PRIMARY PRODUCTION OF THE BIG EAU PLEINE RESERVOIR, WISCONSIN

by

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ABSTRACT

Measurements of primary production and phytoplankton biomass were determined in 1975 and 1976 in the Big Eau Pleine Reservoir, Wisconsin. The data was collected to provide an information base of the phytoplankton dynamics in the reservoir for the calibration of a computer model. Primary production analysis was accomplished using the carbon-14 and oxygen light and dark bottle techniques. Phytoplankton biomass was measured by chlorophyll a analysis and by the determination of phytoplankton volume.

The average rates of carbon-14 productivity for 1975 and 1976 were 1.3 and 2.8 g C/m^2/day, respectively. The estimated annual productivity was 300 g C/m^2 in 1975 and 605 g C/m^2 in 1976. The average surface phytoplankton volume measurements for the summer periods (June-September) of 1975 and 1976 were 32.2 and 53.0 mm^3/l, respectively. Correspondingly, the mean chlorophyll a concentrations for these periods were 53.2 and 103.0 μg/l, respectively. Phytoplankton volume paralleled changes in chlorophyll a throughout the study.

The observed increase in primary productivity and phytoplankton biomass in 1976 were attributed to increased solar radiation, water temperature, and internal phosphorus loading in the summer months of 1976 as compared to the previous summer period. Surface water temperatures were warmer in the summer of 1976 in response to increased solar radiation. The timing and magnitude of the summer drawdown influenced the release of phosphorus from the reservoir sediments. An earlier and more extensive summer drawdown in 1976 provided higher levels of total reactive phosphorus than the previous summer period. The release of phosphorus from the reservoir sediments during the summer months provided a significant source of phosphorus for phytoplankton production.

The phytoplankton biomass was dominated by a bloom forming blue-green alga, *Aphanizomenon flos-aquae*. Results of nutrient enrichment bioassays and the determination of the chemical composition of *A. flos-aquae* indicated that phosphorus was the primary limiting nutrient. A discussion of computer model coefficients for algae is presented.

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INTRODUCTION

The Big Eau Pleine Reservoir has been the focus of several research projects within the last several years. The reservoir was investigated by the U.S. Environmental Protection Agency National Eutrophication Survey in 1972 to determine the factors responsible for its trophic state (U.S. EPA 1974). Additional data on the Big Eau Pleine Reservoir environment was compiled in 1972 and 1973 by a Student-Originated Studies Program (National Science Foundation) at the University of Wisconsin - Stevens Point (Bartelt et al. 1973). The impact of water level manipulation of the aquatic macroinvertebrate and zooplankton communities have been studied by Kaster (1976) and Buchanan (1976), respectively.

The primary goal of this research was to provide an information base of the phytoplankton dynamics in the reservoir for the calibration of a computer model by fellow graduate students. This included an analysis of the environmental factors regulating the phytoplankton community in the reservoir and a comparison of techniques used to measure primary production and phytoplankton biomass.

The Big Eau Pleine Reservoir is located in southern Marathon County in north central Wisconsin (Fig. 1). The reservoir was constructed by the Wisconsin Valley Improvement Company (WVIC) in 1939 and is used primarily for flow augmentation of the Wisconsin River (Martin and Hanson 1966). The Big Eau Pleine River, the major tributary, has a mean

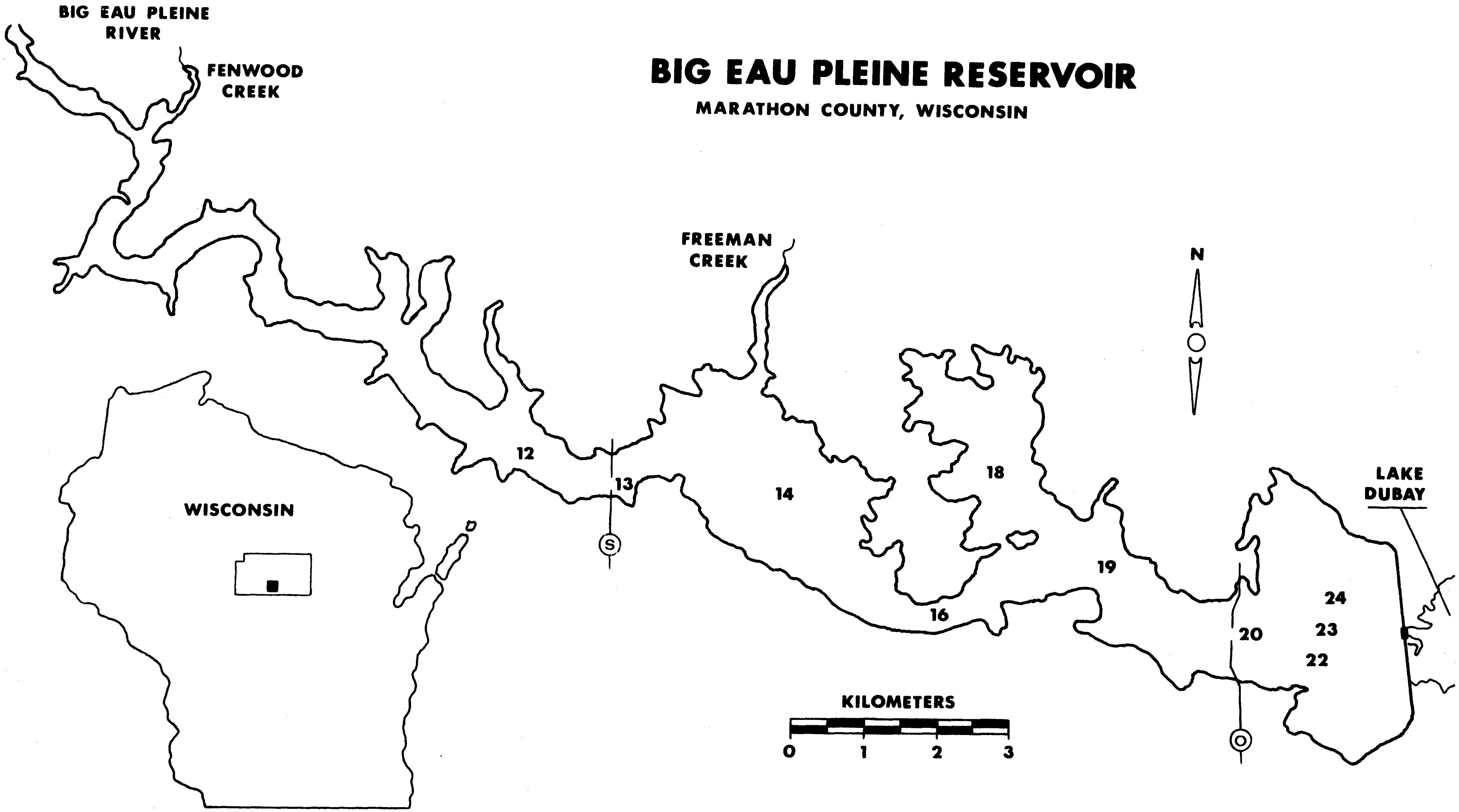

Figure 1. The Big Eau Pleine Reservoir indicating sampling stations.

annual flow of 4.81 m^3/s (USGS 1976). Two smaller tributaries, Fenwood and Freeman Creek, contribute approximately 16 percent of the flow of the Big Eau Pleine River (U.S. EPA 1974). Physical and limnological data of the study area are summarized in Table 1.

Table 1. Physical and limnological data of the Big Eau Pleine Reservoir (U.S. EPA 1974).

Surface Area*	27.6 km^2	Shoreline*	106.2 km
Max Volume	131.5 x 10^6 m^3	Watershed Area	945.4 km^2
Mean Depth*	4.8 m	Mean Detention Time	0.4 yr
Length*	24.8 km		
Breadth*	4.5 km	Total Alkalinity (mg $CaCO_3$/1)	17-35

*At maximum volume.

Water level fluctuations of up to 9.0 m are common during a normal year of regulation. The reservoir reaches its maximum volume in April or early May (Fig. 2) after spring runoff. The WVIC usually draws down the reservoir in July and August, and November through March, and stores water at other times of the year (Wiley 1977). The actual pattern of water level manipulation changes from year to year because of changes in seasonal or annual precipitation. Abnormally low precipitation (Fig. 2), coupled with reservoir discharge in the summer and fall periods of 1976, resulted in a marked reduction in reservoir volume in the latter part of 1976 and early 1977.

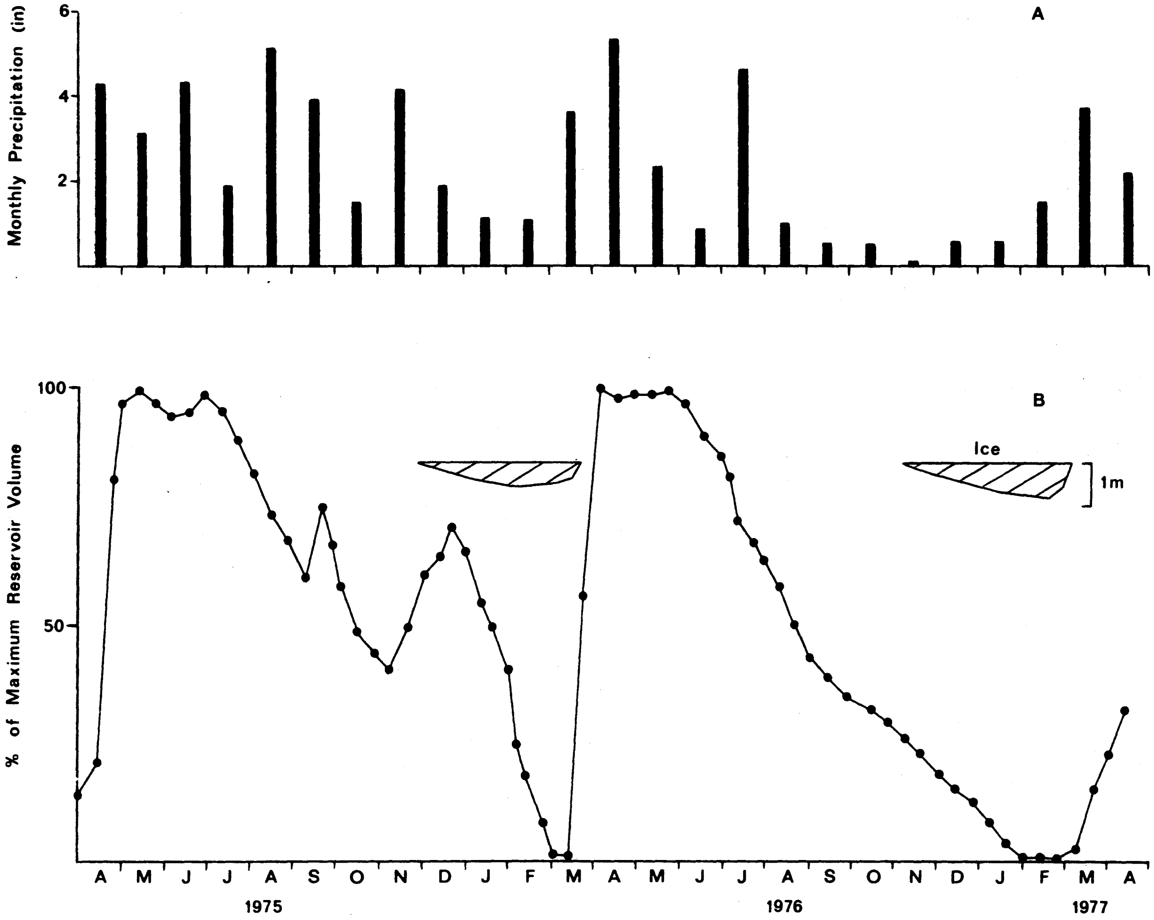

Figure 2. A. Monthly precipitation. Averaged data for the Marshfield Experimental Farm and the Big Eau Pleine Reservoir Dam. B. Relative changes in reservoir volume during the study period (Vennie 1978).

The reservoir is eutrophic and experiences dense blooms of algae in the summer months and fish kills in the winter when dissolved oxygen concentrations and water levels are low (Kloppenburg 1974). The reservoir is usually unstratified for most of the open-water period; however, weak thermal stratification may be established during periods of hot, calm weather.

The watershed is characterized by gentle rolling hills and by fine textured soils that are subject to runoff (Kaminski 1977). Nitrogen and phosphorus loading from agricultural activities account for a large portion of nutrients sources for the reservoir, particularly during spring runoff (Shaw 1976).

MATERIALS AND METHODS

Primary Production

Measurements of primary production were determined by *in situ* incubations from May 1975 to January 1977 using the oxygen and the carbon-14 methods. Measurements were made biweekly during the open-water periods and less frequently during the winter season. The actual number of sites sampled on any sampling day varied with the time available and the method used. Two stations, 19 and 23, (Fig. 1) were sampled from May through September 1975 using the carbon-14 method. The oxygen method was run in parallel with the carbon-14 technique at station 23 from June 1975 through October 1976. Production measurements were normally made on days with minimal cloud cover in order to estimate photosynthetic rates under optimal light conditions. Samples for photosynthetic-depth incubations were collected from the surface and at depths of 0.5, 1.0, 1.5, 2.0, 3.0, and 5.0 meters using either a van Dorn sampler or peristalic pump. One dark and two light bottles (300 ml) were incubated at their respective collection depths. Sample bottles were suspended horizontally from a calibrated chain that was attached to a metal bar at the surface. The metal bar was supported by two buoys that were anchored at the sampling station. The exposure period varied from 3 to 5 hours during the hours of 1000 to 1500.

The azide modification of the Winkler analysis was used to determine gross and net production of dissolved oxygen (APHA 1976). The oxygen samples were fixed in the field and titrated within 6 hours in the laboratory. A photosynthetic quotient of 1.2 was used to express oxygen production in terms of carbon assimilated (Strickland 1960).

Three to five μCi (0.2 ml) of $NaH^{14}CO_3$ were added with a Hamilton syringe to light and dark bottles in the carbon-14 method. These samples were packed in ice and transported back to the laboratory in the dark at the end of the incubation period. They were prepared for liquid scintillation counting within 12 hours. The activity of fixed carbon-14 was determined on all samples by the membrane filtration technique (Lind 1974) and less frequently by the acidification and bubbling procedure (Schindler et al. 1972). In the filtration technique, 25 ml samples were vacuum filtered through 47 mm diameter Millipore filters with a 0.45 μ pore size at less than 150 mm of mercury. The wet filters were placed directly into scintillation vials and dissolved in a scintillation cocktail described by Schindler (1966). In the acidification and bubbling procedure, 10 ml samples were acidified to a pH of 3.0 to 3.4 and bubbled with air that was passed through 10N NaOH to remove carbon dioxide. Two milliliter aliquots of the resulting samples were placed in scintillator vials and counted using the same fluor used in the filtration technique. The absolute activity of fixed carbon-14 was determined by internal standardization using liquid scintillation analysis (Packard Instruments Model 3320).

Total carbon assimilated during the incubation period was determined by the procedure of Lind (1974).

Total areal production (integral photosynthesis) for the incubation period in both the carbon-14 and oxygen techniques was estimated by determining the area enclosed by the photosynthetic-depth profile. Daily integral photosynthesis was estimated by multiplying the incubation period values by the ratio of the total daily solar radiation to the solar radiation for the incubation period (Schindler and Holmgren 1971).

Additional daily integral production measurements for 4 other stations were obtained by collecting samples from sites 14, 16, 19, 20 (Fig. 1) at the depth of maximum photosynthesis and incubating them at station 23 at the same depth. The depth of maximum photosynthesis (pmax) was normally 0.5 m. The approach to these integral production measurements is an empirical one and utilizes the relationship discussed by Vollenweider (1965, 1974). The equation is

$$\mathrm{Ip} = \frac{\mathrm{pmax}}{e} \cdot F(i) \cdot L_f$$

where Ip is the daily integral photosynthesis (g C/m^2/day). The value pmax represents the maximum photosynthetic rate (g C/m^3/period) at optimal light. The parameter, e, is the vertical extinction coefficient of photosynthetic active light. The F(i) term is a function of photosynthetically active radiation. A light factor, L_f, adjusts the rates obtained for the exposure period to daily rates. This empirical approach was normally determined with the carbon-14 method. The oxygen technique was utilized in June and July of 1976 because of a delayed shipment of carbon-14. The function F(i) was determined empirically from the integral photosynthetic rates determined for site 23.

Phytoplankton Biomass

Phytoplankton biomass was determined by the trichromatic chlorophyll method and was not corrected for pheophytin (APHA 1976) and also by direct phytoplankton enumeration. A Palmer counting chamber (Palmer and Maloney 1954) was used to make quantitative phytoplankton counts at 400X. Phytoplankton samples were concentrated by sedimentation and were preserved with merthiolate (APHA 1976). Cell counts were transformed into volumetric units by determining the average cell, colony, or filament size of the particular taxa (Vollenweider 1974). The taxonomic keys of Smith (1950) and Prescott (1973) were used to identify algae.

Samples for phytoplankton biomass analysis were normally collected biweekly with a van Dorn water sampler during the open-water periods of 1975 and 1976 and less frequently during the winter months. Phytoplankton samples were collected by staff members of the Environmental Task Force (University of Wisconsin - Stevens Point) during biweekly water chemistry sampling. Chlorophyll samples were also collected by the Environmental Task Force and also when primary production measurements were made.

Phytoplankton samples were collected from surface (0.5 m), middle (mid-depth), and bottom (1.0 m above sediment) depths at stations 13, 16, and 23 in the open-water period (April-November) of 1975. Only surface samples were collected during the remaining study period (December 1975-April 1977). Additional surface phytoplankton samples were collected at stations 14 and 20 during the winter months (November-March) of 1976-1977.

Chlorophyll samples were collected from surface, middle, and bottom depths at stations 13, 14, 16, 20, and 23. In addition, surface chlorophyll samples were obtained at stations 12, 18, 22, and 24 when reservoir stage was high enough to permit sampling at these sites. The inflow and outflow stations, 6 and 25 respectively, were sampled infrequently during the two year study period. Additional surface chlorophyll samples were taken at stations 14, 16, 19, 20, and 23 when measurements of primary production were made. At this time, the depth distribution of chlorophyll at the surface and at depths of 0.5, 1.0, 1.5, 2.0, 3.0, and 5.0 meters were usually determined at sites 23 and 19.

Algal Bioassays

Laboratory algal bioassays were performed on samples collected on June 8, July 7, and October 26, 1976 to determine the response to various treatments and nutrient additions. The bioassay methods followed the Algal Assay Procedure (AAP) Bottle Test which is summarized by Weber (1973). The test alga used was the green alga, *Selenastrum capricornutum* Printz. Measurements of growth were determined by monitoring the optical density at 750 with a spectrophotometer (Bausch and Lomb Spectronic 88) for the June and July bioassays. The October bioassay was monitored with a Turner fluorimeter (model 111) set up for *in vivo* chlorophyll analysis. The growth response to the various treatments was measured several times over a two week period.

Water samples were collected from sites 23 and 14, and 23 and 16 for the June and July bioassays, respectively. A composite of sites 13, 14, 16, 20, and 23 was used in the October bioassay. Water samples were prepared for the various treatments in triplicate immediately upon return to the laboratory. Treatments for nutrient additions (N, P, N & P) were first filtered through a 0.8 μ diameter pore size glass fiber filters (Whatman GF/A) and next through a 0.45 μ diameter pore size membrane filters (Millipore Corp.). Nitrogen and phosphorus additions were 0.587 and 0.029 mg/l, respectively. Treatments were also prepared on autoclaved and double filtered samples. In the October bioassay an autoclaved (not filtered) treatment was added. Controls were made on double filtered samples as described above. The growth response of the various treatments was compared to a standard culture media described by Weber (1973).

Ancillary Measurements

Daily solar radiation measurements were determined with a star pyranometer (Weather Measure Corp.) located in Stevens Point, Wisconsin approximately 55 km from the Big Eau Pleine Reservoir. Additional daily solar radiation measurements were obtained from the U.S. Weather Bureau located in Madison, Wisconsin which is located about 180 km from the reservoir. A regression equation ($r^2 = 0.825$) between the Madison and Stevens Point stations was used to estimate missing solar radiation measurements for the Stevens Point station.

Total light extinction was determined with a Whitney submarine photometer (Montedoro Corp.) during *in situ* primary production studies at stations 14, 16, 19, 20, and 23. Additional data on light penetration was collected with a 20 cm diameter Secchi disc.

Water chemistry analysis was performed by the Environmental Task Force at the University of Wisconsin - Stevens Point. The parameters measured were pH, conductivity, alkalinity, total hardness, calcium hardness, dissolved oxygen, BOD_5, total reactive phosphorus, total phosphorus, ammonium nitrogen, nitrite+nitrate nitrogen, and Kjeldahl nitrogen and followed the procedures listed in *Standard Methods, 14th Edition* (APHA 1976). An exception was inorganic nitrogen determination where ammonium and nitrite+nitrate nitrogen were measured by the method of Bremner and Keeney (1965). A field pH meter (Beckman Instruments) was used to determine in situ pH for primary production studies.

Composite phytoplankton samples were collected with a Wisconsin plankton net during the summer of 1976 (June-August) to determine the nutrient and pigment content of Aphanizomenon flos-aquae, the dominant alga in the reservoir. These samples were passed through a 0.5 mm sieve to remove large zooplankton. Subsamples were filtered on glass fiber filters (Whatman GF/A), folded in half and placed in plastic petri dishes (Millipore Corp.). These samples were stored in a freezer until analysis of total phosphorus, Kjeldahl nitrogen, and chlorophyll a content could be performed. Analysis of these parameters followed the procedures recommended in Standard Methods, 14th Edition (APHA 1976).

The maximum specific growth of Aphanizomenon flos-aquae was determined under laboratory conditions using an inorganic media defined by O'Flaherty and Phinney (1970). Individual trichomes of A. flos-aquae were isolated from reservoir samples in June of 1976 to obtain a pure culture (not axenic) for growth studies. Cultures were grown in an environmental chamber in aerated 250 ml erlenmeyer flasks at 20 ^{o}C using cool white fluorescent lighting which provided 4000 lux at the base of the flasks. Growth was monitored by turbidometric analysis using a spectrophotometer (Bausch and Lomb model 88) at 750 nm.

Statistical Procedures

All of the statistical procedures used in this research were available as statistical packages on a Burroughs 6700 digital computer. One-way analysis of variance, Pearson's product moment correlation, and regression analysis were available through the use of the "Minitab" package (Ryan et al. 1976). The Statistical Package for the Social Sciences (SPSS) was used for stepwise multiple regression analysis (Nie et al. 1975). Dependent and independent variables used in regression analysis are presented in Table 2.

Table 2. Dependent and independent variables used in linear regression analysis.

Dependent Variable	Independent Variable	Unit of Measurement
Chlorophyll a (µg/l)	BOD_5*	mg/l
	NO_2+NO_3 Nitrogen	mg/l
	Kjeldahl Nitrogen	mg/l
	Ammonium Nitrogen	mg/l
	Total Phosphorus	mg/l
	Total Reactive Phosphorus	mg/l
	Dissolved Oxygen	mg/l
	Organic Phosphorus*	mg/l
	Organic Nitrogen*	mg/l
	Alkalinity ($CaCO_3$)	mg/l
	Temperature	°C
	Vertical Extinction Coefficient*	1/m
Integral Photosynthesis (g C/m^2/day)	Chlorophyll a	mg/m^2
	Solar Radiation	Langleys/day
	Vertical Extinction Coefficient	1/m
	Temperature	°C
	I_k**	Langleys/day
	F(i)***	dimensionless
pmax (g C/m^3/hr)	Chlorophyll a	µg/l
	Solar Radiation	Langleys/hr
	Vertical Extinction Coefficient	1/m
	Temperature	°C
	I_k**	Langleys/hr
	F(i)***	dimensionless

*Not used in multiple regression analysis

**A value that is about two times the onset of light saturation (Vollenweider 1965).

***A function of photosynthetic active light (Vollenweider 1974).

RESULTS AND DISCUSSION

Primary Production

Current research on aquatic primary production is centered on the flow of carbon in aquatic ecosystems (Vollenweider 1974 and Megard and Smith 1974). This approach involves a measurement of the photosynthetic rate of the aquatic flora. The development of the carbon-14 primary production technique by Steemann Nielsen (1952) has facilitated rate determinations of photosynthesis and is now a common method in limnological research. The carbon-14 technique is widely used because it offers one of the best methods available for the regional classification of lakes (Rodhe 1958). A major objective of primary production research is not to establish the magnitude of production, but rather to determine the factors responsible for controlling productivity (Lund 1964).

A discussion of the primary production of the Big Eau Pleine Reservoir is somewhat simplified since only the phytoplankton community need be considered. Aquatic macrophytes are absent as a result of the continual water level manipulations. Primary productivity was determined mainly during the ice-free season (April-November) because phytoplankton biomass was largest during this period and because of difficulties in measuring production during winter conditions. Results of primary production and associated data are presented in Appendix A.

Seasonal Trends of Primary Production

A definite seasonal pattern in carbon-14 productivity measurements was apparent during the two year study period (Fig. 3). Production exhibited a bimodal form with a maximum spring rate in May of 1.5 to 2.5 g C/m^2/day, and a summer maxima in July of 3.0 to 4.5 g C/m^2/day. In general, changes in primary productivity paralleled changes in surface chlorophyll a (Fig. 3). A similar relationship between chlorophyll and primary production has been reported for Lake Ontario and Lake Erie (Glooshenko et al. 1974). The maximum spring productivity in the reservoir was associated with a small bloom of diatoms and cryptomonads (Fig. 8). The summer bloom was attributed mainly to the blue-green alga, *Aphanizomenon flos-aquae*.

The seasonal distribution of primary production and phytoplankton biomass correlated with seasonal changes in solar radiation (Fig. 3). Maximum production occurred during the greatest insolation. A similar relationship between production and solar radiation has been reported for Lake Wingra, Wisconsin (Baumann et al. 1973). The rapid decline in productivity in the fall period (September-November) was attributed to decreasing phytoplankton biomass, solar radiation, and water temperature. Photosynthetic rates were minimal or undetectable during the winter periods (December-March) because of the high light attenuation of ice and snow.

Productivity measurements derived from photosynthetic-

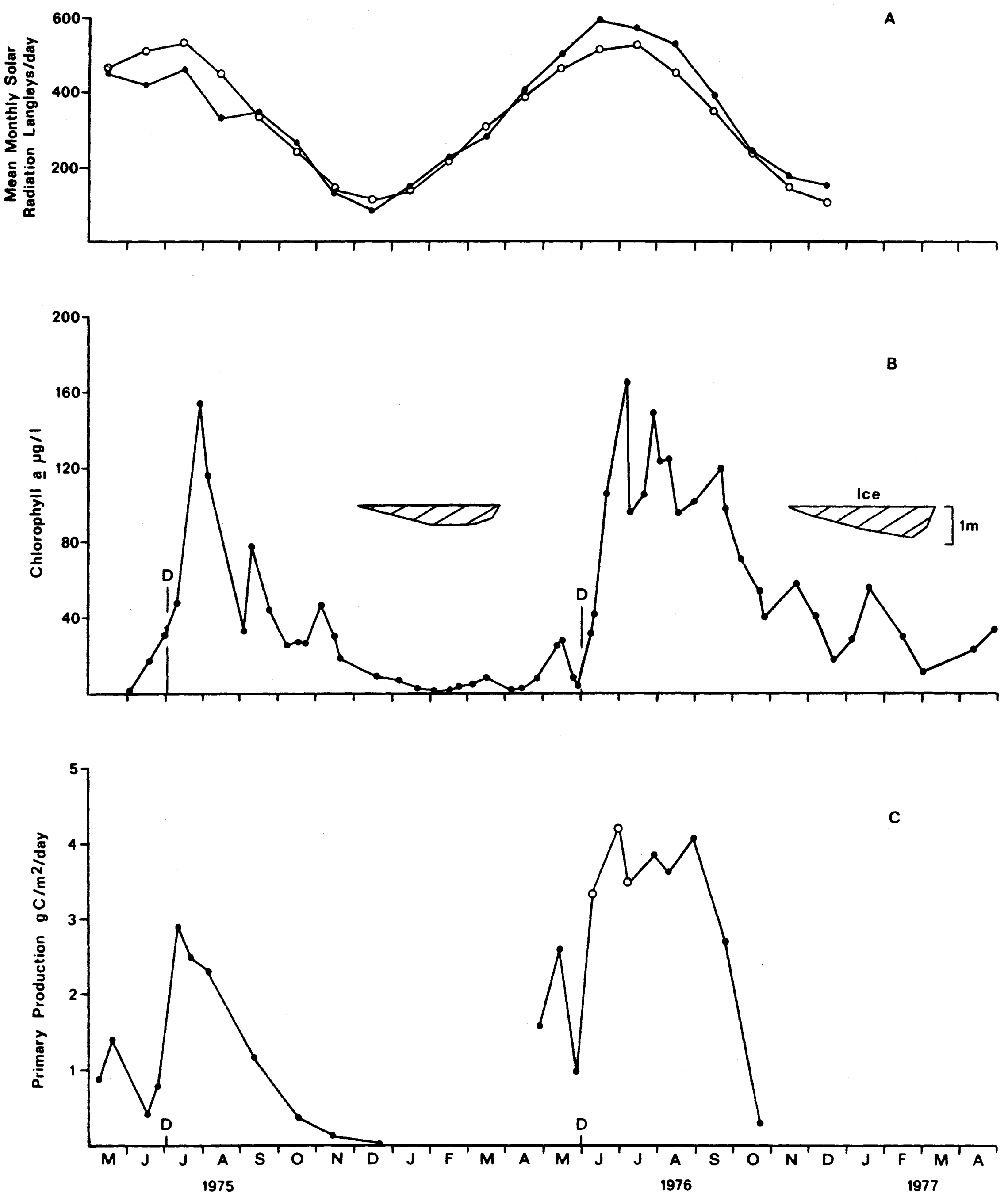

Figure 3. A. Mean monthly solar radiation (○) for a 46 year period and monthly solar radiation (●) for the study period at Madison, Wisconsin. B. Mean surface chlorophyll *a* concentration. The letter (D) indicates the onset of reservoir drawdown. C. Carbon-14 primary production at site 23. The (○) denotes carbon-14 production estimated from the oxygen technique using a regression equation. The letter (D) indicates the onset of reservoir drawdown.

depth profiles at site 23 were similar to those determined empirically at sites 20, 19, 16, and 14 (Table 3). Primary production measurements at station 23 were considered to be representative of the entire reservoir. There appeared to be a slight decline in integral photosynthetic rates from the southeastern to the northwestern reservoir area.

Table 3. Integral photosynthetic rates (g C/m^2/day) determined at five stations from April to October 1976 using the carbon-14 method. Data derived from 10 days when all five sites were sampled.

	Site				
	23	20	19	16	14
Mean	2.67	2.72	2.54	2.53	2.46
S.D.	1.40	1.40	1.32	1.49	1.22

However, the average integral production measurements for the five stations were not significantly different when analysis of variance was applied to the data. The trend, if real, may be attributable to increased attentuation of light by algae (Sakamoto 1966) since chlorophyll _a_ concentrations increased along this transect (Table 9).

The mean carbon-14 productivity during the open-water period in 1975 and 1976 was 1.3 and 2.8 g C/m^2/day, respectively. This increase in production in 1976 over that of 1975 was significant at the 0.01 percent probability level. The average production in 1975 and 1976 correspond to an approximate assimilation of 340 to 685 g C/m^2 for the open-water period (244 days) of 1975 and 1976, respectively. The total production for these periods are probably overestimated since photosynthetic rates were determined on days with minimal cloud cover.

A multiple regression equation ($R^2 = 0.757$) was used to estimate total production during the open-water period of 1976 that considered daily changes in water temperature, chlorophyll a, solar radiation, and light extinction (Table 4).

Table 4. Results of forced variable multiple regression using integral photosynthesis (g C/m^2/day) as the dependent variable and physical and biological parameters as the independent variables. Combined data of the open-water period of 1975 and 1976.

Intercept	N	Independent Variable	b	R^2
-2.95	17	Temperature (°C)	0.077	0.757**
		Chlorophyll a (mg/m^2)	0.003	
		Solar Radiation (Langleys/day)	0.004	
		Light Extinction (1/m)	0.783	

**Significant at 0.01 level.

Daily values for water temperature, chlorophyll a, and light extinction were obtained from interpolation between sampling dates. The adjusted total production for the open-water period of 1976 was 605 g C/m^2, a reduction of 11.6 percent. By applying a similar percent reduction on the 1975 period, the total production was approximately 300 g C/m^2. These seasonal estimates of total production are probably below annual productivity since winter rates are not included. However, it is doubtful that a consideration of winter production would significantly increase the production determined for the open-water season. Seasonal estimates of primary production indicate that the Big Eau Pleine Reservoir is highly eutrophic. Eutrophic temperate lakes are reported to have annual productions of 300 to 640 g C/m^2 (Wetzel 1975).

Photosynthetic-depth profiles and chlorophyll a profiles for the open-water periods of 1975 and 1976 are illustrated in Figure 4. Maximum volumetric rates of photosynthesis usually occurred at 0.5 m on clear days and at the surface on cloudy days. The trophogenic zone was normally less than 2.5 m deep during the summer months (June-September). Production occurred in deeper water (4.0 to 5.0 m) in late May when phytoplankton biomass was low (Fig. 3). The trophogenic zone remained compressed to only a few meters in the fall period (October-November) even though chlorophyll a concentrations were lower. The compensation depth was reduced in the fall season because the light attenuation of water increased (Table 21). This was probably associated with an increased suspension of

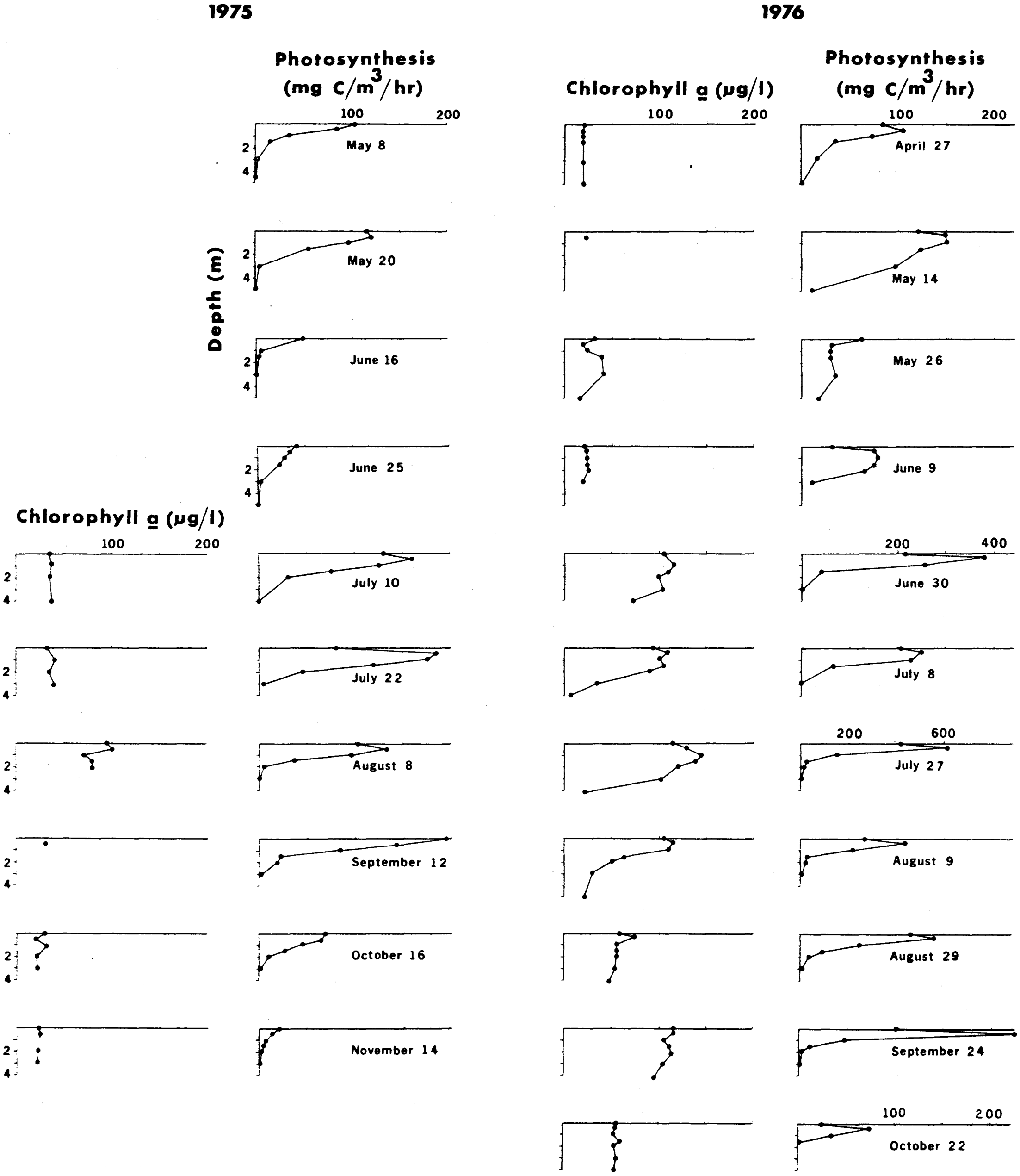

Figure 4. Photosynthetic-depth profiles and chlorophyll a depth distributions at site 23 for the two year open-water period.

detritus during the fall period as a result of reservoir drawdown and wind mixing. The amount of abiotic turbidity present may be an important factor retarding primary production in reservoirs (Osborne and Marzolf 1972 and Murphy 1962) because of its depressing effect on light penetration. The combination of increased light attenuation and decreased insolation in autumn may be an important factor restricting production during the fall period.

Light, Nutrients, Temperature, and Primary Production

The essential regulating factors of phytoplankton productivity are light, nutrients, and temperature (Murphy 1962). The results of stepwise linear multiple regression indicated that surface temperature, light extinction, and solar radiation explained 74.8 percent of the variation in the daily rates of primary production observed during the 1975 and 1976 open-water periods (Table 5). The relationship between nutrients and productivity could not be established directly since nutrient concentrations were not determined during in situ photosynthetic studies. Light extinction considers changes in phytoplankton biomass since light attenuation and chlorophyll a concentrations are directly related (Bindloss et al. 1972, and Ganf 1972, 1974). Chlorophyll a concentration is normally directly related to total nitrogen or phosphorus concentration (Sakamoto 1966 and Dillon and Rigler 1974) and therefore the multiple regression equation was not independent of nutrient concentrations. Brylinsky and Mann (1973) have shown that when nutrients and solar energy are considered in a multiple regression equation, an accurate estimate of primary production is possible.

Table 5. Results of stepwise multiple regression using integral photosynthesis (g $C/m^2/day$) and pmax (g $C/m^3/hr$) as the dependent variables with various physical and biological variables as independent variables. Combined data for the open-water periods of 1975 and 1976.

Intercept	N	Independent Variable	b	R^2
Integral Photosynthesis				
-3.08	17	Temperature**	0.098	0.748**
		Light Extinction**	0.901	
		Solar Radiation*	0.004	
pmax				
-8.99	17	Chlorophyll _a_**	0.783	0.612**

*Significant at 0.05 level.
**Significant at 0.01 level.

The concentration of chlorophyll _a_ was the only significant variable describing variation of maximum specific photosynthesis (pmax). Chlorophyll _a_ levels explained 61.2 percent of the variation of pmax (Table 5).

The importance of solar energy as a regulating factor in aquatic primary production has been established by Brylinsky and Mann (1973). These authors have demonstrated that on a global scale, factors related to solar energy input are most important in explaining variations of primary productivity. However, they believe nutrient input becomes more important on a regional scale. Their finding supports the work of Sakamoto (1966) and Dillon and Rigler (1974). It is believed that light may limit primary production through the rapid attenuation of light by high phytoplankton biomass (Sakamoto 1966). With reduced light energy input during high phytoplankton biomass, phosphorus deficiency may develop as a result of lower phosphorus uptake (Megard and Smith 1974).

The mean solar radiation for the summer periods (June-September) of 1975 and 1976 were 401 and 524 langleys/day, respectively. The observed increase in the mean daily insolation in the summer of 1976 over the summer of 1975 was significantly higher ($p = 0.01$). Correspondingly, precipitation was considerably lower (Fig. 2) and water temperatures were warmer (Fig. 9) in the summer of 1976 as compared to the previous summer period. Seasonal changes in solar energy input may be an important factor regulating primary production. Wetzel (1975) attributed a 25 percent reduction in annual primary production in Lawrence Lake, Michigan in 1972 to "abnormally high cloud cover and rainfall". Increased productivity in Lake Washington in the summer of 1968 was attributed to increased solar radiation at a time when the annual phosphorus loading was declining (Edmundson 1972). Jonasson (1977) presented annual solar radiation and primary production data for an 18 year period for the eutrophic Lake Esrom, Denmark. A regression of his data indicated that annual productivity correlated significantly ($p = 0.01$) with annual insolation. In addition, 46 percent of the variation of annual primary production could be explained by changes in the annual irradiance. Solar radiation input is important because it supplies the light energy input for driving photosynthesis and also plays a major role in heating surface waters. This latter factor is important because photosynthesis may proceed at a faster rate with increased temperature since the photosynthetic process is more temperature sensitive when light intensity and CO_2 concentrations are saturating (Salisbury and Ross 1969).

The effects of nutrient loading, particularly phosphorus, are also very important at regulating rates of primary production. Levels of total reactive phosphorus increased immediately after the onset of reservoir drawdown during the two summer periods (Fig. 6). The relationship between phosphorus concentration, drawdown, and phytoplankton growth are considered in more detail in the discussion of factors affecting the summer phytoplankton biomass.

Maximum Specific Photosynthesis

Maximum specific photosynthesis (Pmax) is an expression of the maximal rate of photosynthesis per unit volume divided by a unit of phytoplankton biomass (Megard and Smith 1974). The value Pmax is a production to biomass (P/B) quotient and has also been termed the "assimilation number" or "activity coefficient" (Vollenweider 1974). Maximum specific photosynthesis is a measure of the photosynthetic capacity of the phytoplankton. Values of Pmax that utilize chlorophyll a as a measure of biomass are normally greater than 3.0 in enriched environments (Glooschenko et al. 1974 and Hickman 1973). The Big Eau Pleine Reservoir can be classified as eutrophic since the average spring and summer Pmax's are greater than 3.0 (Table 6). Maximum specific photosynthesis was usually greatest in the spring (Fig. 5) when the phytoplankton community was composed of small celled organisms, mainly diatoms and cryptomonads. Small phytoplankton are believed

Table 6. Seasonal changes in photosynthesis (mg C/mg Chlorophyll a /hr). Combined data of 1975 and 1976 using the carbon-14 method. The winter data was determined in an environmental chamber at 2.0 °C using cool white fluorescent lighting at 3,000 lux.

	Spring (April-May)	Summer (June-Sept)	Fall (Oct-Nov)	Winter (Dec-March)
Mean	10.3	6.2	1.5	1.4
S.D.	8.1	2.9	0.6	1.2
N	14	24	9	4

to exhibit a large photosynthetic capacity because the surface area to volume ratio is larger in small cells which facilitates nutrient assimilation (Findenegg 1965). Maximum specific photosynthesis declined during the initial bloom of the blue-green alga, Aphanizomenon flos-aquae in 1975 and 1976. A similar inverse relationship between Pmax

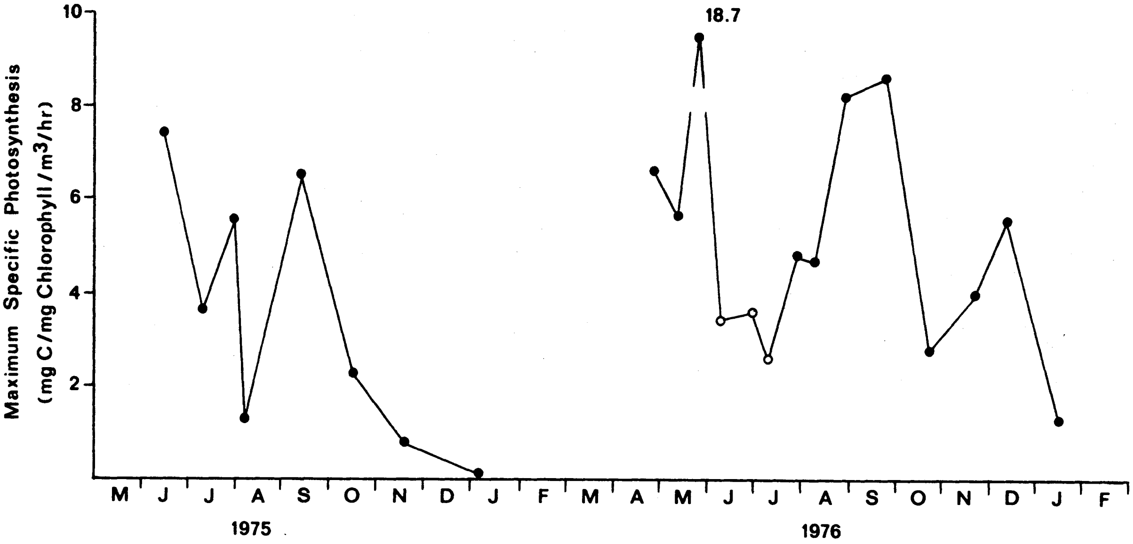

Figure 5. Seasonal changes in maximum specific photosynthesis. Each sample represents a mean of all sites sampled using the carbon-14 method. The (o) indicates a value estimated from a regression of the oxygen technique.

and phytoplankton biomass has been reported by Findenegg (1965), Wright (1959), Bindloss et al. (1972), and Megard and Smith (1974). The drop in the photosynthetic capacity during increases in phytoplankton biomass may indicate nutrient deficiency (Megard and Smith 1974 and Hickman 1973). Inorganic nitrogen and total reactive phosphorus concentrations were at very low levels during the decline in Pmax in June (Fig. 6). Maximum specific photosynthesis exhibited a second peak in September (Fig. 5) when chlorophyll _a_ concentrations were high and the phytoplankton flora remained dominated by _A_. _flos-aquae_. Glooschenko et al. (1974) have reported a similar bimodal pattern in Pmax for Lake Erie. The increase in Pmax in the reservoir in September may be associated with increased nitrogen and phosphorus concentrations in the late summer period (Fig. 6). The photosynthetic capacity of the phytoplankton declined rapidly in the fall of 1975 and remained low during the winter period. The decline in Pmax during the latter seasons can probably be attributed to decreasing water temperature, light energy, and changes in species composition (Hickman 1973, Bindloss et al. 1972). Maximum specific photosynthesis was higher in the early winter period (November-January) of 1976-1977 than compared to the previous winter. This response was attributed to increased phytoplankton biomass (Fig. 3) in response to increased light availability. Light was more available in the second winter period because the attenuation of light by the ice and snow pack was considerably lower than the first winter studied (Marano 1978).

Photosynthetic Efficiency

Photosynthetic efficiency is a measure of the light utilization by plants. The efficiency of light utilization by the phytoplankton community was estimated in this work

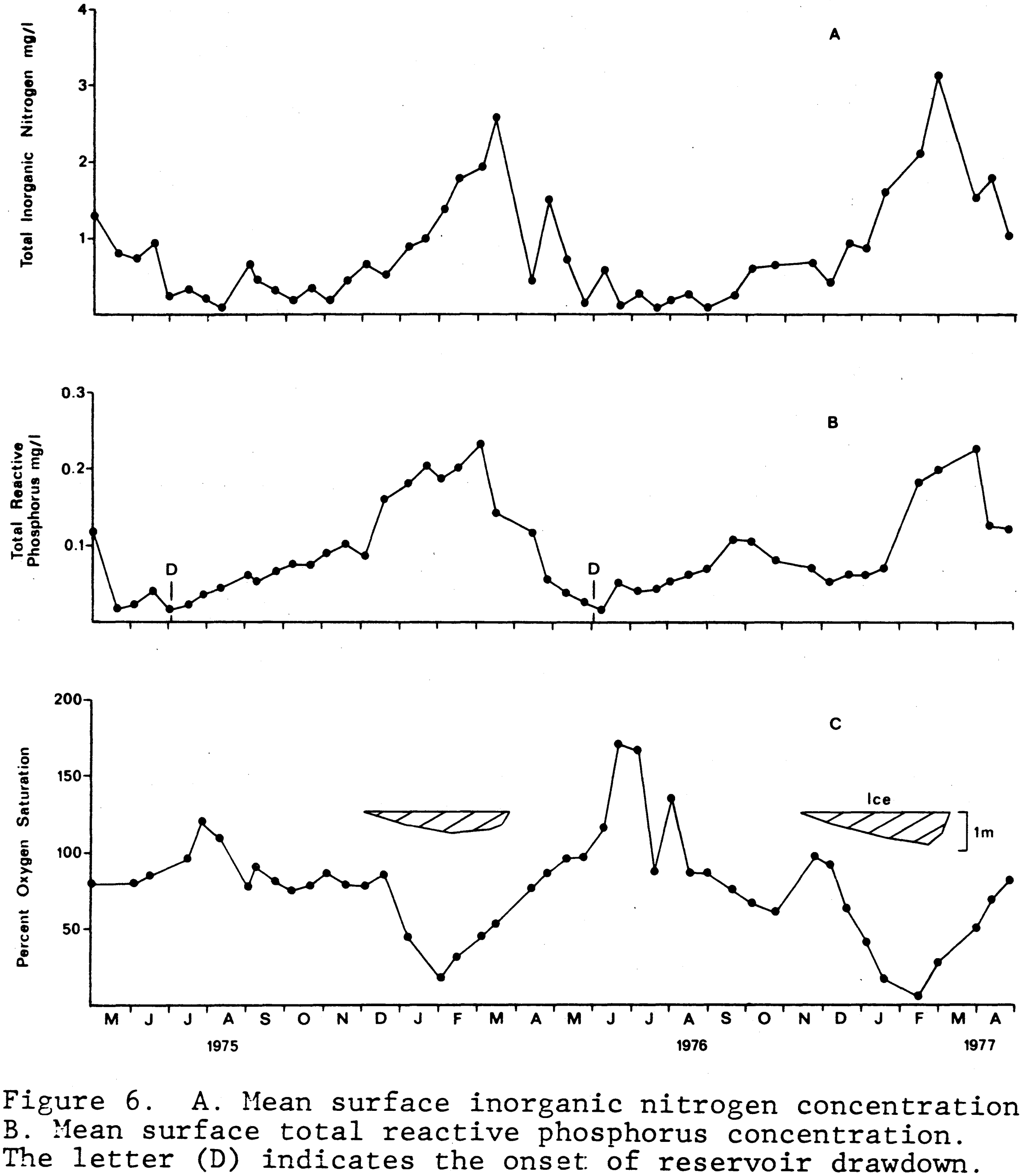

Figure 6. A. Mean surface inorganic nitrogen concentration. B. Mean surface total reactive phosphorus concentration. The letter (D) indicates the onset of reservoir drawdown. C. Mean surface percent oxygen saturation.

by assuming 1 gram of carbon assimilated was equivalent to 10 kcal of energy (Tilzer et al. 1975). The caloric equivalent of daily integral production was divided by the total solar radiation (kcal) which gave an estimate of photosynthetic efficiency. The average summer efficiency derived from carbon-14 production measurements at site 23 were 0.4 and 0.7 percent in 1975 and 1976, respectively. The maximum efficiency recorded was 0.9 percent on September 29, 1976. Efficiencies determined for the reservoir are in the range of data presented for eutrophic temperate lakes (Wetzel 1975). Wetzel has indicated that the highest photosynthetic efficiencies (2.0 to 3.0 percent) are reported for productive tropical lakes; where as, eutrophic temperate lakes have efficiencies of 0.4 to 1.0 percent. Photosynthetic efficiency is controlled mainly by the phytoplankton biomass present at the surface layers of lakes (Tilzer et al. 1975 and Wetzel 1975). This is a result of greater light absorption by phytoplankton pigments with increases in phytoplankton biomass. Surface chlorophyll _a_ concentrations were significantly greater in the 1976 summer period (Fig. 3) and probably accounted for the increased efficiency of light utilization by the phytoplankton at that time.

Comparison of Primary Production Techniques

The results of primary production measurements are presented in Appendix A. _In situ_ measurements of primary production were made on 25 days from May of 1975 to

November of 1976. The carbon-14 and oxygen methods were run in parallel on 13 days during the open-water periods of 1975 and 1976. A summary of the two techniques is given in Table 7. Integral production determined by the filtration and the acidification and bubbling carbon-14 methods were identical (Table 7) and an excellent correlation was found (r = 0.986) between the two techniques (Table 8).

Table 7. Primary production measurements using the filtration and acidification and bubbling carbon-14 techniques, and the gross and net oxygen methods. The data is expressed as g $C/m^2/day$.

	Carbon-14 Method		Oxygen Method	
	Filtration	Acid. & Bubbling	Gross	Net
Mean	2.10	2.10	1.34	1.10
S.D.	1.45	1.44	1.13	0.74
N	13	13	13	13

Table 8. Results of linear regressions of the carbon-14 and oxygen methods used to measure primary production.

Dependent Variable	N	b	Independent Variable	Intercept	r
Filtration[1]	13	0.818	Bubbling[1]	1.010	0.986**
Bubbling[1]	13	0.980	Filtration[1]	0.456	0.986**
Bubbling[1]	13	1.601	Net (O_2)[1]	0.350	0.810**
Bubbling[1]	13	0.818	Gross (O_2)[1]	1.010	0.600*
Bubbling[2]	72	1.028	Filtration[2]	-3.764	0.973**

[1] g $C/m^2/day$.
[2] mg $C/m^3/hr$.
*Significant at 0.05 level.
**Significant at 0.01 level.

Schlinder et al. (1972) found the filtration method consistently underestimated total carbon assimilation when compared to the acidification and bubbling technique. It is believed the filtration procedure should yield lower results because the method omits released extracellular products of photosynthesis (Fogg et al. 1965). Schindler et al. (1972) found the two techniques were similar when they corrected for a filtration error according to the procedure of Arthur and Rigler (1967). Arthur and Rigler believed the filtration correction was necessary to correct for the loss of extracellular products that arise from cell rupture during vacuum filtration. In contrast, Schindler et al. (1972) believed that colloid retention of labelled extracellular products necessitated the filtration correction. Further, these later authors have shown that the retention of labelled extracellular products by colloidal material occurred only when algae were present in the sample. A filtration correction was not applied in the present work; however, the two carbon-14 methods gave similar results (Table 7). It was not definitely established why these methods were identical without the use of a filtration correction. A possible explanation may be associated with the trophic nature of the water body under investigation. The relative amounts of released extracellular products may be lower in eutrophic environments (Fogg, in Vollenweider 1974). Schindler's group conducted their research in the Experimental Lakes Area in northwestern Ontario. These lakes are located in the Canadian Precambrian Shield (Johnson and Vallentyne 1971) and are rather oligotrophic when compared to the Big Eau Pleine Reservoir. Another factor that may influence a comparison of the two carbon-14 methods is the vacuum pressure used during membrane filtration. The recommended maximum pressure differential across the membrane in the filtration technique is 0.4 to 0.5 atmospheres (Vollenweider 1974 and Arthur and Rigler 1967). The maximum vacuum pressure in this work did not exceed 0.2 atmospheres. Therefore, the loss of extracellular products due to cell rupture was probably reduced and the retention of labelled colloidal material was probably enhanced.

The carbon-14 method gave results that were 57 to 91 percent larger than gross and net photosynthesis, respectively (Table 7). The carbon-14 acidification and bubbling method correlated best with net photosynthesis ($r = 0.810$) rather than with gross photosynthesis ($r = 0.600$) (Table 8). It has not been definitely established whether the carbon-14 method measures net or gross photosynthesis or something between the two techniques (Vollenweider and Nauwerck 1961, Goldman 1968, and Fogg 1963). An underestimation of gross photosynthesis may arise in eutrophic waters that are supersaturated with dissolved oxygen (Wrobel 1972). Gross photosynthesis is underestimated during periods of intense photosynthetic activity since oxygen bubbles may form in the light bottles during the incubation period (Strickland 1960). Measurements of gross photosynthesis in the reservoir were probably too low during periods of intense photosynthesis because of oxygen supersaturation (Fig. 6). Gross photosynthesis may also be underestimated if the respiration rate in light bottles exceeds that in dark bottles. Ryther and Vaccaro (1954) believed the respiration rate is greater in light bottles because of increased metabolism of newly formed photosynthetic products. Increased respiration in light bottles has also been attributed to increased oxygen tension (Vollenweider 1974 and Strickland 1960). Arguments supporting increased respiration in dark bottles have been discussed by Steemann Nielson (1952) and Saigo and Ichimura (1961).

Additional sources of error that influence a comparison of the carbon-14 and oxygen methods are associated with the sensitivity of the two techniques and variation in the photosynthetic quotient. The sensitivity of the carbon-14 method is about 40 times the oxygen technique (Ryther and Vaccaro 1954). A comparison of the two methods during low photosynthetic activity may not be possible for this reason. A further difficulty may arise from the use of a constant photosynthetic quotient for the expression of carbon assimilated from oxygen production. Photosynthetic quotients have been found to range from 0.9 to 1.4 (Fott 1972). Therefore, carbon fixation estimates derived from the oxygen technique would vary accordingly.

Phytoplankton Biomass

The determination of phytoplankton volume and chlorophyll a concentrations were used to measure phytoplankton biomass. Phytoplankton enumeration and identification allowed for the determination of phytoplankton volume. Direct counting of phytoplankton flora was important to establish the significance of various taxa to the overall community composition. Knowledge of the general composition of the phytoplankton community offers an excellent indicator of the water quality and the trophic nature of a lake (Vollenweider et al. 1974). A second approach to biomass analysis was accomplished by chlorophyll a analysis. This latter technique required less time and effort.

In this research, phytoplankton volume measurements were used mainly to determine changes in the floristic composition of the phytoplankton; whereas, chlorophyll a analysis was used to assess fluctuations in phytoplankton biomass. The dominant phytoplankton taxa observed in this work are presented in Appendix B. The abundance and percent composition of the phytoplankton biomass, determined from volume measurements, are summarized in Appendix C and illustrated in Figure 7. Chlorophyll a data are presented in Appendix D.

In general, phytoplankton volume paralleled changes in chlorophyll a (Fig. 3) during the two year study period. Measurements of phytoplankton volume were more variable than chlorophyll a analysis (Table 9). The average coefficient of variation for chlorophyll a and volume measurements were 69.2 and 127.9 percent, respectively. Measurements

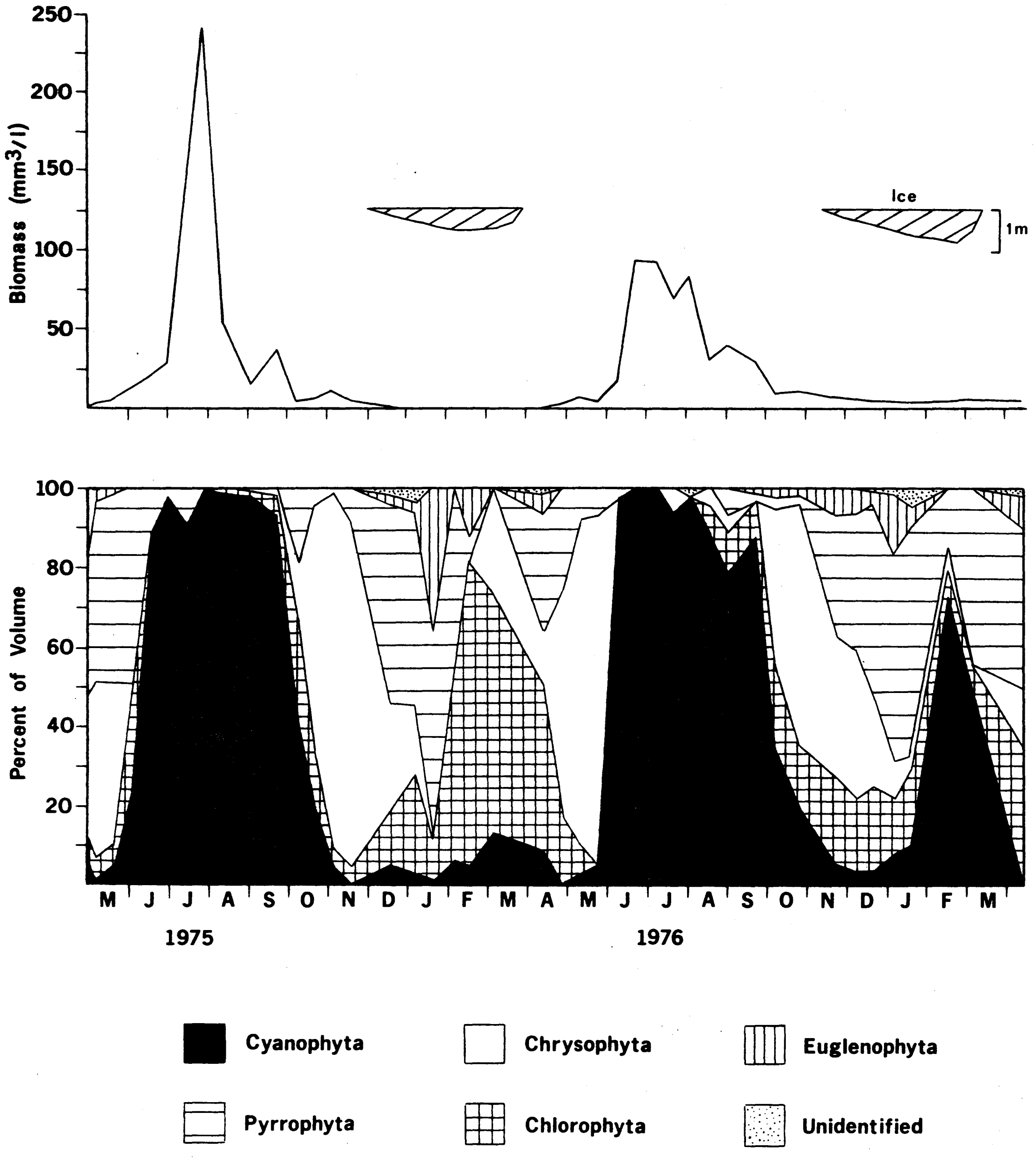

Figure 7. Changes in phytoplankton volume and the percent composition of indigenous phytoplankton. Average of all surface samples.

Table 9. Mean and standard deviation of chlorophyll a ($\mu g/l$) and phytoplankton volume (mm^3/l) measurements. The data was combined for the summer periods (June-August) of 1975 and 1976.

	Chlorophyll a			Volume		
Station	N	Mean	S.D.	N	Mean	S.D.
12	11	123.3	96.0			
13	9	142.6	83.8	12	61.4	60.2
14	11	102.6	91.4			
16	9	54.6	47.5	12	73.4	112.0
20	6	89.1	31.6			
22	11	60.1	45.4			
23	11	65.8	49.2	13	44.7	45.7
24	10	78.6	49.5			
All Data	78	89.3	61.8	37	59.4	76.0

of phytoplankton volume were not very accurate for this reason. This can be illustrated from the phytoplankton volume data collected on July 28, 1975 (Appendix B). On this day the average volume was 239 mm^3/l. The volume at station 16 was 411 mm^3/l on this day which greatly inflated the average biomass determined. The mean phytoplankton volume was 153 mm^3/l when site 16 was omitted.

The average surface chlorophyll a concentrations for the 1975 and 1976 summer periods (June-September) were 53.2 and 103.0 $\mu g/l$, respectively. Correspondingly, the mean surface phytoplankton volume measurements for the summer periods were 32.2 mm^3/l in 1975 and 53.0 mm^3/l in 1976. Vollenweider et al. (1974) have indicated that chlorophyll a concentrations that exceed 9 μg/l and volume measurements that are larger than 10 mg/l (10 mm^3/l) are indicative of eutrophic lakes. Phytoplankton volumes exceeding 10 mm^3/l are classified as hypereutrophic according to the scheme of Wetzel (1975). The biomass data for the reservoir are indicative of a highly eutrophic aquatic environment.

Phytoplankton Composition and Succession

The percent composition of the phytoplankton community was normally very similar at sites 13, 16, and 23 but differed slightly during the early spring and fall periods. There was a tendency for the spring and fall phytoplankton communities to develop about 1 week earlier in the northwestern section of the reservoir (Site 13) as compared to the southeastern area (Site 23). The response was probably due to an earlier warming and cooling of the northwestern reservoir area in the spring and fall seasons, respectively.

The percent composition of surface and mid-depth samples were usually identical. Phytoplankton samples collected from bottom waters were usually dominated by centric diatoms even during the bloom of blue-green algae in the surface waters. The reservoir was normally well mixed during the ice-free season. The lack of a strong thermal stratification was responsible for the observed homogenous distribution of phytoplankton in the upper 3 to 4 meters. In addition, there was apparently sufficient mixing down to the sediments in order to keep large centric diatoms, particularly Stephanodiscus niagarae and Melosira sp., suspended in the lower tropholytic zone.

The spring flora (April-May) was represented mainly by centric diatoms (Cyclotella sp. and Stephanodiscus sp.) and by cryptomonads (Cryptomonas sp.) (Figure 8). The maximum biomass of the spring community occurred in the middle or the latter part of May. The productivity and biomass of the spring flora declined rapidly in late May (Fig. 3). Buchanan (1976) found the concentration of zooplankton was greatest in the reservoir in late May. Increased predation by zooplankton might have diminished the phytoplankton community at that time. However, Lund (1964) and Verduin (1952) believe the impact of grazing pressure by zooplankton is not an important factor regulating spring diatom growth. Phosphate phosphorus and particularly silica have been implicated as primary limiting nutrients in the late stages of spring diatom blooms (Lund 1964). It was observed that total reactive phosphorus concentrations, which includes phosphate phosphorus, were normally at very low levels in late May (Fig. 6). A weak thermal stratification is usually established in the reservoir in mid-May. A decline in the spring diatom community may also be associated with reduced circulation which would lead to increased sinking loss of the diatom flora. All of the above factors may be involved in regulating the spring phytoplankton community. Jonasson

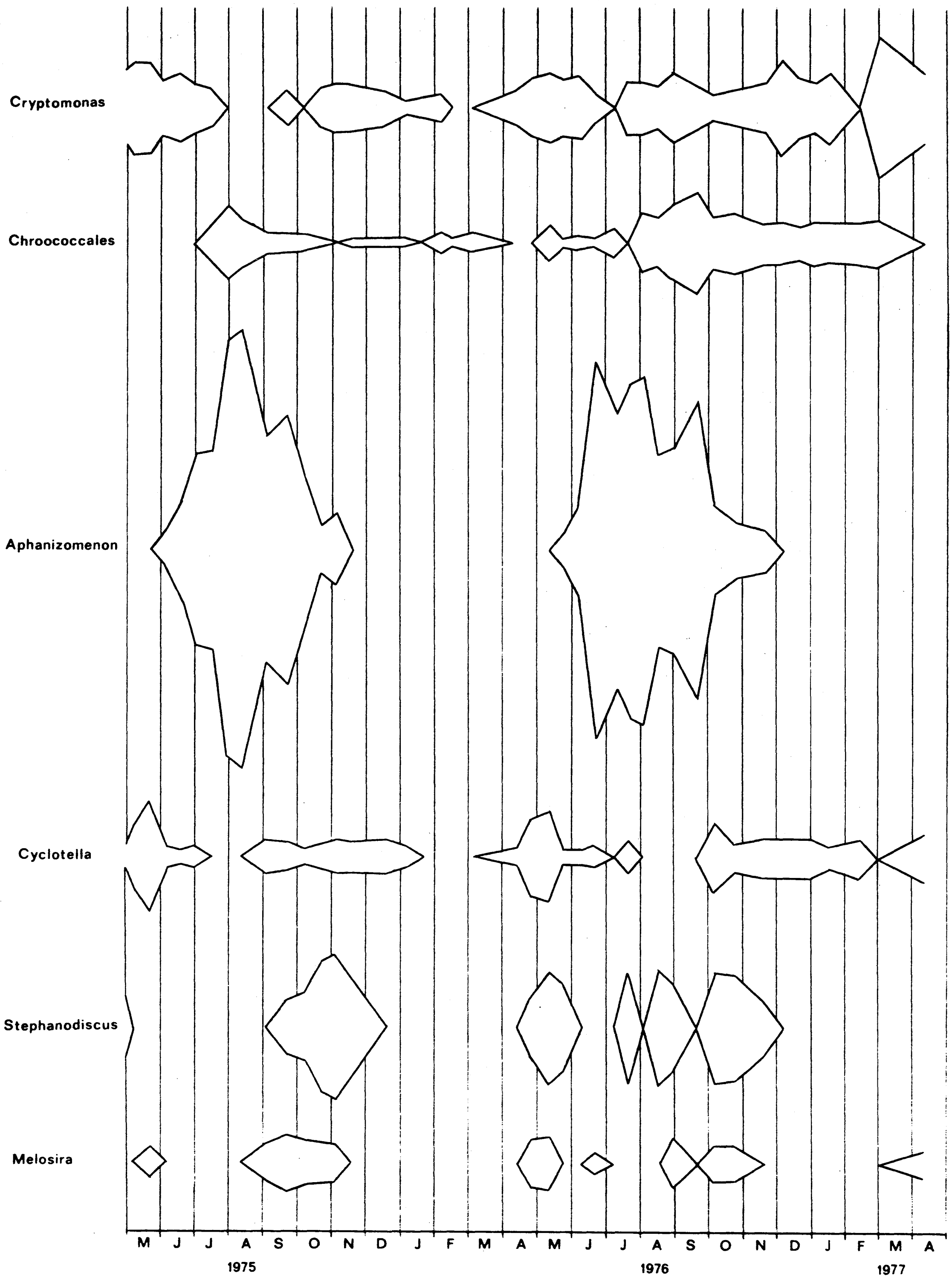

Figure 8. Relative changes in the dominant phytoplankton taxa volumes at site 23 using "spherical curves" (Schwoerbel 1970).

(1977) believed zooplankton grazing, diatom sedimentation, and nutrient depletion were responsible for the decline in the spring bloom in the eutrophic Lake Esrom, Denmark.

The low phytoplankton biomass and nutrient concentrations in late May set the stage for the development of the summer blue-green algae bloom (Fig. 7). The reason for the development of a blue-green algae bloom at a time when inorganic nitrogen and phosphorus are lowest is obscure, but is a common phenomenon in eutrophic lakes (Fogg et al. 1973). These authors believe that excess cellular storage of nitrogen and phosphorus in the form of phycocyanin and polyphosphate, respectively, may allow for rapid blue-green algae growth in waters seemingly low in nutrients. The summer bloom was comprised almost exclusively of *Aphanizomenon flos-aquae* (Appendix B). This species developed rapidly and represented 95 percent or more of the entire phytoplankton biomass in July and August. *Aphanizomenon flos-aquae* usually dominated the summer flora from June through September and remained as a sub-dominant member in the fall (October-November) community (Fig. 8). The rapid growth and prolonged dominance of this species is common in eutrophic lakes (Barica 1975, Grandall and Lundgren 1971, and Hammer 1964). The maximum biomass of *A*. *flos-aquae* occurred during maximum water temperature (Fig. 9). In addition, periods of maximum biomass were responsible for periods of maximum oxygen saturation (Fig. 6). as a result of increased photosynthetic activity. Hammer (1964) indicated that the optimal temperature for A. flos-aquae growth ranges from 23.5 to 26.5 °C. He attributed a marked reduction in summer biomass of this species to low water temperatures in June and August. The higher biomass and productivity observed in the 1976 summer period, when compared to 1975 (Fig. 3), were associated with a longer period of optimal water temperature (Fig. 9) and increased total reactive phosphorus concentrations (Fig. 6). Water temperatures were warmer in the summer of 1976 in response to increased solar radiation as compared to the previous year (Fig. 3). Total reactive phosphorus levels increased earlier and were higher in the summer of 1976 in response to an earlier summer drawdown.

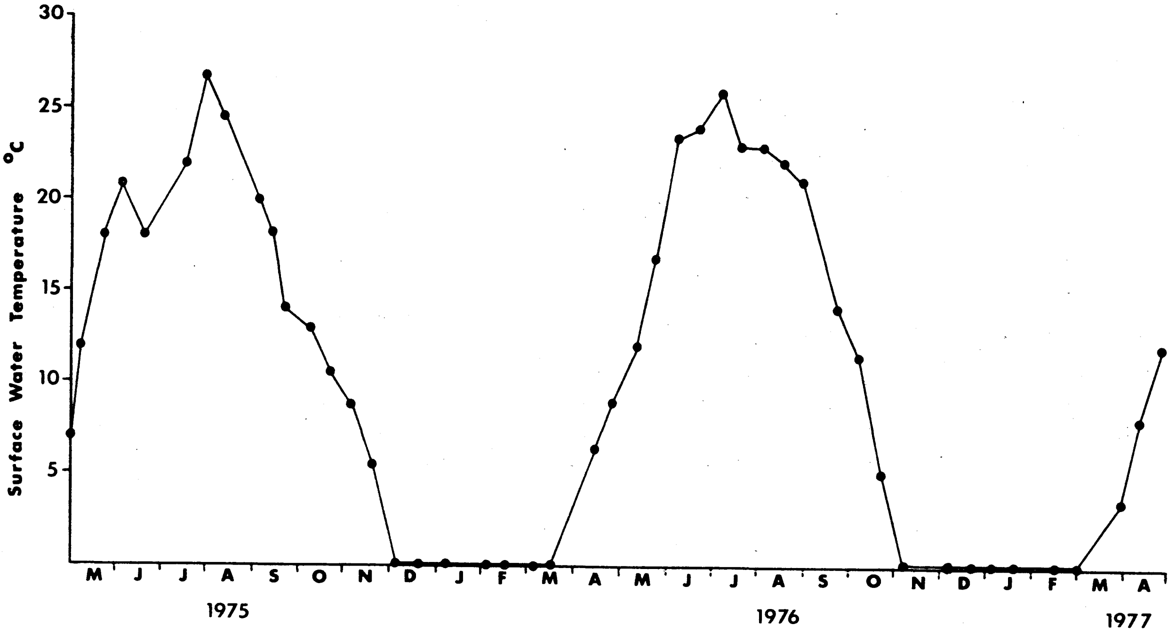

Figure 9. Mean surface water temperature.

The summer phytoplankton community was replaced mainly by centric diatoms and cryptomonads in October and November (Fig. 8). The centric diatom, Stephanodiscus niagarae was the most important species in the fall phytoplankton flora. Hammer (1969) noted that this species usually replaced Aphanizomenon flos-aquae as the dominant taxa in October in Buffalo Pond, Saskatchewan. The occurrence of Stephanodiscus sp. in surface waters in July and August of 1976 (Fig. 8) was attributed to a redistribution of these diatoms from the sediments and lower waters as a result of wind mixing. Correspondingly, the surface bloom of A. flos-aquae was reduced during these mixing events. The absence of this phenomenon in July and August of 1975 may indicate that mixing processes were reduced in that summer period.

The winter phytoplankton community was rather diverse and variable for the two year period (Fig. 7). Phytoplankton biomass was minimal during the 1975-1976 winter period. Cryptomonads were the dominant phytoplankton in the early winter period (December-January) and were replaced by green algae in February. Schults et al. (1976) have reported that green algae dominated the late winter phytoplankton community in the eutrophic Shagawa Lake, Minnesota. The phytoplankton biomass was significantly greater in the 1976-1977 winter season. In addition, blue-green algae dominated the late winter phytoplankton flora rather than green algae (Fig. 7). Light penetration and dissolved oxygen concentrations may have influenced the composition and abundance of the winter phytoplankton community during the two winter periods.

Light penetration through the ice and snow pack was considerably greater in the 1976-1977 winter period (Marano 1978). The percent oxygen saturation at the surface dropped to lower levels in the second winter season as well (Fig. 6). Water below the 0.5 m layer was anaerobic for most of this winter period. It was observed that the winter phytoplankton were concentrated just under the ice in aerobic waters (Table 10). Therefore the 1976-1977 winter phytoplankton flora were restricted to the upper aerobic layers where light was available for photosynthesis. Surface phytoplankton biomass was lower in the 1975-1976 winter period because light penetration through ice and snow was minimal. In addition, the levels of dissolved oxygen in surface waters did not drop as severely in the first winter studied. Therefore, a thicker aerobic layer may have allowed for a greater distribution of the phytoplankton in the 1975-1976 winter period.

Table 10. Dissolved oxygen (mg/l) and chlorophyll a (μg/l) concentrations at two depths using 5 samples collected near station 20 on February 18, 1977.

Sample	0.0 m		1.0 m	
	DO	Chlorophyll a	DO	Chlorophyll a
1	4.4	89.2	0.0	5.6
2	1.6	98.0	0.0	13.7
3	0.7	48.2	0.0	8.0
4	3.4	235.6	0.0	8.0
5	1.3	69.1	0.0	11.2
Mean	2.3	107.9	0.0	9.3

Aphanizomenon flos-aquae

A special discussion of the occurrence of the blue-green alga, *Aphanizomenon flos-aquae* is warranted since this species may comprise 95 to 100 percent of the total phytoplankton biomass during the summer months (Appendix B). This species contributes the greatest input to the annual production of phytoplankton biomass in the reservoir. Lakes that experience dense blooms of *A. flos-aquae* have several environmental factors in common that help to explain its presence in the reservoir. Summer algal blooms of this species are typical in water receiving agricultural runoff (Barica 1975, Mc Lachlan et al. 1963, Jones and Bachmann 1975, and Hammer 1969) and high phosphorus loading (Sager 1971 and Vanderhoef et al. 1974). There is evidence to suggest that iron is a "soil-born factor" that is required for growth of this species (Mc Lachlan et al. 1963). Further, O'Flaherty and Phinney (1970) have shown iron to be a critical factor controlling the development of *A. flos-aquae* in laboratory cultures. This species is associated with unstratified lakes (Jones and Bachmann 1975, Schults et al. 1976, and Barica 1975), with short hydrologic residence times (Jones and Bachman 1975 and Heath and Cooke 1975), and in lakes where anaerobic hypolimnetic waters develop (Schults et al. 1976). All of the above factors seem to fit the description of the Big Eau Pleine Reservoir and probably account for the profuse development of *A. flos-aquae* observed during the summer months.

Environmental Factors Affecting the Summer Biomass

The magnitude of nutrient loading into lakes, particularly nitrogen and phosphorus, is the primary factor responsible for the eutrophication of lakes (Vollenweider 1968). The input of phosphorus into lakes is singled out as the most important factor regulating algae growth in lakes (Schindler 1971, Schindler et al. 1971, Vollenweider and Dillon 1974, and Knauer 1975). Sakamoto (1966) and Dillon and Rigler (1974) established that an estimate of summer chlorophyll *a* concentration can be obtained from total phosphorus levels determined at spring turn-over. Average total phosphorus concentrations at the surface of the reservoir during the spring mixing period (April) were 0.156 and 0.260 mg/l in 1975 and 1976, respectively (Environmental Task Force 1977). Dillon and Rigler's prediction equation for summer chlorophyll *a* gave an estimate of 110 to 230 µg/l for these respective total phosphorus levels. The maximum surface chlorophyll *a* concentration measured was approximately 160 µg/l for the two summer periods (Fig. 3). Apparently, the increase in total phosphorus levels observed during the spring turn-over in 1976 did not affect the maximum phytoplankton biomass but may have influenced the summer (June-September) average biomass. The average surface chlorophyll *a* concentration was 53.2 and 103.0 µg/l for the summer periods of 1975 and 1976, respectively. Dillon and Rigler's prediction equation for chlorophyll *a* was more accurate when the total phosphorus levels at spring turn-over were averaged for 1975 and 1976. The mean total phosphorus concentration was 0.208 mg/l for the two mixing periods. This corresponded to an estimated summer chlorophyll a concentration of 167 μg/l which was similar to the maximum chlorophyll a levels reported for the two summer periods.

Total reactive phosphorus (TRP) concentration (Fig. 6) increased during June through September at an average rate of about 0.7 μg/l/day for the two summer periods. The timing of TRP increase coincided with the onset of reservoir drawdown in both summer periods. It was believed the rise in TRP resulted from sediment release of dissolved phosphorus and "colloidal-bound" phosphorus (Abbot 1957) and was promoted by wind mixing with reservoir drawdown. Reservoir drawdown was earlier and more extensive in 1976 than in 1975 (Fig. 2). The average reservoir volume was 110.6 and 84.6 x 10^6 m^3 for the summer periods (June-September) of 1975 and 1976, respectively (Vennie 1978). Surface TRP concentrations increased earlier and were higher in the summer of 1976 than in 1975. The average surface TRP levels were 0.039 and 0.054 mg/l in the summers of 1975 and 1976, respectively (Environmental Task Force 1977). The reduction in the mean reservoir volume in the summer of 1976 by 23 percent as compared to the previous summer may have been important at decreasing the dilution capacity of the reservoir. With reduced reservoir volume internal release of phosphorus from the sediments may have been more effective in increasing the phosphorus concentrations in the water mass. However, this hypothesis explained only part of the observed increase in TRP since the average TRP concentrations increased by 38 percent in the summer of 1976 as compared to the summer of 1975. External loading of phosphorus from tributary streams or precipitation was not important in the summer of 1976 since there was very little inflow or precipitation during this period (Fig. 2). This indicated that internal phosphorus loading from sediments was more important in the summer of 1976 than the previous summer period. Increased internal loading of phosphorus in the summer of 1976 was probably facilitated by a more extensive reservoir drawdown in combination with wind mixing.

The timing and magnitude of the summer reservoir drawdown is a critical factor controlling the release of phosphorus from the reservoir sediments. Release of phosphorus from the reservoir sediments may be a critical factor regulating the development of the summer blue-green algae bloom. The earlier increase and higher levels of TRP in the summer of 1976 supported more phytoplankton growth than the previous summer. Larsen et al. (1975) have found that internal loading of phosphorus from sediments in Shagawa Lake, Minnesota during the summer period was responsible for continued algal blooms, even after a 70 percent reduction in external phosphorus loading.

Phosphorus assimilation is an active metabolic process and is promoted in light because of its dependency on photosynthetic phosphorylation (Fogg 1973). The significant increase in solar energy (Fig. 3) and water temperature (Fig. 9) in the summer of 1976 may have stimulated phosphorus uptake by A. flos-aquae and its associated flora. Megard and Smith (1974) hypothesized that the phytoplankton bloom in Shagawa Lake collapsed because phosphorus uptake couldn't keep pace with chlorophyll synthesis under low light intensities. Light availability was reduced in Shagawa Lake as a result of increased attenuation of light by high phytoplankton biomass. The impact of algae self-shading in the reservoir on phosphorus assimilation may have been offset by increased photosynthetic activity in the summer of 1976.

The total inorganic nitrogen concentration dropped to very low levels during the summer bloom of A. flos-aquae and its associated flora (Fig. 6). However, it is not likely that nitrogen was limiting the growth of A. flos-aquae. This species is able to satisfy its nitrogen requirement through nitrogen fixation provided phosphorus is not limiting (Healey and Hendzel 1976). Reduced inorganic nitrogen levels during the summer months restricted the development of other non-nitrogen fixing algae. There was no apparent correlation between the onset of reservoir drawdown and the inorganic nitrogen levels. The abrupt increase in inorganic nitrogen concentrations in September of 1975 and 1976 may have resulted from nitrogen fixation, decay of algal biomass, sediment release, or combinations of these processes.

Analysis of Environmental Factors Affecting Biomass Using Regression Techniques

The results of stepwise multiple regression using chlorophyll a as the dependent variable and various environmental parameters as independent variables are presented in Table 11. Correlation coefficients for chlorophyll a and environmental factors are listed in Table 12.

In the spring (April-May), dissolved oxygen concentration and inorganic nitrogen levels explained about 56 percent of the variation in chlorophyll a concentration (Table 11). Dissolved oxygen and chlorophyll a exhibited the highest correlation ($r = 0.485$) during this period as compared to chlorophyll a and inorganic nitrogen (Table 12). A direct and significant relationship between dissolved oxygen and phytoplankton biomass was expected for the spring season. During this period the oxygen saturation was recovering from very low winter levels (Fig. 6). In addition, phytoplankton biomass increased during the spring and led to elevated photosynthetic activity (Fig. 3). The greatest correlation ($r = 0.711$) for the spring period was between chlorophyll a and light extinction (Table 12). This is a result of increased attenuation of light with increases in phytoplankton biomass.

Dissolved oxygen and nitrate+nitrite nitrogen concentrations were also important factors in the summer period. These variables, in addition to the total phosphorus concentration, explained 74 percent of the variation in

Table 11. Results of stepwise multiple regression using chlorophyll a (µg/l) as the dependent variable and various environmental parameters as the independent variables for various seasons. The results are for surface samples collected from June 1975 to April 1977.

Intercept	N	Independent Variable	b	R^2
		Spring (April-May)		
-20.18	26	O_2**	3.16	0.556**
		NH_4^+-N**	-39.23	
		NO_2+NO_3-N**	28.20	
		Summer (June-August)		
-53.27	61	Total-P**	0.66	0.740**
		O_2**	0.39	
		NO_2-NO_3**	-0.22	
		Fall (Sept-Nov)		
-26.28	56	Kjeldahl-N**	39.98	0.564**
		Total-P**	-92.24	
		Temperature**	1.50	
		Winter (Dec-March)		
26.68	47	Reactive-P**	-152.22	0.264*
		Kjeldahl-N**	6.96	

*Significant at 0.05 level.
**Significant at 0.01 level.

Table 12. Correlation coefficients with chlorophyll a (µg/1) as the dependent variable using various environmental parameters as the independent variables. The results are for surface samples collected from June 1975 to April 1977.

Independent Variable	N	r Spring (April-May)	N	r Summer (June-Aug)	N	r Fall (Sept-Nov)	N	r Winter (Dec-March)
BOD_5	26	0.354	61	0.645**	56	0.758**	47	0.520**
Kjeldahl-N	26	-0.060	61	0.585**	56	0.697**	47	0.272
NO_2+NO_3-N	26	0.211	61	-0.540**	56	-0.163	47	-0.375**
NH_4^+-N	26	-0.202	61	-0.363**	56	-0.048	47	-0.022
Total-P	26	-0.204	61	0.711**	56	-0.057	47	-0.296*
Reactive-P	26	-0.364	61	0.514**	56	0.042	47	-0.394**
DO	26	0.485*	61	0.388**	56	-0.062	47	-0.137
Alkalinity	26	0.161	61	0.572**	56	-0.218	47	0.258
Temperature	26	0.179	61	0.432**	56	0.235	47	-0.044
Organic-P		ND	61	0.743**		ND		ND
Organic-N		ND	61	0.605**		ND		ND
Extinction Coefficient	14	0.711**	29	0.822**	9	0.416		ND

*Significant at 0.05 level.
**Significant at 0.01 level.
ND = Not determined.

chlorophyll a for this period (Table 11). The most significant correlation (r = 0.743) observed was between the organic phosphorus (Total P - TRP) and chlorophyll a concentration (Table 12). This finding further supports the important relationship between phosphorus and the magnitude of the summer blue-green alga bloom. It was observed that chlorophyll a correlated significantly with all measured environmental variables during the summer period (Table 12). This phenomenon is a reflection of the impact the blue-green alga bloom has on the overall water quality. In particular, levels of inorganic nitrogen dropped to very low levels during the summer months (Fig. 6) and were inversely related to algal biomass (Fig. 3).

The greatest correlation associated with the fall phytoplankton was with the Kjeldahl nitrogen concentration (r = 0.697) (Table 12). Kjeldahl nitrogen, in combination with total phosphorus and water temperature, explained 56 percent of the chlorophyll a variation (Table 11). The strong correlation between Kjeldahl nitrogen and chlorophyll a concentration reflects the decline in phytoplankton biomass and change in the phytoplankton flora during the fall period (September-November) (Fig. 7). During this time the phytoplankton community changed from one dominated by A. flos-aquae with high biomass to diatoms and cryptomonads with lower biomass (Fig. 8). In addition, the decline in A. flos-aquae biomass may represent a significant loss in the organic nitrogen fraction since this species has a nitrogen content of about 10 percent per dry weight (Prescott 1960 and Birge and Juday 1922).

The relationship between various environmental variables and the winter phytoplankton biomass was obscure. Total reactive phosphorus and Kjeldahl nitrogen were the most important variables but explained only 26 percent of the chlorophyll a variation (Table 11). It is likely that light availability was the primary factor regulating winter phytoplankton biomass, but this data was not available for regression analysis.

Phytoplankton Volume and Chlorophyll a

The relationship between phytoplankton volume and chlorophyll a concentration for various periods is presented in Table 13. A direct and significant relationship was found between these two estimates of phytoplankton biomass.

Table 13. Average phytoplankton volume (mm^3/l) and chlorophyll a ($\mu g/l$) concentrations at various periods of the year.

Period	(1) Chlorophyll a	(2) Volume	(2)/(1)	N	r^2
Spring (Apr-May)	8.4	3.0	0.36	14	0.829**
Summer (Jun-Sep)	56.6	42.8	0.76	55	0.755**
Fall (Oct-Nov)	34.5	6.0	0.17	30	0.416*
Winter (Dec-Mar)	17.3	1.7	0.10	30	0.558**

*Significant at 0.05 level.
**Significant at 0.01 level.

Therefore, measurements of chlorophyll a were considered to be a reasonable estimator of phytoplankton biomass for regression analysis.

The ratio of phytoplankton volume (mm^3/l) to chlorophyll a (μg/l) ranged from 0.10 in the winter period to 0.76 in the summer period. Wright (1959) and Bindloss et al. (1972) reported ratios of 0.5 to 0.25 respectively, for periods without ice cover. The change in the ratio at different periods was attributable to changes in the size and species of the phytoplankton flora. A high phytoplankton volume to chlorophyll ratio was observed during the bloom of the large blue-green alga, *A. flos-aquae* in the summer period. In contrast, lowest ratios were found in the winter period when small coccoid greens, coccoid blue-greens, and cryptomonads were present. The ratio was fairly similar in the fall and spring seasons when centric diatoms were abundant members of the phytoplankton community.

Algal Bioassays and Nutrient Limitation

The results of nutrient enrichment studies using the Algal Assay Procedure Bottle Test in the summer of 1976 are presented in Figure 10. It was evident that both nitrogen and phosphorus additions stimulated the greatest growth of the test alga, *Selenastrum capricornutum*, in the bioassays performed in June and July. The addition of nitrogen alone was more stimulatory than the addition of phosphorus in 3 out of the 4 bioassays conducted. These

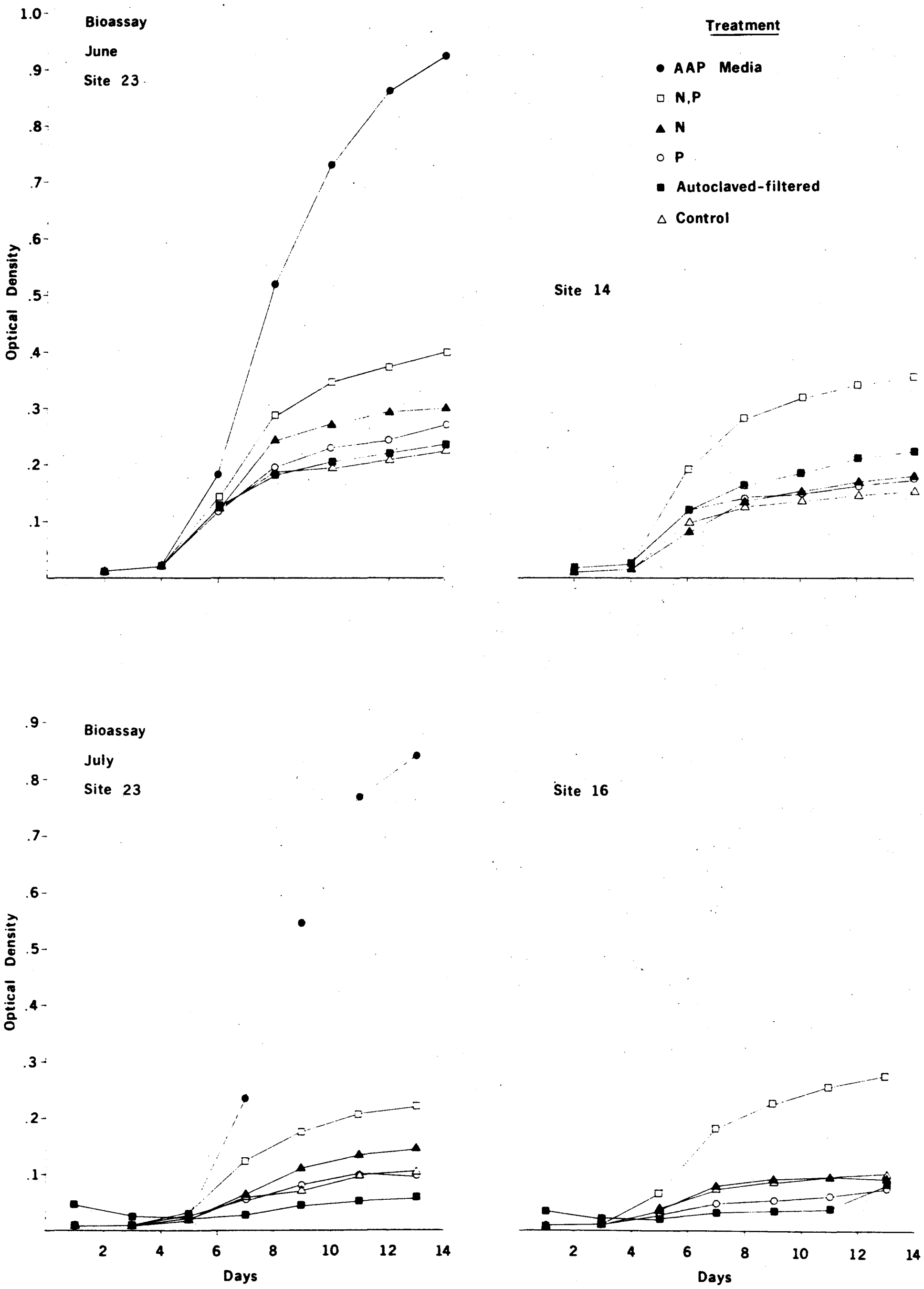

Figure 10. Response of the June and July 1976 algal bioassays.

results indicated that both nitrogen and phosphorus were limiting in June and July, but nitrogen was apparently more critical than phosphorus. The very low levels of inorganic nitrogen observed during the summer period (Fig. 6) lend support to this finding. Bioassay data collected by the National Eutrophication Survey on the Big Eau Pleine Reservoir in 1972 indicated borderline nitrogen limitation (U.S. EPA 1974). However, they obtained the greatest algal growth when both nitrogen and phosphorus were added together. Although nitrogen may have limited the green alga, *S. capricornutum*, in laboratory assays, it is doubtful that nitrogen restricted the growth of the blue-green alga, *Aphanizomenon flos-aquae*, in the reservoir. *Aphanizomenon flos-aquae* is a nitrogen fixer (Stewart et al. 1968) and its development in eutrophic lakes is more dependent upon the phosphorus supply rather than inorganic nitrogen availability (Healey and Hendzel 1976, Jones and Bachmann 1975, and Vanderhoef et al. 1974). Further, the response of the test alga to various nutrient additions in bioassay work may vary with the test species used. Shirogama et al. (1976) found a definite nitrogen limitation when *S. capricornutum* was used and phosphorus limitation when *Anabaena flos-aquae* was used as test algae. Their comparison work was conducted on samples collected from Shagawa Lake, Minnesota. Interestingly, Shagawa Lake experiences blooms of *Aphanizomenon flos-aquae* and *Anabaena sp*. during the summer months and phosphorus is believed to be the critical nutrient controlling phytoplankton production (Powers et al. 1972 and Megard and Smith 1974).

The control yield of the June bioassay was about twice as great as the control in July which indicates higher potential algal growth in the reservoir in June. The autoclaved-filtered treatments stimulated additional growth over controls in the June bioassay but retarded growth in the July bioassay. The reason for this response was not known. Inhibition by algal toxins in the July bioassay is not probable since autoclaving should destroy these compounds (Shirogama et al. 1976). The soluble phosphorus supply may have formed a precipitate during autoclaving that was removed during filtration (Jadlocki et al. 1976). However, the latter authors indicated the problem of phosphorus precipitation is usually restricted to waters of high hardness (> 200 mg/l as $Ca\ CO_3$) which is about 3 times the hardness of the reservoir water.

The results of the October bioassay indicated initially that phosphorus was the critical limiting nutrient (Fig. 11). The nitrogen treatment was identical to the response of the control. The addition of both nitrogen and phosphorus stimulated the greatest growth than either nutrient alone. This may suggest that nitrogen eventually became limiting in the phosphorus treatment. The alga responded with higher growth in the autoclaved-filtered treatment when compared to the control yield. An autoclaved (not filtered) treatment resulted in rapid growth that was similar to the

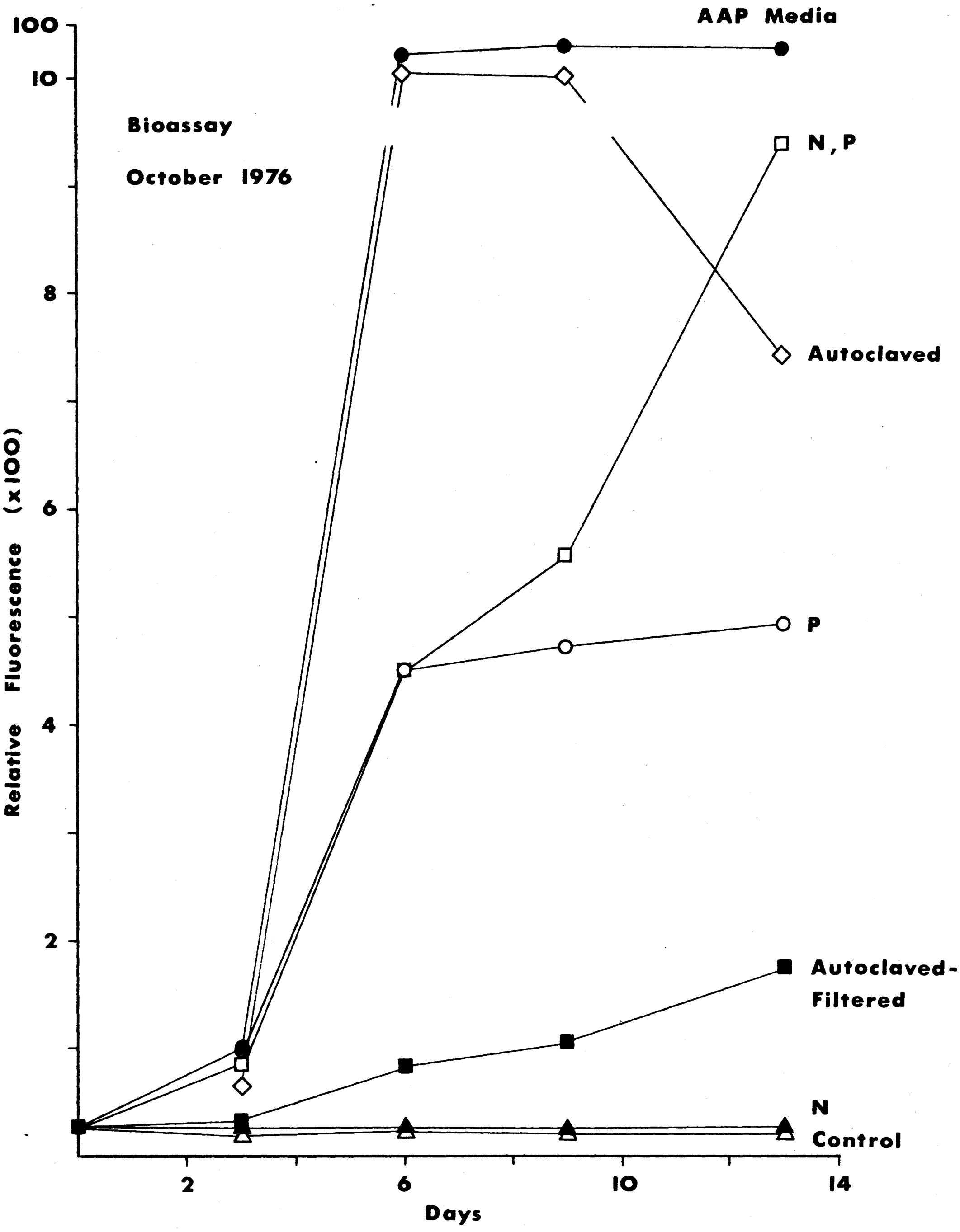

Figure 11. Response of the October 1976 algal bioassay. Note change in ordinate scale.

response of the AAP media for the first week of the bioassay. The difference in the algal response to autoclaved and autoclaved-filtered treatments suggested the filtration procedure was removing a significant portion of the available nutrients. A review of the total reactive phosphorus concentrations in the water sample collected for the October bioassay indicated that 82 percent of the total reactive phosphorus concentration was removed upon filtration. This finding, and the results of the bioassay work, suggests a significant part of the available phosphorus supply may be tied up on particulate and colloidal material that is removed upon filtration. Thus, the phosphorus limitation response observed may be an erroneous result brought on by sample pretreatment. It is not known if the summer bioassays were influenced by a similar phenomenon. It is not likely that filtration removed a large portion of the available phosphorus supply during the summer months. The amount of available phosphorus was probably very low since the bioassays were performed during the bloom of *Aphanizomenon flos-aquae* which was limited by phosphorus.

Analysis of the nitrogen and phosphorus content of *Aphanizomenon flos-aquae* in June through August 1976 indicated phosphorus deficiency (Table 20). The nitrogen content of this species was 9.0 percent (dry weight) on June 5 and 8.3 percent on August 9, a reduction of only 8.4 percent. Birge and Juday (1922) reported an average nitrogen content of 9.3 percent for this species which is only 12 percent larger than the lowest nitrogen composition found in the present work. During this same period, the phosphorus content of A. flos-aquae fell from 0.25 to 0.04 percent, a decline of 84.0 percent. Healey (1973) indicated the mean phosphorus content of algae is about 1.1 percent dry weight which is 27.5 times larger than the lowest phosphorus content determined for A. flos-aquae in this work. The very dramatic drop in the phosphorus composition, while the nitrogen content remained relatively steady, indicated that phosphorus was the major limiting nutrient.

Computer Model Coefficients

One of the primary goals of this research was to provide an information base of the phytoplankton dynamics in the Big Eau Pleine Reservoir for the calibration of a computer model. Computer modeling of phytoplankton communities present an arduous but rewarding challenge for the limnologist. Modeling enables the investigator to study the combined impact of physical, chemical, and biological interactions that regulate phytoplankton in aquatic ecosystems (Thomann et al. 1975 and Lehman et al. 1975). Model coefficients are required for the mathematical expression of phytoplankton dynamics and associated environmental factors. In this research, model coefficients were derived empirically from the data base when possible and also obtained from the literature. Most of these coefficients were determined for the Baca and Arnett (1976) model but are also applicable to models described by

Thomann et al. (1975), Lehman et al. (1975), and Di Toro et al. (1971).

Maximum Specific Growth Rate

The maximum specific or saturation growth rate coefficient is used in the formulation of the gross specific growth rate in the computer model (Baca and Arnett 1976). The gross rate considers the combined effects of light, temperature, and nutrients on phytoplankton growth. The maximum specific growth rate is temperature dependent and species specific (Fogg 1965) and is normally determined in laboratory conditions under saturating light intensities when temperature and nutrients are optimal for growth. Specific growth can be expressed by the exponential growth relationship:

$$k = \frac{\ln(N_t) - \ln(N_o)}{t}$$

where, N_t is the population at time t, N_o is the population at time zero, t is the time interval in days, and k is the specific growth rate per day (Fogg 1965). Measurements of phytoplankton populations can be determined in various ways: cell numbers, optical density, cell carbon, chlorophyll, dry weight, etc. (Thomas 1963).

Specific growth rates of various taxa are presented in Table 14. It is evident that the specific growth rates determined in the laboratory for a single species, *Aphanizomenon flos-aquae*, are quite variable and leave some doubt

Table 14. Specific growth rates, k, in natural log day units, of various phytoplankton taxa.

Taxa	k (divisions/day)	Comments	Reference
Aphanizomenon flos-aquae	1.28	20°C, 5000 lux, ASM-1	Gentile and Moloney 1969
Aphanizomenon flos-aquae	1.50	23°C, Determined in field	Lorenzen and Mitchel 1975
Aphanizomenon flos-aquae	0.50	20°C, 4000 lux, ASM	Present Work
Aphanizomenon flos-aquae	0.18	15-20°C, 860 lux, ASM No. 8a	O'Flaherty and Phinney 1970
Blue Green Algae	2.5	Used in Model	Lehman et al. 1975
Green Algae	3.0	Used in Model	Lehman et al. 1975
Diatoms	3.0	Used in Model	Lehman et al. 1975
Lake Ontario Phytoplankton	2.5	Used in Model	Thormann et al. 1975

as to what constitutes the maximal rate. Clearly, experimental variation of nutrients, light, and temperature influenced the growth rates obtained for _Aphanizomenon flos-aquae_.

Specific growth rates used in various models are often presented for the dominant phytoplankton community present (Lehman et al. 1975 and Baca and Arnett 1976). However, these models fail to describe how specific growth rates, which are species specific, are determined for mixed phytoplankton communities. A possible solution to this problem may be possibly obtained by determining k values from maximum specific photosynthetic rates (Pmax) (Table 6) from _in situ_ exposures. Thomas (1963) describes how specific growth rates can be obtained from photosynthetic measurements. His method involves the expression of population changes in terms of phytoplankton carbon. A sample calculation for the average Pmax determined for the carbon-14 method on August 29, 1976 is illustrated in Table 15. The reservoir was dominated by blue-green algae on this day (Fig. 7). The k value determined was equal to the maximum specific growth rate assigned for the blue-green algae in the model of Lehman et al. (1975) (Table 14). Measurements of specific growth rates for various phytoplankton communities derived by the above rationale are presented in Table 16. These rates are not maximal rates since the data are averaged over the various seasons for the two year period. However, the information should facilitate the

Table 15. Calculation of a maximum specific growth rate from a maximum specific photosynthetic rate. The carbon content was estimated from the relationship: carbon = 0.10 x phytoplankton volume (Vollenweider 1974) using Table 13.

$$\text{Pmax} = 8.2 \text{ mg C/mg chlorophyll } \underline{a}/\text{m}^3/\text{hr}$$

$$\text{Carbon/Chlorophyll ratio} = 77 \text{ mg/mg}$$

$$\text{Pmax} = 0.11 \text{ mg C/mg C/m}^3/\text{hr}$$

$$N_o = 1.0 \text{ mg C/m}^3$$

$$N_t = 1.0 \text{ mg C/m}^3 + 0.11 \text{ mg C/m}^3$$

$$t = 1 \text{ hr}$$

$$k = \frac{\ln(1.11) - \ln(1.0)}{1} = 0.104 \text{ hr}^{-1}$$

$$= 2.50 \text{ day}^{-1}$$

Table 16. Mean specific growth rates, k, in natural log day units, of the major phytoplankton communities in the reservoir.

Phytoplankton Community	Pmax[1]	Carbon/Chl[2]	Pmax[3]	k
Diatoms, Cryptomonads, Green Algae (April-May)	10.3	36	0.29	6.10
Blue-Green Algae <u>Aphanizomenon flos-aquae</u> (June-September)	6.2	77	0.08	1.85
Diatoms, Cryptomonads (October-November)	1.5	17	0.09	2.07
Cryptomonads, Green Algae (December-March)	1.4	10	0.14	3.14

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[1] Pmax = mg C/mg chlorophyll/m^3/hr.
[2] Carbon to chlorophyll ratio (mg/mg).
[3] Pmax = mg C/mg C/hr.

mathematical description of the major phytoplankton communities found in the reservoir. The specific growth rates determined are within the ranges used in computer modeling (Baca and Arnett 1976 and Lehman et al. 1975).

Death Rate

The death rate coefficient is fractioned into two components in the Baca and Arnett (1976) computer model. A phytoplankton respiration rate coefficient accounts for respiration losses in the euphotic zone and a decay or decomposition rate term is used to express the mortality rate in the aphotic zone. Both rates are corrected for temperature by a standard Q_{10} formula. The impact of zooplankton grazing is also considered in the death rate formulation.

Lorenzen and Mitchel (1975) found a specific respiration rate of 0.3 per day at 25 ^{o}C for *Aphanizomenon flos-aquae*. Thomann et al. (1975) reported a maximum specific death rate of 0.25 per day in August in their phytoplankton model of Lake Ontario. They indicated this was primarily due to zooplankton grazing. Lake Ontario has a diverse summer phytoplankton flora with blue-green algae comprising a maximum of about 40 percent of the biomass in August (Vollenweider et al. 1974). The remaining portion of the phytoplankton community in Lake Ontario included diatoms, green algae, and cryptomonads which may have supported zooplankton predation. The effects of zooplankton predation on Aphanizomenon flos-aquae the dominant summer alga, is considered insignificant for modeling purposes because of its large size (Baca and Arnett 1976 and Lorenzen and Mitchel 1975). The impact of zooplankton grazing on phytoplankton mortality may need to be considered in the reservoir during the spring, fall, and winter periods when the phytoplankton flora is more diverse.

Specific respiration measurements of phytoplankton were estimated from dark bottle measurements from in situ photosynthetic studies (Table 17). The specific rates determined overestimate the respiration of phytoplankton since zooplankton and bacteria are included in the estimate. The average community respiration rates ranged from 0.6 to 2.6 mg O_2/mg Chlorophyll a/hr. The respiration rates determined are within the ranges reported in the literature. Bindloss et al. (1972) found values of community respiration ranging from 0.1 to 3.5 mg O_2/mg Chlorophyll a/hr for Loch Leven, Scotland. Ganf (1972) reported a range of 1 to 4 mg O_2/mg Chlorophyll a/hr for Lake George, Uganda.

The specific respiration rates were about 12 percent of the specific growth rates (Table 16) for the spring, summer, and fall seasons. This is in agreement with the respiratory to photosynthetic ratio of phytoplankton at light saturation. Respiration of algal cells is normally 10 percent of photosynthesis at light saturation (Thomas 1963). The specific respiration rate of the winter flora was 31 percent of the specific growth rate. This may

Table 17. Mean community respiration rates based on dark bottle dissolved oxygen analysis and chlorophyll *a* concentrations.

Phytoplankton Community	Respiration/Chlorophyll *a* mg O_2/mg Chl *a*/hr	Specific Respiration[1] mg C/mg C/hr	k^2
Diatoms, Cryptomonads and Green Algae (April-May)	2.6	0.027	0.64
Aphanizomenon flos-aquae (June-September)	1.8	0.009	0.22
Diatoms and Cryptomonads (October-November)	0.6	0.013	0.31
Cryptomonads and Green Algae (December-March)	1.1	0.041	0.96

[1] Determined using a respiratory quotient of 1.0 and the carbon to chlorophyll ratios presented in Table 16.

[2] Specific respiration rate in natural log day units calculated by the procedure in Table 15.

indicate that the specific respiration rate of the winter flora was overestimated. For modeling purposes, it may be best to use a specific respiration rate that equals 10 percent of the specific growth rate.

Light Limitation

There are two light limiting terms used in the model to describe the nature of the photosynthetic-depth profile. The approach used in the Baca and Arnett (1976) model was obtained from a photosynthetic model described by Vollenweider (1965). Estimation of the coefficients needed for Vollenweider's approach is rather difficult and may require the use of numerical optimization by least squares analysis as described by Fee (1969).

A low light coefficient is used to describe the adaptation of the phytoplankton to low light intensities and is inversely related to I_k, an experimentally measurable light intensity (Vollenweider 1965). Empirical measurements of I_k are presented in Appendix A. The latter data are required to use the optimization approach given by Fee (1969). A photoinhibition coefficient incorporates the effect of photosynthetic inhibition at high light intensities. Lorenzen and Mitchel (1975) found a low light adaptation factor of 0.00045 per lux for *Aphanizomenon flos-aquae*. A photoinhibition coefficient for *A. flos-aquae* or other algae was not found in the literature surveyed.

Nutrient Limitation

The Michaelis-Menton formulation is used in the model to determine if nutrient limitation of either nitrogen or phosphorus is present. The nutrient in least supply controls the growth factor used in determining the gross specific growth rate of the phytoplankton (Baca and Arnett 1976). This approach requires the use of half-saturation constants for nitrogen and phosphorus. The half-saturation constant is defined as the concentration supporting one-half the maximal uptake or growth rate (Eppley and Thomas 1969). These constants are species specific and may vary in lakes with the degree of eutrophication (Thomann et al. 1975). Half-saturation constants for uptake and growth are not necessarily similar. Eppley and Thomas (1969) suggest that half-saturation constants for uptake are greater than those for growth. They believe this arises since nutrient uptake "can be separated in time or uncoupled from cell division". Further, the uptake velocity may vary with the nutritional status of the cell. A listing of half-saturation constants for nitrogen and phosphorus of various phytoplankton communities are presented in Table 18.

The reported half-saturation constants for nitrogen are fairly similar for the various phytoplankton, although the blue-greens have a larger nitrogen requirement than other algae. Toetz et al. (1973) found the half-saturation constant for uptake of nitrate nitrogen was 0.043 mg/l for a mixed blue-green algae community containing *Aphanizomenon sp*.

Table 18. Half-saturation constants for (uptake) and growth of nitrogen and phosphorus by various phytoplankton communities.

Phytoplankton Community	Nitrogen (mg/l)	Phosphorus (mg/l)	Reference
Anacystis, *Anabaena* and *Aphanizomenon*	(0.043)	-	Toetz et al. 1973
Blue-Green Algae	(0.070)	0.010	Lehman et al. 1975
Diatoms	(0.021)	0.001	Lehman et al. 1975
Green Algae	(0.028)	0.003	Lehman et al. 1975
Lake Michigan Phytoplankton	0.015	0.0025	Canale et al. 1976
Lake Ontario Phytoplankton	0.025	0.001- 0.010	Thomann et al. 1975

This value would appear to be appropriate for the reservoir since the summer flora is dominated by *Aphanizomenon flos-aquae*. The reported half-saturation constants for phosphorus are more variable. Half-saturation constants for phosphorus are likely to be below 0.010 mg/l for most algae since growth rates are independent of phosphorus concentrations that exceed 0.010 mg/l (Thomas and Dodson 1968). The heterocystous blue-green algae may require higher levels of phosphorus in order to sustain nitrogen fixation during periods of low inorganic nitrogen concentrations. Stewart and Alexander (1971) found saturation of nitrogenase activity in *Anabaena* at 0.020 mg/l of phosphorus. Therefore, the half-saturation constant for phosphorus for *Aphanizomenon flos-aquae* is probably below 0.020 mg/l, but above those reported for other non-heterocystous algae.

Chlorophyll to Carbon Ratio

The ratio of chlorophyll *a* (μg/l) to phytoplankton carbon content (mg/l) is very critical since the model uses this relationship to determine the carbon content of the phytoplankton biomass (Baca and Arnett 1976). Measurements of the phytoplankton carbon content were estimated from phytoplankton volume determinations. The carbon content was assumed to represent 10 percent of the total volume by weight (Vollenweider 1974). A summary of the chlorophyll to carbon ratios determined in this work are presented in Table 19.

Table 19. Average chlorophyll *a* (μg/l) to carbon (mg/l) ratios for various phytoplankton communities. Each sample represents a mean of 3 to 6 samples collected from surface and middle depths.

Phytoplankton Community	Ratio Chl/ C	S.D.	N
Diatoms, Green Algae, and Cryptomonads (April-May)	28	6.1	14
Aphanizomenon flos-aquae Blue-Green Algae (June-September)	13	6.3	14
Diatoms and Cryptomonads (October-November)	58	14.3	6
Cryptomonads, Green Algae and Blue-greens (December-March)	101	66.6	11

The relationship between chlorophyll a and phytoplankton carbon was quite variable. This is attributable to changes in the cell size of the dominant flora. Largest chlorophyll a to carbon ratios (µg/mg) were found in the winter period when the phytoplankton community was dominated by small cryptomonads and green algae. Smallest ratios were found in the summer when the large filamentous blue-green alga, *Aphanizomenon flos-aquae* was dominant. These ratios should facilitate conversions of chlorophyll a and phytoplankton carbon data for the major phytoplankton communities found in the reservoir.

Nitrogen, Phosphorus, and Chlorophyll a content of *Aphanizomenon flos-aquae*

The nitrogen and phosphorus composition of the phytoplankton are important because they are used to establish the relationship between algae and nutrient cycles (Baca and Arnett 1976). The model requires nitrogen to carbon and phosphorus to carbon ratios of the phytoplankton flora. These ratios were determined for the dominant summer alga, *Aphanizomenon flos-aquae* (Table 20). The carbon content was not determined directly but was estimated from phytoplankton volume measurements as discussed previously. A ratio of 13 µg chlorophyll a per mg carbon (Table 19) was used to estimate the carbon content from chlorophyll data. The average chlorophyll a composition of *A. flos-aquae* was 8.7 mg/g-dry wt or 670 mg C/g-dry wt. Correspondingly, the nitrogen and phosphorus to carbon ratios were 0.133 and

Table 20. Nitrogen, phosphorus, and chlorophyll *a* content (mg/g-dry wt) of *Aphanizomenon flos-aquae* in the summer of 1976.

Date		Nitrogen	Phosphorus	Chlorophyll *a*
June 5		90.0	2.50	6.7
June 30		97.0	0.94	11.0
July 16		-	1.00	11.0
August 9		83.0	0.41	7.6
August 29		87.0	0.49	7.2
	Mean	89.2	1.07	8.7
	S.D.	5.9	0.84	2.1

0.002, respectively. The mean nitrogen content of *A. flos-aquae* was 8.9 percent per gram dry weight. Birge and Juday (1922) reported a similar value of 9.3 percent for this species. The mean nitrogen to chlorophyll *a* ratio found was 10.2. Thomann et al. (1975) used a similar ratio of 10 for their phytoplankton model of Lake Ontario. The mean nitrogen to carbon ratio found in this work is within the range suggested by Baca and Arnett (1976). The average phosphorus content of *A. flos-aquae* was 1.1 mg/g-dry wt. Healey (1973) has indicated the mean phosphorus content of algae is about 11 mg/g-dry wt and ranges from 0.5 to 33.0. The phosphorus content of *A. flos-aquae* did not exceed 2.5 mg/g-dry wt and declined steadily during the summer period. The mean N/P ratio was 83.4 which indicates a cellular imbalance of these two nutrients. The ratio of

N/P is normally between 9 and 17 when neither nutrient is limiting (Sakamoto 1966). Therefore the data suggests phosphorus deficiency. However, the N/P ratio was 36 on June 5 prior to the bloom of *Aphanizomenon flos-aquae*. It was unlikely that phosphorus was limiting on June 5 because this was during the exponential growth phase of this species. This may indicate that the phosphorus content was underestimated as well. It was difficult to determine a phosphorus to carbon ratio from these results. If one assumes a phosphorus content of 11 mg/g-dry wt (Healey 1973) then the phosphorus to carbon ratio is 0.016. However, the ratio was not constant since the phosphorus content of the alga declined steadily during the bloom. The phosphorus to carbon ratio for *A. flos-aquae* may range from 0.002 to 0.016 from these results.

Algal and Water Attenuation Coefficients

An algal attenuation term or self-shading factor is used in the Baca and Arnett (1976) model to determine the attenuation of light with respect to the phytoplankton concentration present. The Lambert-Beer equation is used to define light extinction. The formulation for light extinction considers the attenuation due to algae and that associated with the water which includes detritus, zooplankton, and dissolved compounds. The extinction coefficient of the water and the algae were determined by regressing total light attenuation against a unit of algal biomass (Ganf 1974) and are presented in Table 21. Measurements of algal biomass were made using chlorophyll a data and an estimation of the carbon content of the phytoplankton. The carbon content was determined using the chlorophyll to carbon ratios presented in Table 19.

Table 21. Extinction of water and algal attenuation coefficients based on chlorophyll a and phytoplankton carbon content.

Period	Extinction of Water (1/m)	Extinction of Algae Chlorophyll (1/m-mg chl/l)	Carbon (1/m-mg c/l)
Spring (April-May)	0.91	0.032	0.85
Summer (June-September)	1.18	0.014	0.20
Fall (October-November)	1.95	0.019	1.05

The attenuation of coefficients for chlorophyll a compare with those reported by Ganf (1974), Bindloss et al. (1972), and Megard and Smith (1974) for eutrophic lakes. The light extinction coefficient for water was high during the summer and fall periods. Megard and Smith (1974) reported much lower values of 0.7 and 0.9 1/m for eutrophic Lake Minnetonka and Shagawa Lake, Minnesota, respectively. The higher extinction coefficients for water for the reservoir may result from a greater suspension of detritus when compared to natural lakes. Increased levels of particulate material are expected in the reservoir as a result of summer and fall drawdown. Ganf (1974) found very high attenuation coefficients for the water fraction (2.6-2.8 1/m) for a shallow well mixed equatorial lake (Lake George, Uganda). Correspondingly, resuspension of chlorophyll and particulate material occurs daily in Lake George as a result of wind mixing (Ganf 1972).

A prediction equation was needed to explain changes in the extinction coefficient of the water with respect to water level manipulations. Measurements of the attenuation of water were determined and compared to the reservoir stage on eight days during the open water period (May-October) of 1976 (Table 22). An excellent correlation ($r = 0.942$)

Table 22. Extinction of water and reservoir stage on eight days during the open water period of 1976.

Date	Extinction of Water (1/m)	Reservoir Stage (ft)
May 14	1.04	1145
May 26	1.07	1145
June 19	1.10	1145
July 8	0.92	1142
July 27	1.88	1140
August 9	1.76	1139
August 29	2.74	1136
October 22	3.05	1132

was found by regressing the extinction coefficient of the water against the reservoir stage in feet. The prediction equation is:

$$\text{Extinction of Water (1/m)} = 189.4 - 0.165\ (\text{Stage in ft})$$

By incorporating this equation with the self-shading coefficients for chlorophyll or carbon (Table 21), a reasonable estimate of the total light attenuation coefficient is possible.

An approximation of the total light extinction can also be obtained from Secchi disc measurements. Measurements of the total light attenuation using a submarine photometer were taken in parallel with Secchi disc readings on 42 samples during the two year open-water period. The mean vertical extinction coefficient and average Secchi disc were 2.64 1/m and 0.8 m, respectively. The average light intensity at the limit of Secchi disc visibility was 12 percent of the surface light intensity. This is in agreement with the data reviewed by Vollenweider (1974). The realtionship between Secchi disc readings and total light extinction using Vollenweider's approach is:

$$\text{Extinction Coefficient (1/m)} = \frac{\text{Constant}}{\text{Secchi disc (m)}}$$

The constant determined for the reservoir was 2.1. Vollenweider (1974) reported an average value of 2.2 and a range of 1.4 to 3.0.

CONCLUSIONS

1. Annual primary productivity of the Big Eau Pleine Reservoir was indicative of a hypereutrophic lake. The estimated annual productions for 1975 and 1976 were 300 and 605 g C/m^2, respectively. The mean daily integral photosynthetic rates were 1.3 and 2.8 g C/m^2/day for 1975 and 1976, respectively. The marked rise in productivity in 1976 was attributed largely to increased solar radiation and water temperature in the summer of 1976 as compared to 1975. Surface water temperatures were warmer in the summer of 1976 in response to increased solar radiation during that period. Warmer water temperatures provided a longer period of optimal water temperature for the growth of the dominant blue-green alga, Aphanizomenon flos-aquae. An earlier and more extensive drawdown provided higher levels of total reactive phosphorus in the 1976 summer period. The combination of increased solar energy, water temperature, and phosphorus concentrations in the summer period of 1976 provided optimal conditions for phytoplankton growth.

2. The timing and magnitude of the summer reservoir drawdown influenced the release of phosphorus from the reservoir sediments. An earlier and more extensive summer drawdown in 1976 resulted in higher levels of total reactive phosphorus than the previous summer period. It is believed internal phosphorus release from the sediments is promoted by wind mixing with low water levels. Phytoplankton biomass and productivity increased sharply immediately after

summer drawdown began in 1975 and 1976. Reservoir drawdown apparently provides a significant source of phosphorus for phytoplankton growth during the summer months.

3. Measurements of carbon-14 primary production determined with the filtration procedure were identical to those measured with the acidification and bubbling procedure. The carbon-14 method correlated best with net photosynthesis rather than gross photosynthesis.

4. Measurements of phytoplankton volume paralleled changes in the chlorophyll *a* concentration. The mean surface chlorophyll *a* concentrations for the summer periods (June-September) were 53.2 μg/l in 1975 and 103.0 μg/l in 1976. Correspondingly, the average surface volume measurements for these periods were 32.2 and 53.0 mm^3/l respectively. These biomass measurements are characteristic of eutrophic temperate lakes.

5. The summer phytoplankton biomass is dominated by blue-green algae, particularly *Aphanizomenon flos-aquae*. Centric diatoms and cryptomonads were the dominant taxa in other seasons.

6. Results of algal bioassays indicated that both nitrogen and phosphorus were limiting phytoplankton growth in the summer and fall seasons. Phosphorus was believed to be the main limiting nutrient since the phosphorus content of *A. flos-aquae* declined as the bloom developed. A reduction in the external phosphorus loading from spring runoff and internal loading from the sediments in the summer

will decrease the summer phytoplankton growth. In particular, a delayed summer drawdown should reduce the magnitude of the summer blue-green algal bloom since the phosphorus flux from the sediments would be reduced.

7. An information base was collected on the seasonal changes in primary production and phytoplankton biomass for the reservoir computer model. In addition, model coefficients were derived from the data base where possible. This information should facilitate the calibration of the computer model of the Big Eau Pleine Reservoir.

LITERATURE CITED

Abbott, W. 1957. Unusual phosphorus source for plankton algae. Ecology, 38:152.

American Public Health Association. 1976. Standard Methods for the Examination of Water and Wastewater, 14 edition. American Public Health Association, New York. 1193pp.

Arthur, C.R., and F.H. Rigler. 1967. A possible source of error in the ^{14}C method of measuring primary productivity. Limnol. Oceanog., 14:121-124.

Baca, R.G., and R. Arnett. 1976. A limnological model for eutrophic lakes and impoundments. Prepared for Office of Research and Development. U.S. EPA. Washington, D.C. Battelle Pacific Northwest Laboratories, Richland, Washington. 158pp.

Barica, J. 1975. Collapses of algal blooms in prairie pothole lakes: Their mechanisms and ecological impact. Verh. Internat. Verein. Limnol., 19:606-615.

Bartelt, S. et al. 1973. The collection and integration of land, water, and recreation data used in resource planning. Student-Originated Studies Program, Univ. of Wisconsin-Stevens Point. National Science Foundation, Washington, D.C. (unpublished).

Baumann, P.C., A.D. Hasler, J.F. Koonce, and M. Teraguchi. 1973. Biological investigations of Lake Wingra. EPA-R3-73-044. Ecol. Res. Series. Natl. Env. Res. Cntr., U.S. EPA. 118pp.

Bindloss, M.E., A.V. Holden, A.E. Bailey-Watts, and I.R. Smith. 1972. Phytoplankton production, chemical and physical conditions in Lock Leven. pp. 639-659. In: Z. Kajak, and A. Hillbricht-Ilkowska (eds.). Productivity Problems of Freshwaters. Warsaw, PWN. Polish Scientific Publishers.

Birge, E.A., and C. Juday. 1922. The Inland Lakes of Wisconsin. The Plankton. I. Its Quantity and Chemical Composition. Wis. Geol. Nat. Hist. Survey. Bull. No. 64. Madison, Wis. 222pp.

Bremner, J.M., and D.R. Keeney. 1965. Steam distillation methods for determination of ammonium, nitrate, and nitrite. Anal. Chim. Acta., 32:485-495.

Brylinsky, M., and K.H. Mann. 1973. An analysis of factors governing productivity in lakes and reservoirs. Limnol. Oceanog., 18:1-14.

Buchanan, A. 1976. Zooplankton of the Big Eau Pleine Reservoir. M.S. Thesis. University of Wisconsin-Stevens Point. 107pp.

Canale, R.P., L.M. De Palma, and A.H. Vogel. 1976. A plankton-based food web model for Lake Michigan. pp. 33-74. In: R.P. Canale (ed.). Modeling Biochemical Processes in Aquatic Ecosystems. Ann Arbor Science Pub. Inc., Ann Arbor, Michigan.

Dillon, P.J., and F.H. Rigler. 1974. The phosphorus-chlorophyll relationship in lakes. Limnol. Oceanog., 19:767-773.

Di Toro, D.M., D.J. O'Connor, and R.V. Thomann. 1971. A dynamic model of the phytoplankton population in the Sacramento-San Joaquin Delta. Advances in Chemistry No. 106, pp. 131-180. American Chemical Society, Washington, D.C.

Edmundson, W.T. 1972. The present condition of Lake Washington. Verh. Internat. Verein. Limnol., 18: 284-291.

Environmental Task Force. 1977. Water chemistry data, unpublished. University of Wisconsin-Stevens Point.

Eppley, R.W., and W.H. Thomas. 1969. Comparison of half-saturation constants for growth and nitrate uptake of marine phytoplankton. J. Phycol., 5: 375-379.

Fee, E.J. 1969. A numerical model for the estimation of photosynthetic production, integrated over time and depth, in natural waters. Limnol. Oceanog., 14:906-911.

Findenegg, I. 1965. Relationship between standing crop and primary productivity. pp. 271-289. In: C.R. Goldman (ed.). Primary Productivity in Aquatic Environments. Mem. Ist. Ital. Idrobiol., 18 Suppl., University of California Press, Berkeley.

Fogg, G.E. 1963. The role of algae in organic production in aquatic environments. Brit. Phyc. Bull., 2:195-205.

Fogg, G.E. 1965. Algae Cultures and Phytoplankton Ecology. University of Wisconsin Press, Madison. 126pp.

Fogg, G.E. 1973. Phosphorus in primary aquatic plants. Water Research, 7:77-91.

Fogg, G.E., C. Nalewajko, and W.D. Watt. 1965. Extracellular products of phytoplankton photosynthesis. Proc. Roy. Soc. B., 162:517-534.

Fogg, G.E., W.D.P. Stewart, P. Fay, and A.E. Walsby. 1973. The Blue-Green Algae. Academic Press, London. 459pp.

Fott, J. 1972. Observations on primary production of phytoplankton in two fish ponds. pp. 674-683. In: Z. Kajak and A. Hillbricht-Ilkowska (eds.). Productivity Problems of Freshwaters. Warsaw, PWN. Polish Scientific Publishers.

Ganf, G.G. 1972. The regulation of net primary production in Lake George, Uganda, East Africa. pp. 693-708. In: Z. Kajak and A. Hillbricht-Ilkowska (eds.). Productivity Problems of Freshwaters. Warsaw, PWN. Polish Scientific Publishers.

Ganf, G.G. 1974. Incident solar irradiance and underwater light penetration as factors controlling the chlorophyll a content of a shallow equatorial lake (Lake George, Uganda). J. Ecol., 62:593-609.

Gentile, J.H., and T.E. Maloney. 1969. Toxicity and environmental requirements of a strain of Aphanizomenon flos-aquae (L.) Ralfs. Can. J. of Microbiology, 15: 165-173.

Glooschenko, W.A., J.E. Moore, M. Munawata, and R.A. Vollenweider. 1974. Primary production in lakes Ontario and Erie: A comparative study. J. Fish Res. Bd. Canada, 31:253-263.

Goldman, C. 1968. Aquatic primary production. Amer. Zool., 8:31-42.

Grandall, U., and A. Lundgren. 1971. Nitrogen fixation in Lake Erken. Limnol. Oceanog., 16:711-719.

Hammer, U.T. 1964. The succession of "Bloom" species of blue-green algae and some causal factors. Verh. Internat. Verein. Limnol., 15:829-836.

Hammer, U.T. 1969. Blue-green algae blooms in Saskatchewan Lakes. Verh. Internat. Verein. Limnol., 17:116-125.

Healey, F.P. 1973. Inorganic nutrient uptake and deficiency in algae. CRC Crit. Rev. in Microbiol., 3: 69-113.

Healey, F.P., and L.L. Hendzel. 1976. Physiological changes during the course of blooms of Aphanizomenon flos-aquae. J. Fish. Res. Bd. Canada, 33:36-41.

Heath, R.T., and G.D. Cooke. 1975. The significance of alkaline phosphatase in a eutrophic lake. Verh. Internat. Verein. Limnol., 19:959-965.

Hickman, M. 1973. The standing crop and primary productivity of the phytoplankton of Abbot's Pond, North Somerset. J. of Ecology, 61:269-287.

Jadlocki, J.F., J. Saldick, S.E. Coleridge, W.W. Smith, J.W. Brown, and C.J. Nicholson. 1976. Effects of water hardness, phosphorus concentration and sample pretreatment on the Algal Assay Procedure-Bottle Test. pp. 323-333. In: E.J. Middlebrooks, D.H. Falkenborg, and T.E. Maloney (eds.). Biostimulation and Nutrient Assessment. Ann Arbor Science, Ann Arbor, Michigan.

Johnson, W.E., and J.R. Vallentyne. 1971. Rationale, background, and development of experimental lake studies in northwestern Ontario. J. Fish. Res. Bd. Canada, 28:123-128.

Jonasson, P.M. 1977. Lake Esrom Research 1867-1977. Folia Limnol. Scand., 17:59-89.

Jones, J.R., and R.W. Bachmann. 1975. Algal response to nutrient inputs in some Iowa Lakes. Verh. Internat. Verein. Limnol., 19:904-910.

Kaminski, T.A. 1977. Application of an erosion model to a diversified agricultural watershed. M.S. Thesis. University of Wisconsin-Stevens Point. 103pp.

Kaster, J.L. 1976. Benthic macroinvertebrates of the Big Eau Pleine, a fluctuating, central Wisconsin Reservoir. M.S. Thesis. University of Wisconsin-Stevens Point. 97pp.

Kloppenburg, D. 1974. Overflow crowd attends Eau Pleine fishkill hearing. Wausau Herald. April 10.

Knauer, D.R. 1975. The effect of urban runoff on phytoplankton ecology. Verh. Internat. Verein. Limnol., 19:893-903.

Larsen, D.P., K.W. Malueg, D.W. Schults, and R.M. Brice. 1975. Response of eutrophic Shagawa Lake, Minnesota, USA, to point-source, phosphorus reduction. Verh. Internat. Verein. Limnol., 19:884-892.

Lehman, J.T., D.B. Botkin, and G.E.Likens. 1975. The assumptions and rationale of a computer model of phytoplankton population dynamics. Limnol. Oceanog., 20:343-364.

Lind, O.T. 1974. Handbook of Common Methods in Limnology. C.V. Mosby Comp., St. Louis, Mo. 154pp.

Lund, J.W.G. 1964. Edgardo Baldi Memorial Lecture - Primary Production and Periodicity of phytoplankton. Verh. Internat. Verein. Limnol., 15:37-56.

Lorenzen, M.W., and R. Mitchell. 1975. An evaluation of artificial destratification for control of algal blooms. Amer. Water Works Asso. J., 67:373-376.

Marano, M. 1978. Unpublished data. University of Wisconsin-Stevens Point. Personal Communications.

Martin, R.O., and R.L. Hanson. 1966. Reservoirs in the United States. Geol. Surv. Water Supply Paper 1838. 114pp.

McLachlan, J., U.T. Hammer, and P.R. Gorham. 1963. Observations on the growth and colony habits of ten strains of _Aphanizomenon flos-aquae_. Phycologia, 2:157-168.

Megard, R.O., and P.D. Smith. 1974. Mechanisms that regulate growth rates of phytoplankton in Shagawa Lake, Minnesota. Limnol. Oceanog., 19:279-296.

Murphy, G.I. 1962. Effect of mixing depth and turbidity on the productivity of freshwater impoundments. Trans. Amer. Fish. Soc., 91:69-76.

Nie, N.H., C.H. Hull, J.G. Jenkins, K. Steinbrenner and D.H. Bent. 1975. Statistical Package for the Social Sciences. Second Edition. McGraw-Hill, Inc., New York. 675pp.

O'Flaherty, L.M., and H.K. Phinney. 1970. Requirements for the maintenance and growth of _Aphanizomenon flos-aquae_ in culture. J. Phycol., 6:95-97.

Osborne, J.A., and G.R. Marzolf. 1972. Effect of spectral composition on photosynthesis in turbid reservoirs. Photosynthetic production in a turbid reservoir. II. Details of an incubation model and comments on the effect of light quality on photosynthesis. PB-211 368. Office of Water Research, U.S. Dept. of Interior, Washington, D.C. 79pp.

Palmer, C.M., and T.E. Maloney. 1954. A new counting slide for nannoplankton. Spec. Publ. No. 21, Amer. Soc. Limnol. Oceanog. 6pp.

Powers, C.F., D.W. Schults, K.W. Malueg, R.M. Brice and M.D. Schuldt. 1972. Algal responses to nutrient additions in natural waters. pp. 141-156. In: G.E. Likens (ed.). Nutrients and Eutrophication. Amer. Soc. Limnol. Oceanog., Spec. Symp. 1.

Prescott, G.W. 1973. Algae of the Western Great Lakes area. Revised Ed., Wm. C. Brown Comp., Dubuque, Iowa. 977pp.

Prescott, G.W. 1960. Biological disturbances resulting from algal populations in standing water. pp. 22-37. In: The Ecology of Algae. Spec. Pub. No. 2, Pymatuning Laboratory of Field Biology, University of Pittsburg.

Rodhe, W. 1958. The Primary Production in lakes: some results and restrictions of the ^{14}C method. Rapp. Proc. Verb., 144:122-128.

Ryan, T.A., B.L. Joiner, B.F. Ryan. 1976. Minitab Student Handbook. Duxbury Press, Belmont, California. 341pp.

Ryther, J.H., and R.F. Vaccaro. 1954. A comparison of oxygen and ^{14}C methods of measuring marine photosynthesis. J. Cons. Int. Explor. Mer., 20:25-34.

Sager, P.E. 1971. Nutritional ecology and community structure of the phytoplankton of Green Bay. Technical Completion Report. Water Resources Center, University of Wisconsin, Madison. 31pp.

Saigo, Y., and S. Ichimura. 1963. A review of the recent development of techniques measuring primary production. pp. 120-142. In: M.S. Doty (ed.). Proceedings of the Conference on Primary Productivity Measurement, Marine and Freshwater. U.S. AEC Div. Tech. Inf. TID 7633.

Sakamoto, M. 1966. Primary production by phytoplankton community in some Japanese Lakes and its dependence on lake depth. Arch. Hydrobiol., 62:1-28.

Salisbury, F.B., and C. Ross. 1969. Plant Physiology. Wadsworth Publishing Company, Inc., Belmont, California. 747pp.

Schindler, D.W. 1966. A liquid scintillation method for measuring carbon-14 uptake in photosynthesis. Nature, 211:844-845.

Schindler, D.W. 1971. Carbon, nitrogen, and phosphorus and the eutrophication of freshwater lakes. J. Phycol., 7:321-329.

Schindler, D.W., and S.K. Holmgren. 1971. Primary Production and Phytoplankton in the Experimental Lakes area, Northwestern Ontario, and other low-carbonate waters, and a liquid scintillation method for determining ^{14}C activity in photosynthesis. J. Fish. Res. Bd. Canada, 28:189-201.

Schindler, D.W., F.A. Armstrong, S.K. Holmgren and G.J. Brunskill. 1971. Eutrophication of Lake 227, Experimental Lakes Area, northwestern Ontario, by addition of phosphate and nitrate. J. Fish. Res. Bd. Canada, 28:1763-1782.

Schindler, D.W., R.V. Schmidt, and R. Reid. 1972. Acidification and bubbling as an alternative to filtration in determining phytoplankton production by the ^{14}C method. J. Fish. Res. Bd. Canada, 29: 1627-1631.

Schults, D.W., K.W. Malueg, and P.D. Smith. 1976. Limnological comparison of culturally eutrophic Shagawa Lake and adjacent oligotrophic Burntside Lake, Minnesota. Amer. Mid. Nat., 96:161-178.

Schwoerbel, J. 1970. Methods of hydrobiology (Freshwater Biology). Pergamon Press, Oxford. 200pp.

Shaw, B. 1976. Big Eau Pleine watershed and reservoir investigations. Interim report, unpublished. University of Wisconsin-Stevens Point. 65pp.

Shirogama, T., W.E. Miller, and J.C. Greene. 1976. Comparison of the algal growth responses of Selenastrum capricornutum Printz and Anabaena flos-aquae (Lynbg.) De Brebisson in waters collected from Shagawa Lake, Minnesota. pp. 127-148. In: E.J. Middlebrooks, D.H. Falkenborg, and T. E. Maloney (eds.). Biostimulation and Nutrient Assessment. Ann Arbor Science, Ann Arbor, Michigan.

Smith, G.M. 1950. The Fresh-Water algae of the United States. Second ed., McGraw-Hill Book Comp., New York. 719pp.

Steemann Nielsen, E. 1952. The use of radioactive carbon (C^{14}) for measuring organic production in the sea. J. Cons. Explor. Mer., 18:117-140.

Stewart, W.D.P., and G. Alexander. 1971. Phosphorus availability and nitrogenase activity in aquatic blue-green algae. Freshwater Biol., 1:389-404.

Stewart, W.D.P., G.P. Fitzgerald, R.H. Burris. 1968. Acetylene reduction by nitrogen-fixing blue-green algae. Arch. Mikrobiol, 62:336-348.

Strickland, J.D.H. 1960. Measuring the production of marine phytoplankton. Bull. Fish. Res. Bd. Canada, 122:1-172.

Thomann, R.V., D.M. Di Toro, R.P. Winfield, D.J. O'Connor. 1975. Mathematical modeling of phytoplankton in Lake Ontario. I. Model development and Verification. EPA-660/3-75-005. Ecol. Res. Series. Natl. Env. Res. Cntr., U.S. EPA. 177pp.

Thomas, W.H. 1963. Physiological factors affecting the interpretation of phytoplankton production measurements. pp. 120-142. In: M.S. Doty (ed.). Proceedings of the Conference on Primary Productivity Measurement, Marine and Freshwater. U.S. AEC Div. Tech. Inf. TID 7633.

Thomas, W.H., and A.N. Dodson. 1968. Effects of phosphate concentration on cell division rates and yield of a tropical oceanic diatom. Biol. Bull., 134:199-208.

Tilzer, M.M., C.R. Goldman, and E. Amezaga. 1975. The efficiency of photosynthetic light utilization by lake phytoplankton. Verh. Internat. Verein. Limnol., 19:800-807.

Toetz, D.W., L.P. Varga, and E.D. Loughran. 1973. Half-saturation constants for uptake of nitrate and ammonia by reservoir plankton. Ecology, 54:903-908.

U.S. Environmental Protection Agency. 1974. Report on Big Eau Pleine Reservoir Marathon County, Wisconsin. Working Paper No. 33. National Eutrophication Survey. 17pp.

U.S. Geological Survey. 1976. Water Resources Data for Wisconsin. U.S. Department of Interior, Geological Survey.

Vanderhoef, L.N., Chi-Ying Huang, and R. Musil. 1974. Nitrogen fixation (acetylene reduction) by phtyoplankton in Green Bay, Lake Michigan, in relation to nutrient concentrations. Limnol. Oceanog., 19:119-125.

Vennie, J.G. 1978. Unpublished data. University of Wisconsin-Stevens Point. Personal communications.

Verduin, J. 1952. Photosynthesis and growth of two diatom communities in western Lake Erie. Ecology, 33:163-168.

Vollenweider, R.A. 1965. Calculation models of photosynthesis-depth curves and some implications regarding day rate estimates in primary production measurements. pp. 425-457. In: C.R. Goldman (ed.). Primary Productivity in Aquatic Environments. Mem. Ist. Ital. Idrobiol., 18 Suppl., University of California Press, Berkeley.

Vollenweider, R.A. 1968. Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorus as factors in eutrophication. Paris Rep. Organization for Economic Cooperation and Development, DAS/CSI/ 68.27. 192pp.

Vollenweider, R.A. 1974. A Manual on Methods for Measuring Primary Production in Aquatic Environments. (Sec. ed.) IBP Handbook No. 12. Blackwell Scientific Pub., Oxford. 225pp.

Vollenweider, R.A., and P.J. Dillon. 1974. The application of the phosphorus loading concept to eutrophication research. Natural Research Council Canada. No. 13690. 42pp.

Vollenweider, R.A., M. Munawar, and P. Stadelmann. 1974. A comparative review of phytoplankton and primary production in the Laurentian Great Lakes. J. Fish. Res. Bd. Canada, 31:739-762.

Vollenweider, R.A., and A. Nauwerck. 1961. Some observations on the C 14 method of measuring primary productivity. Limnol. Oceanog., 14:121-124.

Weber, C.I. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. EPA-670/4-73-001. Env. Mon. Series. U.S. EPA, Cincinnati, Ohio.

Wetzel, R.G. 1975. Limnology. W.B. Saunders Comp., Philadelphia, Pa. 743pp.

Wiley, R. 1977. Wisconsin Valley Improvement Company. Wausau, Wisconsin. Personal communication.

Wright, J.C. 1959. Limnology of Canyon Ferry Reservoir. II. Phytoplankton standing crop and primary production. Limnol. Oceanog., 4:235-245.

Wrobel, S. 1972. Comparison of some methods of determining the primary production of phytoplankton in ponds. pp. 734-737. In: Z. Kajak, and A. Hillbricht-Ilkowska (eds.). Productivity Problems of Freshwaters. Warsaw, PWN. Polish Scientific Publishers.

APPENDIX A

Primary production data and associated measurements.

						Carbon-14 Technique (mg C/m^3/hr)		Oxygen Technique (mg C/m^3/hr)								
Date	Site	Incubation Period (hr)	L_f[1]	Depth (m)	Temp. (°C)	Filtration	Acid. & Bubbling	Gross	Net	Chlorophyll a (ug/l)	e[2]	F(i)[3]	Ip[4]	I_k[5]	I_{opt}[6]	Solar Radiation[7] (Langleys/day)
05/08/75	23	3.0	34.1	0.0	12.2	103	-	-	-	-	-	-	-	-	-	261*
				0.5	11.5	85	-	-	-	-						
				1.0	11.5	34	-	-	-	-						
				1.5	11.0	2	-	-	-	-						
				3.0	11.0	1	-	-	-	-						
						Ip[8]= 0.873										
05/20/75	23	3.0	34.1	0.0	18.4	115	-	-	-	-	-	-	-	-	-	224*
				0.5	18.3	146	-	-	-	-						
				1.0	18.3	97	-	-	-	-						
				1.5	18.2	55	-	-	-	-						
				3.0	17.5	4	-	-	-	-						
				5.0	16.0	1	-	-	-	-						
						Ip[8]= 1.816										
	19	3.0	34.1	0.0	19.2	78	-	-	-	-	-	-	-	-	-	
				0.5	19.1	57	-	-	-	-						
				1.0	19.1	53	-	-	-	-						
				1.5	18.8	33	-	-	-	-						
				3.0	18.8	4	-	-	-	-						
				5.0	16.0	1	-	-	-	-						
						Ip[8]= 0.978										
06/16/75	23	3.0	13.9	0.0	16.0	47	-	-	-	4.0	-	-	-	-	-	144*
				1.0	16.0	4	-	-	-	5.0						
(Rain)				1.5	16.0	2	-	-	-	-						
				3.0	16.0	1	-	-	-	1.6						
				5.0	16.0	1	-	-	-	1.6						
						Ip[8]= 0.316										
	19	3.0	8.8	0.0	16.0	27	-	-	-	9.4	-	-	-	-	-	
				1.0	16.0	16	-	-	-	5.8						
				1.5	16.0	3	-	-	-	-						
				3.0	16.0	1	-	-	-	2.2						
				5.0	16.0	1	-	-	-	1.4						
						Ip[8]= 0.513										
06/25/75	23	3.0	31.4	0.0	24.0	41	-	-	-	-	-	-	-	-	-	185*
				0.5	24.0	33	-	-	-	-						
				1.0	24.0	27	-	-	-	-						
				1.5	24.0	22	-	-	-	-						
				3.0	24.0	4	-	-	-	-						
				5.0	20.0	1	-	-	-	-						
						Ip[8]= 0.614										
	19	3.0	33.2	0.0	22.0	28	-	-	-	-	-	-	-	-	-	
				0.5	22.0	63	-	-	-	-						
				1.0	21.5	36	-	-	-	-						
				1.5	21.0	34	-	-	-	-						
				3.0	21.0	4	-	-	-	-						
				5.0	19.0	1	-	-	-	-						
						Ip[8]= 0.952										
07/10/75	23	3.0	21.9	0.0	22.0	131	120	-	-	35.5	1.55	2.39	-	0.086	0.232	414*
				0.5	22.0	160	157	-	-	-						
				1.0	22.0	125	156	-	-	37.3						
				1.5	22.0	75	58	-	-	-						
				2.0	22.0	30	2	-	-	36.3						
				3.0	21.0	1	1	-	-	36.8						
						Ip[8]= 3.365	2.163									
	19	4.0	29.6	0.0	22.0	178	-	-	-	61.9	2.21	2.94	-	-	-	
				0.5	22.0	164	-	-	-	-						
				1.0	21.5	126	-	-	-	52.6						
				1.5	21.5	59	-	-	-	-						
				2.0	21.0	17	-	-	-	43.8						
				3.0	20.0	1	-	-	-	45.4						
						Ip[8]= 2.399										

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[1] Percentage of daily solar radiation occurring during the incubation period.

[2] Extinction coefficient (1/m)

[3] A function of the photosynthetic active incident light (Vollenweider 1969) : $F(i) = (Ip \cdot e)/pmax$.

[4] Integral photosynthesis (g C/m^2/day) determined empirically : $Ip = (pmax/e) \cdot F(i) \cdot (100/L_f)$.

[5] An experimentally measurable light intensity (Langleys/minute). The onset of light saturation begins at about $I_k/2$ (Vollenweider 1965).

[6] Light intensity (Langleys/minute) at the depth of optimum photosynthesis (pmax).

[7] An asterisk indicates days when solar radiation was estimated using a regression equation based on solar radiation data collected from Madison, Wisconsin.

[8] Integral photosynthesis (g C/m^2/day) determined from the photosynthetic-depth profile.

APPENDIX A continued

Primary production data and associated measurements.

Date	Site	Incubation Period (hr)	L_f[1]	Depth (m)	Temp. (°C)	Carbon-14 Technique (mg C/m³/hr)		Oxygen Technique (mg C/m³/hr)		Chlorophyll a (ug/l)	e[2]	F(i)[3]	Ip[4]	I_k[5]	Iopt[6]	Solar Radiation[7] (Langleys/day)
						Filtration	Acid. & Bubbling	Gross	Net							
07/22/75	23	4.0	51.8	0.0	-	80	87	148	102	33.0	1.69	2.60	-	0.084	0.342	369*
				0.5	-	186	210	211	180	-						
				1.0	-	176	196	164	133	41.0						
				1.5	-	120	118	133	94	-						
				2.0	-	46	50	86	55	35.4						
				3.0	-	6	5	-	-	38.3						
						Ip[8]= 2.277	2.489	2.75	2.02							
08/05/75	23	4.0	33.6	0.0	25.0	101	149	125	94	94.0	1.96	2.21	-	0.080	0.202	379*
				0.5	25.0	132	164	156	125	101.3						
				1.0	25.0	96	94	102	70	70.6						
				1.5	25.0	36	30	55	39	77.7						
				2.0	25.0	5	6	39	31	77.5						
				3.0	25.0	1	2	8	1	-						
						Ip[8]= 2.074	2.211	3.15	1.95							
	19	3.25	16.0	0.0	25.0	195	-	-	-	138.8	3.07	-	-	-	-	
				0.5	25.0	124	-	-	-	145.6						
				1.0	25.0	27	-	-	-	134.2						
				1.5	24.0	10	-	-	-	103.1						
				2.0	24.0	4	-	-	-	94.8						
				3.0	24.0	3	-	-	-	-						
						Ip[8]= 2.334										
09/12/75	23	4.0 (O_2)	58.9	0.0	16.0	196	108	125	125	30.3	2.24	2.79	-	0.088	0.290	414*
				0.5	16.0	143	119	125	117	30.3						
		4.0 (C-14)	51.0	1.0	16.0	84	86	78	62	30.3						
				1.5	-	22	30	39	24	30.3						
				2.0	-	19	7	24	8	30.3						
				3.0	-	3	4	16	1	30.3						
						Ip[8]= 1.399	1.162	1.00	0.87							
10/16/75	23	4.0 (O_2)	60.6	0.0	10.5	68	64	20	16	29.1	2.10	2.78	-	0.073	0.728	301*
				0.5	10.5	64	47	31	35	19.8						
		4.0 (C-14)	58.1	1.0	10.5	46	32	30	30	30.4						
				1.5	10.5	26	12	20	20	-						
				2.0	10.5	8	6	12	12	21.3						
				3.0	10.5	2	5	-	-	22.3						
						Ip[8]= 0.616	0.442	0.22	0.22							
	19	4.0	58.3	0.5	11.0	86	47	-	-	31.6	2.72	-	0.33	-	-	
	16	4.0	58.3	0.5	11.0	108	64	-	-	34.5	3.24	-	0.38	-	-	
11/14/75	23	4.0 (O_2)	63.3	0.0	5.0	20	22	27	27	22.1	2.09	1.90	-	-	0.500	204
				0.5	5.0	12	11	24	24	23.3						
		4.0 (C-14)	58.8	1.0	5.0	7	7	14	14	-						
				1.5	5.0	4	5	14	14	-						
				2.0	5.0	3	4	1	1	22.0						
				3.0	5.0	1	1	-	1	19.8						
						Ip[8]= 0.131	0.133	0.25	0.25							
	19	4.0	58.8	0.5	5.0	21	32	-	-	38.7	2.87	-	0.14	-	-	
	16	4.0	58.8	0.5	5.0	32	42	-	-	29.2	3.83	-	0.14	-	-	
01/05/76	23	5.0	70.0	0.0	0.0	2.3	-	-	-	10.4	-	-	-	-	-	178*
				0.5	0.5	1.2	-	-	-	-						
				1.0	1.0	1.0	-	-	-	2.8						
						Ip[8]= 0.002										
01/29/76	23	5.0	65.0	0.0	0.0	1.0	-	-	-	-	-	-	-	-	-	218*

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[1] Percentage of daily solar radiation occurring during the incubation period.

[2] Extinction coefficient (1/m)

[3] A function of the photosynthetic active incident light (Vollenweider 1969): F(i) = (Ip · e)/pmax.

[4] Integral photosynthesis (g C/m²/day) determined empirically : Ip = (pmax/e) · F(i) · (100/L_f).

[5] An experimentally measurable light intensity (Langleys/minute). The onset of light saturation begins at about $I_k/2$ (Vollenweider 1965).

[6] Light intensity (Langleys/minute) at the depth of optimum photosynthesis (pmax).

[7] An asterisk indicates days when solar radiation was estimated using a regression equation based on solar radiation data collected from Madison, Wisconsin.

[8] Integral photosynthesis (g C/m²/day) determined from the photosynthetic-depth profile.

APPENDIX A continued

Primary production data and associated measurements.

						Carbon-14 Technique (mg C/m^3/hr)		Oxygen Technique (mg C/m^3/hr)								
Date	Site	Incubation Period (hr)	L_f[1]	Depth (m)	Temp. (°C)	Filtration	Acid. & Bubbling	Gross	Net	Chlorophyll a (ug/l)	e[2]	F(i)[3]	Ip[4]	I_k[5]	Iopt[6]	Solar Radiation[7] (Langleys/day)
04/27/76	23	4.0 (O_2)	49.0	0.0	8.5	83	95	42	40	20.2	1.84	2.52	-	0.389	0.445	619
				0.5	8.5	107	132	62	55	17.6						
		4.0 (C-14)	43.1	1.0	8.5	68	75	46	43	17.6						
				1.5	8.5	35	33	25	16	16.6						
				3.0	8.5	14	15	3	2	18.9						
				5.0	8.5	1	3	1	1	17.9						
						Ip[8]= 1.345	1.670	0.78	0.64							
	19	4.0	46.0	0.5	8.0	-	220	-	-	23.8	2.19	-	2.20	-	-	
	16	4.0	46.0	0.5	8.0	-	124	-	-	23.9	2.09	-	1.30	-	-	
	14	4.0	46.0	0.5	9.0	-	112	-	-	19.4	2.04	-	1.20	-	-	
05/14/76	23	3.0 (O_2)	36.8	0.0	14.0	120	116	39	33	-	1.48	3.06	-	0.080	0.530	553
				0.5	14.0	149	149	47	45	23.8						
		3.0 (C-14)	36.0	1.0	-	150	139	34	41	-						
				1.5	-	123	117	49	40	-						
				3.0	-	97	93	17	10	-						
				5.0	-	9	8	13	1	-						
						Ip[8]= 3.058	2.961	1.16	1.03							
	20	3.0	36.1	0.5	12.8	-	126	-	-	22.8	1.40	-	2.29	-	-	
	19	3.0	36.1	0.5	13.8	-	124	-	-	26.3	1.51	-	2.09	-	-	
	16	3.0	36.1	0.5	13.8	-	159	-	-	28.0	1.54	-	2.62	-	-	
	14	3.0	36.1	0.5	12.5	-	185	-	-	33.0	1.63	-	2.88	-	-	
05/26/76	23	4.0 (O_2)	45.0	0.0	18.0	63	46	29	16	6.4	0.92	2.20	-	0.188	0.589	516
				0.5	18.0	30	32	21	13	3.7						
		4.0 (C-14)	43.5	1.0	-	28	32	14	10	4.7						
				1.5	-	30	42	25	15	7.7						
				3.0	-	34	34	1	6	8.1						
				5.0	-	17	15	-	-	3.2						
						Ip[8]= 0.975	0.984	0.48	0.36							
	20	4.0	47.2	0.5	19.0	-	76	-	-	6.4	0.93	-	0.68	-	-	
	19	4.0	47.2	0.5	18.0	-	124	-	-	5.7	1.02	-	1.12	-	-	
	16	4.0	47.2	0.5	18.0	-	49	-	-	3.0	1.00	-	0.44	-	-	
	14	4.0	47.2	0.5	18.0	-	84	-	-	2.5	0.94	-	0.94	-	-	
06/09/76	23	4.0	50.0	0.0	24.0	-	-	33	28	22.2	1.11	2.69	-	0.106	0.350	511
				0.5	24.0	-	-	76	54	24.2						
				1.0	24.0	-	-	79	52	24.5						
				1.5	24.0	-	-	75	52	22.0						
				2.0	24.0	-	-	65	49	24.6						
				3.0	23.0	-	-	11	9	18.7						
						Ip[8]=		1.53	1.01							
	20	4.0	50.0	0.5	24.0	-	-	185	150	59.9	1.23	-	2.50	-	-	
	19	4.0	50.0	0.5	24.0	-	-	155	132	51.3	1.84	-	1.47	-	-	
	16	4.0	50.0	0.5	24.0	-	-	140	115	43.5	1.54	-	1.54	-	-	
	14	4.0	50.0	0.5	24.5	-	-	169	116	39.3	1.59	-	1.50	-	-	
06/30/76	23	4.0	46.9	0.0	-	-	-	218	173	105.9	3.07	3.70	-	0.082	0.257	597
				0.5	-	-	-	379	334	-						
				1.0	-	-	-	255	272	116.4						
				1.5	-	-	-	36	6	109.0						
				2.0	-	-	-	27	1	98.0						
				3.0	-	-	-	-	-	104.4						
						Ip[8]=		3.90	2.85							

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[1] Percentage of daily solar radiation occurring during the incubation period.

[2] Extinction coefficient (1/m)

[3] A function of the photosynthetic active incident light (Vollenweider 1969) : F(i) = (Ip · e)/pmax.

[4] Integral photosynthesis (g C/m^2/day) determined empirically : Ip = (pmax/e) · F(i) · (100/L_f).

[5] An experimentally measurable light intensity (Langleys/minute). The onset of light saturation begins at about $I_k/2$ (Vollenweider 1965).

[6] Light intensity (Langleys/minute) at the depth of optimal photosynthesis (pmax).

[7] An asterisk indicates days when solar radiation was estimated using a regression equation based on solar radiation data collected from Madison, Wisconsin.

[8] Integral photosynthesis (g C/m^2/day) determined from the photosynthetic-depth profile.

APPENDIX A continued

Primary production data and associated measurements.

						Carbon-14 Technique (mg C/m^3/hr)		Oxygen Technique (mg C/m^3/hr)								
Date	Site	Incubation Period (hr)	L_f[1]	Depth (m)	Temp. (°C)	Filtration	Acid. & Bubbling	Gross	Net	Chlorophyll a (ug/l)	e[2]	F(i)[3]	Ip[4]	I_k[5]	Iopt[6]	Solar Radiation[7] (Langleys/day)
07/08/76	23	4.0	39.5	0.0	26.0	-	-	208	170	90.3	2.30	2.87	-	0.075	0.239	454
				0.5	26.0	-	-	252	241	110.8						
				1.0	25.0	-	-	228	173	100.9						
				1.5	25.0	-	-	65	25	103.8						
				2.0	25.0	-	-	1	20	90.9						
				3.0	24.0	-	-	1	1	34.6						
					Ip^8=			3.19	2.62							
	20	4.0	42.4	0.5	25.8	-	-	200	183	97.5	2.56	-	2.62	-	-	
	19	4.0	42.4	0.5	25.8	-	-	331	247	152.1	3.29	-	2.42	-	-	
	16	4.0	42.4	0.5	25.5	-	-	293	190	101.8	2.09	-	4.29	-	-	
	14	4.0	42.4	0.5	25.0	-	-	248	173	71.3	2.09	-	2.59	-	-	
07/27/76	23	4.0	46.7	0.0	25.8	468	528	265	197	114.2	3.34	2.48	-	0.147	0.199	538
				0.5	25.2	613	693	367	306	128.5						
				1.0	24.9	159	143	157	100	145.0						
				1.5	24.7	24	20	30	4	136.8						
				2.0	24.6	9	8	18	1	118.7						
				3.0	24.2	1	1	1	1	102.5						
					Ip^8=	3.938	4.323	3.19	2.27							
	20	4.0	46.7	0.5	24.7	943	986	-	-	-	3.03	-	6.91	-	-	
	19	4.0	46.7	0.5	24.7	1010	1068	-	-	149.9	3.68	-	6.16	-	-	
	16	4.0	46.7	0.5	25.0	1124	1350	-	-	179.9	4.18	-	6.86	-	-	
	14	4.0	46.7	0.5	24.2	1052	1246	-	-	151.7	4.18	-	6.32	-	-	
08/09/76	23	4.0	48.5	0.0	23.0	263	271	244	172	103.0	2.56	2.06	-	0.151	0.281	497
				0.5	23.0	439	466	324	229	114.5						
				1.0	23.0	216	201	168	134	110.3						
				1.5	22.5	26	24	30	1	62.1						
				2.0	22.5	5	2	1	1	50.8						
				3.0	22.0	1	1	-	-	27.9						
					In^8=	3.172	3.090	2.35	1.64							
	20	4.0	48.0	0.5	23.5	485	462	-	-	87.4	2.39	-	3.31	-	-	
	19	4.0	48.0	0.5	24.5	720	640	-	-	132.3	2.71	-	4.04	-	-	
	16	4.0	48.0	0.5	22.0	615	636	-	-	129.8	2.90	-	3.76	-	-	
	14	4.0	48.0	0.5	23.5	688	723	-	-	180.7	3.12	-	3.97	-	-	
08/29/76	23	4.5 (O_2)	55.9	0.0	22.0	459	215	214	191	59.6	2.00	1.92	-	0.160	0.348	471
				0.5	21.8	564	672	253	235	74.0						
		4.5 (C-14)	54.0	1.0	21.2	245	231	131	111	55.6						
				1.5	21.0	92	221	43	24	54.9						
				2.0	21.0	28	38	8	1	51.5						
				3.0	21.0	6	1	1	1	52.8						
					In^3=	4.514	4.348	1.86	1.66							
	20	4.5	55.2	0.5	22.0	690	911	-	-	68.4	2.30	-	4.27	-	-	
	19	4.5	55.2	0.5	22.0	761	796	-	-	73.0	2.42	-	4.32	-	-	
	16	4.5	55.2	0.5	21.5	575	668	-	-	99.0	3.07	-	4.06	-	-	
	14	4.5	55.2	0.5	21.5	583	628	-	-	80.0	4.19	-	3.40	-	-	
09/24/76	23	4.0 (O_2)	35.3	0.0	14.0	401	294	138	131	116.0	2.88	1.57	-	-	0.222	395
				0.5	14.0	904	813	220	201	116.2						
		3.0 (C-14)	42.4	1.0	14.0	188	148	60	68	105.6						
				1.5	14.0	42	40	21	24	110.8						
				2.0	13.0	12	22	7	12	114.2						
				3.0	13.0	1	1	1	1	102.2						
					Ip^8	3.540	3.138	1.06	1.03							
	20	3.0	42.4	0.5	13.5	980	711	-	-	104.6	3.07	-	4.13	-	-	
	19	3.0	42.4	0.5	13.0	799	782	-	-	108.7	3.54	-	2.10	-	-	
	16	3.0	42.4	0.5	13.5	570	660	-	-	84.3	3.84	-	2.26	-	-	
	14	3.0	42.4	0.5	12.0	648	1140	-	-	55.8	4.19	-	1.89	-	-	

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[1] Percentage of daily solar radiation occurring during the incubation period.

[2] Extinction coefficient (1/m).

[3] A function of the photosynthetic active incident light (Vollenweider 1969), $F(i) = (Ip \cdot e)/pmax$.

[4] Integral photosynthesis (g C/m^2/day) determined empirically : $Ip = (pmax/e) \cdot F(i) \cdot (100/L_f)$.

[5] An experimentally measurable light intensity (Langleys/minute). The onset of light saturation begins at about $I_k/2$ (Vollenweider 1965).

[6] Light intensity (Langleys/minute) at the depth of optimum photosynthesis (pmax).

[7] An asterisk indicates days when solar radiation was estimated using a regression equation based on solar radiation data collected from Madison, Wisconsin.

[8] Integral photosynthesis (g C/m^2/day) determined from the photosynthetic-depth profile.

APPENDIX A continued

Primary production data and associated measurements.

						Carbon-14 Technique (mg C/m^3/hr)		Oxygen Technique (mg C/m^3/hr)								
Date	Site	Incubation Period (hr)	L_f[1]	Depth (m)	Temp. (°C)	Filtration	Acid. & Bubbling	Gross	Net	Chlorophyll a (ug/l)	e[2]	F(i)[3]	Ip[4]	I_k[5]	Iopt[6]	Solar Radiation[7] (Langleys/day)
10/22/76	23	4.0 (O_2)	67.5	0.0	4.0	24	11	4	4	55.8	2.09	1.69	-	0.078	0.284	306
				0.5	4.0	76	51	36	33	53.8						
		3.0 (C-14)	47.8	1.0	4.5	34	50	20	12	52.8						
				1.5	4.5	1	20	8	3	59.1						
				2.0	4.5	1	1	4	2	53.1						
				3.0	4.5	-	-	-	1	56.1						
						Ip[8]= 0.269	0.422	0.25	0.17							
	20	3.0	47.8	0.5	5.0	81	80	-	-	49.6	3.00	-	0.28	-	-	
	19	3.0	47.8	0.5	5.0	99	105	-	-	59.5	3.20	-	0.28	-	-	
	16	3.0	47.8	0.5	4.5	114	79	-	-	58.7	3.00	-	0.35	-	-	
	14	3.0	47.8	0.5	5.0	116	78	-	-	53.2	3.40	-	0.25	-	-	
11/21/76	16	3.0	-	0.0	0.0	81	-	-	-	38.4	-	-	-	-	-	-
12/11/76	23	4.0	-	0.0	0.0	51	-	-	-	17.9	-	-	-	-	-	-
01/13/77	23	5.5	-	0.0	0.0	9	-	-	-	14.0	-	-	-	-	-	-

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[1] Percentage of daily solar radiation occurring during the incubation period.

[2] Extinction coefficient (1/m)

[3] A function of the photosynthetic active incident light (Vollenweider 1969), F(i) = (Ip · e)/pmax.

[4] Integral photosynthesis (g C/m^2/day) determined empirically : Ip = (pmax/e) · F(i) · (100/L_f)

[5] An experimentally measurable light intensity (Langleys/minute). The onset of light saturation begins at about $I_k/2$ (Vollenweider 1965).

[6] Light intensity (Langleys/minute) at the depth of optimum photosynthesis (pmax).

[7] An asterisk indicates days when solar radiation was estimated using a regression equation based on solar radiation data collected from Madison, Wisconsin.

[8] Integral photosynthesis (g C/m^2/day) determined from the photosynthetic-depth profile.

APPENDIX B

Dominant phytoplankton cell numbers and volume measurements for April 30, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.0m)		Bottom (9.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.							19	32			19	19						
Aphanizomenon flos-aquae**																		
Coelosphaerium sp.																		
Chroococcales Order																		
Chroococcus sp.																		
Microcystis sp.																		
Oscillatoria sp.**	37	7									19	19	242	48	410	82	317	60
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	37	18	56	26	19	9	112	53	93	44			56	26	112	53	149	70
Pennales Order	261	36	354	50	336	47	298	42	205	29	56	8						
Melosira sp.			19	78			19	78										
Stephanodiscus sp.			19	448									18	448				
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.																		
Cryptomonas sp.	19	47	19	22	37	45	19	47	19	22			336	839	186	224	75	90
Chlorophyta (green)																		
Ankistrodesmus sp.	75	12	19	1	75	12	94	13	19	1	37	5	186	9	298	15	429	21
Chlamydomonas sp.																		
Chlorella sp.							19	1										
Closterium sp.																		
Crucigenia sp.																		
Pandorina sp.																		
Pediastrum sp.																		
Scenedesmus sp.									37	45								
Schroederia sp.							19	7	37	14			93	35	19	7	19	7
Sphaerocystis sp.																		
Euglenophyta (euglenoids)																		
Euglena sp.									19	19			37	32				
Trachelomonas sp.					19	32												
Flagellates (unidentified)	37	2					131	8	75	4			224	13	242	14	56	3
Total number of genera	6		6		5		9		7		4		7		5		6	
Other taxa No., Vol.	19	1					19	200									19	100
Total taxa No., Vol.	485	123	486	625	486	145	749	481	504	178	131	51	1,190	1,450	1,270	409	1,080	351

*Cell numbers/ml.
+Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for May 6, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (2.0m)		Bottom (5.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.																		
*Aphanizomenon flos-aquae***																		
Coelosphaerium sp.																		
Chroococcales Order																		
Chroococcus sp.															19	1	75	2
Microcystis sp.																		
*Oscillatoria sp.***	19	4	19	4	19	4	19	4			19	4	149	30	60	60	336	67
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	671	316	485	228	373	175	1,640	771	1,980	429	280	132	783	368	895	421	149	70
Pennales Order	149	26	205	29	186	26	149	21	131	18	149	21	93	13	56	8		
Melosira sp.					19	78					93	392					93	392
Stephanodiscus sp.					37	895	19	446			37	895					37	895
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.	112	6	131	6			56	3	37	2			19	1	19	1		
Cryptomonas sp.	224	560	410	492	37	45	149	179	205	246			504	1,260	298	746		
Chlorophyta (green)																		
Ankistrodesmus sp.	149	7	131	23	150	27	75	12	242	43	19	4	168	8	100	13	94	7
Chlamydomonas sp.																		
Chlorella sp.	168	5	373	1	56	2	448	13			75	2	186	6	56	2		
Closterium sp.																		
Crucigenia sp.																		
Pandorina sp.																		
Pediastrum sp.																		
Scenedesmus sp.			19	6			19	22	19	22	19	22					19	6
Schroederia sp.	93	35	149	57	37	14	75	28	56	21			37	14	112	42	37	14
Sphaerocystis sp.	19	16	16	16														
Euglenophyta (euglenoids)																		
Euglena sp.							19	2	19	16			56	48				
Trachelomonas sp.	19	32					19	32			19	32	19	32				
Flagellates (unidentified)	93	5	317	19	75	4	205	12	56	3	19	1	56	3	75	4	19	1
Total number of genera	13		16		12		19		10		9		10		11		8	
Other taxa No., Vol.	112	10	169	300	75	20	280	70	56	7					38	200		
Total taxa No., Vol.	1,830	1,010	2,420	1,180	1,060	1,290	3,170	1,620	2,800	807	729	1,500	2,070	1,780	1,720	1,500	859	1,450

*Cell numbers/ml.
+Phytoplankton volume as mm3/ml.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for May 20, 1975.

Dominant Taxa	Site 13						Site 16					Site 23					
	Surface (0.5m)		Middle (4.0m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom	Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+		No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																	
Anabaena sp.	261	444															
*Aphanizomenon flos-aquae***																	
Coelosphaerium sp.							22	8									
Chroococcales Order																	
Chroococcus sp.							11	1						37	1		
Microcystis sp.																	
*Oscillatoria sp.***	11	2			24	5										97	19
Chrysophyta (yellow-green)																	
Asterionella sp.							48	19	37	15							
Cyclotella sp.	772	363	392	184	209	98	1,040	491	261	123	MISSING	4,770	2,240	1,570	736	2,210	1,040
Pennales Order	336	47	153	23	158	31	86	1	11	2	DATA	597	84	97	14	75	10
Melosira sp.	48	204	37	157	68	287	63	266	63	266		11	47	37	157	97	407
Stephanodiscus sp.	26	626	37	895			11	289	11	269				97	2,330	75	1,790
Pyrrophyta (yellow-brown)																	
Ceratium hirundinella																	
Chroomonas sp.	1,320	66	11	1	15	1	4,140	207	11	1		5,670	284	112	6		
Cryptomonas sp.	1,080	1,390	11	13	15	18	1,290	1,640				742	1,260	97	227		
Chlorophyta (green)																	
Ankistrodesmus sp.	11	1			9	2	11	1	11	1		597	124	97	16	317	37
Chlamydomonas sp.																	
Chlorella sp.							86	2	75	2							
Closterium sp.									11	264							
Crucigenia sp.																	
Pandorina sp.																	
Pediastrum sp.																22	21
Scenedesmus sp.	37	44	68	81	15	2	75	90	63	53		86	103	11	13		
Schroederia sp.												11	4				
Sphaerocystis sp.	11	10	37	32								683	10				
Euglenophyta (euglenoids)																	
Euglena sp.																	
Trachelomonas sp.					9	15			11	19							
Flagellates (unidentified)	996	60	104	6	24	1	533	32	160	10		310	19	194	12	321	19
Total number of genera	14		11		14		13		14			13		10		9	
Other taxa No., Vol.	22	40	22	153	137	60	48	10	60	506		1,230	300	97	10	45	1
Total taxa No., Vol.	4,930	3,300	872	1,540	683	520	6,300	3,060	785	1,530		14,700	4,480	2,450	3,520	3,260	3,340

*Cell numbers/ml.

+Phytoplankton volume as mm^3/m^3.

**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for June 3, 1975.

	Site 13						Site 16						Site 23					
Dominant Taxa	Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (5.0m)		Bottom (10.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	11	19					22	38										
*Aphanizomenon flos-aquae***	22	118			75	392	37	194	37	59			11	59				
Coelosphaerium sp.																		
Chroococcales Order																		
Chroococcus sp.																		
Microcystis sp.																		
Oscillatoria sp.**	37	32	160	40	22	13	60	12	71	17			60	15			45	10
Chrysophyta (yellow-green)																		
Asterionella sp.											11	4						
Cyclotella sp.					134	63	60	28			48	23	22	11	22	11	619	291
Pennales Order	11	2	11	2	134	19							22	3			123	17
Melosira sp.			11	47	37	157			11	47							75	313
Stephanodiscus sp.					22	538			11	269							86	2,060
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.					11	6	97	5	11	1			112	6	11	1		
Cryptomonas sp.	71	177	48	58			172	429	34	55			123	308				
Chlorophyta (green)																		
Ankistrodesmus sp.																		
Chlamydomonas sp.	11	19	11	19	11	19												
Chlorella sp.							22	1							37	1		
Closterium sp.																		
Crucigenia sp.																		
Pandorina sp.																		
Pediastrum sp.	11	11	11	11	11	11			11	11							48	46
Scenedesmus sp.	11	3			11	13											22	27
Schroederia sp.	298	113	421	160	37	14	429	163	272	104	60	23	310	117	298	113	22	85
Sphaerocystis sp.	22	19	22	19			22	2	11	10	11	10			11	10		
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.			11	19													11	19
Flagellates (unidentified)																		
Total number of genera	10		9		11		10		9		5		8		5		9	
Other taxa No., Vol.							22	80			22	50	149	200				
Total taxa No., Vol.	505	513	706	375	505	1,240	943	952	469	573	152	110	809	719	379	136	1,050	2,870

*Cell numbers/ml.
+Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for June 18, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (5.0m)		Bottom (10.0m)		Surface (0.5m)		Middle (4.5m)		Bottom (9.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (9.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	63	108			11	19	11	19										
Aphanizomenon flos-aquae**	4,580	38,900	93	792	112	950	1,490	11,400	37	287			310	1,620	11	59		
Coelosphaerium sp.																		
Chroococcales Order	37	1																
Chroococcus sp.			11	1							11	1			11	1		
Microcystis sp.																		
Oscillatoria sp.**	86	17	19	4	37	8	11	10			11	3	60	15	22	6	45	10
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	11	5	86	40	216	102	86	40	75	35	101	47	11	5	60	28	160	75
Pennales Order	22	3	67	9	153	21	37	5	48	7	37	5			22	3		
Melosira sp.					19	78	11	47			11	47			11	47	22	94
Stephanodiscus sp.	11	268			11	269					22	538			11	269		
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.	11	1					48	2					186	10	11	1		
Cryptomonas sp.	60	102	11	28			671	806	86	132			321	530	37	40		
Chlorophyta (green)																		
Ankistrodesmus sp.							11	1										
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.																		
Crucigenia sp.			37	164														
Pandorina sp.																		
Pediastrum sp.			37	35	19	18	11	11	11	11					37	35	22	21
Scenedesmus sp.	22	27			30	9			11	9								
Schroederia sp.	186	71	75	28	67	25	138	52	48	18	86	33	45	17	60	23	54	21
Sphaerocystis sp.	22	94	48	42	19	16	11	10	37	32			11	10				
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.																		
Flagellates (unidentified)	22	1	18	1	11	1	101	6	48	3	11	1						
					11		13		8		7							
Total number of genera	13		10		11		13		8		7		9		12		5	
Other taxa No., Vol.	11	20					26	6					11	1	22	5		
Total taxa No., Vol.	5,140	39,600	502	1,140	705	1,520	2,660	12,400	401	534	290	675	955	2,210	315	517	303	221

*Cell numbers/ml.

+Phytoplankton volume as mm3/m3.

**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for June 30, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.5m)		Bottom ( )		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena *sp.*	26	44																
Aphanizomenon *flos-aquae***	6,900	40,600	3,470	20,400	93	548			104	548			2,300	12,100	86	450		
Coelosphaerium *sp.*			11	1					11	47							22	1
Chroococcales Order	3,030	91	75	2					11	1					422	13		
Chroococcus *sp.*					56	2			48	2	19	1						
Microcystis *sp.*																		
Oscillatoria *sp.***					37	8					60	19	11	10	22	4	22	4
Chrysophyta (yellow-green)																		
Asterionella *sp.*																		
Cyclotella *sp.*					90	5	MISSING		11	5	104	49	22	11			123	58
Pennales Order	11	2			11	1	DATA		11	2	19	3	11	2	11	2	11	2
Melosira *sp.*					11	47			11	47					11	47	134	564
Stephanodiscus *sp.*																	56	1,430
Pyrrophyta (yellow-brown)																		
Ceratium *hirundinella*	11	784																
Chroomonas *sp.*	11	1											261	13	111	1		
Cryptomonas *sp.*									30	50			86	214	284	340		
Chlorophyta (green)																		
Ankistrodesmus *sp.*																		
Chlamydomonas *sp.*																		
Chlorella *sp.*																		
Closterium *sp.*																		
Crucigenia *sp.*																		
Pandorina *sp.*																		
Pediastrum *sp.*									11	11	11	11	11	11	11	11		
Scenedesmus *sp.*																	22	27
Schroederia *sp.*			26	10					30	11			470	179	11	4		
Sphaerocystis *sp.*									11	10			11	10				
Euglenophyta (euglenoids)																		
Euglena *sp.*																		
Trachelomonas *sp.*																		
Flagellates (unidentified)	26	2	11	1	75	4			11	1	11	1						
Total number of genera	7		4		6				14		6		10		9		8	
Other taxa No., Vol.	556	10			11	20			358	20	37	2	11	20				
Total taxa No., Vol.	10,600	41,500	3,600	20,400	384	635			658	755	261	86	3,190	12,600	969	872	390	2,090

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for July 15, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (5.0m)		Bottom (10.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	11	19					11	19										
*Aphanizomenon flos-aquae***	4,150	18,200	67	294	84	368	7,120	37,800	3,470	18,400	56	297	2,540	13,300	3,360	17,600	112	588
Coelosphaerium sp.							48	2	11	1					97	3		
Chroococcales Order	921	28	47	1			4,480	134	448	13	67	2	3,730	112				
Chroococcus sp.			373	11	67	2	37	1	11	1	37	1			11	336	37	1
Microcystis sp.																		
Oscillatoria sp.**	26	6	19	4			48	41			30	6			11	10	48	17
Chrysophyta (yellow-green)																		
Asterionella sp.											56	22						
Cyclotella sp.	11	5	104	49	186	88			11	5	37	18			48	23	134	63
Pennales Order	11	2	121	26	75	10					9	13						
Melosira sp.	11	47	9	39	9	39					30	125					11	47
Stephanodiscus sp.																	11	269
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella	48	3,400			9	651	11	784					22	1,570	48	3,400		
Chroomonas sp.	571	28							11	1								
Cryptomonas sp.	63	76					11	13	26	31			45	83	11	13		
Chlorophyta (green)																		
Ankistrodesmus sp.																		
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.																		
Crucigenia sp.					9	41												
Pandorina sp.																		
Pediastrum sp.			19	18	19	18												
Scenedesmus sp.	11	13	9	11														
Schroederia sp.	598	227	242	92	93	35	101	38	48	18	30	11	45	17	22	8	11	4
Sphaerocystis sp.	26	22	19	16	28	24	11	10			19	16						
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.																		
Flagellates (unidentified)	75	4	47	3	19	1	249	15	236	14	82	5						
Total number of genera	13		14		14		10		9		11		5		8		8	
Other taxa No., Vol.			9	1	55	2			11	1	19	3					11	20
Total taxa No., Vol.	6,530	22,100	1,080	565	653	1,280	12,100	38,800	4,280	18,500	472	519	6,380	15,100	3,600	21,400	375	1,000

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for July 28, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.5m)		Bottom ( )		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	2,460	4,180	1	19														
Aphanizomenon flos-aquae**	32,800	179,000	48	272			58,600	388,000	2,950	19,500	140	928	22,400	118,000	1,140	5,990	60	313
Coelosphaerium sp.	246	9	25	1			246	1,030	93	3	19	1	37	1				
Chroococcales Order			1,930	58			140,000	4,200	11,900	357	65	2	21,000	631	1,590	18	22	1
Chroococcus sp.			6	2														
Microcystis sp.	466	792							112	190								
Oscillatoria sp.**	1,490	1,270	79	62			466	396	56	48	23	5						
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.					MISSING						11	5					48	23
Pennales Order			11	2	DATA						11	2						
Melosira sp.			11	47					19	78	11	47						
Stephanodiscus sp.																	11	269
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella							246	17,200	19	1,300								
Chroomonas sp.	12	6					112	6										
Cryptomonas sp.							112	280										
Chlorophyta (green)																		
Ankistrodesmus sp.																		
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.									19	439								
Crucigenia sp.																		
Pandorina sp.																		
Pediastrum sp.											11	11			11	11		
Scenedesmus sp.																		
Schroederia sp.	112	43	50	19			112	4	101	38	28	11	8	8			11	4
Sphaerocystis sp.			11	10							11	10						
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.	246	418																
Flagellates (unidentified)			50	1			1,490	90	112	7	75	4						
Total number of genera	8		11				8		9		10		4		3		5	
Other taxa No., Vol.	373	900	11	1														
Total taxa No., Vol.	38,200	187,000	2,250	494			61,500	411,000	15,400	22,000	405	1,030	43,400	119,000	2,740	6,050	152	610

*Cell numbers/ml.

+Phytoplankton volume as mm3/m3.

**Only filaments counted.

Appendix B continued

Dominant phytoplankton cell numbers and volume measurements for August 11, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.0m)		Bottom ( )		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)		Surface (0.5m)		Middle (6.0m)		Bottom (12.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.																		
Aphanizomenon flos-aquae**	298	1,710	224	1,280			4,330	19,700	448	2,350	75	340	26,700	140,000	768	4,030	284	1,490
Coelosphaerium sp.	11	1					26	1	26	1								
Chroococcales Order	6,260	188	3,620	108			4,680	141	1,780	53	235	7	5,970	179	235	7	683	21
Chroococcus sp.			37	1			26	1			11	1	11	1				
Microcystis sp.	11	19					11	19										
Oscillatoria sp.**	26	22					149	127	126	107			11	10	119	25	86	17
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.			19	9	MISSING DATA						37	18			11	5	198	93
Pennales Order			56	8							11	2			22	3	22	3
Melosira sp.									47	47	11	47			11	47	48	204
Stephanodiscus sp.															11	269	60	1,430
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella							11	784										
Chroomonas sp.							75	4	48	2								
Cryptomonas sp.																		
Chlorophyta (green)																		
Ankistrodesmus sp.																		
Chlamydomonas sp.															48	82		
Chlorella sp.																		
Closterium sp.																		
Crucigenia sp.																		
Pandorina sp.																		
Pediastrum sp.	11	11	19	18											11	11	22	21
Scenedesmus sp.																	11	13
Schroederia sp.	37	14	112	42			86	33	86	33	138	5			37	14	11	4
Sphaerocystis sp.									11	10								
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.																		
Flagellates (unidentified)	11	1	1	4					11	1	86	5						
Total number of genera	7		8				10		8		8		5		10		10	
Other taxa No., Vol.			75				11	1			11	3	11	3				
Total taxa No., Vol.	6,670	1,970	4,160	1,470			9,410	20,800	2,580	2,600	615	428	32,700	140,000	1,270	4,490	1,420	3,300

*Cell numbers/ml.

+Phytoplankton volume as mm3/m3.

**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for September 3, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (6.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	4,400	7,480	26	44	130	526	11	19							22	38		
Aphanizomenon flos-aquae**	2,670	5,300	1,120	2,220	1,190	2,360	3,530	12,900	2,260	8,290	48	178	2,510	18,800	1,420	10,600	48	364
Coelosphaerium sp.							11	1										
Chroococcales Order	235	7	436	13			298	9	213	6	11	1	545	16				
Chroococcus sp.	485	14	272	8	75	2	186	6	160	5	123	4						
Microcystis sp.																		
Oscillatoria sp.**	63	42	26	6	22	26	11	10	26	22	37	16			48	41	172	146
Chrysophyta (yellow-green)																		
Asterionella sp.	272	109			63	25												
Cyclotella sp.	26	12	26	12	324	152	63	30	11	5	86	40	149	70	48	23	48	23
Pennales Order	26	4	26	4	150	21	48	7	22	3	48	7	22	3			22	3
Melosira sp.	26	110			63	266			11	47	86	360	22	94	48	204	149	626
Stephanodiscus sp.									11	269							198	4,740
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella															22	1,570		
Chroomonas sp.	48	2	63	3			11	1	97	5			48	2	123	6		
Cryptomonas sp.	48	58	75	186	48	121	37	93	48	107					48	58		
Chlorophyta (green)																		
Ankistrodesmus sp.											11	2						
Chlamydomonas sp.													22	38				
Chlorella sp.																		
Closterium sp.																		
Crucigenia sp.	101	443	11	49	101	443												
Pandorina sp.																		
Pediastrum sp.	11	11											22	21	22	21		
Scenedesmus sp.			11				11	3	11	13	11	13						
Schroederia sp.	11	4	26				26	7	26	10	11	4			22	8	22	8
Sphaerocystis sp.	138	119							11	10								
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.	11	19			26	44	11	19										
Flagellates (unidentified)	26	2	101	6			198	8	101	6	63	4	149	9	75	4		
Total number of genera	16		13		12		16		13		11		8		10		7	
Other taxa No., Vol.			149	70			48	5			11	2						
Total taxa No., Vol.	8,600	13,700	2,370	2,620	2,370	3,980	4,500	13,100	3,010	8,800	546	631	3,490	19,000	1,900	12,600	659	5,910

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for September 23, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.5m)		Bottom (9.0m)		Surface (0.5m)		Middle (3.0m)		Bottom (6.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	2,900	4,930	634	1,080	37	63	4,530	7,700	2,460	4,180	1,640	279	22	38				
Aphanizomenon flos-aquae**	1,150	6,760	634	3,710	522	3,050	6,240	50,900	5,070	41,400	4,910	40,100	4,090	32,700	4,180	33,500	2,940	23,500
Coelospharrium sp.			26	1	11	1			298	10			11	1	11	1		
Chroococcales Order	645	19	140	4	48	2	10,400	312	6,640	199	5,970	179	213	7	149	4	37	1
Chroococcus sp.	63	2	37	1	186	6	11	1	63	2	37	1						
Microcystis sp.	48	82							112	190					48	82		
Oscillatoria sp.**	11	10	11	12	26	22	86	73	101	85	164	139	63	54	11	10	26	22
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	48	23	26	12	26	12							11	52	22	11	11	5
Pennales Order	48	7	26	4	11	2					37	5	11	2			26	4
Melosira sp.	75	95	75	313	37	157	175	1,230	101	423	63	266	63	266	75	313	86	360
Stephanodiscus sp.													11	269				
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.																		
Cryptomonas sp.	86	200	97	179	112	246	86	197	75	186			37	93			26	31
Chlorophyta (green)																		
Ankistrodesmus sp.																		
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.	74	1,760	26	616														
Crucigenia sp.	37	164	123	542	75	328	112	492	11	49								
Pandorina sp.																		
Pediastrum sp.			26	25	11	11			11	11	11	11	11	11	22	21	11	11
Scenedesmus sp.	26	8	11	13	11	13												
Schroederia sp.	75	28	37	14	11	4	48	18			11	4						
Sphaerocystis sp.	75	64	175	151	175	151	11	9					11	10				
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.	37	63			37	63	11	19			37	63	11	19				
Flagellates (unidentified)	272	16	160	10	112	7	48	3	160	10	48	2			22	1		
Total number of genera	16		16		18		12		11		10		13		8		8	
Other taxa No., Vol.			11	40	37	60	149	5										
Total taxa No., Vol.	5,670	14,300	2,140	6,730	1,480	4,200	21,900	60,900	15,100	46,700	12,900	41,000	4,560	33,500	4,540	33,900	3,160	23,900

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for October 7, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (2.5m)		Bottom (5.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.	75	127											22	38				
*Aphanizomenon flos-aquae***	26	137	205	1,080	26	137	101	399	37	148			1,180	4,280	496	402	1,360	1,110
Coelosphaerium sp.	11	1					11	1	26	1							11	1
Chroococcales Order	2,950	88	2,550	77	709	21	1,820	55	162	5	1,310	39	272	8	172	6	209	6
Chroococcus sp.	11	1			26	1	1	1	11	1							147	4
Microcystis sp.																		
Oscillatoria sp.**			19	16			19	13					74	63	37	32	22	12
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	26	12	19	9	11	5							11	5	22	10	60	28
Pennales Order	26	4			48	7					11	2			37	5		
Melosira sp.	48	304	37	157	75	313	26	110	26	324	37	242	37	157	11	47	11	47
Stephanodiscus sp.			37	895	26	626	11	268	37	895	63	1,520	22	538	11	269	48	1,160
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.																		
Cryptomonas sp.	698	1,520	67	168	63	158	90	224	37	45								
Chlorophyta (green)																		
Ankistrodesmus sp.	11	1			11	2												
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.	63	1,500	37	880	48	1,140	11	410			11	264						
Crucigenia sp.			112	492	26	115					11	49						
Pandorina sp.	26	31																
Pediastrum sp.	26	25	19	18	22	21			11	11			22	21	11	11	11	11
Scenedesmus sp.	37	11	19	22	63	358	11	13	11	13					11	13		
Schroederia sp.	48	18	37	14	48	18			26	10								
Sphaerocystis sp.	123	106			198	170	26	22					22	19				
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.			37	63	11	19	26	44	11	19							11	19
Flagellates (unidentified)	310	19	19	1	26	2			26	2					37	2	22	1
Total number of genera	17		13		16		11		13		6		9		9		10	
Other taxa No., Vol.	11	200							26	1								
Total taxa No., Vol.	4,530	4,100	3,210	3,890	1,440	3,110	2,150	1,560	447	1,480	1,440	2,100	1,660	5,130	845	797	1,910	2,400

*Cell numbers/ml.
+Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and cell volume measurements for October 21, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (2.5m)		Bottom (5.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.					11	19	710	1,910										
*Aphanizomenon flos-aquae***	234	1,230	123	646	175	921	12	1	198	533	48	131	594	208	501	2,120	149	631
Coelosphaerium sp.			37	1	11	1	1,940	58	11	1					12	1		
Chroococcales Order	340	10	63	2	86	3			8	24	345	10	12	1				
Chroococcus sp.	53	2	48	2	37	1												
Microcystis sp.																		
*Oscillatoria sp.***			11	10	26	22	89	52			11	2	12	10			37	8
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	41	19	37	18	175	82	50	24			48	23	67	32	52	24	93	44
Pennales Order	53	8	37	5	63	9					26	4	28	4	32	4	11	2
Melosira sp.	12	52	11	5	26	110	27	114	12	50	26	110	28	116			37	157
Stephanodiscus sp.	82	1,970	75	1,790	48	1,160	167	4,000	131	3,140	112	2,680	158	3,800	112	2,700	198	4,740
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.			26	1	101	5												
Cryptomonas sp.	193	428	261	556	101	252	78	159	39	84	75	152	40	99	80	96	48	58
Chlorophyta (green)																		
Ankistrodesmus sp.	12	2			11	2												
Chlamydomonas sp.																		
Chlorella sp.																		
Closterium sp.	53	1,260	112	2,640	26	616	27	642	52	1,220							11	264
Crucigenia sp.	29	126			26	115					11	49						
Pandorina sp.					11	13									12	432		
Pediastrum sp.	29	27	37	35									12	11	20	19		
Scenedesmus sp.	29	9	26	31	26	8												
Schroederia sp.	12	5	101	38	86	33	27	10	12	4	11	4	12	4			11	4
Sphaerocystis sp.	299	257	11	10													11	10
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.	12	21	11	19			39	66	12	20	37	63			12	20	11	19
Flagellates (unidentified)	164	10	86	5	48	3	50	3	12	1	48	3	28	2	20	1	11	1
Total number of genera	18		18		20		13		9		11		10		9		12	
Other taxa No., Vol.	258	50	11	3	3,180	70	24	70									33	3
Total taxa No., Vol.	1,910	5,490	1,120	5,820	4,260	3,440	3,240	7,110	487	5,080	798	3,230	991	4,290	853	5,420	661	5,940

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for November 4, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)		Surface (0.5m)		Middle (2.0m)		Bottom (4.0m)		Surface (0.5m)		Middle (4.0m)		Bottom (7.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.																		
Aphanizomenon flos-aquae**	22	118	22	118							11	59	160	635	37	148	11	44
Coelosphaerium sp.					11	1	26	110							11	1	22	1
Chroococcales Order	11	1					250	8	86	3	86	3						
Chroococcus sp.			11	1	22	1	86	3			22	1						
Microcystis sp.			11	19	11	19												
Oscillatoria sp.**	22	19			22	12	26	22							11	10	22	19
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	861	408	1,320	619	880	414			22	11	63	30	123	58	209	98	149	70
Pennales Order	37	5	63	9	97	14	11	2	11	2	22	3	60	8	37	5	48	7
Melosira sp.	22	94	11	47	22	94	11	47			63	266	22	94	37	157	22	94
Stephanodiscus sp.	496	11,900	324	7,790	422	10,100	410	9,850	235	5,640	235	5,640	2,240	5,370	284	6,800	384	922
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.	272	14	522	26	160	8	48	2			11	1					11	1
Cryptomonas sp.	123	216	123	148	224	462	86	214			63	158	75		97	116	149	179
Chlorophyta (green)																		
Ankistrodesmus sp.	48	2	48	8	22	4												
Chlamydomonas sp.																		
Chlorella sp.							48	1										
Closterium sp.	11	264	22	528	72	529	11	264	11	264			11	264	22	529		
Crucigenia sp.	138	607	149	656	123	542												
Pandorina sp.					11	13											11	13
Pediastrum sp.	11	11	11	11	11	11							11	23	11	11	11	11
Scenedesmus sp.			11	3			37	45							11	13		
Schroederia sp.	97	37	138	52	123	47			11	4	22	8						
Sphaerocystis sp.			37	32									11	10			11	10
Euglenophyta (euglenoids)																		
Euglena sp.																		
Trachelomonas sp.	37	63	22	38			37	63			11	19			11	19		
Flagellates (unidentified)	22	1	37	2	22	1							11	1	22	1		
Total number of genera	17		19		18		14		6		13		9		12		12	
Other taxa No., Vol.	183	1	224	50	157	30	134	5			34	8						
Total taxa No., Vol.	2,410	13,800	3,110	10,200	2,410	12,300	1,220	10,600	376	5,920	643	6,200	2,720	6,460	800	7,910	851	1,370

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for November 18, 1975.

Dominant Taxa	Site 13						Site 16						Site 23					
	Surface (0.5m)		Middle (4.0m)		Bottom (8.0m)		Surface (0.5m)		Middle (2.5m)		Bottom (5.0m)		Surface (0.5m)		Middle (3.5m)		Bottom (7.0m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)																		
Anabaena sp.																		
Aphanizomenon flos-aquae**											11	59			30	156	11	59
Coelosphaerium sp.											11	4			30	1	11	4
Chroococcales Order	22	1	11	1	48	2	448	13	261	8	48	2	26	1				
Chroococcus sp.							63	2	37	1	22	1					30	1
Microcystis sp.																		
Oscillatoria sp.**			22	19	22	19	11	10							11	10		
Chrysophyta (yellow-green)																		
Asterionella sp.																		
Cyclotella sp.	295	138	198	93	86	40	310	146	235	110	634	298	112	53	67	32	86	40
Pennales Order	112	16	209	29	112	15	11	2	63	9	75	10	48	7	63	9	48	7
Melosira sp.	11	47					11	47	37	157	22	94			30	125	19	78
Stephanodiscus sp.	37	895					362	8,680	198	4,740	235	5,640	63	1,520	119	2,860	93	2,240
Pyrrophyta (yellow-brown)																		
Ceratium hirundinella																		
Chroomonas sp.	97	5	37	2	11	1	112	6	112	6	48	2			11	1		
Cryptomonas sp.	86	214	149	179	150	134	86	166	11	28	22	27	138	166	48	58		
Chlorophyta (green)																		
Ankistrodesmus sp.	97	8	209	11	108	16	50	10	48	10	97	10			11	1		
Chlamydomonas sp.																		
Chlorella sp.															11	1		
Closterium sp.									11	264	22	529						
Crucigenia sp.					11	49			22	99								
Pandorina sp.													26	31	11	13		
Pediastrum sp.			11	11	22	27					22	21	26	55	37	35	19	18
Scenedesmus sp.	37	11	22	27					22	27	22	16						
Schroederia sp.							26	9	22	8	37	14						
Sphaerocystis sp.	75	64	60	51	90	128	37	32			22	19						
Euglenophyta (euglenoids)																		
Euglena sp.			22	19	11	10												
Trachelomonas sp.									22	38			11	19	11	19		
Flagellates (unidentified)	86	5	172	10	149	9	86	5	11	1	48	3	63	4	30	2	11	1
Total number of genera	13		12		12		14		16		18		9		19		8	
Other taxa No., Vol.	131	10	22	6	22	6	22	5	45	20	60	10	26	6	111	40		
Total taxa No., Vol.	1,090	1,410	1,140	458	842	456	1,640	9,130	1,160	5,530	1,460	6,760	539	1,860	631	3,360	328	2,450

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for December 18, 1975.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 20 Surface (0.5m) No.*	Site 20 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.	662	19			8	1
Microcystis sp.						
Oscillatoria sp.**			11	10		
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.	62	29	137	64	186	88
Pennales Order	75	10				
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			3,540	177	101	5
Cryptomonas sp.	11	28	771	848	75	90
Chlorophyta (green)						
Ankistrodesmus sp.	48	2	11	1		
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.	11	49				
Pandorina sp.			25	30		
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.			11	10		
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.			11	19	8	13
Flagellates (unidentified)	11	1	1,050	63	63	4
Total number of genera	6		9		7	
Other taxa No., Vol.			48	1	26	1
Total taxa No., Vol.	840	138	5,620	1,220	467	202

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for January 6, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.	186	6			8	1
Microcystis sp.						
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.					56	26
Pennales Order						
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			261	13	131	6
Cryptomonas sp.	11	13	348	595	19	22
Chlorophyta (green)						
Ankistrodesmus sp.	1,060	53	224	11	19	1
Chlamydomonas sp.			373	48		
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.			37	63		
Flagellates (unidentified)	87	5	883	53		
Total number of genera	3		6		5	
Other taxa No., Vol.			11	1		
Total taxa No., Vol.	1,340	77	2,140	784	233	56

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for January 20, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.						
Microcystis sp.						
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.					NO PHYTOPLANKTON OBSERVED	
Cyclotella sp.						
Pennales Order	2	3				
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			62	3		
Cryptomonas sp.	48	29	123	162		
Chlorophyta (green)						
Ankistrodesmus sp.	410	27	149	16		
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	11	19				
Flagellates (unidentified)	37	2	50	3		
Total number of genera	5		3			
Other taxa No., Vol.	11	1				
Total taxa No., Vol.	519	81	384	184		

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for March 4, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**						
Coelosphaerium sp.						
Chroococcales Order			25	1	174	5
Chroococcus sp.					100	3
Microcystis sp.						
Oscillatoria sp.**			11	2		
Chrysophyta (yellow-green)						
Asterionella sp.	MISSING DATA					
Cyclotella sp.						
Pennales Order					11	2
Melosira sp.			11	48		
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.						
Cryptomonas sp.						
Chlorophyta (green)						
Ankistrodesmus sp.			199	40	4,720	945
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.			11	49		
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.						
Flagellates (unidentified)						
Total number of genera			5		4	
Other taxa No., Vol.						
Total taxa No., Vol.			257	140	5,000	955

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for February 6, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.	75	2	174	5	385	12
Microcystis sp.						
*Oscillatoria sp.***	11	10				
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.			11	5		
Pennales Order						
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			37	2		
Cryptomonas sp.	75	186	37	22	22	41
Chlorophyta (green)						
Ankistrodesmus sp.	273	42	3,790	759	137	28
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.						
Flagellates (unidentified)	112	7	286	17		
Total number of genera	4		5		4	
Other taxa No., Vol.					50	5
Total taxa No., Vol.	546	247	4,340	810	594	86

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for February 16, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.						
Chroococcales Order	174	5	311	9	25	1
Chroococcus sp.	1,540	46				
Microcystis sp.			3,440	103		
*Oscillatoria sp.***			48	41		
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.			11	5		
Pennales Order	37	18				
Melosira sp.			37	158		
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.						
Cryptomonas sp.	25	30	73	102		
Chlorophyta (green)						
Ankistrodesmus sp.	3,890	778	10,600	2,120	149	30
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.	11	3				
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.					11	19
Flagellates (unidentified)					25	2
Total number of genera	6		7		3	
Other taxa No., Vol.						
Total taxa No., Vol.	4,140	880	14,500	2,530	210	52

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for April 13, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	11	20				
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.			48	1		
Microcystis sp.						
*Oscillatoria sp.***					149	30
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.	50	23	11	5	22	10
Pennales Order	11	3	37	5	50	7
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			11	1	11	1
Cryptomonas sp.	47	187	22	27	50	60
Chlorophyta (green)						
Ankistrodesmus sp.	100	5	249	12	338	18
Chlamydomonas sp.	323	1,290	37	34		
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.					11	13
Schroederia sp.	22	8				
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.			11	19		
Flagellates (unidentified)	261	16	37	2	87	5
Total number of genera	11		10		8	
Other taxa No., Vol.	82	300	72	11	298	4
Total taxa No., Vol.	907	1,850	498	117	1,020	148

*Cell numbers/ml.

+Phytoplankton volume as mm3/m3.

**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for April 26, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.						
Chroococcales Order						
Chroococcus sp.			62	2		
Microcystis sp.						
*Oscillatoria sp.***					22	4
Chrysophyta (yellow-green)						
Asterionella sp.	199	80				
Cyclotella sp.	1,140	537	2,250	1,060	1,660	782
Pennales Order	370	59	110	18	160	29
Melosira sp.			48	189	37	168
Stephanodiscus sp.			11	170	22	340
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.	174	9	11	1	75	4
Cryptomonas sp.	310	331	609	925	200	297
Chlorophyta (green)						
Ankistrodesmus sp.	48	2	22	8	34	12
Chlamydomonas sp.			22	20	11	10
Chlorella sp.						
Closterium sp.					11	392
Crucigenia sp.	11	49			11	22
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.	11	13				
Schroederia sp.	48	18	149	57	112	42
Sphaerocystis sp.			100	86		
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.					11	19
Flagellates (unidentified)	199	12	249	15	162	10
Total number of genera	19		18		17	
Other taxa No., Vol.	445	100	334	70	370	60
Total taxa No., Vol.	2,960	1,210	3,980	2,620	2,900	2,190

*Cell numbers/ml.

+Phytoplankton volume as mm3/m3.

**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for May 10, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**						
Coelosphaerium sp.						
Chroococcales Order	11	1				
Chroococcus sp.	124	4	11,800	354	2,980	90
Microcystis sp.						
Oscillatoria sp.**	11	9				
Chrysophyta (yellow-green)						
Asterionella sp.	721	288	800	318	1,300	522
Cyclotella sp.	896	421	870	409	2,680	1,180
Pennales Order	484	106	123	27	162	30
Melosira sp.	37	224	199	656	75	246
Stephanodiscus sp.	22	538	112	2,680	100	2,380
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.	771	38	1,720	86	2,360	118
Cryptomonas sp.	11	13	286	343	410	541
Chlorophyta (green)						
Ankistrodesmus sp.	22	4	36	7	11	1
Chlamydomonas sp.	37	34	100	90	62	56
Chlorella sp.	547	16	87	3		
Closterium sp.			11	168	11	45
Crucigenia sp.	37	164				
Pandorina sp.						
Pediastrum sp.					22	21
Scenedesmus sp.	48	58	62	75	100	30
Schroederia sp.	124	47	48	18	50	19
Sphaerocystis sp.					37	32
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	37	63				
Flagellates (unidentified)	249	15	448	27	149	9
Total number of genera	26		21		21	
Other taxa No., Vol.	888	19	612	200	305	40
Total taxa No., Vol.	5,080	5,850	17,300	5,460	10,800	5,360

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for May 24, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.			11	10		
Aphanizomenon flos-aquae**			75	224	22	54
Coelosphaerium sp.						
Chroococcales Order			48	1	62	2
Chroococcus sp.			87	3		
Microcystis sp.						
Oscillatoria sp.**					22	10
Chrysophyta (yellow-green)						
Asterionella sp.	149	60				
Cyclotella sp.	48	23	11	5	11	5
Pennales Order			22	3		
Melosira sp.	274	2,300	11	5		
Stephanodiscus sp.	100	3,400	48	1,660	37	1,280
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.	671	34	11	1	22	1
Cryptomonas sp.	161	242	48	58	199	319
Chlorophyta (green)						
Ankistrodesmus sp.						
Chlamydomonas sp.						
Chlorella sp.			11	1		
Closterium sp.						
Crucigenia sp.			11	45		
Pandorina sp.	11	13			423	507
Pediastrum sp.						
Scenedesmus sp.	22	27				
Schroederia sp.			37	14	37	14
Sphaerocystis sp.	48	42				
Euglenophyta (euglenoids)						
Euglena sp.			11	10		
Trachelomonas sp.						
Flagellates (unidentified)	249	15	22	1	11	1
Total number of genera	13		15		10	
Other taxa No., Vol.	48	30	22	40	37	30
Total taxa No., Vol.	1,780	6,190	486	2,040	883	2,220

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for June 8, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.†	No.*	Vol.†	No.*	Vol.†
Cyanophyta (blue-green)						
Anabaena sp.	75	127	11	76	22	28
Aphanizomenon flos-aquae**	5,070	13,700	4,370	22,300	2,080	10,900
Coelosphaerium sp.			62	2		
Chroococcales Order	48	1	186	6	174	5
Chroococcus sp.						
Microcystis sp.						
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.	11	4				
Cyclotella sp.	22	10			11	5
Pennales Order	37	5	22	3		
Melosira sp.	11	101				
Stephanodiscus sp.			11	268		
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.	100	5	373	19	186	9
Cryptomonas sp.	49	73	445	549	237	381
Chlorophyta (green)						
Ankistrodesmus sp.						
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.						
Pandorina sp.	37	45				
Pediastrum sp.			11	11	11	11
Scenedesmus sp.	37	11				
Schroederia sp.	37	14	75	28	75	28
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.					11	19
Flagellates (unidentified)			37	2	75	4
Total number of genera	13		12		11	
Other taxa No., Vol.	37	10	72	40	34	60
Total taxa No., Vol.	5,570	14,100	5,680	23,300	2,920	11,100

*Cell numbers/ml.
†Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for June 21, 1976.

Dominant Taxa	Site 13		Site 16		Site 23	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.†	No.*	Vol.†	No.*	Vol.†
Cyanophyta (blue-green)						
Anabaena sp.					560	60
Aphanizomenon flos-aquae**			23,000	88,300	20,600	91,400
Coelosphaerium sp.						
Chroococcales Order			995	30		
Chroococcus sp.					87	3
Microcystis sp.						
Oscillatoria sp.**					37	5
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.			37	18	37	18
Pennales Order	MISSING		37	9		
Melosira sp.			37	168	37	22
Stephanodiscus sp.	DATA		37	895		
Pyrrophyta (yellow-brown)						
Ceratium hirundinella			37	2,610		
Chroomonas sp.						
Cryptomonas sp.			112	134	37	45
Chlorophyta (green)						
Ankistrodesmus sp.						
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.					37	164
Pandorina sp.			37	45		
Pediastrum sp.			37	35		
Scenedesmus sp.						
Schroederia sp.			224	85		
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.						
Flagellates (unidentified)			37	2		
Total numbér of genera			11		8	
Other taxa No., Vol.						
Total taxa No., Vol.			24,600	92,300	21,400	91,700

*Cell numbers/ml.
†Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for July 8, 1976.

Dominant Taxa	Site 13 Surface (0.5m)		Site 16 Surface (0.5m)		Site 23 Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.			597	1,010	497	54
Aphanizomenon flos-aquae**	45,400	117,000	55,300	118,000	8,890	34,700
Coelosphaerium sp.	485	17				
Chroococcales Order	2,860	86	2,090	63	1,490	45
Chroococcus sp.					37	1
Microcystis sp.						
Oscillatoria sp.**					22	19
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.			112	52		
Pennales Order			37	5	75	10
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			224	11		
Cryptomonas sp.						
Chlorophyta (green)						
Ankistrodesmus sp.					11	22
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.	112	1,760				
Crucigenia sp.	112	492				
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.					22	19
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.						
Flagellates (unidentified)	112	7			37	2
Total number of genera	7		7		8	
Other taxa No., Vol.	199	600	1,240	134		
Total taxa No., Vol.	49,300	120,000	59,600	119,000	11,100	34,900

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for July 20, 1976.

Dominant Taxa	Site 13 Surface (0.5m)		Site 16 Surface (0.5m)		Site 23 Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	7,710	6,660			3,480	3,010
Aphanizomenon flos-aquae**	20,300	43,800	15,300	51,400	29,500	61,900
Coelosphaerium sp.						
Chroococcales Order	5,470	164	4,970	149		
Chroococcus sp.	3,730	112				
Microcystis sp.						
Oscillatoria sp.**			112	95	224	190
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.	373	175	224	105	112	52
Pennales Order					112	16
Melosira sp.						
Stephanodiscus sp.	373	8,950			112	2,680
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.					622	31
Cryptomonas sp.					226	268
Chlorophyta (green)						
Ankistrodesmus sp.					112	31
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.					112	492
Pandorina sp.						
Pediastrum sp.			112	106		
Scenedesmus sp.	112	34			112	112
Schroederia sp.	373	142				
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.						
Flagellates (unidentified)			100	6		
Total number of genera	8		6		12	
Other taxa No., Vol.			224	56	112	300
Total taxa No., Vol.	38,400	60,000	21,000	51,900	34,800	69,100

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for August 3, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	4,970	4,300				
Aphanizomenon flos-aquae**	36,100	137,000	23,600	69,400		
Coelosphaerium sp.						
Chroococcales Order	25,500	764	11,900	358		
Chroococcus sp.						
Microcystis sp.						
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.						
Pennales Order					MISSING	
Melosira sp.						
Stephanodiscus sp.					DATA	
Pyrrophyta (yellow-brown)						
Ceratium hirundinella	112	7,830				
Chroomonas sp.						
Cryptomonas sp.	224	269	224	268		
Chlorophyta (green)						
Ankistrodesmus sp.						
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.						
Crucigenia sp.	112	492				
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	497	845				
Flagellates (unidentified)	485	29	448	26		
Total number of genera	7		5			
Other taxa No., Vol.			448	400		
Total taxa No., Vol.	68,000	152,000	36,600	70,400		

*Cell numbers/ml.
+Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for August 17, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	653	886	100	86		
Aphanizomenon flos-aquae**	16,600	29,400	4,720	16,200	3,230	12,200
Coelosphaerium sp.			286	10		
Chroococcales Order	19,300	578	3,790	114	7,460	224
Chroococcus sp.	7,460	224	2,100	63		
Microcystis sp.	11,200	1,200				
Oscillatoria sp.**	653	555	86	66	9,700	6,710
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.						
Pennales Order			48	7		
Melosira sp.						
Stephanodiscus sp.			37	895	112	2,680
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.					112	6
Cryptomonas sp.			11	13	112	134
Chlorophyta (green)						
Ankistrodesmus sp.					112	22
Chlamydomonas sp.						
Chlorella sp.						
Closterium sp.	93	1,400	37	560	112	1,760
Crucigenia sp.	373	1,640	48	213		
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.	373	142	37	14	112	42
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	186	317			112	190
Flagellates (unidentified)			584	35		
Total number of genera	11		16		14	
Other taxa No., Vol.	466	200	1,090	300	2,410	5,300
Total taxa No., Vol.	57,400	36,500	13,000	18,600	23,600	29,300

*Cell numbers/ml.
+Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for August 30, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	 Vol.+	Site 16 Surface (0.5m) No.*	 Vol.+	Site 23 Surface (0.5m) No.*	 Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	10,600	3,850	1,180	430	6,650	11,200
Aphanizomenon flos-aquae**	14,900	47,900	3,230	12,900	3,110	14,400
Coelosphaerium sp.					497	17
Chroococcales Order	24,200	727	12,700	382	24,900	746
Chroococcus sp.	995	30	1,860	25	622	19
Microcystis sp.						
Oscillatoria sp.**			56	1	1,490	373
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.						
Pennales Order					56	8
Melosira sp.					57	239
Stephanodiscus sp.			56	1,340	56	1,340
Pyrrophyta (yellow-brown)						
Ceratium hirundinella			56	3,920		
Chroomonas sp.						
Cryptomonas sp.			112	280	485	592
Chlorophyta (green)						
Ankistrodesmus sp.			56	11		
Chlamydomonas sp.					112	101
Chlorella sp.			560	17		
Closterium sp.	112	1,680	56	840	56	840
Crucigenia sp.	1,490	6,560	112	492	242	1,060
Pandorina sp.						
Pediastrum sp.						
Scenedesmus sp.						
Schroederia sp.			112	42	56	21
Sphaerocystis sp.	224	193	1,300	1,120		
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.			56	95	373	634
Flagellates (unidentified)	112	7	56	3	373	22
Total number of genera	8		15		16	
Other taxa No., Vol.	112	300			988	2,200
Total taxa No., Vol.	52,700	61,200	21,600	21,900	40,100	33,800

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for September 22, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	 Vol.+	Site 16 Surface (0.5m) No.*	 Vol.+	Site 23 Surface (0.5m) No.*	 Vol.+
Cyanophyta (blue-green)						
Anabaena sp.	6,840	738	6,220	671	11,300	1,220
Aphanizomenon flos-aquae**	870	3,240	4,350	16,600	13,100	46,600
Coelosphaerium sp.	2,110	74	1,490	52		
Chroococcales Order	21,100	634	22,400	671	36,100	1,260
Chroococcus sp.	9,320	280	6,220	671	11,800	354
Microcystis sp.	56,900	6,150				
Oscillatoria sp.**					112	28
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.	224	105				
Pennales Order	112	16	112	16		
Melosira sp.						
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.						
Cryptomonas sp.	224	560			112	134
Chlorophyta (green)						
Ankistrodesmus sp.						
Chlamydomonas sp.	112	101	224	202		
Chlorella sp.	746	22				
Closterium sp.	112	1,680				
Crucigenia sp.					373	1,640
Pandorina sp.	1,490	1,290				
Pediastrum sp.			112	106		
Scenedesmus sp.	112	112				
Schroederia sp.						
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	485	824				
Flagellates (unidentified)	224	13	224	13	224	13
Total number of genera	16		9		7	
Other taxa No., Vol.	485	100	485	400		
Total taxa No., Vol.	101,000	15,900	41,800	19,400	73,100	51,200

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for October 6, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Vol.+	Site 16 Surface (0.5m) No.*	Vol.+	Site 23 Surface (0.5m) No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.			97	83	75	64
Aphanizomenon flos-aquae**			696	2,760	323	1,040
Coelosphaerium sp.	30,500	1,070	29,100	1,020	6,340	220
Chroococcales Order	1,240	40			1,620	48
Chroococcus sp.	1,240	40				
Microcystis sp.	26,700	2,890				
Oscillatoria sp.**			22	19	75	63
Chrysophyta (yellow-green)						
Asterionella sp.	112	45	75	30	45	18
Cyclotella sp.	373	175	75	35	124	582
Pennales Order	224	31	45	6	22	3
Melosira sp.	224	1,010	97	436	22	94
Stephanodiscus sp.	112	2,680	75	1,790	97	2,330
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.						
Cryptomonas sp.	622	746	199	238	22	27
Chlorophyta (green)						
Ankistrodesmus sp.	112	22				
Chlamydomonas sp.	373	336	45	40	22	20
Chlorella sp.	622	18	97	3	97	3
Closterium sp.	112	1,680	97	1,520	45	672
Crucigenia sp.			149	656		
Pandorina sp.			22	27		
Pediastrum sp.			22	21		
Scenedesmus sp.	112	34	22	7	67	67
Schroederia sp.	112	42	75	28		
Sphaerocystis sp.			22	19	75	64
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	485	824	45	76		
Flagellates (unidentified)	870	52	97	6	323	13
Total number of genera	18		21		16	
Other taxa No., Vol.	485	48	45	100		
Total taxa No., Vol.	64,600	11,800	31,200	8,900	9,390	5,330

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for October 25, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Vol.+	Site 16 Surface (0.5m) No.*	Vol.+	Site 23 Surface (0.5m) No.*	Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
Aphanizomenon flos-aquae**	19	56	37	112	100	298
Coelosphaerium sp.	9,010	315	11,300	396	10,200	355
Chroococcales Order					274	8
Chroococcus sp.	3,260	98	647	19		
Microcystis sp.	6,810	5,790				
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.	37	15				
Cyclotella sp.	2,050	964	87	41	75	35
Pennales Order	37	5			60	12
Melosira sp.	224	772	100	597	37	84
Stephanodiscus sp.	317	7,530	186	4,430	87	2,090
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.	19	1	22	1		
Cryptomonas sp.	280	336	137	164	62	75
Chlorophyta (green)						
Ankistrodesmus sp.	504	106	60	13		
Chlamydomonas sp.	93	84			11	10
Chlorella sp.	690	21	112	3	22	7
Closterium sp.	19	279	22	336	62	930
Crucigenia sp.			12	52	11	49
Pandorina sp.			249	215		
Pediastrum sp.	75	71	48	46		
Scenedesmus sp.			22	22		
Schroederia sp.						
Sphaerocystis sp.	560	481	62	53	124	107
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	560	952	62	106	11	19
Flagellates (unidentified)	130	8	62	4		
Total number of genera	25		20		16	
Other taxa No., Vol.	728	400	134	40	11	20
Total taxa No., Vol.	25,400	18,300	13,400	6,610	11,100	4,100

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for November 21, 1976.

Dominant Taxa	Site 13 Surface (0.5m) No.*	Site 13 Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Vol.+	Site 20 Surface (0.5m) No.*	Site 20 Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.	3,730	131	2,860	100	3,130	110
Chroococcales Order						
Chroococcus sp.	1,230	37			186	6
Microcystis sp.						
Oscillatoria sp.**						
Chrysophyta (yellow-green)						
Asterionella sp.	224	896			22	9
Cyclotella sp.	13,700	6,430	22	10	211	100
Pennales Order					11	2
Melosira sp.					11	47
Stephanodiscus sp.					11	269
Pyrrophyta (yellow brown)						
Ceratium hirundinella						
Chroomonas sp.	75	4	361	18	11	1
Cryptomonas sp.	1,590	2,200	1,960	2,490	111	148
Chlorophyta (green)						
Ankistrodesmus sp.	224	45	37	7	33	7
Chlamydomonas sp.	373	336	348	313	50	45
Chlorella sp.						
Closterium sp.					11	44
Crucigenia sp.						
Pandorina sp.			2,710	1,140		
Pediastrum sp.						
Scenedesmus sp.	112	34				
Schroederia sp.					11	4
Sphaerocystis sp.					149	128
Euglenophyta (euglenoids)						
Euglena sp.						
Trachelomonas sp.	373	634	186	317	48	82
Flagellates (unidentified)	3,230	194	199	12	112	7
Total number of genera	16		10		18	
Other taxa No., Vol.	3,320	800	45	10	14	7
Total taxa No., Vol.	28,200	11,700	8,730	4,420	4,150	1,020

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for December 6, 1976.

Dominant Taxa	Site 23 Surface (0.5m) No.*	Site 23 Vol.+	Site 20 Surface (0.5m) No.*	Site 20 Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Vol.+	Site 14 Surface (0.5m) No.*	Site 14 Vol.+	Site 13 Surface (0.5m) No.*	Site 13 Vol.+
Cyanophyta (blue-green)										
Anabaena sp.										
*Aphanizomenon flos-aquae***										
Coelosphaerium sp.	3,850	135	1,540	54	3,410	119	746	26	1,120	39
Chroococcales Order										
Chroococcus sp.							373	11	1,120	34
Microcystis sp.										
Oscillatoria sp.**										
Chrysophyta (yellow-green)										
Asterionella sp.			48	19	199	80	485	194	224	90
Cyclotella sp.	224	105	448	211	3,130	1,470	4,140	1,950	7,210	3,390
Pennales Order			11	2						
Melosira sp.										
Stephanodiscus sp.										
Pyrrophyta (yellow-brown)										
Ceratium hirundinella										
Chroomonas sp.	100	5	75	4	242	14			1,370	68
Cryptomonas sp.	870	1,530	259	339	1,960	2,570	112	157	2,090	2,570
Chlorophyta (green)										
Ankistrodesmus sp.	37	7			299	60	485	97	112	22
Chlamydomonas sp.	62	56	100	90	124	112				
Chlorella sp.	124	4			19	1				
Closterium sp.										
Crucigenia sp.										
Pandorina sp.			646	140	1,230	1,480				
Pediastrum sp.					19	18				
Scenedesmus sp.			11	3						
Schroederia sp.			22	8			37	14	373	104
Sphaerocystis sp.	100	86								
Euglenophyta (euglenoids)										
Euglena sp.			22	19	11	9				
Trachelomonas sp.	112	190	124	211	56	95	56	95	373	634
Flagellates (unidentified)	100	6	137	8	466	28	93	6	4,100	246
Total number of genera	11		16		19		14		12	
Other taxa No., Vol.	348	500	282	100	1,350	500	386	200	995	1,200
Total taxa No., Vol.	5,930	2,620	3,720	1,200	12,500	6,560	6,910	2,750	19,100	8,400

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for December 20, 1976.

Dominant Taxa	Site 23		Site 20		Site 16		Site 14		Site 13	
	Surface (0.5m)		Surface (0.5m)		Surface (0.5m)		Surface (0.5m)		Surface (0.5m)	
	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+	No.*	Vol.+
Cyanophyta (blue-green)										
Anabaena sp.										
*Aphanizomenon flos-aquae***										
Coelosphaerium sp.	1,989	70	2,002	70	1,130	40	634	22		
Chroococcales Order										
Chroococcus sp.			37	1	261	1				
Microcystis sp.										
Oscillatoria sp.**										
Chrysophyta (yellow-green)										
Asterionella sp.					149	60	149	60		
Cyclotella sp.	174	82	162	5	1,070	502	1,680	789	3,850	1,810
Pennales Order										
Melosira sp.										
Stephanodiscus sp.										
Pyrrophyta (yellow-brown)										
Ceratium hirundinella										
Chroomonas sp.	448	22	22	1	100	5	75	4	373	19
Cryptomonas sp.	321	385	398	996	533	654	421	520	5,070	5,710
Chlorophyta (green)										
Ankistrodesmus sp.	48	10	11	2	162	32			112	22
Chlamydomonas sp.	48	43	37	34	62	56	124	112	995	896
Chlorella sp.	48	1	75	2	137	4	224	7	1,620	48
Closterium sp.										
Crucigenia sp.										
Pandorina sp.	100	120	199	239	11	13				
Pediastrum sp.										
Scenedesmus sp.										
Schroederia sp.					22	8			112	42
Sphaerocystis sp.										
Euglenophyta (euglenoids)										
Euglena sp.										
Trachelomonas sp.	22	38	11	19	75	128	22	38		
Flagellates (unidentified)	137	8	87	5	186	11	249	15	3,850	231
Total number of genera	14		17		18		15		9	
Other taxa No., Vol.	142	60	305	100	599	70	568	400	709	548
Total taxa No., Vol.	3,470	839	3,340	1,440	4,500	1,580	4,150	1,970	16,700	9,330

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for January 4, 1977.

Dominant Taxa	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.†	Site 20 Surface (0.5m) No.*	Site 20 Surface (0.5m) Vol.†	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.†	Site 14 Surface (0.5m) No.*	Site 14 Surface (0.5m) Vol.†	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.†
Cyanophyta (blue-green)										
Anabaena sp.										
*Aphanizomenon flos-aquae***										
Coelosphaerium sp.	3,480	122	2,140	74	2,200	77				
Chroococcales Order	186	6			75	2			8,830	264
Chroococcus sp.							1,990	8		
Microcystis sp.										
*Oscillatoria sp.***			87	17	75	15	336	36	4,350	459
Chrysophyta (yellow-green)										
Asterionella sp.			11	4						
Cyclotella sp.	186	87	22	10	211	99	3,480	1,640	1,860	876
Pennales Order										
Melosira sp.										
Stephanodiscus sp.										
Pyrrophyta (yellow-brown)										
Ceratium hirundinella										
Chroomonas sp.	100	5	746	37	87	4	224	11	373	19
Cryptomonas sp.	148	241	783	987	535	642	4,950	6,230	2,740	3,280
Chlorophyta (green)										
Ankistrodesmus sp.	120	21	146	28	75	15			112	22
Chlamydomonas sp.					62	56	746	671	746	671
Chlorella sp.									224	7
Closterium sp.										
Crucigenia sp.										
Pandorina sp.										
Pediastrum sp.										
Scenedesmus sp.										
Schroederia sp.										
Sphaerocystis sp.										
Euglenophyta (euglenoids)										
Euglena sp.									112	95
Trachelomonas sp.	186	316	62	105	37	63			224	381
Flagellates (unidentified)	75	4	1,300	49	149	9	2,610	130	994	50
Total number of genera	11		14		16		9		16	
Other taxa No., Vol.	357	29	2,390	218	428	200	8,570	1,940	12,300	2,170
Total taxa No., Vol.	4,840	831	7,690	1,340	3,930	1,180	22,900	10,700	32,900	8,300

*Cell numbers/ml.
†Phytoplankton volume as mm^3/m^3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for January 18, 1977.

Dominant Taxa	Site 23 Surface (0.5m) No.*	 Vol.+	Site 20 Surface (0.5m) No.*	 Vol.+	Site 16 Surface (0.5m) No.*	 Vol.+	Site 14 Surface (0.5m) No.*	 Vol.+	Site 13 Surface (0.5m) No.*	 Vol.+
Cyanophyta (blue-green)										
Anabaena sp.										
*Aphanizomenon flos-aquae***										
Coelosphaerium sp.	2,370	83	622	22	2,240	78	1,370	48		
Chroococcales Order	112				5,220	21				
Chroococcus sp.	497	15	970	12			4,350	17		
Microcystis sp.										
*Oscillatoria sp.***	920	58	943	60	4,600	285	5,470	345		
Chrysophyta (yellow-green)										
Asterionella sp.	48	10							SAMPLE TO TURBID TO COUNT	
Cyclotella sp.	37	18	62	29	224	105	224	105		
Pennales Order										
Melosira sp.										
Stephanodiscus sp.										
Pyrrophyta (yellow-brown)										
Ceratium hirundinella										
Chroomonas sp.	112	7	75	4			224	13		
Cryptomonas sp.	286	603	609	957	3,850	5,110	746	895		
Chlorophyta (green)										
Ankistrodesmus sp.	74	15	75	15			373	75		
Chlamydomonas sp.	48	44	22	20			112	101		
Chlorella sp.	11	< 1	22	1						
Closterium sp.										
Crucigenia sp.										
Pandorina sp.	162	140								
Pediastrum sp.										
Scenedesmus sp.			11	3						
Schroederia sp.										
Sphaerocystis sp.										
Euglenophyta (euglenoids)										
Euglena sp.										
Trachelomonas sp.	22	38	75	128	224	381				
Flagellates (unidentified)	534	28	324	20	858	53	373	22		
Total number of genera	19		20		11		10			
Other taxa No., Vol.	3,020	109	4,330	75	760	209	28,900	1,670		
Total taxa No., Vol.	8,250	1,170	8,140	1,350	27,000	6,240	42,100	3,290		

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for February 15, 1977.

Dominant Taxa	Site 23 Surface (0.5m) No.*	 Vol.+	Site 20 Surface (0.5m) No.*	 Vol.+	Site 16 Surface (0.5m) No.*	 Vol.+	Site 14 Surface (0.5m) No.*	 Vol.+
Cyanophyta (blue-green)								
Anabaena sp.								
*Aphanizomenon flos-aquae***								
Coelosphaerium sp.	1,990	70						
Chroococcales Order	2,240	67	46,300	1,620	11,600	347	5,220	157
Chroococcus sp.								
Microcystis sp.							1,240	
*Oscillatoria sp.***	4,720	297	41,000	2,580	373	75		
Chrysophyta (yellow-green)								
Asterionella sp.								
Cyclotella sp.	224	105	186	87			224	105
Pennales Order								
Melosira sp.								
Stephanodiscus sp.								
Pyrrophyta (yellow-brown)								
Ceratium hirundinella								
Chroomonas sp.								
Cryptomonas sp.			4,850	6,060			112	134
Chlorophyta (green)								
Ankistrodesmus sp.	112	22					373	75
Chlamydomonas sp.			1,120	1,007				
Chlorella sp.								
Closterium sp.								
Crucigenia sp.								
Pandorina sp.								
Pediastrum sp.								
Scenedesmus sp.								
Schroederia sp.								
Sphaerocystis sp.								
Euglenophyta (euglenoids)								
Euglena sp.								
Trachelomonas sp.								
Flagellates (unidentified)	224	14						
Total number of genera	8		6		2		6	
Other taxa No., Vol.	336	78	1,860	280			224	7
Total taxa No., Vol.	9,850	653	95,300	11,600	17,000	422	7,390	478

*Cell numbers/ml.

+Phytoplankton volume as mm^3/m^3.

**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for March 1, 1977.

Dominant Taxa	Site 20 Surface (0.5m) No.*	Vol.+	Site 13 Surface (0.5m) No.*	Vol.+
Cyanophyta (blue-green)				
Anabaena sp.				
*Aphanizomenon flos-aquae***				
Coelosphaerium sp.				
Chroococcales Order	5,350	187	224	7
Chroococcus sp.				
Microcystis sp.				
*Oscillatoria sp.***	373	75	29,200	5,840
Chrysophyta (yellow-green)				
Asterionella sp.				
Cyclotella sp.				
Pennales Order				
Melosira sp.				
Stephanodiscus sp.				
Pyrrophyta (yellow-brown)				
Ceratium hirundinella				
Chroomonas sp.				
Cryptomonas sp.	3,700	4,740		
Chlorophyta (green)				
Ankistrodesmus sp.				
Chlamydomonas sp.	870	122		
Chlorella sp.				
Closterium sp.				
Crucigenia sp.				
Pandorina sp.				
Pediastrum sp.				
Scenedesmus sp.				
Schroederia sp.				
Sphaerocystis sp.				
Euglenophyta (euglenoids)				
Euglena sp.	112	95		
Trachelomonas sp.				
Flagellates (unidentified)	373	22	112	7
Total number of genera	6		2	
Other taxa No., Vol.	1,620	19		
Total taxa No., Vol.	12,400	5,260	29,500	5,850

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

Dominant phytoplankton cell numbers and volume measurements for March 7, 1977.

Dominant Taxa	Site 20 Surface (0.5m) No.*	Vol.+
Cyanophyta (blue-green)		
Anabaena sp.		
*Aphanizomenon flos-aquae***		
Coelosphaerium sp.		
Chroococcales Order	1,370	41
Chroococcus sp.		
Microcystis sp.		
*Oscillatoria sp.***	112	22
Chrysophyta (yellow-green)		
Asterionella sp.		
Cyclotella sp.		
Pennales Order		
Melosira sp.		
Stephanodiscus sp.		
Pyrrophyta (yellow-brown)		
Ceratium hirundinella		
Chroomonas sp.		
Cryptomonas sp.	26,300	44,000
Chlorophyta (green)		
Ankistrodesmus sp.		
Chlamydomonas sp.	8,100	7,300
Chlorella sp.		
Closterium sp.		
Crucigenia sp.		
Pandorina sp.		
Pediastrum sp.		
Scenedesmus sp.		
Schroederia sp.		
Sphaerocystis sp.		
Euglenophyta (euglenoids)		
Euglena sp.	112	95
Trachelomonas sp.		
Flagellates (unidentified)	870	52
Total number of genera	5	
Other taxa No., Vol.	7,450	582
Total taxa No., Vol.	44,300	52,100

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX B continued

Dominant phytoplankton cell numbers and volume measurements for April 11, 1977.

Dominant Taxa	Site 23 Surface (0.5m) No.*	Site 23 Surface (0.5m) Vol.+	Site 16 Surface (0.5m) No.*	Site 16 Surface (0.5m) Vol.+	Site 13 Surface (0.5m) No.*	Site 13 Surface (0.5m) Vol.+
Cyanophyta (blue-green)						
Anabaena sp.						
*Aphanizomenon flos-aquae***						
Coelosphaerium sp.						
Chroococcales Order	1,240	37	62	2		
Chroococcus sp.					19	1
Microcystis sp.						
*Oscillatoria sp.***	224	45	99	20	19	4
Chrysophyta (yellow-green)						
Asterionella sp.						
Cyclotella sp.			932	438	398	187
Pennales Order			185	261	243	33
Melosira sp.			37	155	37	33
Stephanodiscus sp.						
Pyrrophyta (yellow-brown)						
Ceratium hirundinella						
Chroomonas sp.			75	4	56	3
Cryptomonas sp.	4,800	6,080	435	522	429	515
Chlorophyta (green)						
Ankistrodesmus sp.	1,240	248	547	109	150	30
Chlamydomonas sp.	2,700	2,460	373	336	1,240	403
Chlorella sp.			373	112	100	3
Closterium sp.					19	304
Crucigenia sp.						
Pandorina sp.						
Pediastrum sp.			11	10		
Scenedesmus sp.						
Schroederia sp.			74	15	112	43
Sphaerocystis sp.						
Euglenophyta (euglenoids)						
Euglena sp.			37	31	19	16
Trachelomonas sp.			37	629	19	32
Flagellates (unidentified)	1,370	87	186	112	416	25
Total number of genera	8		22		19	
Other taxa No., Vol.	448	242	429	124	516	164
Total taxa No., Vol.	12,000	9,200	3,890	2,880	3,790	1,800

*Cell numbers/ml.
+Phytoplankton volume as mm3/m3.
**Only filaments counted.

APPENDIX C

Percent composition of algae divisions and phytoplankton volume measurements.

Station 23 1975

	Algae Divison	04/30	05/06	05/20	06/03	06/18	06/30	07/15	07/28	08/11	09/03	09/23	10/07	10/21	11/04	11/18	12/18
	Surface (0.5m)																
% Composition	Chlorophyta	3.0	1.6	8.4	16.8	1.2	1.8	0.1	+	+	0.3	+	0.8	0.4	4.5	5.0	1.7
	Chrysophyta	32.7	21.4	53.2	1.9	0.3	+				0.9	1.8	13.5	92.1	84.3	84.8	43.3
	Euglenophyta	2.2	4.4	3.3								+				1.0	6.4
	Pyrrhophyta	57.8	70.7	34.6	70.6	24.4	1.8	10.9			+	0.3		2.3	1.4	8.9	46.7
	Cyanophyta	3.3	1.7		10.6	74.0	96.3	89.0	99.9	99.9	98.7	97.8	85.7	5.1	9.7	+	+
	Unidentified	1.0	0.2	0.5	0.1	0.1								0.1	0.1	0.2	1.9
	Total Biomass (mm³/l.)	1.45	1.78	4.48	0.719	2.21	12.6	15.1	119.0	140.0	19.0	33.5	5.13	4.29	6.46	1.86	0.202
	Middle Depth (m)	4.0	6.0	4.0	5.0	4.5	*	4.0	4.0	6.0	4.0	4.0	3.5	3.5	4.0	3.5	*
% Composition	Chlorophyta	5.6	3.8	1.1	91.8	12.1	1.7	+	+	+	+	+	3.0	8.3	6.9	2.0	*
	Chrysophyta	13.3	27.6	91.9	7.8	67.3	5.6	+		7.3	1.8	0.9	41.6	50.2	89.3	90.6	*
	Euglenophyta													0.4	+	0.6	*
	Pyrrhophyta	56.7	64.4	6.6	0.4	7.9	39.0	15.9			13.0			1.8	1.5	1.8	*
	Cyanophyta	20.8	3.8	+		12.5	53.7	83.9	99.8	92.1	85.0	99.0	55.0	39.2	2.0	4.9	*
	Unidentified	3.6	0.4	0.3		0.2							0.4	0.1	0.3	0.1	
	Total Biomass (mm³/l.)	0.409	1.50	3.52	0.136	0.517	0.872	21.4	6.05	4.49	12.6	33.9	0.797	5.42	7.91	3.36	*
	Bottom Depth (m)	8.0	11.0	8.0	10.0	9.0	*	8.5	8.0	12.0	8.0	8.0	7.0	7.0	7.5	7.0	*
% Composition	Chlorophyta	24.8	1.9	1.9	5.5	18.9	2.1	2.2	0.7	1.2	+	+	0.4	4.7	2.4	0.7	*
	Chrysophyta	23.2	93.2	96.5	93.5	76.5	97.6	37.6	47.9	52.5	91.2	1.5	51.6	83.2	79.8	96.8	*
	Euglenophyta				0.7								0.8	0.3			*
	Pyrrhophyta	29.6										0.1		1.0	13.1		*
	Cyanophyta	21.2	4.8	0.6	0.3	4.6	0.3	60.2	51.4	46.2	8.6	98.3	46.8	10.7	4.7	2.5	*
	Unidentified	1.2	0.1	1.0						0.1			0.4	0.1			*
	Total Biomass (mm³/l.)	0.351	1.45	3.34	2.87	0.221	2.09	1.00	0.610	3.30	5.91	23.9	2.40	5.94	1.37	2.45	*

* Missing Data.
\+ Present at less than 0.1%.

APPENDIX C continued

Percent composition of algae divisions and phytoplankton volume measurements.

Station 16 1975

	Algae Divison	04/30	05/06	05/20	06/03	06/18	06/30	07/15	07/28	08/11	09/03	09/23	10/07	10/21	11/04	11/18	12/18
	Surface (0.5m)																
% Composition	Chlorophyta	3.8	7.3	3.4	25.5	0.6	*	0.1	+	0.1	0.1	0.8	28.7	9.5	2.9	0.6	4.1
	Chrysophyta	32.5	78.4	34.5	3.0	0.7	*				0.3	2.0	24.5	58.2	93.2	97.1	5.2
	Euglenophyta	47.6	2.0				*				0.1	+	2.9	0.9	0.6		1.5
	Pyrrhophyta	8.7	11.3	60.8	45.8	6.5	*	2.0	4.2	3.8	0.7	0.3	14.6	2.2	2.0	1.9	83.3
	Cyanophyta	6.0	+	0.3	25.7	92.1	*	97.8	95.7	96.1	98.6	96.8	29.3	29.1	1.3	0.3	0.8
	Unidentified	1.4	0.8	1.0		0.1		0.1			0.2			0.1		0.1	5.1
	Total Biomass (mm³/l.)	0.481	1.62	3.06	0.952	12.4	*	38.8	411.0	20.8	13.1	60.9	1.56	7.11	10.6	9.13	1.23
	Middle Depth (m)	4.0	4.0	4.0	3.5	4.5	*	3.5	3.5	4.0	3.0	3.0	2.5	2.5	2.0	2.5	*
% Composition	Chlorophyta	34.3	11.2	21.1	21.7	13.1	3.2	+	2.2	1.6	0.4	0.1	2.3	24.1	4.5	7.7	*
	Chrysophyta	41.4	55.6	44.1	55.3	7.8	7.6	+	0.4	1.8	3.7	0.9	82.0	62.9	95.4	90.9	*
	Euglenophyta	9.0	2.0	11.1									1.3	0.4		0.7	*
	Pyrrhophyta	12.8	30.8	23.1	9.7	24.7	6.8	0.2	5.9	+	1.3	0.4	3.0	1.6			*
	Cyanophyta				13.3	53.8	80.3	99.6	91.5	96.5	94.6	98.5	11.3	11.0	+	0.3	*
	Unidentified	2.5	0.4	0.6		0.6	2.1					0.1	0.1			0.4	
	Total Biomass (mm³/l.)	0.178	0.807	1.53	0.573	0.534	0.755	18.5	22.0	2.60	8.80	46.7	1.48	5.08	5.92	5.53	*
	Bottom Depth (m)	7.0	7.0	*	7.0	9.0	*	7.0	7.0	8.0	6.0	6.0	5.0	5.0	4.0	5.0	*
% Composition	Chlorophyta	6.9	1.8	*	74.9	4.8	12.5	10.5	3.0	1.9	5.8	+	14.8	1.6	0.2	9.2	*
	Chrysophyta	11.7	95.7	*	25.1	93.4	60.8	32.5	5.3	15.5	63.1	0.7	83.4	87.2	95.9	89.4	*
	Euglenophyta		2.1	*								0.2		2.0	0.3		*
	Pyrrhophyta			*										4.7	2.6	0.4	*
	Cyanophyta	81.4	0.2	*		1.7	23.3	56.0	91.2	81.4	30.6	99.0	1.8	4.4	2.6	0.9	*
	Unidentified		0.2			0.1	3.4	1.0	0.5	1.2	0.5			0.1		0.1	*
	Total Biomass (mm³/l.)	0.051	1.50	*	0.110	0.675	0.086	0.519	1.03	0.428	0.631	41.0	2.10	3.23	6.20	6.76	*

* Missing Data.

\+ Present at less than 0.1%.

APPENDIX C continued

Percent composition of algae divisions and phytoplankton volume measurements.

Station 13 1975

	Algae Divison	Date															
		04/30	05/06	05/20	06/03	06/18	06/30	07/15	07/28	08/11	09/03	09/23	10/07	10/21	11/04	11/18	12/18
	Surface (0.5m)																
% Composition	Chlorophyta	11.2	7.6	2.9	32.4	0.5	+	1.2	+	1.3	4.2	14.2	42.7	31.7	6.9	6.5	37.4
	Chrysophyta	43.6	33.4	37.6	+	0.7	+	0.2			1.7	0.9	5.6	37.3	90.0	77.5	28.7
	Euglenophyta		3.0						0.2		0.1	0.4	3.8	0.4	0.4		
	Pyrrhophyta	37.6	55.1	44.2	34.6	0.2	1.9	15.8	+		0.4	1.4	38.4	7.8	1.7	15.5	20.3
	Cyanophyta	6.0	0.4	13.5	33.0	98.5	98.0	82.8	99.7	98.7	93.5	82.9	8.9	22.6	1.0	+	13.6
	Unidentified	1.6	0.5	1.8		0.1				0.2	0.1	0.2	0.6	0.2		0.4	
	Total Biomass (mm^3/l.)	0.123	1.01	3.30	0.513	39.6	41.5	22.1	187.0	1.97	13.7	14.2	4.10	5.49	13.8	1.41	0.140
	Middle Depth (m)	4.0	2.0	4.0	4.0	5.0	*	5.0	4.5	4.0	4.0	4.5	3.5	3.5	3.5	4.0	*
% Composition	Chlorophyta	0.1	12.3	7.5	55.8	23.6	+	24.2	6.0	4.1	5.6	21.0	36.6	47.4	13.2	23.0	*
	Chrysophyta	96.0	21.9	81.4	13.0	4.3		20.2	9.8	1.1	0.6	4.9	27.3	31.2	83.4	26.7	*
	Euglenophyta				5.1								1.6	0.3	0.4	4.2	*
	Pyrrhophyta	3.6	63.8	10.6	15.5	2.4					7.2	2.7	4.3	9.6	1.7	39.6	*
	Cyanophyta		0.4	+	10.6	69.6	99.9	55.0	83.6	94.8	86.6	71.4	30.1	11.4	1.3	4.2	*
	Unidentified	0.4	1.6	0.4		0.1		0.6	0.6				0.1	0.1		2.3	*
	Total Biomass (mm^3/l.)	0.625	1.18	1.54	0.375	1.14	20.4	0.565	0.494	1.47	2.62	6.73	3.89	5.82	10.2	0.458	*
	Bottom Depth (m)	9.0	5.0	7.0	8.0	10.0	*	10.0	*	*	8.0	9.0	7.0	7.0	7.0	8.0	*
% Composition	Chlorophyta	8.4	4.2	15.4	4.6	4.5	2.8	10.9	*	*	11.1	13.4	58.6	24.8	9.6	49.6	*
	Chrysophyta	38.6	91.7	77.2	62.4	31.0	8.5	10.5	*	*	11.6	4.1	30.5	39.6	86.3	12.3	*
	Euglenophyta	22.0		2.8					*	*	1.1	1.5	0.6			2.1	*
	Pyrrhophyta	31.0	3.5	3.4	0.4			50.0	*	*	3.0	5.9	5.1	7.5	3.8	29.6	*
	Cyanophyta		0.3	0.9	32.6	64.4	88.0	28.4	*	*	73.1	75.0	5.1	28.0	0.3	4.5	*
	Unidentified		0.3	0.3		0.1	0.7	0.2	*		0.1	0.1	0.1	0.1		1.9	
	Total Biomass (mm^3/l.)	0.145	1.29	0.520	1.24	1.52	0.635	1.28	*	*	3.98	4.20	3.11	3.44	12.3	0.456	*

* Missing Data.

+ Present at less than 0.1%.

APPENDIX C continued

Percent composition of algae divisions and phytoplankton volume measurements.

	Algae Division	01/06	01/20	02/03	02/16	03/04	04/13	Date 1976 04/26	05/10	05/24	06/08	06/21	07/08	07/20	08/02	08/17	08/30
								Site 23 Surface (0.5m)									
% Composition	Chlorophyta	1.6	No	38.0	58.4	98.9	21.4	23.9	4.4	24.9	0.8	0.2	+	1.0	0.3	6.8	6.0
	Chrysophyta	46.5	Algae			0.2	11.7	60.8	81.7	57.7		+	+	4.0	0.1	9.2	4.7
	Euglenophyta		Observed		37.2			0.8			0.2					0.6	1.9
	Pyrrhophyta	51.5		48.4		0.8	40.5	13.7	12.1	14.4	3.4	+		0.4	0.1	0.5	1.8
	Cyanophyta	0.4		13.6	1.5	+	22.8	0.2	1.6	2.9	95.4	99.7	99.8	94.6	99.4	82.9	85.6
	Unidentified				2.9		3.6	0.6	0.2	0.1	0.2						
	Total Biomass (mm3/l)	0.056	0.000	0.085	0.051	0.954	0.149	2.19	5.44	2.22	11.4	91.7	34.8	68.8	22.3	29.3	33.7
								Site 16 Surface (0.5m)									
% Composition	Chlorophyta	7.4	8.7	93.7	83.5	63.8	47.9	8.9	8.8	4.7	0.4	0.2	+	0.3	0.6	4.7	11.5
	Chrysophyta	2.2		0.6	6.4	34.2	8.9	55.1	75.5	80.5	1.2	1.2	+	0.2		4.9	6.1
	Euglenophyta	7.9					16.2			0.4							0.4
	Pyrrhophyta	76.0	89.6	3.0	4.1		23.7	35.3	8.6	2.8	2.4	3.0	+		0.4	+	19.2
	Cyanophyta		1.6	0.6	6.0	2.0	1.4	+	6.5	11.4	96.0	95.6	99.8	99.5	99.0	90.3	62.7
	Unidentified	6.5	0.1	2.1			1.9	0.6	0.2								0.1
	Total Biomass (mm3/l)	0.802	0.180	0.810	2.54	0.139	0.117	2.64	5.41	2.08	23.3	92.4	119.0	51.9	70.4	18.5	21.9
								Site 13 Surface (0.5m)									
% Composition	Chlorophyta	68.6	11.6	16.9	86.7	*	73.2	15.7	15.3	1.9	0.6	*	2.4	0.3	0.3	9.2	13.8
	Chrysophyta		1.5		2.3	*	1.4	56.2	80.2	93.4	0.8	*		15.2			
	Euglenophyta		73.4			*			0.9			*			0.6	0.9	
	Pyrrhophyta	17.4	12.6	75.7	4.0	*	23.3	28.0	3.0	4.4	0.5	*			5.3		
	Cyanophyta	7.3		4.7	7.0	*	1.1		0.3	0.2	98.1	*	97.6	84.5	93.8	89.9	86.2
	Unidentified	6.7	0.9	2.7			1.0	0.1	0.3	0.1							
	Total Biomass (mm3/l)	0.080	0.231	0.246	0.073	*	1.83	1.22	6.69	6.22	14.1	*	120.0	60.0	152.0	36.5	61.3

* Missing Data.
\+ Present at less than 0.1%.

APPENDIX C continued

Percent composition of algae divisions and phytoplankton volume measurements.

	Algae Division	Date 09/22	 10/06	 10/25	1976 11/21	 12/06	 12/20	 01/04	1977 01/18	 02/15	 03/01	 04/11
						Site 23	Surface (0.5m)					
% Composition	Chlorophyta	3.2	16.2	27.5	*	6.4	26.4	5.0	22.3	15.3	*	30.0
	Chrysophyta		59.3	54.0	*	22.0	10.9	10.6	3.7	16.1	*	
	Euglenophyta			0.5	*	7.3	4.5	38.4	3.2		*	
	Pyrrhophyta	0.2	0.5	1.8	*	58.9	48.7	30.0	52.1		*	68.1
	Cyanophyta	96.5	23.8	16.2	*	5.2	8.4	15.5	15.1	66.4	*	1.0
	Unidentified	0.1	0.2	—	—	0.2	1.1	0.6	3.6	2.2	—	0.9
	Total Biomass (mm^3/l)	51.2	5.10	4.10	*	2.60	0.837	0.830	1.17	0.653	*	9.20
						Site 16	Surface (0.5m)					
% Composition	Chlorophyta	3.7	27.2	11.4	33.2	28.8	11.1	19.9	1.4		*	22.5
	Chrysophyta	+	25.8	76.5	0.4	25.7	35.8	9.1	1.7		*	29.6
	Euglenophyta		0.8	1.6	7.1	1.6	8.1	5.3	6.1		*	22.9
	Pyrrhophyta		2.7	2.5	56.7	41.7	41.7	57.0	81.9		*	20.4
	Cyanophyta	96.1	43.5	7.9	2.2	1.8	2.6	8.0	6.2	100.0	*	0.8
	Unidentified	0.2	—	0.1	0.4	0.4	0.7	0.7	2.7	—	—	3.8
	Total Biomass (mm^3/l)	19.5	8.92	6.64	4.43	6.51	1.58	1.18	6.24	0.442	*	2.88
						Site 13	Surface (0.5m)					
% Composition	Chlorophyta	20.8	18.5	7.6	9.9	19.4	16.7	13.5	Sample Too Turbid To Count	*		52.7
	Chrysophyta	0.8	33.5	51.1	62.9	40.5	19.4	10.6		*		14.1
	Euglenophyta	5.2	7.0	5.2	5.4	7.1		24.0		*		2.7
	Pyrrhophyta	3.5	6.3	1.8	18.7	29.5	61.4	39.8		*	0.1	28.8
	Cyanophyta	69.6	34.2	34.2	1.4	0.8		8.7		*	99.8	0.3
	Unidentified	0.1	0.5	0.1	1.7	2.7	2.5	3.4	—	—	0.1	1.4
	Total Biomass (mm^3/l)	16.0	11.8	18.3	11.8	8.96	9.33	8.30		*	5.85	1.80

* Missing Data.
+ Present at less than 0.1%.

APPENDIX C continued

Percent composition of algae divisions and phytoplankton volume measurements.

		Date						
	Algae Division		1976				1977	
		11/21	12/06	12/20	01/04	01/18	02/15	03/01
	Site 20 Surface (0.5m)							
% Composition	Chlorophyta	23.0	27.4	26.2	6.2	3.9	11.1	2.3
	Chrysophyta	41.9	20.0	0.3	1.4	2.8	0.7	
	Euglenophyta	8.1	19.1	1.3	7.6	9.5		2.1
	Pyrrhophyta	14.6	28.4	67.0	74.1	71.4	52.1	90.1
	Cyanophyta	11.7	4.5	4.8	6.6	10.0	36.1	5.3
	Unidentified	0.7	0.6	0.4	4.1	2.4	____	0.2
	Total Biomass (mm^3/l.)	1.02	1.21	1.48	1.38	1.35	11.6	5.26
	Site 14 Surface (0.5m)							
% Composition	Chlorophyta	*	8.5	26.1	23.7	44.4	3.2	*
	Chrysophyta	*	80.4	43.4	15.3	3.2	4.0	*
	Euglenophyta	*	3.6	1.9				*
	Pyrrhophyta	*	5.9	26.7	58.6	27.7	5.2	*
	Cyanophyta	*	1.4	1.1	0.4	12.4	87.6	*
	Unidentified	—	0.2	0.8	2.0	12.3	____	*
	Total Biomass (mm^3/l.)	*	2.67	1.96	10.7	3.29	2.59	*

* Missing Data

APPENDIX D

Chlorophyll *a* data.

Chlorophyll *a* (ug/l)

Date	Depth (m)	Site Location												Mean	S.D.
		6	12	13	14	16	18	19	20	22	23	24	26		
06/03/75	0.5	-	1.5	-	1.8	2.1	-	-	-	1.2	0.8	-	-	1.5	0.5
	M*	-	-	-	-	0.4	-	-	-	-	0.4	-	-	0.4	0.0
	B*	-	-	-	-	0.3	-	-	-	-	0.3	-	-	0.3	0.0
06/17/75	0.5	-	-	-	-	-	-	9.4	-	-	4.0	-	-	6.7	3.8
	1.0	-	-	-	-	-	-	5.8	-	-	5.0	-	-	5.4	0.6
	3.0	-	-	-	-	-	-	2.2	-	-	1.6	-	-	1.9	0.4
	5.0	-	-	-	-	-	-	1.4	-	-	1.6	-	-	1.5	0.1
06/18/75	0.5	-	71.4	24.7	14.5	2.5	-	-	-	4.6	7.1	4.5	-	18.5	24.6
	M*	-	-	1.3	3.5	1.2	-	-	-	-	1.3	-	-	1.8	1.1
	B*	-	-	-	2.2	-	-	-	-	-	0.9	-	-	1.6	0.9
06/30/75	0.5	1.3	77.7	78.6	2.4	-	-	-	-	12.8	14.2	15.1	-	28.9	34.1
	M*	-	-	25.7	31.3	2.0	-	-	-	-	1.8	-	-	15.2	15.5
	B*	-	-	45.0	2.4	0.7	-	-	-	-	1.0	-	-	12.3	21.8
07/10/75	0.5	-	-	-	-	-	-	61.9	-	-	35.5	-	-	48.7	18.7
	1.0	-	-	-	-	-	-	52.6	-	-	37.3	-	-	45.0	10.8
	2.0	-	-	-	-	-	-	43.8	-	-	36.3	-	-	40.0	5.3
	4.0	-	-	-	-	-	-	45.4	-	-	36.8	-	-	41.1	6.1
07/22/75	0.5	-	-	-	-	-	-	-	-	-	33.0	-	-		
	1.0	-	-	-	-	-	-	-	-	-	41.0	-	-		
	2.0	-	-	-	-	-	-	-	-	-	35.4	-	-		
	3.0	-	-	-	-	-	-	-	-	-	38.3	-	-		
07/28/75	0.5	-	359.2	179.1	164.6	86.0	-	-	-	59.6	110.0	124.2	-	154.7	99.3
	M*	-	-	6.3	78.6	44.2	-	-	-	-	67.0	-	-	49.0	31.9
08/05/75	0.0	-	-	-	-	-	-	138.1	-	-	94.0	-	-	116.0	31.2
	0.5	-	-	-	-	-	-	145.6	-	-	101.3	-	-	123.4	31.3
	1.0	-	-	-	-	-	-	134.2	-	-	70.6	-	-	102.4	44.8
	2.0	-	-	-	-	-	-	103.1	-	-	77.1	-	-	90.4	18.0
	3.0	-	-	-	-	-	-	94.8	-	-	77.5	-	-	86.2	12.2
09/03/75	0.5	-	70.0	41.7	20.4	29.1	-	-	-	-	17.5	26.4	-	34.2	19.5
	M*	-	-	21.6	23.5	10.7	-	-	-	-	15.4	-	-	17.8	5.9
	B*	-	-	26.1	27.0	3.4	-	-	-	-	8.5	-	-	16.2	12.1
09/09/75	0.5	-	68.6	180.4	86.1	52.2	-	-	-	50.0	67.5	40.9	-	78.0	47.6
	M*	-	-	74.1	28.9	50.5	-	-	-	-	49.2	-	-	50.7	18.4
	B*	-	-	19.5	-	-	-	-	-	-	12.8	-	-	16.2	4.7
09/23/75	0.5	-	26.2	23.2	33.2	104.8	-	-	-	36.0	47.0	43.3	-	44.8	27.8
	M*	-	-	27.4	35.0	55.0	-	-	-	-	45.7	-	-	40.8	12.1
	B*	-	-	23.1	19.4	51.2	-	-	-	-	46.1	-	-	35.0	16.0
10/07/75	0.5	-	7.8	8.4	36.9	13.0	-	-	-	6.1	18.9	94.0	-	26.4	31.6
	M*	-	-	6.4	32.4	12.7	-	-	-	-	17.2	-	-	17.2	11.1
	B*	-	-	11.2	18.8	7.1	-	-	-	-	13.3	-	-	12.6	4.9

*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

APPENDIX D continued

Chlorophyll a data.

Chlorophyll a (ug/l)

Date	Depth (m)					Site Location								Mean	S.D.
		6	12	13	14	16	18	19	20	22	23	24	26		
10/16/75	0.0	-	-	-	-	-	-	-	-	-	29.1	-	-		
	0.5	-	-	-	-	34.5	-	31.6	-	-	19.8	-	-	28.6	7.8
	1.0	-	-	-	-	-	-	-	-	-	30.4	-	-		
	2.0	-	-	-	-	-	-	-	-	-	21.3	-	-		
	3.0	-	-	-	-	-	-	-	-	-	22.4	-	-		
10/21/75	0.5	-	23.9	28.6	23.6	36.8	-	-	-	23.5	30.2	27.1	-	27.8	4.8
	M*	-	-	29.0	33.6	-	-	-	-	-	29.5	-	-	30.7	2.5
	B*	-	-	31.8	33.6	32.1	-	-	-	-	20.2	-	-	29.4	6.2
11/04/75	0.5	-	33.5	42.1	57.0	-	-	-	-	53.2	51.8	47.3	-	47.8	7.9
	M*	-	-	40.0	54.5	50.4	-	-	-	-	53.2	-	-	49.5	6.6
	B*	-	-	41.1	64.4	48.6	-	-	-	-	48.5	-	-	50.6	9.8
11/14/75	0.5	-	-	-	-	29.2	-	38.7	-	-	22.1	-	-	30.0	8.3
	1.0	-	-	-	-	-	-	-	-	-	23.3	-	-		
	2.0	-	-	-	-	-	-	-	-	-	22.0	-	-		
	3.0	-	-	-	-	-	-	-	-	-	19.8	-	-		
	4.0	-	-	-	-	-	-	-	-	-	29.0	-	-		
11/18/75	0.5	-	6.0	7.4	33.0	27.8	-	-	-	17.2	17.7	15.3	-	17.8	9.9
	M*	-	-	7.2	16.8	31.2	-	-	-	-	20.6	-	-	18.9	5.3
	B*	-	-	6.6	15.4	30.4	-	-	-	-	29.9	-	-	20.6	11.6
12/18/75	0.5	-	-	3.4	5.9	24.4	-	-	4.0	-	-	-	-	9.4	10.0
	M*	-	-	5.1	-	1.4	-	-	-	-	-	-	-	3.2	2.6
	B*	-	-	5.6	-	2.6	-	-	3.1	-	-	-	-	3.8	1.6
01/05/76	0.5	-	-	-	-	-	-	-	10.4	-	-	-	-		
	2.0	-	-	-	-	-	-	-	2.8	-	-	-	-		
	4.0	-	-	-	-	-	-	-	1.6	-	-	-	-		
	6.0	-	-	-	-	-	-	-	2.7	-	-	-	-		
01/06/76	0.5	-	7.5	1.0	2.7	17.1	-	-	7.8	-	-	-	8.3	7.4	5.6
	M*	-	-	2.6	1.0	1.7	-	-	-	-	-	-	-	1.8	0.8
	B*	-	-	2.2	1.3	2.9	-	-	-	-	-	-	-	2.1	0.8
01/20/76	0.5	-	1.5	2.9	3.1	5.6	-	-	-	-	2.6	-	-	3.1	1.5
	M*	-	-	0.8	1.5	0.8	-	-	-	-	1.2	-	-	1.1	0.3
	B	-	-	2.7	0.9	1.3	-	-	-	-	0.8	-	-	1.4	0.9
02/03/76	0.5	-	-	1.1	3.6	0.8	-	-	-	-	-	-	-	1.8	1.5
	M*	-	-	1.5	-	-	-	-	-	-	-	-	-		
	B*	-	-	0.8	2.4	2.4	-	-	-	-	-	-	-	1.9	0.9
02/04/76	0.5	-	-	-	-	-	-	-	2.0	-	1.6	-	-	1.8	0.3
	M*	-	-	-	-	-	-	-	-	-	0.8	-	-		
	B*	-	-	-	-	-	-	-	-	-	6.6	-	-		
02/16/76	0.5	-	0.8	4.3	1.5	-	-	-	-	-	-	-	-	2.2	1.8
	M*	-	-	2.3	-	-	-	-	-	-	-	-	-		
	B*	-	-	-	2.0	-	-	-	-	-	-	-	-		

*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

APPENDIX D continued

Chlorophyll a data.

Date	Depth (m)	Chlorophyll a (ug/l) Site Location												Mean	S.D.
		6	12	13	14	16	18	19	20	22	23	24	26		
02/17/76	0.5	-	-	-	-	5.7	-	-	-	-	2.6	-	-	4.2	2.2
	M*	-	-	-	-	-	-	-	-	-	0.9	-	-		
	B*	-	-	-	-	1.5	-	-	-	-	0.8	-	-	1.2	0.5
03/04/76	0.5	-	4.9	5.0	-	5.7	-	-	4.5	-	6.6	-	-	5.3	0.8
	B	-	-	5.9	-	-	-	-	4.8	-	2.2	-	-	4.3	1.9
03/15/76	0.5	-	12.0	4.2	-	14.1	-	-	-	-	5.6	-	5.8	8.3	4.4
04/05/76	0.0	-	-	1.6	-	-	-	-	1.9	-	-	-	-	1.8	0.2
	4.0	-	-	1.6	-	-	-	-	1.2	-	-	-	-	1.4	0.3
04/26/76	0.5	-	8.2	5.4	15.9	8.9	-	-	-	8.6	3.5	9.1	-	8.5	3.8
	M*	-	-	7.2	16.0	18.1	-	-	-	-	9.3	-	-	12.6	5.2
	B*	-	-	9.0	13.9	18.9	-	-	-	-	9.2	-	-	12.8	4.7
04/13/76	0.5	-	9.4	2.7	3.4	1.1	-	-	-	-	1.2	2.5	-	3.4	3.1
	M*	-	-	2.0	3.3	2.2	-	-	-	-	2.5	-	-	2.5	0.6
	B*	-	-	2.8	2.3	2.2	-	-	-	-	2.2	-	-	2.4	0.3
04/27/76	0.5	-	-	-	19.4	23.9	-	23.8	-	-	20.2	-	-	21.8	2.4
	1.0	-	-	-	-	-	-	-	-	-	17.6	-	-		
	2.0	-	-	-	-	-	-	-	-	-	16.6	-	-		
	3.0	-	-	-	-	-	-	-	-	-	18.9	-	-		
	5.0	-	-	-	-	-	-	-	-	-	17.8	-	-		
05/10/76	0.5	-	37.1	21.5	-	15.8	-	-	-	39.4	20.6	-	-	26.7	10.6
	M*	-	-	20.2	-	27.6	-	-	-	-	30.7	-	-	26.2	5.4
	B*	-		20.3	-	27.5	-	-	-	-	31.2	-	-	26.3	5.4
05/14/76	0.0	-	-	-	-	-	-	-	-	-	23.8	-	-		
	0.5	-	-	-	33.3	28.0	-	26.3	22.8	-	31.2	-	-	28.3	4.1
	1.0	-	-	-	-	-	-	-	-	-	27.3	-	-		
	1.5	-	-	-	-	-	-	-	-	-	28.9	-	-		
	2.0	-	-	-	-	-	-	-	-	-	37.3	-	-		
	3.0	-	-	-	-	-	-	-	-	-	33.7	-	-		
	5.0	-	-	-	-	-	-	-	-	-	25.0	-	-		
05/24/76	0.5	-	13.5	12.1	11.6	5.3	-	-	6.7	7.4	3.5	6.9	-	8.4	3.6
	M*	-	-	31.3	15.1	6.5	-	-	22.7	-	13.6	-	-	17.8	9.5
	B*	-	-	47.1	22.6	40.1	-	-	29.3	-	36.6	-	-	35.1	9.5
05/26/76	0.0	-	-	-	-	3.0	-	5.7	6.4	-	6.4	-	-	5.4	1.6
	0.5	-	-	-	-	-	-	-	-	-	3.7	-	-		
	1.0	-	-	-	-	-	-	-	-	-	4.7	-	-		
	1.5	-	-	-	-	-	-	-	-	-	7.7	-	-		
	2.0	-	-	-	-	-	-	-	-	-	6.4	-	-		
	3.0	-	-	-	-	-	-	-	-	-	8.1	-	-		
	5.0	-	-	-	-	-	-	-	-	-	3.2	-	-		

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*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

APPENDIX D continued

Chlorophyll a data.

		Chlorophyll a (ug/l)													
Date	Depth (m)	Site Location												Mean	S.D.
		6	12	13	14	16	18	19	20	22	23	24	26		
06/08/76	0.5	-	49.0	56.8	29.4	22.6	29.3	-	52.8	23.4	10.5	19.1	-	32.5	16.4
	M*	-	-	2.1	17.4	21.4	-	-	2.1	-	17.4	-	-	12.1	9.2
	B*	-	-	-	2.7	3.6	3.6	-	3.7	-	2.0	-	-	3.1	0.7
06/09/76	0.0	-	-	-	39.3	43.5	-	51.3	59.0	-	22.2	-	-	43.1	13.9
	0.5	-	-	-	-	-	-	-	-	-	24.2	-	-		
	1.0	-	-	-	-	-	-	-	-	-	24.5	-	-		
	1.5	-	-	-	-	-	-	-	-	-	22.0	-	-		
	2.0	-	-	-	-	-	-	-	-	-	24.6	-	-		
	3.0	-	-	-	-	-	-	-	-	-	18.7	-	-		
	5.0	-	-	-	-	-	-	-	-	-	5.0	-	-		
06/21/76	0.5	10.4	57.4	288.0	92.5	125.4	48.2	-	-	84.7	120.9	141.9	-	107.8	79.4
	M*	-	-	18.3	25.2	13.6	-	-	-	-	9.5	-	-	16.7	6.7
	B*	-	-	21.3	25.5	10.6	-	-	-	-	10.9	-	-	17.1	7.5
06/30/76	0.5	-	-	-	-	-	-	-	-	-	105.9	-	-		
	1.0	-	-	-	-	-	-	-	-	-	116.4	-	-		
	1.5	-	-	-	-	-	-	-	-	-	109.0	-	-		
	2.0	-	-	-	-	-	-	-	-	-	98.1	-	-		
	3.0	-	-	-	-	-	-	-	-	-	104.4	-	-		
	5.0	-	-	-	-	-	-	-	-	-	72.4	-	-		
07/06/76	0.5	10.3	177.2	197.4	264.5	181.5	-	-	-	-	-	-	-	166.2	93.9
	M*	-	-	9.6	21.3	13.2	-	-	-	-	-	-	-	14.7	6.0
	B*	-	-	9.6	8.1	8.9	-	-	-	-	-	-	-	8.9	0.8
07/08/76	0.0	-	-	-	71.3	101.8	92.7	152.1	97.5	90.4	90.3	85.7	-	97.7	23.8
	M*	-	-	-	-	-	-	-	8.5	-	-	-	-		
	B*	-	-	-	-	-	-	-	7.8	-	-	-	-		
	0.5	-	-	-	-	-	-	-	-	-	110.8	-	-		
	1.0	-	-	-	-	-	-	-	-	-	100.9	-	-		
	2.0	-	-	-	-	-	-	-	-	-	90.9	-	-		
	3.0	-	-	-	-	-	-	-	-	-	34.6	-	-		
	5.0	-	-	-	-	-	-	-	-	-	7.8	-	-		
07/20/76	0.5	-	132.8	119.6	130.6	51.7	102.0	-	84.6	112.1	115.1	116.9	-	107.3	25.4
	M*	-	-	41.2	59.5	22.1	-	-	44.2	-	62.9	-	-	46.0	16.3
	B*	-	-	29.2	38.4	14.4	-	-	27.3	-	54.0	-	-	32.7	14.7
07/27/76	0.0	-	-	-	151.7	179.9	-	149.9	-	-	114.2	-	-	148.9	26.9
	0.5	-	-	-	-	-	-	-	-	-	128.5	-	-		
	1.0	-	-	-	-	-	-	-	-	-	145.0	-	-		
	1.5	-	-	-	-	-	-	-	-	-	136.8	-	-		
	2.0	-	-	-	-	-	-	-	-	-	118.7	-	-		
	3.0	-	-	-	-	-	-	-	-	-	102.5	-	-		
	5.0	-	-	-	-	-	-	-	-	-	23.3	-	-		

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*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

APPENDIX D continued

Chlorophyll a data.

Date	Depth (m)	Chlorophyll a (ug/l) Site Location 6	12	13	14	16	18	19	20	22	23	24	26	Mean	S.D.
08/02/76	0.5	-	122.2	210.6	91.2	122.9	85.2	-	145.1	131.9	111.7	110.3	-	125.7	36.9
	M*	-	-	41.9	77.9	84.1	-	-	34.8	-	110.8	-	-	69.9	31.4
	B*	-	-	44.1	39.9	14.4	81.9	-	38.3	-	18.0	-	-	39.4	24.1
08/09/76	0.0	-	-	-	180.7	129.8	-	132.3	87.4	-	103.9	-	-	126.8	35.4
	0.5	-	-	-	-	-	-	-	-	-	114.5	-	-		
	1.0	-	-	-	-	-	-	-	-	-	110.3	-	-		
	1.5	-	-	-	-	-	-	-	-	-	62.1	-	-		
	2.0	-	-	-	-	-	-	-	-	-	50.9	-	-		
	3.0	-	-	-	-	-	-	-	-	-	27.9	-	-		
	5.0	-	-	-	-	-	-	-	-	-	20.4	-	-		
08/17/76	0.5	-	120.7	807.1	240.7	25.2	143.4	-	68.1	49.6	54.2	71.2	-	96.5	69.7
	M*	-	-	39.9	104.5	23.4	-	-	17.7	-	57.5	-	-	48.6	34.9
	B*	-	-	36.4	56.3	29.5	152.6	-	17.2	-	20.5	-	-	52.1	51.2
08/29/76	0.0	-	-	-	80.0	99.0	-	73.0	68.4	-	59.6	-	-	76.0	14.8
	0.5	-	-	-	-	-	-	-	-	-	74.0	-	-		
	1.0	-	-	-	-	-	-	-	-	-	55.8	-	-		
	1.5	-	-	-	-	-	-	-	-	-	54.9	-	-		
	2.0	-	-	-	-	-	-	-	-	-	51.5	-	-		
	3.0	-	-	-	-	-	-	-	-	-	52.8	-	-		
	5.0	-	-	-	-	-	-	-	-	-	47.4	-	-		
08/30/76	0.5	-	187.4	128.9	96.4	52.9	-	-	86.5	90.9	89.7	96.6	-	103.7	39.6
	M*	-	-	52.3	90.8	53.0	-	-	25.4	-	83.0	-	-	60.9	26.4
	B*	-	-	24.9	83.2	48.2	-	-	42.0	-	56.4	-	-	50.9	21.4
09/22/76	0.5	-	121.2	109.6	85.9	88.9	-	-	128.5	145.1	153.0	-	134.3	120.8	24.6
	M*	-	-	104.1	81.2	82.0	-	-	125.9	-	145.1	-	-	107.7	27.9
	B*	-	-	111.3	-	78.7	-	-	95.7	-	152.5	-	-	109.6	31.6
09/24/76	0.0	-	-	-	78.6	84.3	-	108.7	104.6	-	116.0	-	-	98.4	16.2
	0.5	-	-	-	-	-	-	-	-	-	116.2	-	-		
	1.0	-	-	-	-	-	-	-	-	-	105.6	-	-		
	1.5	-	-	-	-	-	-	-	-	-	110.8	-	-		
	2.0	-	-	-	-	-	-	-	-	-	114.2	-	-		
	3.0	-	-	-	-	-	-	-	-	-	102.2	-	-		
	5.0	-	-	-	-	-	-	-	-	-	94.2	-	-		
10/06/76	0.5	-	-	95.9	65.7	75.0	-	-	62.6	62.2	65.5	-	-	71.8	12.5
	M*	-	-	124.0	60.7	82.2	-	-	69.0	-	57.6	-	-	73.7	27.0
	B*	-	-		50.8	79.4	-	-	74.5	-	61.1	-	-	66.4	13.0

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*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

APPENDIX D continued

Chlorophyll a data.

Date	Depth (m)	Chlorophyll a (ug/l) Site Location 6	12	13	14	16	18	19	20	22	23	24	26	Mean	S.D.
10/22/76	0.0	-	-	-	53.2	58.7	-	59.6	49.6	-	55.8	-	-	55.4	4.1
	0.5	-	-	-	-	-	-	-	-	-	53.3	-	-		
	1.0	-	-	-	-	-	-	-	-	-	52.8	-	-		
	1.5	-	-	-	-	-	-	-	-	-	59.1	-	-		
	2.0	-	-	-	-	-	-	-	-	-	53.1	-	-		
	3.0	-	-	-	-	-	-	-	-	-	56.2	-	-		
	5.0	-	-	-	-	-	-	-	-	-	52.7	-	-		
10/25/76	0.5	-	-	36.9	40.8	38.8	-	-	44.3	37.6	43.3	-	-	40.3	3.0
	M*	-	-	33.3	-	38.7	-	-	48.2	-	40.1	-	-	40.1	6.2
	B*	-	-	30.8	35.9	38.8	-	-	46.1	-	47.9	-	-	39.9	7.1
11/21/76	0.5	-	-	+	-	+	-	-	+	-	-	-	-	38.4+	
11/21/76	0.5	-	-	82.0	-	79.4	-	-	13.4	-	-	-	-	58.3	38.9
12/06/76	0.5	-	-	+	-	+	-	-	+	-	-	-	-	55.7+	
12/06/76	0.5	37.1	-	84.5	33.2	50.2	-	-	22.0	-	16.5	-	-	40.6	24.5
12/11/76	0.5	-	-	+	-	+	-		+	-	-	-	-	18.6+	
12/20/76	0.5	1.4	-	2.5	25.5	24.5	-	-	28.4	13.2	15.6	-	-	18.3	9.7
12/20/76	0.5	-	-	+	-	+	-	-	-	-	+	-		20.7+	
01/04/77	0.5	-	-	+	-	-	-	-	+	-	+	-	-	18.5+	
01/04/77	0.5	-	-	69.5	27.4	16.6	-	23.8	37.6	17.5	12.1	27.1	-	29.0	18.4
01/05/77	0.5	9.4	49.8	-	-	-	-	-	-	-	-	-	-	29.6	
01/13/77	0.5	-	-	-	-	+	-	-	+	-	+	-	-	14.0+	28.6
01/18/77	0.5	-	-	42.5	159.6	81.0	-	-	21.7	17.8	17.9	-	-	56.8	55.9
01/28/77	0.5	-	-	-	-	-	-	-	46.1	-	-	-	-		
02/04/77	0.5	-	-	-	-	-	-	-	61.8	-	-	-	-		
02/09/77	0.5	-	-	-	-	-	-	-	60.6	-	-	-	-		
02/15/77	0.5	-	-	12.8	7.5	8.9	-	-	111.9	-	19.0	-	-		
		-	-	4.5	8.1	5.9	-	-	103.5	-	16.6	-	-		
TRIPLICATE SAMPLING		-	-	2.3	10.3	9.2	-	-	124.5	-	14.4	-	-		
			Mean	6.5	8.6	8.0			113.3		16.7			30.6	43.2
			S.D.	5.5	1.5	1.8			10.6		2.3				
02/17/77	0.5	-	-	-	-	-	-	-	130.8	-	-	-	-		

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*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.

+ Composite sample.

APPENDIX D continued

Chlorophyll a data.

Date	Depth (m)	Chlorophyll a (ug/l) Site Location												Mean	S.D.
		6	12	13	14	16	18	19	20	22	23	24	26		
02/18/77	0.0	-	-	-	-	-	-	-	88.5	-	-	-	-		
	1.0	-	-	-	-	-	-	-	7.9	-	-	-	-		
03/01/77	0.5	-	-	2.8	-	-	-	-	26.8	-	-	-	-	14.8	16.9
03/02/77	0.5	-	-	0.8	-	-	-	-	21.9	-	-	-	-	11.4	14.9
03/05/77		-	-	-	-	-	-	-	190.9	-	-	-	-		
		-	-	-	-	-	-	-	174.9	-	-	-	-		
TRIPLICATE SAMPLING		-	-	-	-	-	-	-	200.3	-	-	-	-		
								Mean	188.7						
								S.D.	12.8						
04/11/77	0.5	-	-	14.5	9.8	15.7	-	-	21.3	-	60.7	-	-	24.4	20.7
	M*	-	-	9.8	-	15.2	-	-	21.0	-	38.5	-	-	21.1	12.4
04/28/77	0.5	-	-	41.0	35.5	26.9	-	-	28.0	37.6	35.4	33.6	-	34.0	5.0
	M*	-	-	29.7	-		-	-	55.8	32.6	75.2	-	-	48.3	21.4

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*M = middle depth. B = one meter above bottom. These samples and the surface sample (0.5m) were collected by the Environmental Task Force, University of Wisconsin-Stevens Point.