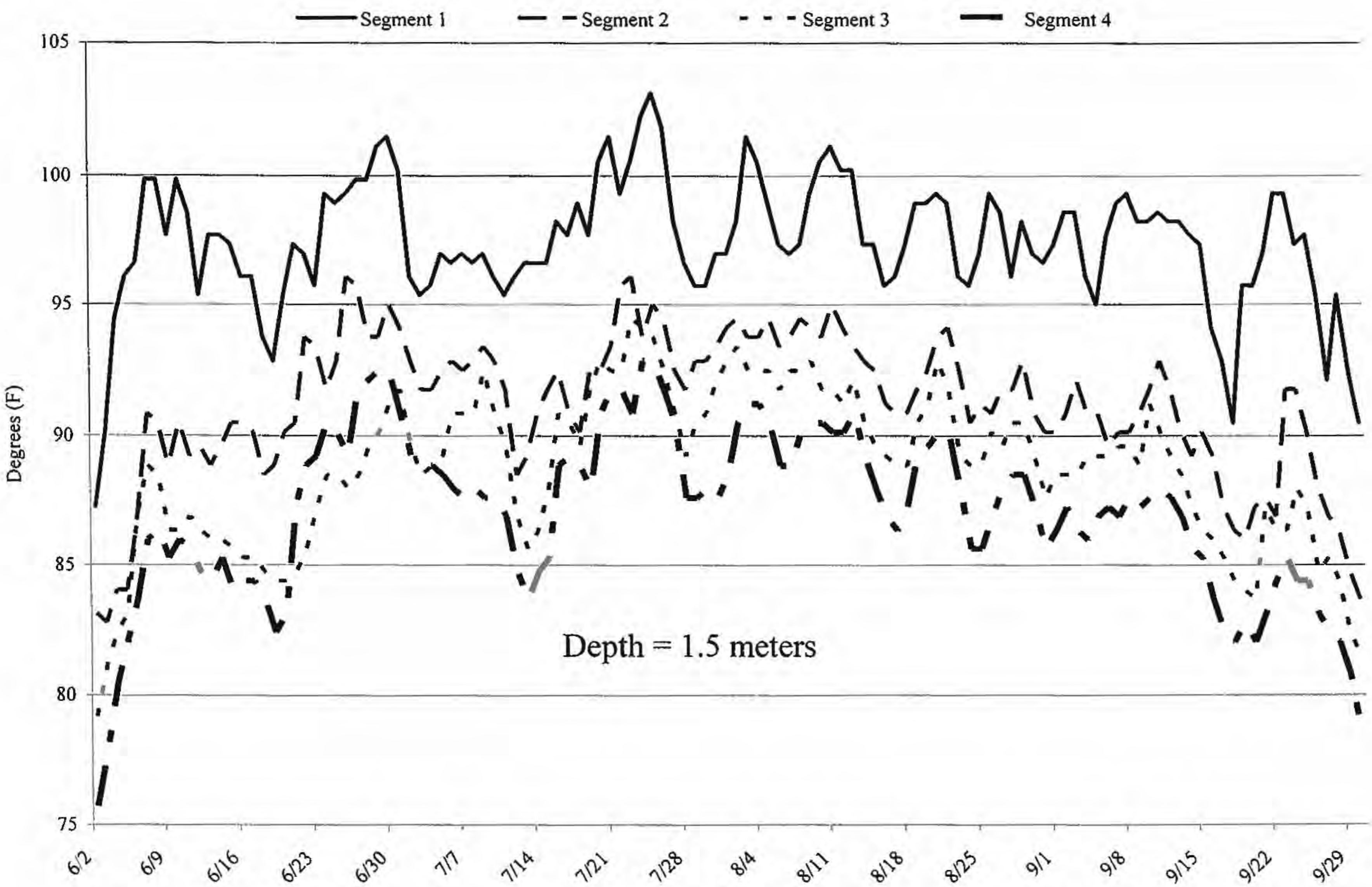


Figure 3. Mean daily temperatures during 2005 at four monitoring stations in Newton Lake at a depth of 1.5 meters. Segment one represents discharge mixng area, and the stations a spaced throughout the lake to Segment 4 which is near the water intake area.

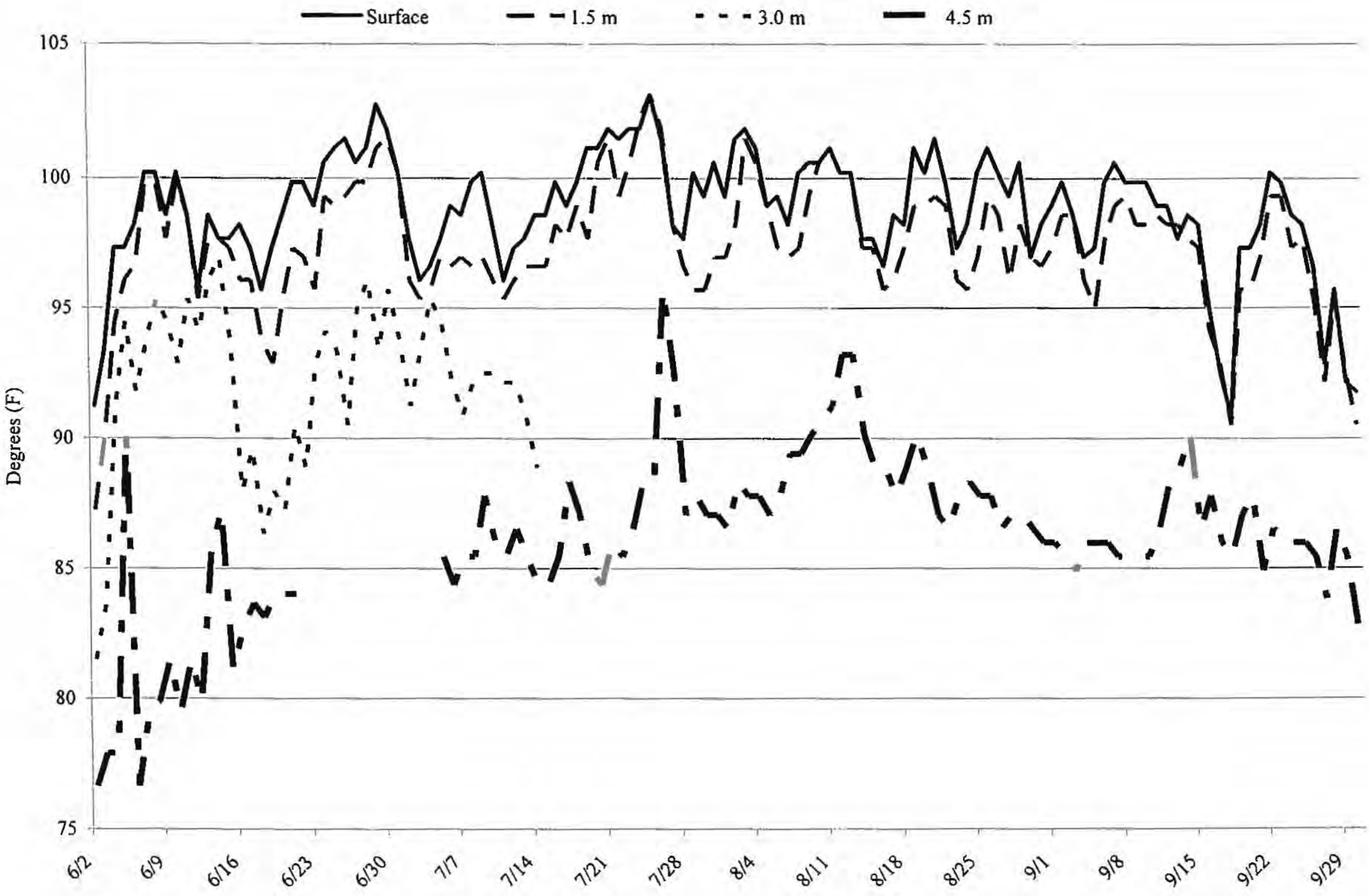


Figure 4. Mean daily temperatures during 2005 in Newton Lake Segment 1. Lake bottom is approximately 16.4 feet.

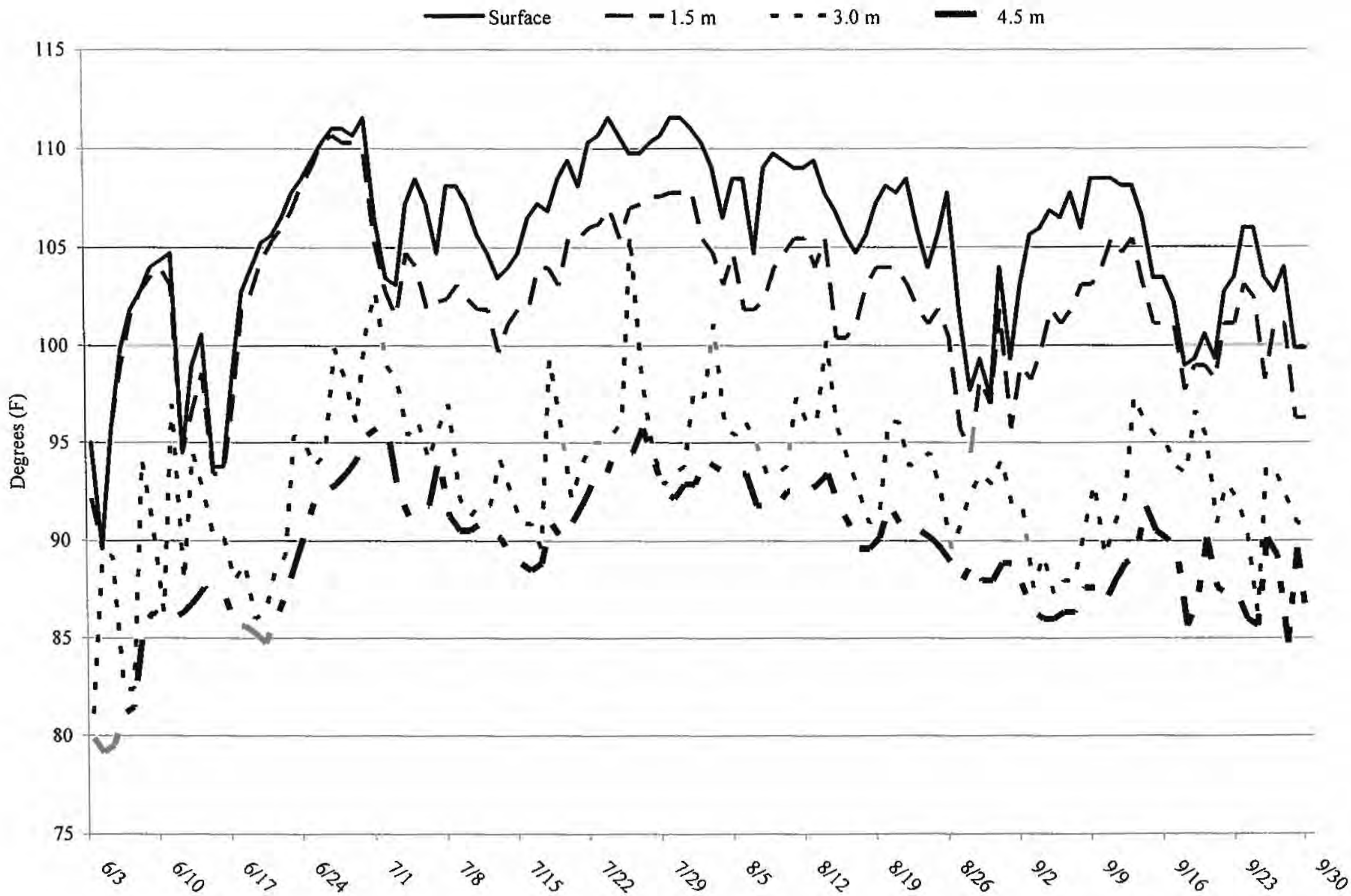


Figure 5. Mean daily temperatures in Segment 1 (mixing zone) during 2005 in Coffeen Lake. Lake bottom is approximately 18.0 feet.

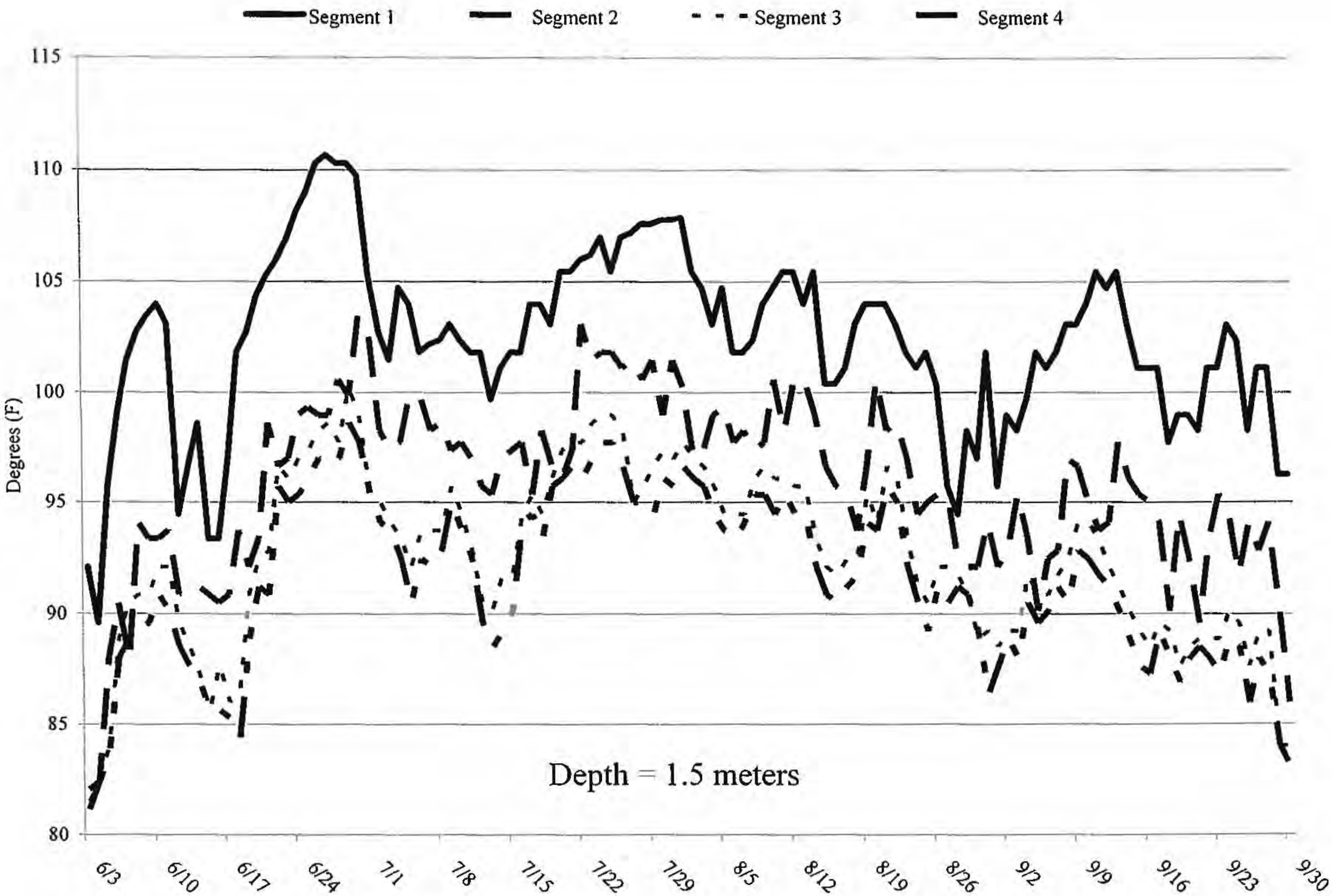


Figure 6. Mean daily temperatures during 2005 at four monitoring stations in Coffeen Lake at a depth of 1.5 meters. Segment one represents discharge mixng area, and the stations a spaced throughout the lake to Segment 4 which is near the water intake area.

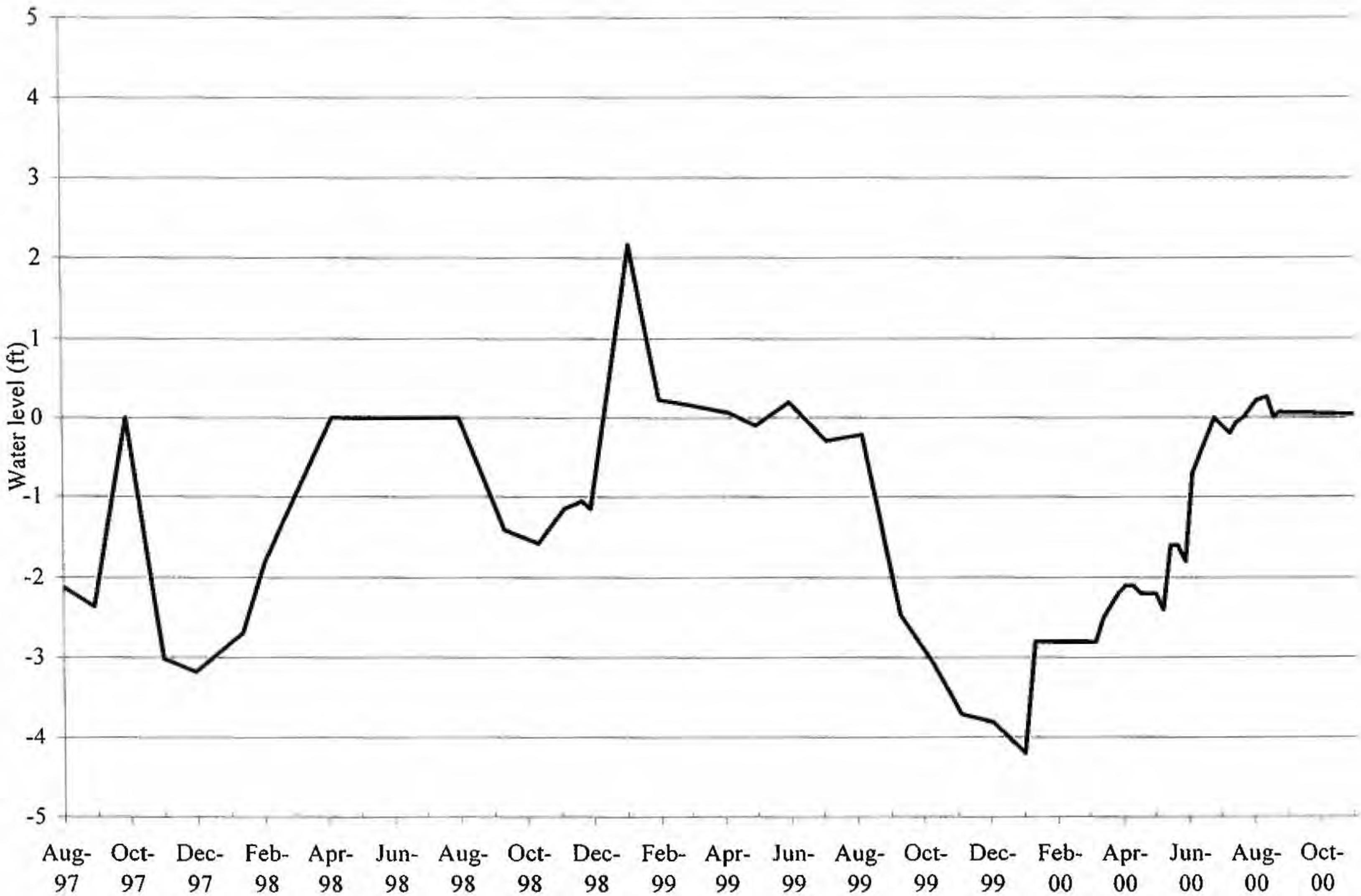


Figure 7. Water levels (feet) in relation to pool level in Newton Lake during 1997-2000.

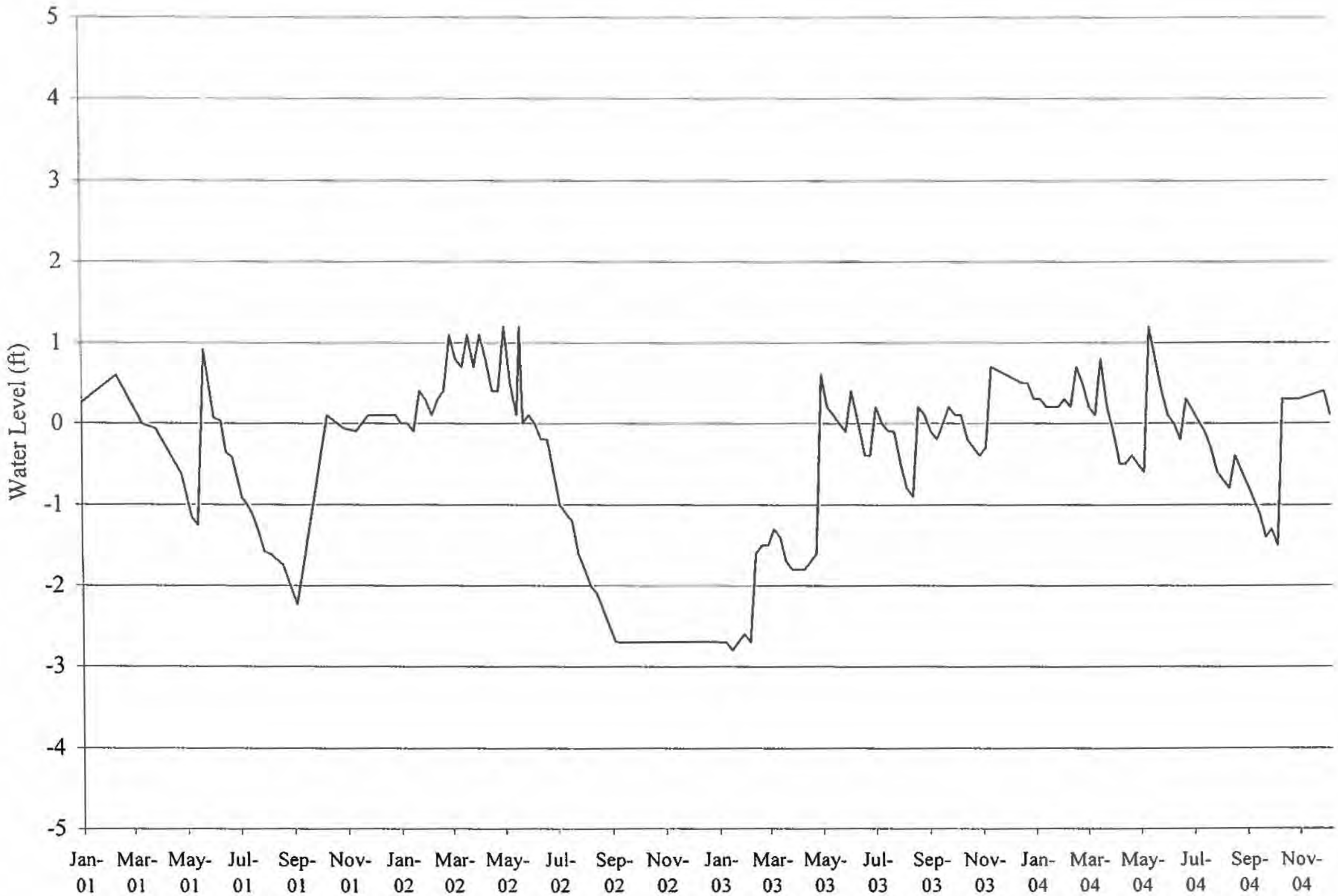


Figure 8. Water levels (feet) in relation to pool level in Newton Lake during 2001-2004.

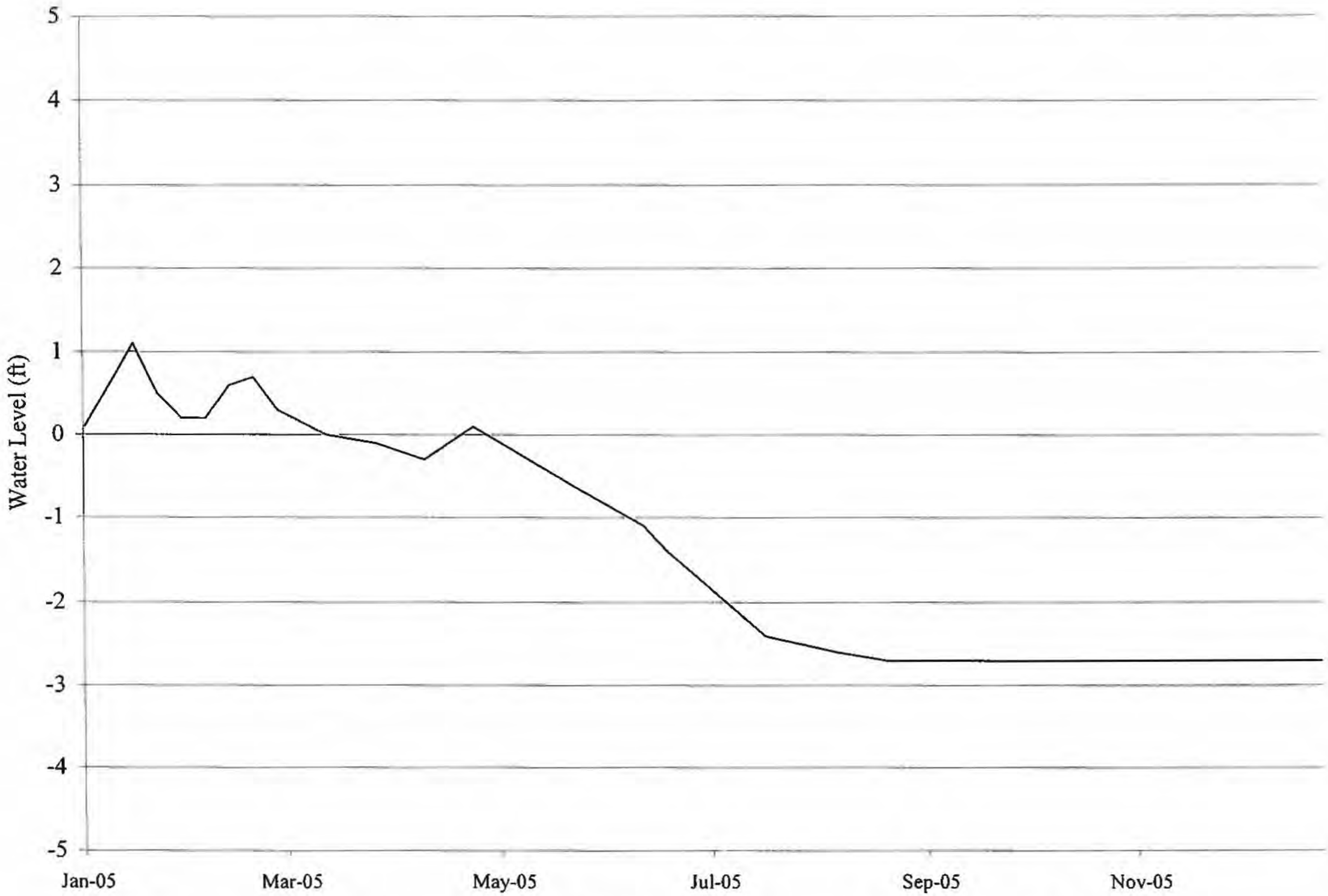


Figure 9. Water levels (feet) in relation to pool level in Newton Lake during 2005. Water levels after August 2005 were reported only as less than 2.7 feet below pool.

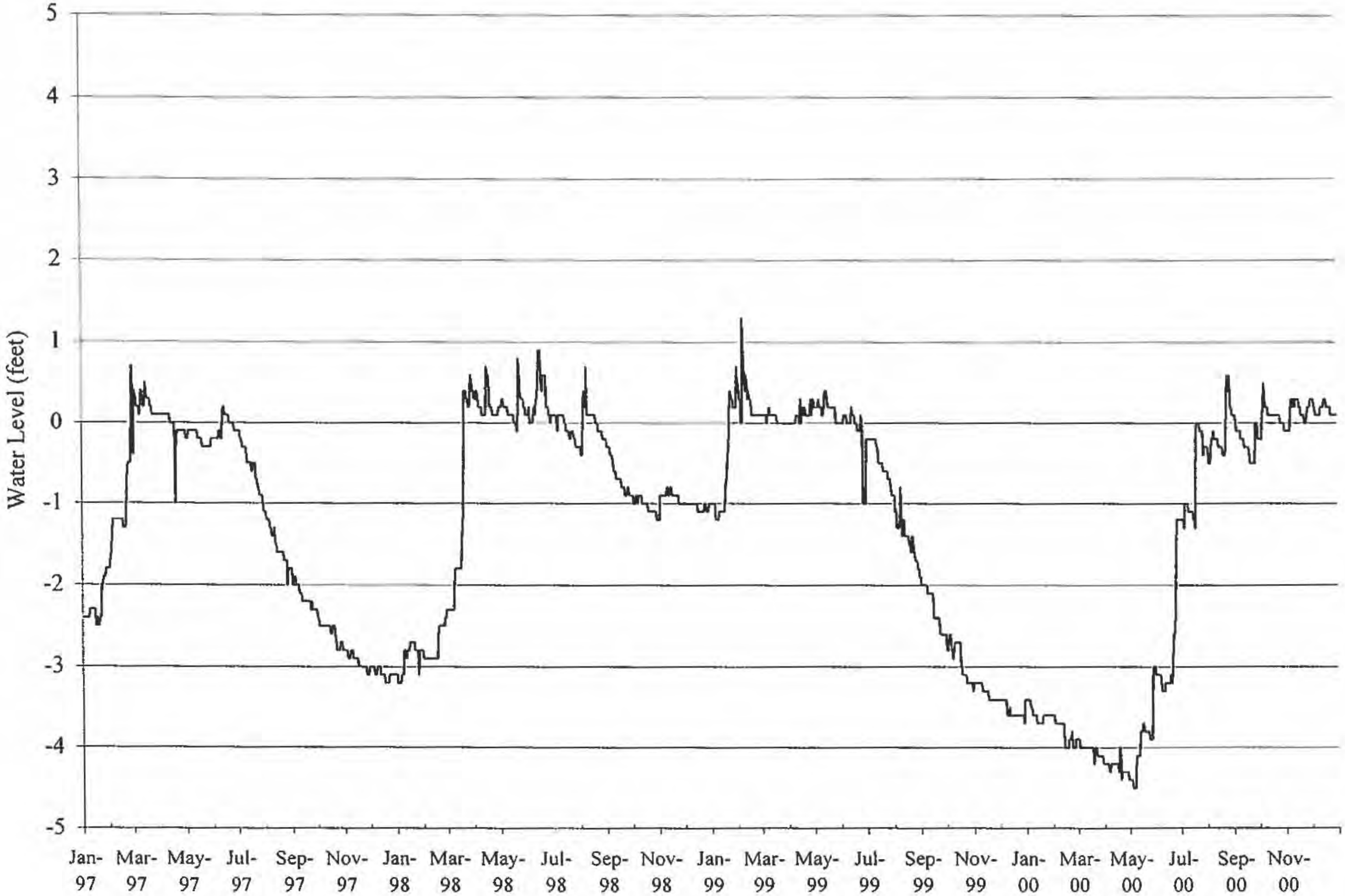


Figure10. Water levels (feet) in relation to pool level in Coffeen Lake during 1997-2000.

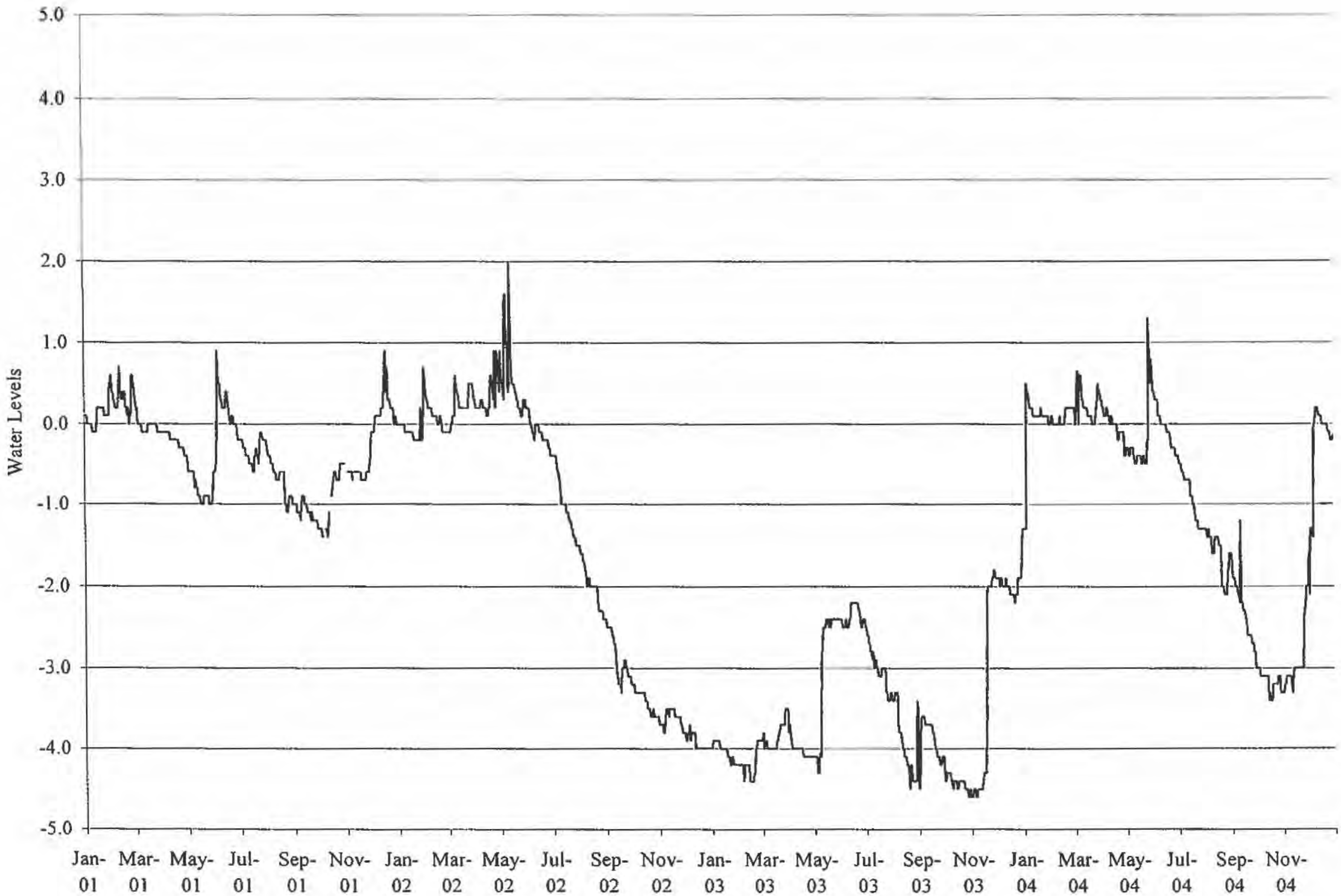


Figure 11. Water levels (feet) in relation to pool level in Coffeen Lake during 2001-2004.

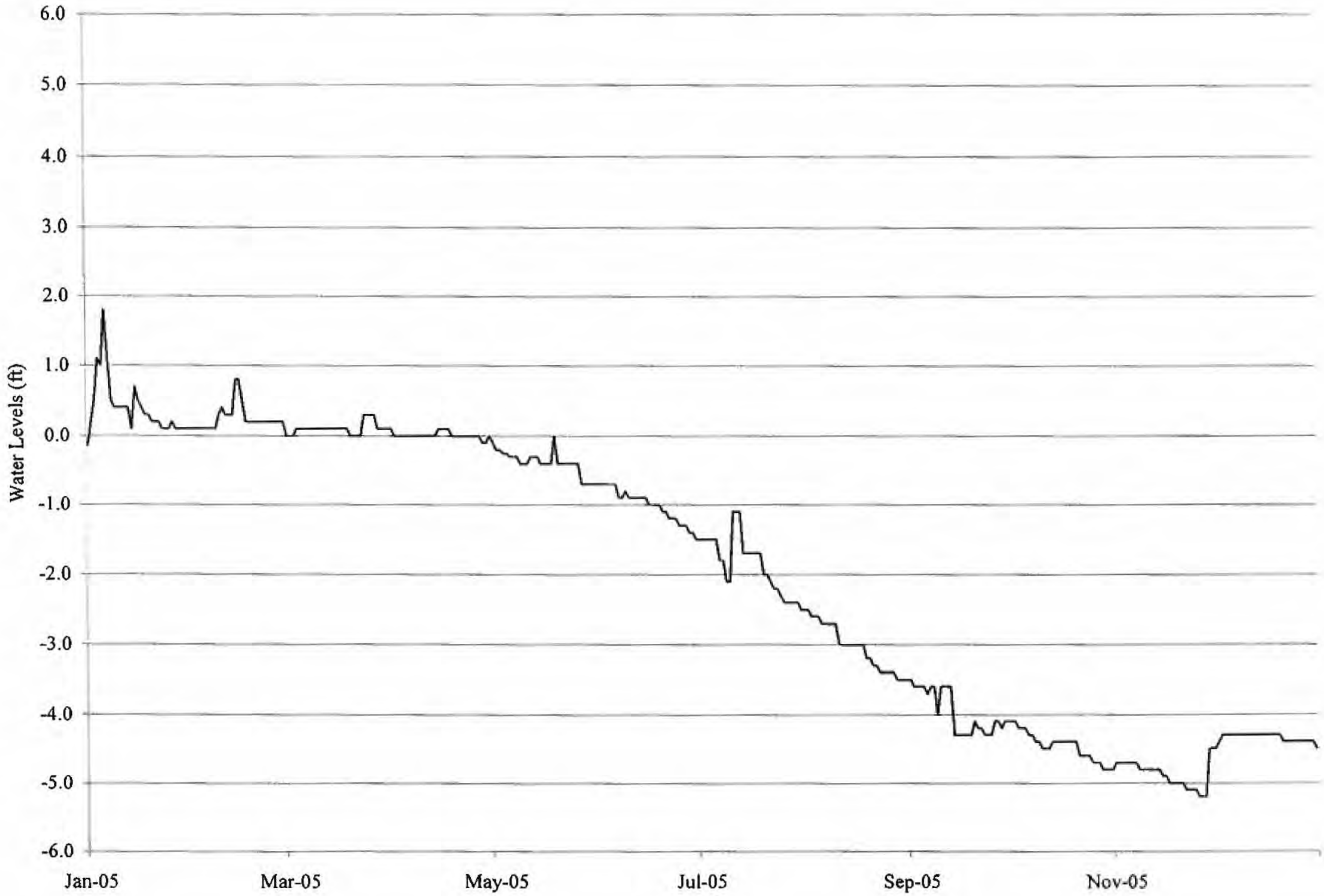


Figure 12. Water levels (feet) in relation to pool level in Coffeen Lake during 2005.

Appendix A. Depth, Temperature, Oxygen Profile

Materials and Methods:

Methods used in 2005 to determine temperature and temperature, oxygen and depth profiles were the same as methods used during previous years of this study (1997-2004). The timeline was slightly different among the years due to the grant confirmations in each year. Temperature and oxygen were sampled in weekly during 2005 beginning in June Newton and Coffeen lakes, and sampling continued through September 2005. In order to compare the eight years of data, temperature, oxygen, and depth profiles were taken in the same four stations Newton Lake (Figure F1) and Coffeen Lake (Figures F2) during 2005 as in the previous years.. Two probes from YSI Model 550A temperature/oxygen meters were used in tandem for sampling. Measurements were taken at 0.5-m intervals from the surface to the bottom; therefore, the final reading taken each sample date is within 0.5 – m of the bottom of the lake. Measurements were taken at the midpoint of each of four segments of each lake. Oxygen membranes were changed frequently. Graphs depicting the temperature and depth profiles taken are given in this appendix.

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

In Coffeen Lake, temperature loggers were set at the same depth intervals as described for Newton Lake in four stations located at on either Ameren' biostations or buoys. The loggers were set at biostations at the mixing zone, near the dam, and near the intake (Figure F2). Additional loggers were set outside of the immediate cooling loop on a buoy provided by IDNR near the railroad bridge.

In both lakes, mean daily temperature and maximum daily temperature was determined from the hourly readings. Monthly mean temperature was determined by averaging the mean daily temperatures each month. Table A-1 gives mean monthly temperatures recorded by Ameren's recorders located at the biostations in the mixing zones of Newton Lake during 1997 through 2005. Similar data is given for Coffeen Lake mixing zone temperatures in Table A-2.

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

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

Table A-1. Mean monthly water surface temperatures at the outer edge of the Newton Lake mixing zone. Mean temperatures were calculated from hourly temperature data provided by Ameren.

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

Table A-1. Continued.

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

Table A-1. Continued.

Year	Month	Number of days	Surface temperature monthly average
2003	January	31	68.9
2003	February	28	68.8
2003	March	31	76.3
2003	April	30	75.3
2003	May	31	84.6
2003	June	30	90.8
2003	July	31	96.9
2003	August	31	98.3
2003	September	24	92.7
2003	October	23	84.8
2003	November	30	77.8
2003	December	31	69.3
2004	January	31	68.0
2004	February	28	72.6
2004	March	31	--[a]
2004	April	30	81.5
2004	May	31	93.2
2004	June	30	96.7
2004	July	31	96.8
2004	August	31	95.3
2004	September	24	93.3
2004	October	23	84.2
2004	November	30	75.3
2004	December	31	67.2
2005	January	31	66.9
2005	February	28	73.2
2005	March	31	74.2
2005	April	30	82.5
2005	May	31	91.4
2005	June	30	99.0
2005	July	31	99.3
2005	August	31	99.3
2005	September	30	97.7
2005	October	31	86.9
2005	November	30	77.6
2005	December	31	70.9

[a]/ No data available.

Table A-2. Mean monthly water surface temperatures at the outer edge of the Coffeen Lake mixing zone. Mean temperatures were calculated from hourly temperature data provided by Ameren.

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

Table A-2. Continued.

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

Table A-2. Continued.

Year	Month	Number of days	Surface temperature monthly average
2003	January	31	72.9
2003	February	28	74.6
2003	March	31	62.4
2003	April	30	84.0
2003	May	31	86.3
2003	June	30	96.7
2003	July	31	--[a]
2003	August	31	102.2
2003	September	24	97.2
2003	October	23	81.8
2003	November	30	78.2
2003	December	31	72.5
2004	January	31	75.0
2004	February	28	75.3
2004	March	31	72.1
2004	April	30	81.5
2004	May	31	88.4
2004	June	30	100.8
2004	July	31	--[a]
2004	August	31	--[a]
2004	September	24	102.9
2004	October	23	85.3
2004	November	30	--[a]
2004	December	31	--[a]
2005	January	31	63.1
2005	February	28	48.4
2005	March	31	57.9
2005	April	30	74.2
2005	May	31	83.7
2005	June	30	99.9
2005	July	31	104.2
2005	August	31	102.6
2005	September	30	100.5
2005	October	31	84.2
2005	November	30	77.8
2005	December	31	71.6

[a]/ No data available.

Table A-3. Estimated percent habitat available in Newton Lake at 1100 hours on 2 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	11	8	18	19	14
4	88	11	10	18	19	15
4	89	17	14	18	19	17
4	90	25	14	18	19	19
4	91	25	14	18	19	19
4	92	25	14	18	19	19
4	93	25	14	18	19	19
4	94	25	14	18	19	19
4	95	25	14	18	19	19
4	96	25	14	18	19	19
4	97	25	14	18	19	19
3	87	11	10	18	22	15
3	88	11	11	18	22	16
3	89	17	16	18	22	18
3	90	25	16	18	22	20
3	91	25	16	18	22	20
3	92	25	16	18	22	20
3	93	25	16	18	22	20
3	94	25	16	18	22	20
3	95	25	16	18	22	20
3	96	25	16	18	22	20
3	97	25	16	18	22	20
2	87	15	10	19	24	17
2	88	15	11	19	24	17
2	89	21	16	19	24	20
2	90	29	16	19	24	22
2	91	29	16	19	24	22
2	92	29	16	19	24	22
2	93	29	16	19	24	22
2	94	29	16	19	24	22
2	95	29	16	19	24	22
2	96	29	16	19	24	22
2	97	29	16	19	24	22
1	87	15	11	19	27	18
1	88	15	13	19	27	19
1	89	21	18	19	27	21
1	90	29	18	19	27	23
1	91	29	18	19	27	23
1	92	29	18	19	27	23
1	93	29	18	19	27	23
1	94	29	18	19	27	23
1	95	29	18	19	27	23
1	96	29	18	19	27	23
1	97	29	18	19	27	23

Table A-4. Estimated percent habitat available in Newton Lake at 1000 hours on 7 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	4	9	30	11
4	88	0	4	9	30	11
4	89	0	4	14	30	12
4	90	0	4	15	30	12
4	91	0	4	15	30	12
4	92	0	4	15	30	12
4	93	0	6	15	30	13
4	94	0	6	15	30	13
4	95	4	9	15	30	15
4	96	11	13	15	30	17
4	97	21	13	15	30	20
3	87	0	4	11	30	11
3	88	0	4	11	30	11
3	89	0	4	16	30	13
3	90	0	4	17	30	13
3	91	0	4	17	30	13
3	92	0	4	17	30	13
3	93	0	6	17	30	13
3	94	0	6	17	30	13
3	95	4	9	17	30	15
3	96	11	13	17	30	18
3	97	21	13	17	30	20
2	87	8	8	11	30	14
2	88	8	8	11	30	14
2	89	8	8	16	30	16
2	90	8	8	17	30	16
2	91	8	8	17	30	16
2	92	8	8	17	30	16
2	93	8	10	17	30	16
2	94	8	10	17	30	16
2	95	11	13	17	30	18
2	96	19	17	17	30	21
2	97	29	17	17	30	23
1	87	8	8	13	30	15
1	88	8	8	13	30	15
1	89	8	8	18	30	16
1	90	8	8	19	30	16
1	91	8	8	19	30	16
1	92	8	8	19	30	16
1	93	8	10	19	30	17
1	94	8	10	19	30	17
1	95	11	13	19	30	18
1	96	19	17	19	30	21
1	97	29	17	19	30	24

Table A-5. Estimated percent habitat available in Newton Lake at 1200 hours on 14 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	13	30	11
4	88	0	0	13	30	11
4	89	0	0	13	30	11
4	90	0	0	13	30	11
4	91	0	2	13	30	11
4	92	0	2	13	30	11
4	93	0	4	13	30	12
4	94	0	4	13	30	12
4	95	4	13	13	30	15
4	96	4	13	13	30	15
4	97	25	13	13	30	20
3	87	0	0	14	30	11
3	88	0	0	14	30	11
3	89	0	0	14	30	11
3	90	0	0	14	30	11
3	91	0	2	14	30	12
3	92	0	2	14	30	12
3	93	4	4	14	30	13
3	94	4	4	14	30	13
3	95	8	13	14	30	16
3	96	8	13	14	30	16
3	97	29	13	14	30	22
2	87	0	2	14	30	12
2	88	0	2	14	30	12
2	89	0	2	14	30	12
2	90	0	2	14	30	12
2	91	0	4	14	30	12
2	92	0	4	14	30	12
2	93	4	6	14	30	14
2	94	4	6	14	30	14
2	95	8	15	14	30	17
2	96	8	15	14	30	17
2	97	29	15	14	30	22
1	87	0	6	16	30	13
1	88	0	6	16	30	13
1	89	0	6	16	30	13
1	90	0	6	16	30	13
1	91	0	8	16	30	14
1	92	0	8	16	30	14
1	93	4	10	16	30	15
1	94	4	10	16	30	15
1	95	8	19	16	30	18
1	96	8	19	16	30	18
1	97	29	19	16	30	24

Table A-6. Estimated percent habitat available in Newton Lake at 1100 hours on 21 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	2	7	27	9
4	88	0	2	13	27	11
4	89	0	4	17	27	12
4	90	0	4	17	27	12
4	91	0	4	17	27	12
4	92	0	6	17	27	13
4	93	8	8	17	27	15
4	94	17	10	17	27	18
4	95	21	13	17	27	20
4	96	21	13	17	27	20
4	97	21	13	17	27	20
3	87	0	4	9	27	10
3	88	0	4	14	27	11
3	89	0	6	19	27	13
3	90	0	6	19	27	13
3	91	0	6	19	27	13
3	92	0	8	19	27	14
3	93	8	10	19	27	16
3	94	17	12	19	27	19
3	95	21	15	19	27	21
3	96	21	15	19	27	21
3	97	21	15	19	27	21
2	87	0	4	9	27	10
2	88	0	4	14	27	11
2	89	0	6	19	27	13
2	90	0	6	19	27	13
2	91	0	6	19	27	13
2	92	0	8	19	27	14
2	93	8	10	19	27	16
2	94	17	12	19	27	19
2	95	21	15	19	27	21
2	96	21	15	19	27	21
2	97	21	15	19	27	21
1	87	0	6	11	27	11
1	88	0	6	16	27	12
1	89	4	8	21	27	15
1	90	4	8	21	27	15
1	91	4	8	21	27	15
1	92	4	10	21	27	16
1	93	11	12	21	27	18
1	94	21	14	21	27	21
1	95	25	17	21	27	23
1	96	25	17	21	27	23
1	97	25	17	21	27	23

Table A-7. Estimated percent habitat available in Newton Lake at 1000 hours on 28 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	0	0	3	1
4	91	0	0	0	9	2
4	92	0	0	9	23	8
4	93	4	0	10	23	9
4	94	4	0	10	23	9
4	95	4	2	10	23	10
4	96	4	8	10	23	11
4	97	8	12	10	23	13
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	3	1
3	90	0	0	0	6	2
3	91	0	0	0	12	3
3	92	0	0	9	26	9
3	93	4	0	10	26	10
3	94	4	0	10	26	10
3	95	4	2	10	26	11
3	96	4	8	10	26	12
3	97	8	12	10	26	14
2	87	0	0	0	0	0
2	88	0	0	2	0	1
2	89	4	0	2	3	2
2	90	4	2	2	6	4
2	91	4	2	2	12	5
2	92	4	2	10	26	11
2	93	8	2	12	26	12
2	94	8	2	12	26	12
2	95	8	4	12	26	13
2	96	8	10	12	26	14
2	97	11	14	12	26	16
1	87	0	0	2	3	1
1	88	0	0	4	3	2
1	89	4	0	4	6	4
1	90	4	2	4	9	5
1	91	4	2	4	15	6
1	92	4	2	12	29	12
1	93	8	2	14	29	13
1	94	8	2	14	29	13
1	95	8	4	14	29	14
1	96	8	10	14	29	15
1	97	11	14	14	29	17

Table A-8. Estimated percent habitat available in Newton Lake at 1100 hours on 5 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	9	29	10
4	89	0	0	18	29	12
4	90	0	0	18	29	12
4	91	0	2	18	29	12
4	92	0	2	18	29	12
4	93	0	5	18	29	13
4	94	3	13	18	29	16
4	95	19	13	18	29	20
4	96	19	13	18	29	20
4	97	19	13	18	29	20
3	87	0	0	0	0	0
3	88	0	0	9	29	10
3	89	0	0	18	29	12
3	90	0	0	18	29	12
3	91	0	5	18	29	13
3	92	0	5	18	29	13
3	93	0	7	18	29	14
3	94	3	15	18	29	16
3	95	19	15	18	29	20
3	96	19	15	18	29	20
3	97	19	15	18	29	20
2	87	0	0	0	0	0
2	88	0	0	9	29	10
2	89	0	0	18	29	12
2	90	0	0	18	29	12
2	91	0	5	18	29	13
2	92	0	5	18	29	13
2	93	0	7	18	29	14
2	94	3	15	18	29	16
2	95	19	15	18	29	20
2	96	19	15	18	29	20
2	97	19	15	18	29	20
1	87	0	2	2	0	1
1	88	0	2	10	30	11
1	89	0	2	20	30	13
1	90	0	2	20	30	13
1	91	3	7	20	30	15
1	92	3	7	20	30	15
1	93	3	9	20	30	16
1	94	7	18	20	30	19
1	95	22	18	20	30	23
1	96	22	18	20	30	23
1	97	22	18	20	30	23

Table A-9. Estimated percent habitat available in Newton Lake at 1400 hours on 12 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	18	12	8
4	88	0	0	18	12	8
4	89	0	0	18	12	8
4	90	0	0	18	12	8
4	91	0	0	18	12	8
4	92	0	4	18	12	9
4	93	0	6	18	12	9
4	94	4	6	18	12	10
4	95	4	6	18	12	10
4	96	9	6	18	12	11
4	97	9	6	18	12	11
3	87	0	0	20	22	11
3	88	0	0	20	22	11
3	89	0	0	20	22	11
3	90	0	5	20	22	12
3	91	0	7	20	22	12
3	92	0	13	20	22	14
3	93	0	15	20	22	14
3	94	11	15	20	22	17
3	95	15	15	20	22	18
3	96	20	15	20	22	19
3	97	20	15	20	22	19
2	87	0	0	22	29	13
2	88	0	0	22	29	13
2	89	0	2	22	29	13
2	90	0	9	22	29	15
2	91	0	12	22	29	16
2	92	0	18	22	29	17
2	93	0	20	22	29	18
2	94	11	20	22	29	21
2	95	15	20	22	29	22
2	96	20	20	22	29	23
2	97	20	20	22	29	23
1	87	0	2	22	30	14
1	88	0	5	22	30	14
1	89	0	7	22	30	15
1	90	0	14	22	30	17
1	91	0	16	22	30	17
1	92	0	22	22	30	19
1	93	0	25	22	30	19
1	94	11	25	22	30	22
1	95	15	25	22	30	23
1	96	20	25	22	30	24
1	97	20	25	22	30	24

Table A-10. Estimated percent habitat available in Newton Lake at 1500 hours on 19 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	2	0	1
4	88	0	0	10	17	7
4	89	0	2	13	21	9
4	90	0	2	13	25	10
4	91	0	2	15	25	11
4	92	0	4	15	30	12
4	93	0	4	17	30	13
4	94	0	7	20	30	14
4	95	0	9	20	30	15
4	96	0	11	20	30	15
4	97	4	13	20	30	17
3	87	0	0	2	0	1
3	88	0	0	10	17	7
3	89	0	2	13	21	9
3	90	0	2	13	25	10
3	91	4	2	15	25	12
3	92	4	4	15	30	13
3	93	4	4	17	30	14
3	94	4	7	20	30	15
3	95	4	9	20	30	16
3	96	4	11	20	30	16
3	97	9	13	20	30	18
2	87	0	2	2	0	1
2	88	0	2	10	17	7
2	89	0	4	13	21	10
2	90	0	4	13	25	11
2	91	4	4	15	25	12
2	92	4	7	15	30	14
2	93	4	7	17	30	15
2	94	4	9	20	30	16
2	95	4	11	20	30	16
2	96	4	13	20	30	17
2	97	9	15	20	30	19
1	87	0	4	4	0	2
1	88	0	4	11	17	8
1	89	0	7	15	21	11
1	90	0	7	15	25	12
1	91	4	7	17	25	13
1	92	4	9	17	30	15
1	93	4	9	19	30	16
1	94	4	11	22	30	17
1	95	4	13	22	30	17
1	96	4	15	22	30	18
1	97	9	17	22	30	20

Table A-11. Estimated percent habitat available in Newton Lake at 1500 hours on 26 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	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	3	8	3
4	93	0	0	30	24	14
4	94	0	0	30	24	14
4	95	0	0	30	24	14
4	96	0	0	30	24	14
4	97	0	0	30	24	14
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	3	11	4
3	93	0	0	30	26	14
3	94	0	0	30	26	14
3	95	0	0	30	26	14
3	96	0	0	30	26	14
3	97	0	0	30	26	14
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	3	1
2	92	0	0	3	14	4
2	93	0	0	30	29	15
2	94	0	0	30	29	15
2	95	0	0	30	29	15
2	96	0	0	30	29	15
2	97	0	0	30	29	15
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	0	0	0	3	1
1	92	0	0	3	14	4
1	93	0	0	30	29	15
1	94	0	0	30	29	15
1	95	0	2	30	29	15
1	96	0	2	30	29	15
1	97	0	2	30	29	15

Table A-12. Estimated percent habitat available in Newton Lake at 1600 hours on 2 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	2	11	3
4	90	0	0	4	15	5
4	91	0	0	10	19	7
4	92	0	0	10	23	8
4	93	0	2	10	29	10
4	94	0	5	10	29	11
4	95	5	7	16	29	14
4	96	5	9	16	29	15
4	97	5	15	16	29	16
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	2	11	3
3	90	0	0	4	15	5
3	91	0	0	10	19	7
3	92	0	0	10	23	8
3	93	0	2	10	29	10
3	94	0	5	10	29	11
3	95	5	7	16	29	14
3	96	5	9	16	29	15
3	97	5	15	16	29	16
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	4	11	4
2	90	0	0	6	15	5
2	91	0	0	11	19	8
2	92	0	0	11	23	9
2	93	0	2	11	29	11
2	94	0	5	11	29	11
2	95	5	7	18	29	15
2	96	5	9	18	29	15
2	97	5	15	18	29	17
1	87	0	0	0	0	0
1	88	0	0	0	2	1
1	89	0	0	4	13	4
1	90	0	0	6	17	6
1	91	0	0	11	21	8
1	92	0	2	11	25	10
1	93	0	5	11	30	12
1	94	0	7	11	30	12
1	95	5	9	18	30	16
1	96	5	12	18	30	16
1	97	5	18	18	30	18

Table A-13. Estimated percent habitat available in Newton Lake at 1300 hours on 9 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	0	2	11	3
4	91	0	0	4	19	6
4	92	0	0	10	29	10
4	93	0	0	10	29	10
4	94	0	2	15	29	12
4	95	0	7	15	29	13
4	96	0	9	15	29	13
4	97	0	9	15	29	13
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	2	1
3	90	0	0	4	13	4
3	91	0	0	6	21	7
3	92	0	0	12	30	11
3	93	0	2	12	30	11
3	94	4	5	17	30	14
3	95	4	9	17	30	15
3	96	4	12	17	30	16
3	97	4	12	17	30	16
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	4	2	2
2	90	0	0	8	13	5
2	91	0	0	10	21	8
2	92	0	0	16	30	12
2	93	0	2	16	30	12
2	94	4	5	21	30	15
2	95	4	9	21	30	16
2	96	4	12	21	30	17
2	97	4	12	21	30	17
1	87	0	0	0	0	0
1	88	0	0	0	0	0
1	89	0	0	4	2	2
1	90	0	0	8	13	5
1	91	0	2	10	21	8
1	92	0	2	16	30	12
1	93	0	5	16	30	13
1	94	4	7	21	30	16
1	95	4	12	21	30	17
1	96	4	14	21	30	17
1	97	4	14	21	30	17

Table A-14. Estimated percent habitat available in Newton Lake at 1500 hours on 16 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	15	4
4	88	0	0	4	59	16
4	89	0	0	45	59	26
4	90	0	0	45	59	26
4	91	0	9	45	59	28
4	92	0	34	45	59	35
4	93	9	34	45	59	37
4	94	17	34	45	59	39
4	95	26	34	45	59	41
4	96	35	34	45	59	43
4	97	35	34	45	59	43
3	87	0	0	0	15	4
3	88	0	0	8	59	17
3	89	0	0	49	59	27
3	90	0	4	49	59	28
3	91	0	13	49	59	30
3	92	0	38	49	59	37
3	93	9	38	49	59	39
3	94	17	38	49	59	41
3	95	26	38	49	59	43
3	96	35	38	49	59	45
3	97	35	38	49	59	45
2	87	0	0	0	15	4
2	88	0	0	8	59	17
2	89	0	0	49	59	27
2	90	0	9	49	59	29
2	91	0	17	49	59	31
2	92	0	42	49	59	38
2	93	9	42	49	59	40
2	94	17	42	49	59	42
2	95	26	42	49	59	44
2	96	35	42	49	59	46
2	97	35	42	49	59	46
1	87	0	0	4	15	5
1	88	0	0	11	59	18
1	89	0	0	52	59	28
1	90	0	9	52	59	30
1	91	0	17	52	59	32
1	92	0	42	52	59	38
1	93	9	42	52	59	41
1	94	17	42	52	59	43
1	95	26	42	52	59	45
1	96	35	42	52	59	47
1	97	35	42	52	59	47

Table A-15. Estimated percent habitat available in Newton Lake at 1300 hours on 23 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	20	5
4	88	0	0	0	29	7
4	89	0	0	2	29	8
4	90	0	0	23	29	13
4	91	0	5	23	29	14
4	92	0	9	23	29	15
4	93	0	18	23	29	18
4	94	4	18	23	29	19
4	95	9	18	23	29	20
4	96	28	18	23	29	25
4	97	28	18	23	29	25
3	87	0	0	0	22	6
3	88	0	0	0	30	8
3	89	0	0	2	30	8
3	90	0	0	23	30	13
3	91	0	5	23	30	15
3	92	0	9	23	30	16
3	93	0	18	23	30	18
3	94	4	18	23	30	19
3	95	9	18	23	30	20
3	96	28	18	23	30	25
3	97	28	18	23	30	25
2	87	0	0	0	22	6
2	88	0	0	0	30	8
2	89	0	0	2	30	8
2	90	0	5	23	30	15
2	91	0	9	23	30	16
2	92	0	14	23	30	17
2	93	0	22	23	30	19
2	94	4	22	23	30	20
2	95	9	22	23	30	21
2	96	28	22	23	30	26
2	97	28	22	23	30	26
1	87	0	0	0	22	6
1	88	0	0	2	30	8
1	89	0	0	4	30	9
1	90	0	5	25	30	15
1	91	0	9	25	30	16
1	92	0	14	25	30	17
1	93	0	22	25	30	19
1	94	4	22	25	30	20
1	95	9	22	25	30	22
1	96	28	22	25	30	26
1	97	28	22	25	30	26

Table A-16. Estimated percent habitat available in Newton Lake at 1800 hours on 31 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	14	29	11
4	88	0	0	18	29	12
4	89	0	0	27	29	14
4	90	0	0	27	29	14
4	91	0	4	27	29	15
4	92	3	6	27	29	16
4	93	3	6	27	29	16
4	94	3	13	27	29	18
4	95	3	13	27	29	18
4	96	8	13	27	29	19
4	97	13	13	27	29	21
3	87	0	0	16	30	12
3	88	0	0	20	30	13
3	89	0	2	29	30	15
3	90	0	2	29	30	15
3	91	0	6	29	30	16
3	92	3	8	29	30	18
3	93	3	8	29	30	18
3	94	3	15	29	30	19
3	95	3	15	29	30	19
3	96	8	15	29	30	21
3	97	13	15	29	30	22
2	87	0	2	16	30	12
2	88	0	2	20	30	13
2	89	0	4	29	30	16
2	90	0	4	29	30	16
2	91	0	8	29	30	17
2	92	3	10	29	30	18
2	93	3	10	29	30	18
2	94	3	17	29	30	20
2	95	3	17	29	30	20
2	96	8	17	29	30	21
2	97	13	17	29	30	22
1	87	0	2	17	30	12
1	88	0	4	21	30	14
1	89	0	6	30	30	17
1	90	0	6	30	30	17
1	91	0	10	30	30	18
1	92	3	12	30	30	19
1	93	3	12	30	30	19
1	94	3	19	30	30	21
1	95	3	19	30	30	21
1	96	8	19	30	30	22
1	97	13	19	30	30	23

Table A-17. Estimated percent habitat available in Newton Lake at 1800 hours on 8 September 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	4	7	3
4	88	0	0	8	14	6
4	89	0	0	8	29	9
4	90	0	0	11	29	10
4	91	0	0	18	29	12
4	92	0	2	18	29	12
4	93	0	2	18	29	12
4	94	0	4	18	29	13
4	95	0	4	18	29	13
4	96	0	12	18	29	15
4	97	4	12	18	29	16
3	87	0	0	6	7	3
3	88	0	0	10	14	6
3	89	0	0	10	29	10
3	90	0	0	13	29	11
3	91	4	0	20	29	13
3	92	4	2	20	29	14
3	93	4	2	20	29	14
3	94	4	4	20	29	14
3	95	4	4	20	29	14
3	96	4	12	20	29	16
3	97	9	12	20	29	18
2	87	0	4	8	8	5
2	88	0	7	11	15	8
2	89	0	7	11	30	12
2	90	0	7	15	30	13
2	91	7	7	22	30	17
2	92	7	9	22	30	17
2	93	7	9	22	30	17
2	94	7	11	22	30	18
2	95	7	11	22	30	18
2	96	7	19	22	30	20
2	97	11	19	22	30	21
1	87	0	9	11	8	7
1	88	0	11	15	15	10
1	89	0	11	15	30	14
1	90	0	11	19	30	15
1	91	7	11	26	30	19
1	92	7	13	26	30	19
1	93	7	13	26	30	19
1	94	7	15	26	30	20
1	95	7	15	26	30	20
1	96	7	23	26	30	22
1	97	11	23	26	30	23

Table A-18. Estimated percent habitat available in Newton Lake at 1000 hours on 14 September 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available: Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	24	29	13
4	88	0	0	25	29	14
4	89	0	0	25	29	14
4	90	0	0	25	29	14
4	91	0	0	25	29	14
4	92	0	5	25	29	15
4	93	0	5	25	29	15
4	94	0	7	25	29	15
4	95	28	9	25	29	23
4	96	28	15	25	29	24
4	97	28	15	25	29	24
3	87	0	0	24	29	13
3	88	0	0	25	29	14
3	89	0	0	25	29	14
3	90	0	2	25	29	14
3	91	0	2	25	29	14
3	92	0	7	25	29	15
3	93	0	7	25	29	15
3	94	0	9	25	29	16
3	95	28	12	25	29	24
3	96	28	18	25	29	25
3	97	28	18	25	29	25
2	87	0	2	28	29	15
2	88	0	2	29	29	15
2	89	0	2	29	29	15
2	90	0	5	29	29	16
2	91	0	5	29	29	16
2	92	0	9	29	29	17
2	93	0	9	29	29	17
2	94	0	12	29	29	18
2	95	30	14	29	29	26
2	96	30	20	29	29	27
2	97	30	20	29	29	27
1	87	0	13	29	30	18
1	88	0	13	30	30	18
1	89	0	13	30	30	18
1	90	0	15	30	30	19
1	91	0	15	30	30	19
1	92	0	20	30	30	20
1	93	0	20	30	30	20
1	94	0	22	30	30	21
1	95	30	25	30	30	29
1	96	30	30	30	30	30
1	97	30	30	30	30	30

Table A-19. Estimated percent habitat available in Newton Lake at 1700 hours on 21 September 2005. Habitat was considered available if it contained no less than the minimum oxygen o no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available: Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	24	28	13
4	88	0	0	24	28	13
4	89	0	0	24	28	13
4	90	0	0	24	28	13
4	91	0	0	24	28	13
4	92	0	2	24	28	14
4	93	0	3	24	28	14
4	94	3	12	24	28	17
4	95	7	12	24	28	18
4	96	17	12	24	28	20
4	97	20	12	24	28	21
3	87	0	0	24	28	13
3	88	0	0	24	28	13
3	89	0	0	24	28	13
3	90	0	2	24	28	14
3	91	0	2	24	28	14
3	92	3	4	24	28	15
3	93	3	5	24	28	15
3	94	7	14	24	28	18
3	95	10	14	24	28	19
3	96	20	14	24	28	22
3	97	24	14	24	28	23
2	87	0	0	28	28	14
2	88	0	0	28	28	14
2	89	0	0	28	28	14
2	90	0	2	28	28	15
2	91	0	2	28	28	15
2	92	3	4	28	28	16
2	93	3	5	28	28	16
2	94	7	14	28	28	19
2	95	10	14	28	28	20
2	96	20	14	28	28	23
2	97	24	14	28	28	24
1	87	0	0	30	30	15
1	88	0	0	30	30	15
1	89	0	0	30	30	15
1	90	0	2	30	30	16
1	91	0	2	30	30	16
1	92	3	4	30	30	17
1	93	3	5	30	30	17
1	94	7	14	30	30	20
1	95	10	14	30	30	21
1	96	20	14	30	30	24
1	97	24	14	30	30	25

Table A-20. Estimated percent habitat available in Newton Lake at 1100 hours on 29 September 2005. Habitat as considered available if it contained no less than the minimum oxygen o no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	18	30	30	20
4	88	7	18	30	30	21
4	89	30	18	30	30	27
4	90	30	18	30	30	27
4	91	30	18	30	30	27
4	92	30	18	30	30	27
4	93	30	18	30	30	27
4	94	30	18	30	30	27
4	95	30	18	30	30	27
4	96	30	18	30	30	27
4	97	30	18	30	30	27
3	87	0	20	30	30	20
3	88	7	20	30	30	22
3	89	30	20	30	30	28
3	90	30	20	30	30	28
3	91	30	20	30	30	28
3	92	30	20	30	30	28
3	93	30	20	30	30	28
3	94	30	20	30	30	28
3	95	30	20	30	30	28
3	96	30	20	30	30	28
3	97	30	20	30	30	28
2	87	0	20	30	30	20
2	88	7	20	30	30	22
2	89	30	20	30	30	28
2	90	30	20	30	30	28
2	91	30	20	30	30	28
2	92	30	20	30	30	28
2	93	30	20	30	30	28
2	94	30	20	30	30	28
2	95	30	20	30	30	28
2	96	30	20	30	30	28
2	97	30	20	30	30	28
1	87	0	22	30	30	21
1	88	7	22	30	30	22
1	89	30	22	30	30	28
1	90	30	22	30	30	28
1	91	30	22	30	30	28
1	92	30	22	30	30	28
1	93	30	22	30	30	28
1	94	30	22	30	30	28
1	95	30	22	30	30	28
1	96	30	22	30	30	28
1	97	30	22	30	30	28

Table A-21. Estimated percent habitat available in Coffeen Lake at 1100 hours on 3 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	8	12	21	23	16
4	88	10	12	21	23	17
4	89	12	12	21	23	17
4	90	12	12	21	23	17
4	91	12	12	21	23	17
4	92	12	12	21	23	17
4	93	12	12	21	23	17
4	94	12	12	21	23	17
4	95	12	12	21	23	17
4	96	12	12	21	23	17
4	97	12	12	21	23	17
3	87	10	13	27	23	18
3	88	11	13	27	23	19
3	89	13	13	27	23	19
3	90	13	13	27	23	19
3	91	13	13	27	23	19
3	92	13	13	27	23	19
3	93	13	13	27	23	19
3	94	13	13	27	23	19
3	95	13	13	27	23	19
3	96	13	13	27	23	19
3	97	13	13	27	23	19
2	87	11	14	29	25	20
2	88	12	14	29	25	20
2	89	15	14	29	25	21
2	90	15	14	29	25	21
2	91	15	14	29	25	21
2	92	15	14	29	25	21
2	93	15	14	29	25	21
2	94	15	14	29	25	21
2	95	15	14	29	25	21
2	96	15	14	29	25	21
2	97	15	14	29	25	21
1	87	14	18	29	27	22
1	88	15	18	29	27	22
1	89	17	18	29	27	23
1	90	17	18	29	27	23
1	91	17	18	29	27	23
1	92	17	18	29	27	23
1	93	17	18	29	27	23
1	94	17	18	29	27	23
1	95	17	18	29	27	23
1	96	17	18	29	27	23
1	97	17	18	29	27	23

Table A-22. Estimated percent habitat available in Coffeen Lake at 1200 hours on 8 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	9	7	2	8	7
4	88	9	7	6	10	8
4	89	9	7	19	18	13
4	90	9	8	19	18	14
4	91	9	9	19	18	14
4	92	9	9	19	18	14
4	93	9	14	19	18	15
4	94	9	14	19	18	15
4	95	9	14	19	18	15
4	96	9	14	19	18	15
4	97	10	14	19	18	15
3	87	9	7	4	10	8
3	88	9	7	8	11	9
3	89	9	7	21	20	14
3	90	9	8	21	20	15
3	91	9	9	21	20	15
3	92	9	9	21	20	15
3	93	9	14	21	20	16
3	94	9	14	21	20	16
3	95	9	14	21	20	16
3	96	9	14	21	20	16
3	97	10	14	21	20	16
2	87	10	8	6	10	9
2	88	10	8	10	11	10
2	89	10	8	23	20	15
2	90	10	9	23	20	16
2	91	10	11	23	20	16
2	92	10	11	23	20	16
2	93	10	15	23	20	17
2	94	10	15	23	20	17
2	95	10	15	23	20	17
2	96	10	15	23	20	17
2	97	12	15	23	20	18
1	87	10	9	8	15	11
1	88	10	9	12	17	12
1	89	10	9	25	26	18
1	90	10	11	25	26	18
1	91	10	12	25	26	18
1	92	10	12	25	26	18
1	93	10	17	25	26	20
1	94	10	17	25	26	20
1	95	10	17	25	26	20
1	96	10	17	25	26	20
1	97	12	17	25	26	20

Table A-23. Estimated percent habitat available in Coffeen Lake at 1300 hours on 16 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	2	13	29	28	18
4	88	3	15	29	30	19
4	89	5	18	29	30	21
4	90	6	18	29	30	21
4	91	6	18	29	30	21
4	92	8	18	29	30	21
4	93	11	18	29	30	22
4	94	11	18	29	30	22
4	95	11	18	29	30	22
4	96	11	18	29	30	22
4	97	11	18	29	30	22
3	87	2	13	29	28	18
3	88	3	15	29	30	19
3	89	5	18	29	30	21
3	90	6	18	29	30	21
3	91	6	18	29	30	21
3	92	8	18	29	30	21
3	93	11	18	29	30	22
3	94	11	18	29	30	22
3	95	11	18	29	30	22
3	96	11	18	29	30	22
3	97	11	18	29	30	22
2	87	6	15	30	28	20
2	88	8	16	30	30	21
2	89	9	19	30	30	22
2	90	11	19	30	30	23
2	91	11	19	30	30	23
2	92	12	19	30	30	23
2	93	16	19	30	30	24
2	94	16	19	30	30	24
2	95	16	19	30	30	24
2	96	16	19	30	30	24
2	97	16	19	30	30	24
1	87	8	16	30	28	21
1	88	9	17	30	30	22
1	89	11	21	30	30	23
1	90	12	21	30	30	23
1	91	12	21	30	30	23
1	92	14	21	30	30	24
1	93	18	21	30	30	25
1	94	18	21	30	30	25
1	95	18	21	30	30	25
1	96	18	21	30	30	25
1	97	18	21	30	30	25

Table A-24. Estimated percent habitat available in Coffeen Lake at 1500 hours on 21 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	2	4	10	9	6
4	88	4	5	10	12	8
4	89	5	5	12	14	9
4	90	5	7	16	19	12
4	91	5	7	18	19	12
4	92	6	8	23	21	15
4	93	6	9	23	21	15
4	94	6	9	23	23	15
4	95	6	12	23	27	17
4	96	6	14	23	27	18
4	97	6	14	23	27	18
3	87	4	5	14	12	9
3	88	5	7	14	14	10
3	89	6	7	16	16	11
3	90	6	8	20	21	14
3	91	6	8	22	21	14
3	92	7	9	27	23	17
3	93	7	11	27	23	17
3	94	7	11	27	26	18
3	95	7	13	27	29	19
3	96	7	15	27	29	20
3	97	7	15	27	29	20
2	87	4	7	14	12	9
2	88	5	8	14	14	10
2	89	6	8	16	16	12
2	90	6	9	20	21	14
2	91	6	9	22	21	15
2	92	7	11	27	23	17
2	93	7	12	27	23	17
2	94	7	12	27	26	18
2	95	7	15	27	29	20
2	96	7	17	27	29	20
2	97	7	17	27	29	20
1	87	5	8	14	12	10
1	88	6	9	14	14	11
1	89	7	9	16	16	12
1	90	7	11	20	21	15
1	91	7	11	22	21	15
1	92	8	12	27	23	18
1	93	8	13	27	23	18
1	94	8	13	27	26	19
1	95	8	16	27	29	20
1	96	8	18	27	29	21
1	97	8	18	27	29	21

Table A-25. Estimated percent habitat available in Coffeen Lake at 1600 hours on 28 June 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	0	2	0	1
4	91	0	0	2	0	1
4	92	0	1	2	0	1
4	93	1	3	2	0	2
4	94	4	6	4	5	5
4	95	7	7	9	12	9
4	96	9	9	15	14	12
4	97	9	10	21	22	16
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	2	0	1
3	90	0	0	4	0	1
3	91	0	0	4	0	1
3	92	1	1	4	0	2
3	93	3	3	4	0	3
3	94	6	6	7	5	6
3	95	9	7	11	12	10
3	96	10	9	17	14	13
3	97	10	10	23	22	16
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	2	0	1
2	90	0	1	4	0	1
2	91	0	1	4	2	2
2	92	3	3	4	2	3
2	93	4	4	4	2	4
2	94	7	7	7	7	7
2	95	10	9	11	14	11
2	96	12	10	17	16	14
2	97	12	12	23	25	18
1	87	0	0	0	0	0
1	88	0	1	0	0	0
1	89	0	1	2	0	1
1	90	0	3	4	0	2
1	91	0	3	4	2	2
1	92	3	4	4	2	3
1	93	4	6	4	2	4
1	94	7	9	7	7	8
1	95	10	10	11	14	11
1	96	12	12	17	16	14
1	97	12	13	23	25	18

Table A-26. Estimated percent habitat available in Coffeen Lake at 1600 hours on 7 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	1	7	0	2
4	91	0	6	19	7	8
4	92	0	7	23	14	11
4	93	0	9	29	21	15
4	94	0	10	29	27	17
4	95	0	17	29	27	18
4	96	2	17	29	27	19
4	97	2	17	29	27	19
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	0	0
3	90	0	4	7	2	3
3	91	0	9	19	9	9
3	92	0	10	23	16	12
3	93	0	12	29	23	16
3	94	2	13	29	29	18
3	95	2	20	29	29	20
3	96	3	20	29	29	20
3	97	3	20	29	29	20
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	1	0	0	0
2	90	0	6	7	2	4
2	91	0	10	19	9	10
2	92	0	12	23	16	13
2	93	2	13	29	23	17
2	94	3	15	29	29	19
2	95	3	21	29	29	21
2	96	5	21	29	29	21
2	97	5	21	29	29	21
1	87	0	0	0	0	0
1	88	0	0	0	0	0
1	89	0	1	0	0	0
1	90	3	6	7	2	5
1	91	5	10	19	9	11
1	92	5	12	23	16	14
1	93	6	13	29	23	18
1	94	8	15	29	29	20
1	95	8	21	29	29	22
1	96	10	21	29	29	22
1	97	10	21	29	29	22

Table A-27. Estimated percent habitat available in Coffeen Lake at 1400 hours on 13 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	17	0	4
4	89	0	0	17	15	8
4	90	0	0	17	15	8
4	91	0	0	17	15	8
4	92	0	0	17	15	8
4	93	0	0	17	15	8
4	94	0	0	17	15	8
4	95	0	0	17	15	8
4	96	2	0	17	15	9
4	97	9	0	17	15	10
3	87	0	0	2	0	1
3	88	0	0	27	9	9
3	89	0	3	27	26	14
3	90	0	4	27	26	14
3	91	0	15	27	26	17
3	92	0	15	27	26	17
3	93	0	15	27	26	17
3	94	0	15	27	26	17
3	95	2	15	27	26	18
3	96	4	15	27	26	18
3	97	10	15	27	26	20
2	87	0	0	2	0	1
2	88	0	1	27	13	10
2	89	0	6	27	30	16
2	90	0	9	27	30	17
2	91	0	21	27	30	20
2	92	0	21	27	30	20
2	93	0	21	27	30	20
2	94	0	21	27	30	20
2	95	2	21	27	30	20
2	96	4	21	27	30	21
2	97	10	21	27	30	22
1	87	0	3	4	0	2
1	88	0	4	29	13	12
1	89	0	9	29	30	17
1	90	0	12	29	30	18
1	91	0	24	29	30	21
1	92	2	24	29	30	21
1	93	3	24	29	30	22
1	94	3	24	29	30	22
1	95	5	24	29	30	22
1	96	7	24	29	30	23
1	97	14	24	29	30	24

Table A-28. Estimated percent habitat available in Coffeen Lake at 1200 hours on 20 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	1	2	0	1
4	91	0	1	2	0	1
4	92	5	4	2	5	4
4	93	5	4	4	12	6
4	94	6	6	13	16	10
4	95	6	7	17	19	12
4	96	6	9	25	25	16
4	97	6	9	25	25	16
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	0	0
3	90	2	3	2	0	2
3	91	3	3	2	0	2
3	92	8	6	2	5	5
3	93	8	6	4	12	8
3	94	9	7	13	16	11
3	95	9	9	17	19	14
3	96	9	10	25	25	17
3	97	9	10	25	25	17
2	87	0	0	0	0	0
2	88	0	0	2	0	1
2	89	0	1	4	0	1
2	90	3	4	7	2	4
2	91	5	4	7	2	5
2	92	9	7	7	7	8
2	93	9	7	9	14	10
2	94	11	9	17	19	14
2	95	11	10	22	21	16
2	96	11	12	29	27	20
2	97	11	12	29	27	20
1	87	0	0	1	0	0
1	88	0	0	3	0	1
1	89	0	3	5	0	2
1	90	3	6	8	2	5
1	91	5	6	8	2	5
1	92	9	9	8	7	8
1	93	9	9	10	14	11
1	94	11	10	19	19	15
1	95	11	12	23	21	17
1	96	11	13	30	27	20
1	97	11	13	30	27	20

Table A-29. Estimated percent habitat available in Coffeen Lake at 1200 hours on 27 July 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	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	7	2
4	93	0	1	23	29	13
4	94	0	10	23	29	16
4	95	2	15	23	29	17
4	96	5	20	23	29	19
4	97	6	20	23	29	20
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	2	7	2
3	93	0	1	25	29	14
3	94	0	10	25	29	16
3	95	3	15	25	29	18
3	96	6	20	25	29	20
3	97	8	20	25	29	21
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	2	7	2
2	93	0	1	25	29	14
2	94	0	10	25	29	16
2	95	6	15	25	29	19
2	96	10	20	25	29	21
2	97	11	20	25	29	21
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	0	1	2	0	1
1	92	0	1	7	7	4
1	93	0	3	29	29	15
1	94	0	12	29	29	18
1	95	6	17	29	29	20
1	96	10	21	29	29	22
1	97	11	21	29	29	23

Table A-30. Estimated percent habitat available in Coffeen Lake at 1300 hours on 2 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available: Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	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	0	0
4	93	0	0	0	2	1
4	94	0	1	2	4	2
4	95	2	4	7	13	7
4	96	2	6	23	15	12
4	97	3	13	23	23	16
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	4	0	1
3	91	0	0	4	0	1
3	92	0	0	4	0	1
3	93	0	0	7	2	2
3	94	3	1	9	4	4
3	95	5	4	13	13	9
3	96	5	6	29	15	14
3	97	6	13	29	23	18
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	4	0	1
2	91	0	0	4	0	1
2	92	0	0	4	0	1
2	93	0	3	7	2	3
2	94	5	4	9	4	6
2	95	6	7	13	13	10
2	96	6	8	29	15	15
2	97	8	16	29	23	19
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	4	0	1
1	91	0	0	4	0	1
1	92	0	0	4	2	2
1	93	2	3	7	4	4
1	94	6	4	9	7	7
1	95	8	7	13	15	11
1	96	8	8	29	17	16
1	97	9	16	29	25	20

Table A-31. Estimated percent habitat available in Coffeen Lake at 1600 hours on 9 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	2	0	1
4	90	0	0	2	0	1
4	91	0	0	4	0	1
4	92	0	3	7	2	3
4	93	2	4	9	9	6
4	94	3	6	11	16	9
4	95	3	9	15	19	12
4	96	3	9	29	27	17
4	97	5	10	29	27	18
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	2	0	1
3	90	0	0	2	0	1
3	91	0	0	4	0	1
3	92	0	4	7	2	3
3	93	5	6	9	9	7
3	94	6	7	11	16	10
3	95	6	10	15	19	13
3	96	6	10	29	27	18
3	97	8	12	29	27	19
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	2	0	1
2	90	0	0	2	0	1
2	91	0	0	4	2	2
2	92	2	4	7	5	5
2	93	6	6	9	12	8
2	94	8	7	11	19	11
2	95	8	10	15	21	14
2	96	8	10	29	29	19
2	97	10	12	29	29	20
1	87	0	0	0	0	0
1	88	0	1	1	0	1
1	89	0	3	3	0	2
1	90	0	3	3	0	2
1	91	0	4	5	2	3
1	92	5	9	8	5	7
1	93	10	10	10	12	11
1	94	11	12	12	19	14
1	95	11	15	16	21	16
1	96	11	15	30	29	21
1	97	13	16	30	29	22

Table A-32. Estimated percent habitat available in Coffeen Lake at 1200 hours on 18 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	2	2	2	2
4	90	0	8	8	13	7
4	91	0	9	29	29	17
4	92	0	12	29	29	18
4	93	0	19	29	29	19
4	94	0	19	29	29	19
4	95	0	19	29	29	19
4	96	0	19	29	29	19
4	97	2	19	29	29	20
3	87	0	0	0	0	0
3	88	0	2	0	0	1
3	89	0	5	2	2	2
3	90	0	11	8	13	8
3	91	0	12	29	29	18
3	92	0	15	29	29	18
3	93	0	22	29	29	20
3	94	0	22	29	29	20
3	95	0	22	29	29	20
3	96	0	22	29	29	20
3	97	2	22	29	29	21
2	87	0	2	0	0	1
2	88	0	3	0	0	1
2	89	0	6	2	2	3
2	90	5	12	8	13	10
2	91	6	14	29	29	20
2	92	8	17	29	29	21
2	93	8	24	29	29	23
2	94	8	24	29	29	23
2	95	8	24	29	29	23
2	96	8	24	29	29	23
2	97	10	24	29	29	23
1	87	0	3	0	0	1
1	88	0	5	0	0	1
1	89	0	8	2	2	3
1	90	8	14	8	13	11
1	91	10	15	29	29	21
1	92	11	18	29	29	22
1	93	11	25	29	29	24
1	94	11	25	29	29	24
1	95	11	25	29	29	24
1	96	11	25	29	29	24
1	97	13	25	29	29	24

Table A-33. Estimated percent habitat available in Coffeen Lake at 1700 hours on 23 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	1	0	0
4	89	0	0	1	0	0
4	90	0	2	1	1	1
4	91	0	5	8	4	4
4	92	0	8	30	30	17
4	93	2	8	30	30	18
4	94	2	14	30	30	19
4	95	3	18	30	30	20
4	96	3	18	30	30	20
4	97	5	18	30	30	21
3	87	0	0	0	0	0
3	88	0	0	1	0	0
3	89	0	0	1	0	0
3	90	0	3	1	1	1
3	91	0	6	8	4	5
3	92	2	9	30	30	18
3	93	3	9	30	30	18
3	94	3	16	30	30	20
3	95	5	19	30	30	21
3	96	5	19	30	30	21
3	97	7	19	30	30	22
2	87	0	0	0	0	0
2	88	0	0	1	0	0
2	89	0	0	1	0	0
2	90	0	5	1	1	2
2	91	0	8	8	4	5
2	92	3	11	30	30	19
2	93	5	11	30	30	19
2	94	5	18	30	30	21
2	95	7	21	30	30	22
2	96	7	21	30	30	22
2	97	8	21	30	30	22
1	87	0	0	0	0	0
1	88	0	0	1	0	0
1	89	0	2	1	0	1
1	90	0	6	1	1	2
1	91	2	9	8	4	6
1	92	5	12	30	30	19
1	93	7	12	30	30	20
1	94	7	19	30	30	22
1	95	8	22	30	30	23
1	96	8	22	30	30	23
1	97	10	22	30	30	23

Table A-34. Estimated percent habitat available in Coffeen Lake at 1400 hours on 31 August 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	9	29	19	14
4	88	2	15	29	22	17
4	89	5	18	29	30	21
4	90	5	23	29	30	22
4	91	5	23	29	30	22
4	92	5	23	29	30	22
4	93	5	23	29	30	22
4	94	5	23	29	30	22
4	95	5	23	29	30	22
4	96	9	23	29	30	23
4	97	15	23	29	30	24
3	87	0	9	30	19	15
3	88	4	15	30	22	18
3	89	7	18	30	30	21
3	90	7	23	30	30	23
3	91	7	23	30	30	23
3	92	7	23	30	30	23
3	93	7	23	30	30	23
3	94	7	23	30	30	23
3	95	7	23	30	30	23
3	96	11	23	30	30	24
3	97	17	23	30	30	25
2	87	0	11	30	19	15
2	88	5	17	30	22	19
2	89	9	20	30	30	22
2	90	9	24	30	30	23
2	91	9	24	30	30	23
2	92	9	24	30	30	23
2	93	9	24	30	30	23
2	94	9	24	30	30	23
2	95	9	24	30	30	23
2	96	13	24	30	30	24
2	97	19	24	30	30	26
1	87	0	12	30	19	15
1	88	5	18	30	22	19
1	89	9	21	30	30	23
1	90	9	26	30	30	24
1	91	9	26	30	30	24
1	92	9	26	30	30	24
1	93	9	26	30	30	24
1	94	9	26	30	30	24
1	95	9	26	30	30	24
1	96	13	26	30	30	25
1	97	19	26	30	30	26

Table A-35. Estimated percent habitat available in Coffeen Lake at 1400 hours on 8 September 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	2	7	3	3
4	88	5	5	12	10	8
4	89	6	6	12	15	10
4	90	8	8	19	20	14
4	91	8	9	26	23	17
4	92	9	12	29	27	19
4	93	9	14	29	29	20
4	94	9	18	29	29	21
4	95	11	18	29	29	22
4	96	11	18	29	29	22
4	97	11	18	29	29	22
3	87	0	3	7	3	3
3	88	5	6	12	10	8
3	89	6	8	12	15	10
3	90	8	9	19	20	14
3	91	8	11	26	23	17
3	92	9	14	29	27	20
3	93	9	16	29	29	21
3	94	9	19	29	29	22
3	95	11	19	29	29	22
3	96	11	19	29	29	22
3	97	11	19	29	29	22
2	87	2	8	7	4	5
2	88	6	11	12	11	10
2	89	8	12	12	17	12
2	90	9	14	19	22	16
2	91	9	15	26	24	19
2	92	11	18	29	28	22
2	93	11	21	29	30	23
2	94	11	24	29	30	24
2	95	12	24	29	30	24
2	96	12	24	29	30	24
2	97	12	24	29	30	24
1	87	3	9	8	4	6
1	88	8	12	13	11	11
1	89	9	14	13	17	13
1	90	11	15	20	22	17
1	91	11	17	27	24	20
1	92	12	20	30	28	23
1	93	12	22	30	30	24
1	94	12	25	30	30	24
1	95	14	25	30	30	25
1	96	14	25	30	30	25
1	97	14	25	30	30	25

Table A-36. Estimated percent habitat available in Coffeen Lake at 1400 hours on 14 September 2005. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	1	0	2	0	1
4	88	1	2	8	9	5
4	89	1	5	27	13	12
4	90	1	10	27	27	16
4	91	3	12	27	27	17
4	92	4	20	27	27	20
4	93	6	20	27	27	20
4	94	8	20	27	27	21
4	95	8	20	27	27	21
4	96	8	20	27	27	21
4	97	11	20	27	27	21
3	87	1	0	2	0	1
3	88	1	3	8	9	5
3	89	3	6	27	13	12
3	90	4	11	27	27	17
3	91	6	14	27	27	19
3	92	8	22	27	27	21
3	93	9	22	27	27	21
3	94	11	22	27	27	22
3	95	11	22	27	27	22
3	96	11	22	27	27	22
3	97	14	22	27	27	23
2	87	3	7	4	2	4
2	88	3	10	10	11	9
2	89	8	14	29	15	17
2	90	9	18	29	29	21
2	91	11	21	29	29	23
2	92	13	29	29	29	25
2	93	14	29	29	29	25
2	94	16	29	29	29	26
2	95	16	29	29	29	26
2	96	16	29	29	29	26
2	97	19	29	29	29	27
1	87	8	9	5	3	6
1	88	11	12	11	12	12
1	89	16	15	30	16	19
1	90	18	20	30	30	25
1	91	19	22	30	30	25
1	92	21	30	30	30	28
1	93	23	30	30	30	28
1	94	25	30	30	30	29
1	95	25	30	30	30	29
1	96	25	30	30	30	29
1	97	28	30	30	30	30

Table A-37. Estimated percent habitat available in Coffeen Lake at 1700 hours on 21 September 2005. Habitat was considered available if it contained no less than the minimum oxygen o no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	14	8	13	9
4	88	0	14	16	19	12
4	89	0	17	30	27	19
4	90	0	20	30	27	19
4	91	0	22	30	27	20
4	92	0	22	30	27	20
4	93	0	22	30	27	20
4	94	2	22	30	27	20
4	95	2	22	30	27	20
4	96	2	22	30	27	20
4	97	3	22	30	27	21
3	87	0	17	8	15	10
3	88	2	17	16	21	14
3	89	2	20	30	29	20
3	90	2	23	30	29	21
3	91	2	25	30	29	22
3	92	2	25	30	29	22
3	93	2	25	30	29	22
3	94	3	25	30	29	22
3	95	3	25	30	29	22
3	96	3	25	30	29	22
3	97	5	25	30	29	22
2	87	5	17	8	15	11
2	88	6	17	16	21	15
2	89	6	20	30	29	21
2	90	6	23	30	29	22
2	91	6	25	30	29	23
2	92	6	25	30	29	23
2	93	6	25	30	29	23
2	94	8	25	30	29	23
2	95	8	25	30	29	23
2	96	8	25	30	29	23
2	97	10	25	30	29	24
1	87	10	17	8	15	13
1	88	11	17	16	21	16
1	89	11	20	30	29	23
1	90	11	23	30	29	23
1	91	11	25	30	29	24
1	92	11	25	30	29	24
1	93	11	25	30	29	24
1	94	13	25	30	29	24
1	95	13	25	30	29	24
1	96	13	25	30	29	24
1	97	14	25	30	29	25

Table A-38. Estimated percent habitat available in Coffeen Lake at 1600 hours on 29 September 2005. Habitat as considered available if it contained no less than the minimum oxygen o no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	24	30	30	21
4	88	0	28	30	30	22
4	89	2	28	30	30	23
4	90	2	28	30	30	23
4	91	2	28	30	30	23
4	92	3	28	30	30	23
4	93	3	28	30	30	23
4	94	3	28	30	30	23
4	95	3	28	30	30	23
4	96	6	28	30	30	24
4	97	7	28	30	30	24
3	87	6	26	30	30	23
3	88	6	30	30	30	24
3	89	8	30	30	30	25
3	90	8	30	30	30	25
3	91	8	30	30	30	25
3	92	10	30	30	30	25
3	93	10	30	30	30	25
3	94	10	30	30	30	25
3	95	10	30	30	30	25
3	96	12	30	30	30	26
3	97	14	30	30	30	26
2	87	13	26	30	30	25
2	88	13	30	30	30	26
2	89	14	30	30	30	26
2	90	14	30	30	30	26
2	91	14	30	30	30	26
2	92	16	30	30	30	27
2	93	16	30	30	30	27
2	94	16	30	30	30	27
2	95	16	30	30	30	27
2	96	18	30	30	30	27
2	97	20	30	30	30	28
1	87	18	26	30	30	26
1	88	18	30	30	30	27
1	89	19	30	30	30	27
1	90	19	30	30	30	27
1	91	19	30	30	30	27
1	92	21	30	30	30	28
1	93	21	30	30	30	28
1	94	21	30	30	30	28
1	95	21	30	30	30	28
1	96	23	30	30	30	28
1	97	25	30	30	30	29

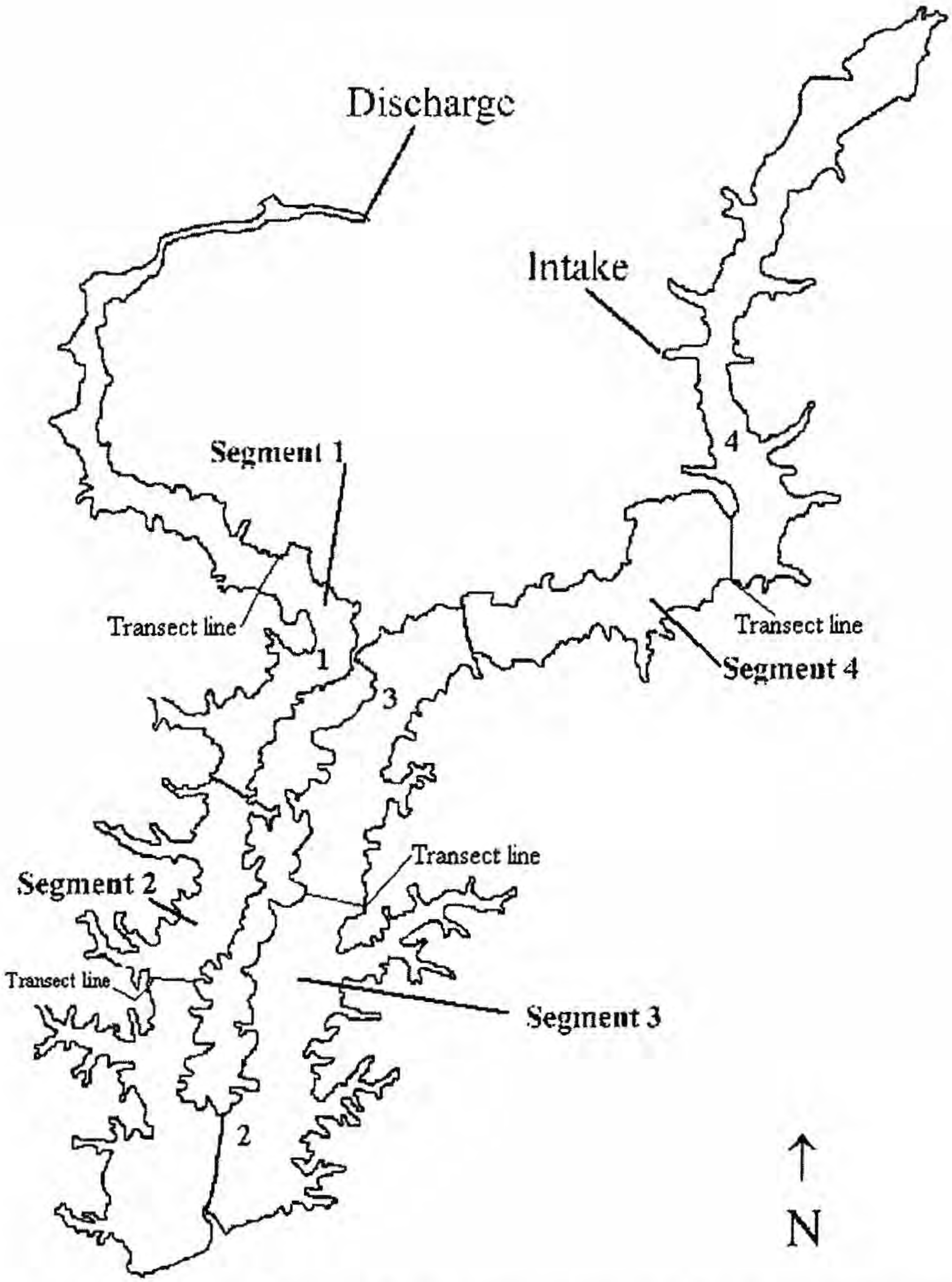


Figure A--1. Four segments in Newton Lake where water temperature and dissolved oxygen were sampled. Data were collected weekly at each transect line from June 2005 through September 2005. Numbers in lake boundaries represent locations of continuous temperature recorders set during same periods.

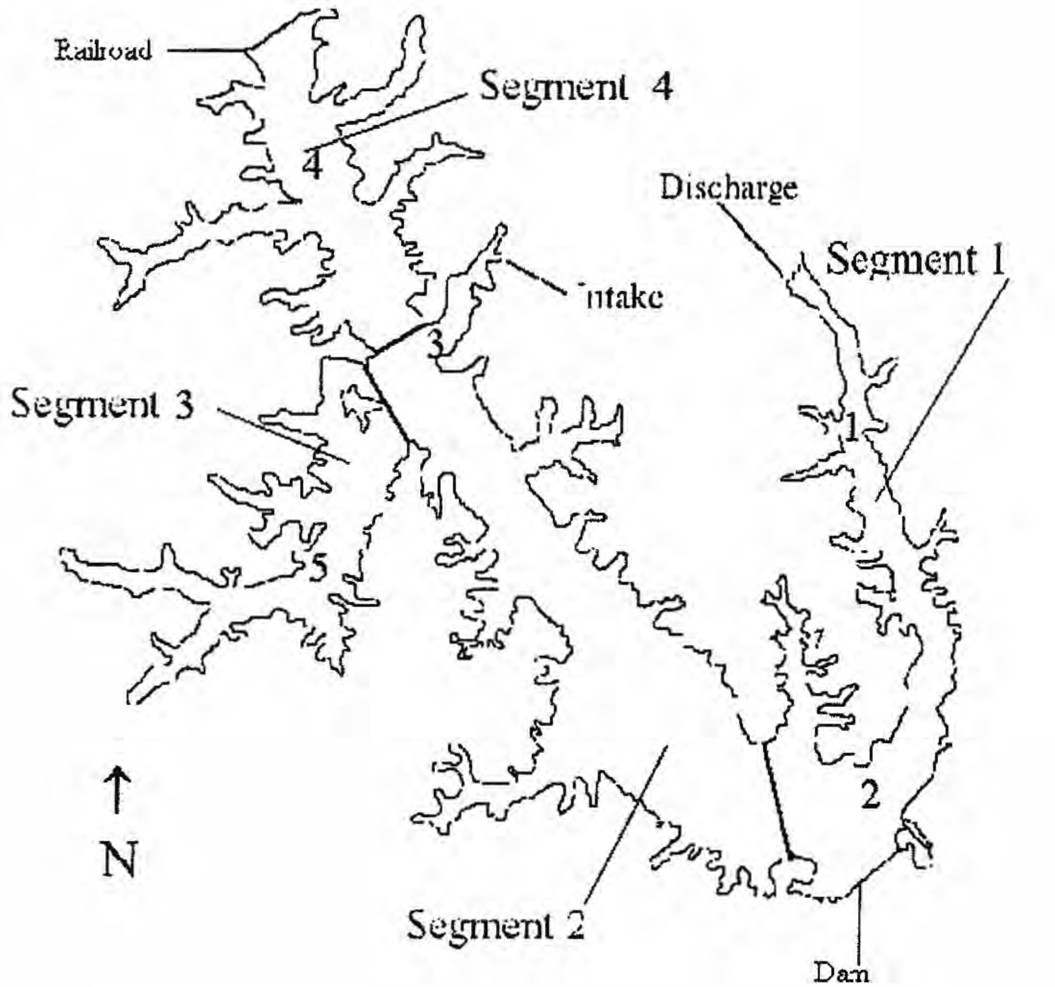


Figure A-2. Four segments in Coffeen Lake where water temperature and dissolved oxygen were sampled. Data were collected weekly at each segment number from June 2005 through September 2005. Numbers in lake boundaries represent locations of continuous temperature recorders set during same periods.

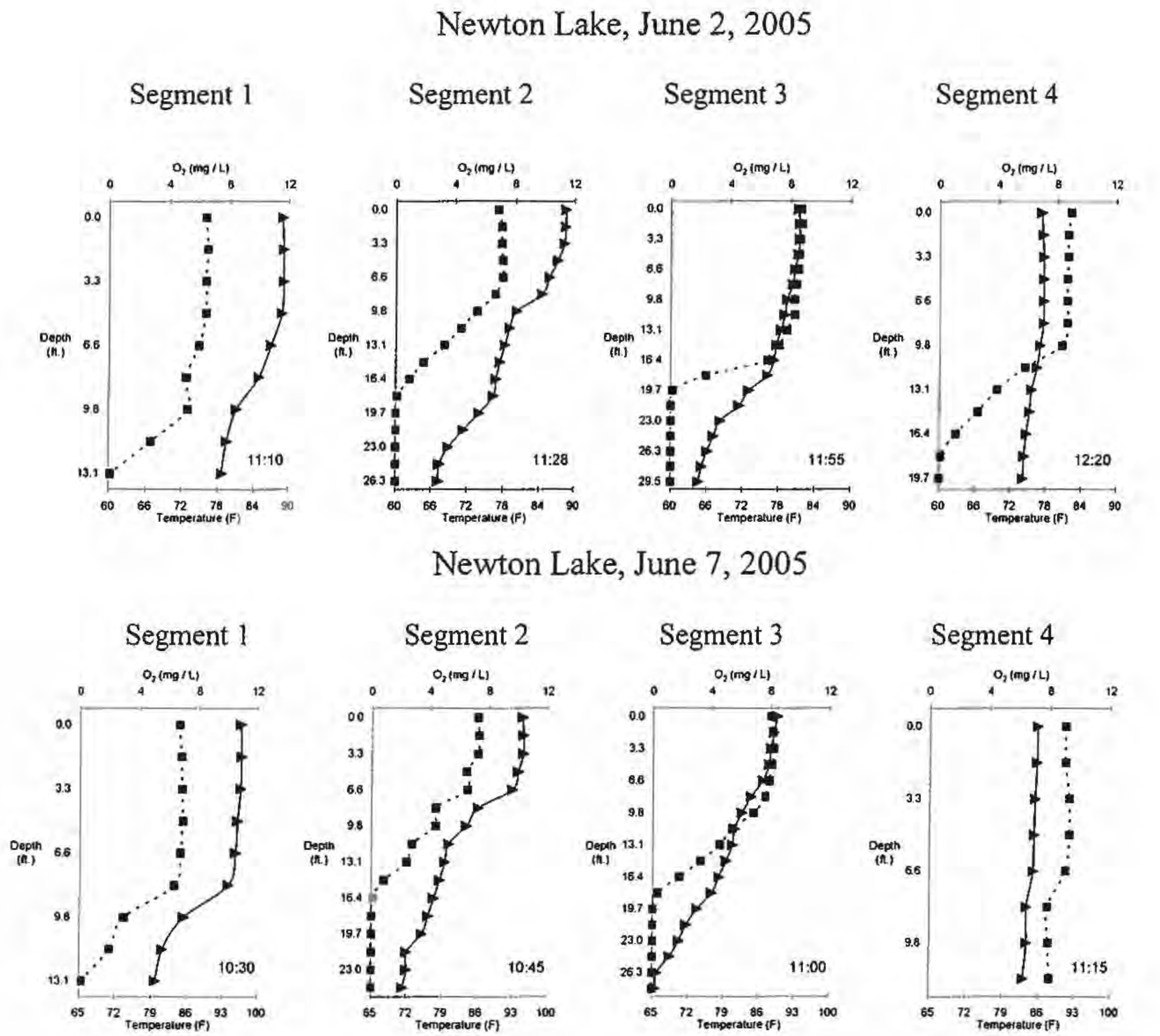
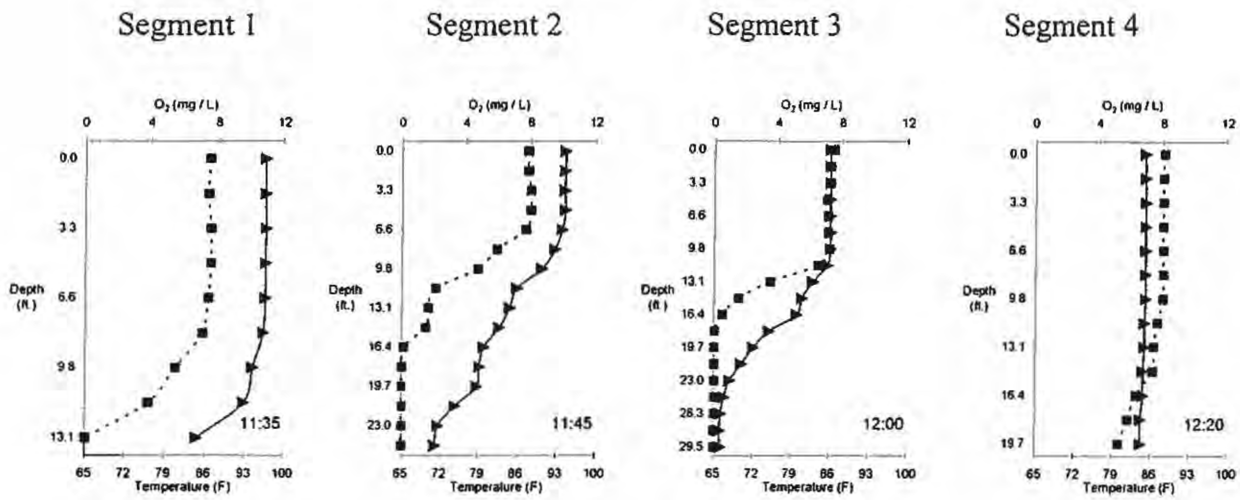


Figure A-3. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, June 14, 2005



Newton Lake, June 21, 2005

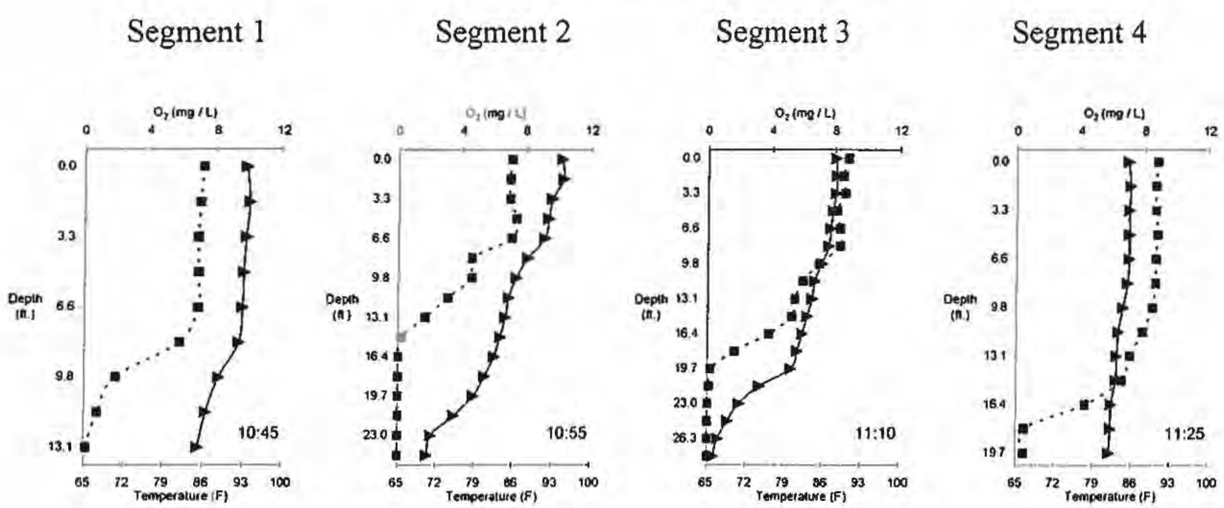
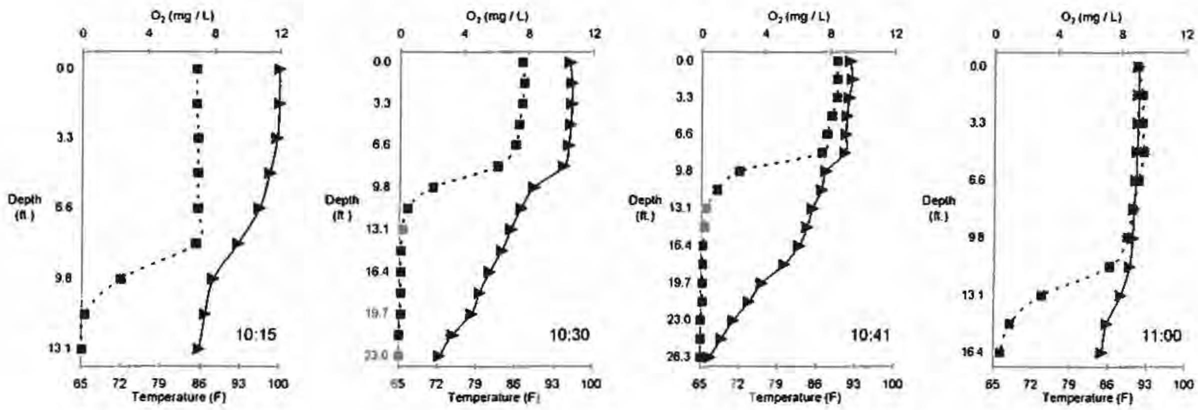


Figure A-4. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, June 28, 2005

Segment 1 | Segment 2 | Segment 3 | Segment 4



Newton Lake, July 5, 2005

Segment 1 | Segment 2 | Segment 3 | Segment 4

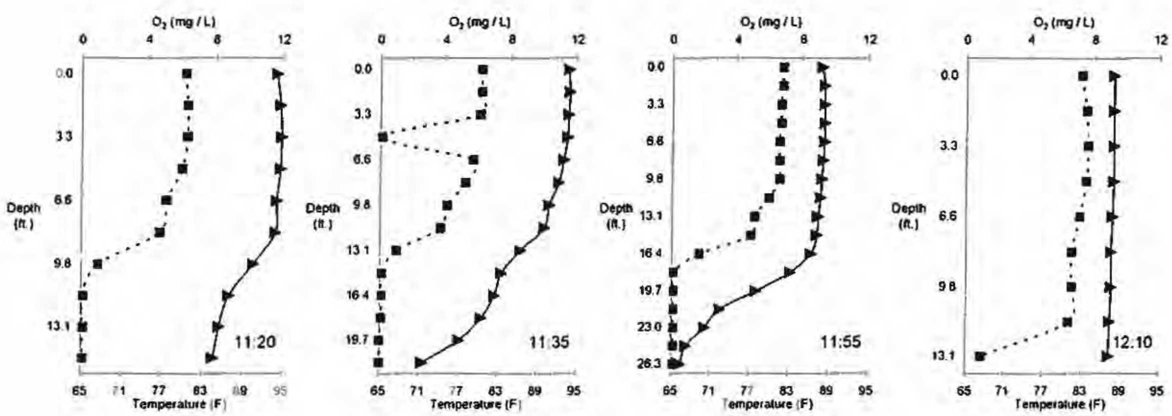


Figure A-5. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

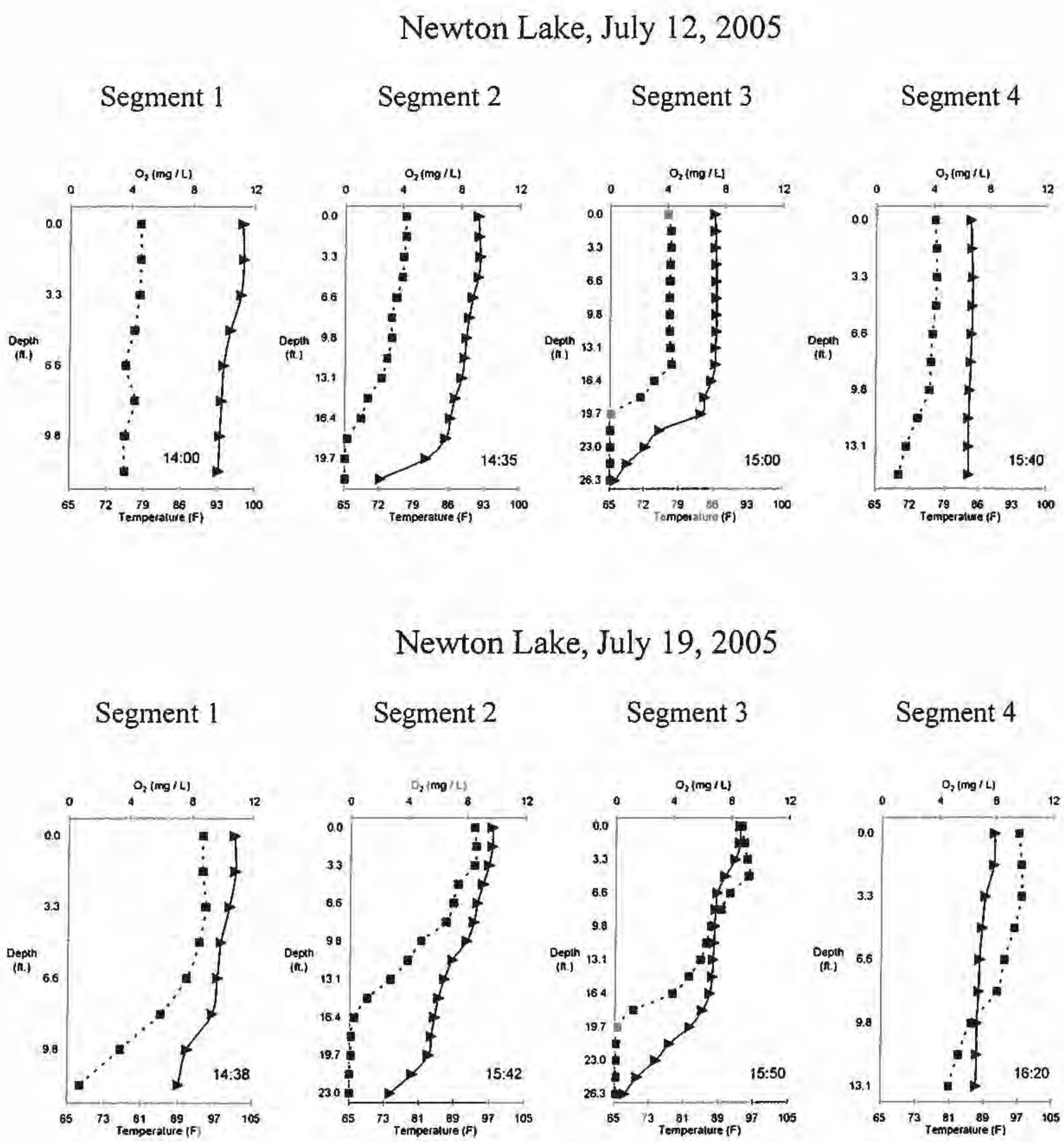
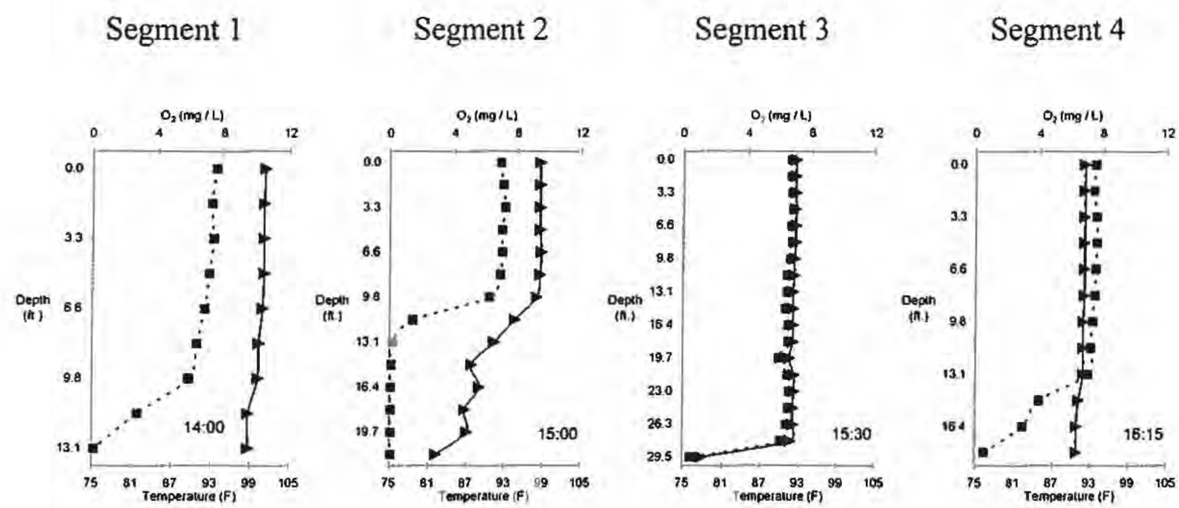


Figure A-6. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, July 26, 2005



Newton Lake, August 2, 2005

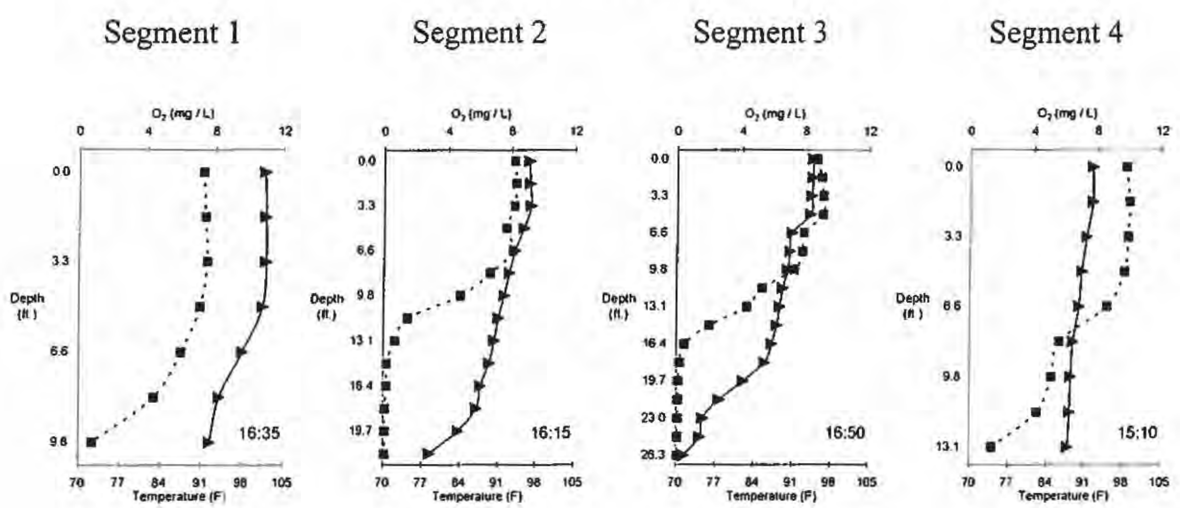
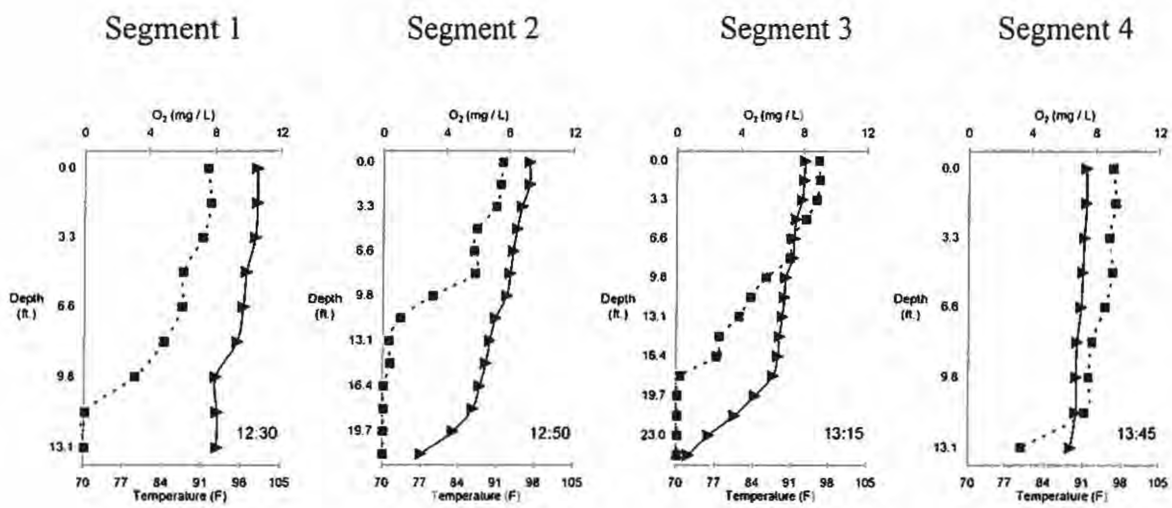


Figure A-7. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, August 9, 2005



Newton Lake, August 16, 2005

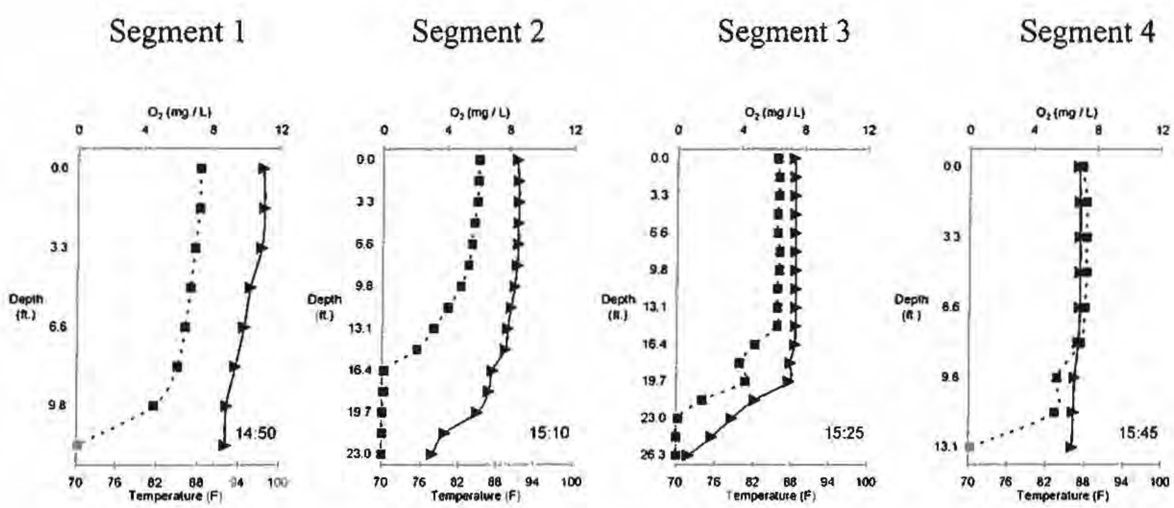


Figure A-8. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

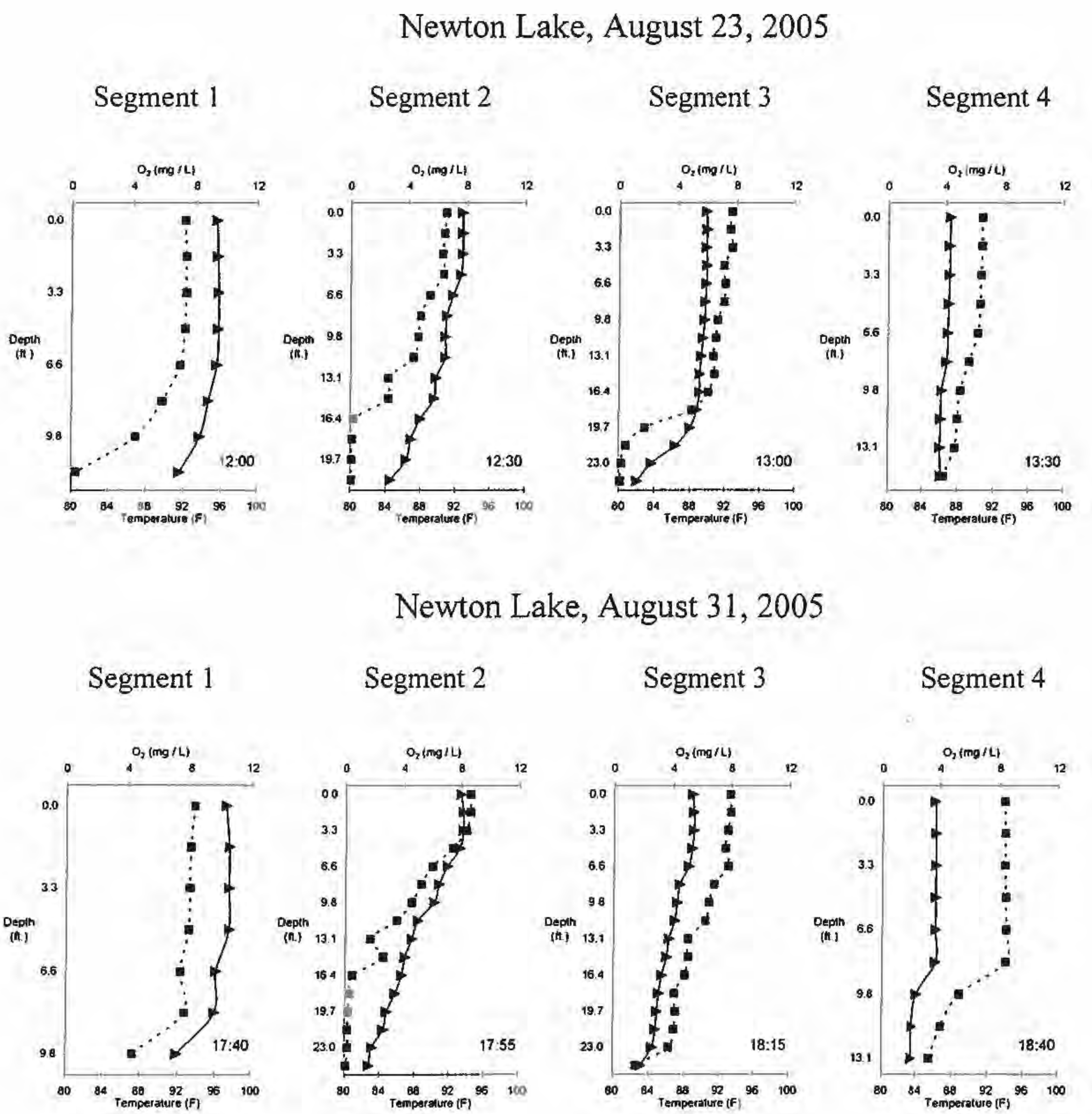
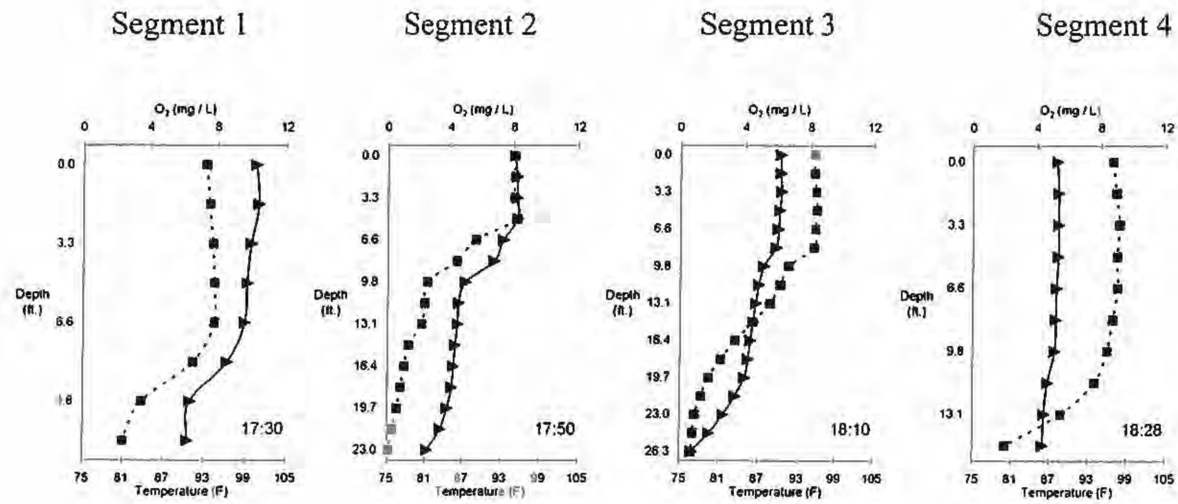


Figure A-9. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, September 8, 2005



Newton Lake, September 14, 2005

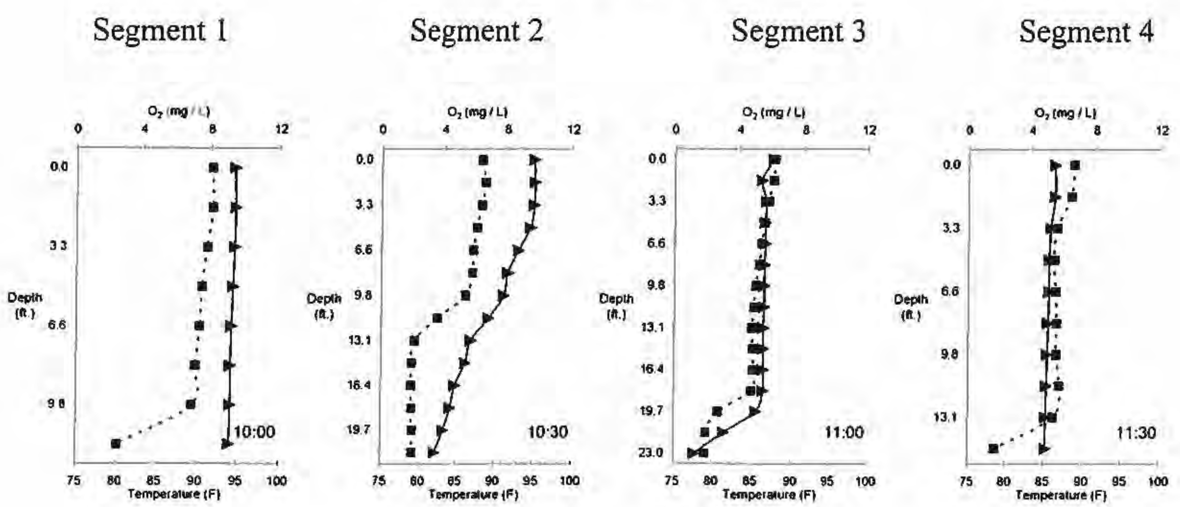
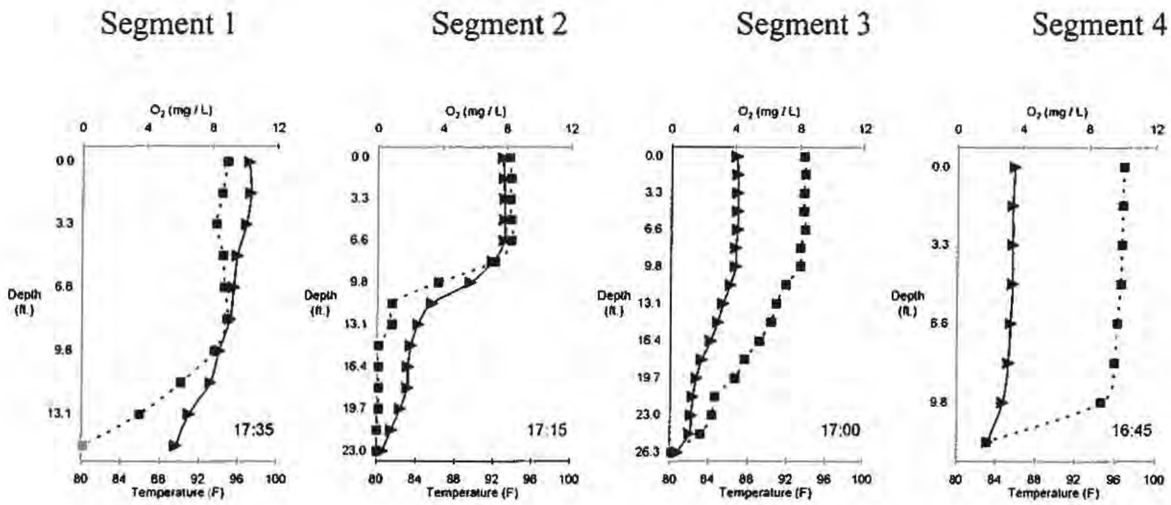


Figure A-10. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, September 22, 2005



Newton Lake, September 29, 2005

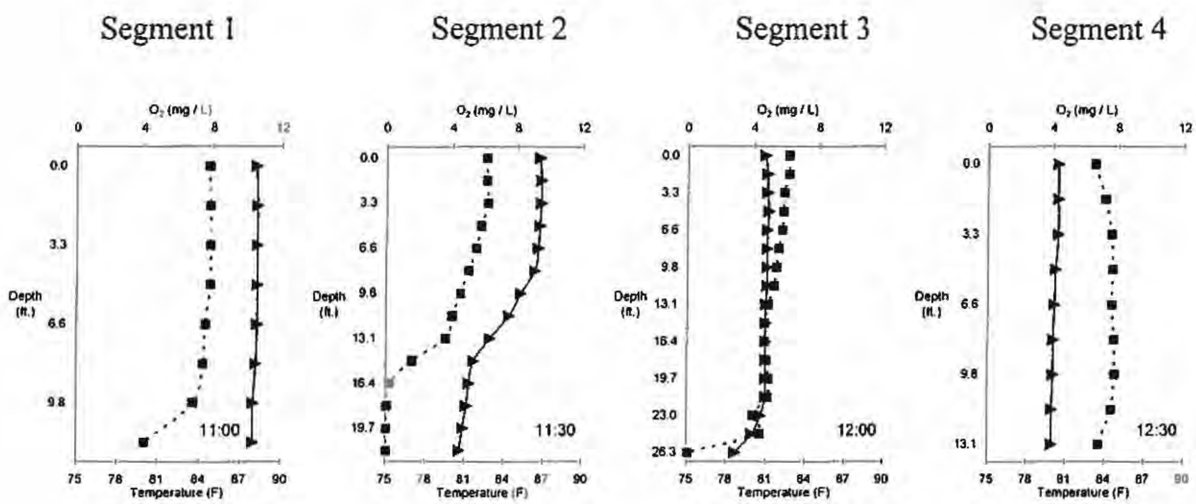


Figure A-11. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

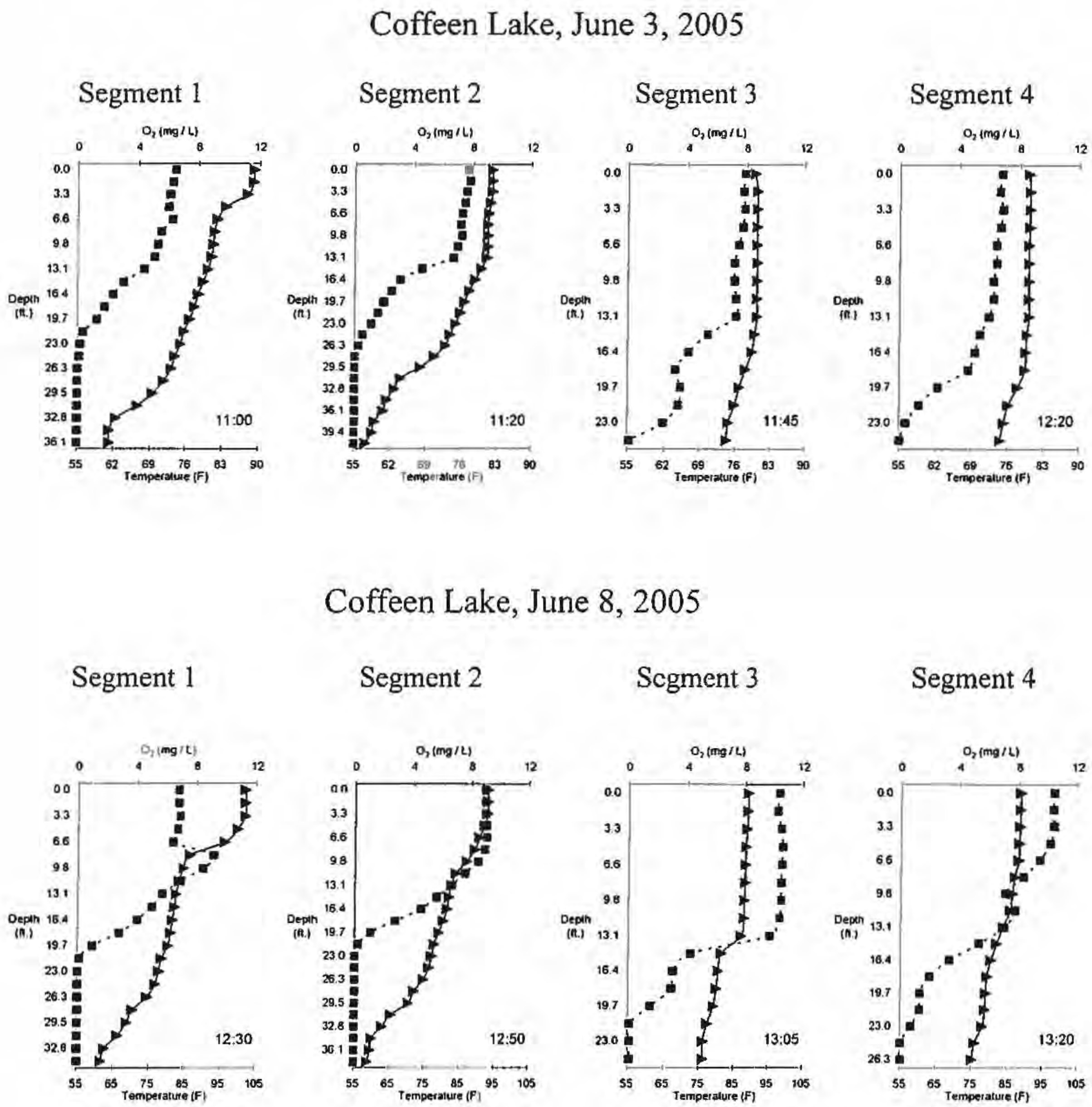
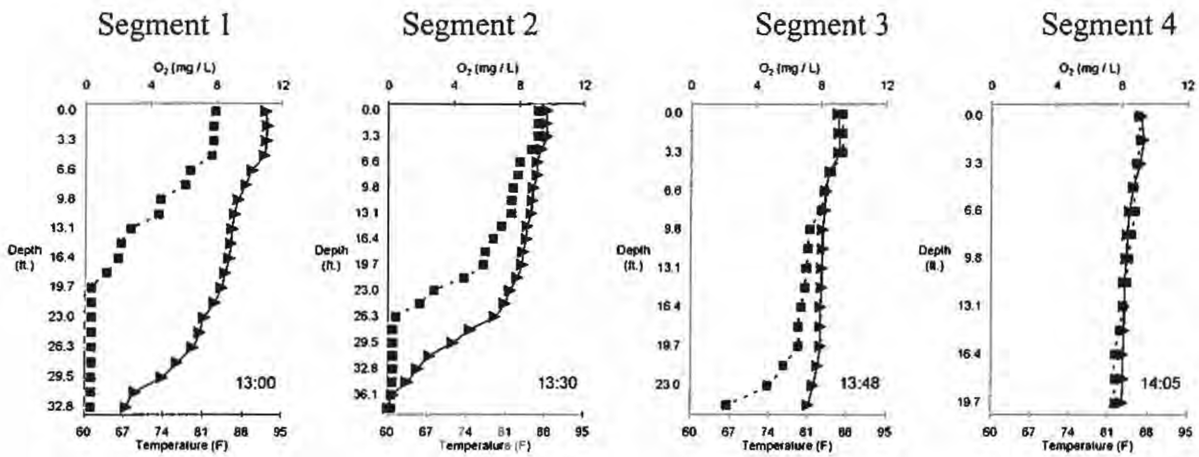


Figure A-12. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, June 16, 2005



Coffeen Lake, June 21, 2005

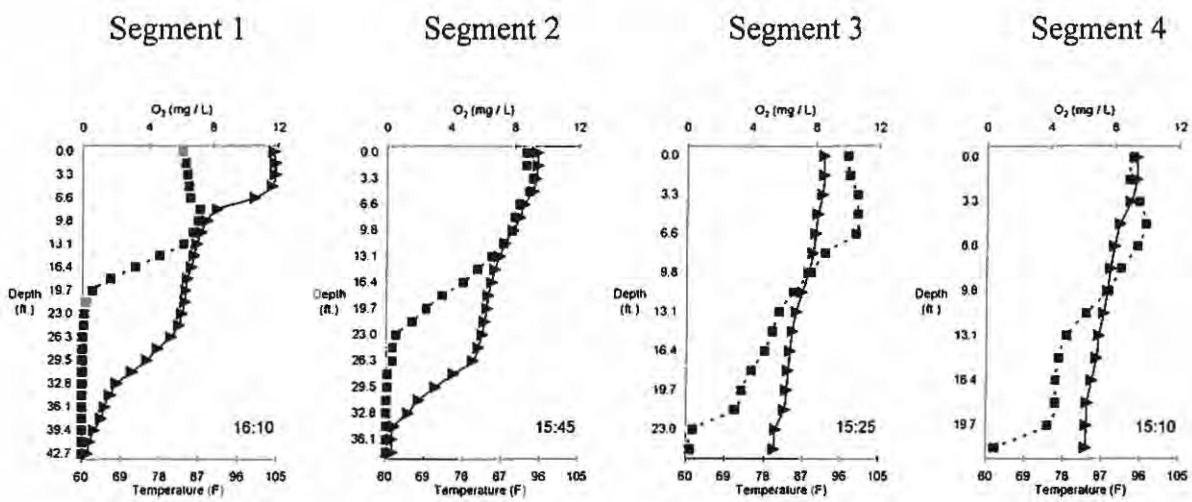
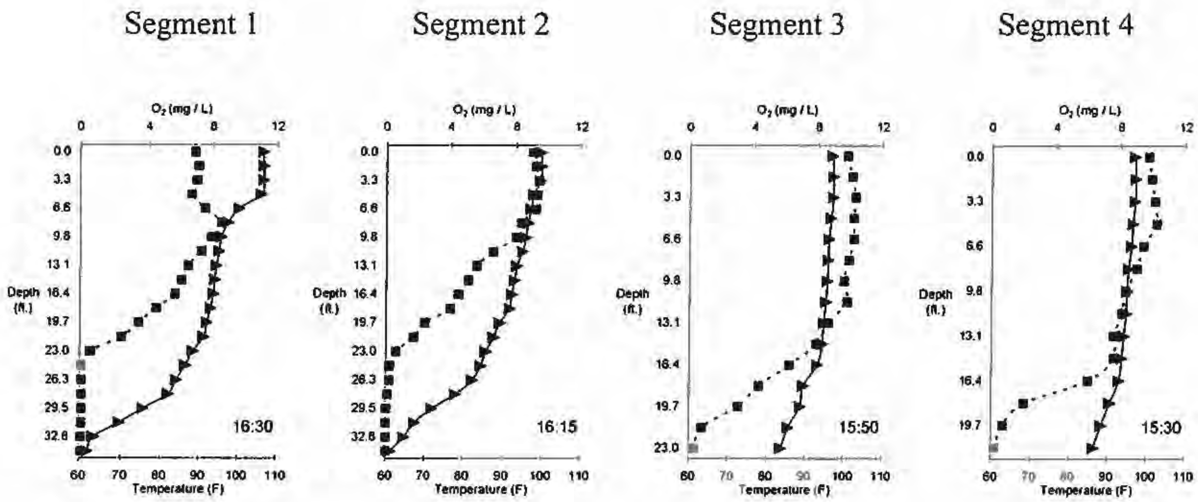


Figure A-13. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, June 28, 2005



Coffeen Lake, July 7, 2005

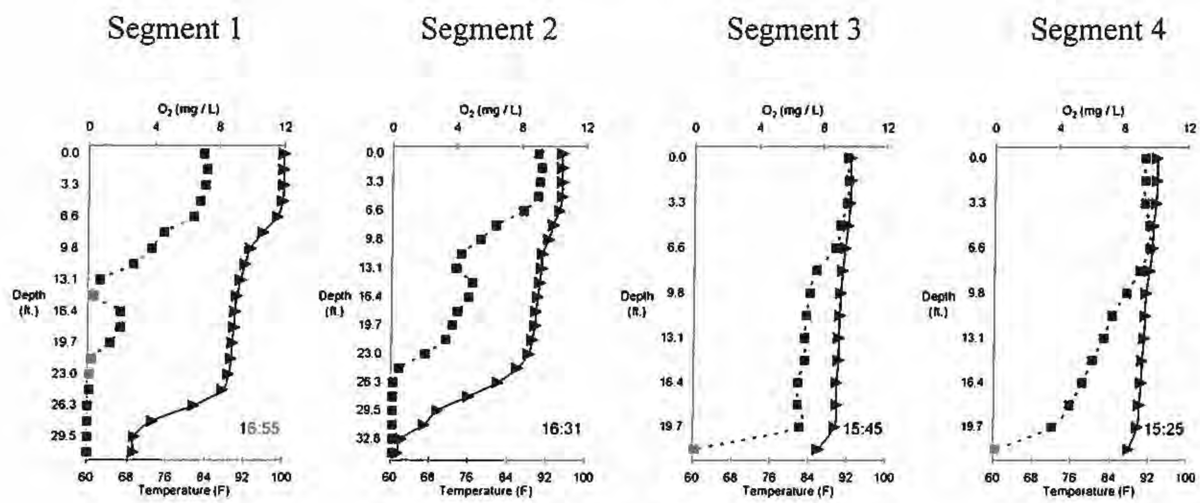


Figure A-14. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

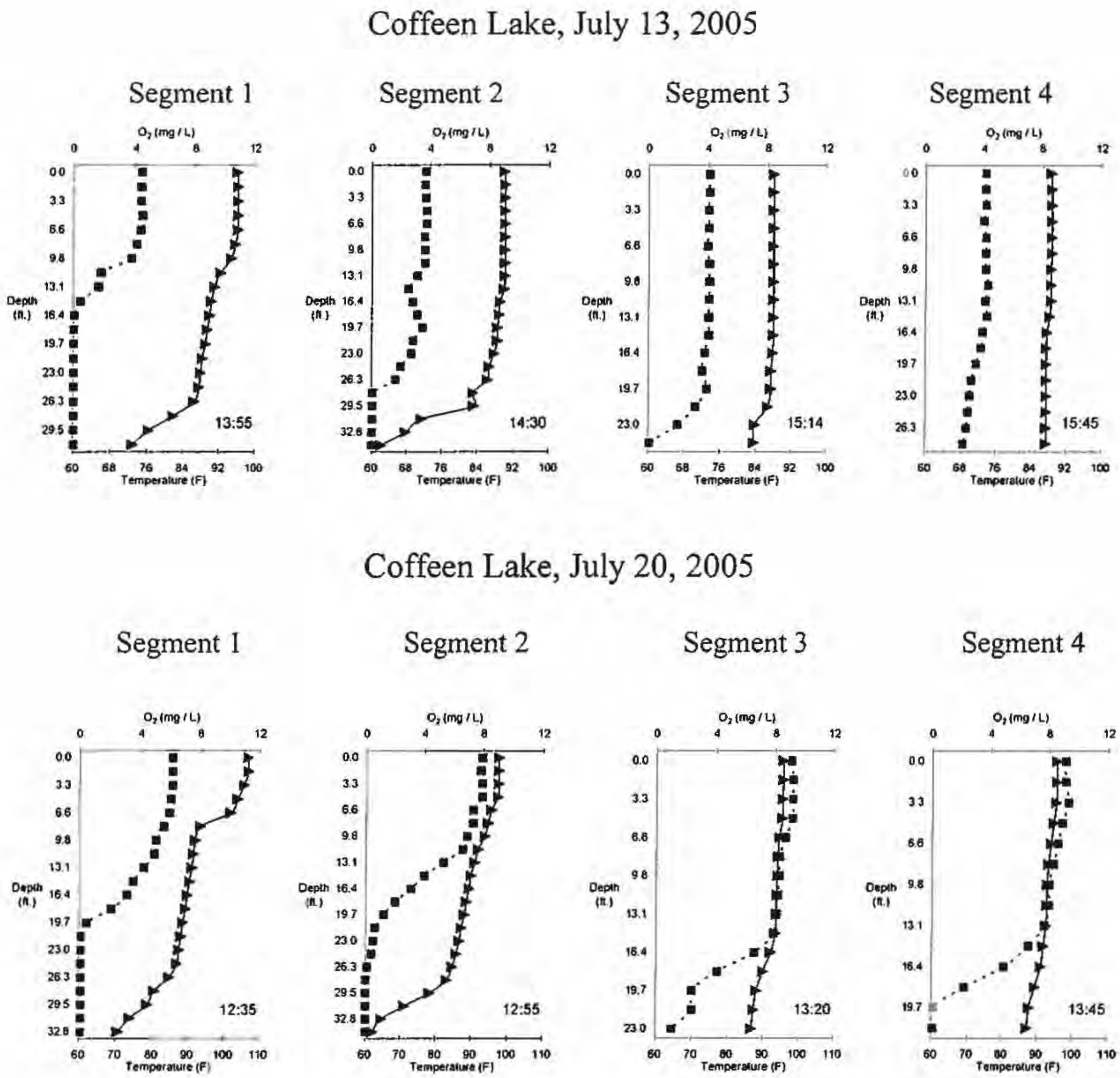
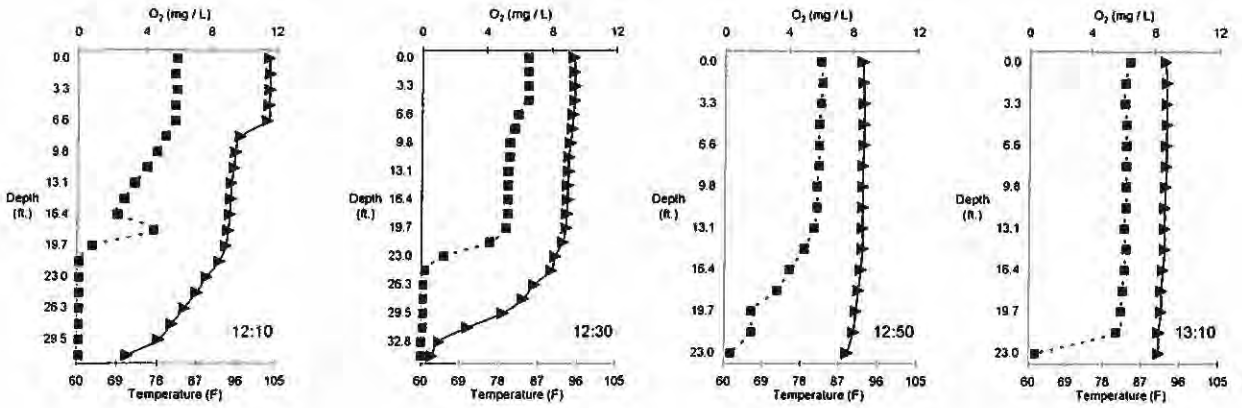


Figure A-15. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, July 27, 2005

Segment 1 Segment 2



Coffeen Lake, August 2, 2005

Segment 1 Segment 2 Segment 3 Segment 4

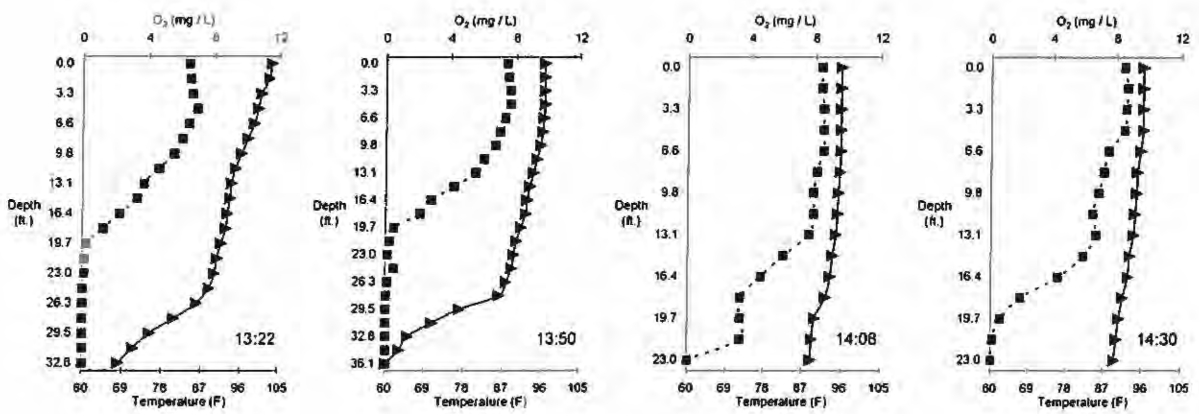
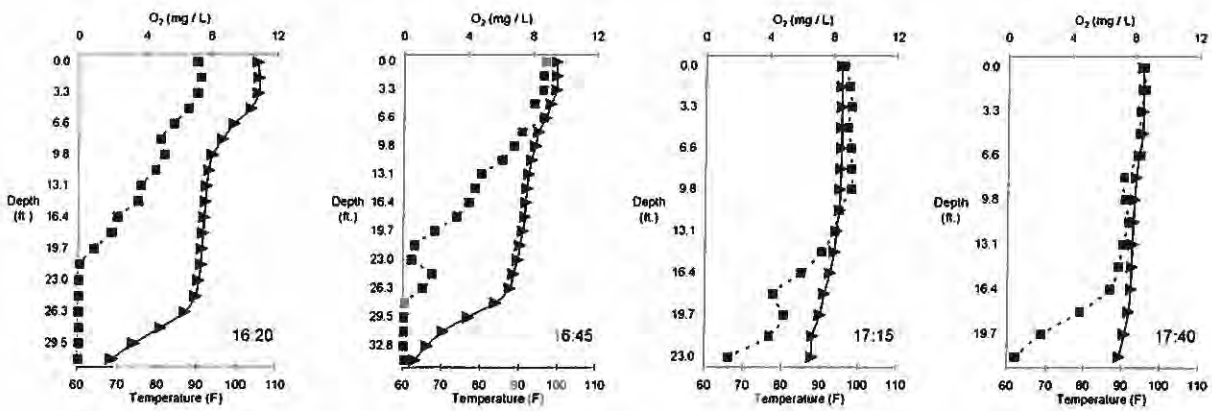


Figure A-16. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, August 9, 2005

Segment 1 | Segment 2 | Segment 3 | Segment 4



Coffeen Lake, August 18, 2005

Segment 1 | Segment 2 | Segment 3 | Segment 4

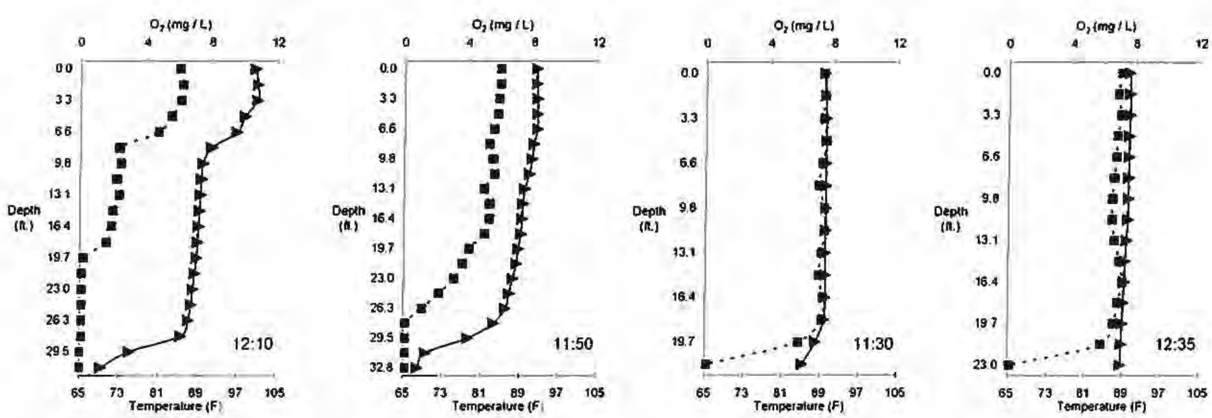
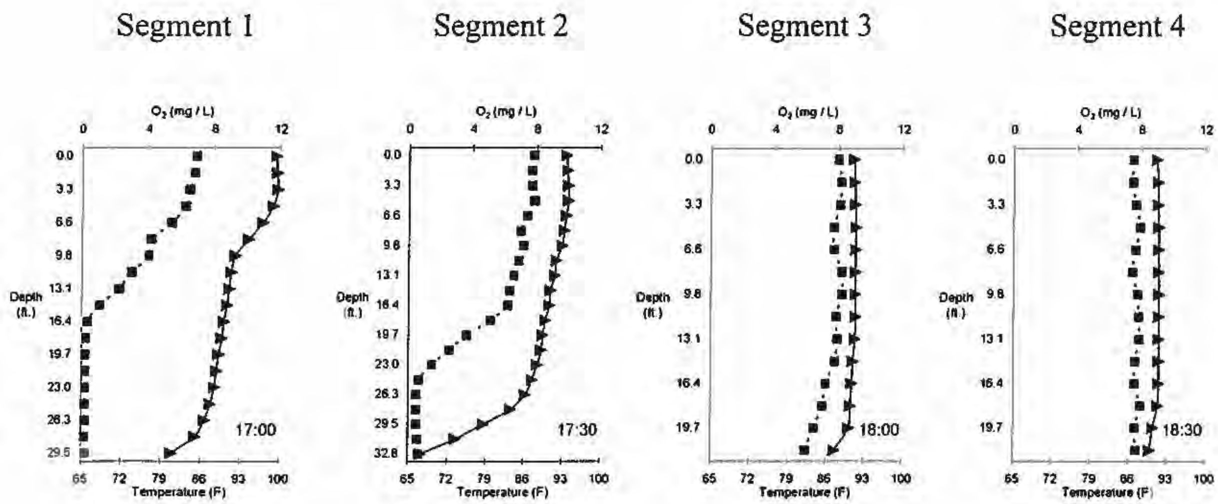


Figure A-17. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, August 23, 2005



Coffeen Lake, August 31, 2005

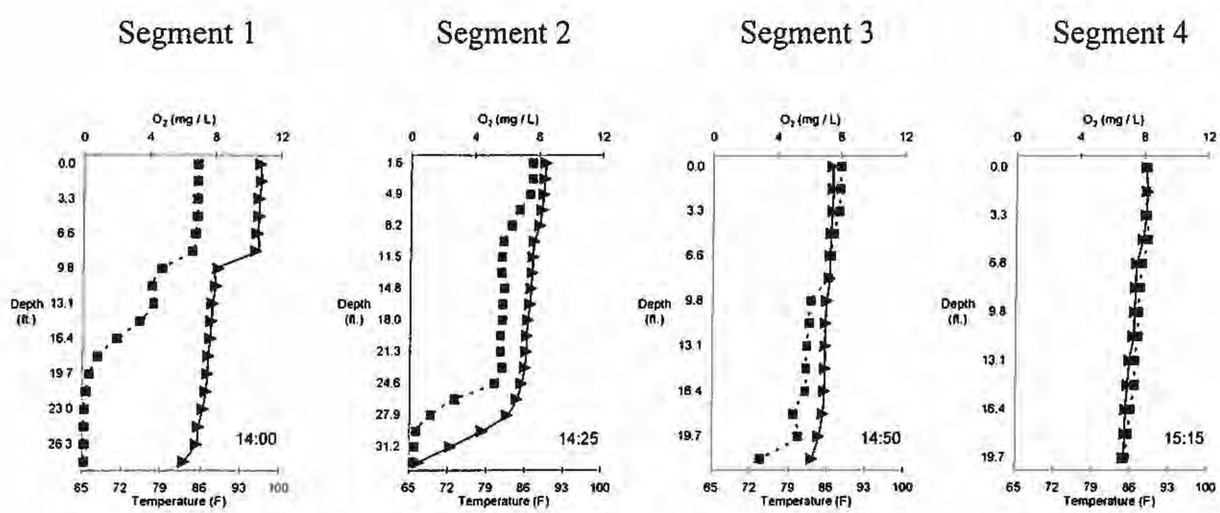


Figure A-18. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

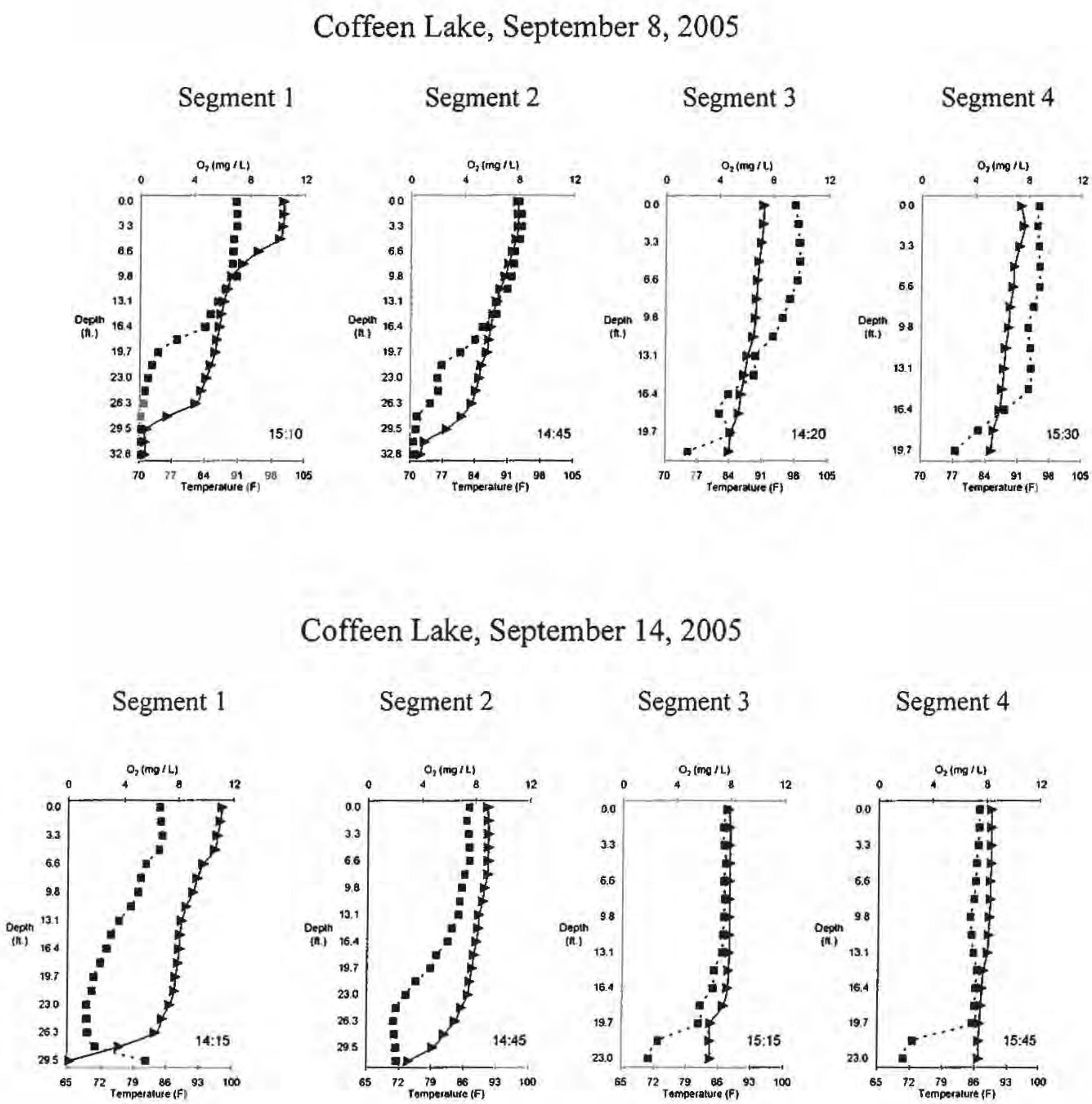
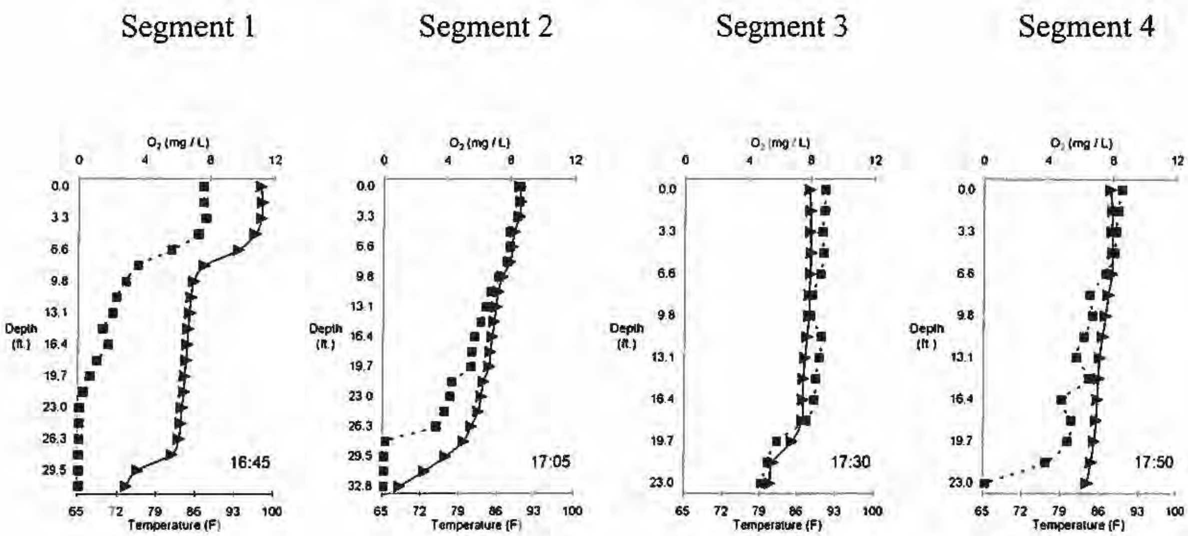


Figure A-19. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, September 21, 2005



Coffeen Lake, September 29, 2005

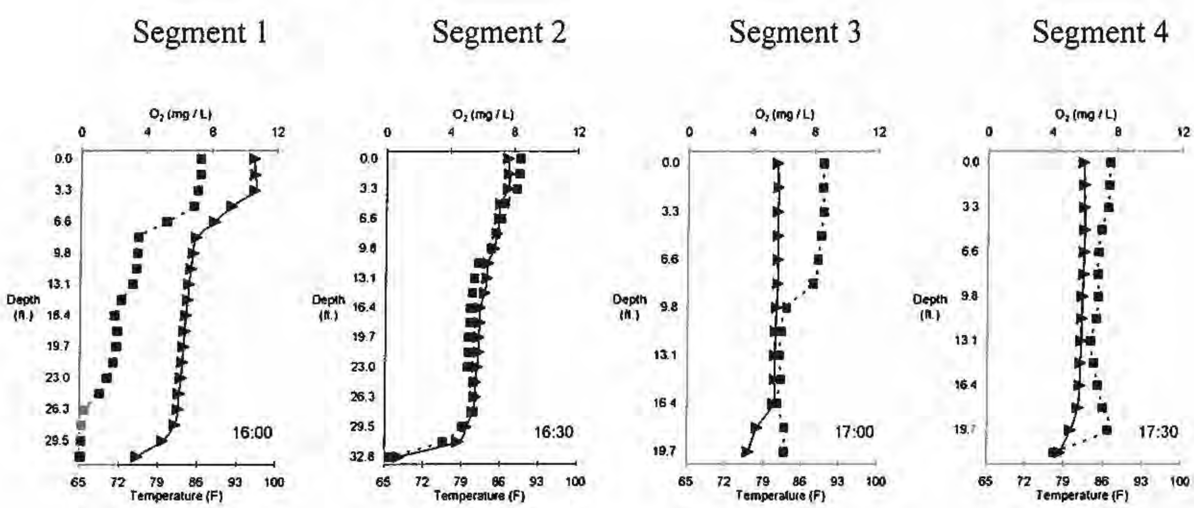


Figure A-20. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

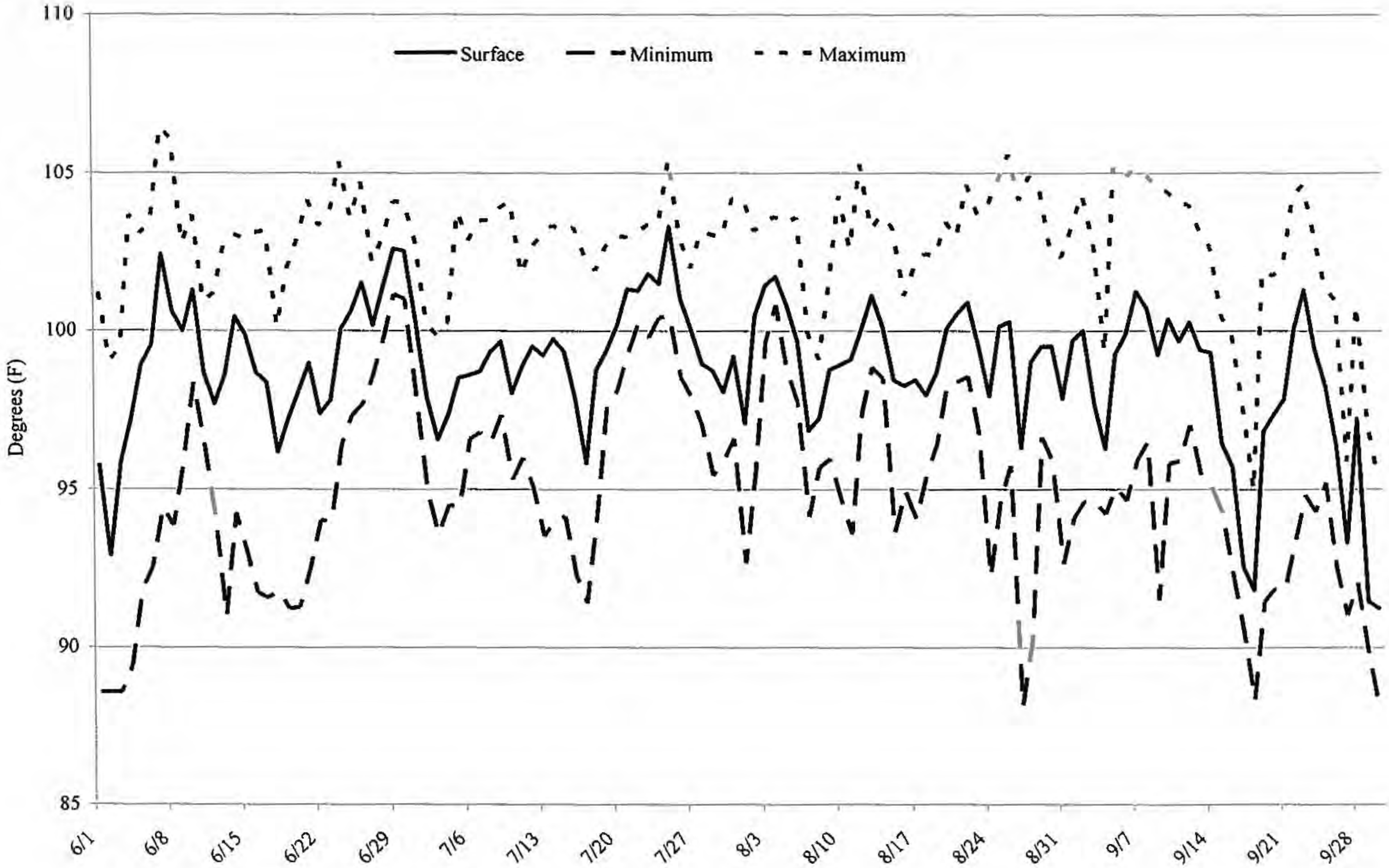


Figure A-21.Mean, minimum, and maximum daily surface temperatures during 2005 at the Newton Lake mixing zone.

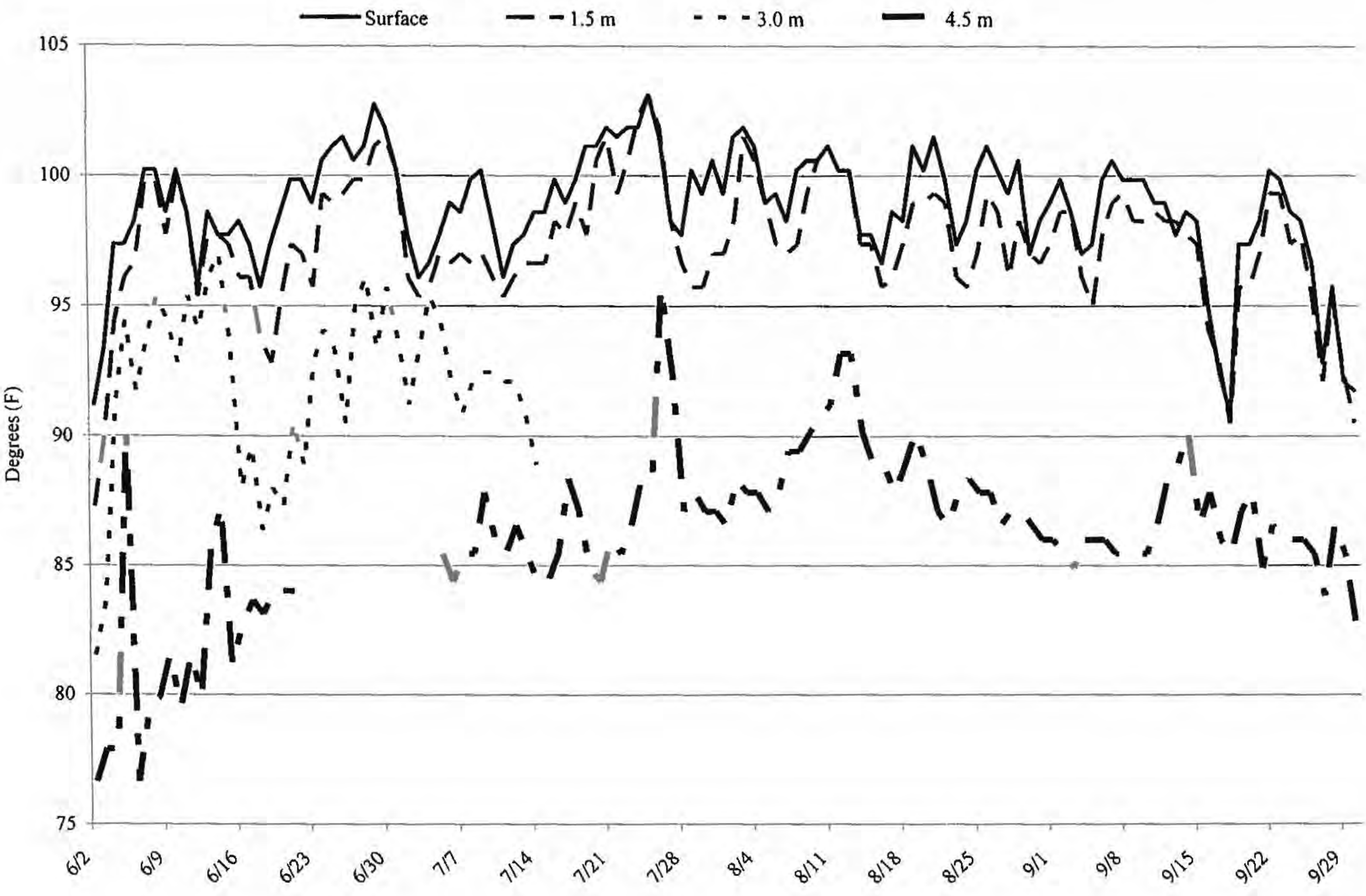


Figure A-22. Mean daily temperatures during 2005 in Newton Lake Segment 1. Lake bottom is approximately 16.4 feet.

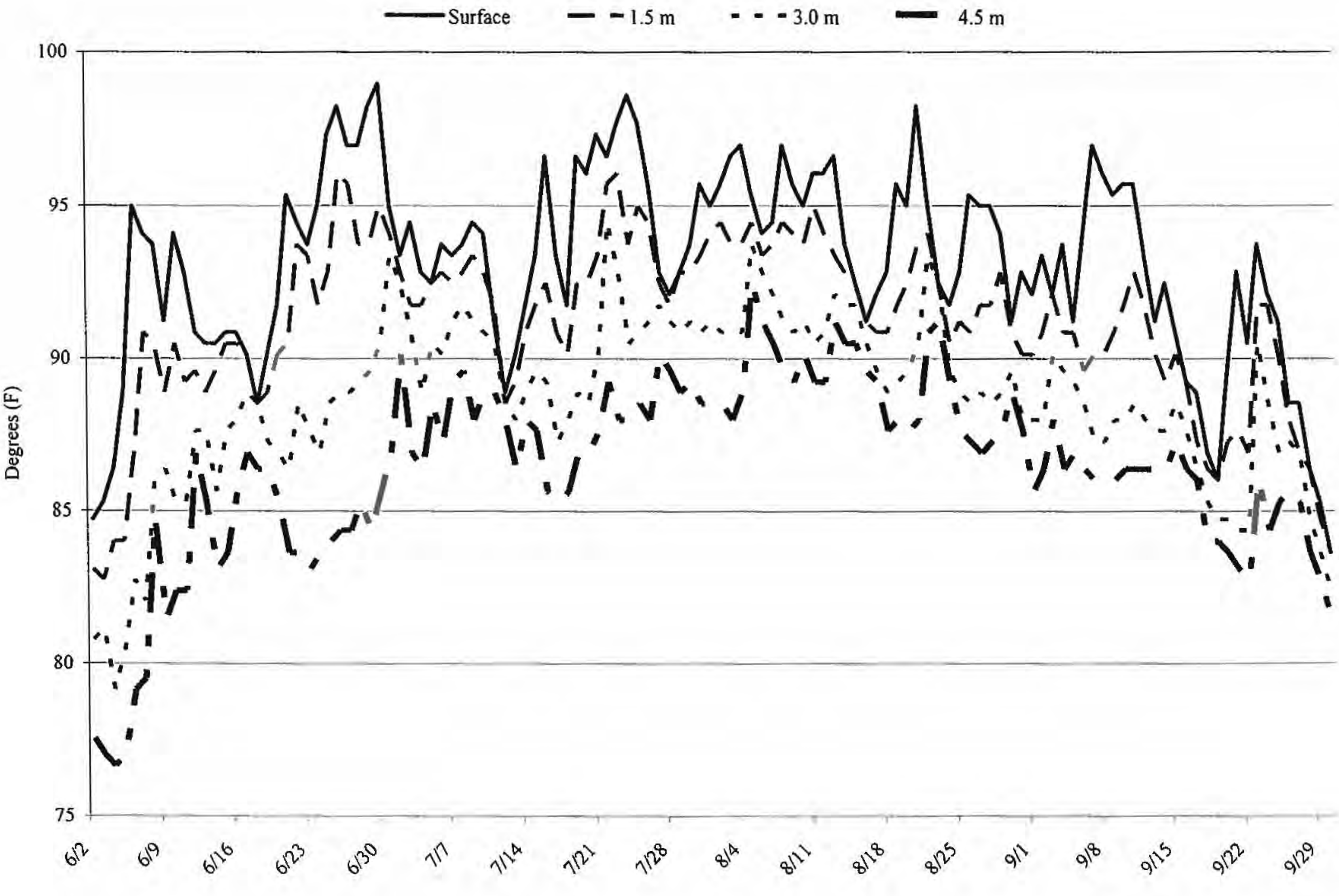


Figure A-23. Mean daily temperatures during 2005 in Newton Lake Segment 2. Lake bottom is approximately 32.8 feet.

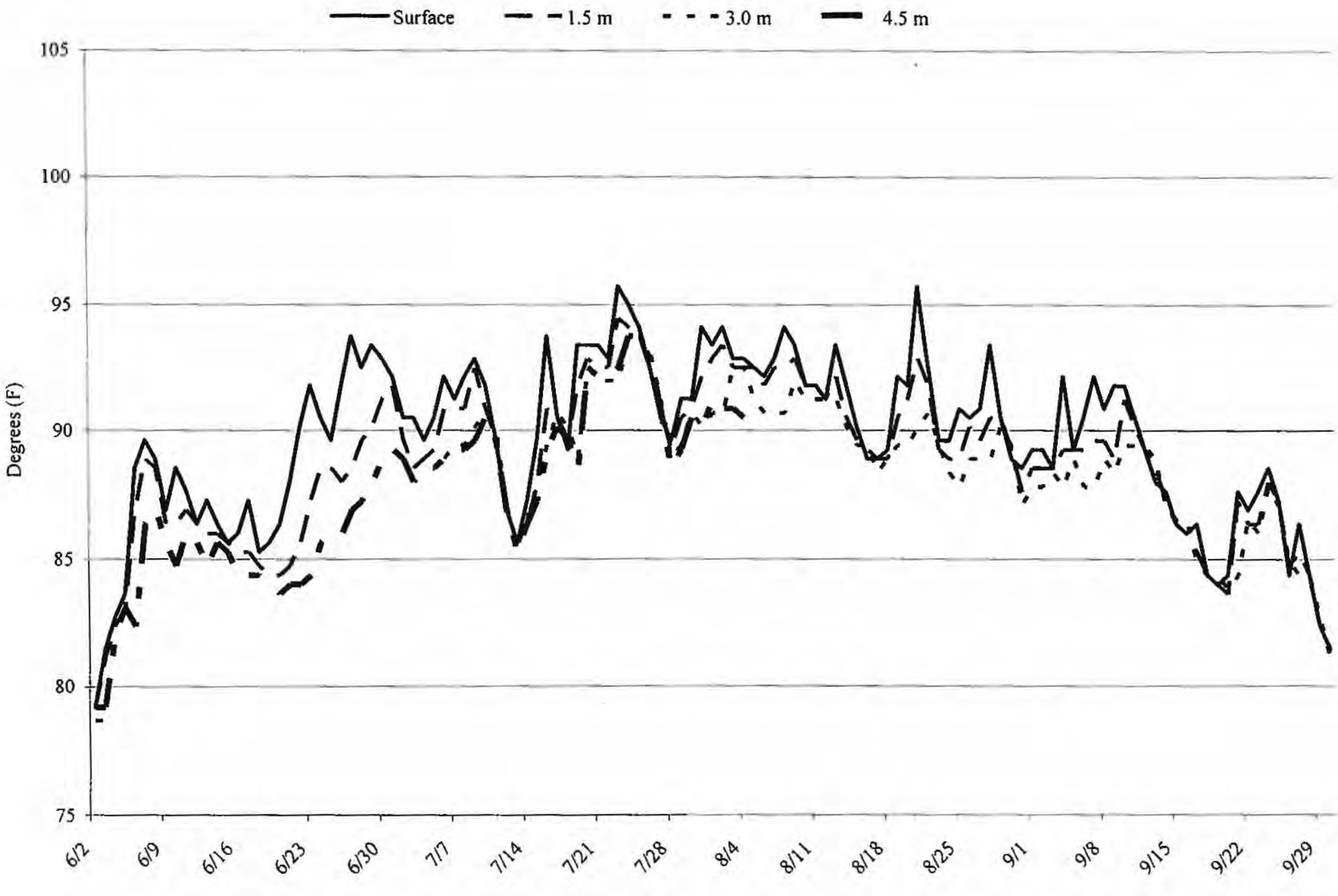


Figure A-24. Mean daily temperatures during 2005 in Newton Lake Segment 3. Lake bottom is approximately 32.8 feet.

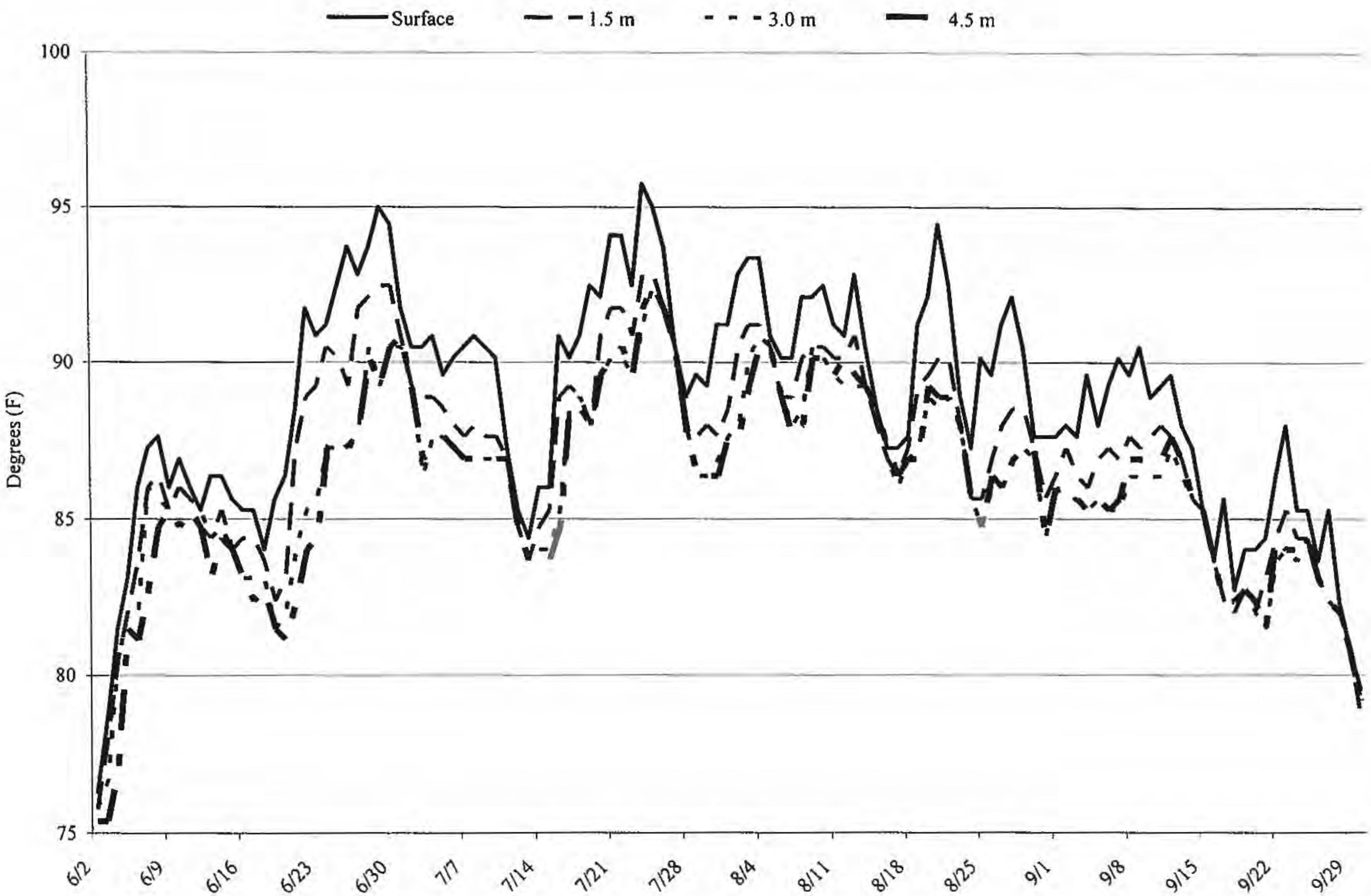


Figure A-25. Mean daily temperatures during 2005 in Newton Lake Segment 4. Lake bottom is approximately 29.5 feet.

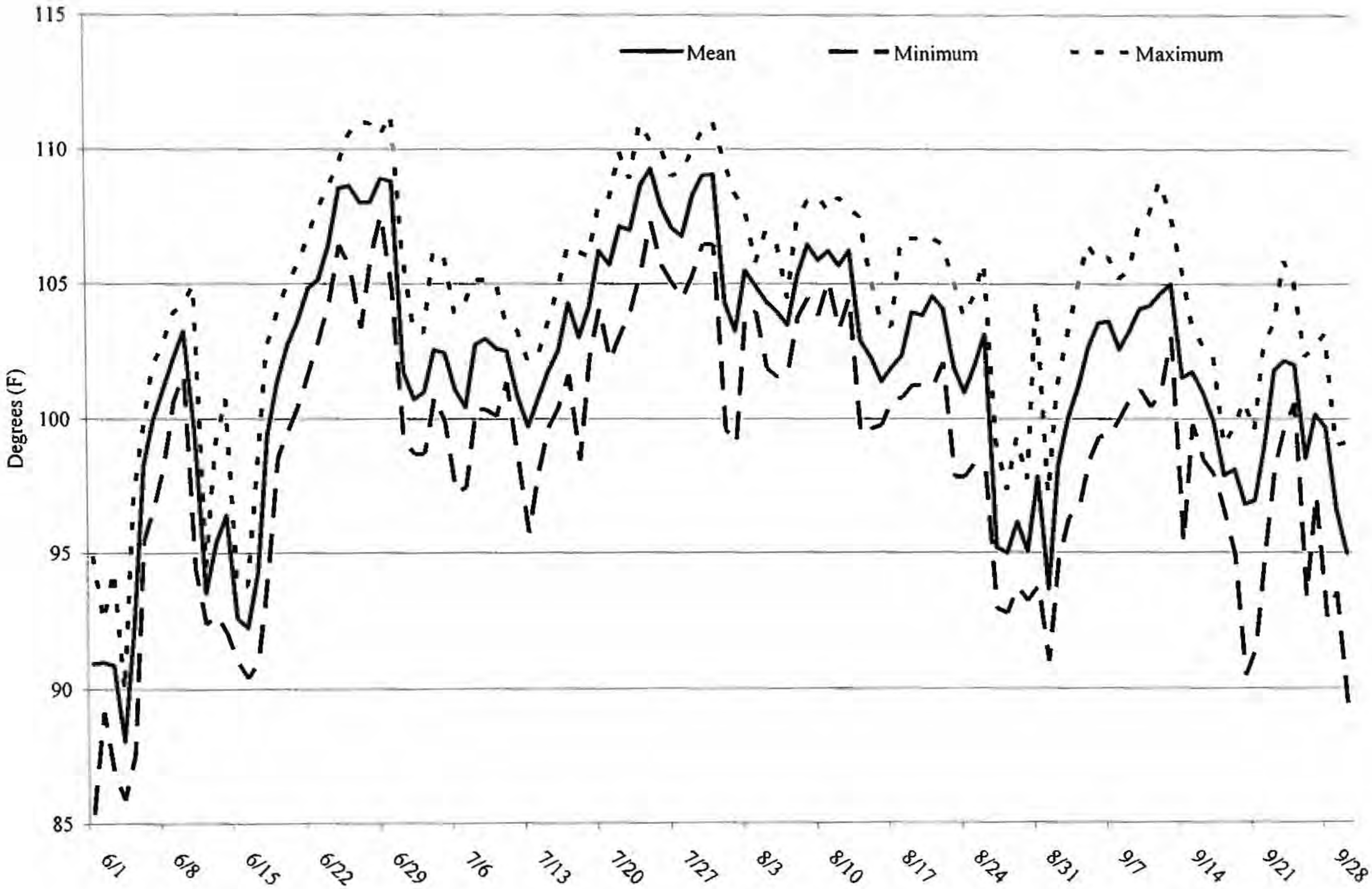


Figure A-26. Mean daily temperatures during 2005 in the Coffeen Lake discharge. Lake bottom is approximately 18.0 feet.

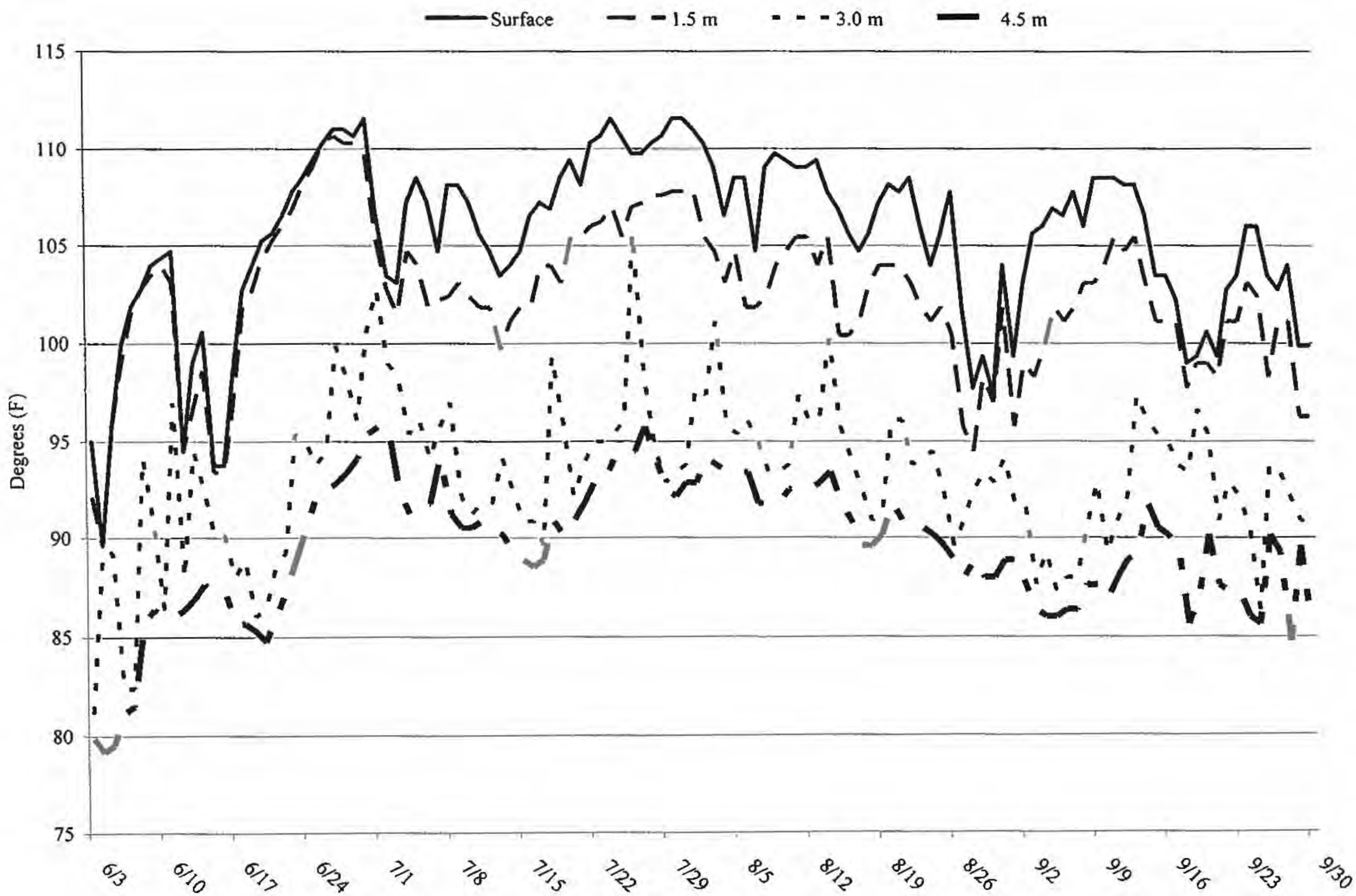


Figure A-27. Mean daily temperatures in Segment 1 (mixing zone) during 2005 in Coffeen Lake. Lake bottom is approximately 18.0 feet.

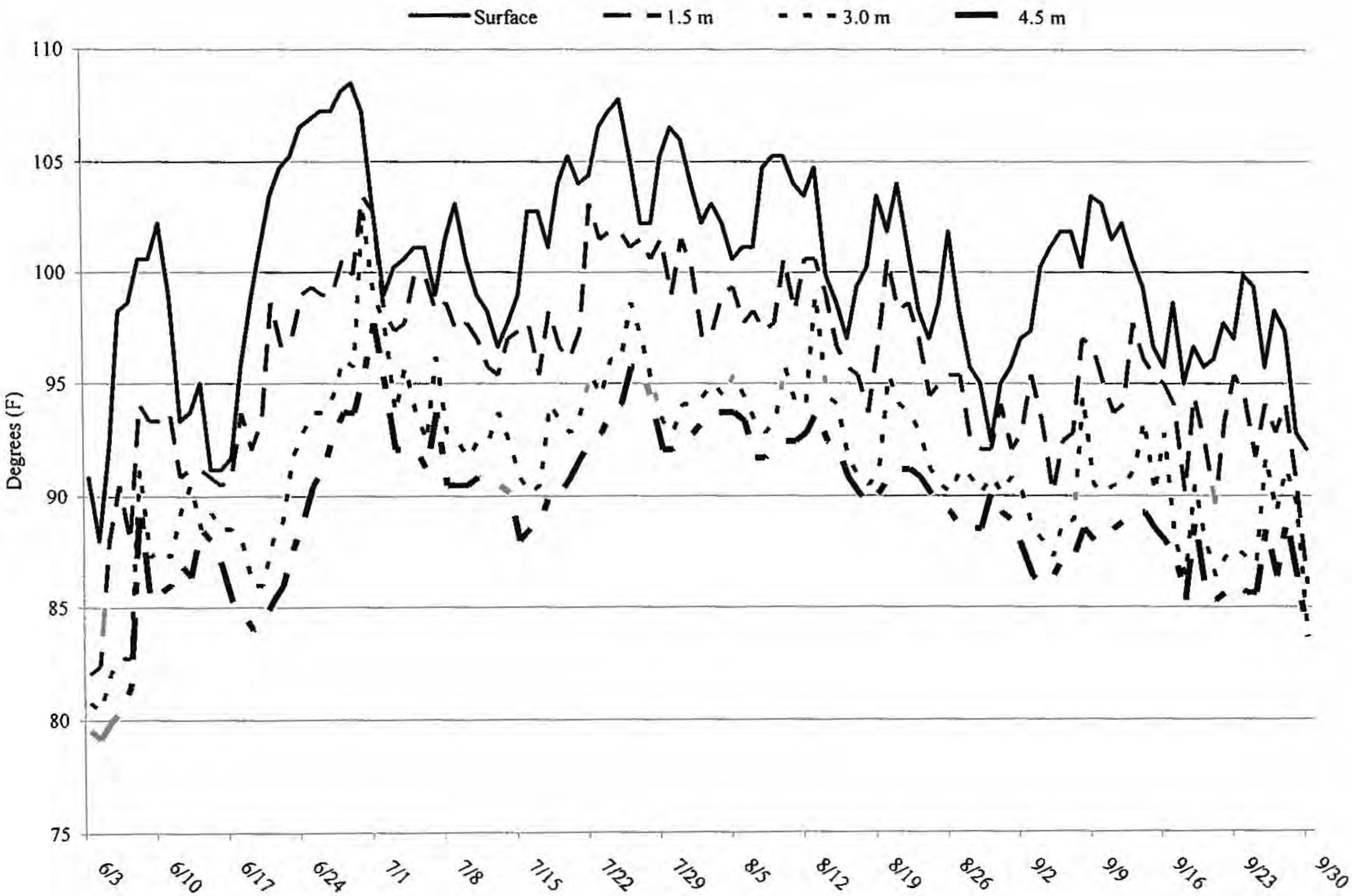


Figure A-28. Mean daily temperatures during 2005, Coffeen Lake at the dam. Lake bottom is approximately 42.6 feet.

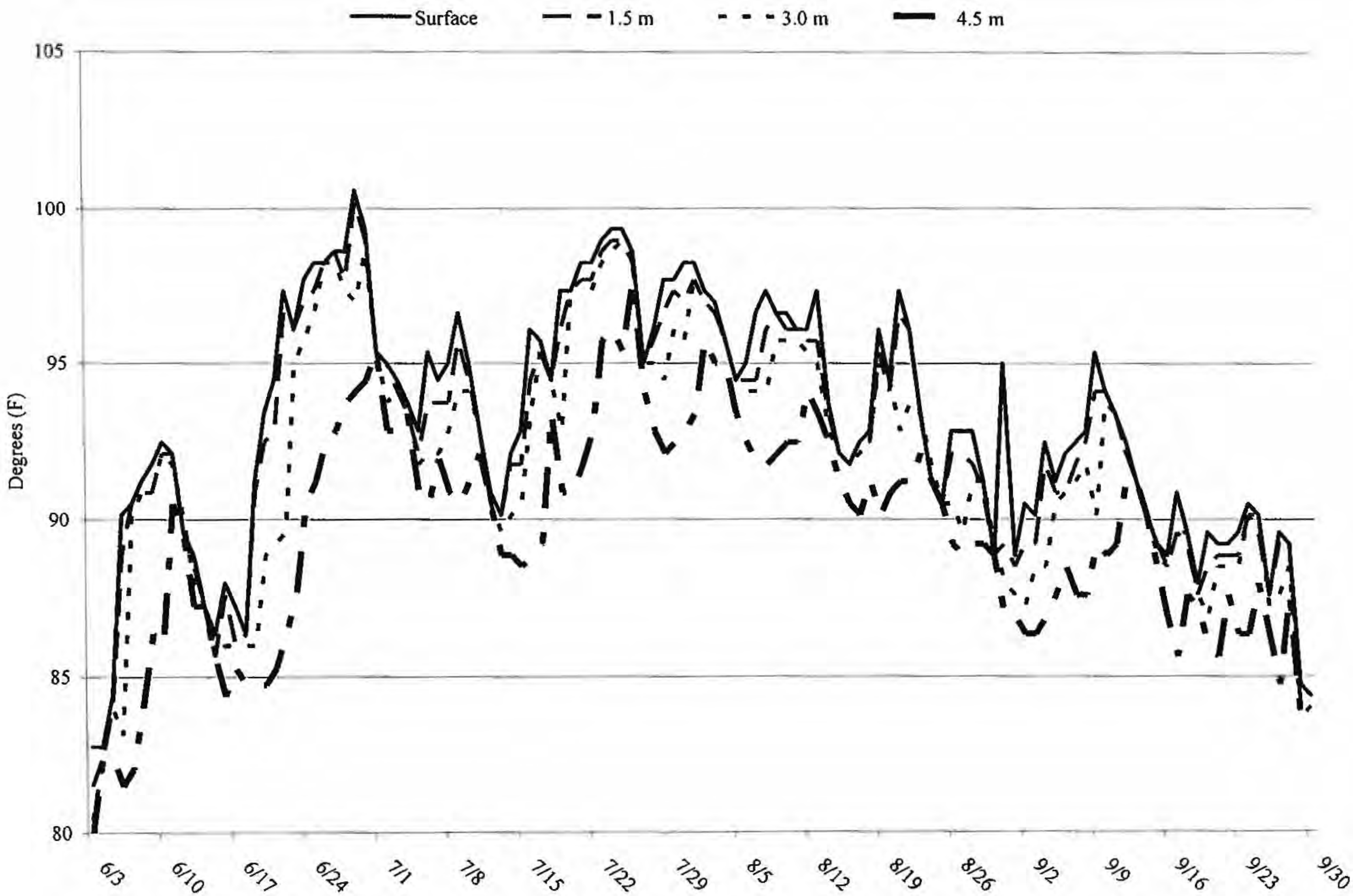


Figure A-29. Mean daily temperatures during 2005, Coffeen Lake at the intake. Lake bottom is approximately 26.2 feet.

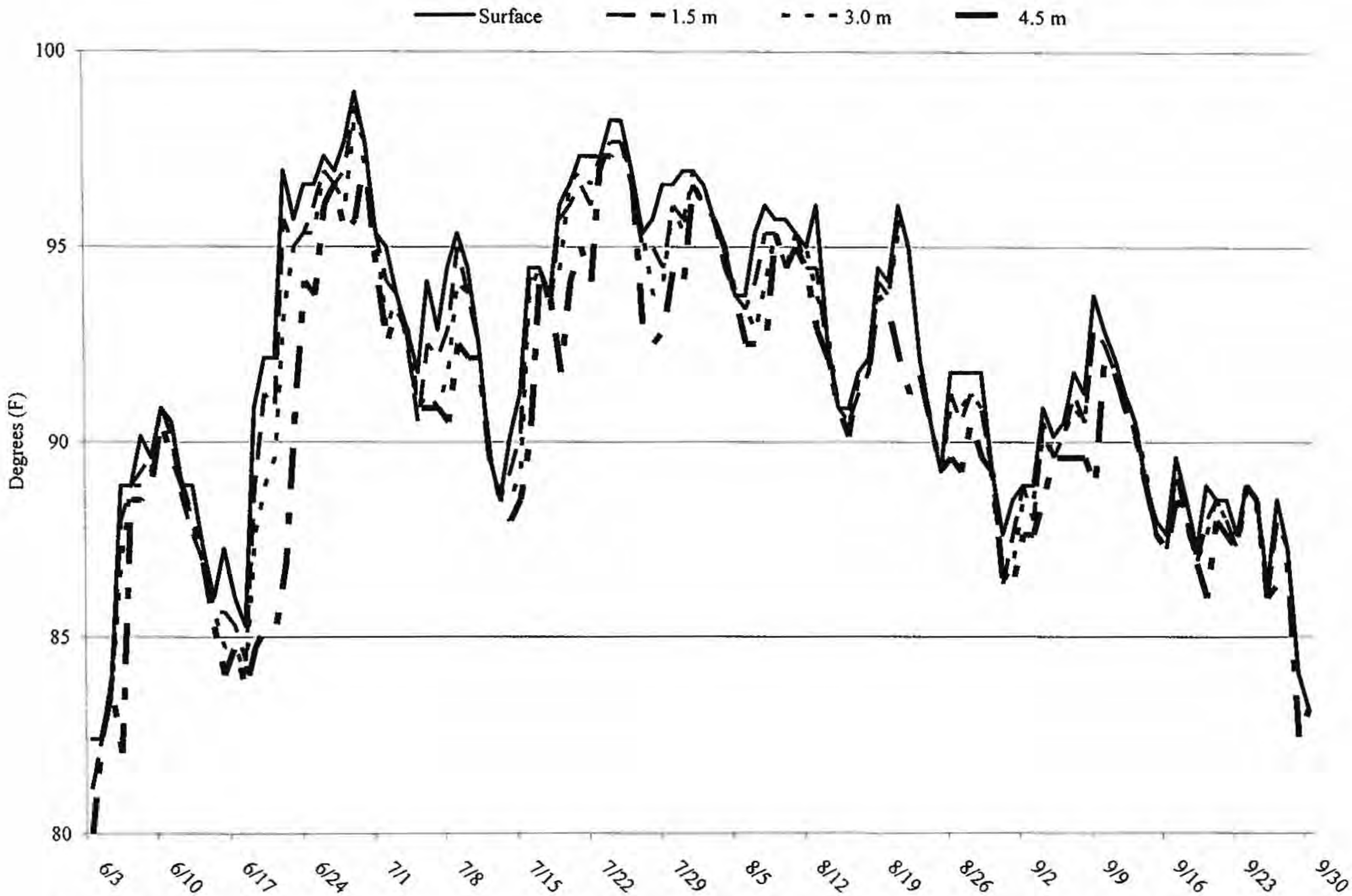


Figure A-30. Mean daily temperatures during 2005, Coffeen Lake located near the railroad bridge. Lake bottom is approximately 24.7 feet.

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

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

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

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

Appendix B-2. 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

Appendix B-3. 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

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

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

Appendix B-5. 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

Appendix B-6. 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

Appendix B-7. Estimated percent habitat available outside of Coffeen Lake cooling loop, July 21, 1999 (time unknown). Data was obtained by Ameren. 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	

Appendix B-8. Estimated percent habitat available in Coffeen Lake, July 23, 1999 (Segment 1 = 3:10 PM, Segment 2 = 2:50 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

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

Appendix B-9. 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

Appendix B-10. 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	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	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

Appendix B-11. 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	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	36
4	94	0	45
4	95	0	45
4	96	0	45
4	97	0	66
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	5
3	92	0	14
3	93	0	41
3	94	0	50
3	95	0	50
3	96	0	50
3	97	6	70
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	0
2	91	0	9
2	92	0	18
2	93	0	45
2	94	0	55
2	95	0	55
2	96	0	55
2	97	6	75
1	87	0	0
1	88	0	0
1	89	0	5
1	90	0	5
1	91	0	14
1	92	0	23
1	93	6	50
1	94	11	59
1	95	17	59
1	96	17	59
1	97	22	80

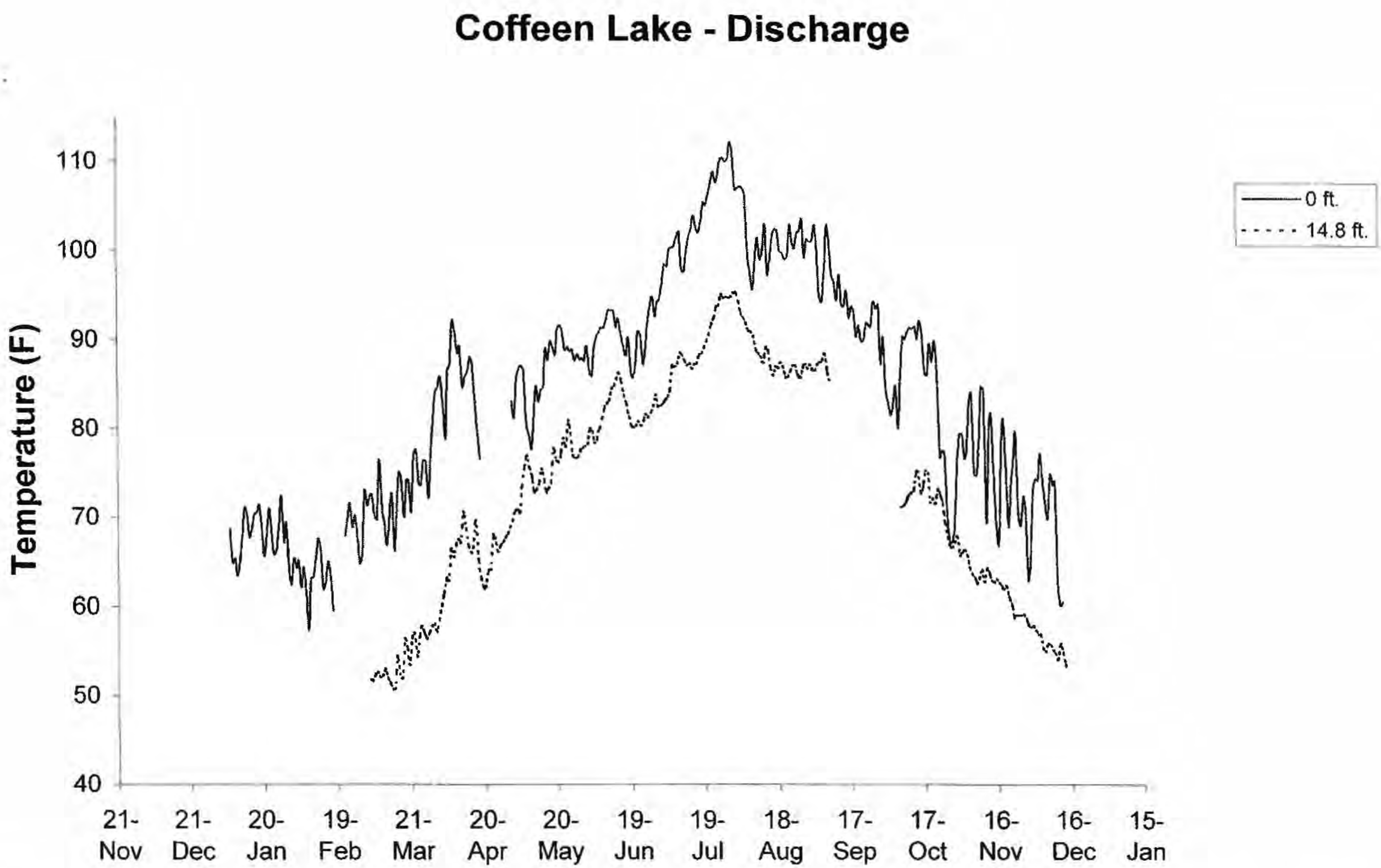


Figure B-1. Mean daily temperature during 1999 at the Coffeen Lake discharge mixing zone. Lake bottom is approximately 42.6 feet .

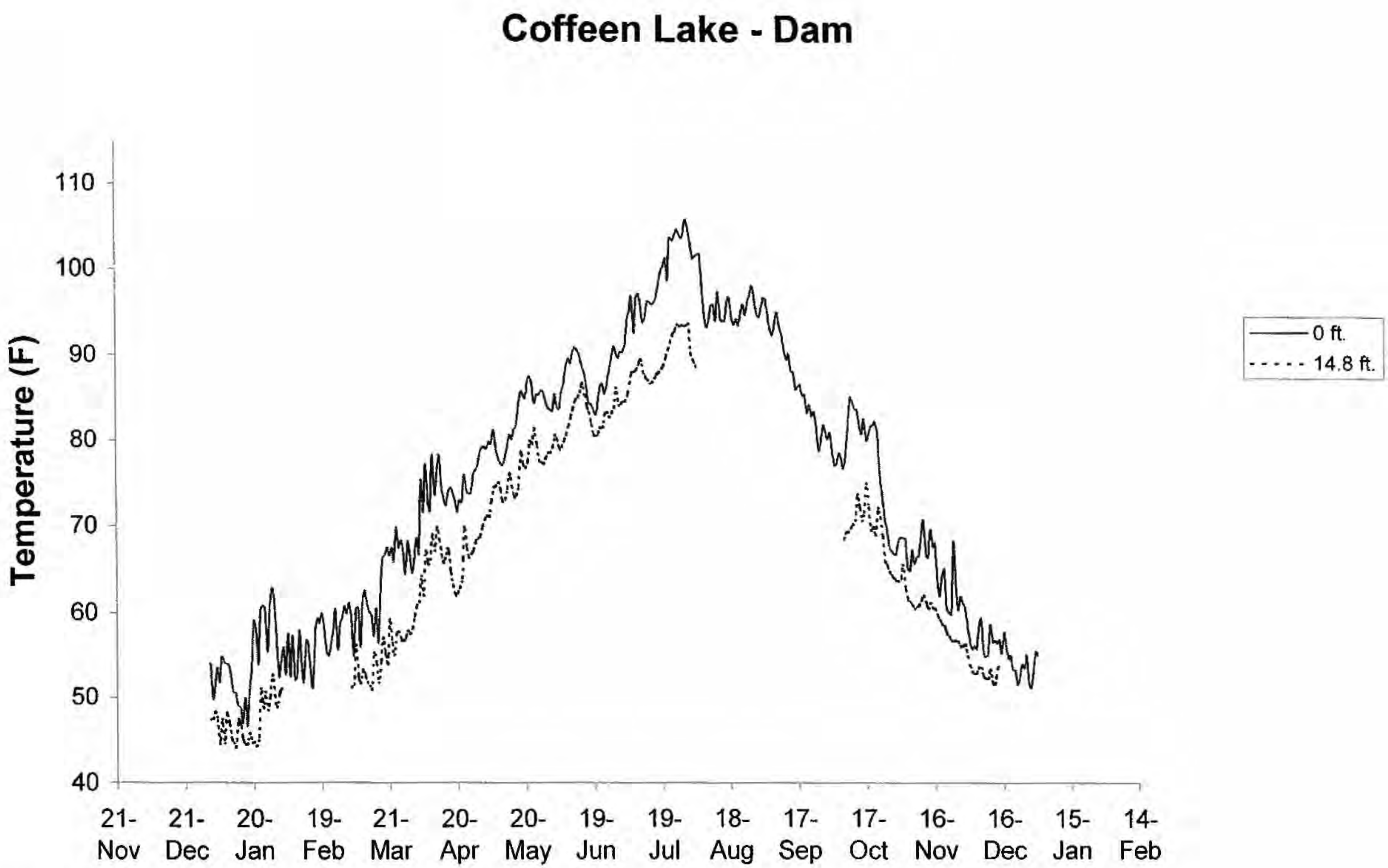


Figure B-2. Mean daily temperature during 1999 at the Coffeen Lake dam. Lake bottom is approximately 42.6 feet.

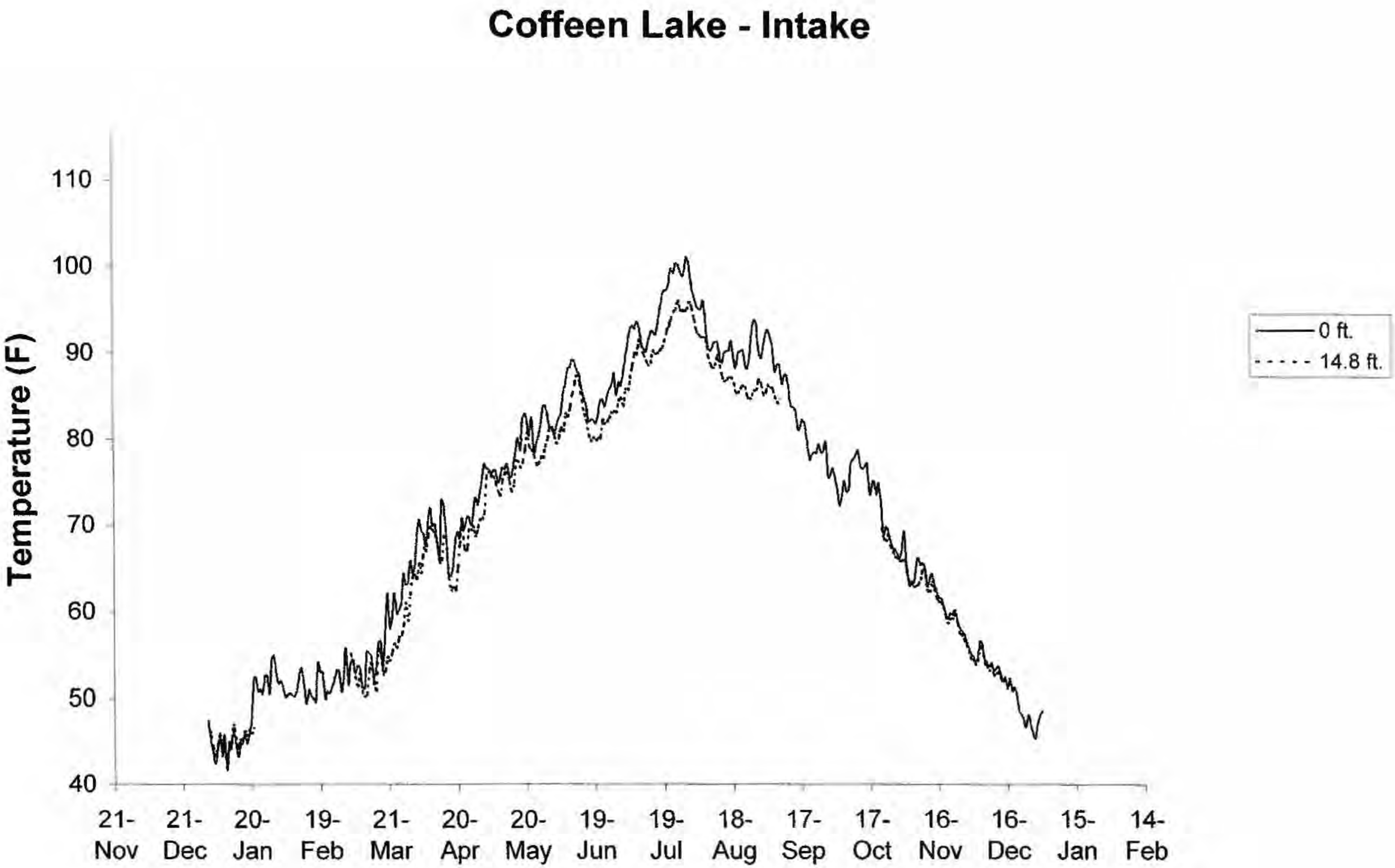


Figure B-3. Mean daily temperature during 1999 at the Coffeen Lake intake. Lake bottom is approximately 42.6 feet.

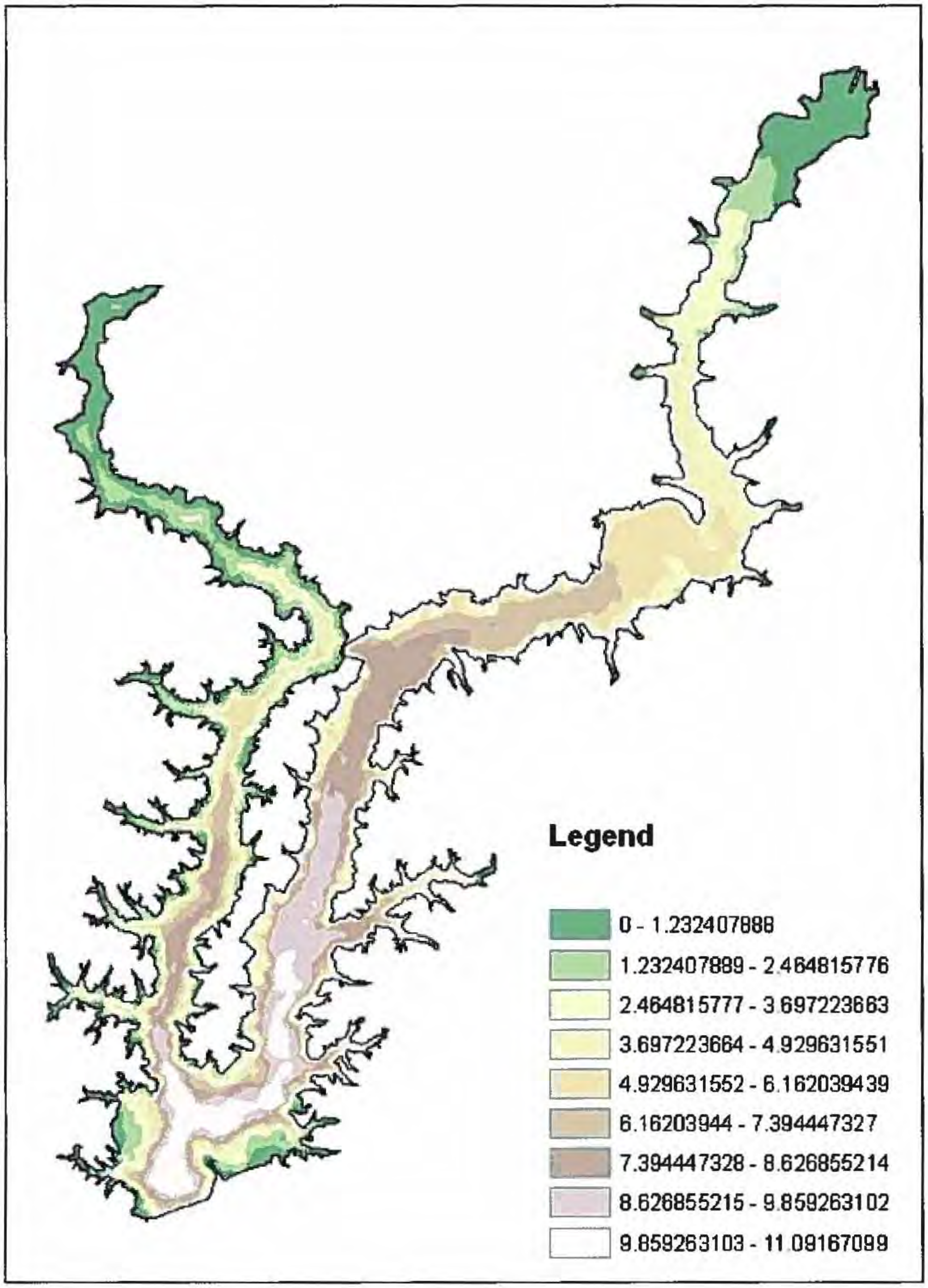


Figure C-1. Contour map of Newton Lake during 2003. Depth is indicated in meters.

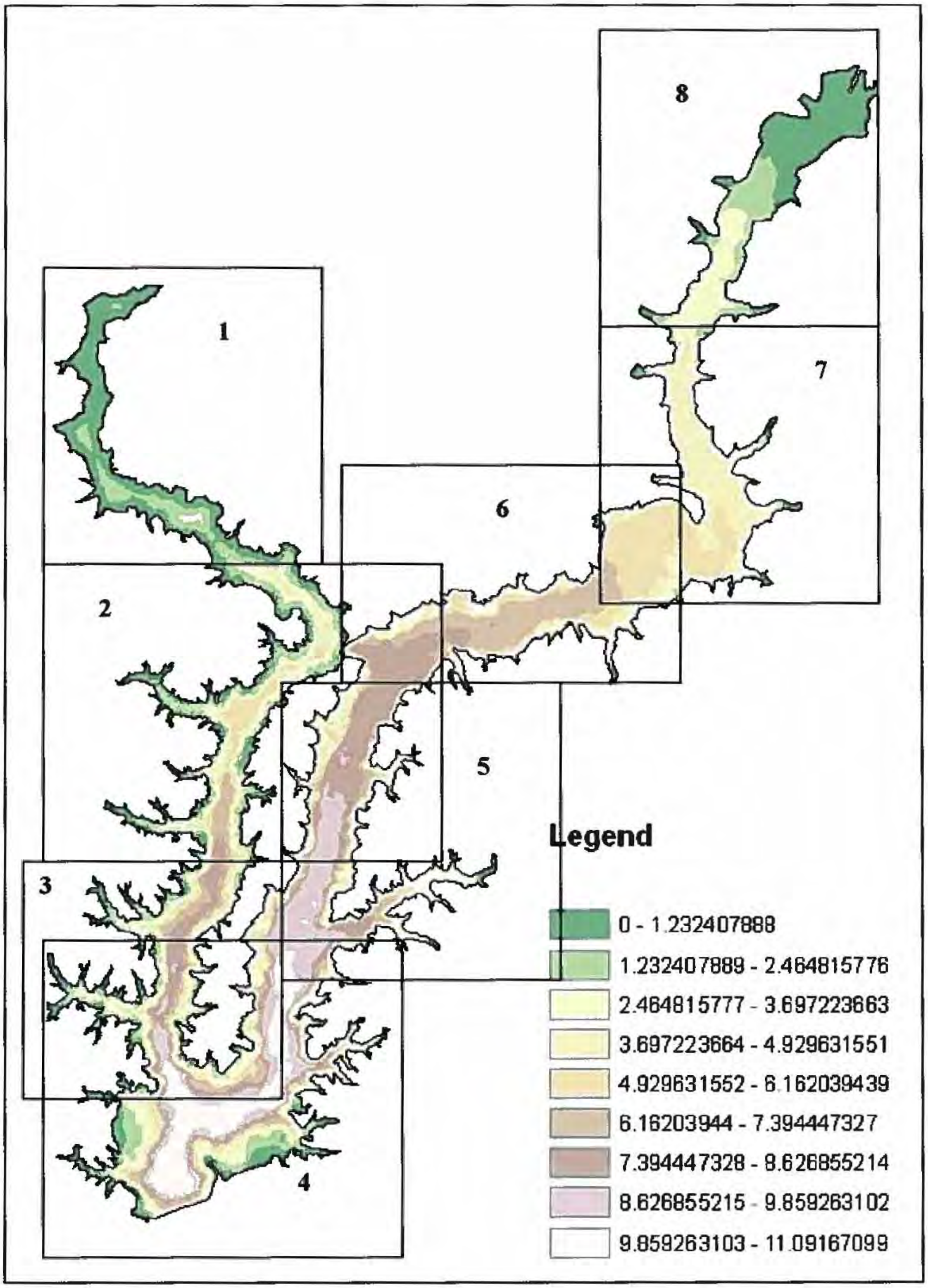


Figure C-2. Contour map of Newton Lake during 2003 showing plates illustrated in following figures.

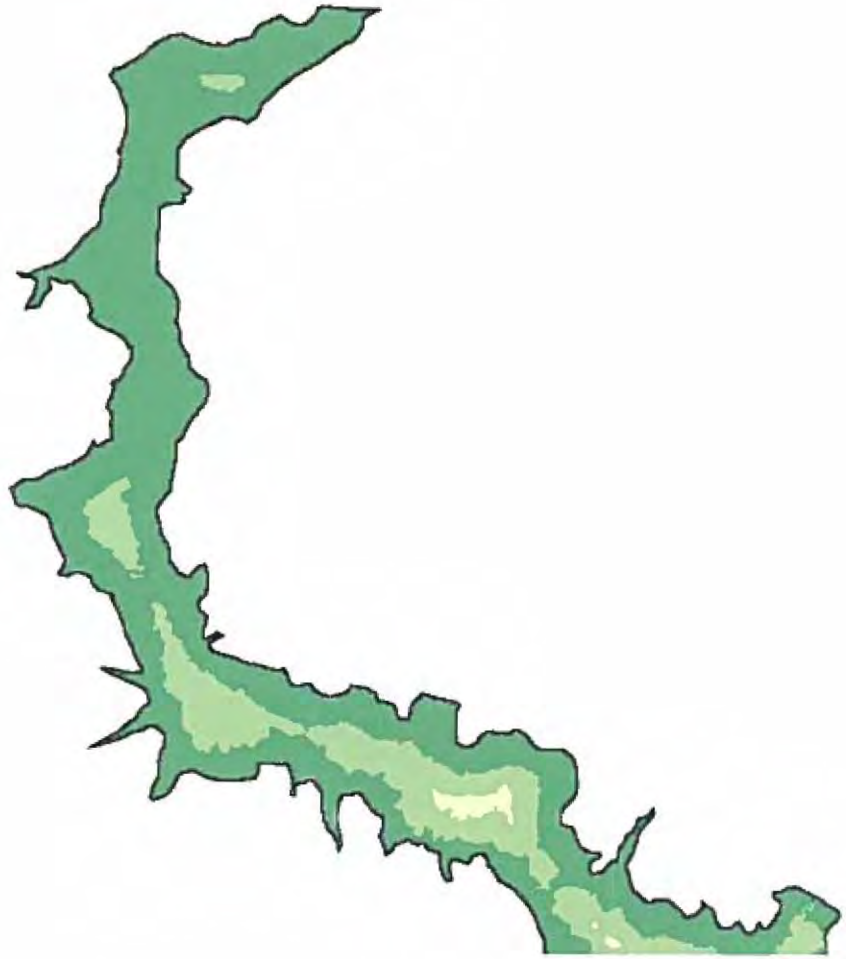


Plate C-1. Closeup of contour map illustrated in Figure 1.

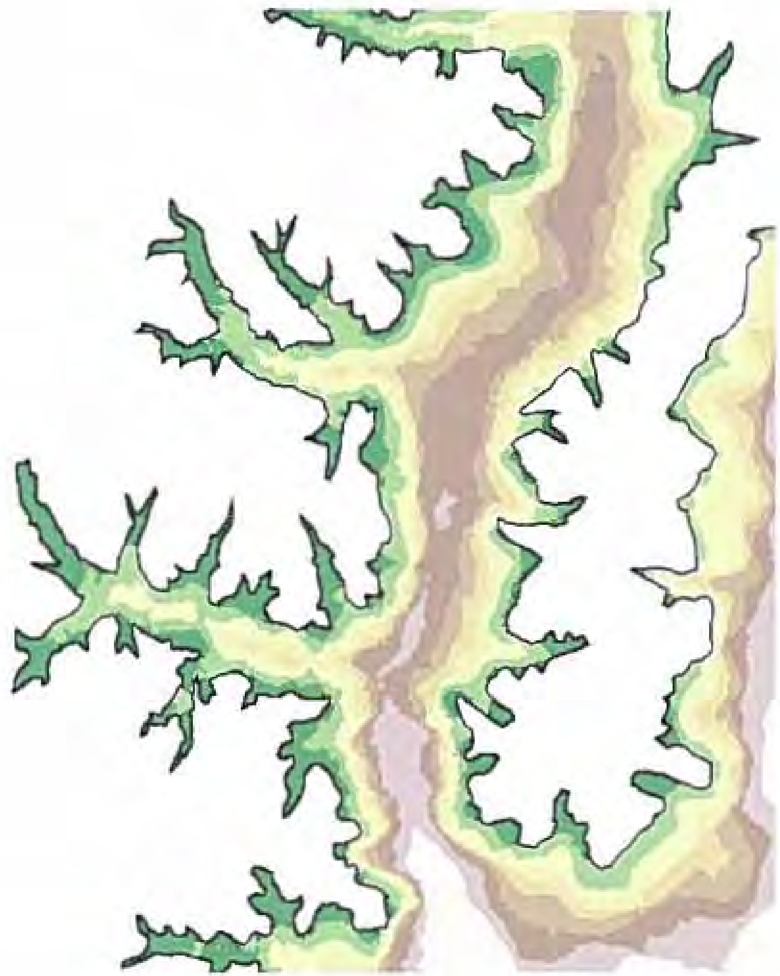


Plate C-2. Closeup of contour map illustrated in Figure 1.

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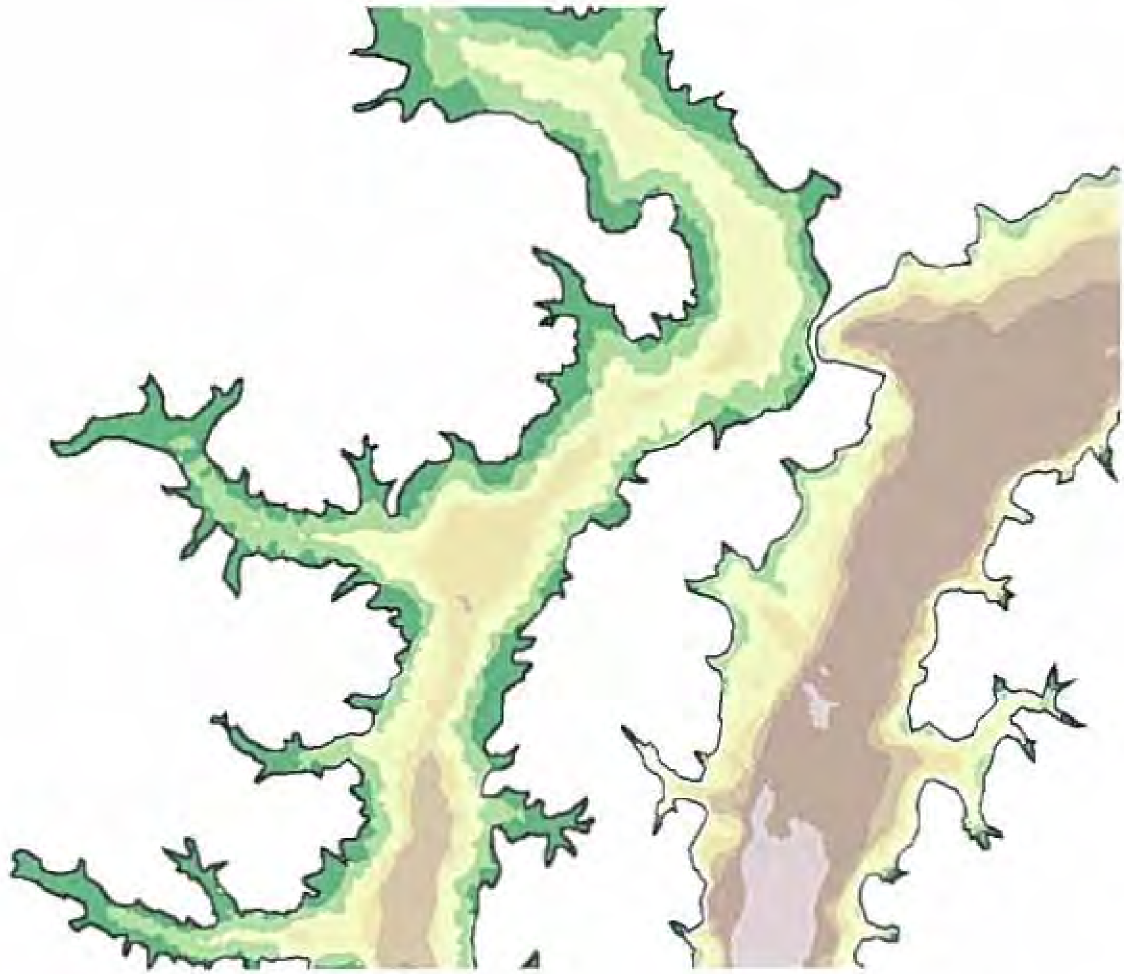

Plate C-3. Closeup of contour map illustrated in Figure 1.

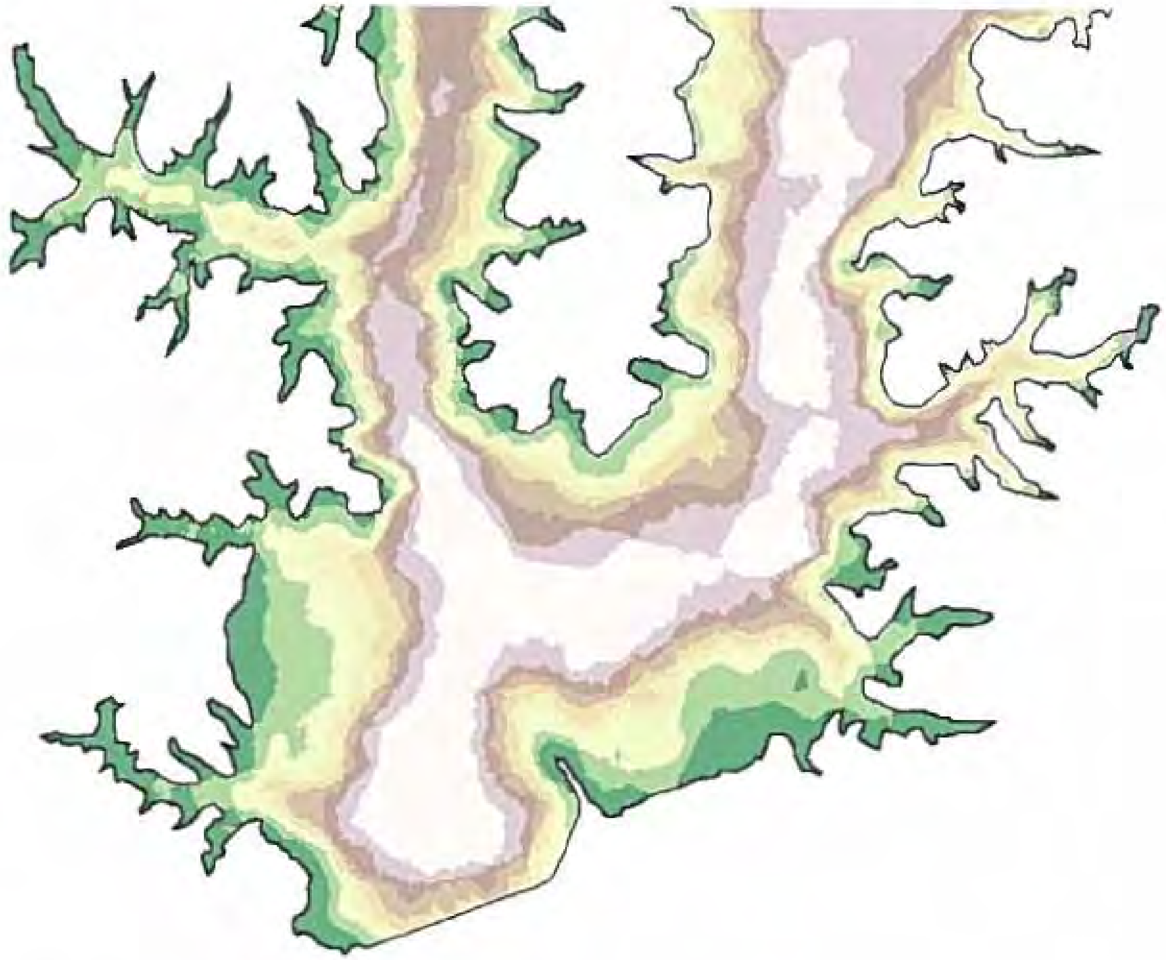

Plate C-4. Closeup of contour map illustrated in Figure 1.

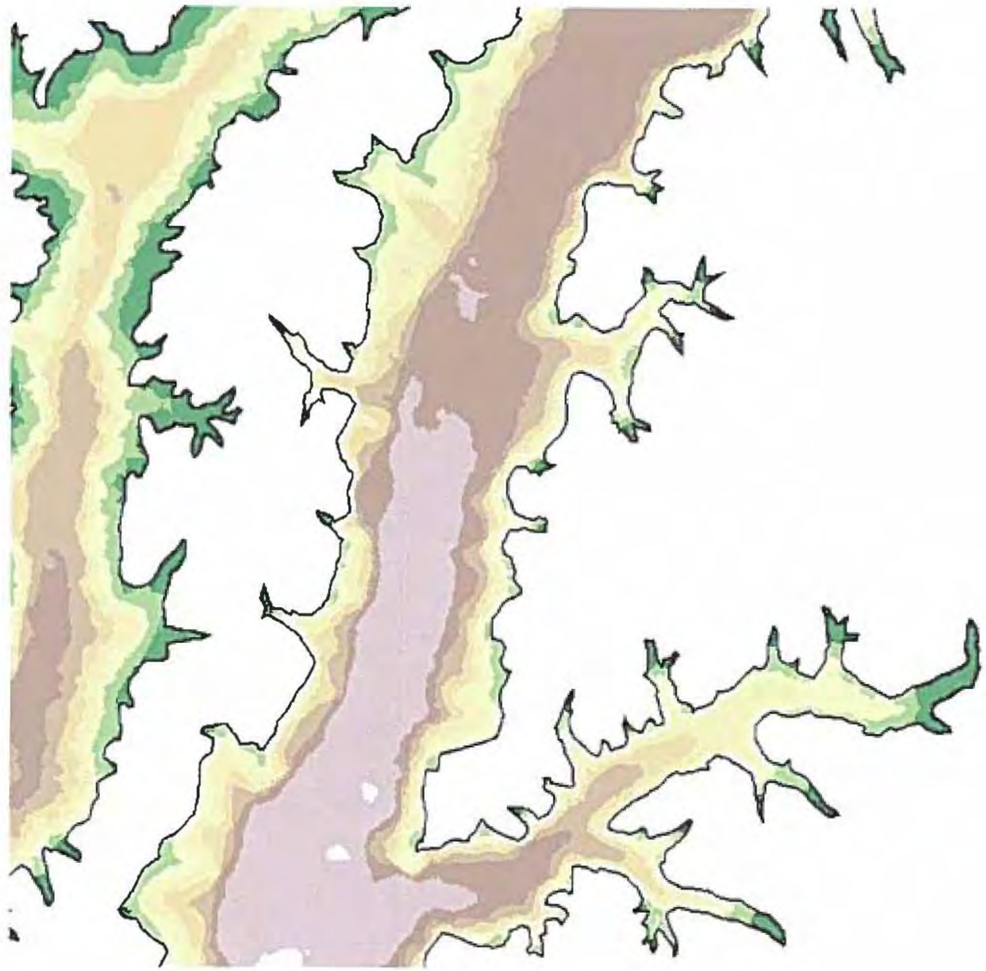

Plate C-5. Closeup of contour map illustrated in Figure 1.

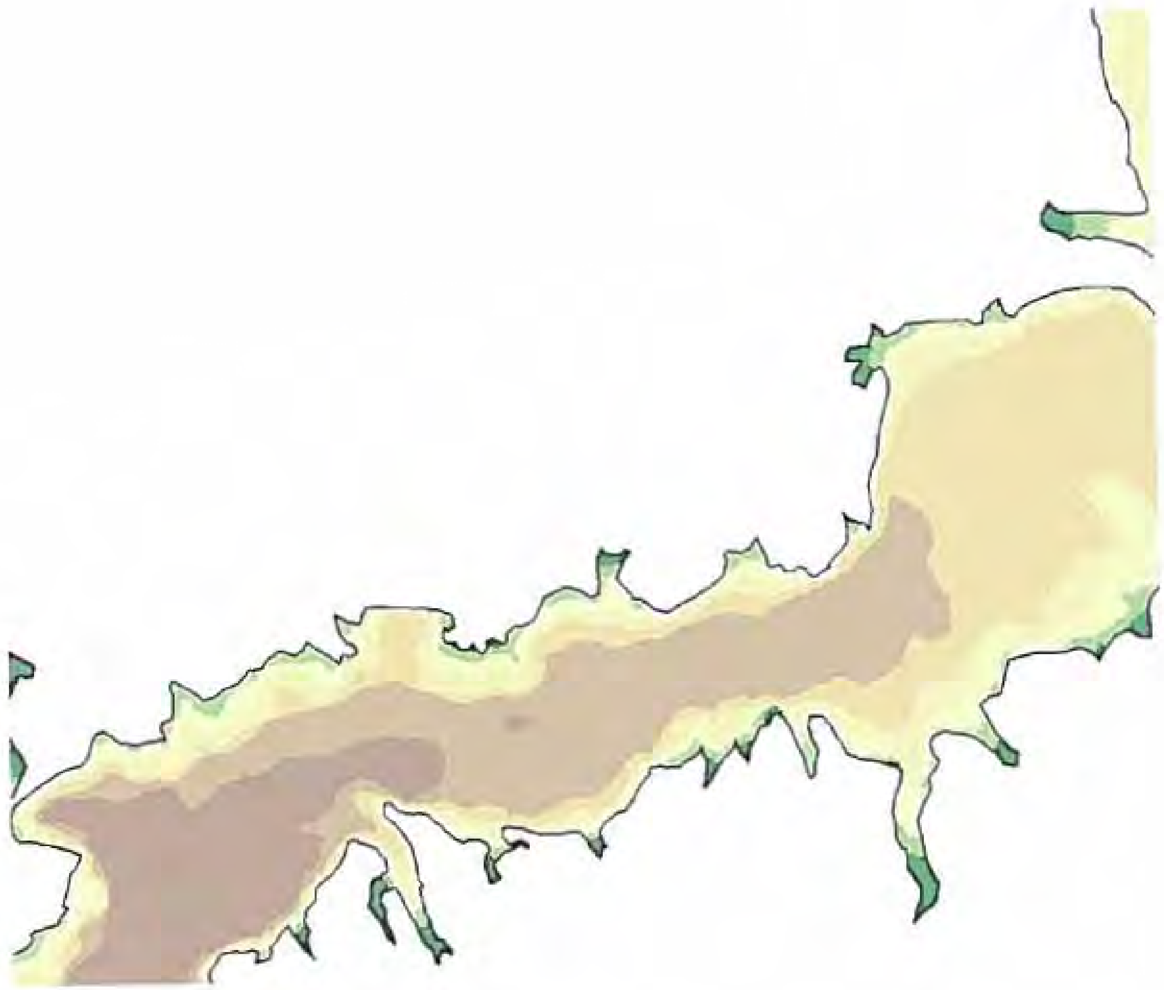

Plate C-6. Closeup of contour map illustrated in Figure 1.

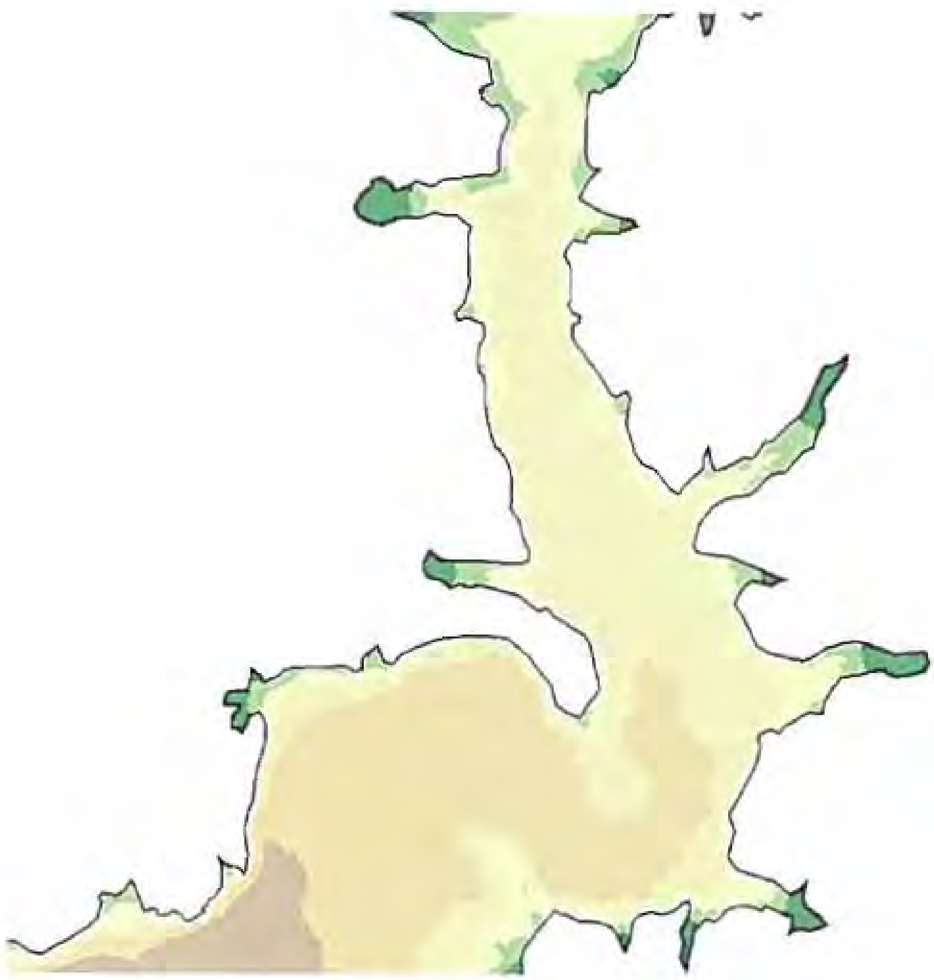

Plate C-7. Closeup of contour map illustrated in Figure 1.

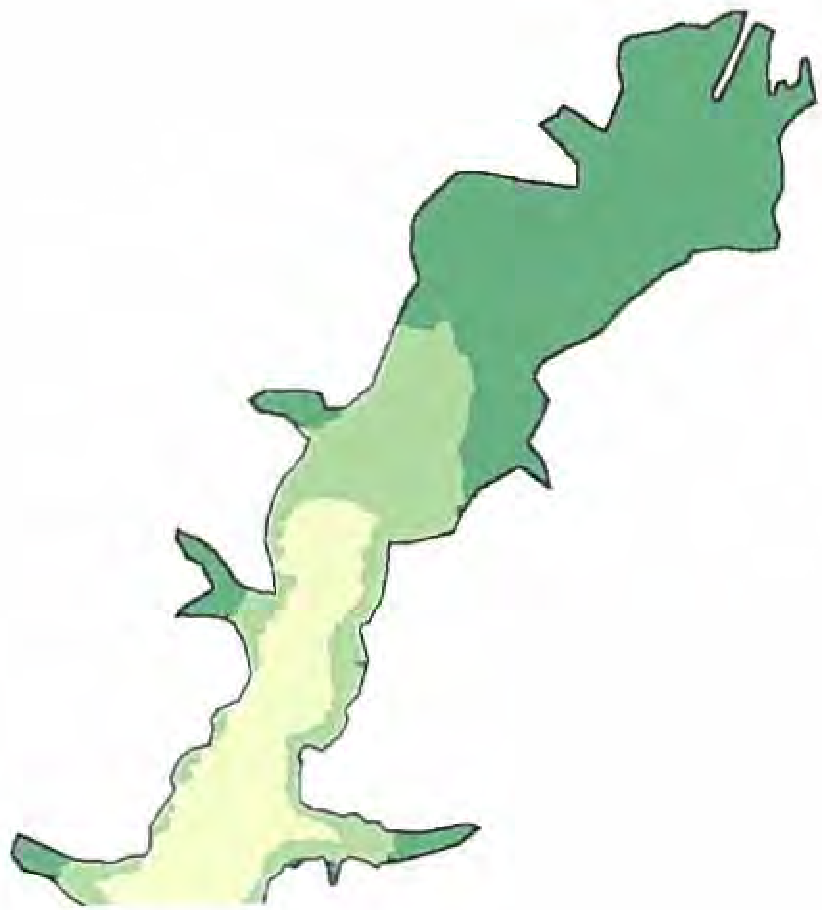

Plate C-8. Closeup of contour map illustrated in Figure 1.