POCONO LAKES:

REPORT ON LIMNOLOGICAL CONDITIONS IN 1991

Robert E. Moeller
Craig E. Williamson

POCONO COMPARATIVE LAKES PROGRAM

Lehigh University

Department of Earth & Environmental Sciences
31 Williams Drive
Bethlehem, Pennsylvania 18015

1 October 1992

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INTRODUCTION

Personnel from Lehigh University sampled Lake Lacawac on 16 dates during 1991 as part of a routine monitoring program of three lakes. These lakes were selected to span a trophic gradient, Lake Lacawac occupying the intermediate ("mesotrophic") position in the gradient. Similar reports will be submitted to the owners of Lake Giles, an acidic, unproductive ("oligotrophic") lake, and Lake Waynewood, a nutrient-rich ("eutrophic") lake potentially affected by homes and agricultural practices within its drainage basin. Because Lake Lacawac has been little disturbed throughout its recent history, and is currently preserved as part of The Lacawac Sanctuary, it serves as a valuable reference lake for the region.

The monitoring of these lakes in the Pocono region of northeastern Pennsylvania is a key component of Lehigh's Pocono Comparative Lakes Program (PCLP). This program aims to better understand the natural functioning of lakes, differences in lakes that arise through natural or man-made differences in their watersheds, and long-term trends that may be occurring in northeastern Pennsylvania. Through the cooperation of lake owners, scientists from Lehigh and other institutions are obtaining basic information that provides objective documentation of current lake conditions as well as a context for more intensive studies. Financial support from the Andrew W. Mellon Foundation has made these studies possible.

1991 was the fourth consecutive year of the monitoring program, and the fourth year for summer sampling. This is the second year that winter and spring data were obtained. The present report summarizes conditions in Lake Lacawac over the full twelve-month period for 1991. Physical/chemical data are presented as tables for each date, and are summarized in figures. The following parameters were measured: **TEMPERATURE, LIGHT PENETRATION, SECCHI DEPTH, DISSOLVED OXYGEN, ALKALINITY, pH,** and algal **CHLOROPHYLL-a. ZOOPLANKTON DATA** are presented as graphs that give the concentration (number of individuals per liter) averaged over the entire water column.

A chemical sampling program similar to that carried out in 1989 was also initiated, with samples collected from 6 depths on 4 occasions (in April, July, September, and November). Analyses will be carried out by Jon Cole and Nina Caraco at the Institute of Ecosystem Studies, New York Botanical Garden, Millbrook, New York.

The Lacawac Sanctuary plays a major role in this program as the field laboratory and summer residence for the investigators. We especially appreciate the interest and cheerful assistance of its director, Sally Jones, the support of Board members and the impressive efforts of volunteers who have completed major improvements to the laboratory facilities.

1991 METHODS AND RESULTS

Data included in this report are extracted from an electronic database maintained at Lehigh University by Dr. Craig Williamson. The field sampling, laboratory analyses, and computer data entry were supervised by Dr. Robert Moeller and Gina Novak. Gina Novak, Timothy Vail, John Aufderheide and Scott Carpenter carried out most of the field sampling and laboratory analyses. John counted the microzooplankton through August, and trained Gina, who counted samples after August. Macrozooplankton samples through May were counted by Karen Basehore. After 1 June, Tim Vail counted all macrozooplankton samples. Gina managed all aspects of the computer database including data entry and printing of zooplankton graphs. Dr. Bruce Hargreaves and Scott Carpenter have played major roles in the development of the computerized database. Natasha Vinogradova and Brian Sharer verified the zooplankton data entries. Gina Novak, along with Tim Vail, Robert Moeller and Vanessa Jones analyzed chlorophyll samples. Alkalinity and pH were determined by Scott Carpenter (through April), John Aufderheide and Tim Vail (May-July), and Tim Vail and Gina Novak (August-December). Gina entered the physical/chemical data, which Robert Moeller checked and abstracted as tables and graphs.

Although efforts have been made to assure the accuracy of data included in the database, and compiled in this report, we cannot guarantee complete accuracy and do not claim specific levels of accuracy or precision. The data have been collected as part of a lake characterization program and may not be suitable for uses not envisioned by the investigators. A brief description of sampling and analytical techniques is included here; a more complete description will be issued later in 1992 as a special report.

Information acquired through the Pocono Comparative Lakes Program is to be shared among scientists desiring to make broad comparative studies or considering research projects in these lakes. Inquiries to examine or use the data are invited. Of course, the primary right to publish extensive extracts from the database, or from this unpublished report to the lake owners, resides with the PCLP cooperating investigators and students who generated the data. As of May, 1992, most of the existing information is accessible through the software program Reflex™ (version 2, Borland International, copyright 1989) running on IBM PC-type microcomputers. Instructional workshops are offered periodically at Lehigh University

SAMPLING PROGRAM

On each sampling occasion, Lake Lacawac was visited twice, once during the day (the nominal date) and again after dark (sometimes the previous night). The night-time visit was required for zooplankton sampling. Usually, other parameters were measured, and samples were collected, during the day. Sampling was carried out at a fixed station (site "A") in the deepest part of the lake (about 12.7 meters or 42 feet).

The thermal stratification existing on any date dictated the depths from which other samples were collected (**Figure 1**). The lake was sampled twice monthly when surficial water temperature stayed above 20°C, (June through September), then once monthly during cooler times. The lake was not sampled in December--thin ice cover first developed on 18-19 December, the planned sampling date.

TEMPERATURE AND PHYSICAL STRATIFICATION

Temperature was measured at 1-meter intervals with the thermister of a YSI™ oxygen meter, in degrees Celsius. Accuracy should be within 1 degree. (This is **Method #10.**)

Figure 2 shows the thermal stratification that develops during late spring and summer, then breaks down in the autumn. On day 19 (19 January) the lake was ice-covered, and displayed a "reverse stratification". After ice-out (sometime just before 17 March) the water column circulated from top to bottom during "spring turnover". By day 102 (12 April) the lake had warmed enough to become weakly stratified. Stratification was pronounced by day 184 (3 July), producing an upper warm water layer circulating in contact with the atmosphere (the EPILIMNION, 0-3 meters, temperature 23.5°C); an intermediate layer of rapid temperature decrease with depth (the METALIMNION, 3-7 meters); and a deep layer of cold water (the HYPOLIMNION, 7-12+ meters, temperature 7-9°C).

The usual course of thermal stratification is that of slow, gradual thickening of an epilimnion during the summer. By day 265 (22 September) Lake Lacawac's epilimnion extended to 6 meters. As the lake cooled during the autumn, the epilimnion thickened more rapidly until the lakewater was circulating from top to bottom. This period of full circulation, or "fall turnover", was in progress long before day 327 (23 November), although warm weather had temporarily reestablished a weak thermal stratification on that date. The lake continued to cool, down to 3°C, before freezing the night of 18 December. **Figure 3** presents the detailed trends of water temperature at three fixed depths (2,6,10 meters) for comparison with other years.

The temperature pattern in the lake is controlled by climate, and will differ only slightly from year to year. Two major variables are the durations of winter ice-cover (ca. 12 weeks in 1990-91) and the completeness of spring turnover. Spring turnover was complete in 1991. During an especially warm spring, Lake Lacawac might stratify quickly without a thorough mixing of deep and surficial layers. We have not yet observed an incomplete spring mixing during our study.

Water samples for **pH, alkalinity, chlorophyll,** and **algae** were collected from mid-depths of the three layers when thermal stratification was well developed. During turnover periods, the lake was divided into three equal layers. Under ice-cover (e.g. 19 January), the topmost layer was 0-1m, and the remaining depths were divided at the Secchi depth (see SECCHI DEPTH below).

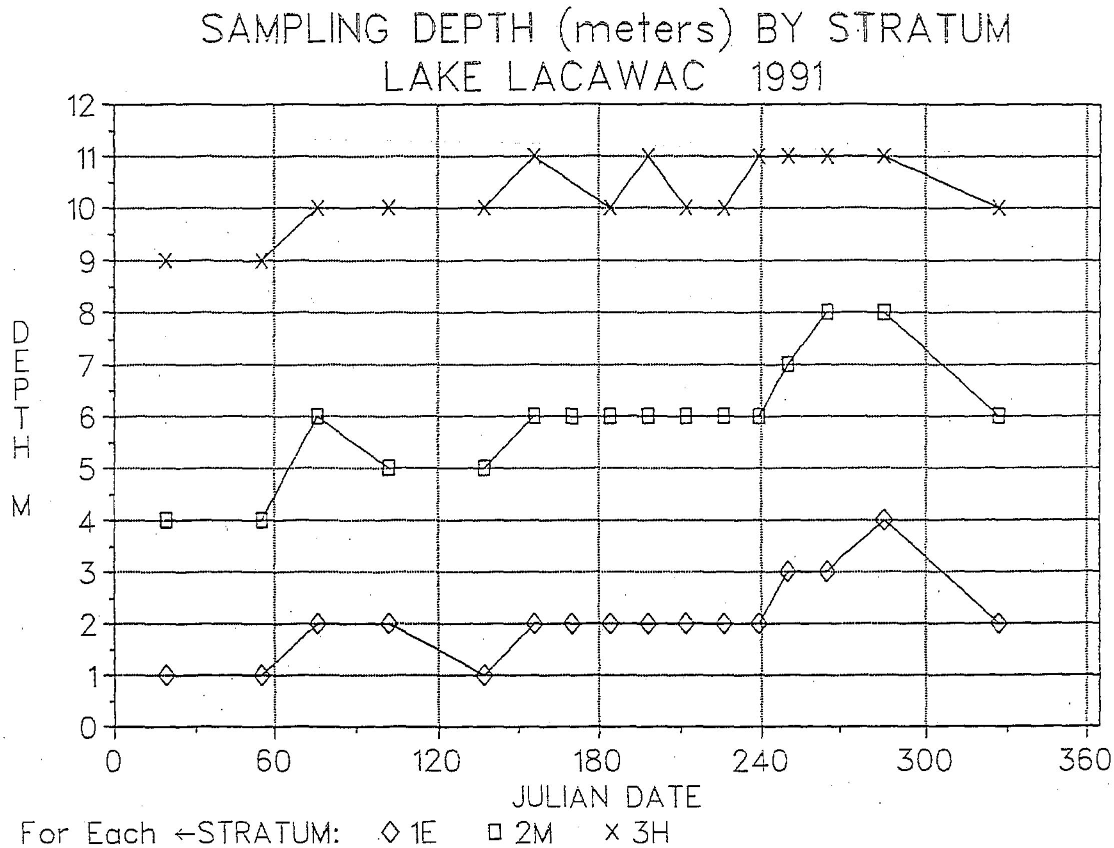


Figure 1. Depths of "EPI", "META", and "HYPO" samples from Lake Lacawac, 1991.

Sampling depths were selected by the field sampling crew based on the temperature profile on each date (see text for discussion).

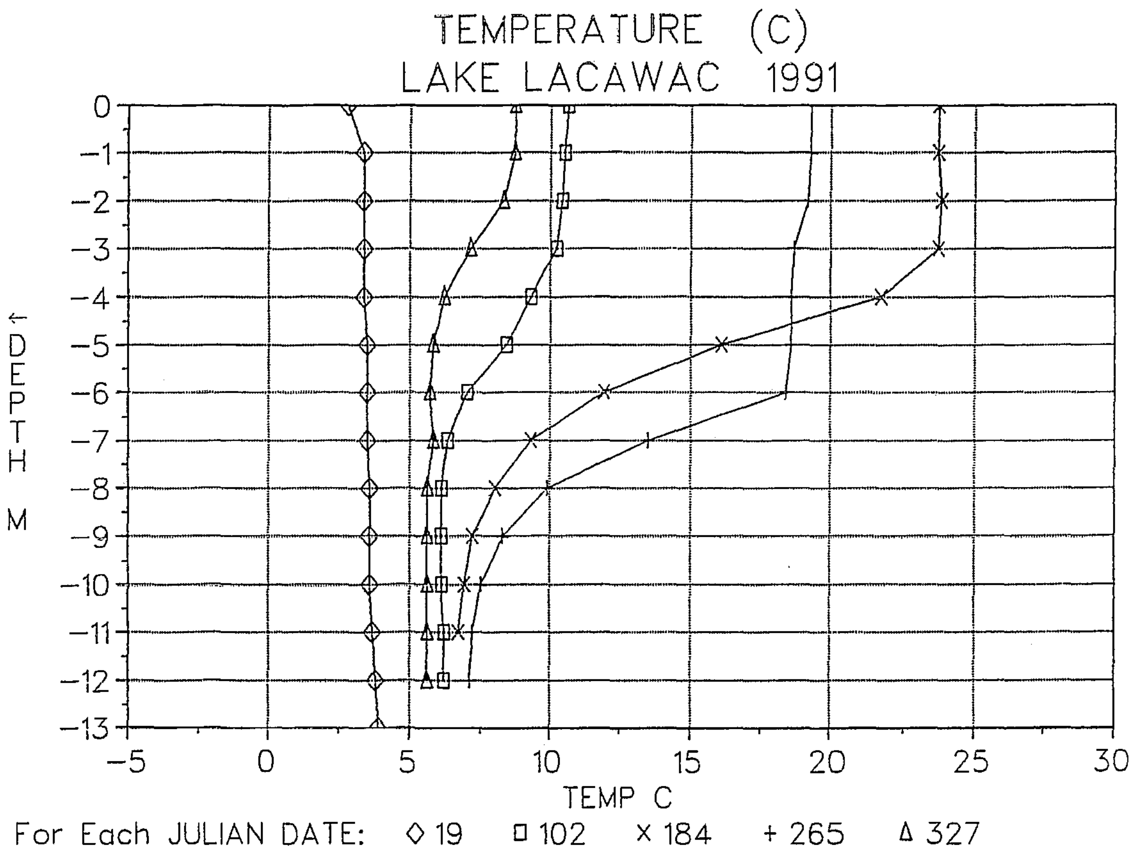


Figure 2. Temperature profiles in Lake Lacawac, 1991.

Values (°C) are plotted for five dates: **19 January** (day 19 --winter ice cover), **12 April** (day 102 --immediately following spring turnover), **3 July** (day 184 --midsummer stratification), **22 September** (day 265 --late stratification), **23 November** (day 327 --fall turnover).

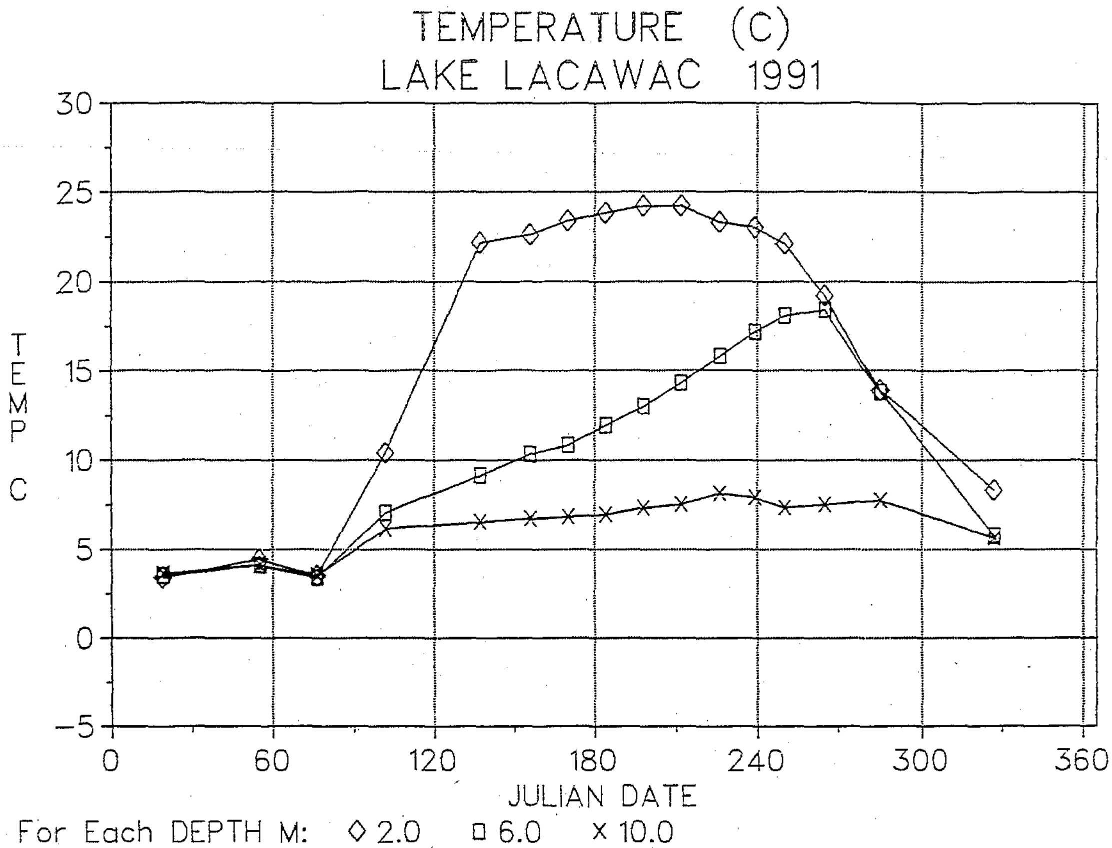


Figure 3. Temperature trends within Lake Lacawac, 1991.

Values (°C) are plotted for three fixed depths.

LIGHT PENETRATION

Light intensity at 1-meter intervals was calculated as a percentage of the light just below the lake surface (10 cm). Since 1988, three slightly different methods have been used to construct a 0-12 m profile of light penetration; method #12 (numbers correspond to codes from data tables) was used on all but one date in 1991:

Method 12. Two Licor quantum sensors, mounted 1-m apart on a common line, electronically computed the ratio of quantum intensities between the nominal depth and the depth above it. The percentage penetration profile was constructed from these ratios.

Light penetration is plotted on a logarithmic scale for five dates (**Figure 4**). During the summer, depths above 5 m (i.e. the epilimnion and upper metalimnion) usually received 4% or more of the light penetrating the lake surface. Light penetration was not substantially decreased during autumnal circulation in 1991--unlike 1990--even though algal abundance was not markedly different (see **Figure 9**). Low light levels probably precluded much algal growth below a depth of 8 m.

SECCHI DEPTH

Secchi depth is the depth, in meters, at which a white-and-black quartered disk 20 cm in diameter just ceases to be visible to an observer lowering it from a boat. It is a measure of water transparency. We observed the Secchi disk with a small glass-bottomed viewing box to reduce glare from the lake surface.

Secchi transparency (**Figure 5**) tended to increase during the course of the year. Transparency from late spring through autumn was somewhat greater than in 1989 or especially 1990. Values generally exceeded 5m during this period, reaching 6-7m in September.

OXYGEN CONTENT OF THE LAKEWATER

Dissolved oxygen was measured polarographically using a YSI™ submersible temperature-compensating oxygen meter. The meter was calibrated in air to 100% saturation immediately before use in the lake. The effect of Lake Lacawac's elevation above sea-level (1439 feet) was not taken into account when calibrating the meter, so all compiled values are roughly 5% too high. Units are mg O_2 per liter. (This is **Method #10.**)

Often the meter did not give a true "zero" when dropped into definitely anoxic (oxygen-free) water. Values flagged with error code "4" in the data tables, and plotted at depths greater than 9 meters for days 184 (3 July) and 265 (22 September) in **Figure 6**, should be treated as true zeros.

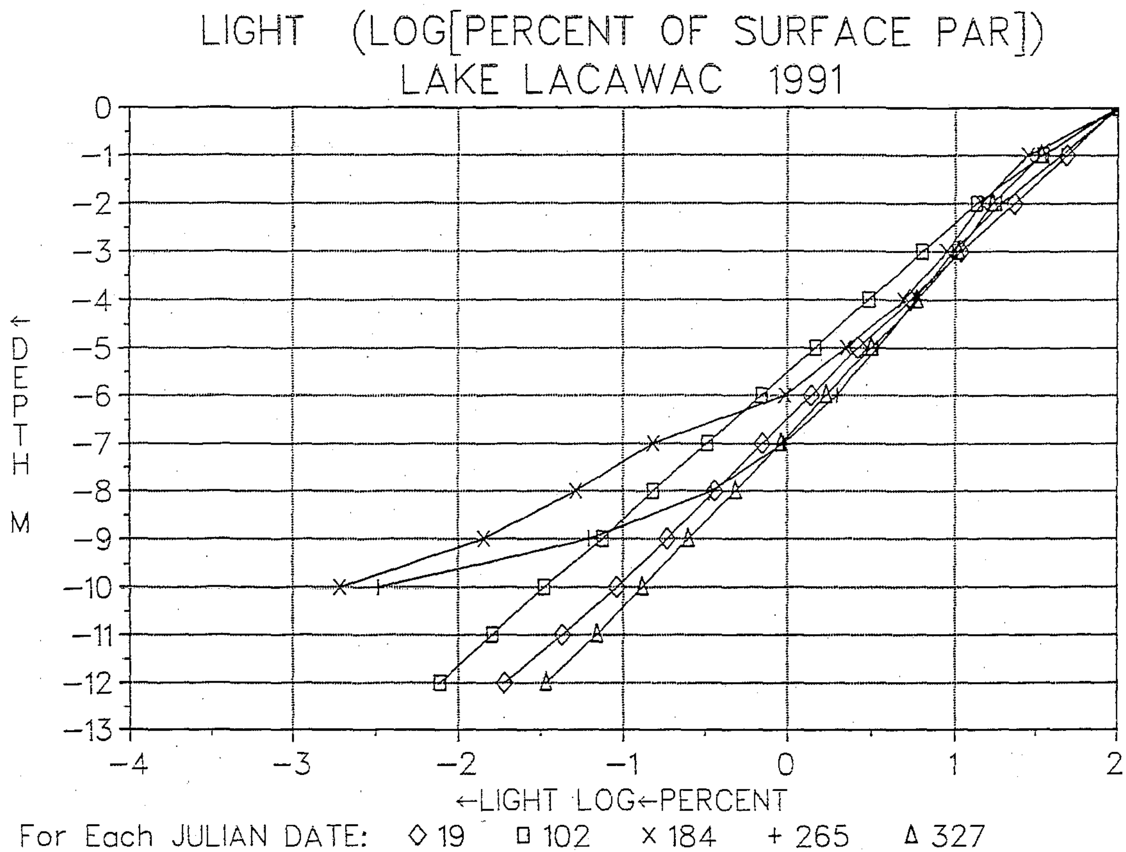


Figure 4. Light penetration in Lake Lacawac, 1991.

Values are percentages of the light at 0.1 m depth and are graphed on a logarithmic scale (i.e., 100% ="2", 10% ="1", 1% ="0", etc.) for five dates: **19 January** (day 19 --winter ice cover), **12 April** (day 102 --immediately following spring turnover), **3 July** (day 184 --midsummer stratification), **22 September** (day 265 --late stratification), **23 November** (day 327 --fall turnover).

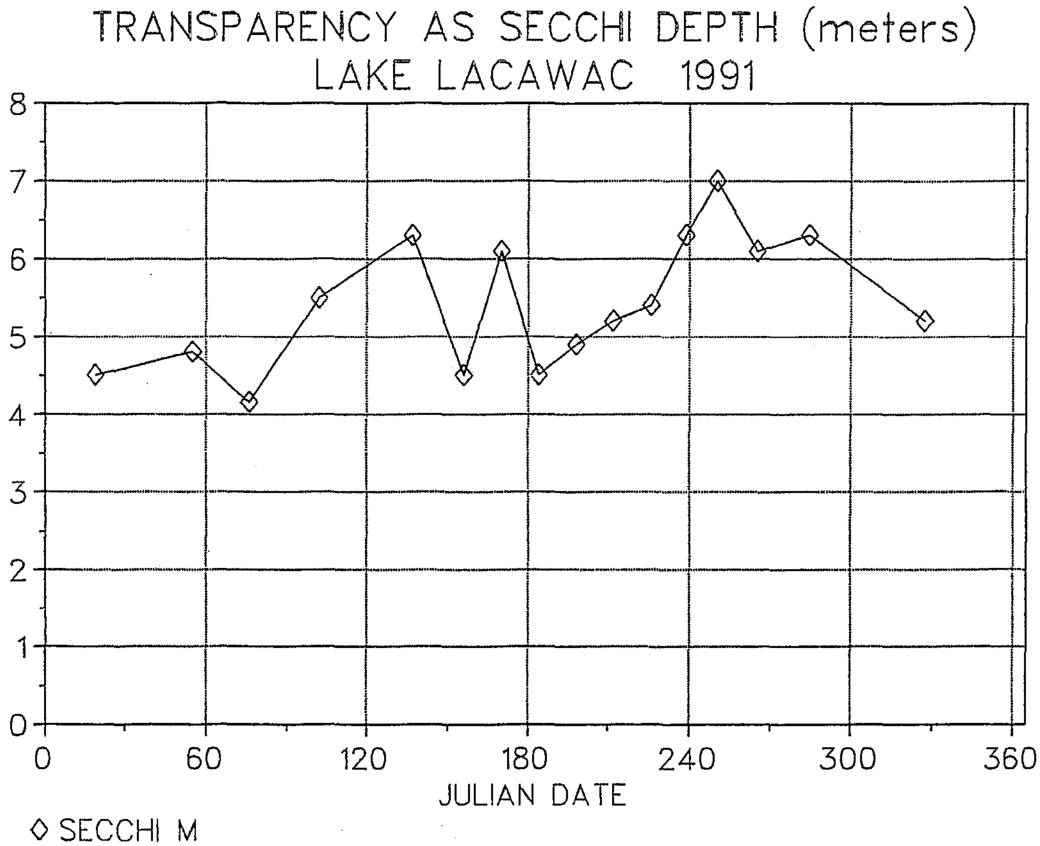


Figure 5. Transparency in Lake Lacawac, 1991.

Values plotted are the Secchi depths, in meters.

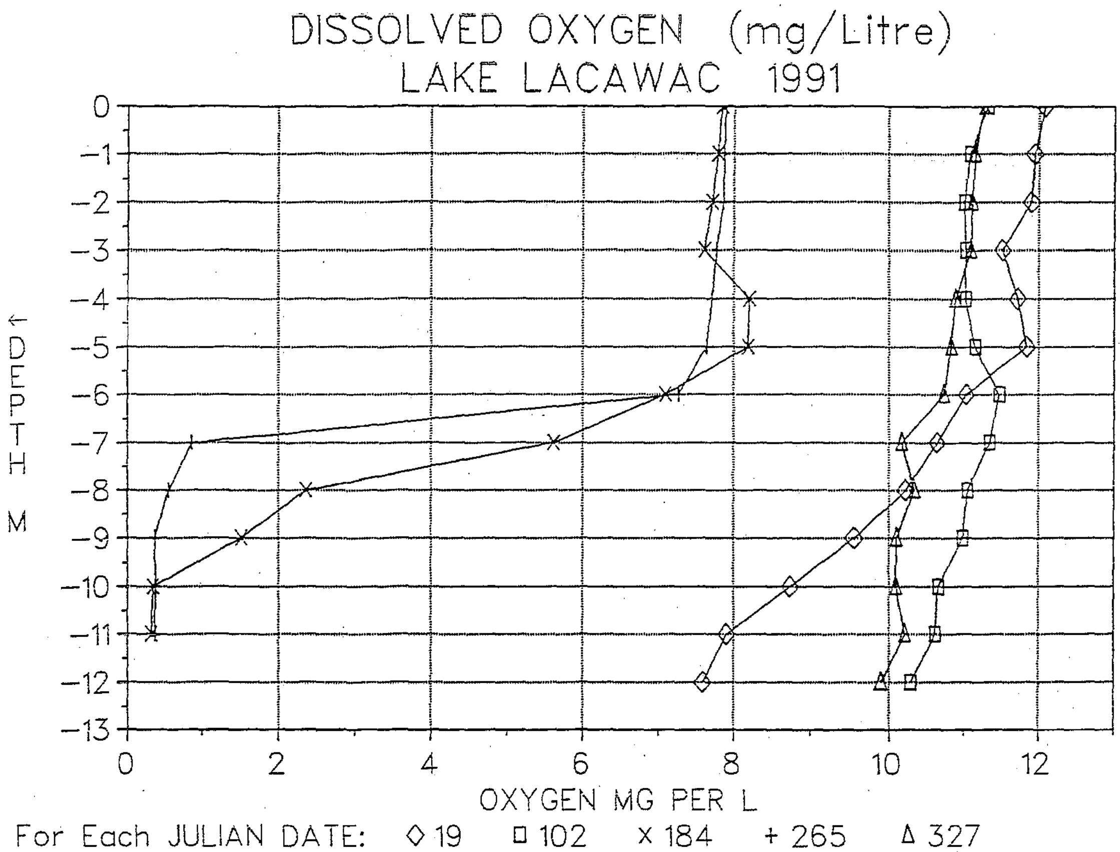


Figure 6. Dissolved oxygen in Lake Lacawac, 1991.

Values (mg oxygen per liter) are plotted for five dates: **19 January** (day 19 --winter ice cover), **12 April** (day 102 --immediately following spring turnover), **3 July** (day 184 --midsummer stratification), **22 September** (day 265 --late stratification), **23 November** (day 327 --fall turnover). Values of <0.7 mg/L on days 183 and 265 represent anoxic conditions (oxygen = 0 mg/L).

Oxygen was partly depleted during winter ice cover, then recharged during spring turnover. The onset of thermal stratification in mid-spring marked the onset of renewed gradual depletion of oxygen within the hypolimnion. By day 184 (3 July) the hypolimnion was anoxic (**Figure 6**). By day 265 (22 September), the lower portion of the metalimnion was anoxic as well. Oxygen content of the epilimnion in summer was maintained near atmospheric saturation. During autumn turnover the water column was progressively recharged with oxygen. On day 327 (23 November), halfway through the turnover period, the oxygen content of 12-m water was already ca. 10.5 mg/L, though not yet saturated with respect to the atmosphere for that temperature (ca. 12 mg/L at 5.6°C).

ALKALINITY AND pH

Alkalinity is a measure of the acid neutralizing, or buffering capacity. Alkalinity was determined by potentiometric titration of a 100-ml sample using 0.01 or 0.1 N sulfuric acid as titrant and monitoring pH change with an Orion™ model SA250 pH meter and Ross™ epoxy-body combination electrode. Titration points between pH 4.4 and 3.7 were plotted, after Gran transformation, to give alkalinity in microequivalents per liter (μeq./L). (This is **Method #11.**) Alkalinity was analyzed monthly, on alternate sampling dates during summer.

Samples for alkalinity and pH were taken from duplicate water collections (acrylic plastic Van Dorn bottle) at three depths, designated "**E**" (epilimnion), "**M**" (metalimnion), and "**H**" (hypolimnion). Selection of these depths is described in the section **TEMPERATURE AND THERMAL STRATIFICATION.** Samples were stored in air-tight polypropylene bottles for up to 24 hr (refrigerated) before analysis. Samples were warmed to room temperature before analysis. The pH meter and electrode described above were calibrated with commercial high ionic strength buffers. The pH was measured in 50-ml aliquots of sample with gently mixing. Three variants of the method were employed:

Method 10. As above. **Method 11.** As above, but with a quality assurance protocol to verify electrode performance in distilled water and to check stability of the calibration. **Method 12.** As in **11** but 0.5 ml salt solution (Orion™ pHix/pHisa™ solution) was added to increase ionic strength. Usually, this had little or no effect on the sample (pH change <0.1 unit), but generally gave more reproducible values.

Trends of pH are plotted for each layer in **Figure 7**. In the absence of intense biological activity, the pH of Lacawac would be about 6 with an alkalinity of about 30 ueq/L (**Figure 8**), judging from values in late spring and late autumn. These values portray a poorly buffered softwater lake. Seasonal pH trends were not pronounced, though both epilimnial algal photosynthesis and hypolimnetic microbial processes tended to increase pH somewhat. Summer epilimnial pH was in the 6.2-6.5 range as in previous years. Microbial metabolism generated substantial alkalinity in the anoxic hypolimnion (**Figure 8**), but this was lost upon reoxidation of the water column during fall turnover.

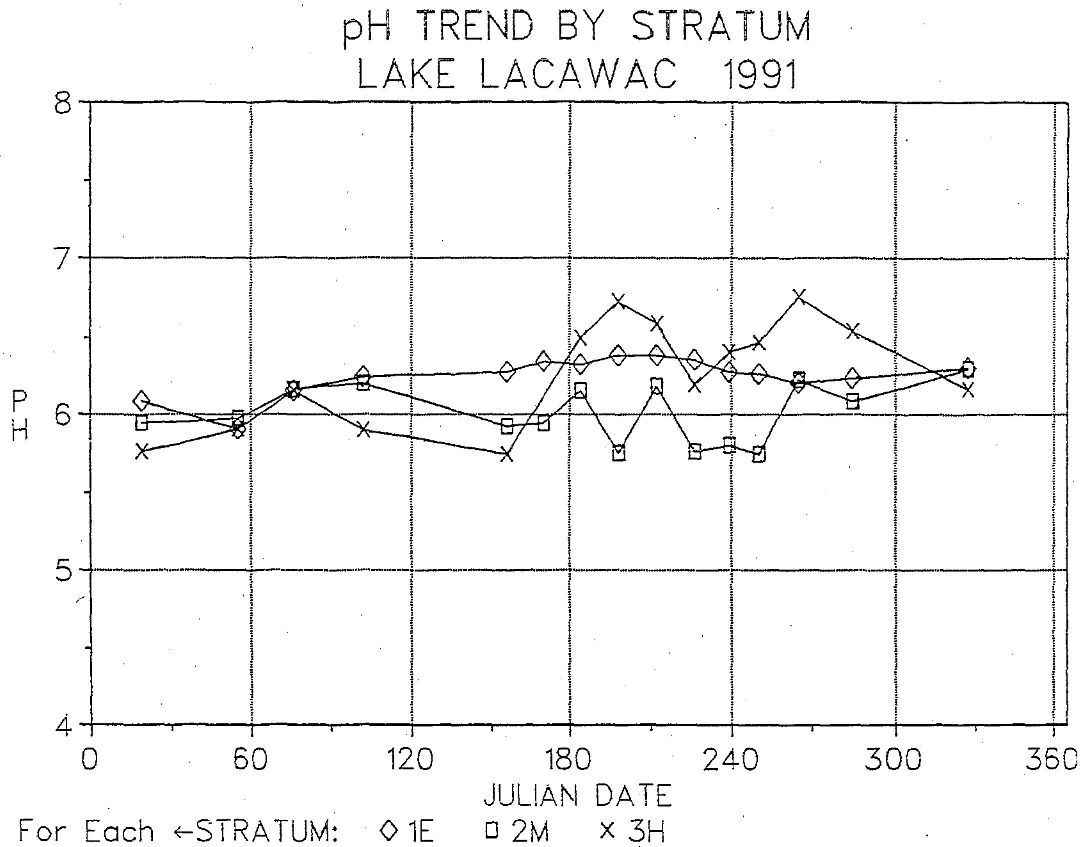


Figure 7. Trends of pH in Lake Lacawac, 1991.

Values are plotted for the mid-depths of the three layers, Epilimnion (**1E**), Metalimnion (**2M**), and Hypolimnion (**3H**). In autumn and winter, when these layers are not developed, samples are collected as described in **RESULTS AND METHODS**.

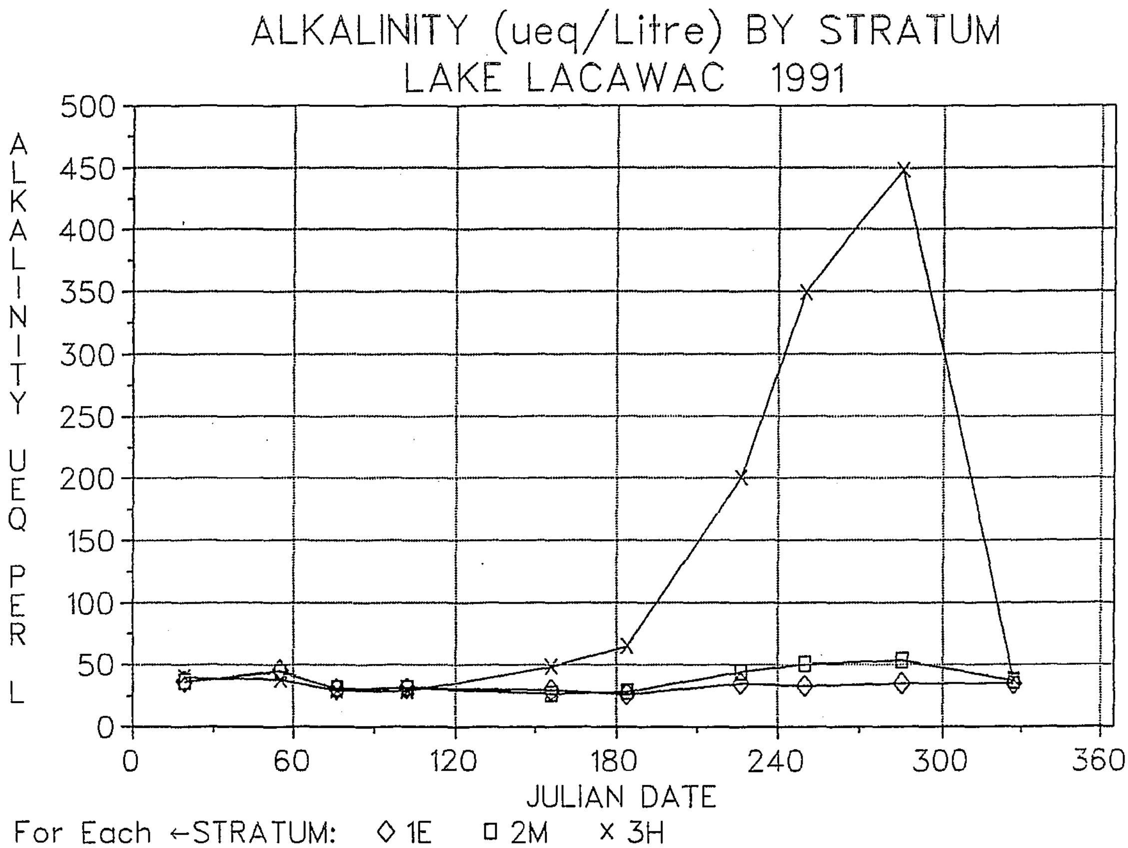


Figure 8. Trends of Alkalinity in Lake Lacawac, 1991.

Values are plotted for the mid-depths of the three layers, Epilimnion (1E), Metalimnion (2M), and Hypolimnion (3H). In autumn and winter, when these layers are not developed, samples are collected as described in **RESULTS AND METHODS.**

ALGAL CHLOROPHYLL-a

Chlorophyll-a is a measure of algal mass, since all algae contain this pigment. It is a widely used parameter for comparisons of lake trophic conditions.

Chlorophyll samples came from the same Van Dorn collections used for pH and alkalinity. Samples were stored in 1-L polyethylene bottles for 2-24 hr (refrigerated in darkness) before being filtered (0.5 L onto Gelman™ A/E filters) and frozen. Two samples were analyzed from each depth: a whole-water sample (for total chlorophyll-a) and a sample fractionated with a 22-μm nitex net. Often the sum of fractions was less than the total. This sum was accepted as a replicate for total chlorophyll-a if it was greater than or equal to 85% of the whole sample. The percentage of chlorophyll passing the 22um net (percent of the summed fractions) is presented in the data tables **(CHLAC P)**. **Method 12** was used for all chlorophyll extractions:

Method 12. Intact filters were extracted overnight at 2-4°C, in darkness, in 12 ml of a 5:1 (vol/vol) mixture of 90% basic acetone and methanol. Extracts were centrifuged and read in a Sequoia-Turner™ model 112 fluorometer equipped with F4TB/B lamp, red-sensitive photomultiplier, 5-60 excitation filter and 2-64 emission filter. The meter was calibrated with dilutions of pure chlorophyll-a or chlorophyll-a,b extracts from higher plants; these were assayed first by standard spectrophotometric techniques. Each sample was reread after acidification (to 0.03 N) to allow correction for pheopigments. We verified that chlorophyll behaves virtually the same in the mixed solvent as in 90% acetone alone, and that the extractions gave similar results. Two values are presented: Chlorophyll-a corrected for pheopigments (**CHLAC** in data tables and **Figure 8**) and Chlorophyll-a including pheopigments (**CHLASUM** in data tables).

In Lake Lacawac, hypolimnetic samples taken after anoxia is established (late July through October) are affected by an analytical interference, possibly a bacterial chlorophyll. Fluorescence increases upon acidification, causing all chlorophyll to be classed as pheopigment. This is an exaggeration, though microscopic examination verifies that algae are not common during this period. There is a good deal of pigment in the hypolimnion during the anoxic period (see Data Tables), but we cannot distinguish between algal pheopigment and whatever the interfering pigment is.

Chlorophyll levels in Lake Lacawac were usually in the 1-5 μg/L range during summer(**Figure 9**). Somewhat higher levels (5-9 μg/L) prevailed in spring and late autumn, at least in the epilimnion. High metalimnetic peaks were only encountered in late September, when the lake was exceptionally transparent (Secchi depth 6-7 m). Chlorophyll was much higher in the surficial "epilimnion" layer than at greater depths in November, in the middle of fall turnover. Apparently an ephemeral thermal stratification present at that time had stimulated growth of the surficial algae by keeping them within the photic zone.

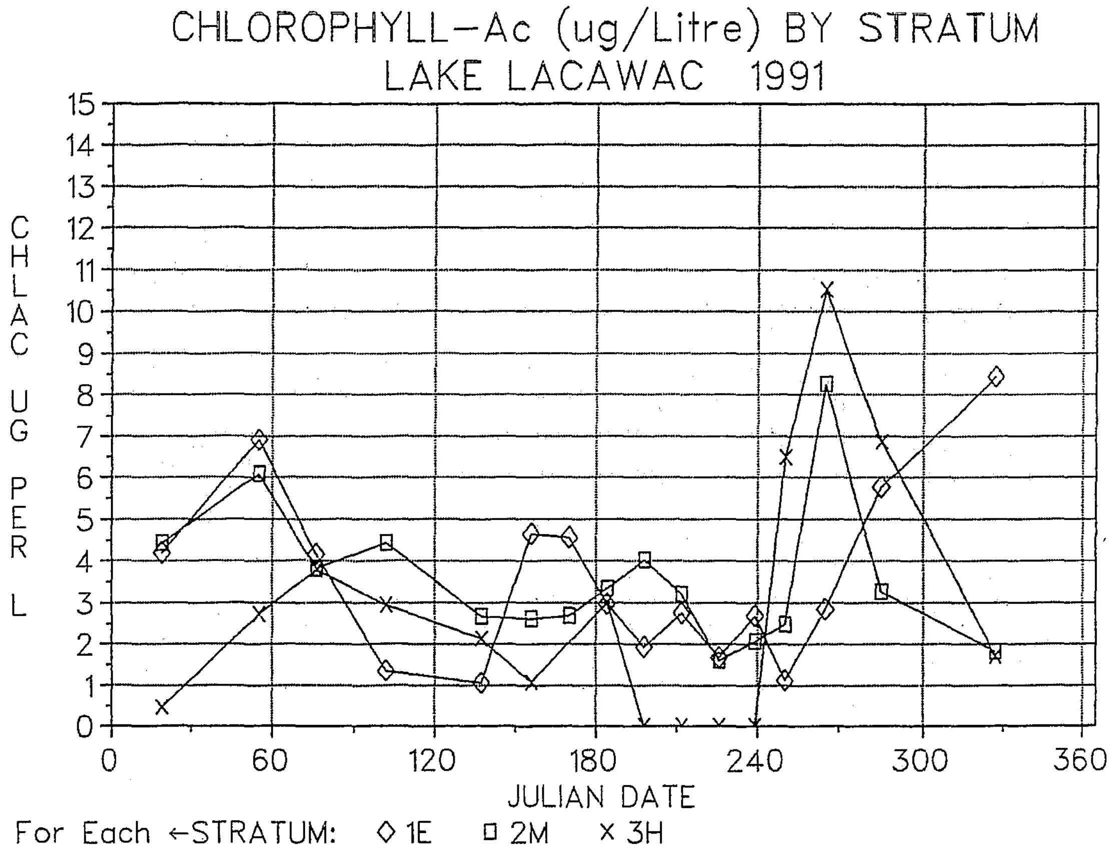


Figure 9. Trends of Chlorophyll-a in Lake Lacawac, 1991.

Values are plotted for the mid-depths of the three layers, Epilimnion (**1E**), Metalimnion (**2M**), and Hypolimnion (**3H**). In autumn and winter, when these layers are not developed, samples are collected as described in **RESULTS AND METHODS**. Chlorophyll-a values are corrected for pheopigments. Values of "0.0" for hypolimnia samples in late summer are underestimates caused by an interference in the fluorimetric analysis.

ZOOPLANKTON

Zooplankton receive a major emphasis in the PCLP program. These animals represent the key link between algal primary producers and fish populations. The intensity of grazing by herbivorous zooplankton strongly affects the kind of algae that dominate, and potentially can control (i.e. reduce) algal populations even in the face of abundant nutrient supply. Consequently the kinds and abundances of zooplankton have important implications for the perceived recreational quality of a lake.

Zooplankton were sampled at day and night, but only the nighttime data are presented here. Some species avoid the water column during the day. Zooplankton were collected with closing-style plankton nets that could be pulled through part of the water column open, collecting animals, then closed and pulled the rest of the way to the surface. In this way the water column was sampled as the three layers defined by temperature. In the present report, data are calculated as mean concentrations (numbers of individuals per liter) over the entire 13-m water column. Details of the depth-distributions, and daily patterns of vertical movement, are still being analyzed.

Two sizes of nets were used: a 30-cm diameter net with a mesh of 202 μm, for some macrozooplankton; and a 15-cm diameter Wisconsin-style net with a 48-μm mesh for microzooplankton as well as other macrozooplankton. These were mounted side-by-side in "bongo" configuration. Microzooplankton includes mainly rotifers, but some copepods and small Cladocera also were counted from these samples. Our counting strategy was somewhat different in 1991 from 1989 or 1990, with *Chaoborus* and some copepods (including *Diaptomus minutus*) being counted from the 48-μm sample that had been counted from 202-μm samples in previous years. This change was made to increase collection efficiency of forms (e.g. small instar *Chaoborus*, copepodids, male copepods, etc.) that were going through the 202-μm mesh net. Collections were duplicated for each depth range. Mean values are presented.

Seasonal trends in abundance are presented as a series of graphs for the most frequently encountered zooplankton, identified to genus and sometimes to species **(Figures 11-36)**. **Table 1** lists the zooplankton identified to date. Several points can be highlighted:

(1)The dominant grazers in 1991 were, as in earlier years, the cladocerans *Daphnia* spp. and *Holopedium gibberum*, and the calanoid copepod *Diaptomus minutus*. *Holopedium* was most abundant during the summer; at 0.5-4/L it was about as abundant as in 1990, but less than in 1989 (4-12/L). *Daphnia* (mostly *D. catawba*) was most prevalent in spring and fall (ca. 5/L vs ca. 10/L in 1990), but persisted through summer at higher levels than in 1990 (2-5/L vs. 1-2/L). *Diaptomus minutus* displayed a spring peak similar to that of 1990 (ca. 30/L), and similarly declined to low levels by late summer (1-2 adults/L).

(2)Rotifer density was similar to that of previous years, showing the same summer decline (to 150-300/L) between higher levels in spring and fall (>500/L). The various species displayed contrasting seasonalities; their relative abundances changed somewhat from 1990. In particular, *Gastropus* spp were more prominent in the spring rotifer peak. As in the previous two years, the summer rotifer population was dominated by types that may resist predation: species of *Polyarthra* (swift escape behavior) and *Keratella* (hard-bodied), in particular.

Table 1. Zooplankton species recorded from open-water samples in Lake Lacawac, 1988-1991. Seasons of especially high or low abundance in 1991 are indicated.

	Taxon	Seasonal Abundance in 1991 High	Low
Diptera			
**	*Chaoborus* spp.	Sp,Su	[W]
	C. flavicans		
	C. punctipennis		
Cyclopoid Copepoda			
**	*Cyclops scutifer*	W,Sp	[Su,F]
	Eucyclops agilis (rare)		
*	*Mesocyclops edax*	Sp,F	[mid-Su,W]
*	*Orthocyclops modestus*	Su,F	[W,Sp]
	Tropocyclops prasinus		
Calanoid Copepoda			
**	*Diaptomus minutus*	late F,W,Sp	
Cladocera			
	Bosmina		
	Chydorus spp.		
**	*Daphnia* spp.	irregularly abundant all year	
	D. catawba		
	Diaphanosoma spp.		
**	*Holopedium gibberum*	Su	[W]
*	*Leptodora kindtii*	Su	[F,W,Sp]
Rotifera			
*	*Ascomorpha* spp.	W	
*	*A. ovalis*	Su	[W,F]
*	*Asplanchna* spp.	late Sp	[W,Su]
*	*Collotheca* spp.	late Sp,F	[W]
*	*C. mutabilis*	late Sp,F	[W]
**	*Conochilus* spp.	Sp, late F	[late Su]
	Gastropus spp.		
**	*G. hyptopus*	late Sp	[W,Su]
**	*G. stylifer*	Sp, late F	[Su]

continued next page

Table 1. Zooplankton in Lake Lacawac, 1991 (continued)

		Seasonal Abundance in 1991	
	Taxon	High	Low
	Kellicottia spp.		
**	*K. bostoniensis*	F	[mid-Su]
*	*K. longispina*	late Sp	[Su,F,W]
	Keratella spp.		
**	*K. cochlearis*	late Sp, late F	[W]
*	*K. crassa*	Su, late F	[W,Sp]
*	*K. gracilenta*		
*	*K. hiemalis*	W,Sp	[Su,F]
**	*K. taurocephala*	Sp, late F	
	Lecane spp.		
	L. flexilis		
	L. signifera		
	L. tenuiseta		
	Lepadella sp.		
	Monommata spp.		
	Monostyla spp.		
	M. closterocerca		
	M. copeis		
	M. lunaris		
	Notholca spp.		
	N. squamula		
	Ploesoma spp.		
*	*P. truncatum*	late Sp	[F,W]
	Polyarthra spp.		
**	*Polyarthra* ("large")	Sp,Su	
**	*Polyarthra* ("small")	W	
*	*Synchaeta* spp.		
*	*Trichocerca* spp.		
*	*T. cylindrica*		
*	*T. multicrinus*		
*	*T. porcellus*		
*	*T. rousseleti*		
*	*T. similis*	late Su	[W,Sp]

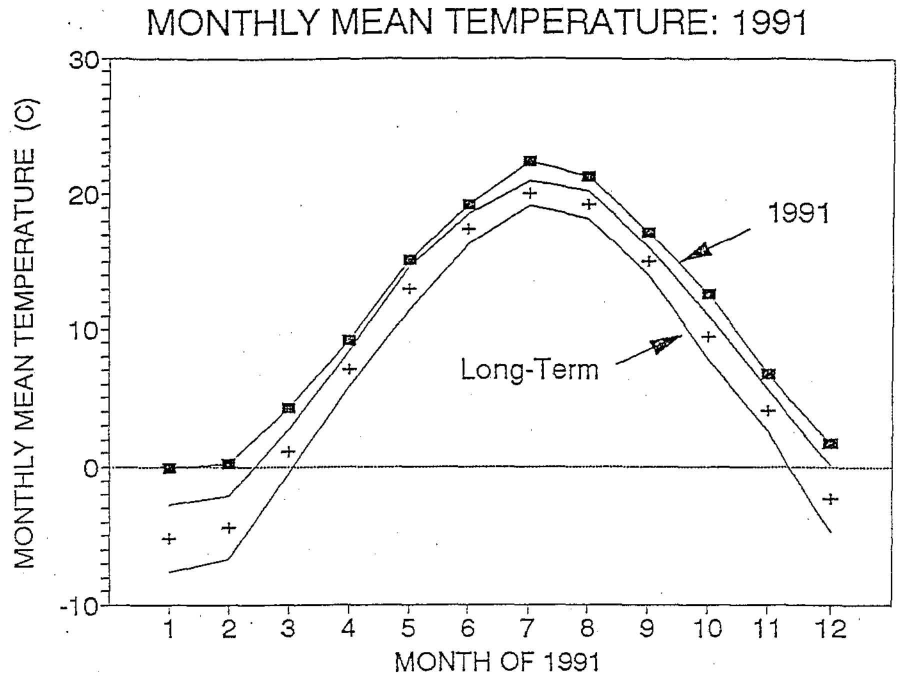
Abbreviations for seasons of maximal or [minimal] abundance:
W (winter), Sp (spring), Su (summer), F (fall).

** Dominant species included in Figures
* Other common species included in Figures

(3)Predatory zooplankton were well represented. The dipteran *Chaoborus* spp at ca. 0.25/L in summer was at the same density as in 1989 and 1990. The winter post-diapause population of *Cyclops scutifer* copepodids (at ca. 2.5/L in 1991 vs 10/L in 1990) produced a smaller spring population of adults (at ca. 1.5/L in 1991 vs 2-3/L in 1990). *Mesocyclops edax* displayed a small population (up to 0.5 adults/L) in late spring through early fall, suppressed in midsummer to very low densities. The switch to the 48-μm net for collecting *M. edax* copepodids revealed a late spring pulse of copepodids (emerging from winter diapause?) not evident in 1990. The predaceous cladoceran *Leptodora kindtii* was present during summer at ca. 0.05/L, possibly a little higher density than in 1989 and 1990.

CLIMATE IN 1991

Weather data from Hawley, PA (20 km N of Lake Lacawac) have been compiled for 1991 and the previous 30 years **(Figure 10)**. These data are from a NOAA cooperator's station. 1991 was relatively warm and dry compared to the 30-year monthly averages. Rainfall was only 60% of normal for spring through summer.



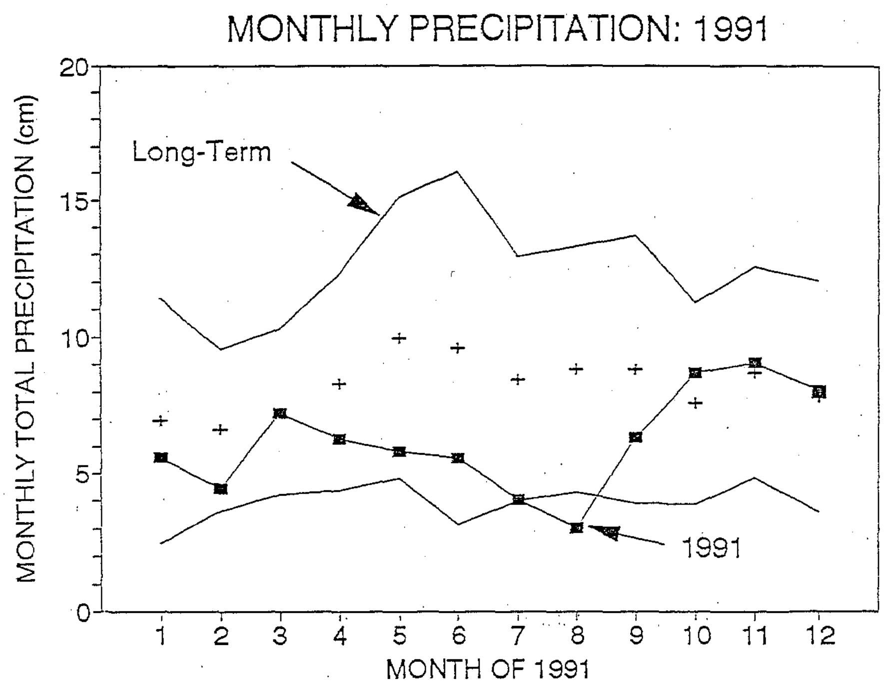


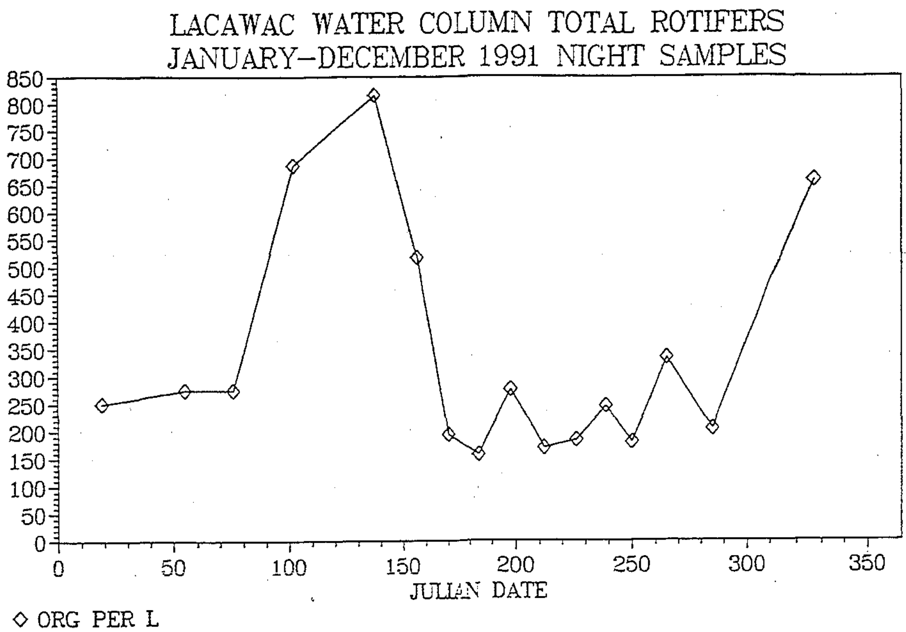
Figure 10. Monthly climate in 1991 compared to the 30-year averages.

(**Top**) Mean temperature (degrees Celsius). (**Bottom**) Monthly mean precipitation (cm rain or thawed snow). Data are from the NOAA cooperator's station at Hawley, PA. Long-term values (+) are enclosed in an envelope defined by one standard deviation of the monthly values.

ZOOPLANKTON GRAPHS

The following graphs present water-column mean nighttime concentrations of the common zooplankton at the main sampling station. Each data point is calculated by weighting concentrations in the three layers (EPI,META,HYPO) on each date by the relative thickness of the layer at the station, which is in the deepest part of the lake. Two replicate samples were taken in quick succession.

The electronic database contains the component concentrations within the three layers, separate counts for the two replicates, and similarly complete data from the comparable daytime sampling.



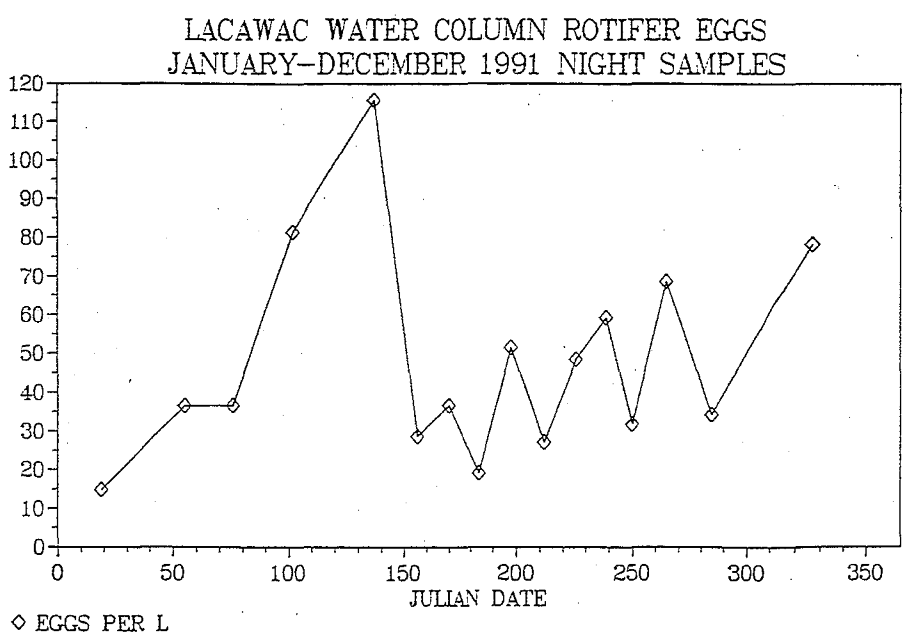
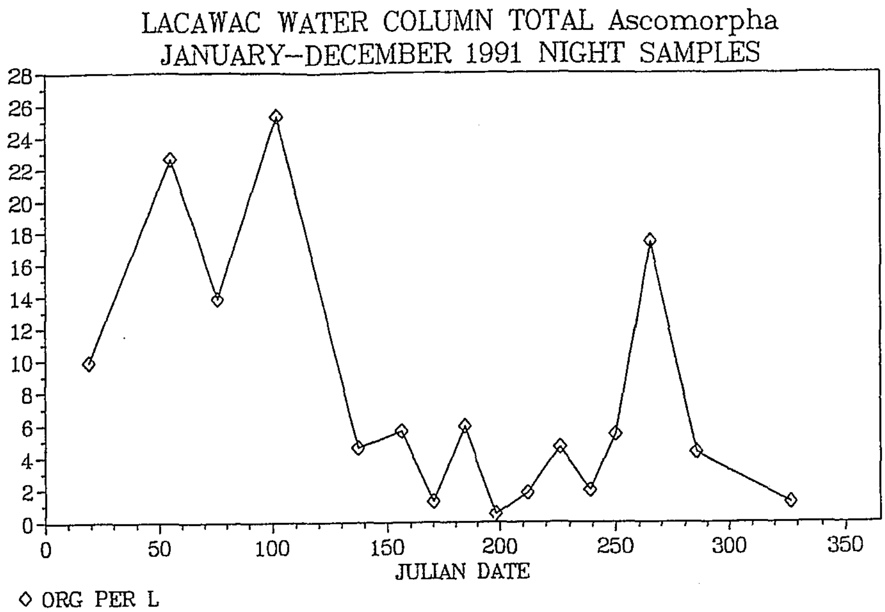


Figure 11. Rotifers in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** Rotifer eggs per liter.



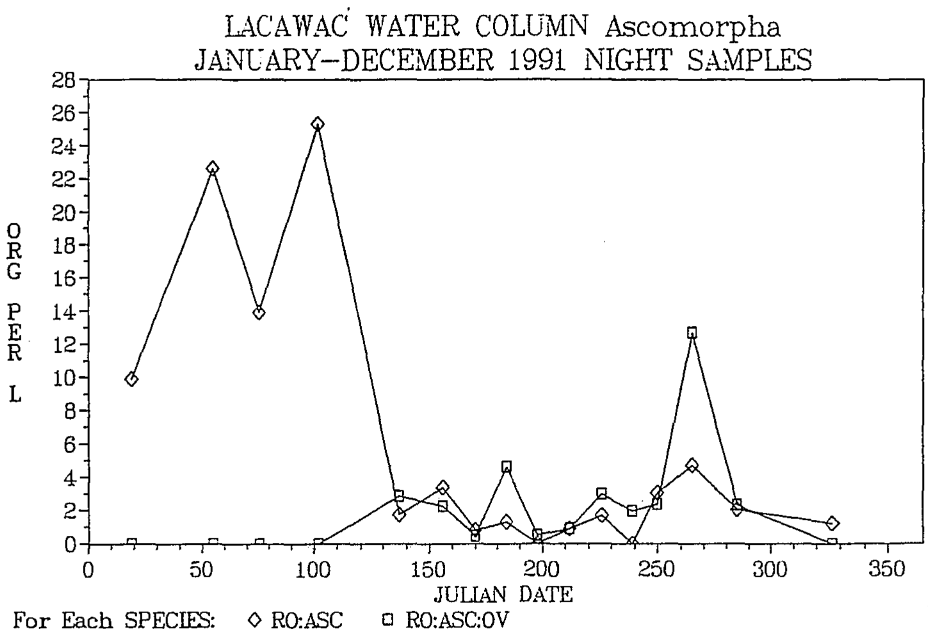


Figure 12. The rotifer *Ascomorpha* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Ascomorpha* by species: **OV** *A. ovalis* and **ASC** undifferentiated species.

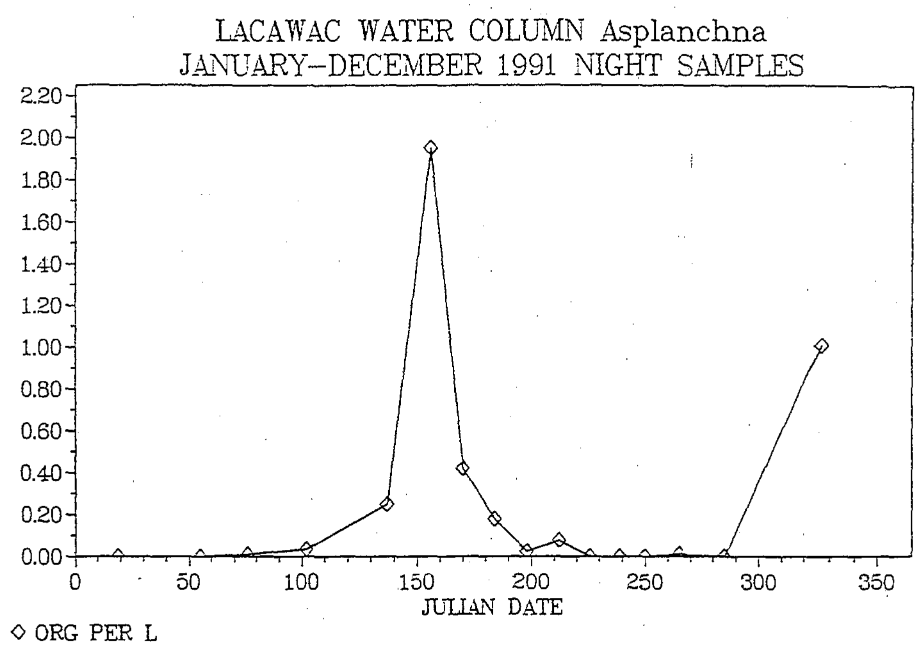
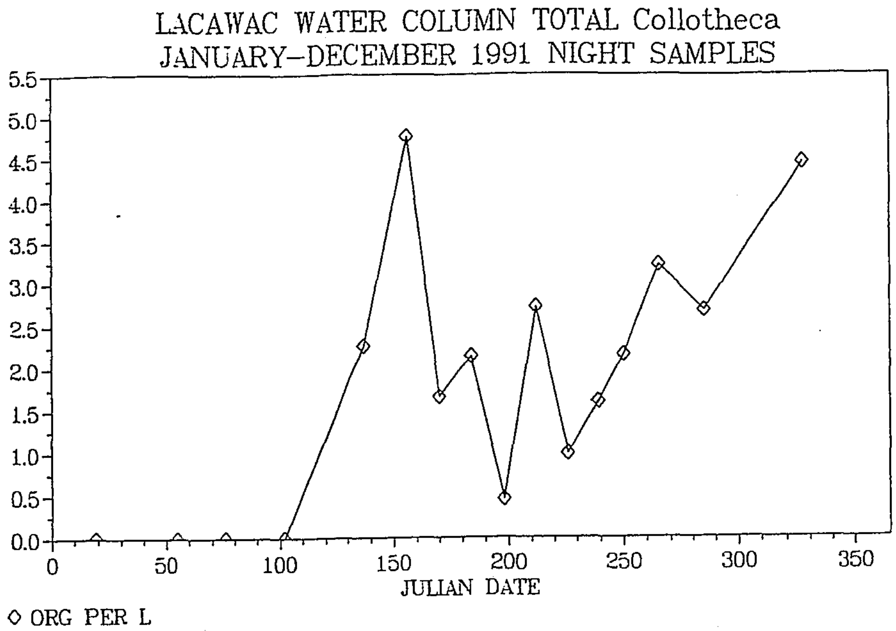


Figure 13. The rotifer *Asplanchna* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean.



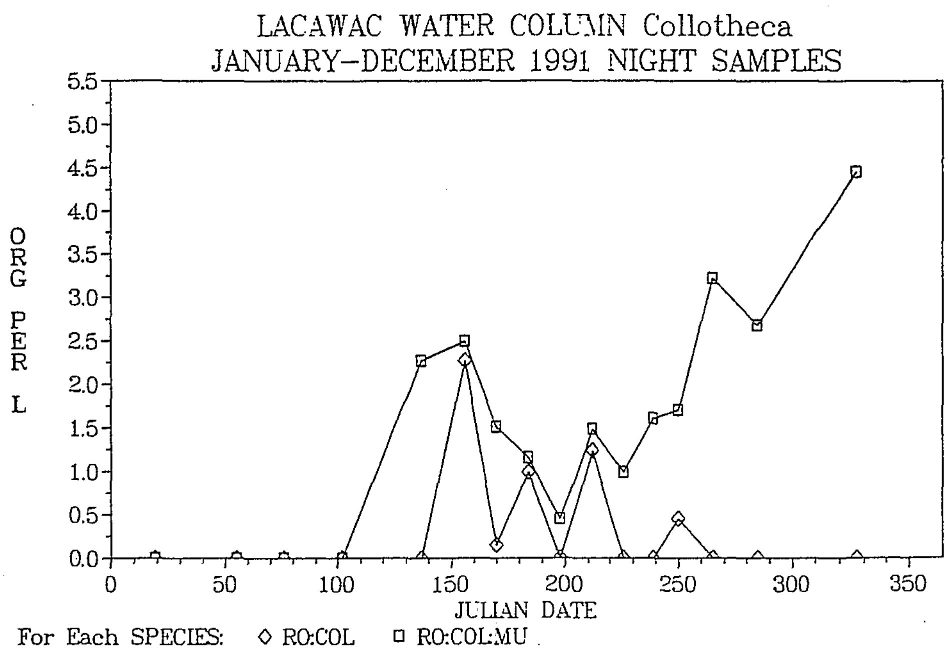
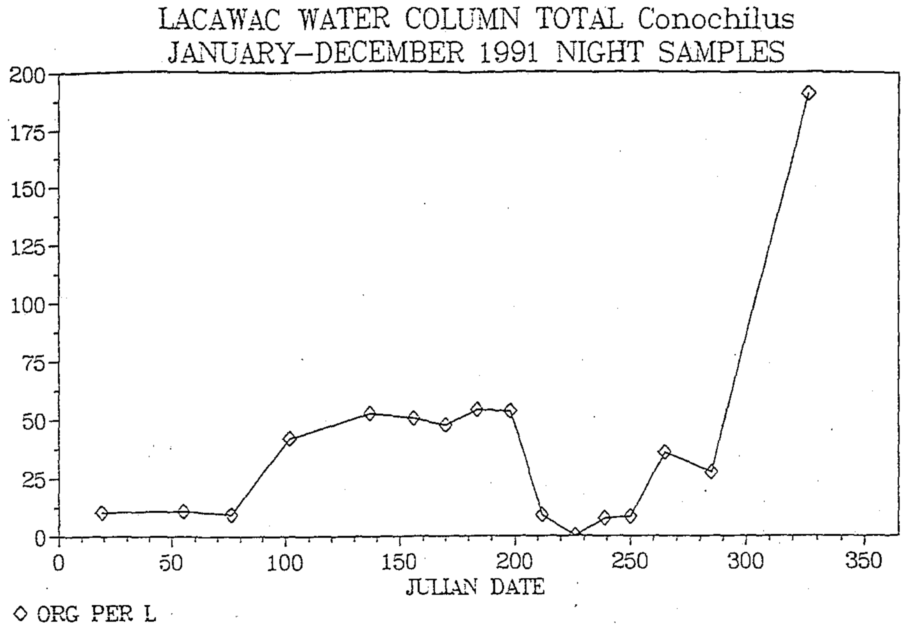


Figure 14. The rotifer *Collotheca* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Collotheca* by species: **MU** *C. mutabilis* and **COL** undifferentiated species.



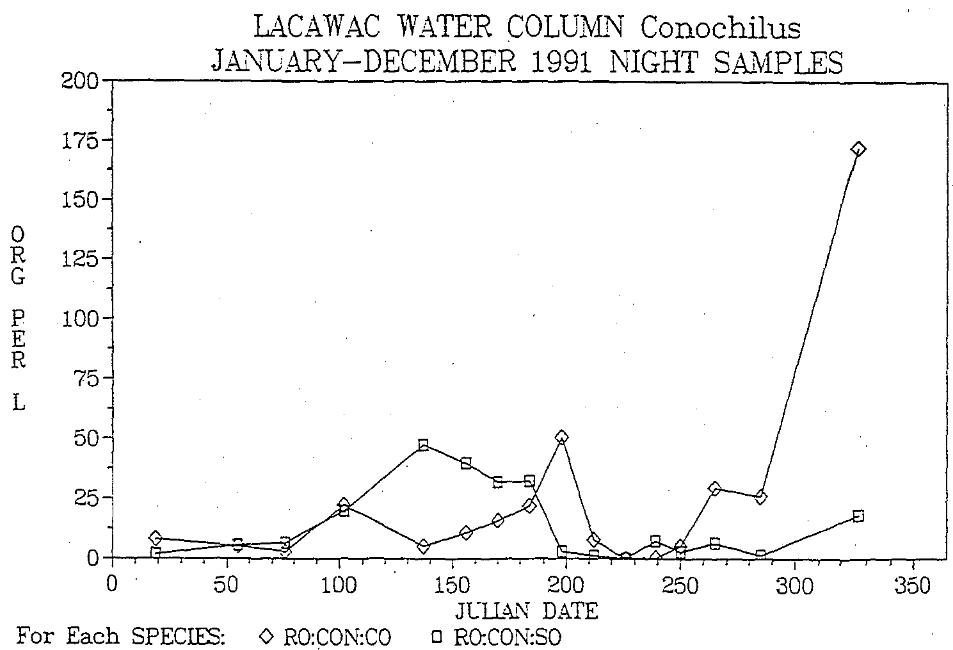
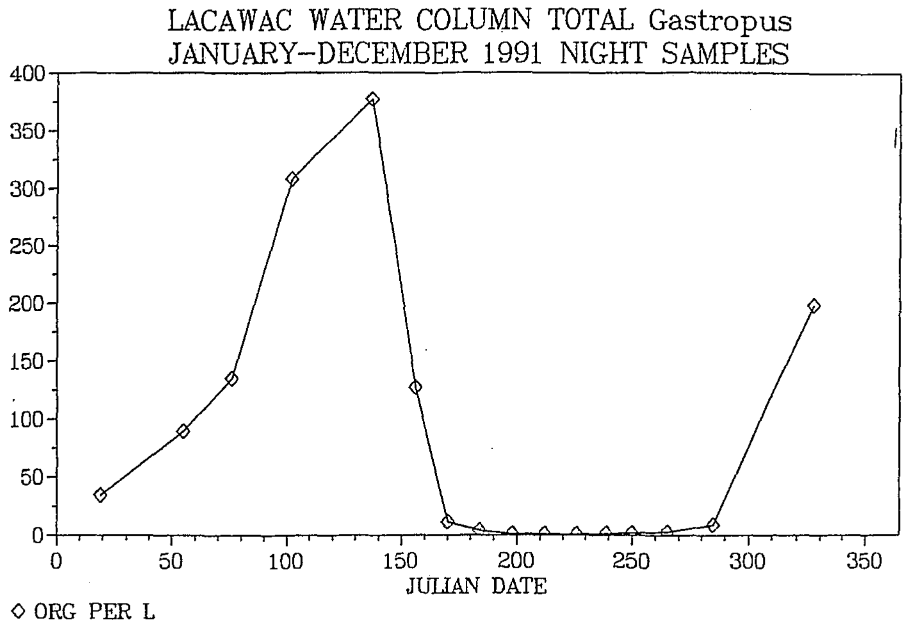


Figure 15. The rotifer *Conochilus* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Conochilus* by form: **CO** colonial and **SO** solitary.



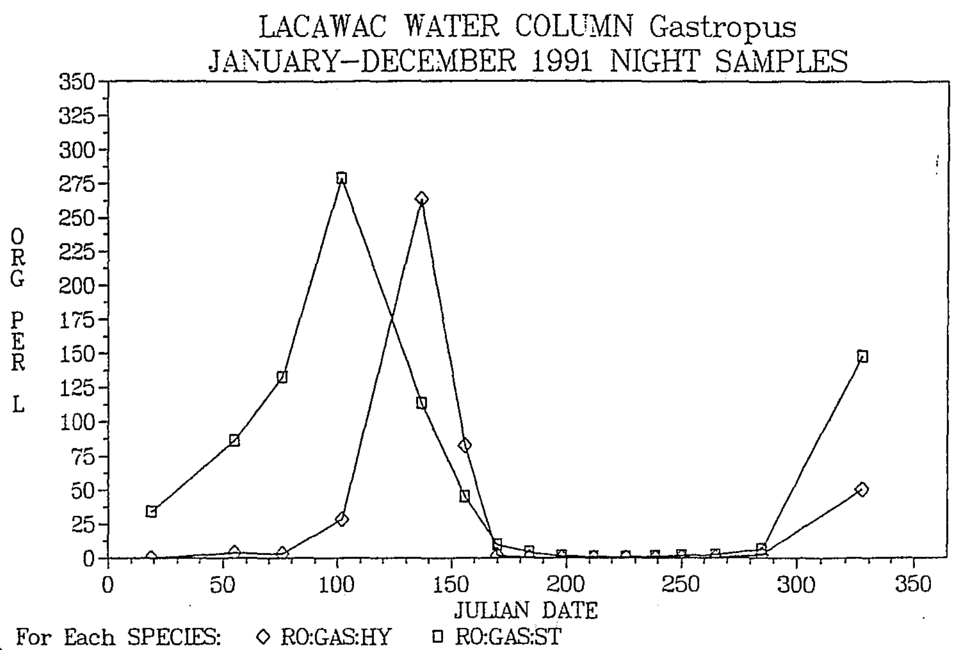


Figure 16. The rotifer *Gastropus* in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Gastropus* by species: **HY** *G. hyptopus* and **ST** *G. stylifer*.

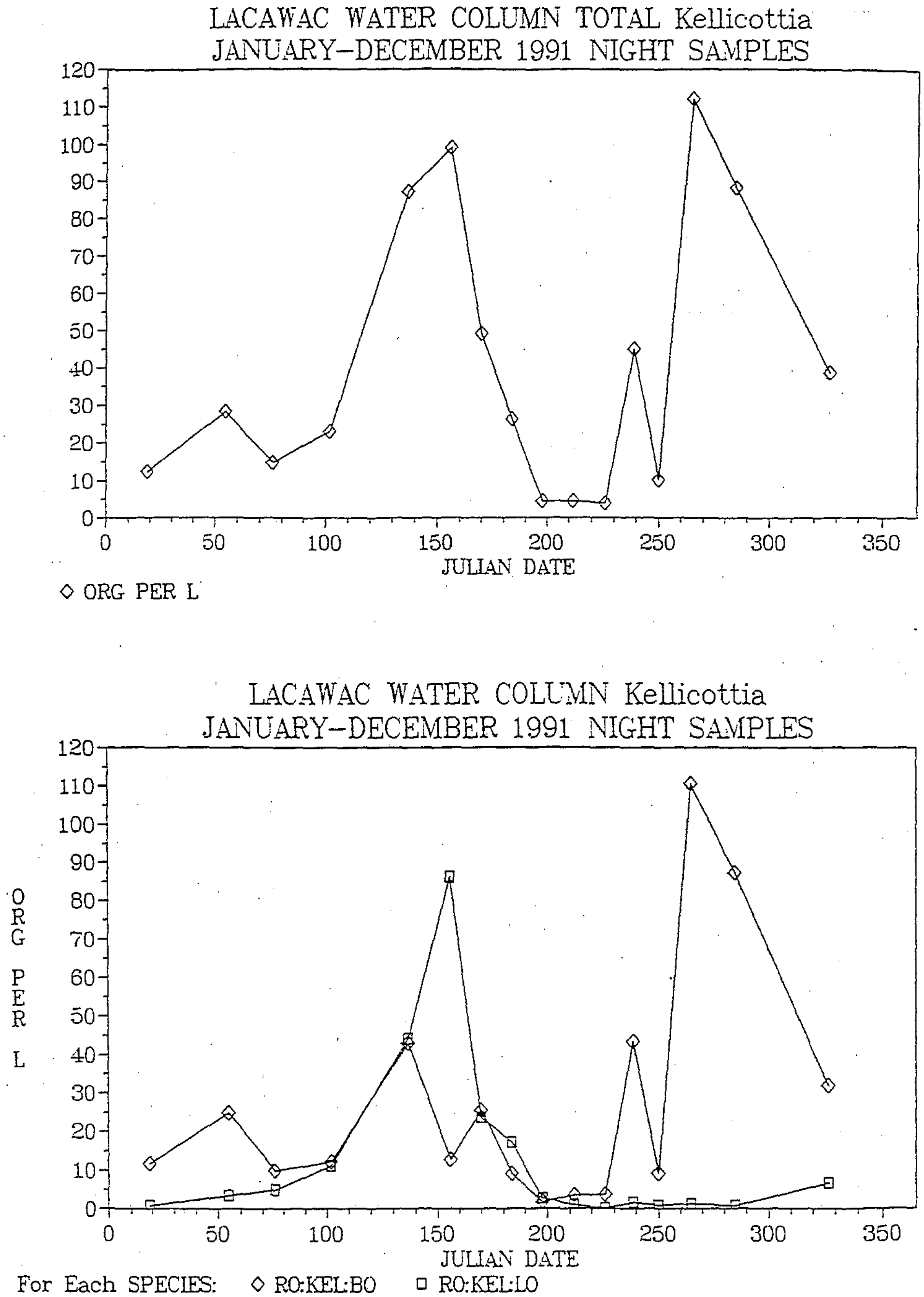
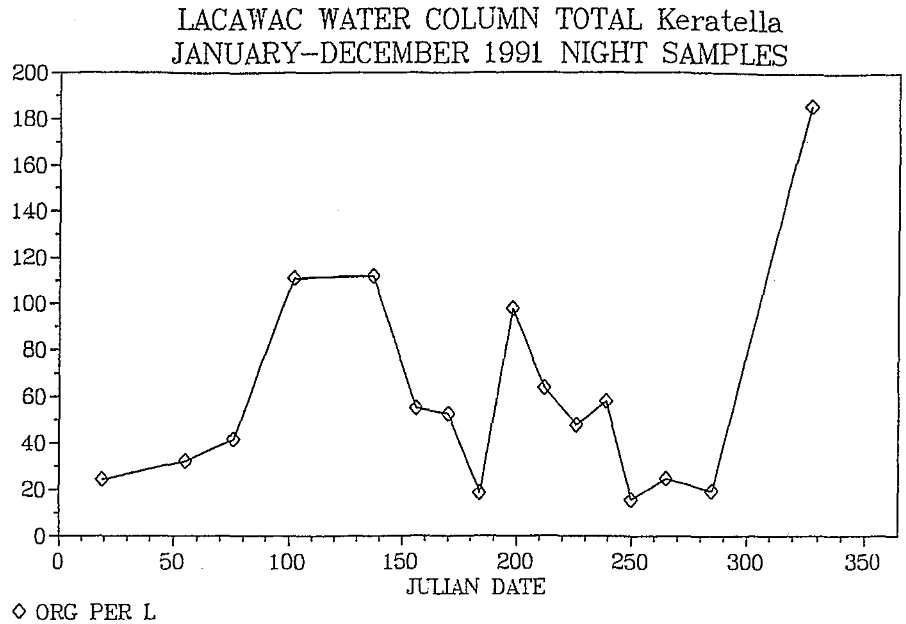


Figure 17. The rotifer *Kellicottia* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Kellicottia* by species: **BO** *K. bostoniensis* and **LO** *K. longispina*.



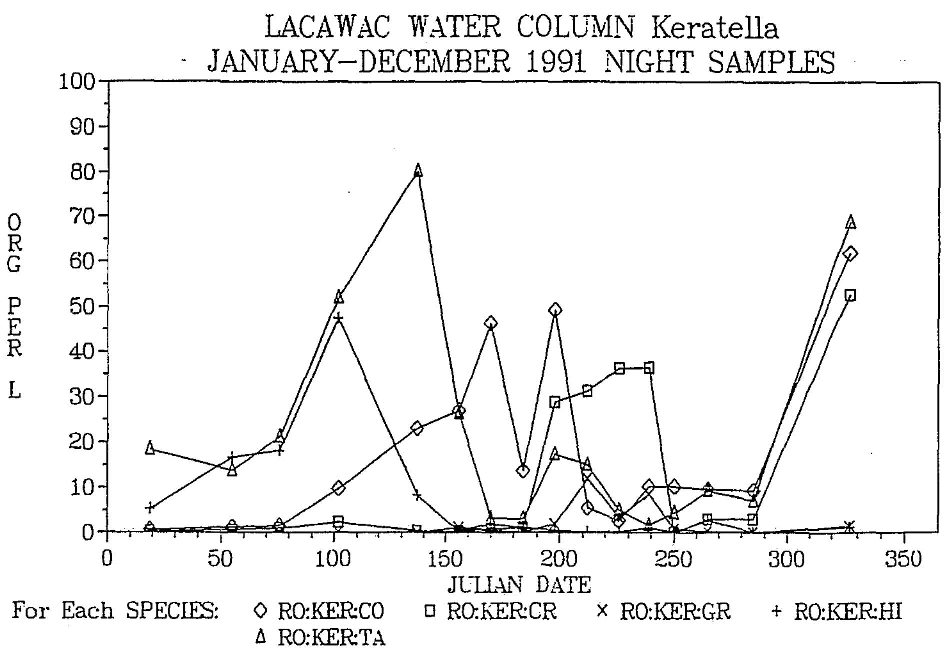


Figure 18. The rotifer *Keratella* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Keratella* by species: **CO** *K. cochlearis*, **CR** *K. crassa*, **GR** *K. gracilenta* and **HE** *K. hiemalis*, and **TA** *K. taurocephala*.

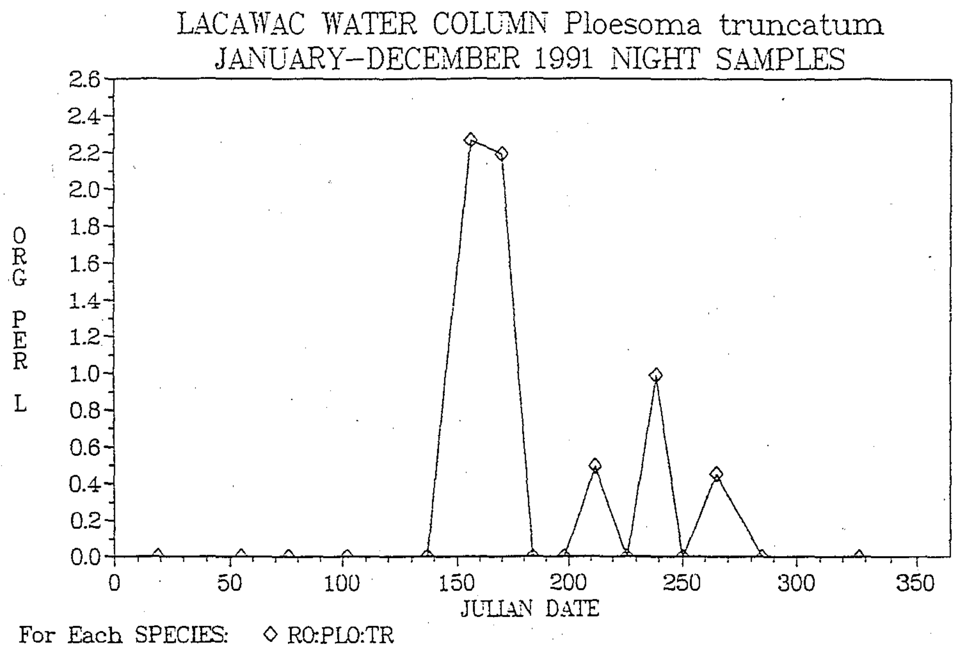
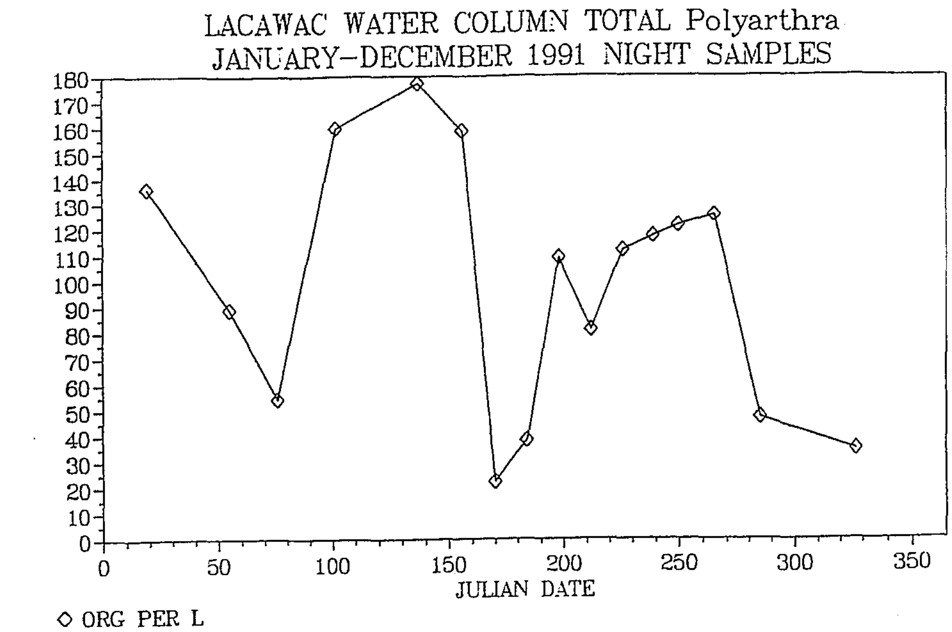


Figure 19. The rotifer *Ploesoma truncatum* in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean.



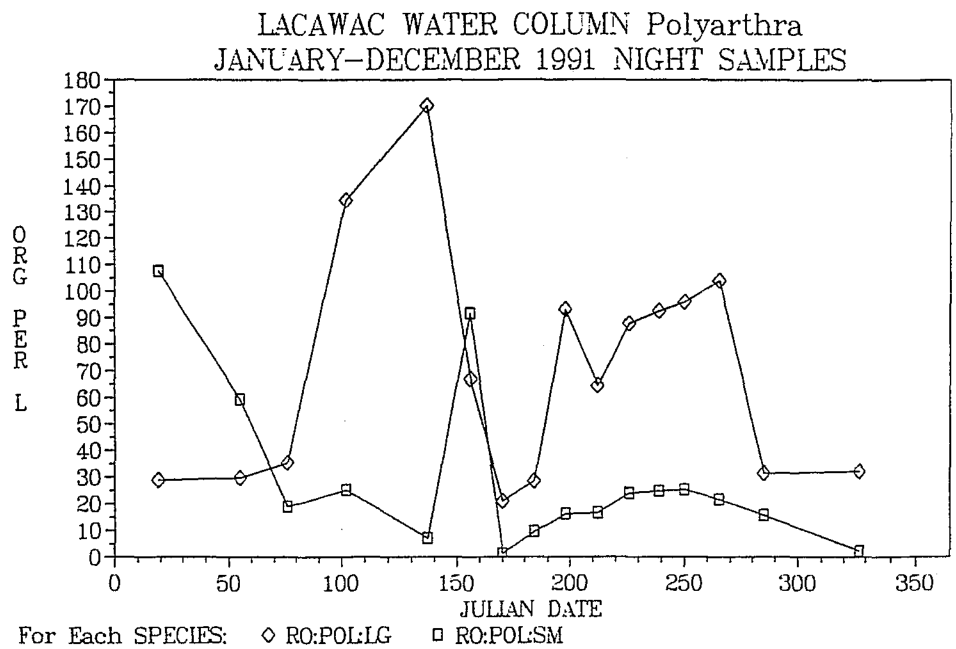


Figure 20. The rotifer *Polyarthra* spp. in Lake Lacawac, 1991.

Nighttime net collections ($48\mu m$) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Polyarthra* by size classes: **LG** large and **SM** small.

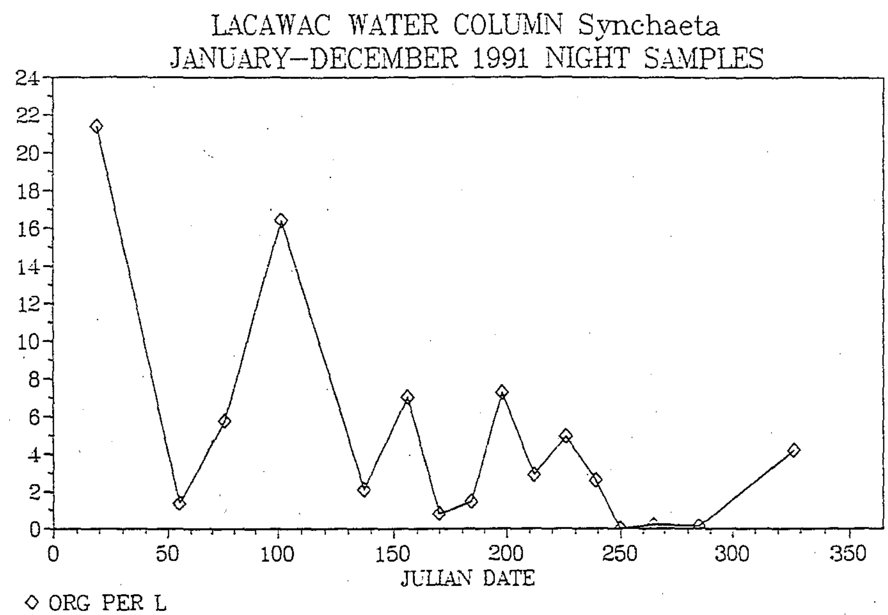
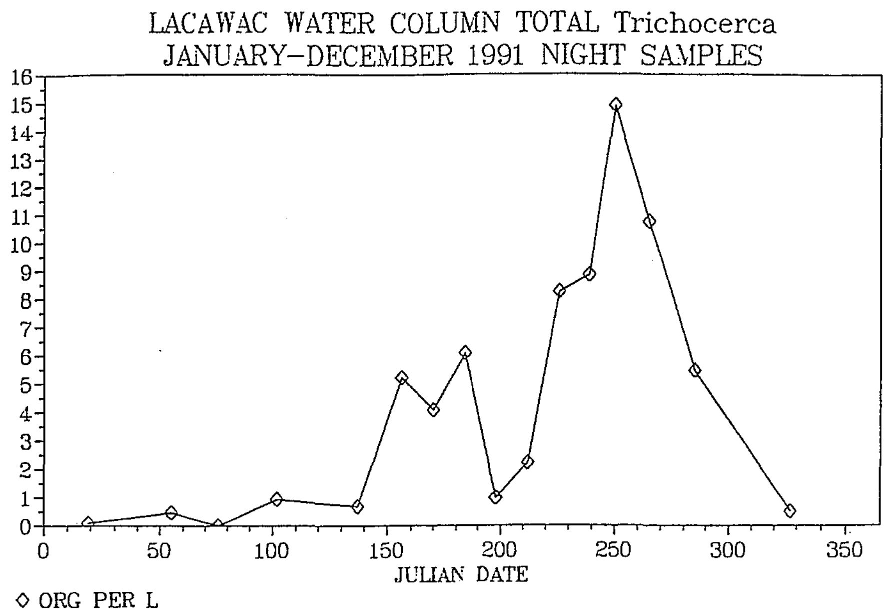


Figure 21. The rotifer *Synchaeta* in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean.



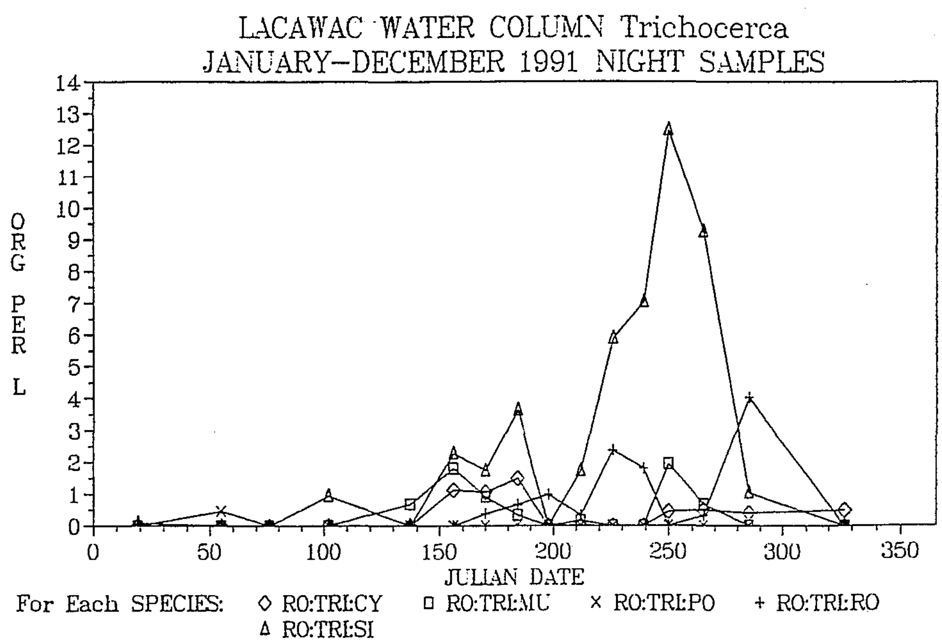


Figure 22. The rotifer *Trichocerca* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** *Trichocerca* by species: **CY** *T. cylindrica*, **MU** *T. multicrinus*, **PO** *T. porcellus*, **RO** *T. rousseleti* and **SI** *T. similis*.

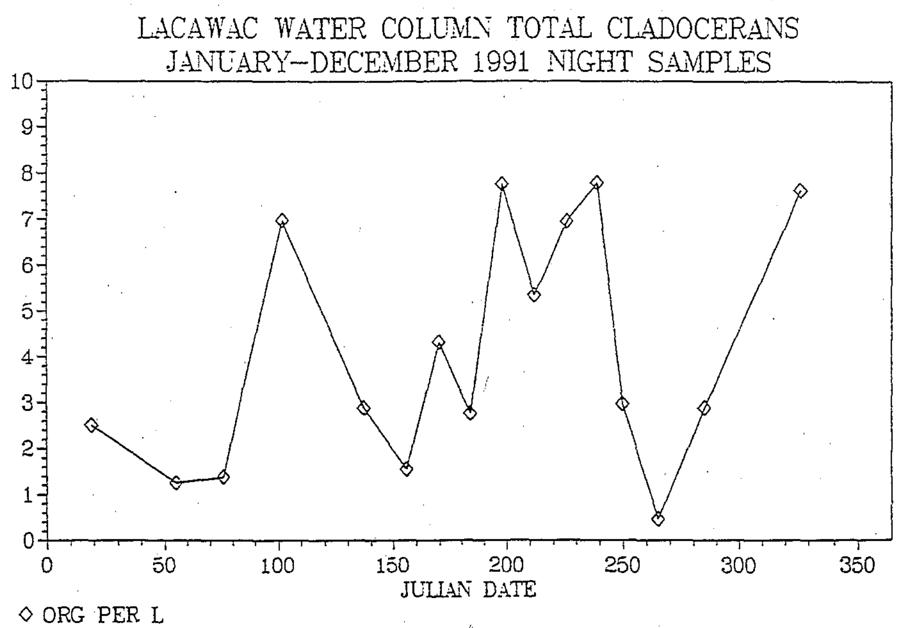
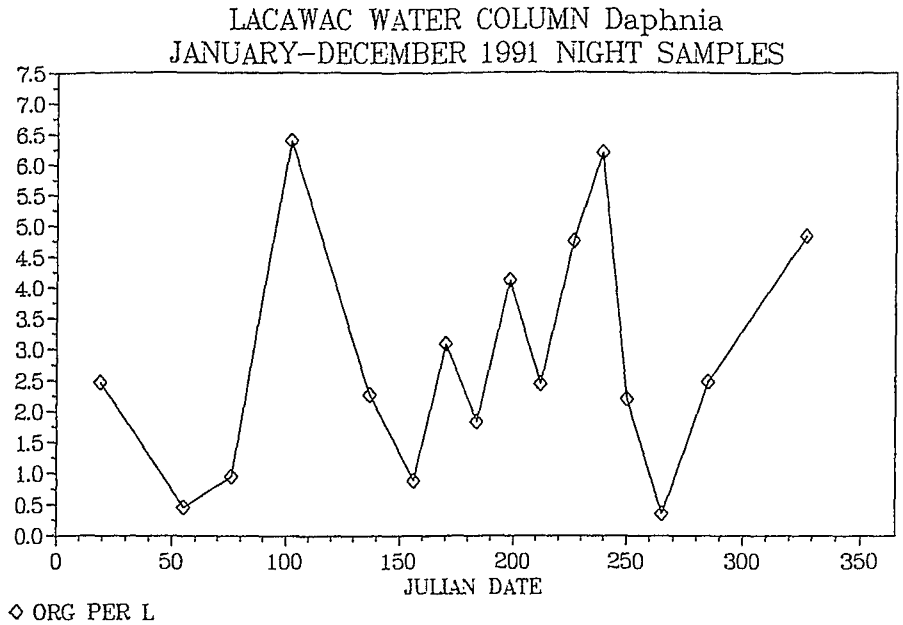


Figure 23. Cladocera in Lake Lacawac, 1991.

Nighttime net collections (202μm or 48μm, depending on taxon) from three depths have been combined to give a water column mean.



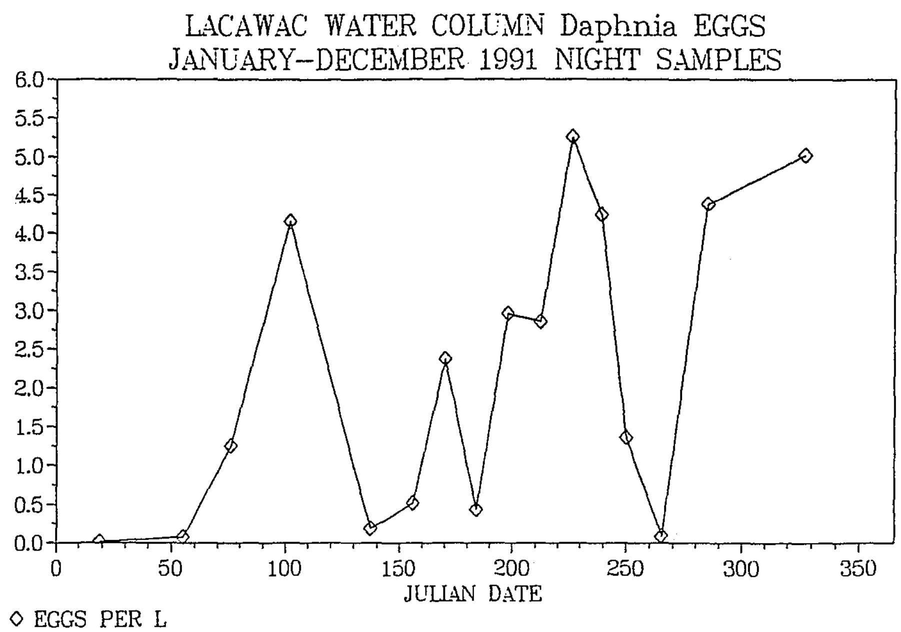
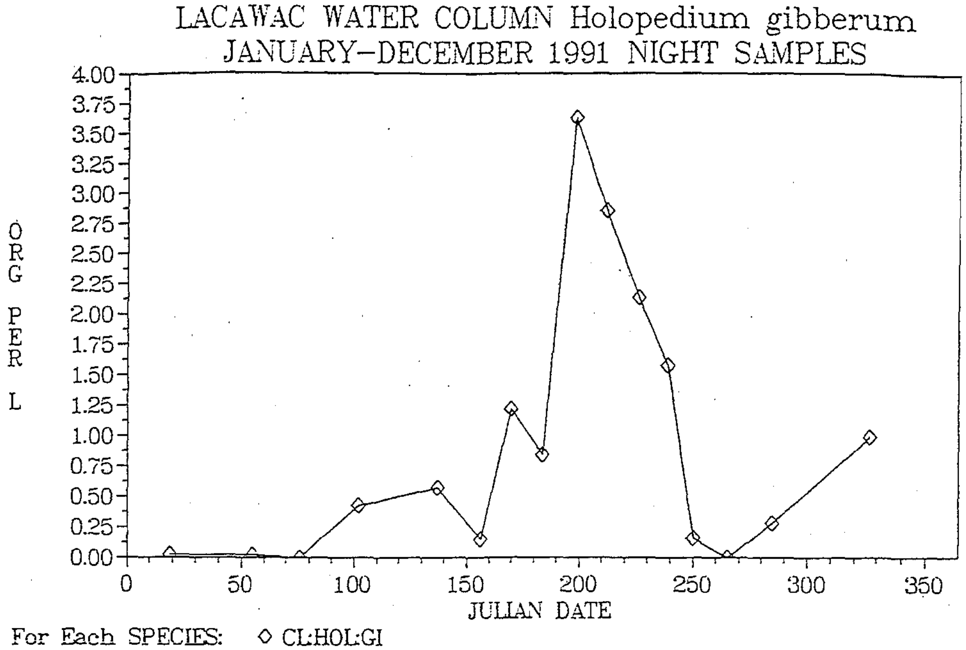


Figure 24. The cladoceran *Daphnia* spp. in Lake Lacawac, 1991.

Nighttime net collections (202μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** Total eggs per liter.



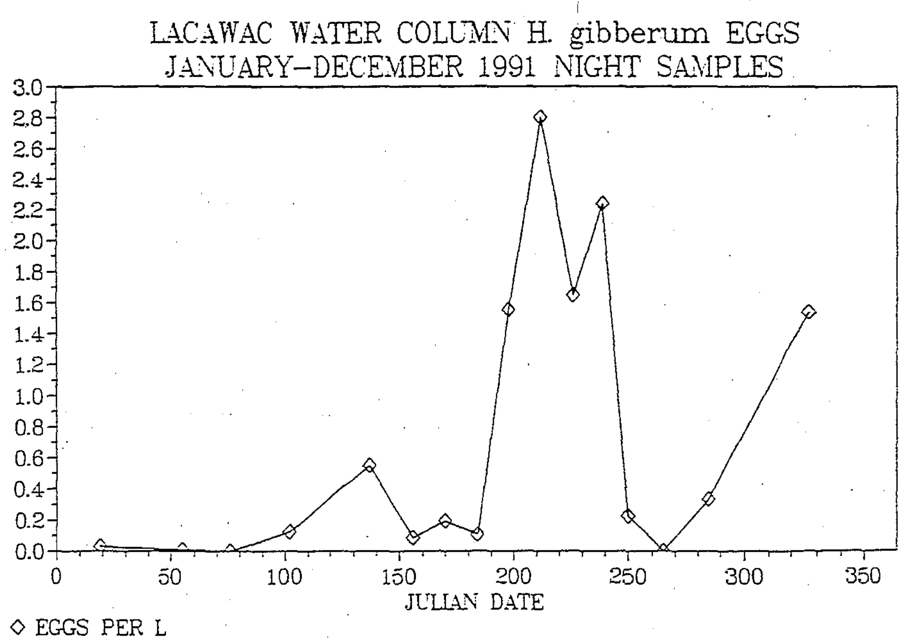


Figure 25. The cladoceran *Holopedium gibberum* in Lake Lacawac, 1991.

Nighttime net collections (202μm) from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter. **(Bottom)** Total eggs per liter.

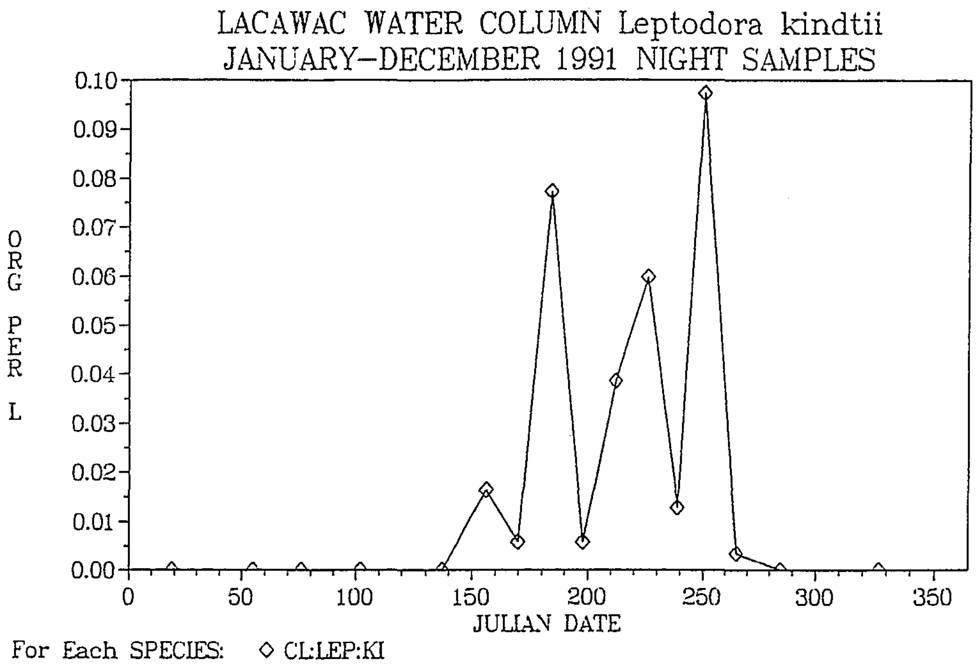


Figure 26. The cladoceran *Leptodora kindti* in Lake Lacawac, 1991.

Nighttime net collections (202μm) from three depths have been combined to give a water column mean.

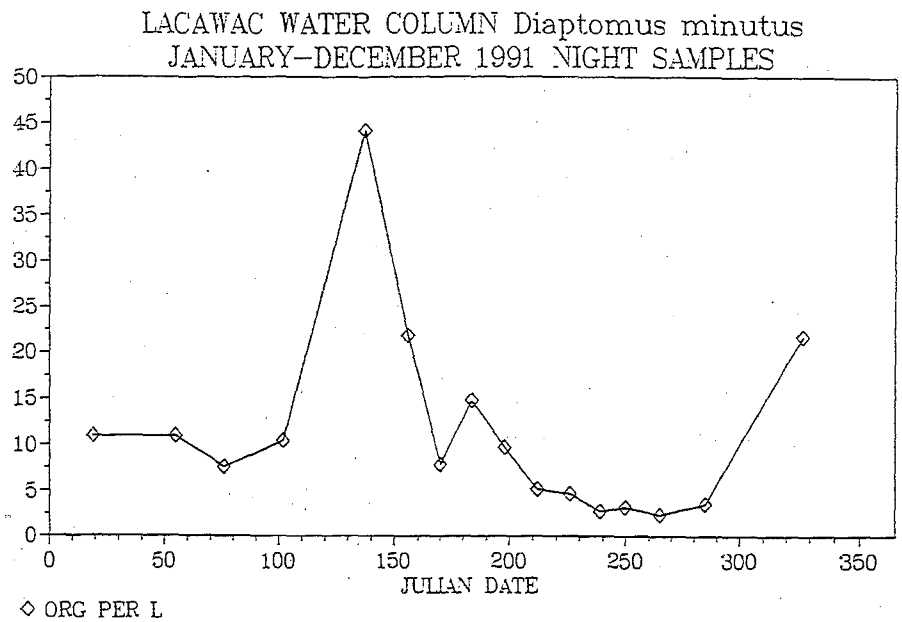
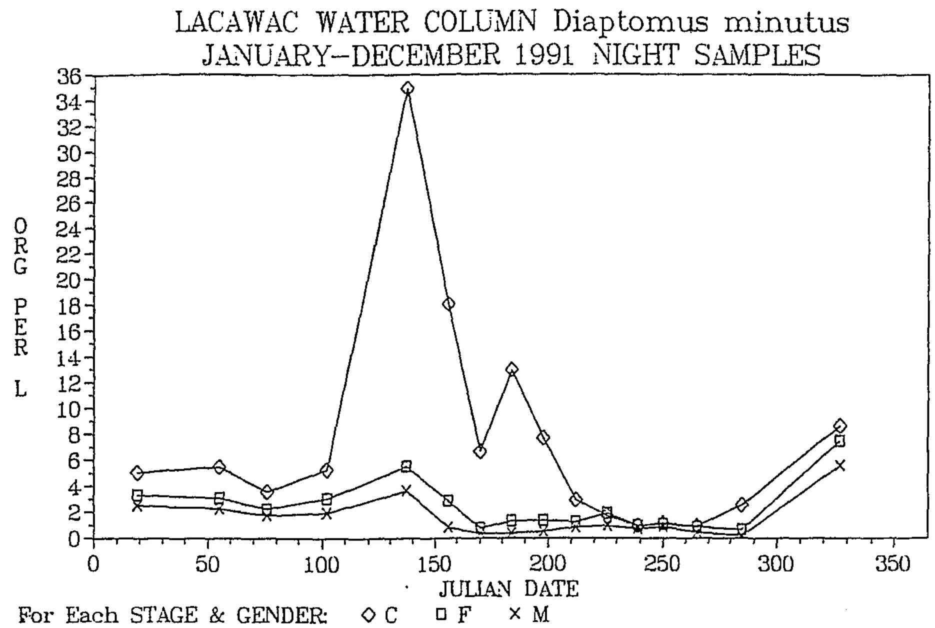


Figure 27. The calanoid copepod *Diaptomus minutus* in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean of total individuals per liter, excluding nauplii. *D. minutus* was the only calanoid present.



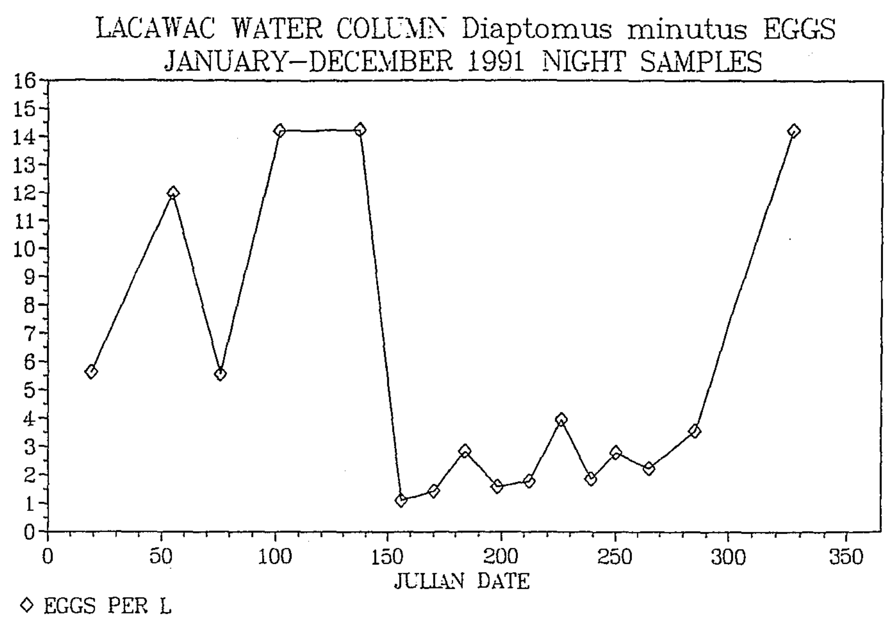


Figure 28. The calanoid copepod *Diaptomus minutus* in Lake Lacawac, 1991, by stage and gender.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** Adults (males and females separately) and copepodids. **(Bottom)** *D. minutus* eggs per liter.

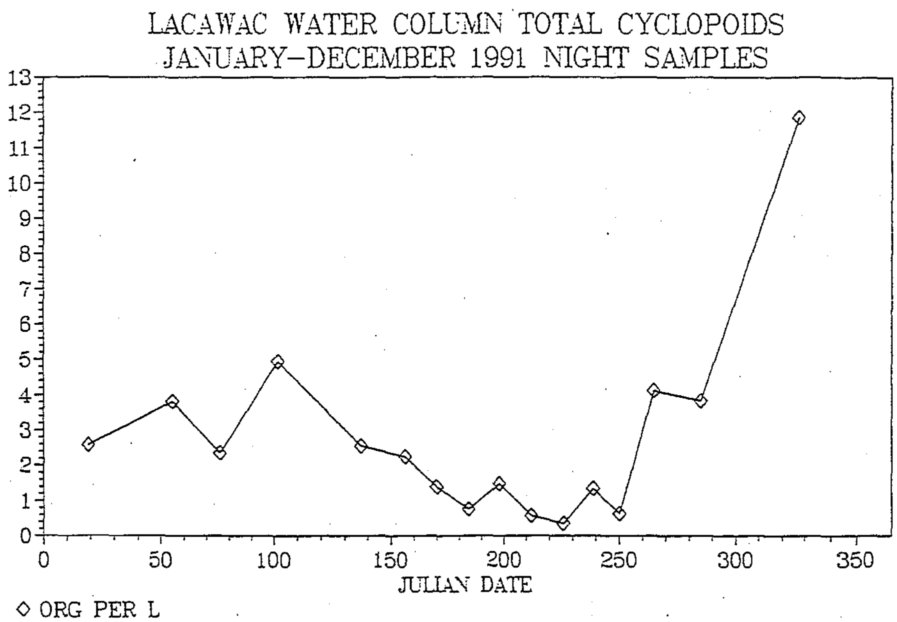


Figure 29. Cyclopoid copepods in Lake Lacawac, 1991.

Nighttime net collections from three depths have been combined to give a water column mean. Adult females were counted from 202μm net samples, other stages from 48μm net samples (nauplii are not included).

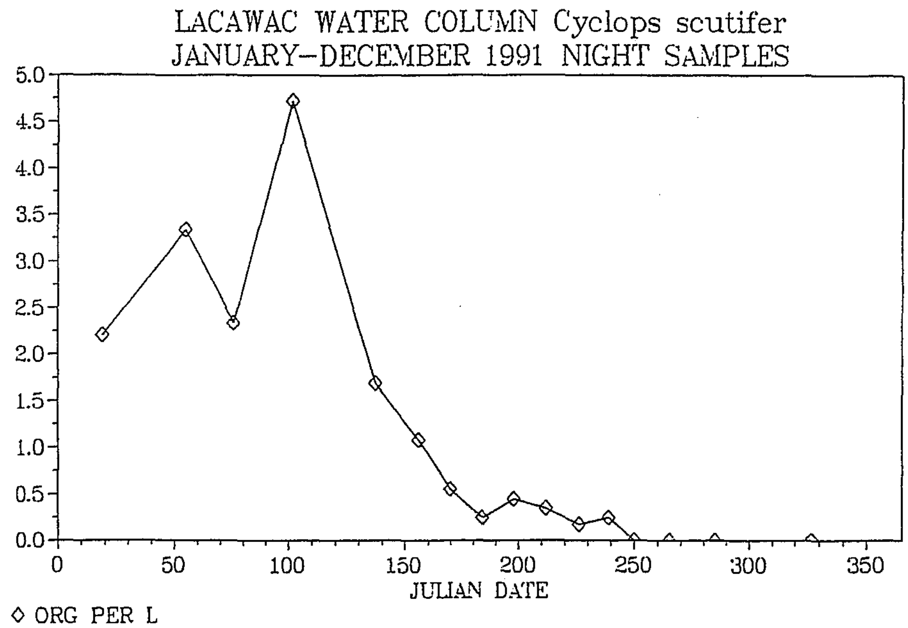
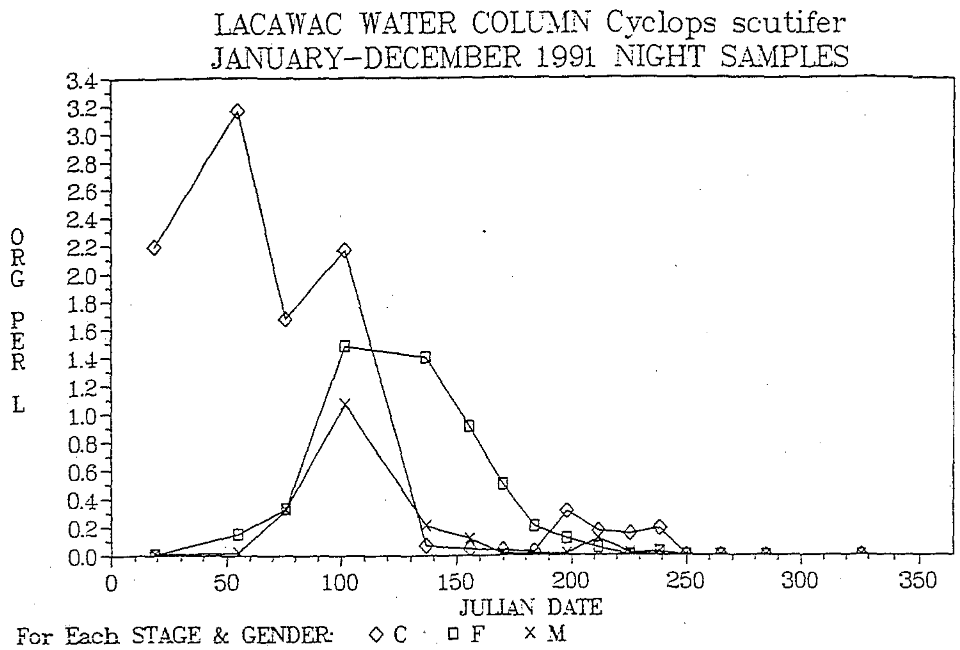


Figure 30. The cyclopoid copepod *Cyclops scutifer* in Lake Lacawac, 1991.

Nighttime net collections from three depths have been combined to give a water column mean. Adult females were counted from 202μm net samples, males and copepodids from 48μm net samples (nauplii are not included).



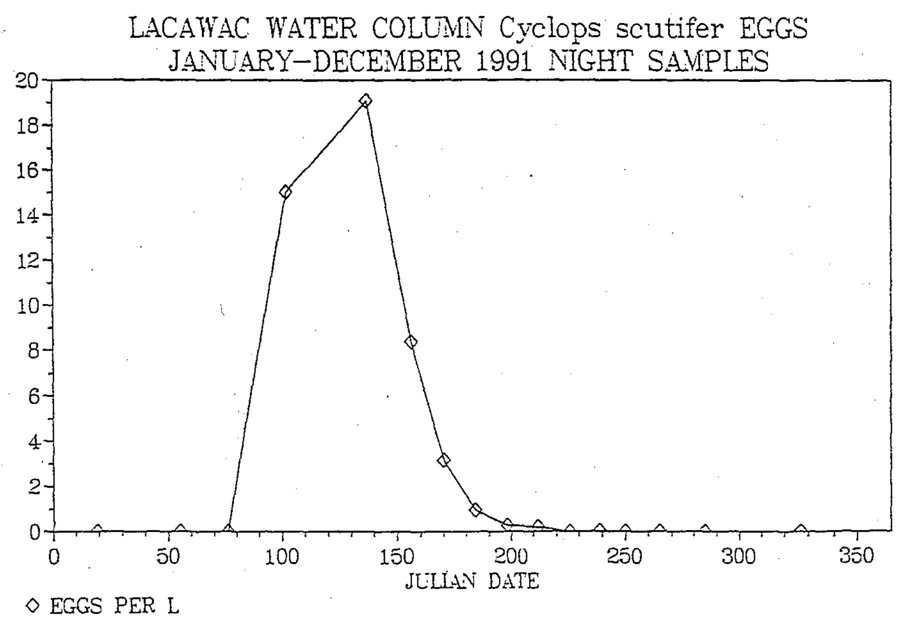


Figure 31. The cyclopoid copepod *Cyclops scutifer* in Lake Lacawac, 1991, by stage and gender.

Nighttime net collections from three depths have been combined to give a water column mean. **(Top)** Adults (males and females separately) and copepodids. **(Bottom)** *C. scutifer* eggs per liter. Adult females were counted from 202μm net samples, males and copepodids from 48μm net samples (nauplii are not included).

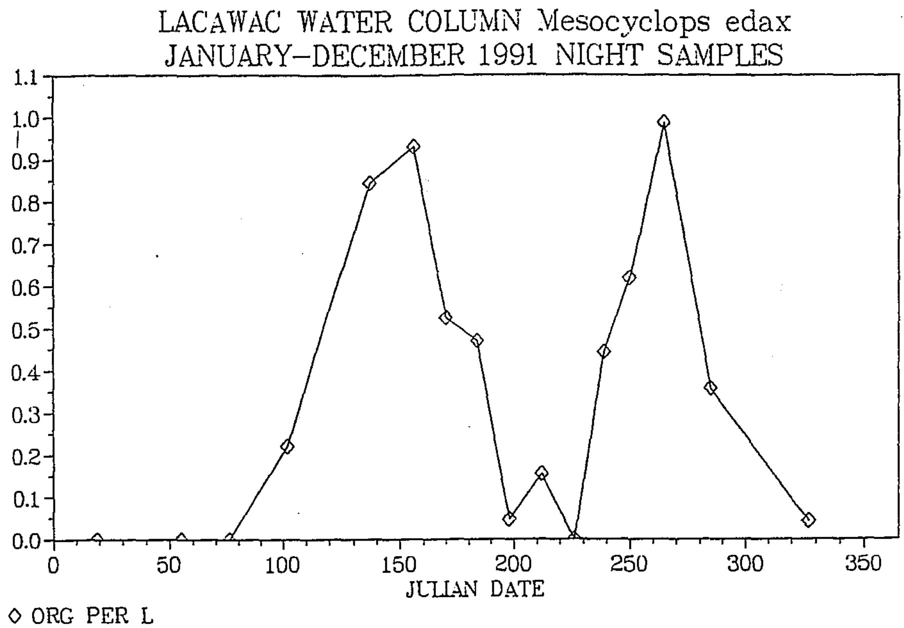
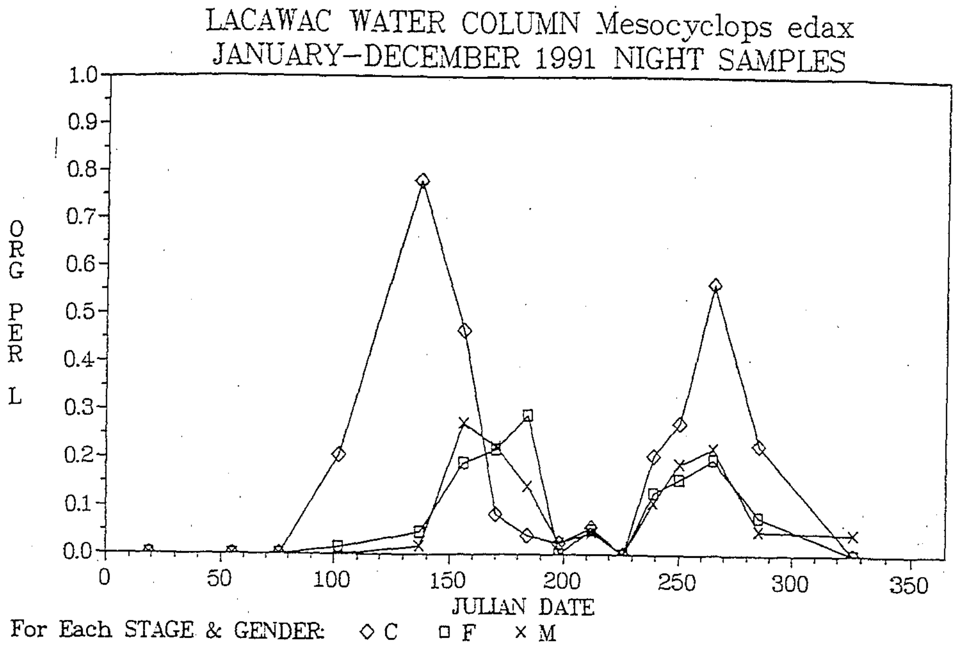


Figure 32. The cyclopoid copepod *Mesocyclops edax* in Lake Lacawac, 1991.

Nighttime net collections from three depths have been combined to give a water column mean. Adult females were counted from 202μm net samples, males and copepodids from 48μm net samples (nauplii are not included).



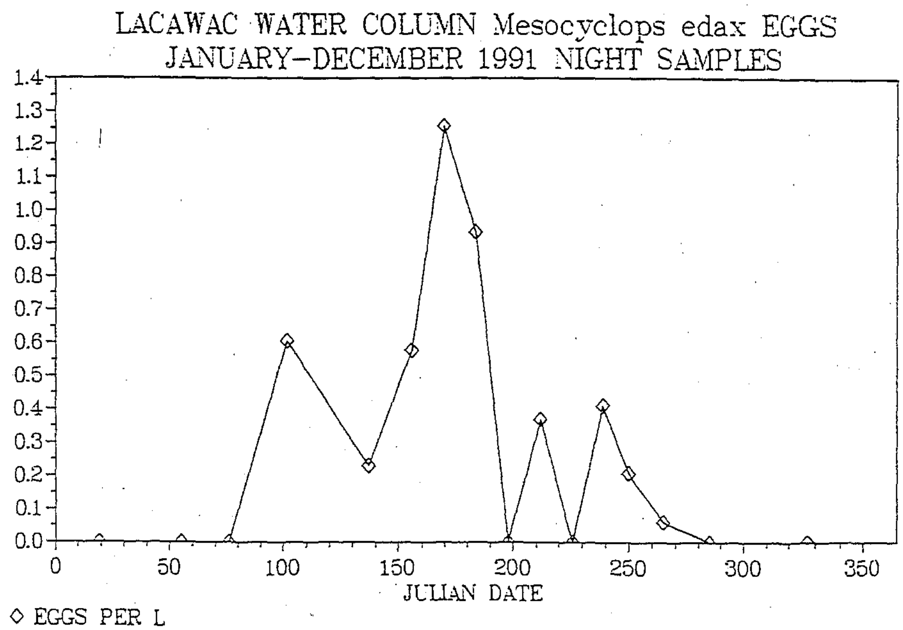
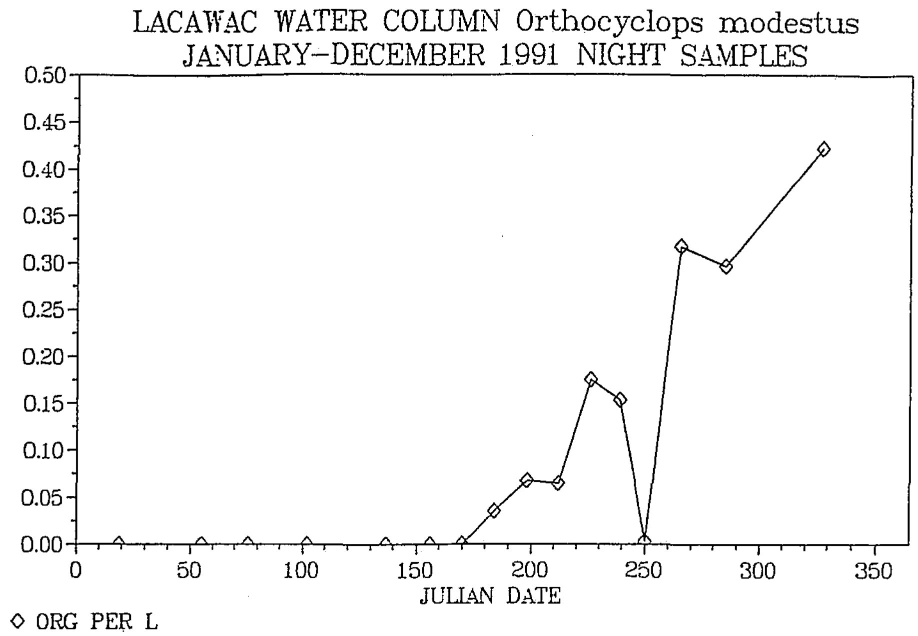


Figure 33. The cyclopoid copepod *Mesocyclops edax* in Lake Lacawac, 1991, by stage and gender.

Nighttime net collections from three depths have been combined to give a water column mean. **(Top)** Adults (males and females separately) and copepodids. **(Bottom)** *M. edax* eggs per liter. Adult females were counted from 202μm net samples, males and copepodids from 48μm net samples (nauplii are not included).



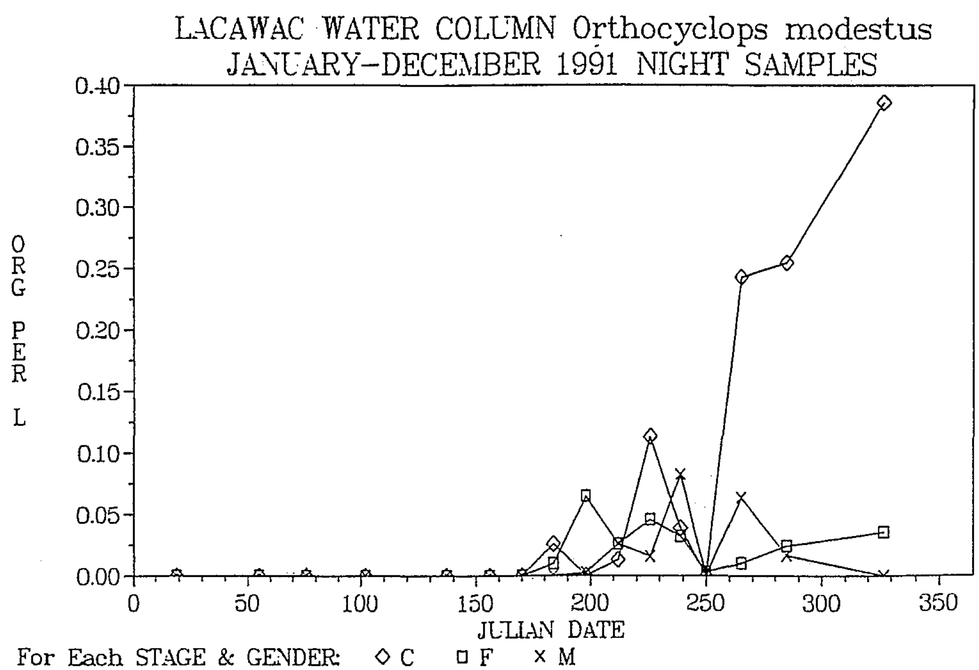


Figure 34. The cyclopoid copepod *Orthocyclops modestus* in Lake Lacawac, 1991, by stage and gender.

Nighttime net collections from three depths have been combined to give a water column mean. **(Top)** Total individuals per liter (excluding nauplii). **(Bottom)** *O. modestus* by stage and gender: adult females were counted from 202μm net samples, males and copepodids from 48μm net samples (nauplii are not included).

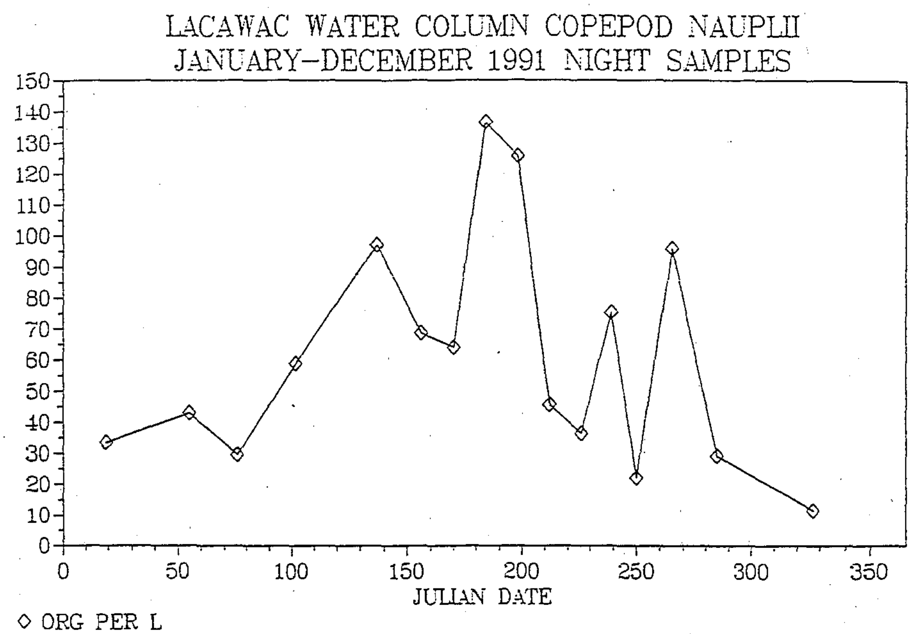


Figure 35. Total copepod nauplii in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean. Nauplii of calanoid and cyclopoid species were not differentiated.

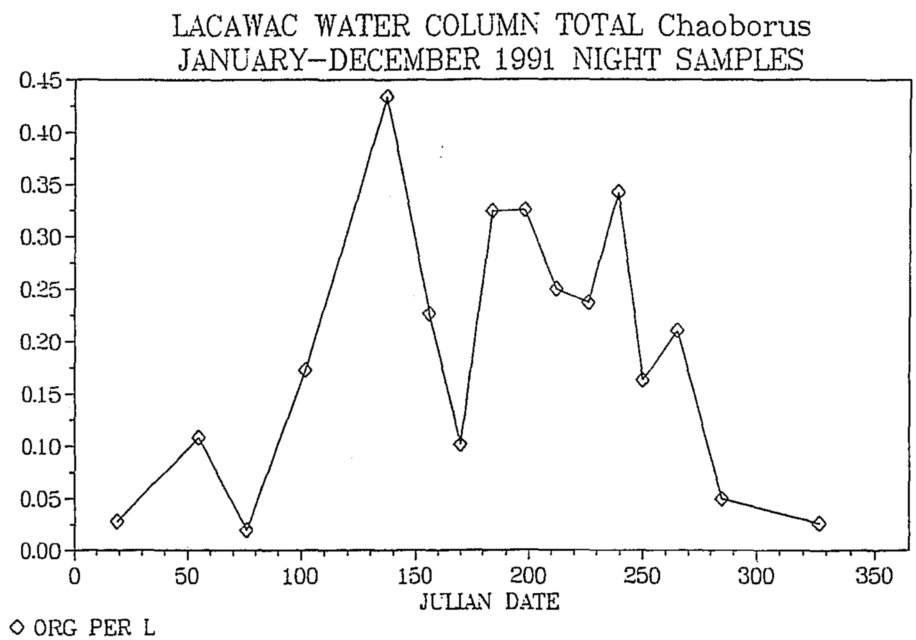


Figure 36. The dipteran *Chaoborus* spp. in Lake Lacawac, 1991.

Nighttime net collections (48μm) from three depths have been combined to give a water column mean.

EXPLANATION OF DATA TABLES

The following 16 tables present the physical/chemical information acquired on each date in 1991. The headings, abbreviations, and analytical units are explained here.

DATE OF SAMPLE: Date of the daytime visit, as month/day/year.

JULIAN DATE: Day of the year, from 1-365.

TIME: Approximate mid-time of sampling, 24-hr clock in decimal format (e.g. 1:30 PM is "13.50").

SECCHI M: Secchi depth in meters (m).

WEATHER: Brief comments on weather, especially cloudiness.

PERSONNEL: Initials of sampling crew (see names below).

TMETHOD: Temperature method #10 (see METHODS AND RESULTS).

LMETHOD: Light method #12 (see METHODS AND RESULTS).

AMETHOD: Alkalinity method #11 (see METHODS AND RESULTS).

OMETHOD: Oxygen method #10 (see METHODS AND RESULTS).

PHMETHOD: pH methods 10,11,12 (see METHODS AND RESULTS).

CAMETHOD: Chlorophyll-a method #12 (see METHODS AND RESULTS).

COMMENTS: Notes on unusual procedures, also ice thickness.

DATE OF: Date of sample (month/day/year).

JULIAN: Julian date.

STRA: Stratum or layer: S (air above surface), E (epilimnion), M(metalimnion), H (hypolimnion).

REP: Replicate (1 or 2); Replicates were usually analyzed for pH, alkalinity, chlorophyll--other data are merely repeated on rep 2 line for convenience in graphing.

DEPTH: Depth of sample (meters); **-1** for air above surface.

TEMP C: Temperature in degrees Celsius (°C).

OXYGEN: Dissolved oxygen (mg per liter--not corrected for elevation).

OFLAG: Error flag for oxygen; "**4**" means reported value should be interpreted as a true "zero".

LIGHT PC: Light as percent of intensity at 0.1-m depth.

pH: pH.

ALKAL: Alkalinity as microequivalents per liter (μeq/L).

CHLAC: Chlorophyll-a, corrected for pheopigments (μg/L).

CHLASUM: Chlorophyll-a, including pheopigments (μg/L).

CHLAC P: Percentage of CHLAC passing 22-μm net.

Names of Sampling Personnel:

JAA	John Aufderheide
GLB	Greg Brockway
SRC	Scott Carpenter
PRG	Pat Gorski
GG	Gaby Grad
EWH	Erik Hoyer
SLM	Shawna McConnell
REM	Robert Moeller
EMN	Gina Novak
AMS	Alice Shumate
PLS	Paul Stutzman
TLV	Tim Vail

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 1/19/91 JULIAN DATE: 19 TIME: 14.67

SECCHI M: 4.5 WEATHER: Sunny, clear

PERSONNEL: JAA SRC EMN

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 10 CAMETHOD: 12

COMMENTS: 15cm candled ice, no snow cover

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
1/19/91	19	S	1	-1.0	5.6								
1/19/91	19		1	0.0	2.8	12.08		100.0000					
1/19/91	19	E	1	1.0	3.4	11.95		48.2625	6.20	37	4.19	4.75	
1/19/91	19	E	2	1.0	3.4	11.95		48.2625	5.96	35	2.88	3.64	35.10
1/19/91	19		1	2.0	3.4	11.91		23.4398					
1/19/91	19		1	3.0	3.4	11.53		10.8467					
1/19/91	19	M	1	4.0	3.4	11.73		5.2808	5.96	34	4.23	5.02	
1/19/91	19	M	2	4.0	3.4	11.73		5.2808	5.93	37	4.62	5.41	17.50
1/19/91	19		1	5.0	3.5	11.85		2.6861					
1/19/91	19		1	6.0	3.5	11.03		1.3946					
1/19/91	19		1	7.0	3.5	10.63		0.7008					
1/19/91	19		1	8.0	3.6	10.21		0.3622					
1/19/91	19	H	1	9.0	3.6	9.58		0.1862	5.76	44	0.45	2.63	
1/19/91	19	H	2	9.0	3.6	9.58		0.1862	5.75	35	0.39	2.64	61.50
1/19/91	19		1	10.0	3.6	8.74		0.0915					
1/19/91	19		1	11.0	3.7	7.90		0.0430					
1/19/91	19		1	12.0	3.8	7.58		0.0192					
1/19/91	19		1	13.0	3.9			0.0000					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 2/24/91 JULIAN DATE: 55 TIME: 14.00

SECCHI M: 4.8 WEATHER: Overcast, windy

PERSONNEL: JAA SRC EMN

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 11 CAMETHOD: 12

COMMENTS: 12cm translucent ice, <1% snow cover

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
2/24/91	55	S	1	-1.0	2.6								
2/24/91	55		1	0.0	4.2	12.40		100.0000					
2/24/91	55	E	1	1.0	4.2	12.42		33.7950	5.96	53	6.94	7.25	
2/24/91	55	E	2	1.0	4.2	12.42		33.7952	5.84	37	6.85	7.18	32.30
2/24/91	55		1	2.0	4.4	12.36		18.1110					
2/24/91	55		1	3.0	4.3	12.27		9.6387					
2/24/91	55	M	1	4.0	4.2	12.02		4.8411	5.85	38	5.88	5.99	
2/24/91	55	M	2	4.0	4.2	12.02		4.8411	6.09	51	6.27	6.74	45.90
2/24/91	55		1	5.0	4.1	11.89		2.4230					
2/24/91	55		1	6.0	4.1	11.88		1.2413					
2/24/91	55		1	7.0	4.1	11.86		0.6435					
2/24/91	55		1	8.0	4.1	11.49		0.3345					
2/24/91	55	H	1	9.0	4.1	10.76		0.1674	5.95	39	2.83	3.76	
2/24/91	55	H	2	9.0	4.1	10.76		0.1674	5.84	37	2.61	3.62	48.70
2/24/91	55		1	10.0	4.1	8.93		0.0796					
2/24/91	55		1	11.0	4.1	7.78		0.0357					
2/24/91	55		1	12.0	4.1	4.78		0.0137					
2/24/91	55		1	13.0				0.0000					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 3/17/91 JULIAN DATE: 76 TIME: 16.33

SECCHI M: 4.2 WEATHER: Sunny, a few clouds, very sl. breeze

PERSONNEL: JAA EMN TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 11 CAMETHOD: 12

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
3/17/91	76	S	1	-1.0	12.2								
3/17/91	76		1	0.0	3.7	13.05		100.0000					
3/17/91	76		1	1.0	3.5	13.13		26.8962					
3/17/91	76	E	1	2.0	3.5	12.99		9.7627	6.16	29	4.15	4.52	
3/17/91	76	E	2	2.0	3.5	12.99		9.7627	6.14	30	3.56	4.16	42.40
3/17/91	76		1	3.0	3.5	12.99		4.3956					
3/17/91	76		1	4.0	3.5	13.02		2.0210					
3/17/91	76		1	5.0	3.5	12.88		0.8604					
3/17/91	76	M	1	6.0	3.4	12.92		0.4047	6.17	32	3.96	4.43	
3/17/91	76	M	2	6.0	3.4	12.92		0.4047	6.15	29	3.66	4.28	39.10
3/17/91	76		1	7.0	3.4	12.86		0.1954					
3/17/91	76		1	8.0	3.4	12.77		0.0883					
3/17/91	76		1	9.0	3.4	12.85		0.0408					
3/17/91	76	H	1	10.0	3.5	12.84		0.0206	6.14	30	3.96	4.65	
3/17/91	76	H	2	10.0	3.5	12.84		0.0206	6.16	28	3.62	4.15	41.90
3/17/91	76		1	11.0	3.5	12.89		0.0097					
3/17/91	76		1	12.0	3.5	12.83		0.0047					
3/17/91	76		1	13.0									

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 4/12/91 JULIAN DATE: 102 TIME: 17.00

SECCHI M: 5.5 WEATHER: Sunny, light breeze

PERSONNEL: REM SRC

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: Extra pump sampling: 0.5, 2, 5, 8, 10, 12 m

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
4/12/91	102	S	1	-1.0	10.2								
4/12/91	102		1	0.0	10.6	11.32		100.0000					
4/12/91	102		1	1.0	10.5	11.07		34.2583					
4/12/91	102	E	1	2.0	10.4	11.00		13.5784	6.26	33	1.35	2.29	
4/12/91	102	E	2	2.0	10.4	11.00		13.5784	6.21	29	0.91	1.43	28.60
4/12/91	102		1	3.0	10.2	11.01		6.3126					
4/12/91	102		1	4.0	9.3	11.01		3.0733					
4/12/91	102	M	1	5.0	8.4	11.15		1.4607	6.18	31	4.44	5.16	
4/12/91	102	M	2	5.0	8.4	11.15		1.4607	6.23	31	3.12	3.93	17.30
4/12/91	102		1	6.0	7.0	11.49		0.6919					
4/12/91	102		1	7.0	6.3	11.35		0.3256					
4/12/91	102		1	8.0	6.1	11.05		0.1510					
4/12/91	102		1	9.0	6.1	10.98		0.0747					
4/12/91	102	H	1	10.0	6.1	10.65		0.0331	5.86	28	2.36	3.45	
4/12/91	102	H	2	10.0	6.1	10.65		0.0331	5.93	29	3.54	3.74	74.00
4/12/91	102		1	11.0	6.2	10.61		0.0160					
4/12/91	102		1	12.0	6.2	10.28		0.0077					
4/12/91	102		1	13.0									

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 5/17/91 JULIAN DATE: 137 TIME: 12.25

SECCHI M: 6.3 WEATHER: Mostly sunny, windy

PERSONNEL: JAA EMN

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: CAMETHOD: 12

COMMENTS: pH, Alkalinity data lost

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
5/17/91	137	S	1	-1.0	20.6								
5/17/91	137		1	0.0	22.2	8.53		100.0000					
5/17/91	137	E	1	1.0	22.2	8.30		42.3908			1.05	1.12	
5/17/91	137	E	2	1.0	22.2	8.30		42.3908			0.81	0.96	77.80
5/17/91	137		1	2.0	22.2	8.35		24.9652					
5/17/91	137		1	3.0	16.4	10.00		17.2769					
5/17/91	137		1	4.0	14.2	10.36		7.9581					
5/17/91	137	M	1	5.0	11.2	11.11		3.8352			2.67	3.08	
5/17/91	137	M	2	5.0	11.2	11.11		3.8352			2.12	2.42	66.50
5/17/91	137		1	6.0	9.1	9.85		2.0653					
5/17/91	137		1	7.0	7.9	8.40		1.4194					
5/17/91	137		1	8.0	7.2	7.14		0.7393					
5/17/91	137		1	9.0	6.7	6.46		0.3962					
5/17/91	137	H	1	10.0	6.5	5.53		0.1661			2.13	4.83	
5/17/91	137	H	2	10.0	6.5	5.53		0.1661			1.78	4.96	75.80
5/17/91	137		1	11.0	6.4	5.23		0.0749					
5/17/91	137		1	12.0	6.3	4.63		0.0322					
5/17/91	137		1	13.0	6.3	3.76							

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 6/05/91   JULIAN DATE: 156   TIME: 11.00

SECCHI M: 4.5   WEATHER: Cloudy, windy

PERSONNEL: JAA TLV SLM PRG AMS

TMETHOD: 10   LMETHOD: 12   AMETHOD: 11
OMETHOD: 10   PHMETHOD: 12   CAMETHOD: 12

COMMENTS: Clouds during light measurements

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
6/05/91	156	S	1	-1.0	19.0								
6/05/91	156		1	0.0	22.6	7.52		100.0000					
6/05/91	156		1	1.0	22.6	7.16		29.1036					
6/05/91	156	E	1	2.0	22.6	6.92		15.2615	6.19	29	4.64	4.64	
6/05/91	156	E	2	2.0	22.6	6.92		15.2615	6.35	30	3.86	3.86	70.20
6/05/91	156		1	3.0	22.6	6.73		8.3214					
6/05/91	156		1	4.0	16.3	8.38		4.5899					
6/05/91	156		1	5.0	12.4	8.67		2.2510					
6/05/91	156	M	1	6.0	10.3	7.96		1.1210	5.90	27	2.74	3.35	
6/05/91	156	M	2	6.0	10.3	7.96		1.1210	5.93	26	2.46	3.04	45.50
6/05/91	156		1	7.0	8.6	5.99		0.5533					
6/05/91	156		1	8.0	7.5	4.84		0.2659					
6/05/91	156		1	9.0	7.0	3.68		0.1117					
6/05/91	156		1	10.0	6.7	3.14		0.0407					
6/05/91	156	H	1	11.0	6.6	2.53		0.0131	5.73	52	1.16	4.10	
6/05/91	156	H	2	11.0	6.6	2.53		0.0131	5.74	44	0.98	3.94	72.40
6/05/91	156		1	12.0	6.5	2.00		0.0045					
6/05/91	156		1	13.0									

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 6/19/91 JULIAN DATE: 170 TIME: 10.25

SECCHI M: 6.1 WEATHER: Overcast, slight drizzle then steady rain

PERSONNEL: JAA EWH TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: No alkalinity this date

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
6/19/91	170	S	1	-1.0	19.9								
6/19/91	170		1	0.0	23.4	8.20		100.0000					
6/19/91	170		1	1.0	23.3	8.18		49.8008					
6/19/91	170	E	1	2.0	23.4	8.11		26.6600	6.36		3.00	3.00	
6/19/91	170	E	2	2.0	23.4	8.11		26.6600	6.33		6.11	6.42	36.80
6/19/91	170		1	3.0	22.6	8.00		14.3410					
6/19/91	170		1	4.0	19.4	8.55		8.0028					
6/19/91	170		1	5.0	14.1	9.06		4.1465					
6/19/91	170	M	1	6.0	10.8	8.58		1.9268	5.93		2.73	3.10	
6/19/91	170	M	2	6.0	10.8	8.58		1.9268	5.96		2.62	3.08	60.70
6/19/91	170		1	7.0	8.9	5.75		0.8571					
6/19/91	170		1	8.0	7.6	3.41		0.3503					
6/19/91	170		1	9.0	7.0	2.35		0.0998					
6/19/91	170	H	1	10.0	6.8	1.36		0.0180	5.77		1.25	3.94	
6/19/91	170	H	2	10.0	6.8	1.36		0.0180	5.79		1.26	3.89	85.70
6/19/91	170		1	11.0	6.7	0.77		0.0007					
6/19/91	170		1	12.0	6.6	0.37	4	0.0000					
6/19/91	170		1	13.0									

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 7/03/91 JULIAN DATE: 184 TIME: 10.83

SECCHI M: 4.5 WEATHER: Overcast, rain

PERSONNEL: SLM EMN TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
7/03/91	184	S	1	-1.0	19.1								
7/03/91	184		1	0.0	23.7	7.83		100.0000					
7/03/91	184		1	1.0	23.7	7.78		27.8784					
7/03/91	184	E	1	2.0	23.8	7.70		14.5884	6.29	26	3.12	3.39	
7/03/91	184	E	2	2.0	23.8	7.70		14.5884	6.34	25	2.82	3.90	60.30
7/03/91	184		1	3.0	23.7	7.60		8.8522					
7/03/91	184		1	4.0	21.7	8.20		4.8452					
7/03/91	184		1	5.0	16.1	8.18		2.2599					
7/03/91	184	M	1	6.0	11.9	7.09		0.9641	6.19	28	3.33	4.16	
7/03/91	184	M	2	6.0	11.9	7.09		0.9641	6.11	28	2.81	3.48	42.00
7/03/91	184		1	7.0	9.3	5.62		0.1515					
7/03/91	184		1	8.0	8.0	2.36		0.0519					
7/03/91	184		1	9.0	7.2	1.51		0.0143					
7/03/91	184	H	1	10.0	6.9	0.34	4	0.0019	6.45	69	3.03	6.04	
7/03/91	184	H	2	10.0	6.9	0.34	4	0.0019	6.53	60	2.98	5.95	79.20
7/03/91	184		1	11.0	6.7	0.31	4	0.0000					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 7/17/91 JULIAN DATE: 198 TIME: 10.17

SECCHI M: 4.9 WEATHER: Sunny, windy

PERSONNEL: JAA EWH EMN

TMETHOD: 10 LMETHOD: 10 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: Light meter erratic; ratios calculated from readings at successive depths

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
7/17/91	198	S	1	-1.0	29.8								
7/17/91	198		1	0.0	24.9	8.30		100.0000					
7/17/91	198		1	1.0	24.6	8.24		52.5819					
7/17/91	198	E	1	2.0	24.2	8.33		28.8649	6.36		1.93	1.99	
7/17/91	198	E	2	2.0	24.2	8.33		28.8649	6.41		1.52	1.92	83.60
7/17/91	198		1	3.0	23.9	8.11		18.4612					
7/17/91	198		1	4.0	23.1	8.00		10.7154					
7/17/91	198		1	5.0	18.4	7.26		5.2186					
7/17/91	198	M	1	6.0	13.0	6.43		2.2038	5.77		4.15	5.71	
7/17/91	198	M	2	6.0	13.0	6.43		2.2038	5.73		3.87	4.90	59.40
7/17/91	198		1	7.0	10.3	4.34		1.0044					
7/17/91	198		1	8.0	8.7	1.67		0.4209					
7/17/91	198		1	9.0	7.8	0.35	4	0.1265					
7/17/91	198		1	10.0	7.3	0.25	4	0.0414					
7/17/91	198	H	1	11.0	7.1	0.23	4	0.0104	6.68		0.00	17.54	
7/17/91	198	H	2	11.0	7.1	0.23	4	0.0104	6.75		0.20	14.05	N/A
7/17/91	198		1	12.0	7.0	0.21	4	0.0016					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 7/31/91 JULIAN DATE: 212 TIME: 10.93

SECCHI M: 5.2 WEATHER: Partly cloudy, sl. breeze

PERSONNEL: PRG EMN TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: Overcast during light measurements

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
7/31/91	212	S	1	-1.0	22.7								
7/31/91	212		1	0.0	24.2	8.03		100.0000					
7/31/91	212		1	1.0	24.3	8.00		53.9374					
7/31/91	212	E	1	2.0	24.2	7.93		34.9336	6.34		2.25	2.77	
7/31/91	212	E	2	2.0	24.2	7.93		34.9336	6.42		3.25	3.79	76.30
7/31/91	212		1	3.0	24.2	7.91		19.1103					
7/31/91	212		1	4.0	24.1	7.84		10.4944					
7/31/91	212		1	5.0	19.4	6.13		5.3652					
7/31/91	212	M	1	6.0	14.3	4.53		2.7571	6.22		3.20	4.28	
7/31/91	212	M	2	6.0	14.3	4.53		2.7571	6.13		2.71	4.08	74.50
7/31/91	212		1	7.0	11.1	3.05		1.3489					
7/31/91	212		1	8.0	8.9	0.36	4	0.5488					
7/31/91	212		1	9.0	8.0	0.26	4	0.1851					
7/31/91	212	H	1	10.0	7.5	0.22	4	0.0547	6.57		0.00	44.09	
7/31/91	212	H	2	10.0	7.5	0.22	4	0.0547	6.60		0.39	66.97	N/A
7/31/91	212		1	11.0	7.3	0.22	4	0.0178					
7/31/91	212		1	12.0	7.2	0.20	4	0.0052					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 8/14/91 JULIAN DATE: 226 TIME: 11.33

SECCHI M: 5.4 WEATHER: Sunny, some clouds

PERSONNEL: EMN AMS TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: Light measurements 5-10m in overcast

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
8/14/91	226	S	1	-1.0	25.9								
8/14/91	226		1	0.0	24.2	8.89		100.0000					
8/14/91	226		1	1.0	23.5	8.53		50.3525					
8/14/91	226	E	1	2.0	23.3	8.37		28.1456	6.36	34	1.67	2.09	
8/14/91	226	E	2	2.0	23.3	8.37		28.1456	6.34	35	1.68	2.20	83.90
8/14/91	226		1	3.0	23.1	7.92		16.1385					
8/14/91	226		1	4.0	22.8	7.51		10.4932					
8/14/91	226		1	5.0	21.6	5.83		6.1364					
8/14/91	226	M	1	6.0	15.8	3.38		2.8475	5.86	44	1.62	2.61	
8/14/91	226	M	2	6.0	15.8	3.38		2.8475	5.67	44	1.58	2.52	77.80
8/14/91	226		1	7.0	12.4	2.62		1.2701					
8/14/91	226		1	8.0	9.4	0.57		0.4879					
8/14/91	226		1	9.0	8.5	0.42	4	0.0759					
8/14/91	226	H	1	10.0	8.1	0.38	4	0.0134	6.27	240	0.00	47.44	
8/14/91	226	H	2	10.0	8.1	0.38	4	0.0134	6.11	160	0.31	41.16	N/A
8/14/91	226		1	11.0	7.6	0.31	4	0.0000					
8/14/91	226		1	12.0	7.4	0.32	4	0.0000					

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 8/27/91 JULIAN DATE: 239 TIME: 9.58

SECCHI M: 6.3 WEATHER: Sunny, windy

PERSONNEL: EMN

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: No alkalinity this date

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
8/27/91	239	S	1	-1.0	22.7								
8/27/91	239		1	0.0	23.1	8.13		100.0000					
8/27/91	239		1	1.0	23.1	8.26		51.6796					
8/27/91	239	E	1	2.0	23.0	8.18		21.7782	6.23		1.96	2.36	
8/27/91	239	E	2	2.0	23.0	8.18		21.7782	6.31		3.41	4.13	85.90
8/27/91	239		1	3.0	22.9	7.95		11.6773					
8/27/91	239		1	4.0	22.8	7.76		7.0987					
8/27/91	239		1	5.0	21.7	5.28		3.9768					
8/27/91	239	M	1	6.0	17.2	1.73		1.7374	5.83		1.94	2.93	
8/27/91	239	M	2	6.0	17.2	1.73		1.7374	5.77		2.18	3.28	60.60
8/27/91	239		1	7.0	12.5	0.99		0.7399					
8/27/91	239		1	8.0	10.6	0.43	4	0.2961					
8/27/91	239		1	9.0	8.6	0.36	4	0.7000					
8/27/91	239		1	10.0	7.9	0.36	4	0.0064					
8/27/91	239	H	1	11.0	7.6	0.35	4	0.0010	6.36		0.00	61.23	
8/27/91	239	H	2	11.0	7.6	0.35	4	0.0010	6.44		0.24	56.13	N/A
8/27/91	239		1	12.0	7.4	0.35	4	0.0000					
8/27/91	239		1	13.0	7.3								

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 9/07/91 JULIAN DATE: 250 TIME: 13.25

SECCHI M: 7.0 WEATHER: Partly sunny

PERSONNEL: GLB GG EMN

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: Night tows taken on 9/06/91; Light readings overcast except 7-9m

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
9/07/91	250	S	1	-1.0	25.3								
9/07/91	250		1	0.0	23.2	8.03		100.0000					
9/07/91	250		1	1.0	22.3	7.86		39.0320					
9/07/91	250		1	2.0	22.1	7.90		35.3231					
9/07/91	250	E	1	3.0	21.9	7.83		23.8831	6.25	32	0.91	1.09	
9/07/91	250	E	2	3.0	21.9	7.83		23.8831	6.26	33	1.33	1.89	66.90
9/07/91	250		1	4.0	21.8	7.69		16.1700					
9/07/91	250		1	5.0	21.6	7.49		10.7086					
9/07/91	250		1	6.0	18.1	1.69		6.3029					
9/07/91	250	M	1	7.0	12.4	1.13		3.2323	5.69	53	2.27	3.86	
9/07/91	250	M	2	7.0	12.4	1.13		3.2323	5.79	47	2.69	4.78	73.20
9/07/91	250		1	8.0	9.7	0.65		1.4861					
9/07/91	250		1	9.0	7.8	0.47	4	0.3373					
9/07/91	250		1	10.0	7.3	0.45	4	0.0273					
9/07/91	250	H	1	11.0	7.1	0.44	4	0.0000	6.46	364	4.62	56.89	
9/07/91	250	H	2	11.0	7.1	0.44	4	0.0000	6.47	335	8.35	43.91	97.40
9/07/91	250		1	12.0	7.1	0.42	4	0.0000					
9/07/91	250		1	13.0	7.0								

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 9/22/91 JULIAN DATE: 265 TIME: 14.75

SECCHI M: 6.1 WEATHER: Sunny, breezy

PERSONNEL: GLB EMN EAMV TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS: No alkalinity this date

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
9/22/91	265	S	1	-1.0	19.6								
9/22/91	265		1	0.0	19.3	7.88		100.0000					
9/22/91	265		1	1.0	19.3	7.86		44.6828					
9/22/91	265		1	2.0	19.2	7.85		19.2931					
9/22/91	265	E	1	3.0	18.7	7.76		9.6417	6.21		2.60	2.60	
9/22/91	265	E	2	3.0	18.7	7.76		9.6417	6.20		3.08	3.36	64.60
9/22/91	265		1	4.0	18.6	7.70		5.6616					
9/22/91	265		1	5.0	18.6	7.63		3.4313					
9/22/91	265		1	6.0	18.4	7.27		1.9845					
9/22/91	265		1	7.0	13.5	0.86		0.9437					
9/22/91	265	M	1	8.0	9.9	0.55	4	0.3440	6.20		8.35	9.57	
9/22/91	265	M	2	8.0	9.9	0.55	4	0.3440	6.25		8.17	11.07	80.90
9/22/91	265		1	9.0	8.3	0.36	4	0.0622					
9/22/91	265		1	10.0	7.5	0.37	4	0.0033					
9/22/91	265	H	1	11.0	7.2	0.36	4	0.0000	6.74		11.64	54.48	
9/22/91	265	H	2	11.0	7.2	0.36	4	0.0000	6.76		9.40	61.91	97.80
9/22/91	265		1	12.0	7.1								

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 10/12/91   JULIAN DATE: 285   TIME: 11.25

SECCHI M: 6.3   WEATHER: Mostly sunny

PERSONNEL: EMN TLV

TMETHOD: 10   LMETHOD: 12   AMETHOD: 11
OMETHOD: 10   PHMETHOD: 12   CAMETHOD: 12

COMMENTS: Chlorophyll samples taken on 10/22/91 from depths: 4, 9, 11; Light readings overcast 0-8m

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
10/12/91	285	S	1	-1.0	10.6								
10/12/91	285		1	0.0	14.1	8.91		100.0000					
10/12/91	285		1	1.0	14.0	8.81		36.8189					
10/12/91	285		1	2.0	13.9	8.75		17.8819					
10/12/91	285		1	3.0	13.9	8.72		10.8441					
10/12/91	285	E	1	4.0	13.8	8.65		6.5602	6.24	35	5.77	6.43	
10/12/91	285	E	2	4.0	13.8	8.65		6.5602	6.22	34	3.07	3.78	57.70
10/12/91	285		1	5.0	13.8	8.62		3.7444					
10/12/91	285		1	6.0	13.8	8.65		2.1409					
10/12/91	285		1	7.0	13.7	8.70		1.1980					
10/12/91	285	M	1	8.0	12.5	5.48		0.6309	6.02	69	2.94	5.36	
10/12/91	285	M	2	8.0	12.5	5.48		0.6309	6.13	37	3.56	5.84	73.60
10/12/91	285		1	9.0	8.5	0.41	4	0.1314					
10/12/91	285		1	10.0	7.7	0.30	4	0.0205					
10/12/91	285	H	1	11.0	7.5	0.28	4	0.0016	6.52	440	7.21	31.39	
10/12/91	285	H	2	11.0	7.5	0.28	4	0.0016	6.54	456	6.52	32.43	88.80
10/12/91	285		1	12.0	7.4	0.25	4	0.0000					
10/12/91	285		1	13.0	7.3								

LAKE LACAWAC: SUMMARY OF PHYSICAL/CHEMICAL DATA

DATE OF SAMPLE: 11/23/91 JULIAN DATE: 327 TIME: 9.83

SECCHI M: 5.2 WEATHER: Overcast

PERSONNEL: EMN, TLV, PLS

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 12

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
11/23/91	327	S	1	-1.0	11.5								
11/23/91	327		1	0.0	8.7	11.27		100.0000					
11/23/91	327		1	1.0	8.7	11.15		33.6134					
11/23/91	327	E	1	2.0	8.3	11.11		16.9937	6.25	34	8.24	8.24	
11/23/91	327	E	2	2.0	8.3	11.11		16.9937	6.36	35	8.63	8.63	24.70
11/23/91	327		1	3.0	7.1	11.09		10.4770					
11/23/91	327		1	4.0	6.2	10.88		5.8368					
11/23/91	327		1	5.0	5.8	10.82		3.1791					
11/23/91	327	M	1	6.0	5.7	10.73		1.7073	6.30	37	1.86	1.86	
11/23/91	327	M	2	6.0	5.7	10.73		1.7073	6.28	37	1.79	2.02	62.60
11/23/91	327		1	7.0	5.8	10.16		0.9120					
11/23/91	327		1	8.0	5.6	10.33		0.4818					
11/23/91	327		1	9.0	5.6	10.09		0.2494					
11/23/91	327	H	1	10.0	5.6	10.08		0.1299	6.18	37	1.70	1.98	
11/23/91	327	H	2	10.0	5.6	10.08		0.1299	6.15	39	1.13	1.35	47.80
11/23/91	327		1	11.0	5.6	10.20		0.0692					
11/23/91	327		1	12.0	5.6	9.90		0.0339					