ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

PRODUCTION NOTE

University of Illinois at
Urbana-Champaign Library
Large-scale Digitization Project, 2007.

Annual Report

Environmental Studies at Newton Lake, Illinois: Tasks 4, 5, and 7

(Project No. 33-16-053)

Pamela P. Tazik, Lewis L. Osborne
Carolyn Nixon, and Diane Szafoni
Center for Aquatic Ecology

and

Mark Wetzel
Center for Biogeographic Information

Illinois Natural History Survey
607 E. Peabody Drive
Champaign, Illinois 61820

Submitted to

Dr. Bruce Cox
Marathon Oil Company
P.O. Box 190168
Anchaorag, AK 99159

Aquatic Ecology Technical Report 91/6
March 1991

Environmental Studies at Newton Lake, Illinois: Tasks 4, 5, and 7 (Project No. 33-16-053) was conducted under a memorandum of understanding between the Marathon Oil Company and the Board of Trustees of the University of Illinois. The actual research was performed by the Illinois Natural History Survey, a division of the Department of Energy and Natural Resources. The form, content, and data interpretation are the responsibility of the University of Illinois and the Illin ois Natural History Survey.

Section 3 of this annual report addresses Task 5 (Aquatic Macrophyte Monitoring); Section 4, Task 4 (Benthic Macroinvertebrate Assessment); and Section 5, Task 7 (Dissolved Oxygen/Temperature Profiles).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Acknowledgments

We express our sincere gratutude to Deborah Bruce, Central Illinois Public Service Company, for providing data and information on Newton Lake, and for arranging access to the lake for data collection. She made several trips to the lake at our request in 1990 and provided precipitation, temperature, and lake level data that are used in this report. Our thanks go to Eric Ohler, Kara Wittler, Dana Wood, Tim Smith, and Jack Wagner for their assistance in sample collection and data entry. Rick Phillippe identified vegetation specimens and facilitated archiving voucher specimens in the Illinois Natural History Survey Herbarium.

Section 1. Introduction

Aquatic ecosystems contain key biotic and abiotic components that are interconnected by numerous functions and processes. Disturbances often trigger alterations in these components, producing undesirable changes in system functions. With increasing demand for petroleum and petrochemical products has come a concomitant increase in levels of petroleum hydrocarbons in aquatic ecosystems. Accidental release of petroleum products into both marine and freshwater aquatic systems has occurred with increasing regularity during the past two decades. This has generated environmental concern resulting in research to determine the impacts of oil pollution (Blankenship & Larson 1978, Kinako 1981).

Ecological, biological, and chemical research has been conducted in areas subjected to oil spills. Although it is still difficult to predict environmental damage from any particular spill, some general trends have been noted. Oil pollution (1) reduces oxygen exchange, (2) stimulates the decomposer community, and (3) increases biological oxygen demand in water and sediments (Werner et al. 1985). The impact of a spill depends on the type and amount of oil spilled, physiography of the spill area, time of year, and weather conditions during spillage (Burk 1977, Ferrell et al. 1984, Kinako 1981, Laubier 1980).

On 27 April 1985, 10,775 barrels (452,550 gallons) of heavy Louisiana sweet crude oil entered Laws Creek (T6N, R8E, S18) at the north end of the east arm of Newton Lake from a ruptured pipeline owned by Marathon Pipeline Company. Floating booms were installed by Marathon to contain the oil in the northern end of the lake. Inclement weather and excessive spring runoff caused the booms to fail and allowed oil to spread to other portions of lake. Clean-up operations expanded as the area of oil contamination increased. Cleanup was completed in August 1985.

After the spill, Central Illinois Public Service Company (CIPS), the Illinois Department of Conservation (IDOC), and Environmental Science and Engineering, Inc. (ESE) surveyed Newton Lake to document the spread of oil and to identify the degree of contamination in areas of the lake (later referred to a zones). ESE conducted post-spill investigations in 1985 and 1986, documenting water quality, sediment quality, ichthyoplankton, adult and juvenile fish, benthic macroinvertebrates, and aquatic macrophytes (ESE 1987). Zone 1, the upper cold-water arm, was identified as having the most degraded habitat and biotic communities in the lake with negligible recovery during the 16-month post-spill period. Field observations through spring 1988 revealed little further recovery in habitats or biota. These post-spill monitoring results prompted IEPA to request further environmental studies of Newton Lake to document resource recovery.

The purpose of this environmental assessment is to characterize the status and recovery patterns in several biotic and abiotic components of Newton Lake. It is a cooperative project involving staff at the Illinois Natural History Survey (INHS) and Arthur D. Little, Inc. (ADL). Components under study include benthic macroinvertebrates (INHS), aquatic macrophytes (INHS), disolved oxygen/temperature profiles (INHS), and sediment and water chemistry (ADL).

This annual report contain results from the second year of a 3-year study designed to quantitatively describe macrophyte and macroinvertebrate communities in Newton Lake and to assess impacts and recovery from the 1985 oil spill. Because dissolved oxygen concentrations are critical to the development and maintenance of benthic macroinvertebrate communities, dissolved oxygen/temperature profiles are included as part of the environmental assessment.

References

Blankenship, D.W., and R.A. Larson. 1978. Plant growth inhibition by the water extract of a crude oil. Water, Air, Soil Pollut. 10:471-476.

Burk, C.J. 1977. A four year analysis of vegetation following an oil spill in a freshwater marsh. J. Appl. Ecol. 14:515-522.

Environmental Science and Engineering, Inc (ESE). 1987. 1985/86 Newton Lake oil spill studies. Final report to Central Illinois Public Service Company, Springfield, IL. ESE No. 85-823.

Ferrell, R.E., E.D. Seneca, and R.A. Linthurst. 1984. The effects of crude oil on the growth of *Spartina alterniflora* Loisel. and *Spartina cynosuroides* (L.) Roth. J. Exp. Mar. Biol. Ecol. 82(1):27-40.

Kinako, P.D.S. 1981. Short-term effects of oil pollution on species numbers and productivity of a simple terrestrial ecosystem. Environ. Pollut. 26A:87-91.

Krueger, H.O., J. P. Ward, and S.H. Anderson. 1988. A resource manager's guide for using aquatic organisms to assess water quality for evaluation of contaminants. U.S. Fish Wildl. Serv. Biol. Rep. 88(20).

Laubier, L. 1980. The Amoco Cadiz oil spill: an ecological impact study. Ambio 9(6):286-276.

Werner, M.D., V.D. Adams, V.A. Lamarra, and N.L. Winters. 1985. Responses of model freshwater ecosystems to crude oil. Water Res. 19(3):285-292.

Section 2. Description of the Study Area

Newton Lake (Fig. 2-1) is located in Jasper County, Illinois (T5N, T6N, R8E, R9E). The primary purpose of this 1,750-acre lake is to provide cooling water for the Newton Lake Power Station, which is operated by the Central Illinois Public Service Company (CIPS), Springfield, Illinois. The lake was created in 1975 by constructing a 50-ft high dam at Weather Creek. Normal lake level (505.0 ft elevation) was attained in 1977 concomitant with initial operation of Unit 1 of the power plant.

The lake has a drainage area of 48 mi^2 and two tributaries, Sandy Creek and Laws Creek. Lake length is approximately 6.5 mi along Laws Creek and 5 mi along Sandy Creek. Maximum depth at construction was 40 ft, and average depth 16 ft. CIPS purchased 8,000 acres for construction of the lake and they manage terrestrial areas near the lake as wildlife habitat. Much of the lake perimeter is gently sloping wooded areas, with agricultural lands beyond the wooded areas.

CIPS has 16 permanent temperature/dissolved oxygen monitoring stations throughout the lake, where measurements are recorded at 1-m depth intervals May through September. There are five monitoring platforms for recording temperature at a depth of 1 m; these platforms are operated year-round. The sport fishery of the lake is monitored and managed by the Illinois Department of Conservation (IDOC) in cooperation with CIPS, and fishery reports are prepared for Newton Lake semi-annually. A public boat ramp and picnic area at the south end of the lake (west of the dam) is maintained by the IDOC (Fig. 2-1).

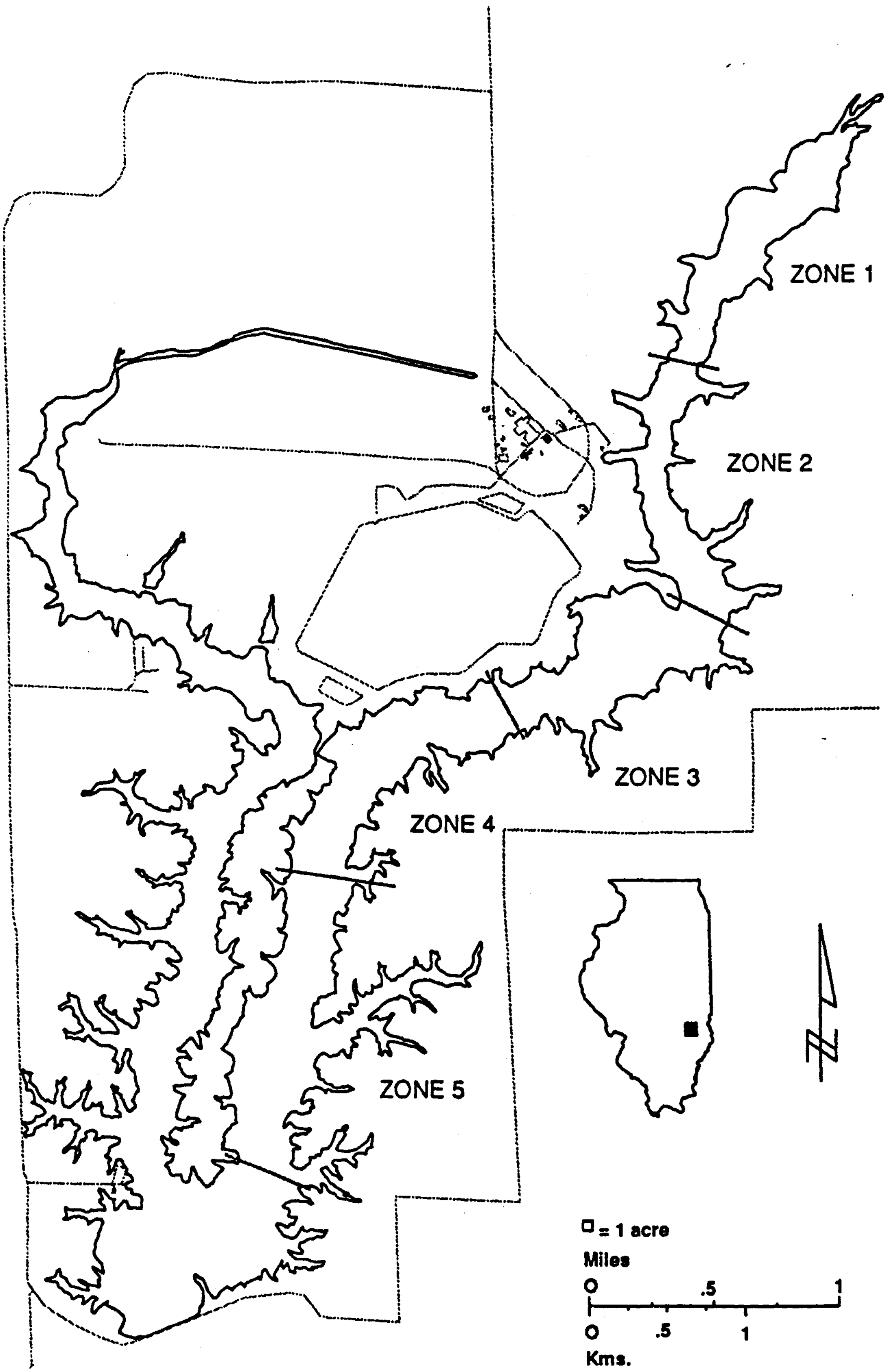

Fig. 2-1. Newton Lake, Jasper Co., Illinois, with zone designations. Zones 1 and 2 were areas most impacted by the oil spill. Zones 3-5 were relatively unaffected by the spill and served basically as controls.

Section 3. Aquatic Macrophyte Monitoring

Introduction

Macrophytes are an integral part of aquatic systems. They diversify lentic habitats and fuel secondary production by producing oxygen, cycling nutrients, and providing cover for fishes and substrate for fish food organisms (Raschke 1978, Wright et al. 1981, Engel 1985, Barko et al. 1986).

Macrophyte communities interact with both biotic and abiotic system components. Sudden changes in turbidity, water depth, and pollutants can adversely affect established communities. Conversely, macrophytes can modify their environment by altering water flow and depositional patterns, by modifying sediment and water chemistry (Sculthorpe 1967, Westlake 1973, Hutchinson 1975, Dawson et al. 1978), and through substance uptake and release (Hill 1979, Jaynes & Carpenter 1986, Smith & Adams 1986). These interactions cause communities to change in abundance, distribution, and species composition resulting in impacts on other ecosystem components.

Significant quantities of petroleum and petrochemical products have been introduced into aquatic habitats in recent years through spills and via wastewater and stormwater drainages (Green and Trett 1989). Environmental concern over the effect of petroleum, particularly from oil spills, has resulted in increased biological, chemical, and ecological research on this topic. Measurement of the impact of any particular contaminant on an aquatic ecosystem is difficult. Nonetheless, several factors have been identified as important in assessing environmental damage (Krueger et al. 1988). For instance, the degree of impact caused by oil spills depends on the type and amount of oil spilled, physiography of the spill area, time of year, and weather conditions during spillage (Burk 1977, Laubier 1980, Kinako 1981, Ferrell et al. 1984). General trends that have been associated with oil spills include: 1) reduction in oxygen exchange, (2) stimulation of the decomposer community, and (3) increases in the biological oxygen demand in the water and sediments (Werner et al. 1985).

Oil spillage may cause widespread damage to plant communities (Green and Trett 1989). Although the mechansims are not well understood, impacts of oil on aquatic vegetation communities relate primarily to interference with photosynthesis, the pattern and timing of recovery, and impacts on decomposition rates of vascular plant litter. Oil interferes with photosynthesis by interrupting physiological processes of oxygen production or carbon dioxide use, limiting light access, and impeding gas exchange (DuLaune et al. 1979, Bate & Crafford 1985, Tukaj 1987, Singh & Gaur 1988). Oil adds to the biological oxygen demand of the system and reduces the rate and extent of plant litter decomposition by reducing oxygen below levels needed for complete decomposition (Werner et al. 1984a, 1984b).

This study is designed to characterize the status of the aquatic macrophyte community in Newton Lake, Jasper County, Illinois, and to assess community impacts and recovery from a 1985 oil spill in the northeast arm of the lake. Species composition, abundance, and distribution of aquatic macrophytes are being monitored in areas directly subjected to the oil spill and in those areas relatively unaffected by the spill. Community changes are being documented over a 3-year period (1989-1991). Modifications to the initial study design were implemented prior to the second year of research to clarify interactions between sediment PAH levels and aquatic macrophyte populations in Newton Lake (Tazik *et al.* 1990). Below we provide an initial analysis of the second year of data.

Materials and Methods

Stations for vegetation analysis and sediment chemistry were selected according to a stratified random sampling design. A total of 16 stations were established in Zone 1+2 (Zones 1 and 2 combined) and Zone 4. Within each of the two zones, four stations were established in each of two strata, vegetated and non-vegetated. Each station included an 80-100 m length of shoreline. All vegetated and non-vegetated stations in Zone 1+2 and Zone 4 were established in May 1990, except station 191, which was established in July (Figs 3-1 and 3-2). Station numbers and their associated strata designations are given in Table 3-1.

Table 3-1. Station numbers selected for sampling of aquatic macrophytes in Newton Lake in 1990. Strata designations are V = vegetated and NV = non-vegetated. Station locations are given in Figs. 3-1 and 3-2.

Zone	Station Number	Strata
1+2	17	NV
1+2	39	NV
1+2	55	NV
1+2	66	V
1+2	67	V
1+2	104	NV
1+2	112	V
1+2	113	V
4	161	V
4	169	NV
4	172	V
4	182	NV
4	187	V
4	190	NV
4	191	V
4	197	NV
4	205	V
4	214	NV

To minimize variation between vegetated and non-vegetated strata, shoreline areas of Zones 1+2, and 4 were screened for the slope, water depth, exposure (orientation), fetch, and sediment type. Specific criteria for each of these physical parameters are as follows:

Slope: $\leq$ 1:3 (vertical:horizontal), samples collected within 5 m of shoreline
Water Depth: $\leq$ 1 m of water
Exposure: fetch < 0.25 miles, shoreline orientation approximately perpendicular to wind direction (NE)
Sediment type: predominantly sand

Sampling for macrophyte standing crop biomass took place during the weeks of 21 May, 11 June, 9 July, 6 August, and 1 October. Additional trips were made to Newton Lake to examine the plant populations during the weeks of 25 June and 3 September. Above-ground standing crop biomass of the dominant macrophytes (submersed and emersed) was measured using a standard cylindrical sampling technique (APHA *et al.* 1980), where all plant material is removed from within a 0.25-m^2 sampler. Samples were rinsed, and tissue types (e.g. above-ground plant parts versus below-ground parts) were separated. Samples were spun dry, weighed (fresh weight), and later oven dried (dry weight) in a forced air drying oven at 80°C (Grubaugh *et al.* 1986) to a constant weight. All results are expressed in grams dry weight. A minimum of 3 samples of each abundant macrophyte species were collected at the each of the 8 vegetated stations, except when plant material was not available.

In 1990 collections were made monthly May-August and in October. During field collections any plant specimens not identified during 1989 were collected for identification, and representative specimens were archived in the Illinois Natutral History Survey Herbarium. Specimens were identified according to Fassett (1957), Gleason and Cronquist (1963), Swink and Wilhelm (1979); nomenclature follows that of the latter two. Also, 35-mm photographs were taken during collections to document general conditions at the stations. All stations were marked with foresters flags and foresters tree tape.

Sediments were collected once from each of the 16 stations and chemically analyzed for PAH concentrations (Dr. Ted Saur, A.D. Little & Co.). Correlation analyses of macrophyte standing crop and PAH levels will be included in the final report.

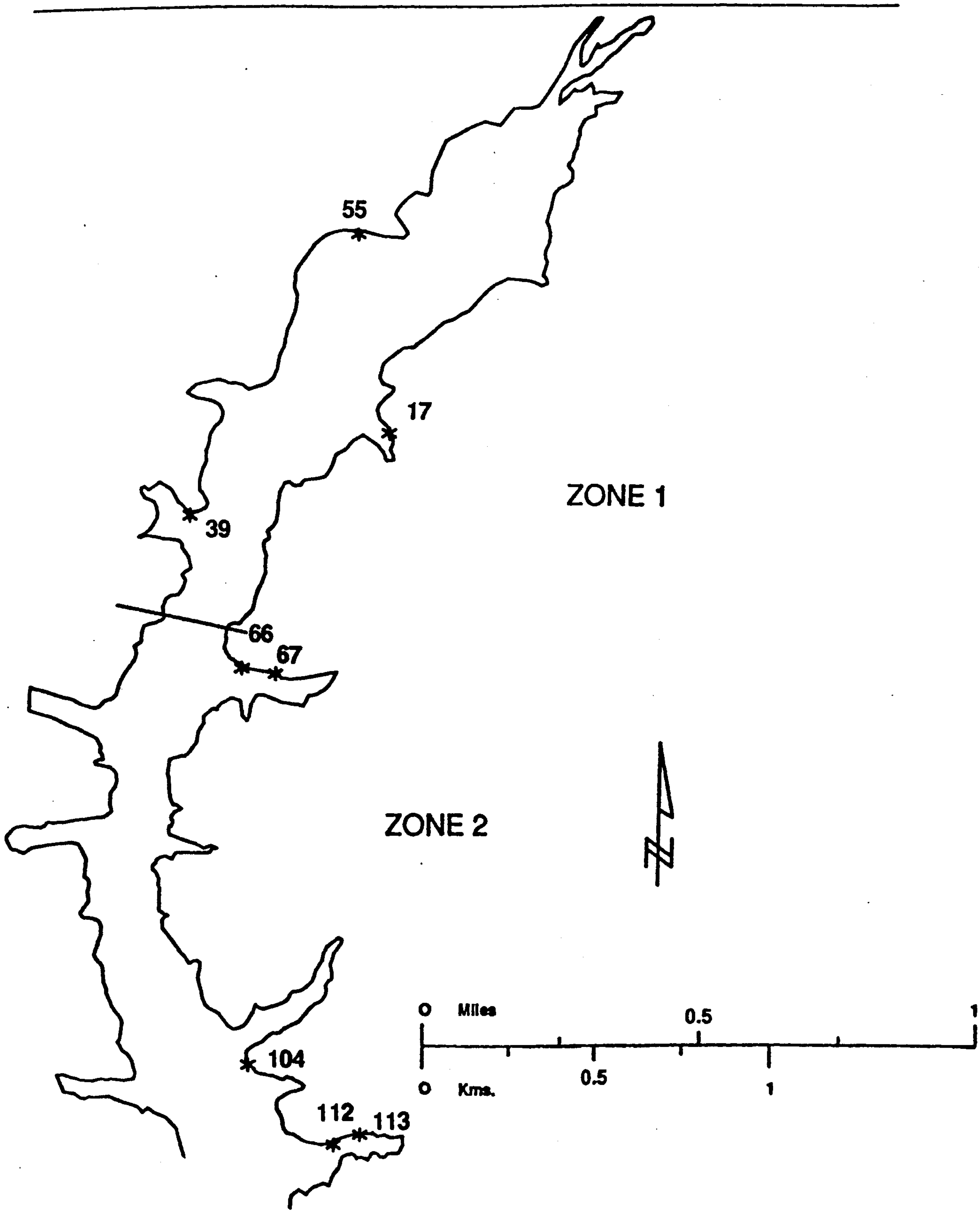

Figure 3-1. Aquatic macrophyte sampling stations in Zone 1+2, Newton Lake. Stations are marked with a star (*) and labeled with numbers. For strata designations see Table 3-1.

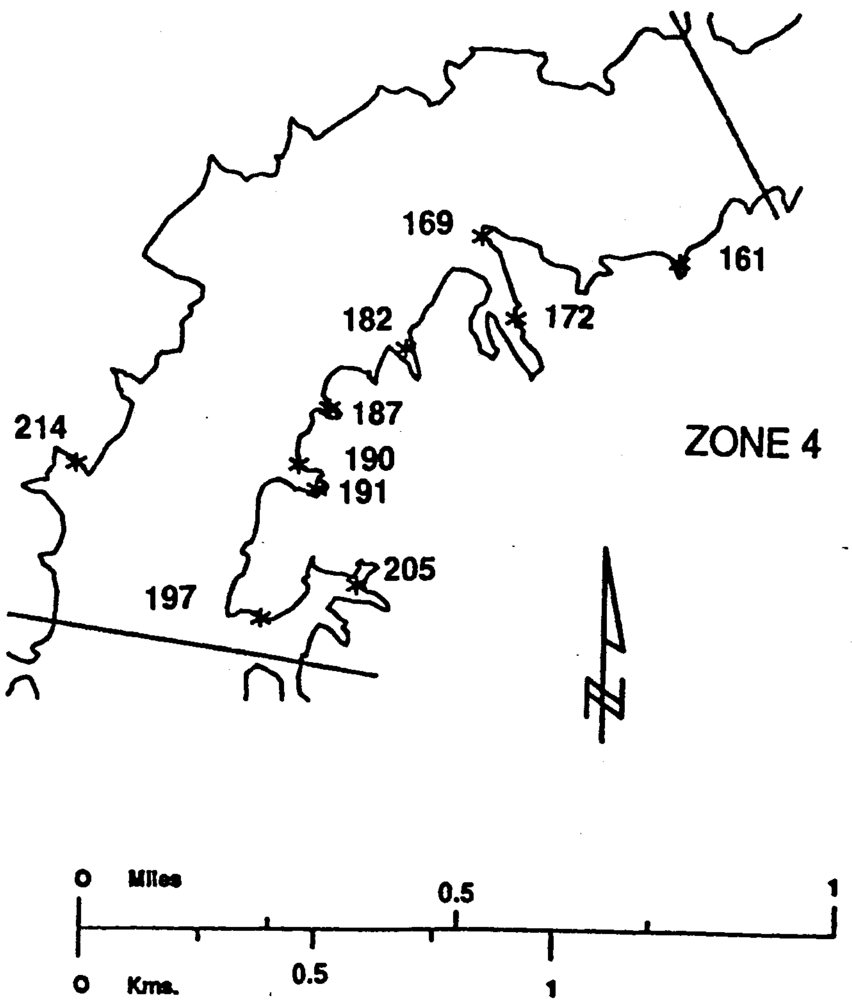

Figure 3-2. Aquatic macrophyte sampling stations in Zone 4, Newton Lake. Stations are marked with a star (*) and labeled with numbers. For strata designations see Table 3-1.

Results and Discussion

MACROPHYTE TAXA. Thirteen vascular plant genera were identified in Newton Lake during the 1989 growing season and an additional 3 genera (4 species, one species confirmation) were identified in 1990. (Table 3-2). Several specimens had insufficient morphological characteristics for definitive identifications, but probable species were identified (c.f., Table 3-2).

Table 3-2. Vascular plant taxa collected in Newton Lake in 1989 and 1990. Macrophyte growth forms are rooted (R), submersed (S), emersed(E), aquatic (A), terrestrial (T), floating (F), and floating-leaved (FL). The absence of essential morphological characteristics allowed only probable identifications (c.f.) in some cases.

Scientific name	Common name	Growth form
Carex squarrosa L.	Sedge	R E A
Carex vulpinoidea Michx	Sedge	REA
Ceratophyllum demersum L.*	Coontail	F A
Cyperus ferruginescens Buckl.	Flatsedge	R E A
Eleocharis spp.	Spikerush	R E A
cf. *acicularis* (L.) R. & S.*	Needle rush	R E A
cf. *smallii* Britt	Needle rush	R E A
Juncus acuminatus Michx.	Rush	R E A
Justicia americana (L.) Vahl.*	American water willow	R E A
Ludwigia peploides (H.B.K.) Raven	Creeping water primrose	R E A
Panicum rigidulum Bosc ex. Nees	Panic grass	RT
Phalaris arundinaceae L.	Reed canary grass	R E A
Phragmites communis Trin	Reed grass	R E A
Potamogeton nodosus Poir*	American pondweed	R FL A
Rorippa islandica var. *fernaldiana* Butt. & Abbe.	Bog marsh-cress	R E A
Rumex cf. *altissimus* Wood	Pale dock	R E A
Rumex verticillatus L.	Swamp dock	R E A
Sagittaria cf. *latifolia* L.	Common arrowhead	R E A
Salix exigaua Nutt.	Gray sandbar willow	R T
Saururus cernuus L.	Lizard's tail	R E A
Scirpus acutus Muhl.*	Hard-stem bulrush	R E A
Scirpus americanus Pers.*	Three-square bulrush	R E A
Scirpus lineatus Michx.	Bulrush	R E A
Typha angustifolia L.*	Narrowleaf cattail	R E A
Typha latifolia L.*	Common cattail	R E A

*species included in biomass estimates in 1989 and/or 1990

AQUATIC VEGETATION STANDING CROP. Macrophyte standing crop estimates for each station sampled during each sampling period are given in Tables 3-3, and 3-4. Species collected included *Ludwigia peploides* (creeping water primrose, formerly *Jussiaea repens*), *Ceratophyllum demersum* (coontail), *Eleocharis acicularis* (needlerush), *Cyperus ferruginescens* (flatsedge), and *Justicia americana* (American water willow). Of those collected in 1990, only coontail and creeping water primrose were collected in 1989.

Development of *C. demersum* and *L. peploides* populations was dramatically different beteween 1989 and 1990; in many instances, plants were absent or non-existent in 1990 where they had been present in 1989. Thus, the overall standing crop estimates for Newton Lake were lower in 1990 compared to those from 1989 (Table 3-5, Figs. 3-3 and 3-4) (Tazik *et al.* 1990). Because of the absence of plants in 1990, no statistical comparisons were necessary to test for differences between years and zones for *C. demersum* and *L. peploides* standing crop in August or October. In essence, the 1990 biomass values at these stations were zero.

Not all stations were devoid of submersed vegetation in 1990. For instance *C. demersum* and *L. peploides* were collecd at several stations in June, 1990. We therefore addressed the question 'Was there are significant effect of zone (Zone 1+2 vs 4) or year (1989 vs 1990) on the standing crop of *C. demersum* in June. Using a two-way analysis of variance, we found no significant effects of zone or year on the standing crop biomass of *C. demersum* in June (Table 3-6). We also compared the standing crop of *L. peploides* between June 1989 and June 1990 within Zone 1+2 and found no significant effects due to years ($t = 0.729$, $df = 5$, $p = 0.499$).

Unlike stations that supported *C. demersum* and *L. peploides* populations, those with emersed species, such as *Justicia americana* and *Eleocharis acicularis*, were vegetated in August and October. These have not been the dominant emersed species in Newton Lake,and they were not present at emersed species stations sampled in 1989. Therefore, we cannot analyze for difference in standing crop between years for these emersed species. Further, because they did not occur at sampling stations in both zones in 1990, we cannot analyze for the effects of zones on standing crop.

Table 3-3. Seasonal standing crop biomass estimates for the aquatic macrophytes in Zone 1+2 of Newton Lake, Jasper County, Illinois in 1990. Biomass estimates are expressed as g dry weight m^{-2}, except for *C. demersum* which are expressed as g dry weight m^{-3}. Station locations are given in Fig. 3-1.

Month	Zone	Station	Depth(m)	Species	Mean Biomass	Standard deviation	N
May	1+2	66	0.41	*L. peploides*	7.22	6.91	5
		67	0.35	*L. peploides*	1.47	1.39	4
			0.40	*E. acicularis*	22.29	7.01	3
		112	0.29	*C. demersum*	22.45	28.12	6
			0.32	*L. peploides*	6.41	4.62	3
		113	0.30	*C. demersum*	14.45	11.88	5
June	1+2	66	0.13	*L. peploides*	14.09	6.11	4
		67	0.25	*L. peploides*	6.43	2.10	2
			0.26	*E. acicularis*	117.26	52.55	6
		112	0.17	*C. demersum*	8.58	6.40	6
			0.15	*L. peploides*	4.49	5.35	2
		113	0.25	*C. demersum*	9.96	13.60	6
			0.20	*L. peploides*	.86		1
		152	0.35	*C. demersum*	4.88	6.96	4
July	1+2	67	0.10	*E. acicularis*	55.98	15.36	6
August	1+2	67	0.00	*E. acicularis*	129.25	109.7	6
October	1+2	67	0.00	*C. ferruginscens*	7.96	7.12	4
			0.00	*E. acicularis*	86.56	33.03	6

These results indicate that when submersed plants (*C. demersum* and *L. peploides*) were present there was no difference in standing crop due to zones or years. However, the greatest difference was the absence of plants at most sites during August and October 1990. Our observations indicate that after limited spring germination, populations of *C.*

Table 3-4. Seasonal standing crop biomass estimates for the aquatic macrophytes in Zone 4 of Newton Lake, Jasper County, Illinois in 1990. Biomass estimates are expressed as g dry weight m^{-2}, except for *C. demersum* which are expressed as g dry weight m^{-3}. Station locations are given in Fig. 3-2

Month	Zone	Station	Depth (m)	Species	Mean Biomass	Standard deviation	N
May	4	161	0.40	*C. demersum*	9.19	4.78	5
		172	0.50	*C. demersum*	9.68	12.79	5
		187	0.33	*L. peploides*	2.72	0.72	2
			1.05	*C. demersum*	8.75	3.05	2
		200	0.48	*C. demersum*	2.84	3.85	4
		205	0.52	*C. demersum*	12.70	16.54	6
June	4	161	0.46	*C. demersum*	10.68	7.10	6
		172	0.26	*C. demersum*	10.39	6.60	4
		187	0.75	*C. demersum*	5.88	2.63	4
		205	0.41	*C. demersum*	12.04	8.03	5
July	4	191	0.33	*J. americana*	180.71	70.50	6
August	4	191	0.18	*J. americana*	179.67	161.4	6
October	4	191	0.0	*J. americana*	265.41	147.57	6

dermersum and *L. peploides* failed to develop through the 1990 growing season; standing crop fell to zero and did not recover (Table 3-5, Figs 3-3 and 3-4). There are a number of possible explanations for this including: 1) contamination of the lake by a exogenous toxic substance (e.g., agricultural herbicides, complex hydrocarbons), and 2) changes in physical factors or environmental conditions during critical stages of the life history of the vegetation.

Table 3-5. Standing crop biomass estimates for *C. demersum* (g dry weight m^{-3}) and *L. peploides* (g dry weight m^{-2}) in all zones sampled in 1989 and 1990 for the sample periods (months) when they were present at the selected stations. Sample size (n) and standard deviation (SD) are given for all zones.

		Zone	Species	Mean Standing Crop Biomass	SD	N
1989						
	June	1	*C. demersum*	10.04	4.18	6
		2	*C. demersum*	171.04	57.81	6
		1+2	*C. demersum*	90.54	92.72	12
		1	*L. peploides*	4.77	5.06	10
		2	*L. peploides*	29.66	18.25	5
		1+2	*L. peploides*	10.52	13.92	15
		3	*C. demersum*	14.13	16.95	3
		3	*L. peploides*	7.21	2.60	3
		4	*C. demersum*	208.46	70.34	4
		4	*L. peploides*	35.83	28.01	3
	August	1	*C. demersum*	53.93	26.00	6
		2	*C. demersum*	155.23	125.32	6
		1+2	*C. demersum*	104.58	101.22	12
		1	*L. peploides*	8.40	3.30	3
		2	*L. peploides*	58.38	17.02	6
		1+2	*L. peploides*	41.72	28.43	9
		3	*C. demersum*	82.83	23.19	6
		3	*L. peploides*	57.24	41.66	6
		4	*C. demersum*	147.68	48.45	3
		4	*L. peploides*	45.19	14.65	3
	October	2	*C. demersum*	78.08	61.04	12
		1	*L. peploides*	2.26	1.33	6
		2	*L. peploides*	9.84	5.08	6
		1+2	*L. peploides*	6.05	5.31	12
		3	*C. demersum*	139.61	149.04	9
		3	*L. peploides*	7.31	6.44	6
		4	*C. demersum*	44.97	26.78	6
		4	*L. peploides*	15.24	16.23	3

Table 3-5 concluded.

		Zone	Species	Mean Standing Crop Biomass	SD	N
1990						
	May	1+2	*C. demersum*	18.82	21.67	11
		1+2	*L. peploides*	5.10	5.39	12
		4	*C. demersum*	10.45	11.30	18
		4	*L. peploides*	2.72	0.72	2
	June	1+2	*C. demersum*	8.17	9.45	16
		4	*C. demersum*	9.96	6.47	19
	July	1+2	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-
		4	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-
	August	1+2	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-
		4	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-
	October	1+2	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-
		4	*C. demersum*	0.00	0.00	-
			L. peploides	0.00	0.00	-

Zone 4

Ceratophyllum demersum seasonal standing crop

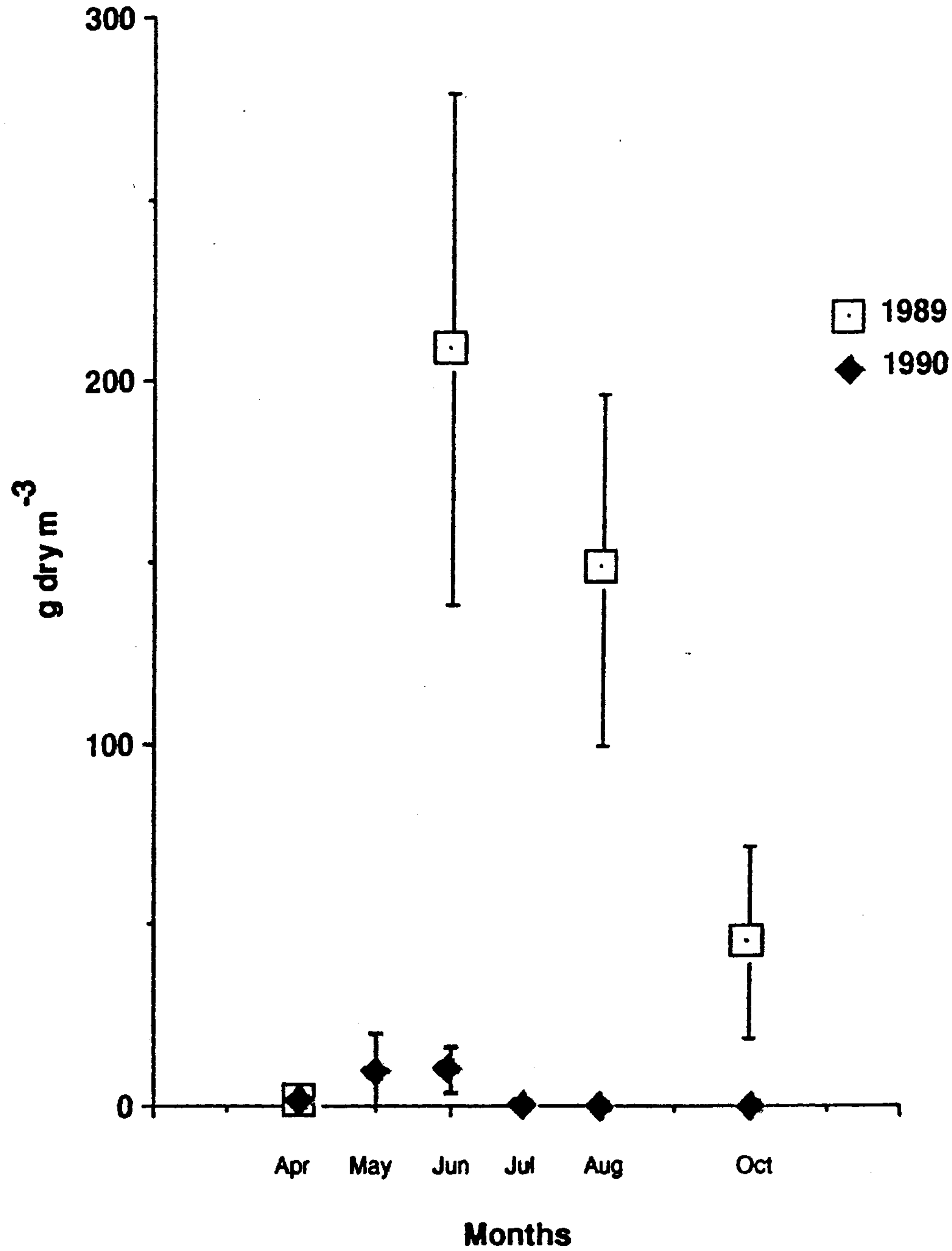

Figure 3-3. Seasonal standing crop fluctuations for *Ceratophyllum demersum* in Zone 4 in Newton Lake in 1989 and 1990. Standing crop estimates are expressed in g dry weight m^{-3}, and standard error bars are given for the means.

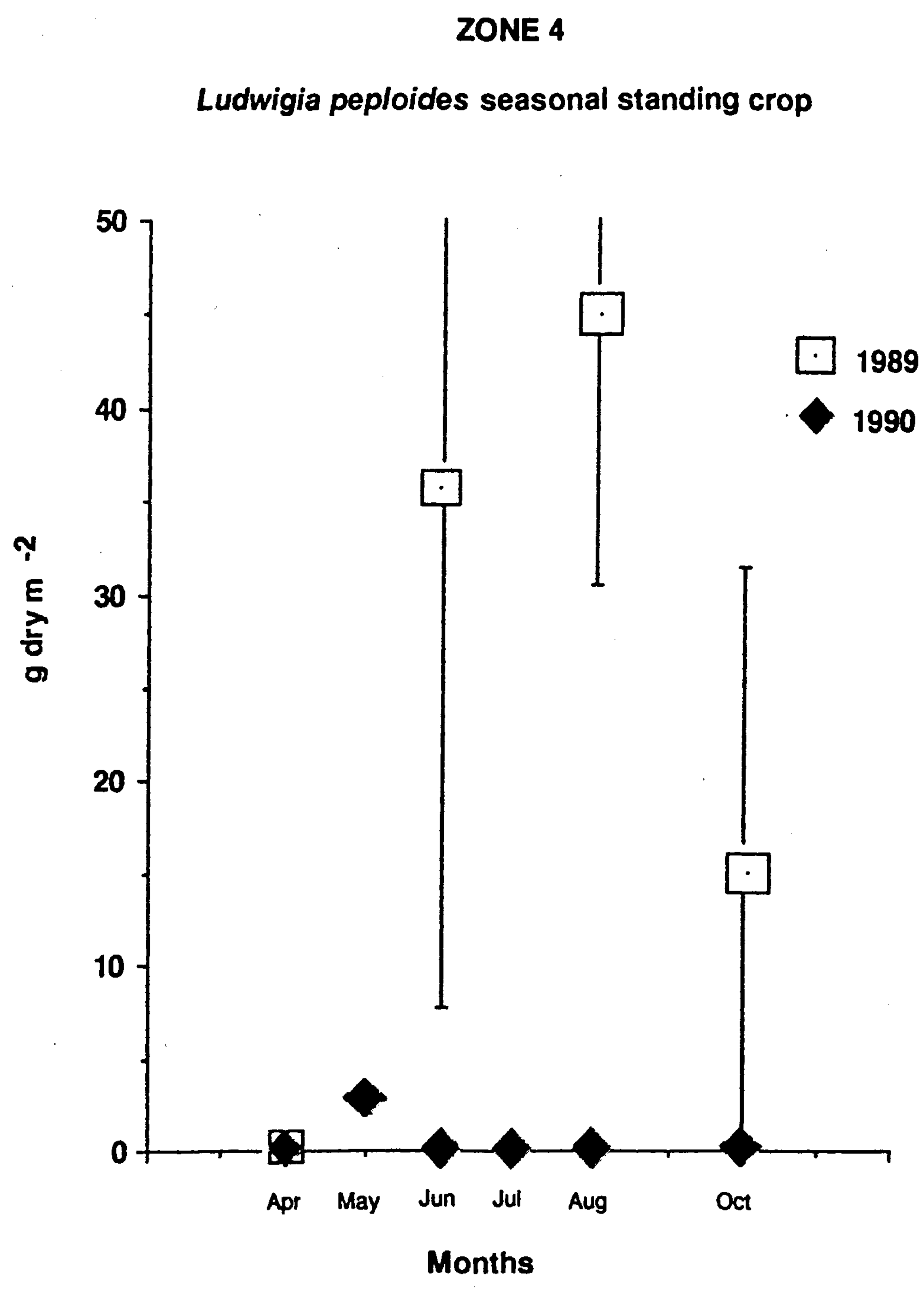

Figure 3-4. Seasonal standing crop fluctuations for *Ludwigia peploides* in Zone 4 in Newton Lake in 1989 and 1990. Standing crop estimates are expressed in g dry weight m^{-2}, and standard error bars are given for the means.

Table 3-6. Results of two-way analysis of variance on ln(biomass) of *Ceratophyllum demersum* at stations in Newton Lake, Illinois during June.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Year	2.854	1	2.854	1.146	0.312
Zone	0.594	1	0.594	0.238	0.637
Year*Zone	1.267	1	1.267	0.509	0.494
Error	22.404	9	2.489		

Beginning in June and continuing through October 1990, sample trips to Newton Lake included an examination of stations that had been sampled for macrophyte biomass in 1989, e.g., 1-3, 1-4, 2-1, 2-2, 3-2, 4-1, and 4-2. This allowed us to identify whether trends observed in 1990 seasonal development at the 1989 stations were following the patterns being exhibited at 1990 stations. The 1989 stations showed no development of vegetation, i.e., the vegetation populations were clearly not developing as they had in 1989. It appeared that the trend of 'lack of development' was a lake-wide occurrence.

Weather patterns may have influenced development of the plant populations at Newton Lake in 1990. The Central Illinois Public Service Company has provided us with data on precipitation, temperature and lake level at Newton Lake since 1985. Precipitation was particularly heavy in the central Illinois area in Spring 1990, causing severe flooding virtually throughout the area. Lake levels measured well above normal in Newton Lake for several days during May 1990 (Figs. 3-7 and 3-8). Generally, lake levels in May are at, or slightly below, normal pool (505.0 ft. elevation). However, on 16 May 1990 Newton Lake reached 508.3 ft. elevation and remained above normal pool until 23 May 1990. The coefficient of variation (standard deviation expressed as a percentage of the mean) is used to compare the magnitudes of standard deviations from different populations (Sokal and Rohlf 1969), or fundamentally reflects the degree of variation in the data set. Using this measure, it is clear that variability of precipitation in May 1990 was well above any other month for the past several years (Fig. 3-9). Spring is a critical time in the development of macrophytic vegetation. Highly variable environmental conditions such as fluctuating water levels and decreased water clarity that occurred during the spring and early summer may have adversely affected population development.

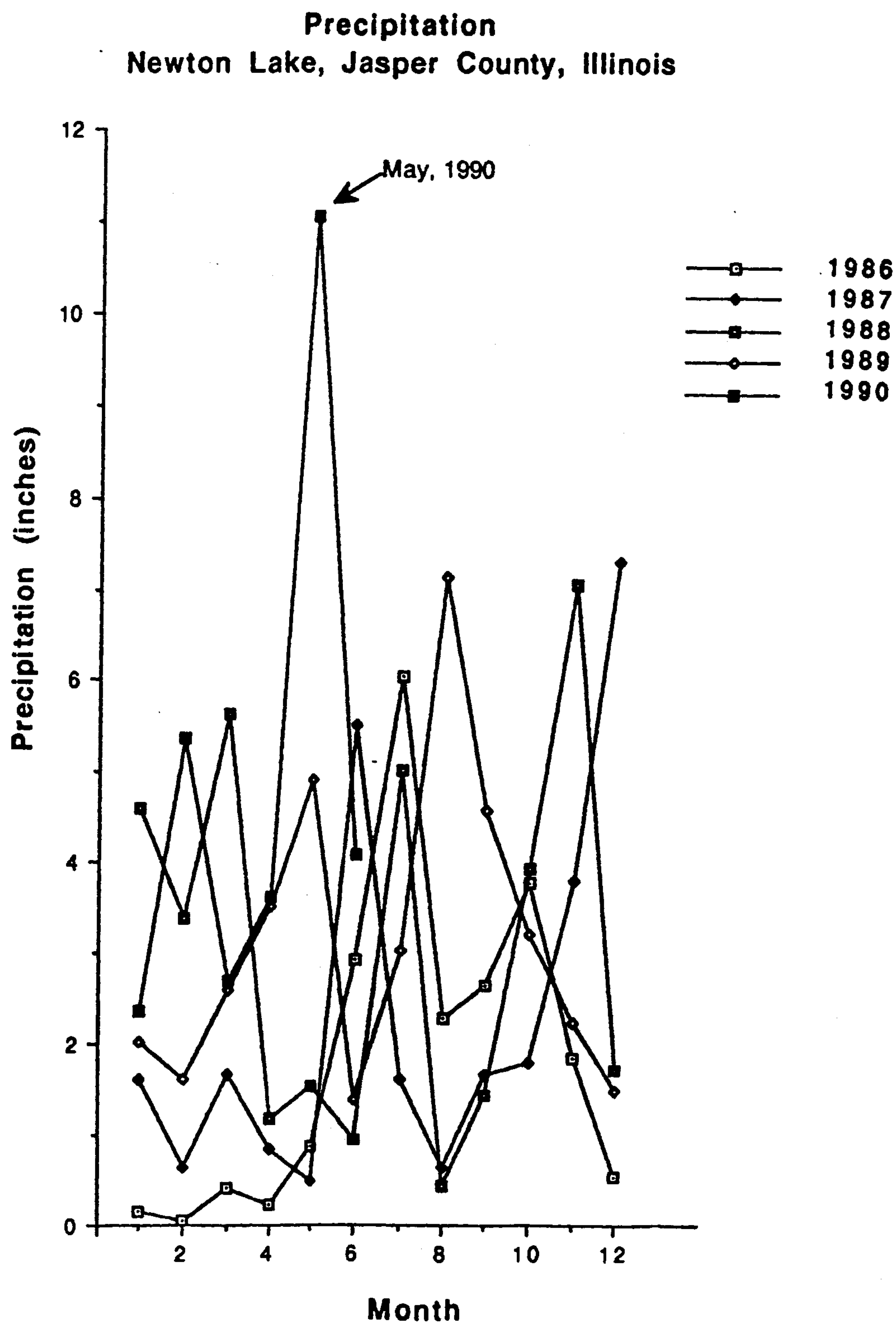

Figure 3-5. Precipitation (in.) at Newton Lake from January 1986 through June 1990. These data were collected by the Central Illinois Public Service Company.

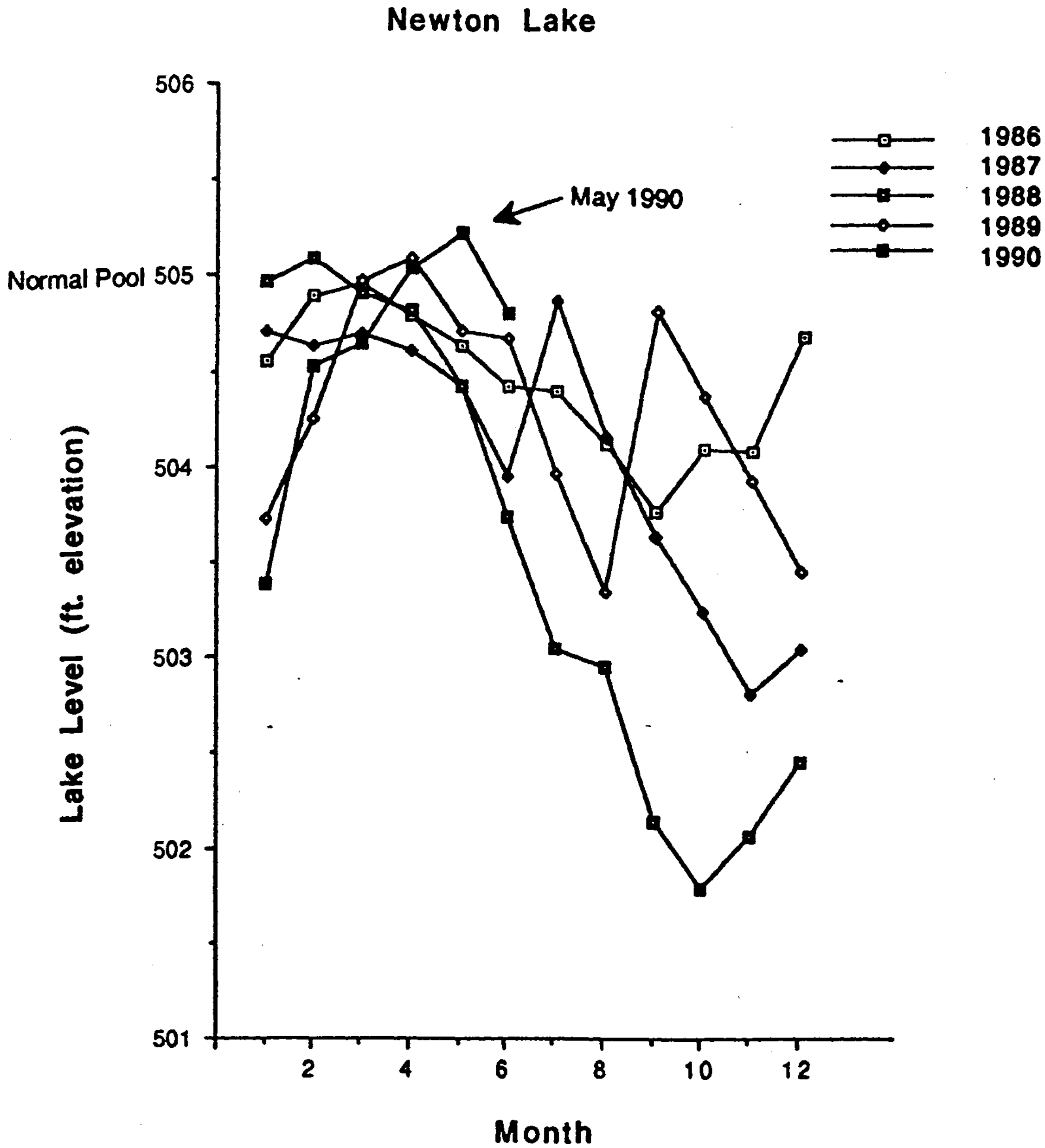

Figure 3-6. Lake levels (ft. elevation) in Newton Lake from January 1986 through June 1990. These data were collected by the Central Illinois Public Service Company. Normal pool level for Newton Lake is 505.0 ft. elevation.

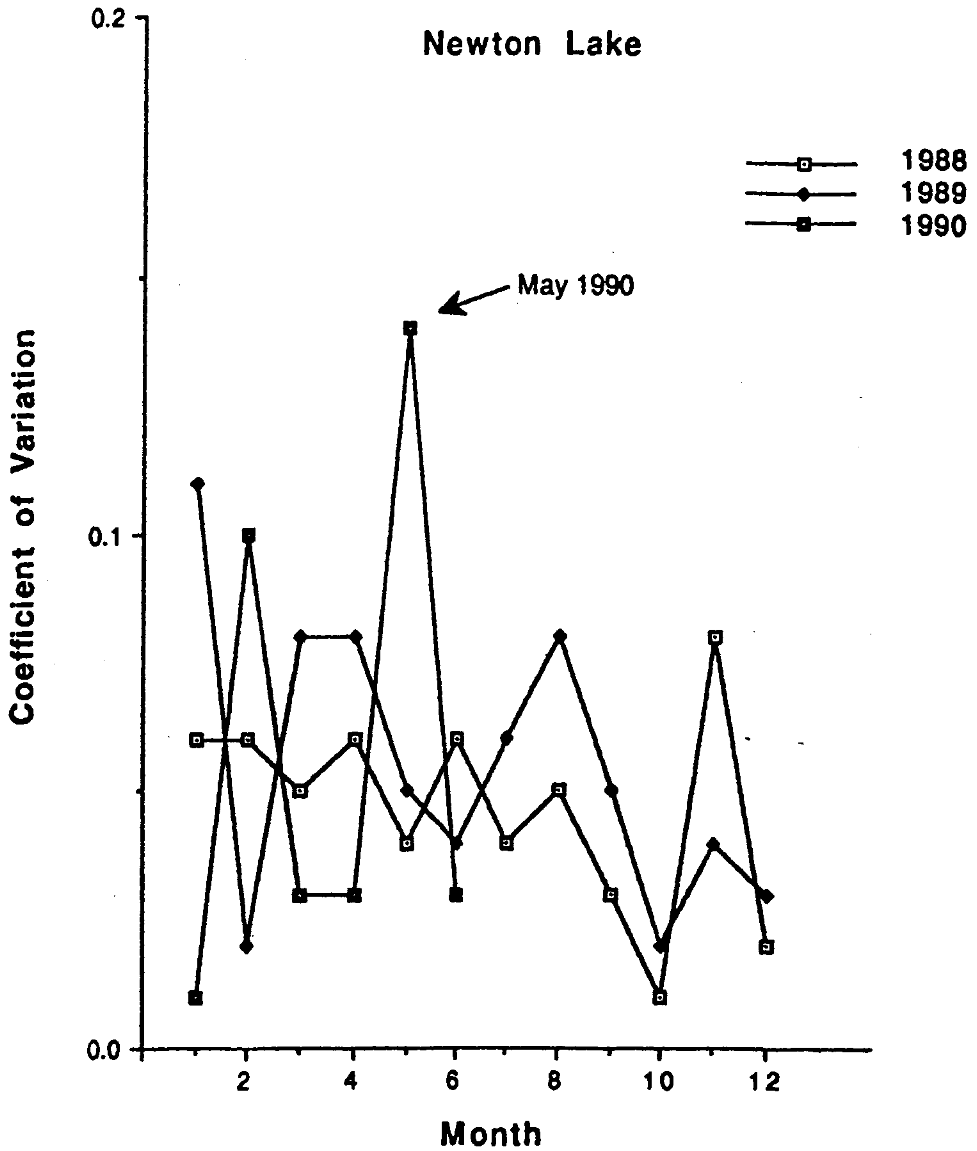

Figure 3-7. Coefficient of variation for lake levels in Newton Lake from January 1988 through June 1990. The coefficient of variation is the standard deviation expressed as a percentage of the mean and is used to compare the magnitudes of standard deviations from different populations (Sokal and Rohlf 1969).

Summary

The aquatic vegetation in Newton Lake was relatively sparse in 1989; submersed vegetation was patchy and tended to occur in coves around the lake, while clumps of emersed vegetation occur in somewhat less protected areas. Although there was no significant difference between early season standing crop (June) between the two years, the seasonal development of *Ceratophyllum demersum* and *Ludwigia peploides* in Newton Lake was dramatically different. Essentially, after limited spring germination, populations of *C. dermersum* and *L. peploides* failed to develop through the 1990 growing season; standing crop fell to zero and did not recover. There are a number of possible explanations for this including: 1) contamination of the lake by a toxic substance (e.g., herbicides, petroleum products), and 2) changes in physical factors or environmental conditions during critical stages of the life history of the vegetation. Precipitation and lake level information provided by the Central Illinois Public Service Company showed that heavy precipitation caused increased lake levels during Spring 1990, a critical period of the life history. This may have influenced seasonal development of some macrophytes at Newton Lake in 1990.

Literature Cited

APHA, AWWA, and WPCF. 1980. Standard methods for the examination of water and waste water, 15th ed. APHA, Washington, DC.

Barko, J.W., M.S. Adams, and N.L. Clesceri. 1986. Environmental factors and their consideration in the management of submersed aquatic vegetation: a review. J. Aquat. Plant Manage. 24:1-10.

Bate, G.C., and S.D. Crafford. 1985. Inhibition of phytoplankton photosynthesis by the WSF of used lubricating oil. Marine Pollut. Bull. 16: 401-404.

Burk, C.J. 1977. A four year analysis of vegetation following an oil spill in a freshwater marsh. J. Appl. Ecol. 14:515-522.

Correll, D.S., and H.B. Correll. 1972. Aquatic and wetland plants of Southwestern United States. Water Pollut. Cont. Res. Ser. 16030 DNL 01/72. U.S. Environmental Protection Agency.

Dawson, F. H., E. Castellano, and M. Ladle. 1978. Concept of species succession in relation to river vegetation and management. Verh. Internat. Verein. Limnol. 20:1429-1434.

DeLaune, R.D., W.H. Patrick, Jr., and R.J. Buresh. 1979. Effect of crude oil on a Louisiana *Spartina alterniflora* salt marsh. Environ. Pollut. 20:21-32.

Engel, S. 1985. Aquatic community interactions of submerged macrophytes. Wisc. Dept. Nat. Resour. Tech. Bull. 156.

Fassett, N.C. 1957. A manual of aquatic plants, 2nd ed. McGraw Hill Book Co. Madison, WI.

Ferrell, R.E., E.D. Seneca, and R.A. Linthurst. 1984. The effects of crude oil on the growth of *Spartina alterniflora* Loisel. and *Spartina cynosuroides* (L.) Roth. J. Exp. Mar. Biol. Ecol. 82(1):27-40.

Gleason, H.A., and A. Cronquist. 1963. Manual of vascular plants of northeastern United States and adjacent Cdanada. VanNostrand Reinhold Co., New York.

Green, J., and M.W. Trett, (eds). 1989. The fate and effects of oil in freshwater. Elsevier Applied Science, New York.

Grubaugh, J.W., R.V. Anderson, D.M. Day, K.S. Lubinski, and R.E. Sparks. 1986. Production and fate of organic material from Sagittaria latifolia and Nelumbo lutea on Pool 19, Mississippi River. J. Freshw. Ecol. 3:477-484.

Hill, B.H. 1979. Uptake and release of nutrients by aquatic macrophytes. Aquat. Bot. 7:87-93.

Hutchinson, G.E. 1975. A treatise on limnology. Vol III. Limnological botany. John Wiley & Sons, New York, N.Y.

Jaynes, M.L., and S.R. Carpenter. 1986. Effects of vascular and nonvascular macrophytes on sediment redox and solute dynamics. Ecology 67: 875-882.

Kinako, P.D.S. 1981. Short-term effects of oil pollution on species numbers and productivity of a simple terrestrial ecosystem. Environ. Pollut. 26A:87-91.

Krueger, H.O., J.P. Ward, and S.H. Anderson. 1988. A resource manager's guide for using aquatic organisms to assess water quality for evaluation of contaminants. U.S. Fish Wildl. Serv. Biol. Rep. 88(20).

Laubier, L. 1980. The Amoco Cadiz oil spill: an ecological impact study. Ambio 9(6):286-276.

Raschke, R.L. 1978. Macrophyton. Pages 39-50 *in* W.T. Mason, ed. Methods for the assessment and prediction of mineral mining impacts on aquatic communities: a review and analysis. Workshop Proc. U.S .Fish Wildl. Serv. Biol. Serv. Prog. FWS/OBS-78/30.

Rohlf, F.J., and R.R. Sokal. 1969. Statistical tables. W.H. Freeman and Co., San Franscisco, CA.

Sculthorpe, C.D. 1967. The biology of aquatic vascular plants. Edward Arnold Publishers Ltd., London.

Singh, A.K., and J.P. Gaur. 1988. Effect of assam crude on photosynthesis and associated electron transport system in *Anabaena dolium*. Bull. Environ. Contam. Toxicol. 41:776-780.

Smith, C.S., and M.S. Adams. 1986. Phosphorus transfer from sediments by *Myriophyllum spicatum*. Limnol. Oceanogr. 31:1312-1321.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co., San Francisco.

Swink, , F., and G. Wilhelm. 1979. Plants of the Chicago Region. Morton Arboretum, Lisle, IL.

Tazik, P.P., L.L. Osborne, C. Nixon, and D. Szafoni. 1990. Environmental studies at Newton Lake, Illinois: Tasks 4, 5, and 7. Project No. 33-16-053. Report to Marathon Oil Company. Aquatic Ecol. Tech. Rept 90/15. 80 pp.

Tukaj, Z. 1987. The effects of crude and fuel oils on the growth, chlorophyll 'a' content and dry matter production of a green alga *Scenedesmus quadricauda* (Turp.) Breb. Environ. Pollut. 47:9-24.

Werner, M.D., V.D. Adams, and V.A. Lamarra. 1984a. Consequences of oil pollution on the decomposition of vascular plant litter in freshwater lakes: Part 1. Decomposition rates and dissolved oxygen utilization. Environ. Pollut. 34A:83-100.

Werner, M.D., V.D. Adams, and V.A. Lamarra. 1984b. Consequences of oil pollution on the decomposition of vascular plant litter in freshwater lakes: Part 2. Nutrient exchange between litter and the environment. Environ. Pollut. 34A:101-117.

Werner, M.D., V.D. Adams, V.A. Lamarra, and N.L. Winters. 1985. Responses of model freshwater ecosystems to crude oil. Water Res. 19(3)285-292.

Westlake, D.F. 1973. Aquatic macrophytes in rivers. A review. Pol. Arch. Hydrobiol. 20:31-40.

Wright, J.F., P.D. Hiley, S.F. Ham, and A.D. Berrie. 1981. Comparison of three mapping procedures developed for river macrophytes. Freshw. Biol. 11:369-380.

Section 4. Benthic Macroinvertebrates

Collecting and Processing Methods

Three benthic macroinvertebrate samples were collected at each of 20 stations (Table 4.1, Figure 4-1) on 10 and 11 October, 1989, and again on 23 and 24 May 1990, using a petite Ponar dredge, a total of 60 samples per sampling period. These sampling stations were the same stations that were sampled in May, 1989 and reported in Tazik et al. (1990). Samples were rinsed in the field through a fine-meshed sieve and stored in jars containing 7% formalin. The jars had both internal and external labels noting sample location and date. Samples were returned immediately to the Illinois Natural History Survey's benthos laboratory where they were stored in locked cabinets until processed. A chain-of-custody form was maintained for each sample, which recorded the date and time of processing, type of procedure conducted, and the processor's signature.

Preserved benthic samples were sorted in the laboratory under a 10 x magnification stereo dissection microscope. Large samples (over 250 ml) were sub-sampled (25 or 50%) prior to sorting. Immature Chironomidae (Diptera) and aquatic Oligochaeta were not sub-sampled further. Each major taxonomic group was placed in separate vials containing 7% formalin. Aquatic Oligochaeta and Chironomidae (Diptera) were stored separately in 70% ethanol.

Aquatic Oligochaeta were permanently mounted on slides with either Harleco's Synthetic Resin or Permount. Only whole individuals and fragments identified as anterior ends were counted. After mounting, specimens were identified and counted. Identifications of aquatic Oligochaeta were made using an Olympus model BH-2 compound microscope equipped with Nomarski differential interference contrast.

Immature Chironomidae (Diptera) were permanently mounted on slides with ASCO Laboratories' Euparal; larger specimens were first cleared overnight in 10% KOH. Specimens were identified using a Zeiss stereo-compound microscope with Nomarski interference and phase contrast. All other macroinvertebrates were identified using a Zeiss stereo-dissecting microscope. In all instances identifications were made to the lowest practical taxon.

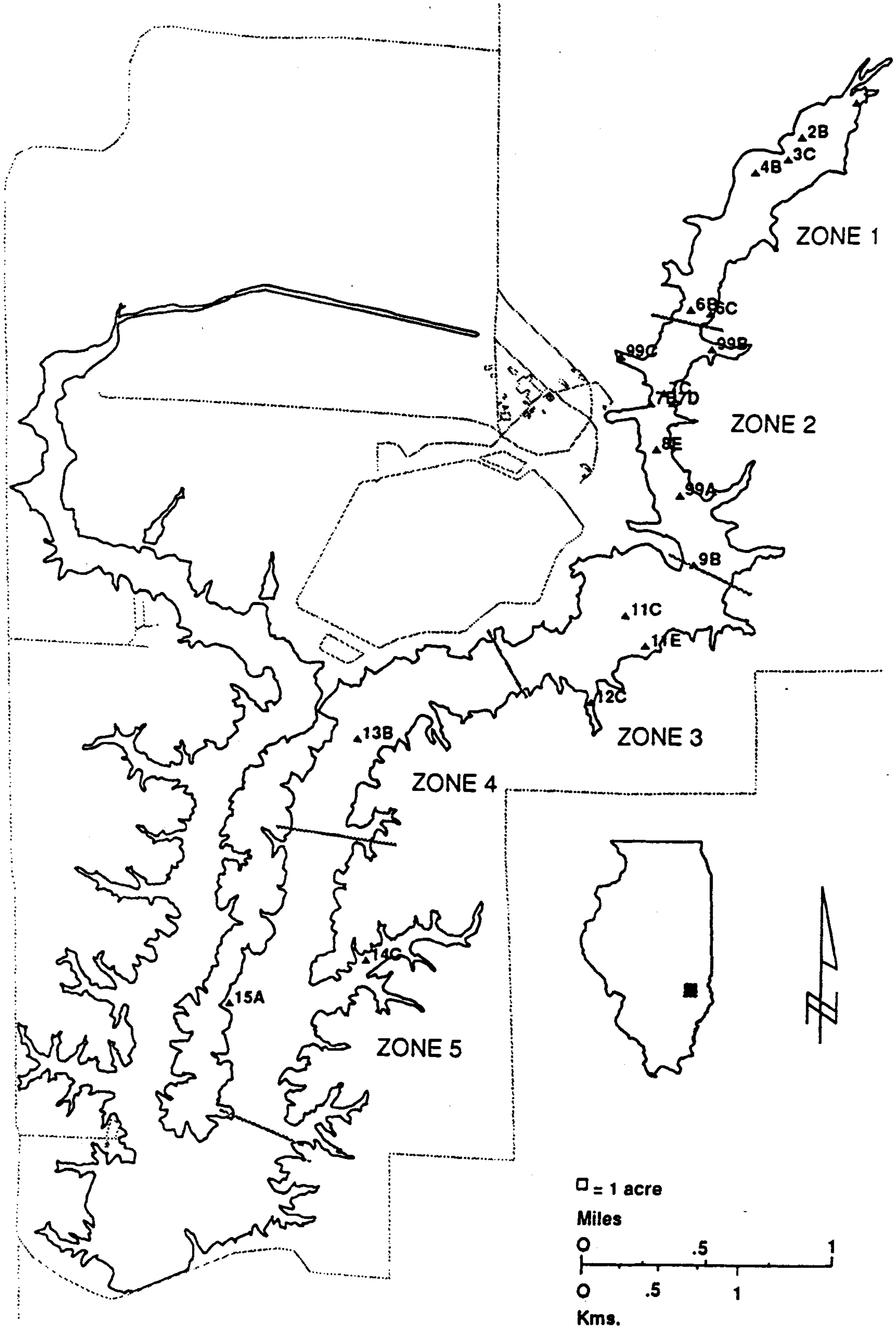

Fig. 4-1. Macroinvertebrate sampling stations, Newton Lake, Illinois.

Systematic and ecological works consulted during the identification of aquatic macroinvertebrates were: Brigham et al. (1982), Brinkhurst (1986), Brinkhurst & Jamieson (1971), Brinkhurst & Wetzel (1984), Brown (1976), Burch (1972, 1973, 1989), Burks (1953), ESE (1987), Hiltunen & Klemm (1980), Johannsen & Thomsen (1969), Klemm (1982), Loden & Harman (1980), Merritt & Cummins (1984), Page (1985), Parmalee (1967), Reynolds & Cook (1976, 1981, 1989), Roback (1977, 1980), Ross (1944), Simpson et al. (1983), Stimpson et al. (1982), Usinger (1974), Wetzel (1981, unpublished), Weiderholm (1983), and Wiggins (1927).

Data (taxa and abundance) from each sample were recorded on separate data sheets; data were entered into a computerized database along with the associated sample location, sampling date, sample code, taxa, and abundance.

Table 4-1. Categorization of stations among the five treatments used in analysis of benthic species richness and H' diversity in Newton Lake and characteristics of each treatment. For station locations, see Figure 4-1.

Treatment	Name	Stations	Characteristics
A	Control middle deep	11C, 13B, 14C	In zones 3-5, depth >10 ft, and >50 ft from shoreline
B	Control edge	15A, 12C, 11E	In zones 3-5, depth <10 ft, and <50 ft from shoreline
C	Middle deep	9B, 7C, 99A, 8E	In zone 1 or 2, depth >10 ft, and >50 ft from shoreline
D	Edge	1D, 7B, 7D, 6C, 99B, 99C	In zone 1 or 2, depth <10 ft, and <50 ft from shoreline
E	Middle shallow	6B, 2B, 4B, 3C	In zone 1 or 2, depth <10 ft, and >50 ft from shoreline

Statistical Analysis

An H' index of diversity was calculated for each sample replicate at each station using the formula:

$$H' = -\Sigma\, p_i \ln p_i$$

where p_i is the proportion of individuals belonging to taxa i relative to the total number of individuals belonging to all species in the community. The magnitude of this index is influenced by both the number of taxa in the community and the equitability with which individuals are distributed among the taxa.

The total number of taxa (species richness) and H' diversity at each station and for each replicate sampled in May 1989 were determined and assigned to one of five general treatment categories (Table 4-1). The October, 1989 data from stations comprising treatments A-D were analyzed using a balanced, two-way design to test for the effects of location (i.e., zones 1 and 2 vs zones 3-5) (Fig. 4-2) and relative depth (i.e., shallow (<10 ft) vs deep (>10 ft)) using a two-way ANOVA (Wilkinson 1989). Zones 1 and 2 were reported by ESE to be impacted most by the initial pipeline break. Differences in species richness among shallow stations within Zones 1 and 2 attributable to proximity to the shoreline (i.e., edge - within 50 ft of the shoreline, and middle - greater than 50 ft from the shoreline) were determined using a t-test (Wilkinson 1989). The May, 1990 and the May, 1989 species richness and H' data from stations comprising treatments A-D were analyzed using a balanced, three-way design to test for the effects of location, depth, and year (i.e., 1989 vs 1990). Differences in species richness and H' diversity within Zones 1 and 2 attributable to proximity to shoreline among stations with depths less than 10' deep were assessed using a standard t-test.

Results

October 1989

A phylogenetic list of taxa collected in October 1989 is presented in Appendix 4A and the abundance of taxa collected at each sampling station during this period is reported in Appendix 4B. Mean species richness (average of three replicate samples) at each station ranged from a minimum of 3 at station 13B to an average maximum of 15 taxa at station 2B (Table 4-2) in October, 1989.

We addressed the question - In October 1989, was there a difference in the species richness of macroinvertebrates due to depth or due to location within Newton Lake? No significant effects of location among zones were found on the October, 1989 log transformed species richness data, nor was there a significant interaction detected between depth and zone (Table 4-3). These data demonstrate that in October, 1989 there was no difference in the species richness of macroinvertebrates at sampling stations in Zones 1 and 2 compared with sampling stations located within other zones of Newton Lake.

A significant effect of depth on the species richness of macroinvertebrates was found to exist (Table 4-3). Subsequent analysis further revealed that the mean species richness at the shallow stations was significantly higher than was the species richness at stations with depths greater than 10 feet. The average species richness within samples at sampling stations less than 10 feet in depth was 11.8 ± 0.67 while the species richness at the deeper stations was 7.1 ± 0.90.

Table 4-2. The average ± S.E. (n=3) number of taxa (species richness) that occurred at each Newton Lake sampling station in October, 1989.

Station	Mean no. taxa	S.E.
11C	11.0	0.057
11E	14.3	4.667
12C	9.3	0.882
13B	3.0	0.577
14C	6.7	0.882
15A	13.3	1.453
1D	14.7	1.453
2B	15.3	1.856
3C	14.0	2.887
4B	12.0	1.528
6B	9.0	2.646
6C	13.3	1.453
7B	11.3	0.333
7C	8.3	1.202
7D	9.7	0.333
8E	7.7	1.333
99A	6.3	3.756
99B	8.0	2.082
99C	10.3	1.764
9B	7.0	1.155

Table 4-3. Results of two-way analysis of variance on ln(species richness) at stations in Newton Lake, Illinois during October, 1989.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.024	1	0.024	0.265	0.614
Depth	1.260	1	1.260	13.858	0.002
Zone*Depth	0.047	1	0.047	0.517	0.483
Error	1.455	16	0.091		

We compared the mean species richness of those sampling stations within Zones 1 and 2 whose depth was less than 10 ft. deep to determine if there was an effect of proximity to the shoreline (i.e., stations < 50 ft from the shoreline vs stations > 50 ft from the shoreline) using a standard t-test and found no significant difference in the mean species richness among stations within Zones 1 and 2 attributable to proximity to the shoreline ($t = -0.819$, $df = 8$, $p=0.437$).

In October, 1989, the H' diversity of benthic macroinvertebrates ranged from a minimum of 0.458 at station 13B to maximums of 1.98 and 1.99 that occurred at stations 3C and 15A, respectively. We found no significant effect of either location of stations within the lake (zone) or station depth on the October, 1989 H' values (Table 4-4). These results, in conjunction with earlier findings, suggests that while depth is obviously reducing the number of species at the deeper stations it did not alter the manner in which individuals were distributed among the species.

Table 4-4. Results of two-way analysis of variance on the H' diversity at stations in Newton Lake, Illinois during October, 1989.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.007	1	0.007	0.052	0.822
Depth	0.298	1	0.298	2.142	0.163
Zone*Depth	0.078	1	0.078	0.563	0.464
Error	2.223	16	0.139		

May 1990 Results

The May 1990 benthic macroinvertebrate data were added to the previously collected and reported (Tazik et al. 1990) May 1989 benthic macroinvertebrate data and analyzed to assess the effects of station location within a zone (Zones 1&2 vs Zones 3-5), water depth (shallow, <10 ft vs deep, >10 ft), and year (May, 1989 vs May 1990) using a three way analysis of variance. As in previous analyses, species richness values were transformed (natural logarithm) to meet the assumptions of the parametric tests. The average numbers of taxa collected at each station in May, 1990 are reported in Table 4-5.

There was a highly significant effect of depth on species richness (Table 4-6). Further analysis revealed that there were significantly more taxa collected at shallow stations (<10 ft deep) than were collected at stations with water depths greater than 10 feet (Figure 4-2).

An average of 12.9 ± 0.9 taxa were collected at the shallow water stations while deeper stations supported an average of 7.6 ± 0.9 taxa. These results are consistent with our earlier results (Tazik et al. 1990) and suggest that within Newton Lake, fewer taxa are to be expected in waters with depths greater than 10 feet, regardless of the location (zone) of the station within the lake.

Table 4-5. The average ± S.E. (n=3) number of taxa (species richness) and the calculated H' diversity of the macroinvertebrate communities at each Newton Lake sampling station in May, 1990.

Station	Mean no. taxa	S.E.	H'
11C	7.0	2.0	1.57
11E	12.0	0.0	1.85
12C	10.7	1.2	2.11
13B	5.3	0.3	1.49
14C	5.0	2.0	1.14
15A	11.3	1.5	1.42
1D	12.0	0.6	1.42
2B	13.7	2.8	1.88
3C	10.7	0.9	2.07
4B	12.7	3.3	2.11
6B	11.3	3.0	2.02
6C	11.7	3.0	1.42
7B	15.7	0.9	2.51
7C	10.7	3.8	1.91
7D	8.7	1.9	1.86
8E	5.3	1.2	1.28
99A	10.3	4.3	1.17
99B	11.7	2.9	1.81
99C	9.3	1.9	1.59
9B	7.0	1.5	1.59

Table 4-6. Results of three-way analysis of variance on the transformed species richness (natural logarithm) values among stations in Newton Lake, Illinois during May, 1989 and 1990.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.057	1	0.057	0.386	0.539
Depth	3.954	1	3.954	26.932	0.000
Year	0.166	1	0.166	1.131	0.296
Zone * Depth	0.615	1	0.615	4.188	0.049
Zone * Year	0.552	1	0.552	3.762	0.061
Depth * Year	0.263	1	0.263	1.791	0.190
Zone*Depth*Year	0.117	1	0.117	0.799	0.378
Error	4.698	32	0.147		

We found no significant influence of year or zone on the transformed species richness values (Table 4-6). However, the significant 1st order interaction between zone and depth suggests that the absence of a significant influence of zone on species richness in the main effects may have been masked (Table 4-6). Therefore, we investigated the influence of zone within each depth category on the transformed species richness values. These analyses revealed no significant effect of zonal location on species richness among stations with water depths greater than 10 feet deep (Table 4-7). A significant effect of zonal location on species richness did occur among the shallow sampling stations (Table 4-8). Sampling stations less than 10 feet deep in Zones 1 and 2 supported significantly fewer taxa than did shallow stations in other regions of the lake (Figure 4-3). Among the stations less than 10 feet in depth, the average species richness at stations in Zones 1 & 2 was 11.5 ± 0.6 while the average species richness at stations in Zones 3,4, and 5 was 17.27 ± 2.72. Thus, these data indicate that the species richness was depressed at shallow water stations in Zones 1 & 2 compared with the species richness at shallow water stations located in other areas of Newton Lake.

Table 4-7. Results of one-way analysis of variance on the transformed species richness (natural logarithm) values among stations with depths greater than 10 feet deep in Newton Lake, Illinois during May, 1989 and 1990.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.130	1	0.130	0.416	0.531
Error	3.745	12	0.312		

Table 4-8. Results of one-way analysis of variance on the transformed species richness (natural logarithm) values among stations with depths less than 10 feet deep in Newton Lake, Illinois during May, 1989 and 1990.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.613	1	0.613	8.089	0.009
Error	1.819	24	0.076		

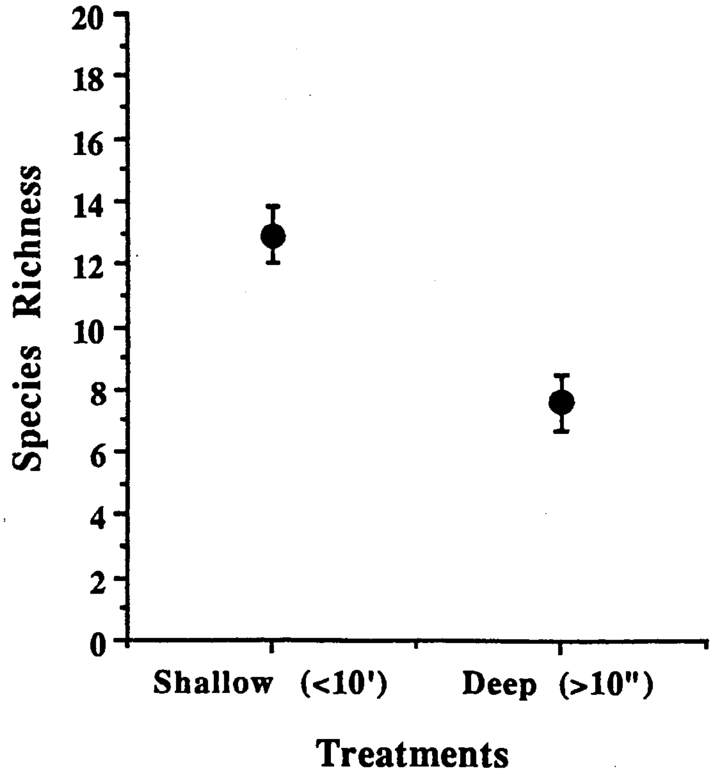

Figure 4-2. The average number of taxa (± standard error) collected at shallow and deep stations in Newton Lake during May 1989 and May 1990.

Initial screening of sediment chemical composition by A.D. Little and Associates suggested the potential for different chemical conditions to exist among sediments collected near the shoreline (edges) compared with sediments collected from the middle of the lake. Therefore, we examined the effect of sampling stations proximity to a shoreline on the species richness at stations in Zones 1 and 2 in an attempt to eliminate factors potentially contributing to the lower number of taxa in Zones 1 and 2. Because earlier results indicated that sampling stations with water depths greater than 10' had significantly lower taxa richness values than did shallow stations, all deep stations within Zones 1 and 2 were eliminated from this analysis. We found no significant effect of a stations proximity to a shoreline on species richness of the benthic macroinvertebrate communities within Zones 1 and 2 using a standard t-test ($T=-0.037$, $df = 18$; $p = 0.971$).

Although there was no significant effect of year on the species richness recorded at sampling stations (Table 4-6) it is interesting to note that some individual stations displayed substantial reductions in species richness between the May 1989 and May 1990 sampling periods. Especially noticeable was the reduction in taxa from 23 to 12 and from 18 to 9 at stations 11E and 99C, respectively. The reduction in the number of benthic taxa at these two stations may have been a function of a lower standing crop of aquatic plants in 1990 compared with 1989. Station 11E had a dense stand of coontail in 1989 and very low abundances in 1990. Similarly, station 99C had very high biomass of creeping water primrose in 1989 and absolutely no aquatic vegetation collected in 1990. Thus, the lower richness of macroinvertebrates at these two stations could be related to the obvious decreases in aquatic vegetation. A reduction in aquatic vegetation does not appear to be the only factor responsible for the lower species richness at some stations. For instance, station 6C also had lower biomass estimates of coontail and creeping water primrose, but average macroinvertebrate species richness increased from 9 to 12 taxa between 1989 and 1990. Thus, changes in the aquatic vegetation may contribute to fluctuations in the community composition of macroinvertebrates at some stations, but it is not the sole factor dictating community structure.

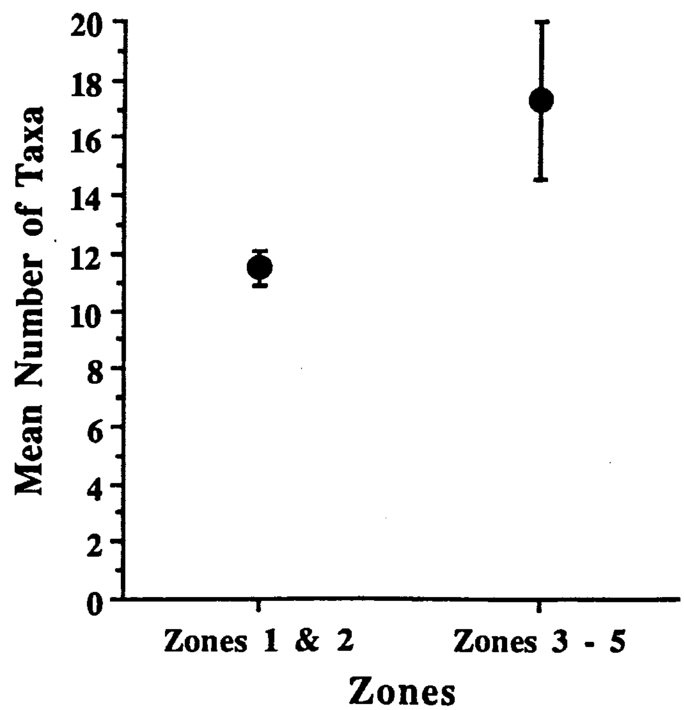

Figure 4-3. The mean number of taxa (± standard error) at sampling stations with water depths less than 10 feet deep in Zones 1 & 2 and Zones 3-5 in Newton Lake. The data were collected in May 1989 and May 1990.

Examination of the H' diversity indices calculated for sampling stations in May 1989 and May 1990 revealed a marginally insignificant effect of zonal location within the lake and no effect of year (Table 4-9). A highly significant effect of water depth on the H' diversity of macroinvertebrate communities in Newton Lake was, however, identified (Table 4-9). Unlike the species richness results, there was no significant interactions among the main effects tested.. Further analysis revealed that the H' diversity was significantly lower at sampling station with water depth exceeding 10 feet. The average H' diversity at shallow stations was 1.75 ± 0.09 compared with an average H' value of 1.37 ± 0.11 at deep water stations. These results are generally consistent with the observed patterns in species richness reported earlier. These data strongly suggest that deep water stations (water depth greater than 10') in Newton Lake have a significantly less diverse community structure than do shallow water sampling stations. Periodic depressions in oxygen concentrations at the water-sediment interface at deep sampling stations is a probable candidate for the lower complexity of macroinvertebrates. The May results further indicate that among shallow stations, those located in Zones 1 and 2 had significantly lower species richness values.

Table 4-9. Results of three-way analysis of variance on H' diversity indices among stations in Newton Lake, Illinois during May, 1989 and 1990.

Source	Sum of Squares	df	Mean Squares	F Ratio	P
Zone	0.565	1	0.565	3.826	0.059
Depth	2.073	1	2.073	14.051	0.001
Year	0.128	1	0.128	0.865	0.359
Zone * Depth	0.366	1	0.366	2.481	0.125
Zone * Year	0.469	1	0.469	3.175	0.084
Depth * Year	0.003	1	0.003	0.018	0.895
Zone*Depth*Year	0.083	1	0.083	0.563	0.458
Error	4.722	32	0.148		

Status Of October, 1990 Benthic Samples

Samples of benthic macroinvertebrates were collected in October 1990. The data were not included here because the samples were not completed at the time this report was written. At this time, all samples are picked and pre-sorted. Approximately 90% of the macroinvertebrates excluding the Oligochaeta have been identified. We anticipate that all samples will be identified and computerized by May 1991, the next scheduled sampling period.

Literature Cited

Brigham, A.R., W.U. Brigham, and A. Gnilka, eds. 1982. Aquatic insects and oligochaetes of North and South Carolina. Midwest Aquatic Enterprises, Mahomet, Ill.

Brinkhurst, R.O. 1986. Guide to the freshwater aquatic micodrile oligochaetes of North America. Can. Spec.Publ. Fish.Aquat. Sci. 84.

Brinkhurst, R.O., and B.G.M. Jamieson. 1971. Aquatic Oligochaeta of the world. University of Toronto Press, Buffalo, NY.

Brinkhurst, R.O., and M.J. Wetzel. 1984. Aquatic Oligochaeta of the world: Supplement. A catalogue of new freshwater species, descriptions, and revisions. Can. Tech. Rep. Hydrogr. Ocean Sci.

Brown, H.P. 1976. Aquatic dryopoid beetles (Coleoptera) of the United States. Identification Manual No. 6, Biota of Freshwater Ecosystems, Water Pollution Control Research Series 108050 ELDO4/72.

Burch, J.B. 1972. Freshwater sphaericean clams (Mollusca: Pelecypoda) of North America. Identification Manual No. 3, Biota of Freshwater Ecosystems, Water Pollution Control Research Series 108050 ELDO4/72.

Burch, J.B. 1973. Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. Identification Manual No. 11, Biota of Freshwater Ecosystems, Water Pollution Control Research Series 108050 ELDO3/73.

Burch, J.B.. 1989. North American Freshwater Snails. Malacological Publications, Hamburg, MI.

Burks, B.D. 1953. The mayflies, or Ephemeroptera, of Illinois. Bull. Ill. Nat. His. Surv. 26(1):1-216.

Edmunds, G.F., Jr., S.L. Jensen, and L. Berner. 1976. The mayflies of North and Central America. University of Minnesota Press, Minneapolis.

Environmental Science and Engineering, Inc. 1987. 1985/86 Newton Lake oil spill studies. Final report to Central Illinois Public Service Company, Springfield, IL. ESE No. 85-823.

Hiltunen, J.K. and D.J. Klemm. 1980. A guide to the Naididae (Annelida: Clitellata: Oligochaeta) of North America. EPA 600/4-80-031. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.

Johannsen, O.A., and L.C. Thomsen. 1969. Aquatic Diptera: eggs, larvae and pupae of aquatic flies. Entomological Reprint Specialists, Los Angeles, CA.

Klemm, D.J. 1982. Leeches (Annelida: Hirudinea) of North America. EPA-600/3-82-025. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.

Loden, M.S., and W.J. Harman. 1980. Ecophenotypic variation in setae of Naididae (Oligochaeta). Pages 33-40 *in* R.O. Brinkhurst and D.G. Cook, eds. Aquatic Oligochaete Biology. Plenum Press, New York.

Merritt, R.W., and K.W. Cummins, eds. 1984. An introduction to the aquatic insects of North America, 2nd ed. Kendall/Hunt Publishing Company, Dubuque, IA.

Page, L.M., 1985. The crayfishes and shrimps (Decapoda) of Illinois. Bull. Ill. Nat. His. Surv. 33(4):335-448.

Parmalee, P.W. 1967. The Freshwater Mussels of Illinois. Popular Science Series , Vol. VIII, Illinois State Museum.

Reynolds, J.W., and D.G. Cook. 1976. Nomenclatura oligochaetologica. A catalogue of names, descriptions and type specimens of the Oligochaeta. Univ. New Brunswick, Fredericton.

Reynolds, J.W., and D.G. Cook. 1981. Nomenclatura oligochaetologica. Supplementum primum. A catalogue of names, descriptions and type specimens of the Oligochaeta. Univ. New Brunswick, Fredericton.

Reynolds, J.W., and D.G. Cook. 1989. Nomenclatura oligochaetologica. Supplementum secundum. A catalogue of names, descriptions and type specimens of the Oligochaeta. New Brunswick Museum, Saint John.

Roback, S.S. 1977. The immature chironomids of the Eastern United States II. Tanypodinae-Tanypodini. Proc. Acad. Nat. Sci. Philadelphia 128:55-87.

Roback, S.S. 1977. The immature chironomids of the Eastern United States IV. Tanypodinae-Procladini. Proc. Acad. Nat. Sci. Philadelphia 132:1-63.

Ross, H.H. 1944. The caddis flies, or Trichoptera, of Illinois. Bull. Ill. Nat. His. Surv. 23(1):1-326.

Simpson, K.W., R.W. Bode, and P. Albu. 1983. Keys for the Genus *Cricotopus* adapted from "Revision der Gattung Cricotopus van der Wulp und ihrer Verwandten (Diptera, Chironomidae)" by M. Hirvenoja. Bull. N.Y. State Museum 450

Stimpson, K.S., D.J. Klemm, and J.K. Hiltunen. 1982. A guide to the freshwater Tubificidae (Annelida: Clitellata: Oligochaeta) of North America. EPA-600/3-82-033. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.

Tazik, P.P., L.L. Osborne, C. Nixon, and D. Szafoni. 1990. Environmental studies at Newton Lake, Illinois: Tasks 4, 5, and 7. Project No. 33-16-053. Report to Marathon Oil Company. Aquatic Ecol. Tech. Rept 90/15. 80 pp.

Usinger, R.L. 1956. Aquatic Insects of California, with Keys to North American Genera and California Species. University of California Press.

Wetzel, M.J. 1981. The distribution and relative abundance of aquatic Oligochaeta in the upper Cache River basin, southern Illinois, in relation to water quantity. M.S. thesis, Eastern Illinois University, Charleston.

Wetzel, M.J. (unpublished). The aquatic Oligochaeta (Annelida: Clitellata) of Illinois. II. A preliminary checklist and review of pertinent literature.
Wetzel, M.J. (unpublished). The aquatic leeches (Annelida: Hirudinea) of Illinois. I. A preliminary checklist and review of pertinent literature.
Wiederholm, T., ed. 1983. Chironomidae of the Holarctic region. Keys and diagnoses. Part I. Larvae. Entomol. Scand. Suppl. No. 19.
Wiggins, G.B. 1927. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press, Toronto.
Wilkinson, L. 1989. SYSTAT. The system for statistics. Systat, Inc. Evanston, IL

Appendix 4A-1. Phylogenetic classification of aquatic macroinvertebrates from Newton Lake, Jasper Co., Illinois, collected October 1989.

Phylum PORIFERA
Phylum COELENTERATA
  Class HYDROZOA
Phylum NEMATODA
Phylum MOLLUSCA
  Class GASTROPODA
    Subclass Pulmonata
      Order Lymnophila
        Family Physidae
        Family Ancylidae
  Class BIVALVIA
      Order Veneroida
        Family Sphaeriidae
        Family Corbiculidae
          Genus *Corbicula*
            Corbicula fluminea
Phylum Annelida
  Class CLITELLATA
    Subclass Oligochaeta
      Order Tubificida
        Family Naididae
          Unidentidied species A
          Genus *Bratislavia*
            Bratislavia unindata
          Genus *Dero*
            Dero *digitata*
            Dero cf. *digitata* ---specimens lacked gills, so a positive identification could not be made. Chaetae most closely resemble *D digitata;* no other naidids with similar chaetae are known to occur in Newtons Lake.
          Genus *Haemonais*
            Haemonais waldvogeli
          Genus *Nais*
            Nais pardalis
          Genus *Pristina*
            Pristina leidyi
          Genus *Slavina*
            Slavina appendiculat
        Family Tubificidae
          Genus *Aulodrilus*
            Aulodrilus piqueti
          Genus *Branchiura*
            Branchiura sowerbyi
          Genus *Ilyodrilus*
            Ilyodrilus templetoni
          Genus *Limnodrilus*
            Limnodrilus claparedianus
            Limnodrilus-claparedianus-cervix complex
            Limnodrilus hoffmeisteri
        UIW/OCC (unidentifiable immature without capilliform chaetae; almost exclusively Tubificidae)

UW/CC (unidentifiable with capilliform chaetae; almost exclusively Tubificidae)

Family Enchytraeidae

Phylum ARTHROPODA

- Class ARACHNIDA
  - Order Acarina
- Class INSECTA
  - Order Hemipera
    - Family Corixidae
  - Order Coleoptera
    - Family Elmidae
      - Genus *Dubiraphia*
  - Order Ephemeroptera
    - Family Caenidae
      - Genus *Caenis*
    - Family Ephemeridae
      - Genus *Hexagenia*
        - *Hexagenia limbata*
  - Order Odonata
    - Family Coenagrionidae
  - Order Trichoptera
    - Family Leptoceridae
      - Genus *Oecetis*
        - *Oecetis inconspicua*
    - Family Hydroplilidae
      - Genus *Orthotricia*
    - Family Polycentropidae
      - Genus *Neureclipsis*
  - Order Diptera
    - Family Chaoboridae
      - Genus *Chaoborus*
        - *Chaoborus punctipennis*
    - Family Ceratopogonidae
      - Genus *Palpomyia* complex
    - Family Chironomidae
      - Subfamily Chironomoni
        - Genus *Chironomus*
        - Genus *Cryptochironomus*
        - Genus *Microchironomus*
        - Genus *Polypedilum*
        - Genus *Dicrotendipes*
        - Genus *Glyptotendipes*
        - Genus *Parachironomus*
        - Genus *Endochironomus*
        - Genus *Stenochironomus*
        - Genus *Strictochironomus*
        - Genus *Cladopelma*
        - Genus *Kieferulus*
      - Subfamily Tanypodinae
        - Genus *Procladius*
        - Genus *Tanypus*
        - Genus *Coelotanypus*
        - Genus *Macropelopia*
      - Subfamily Orthocladiinae

Genus *Cricotopus*

Cricotopus fuscus group

Genus *Corynoneura*

Genus *Acricotopus*

Subfamily *Tanytarsoni*

Genus *Lenziella*

Genus *Tanytarsus*

Genus *Paratanytarsus*

Genus *Sublettea*

Subfamily *Pseudochironomoni*

Genus *Pseudochironomus*

Appendix 4B-1-1. Benthic macroinvertebrate taxa and abundance by sample replicate for station 1D, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Enchytraeidae	2	-	-
Naididae	28	38	128
Dero digitata	2	22	40
Tubificidae			
Aulodrilus pigueti	-	12	72
Limnodrilus claparedianus	2	-	-
L. claparedianus-cervix complex	-	4	-
L. hoffmeisteri	6	4	-
UIW/OCC	18	30	36
Nematoda	6	434	126
Hemiptera			
Corixidae	-	10	-
Odonata			
Coenagrionidae	-	2	-
Diptera			
Palpomyia complex	-	2	2
Chironomidae	-	10	2
Chironomini	-	-	6
Chironomus	4	12	10
Polypedilum	4	-	-
Dicrotendipes	18	62	34
Glyptotendipes	12	32	18
Endochironomus	-	2	-
Tanypodidae	-	2	-
Procladius	-	-	2
Orthocladiinae	-	4	6
Cricotopus fuscus group	-	-	6
Tanytarsus	2	-	2

Appendix 4B-2. Benthic macroinvertebrate taxa and abundance by sample replicate for station 2B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	20	10	2
Dero digitata	4	-	2
Tubificidae			
Aulodrilus pigueti	228	52	72
Branchiura sowerbyi	-	-	4
UIW/OCC	32	22	34
Nematoda	86	114	97
Hemiptera			
Corixidae	1	-	-
Coleoptera			
Dubiraphia	1	-	-
Odonata			
Coenagrionidae	1	-	-
Diptera			
Chaoborus punctipennis	-	2	1
Palpomyia complex	2	2	2
Chironomidae	2	-	-
Chironomini	1	-	10
Chironomus	4	9	4
Cryptochironomus	-	2	1
Microchironomus	17	7	2
Polypedilum	1	-	-
Dicrotendipes	2	-	-
Glyptotendipes	2	-	-
Kieferulus	-	2	-
Procladius	122	77	101
Tanypus	-	5	-
Coelotanypus	7	3	2

Appendix 4B-3. Benthic macroinvertebrate taxa and abundance by sample replicate for station 3C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	-	10	14
Dero digitata	-	-	21
(*D. digitata*??)	1	8	3
Tubificidae			
Aulodrilus pigueti	-	38	24
Branchiura sowerbyi	-	-	2
UIW/OCC	-	12	3
UW/CC	4	4	1
Nematoda	2	4	-
Arachnida			
Acarina	-	-	1
Bivalvia			
Sphaeriidae	1	-	-
Diptera			
Palpomyia complex	1	2	1
Chironomini	-	1	1
Chironomus	-	2	-
Cryptochironomus	1	1	1
Microchironomus	9	2	1
Polypedilum	-	-	1
Dicrotendipes	-	-	1
Glyoptotendipes	-	-	3
Parachironomus	-	-	1
Procladius	10	4	14
Coelotanypus	-	1	-
Macropelopia	1	-	-
Orthocladiinae	-	-	6
Tanytarsus	-	1	1

Appendix 4B-4. Benthic macroinvertebrate taxa and abundance by sample replicate for station 4B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	3	13	3
Dero digitata	-	11	12
(*D. digitata*??)	-	4	-
Tubificidae			
Aulodrilus pigueti	44	63	156
UIW/OCC	12	12	15
UW/CC	3	1	9
Nematoda	2	6	4
Diptera			
Chaoborus punctipennis	1	1	2
Palpomyia complex	1	3	1
Chironomini	-	1	-
Chironomus	-	-	1
Cryptochironomus	-	-	2
Microchironomus	-	-	2
Polypedilum	-	1	-
Procladius	17	36	136
Coelotanypus	7	3	2
Tanytarsoni	-	-	1

Appendix 4B-5. Benthic macroinvertebrate taxa and abundance by sample replicate for station 6B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	-	9	3
Dero digitata	-	6	-
(*D. digitata* ??)	-	3	3
Tubificidae			
Aulodrilus pigueti	5	195	39
UIW/OCC	-	-	9
UW/CC	-	9	-
Nematoda	-	1	-
Diptera			
Chaoborus punctipennis	4	2	-
Palpomyia complex	-	1	1
Chironomidae	-	2	-
Chironomini	-	1	-
Chironomus	-	2	-
Microchironomus	-	-	1
Procladius	2	12	8
Tanypus	-	1	-
Coelotanypus	1	4	1
Acricotopus	1	-	-

Appendix 4B-6. Benthic macroinvertebrate taxa and abundance by sample replicate for station 6C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	30	80	448
unidentified species A	24	80	416
Dero digitata	-	24	96
Nais pardalis	6	-	-
Nais sp.	-	-	32
Slavina appendiculata	-	8	-
Tubificidae			
Aulodrilus pigueti	108	144	352
UIW/OCC	72	72	192
UW/CC	-	-	96
Nematoda	-	2	12
Sphaeriidae	-	2	6
Ephemeroptera			
Caenis	12	24	6
Hexagenia limbata	-	12	8
Diptera			
Palpomyia complex	4	2	4
Chironomidae	-	2	-
Cryptochironomus	6	2	2
Glyoptotendipes	-	2	-
Procladius	2	10	-
Tanypus	-	2	-
Lenziella	2	-	-
Tanytarsus	2	-	-

Appendix 4B-7. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	-	2	-
unidentified species A	2	2	-
Dero digitata	4	4	1
(*D. digitata* ??)	2	1	3
Tubificidae			
Aulodrilus pigueti	31	39	19
UIW/OCC	1	3	3
UW/CC	-	1	1
Diptera			
Chaoborus punctipennis	3	8	2
Palpomyia complex	2	6	4
Chironomidae	-	-	1
Chironomus	1	-	1
Endochironomus	-	1	-
Cladopelma	1	-	-
Procladius	9	7	5
Coelotanypus	3	5	2

Appendix 4B-8. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	-	-	8
unidentified species A	1	-	-
Dero digitata	9	4	10
(*D. digitata* ??)	2	-	-
Tubificidae			
Aulodrilus pigueti	1	-	3
UIW/OCC	3	4	9
Nematoda	-	1	2
Diptera			
Chaoborus punctipennis	10	2	6
Cryptochironomus	-	-	1
Tanypodinae	1	-	-
Procladius	6	3	19
Tanypus	1	-	1
Coelotanypus	-	1	2

Appendix 4B-9. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7D, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	3	2	12
unidentified species A	6	-	12
Nais pardalis	1	-	-
Tubificidae			
Aulodrilus pigueti	28	20	44
UIW/OCC	-	4	40
UW/CC	4	4	-
Sphaeriidae	1	12	12
Corbuculidae			
Corbicula fluminea	-	2	-
Ephemeroptera			
Caenis	-	-	8
Diptera			
Chaoborus punctipennis	1	-	-
Chironomidae	1	-	-
Chironomus	-	-	4
Cryptochironomus	-	2	4
Polypedilum	1	2	12
Dicrotendipes	2	-	-
Glyoptotendipes	-	2	-
Tanypus	-	-	4

Appendix 4B-10. Benthic macroinvertebrate taxa and abundance by sample replicate for station 8E, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae			
(*Dero digitata* ??)	-	1	-
Tubificidae			
Aulodrilus pigueti	-	4	-
UIW/OCC	2	1	-
Nematoda	-	5	8
Sphaeriidae	-	-	4
Diptera			
Chaoborus punctipennis	12	30	30
Palpomyia complex	2	8	19
Cladopelma	-	-	2
Procladius	1	9	46
Tanypus	-	2	1
Coelotanypus	2	3	3
Macropelopia	-	-	2

Appendix 4B-11. Benthic macroinvertebrate taxa and abundance by sample replicate for station 9B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae			
unidentified species A	-	-	4
Dero digitata	-	124	-
(*D. digitata* ??)	2	66	-
Tubificidae			
Aulodrilus pigueti	2	162	12
UIW/OCC	12	42	16
Nematoda	6	4	4
Diptera			
Chaoborus punctipennis	8	2	20
Chironomini	-	2	-
Cryptochironomus	2	-	-
Kieferulus	-	2	-
Procladius	16	4	-

Appendix 4B-12. Benthic macroinvertebrate taxa and abundance by sample replicate for station 11C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	24	20	26
Dero digitata	70	16	22
Tubificidae			
Aulodrilus pigueti	54	50	60
UIW/OCC	10	28	2
UW/CC	-	4	4
Nematoda	4	17	44
Sphaeriidae	1	-	1
Diptera			
Chaoborus punctipennis	4	6	17
Palpomyia complex	-	1	-
Chironomidae	-	-	1
Chironomini	1	-	-
Cladopelma	1	1	-
Procladius	8	10	17
Tanypus	-	5	2
Lenziella	-	1	-

Appendix 4B-13. Benthic macroinvertebrate taxa and abundance by sample replicate for station 11E, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	21	24	-
unidentified species A	12	224	-
Dero digitata	20	-	-
Pristina leidyi	15	-	-
Tubificidae			
Aulodrilus pigueti	25	448	-
Ilyodrilus templetoni	-	8	-
UIW/OCC	-	32	-
UW/CC	2	8	-
Nematoda	11	132	14
Acarina	1	-	-
Ephemeroptera			
Caenis	20	20	2
Hexagenia limbata	-	-	2
Trichoptera			
Oecetis inconspicua	1	-	-
Hydroptilidae	1	-	-
Orthotricia	1	-	-
Diptera			
Palpomyia complex	1	4	-
Chironomidae	7	-	-
Chironomini	-	4	-
Cryptochironomus	-	4	-
Polypedilum	2	-	2
Dicrotendipes	2	-	-
Glyoptotendipes	54	-	-
Parachironomus	12	-	-
Endochironomus	26	-	-
Procladius	2	20	4
Coelotanypus	-	4	2
Cricotopus	3	-	-
Corynoneura	1	-	-
Tanytarsus	-	-	2

Appendix 4B-14. Benthic macroinvertebrate taxa and abundance by sample replicate for station 12C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	2	-	3
unidentified species A	4	-	3
Tubificidae			
Aulodrilus pigueti	202	48	19
Nematoda	-	6	1
Sphaeriidae	1	2	-
Acarina	-	1	-
Diptera			
Chaoborus punctipennis	-	3	-
Palpomyia complex	6	35	13
Chironomidae	-	1	-
Cryptochironomus	1	1	1
Microchironomus	-	-	1
Procladius	12	25	4
Coelotanypus	7	6	3
Paratanytarsus	-	3	-

Appendix 4B-15. Benthic macroinvertebrate taxa and abundance by sample replicate for station 13B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Tubificidae			
Aulodrilus pigueti	1	-	-
Nematoda	8	2	22
Diptera			
Chaoborus punctipennis	69	84	40
Procladius	3	-	1

Appendix 4B-16. Benthic macroinvertebrate taxa and abundance by sample replicate for station 14C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae			
unidentified species A	1	-	-
Dero digitata	3	9	12
(*D. digitata* ??)	4	7	24
Tubificidae			
Aulodrilus pigueti	1	-	4
Diptera			
Chaoborus punctipennis	4	6	-
Chironomidae	-	1	-
Chironomus	-	3	-
Strictochironomus	-	-	4
Cladopelma	4	3	4
Tanypodinae	-	2	-
Procladius	2	-	-
Coelotanypus	-	1	-

Appendix 4B-17. Benthic macroinvertebrate taxa and abundance by sample replicate for station 15A, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	8	12	1
unidentified species A	38	138	5
Tubificidae			
Aulodrilus pigueti	6	42	5
UIW/OCC	12	12	1
UW/CC	2	9	1
Nematoda	-	16	2
Acarina	-	-	1
Sphaeriidae	2	33	2
Trichoptera			
Oecetis inconspicua	-	-	1
Diptera			
Chironomidae	-	-	1
Chironomus	2	12	-
Cryptochironomus	-	5	-
Polypedilum	34	8	7
Dicrotendipes	2	1	-
Glyoptotendipes	-	3	-
Parachinonomus	-	2	-
Endochironomus	2	7	-
Lenziella	-	2	-
Paratanytarsus	2	-	-
Sublettea	-	-	5
Pseudochironomus	-	1	3

Appendix 4B-18. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99A, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	4	-	64
Bratislavia unindata	-	-	16
Dero digitata	2	-	68
Haemonais waldvogeli	-	-	12
Tubificidae			
Aulodrilus pigueti	2	-	40
UIW/OCC	-	-	20
Porifera	-	-	1
Hydrozoa	4	-	-
Physidae	1	-	-
Ancylidae	-	-	1
Trichoptera			
Neureclipsis	-	-	1
Diptera			
Dicrotendipes	-	-	14
Glyoptotendipes	-	-	10
Stenochironomus	-	-	2
Procladius	-	-	1
Tanytarsus	1	-	-

Appendix 4B-19. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99B, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	2	6	32
unidentified species A	1	-	-
Dero digitata	-	5	32
Tubificidae			
Aulodrilus pigueti	30	39	176
UIW/OCC	2	9	56
Ephemeroptera			
Caenis	-	-	1
Diptera			
Chaoborus punctipennis	-	-	1
Palpomyia complex	-	1	4
Chironomini	-	-	2
Cryptochironomus	-	-	4
Microchironomus	-	-	2
Polypedilum	-	-	1
Tanypodinae	1	-	-
Procladius	-	1	1
Coelotanypus	-	3	-

Appendix 4B-20. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99C, Newton Lake, October 1989.

Taxa	A	B	C
Oligochaeta			
Naididae	20	14	24
unidentified species A	60	152	260
Dero digitata	20	12	24
Tubificidae			
Aulodrilus pigueti	26	38	68
Limnodrilus hoffmeisteri	2	-	8
UIW/OCC	50	64	92
Nematoda	-	2	12
Sphaeriidae	-	2	2
Ephemeroptera			
Caenis	-	1	2
Diptera			
Palpomyia complex	1	1	6
Chironomini	-	-	2
Cryptochironomus	-	1	4
Strictochironomus	-	-	2
Procladius	-	2	-

Appendix 4C-1. Phylogenetic classification of aquatic macroinvertebrates from Newton Lake, Jasper Co., Illinois, collected May 1990.

Phylum PORIFERA
Phylum COELENTERATA
  Class HYDROZOA
Phylum NEMATODA
Phylum MOLLUSCA
  Class GASTROPODA
    Subclass Pulmonata
      Order Lymnophila
        Family Physidae
        Family Lymnaeidae
        Family Ancylidae
  Class BIVALVIA
      Order Veneroida
        Family Sphaeriidae
            Genus *Sphaerium*
              Sphaerium simile
        Family Corbiculidae
            Genus *Corbicula*
              Corbicula fluminea
      Order Unionoida
        Family Unionidae
            Genus *Arcidens*
              Arcidens confragosus
Phylum Annelida
  Class CLITELLATA
    Subclass Oligochaeta
      Order Tubificida
        Family Naididae
            Unidentidied species A
            Genus *Dero*
              Dero *digitata*
              Dero cf. *digitata* ---specimens lacked gills, so a positive identification could not be made. Chaetae most closely resemble *D digitata;* no other naidids with similar chaetae are known to occur in Newtons Lake.
            Genus *Haemonais*
              Haemonais waldvogeli
            Genus *Nais*
              Nais pardalis
              N. communis
              N. simplex
              N variabilis
            Genus Ophidonais
              O.serpentina
            Genus *Pristina*
              Pristina leidyi
              P. aequiseta
            Genus *Slavina*
              Slavina appendiculat
        Family Tubificidae
            Genus *Aulodrilus*

- *Aulodrilus piqueti*
- *A. limnobius*
- Genus *Branchiura*
  - *Branchiura sowerbyi*
- Genus *Ilyodrilus*
  - *Ilyodrilus templetoni*
- Genus *Limnodrilus*
  - *L. cervix*
  - *L.claparedianus-cervix complex*
  - *L. hoffmeisteri*
- UIW/OCC (unidentifiable immature without capilliform chaetae; almost exclusively Tubificidae)
- UW/CC (unidentifiable with capilliform chaetae; almost exclusively Tubificidae)
- Family Enchytraeidae

Phylum ARTHROPODA
- Class ARACHNIDA
  - Order Aracnoidea
- Class INSECTA
  - Order Ephemeroptera
    - Family Caenidae
      - Genus *Caenis*
    - Family Ephemeridae
      - Genus *Hexagenia*
        - *Hexagenia limbata*
  - Order Trichoptera
    - Family Hydroplilidae
      - Genus *Orthotricia*
    - Family Polycentropidae
      - Genus *Polycentropus*
  - Order Diptera
    - Family Chaoboridae
      - Genus *Chaoborus*
        - *Chaoborus punctipennis*
    - Family Ceratopogonidae
      - Genus *Palpomyia* complex
    - Family Chironomidae
      - Subfamily Chironomoni
        - Genus *Chironomus*
        - Genus *Einfeldia*
        - Genus *Cryptochironomus*
        - Genus *Microchironomus*
        - Genus *Polypedilum*
        - Genus *Dicrotendipes*
        - Genus *Glyptotendipes*
        - Genus *Endochironomus*
        - Genus *Cladopelma*
      - Subfamily Tanypodinae
        - Genus *Procladius*
        - Genus *Tanypus*
          - *Tanypus stellatus*
        - Genus *Coelotanypus*
        - Genus *Clinotanypus*
        - Genus *Paramerina*

Subfamily Orthocladiinae
- Genus *Orthocladius*
- Genus *Cricotopus*
- Genus *Acricotopus*

Subfamily *Tanytarsoni*
- Genus *Lenziella*
- Genus *Tanytarsus*

Appendix 4D-1. Benthic macroinvertebrate taxa and abundance by sample replicate for station 1D, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Enchytraeidae	4	-	-
Naididae	4	4	-
unidentified species A	4	-	-
Dero digitata	4	8	4
(*D. digitata* ??)	4	-	-
Tubificidae			
Aulodrilus pigueti	16	12	28
Branchiura sowerbyi	4	-	4
Ilyodrilus templetoni	-	4	-
Limnodrilus cervix	-	4	8
L. hoffmeisteri	-	-	4
UIW/OCC	300	104	272
UW/CC	8	4	4
Nematoda	44	40	60
Diptera			
Chironomidae	-	4	-
Chironomini	-	-	4
Chironomus	52	16	-
Einfeldia	-	-	4
Microchironomus	-	8	-
Procladius	20	4	12
Tanytarsus	4	-	-

Appendix 4D-2. Benthic macroinvertebrate taxa and abundance by sample replicate for station 2B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	1	–	–
Dero digitata	2	–	1
(*D. digitata* ??)	5	–	6
Tubificidae			
Aulodrilus pigueti	5	–	7
Branchiura sowerbyi	1	–	–
Ilyodrilus templetoni	1	–	1
Limnodrilus hoffmeisteri	7	–	3
UIW/OCC	5	2	9
UW/CC	5	–	5
Nematoda	22	–	31
Diptera			
Palpomyia complex	–	3	2
Chironomidae	2	–	–
Chironomus	1	1	2
Cryptochironomus	–	1	1
Microchironomus	5	4	3
Dicrotendipes	–	1	–
Cladopelma	–	–	1
Procladius	41	18	25
Tanypus	3	1	1
Coelotanypus	2	–	2
Cricotopus	-	-	1

Appendix 4D-3. Benthic macroinvertebrate taxa and abundance by sample replicate for station 3C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	–	–	4
Dero digitata	24	–	–
(*D. digitata* ??)	8	–	12
Tubificidae			
Aulodrilus pigueti	16	–	20
Branchiura sowerbyi	–	4	–
Ilyodrilus templetoni	12	8	–
Limnodrilus hoffmeisteri	–	–	20
UIW/OCC	12	20	24
UW/CC	36	4	8
Nematoda	12	–	36
Diptera			
Chironomus	–	4	4
Cryptochironomus	4	4	–
Microchironomus	4	–	4
Glyoptotendipes	4	–	–
Procladius	36	28	20
Tanypus	4	4	–
Coelotanypus	-	8	4

Appendix 4D-4. Benthic macroinvertebrate taxa and abundance by sample replicate for station 4B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	–	2	–
Dero digitata	4	8	36
(*D. digitata* ??)	–	22	–
Tubificidae			
Aulodrilus pigueti	12	34	8
Ilyodrilus templetoni	12	14	12
UIW/OCC	20	18	28
UW/CC	16	22	28
Nematoda	–	2	4
Diptera			
Chaoborus punctipennis	–	1	–
Chironomidae	–	1	–
Chironomini	–	1	–
Chironomus	4	8	–
Cryptochironomus	4	1	4
Microchironomus	4	4	–
Procladius	8	12	–
Tanypus	4	3	4
Coelotanypus	4	2	–
Orthocladius	–	1	–
Tanytarsus	-	1	-

Appendix 4D-5. Benthic macroinvertebrate taxa and abundance by sample replicate for station 6B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	–	–
unidentified species A	19	4	8
Dero digitata	2	4	8
(*D. digitata* ??)	–	4	8
Nais communis	1	–	–
Tubificidae			
Ilyodrilus templetoni	–	4	8
Limnodrilus cervix	–	–	4
UIW/OCC	5	8	28
UW/CC	1	4	56
Nematoda	1	–	–
Diptera			
Palpomyia complex	5	–	–
Chironomidae	2	–	–
Cryptochironomus	2	–	4
Microchironomus	3	–	–
Polypedilum	1	–	–
Procladius	5	4	4
Tanypus	1	–	–
Coelotanypus	1	–	4
Cricotopus	3	–	–
Acricotopus	1	-	-

Appendix 4D-6. Benthic macroinvertebrate taxa and abundance by sample replicate for station 6C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	4	-
unidentified species A	284	-	-
Dero digitata	24	12	12
(*D. digitata* ??)	-	4	32
Nais pardalis	12	-	-
Nais variabilis	12	-	-
Tubificidae			
Aulodrilus pigueti	8	-	-
Ilyodrilus templetoni	4	-	-
Limnodrilus claparedianus-cervix complex	4	-	-
Limnodrilus sp.	-	4	-
UIW/OCC	56	132	96
UW/CC	4	-	-
Nematoda	-	4	4
Sphaeriidae	-	12	-
Ephemeroptera			
Caenis	4	-	-
Hexagenia limbata	-	4	-
Trichoptera			
Orthotricia	-	4	-
Diptera			
Palpomyia complex	4	12	-
Cryptochironomus	8	8	-
Microchironomus	4	8	4
Polypedilum	-	-	4
Glyoptotendipes	4	-	-
Procladius	20	16	-

Appendix 4D-7. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	12	_	_
unidentified species A	4	_	4
Dero digitata	12	4	20
(*D. digitata* ??)	12	12	36
Nais communis	_	4	_
Nais simplex	_	32	4
Tubificidae			
Aulodrilus pigueti	16	_	32
Ilyodrilus templetoni	4	4	16
Limnodrilus hoffmeisteri	_	_	4
UIW/OCC	16	32	28
UW/CC	20	12	28
Nematoda	12	8	8
Sphaeriidae	_	4	12
Corbuculidae			
Corbicula fluminea	4	_	_
Ephemeroptera			
Caenis	_	4	_
Hexagenia limbata	4	_	_
Diptera			
Palpomyia complex	8	1	4
Chironomini	_	16	_
Einfeldia	4	_	_
Cryptochironomus	4	_	16
Microchironomus	_	12	_
Polypedilum	8	4	_
Dicrotendipes	_	16	_
Glyoptotendipes	_	16	_
Procladius	12	_	4
Paramarina	4	-	-

Appendix 4D-8. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	_	6	1
unidentified species A	3	20	_
Dero digitata	10	18	1
(*D. digitata* ??)	4	7	_
Pristina aequiseta	1	_	_
Slavinia appendiculata	4	_	_
Tubificidae			
Aulodrilus pigueti	6	35	_
Ilyodrilus templetoni	_	1	_
UIW/OCC	1	19	1
UW/CC	_	2	_
Nematoda	_	_	1
Diptera			
Chaoborus punctipennis	_	1	_
Chironomidae	_	2	_
Chironomus	_	2	_
Einfeldia	_	1	_
Cryptochironomus	_	1	_
Glyoptotendipes	_	1	_
Cladopelma	_	1	_
Procladius	_	8	1
Tanypus	1	4	_
Coelotanypus	_	1	_
Lenziella	1	-	-

Appendix 4D-9. Benthic macroinvertebrate taxa and abundance by sample replicate for station 7D, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	4	4
Dero digitata	8	_	16
(*D. digitata* ??)	12	_	16
Tubificidae			
Aulodrilus pigueti	4	4	20
Ilyodrilus templetoni	4	_	_
UIW/OCC	20	20	24
UW/CC	24	12	12
Nematoda	_	_	4
Sphaeriidae	_	4	4
Trichoptera			
Polycentropus	_	_	4
Diptera			
Palpomyia complex	4	_	_
Cryptochironomus	4	_	12
Polypedilum	4	_	_
Glyoptotendipes	4	-	-

Appendix 4D-10. Benthic macroinvertebrate taxa and abundance by sample replicate for station 8E, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	28	-
unidentified species A	8	-	-
Dero digitata	8	8	32
(*D. digitata* ??)	4	16	-
Tubificidae			
Aulodrilus pigueti	92	20	48
UIW/OCC	28	4	24
Diptera			
Cryptochironomus	-	4	-
Procladius	4	-	-

Appendix 4D-11. Benthic macroinvertebrate taxa and abundance by sample replicate for station 9B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	-	8	4
Dero digitata	1	8	4
Tubificidae			
Aulodrilus pigueti	2	8	-
UIW/OCC	10	32	12
Nematoda	2	4	-
Diptera			
Chaoborus punctipennis	2	-	-
Chironomus	1	-	-
Glyoptotendipes	1	4	-
Procladius	-	12	-
Tanypus	1	4	-
Coelotanypus	1	-	4

Appendix 4D-12. Benthic macroinvertebrate taxa and abundance by sample replicate for station 11C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	-	-
Dero digitata	36	40	8
(*D. digitata* ??)	16	-	16
Tubificidae			
Aulodrilus pigueti	20	-	20
Limnodrilus cervix	-	4	-
Limnodrilus hoffmeisteri	-	-	4
UIW/OCC	12	16	12
UW/CC	-	-	8
Nematoda	4	-	20
Sphaeriidae	4	-	-
Diptera			
Chaoborus punctipennis	4	-	-
Chironomus	-	-	8
Tanypus	-	-	4
Clinotanypus	4	-	-

Appendix 4D-13. Benthic macroinvertebrate taxa and abundance by sample replicate for station 11E, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	-	20	4
unidentified species A	74	52	120
Dero digitata	10	32	16
(*D. digitata* ??)	2	8	-
Tubificidae			
Aulodrilus limnobius	10	24	16
Aulodrilus pigueti	10	36	20
Ilyodrilus templetoni	-	4	4
UIW/OCC	22	64	56
UW/CC	6	20	20
Nematoda	-	4	-
Arachnoidea	1	-	-
Corbuculidae			
Corbicula fluminea	1	-	4
Unionidae			
Arcidens confragosus	1	-	-
Diptera			
Palpomyia complex	-	4	4
Chironomidae	-	-	4
Cryptochironomus	1	16	4
Polypedilum	2	-	-

Appendix 4D-14. Benthic macroinvertebrate taxa and abundance by sample replicate for station 12C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	8	4	8
unidentified species A	24	36	36
Dero digitata	28	20	16
(*D. digitata* ??)	8	_	8
Nais simplex	4	_	12
Ophidonais serpentina	4	_	_
Tubificidae			
Aulodrilus limnobius	_	4	_
Aulodrilus pigueti	54	28	16
Ilyodrilus templetoni	4	_	_
UIW/OCC	24	16	28
UW/CC	20	20	16
Corbuculidae			
Corbicula fluminea	12	_	4
Diptera			
Chironomidae	4	_	_
Cryptochironomus	_	8	8
Microchironomus	12	_	_
Glyoptotendipes	-	8	-

Appendix 4D-15. Benthic macroinvertebrate taxa and abundance by sample replicate for station 13B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	_	_
unidentified species A	_	8	4
Dero digitata	8	28	20
(*D. digitata* ??)	12	_	4
Nematoda	12	12	_
Diptera			
Chaoborus punctipennis	8	8	_
Chironomus	4	8	4
Tanypus	-	-	4

Appendix 4D-16. Benthic macroinvertebrate taxa and abundance by sample replicate for station 14C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	8	_	_
Dero digitata	_	_	12
(*D. digitata* ??)	12	_	8
Tubificidae			
Aulodrilus pigueti	48	_	12
Diptera			
Chironomus	_	_	4
Cladopelma	16	_	8
Procladius	4	_	4
Tanypus	16	_	20
T. stellatus	_	1	_
Coelotanypus	4	-	-

Appendix 4D-1-17. Benthic macroinvertebrate taxa and abundance by sample replicate for station 15A, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	_	_	4
unidentified species A	60	56	12
Dero digitata	40	8	20
(*D. digitata* ??)	16	4	16
Tubificidae			
Aulodrilus pigueti	4	_	12
Ilyodrilus templetoni	_	_	8
UIW/OCC	36	_	68
UW/CC	20	12	44
Corbuculidae			
Corbicula fluminea	4	_	_
Ephemeroptera			
Hexagenia limbata	_	4	4
Diptera			
Microchironomus	24	_	20
Polypedilum	8	4	4
Cladopelma	_	16	4
Procladius	12	16	12
Lenziella	40	8	16

Appendix 4D-18. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99A, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	1	4	36
Dero digitata	1	7	20
(*D. digitata* ??)	_	2	4
Haemonais waldvogeli	_	_	2
Nais communis	_	_	4
Nais variabilis	_	4	64
Ophidonais serpentina	_	_	16
Pristina leidyi	_	1	_
Tubificidae			
Aulodrilus pigueti	_	1	2
UIW/OCC	_	_	4
Porifera	_	4	4
Coelenterata	1	44	_
Hydrazoa	_	_	1804
Lymnaeidae	_	_	4
Ancylidae	_	_	8
Sphaeriidae	_	_	8
Ephemeroptera			
Caenis	_	_	4
Diptera			
Chironomidae	_	_	4
Dicrotendipes	_	24	48
Glyoptotendipes	-	4	140

Appendix 4D-19. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99B, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	4	8	4
unidentified species A	40	36	144
Dero digitata	12	36	16
(*D. digitata* ??)	_	4	4
Nais communis	_	4	4
Tubificidae			
Aulodrilus pigueti	12	4	44
Limnodrilus cervix	_	8	_
UIW/OCC	4	12	4
UW/CC	_	8	12
Ephemeroptera			
Hexagenia limbata	4	_	4
Diptera			
Limonia	_	4	_
Ceratopogonidae	_	28	_
Chironomus	_	4	_
Dicrotendipes	_	8	_
Glyoptotendipes	_	12	_
Procladius	4	4	8
Coelotanypus	_	4	4
Lenziella	-	4	-

Appendix 4D-20. Benthic macroinvertebrate taxa and abundance by sample replicate for station 99C, Newton Lake, May 1990.

Taxa	A	B	C
Oligochaeta			
Naididae	12	_	_
unidentified species A	144	_	_
Dero digitata	64	16	16
(*D. digitata* ??)	32	24	4
Tubificidae			
Aulodrilus pigueti	44	4	4
Limnodrilus cervix	4	8	8
L. hoffmeisteri	4	_	_
UIW/OCC	92	76	74
UW/CC	12	_	_
Nematoda	_	4	8
Physidae	_	4	_
Sphaeriidae			
Shpaerium simile	_	_	4
Diptera			
Palpomyia complex	8	_	_
Chironomidae	4	_	_
Cryptochironomus	4	_	_
Endochironomus	_	4	_
Procladius	4	-	-

Section 5. Dissolved Oxygen/Temperature Profiles

Field Methodology

Beginning in May and continuing through October 1990, vertical profiles of temperature and dissolved oxygen concentration were measured monthly at each of the 20 benthic sampling stations (Fig. 4-1). Measurements were taken with a YSI Model 57 DO/temperature meter at 1- or 2-ft intervals (depending on depth). The meter was air calibrated in the field prior to each profile. Plastic buoys anchored to large concrete blocks were used to identify sampling locations. Prior to sampling the depth of each location was checked with a depth finder to insure that the marker buoys had not moved appreciably since the previous sample. Because oxygen concentrations at the bottom of the profile are most pertinent to benthic organisms, they were examined for low levels (<1 mg/L) during this initial analysis.

Results

The monthly temperature and oxygen profiles for each station throughout the 1990 sampling period are reported in Figures 5-1 to 5-20. Examination of these profiles will reveal that water surface elevations varied approximately 3 ft during the study. Station 1D was exposed to the atmosphere during the months of September and October, the periods of lowest lake water levels. Similarly, Station 2B was exposed to the atmosphere in October, the month of lowest water levels. These fluctuations in water level are to be expected in Newton Lake and reflect the fact that it is a cooling water reservoir in a region with variable climate.

Similar to the 1989 results, there was no strong vertical stratification of Newton Lake during the study (Figures 5-1 to 5-20). The lack of strong vertical stratification is typical of many Illinois reservoirs and reflects the generally windy atmospheric conditions in addition to the relatively shallow depths. Despite the absence of a pronounced stratification oxygen concentrations dropped to very low levels at several sampling stations during the year. For instance, oxygen concentrations dropped to critical (defined here as concentrations <1.0 mg/L) levels at least once during 1990 at nine stations (Table 5-1). Critical oxygen concentrations were only recorded once during the study at six of these nine stations. Of these six stations, five were shallow water stations, or, had depths less than 10 feet.

Oxygen concentrations reached the critical level at three of the stations more than once during the study (Table 5-1). All three of these stations had depths greater than 10 feet. The fact that anoxic conditions were not uncommon at stations with deeper depths is consistent with our earlier hypothesis that low oxygen concentrations are largely responsible for the lower diversity and complexity of macroinvertebrates at deep water stations (see previous section). Thus, these data suggest that dissolved oxygen could continue to be a limiting factor in some regions of Newton Lake.

Table 5-1. Stations and months when the recorded dissolved oxygen concentration at the sediment/water interface was <1.0 mg/L during 1990. (D) designates that water depth at the station was >10 ft. All other stations are <10 ft deep.

Station	Months
2B	Sep
3C	Oct
4B	Jul
6B	Jul
(D) 9B	Jun
(D) 11C	Jul, Aug, Sep
(D) 13B	Jul, Aug, Sep
(D) 14C	Jul, Sep
99C	May

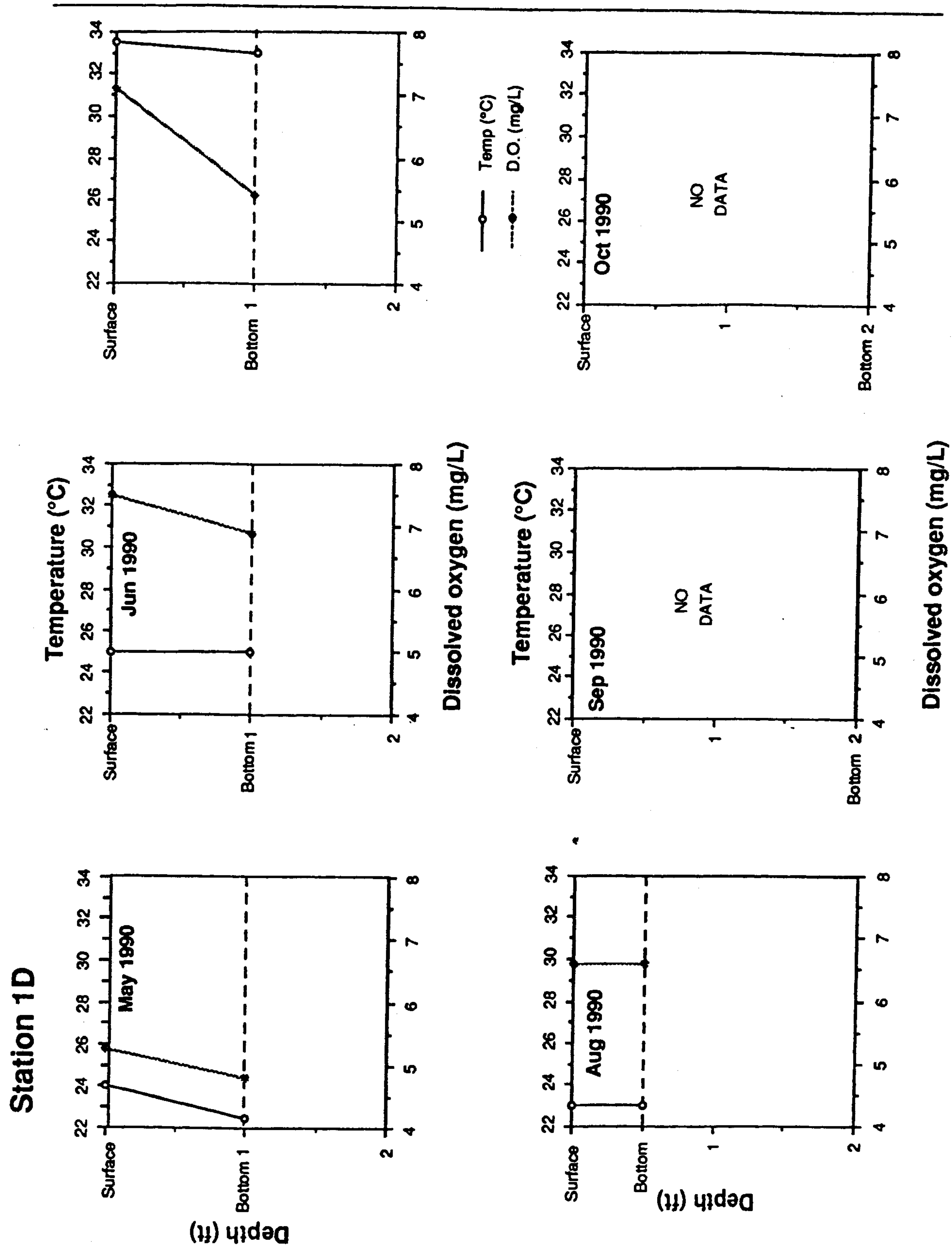

Fig.5-1. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 1D in Zone 1.

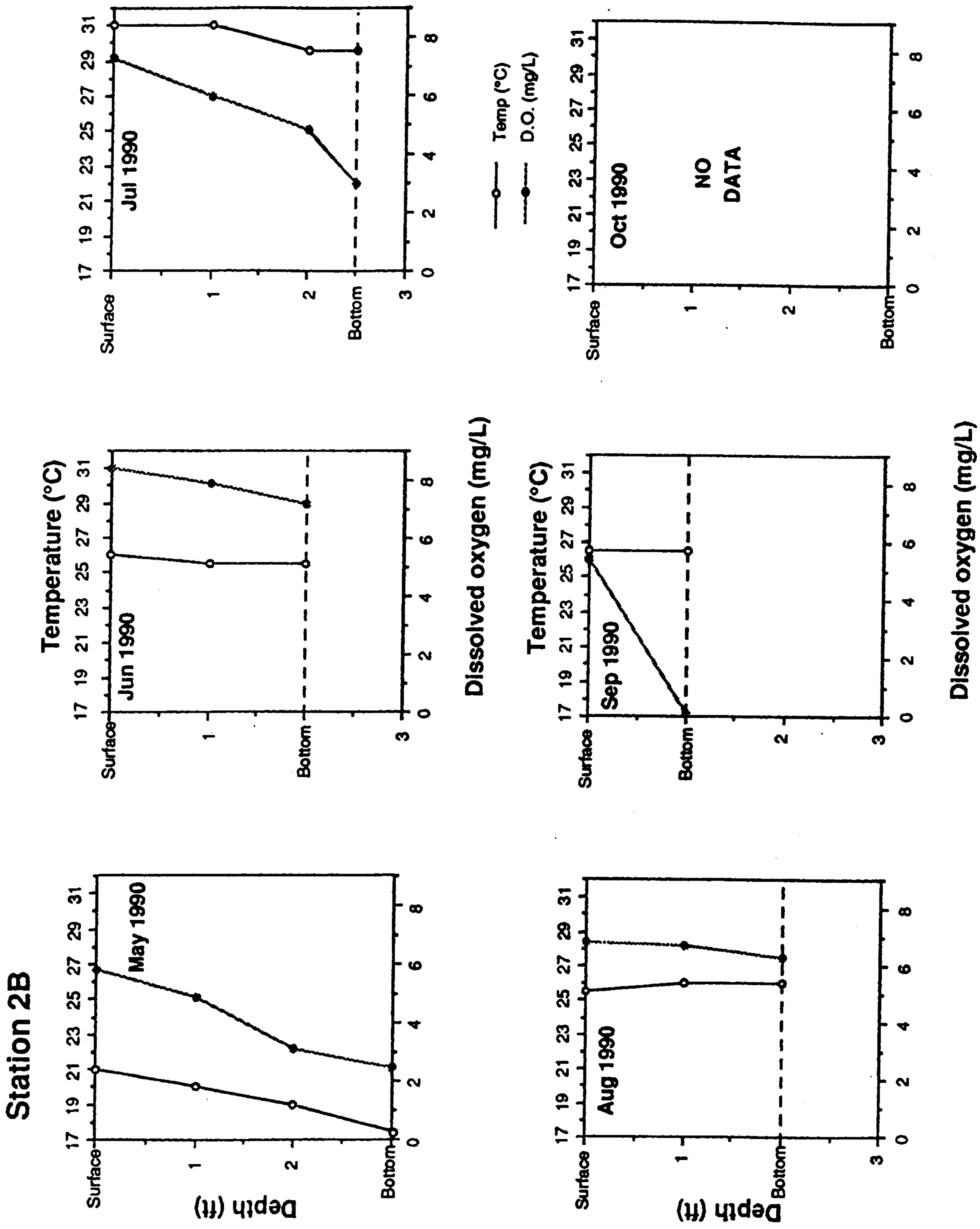

Fig.5-2. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 2B in Zone 1.

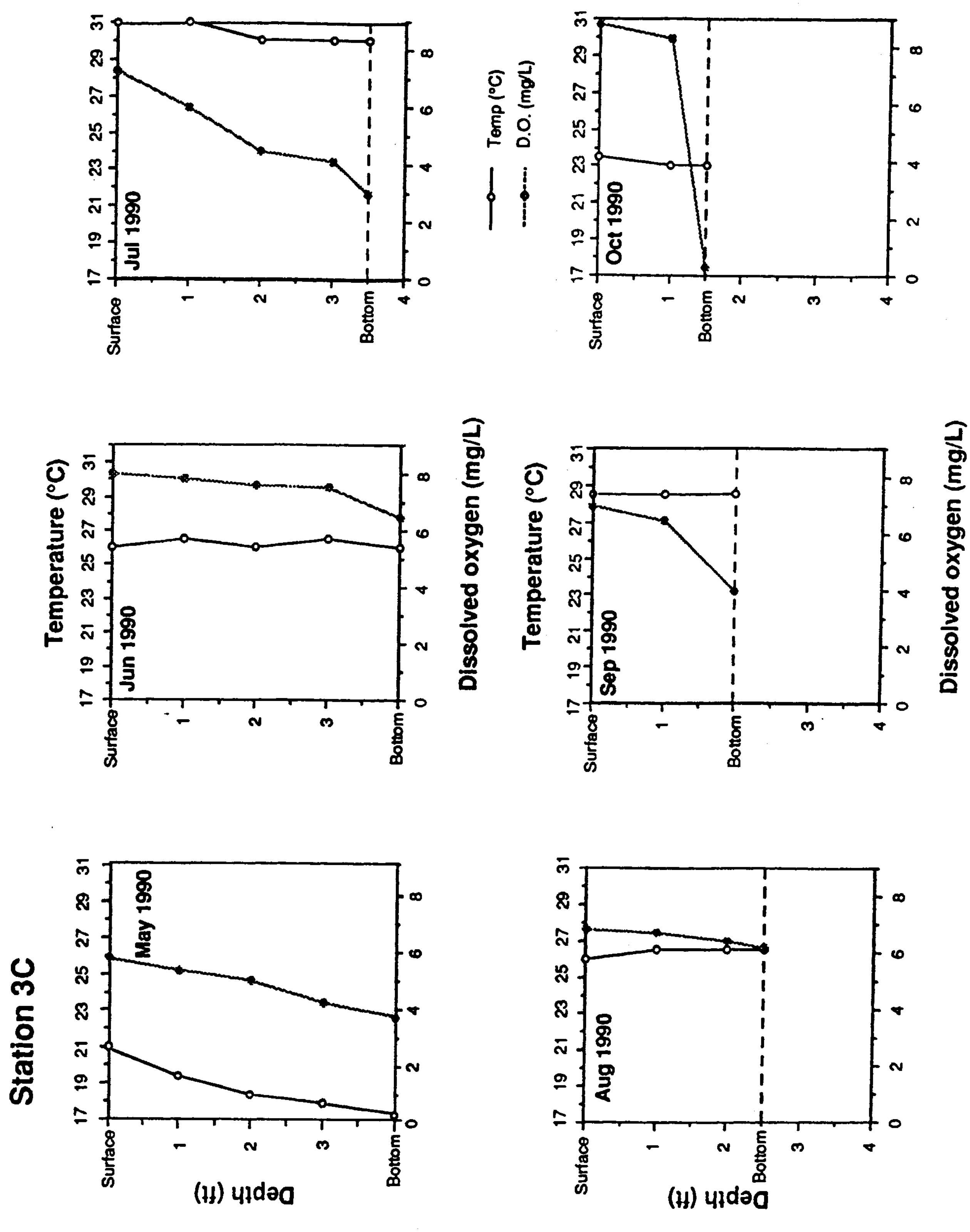

Fig.5-3. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 3C in Zone 1.

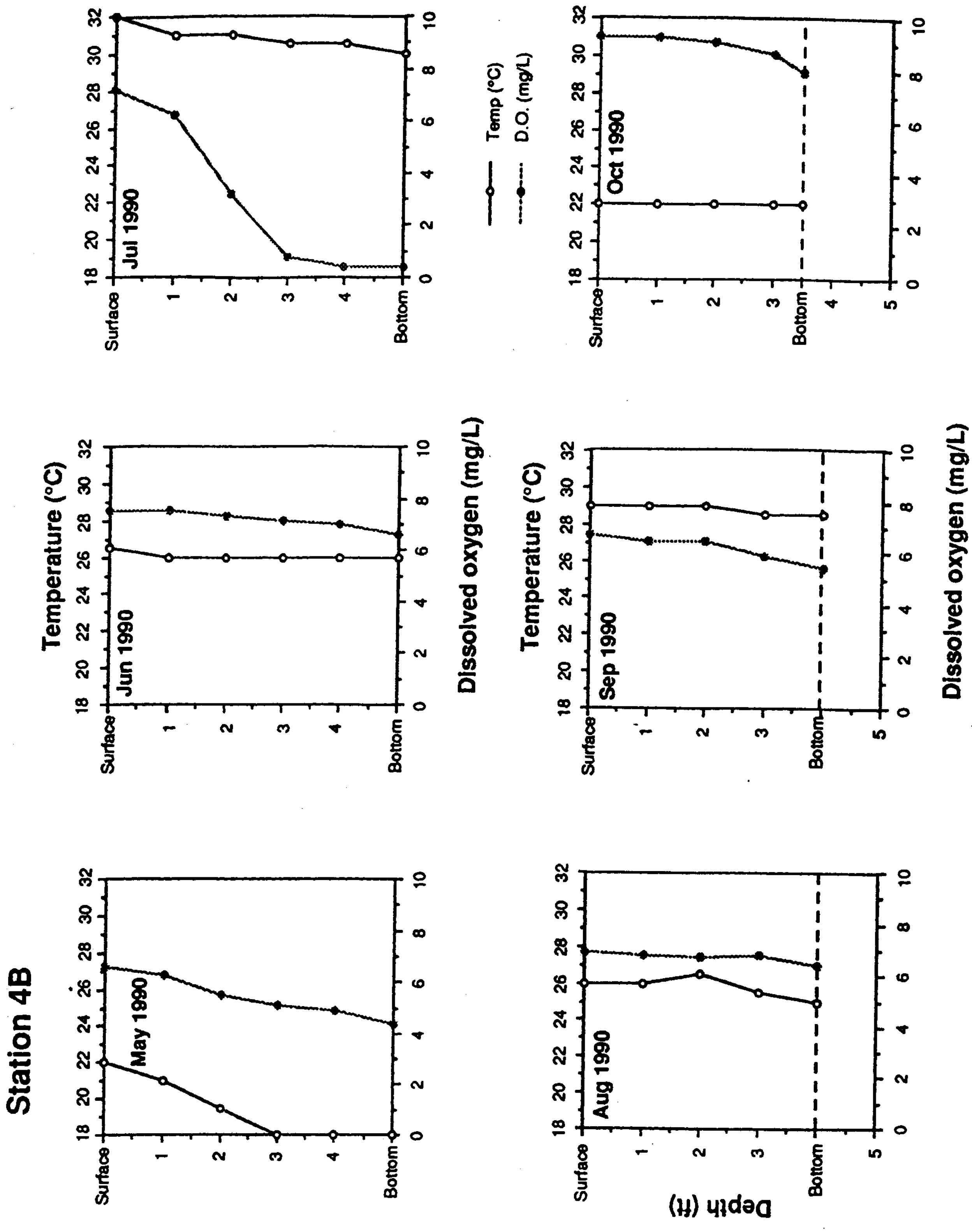

Fig.5-4. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 4B in Zone 1.

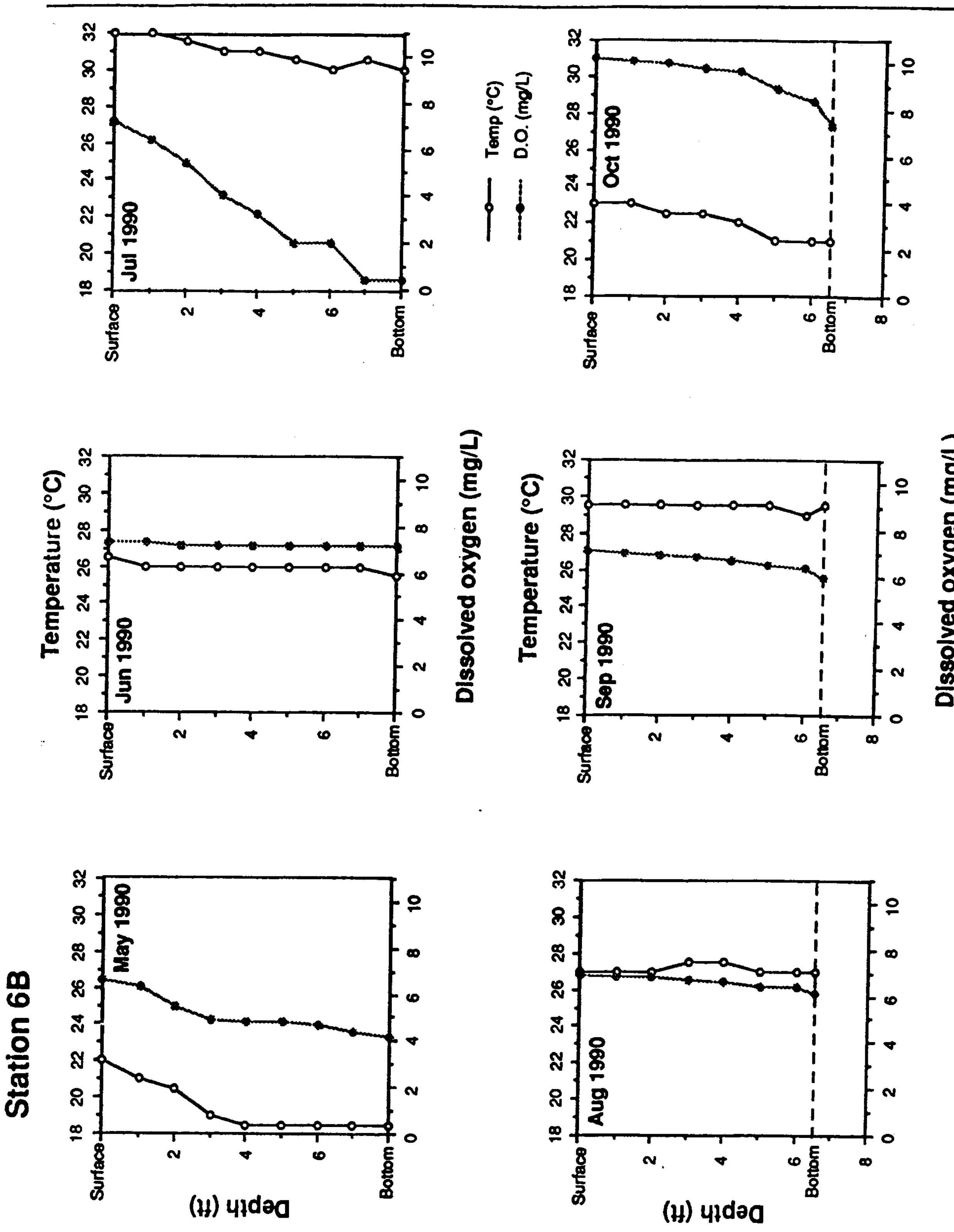

Fig.5-5. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 6B in Zone 1.

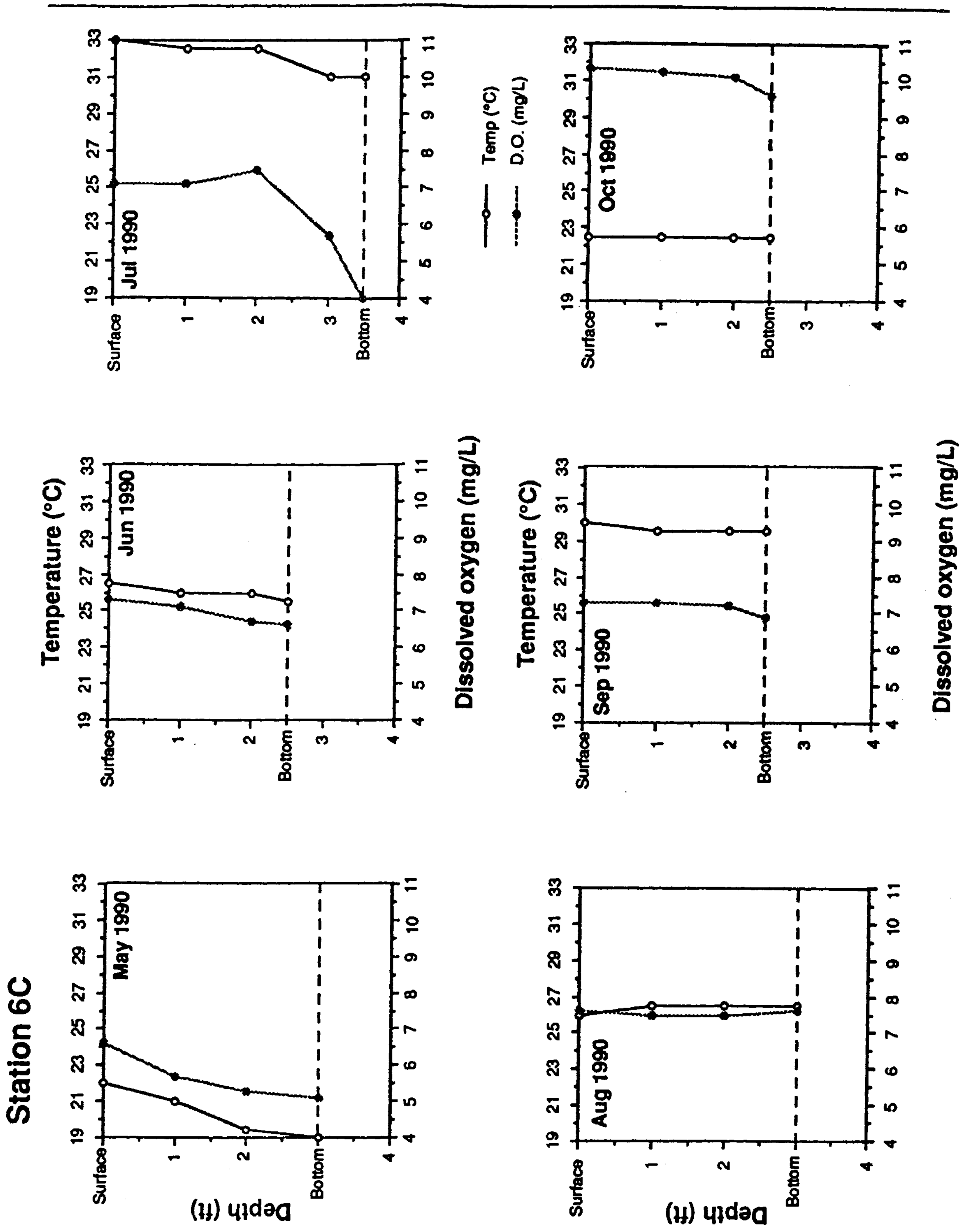

Fig.5-6. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 6C in Zone 1.

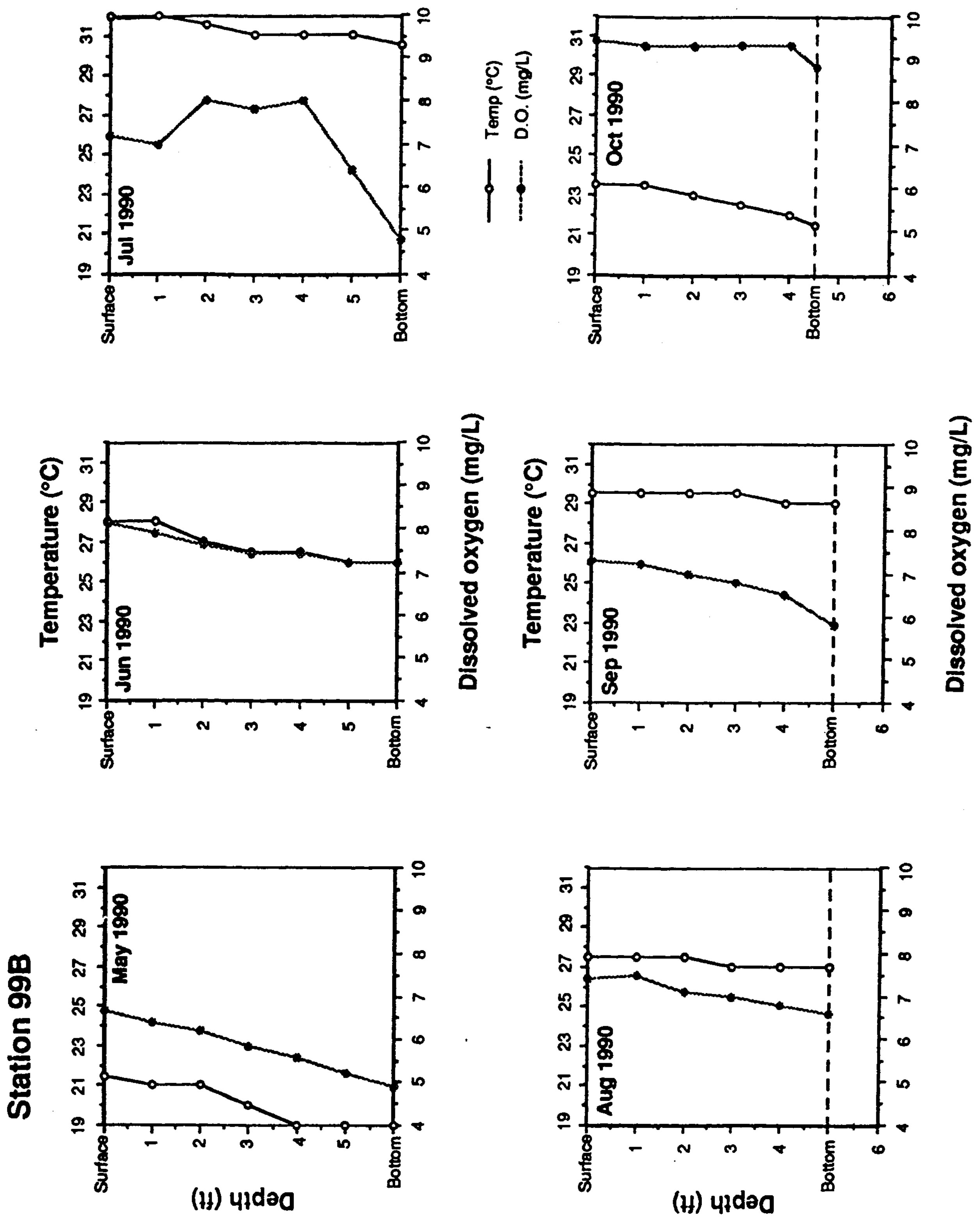

Fig.5-7. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 99B in Zone 2.

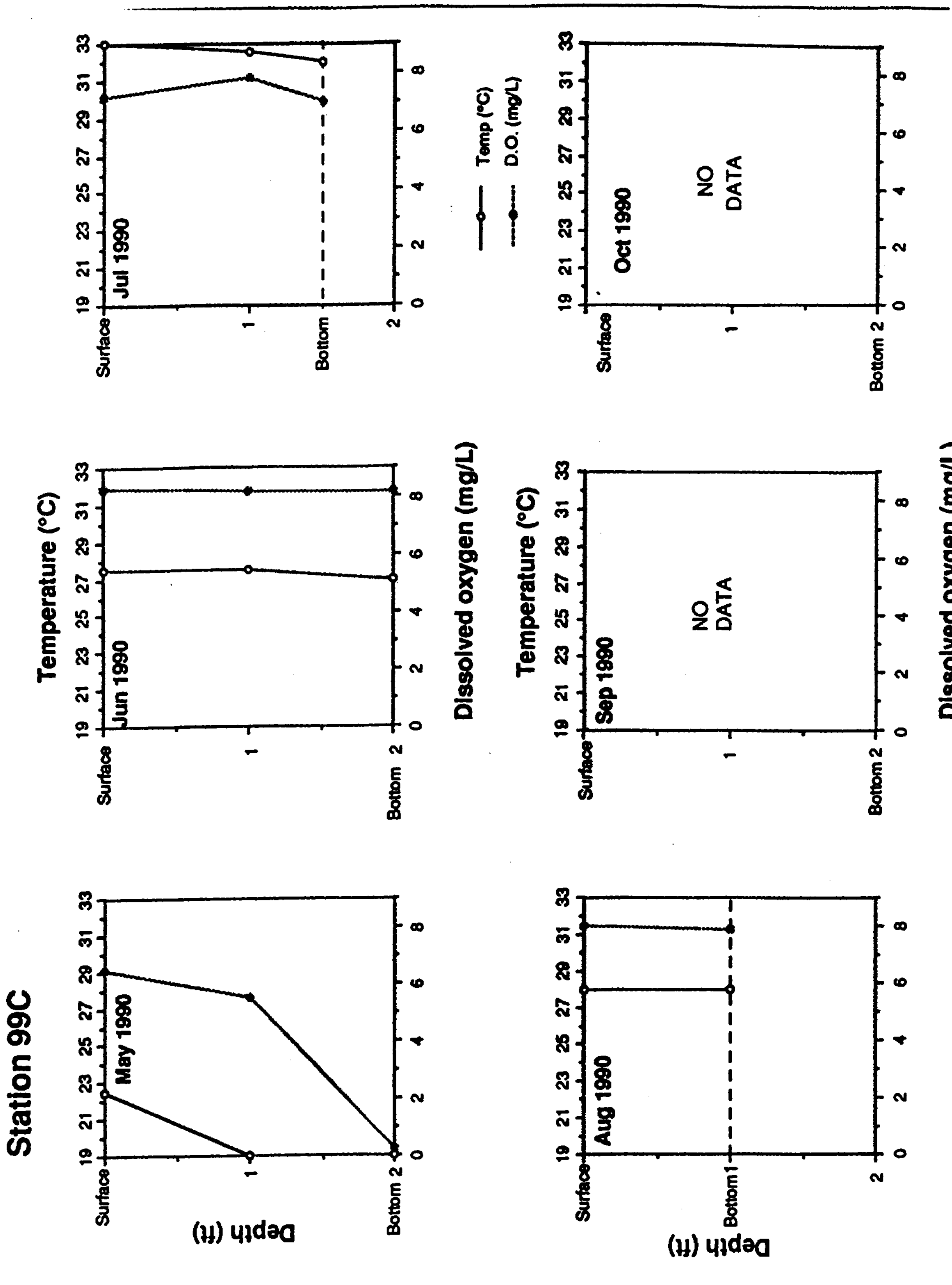

Fig.5-8. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 99C in Zone 2.

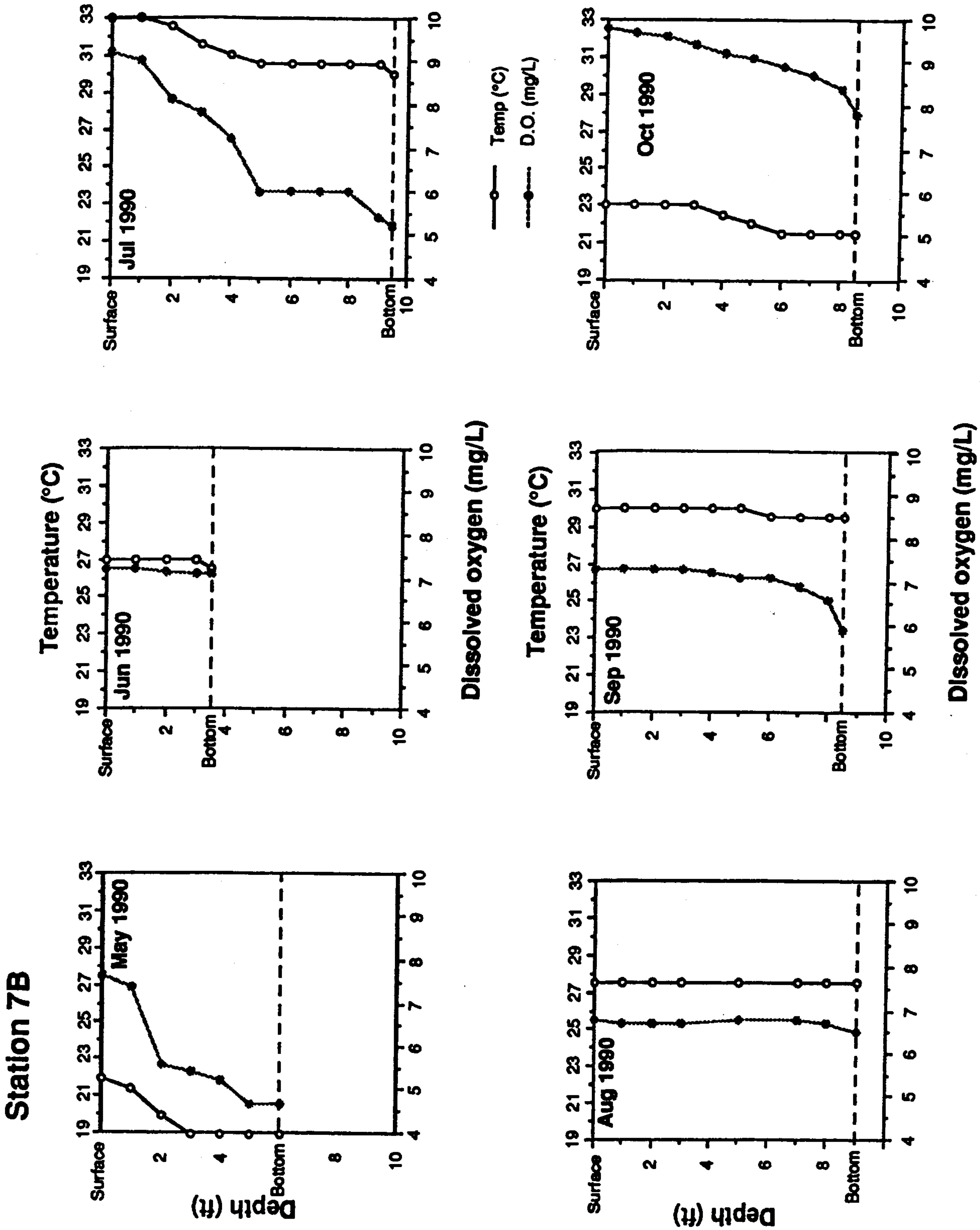

Fig.5-9. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 7B in Zone 2.

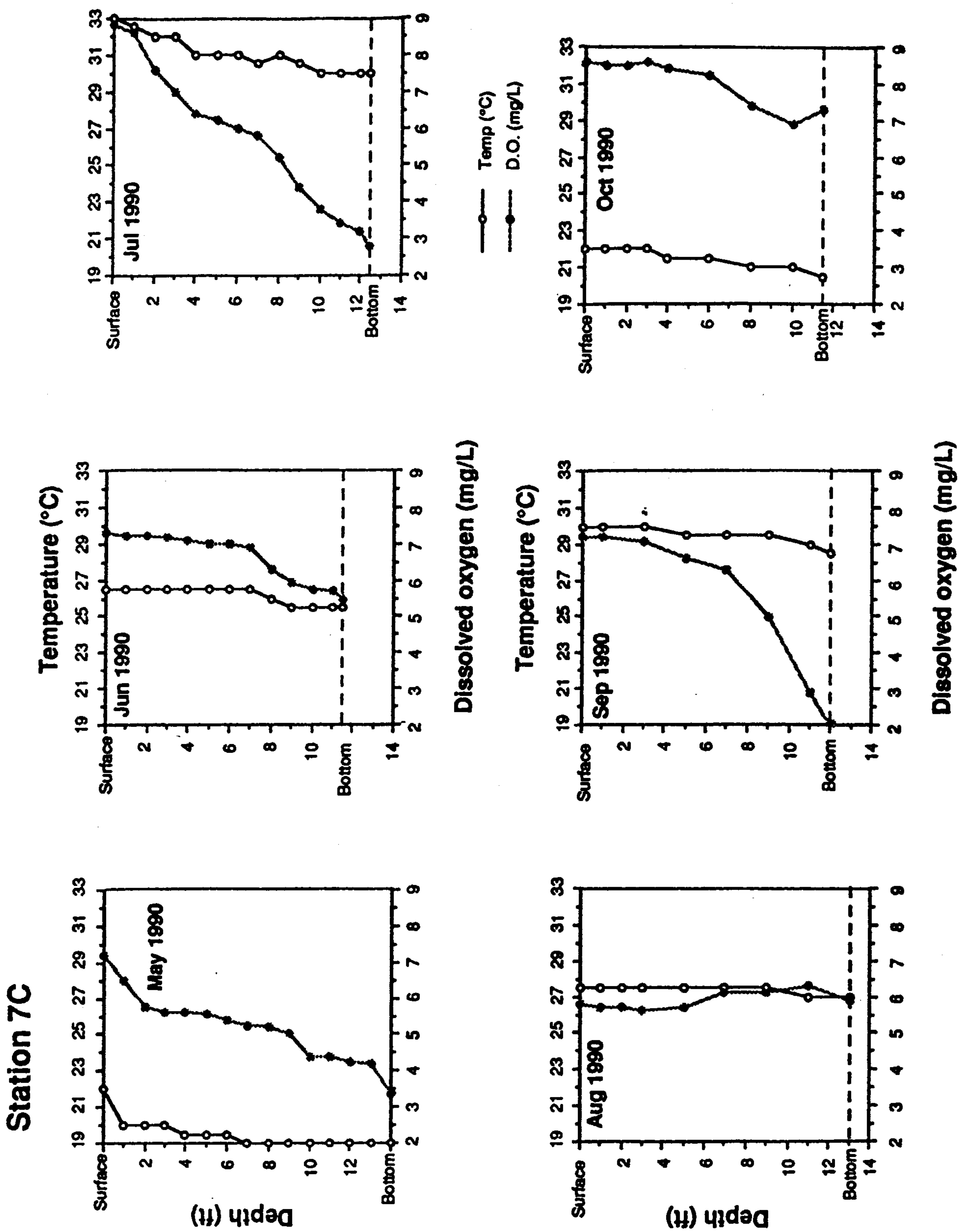

Fig.5-10. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 7C in Zone 2.

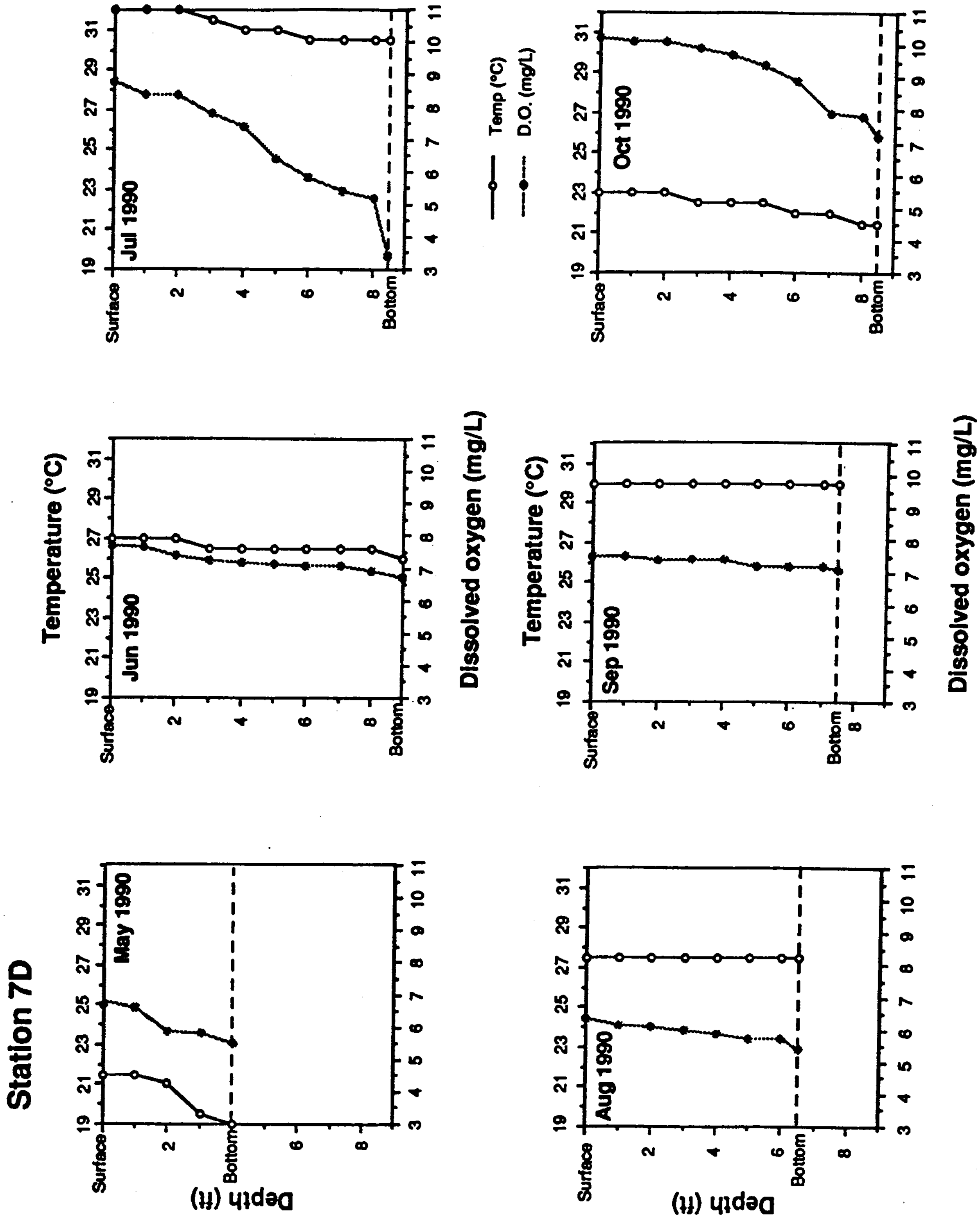

Fig.5-11. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 7D in Zone 2.

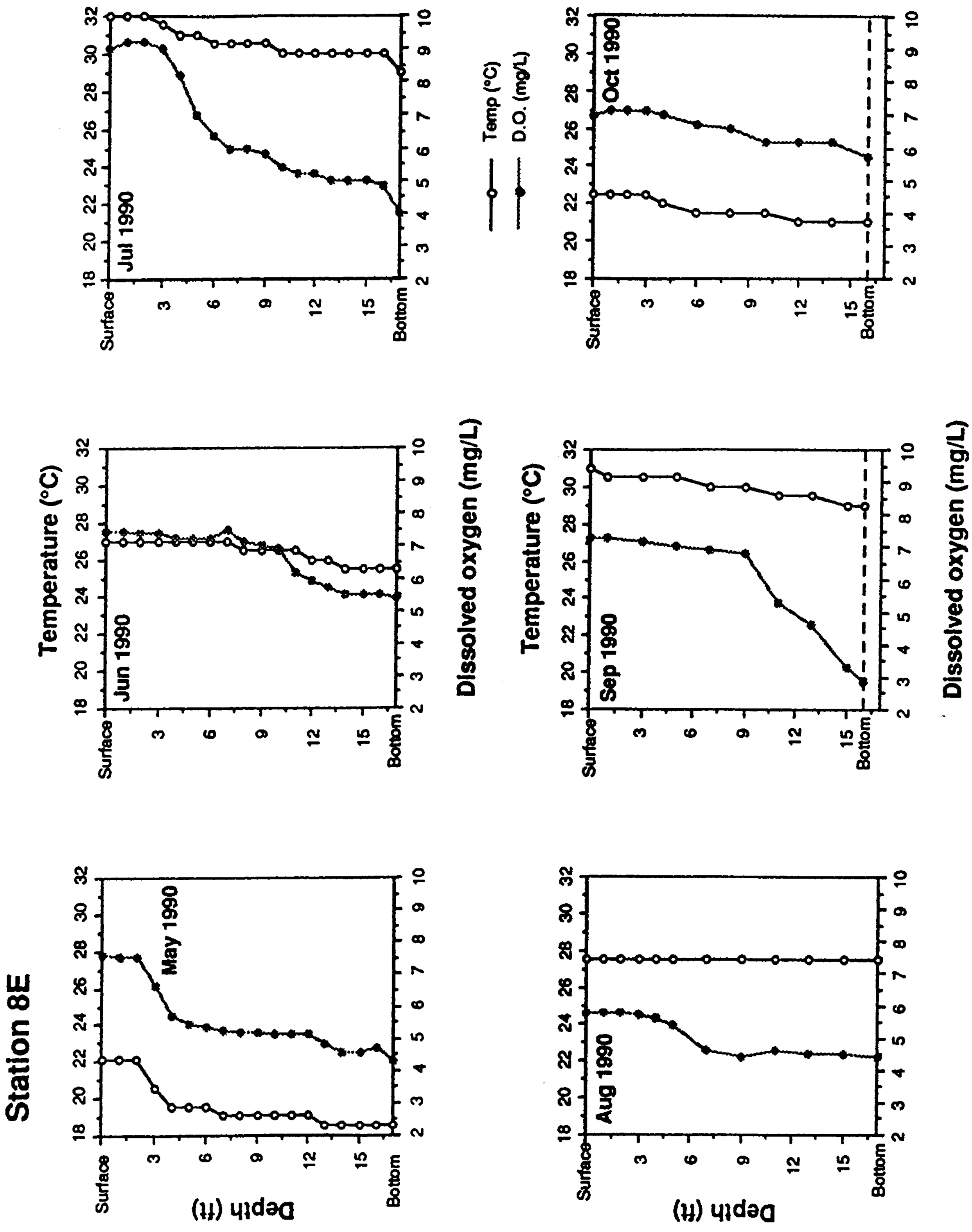

Fig.5-12. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 8E in Zone 2.

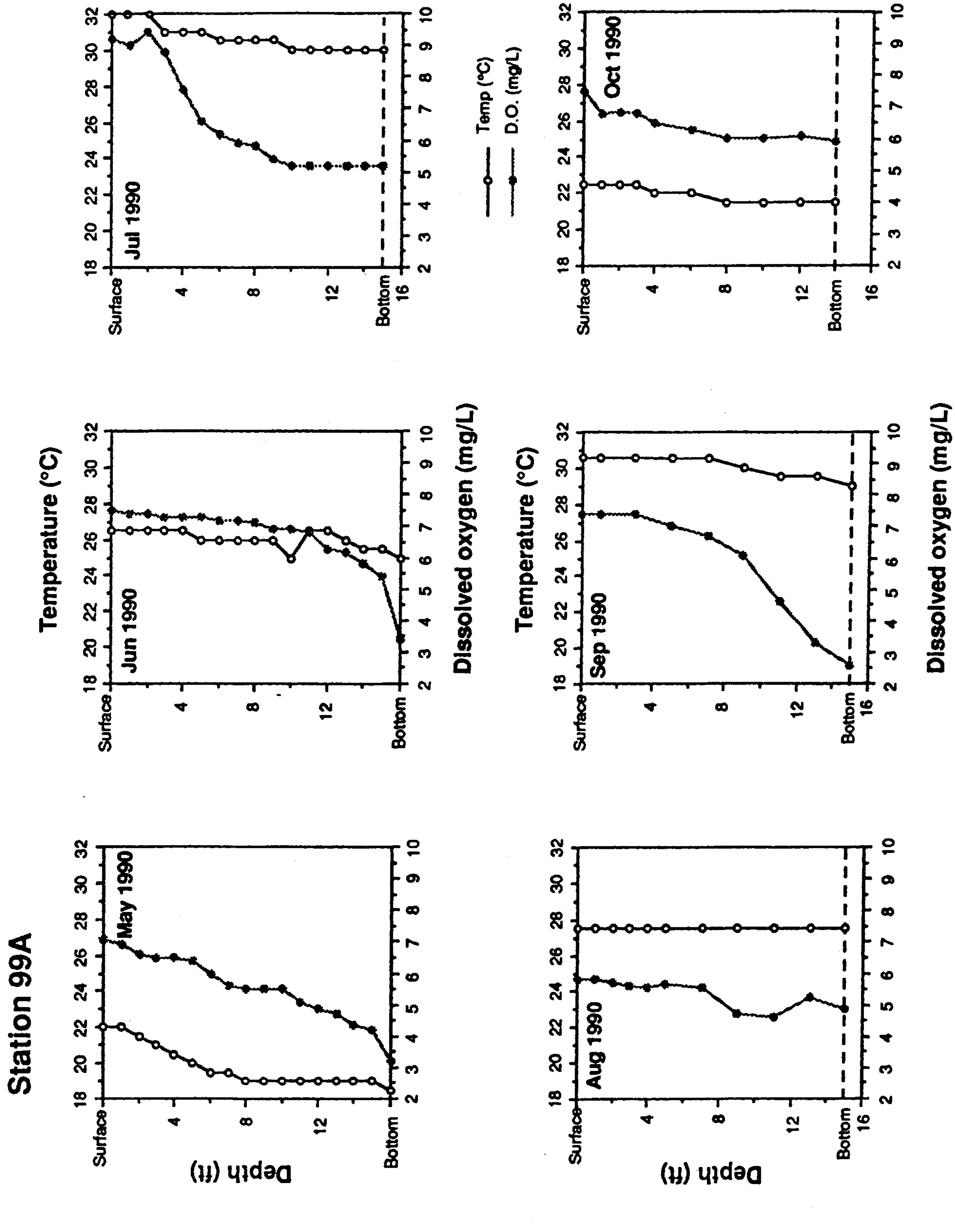

Fig.5-13. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 99A in Zone 2.

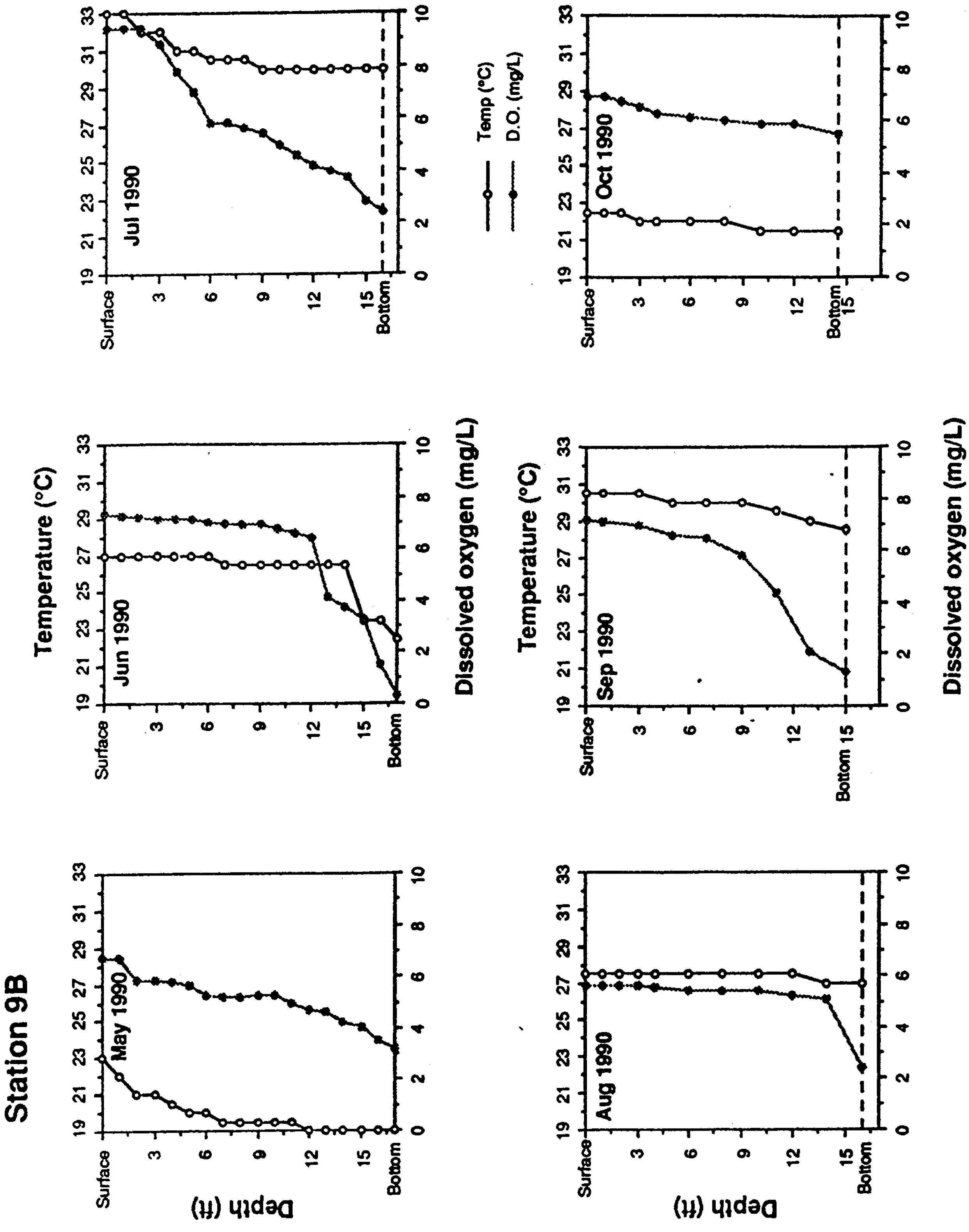

Fig.5-14. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 9B in Zone 2.

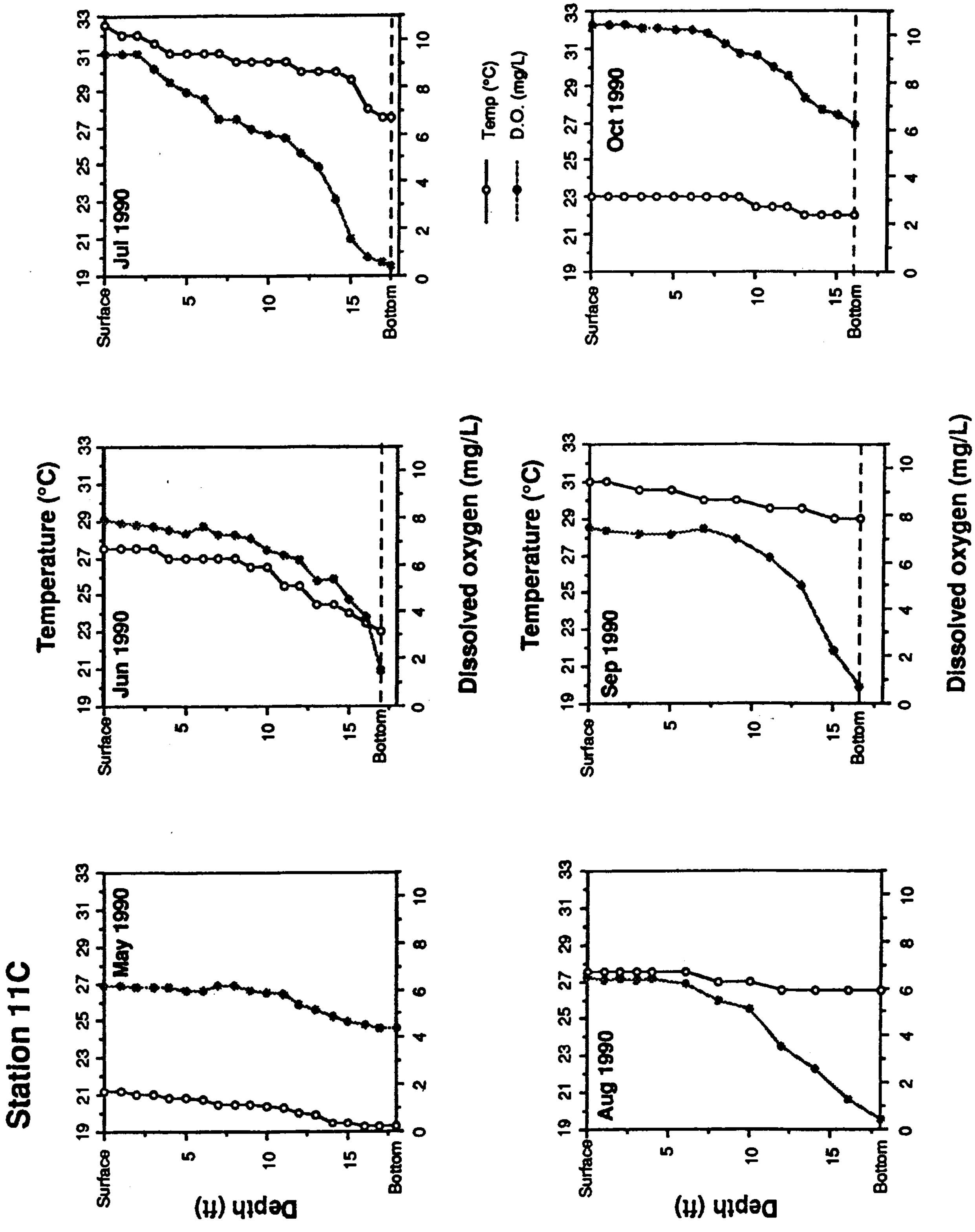

Fig.5-15. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 11C in Zone 3.

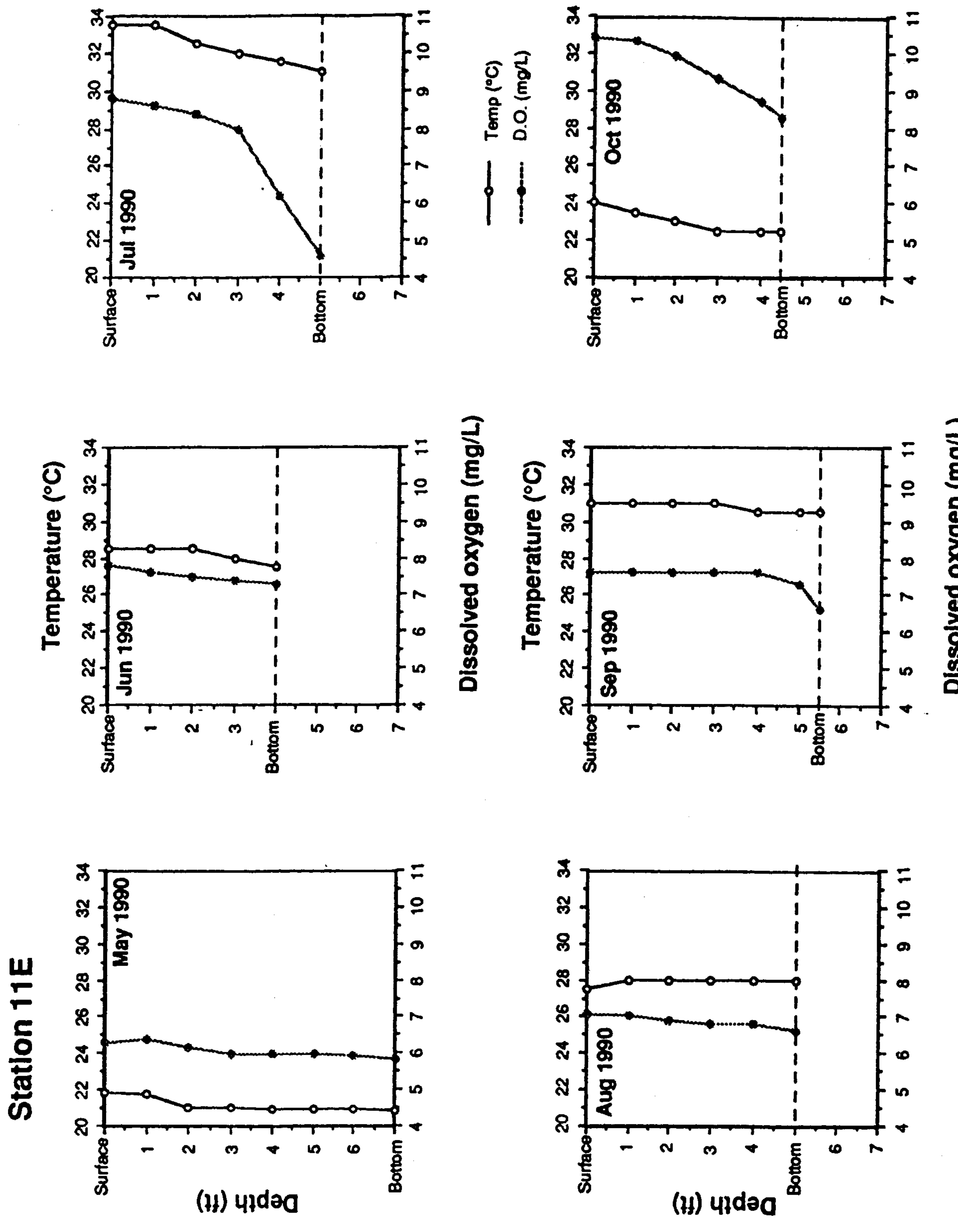

Fig.5-16. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 11E in Zone 3.

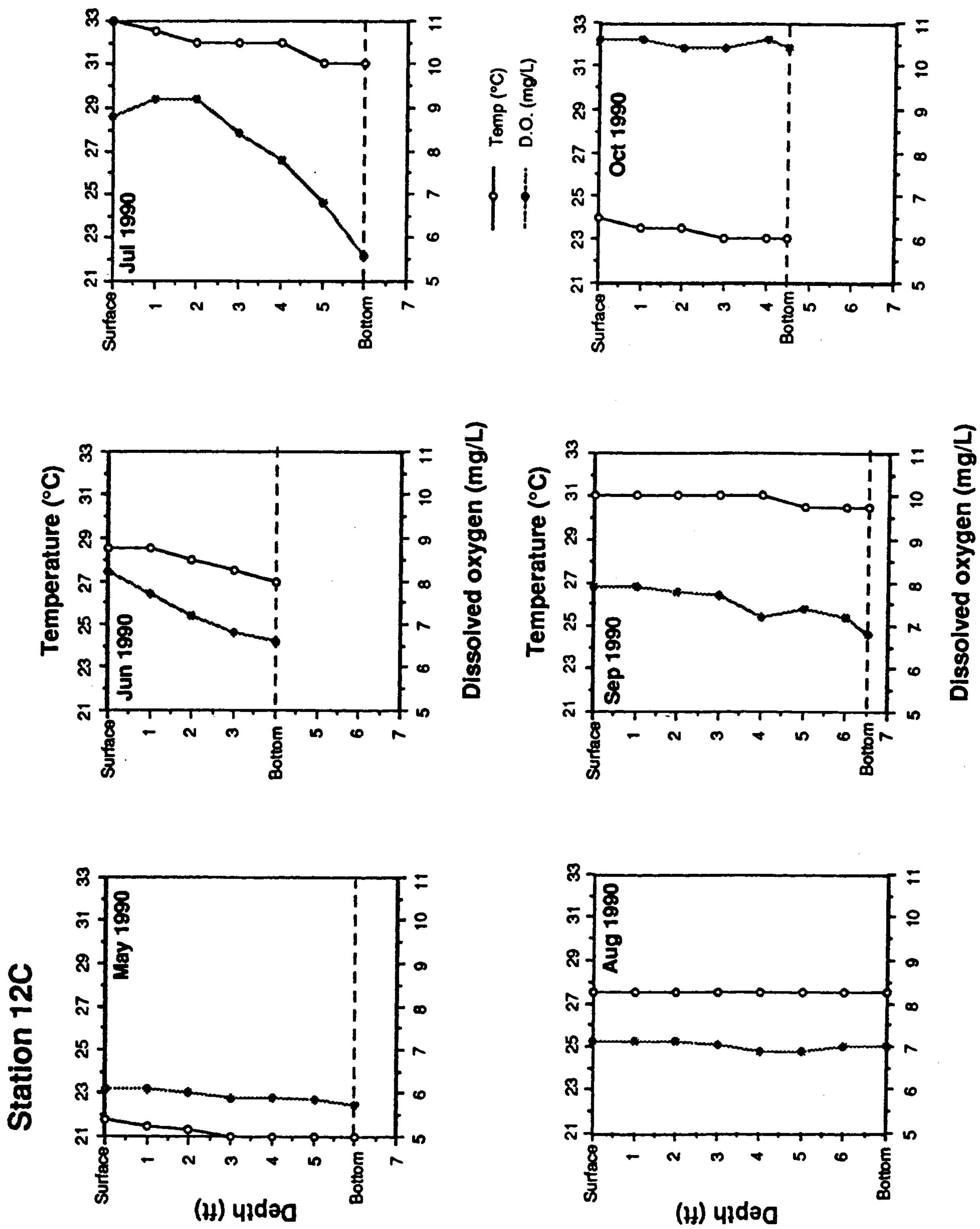

Fig.5-17. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 12C in Zone 3.

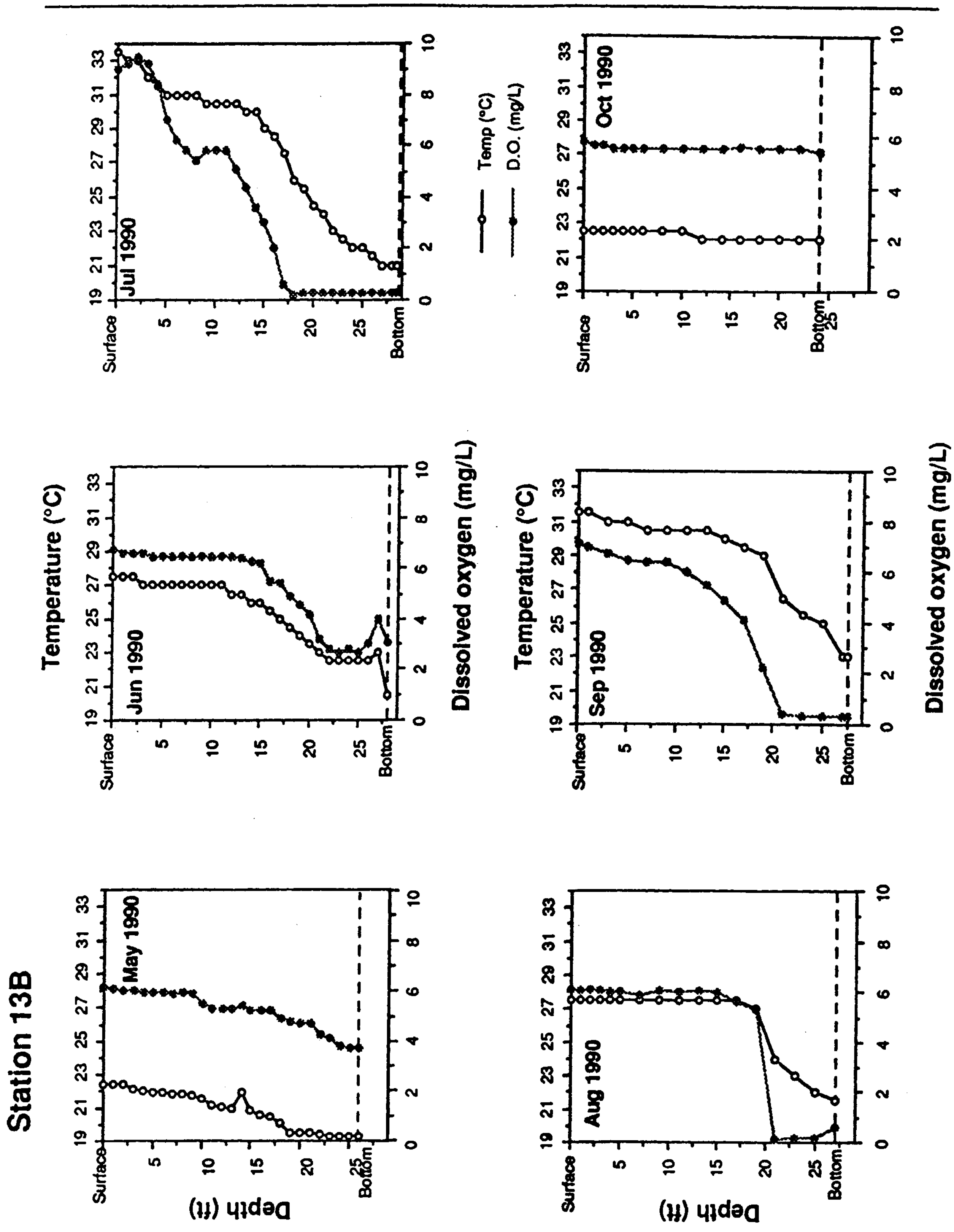

Fig.5-18. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 13 in Zone 4.

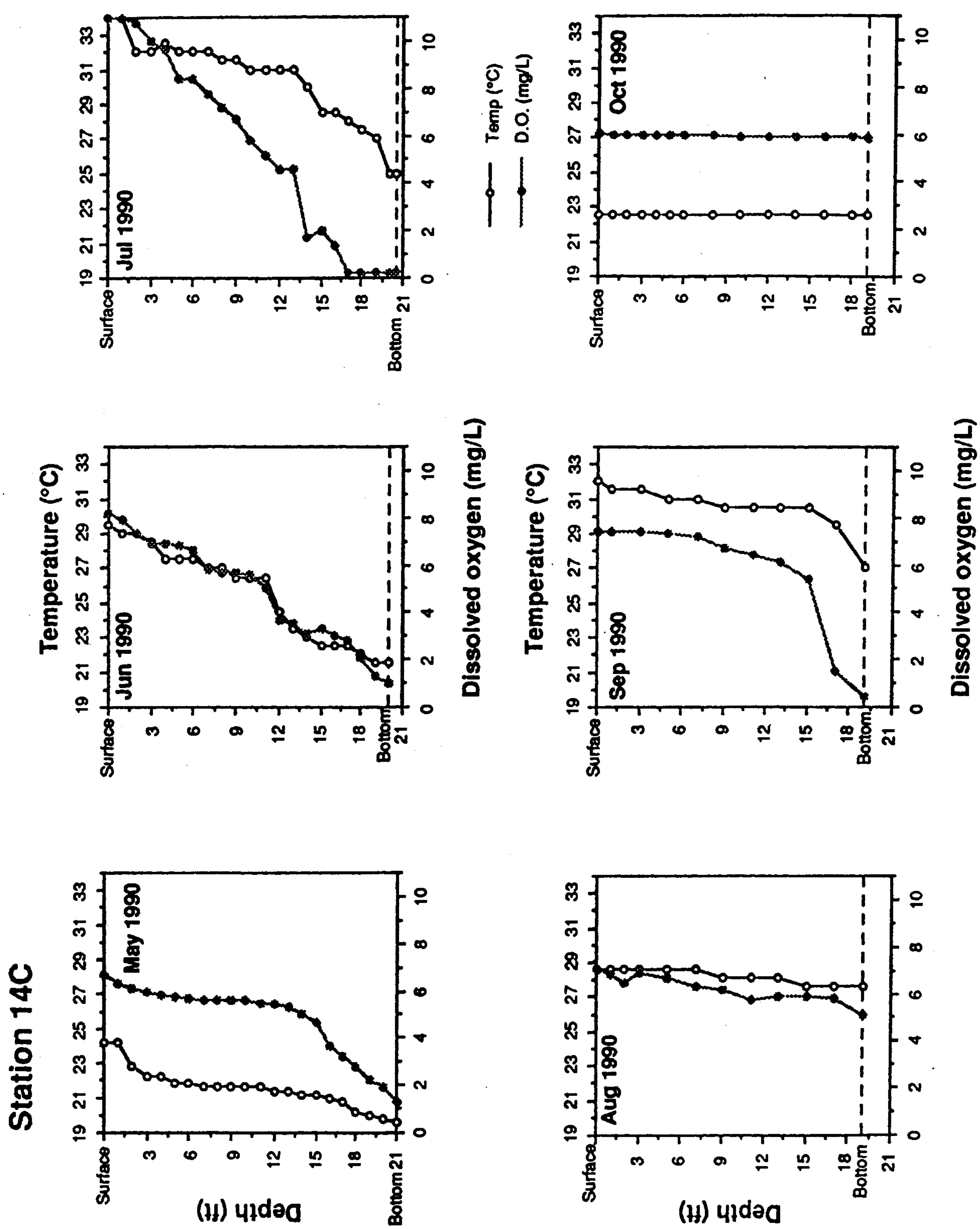

Fig.5-19. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 14C in Zone 5.

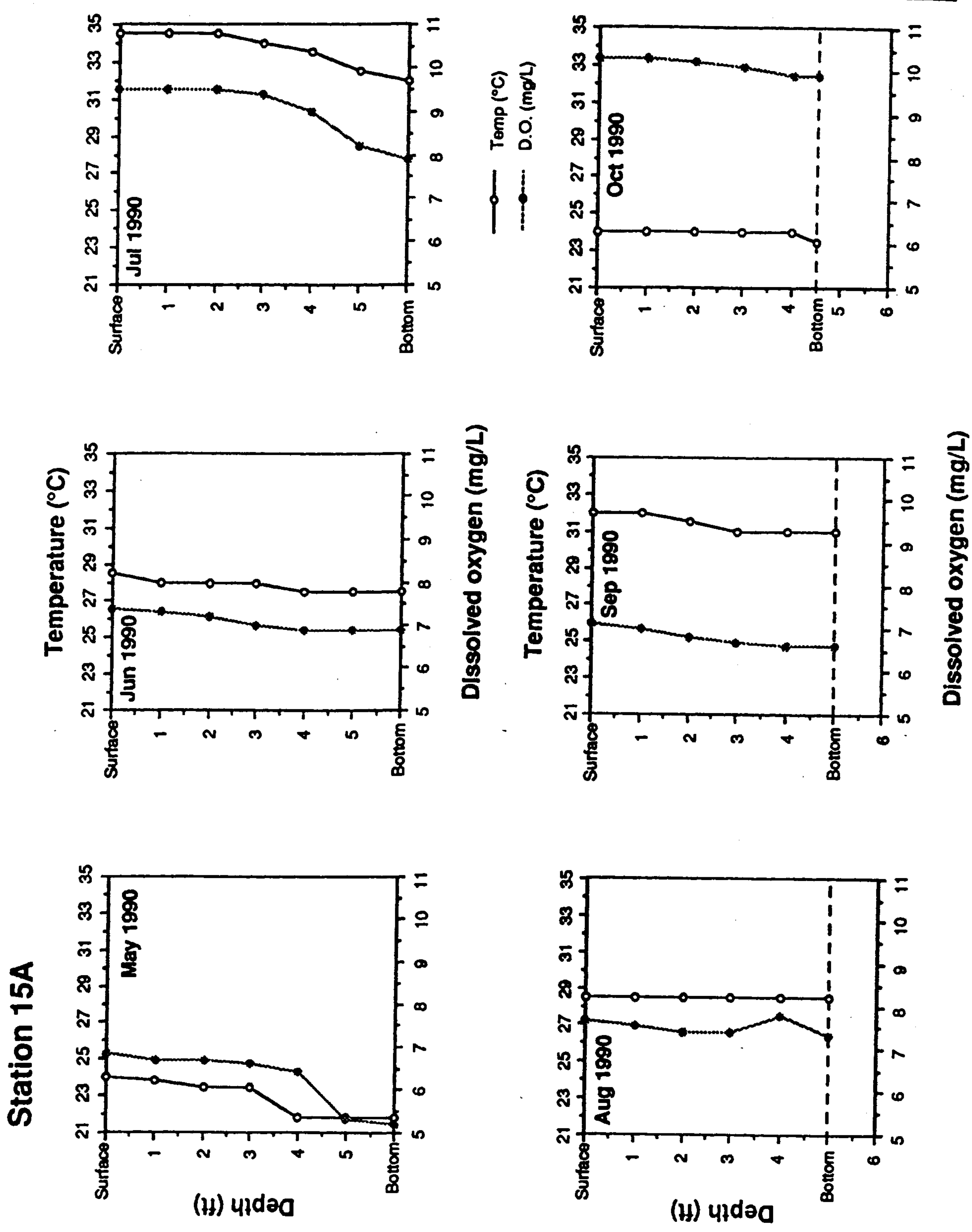

Fig.5-20. Temperature and dissolved oxygen profiles at Newton Lake, Illinois, from May through October 1990, at Station 15A in Zone 5.