LAKE GILES

REPORT ON LIMNOLOGICAL CONDITIONS IN 1993

Robert E. Moeller
Craig E. Williamson

POCONO COMPARATIVE LAKES PROGRAM

Lehigh University

Department of Earth and Environmental Sciences
31 Williams Drive
Lehigh University
Bethlehem, Pennsylvania 18015

25 April 1994

<A Copy of This Report is Available on Loan Through the Lehigh University Library System>

Moeller, R. E. and C. E. Williamson. 1994. Lake Giles: Report on Limnological Conditions in 1993. Unpublished Report to the Blooming Grove Hunting and Fishing Club. Department of Earth and Environmental Sciences, Lehigh University, 25 April 1994.

INTRODUCTION

Personnel from Lehigh University visited Lake Giles on 13 dates throughout 1993 as part of a routine monitoring program of three lakes. These lakes were selected in 1988 to span a trophic gradient, Lake Giles occupying the unproductive ("oligotrophic") end of the gradient. Similar reports will be submitted to the owners of Lake Waynewood, a nutrient-rich ("eutrophic") lake potentially affected by homes and agricultural practices within its drainage basin, and Lake Lacawac, a well protected lake of intermediate productivity ("mesotrophic"). 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.

1993 was the sixth consecutive year of the monitoring program. The spring sampling in May completed the fourth full year of monthly sampling. With pending exhaustion of the Mellon grant, we initiated some changes beginning with the summer 1993 sampling (the sixth consecutive summer) to reduce sampling costs and to acquire additional data more closely tailored to continuing research efforts of the Lehigh investigators. These changes will be listed below, and in the **METHODS** section. They include reducing the non-summer sampling frequency (Giles was sampled only twice after the end of August). The present report summarizes conditions in Lake Giles over the full twelve-month period for 1993.

The format closely follows that of the previous four years. 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. This report also includes a test of the sampling effectiveness of the 202-μm and 48-μm mesh plankton nets for the major large zooplankton. The nets are compared side-by-side to collections with a Schindler trap (**APPENDIX III**).

Samples of the algal **PHYTOPLANKTON** have been routinely collected but not usually analyzed. We did, however, prepare seasonal composite samples for three years (summer 1989 through spring 1992). These twelve samples have now been counted for us by algal specialists at PhycoTech (Baroda, MI). The results are tabulated in **APPENDIX II**.

Also included with the 1993 report is a table of chemical data from 1991-92 (**APPENDIX I**). Giles was sampled at 5-6 depths on 6 dates (in April, July, September, and November 1991, plus February and April 1992). Values were obtained for **major cations (Ca, Mg, Na, K)** and for **chloride (Cl)** -- results for sulfate are not yet available. Nutrient analyses included (on most dates): **soluble reactive phosphorus (SRP)**, **total dissolved plus particulate phosphorus (TP)**, **ammonium (NH_4)**, **nitrate (NO_3)**, and (on 3 dates only) **particulate carbon and nitrogen**. These analyses were supervised by Dr. Nina Caraco and Dr. Jonathan Cole at the Institute of Ecosystem Studies in Millbrook, NY. Dr. Robert Moeller also analyzed **total dissolved inorganic carbon (DIC)** and **pH** from each sample. Analyses from the second year of sampling (April 1992 through February 1993) have been suspended because of lack of funding, but the samples will be stored in case new support becomes available. Methods for the 1989 and 1991-92 analyses are summarized in **APPENDIX I.**

Changes effective in June 1993 included deleting the nighttime zooplankton sampling, adding a suite of chemical analyses of the regular water bottle collections from three depths, and changing the analytical procedure for chlorophyll analysis. The chemical analyses include **dissolved organic carbon (DOC)** as well as nutrients: **soluble reactive phosphorus (SRP)**, **total dissolved phosphorus (TDP)**, **total particulate phosphorus (TPP)**, **ammonium** (NH_4) and **nitrate** (NO_3). Also, **total particulate matter** was measured as dry mass of seston per liter of water filtered. These analyses were performed at Lehigh under the supervision of Dr. Donald Morris.

A new research focus for investigators at Lehigh is the role of ultraviolet radiation in lakes. Lake Giles is an important study site in this regard because of its great water clarity and -- as we now find -- high transparency to ultraviolet radiation. Lehigh has purchased instruments that measure ultraviolet radiation in addition to the visible wavelengths of solar radiation that we have monitored during the routine sampling. An example of the penetration of ultraviolet radiation is plotted in the **LIGHT** section of the report. In September 1993, Lehigh sponsored a workshop at the Lacawac Sanctuary to bring together investigators interested in comparing ideas, findings, and analytical methodologies regarding the role of potentially harmful levels of ultraviolet radiation in lakes. Part of the workshop involved an assessment of several different UV-measuring instruments, and was carried out on Lake Giles. Several of the scientific reports being prepared for publication as a result of the Lacawac workshop will contain information on Lake Giles, and will be cited in next year's report.

We wish to thank the members and management at the Blooming Grove Hunting and Fishing Club, and most particularly Ken Ersbak, for encouraging the inclusion of Lake Giles in this study of regional limnology. The Lacawac Sanctuary also continues to play a major role in this program as field laboratory and summer residence for the investigators. We especially appreciate the cheerful assistance of its curator, Sally Jones, and the long-term interest and encouragement of Arthur Watres.

1993 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 Gina Brockway, in collaboration with Dr. Robert Moeller, Dr. Donald Morris, and Dr. Bruce Hargreaves. Gina Brockway and Timothy Vail carried out most of the field sampling and laboratory analyses. Gina and Tim determined alkalinity and pH, and along with Yin Zhong analyzed chlorophyll samples. Gina analyzed most of the nutrient samples. Tim counted macrozooplankton samples. Natasha

Vinogradova (Jan-Jul) and Gina (Aug-Nov) counted microzooplankton. Gina managed all aspects of the computer database including data entry, data analysis, and printing of zooplankton graphs. Dr. Bruce Hargreaves has continued to oversee maintenance of the computerized database, which he and Scott Carpenter developed. 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 was distributed in 1993:

Moeller, R.E., C.E. Williamson, J. A. Aufderheide and E. M. Novak. 1993. Sampling Protocols (1988-1993) of the Pocono Comparative Lakes Program. Unpublished Report, Lehigh University. (Available on loan through the Lehigh University Library System as part of the 1992 Annual Reports to lake owners.)

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 April, 1994, most of the existing information is accessible through the software program Reflex™ (version 2, Borland International, copyright 1989) running on IBM PC-type microcomputers.

SAMPLING PROGRAM

On each sampling occasion, Lake Giles was visited during the day. The January through May sampling included a second visit after dark, following the 1989-1993 protocol. The night-time visit was required for optimal sampling of certain migrating zooplankton. Other parameters were measured, and samples were collected, during the day. Sampling was carried out at a fixed station (site "A") near the deepest part of the lake (about 23 meters or 75 feet). The thermal stratification existing on any date dictated the depths from which other samples were collected **(Figure 1)**. The lake was sampled monthly until June (5 dates), then biweekly through August (6 dates) when surficial water temperature stayed above 20°C, then twice during the autumn (2 dates--late September and mid-November).

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 20 (20 January) the lake was ice-covered, and displayed a weak "reverse stratification", which was more pronounced near the end of ice cover on day 81 (22 March). After ice-out (ca. 10 April--ice out date at Lacawac) the water column briefly circulated from top to bottom during "spring turnover", as evident in the nearly isothermal 5-6°C water column on day 109 (19 April). By day 187 (6 July) the

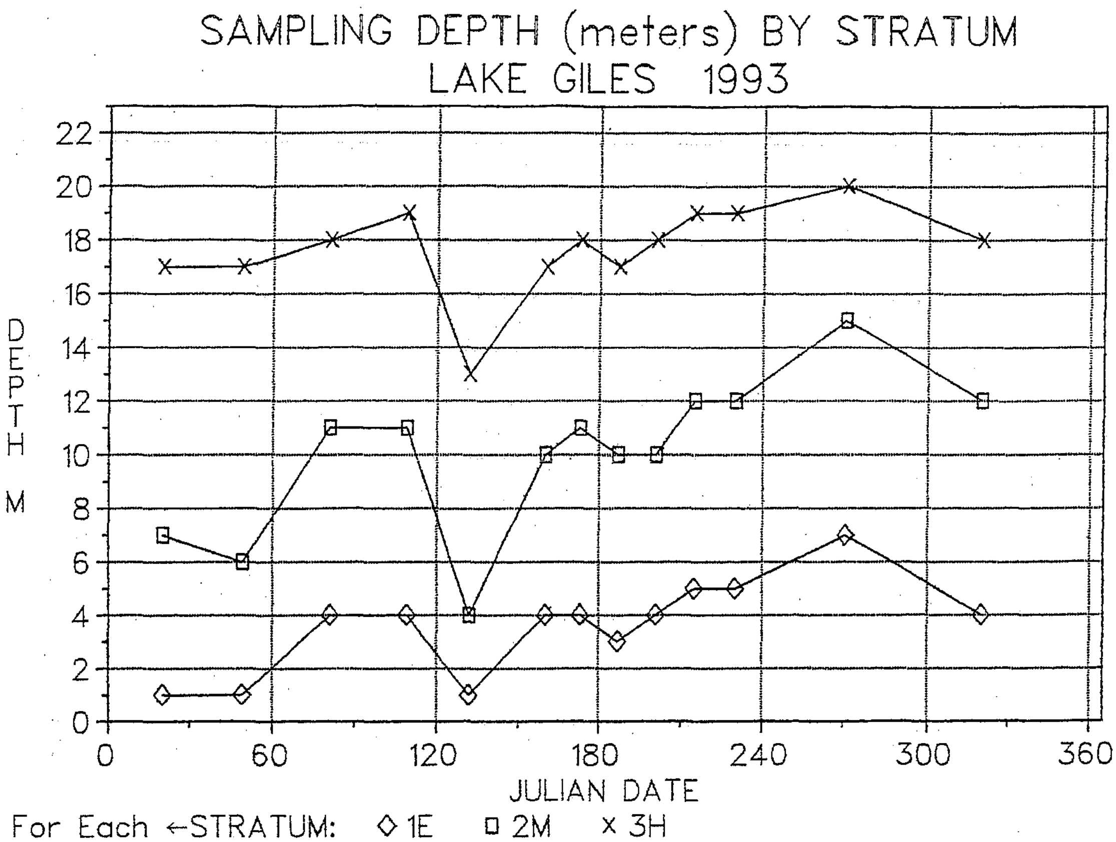


Figure 1. Depths of "EPI", "META", and "HYPO" samples from Lake Giles, 1993.

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

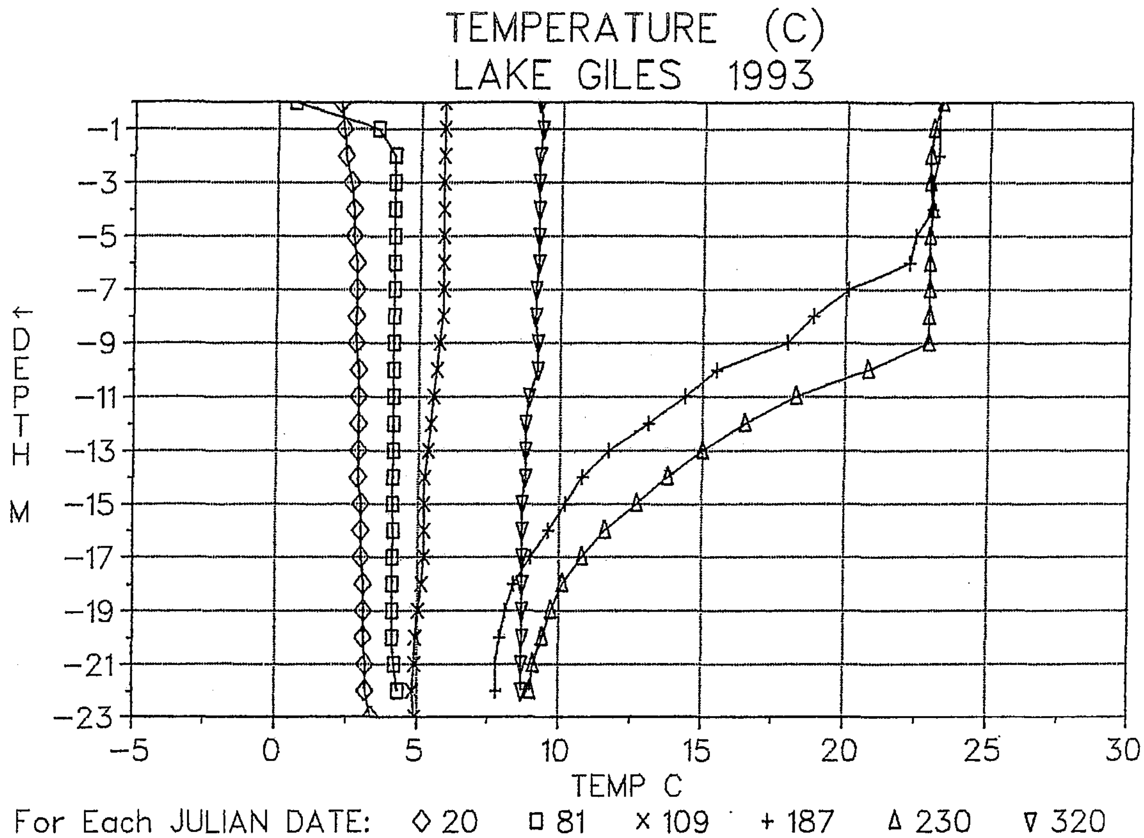


Figure 2. Temperature profiles in Lake Giles, 1993.

Values (°C) are plotted for six dates: **20 January** (day 20 --early winter ice cover), **22 March** (day 81 --late ice cover), **19 April** (day 109 --spring turnover), **6 July** (day 187 --early summer stratification), **13 August** (day 230 --mid-summer stratification), and **16 November** (day 320 --fall turnover).

surface water was warmed to 23°C. The water column was strongly stratified, consisting of: an upper warm water layer circulating in contact with the atmosphere (the **EPILIMNION**, 0-6 meters, temperature 22-23°C); an intermediate layer of rapid temperature decrease with depth (the **METALIMNION**, 6-13 meters, temperature changing >1°C per meter); and a deep layer of cold water (the **HYPOLIMNION**, 13-23 meters, temperature 5.5-12°C). Lake Gile's transparency allows appreciable absorptive heating of the deeper part of the water column, creating a broad metalimnion which grades smoothly into the hypolimnion. Lake heating during midsummer occurred in the metalimnion and hypolimnion; epilimnial temperature showed no net increase between day 187 and day 230.

The usual course of thermal stratification is that of slow, gradual thickening of an epilimnion during the summer. By day 230 (13 August) Lake Giles' epilimnion extended to 9 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 by day 320 (16 November). The lake was visited 31 December, but not sampled because of partial ice cover. The 1992-93 winter ice cover began in early January 1993, but subsequent relatively warm weather left the ice in deteriorating condition ("candled") on 20 January, when we sampled. Cold weather in February and March produced a thick (55-cm) ice cover by 22 March. Ice did not go out until mid-April.

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. 12-14 weeks in 1992-93) and the completeness of spring turnover. Spring turnover was probably complete in 1993, but in Giles, given the well oxygenated conditions even under the snow-covered ice in late March, it is difficult to tell without more frequent sampling.

Although January 1993 was relatively warm, accounting for the late date of first complete ice cover (early January), air temperatures during February and March were colder than normal (**Figure 12**). Summer was again warmer than usual, returning to a climatic trend that had been interrupted by a "normal" summer in 1992. **Figure 3** presents the detailed trends of water temperature at three fixed depths (2,11,21 meters) for comparison with other years.

Water samples for **pH**, **alkalinity**, **chlorophyll**, **algae**, and -- starting in June -- **dissolved organic carbon**, **sestonic particulate matter**, and **nutrients** 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. 20 January), the topmost layer was 0-1m, and the remaining depths were divided at the Secchi depth (see **SECCHI DEPTH** below).

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, four slightly different methods have been used to construct a 0-23 m profile of light penetration; method #12 (numbers correspond to codes from data tables) was used in 1993 through August, then method #13 was introduced:

Method 12. Two sensors, mounted 1-m apart on a common line, electronically computed the ratio of light intensities between the nominal depth and the depth above it. The percentage penetration profile was constructed from these ratios. The sensors are Licor™ submersible flat-plate sensors filtered to give a quantum response to photosynthetically available radiation ("PAR"). Units are microeinsteins per square meter

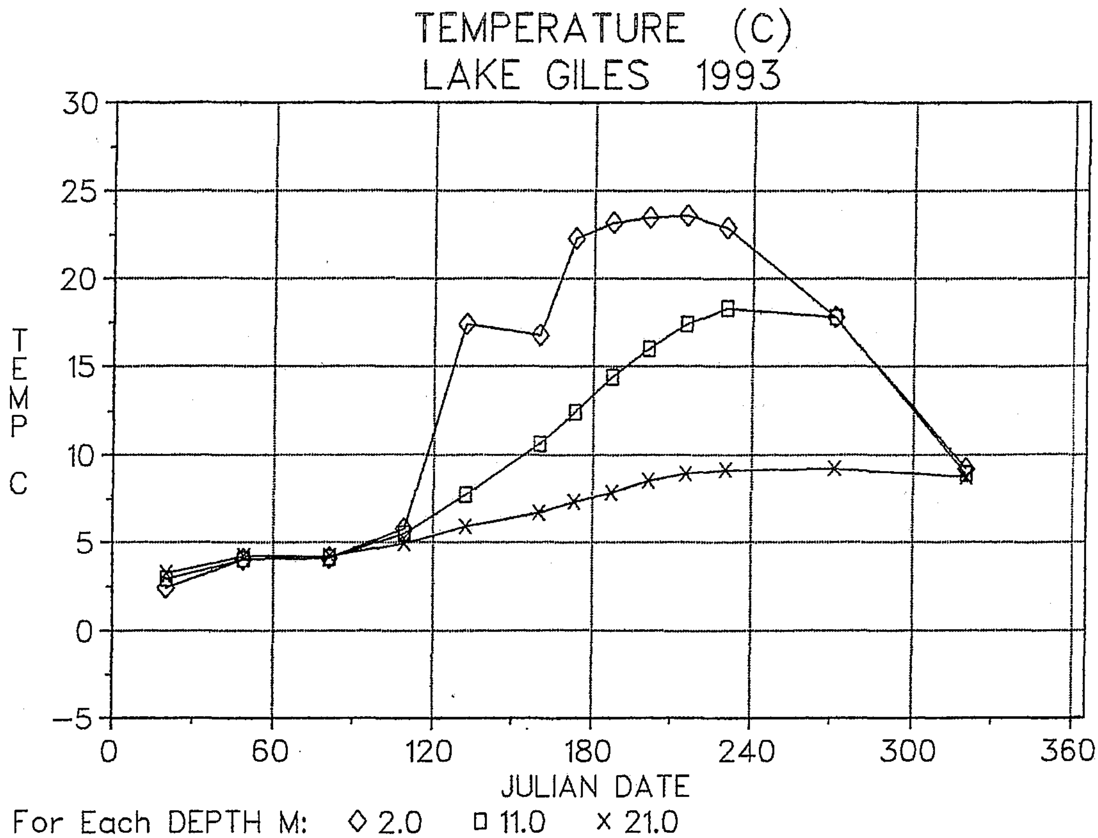


Figure 3. Temperature trends within Lake Giles, 1993.

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

per second ($\mu E/m^2.sec$).

Method 13. A single sensor, separately measuring both UV wavelengths and PAR, is lowered 1-several times from a boom extending beyond the side of the boat. Water depth, temperature, and irradiance in 5 wavebands are logged automatically and continuously to a microcomputer disk for later data reduction. The instrument is a Biospherical Instruments PUV-500™ fitted with a high-resolution depth sensor. Like the Licor instrument, the sensor is calibrated to give a cosine response for measurement of downwelling radiation. It measures PAR (400-700 nm) as well as UV irradiance in ca. 10-nm bands around 380, 340, 320 and roughly 305 nm. Profiles with this instrument are more prone to noise from changing cloudiness than the dual-Licor unit used in Method 12, but we attempt to minimize problems by averaging or combining multiple profiles.

Light ("PAR") penetration is plotted on a logarithmic scale for six dates **(Figure 4)**. During the summer, depths above 10 m (i.e. all of the epilimnion) received at least 2-8% of the light penetrating the lake surface. The metalimnion received 0.5-5% of surface light, enough for moderate rates of algal growth. Enough light reached the deepest waters to allow slow growth of low-light adapted algae. Transparency was only slightly reduced during spring (day 109) and similarly reduced in mid-August (day 230), but was quite clear again during early fall turnover in mid-November (day 320). Under thick ice and snow cover on 22 March (day 81), however, light was strongly attenuated both through the ice/snow, and in the top meter of the water column.

Ultraviolet light is attenuated more rapidly than PAR in Lake Giles **(Figure 5)**. Compared to most other lakes we have examined, however, Giles has exceptionally high penetration of UV. The 1% level for the mid-UV-B wavelengths was at ca. 10 meters on 24 July 1993, compared to ca. 1 meter in lakes Lacawac and Waynewood. This means that organisms in the warm summer epilimnion of Lake Giles (0-6 m) are much more exposed to potentially harmful levels of UV than in the other lakes. Whether these levels of natural ultraviolet radiation actually do play important ecological roles in Lake Giles and other very clear lakes is the subject of additional experimental investigations by Lehigh scientists.

We took advantage of having a scanning underwater radiometer at Lake Giles during the UV workshop to acquire a continuous plot of UV attenuation from 400 to 305nm **(Figure 6)**. Attenuation increased fairly smoothly with decreasing wavelength. The attenuation coefficients measured with the PUV-500 instrument at four UV wavelengths adequately defined the attenuation pattern revealed by the more sophisticated instrument.

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 was typically greater than 10 meters **(Figure 7)**. The spring-summer-fall oscillation was fairly pronounced, being driven presumably by fluctuating algal populations. Transparency reached maximal readings of 12-16.2 meters during summer, as in 1989-92, with the clearest conditions prevailing during July.

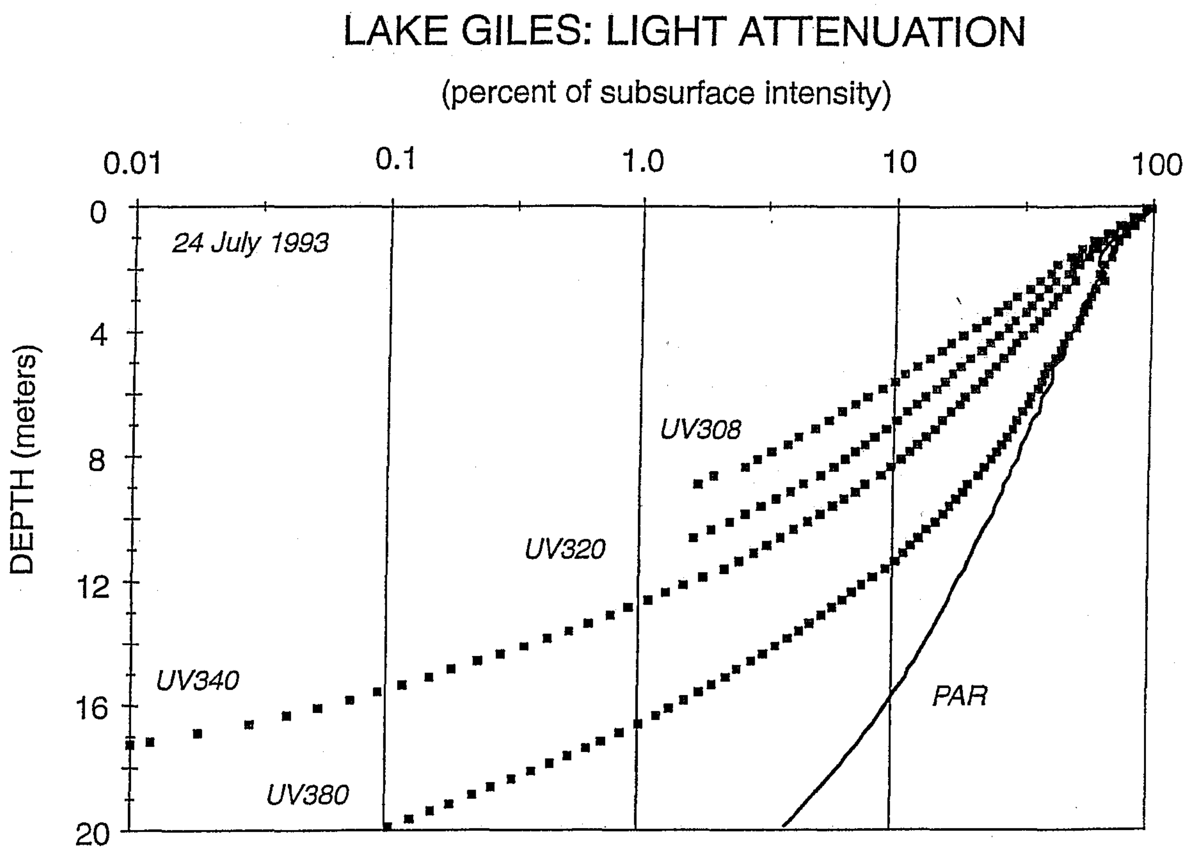


Figure 5. Attenuation of PAR and UV irradiance in Lake Giles on 23 July 1993.

Data are from the PUV-500. All points within 0.25-m depth increments were averaged before plotting points (UV308, UV320, UV340, UV380 irradiance bands) or plotting a thick line connecting points (PAR).

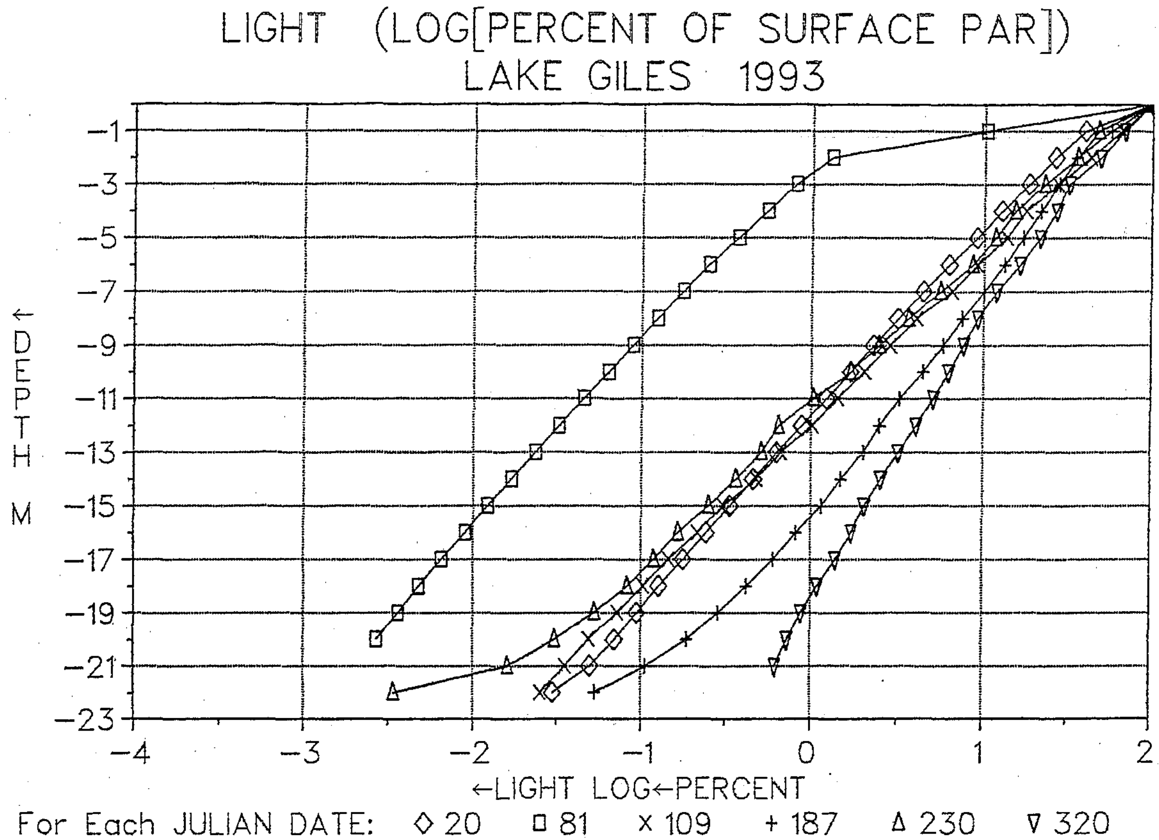


Figure 4. Light penetration in Lake Giles, 1993.

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 six dates: **20 January** (day 20 --early winter ice cover), **22 March** (day 81 --late ice cover), **19 April** (day 109 --spring turnover), **6 July** (day 187 --early summer stratification), **13 August** (day 230 --mid-summer stratification), and **16 November** (day 320 --fall turnover).

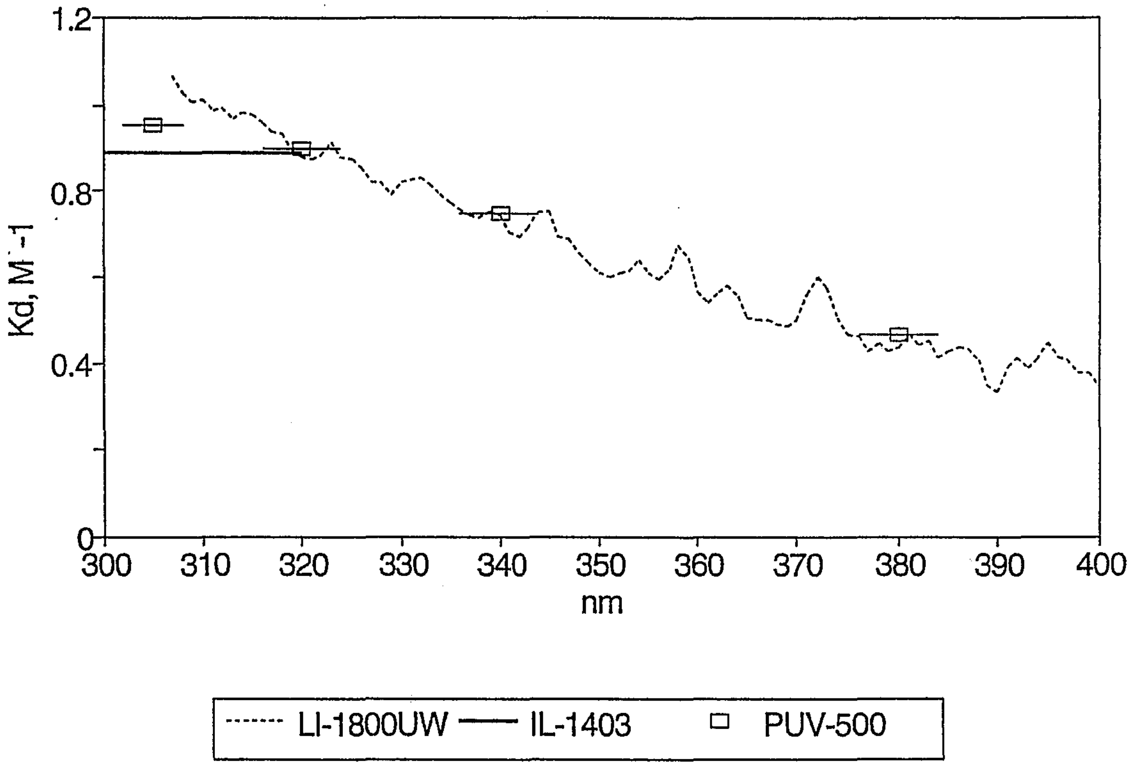


Figure 6. Spectral attenuation coefficients for UV irradiance in Lake Giles, 13 September 1993.

Data are averages for 0.9-4.9 m depths on 13 September 1993. Continuous data from a scanning spectroradiometer (Licor 1800UW) are compared to narrow band measurements at 4 wavelengths by the Biospherical Instruments PUV-500. The attenuation coefficient, Kd, is proportional to the percentage of light lost per meter of penetration: Kd = -ln[0.01*(100 - %Atten/m)]. So Kd equal to 1 (e.g. for UV at 310 nm) means 63% attenuation per meter.

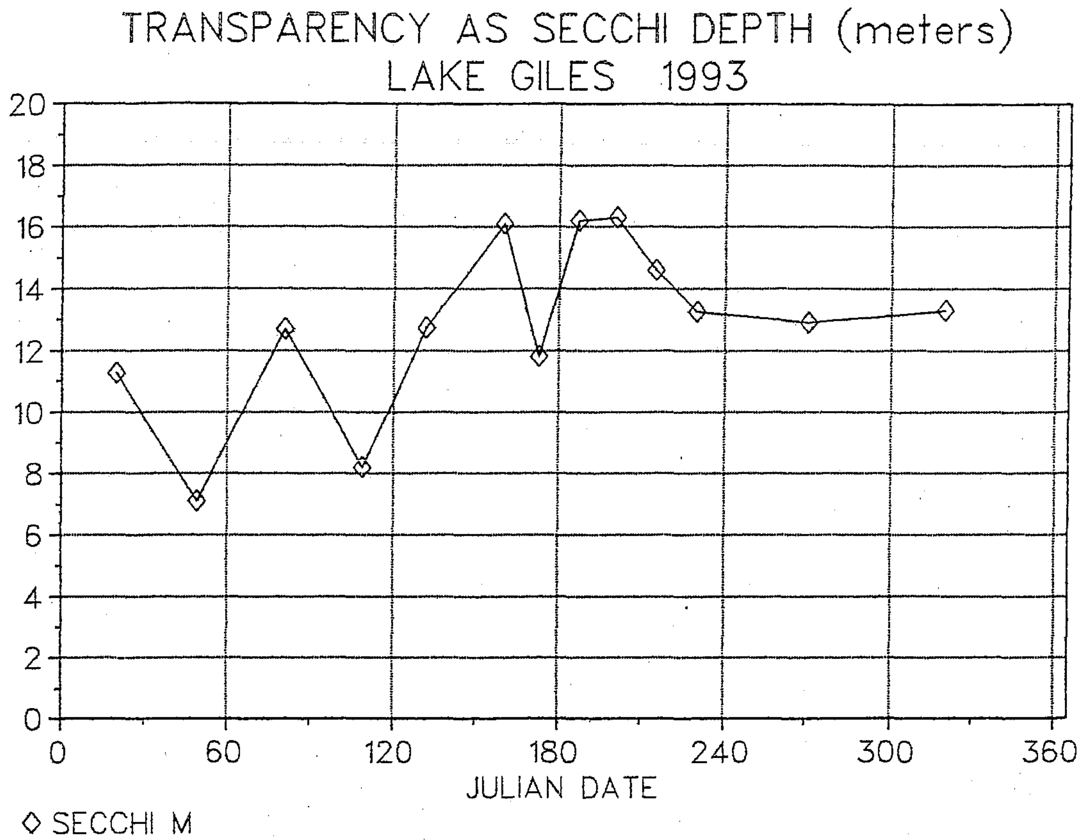


Figure 7. Transparency in Lake Giles, 1993.

Values plotted are the Secchi depths, in meters.

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 Giles' elevation above sea-level (1404 feet) was not taken into account when calibrating the meter, so compiled values are roughly 5% too high. Units are mg O_2 per liter. (This is **Method #10**.).

Oxygen was not appreciably depleted even during the relatively long winter ice/snow cover, evidence of a very low winter deep-water oxygen consumption. Oxygen concentration was set at atmospheric saturation during spring turnover, when the lake was still cold. During summer stratification, oxygen was slowly consumed within the deeper hypolimnion, and lost from the warming epilimnion via outgassing to the atmosphere. These processes created the metalimnetic oxygen maximum that persisted throughout the summer (**Figure 8**). Oxygen was maintained at concentrations greater than 3 mg/L, except for the bottommost meter of the lake in late summer.

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 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, or, more usually, analyzed within a few hours of collection. 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, usually with gentle mixing. The following variant of the method was employed on all dates on 1993:

Method 12. As above, with 0.5 ml salt solution (Orion™ pHisa™ solution) added to increase ionic strength. Usually, this had little or no effect on the sample (pH change <0.1 unit). Also, a quality assurance protocol was followed, verifying electrode performance in distilled water and the stability of calibration.

Trends of pH are plotted for each layer in **Figure 9**. In the absence of seasonal biological activity, the pH of Lake Giles would be about 5.3-5.4 with an alkalinity of ca. -5 μeq./L (**Figure 10**), judging from values in late spring and late autumn. These values represent a lake without bicarbonate buffering. There was a modest within-lake generation of alkalinity in the hypolimnion during late summer and early fall; the metabolic processes responsible for this increase in alkalinity were probably located at the sediment surface. Levels and seasonal trends of alkalinity and pH have been remarkably consistent for the five years we have measured them.

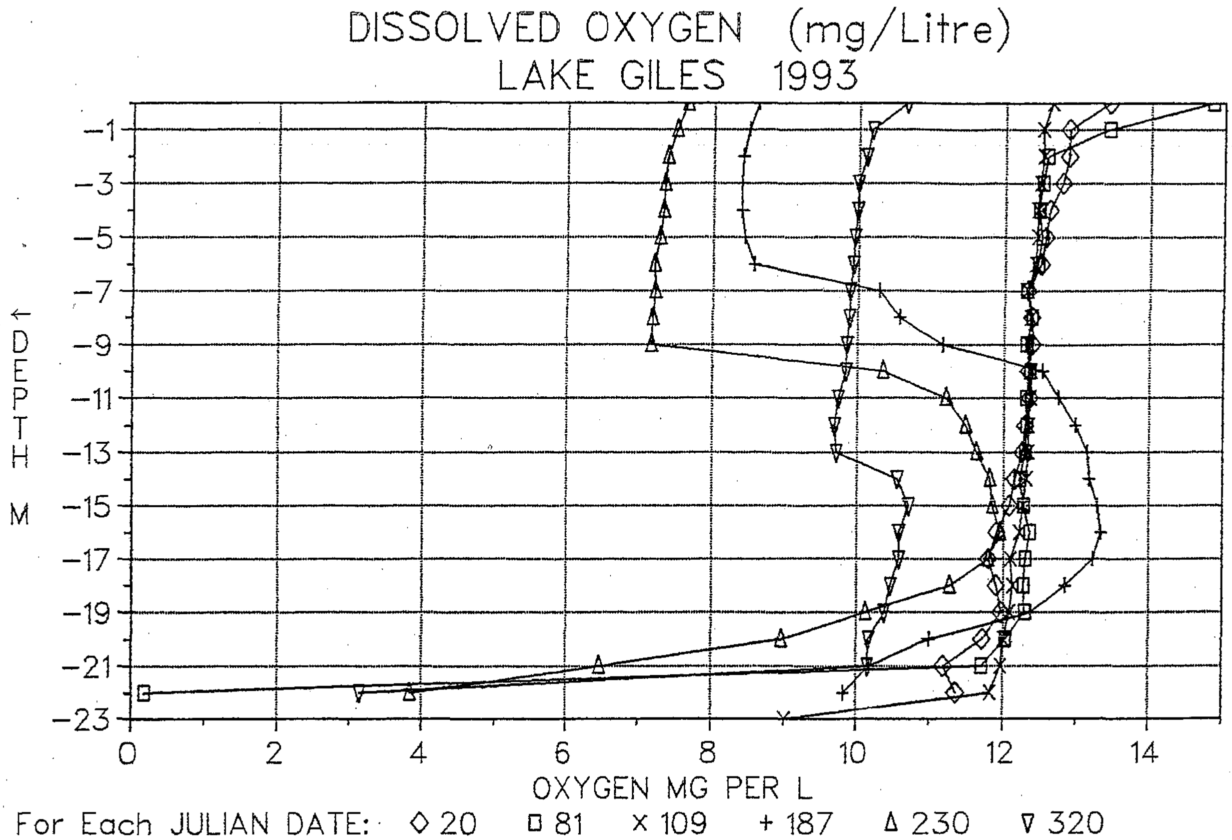


Figure 8. Dissolved oxygen in Lake Giles, 1993.

Values (mg oxygen per liter) are plotted for six dates: **20 January** (day 20 --early winter ice cover), **22 March** (day 81 --late ice cover), **19 April** (day 109 --spring turnover), **6 July** (day 187 --early summer stratification), **13 August** (day 230 --mid-summer stratification), and **16 November** (day 320 --fall turnover).

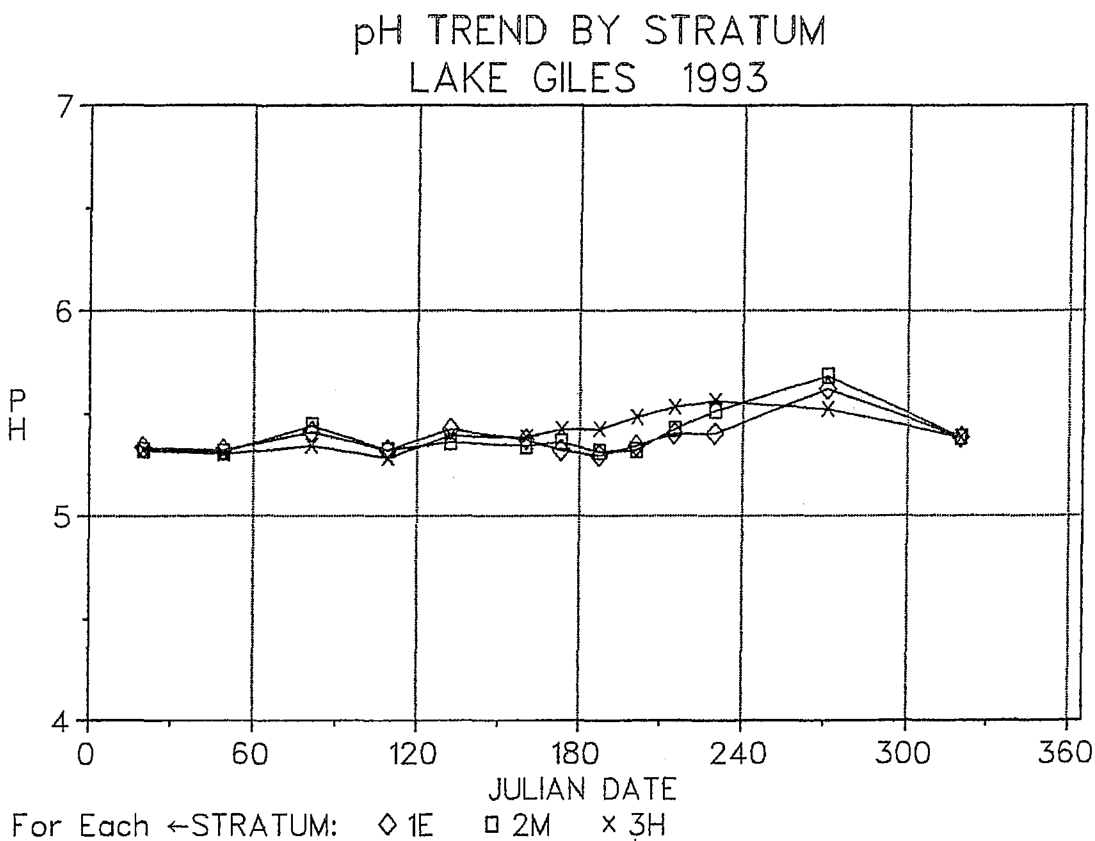


Figure 9. Trends of pH in Lake Giles, 1993.

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**.

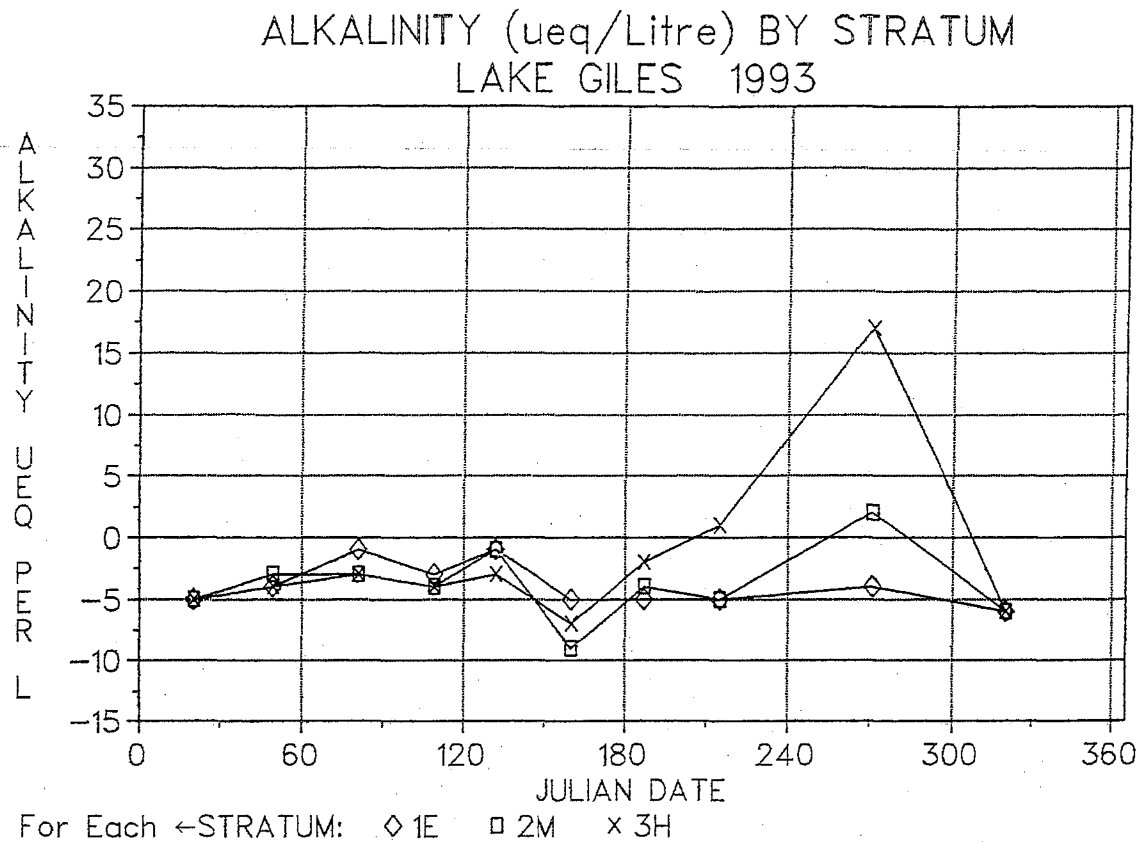


Figure 10. Trends of Alkalinity in Lake Giles, 1993.

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**.

CHEMISTRY

Data from the 1991-92 chemical samplings are presented in **APPENDIX I**. Six depths were sampled on each of five dates distributed throughout the year. The 1989 data were included in the 1990 Annual Report. The sampling and analytical methods for both series are summarized in the **APPENDIX I**.

Cation concentrations were similar in 1989 and 1991-92. Combining 1989 sulfate with 1991-92 chloride and other ion concentrations, calculating H^+ concentration from pH, and calculating bicarbonate (HCO_3^-) from pH and total dissolved inorganic carbon (DIC), gives a generalized ion balance for Lake Giles water. These averages were not weighted for volume differences at different depths. Depths below 18 m were excluded, however, because they contribute so little to total volume. Other parameters also were extracted from the chemical database to more broadly characterize the lake.

Table 1. Chemical Characterization of Lake Giles.

Cations					
Sulfate	$SO4^{-2}$	94.	μM	188.	μeq/L
Chloride	Cl^{-1}	160.		160.	
Bicarbonate	$HCO3^{-1}$	3.3		3.3	
Nitrate	$NO3^{-1}$	0.5		0.5	
Anions					
Sodium	Na^{+1}	163.	μM	163.	μeq/L
Calcium	Ca^{+2}	52.0		104.	
Magnesium	Mg^{+2}	31.6		63.2	
Potassium	K^{+1}	12.1		12.1	
Hydrogen ion	H^+	4.4		4.4	
Ammonium	$NH4^{+1}$	2.5		2.5	
Other Chemical Parameters					
pH		5.35			
Alkalinity		-4.1	ueq/L		
Conductivity (1989 data)		42.	umho/cm		
Dissolved Inorganic Carbon (DIC)		33.	uM		
Dissolved Organic Carbon (DOC)		91.	uM		
Total Phosphorus (totP)		0.23	uM		

The ion balance is very good (352 μeq/L for anions, 349 μeq/L for cations). Sodium is the dominant cation, and chloride and sulfate are equally important anions. At Lake Giles' pH of 5.35, strong acidity (of HCl and H_2SO_4) is evident in the slightly negative alkalinity. Bicarbonate makes up only ca. 10% of the total dissolved inorganic carbon, and is a negligible component of the ion balance. Although dissolved organic carbon is relatively low in Lake Giles (91 μM C from summer-fall 1993 data), there is three times as much dissolved organic carbon as inorganic carbon.

Chemical analyses from 1993, which emphasized nutrients and dissolved organic carbon, are presented in **Table 2**. Dissolved organic carbon was consistently ca. 1.25 mg C/L (i.e. 91 μM, as cited above) from June through November, but showed a depth-related

Table 2. Lake Giles: Chemical Parameters in 1993.

Abbreviations: dissolved organic carbon (DOC), chlorophyll-a (Chl-a), pheophytin-a (Pheo-a), soluble reactive phosphorus (SRP), total dissolved phosphorus (TDP), total particulate phosphorus (TPP), ammonia (NH3), nitrate (NO3), particulate matter. Chlorophyll-a values are corrected for pheopigment.

Date	Stratum	Depth (m)	DOC (mg C/L)	Chl-a (ug/L)	Pheo-a (ug/L)	SRP (ug P/L)	TDP (ug P/L)	TPP (ug P/L)	NH3 (ug N/L)	NO3 (ug N/L)	Part. Matter (mg/L)
09 Jun 93	E	4	0.89	0.1	0.6	2.1		1.7		<0.1	0.24
	M	10	0.95	0.4	0.6	1.6		2.2		13.3	0.17
	H	17	1.22	0.4	1.3	2.1		4.3		27.8	0.55
22 Jun 93	E	4	0.97	0.4	0.1	0.9	1.5	0.8	12.1	13.6	
	M	11	1.09	0.6	0.2	1.2	3.3	3.2	11.1	3.1	0.35
	H	18	1.25	1.5	0.2	0.7	3.4	3.1	4.1	4.7	0.42
06 Jul 93	E	3	0.90	0.4	0.2	0.4	1.3	2.2	7.6	3.0	0.01
	M	10	1.00	0.7	0.0	0.4	1.8	4.1	5.5	7.6	0.32
	H	17	1.25	0.9	0.3	0.6	3.5	5.3	7.4	3.7	0.23
20 Jul 93	E	4	1.07	0.7	0.2	0.6	1.3		6.7	1.0	0.23
	M	10	1.50	0.5	0.6	0.6	2.0		9.2	3.8	0.49
	H	18	1.22	2.2	0.4	0.7	2.9		4.6	4.3	0.80
03 Aug 93	E	5	0.95	0.7	0.3	0.6	1.8		23.1	<0.1	0.34
	M	12	1.25	0.7	1.6	0.7	2.7		4.5	3.9	0.63
	H	19		3.6	1.2	1.2	4.4		3.3	<0.1	1.11
18 Aug 93	E	5	0.73	1.0	0.0	0.7	3.2		6.8		0.27
	M	12	0.82	2.6	0.8	0.7	4.7		8.5		
	H	19	1.14	1.9	0.6	0.4	4.6		8.7		0.69
13 Sep 93	E		1.14	1.2	0.4						
28 Sep 93	E	7	1.02	4.8	1.7	0.6	2.6		8.2		0.42
	M	15	1.18	1.9	1.8	0.9	2.4		5.6		0.27
	H	20	1.12	0.8	1.4	6.7	12.3		27.4		0.62
16 Nov 93	E	4	1.26	0.9	0.3	1.1	4.9		12.4		0.22
	M	12	1.12	1.1	0.4	0.5	5.0		13.4		0.26
	H	18	1.08	0.7	0.5	0.7	4.7		14.4		0.31

trend on dates when the water column was stratified. Higher values occurred deeper in the lake, possibly owing to photooxidation by ultraviolet light in the surface waters. Unlike some strongly acidified lakes, Lake Giles does not accumulate excess nitrate or ammonium in the water column in summer. Values of 1-8 $\mu g/L$ NH_4-N or NO_3-N are consistent with nitrogen colimitation (with P) of the phytoplankton, as observed in September 1992.

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 2-12 hr (cool in darkness) before being filtered. Two analytical methods were used in 1993, both giving presumably comparable values for chlorophyll-a corrected for pheopigments (**CHLAC** in data tables and **Figure 11**), and chlorophyll-a including pheopigments (**CHLASUM** in data tables).

Method 12 (January-May). Subsamples were filtered and stored frozen (0.5 L onto Gelman™ A/E filters). Two samples were filtered 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 only treated 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 22μm net (percent of the summed fractions) is presented in the data tables **(CHLAC P)**. 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 F4T5/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 mixed solvent extraction gave results that were the same as or greater than those from parallel extraction in 90% acetone with grinding.

Method 13 (June-November). Samples were filtered onto glass fiber filters (Whatman GF/F). These were immediately placed in 10 ml of 90% ethanol, heated to boiling, extracted overnight in a freezer, and analyzed spectrophotometrically for chlorophyll-a and pheopigment (see citations in D.P. Morris and W.M. Lewis, Jr. 1992. Limnology and Oceanography 37(6):1179-1192). No size-partitioning was performed.

In Lake Giles there was a distinct seasonal pattern of chlorophyll-a (**Figure 11**) that was consistent with previous years. Values were low (less than 1 $\mu g/L$) under the ice in January and increased slightly to ca. 1 $\mu g/L$ during the winter. A very high peak of 23 $\mu g/L$ in the top meter in February likely represented motile algae that congregated in the higher light environment at the top of the ice and snow covered water column. Spring values of 1-2 $\mu g/L$ hardly signify a spring "bloom" as seen in many more nutrient-rich lakes. Phytoplankton were, however, subsequently reduced to very low levels (< 0.5 $\mu g/L$) throughout the water column during May. This drop in algal populations was possibly related to intense grazing by rapidly increasing zooplankton populations, especially *Daphnia catawba*, and is the most consistent feature of the seasonal chlorophyll-a trend. Epilimnial concentrations remained below 1 $\mu g/L$ until late summer. During summer stratification, algae gradually increased at all depths, reaching relatively high levels (2-3 $\mu g/L$) first in the hypolimnion (late July), then in the metalimnion (late August), and eventually even in the epilimnion (late September). The period of greater algal populations did not persist through fall turnover. Levels declined back to ca. 1 $\mu g/L$ in the circulating water column by mid-November, as in earlier years.

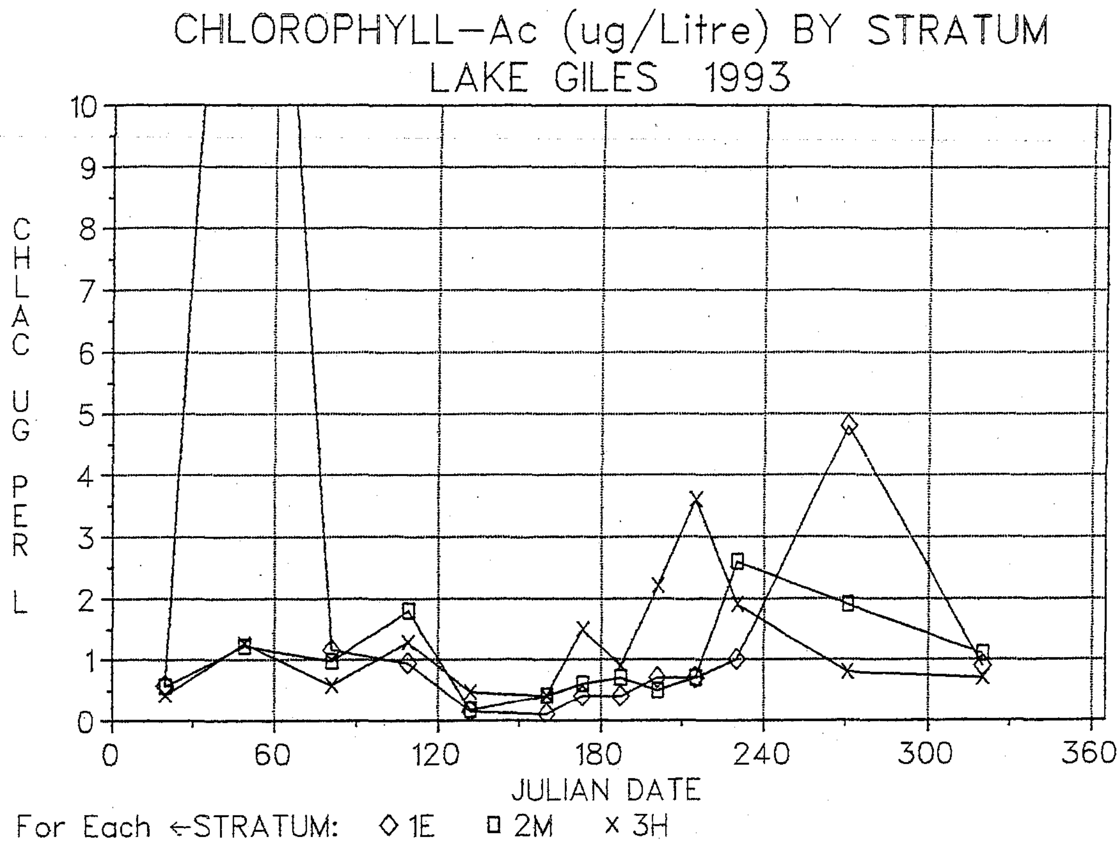


Figure 11. Trends of Chlorophyll-a in Lake Giles, 1993.

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 were collected as described in **RESULTS AND METHODS**. Chlorophyll-a values are corrected for pheopigments. The exceptionally high level reached under the ice in February was 23.2 μg/L.

PHYTOPLANKTON

Phytoplankton subsamples are preserved from the EPI, META, and HYPO samples. These were not routinely analyzed because of the effort required. To provide some idea of the algal communities prevalent at different seasons in the three study lakes, we prepared composite seasonal samples for three separate years (summer 1989 through spring 1992), which were submitted to a subcontractor (PhycoTech, Baroda, Michigan) for analysis. The original acid-Lugol's preserved samples are archived at Lehigh.

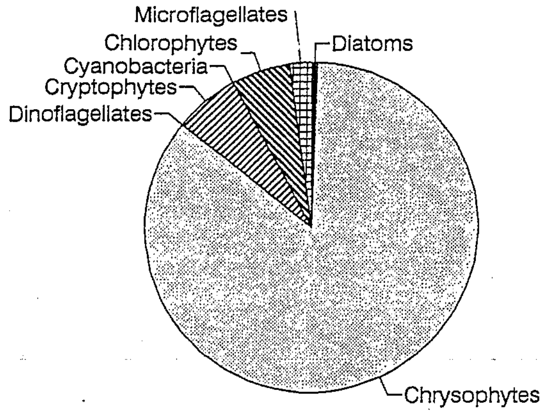
At PhycoTech, an appropriate volume was filtered onto a membrane filter, mounted on a microscope slide in resin (HPMA), and counted at 200x magnification. The count included a minimum of 300 cells/colonies. In most samples, an additional 100 cells of the smallest types were counted at 400x. For a few very large types the whole slide was scanned. Biovolumes were estimated from simple geometric shapes fitted to 1-several dimensions of the cells encountered.

The analyses are presented as species biovolumes in **APPENDIX II**. Identifications at the genus or species level were directed by Ann St Amand at PhycoTech. These counts should include the several most abundant taxa, with a scattered inclusion of less common types. A summary of the seasonal representation of the main groups of algae is given as pie charts on the next page, along with the total algal biovolume for each season. Note that all depths (EPI, META, HYPO) contributed to each sample. "Winter" samples were collected beneath ice cover in January and February, "Spring" samples after ice-out in March through May, "Summer" samples during thermal stratification of June through September, and "Autumn" samples late in stratification (October) or during fall turnover in November or December.

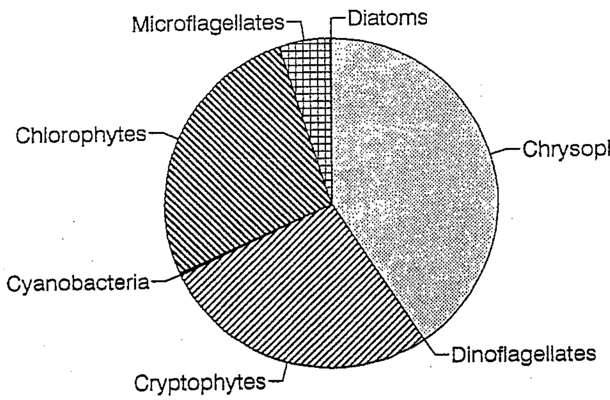
In Lake Giles, phytoplankton are usually relatively sparse, even when denser deep--water populations are averaged in, and this shows up in the seasonal biovolumes of only 60-200 x10^3 μm^3/mL for the entire algal assemblage. Biovolume was highest in winter, and then strongly dominated by flagellated chrysophytes (golden brown algae) in the genera *Mallomonas* and *Synura*. Chrysophytes were important year-round. Cryptophytes were a significant component during the ice-free portion of the year. Chlorophytes (green algae) were common in summer and autumn, although the strong role of chlorophytes in the summer plankton hinges on a few big colonies of *Botryococcus* encountered only in the 1991 sample. Several groups of algae that are important in many other lakes -- diatoms, dinoflagellates, and cyanobacteria (bluegreen algae) -- were unimportant in the Giles samples. In comparison to Lake Waynewood and especially Lake Lacawac, the phytoplankton from Lake Giles seems less diverse in species. This may reflect the low pH of the water.

ZOOPLANKTON

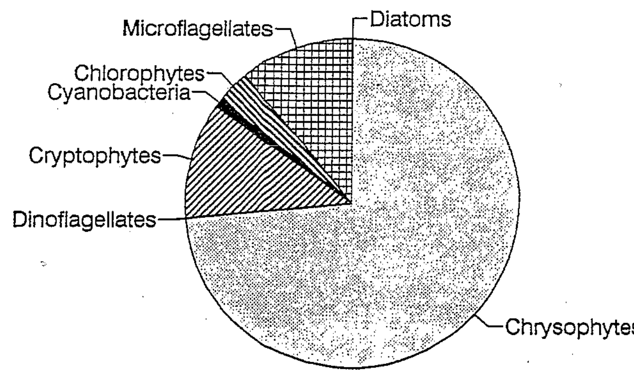
Zooplankton receive a major emphasis in the PCLP program. These animals represent the key link between algal primary producers and fish populations. The intensity of grazing by herbivorous zooplankton strongly affects the kind of algae that dominate, and potentially can control (i.e. reduce) algal populations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



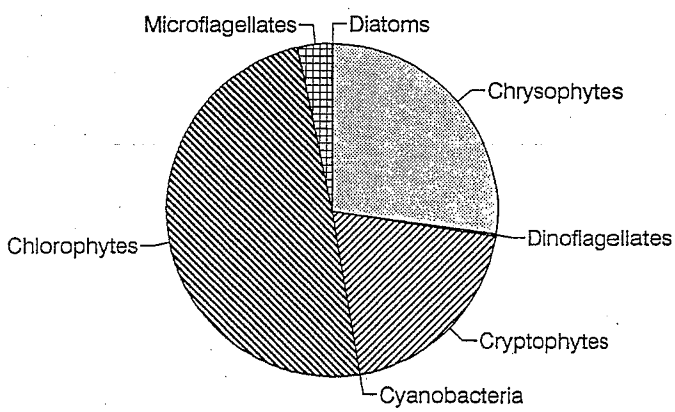
GILES (WINTER 177 x10^3 um^3/mL)



GILES (AUTUMN 67 x10^3 um^3/mL)



GILES (SPRING 65 x10^3 um^3/mL)



GILES (SUMMER 93 x10^3 um^3/mL)

Zooplankton were sampled at day and night (January-May) or only during the day (June-November). The data presented here include nighttime samples when available, for consistency with previous years. Some species avoid the water column during the day, especially *Chaoborus*; for these taxa concentrations from summer and fall 1993 are not comparable to earlier data. Hopefully for most species, including copepods, Cladocera, and certainly rotifers, the whole water-column means were little affected by sampling time. 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 given as mean concentrations (numbers of individuals per liter) over the entire ca 21-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.

The effectiveness of these nets for sampling macrozooplankton was checked on 16 June 1993 in lakes Giles, Lacawac, and Waynewood. Each lake was visited after dark. At five stations the nets were hauled from 5 meter depth to the surface, and a parallel composite Schindler trap sample was collected from 0.5, 1.5, 2.5, 3.5, and 4.5 meters. Dr. Peter Schulze and Gaby Grad collected and preserved the samples. Gaby Grad later subsampled and counted the samples. The Schindler trap is a quick-closing transparent box (here 25-L in volume) that should minimize avoidance-responses of some zooplankton to the hydrodynamic effects of nets. The results for all three lakes are presented in **APPENDIX III**. Both nets performed well, the 48-μm net apparently somewhat better than the 202-μm net in lakes Giles and Lacawac. There may have been some underestimation of *Daphnia* even with the 48-μm net, but the pattern was not consistent across all three lakes. Basically, the 48-μm mesh Wisconsin net gave mean concentrations within 25% of those calculated from the Schindler trap series, with no compelling evidence of any serious systematic underrepresentation caused by net clogging or avoidance.

Microzooplankton includes mainly rotifers, but some copepods and small Cladocera also were counted from these samples. Our counting strategy was somewhat different in 1991-93 from that used in 1989 or 1990, with *Chaoborus* and some copepods (e.g. cyclopoid males and copepodids) being counted from the 48-μm sample that had been counted from 202-μm samples in 1989-90 samples. 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. In addition, starting in June 1993 we only sampled during the day, potentially missing plankton that congregated within a meter of the lake bottom during daylight. 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 13-33)**. **Table 3** lists the zooplankton identified to date. Updating some of the major features of Giles zooplankton community:

(1) The herbivorous zooplankton were dominated by the cladoceran *Daphnia* ($\leq$2/L through most of the summer) and the calanoid copepod *Diaptomus minutus* (ca. 6-10 adults/L in summer). Another cladoceran, *Diaphanosoma*, was present at up to 2-4/L during late summer and early autumn. An additional calanoid, *Diaptomus spatulocrenatus*, was present in low numbers throughout most of the year, increasing to 2 adults/L in fall.

Table 3. Zooplankton species recorded from open-water samples in Lake Giles 1988-1993. Seasons of especially high or low abundance in 1993 are indicated.

	Taxon	Seasonal Abundance in 1993 High	Low
Diptera			
**	*Chaoborus punctipennis*	Su	[F,W]
Cyclopoid Copepoda			
**	*Cyclops scutifer*		[F]
*	*Orthocyclops modestus* (rare)	Su	
Calanoid Copepoda			
	Diaptomus spp.		
**	*D. minutus*	late F,W,Sp	[late Su]
*	*D. spatulocrenatus*	F,W	[Sp]
Cladocera			
	Chydorus sp. (rare)		
**	*Daphnia* spp.	F,W,late Sp	[late Sp]
	D. catawba		
*	*Diaphanosoma* sp.	Su	[F,W,Sp]
	Leptodora kindtii		
	Polyphemus pediculus		
Rotifera			
*	*Ascomorpha* spp.	late Su, early F	[late F,W,Sp]
	Collotheca spp. (rare)		
*	*Conochilus* spp.	Su	[W,Sp]
	Euchlanis parva (rare)		
**	*Gastropus* spp.	late Sp, late Su	[late F,W]
	G. hyptopus (?)		
	G. stylifer		
	Kellicottia sp. (rare)		
	K. longispina		
	K. bostonensis		
	Keratella spp.		
	K. hiemalis		
**	*K. taurocephala*	Su,F	[W,Sp]
	Lecane spp. (rare)		
	L. flexilis		
	L. ligona		
	L. luna		
	L. mira		
	L. tenuiseta		

Continued next page

Table 3. Zooplankton in Lake Giles, 1993 (continued).

	Taxon	Seasonal Abundance in 1993 High	Low
	Monommata spp. (rare)		
	Monostyla spp (rare)		
	M. copeis		
	Ploesoma spp. (rare)		
**	*Polyarthra* spp. ("large")		[late Sp]
*	*Synchaeta* spp.	late Su	
	Testudinella spp. (rare)		
	T. parva		
	Trichocerca spp. (rare)		
	T. multicrinis		
	T. pusilla		
	T. similis		

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

** Dominant species included in Figures.
* Other species included in Figures.

Although *Daphnia* and *D. spatulocrenatus* were somewhat less abundant than in the previous 4 years, *D. minutus* and *Diaphanosoma* were not at especially low levels.

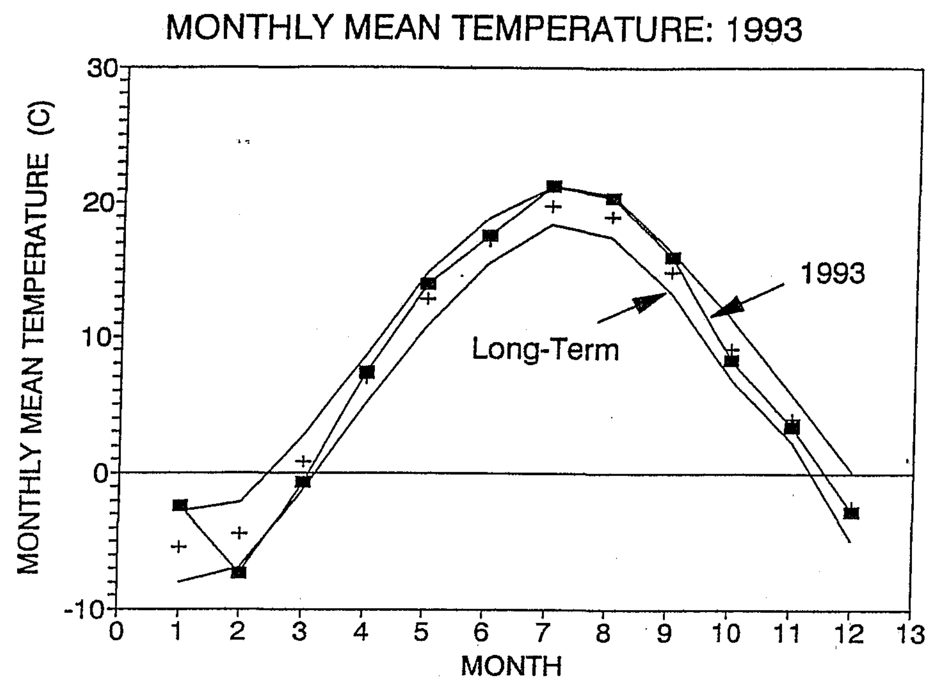
(2) Rotifers were present at low concentrations throughout the year (10-100/L). In 1992 and 1993 rotifers were generally less abundant than in previous years. Rotifers decreased to a midsummer minimum at 10-20/L, roughly at the time when chlorophyll also is very low throughout the water column. Individual species showed pronounced seasonality. Often this was more or less consistent among years. *Keratella taurocephala* shows a remarkable 2-year population cycle: they are relatively abundant in late summer through spring of alternate years. In 1993, the winter-spring concentration was only ca. 1/L, but they increased during the summer to ca. 10/L by autumn. *Polyarthra* was the most common throughout the year, but every year has shown a pronounced minimum between days 100 and 150 (late spring--early summer). The Giles rotifer assemblage is distinctly less diverse than those in the other PCLP lakes.

(3) Predatory macrozooplankton included *Cyclops scutifer*, which was a late spring and early summer species (adults at 0.5-1/L in May through July) and *Chaoborus punctipennis*, which was caught erratically at $\leq$0.05/L in late spring and summer. *Chaoborus* did not reach the concentrations seen in previous years -- probably the change to daytime sampling was responsible.

(4) Unlike rotifers, the main herbivorous macrozooplankton have been at similar densities each year, even in the winter-spring period when chlorophyll-a concentrations have differed so much. *Daphnia catawba* and *Diaptomus minutus* have shown very similar seasonal patterns each year (again, unlike some of the common rotifers), and these patterns are similar to each other. Both populations are high in the spring, which is an important period of reproduction, and adults of both become less common during the summer. *Diaptomus*, however, remains abundant as copepodids during the summer. Adults of both species overwinter at intermediate densities, with little or no reproduction.

CLIMATE IN 1993

Weather data were again obtained from NOAA for the cooperator's station at Hawley, PA (ca. 20 km NW of Lake Giles). The monthly mean temperatures (monthly means of daily means) are plotted along with total monthly rainfall for 1993 versus the average of the previous 31 years (**Figure 12**). The year included both relatively cold (February) and warm months (January, July, August). The summer was slightly warmer and drier than usual. The winter was cold enough for a long ice cover (early January to early April), and fairly snowy. A week after the major snowstorm of 14-15 March, we encountered 15 cm of melting snow on top of 55 cm of still-solid ice -- quite a contrast with the poor ice conditions of preceding winters.



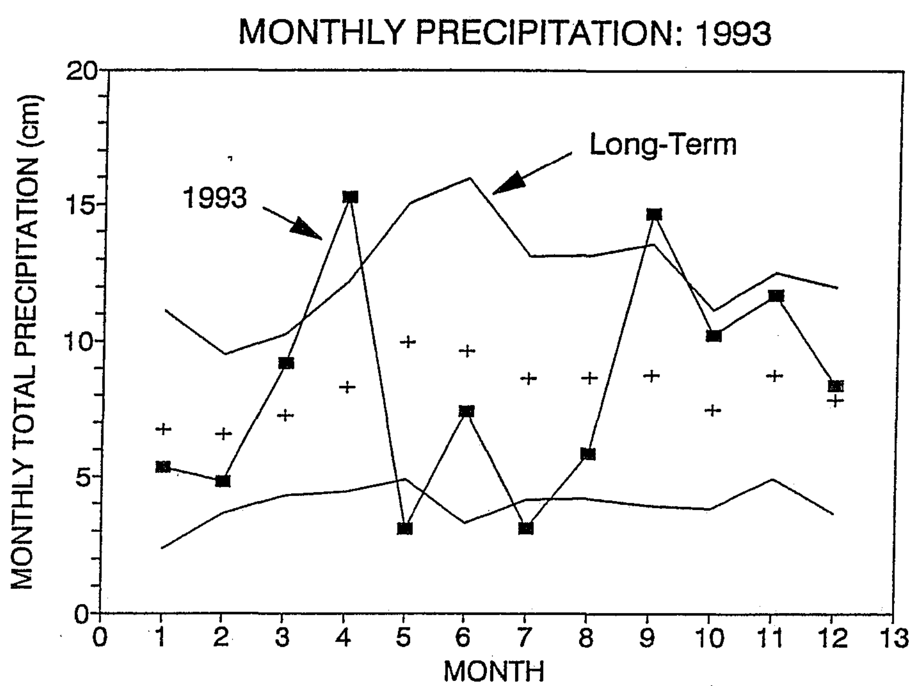


Figure 12. Monthly climate in 1993 compared to the 31-year averages.

(Top) Mean temperature (degrees Celsius). **(Bottom)** Monthly mean prcipitation (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. Data were not reported for July, so values from the Lacawac weathér station were substituted. Lacawac values of temperature were adjusted down 0.7°C and precipitation was adjusted up by a factor of 1.32 to match average May, June, and August differences between the stations.

EXPLANATION OF DATA TABLES

The following 13 tables present the physical/chemical information acquired on each date in 1993. 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 methods #12, 13 (see **METHODS AND RESULTS**).

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

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

PHMETHOD: pH method #12 (see **METHODS AND RESULTS**).

CAMETHOD: Chlorophyll-a methods #12, 13 (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

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:

EMB	Gina Brockway
LG	Lauren Graves
BKS	Brian Sharer
PLS	Paul Stutzman
HS	Henry Su
TLV	Tim Vail
YZ	Yin Zhong

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 1/20/93 JULIAN DATE: 20 TIME: 11.50

SECCHI M: 11.3 WEATHER: sunny, windy (NW)

PERSONNEL: TLV EMN

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

COMMENTS: 11cm candled ice

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
1/20/93	20	S	1	-1.0	5.7								
1/20/93	20		1	0.0	2.2	13.43		100.0000					
1/20/93	20	E	1	1.0	2.3	12.88		39.7931	5.33	-6	0.57	0.71	
1/20/93	20	E	2	1.0	2.3	12.88		39.7931	5.33	-5	0.35	0.49	82.90
1/20/93	20		1	2.0	2.4	12.87		26.3880					
1/20/93	20		1	3.0	2.6	12.79		18.4402					
1/20/93	20		1	4.0	2.7	12.61		12.7968					
1/20/93	20		1	5.0	2.7	12.56		9.1081					
1/20/93	20		1	6.0	2.8	12.49		6.2214					
1/20/93	20	M	1	7.0	2.8	12.32		4.4154	5.33	-5	0.56	0.75	
1/20/93	20	M	2	7.0	2.8	12.32		4.4154	5.32	-4	0.37	0.56	64.90
1/20/93	20		1	8.0	2.8	12.38		3.1607					
1/20/93	20		1	9.0	2.8	12.39		2.3189					
1/20/93	20		1	10.0	2.9	12.33		1.7126					
1/20/93	20		1	11.0	2.9	12.35		1.2242					
1/20/93	20		1	12.0	2.9	12.29		0.8801					
1/20/93	20		1	13.0	2.9	12.25		0.6228					
1/20/93	20		1	14.0	2.9	12.15		0.4570					
1/20/93	20		1	15.0	3.0	12.08		0.3353					
1/20/93	20		1	16.0	3.0	11.90		0.2449					
1/20/93	20	H	1	17.0	3.0	11.78		0.1786	5.30	-6	0.44	0.80	
1/20/93	20	H	2	17.0	3.0	11.78		0.1786	5.33	-4	0.38	0.66	60.50
1/20/93	20		1	18.0	3.1	11.89		0.1281					
1/20/93	20		1	19.0	3.1	11.96		0.0937					
1/20/93	20		1	20.0	3.1	11.70		0.0694					
1/20/93	20		1	21.0	3.2	11.19		0.0497					
1/20/93	20		1	22.0	3.2	11.35		0.0300					
1/20/93	20		1	23.0	3.4								

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 2/18/93 JULIAN DATE: 49 TIME: 10.50

SECCHI M: 7.1 WEATHER: mostly cloudy, wind

PERSONNEL: EMN TLV BKS

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

COMMENTS: 21cm clear ice, 7cm snow cover

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
2/18/93	49	S	1	-1.0	3.0								
2/18/93	49		1	0.0	3.2	13.10		100.0000					
2/18/93	49	E	1	1.0	3.6	12.31		8.6881	5.30	-4	23.32	23.32	
2/18/93	49	E	2	1.0	3.6	12.31		8.6881	5.34	-4	19.98	19.98	16.30
2/18/93	49		1	2.0	4.0	12.29		2.2357					
2/18/93	49		1	3.0	4.0	12.29		0.9784					
2/18/93	49		1	4.0	4.0	12.24		0.5062					
2/18/93	49		1	5.0	4.0	12.22		0.3013					
2/18/93	49	M	1	6.0	4.0	12.22		0.1828	5.31	-3	0.75	0.81	
2/18/93	49	M	2	6.0	4.0	12.22		0.1828	5.31	-4	1.70	1.82	40.60
2/18/93	49		1	7.0	4.0	12.20		0.1167					
2/18/93	49		1	8.0	4.0	12.22		0.0778					
2/18/93	49		1	9.0	4.0	12.19		0.0532					
2/18/93	49		1	10.0	4.0	12.10		0.0343					
2/18/93	49		1	11.0	4.0	12.15		0.0241					
2/18/93	49		1	12.0	4.0	12.20		0.0171					
2/18/93	49		1	13.0	4.0	12.12		0.0122					
2/18/93	49		1	14.0	4.0	12.10		0.0086					
2/18/93	49		1	15.0	4.1	12.08		0.0063					
2/18/93	49		1	16.0	4.1	12.08		0.0046					
2/18/93	49	H	1	17.0	4.1	12.04		0.0034	5.30	-3	1.31	1.52	
2/18/93	49	H	2	17.0	4.1	12.04		0.0034	5.31	-4	1.21	1.35	47.10
2/18/93	49		1	18.0	4.2	11.95		0.0025					
2/18/93	49		1	19.0	4.2	11.85		0.0019					
2/18/93	49		1	20.0	4.2	11.85		0.0014					
2/18/93	49		1	21.0	4.2	11.78		0.0010					
2/18/93	49		1	22.0	4.2								
2/18/93	49		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 3/22/93 JULIAN DATE: 81 TIME: 13.00

SECCHI M: 12.7 WEATHER: sunny, clear

PERSONNEL: TLV BKS

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

COMMENTS: 15cm slushy snow/55cm ice; oxygen/temperature probe B used

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
3/22/93	81	S	1	-1.0	9.6								
3/22/93	81		1	0.0	0.6	14.83		100.0000					
3/22/93	81		1	1.0	3.5	13.42		10.2606					
3/22/93	81		1	2.0	4.1	12.57		1.2975					
3/22/93	81		1	3.0	4.1	12.51		0.8034					
3/22/93	81	E	1	4.0	4.1	12.46		0.5414	5.44	1	1.14	1.40	
3/22/93	81	E	2	4.0	4.1	12.46		0.5414	5.38	-3	1.19	1.65	65.50
3/22/93	81		1	5.0	4.1	12.50		0.3678					
3/22/93	81		1	6.0	4.1	12.45		0.2509					
3/22/93	81		1	7.0	4.1	12.29		0.1754					
3/22/93	81		1	8.0	4.1	12.38		0.1244					
3/22/93	81		1	9.0	4.1	12.30		0.0884					
3/22/93	81		1	10.0	4.1	12.35		0.0630					
3/22/93	81	M	1	11.0	4.1	12.30		0.0451	5.54	-4	0.97	1.27	
3/22/93	81	M	2	11.0	4.1	12.30		0.0451	5.33	-1	0.63	0.88	61.90
3/22/93	81		1	12.0	4.1	12.31		0.0323					
3/22/93	81		1	13.0	4.1	12.29		0.0233					
3/22/93	81		1	14.0	4.1	12.22		0.0168					
3/22/93	81		1	15.0	4.1	12.27		0.0122					
3/22/93	81		1	16.0	4.1	12.36		0.0090					
3/22/93	81		1	17.0	4.1	12.30		0.0065					
3/22/93	81	H	1	18.0	4.1	12.27		0.0048	5.33	-2	0.52	0.72	
3/22/93	81	H	2	18.0	4.1	12.27		0.0048	5.34	-4	0.64	0.90	50.00
3/22/93	81		1	19.0	4.1	12.29		0.0036					
3/22/93	81		1	20.0	4.1	12.02		0.0027					
3/22/93	81		1	21.0	4.2	11.69							
3/22/93	81		1	22.0	4.3	0.19							
3/22/93	81		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 4/19/93 JULIAN DATE: 109 TIME: 10.50

SECCHI M: 8.2 WEATHER: sunny, windy

PERSONNEL: 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
4/19/93	109	S	1	-1.0	12.8								
4/19/93	109		1	0.0	5.8	12.64		100.0000					
4/19/93	109		1	1.0	5.8	12.51		64.8088					
4/19/93	109		1	2.0	5.8	12.52		42.4697					
4/19/93	109		1	3.0	5.8	12.48		27.2242					
4/19/93	109	E	1	4.0	5.8	12.44		17.7704	5.33	-3	0.61	0.71	
4/19/93	109	E	2	4.0	5.8	12.44		17.7704	5.30	-3	1.28	1.41	82.80
4/19/93	109		1	5.0	5.8	12.44		13.6906					
4/19/93	109		1	6.0	5.8	12.41		9.1028					
4/19/93	109		1	7.0	5.8	12.31		6.4742					
4/19/93	109		1	8.0	5.8	12.36		4.0313					
4/19/93	109		1	9.0	5.7	12.33		2.8469					
4/19/93	109		1	10.0	5.6	12.37		2.0585					
4/19/93	109	M	1	11.0	5.5	12.36		1.4158	5.32	-4	1.80	1.97	
4/19/93	109	M	2	11.0	5.5	12.36		1.4158	5.31	-4	1.44	2.07	53.50
4/19/93	109		1	12.0	5.4	12.33		1.0134					
4/19/93	109		1	13.0	5.3	12.33		0.6598					
4/19/93	109		1	14.0	5.2	12.31		0.4723					
4/19/93	109		1	15.0	5.2	12.26		0.3059					
4/19/93	109		1	16.0	5.2	12.22		0.2180					
4/19/93	109		1	17.0	5.2	12.09		0.1457					
4/19/93	109		1	18.0	5.1	12.12		0.1026					
4/19/93	109	H	1	19.0	5.0	12.08		0.0717	5.29	-4	1.37	1.77	
4/19/93	109	H	2	19.0	5.0	12.08		0.0717	5.28	-4	1.20	1.46	55.80
4/19/93	109		1	20.0	4.9	12.00		0.0490					
4/19/93	109		1	21.0	4.9	11.96		0.0355					
4/19/93	109		1	22.0	4.8	11.81		0.0251					
4/19/93	109		1	23.0	4.9	9.00							

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 5/12/93 JULIAN DATE: 132 TIME: 11.50

SECCHI M: 12.8 WEATHER: sunny, windy

PERSONNEL: EMB TLV

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

COMMENTS: secchi without viewing box

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
5/12/93	132	S	1	-1.0	21.5								
5/12/93	132		1	0.0	17.5	9.09		100.0000					
5/12/93	132	E	1	1.0	17.5	8.89		62.2278	5.42	-2	0.14	0.15	
5/12/93	132	E	2	1.0	17.5	8.89		62.2278	5.42	-1	0.11	0.12	90.90
5/12/93	132		1	2.0	17.4	8.78		52.4244					
5/12/93	132		1	3.0	14.8	9.81		40.5762					
5/12/93	132	M	1	4.0	12.6	10.78		30.9742	5.36	-2	0.17	0.18	
5/12/93	132	M	2	4.0	12.6	10.78		30.9742	5.37	-1	0.17	0.19	88.20
5/12/93	132		1	5.0	11.0	11.12		21.7974					
5/12/93	132		1	6.0	10.5	11.08		14.5705					
5/12/93	132		1	7.0	9.9	11.23		10.9142					
5/12/93	132		1	8.0	9.4	11.19		7.6915					
5/12/93	132		1	9.0	8.8	11.36		5.5414					
5/12/93	132		1	10.0	8.2	11.53		3.9441					
5/12/93	132		1	11.0	7.7	11.57		2.8313					
5/12/93	132		1	12.0	7.4	11.67		2.0369					
5/12/93	132	H	1	13.0	7.2	11.73		1.4395	5.40	-3	0.40	0.55	
5/12/93	132	H	2	13.0	7.2	11.73		1.4395	5.38	-2	0.54	0.70	42.60
5/12/93	132		1	14.0	7.0	11.80		1.0253					
5/12/93	132		1	15.0	6.7	11.80		0.7057					
5/12/93	132		1	16.0	6.5	11.69		0.5022					
5/12/93	132		1	17.0	6.3	11.45		0.3405					
5/12/93	132		1	18.0	6.2	11.34		0.2324					
5/12/93	132		1	19.0	6.1	11.13		0.1562					
5/12/93	132		1	20.0	6.0	10.58		0.1012					
5/12/93	132		1	21.0	5.9	9.94		0.0636					
5/12/93	132		1	22.0	5.9	9.36		0.0241					
5/12/93	132		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 6/09/93 JULIAN DATE: 160 TIME: 10.92

SECCHI M: 16.1 WEATHER: sunny

PERSONNEL: EMB TLV HS

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS: light data taken on 6/8/93 at 11.25, partly cloudy but stable

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
6/09/93	160	S	1	-1.0	25.8								
6/09/93	160		1	0.0	17.6	10.11		100.0000					
6/09/93	160		1	1.0	17.3	9.99		61.6523					
6/09/93	160		1	2.0	16.8	10.04		40.8023					
6/09/93	160		1	3.0	16.5	10.13		33.1996					
6/09/93	160	E	1	4.0	16.4	10.15		21.6284	5.36	-2	0.10	0.70	
6/09/93	160	E	2	4.0	16.4	10.15		21.6284	5.38	-8			
6/09/93	160		1	5.0	16.0	10.08		16.9502					
6/09/93	160		1	6.0	15.8	10.23		13.4099					
6/09/93	160		1	7.0	15.7	10.27		11.5206					
6/09/93	160		1	8.0	14.5	11.99		9.0216					
6/09/93	160		1	9.0	12.6	12.78		6.9131					
6/09/93	160	M	1	10.0	11.7	13.07		4.9485	5.34	-9	0.40	1.00	
6/09/93	160	M	2	10.0	11.7	13.07		4.9485	5.33	-8			
6/09/93	160		1	11.0	10.6	13.38		3.5729					
6/09/93	160		1	12.0	9.8	13.43		2.4951					
6/09/93	160		1	13.0	9.3	13.56		1.7243					
6/09/93	160		1	14.0	8.5	13.62		1.3471					
6/09/93	160		1	15.0	8.0	13.64		0.9602					
6/09/93	160		1	16.0	7.6	13.43		0.7296					
6/09/93	160	H	1	17.0	7.4	13.34		0.5113	5.40		0.40	1.70	
6/09/93	160	H	2	17.0	7.4	13.34		0.5113	5.37	-7			
6/09/93	160		1	18.0	7.1	12.72		0.3801					
6/09/93	160		1	19.0	7.0	12.36		0.2789					
6/09/93	160		1	20.0	6.9	11.60		0.1985					
6/09/93	160		1	21.0	6.7	10.09		0.1361					
6/09/93	160		1	22.0	6.7	7.16		0.0579					
6/09/93	160		1	23.0	6.7	8.18							

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 6/22/93 JULIAN DATE: 173 TIME: 14.33

SECCHI M: 11.8 WEATHER: mostly sunny, wind 15k (N)

PERSONNEL: TV LG

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS: many sun/cloud episodes

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
6/22/93	173	S	1	-1.0	26.4								
6/22/93	173		1	0.0	22.3	9.12		100.0000					
6/22/93	173		1	1.0	22.3	8.40		66.9344					
6/22/93	173		1	2.0	22.3	8.41		49.6546					
6/22/93	173		1	3.0	22.2	8.26		37.0004					
6/22/93	173	E	1	4.0	20.6	9.01		28.7271	5.32		0.40	0.50	
6/22/93	173	E	2	4.0	20.6	9.01		28.7271	5.32				
6/22/93	173		1	5.0	19.7	9.74		21.8457					
6/22/93	173		1	6.0	18.8	9.77		17.2693					
6/22/93	173		1	7.0	17.9	9.68		14.1784					
6/22/93	173		1	8.0	16.8	10.48		11.5459					
6/22/93	173		1	9.0	15.7	11.95		8.8883					
6/22/93	173		1	10.0	13.9	12.30		6.6981					
6/22/93	173	M	1	11.0	12.4	12.72		4.8607	5.36		0.60	0.80	
6/22/93	173	M	2	11.0	12.4	12.72		4.8607	5.37				
6/22/93	173		1	12.0	11.4	12.84		3.5172					
6/22/93	173		1	13.0	10.8	12.93		2.6951					
6/22/93	173		1	14.0	10.1	12.98		1.9265					
6/22/93	173		1	15.0	8.9	13.02		1.4144					
6/22/93	173		1	16.0	8.3	13.02		1.0385					
6/22/93	173		1	17.0	8.0	12.59		0.7329					
6/22/93	173	H	1	18.0	7.8	12.36		0.5158	5.41		1.50	1.70	
6/22/93	173	H	2	18.0	7.8	12.36		0.5158	5.42				
6/22/93	173		1	19.0	7.5	11.64		0.3523					
6/22/93	173		1	20.0	7.4	10.58		0.2364					
6/22/93	173		1	21.0	7.3	10.09		0.1520					
6/22/93	173		1	22.0	7.4	6.83							
6/22/93	173		1	23.0	7.4								

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 7/06/93 JULIAN DATE: 187 TIME: 10.67

SECCHI M: 16.2 WEATHER: hazy, windy

PERSONNEL: EMB TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS: rep 2 CHLA by method 12

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
7/06/93	187	S	1	-1.0	27.1								
7/06/93	187		1	0.0	23.2	8.60		100.0000					
7/06/93	187		1	1.0	23.2	8.48		56.4653					
7/06/93	187		1	2.0	23.2	8.40		35.1371					
7/06/93	187	E	1	3.0	23.0	8.38		27.8645	5.26	-7	0.40	0.60	
7/06/93	187	E	2	3.0	23.0	8.38		27.8645	5.31	-2	0.42	0.45	91.90
7/06/93	187		1	4.0	23.0	8.38		21.8373					
7/06/93	187		1	5.0	22.4	8.42		17.1139					
7/06/93	187		1	6.0	22.2	8.56		13.2461					
7/06/93	187		1	7.0	20.1	10.29		10.0273					
7/06/93	187		1	8.0	18.9	10.58		7.4663					
7/06/93	187		1	9.0	18.0	11.16		5.8240					
7/06/93	187	M	1	10.0	15.5	12.53		4.4289	5.30	-3	0.70	0.70	
7/06/93	187	M	2	10.0	15.5	12.53		4.4289	5.32	-4	0.29	0.31	87.20
7/06/93	187		1	11.0	14.4	12.75		3.2070					
7/06/93	187		1	12.0	13.1	12.98		2.5252					
7/06/93	187		1	13.0	11.7	13.15		2.0447					
7/06/93	187		1	14.0	10.8	13.18		1.4892					
7/06/93	187		1	15.0	10.2	13.29		1.1438					
7/06/93	187		1	16.0	9.6	13.34		0.8199					
7/06/93	187	H	1	17.0	9.0	13.23		0.5959	5.43	-3	0.90	1.20	
7/06/93	187	H	2	17.0	9.0	13.23		0.5959	5.41	-2	1.06	1.08	83.30
7/06/93	187		1	18.0	8.4	12.85		0.4150					
7/06/93	187		1	19.0	8.1	12.38		0.2866					
7/06/93	187		1	20.0	7.9	11.00		0.1892					
7/06/93	187		1	21.0	7.8	10.18		0.1061					
7/06/93	187		1	22.0	7.8	9.82		0.0529					
7/06/93	187		1	23.0			10						

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 7/20/93 JULIAN DATE: 201 TIME: 14.42

SECCHI M: 16.3 WEATHER: mostly sunny, windy (NE)

PERSONNEL: EMB TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
7/20/93	201	S	1	-1.0	27.0								
7/20/93	201		1	0.0	23.7	8.26		100.0000					
7/20/93	201		1	1.0	23.6	8.22		64.6412					
7/20/93	201		1	2.0	23.5	8.16		49.5715					
7/20/93	201		1	3.0	23.4	8.13		44.4189					
7/20/93	201	E	1	4.0	23.4	8.13		33.1484	5.36		0.70	0.90	
7/20/93	201	E	2	4.0	23.4	8.13		33.1484	5.33				
7/20/93	201		1	5.0	23.4	8.09		25.3428					
7/20/93	201		1	6.0	23.3	8.07		19.5245					
7/20/93	201		1	7.0	23.2	8.06		14.3774					
7/20/93	201		1	8.0	21.2	10.44		11.7367					
7/20/93	201		1	9.0	19.9	11.60		8.7784					
7/20/93	201	M	1	10.0	17.7	12.08		7.0736	5.31		0.50	1.10	
7/20/93	201	M	2	10.0	17.7	12.08		7.0736	5.32				
7/20/93	201		1	11.0	16.0	12.72		5.2592					
7/20/93	201		1	12.0	14.5	13.02		4.0147					
7/20/93	201		1	13.0	13.2	13.22		3.1636					
7/20/93	201		1	14.0	12.3	13.38		2.3400					
7/20/93	201		1	15.0	11.3	13.53		1.6895					
7/20/93	201		1	16.0	10.5	13.64		1.2190					
7/20/93	201		1	17.0	9.8	13.56		0.8744					
7/20/93	201	H	1	18.0	9.3	13.25		0.6081	5.49		2.20	2.60	
7/20/93	201	H	2	18.0	9.3	13.25		0.6081	5.48				
7/20/93	201		1	19.0	8.9	13.08		0.4313					
7/20/93	201		1	20.0	8.7	12.36		0.2707					
7/20/93	201		1	21.0	8.5	11.12		0.1655					
7/20/93	201		1	22.0	8.5	9.49							
7/20/93	201		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 8/03/93 JULIAN DATE: 215 TIME: 13.50

SECCHI M: 14.6 WEATHER: partly cloudy

PERSONNEL: EMB TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
8/03/93	215	S	1	-1.0	27.7								
8/03/93	215		1	0.0	24.0	9.11		100.0000					
8/03/93	215		1	1.0	23.7	9.06		60.4595					
8/03/93	215		1	2.0	23.6	9.02		48.5229					
8/03/93	215		1	3.0	23.5	8.99		39.9694					
8/03/93	215		1	4.0	23.5	9.02		33.7865					
8/03/93	215	E	1	5.0	23.5	9.01		25.1014	5.40	-5	0.70	1.20	
8/03/93	215	E	2	5.0	23.5	9.01		25.1014	5.40	-5			
8/03/93	215		1	6.0	23.4	8.99		19.0451					
8/03/93	215		1	7.0	23.4	8.98		14.0554					
8/03/93	215		1	8.0	23.2	8.94		10.4114					
8/03/93	215		1	9.0	21.9	11.26		7.5996					
8/03/93	215		1	10.0	18.9	13.52		5.7747					
8/03/93	215		1	11.0	17.4	13.76		4.2461					
8/03/93	215	M	1	12.0	15.7	14.32		3.2339	5.44	-4	0.70	2.30	
8/03/93	215	M	2	12.0	15.7	14.32		3.2339	5.40	-6			
8/03/93	215		1	13.0	14.1	14.48		2.3991					
8/03/93	215		1	14.0	13.2	14.60		1.7944					
8/03/93	215		1	15.0	12.2	14.79		1.3213					
8/03/93	215		1	16.0	11.0	14.99		0.9292					
8/03/93	215		1	17.0	10.5	14.92		0.6178					
8/03/93	215		1	18.0	9.9	14.89		0.4020					
8/03/93	215	H	1	19.0	9.4	13.76		0.2552	5.53	2	3.60	4.80	
8/03/93	215	H	2	19.0	9.4	13.76		0.2552	5.53	1			
8/03/93	215		1	20.0	9.2	12.90		0.1543					
8/03/93	215		1	21.0	8.9	11.75		0.0848					
8/03/93	215		1	22.0	8.9	1.09							
8/03/93	215		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 8/18/93 JULIAN DATE: 230 TIME: 15.33

SECCHI M: 13.3 WEATHER: mostly sunny

PERSONNEL: EMB TLV

TMETHOD: 10 LMETHOD: 12 AMETHOD:
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS:

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
8/18/93	230	S	1	-1.0	25.3								
8/18/93	230		1	0.0	23.3	7.63		100.0000					
8/18/93	230		1	1.0	23.0	7.49		47.5059					
8/18/93	230		1	2.0	22.9	7.37		35.7188					
8/18/93	230		1	3.0	22.9	7.33		22.7363					
8/18/93	230		1	4.0	23.0	7.31		15.3832					
8/18/93	230	E	1	5.0	22.9	7.27		11.7788	5.40		1.00	1.00	
8/18/93	230	E	2	5.0	22.9	7.27		11.7788	5.41				
8/18/93	230		1	6.0	22.9	7.20		8.5914					
8/18/93	230		1	7.0	22.9	7.21		5.5608					
8/18/93	230		1	8.0	22.9	7.18		3.6464					
8/18/93	230		1	9.0	22.9	7.16		2.4975					
8/18/93	230		1	10.0	20.8	10.35		1.7060					
8/18/93	230		1	11.0	18.3	11.21		1.0277					
8/18/93	230	M	1	12.0	16.5	11.46		0.6415	5.50		2.60	3.40	
8/18/93	230	M	2	12.0	16.5	11.46		0.6415	5.52				
8/18/93	230		1	13.0	15.0	11.61		0.5079					
8/18/93	230		1	14.0	13.8	11.80		0.3625					
8/18/93	230		1	15.0	12.7	11.84		0.2516					
8/18/93	230		1	16.0	11.6	11.94		0.1660					
8/18/93	230		1	17.0	10.8	11.78		0.1191					
8/18/93	230		1	18.0	10.1	11.26		0.0826					
8/18/93	230	H	1	19.0	9.7	10.12		0.0526	5.58		1.90	2.50	
8/18/93	230	H	2	19.0	9.7	10.12		0.0526	5.54				
8/18/93	230		1	20.0	9.4	8.96		0.0306					
8/18/93	230		1	21.0	9.1	6.47		0.0162					
8/18/93	230		1	22.0	9.0	3.84		0.0034					
8/18/93	230		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 9/28/93 JULIAN DATE: 271 TIME: 10.92

SECCHI M: 12.9 WEATHER: very windy, mostly cloudy, some sun

PERSONNEL: EMB YZ

TMETHOD: 10 LMETHOD: 13 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS: light from PUV500 profiles

DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
9/28/93	271	S	1	-1.0	11.5								
9/28/93	271		1	0.0	17.8	8.80		100.0000					
9/28/93	271		1	1.0	17.8	8.58		71.6600					
9/28/93	271		1	2.0	17.8	8.49		46.2700					
9/28/93	271		1	3.0	17.8	8.49		30.5500					
9/28/93	271		1	4.0	17.8	8.45		25.3500					
9/28/93	271		1	5.0	17.9	8.43		18.8800					
9/28/93	271		1	6.0	17.8	8.39		15.2400					
9/28/93	271	E	1	7.0	17.8	8.45		12.5700	5.71	-3	4.80	6.50	
9/28/93	271	E	2	7.0	17.8	8.45		12.5700	5.52	-5			
9/28/93	271		1	8.0	17.8	8.52		9.7500					
9/28/93	271		1	9.0	17.8	8.53		8.5600					
9/28/93	271		1	10.0	17.8	8.50		6.7100					
9/28/93	271		1	11.0	17.8	8.45		5.3200					
9/28/93	271		1	12.0	17.8	8.47		4.2100					
9/28/93	271		1	13.0	17.8	8.46		3.4000					
9/28/93	271		1	14.0	15.2	11.06		2.7600					
9/28/93	271	M	1	15.0	13.4	11.29		2.1700	5.72	6	1.90	3.70	
9/28/93	271	M	2	15.0	13.4	11.29		2.1700	5.64	-1			
9/28/93	271		1	16.0	12.4	11.40		1.6500					
9/28/93	271		1	17.0	11.5	10.85		1.1600					
9/28/93	271		1	18.0	10.5	8.66		0.8400					
9/28/93	271		1	19.0	9.9	7.16		0.6600					
9/28/93	271	H	1	20.0	9.3	4.58		0.3900	5.55	18	0.80	2.20	
9/28/93	271	H	2	20.0	9.3	4.58		0.3900	5.48	15			
9/28/93	271		1	21.0	9.2	3.65		0.3400					
9/28/93	271		1	22.0	9.0	1.46							
9/28/93	271		1	23.0									

LAKE GILES: SUMMARY OF PHYSICAL/CHEMICAL DATA FOR 1993

DATE OF SAMPLE: 11/16/93 JULIAN DATE: 320 TIME: 9.83

SECCHI M: 13.3 WEATHER: Overcast in am; clear, calm pm

PERSONNEL: EMB PLS

TMETHOD: 10 LMETHOD: 13 AMETHOD: 11
OMETHOD: 10 PHMETHOD: 12 CAMETHOD: 13

COMMENTS: Light collected with PUV at 1:40 pm

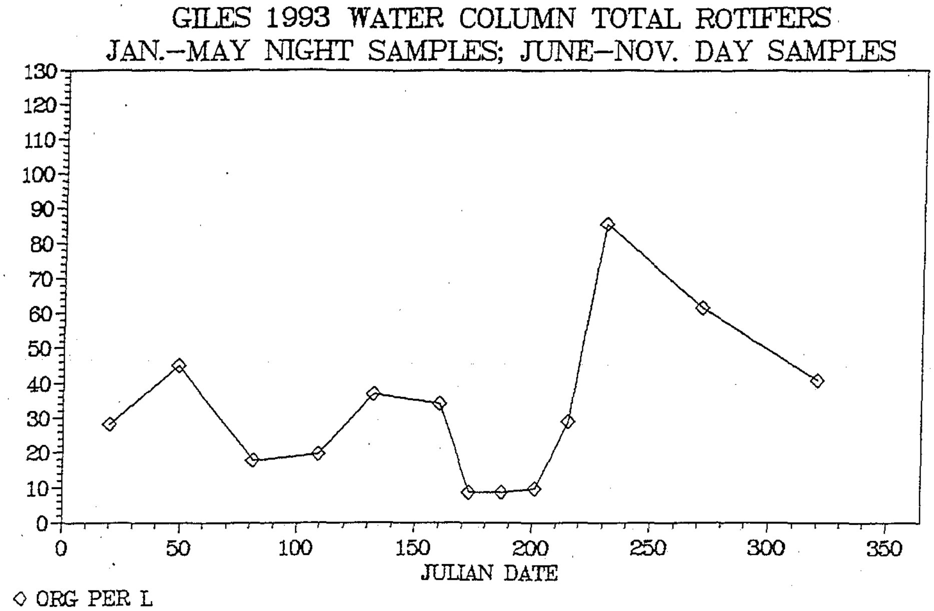
DATE OF	JULIAN	STRA	REP	DEPTH	TEMP C	OXYGEN	OFLAG	LIGHT PC	PH	ALKAL	CHLAC U	CHLASUM	CHLAC P
11/16/93	320	S	1	-1.0	11.9								
11/16/93	320		1	0.0	9.2	10.66		100.0000					
11/16/93	320		1	1.0	9.3	10.18		68.0600					
11/16/93	320		1	2.0	9.2	10.10		48.9500					
11/16/93	320		1	3.0	9.2	9.99		31.8190					
11/16/93	320	E	1	4.0	9.2	9.98		27.1440	5.38	-6	0.90	1.20	
11/16/93	320	E	2	4.0	9.2	9.98		27.1440	5.39	-7			
11/16/93	320		1	5.0	9.2	9.94		21.6200					
11/16/93	320		1	6.0	9.2	9.93		16.3770					
11/16/93	320		1	7.0	9.1	9.88		11.9330					
11/16/93	320		1	8.0	9.1	9.88		9.2360					
11/16/93	320		1	9.0	9.2	9.85		7.6500					
11/16/93	320		1	10.0	9.2	9.84		6.2350					
11/16/93	320		1	11.0	8.9	9.73		5.1058					
11/16/93	320	M	1	12.0	8.8	9.68		4.0604	5.38	-6	1.10	1.50	
11/16/93	320	M	2	12.0	8.8	9.68		4.0604	5.38	-6			
11/16/93	320		1	13.0	8.8	9.70		3.1925					
11/16/93	320		1	14.0	8.8	10.56		2.5700					
11/16/93	320		1	15.0	8.7	10.72		2.0800					
11/16/93	320		1	16.0	8.7	10.58		1.7590					
11/16/93	320		1	17.0	8.7	10.58		1.3960					
11/16/93	320	H	1	18.0	8.7	10.47		1.0916	5.40	-5	0.70	1.20	
11/16/93	320	H	2	18.0	8.7	10.47		1.0916	5.37	-6			
11/16/93	320		1	19.0	8.7	10.38		0.8730					
11/16/93	320		1	20.0	8.7	10.17		0.7240					
11/16/93	320		1	21.0	8.7	10.16		0.6120					
11/16/93	320		1	22.0	8.7	3.15							

ZOOPLANKTON GRAPHS

The following graphs present water-column mean 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.

Data from January through May are from nighttime sampling (as in previous Annual Reports). Starting in June only daytime sampling was performed.

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 for the January--May dates.



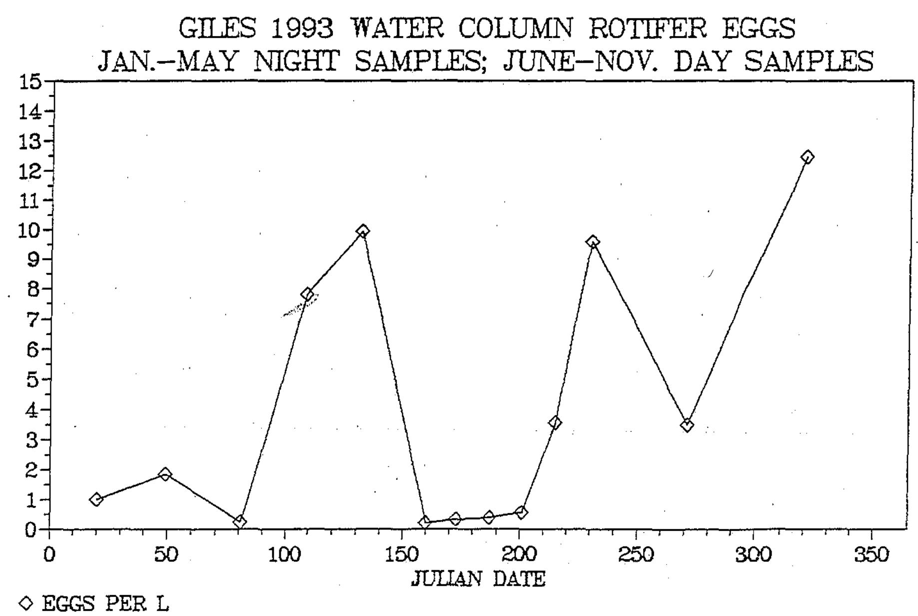
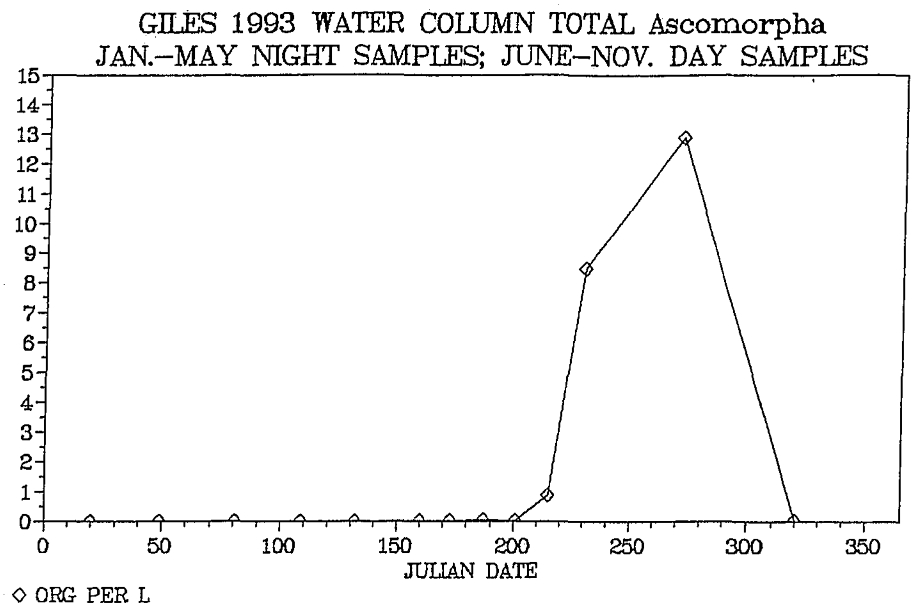


Figure 13. Rotifers in Lake Giles, 1993.

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.



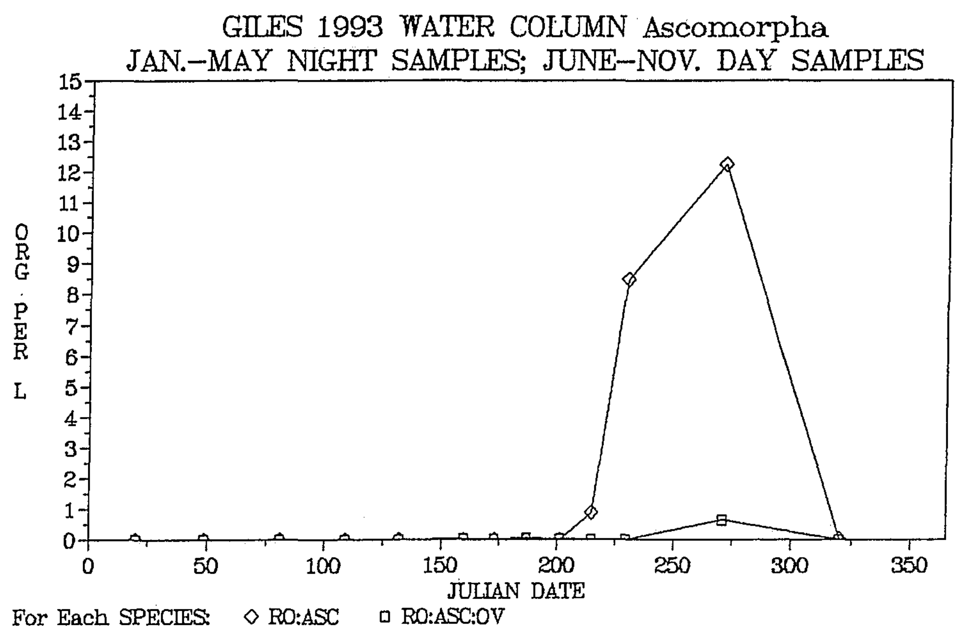
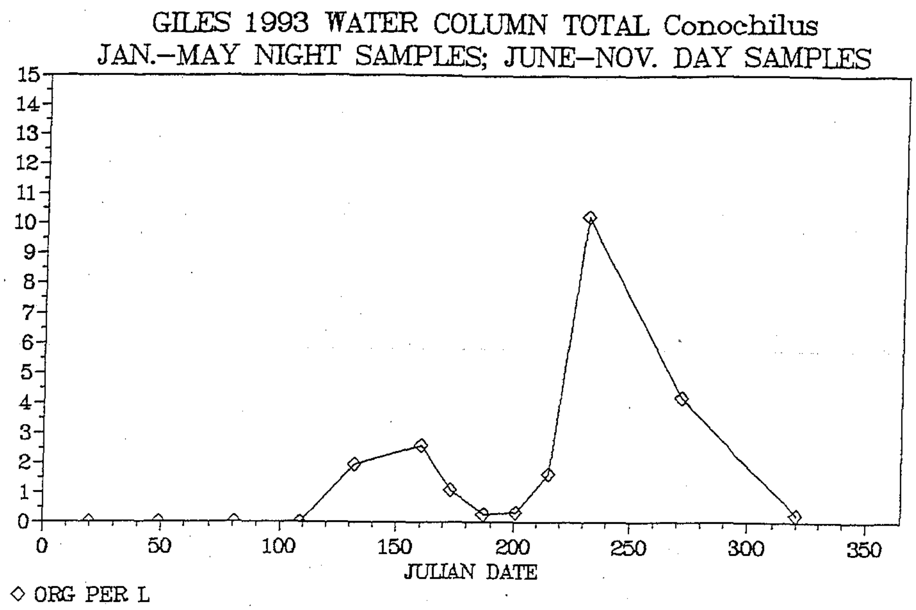


Figure 14. The rotifer *Ascomorpha* spp. in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** all species. **(Bottom)** *Ascomorpha* by species: **ASC** undifferentiated species, **OV** *A. ovalis*.



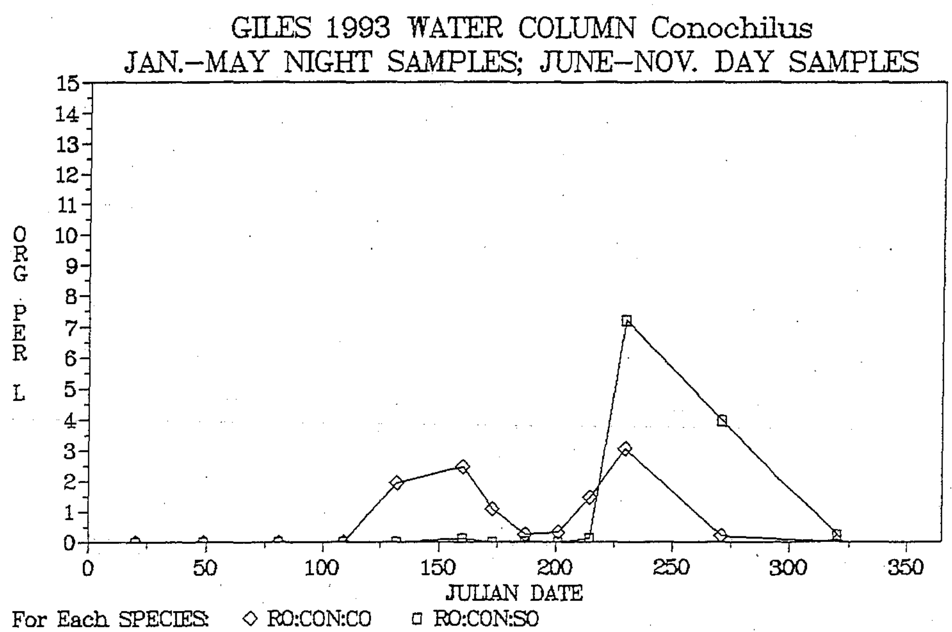
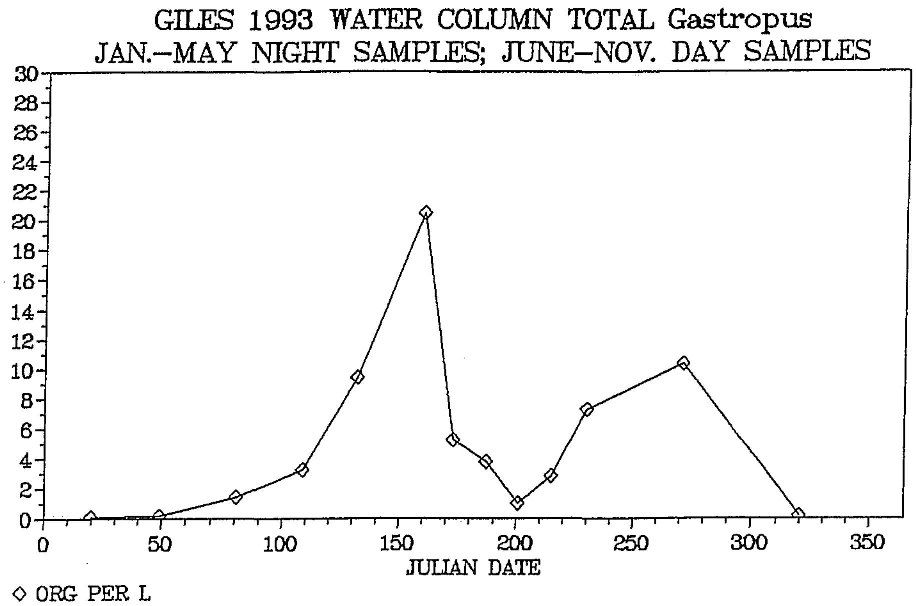


Figure 15. The rotifer *Conochilus* spp. in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** all forms. **(Bottom)** by forms: **CO** colonial, **(SO)** solitary.



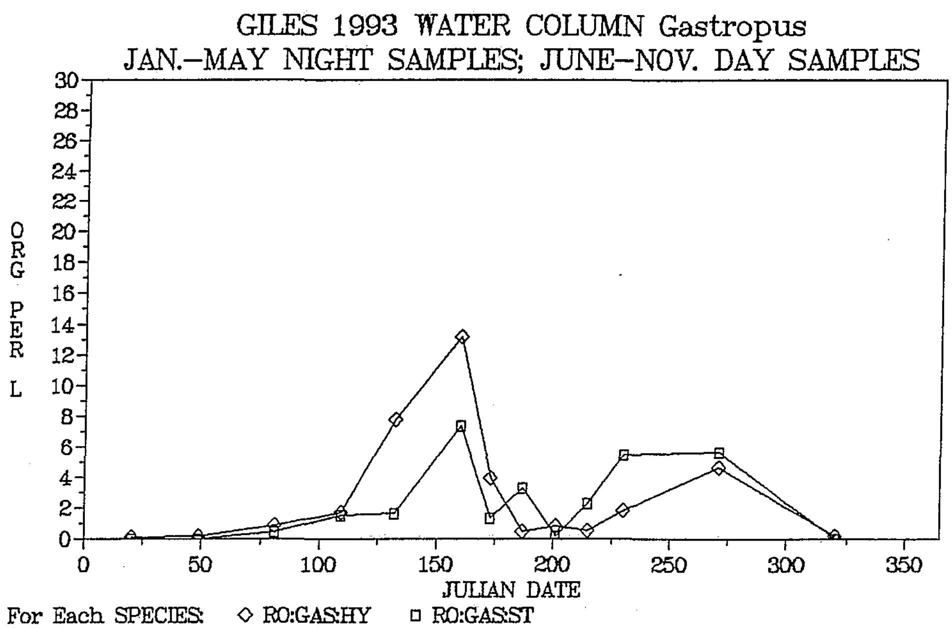
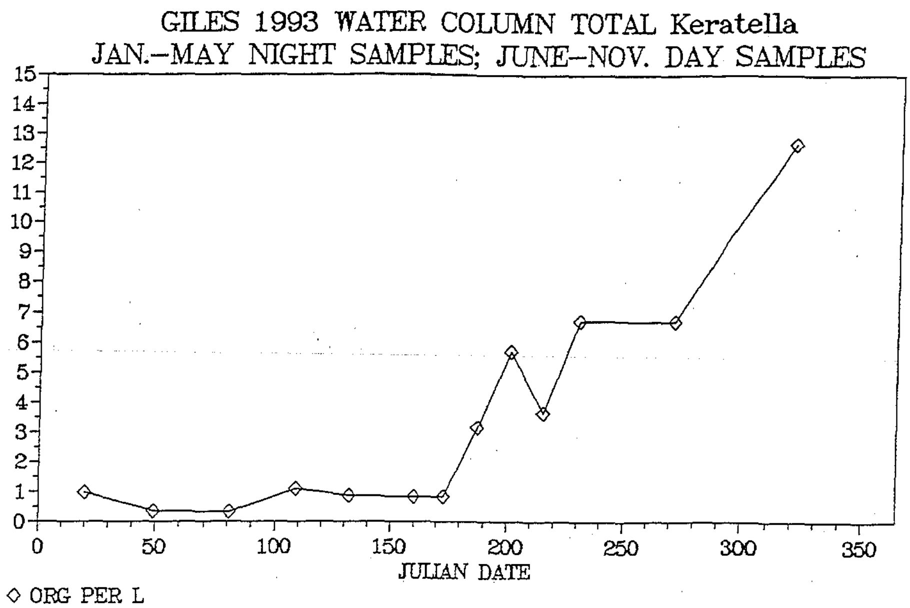


Figure 16. The rotifer *Gastropus* in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. **(Top)** all species. **(Bottom)** *Gastropus* by species: **HY** *G. hyptopus*, **ST** *G. stylifer*.



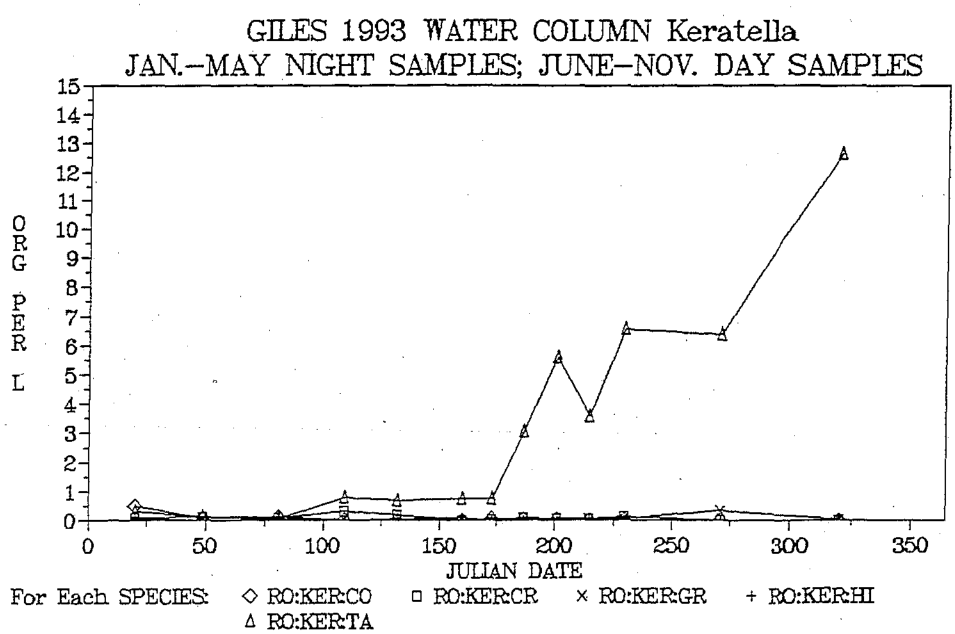


Figure 17. The rotifer *Keratella* spp. in Lake Giles, 1993.

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*, **HI** *K. hiemalis*, **TA** *K. taurocephala*.

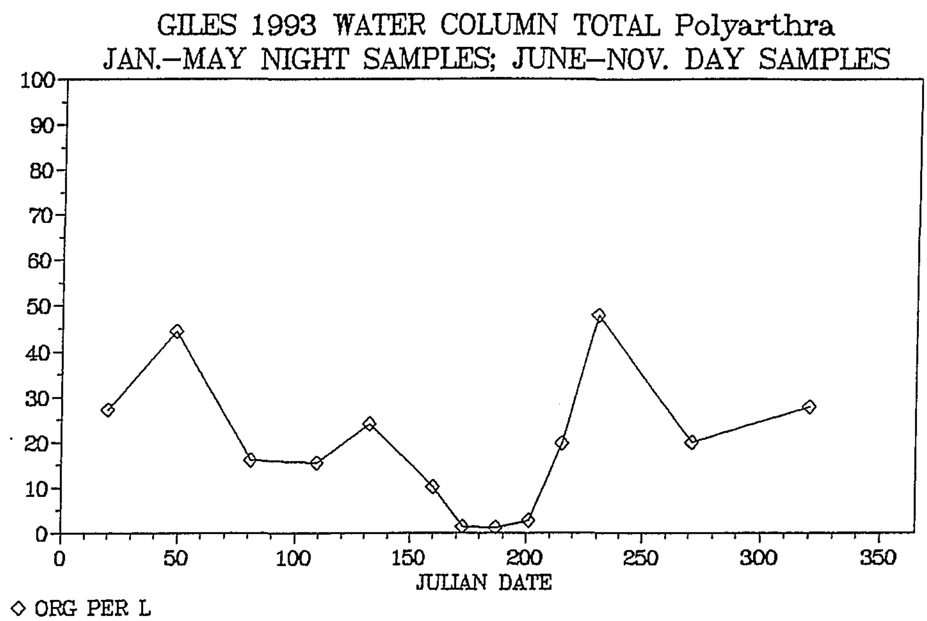


Figure 18. The rotifer *Polyarthra* spp. in Lake Giles, 1993.

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

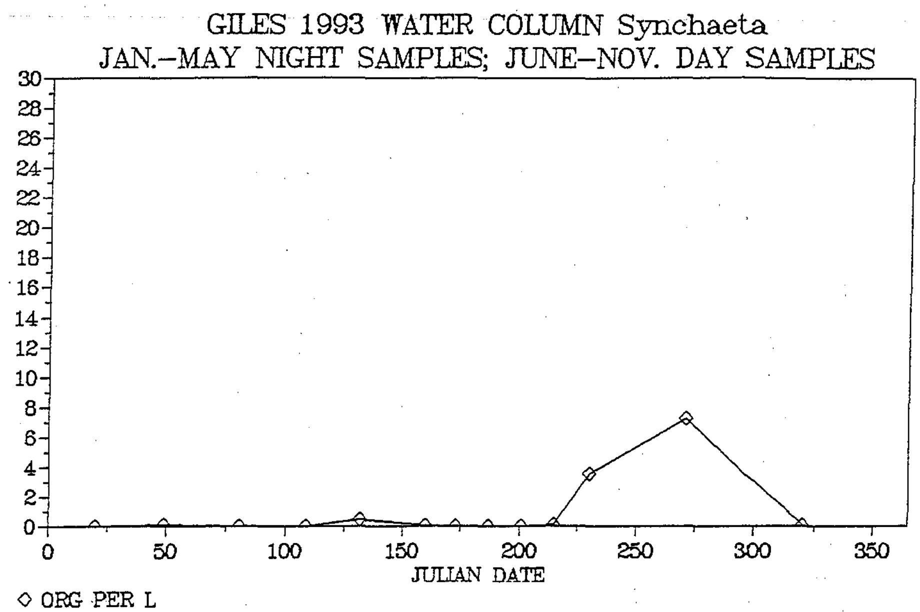


Figure 19. The rotifer *Synchaeta* spp. in Lake Giles, 1993.

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

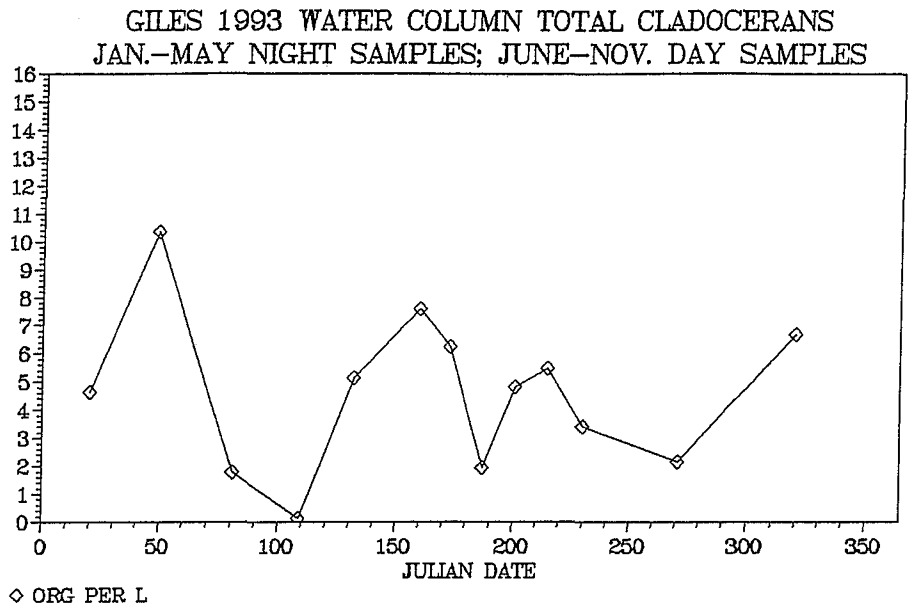
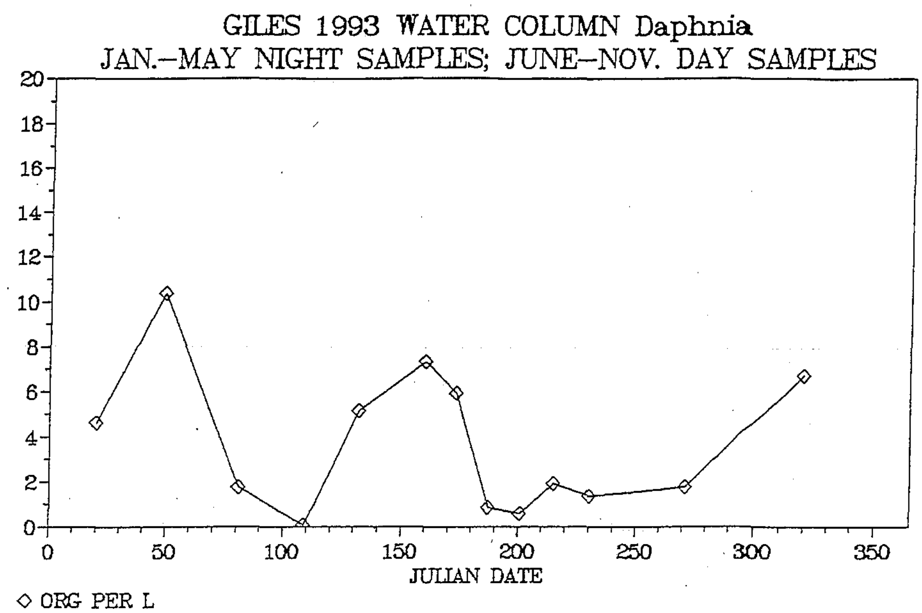


Figure 20. Cladocera in Lake Giles, 1993.

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



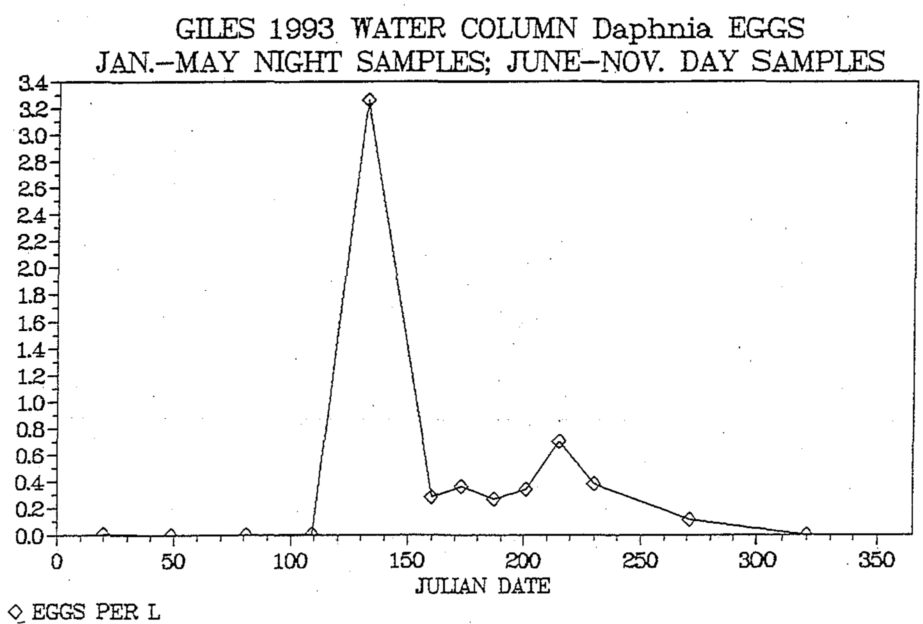
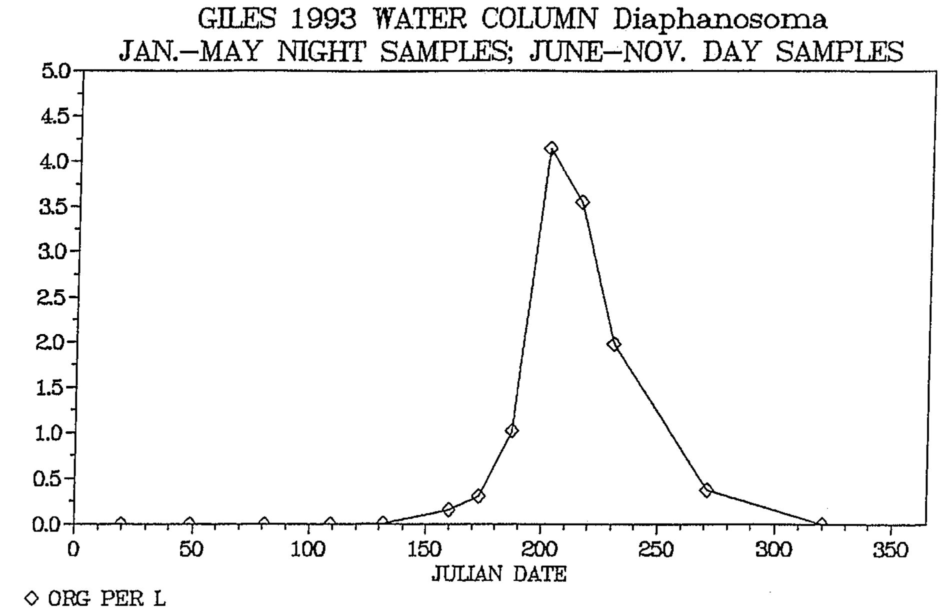


Figure 21. The cladoceran *Daphnia* spp. in Lake Giles, 1993.

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.



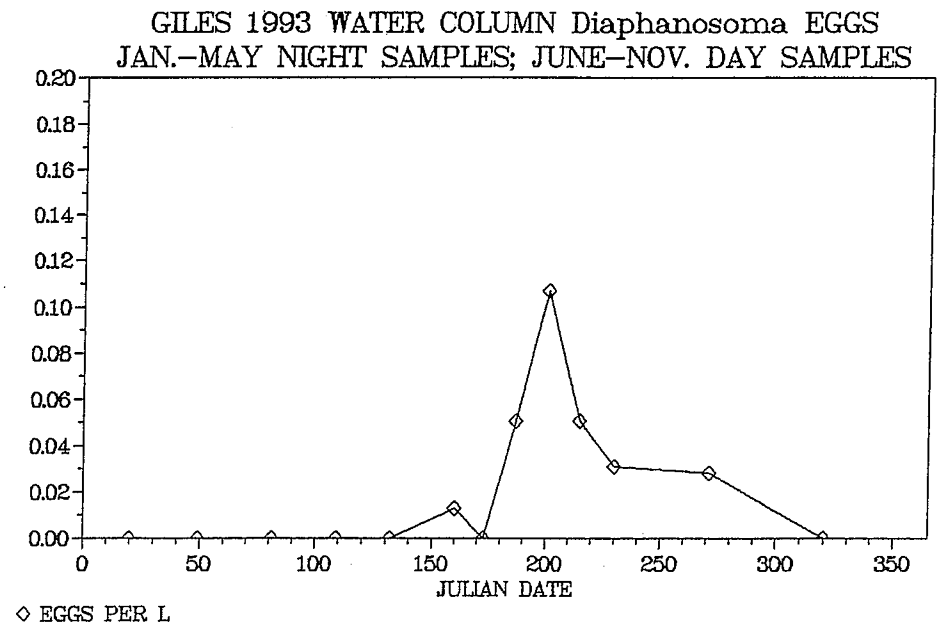


Figure 22. The cladoceran *Diaphanosoma* spp. in Lake Giles, 1993.

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.

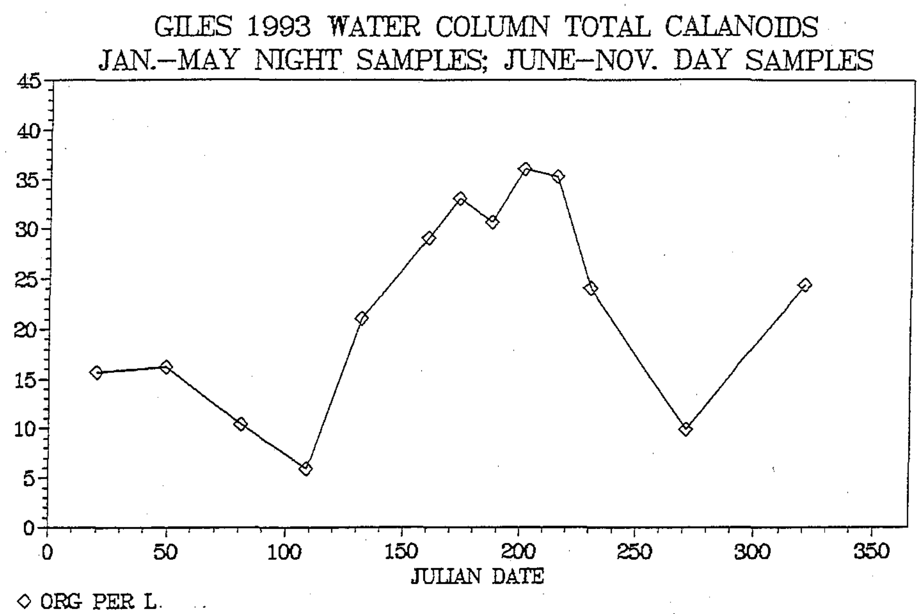


Figure 23. Calanoid copepods in Lake Giles, 1993.

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

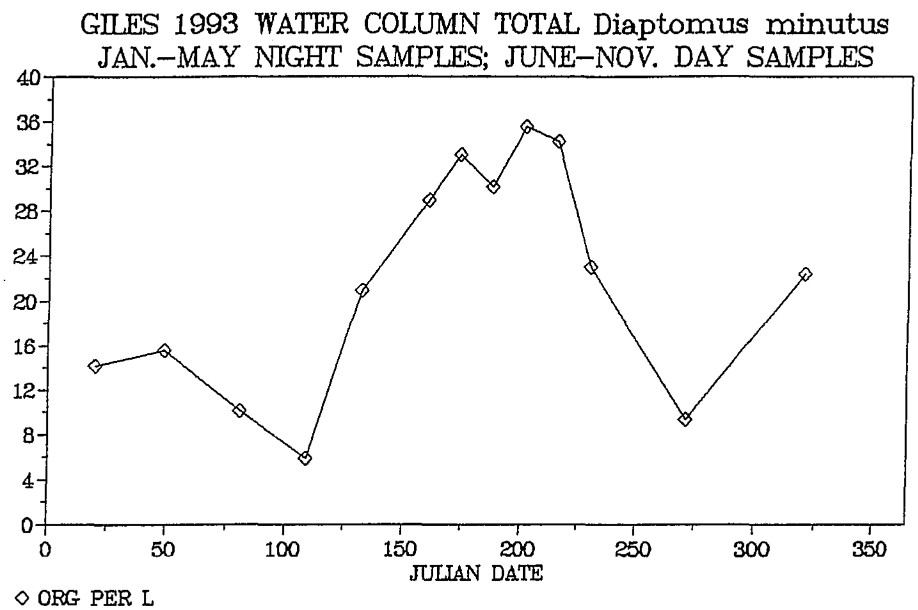
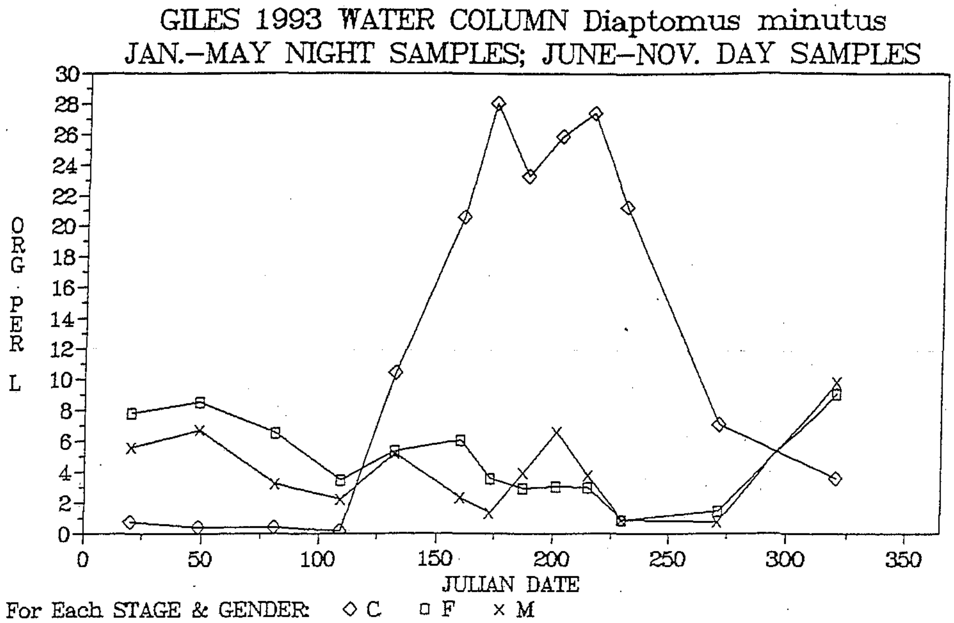


Figure 24. The calanoid copepod *Diaptomus minutus* in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. Concentrations are total individuals per liter (excluding nauplii).



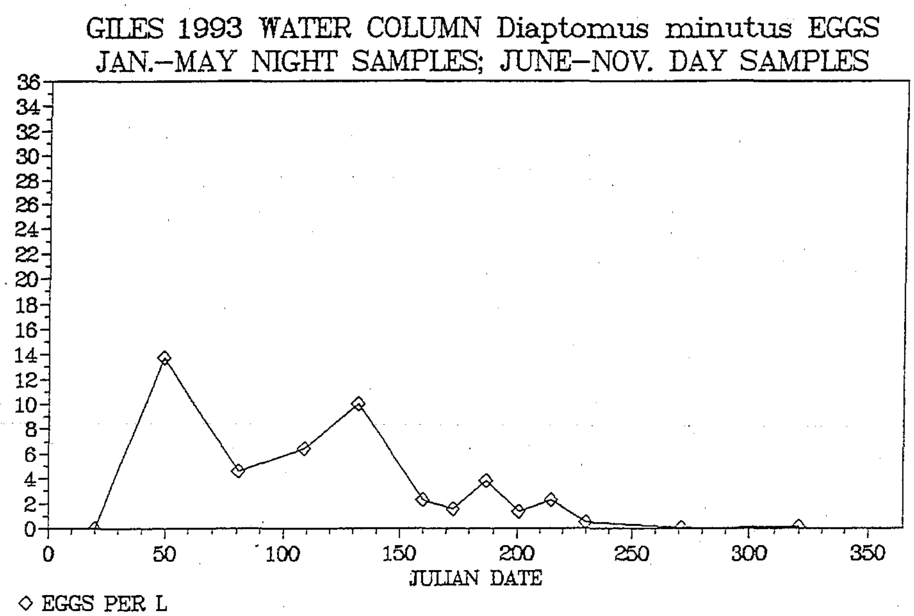


Figure 25. The calanoid copepod *Diaptomus minutus* in Lake Giles, 1993, by stage and gender.

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.

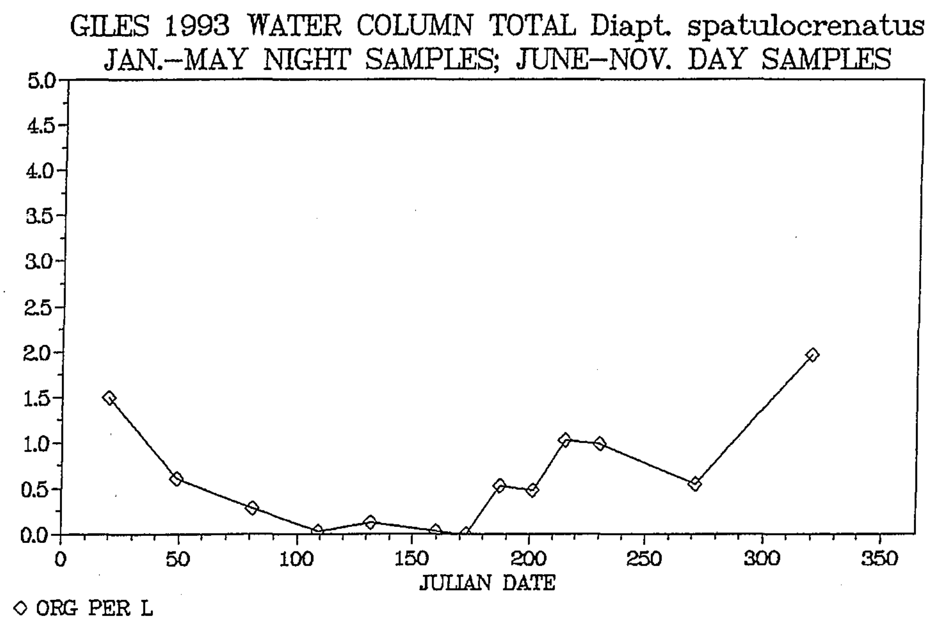
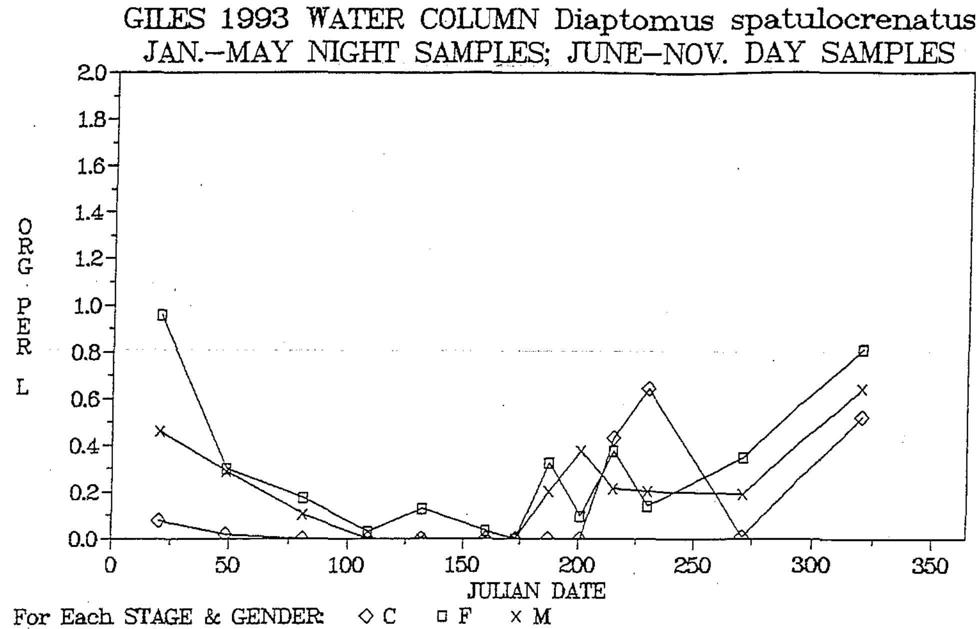


Figure 26. The calanoid copepod *Diaptomus spatulocrenatus* in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. Concentrations are total individuals per liter (excluding nauplii).



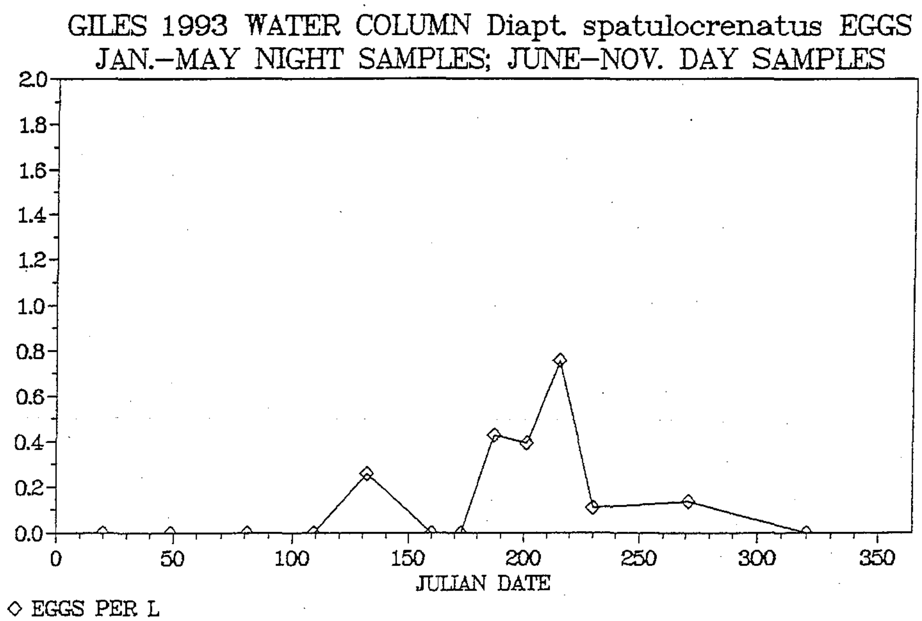


Figure 27. The calanoid copepod *Diaptomus spatulocrenatus* in Lake Giles, 1993, by stage and gender.

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. spatulocrenatus* eggs per liter.

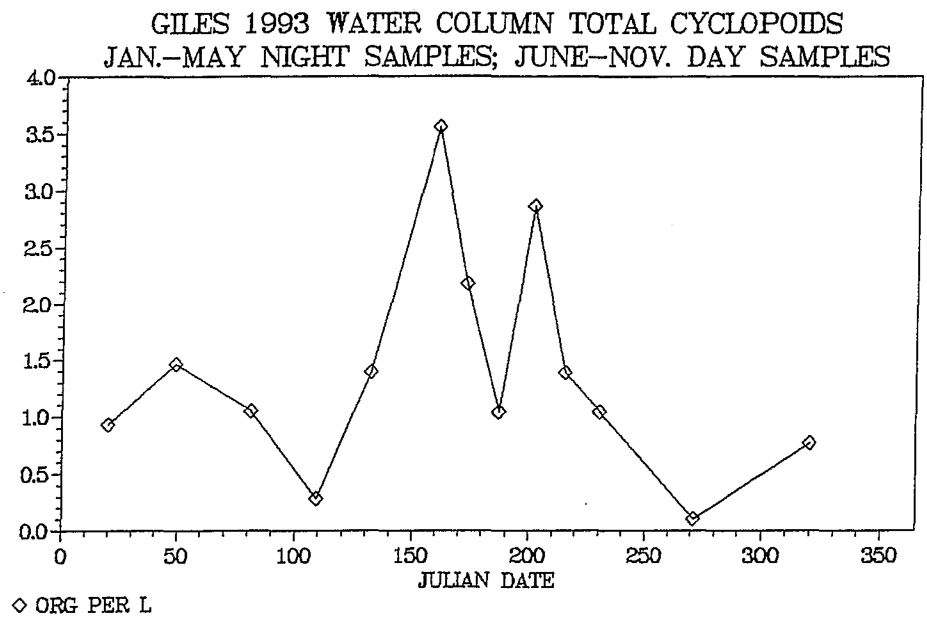


Figure 28. Total cyclopoid copepods in Lake Giles, 1993.

Net collections from three depths have been combined to give a water column mean. Total individuals per liter, excluding nauplii.

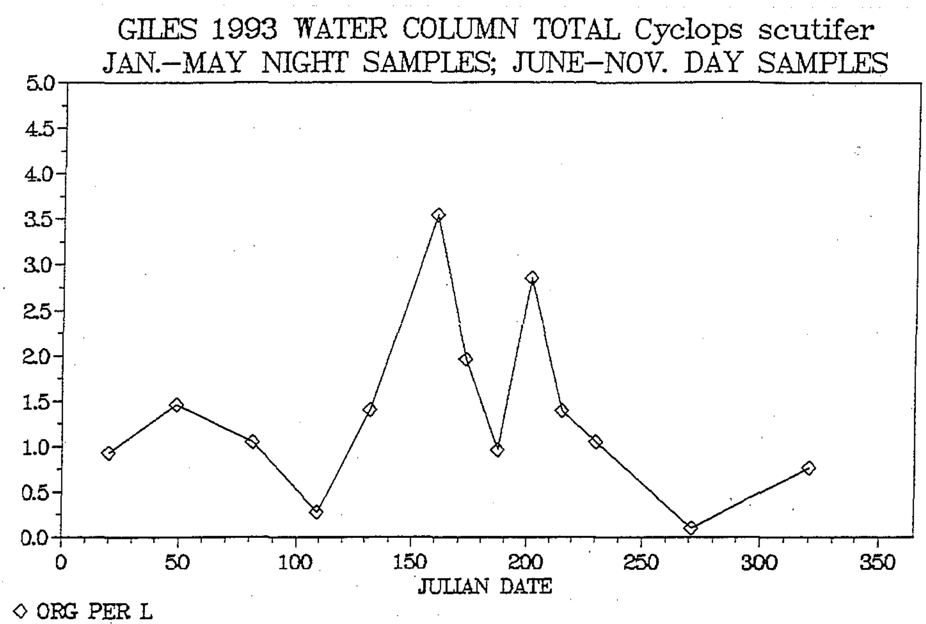
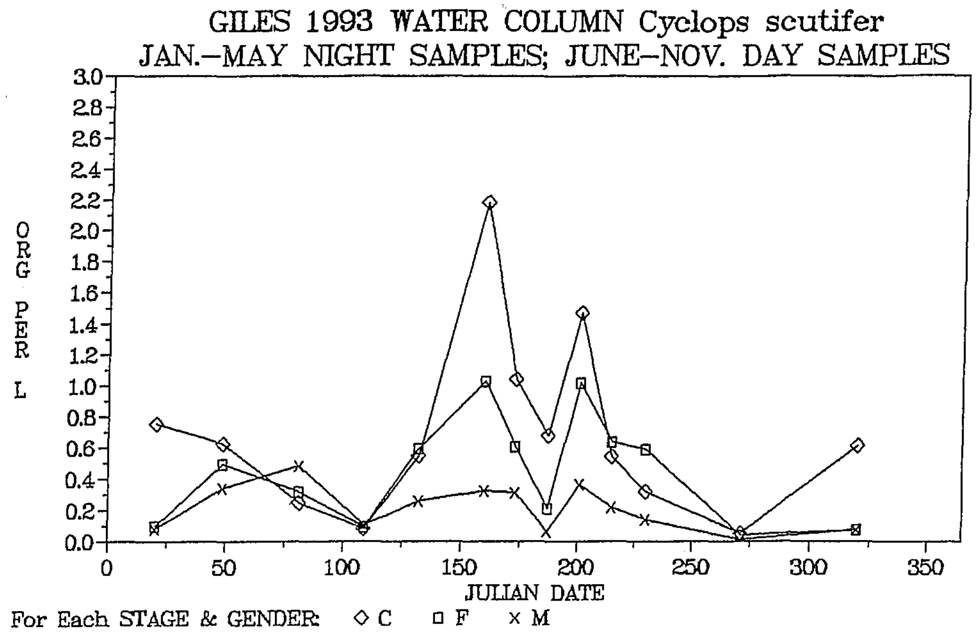


Figure 29. The cyclopoid copepod *Cyclops scutifer* in Lake Giles, 1993.

Net collections from three depths have been combined to give a water column mean. Total individuals per liter, excluding nauplii. Adult females were collected with a 202μm net, males and copepodids with the 48μm net.



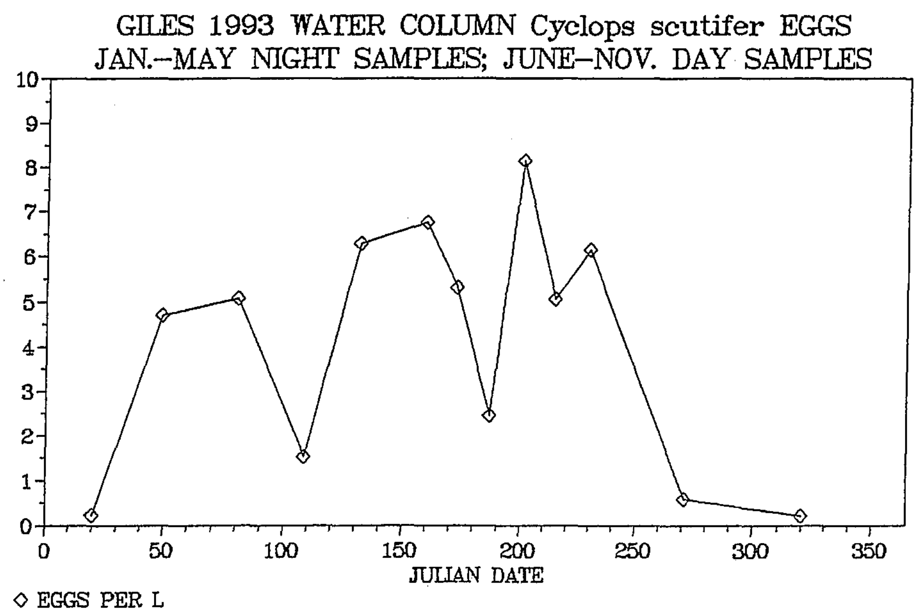
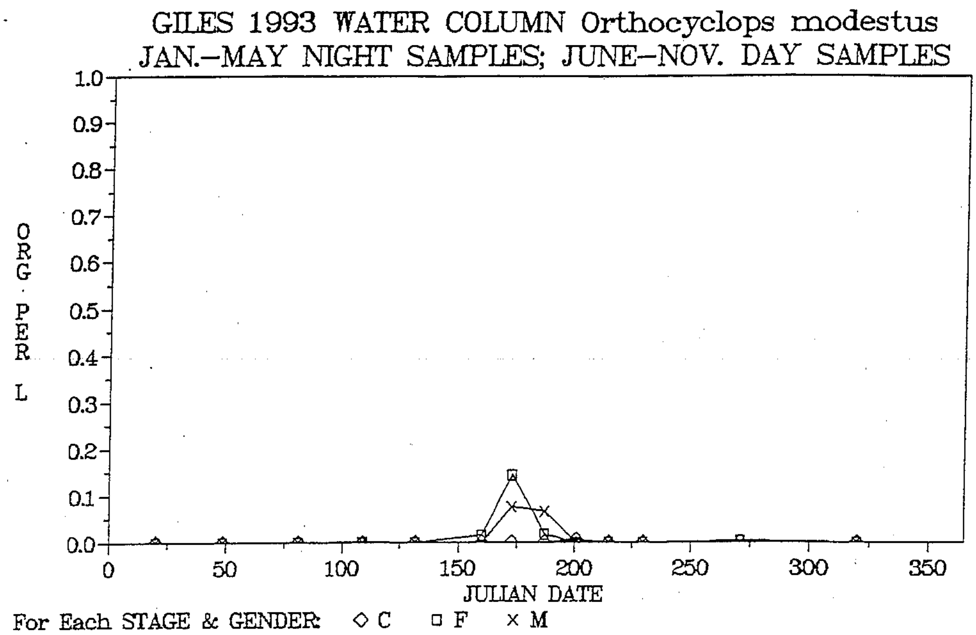


Figure 30. The cyclopoid copepod *Cyclops scutifer* in Lake Giles, 1993, by stage and gender.

Net collections from three depths have been combined to give a water column mean. **(Top)** Adults (males and females separately) and copepodids. Adult females were collected with a 202μm net, males and copepodids with the 48μm net. **(Bottom)** *C. scutifer* eggs per liter.



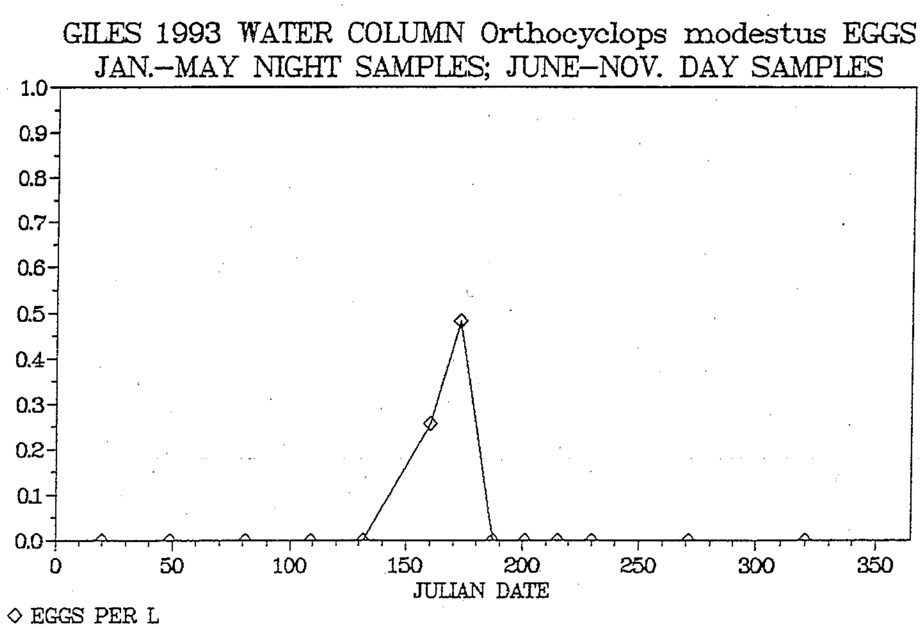


Figure 31. The cyclopoid copepod *Orthocyclops modestus* in Lake Giles, 1993, by stage and gender.

Net collections from three depths have been combined to give a water column mean. **(Top)** Adults (males and females separately) and copepodids. Adult females were collected with a 202μm net, males and copepodids with the 48μm net. **(Bottom)** *O. modestus* eggs per liter.

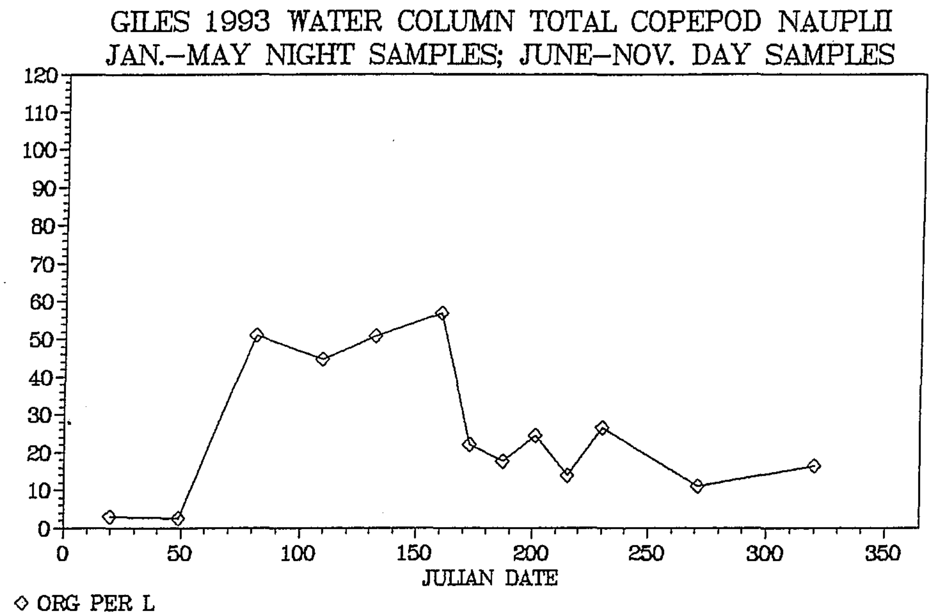


Figure 32. Total copepod nauplii in Lake Giles, 1993.

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

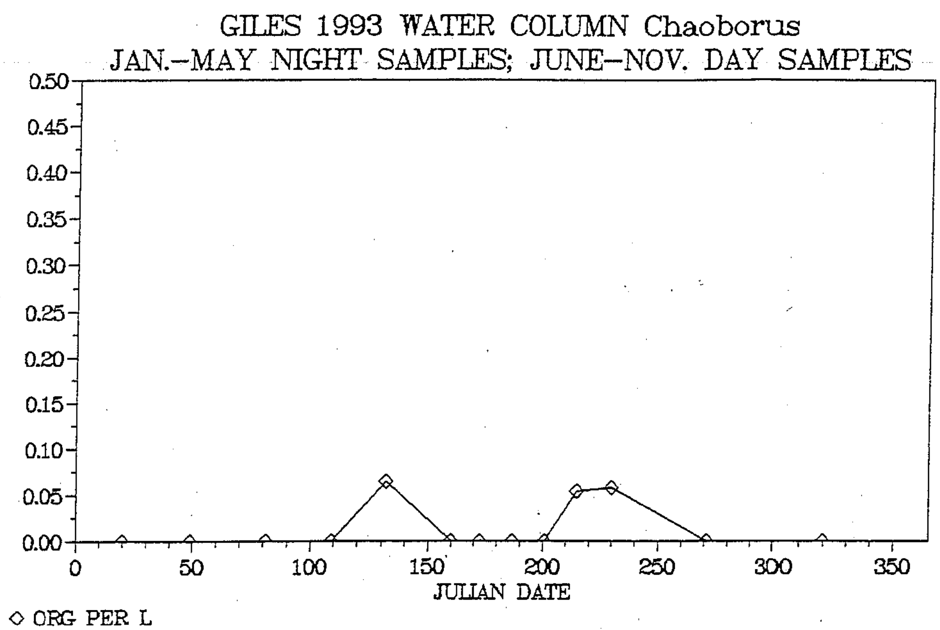


Figure 33. The dipteran *Chaoborus* spp. in Lake Giles, 1993.

Net collections (48μm) from three depths have been combined to give a water column mean. The change from night to day sampling in June has probably caused some underestimation of the population size following the change.

APPENDIX I: CHEMISTRY 1991-92

Chemical sampling in 1991-92 used field and analytical procedures similar to those employed in the 1989 sampling by Dr. Jonathan Cole and Dr. Nina Caraco of the Institute of Ecosystem Studies. A brief resume of the methods is presented here, highlighting differences between the two years. The 1989 results are summarized in the 1990 Annual Report (R.E. Moeller and C.E. Williamson, unpublished report, 1991). The 1991-92 results, from 6 dates, are presented in **Table G.AI**.

FIELD SAMPLING

Samples were collected during the day at the routine sampling station. Water was collected with a battery-operated peristaltic pump through 6-mm inside diameter clear tygon tubing. On the same day, profiles for temperature and dissolved oxygen were obtained *in situ* with a YSI meter (the usual PCLP methods #10 for temperature and dissolved oxygen). Six depths were sampled, including the regular "EPI", "META", and "HYPO" depths, plus 0.5 m and two other meta- or hypolimnetic depths.

Several discrete samples were collected at each depth: (1) a 250-ml polypropylene bottle of unfiltered sample for Ca, Mg, K, Na, Cl, and total phosphorus; (2) a second 250-ml polypropylene bottle of unfiltered sample for pH; (3) a 125-ml polypropylene bottle of filtered water for nutrients (47-mm Whatman GF/F glass fiber filter in a filter holder inserted into collection line just before pump); (4) a 60-ml glass BOD bottle of unfiltered water for total dissolved inorganic carbon; and (5) 35-ml of unfiltered sample into a 50-ml polypropylene centrifuge tube containing 5 ml of zinc acetate solution for sulfate (also sulfide in 1989). The zinc acetate solution was prepared as follows: add 5 volumes of solution I (26 g/L of zinc acetate) to 1 volume of solution II (sodium hydroxide 60 g/L), mix well and pipet suspension from a continuously mixed beaker. Finally, several liters of water were collected from 0.5 m or the "EPI" depth with Van Dorn bottle for particulate total organic carbon and nitrogen.

Soon after collection (in boat or back in laboratory), samples were acidified as follows:

DIC -- add 1.5 ml of 5N H_2SO_4 and place plastic cap over the stopper
Cation sample -- add 2 ml of 1N H_2SO_4
Nutrient sample -- add 1 ml of 1N H_2SO_4

ANALYTICAL METHODS

Analyses of pH were performed in the laboratory at room temperature within 4-8 hr of sampling (routine PCLP method #12, using Ross electrode and adding pHisa solution). Alkalinities are reported for the separate PCLP sampling (same day, different time using Van Dorn sampler, then Gran titration -- Method #11). Total dissolved inorganic carbon was determined by equilibrating 25 ml of acidified solution with 25 ml of N_2 in a 50-ml polypropylene syringe, then injecting 0.5 ml into a gas chromatograph (Shimadzu GC 8A, TCD detector, column of Poropak-Q, He carrier) calibrated with sodium carbonate solutions acidified in the BOD bottles (modified from M.P. Stainton. 1973. J. Fish. Res. Bd Canada 30:1441-1445). Blanks were subtracted from standards but not samples. DIC

Table G.A.1. CHEMICAL CHARACTERIZATION OF LAKE GILES (1991-92).

Date	Depth m	Temp C	O2 mg/L	pH	Alkalinity uEq/L	DIC uM	Ca mg/L	Mg mg/L	K mg/L	Na mg/L	Cl uM	SO4 uM	NH4 uM	NO2 uM	P SRP uM	P totP uM
04/13/91	0.5	8.1	10.78	5.39	--	28	2.10	0.75	0.46	3.57	158	--	3.3	<0.5	0.06	--
04/13/91	4	8.3	10.65	5.39	-1.6	29	2.14	0.77	0.46	3.59	155	--	3.2	<0.5	0.05	--
04/13/91	10	6.7	11.10	5.39	-0.5	26	2.04	0.73	0.46	3.58	156	--	2.7	<0.5	<0.05	--
04/13/91	14	5.5	11.44	5.41	--	27	2.01	0.74	0.46	3.59	153	--	3.0	<0.5	<0.05	--
04/13/91	18	5.1	11.46	5.39	-0.7	35	2.08	0.76	0.47	3.54	146	--	2.5	<0.5	<0.05	--
04/13/91	22	5.0	11.28	5.34	--	48	2.08	0.75	0.46	3.54	151	--	3.0	<0.5	0.07	--
07/01/91	0.5	23.5	7.31	5.34	--	19	2.07	0.75	0.48	3.58	160	--	2.6	<0.5	0.05	0.32
07/01/91	4	23.3	7.27	5.34	-1.0	18	2.17	0.75	0.49	3.76	159	--	2.9	<0.5	<0.05	0.20
07/01/91	7	22.3	7.82	5.33	--	17	2.11	0.77	0.48	3.78	154	--	2.9	<0.5	0.05	0.30
07/01/91	10	15.0	10.52	5.32	-2.6	20	2.05	0.77	0.46	3.73	157	--	2.7	<0.5	0.05	0.18
07/01/91	17	7.6	11.55	5.44	-9.0	22	2.07	0.76	0.44	3.69	153	--	2.4	<0.5	0.07	0.13
07/01/91	22	6.9	8.47	5.40	--	110	2.17	0.74	0.48	3.63	149	--	2.4	<0.5	0.12	0.30
09/21/91	0.5	20.4	7.05	5.32	--	28	2.17	0.77	0.49	3.77	160	--	2.6	<0.5	<0.05	--
09/21/91	5	20.4	6.99	5.30	--	26	2.09	0.76	0.48	3.74	160	--	2.5	<0.5	<0.05	--
09/21/91	9	20.3	6.95	5.31	--	27	2.14	0.75	0.48	3.74	156	--	2.8	<0.5	<0.05	--
09/21/91	13	14.2	9.34	5.36	--	70	2.11	0.76	0.46	3.61	156	--	3.4	<0.5	0.07	--
09/21/91	19	8.1	5.16	5.45	--	231	2.21	0.74	0.50	3.59	153	--	6.8	0.5	0.20	--
09/21/91	22	7.6	1.18	5.61	--	411	2.37	0.74	0.51	3.57	153	--	16.2	0.9	0.14	--
11/22/91	0.5	10.5	9.81	5.41	--	33	2.07	0.72	0.47	3.53	146	--	3.9	0.7	0.05	0.36
11/22/91	3	9.3	9.52	5.42	-4.7	36	2.10	0.75	0.45	3.70	154	--	2.5	<0.5	0.05	0.28
11/22/91	11	8.6	9.13	5.41	--	40	2.16	0.75	0.47	3.69	152	--	2.7	<0.5	0.05	0.35
11/22/91	15	8.5	9.05	5.41	-3.9	41	2.14	0.76	0.49	3.71	153	--	3.3	<0.5	0.05	0.37
11/22/91	18	8.4	9.04	5.42	-4.6	43	2.11	0.79	0.51	3.68	154	--	3.1	<0.5	0.09	0.39
11/22/91	21	8.4	8.77	5.35	--	53	2.14	0.76	0.50	3.71	151	--	4.9	0.5	0.12	0.44
02/21/92	1	2.5	12.22	5.28	-5.5	40	2.13	0.81	0.48	3.88	174	--	1.7	1.5	<0.05	0.38
02/21/92	6	2.5	11.94	5.28	-5.7	41	2.17	0.78	0.48	3.89	174	--	1.7	1.5	<0.05	0.35
02/21/92	12	2.5	11.84	5.33	--	42	2.20	0.79	0.47	3.87	162	--	2.3	1.6	<0.05	0.25
02/21/92	17	2.5	11.49	5.27	-5.2	44	2.20	0.80	0.47	3.85	163	--	2.3	1.8	<0.05	0.22
02/21/92	20	2.7	11.00	5.25	--	56	2.19	0.79	0.47	3.90	164	--	2.4	2.2	0.07	0.37
02/21/92	22	2.9	9.99	5.23	--	78	2.24	0.81	0.47	3.91	157	--	3.1	2.4	0.06	0.20
04/09/92	0.5	4.0	11.68	5.30	--	32	2.16	0.80	0.48	3.90	165	--	2.5	1.1	<0.05	0.33
04/09/92	4	3.9	11.35	5.30	-5.6	30	2.12	0.79	0.46	3.94	175	--	1.6	1.3	<0.05	0.56
04/09/92	11	3.9	11.19	5.31	-6.1	30	2.12	0.78	0.46	3.91	179	--	1.8	1.3	<0.05	0.35
04/09/92	15	3.8	11.17	5.31	--	30	2.17	0.79	0.47	3.94	178	--	1.7	1.4	<0.05	0.14
04/09/92	18	3.8	11.16	5.30	-5.5	31	2.13	0.79	0.48	3.91	177	--	2.3	1.4	<0.05	0.12
04/09/92	22	3.7	11.10	5.30	--	33	2.11	0.79	0.46	3.83	176	--	2.4	1.4	<0.05	0.43

was analyzed within a few days of collection. Particulate C,N samples were prepared by filtering 1-2.5 liters (Lake Giles) onto precombusted 47 mm Whatman GF/F glass fiber filters, which were stored frozen

Water samples for other chemical samples were stored at room temperature for many months before analysis at the Institute of Ecosystem Studies. Calcium (Ca) and magnesium (Mg) were determined by ICP emission, potassium (K) and sodium (Na) by atomic absorption spectrophotometry. Auto-analyzer methods were used for chloride (Cl), nitrate (NO_3, using cadmium reduction), soluble reactive phosphorus (SRP, using molybdenum blue reaction), and ammonium (NH_4, using the phenol-hypochlorite method of Solorzano). Sulfate (SO_4) was determined by ion chromatography -- these analyses are not yet reported for the 1991-92 series. Sulfide (S_2-, 1989 only) was determined spectrophotometrically (N. Gilboa-Garber. 1971. Anal. Biochem. 43:129-133). In the 1989 series, total and total dissolved iron (tFe and tdFe) were measured spectrophotometrically using the α,α-bipyridyl method. Total phosphorus (tP) was measured by molybdenum blue reaction after persulfate digestion. Particulate carbon and nitrogen were determined using a Perkin-Elmer elemental analyzer.

The earlier June-October 1989 sampling series differed from that described above for 1991-92 as follows. In 1989, temperature and oxygen profiles were obtained simultaneously with the pump sampling, as was *in situ* conductivity (not measured in 1991-92). pH was measured immediately in the boat with a battery-powered meter. Methane as well as CO_2 was determined gas chromatographically from the acidified sample in the 60-ml BOD bottle. Chloride was not determined in 1989. The persulfate digest of the unfiltered sample (for total phosphorus) also was analyzed for total iron (tFe). The total phosphorus and iron procedures were repeated on the filtered nutrient sample to give values for total dissolved phosphorus (tdP) and total dissolved iron (tdFe). This was not done in 1991-92.

SUMMARY OF PARTICULATE C,N DATA

Particulate organic carbon (C) and nitrogen (N) were determined on several dates in 1989 and 1991-92. Analyses are not available for other dates, because not enough sample was filtered to give reliable values.

Lake	Date	Depth m	C μM	N μM	C/N molar
Giles	06/20/89	0.5	6.8	1.11	6.13
Giles	10/06/89	0.5	14.0	1.70	8.24
Giles	"	14.	13.1	1.62	8.08
Giles	"	21.	49.4	3.64	13.6
Giles	09/21/91	5.	19.4	2.45	7.92
Giles	11/22/91	0.5	17.7	2.26	7.83
Giles	21/02/92	1.	13.0	1.39	9.35

analyses of N. Caraco and J. Cole

APPENDIX II: PHYTOPLANKTON (1989-1992)

The following 5 pages present phytoplankton data in the form of species biovolumes. The first table summarizes the seasonal data over all three years. The subsequent four tables present the counts for the 12 composite samples. The samples were analyzed by A. St Amand (PhycoTech).

Table G.AII.1. Phytoplankton from Lake Giles, 1989-1992. Major species with their abundance as biovolume.

Values are means of three years, where a single sample was counted from each season each year, representing a composite of all dates and sampling depths during the periods January--February (winter), March--May (spring), June--September (summer) and October--December (autumn).
[Corrected version of 1/27/95]

Alga	Biovolume of species ($10^3 \mu m^3$/mL)			
	winter	spring	summer	autumn
Diatoms				
Asterionella formosa			0.3	
Navicula sp.			0.3	
Nitzschia acicularis		0.3		
Chrysophytes				
Chrysosphaerella longispina		8.1		
Diceras sp.	0.9		0.5	1.0
Dinobryon cylindricum	0.6			0.6
Dinobryon spp. (monads)		1.0		
Epipyxis utriculus v. acuta			0.1	0.3
Mallomonas caudata	56.			16.
Mallomonas spp.	7.5	10.	1.7	
Ochromonas sp.	0.9	3.2	1.0	
Synura uvella/sphagnicola	68.	17.	18.	4.7
Uroglena sp.	17.	10.	6.2	5.9
Cryptophytes				
Cryptomonas sp.		0.3	1.8	0.1
Cryptomonas erosa	5.3	3.7	12.	12.
Cryptomonas ovata	6.3	2.3	5.0	5.3
Rhodomonas minuta	0.1		0.5	0.5
Chlorophytes				
Ankistrodesmus falcatus	0.1			0.1
Botryococcus braunii			32.	5.0
Closterium moniliferum				1.0
Elakatothrix gelatinosa			0.1	
Kirchneriella contorta			2.5	0.4
Monomastix astigmata	2.1	0.8	0.1	2.8
Oocystis parva			1.2	
Schroederia judayi	8.3	0.9	5.2	8.1
Selenastrum minutum			0.1	0.1
Sphaerocystis schroeteri			0.4	
colonial Chlorophyte			0.1	
misc. Chlorococcales		0.1		
Dinoflagellates				
Gymnodinium spp.			0.3	
Cyanobacteria				
coccoid Cyanobacteria		0.5		0.1
Other				
microflagellates (misc.)	4.3	6.0	3.3	3.2
Total Biovolume ($10^3 \mu m^3$/mL):	177.	65.	93.	67.

Table G.AII.2. Spring phytoplankton from Lake Giles--major species and their abundance as biovolume.

A composite sample from each year of all dates and sampling depths during the period March through May was counted.

Alga	Type	Biovolume of species ($10^3 \mu m^3$/mL)			
		1990	1991	1992	mean
Diatoms					
Nitzschia acicularis	Dia			1.0	0.3
Chrysophytes					
Chrysosphaerella longispina	Chr	24.2			8.1
Dinobryon sp.	Chr			3.1	1.0
Mallomonas sp. 3	Chr	23.3	8.3		10.4
Ochromonas sp.	Chr			9.6	3.2
Synura uvella/sphagnicola	Chr	5.8	45.7		17.2
Uroglena sp.	Chr	8.7	9.8	12.6	10.4
Cryptophytes					
Cryptomonas sp. 1	Cry	0.4		0.6	0.3
Cryptomonas erosa	Cry	1.3	5.8	4.1	3.7
Cryptomonas ovata	Cry	3.5	3.5		2.3
Chlorophytes					
Monomastix astigmata	Chl	0.8		1.6	0.8
Schroederia judayi	Chl	0.1	0.1	2.5	0.9
misc. Chlorococcales	Chl		0.2		0.1
Other					
coccoid Cyanobacteria	Cya			1.4	0.5
microflagellates (misc.)	var	7.6	5.3	5.2	6.0
Total Counted Biovolume ($10^3 \mu m^3$/mL):		75.7	78.7	41.7	65.4

Table G.AII.3. Summer phytoplankton from Lake Giles--major species and their abundance as biovolume.

A composite sample from each year of all dates and sampling depths during the period June through September was counted.

Alga	Type	Biovolume of species ($10^3 \mu m^3$/mL)			
		1989	1990	1991	mean
Diatoms					
Asterionella formosa	Dia	0.5		0.5	0.3
Navicula sp. 1	Dia		0.9		0.3
Chrysophytes					
Diceras sp.	Chr		1.4		0.5
Epipyxis utriculus v. acuta	Chr	0.3			0.1
Mallomonas sp. 3	Chr	5.0			0.2
Ochromonas sp.	Chr			2.9	1.0
Synura uvella/sphagnicola	Chr	10.7	30.5	14.1	18.4
Uroglena sp.	Chr			18.5	6.2
Cryptophytes					
Cryptomonas sp. 1	Cry	1.9	1.1	2.3	1.8
Cryptomonas erosa	Cry	5.9	13.5	17.1	12.2
Cryptomonas ovata	Cry		7.9	7.0	5.0
Rhodomonas minuta	Cry		1.6		0.5
Chlorophytes					
Botryococcus braunii	Chl			97.2	32.4
Elakatothrix gelatinosa	Chl		0.2	0.1	0.1
Kirchneriella contorta	Chl	2.8	4.7		2.5
Monomastix astigmata	Chl		0.3		0.1
Oocystis parva	Chl		3.1	0.5	1.2
Schroederia judayi	Chl		8.1	7.4	5.2
Selenastrum minutum	Chl		0.2		0.1
Sphaerocystis schroeteri	Chl		1.2		0.4
colonial Chlorophyte	Chl			0.1	0.1
Dinoflagellates					
Gymnodinium sp. 3	Din	1.0			0.3
Other					
microflagellates (misc.)	var	1.4	4.5	3.9	3.3
Total Counted Biovolume ($10^3 \mu m^3$/mL):		29.4	79.1	171.6	93.4

Table G.AII.4. Autumn phytoplankton from Lake Giles--major species and their abundance as biovolume.

A composite sample from each year of all dates and sampling depths during the period October through December was counted.

Alga	Type	Biovolume of species ($10^3 \mu m^3$/mL)			
		1989	1990	1991	mean
Chrysophytes					
Diceras sp.	Chr	1.3	1.3	0.4	1.0
Dinobryon cylindricum	Chr	0.6		1.2	0.6
Epipyxis utriculus v. acuta	Chr	1.0			0.3
Mallomonas caudata	Chr	48.4			16.1
Synura uvella/sphagnicola	Chr		7.1	7.0	4.7
Uroglena sp.	Chr		4.6	12.0	5.5
Cryptophytes					
Cryptomonas sp. 1	Cry	0.4			0.1
Cryptomonas erosa	Cry	5.3	14.2	16.2	11.9
Cryptomonas ovata	Cry		5.3	10.6	5.3
Rhodomonas minuta	Cry		1.6		0.5
Chlorophytes					
Ankistrodesmus falcatus	Chl	0.2			0.1
Botryococcus braunii	Chl		15.0		5.0
Closterium moniliferum	Chl		2.9		1.0
Kirchneriella contorta	Chl			1.2	0.4
Monomastix astigmata	Chl	0.2	1.5	6.7	2.8
Schroederia judayi	Chl	4.5	9.3	10.5	8.1
Selenastrum minutum	Chl			0.1	0.1
Other					
coccoid Cyanophyta	Cya	0.2			0.1
microflagellates (misc.)	var	0.2	4.8	4.6	3.2
Total Counted Biovolume ($10^3 \mu m^3$/mL):		62.3	67.6	70.5	66.8

Table G.AII.5. Winter phytoplankton from Lake Giles--major species and their abundance as biovolume.

A composite sample from each year of all dates and sampling depths during the period January through February was counted.

Alga	Type	Biovolume of species ($10^3 \mu m^3$/mL)			
		1990	1991	1992	mean
Chrysophytes					
Diceras sp.	Chr		1.3	1.3	0.9
Dinobryon cylindricum	Chr	1.8			0.6
Mallomonas caudata	Chr	166.4			55.5
Mallomonas sp. 3	Chr		22.6		7.5
Ochromonas sp.	Chr	1.0	1.7		0.9
Synura uvella/sphagnicola	Chr	36.6	166.0		67.5
Uroglena sp.	Chr	28.8	20.9	2.2	17.3
Cryptophytes					
Cryptomonas erosa	Cry	9.7	4.1	2.0	5.3
Cryptomonas ovata	Cry	15.5	3.5		6.3
Rhodomonas minuta	Cry		0.2		0.1
Chlorophytes					
Ankistrodesmus falcatus	Chl		0.1		0.1
Monomastix astigmata	Chl	0.6	0.2	5.6	2.1
Schroederia judayi	Chl	1.4	0.8	22.6	8.3
Other					
microflagellates (misc.)	var	3.3	3.5	6.1	4.3
Total Counted Biovolume ($10^3 \mu m^3$/mL):		265.1	224.9	39.8	176.6

APPENDIX III: ZOOPLANKTON SAMPLING

Table. G.AIII. Zooplankton collection with nets compared to Schindler trap.

Values are concentrations (avg #/L ±SD) from N=5 vertical hauls or trap series (1 each at five stations in each lake). The ratios (R_{48}, R_{202}) are net values divided by trap values. The lakes were sampled the evening of 16 June 1993. Details of methods are discussed in the text (see **ZOOPLANKTON**).

	Schindler Trap		202-μm Net			48-μm Net		
	avg	±SD	avg	±SD	R_{202}	avg	±SD	R_{48}
Lake Giles								
Daphnia (total)	22.38	±2.17	15.81	±2.18	*0.706*	18.53	±1.19	*0.828*
Daphnia (large)	19.07	1.71	14.59	2.13	*0.765*	16.03	1.36	*0.841*
Daphnia (small)	3.31	0.70	1.21	0.18	*0.366*	2.49	0.21	*0.753*
Holopedium gibberum								
Diaptomus (total)	23.23	3.38	19.97	2.04	*0.860*	23.79	3.13	*1.024*
D. minutus	23.07	3.40	19.85	2.09	*0.860*	23.60	3.12	*1.023*
D. oregonensis								
D. spatulocrenatus	0.16	0.08	0.12	0.09	*0.775*	0.18	0.11	*1.138*
Cyclopoid copepods								
Asplanchna								
Lake Lacawac								
Daphnia (total)	6.16	±0.90	4.17	±0.75	*0.677*	5.03	±0.80	*0.817*
Daphnia (large)	4.08	0.79	2.46	0.36	*0.602*	3.22	0.73	*0.789*
Daphnia (small)	2.08	0.18	1.71	0.42	*0.823*	1.81	0.10	*0.871*
Holopedium gibberum	1.33	0.53	1.32	0.40	*0.995*	1.11	0.60	*0.839*
Diaptomus (total)								
D. minutus	5.36	0.66	4.04	0.52	*0.754*	6.31	0.92	*1.178*
D. oregonensis								
D. spatulocrenatus								
Cyclopoid copepods	1.84	0.53	1.26	0.25	*0.686*	1.92	0.31	*1.045*
Asplanchna	0.52	0.20	1.03	0.18	*1.981*	0.68	0.29	*1.308*
Lake Waynewood								
Daphnia (total)	21.55	±2.52	21.70	±4.93	*1.007*	25.83	±4.82	*1.199*
Daphnia (large)	14.55	1.51	12.96	2.76	*0.891*	16.86	3.26	*1.159*
Daphnia (small)	7.00	1.16	8.74	2.35	*1.248*	8.97	1.68	*1.282*
Holopedium gibberum								
Diaptomus (total)								
D. minutus								
D. oregonensis	0.10	0.04	0.14	0.04	*1.469*	0.12	0.04	*1.245*
D. spatulocrenatus								
Cyclopoid copepods	0.05	0.02	0.05	0.02	*1.174*	0.05	0.02	*1.043*
Asplanchna	1.88	0.45	2.46	0.64	*1.309*	2.44	0.74	*1.298*