TROPHIC STATUS & ASSESSMENT OF NON-POINT NUTRIENT ENRICHMENT OF LAKE CRESCENT OLYMPIC NATIONAL PARK

Technical Report NPS/PNRWR/NRTR-91/01

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United States Department of the Interior

National Park Service

Pacific Northwest Region

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Excutive Summary

A limited effort study was conducted in Lake Crescent, Olympic National Park to determine the trophic status and assess whether non-point nutrients were leaching into the lake and affecting biological resources. The concentration of chlorophyll *a*, total nitrogen concentration, and Secchi disk transparency used as paramenters of the Trophic Status Index revealed that Lake Crescent in Olympic National Park was in the oligotrophic range. Evualation of the nitrogen to phosphorus ratio revealed that nitrogen was the nutrient limiting to overall lake productivity. Single species and community bioassays indicated that other nutrients, possibly iron, had some secondary control over community composition of the algal community. Assessment of six near-shore sites for the presence and effects of non-point nutrients revealed that La Poel Point which formerly was the site of a resort had slightly higher algal bioassay and periphyton response than the other sites. No conditions that would require immediate action by resource management of Olympic National Park were identified. The general recommendations for a long term lake monitoring plan are discussed.

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INTRODUCTION

Management of natural resources in the National Park System is dependent on adequate information assessing their status. As part of the National Park Service's 1987 stated Inventory and Monitoring Policy, individual parks are mandated to collect basic information on the characterization of natural resources under their stewardship and are charged with the responsibility to monitor those resources in perpetuity. Olympic National Park has identified Lake Crescent as one of the foremost resources in the Park and outlined concerns as to potential impacts (OLYM, 1984). Two of the concerns elaborated by the report are the determination of the trophic status of the lake as baseline information for potential future comparisons and identification of several sites where non-point nutrient additions might be a problem. Preliminary data indicates that the lake is extremely transparent, indicating oligotrophic conditions. Kemmerer *et al* (1923) and Pierce (1984) listed Secchi disc readings of 17.5 m and 18.3 m respectively. The limited water quality data base information available indicates extremely low values for dissolved nutrients (Pierce, 1984).

This report covers an initial study conducted during 1986 and 1987 addressing the natural resource concerns expressed by the Park. The specific objectives of the study were: 1) to determine the current trophic status of Lake Crescent as baseline data to assess future change, and, 2) to assess potential impacts of several non-point sources of nutrients.

METHODS

Study sites:

Lake Crescent has a surface area of 2075 ha, a maximum depth of 189 m, and a mean depth of 92 m. It has an estimated watershed area of 12,127 ha of which 11,067 ha (91%) is within Olympic National Park (Pierce, 1984). Two open water sites called Maple Point and Devil Point, located approximately in the center of two main basins were chosen for depth integrated study of key variables to evaluate the trophic status of the lake. Six near-shore sites were chosen by park personnel for assessment of potential non-point nutrient additions based on high commercial and visitor use.

Water Samples:

Water samples were taken five times in 1986 and six times in 1987, at monthly intervals beginning in June. At the open water sites, Maple Point (MPT) and Devil Point (DPT), the euphotic zone was estimated to be twice Secchi disc depth (Walker, 1980) and the water column was sampled with a Van Dorn bottle at ten equal intervals to the depth of the euphotic zone. At the six near-shore sites at Log Cabin (LOG), Barnes Point (BPT), Lapoel (LAP), Fairholm (FHO), Punchbowl Tunnel(PBT), and Devil Point Bridge (DBP), water samples were taken at 4.0 m. (Figure 1). Water temperature, pH, and dissolved oxygen were measured on each of the samples in the field. The water samples taken from the different depths were analyzed by the Cooperative Chemical Analytical Laboratory (CCAL), Corvallis, Oregon for total phosphorus, total

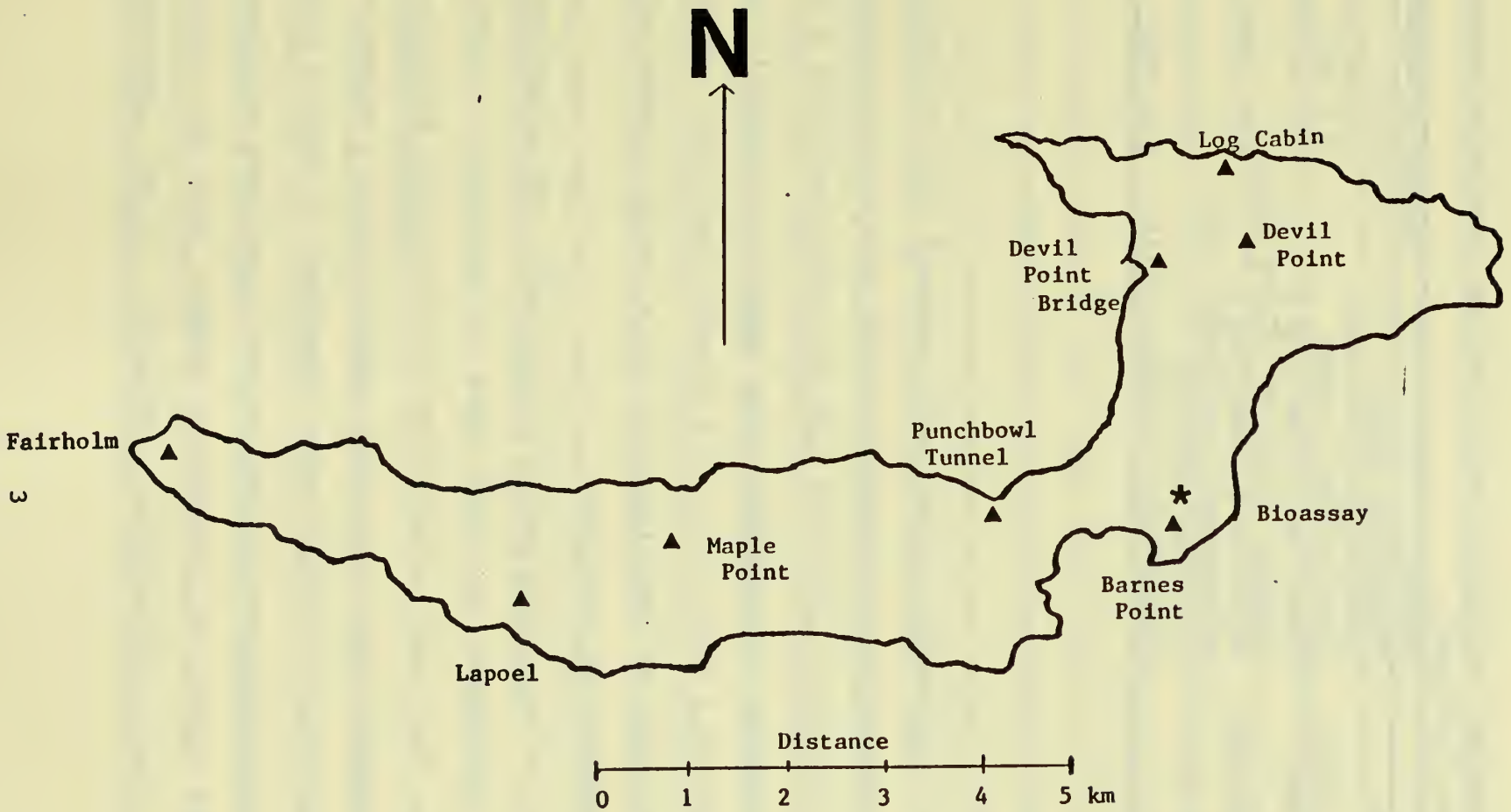

Figure 1. Crescent Lake, Olympic National Park

nitrogen, and chlorophyll *a* as shown in Table 1.

Table 1. Physical, chemical, and biological variables measured in Lake Crescent 1986-1987.

Variable	Method	Level of detection
Temperature	Thermistor probe	1 C°
pH	Combination electrode	0.1 pH unit
Dissolved oxygen	Polarographic probe	0.1 mg/L
Total nitrogen	Persulfate digestion & cadmium reduction (USEPA 1974)	1.0 µg/L as N
Total phosphorus	Persulfate digestion & molybdenum blue (USEPA 1974)	1.0 µg/L as P
Chlorophyll *a*	*In vitro* extracted fluorometric (Turner 1983)	0.1 µg/L

Periphyton:

The six near-shore sites were assessed for differences in community composition of periphyton growth on artificial substrates in 1987. Artificial substrates were two styrofoam balls 5.0 cm in diameter attached to a weighted line suspended vertically in the water column by a float 1.0 - 2.0 m below the water surface. A single substrate was positioned at 5.0 m depth at each end of a crossbar attached to the line.

After a colonization period of six weeks, the substrates were retrieved underwater to avoid loss of periphytic growth from disturbance. They were collected by enclosing each styrofoam ball in a wide mouth plastic jar and securing with a screw-on top. After collection the samples were preserved in Lugol's solution. Dislodged periphyton was allowed to settle and each styrofoam ball was brushed clean of periphytic growth into the collection container with a soft bristle toothbrush. In the laboratory all

samples were allowed to settle for a period of at least 48 hours and concentrated to a volume of 30.0 ml by removal of excess water. A 3.0 ml volume of completely mixed sample was removed for cleaning by organic digestion with hydrogen peroxide for diatom analysis.

Complete Palmer Cell counts gave the equivalent of the algal community on 0.272 cm^2 of the artificial substrate, and were used to count non-diatom algae to the generic level at 320X total magnification. For the non-diatom algae, complete Palmer cells were observed, the filamentous algae and colonial forms estimated to the nearest tens of cells when impractical to count. Diatoms were noted as either centric or pennate and only counted.

The diatom slides were prepared after digestion with hydrogen peroxide followed by dilution with deionized water. Samples were concentrated to a known volume and diatoms were mounted in Hyrax mounting media, and observed at 1000X total magnification. Each slide contained an algal sample equivalent to 0.204 cm^2 on the artificial substrate. Diatom taxa were identified to lowest possible taxonomic levels, counted until a total of 500 diatom valves were observed. The total area observed on the coverslip recorded in order to determine diatom density.

Laboratory bioassay:

To assess potential non-point nutrient enrichment at the six near-shore sites, water was withdrawn in August, 1986, and 1987, from the 4.0 m depth. A laboratory bioassay growth response determination using the Algal Assay Bottle Test (Miller *et al*, 1979) was performed by Biochem Environmental Services Inc.,

Seattle.

In situ bioassay:

To answer the iron limitation question raised by the data from the laboratory bioassay (see results section), an *in situ* bioassay was performed using the natural phytoplankton community from Lake Crescent. Twenty-four 1.0 L glass jars were used as phytoplankton incubation chambers at the BPT site with four replicate samples for two control treatments and four iron treatments. Concentrations of iron, (as $FeCl_3$) and EDTA as a chelating agent were designed to augment the standard *Selenastrum capricornutum* Algal Bioassay Test. Control treatments were lake water alone, and lake water with 2.13 mg/L EDTA and test treatments were 40, 80, 160, and 320 mg/L $FeCl_3$ with 2.13 mg/L EDTA each treatment. Lake water was collected in a 10 L Nalgene carboy at the BPT site by submerging the carboy with cement blocks and removing the top at 4.0 m depth. To avoid exposing the algae collected at this depth to light and temperature shock, all collections of water samples, preparations, and the placement and collection of bioassay treatments were done late in the day within coolers and shade provided by the boat cabin. All treatment jars were half filled, and an additional water sample taken at 4.0 m depth. All sample jars were topped off as iron and EDTA concentrations were added for each treatment. Parafilm was used to cover the top of each jar to aid in sealing and prevent contamination. All jars were permanently labelled by treatment and replicate number, then randomly replaced on a sand substrate bottom at 4.0 m depth. After 14 days incubation, all sample jars were

retrieved, immediately placed in coolers and transported to shore for preservation with Lugol's solution. To avoid loss of sample, any periphytic growth on the inside of the sample jars was dislodged with the aid of a rubber baking spatula. All samples were allowed to settle for a minimum of 24 hours and excess water removed to a remaining volume of 250 ml. Samples were completely transferred to plastic containers and shipped to the laboratory where they were resettled and concentrated to a volume of 30.0 ml. Mixed samples representing a 32-fold concentration factor were observed at 320X total magnification in a Palmer Cell and observed taxa enumerated and identified to the species level when possible with the exception of the diatoms, which were only counted.

Quality control:

Quality control steps included observation of each artificial substrate and the toothbrush used for cleaning the substrate under a dissecting scope at 80X total magnification for remaining debris after brushing. On two occasions, noticeable debris was observed and this material was removed by forceps and observed under 320X total magnification. In both cases the material was non-algal debris and only two diatom cells were observed. During brushing of the artificial substrate, some styrofoam particles were dislodged and maintained in the sample. This posed no problem for the Palmer Cell counts as any attached algae would be counted, but in order to check the cleanliness of the styrofoam particles algae cells attached to styrofoam were noted during Palmer Cell counts. In five Palmer Cell counts, a total of only 17 cells and 5 taxa of

diatoms were attached to 58 pieces of styrofoam. To insure cleanliness of the styrofoam particles during cleaning of the subsamples for diatom analysis, the styrofoam particles were picked out after five hours of digestion in hydrogen peroxide and observed at 320 total magnification. No algal cells were observed from three random samples.

Quality control steps for the *in situ* algal bioassay included concentrating the removed excess water from three random samples and counting the total number of cells in each of three replicate Palmer Cell counts. A total of 8 cells and 4 taxa, 10 cells and 4 taxa, and 5 cells and 3 taxa were observed from the three random samples respectively. *Ankistrodesmus* was the only non-diatom taxa observed. Complete Palmer Cell counts were used for both QA purposes and test analysis purposes.

RESULTS & DISCUSSION

Trophic status:

A Trophic Status Index (TSI) of lakes can be determined by the analysis of several variables: an estimation of the transparency of the water as measured by Secchi disk depth, the concentration of the limiting nutrients such as phosphorous and nitrogen, and the density of the phytoplankton community as estimated by chlorophyll *a* (Carlson, 1977; Kratzer and Brezonik, 1981) (Table 2).

TABLE 2. Trophic States Associated With the Trophic State Index (TSI).

TSI	Trophic State*	Chlorophyll a m	Total P (ug/L)	Total N (ug/L)	Secchi Disk (mg/L)
0	Ultraoligotrophic	64	0.04	0.75	0.02
10	Ultraoligotrophic	32	0.12	1.5	0.05
20	Ultraoligotrophic	16	0.34	3	0.09
30	Oligotrophic	8	0.94	6	0.18
40	Oligotrophic	4	2.6	12	0.37
45	Mesotrophic	2.8	5	17	0.52
50	Mesotrophic	2	7.3	24	0.74
53	Eutrophic	1.6	10	30	0.92
60	Eutrophic	1	20	48	1.47
70	Hypereutrophic	0.5	56	96	2.94
80	Hypereutrophic	0.25	154	192	5.89
90	Hypereutrophic	0.12	427	384	11.70
100	Hypereutrophic	0.06	1183	768	23.60

TSI (SD) = 10(6 - ln (SD/ln 2), SD in meters (Carlson, 1977).
TSI (CHA) = 10(6 - (2.04 - 0.68 ln (CHA))/ln 2), CHA in ug/L (Carlson, 1977).
TSI (TP) = 10(6 - ln(48/TP)/ln 2), TP in ug/L (Carlson, 1977).
TSI (TN) = 10(6 - ln(1.47/TN)/ln 2), TN in mg/L (Kratzer & Brezonik 1981)
* Approximate trophic states based on trophic indicator values; names assigned by Kratzer and Brezonik (1981), and not by Carlson.

The transparency of the waters in Lake Crescent as indicated by the Secchi disc depth of the two main basin from measurements taken in 1986 and 1987 varied between 11 m and 22 m (Figures 2 and 3). Preliminary assessment of these measurements indicate

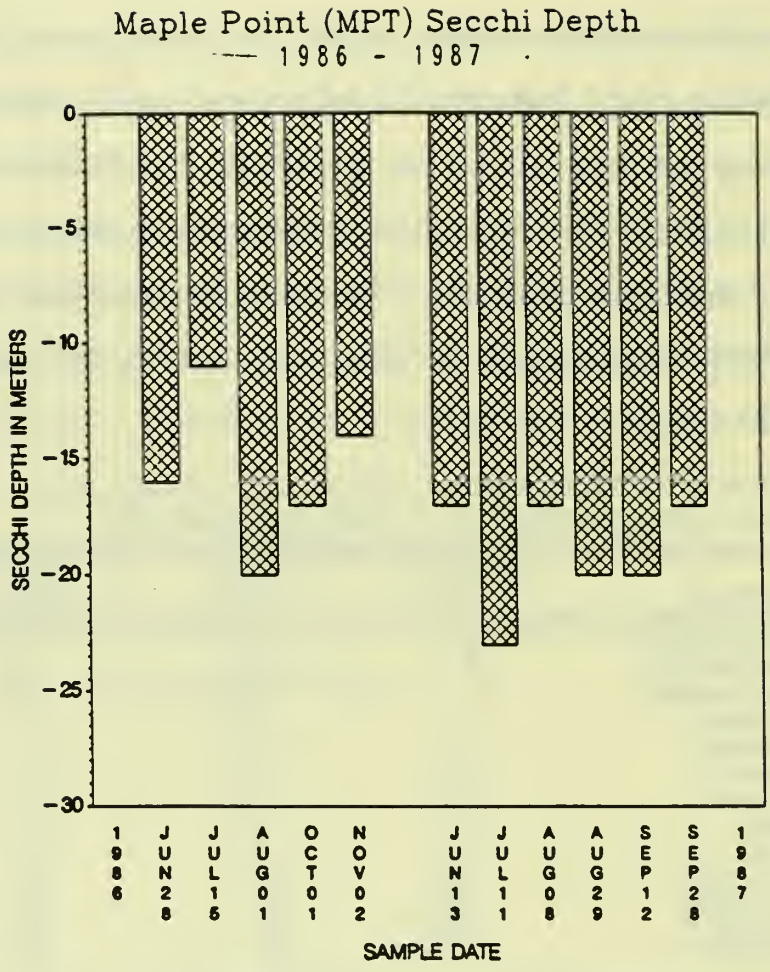

Figure 2. Secchi disk depth at Maple Point (MPT).

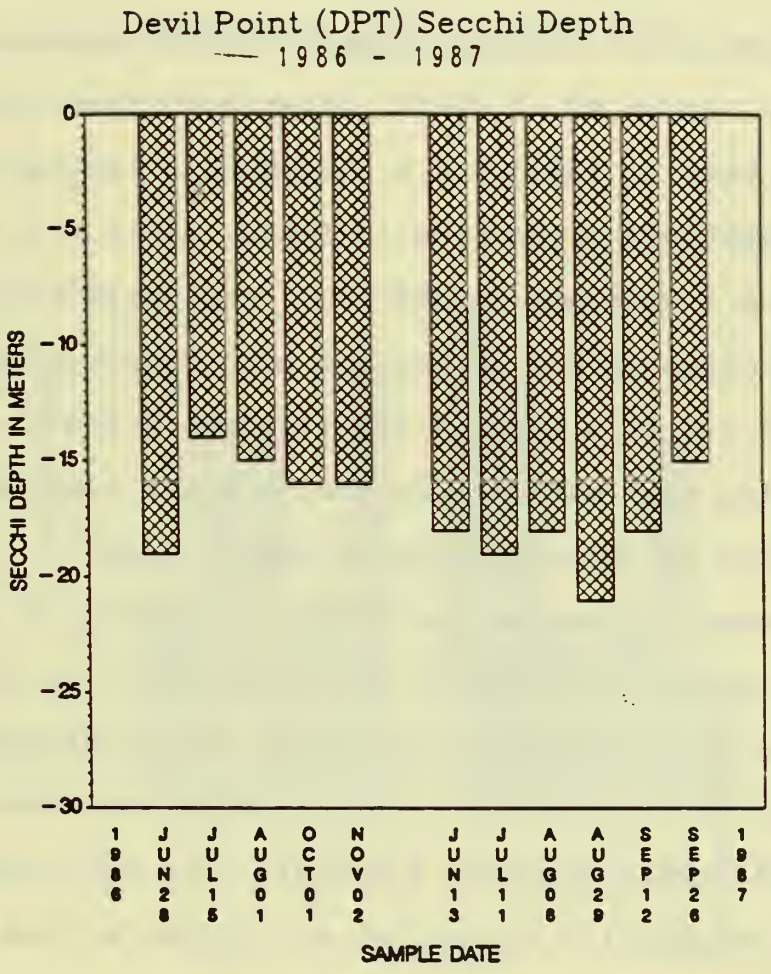

Figure 3. Secchi disk depth at Devil Point (DPT).

the lake is in the ultraoligotrophic to oligotrophic range.

The nutrient limiting overall primary production in Lake Crescent was determined by plotting the ratio of the mean concentration of total nitrogen to total phosphorous in the water column. Lambou *et al* (1976) determined that ratios of N:P greater than 14 indicated a phosphorous limitation to phytoplanktonic production in lakes, while N:P ratios below 10 indicated a nitrogen limitation. The ratio of the mean concentration of N:P at the two main sample stations ranged from a low of 1.2 to a high of 6.6 (Figures 4 and 5), strongly indicating that nitrogen is the nutrient limiting to the production of phytoplankton in Lake Crescent.

In order to assess the trophic condition of Lake Crescent a Trophic Status Index (TSI) was calculated for Secchi disc readings and extracted chlorophyll *a* determinations according to Carlson (1977), and for total nitrogen according to Kratzer and Brezonik (1981) (Figures 6 and 7). The TSI calculated using the mean chlorophyll *a* values for all depths at the Maple Point and Devil Point main basin stations was close to a value of 39.0 for the collections throughout 1986 and 1987. The TSI calculated using the Secchi disc data ranged from 17.5 to 26.0 depending on the station and sample date. The TSI calculated using the mean total nitrogen data for each station at the various dates ranged from -6.0 to 42.0 at Maple Point and -6.0 to 13.0 at Devil Point.

The discrepancy among the TSI calculations using different variables has been recognized in the literature. Osgood (1982) suggested that the differences could be resolved by subsetting

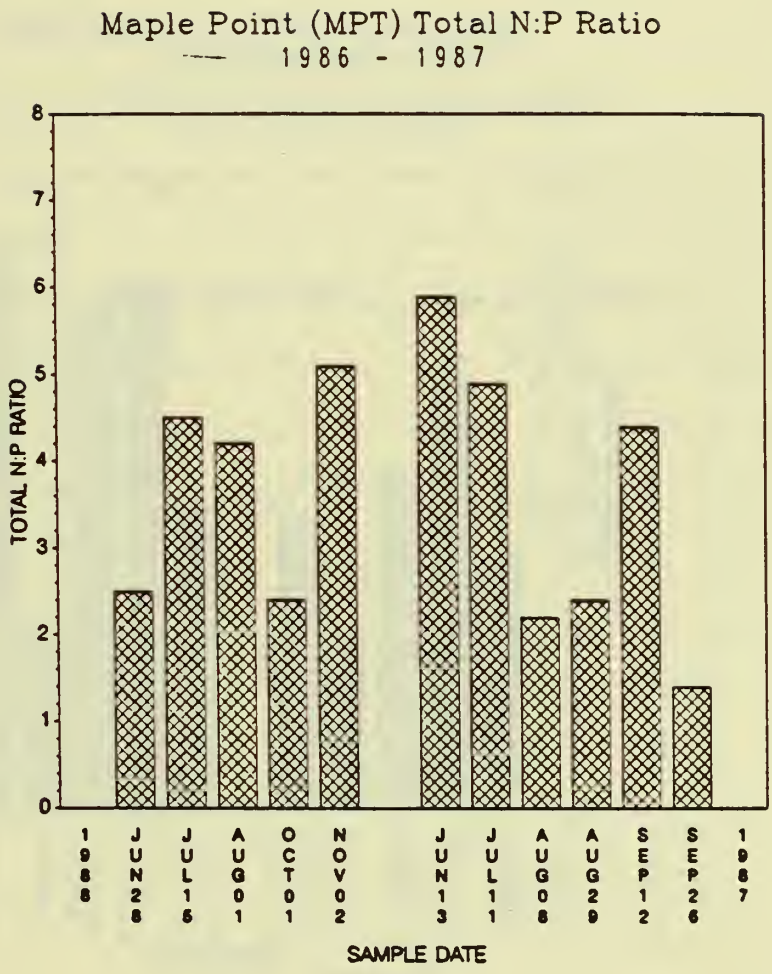

Figure 4. Total nitrogen to total phosphorous ratio (N:P) at Maple Point (MPT).

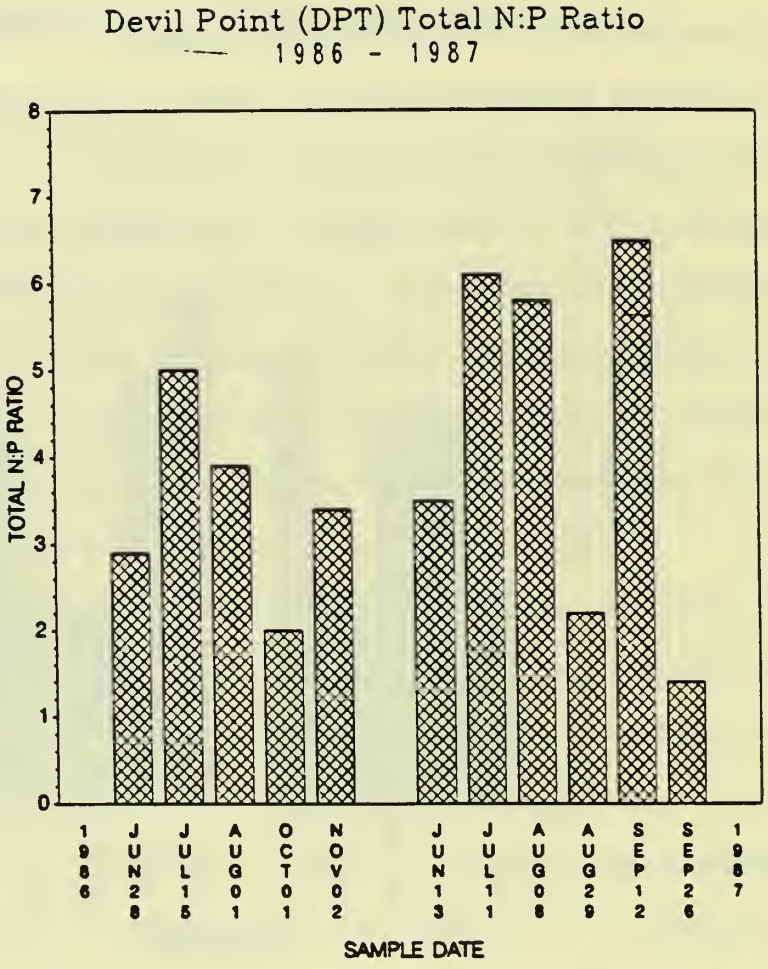

Figure 5. Total nitrogen to total phosporus ratio (N:P) at Devil Point (DPT).

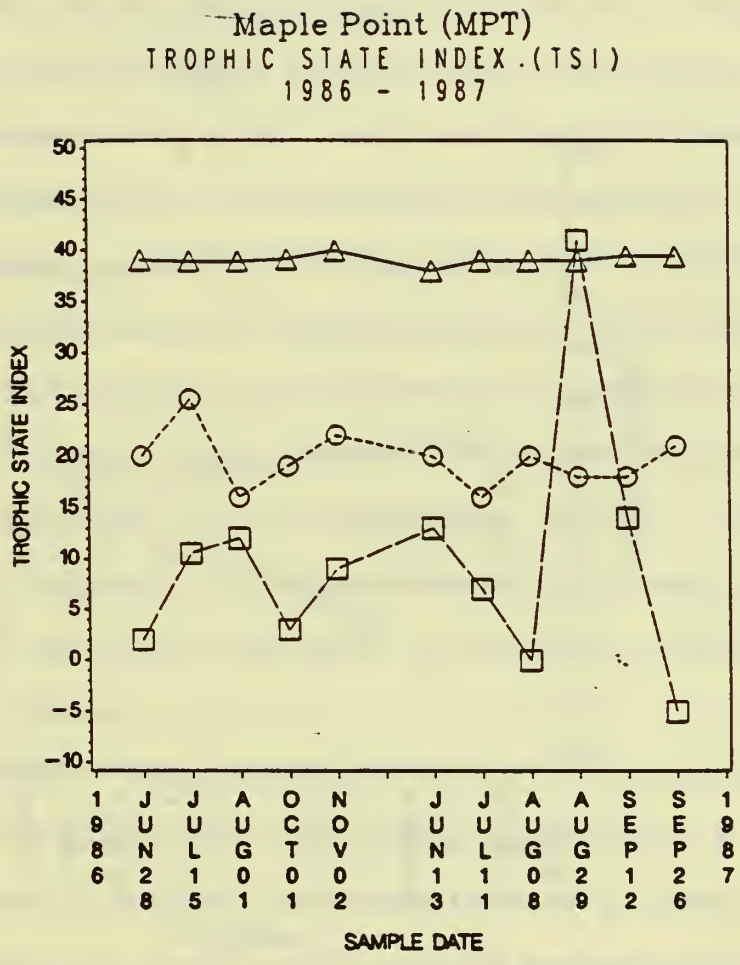

Figure 6. Trophic Status Index (TSI) at Maple Point. (△) TSI based on chlorophyll *a*, (○) TSI based on Secchi Disk depth, and (□) TSI based on total nitrogen.

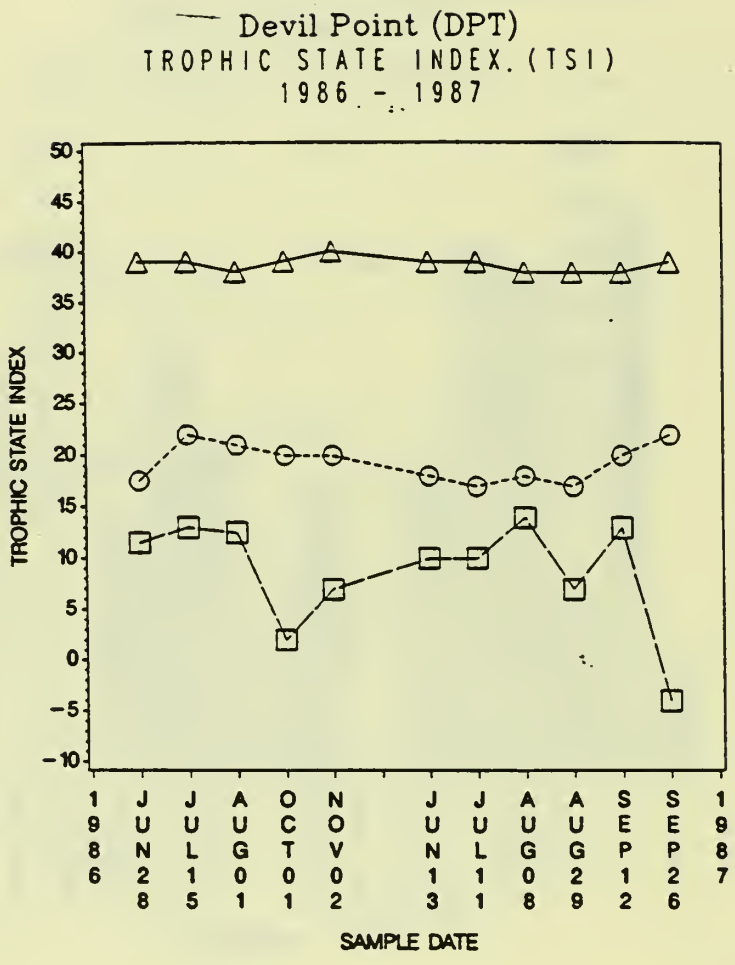

Figure 7. Trophic Status Index (TSI) at Devil Point. (Δ) TSI based on chlorophyll a, (O) TSI based on Secchi Disk depth, and (□) TSI based on total nitrogen.

the data used to calculate the TSI by region and averaging the various TSI's calculated by different variables. The TSI equation derived by Kratzer and Brezonik (1981) for nitrogen was based on 39 nitrogen limited lakes in Florida. Canfield (1983) looked at the relationship between total nitrogen and chlorophyll *a* from 223 lakes in Florida, and found that nitrogen was limiting to primary production in mesotrophic and eutrophic lakes. Even though nitrogen is limiting in Lake Crescent, the TSI generated by total nitrogen may be inappropriate for Lake Crescent because of regional differences and because Lake Crescent is at the opposite end of the trophic scale from where the published nitrogen-chlorophyll *a* relationship was derived. The TSI's derived from the Secchi disc measurements in Lake Crescent were approximately half the magnitude of the TSI's derived from the chlorophyll *a* data.

Carlson (1983) indicated that of the three variables determining trophic status in lakes, chlorophyll *a* was the most indicative of the density of phytoplankton in lentic systems. Moreover, there is little relationship between chlorophyll *a* and Secchi disc depth in oligotrohic lakes with water of high transmissivity (Carlson, 1977). Trophic status is an estimate of the productivity of a lake. Phytoplankton communities are the major primary producers in most deep-water lakes. Because of the apparent stability of the chlorophyll *a* in Lake Crescent, and because chlorophyll *a* is the most critical parameter determining trophic status in lentic ecosystems, we are recommending its use in establishing the TSI for Lake Crescent.

The variables water temperature, pH, dissolved oxygen concentration, chlorophyll *a*, total phosphorus, and total nitrogen were plotted by depth for available data and are presented in the Appendix. At the depths measured, there was no evidence of formation of a thermocline. The pH and dissolved oxygen showed little variabity with depth and were in the expected ranges for an oligotrophic lake. Chlorophyll *a* showed some fluctuations with depth that could be explained by different groups of algae stratified by specific depths (Hutchinson, 1967). The fluctuations of total phosphorus and nitrogen with depth was not associated with the variation of chlorophyll *a*.

Assessment of non-point nutrient enrichment:

The six near-shore sites chosen by the Park staff for assessment were evaluated in three ways: 1) Calculation of the TSI using chlorophyll *a*, 2) Comparison of the growth and community structure of periphyton on artificial substrate, and 3) response of *Selenastrum capricornutum* to water taken from each of the near-shore sites.

Near-shore TSI. The chlorophyll *a* collected at 4.0 m at each of the near-shore sites during 1986 and 1987 was used to derive a TSI value. The magnitude of the TSI for the six sites was greater in 1986 than in 1987 (Figure 8 and 9); however, no pattern of differences could be detected among the various sites. The magnitude of the chlorophyll *a* and the resulting TSI never exceeded the values for the open-water stations at Maple and

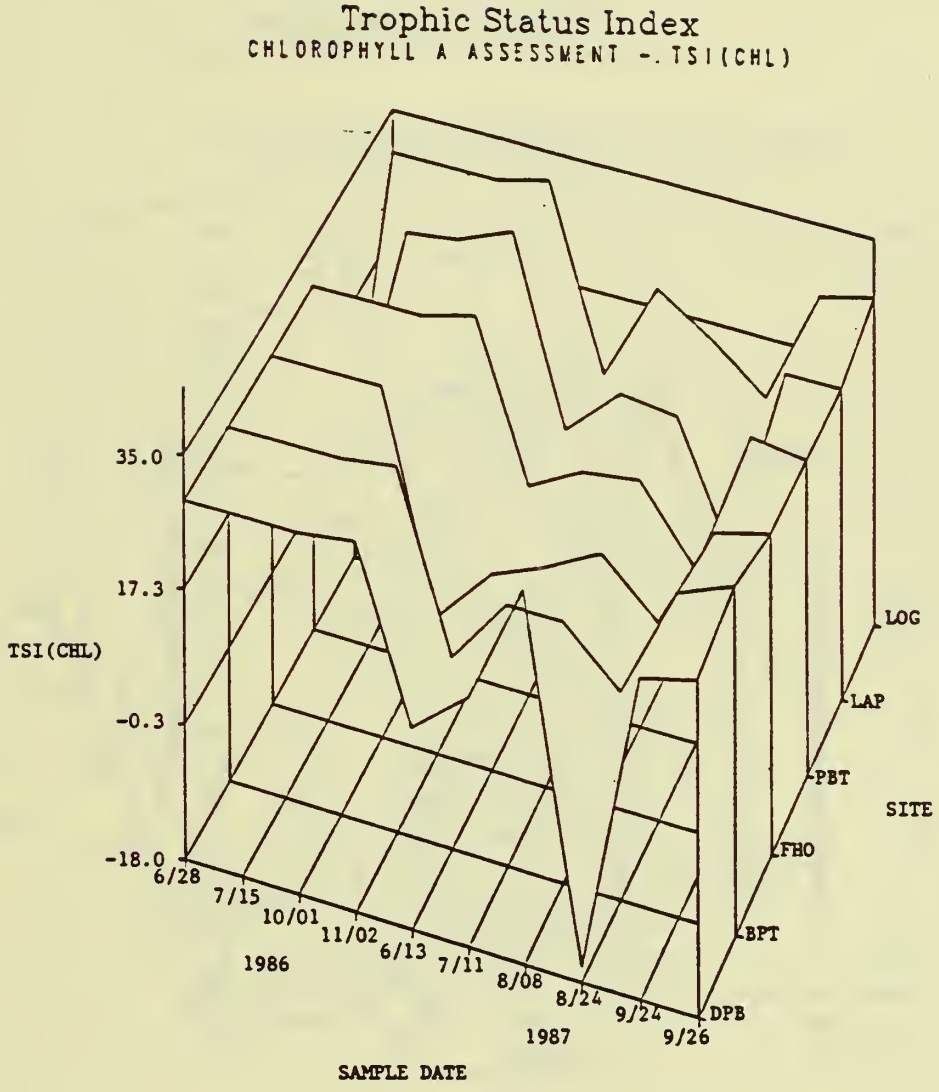

Figure 8. Trophic Status Index (TSI) based on chlorophyll *a* for the potentially impacted near-shore sites.

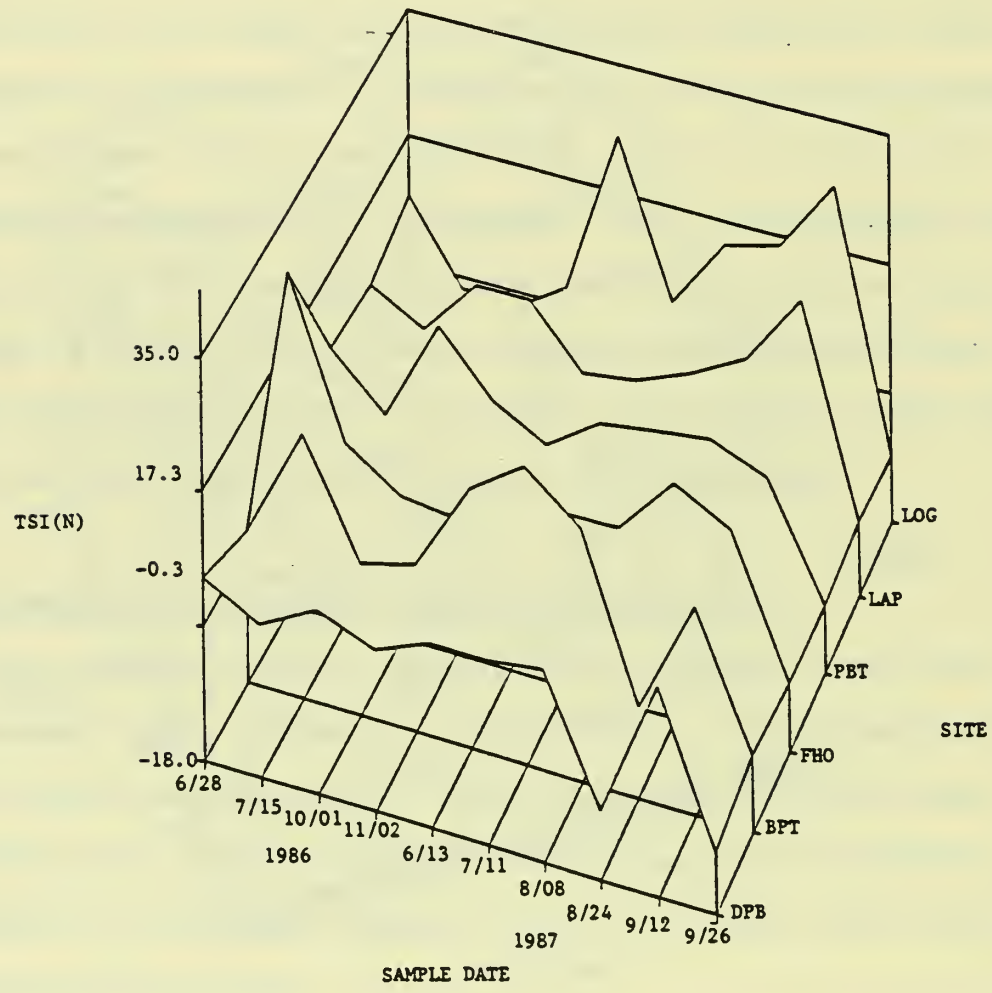

Figure 9. Trophic Status Index (TSI) based on total nitrogen for the potentially impacted near-shore sites.

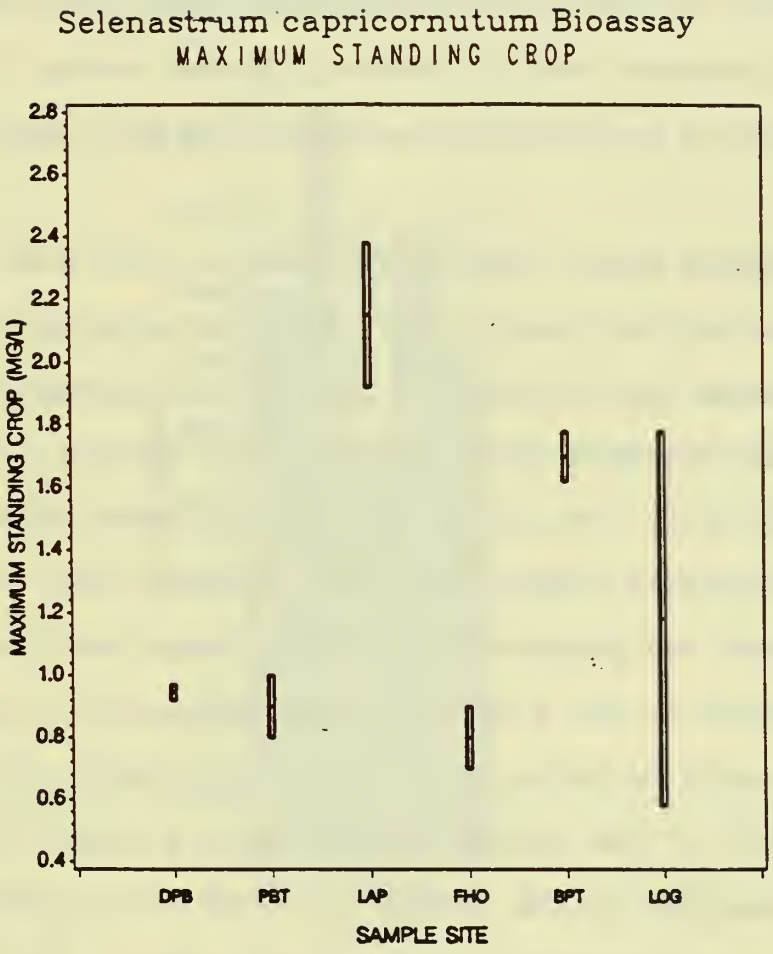

Figure 10. ***Selenastrum capricornutum*** **algal bioassay results showing mean maximum standing crop and 95% confidence intervals at the near-shore sites.**

exceeded the values for the open-water stations at Maple and Devil Points. The recorded differences in the two years could have been due to analytical differences since the samples were analyzed in two lots, or reflect real differences in phytoplankton density between the two years. Chlorophyll *a* did not reveal any differences among the near-shore stations.

Near-shore Algal Assay. The results from the Algal Assay Bottle Test using the growth of *S. capricornutum* as a response indicated that water collected from LAP had the significantly highest maximum standing crop at the end of the two week growth period (Figure 10). The water from BPT promoted algal growth significantly higher than DPB, PBT and FHO. The analysis for nitrogen and phosphorus from the water used in the bioassay collected at the six near-shore stations did not show differences that could be associated with the differential bioassay response. Analysis of the series of preliminary tests indicated that iron was limiting to the specific growth of *S. capricornutum* when using Lake Crescent water as the medium. It is possible that there was some factor such as iron in the water off Lapoel Point other than nitrogen that was stimulating the significant increase in the bioassay response.

Near-shore periphyton analysis. The periphyton community collected from the artificial substrate was analyzed for a number of structural parameters. Algal density was highest at LAP followed by BPT, PBT, LOG, and FHO (Figure 11). There was nearly

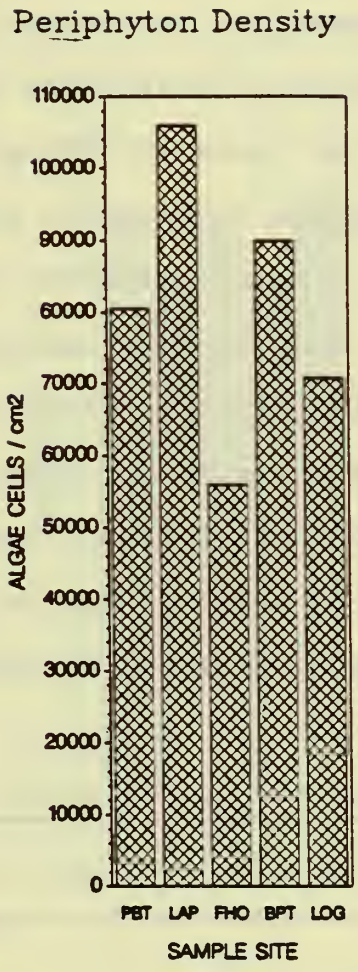

Figure 11. Periphyton algal cell density from artificial substrates at the near-shore sites.

a two-fold difference in the range of densities observed. The total taxa richness ranged between 90 and 103 and did not appear to vary substantially among sites (Figure 12). The two diversity indices, Shannon-Wiener and Simpson's, both showed reduced diversity at the LAP site relative to the others (Figure 13 and 14). From analysis of these structural indices it can be inferred that at LAP the increase in density was due to the differential growth response of a few taxa perhaps at the expense of some other taxa, and the lower diversity values were due to the dominance of a few taxa. A cluster analysis performed on the periphyton community revealed two clusters of stations and their characteristic algal taxa. Table 3 indicates the taxa ranked by abundance for each cluster of sites as shown by output from Cornell Ecology Program COMPCLUS procedure (Gauch 1983).

Table 3. Cluster analysis of periphyton communities.

Cluster 1	Cluster 2
FHO, LOG, PBT:	BPT, LAP:
Fragilaria pinnata	*Synedra rumpens var. familiaris*
Amphipleura pellucida	*Achnanthes minutissima*
Fragilaria construens var. venter	*Fragilaria capucina*
Synedra rumpens var. familiaris	*Amphipleura pellucida*
Achnanthes minutissima	*Nitzschia fonticola*
Fragilaria brevistriata	*Cymbella angustata*
Nitzschia fonticola	*Nitzschia gracilis*
Cymbella angustata	*Synedra minuscule*
Rhopalodia gibba	*Achnanthes microcephala*
Fragilaria contruens var. venter	*Fragilaria construens var. venter*

Based on information for each of the above taxa from Lang-Bertalot (1979), Lowe (1974), Stoermer and Yang (1970), Evanson

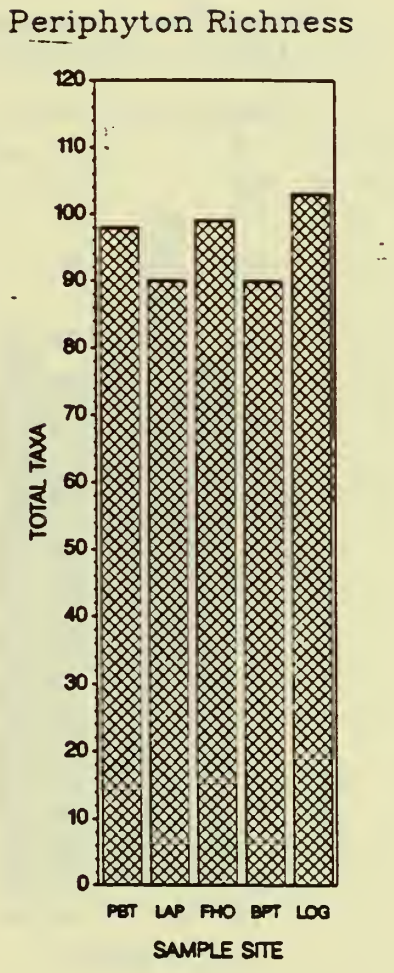

Figure 12. Periphyton algal taxonomic richness from artificial substrates at the near-shore sites.

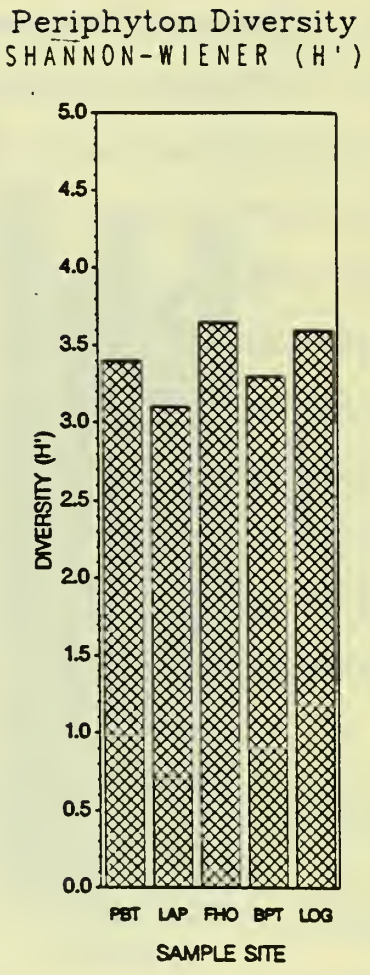

Figure 13. Periphyton algae Shannon-Weiner Diversity from artificial substrates at the near-shore sites.

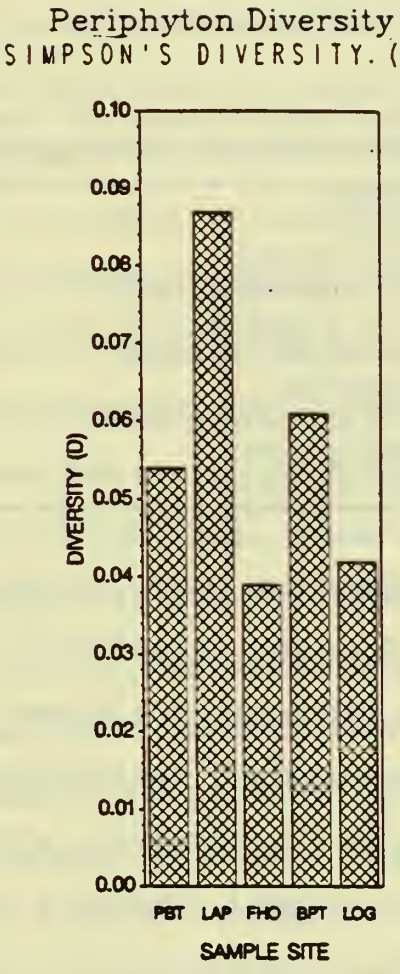

Figure 14. Periphyton algae Simpson's Diversity from artificial substrates at the near-shore site.

et al. (1981), Rawson (1956), Palmer (1969), Schuette and Bailey (1980), Hansmann and Phinney (1973), Fairchild and Lowe (1984), Fairchild *et al.* (1985) and Patrick (1977), the following comparisons are made for each cluster of sample locations.

Table 4 . Environmental attributes of cluster analysis

	Cluster 1	Cluster 2
Pollution sensitive taxa	47.2 %	80.9 %
High calcium preference	45.8 %	64.7 %
High O_2 preference indicators	27.9 %	20.4 %
Shallow water/Land disturbance taxa (*A. minutissima / S. rumpens* vars.)	21.0 %	47.8 %
Symbiotic Blue-Greens associations (high P - low N enrichment)	present	none
F. brevistriata (nutrient enrichment)	8.8 %	none
F. capucina / A. minutissima (oligotrophic indicators)	10.1 %	36.3 %

The artificial substrate algae collected from Lake Crescent are representative of clean, oligotrophic, cold water conditions. The non-diatom algae represent the Green algae (Chlorophyta), Blue-Green algae (Cyanophyta), Yellow-Brown algae (Chrysophyta) and the Dinoflagellates (Pyrrhophyta) with a total of 81 taxa. The diatoms (Bacillariophyta) dominated the substrate samples and were primarily pennate, tychoplanktonic forms (usually associated with periphytic growth but can be dislodged into the water column) with 145 different taxa observed. All collections exhibit a healthy mix of Blue-Green and Green algae as shown by the high diversity, richness and density values. All taxa that could be assigned to the nutrient spectrum (Lowe 1974) were categorized as Oligotrophic or Oligotrophic-Mesotrophic.

The appearance of Dinoflagellates and desmid Chlorophyta are indicative of soft waters. The Dinoflagellates and particularly

desmids are common in acidic soft waters (Prescott 1951) but the pH of Lake Crescent (mean pH = 7.2) appears too alkaline for large Dinoflagellate or desmid populations. The desmid Chlorophyta occur in the phytoplankton when calcium is present (Rawson 1956), which supports the observations that calcium preference diatom taxa exist in the abundance ranking from the cluster procedure. In light of the overall low nutrient content of Lake Crescent as indicated by the chemical and physical parameters it appears that the relative concentration of calcium to other constituents may be sufficient to support these taxa. Data provided by the University of Washington heavy metal analysis study (OLY NP Database, unpubl.) showed the calcium concentration in Lake Crescent to range from 10 to 12 mg/L.

Results from both the near-shore algal assay and the near-shore periphyton analysis indicate waters at LAP, and to a lesser extent BPT, stimulate algal growth. Moreover, LAP was the site of a resort that, according to Park records, was active from the 1930's to the early 1950's. Possibly leachate from old landfills, or septic systems are potentially having a local effect on the community composition of the phytoplankton and periphyton off Lapoel Point.

Near-shore iron bioassay. Because the laboratory bioassay revealed that the water of Lake Crescent was deficient in iron for *S. capricornutum* growth, we tested the effects of iron on algal communities within Lake Crescent. A total of 42 different taxa representing the Blue-Green, Green, Red, Yellow-Green,

Dinoflagellates and Diatoms were observed from the *in situ* bioassay test at BPT. The bioassay tested the overall growth of natural lake phytoplankton collected at 4.0 m depth to a control and five treatments of four replicates each, of EDTA combined with concentrations of 0, 40, 80, 160, and 320 ug/l iron as $FeCl_3$, an EDTA control and a lake water control. Analysis of variance (ANOVA) was performed on the data followed by mean treatment separations by the Student-Neuman-Keuls multiple range test on total cell numbers (density), richness, Shannon-Wiener Diversity, Simpson's Diversity and the abundance of each algal group (SAS 1985). No statistical differences were found among the six treatments for overall density, richness, and diversity. In all treatments the variability among replicate samples was high. Richness values ranged from 15 taxa to 21 taxa, density values were highly variable and ranges from 666 organisms/ml to 18,684 organisms/ml, Shannon-Wiener Diversity values ranges from .727 to 2.57 and Simpson's Diversity values ranges from .715 to .094.

Within the algal groups, only the Dinoflagellates showed a significant increase in mean abundance for the EDTA control (mean = 14.7%) and 40 ug/L $FeCl_3$ + EDTA treatmenmt (mean = 17.5%) over all other treatments ($F=8.52$, $df = 6,18$, $P > .0002$) where Dinoflagellate mean abundance ranged from 1.75% to 8.3% of the total density. Although the diatoms as an algal group were not found significantly different, it was observed during the enumeration process that the 80 ug/l iron treatment had two replicate samples with a high number of diatoms of a few pennate

taxa. A separate diatom slide was prepared for taxa identification and *Synedra rumpens* var. *rumpens*, *S. rumpens* var. *familiaris* and *Fragilaria vaucheriae* var. *vaucheriae* accounted for 90% of the diatoms present. *Fragilaria vaucheriae* var. *vaucheriae* is reported to be a periphytic, eutrophic taxa (Lowe 1974). The abundance of these taxa in a few replicate samples of a single treatment suggests the possibility of replicate contamination during the jar filling and inoculation.

Lake Crescent supports chemical and biological attributes characteristic of highly oligotrophic lakes. Trophic State Index scores determined seperately for chlorophyll *a*, total nitrogen and Secchi depth at both deep-water and near-shore sites are in the ultraoligotrophic to oligotrophic range. Differences in the community structure of the periphyton, and higher productivity in the algal assay differentiate LAP from all other near-shore sites. These changes were minor relative to potential large scale changes induces by cultural eutrophication.

CONCLUSIONS

1) The trophic status of Lake Crescent as indicated by the Trophic Status Index was approximately 39, indicating an oligotrophic lake.

2) The nutrient limiting to primary production of the algal communities in Lake Crescent was nitrogen.

3) There is some indication that iron may be limiting to some groups or taxa of algae, however iron was not limiting to the overall primary production.

4) The was no evidence that non-point nutrient enrichment was occurring at expected near-shore sites. However, both laboratory bioassay results and analysis of the periphyton community indicate that there are different conditions present at Lapoel Point, possibly associated with leachates from old septic systems or local landfill.

LONG TERM MONITORING CONSIDERATIONS

Sampling Sites:

The two-basin morphology and depth of Lake Crescent indicate that two deep-water sites be monitored for whole-lake trophic status. The varied commercial, visitor and land use practices indicate that near-shore sites also be monitored as non-point sources for local changes in trophic status.

The established Maple Point (MPT) and Devils Point (DPT) deep water sites are excellent monitoring sites because; 1) MPT and DPT indicate overall lake trophic status and delineate any differences between the major basins of the lake, 2) any trophic status changes can indicate the relative sensitivity to land use practices associated with each basin, and, 3) standard limnological associations between selected physical and biological attributes will be added to the existing data base specific for MPT and DPT.

The most efficient selection of near-shore sites would include locations that could provide early warning signs of trophic change. Based on the artificial substrate periphyton results from this report, the Fairholm (FHO), Log Cabin (LOG) and Lapoel (LAP) near-shore sites are reliable choices. The FHO and LOG sites are desirable because; 1) each near-shore site is located in a separate basin, 2) a low percentage of pollution sensitive taxa were observed at these sites and increases in specific pollution sensitive taxa may be more apparent than from other sites with greater abundance of pollution sensitive taxa, 3) symbiotic blue-green algae associations exist in the

periphyton corresponding with nitrogen limitation, corroborating observations from in the deep-water basin sites, and 4) each site is associated within a basin and with different land use practices. The LAP site is important because of the potential local effects from an previous resort shown by the increased algal density on artificial substrates and statistically significant higher productivity from the algal bioassay tests at this site.

Collections:

The collections and methods adhere to the procedures followed in this report in order to provide comparable results while adding to the existing data base. The collections listed herein are minimal efforts, and the inclusion of additional collections or tests such as the *Selenastrum capricornutum* algal bioassay is recommended if monetary support if available.

1) Secchi depth with use of a water scope to record clarity and allow the calculation of TSI(SD).

2) Chlorophyll *a* of the water column in ten equal increments to twice the secchi depth to check the recommended TSI(CHA) and build secchi depth-chlorophyll *a* relationships.

3) Phytoplankton collected at chlorophyll *a* sampling depths for taxonomic records, comparison with periphyton analysis, and possible inferences and relationships with chlorophyll *a* values. The importance of phytoplankton and periphyton algal samples (listed below) in early detection of lake trophic conditions is illustrated in Goldman (1981) for studies in oligotrophic Lake Tahoe.

4) Total N and Total P as a check on N:P ratios and inputs.

5) Periphyton on artificial styrofoam substrate from near-shore sites at a depth of 4.0 m for taxonomic and community parameters check. Items listed in 3 and 5 could be collected, archived, and analyzed as necessary.

Sampling Schedule:

A sampling schedule that is most effective will produce results that indicate differences or changes between the basins, and be compatible with existing data. Carlson (1977) states that prior to fall overturn is the most effective time to measure chlorophyll *a* for TSI evaluation. An appropriate time to make the long-term collections and measurements in Lake Crescent would be in late summer. Results from the present study indicate that chlorophyll *a* TSI values at MPT and DPT do not vary appreciably throughout the summer, however, setting a standardized sample time will allow greater comparability among years.

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APPENDIX

Depth response of

temperature, pH, dissolved oxygen,

chlorophyll *a*, total phosphorus, and total nitrogen.

LAKE CRESCENT
LAKE CHEMISTRY AND PHYSICAL DATA
1987

VARIABLE LIST: SITE = SAMPLE LOCATION WHERE;

NEAR-SHORE STATIONS

BPT = BARNES POINT
DPB = DEVILS POINT BRIDGE
FHO = FAIRHOLM
LAP = LAPOEL POINT
LOG = LOG CABIN
PBT = PUNCHBOWL TUNNEL

DEEP-WATER STATIONS

DPT = DEVILS POINT
MPT = MAPLE POINT

DATE = MONTH AND DAY, AS;

613 = JUNE 16
711 = JULY 11
808 = AUGUST 8
829 = AUGUST 29
ETC.

DEPTH = SAMPLE DEPTH IN METERS
SD = SECCHI DEPTH
SDS = SECCHI DEPTH WITH WATER SCOPE
DO = DISSOLVED OXYGEN IN mg/L
P = TOTAL PHOSPHOROUS IN mg/L
N = TOTAL NITROGEN IN mg/L
NP = N:P RATIO
CHLA = CHLOROPHYLL A (CORRECTED) IN µg/L
COND = CONDUCTIVITY IN µMHO/cm
PH = STANDARD pH SCALE
TEMP = WATER TEMPERATURE IN °C

CHEMICAL AND PHYSICAL LAKE DATA

SITE	DATE	DEPTH	CHLA	TEMP	PH	COND	SD	SDS	DO	P	N	NP
BPT	613	4	0.092	15	6.87	135	18.0	23.0	9.9	0.014	0.071	5.0714
BPT	711	4	0.240	18	7.18	115	18.0	22.0	9.2	0.127	0.099	0.7795
BPT	808	4	0.226	19	7.26	120	20.5	22.5	9.0	0.017	0.068	4.0000
BPT	829	4	0.109	19	6.38	120	21.0	24.0	9.2	0.015	0.015	1.0000
BPT	912	4	0.518	18	7.09	120	20.0	23.0	9.4	0.009	0.043	4.7778
BPT	926	4	0.703	19	7.04	140	18.0	23.0	11.6	0.009	0.013	1.4444
DPB	613	4	0.099	15	6.80	165	15.0	23.0	9.4	0.010	0.036	3.6000
DPB	711	4	0.198	18	6.44	131	17.5	21.0	9.1	0.011	0.035	3.1818
DPB	808	4	1.000	19	7.45	120	17.0	22.0	9.2	0.012	0.038	3.1667
DPB	829	4	0.008	19	6.88	105	21.0	24.0	9.7	0.017	0.012	0.7059
DPB	912	4	0.451	17	7.19	120	20.0	22.0	9.4	0.121	0.043	0.3554
DPB	926	4	0.555	17	8.73	140	15.0	21.0	9.2	0.011	0.011	1.0000
DPT	613	4	0.078	14	7.20	140	17.0	24.0	10.2	0.013	0.050	3.8462
DPT	613	8	0.318	14	6.90	140	17.0	24.0	10.6	0.013	0.041	3.1538
DPT	613	12	1.000	14	7.10	150	17.0	24.0	10.2	0.012	0.035	2.9167
DPT	613	16	0.155	14	7.00	120	17.0	24.0	10.5	0.071	0.067	0.9437
DPT	613	20	1.000	12	7.00	140	17.0	24.0	10.7	0.010	0.035	3.5000
DPT	613	24	1.000	12	7.00	160	17.0	24.0	10.9	0.010	0.026	2.6000

SITE	DATE	DEPTH	CHLA	TEMP	PH	COND	SD	SDS	DO	P	N	NP
DPT	613	28	0.402	10	7.30	125	17.0	24.0	11.3	0.010	0.037	3.7000
DPT	613	32	0.296	10	7.20	125	17.0	24.0	11.4	0.011	0.052	4.7273
DPT	613	36	0.304	9	7.30	155	17.0	24.0	11.3	0.011	0.038	3.4545
DPT	613	40	1.000	9	7.30	140	17.0	24.0	11.2	0.011	0.068	6.1818
DPT	711	5	0.212	18	7.28	130	22.0	25.0	8.8	0.010	0.064	6.4000
DPT	711	10	0.226	17	7.16	120	22.0	25.0	8.8	0.004	0.062	15.5000
DPT	711	15	1.000	17	7.29	120	22.0	25.0	9.7	0.008	0.045	5.6250
DPT	711	20	0.424	16	7.28	120	22.0	25.0	10.1	0.006	0.044	7.3333
DPT	711	25	0.494	14	7.03	120	22.0	25.0	10.5	0.007	0.029	4.1429
DPT	711	30	1.000	14	6.88	120	22.0	25.0	9.2	0.010	0.034	3.4000
DPT	711	35	0.635	13	6.74	115	22.0	25.0	10.5	0.010	0.040	4.0000
DPT	711	40	1.000	12	6.74	105	22.0	25.0	10.2	0.009	0.043	4.7778
DPT	711	45	0.544	10	6.72	105	22.0	25.0	8.4	0.006	0.042	7.0000
DPT	711	50	0.551	9	6.54	125	22.0	25.0	8.3	0.011	0.030	2.7273
DPT	808	4	0.268	19	7.35	130	17.0	21.0	9.7	0.010	0.052	5.2000
DPT	808	8	0.268	19	7.25	125	17.0	21.0	9.6	0.010	0.092	9.2000
DPT	808	12	0.339	19	7.33	120	17.0	21.0	9.5	0.010	0.062	6.2000
DPT	808	16	0.268	19	7.20	130	17.0	21.0	9.0	0.010	0.032	3.2000
DPT	808	20	0.424	19	7.30	120	17.0	21.0	9.6	0.010	0.058	5.8000
DPT	808	24	1.000	17	7.35	135	17.0	21.0	10.1	0.010	0.038	3.8000
DPT	808	28	0.480	15	7.31	120	17.0	21.0	10.7	0.010	0.052	5.2000
DPT	808	32	0.374	14	7.39	130	17.0	21.0	11.1	0.010	0.070	7.0000
DPT	808	36	0.438	14	7.25	120	17.0	21.0	10.9	0.010	0.057	5.7000
DPT	808	40	0.325	12	7.13	130	17.0	21.0	10.7	0.010	0.049	4.9000
DPT	829	5	0.229	19	7.00	125	20.0	23.0	9.2	0.015	0.031	2.0667
DPT	829	10	0.296	18	7.00	120	20.0	23.0	9.6	0.015	0.014	0.9333
DPT	829	15	1.000	18	7.00	120	20.0	23.0	9.6	0.015	0.071	4.7333
DPT	829	20	0.266	18	7.05	120	20.0	23.0	9.7	0.015	0.032	2.1333
DPT	829	25	0.540	15	7.15	120	20.0	23.0	11.3	0.015	0.031	2.0667
DPT	829	30	0.592	12	7.13	120	20.0	23.0	11.8	0.015	0.043	2.8667
DPT	829	35	0.459	11	6.95	120	20.0	23.0	12.1	0.018	0.058	3.2222
DPT	829	40	0.326	15	6.94	120	20.0	23.0	10.4	0.019	0.017	0.8947
DPT	829	45	0.681	10	6.96	120	20.0	23.0	11.4	0.022	0.046	2.0909
DPT	829	50	0.710	9	6.88	120	20.0	23.0	10.3	0.014	0.013	0.9286
DPT	912	4	0.400	17	6.90	120	20.0	22.0	8.8	0.008	0.056	7.0000
DPT	912	8	0.429	17	7.17	120	20.0	22.0	8.8	0.008	0.068	8.5000
DPT	912	12	0.496	17	7.12	120	20.0	22.0	9.2	0.008	0.076	9.5000
DPT	912	16	0.340	17	7.11	120	20.0	22.0	8.8	0.008	0.041	5.1250
DPT	912	20	0.296	17	7.15	120	20.0	22.0	8.8	0.007	0.038	5.4286
DPT	912	24	0.518	15	7.26	120	20.0	22.0	10.4	0.007	0.070	10.0000
DPT	912	28	0.525	13	7.16	120	20.0	22.0	11.6	0.008	0.058	7.2500
DPT	912	32	0.474	12	7.12	120	20.0	22.0	10.6	0.010	0.034	3.4000
DPT	912	36	0.444	11	7.06	120	20.0	22.0	11.1	0.010	0.045	4.5000
DPT	912	40	0.488	10	7.00	120	20.0	22.0	10.6	0.005	0.026	5.2000
DPT	926	5	0.577	17	7.31	130	17.0	23.0	9.6	0.010	0.019	1.9000
DPT	926	10	0.673	17	6.98	120	17.0	23.0	9.4	0.011	0.016	1.4545
DPT	926	15	0.666	16	7.27	120	17.0	23.0	9.7	0.015	0.017	1.1333
DPT	926	20	0.659	16	7.27	120	17.0	23.0	9.2	0.011	0.016	1.4545
DPT	926	25	0.585	17	7.37	120	17.0	23.0	9.3	0.011	0.013	1.1818
DPT	926	30	0.592	16	6.93	120	17.0	23.0	9.6	0.011	0.011	1.0000
DPT	926	35	0.666	14	7.77	120	17.0	23.0	11.2	0.012	0.015	1.2500
DPT	926	40	0.659	9	7.95	125	17.0	23.0	10.7	0.012	0.010	0.8333

SITE	DATE	DEPTH	CHLA	TEMP	PH	COND	SD	SDS	DO	P	N	NP
DPT	926	45	0.592	10	7.99	120	17.0	23.0	11.4	0.011	0.017	1.5455
DPT	926	50	0.607	9	8.48	120	17.0	23.0	10.0	0.012	0.018	1.5000
FHO	613	4	0.099	15	7.40	115	20.0	23.0	10.6	0.011	0.026	2.3636
FHO	711	4	0.141	18	7.00	120	19.0	24.0	8.8	0.007	0.032	4.5714
FHO	808	4	0.205	20	7.40	120	19.0	22.0	9.2	0.010	0.032	3.2000
FHO	829	4	0.103	19	7.45	125	18.0	24.0	9.3	0.014	0.058	4.1429
FHO	912	4	0.429	16	7.03	120	19.0	23.0	8.8	0.007	0.044	6.2857
FHO	926	4	0.511	18	7.78	130	17.0	21.0	10.3	0.009	0.012	1.3333
LAP	613	4	0.099	14	7.30	120	20.0	23.0	9.5	0.013	0.027	2.0769
LAP	711	4	0.212	18	6.90	120	20.0	23.0	9.2	0.004	0.029	7.2500
LAP	808	4	0.184	20	7.40	120	19.0	23.5	8.8	0.010	0.035	3.5000
LAP	829	4	0.033	19	7.60	120	17.0	23.5	9.1	0.015	0.045	3.0000
LAP	912	4	0.533	17	7.15	120	19.0	23.0	9.0	0.007	0.096	13.7143
LAP	926	4	0.518	14	7.78	140	15.0	18.0	9.4	0.008	0.013	1.6250
LOG	613	4	0.085	15	7.08	155	16.0	24.0	9.8	0.021	0.131	6.2381
LOG	711	4	0.353	18	6.66	135	17.5	22.5	9.1	0.008	0.030	3.7500
LOG	808	4	0.207	19	7.30	130	18.0	20.0	9.0	0.010	0.059	5.9000
LOG	829	4	0.107	21	7.38	140	20.0	21.0	8.8	0.021	0.071	3.3810
LOG	912	4	0.585	17	7.22	120	18.0	21.5	9.8	0.102	0.143	1.4020
LOG	926	4	0.710	17	8.58	140	15.0	19.0	10.2	0.007	0.012	1.7143
MPT	613	4	0.120	15	7.40	130	18.0	23.0	11.0	0.009	0.223	24.7778
MPT	613	8	0.085	14	7.20	140	18.0	23.0	10.9	0.009	0.054	6.0000
MPT	613	12	.	14	7.40	140	18.0	23.0	10.8	0.009	0.034	3.7778
MPT	613	16	0.092	14	7.40	130	18.0	23.0	10.4	0.009	0.017	1.8889
MPT	613	20	0.226	14	7.30	120	18.0	23.0	10.7	0.009	0.040	4.4444
MPT	613	24	0.290	13	7.10	110	18.0	23.0	11.3	0.009	0.060	6.6667
MPT	613	28	0.261	12	7.40	105	18.0	23.0	11.3	0.009	0.069	7.6667
MPT	613	32	0.261	11	7.30	110	18.0	23.0	11.2	0.014	0.037	2.6429
MPT	613	36	0.459	10	7.50	120	18.0	23.0	11.3	0.013	0.008	0.6154
MPT	613	40	0.459	9	7.30	115	18.0	23.0	11.4	0.013	0.012	0.9231
MPT	711	5	0.169	17	6.90	135	19.0	23.0	9.5	0.007	0.048	6.8571
MPT	711	10	0.191	17	6.93	120	19.0	23.0	9.5	0.008	0.036	4.5000
MPT	711	15	0.240	16	7.00	130	19.0	23.0	9.2	0.008	0.031	3.8750
MPT	711	20	1.000	15	6.90	140	19.0	23.0	9.7	0.012	0.032	2.6667
MPT	711	25	0.353	14	6.76	120	19.0	23.0	11.0	0.011	0.036	3.2727
MPT	711	30	0.395	12	7.00	125	19.0	23.0	10.2	0.009	0.035	3.8889
MPT	711	35	0.565	12	6.90	140	19.0	23.0	10.6	0.010	0.036	3.6000
MPT	711	40	0.642	11	6.80	140	19.0	23.0	10.7	0.010	0.032	3.2000
MPT	711	45	0.614	10	6.80	135	19.0	23.0	10.3	0.010	0.039	3.9000
MPT	711	50	0.290	15	6.90	120	19.0	23.0	9.8	0.010	0.034	3.4000
MPT	808	5	0.226	19	7.40	130	18.0	24.0	9.3	0.011	0.019	1.7273
MPT	808	10	0.198	19	7.40	120	18.0	24.0	9.4	0.011	0.073	6.6364
MPT	808	15	0.233	18	7.45	120	18	24.0	10.2	0.011	0.020	1.81818
MPT	808	20	0.304	18	7.42	120	18	24.0	9.3	0.011	0.024	2.18182
MPT	808	25	0.367	16	7.45	110	18	24.0	10.3	0.011	0.012	1.09091
MPT	808	30	0.534	13	7.50	110	18	24.0	11.3	0.010	0.015	1.50000
MPT	808	35	0.452	12	7.45	110	18	24.0	11.3	0.010	0.022	2.20000
MPT	808	40	0.501	12	7.42	110	18	24.0	11.1	0.010	0.016	1.60000
MPT	808	45	0.565	11	7.40	100	18	24.0	10.8	0.010	0.012	1.20000
MPT	808	50	0.628	10	7.35	110	18	24.0	12.6	0.010	0.016	1.60000
MPT	829	5	.	19	7.13	140	21	24.0	9.8	0.019	0.016	0.84211
MPT	829	10	0.274	19	7.45	120	21	24.0	9.8	0.015	0.053	3.53333

SITE	DATE	DEPTH	CHLA	TEMP	PH	COND	SD	SDS	DO	P	N	NP
MPT	829	15	0.318	19	6.88	130	21	24.0	9.3	0.018	0.016	0.88889
MPT	829	20	0.178	18	7.30	120	21	24.0	9.7	0.016	0.050	3.12500
MPT	829	25	0.259	17	6.84	140	21	24.0	9.8	0.017	0.039	2.29412
MPT	829	30	0.363	16	6.85	120	21	24.0	11.1	0.017	0.057	3.35294
MPT	829	35	0.429	14	7.00	110	21	24.0	11.4	0.019	0.050	2.63158
MPT	829	40	0.422	11	7.04	140	21	24.0	10.2	0.015	0.048	3.20000
MPT	829	45	0.370	12	6.93	150	21	24.0	10.2	0.016	0.041	2.56250
MPT	829	50	0.540	11	7.49	140	21	24.0	9.7	0.016	0.017	1.06250
MPT	912	4	0.414	18	7.23	120	18	23.0	9.2	0.015	0.007	0.46667
MPT	912	8	0.400	18	7.24	120	18	23.0	9.3	0.011	0.107	9.72727
MPT	912	12	0.451	18	7.24	120	18	23.0	9.4	0.014	0.057	4.07143
MPT	912	16	0.363	17	7.27	120	18	23.0	9.4	0.011	0.036	3.27273
MPT	912	20	.	18	7.34	120	18	23.0	9.7	0.013	0.052	4.00000
MPT	912	24	0.459	17	7.30	120	18	23.0	9.8	0.011	0.043	3.90909
MPT	912	28	0.451	16	7.20	120	18	23.0	10.3	0.012	0.042	3.50000
MPT	912	32	0.429	10	7.13	122	18	23.0	11.0	0.013	0.116	8.92308
MPT	912	36	0.585	9	7.08	120	18	23.0	10.6	0.011	0.044	4.00000
MPT	912	40	0.548	9	6.78	120	18	23.0	10.6	0.009	0.030	3.33333
MPT	926	4	0.407	16	7.52	120	15	21.0	9.2	0.009	0.011	1.22222
MPT	926	8	0.621	16	7.73	120	15	21.0	9.8	0.014	0.016	1.14286
MPT	926	12	0.444	16	7.78	120	15	21.0	9.4	0.012	0.015	1.25000
MPT	926	16	0.496	17	7.81	120	15	21.0	9.4	0.011	0.015	1.36364
MPT	926	20	0.466	16	7.32	120	15	21.0	9.2	0.012	0.022	1.83333
MPT	926	24	0.422	15	7.80	120	15	21.0	9.6	0.012	0.013	1.08333
MPT	926	28	0.688	14	7.80	120	15	21.0	11.4	0.012	0.013	1.08333
MPT	926	32	0.747	12	7.74	120	15	21.0	13.6	0.015	0.025	1.66667
MPT	926	36	0.533	11	7.68	120	15	21.0	11.6	0.009	0.012	1.33333
MPT	926	40	0.525	11	7.69	120	15	21.0	11.5	0.010	0.011	1.10000
PBT	613	4	0.127	15	7.30	140	16	22.0	8.5	0.012	0.027	2.25000
PBT	711	4	0.184	18	7.02	120	20	22.5	9.3	0.005	0.038	7.60000
PBT	808	4	0.200	19	7.35	120	19	24.0	8.6	0.014	0.039	2.78571
PBT	829	4	0.073	20	7.22	120	20	24.0	9.4	0.015	0.042	2.80000
PBT	912	4	0.585	18	7.18	120	16	22.0	9.2	0.012	0.036	3.00000
PBT	926	4	0.503	18	8.70	140	17	22.0	9.4	0.011	0.012	1.09091

LAKE CRESCENT
PHYTOPLANKTON DATA FOR *IN SITU* IRON BIOASSAY
1987

VARIABLE LIST: TEST = INCUBATION TEST CONCENTRATIONS WHERE;
1 = LAKE WATER ONLY
2 = LAKE WATER + 2.13 g EDTA
3 = 40.0 μg $FeCl_3$ + 2.13 g EDTA
4 = 80.0 μg $FeCl_3$ + 2.13 g EDTA
5 = 160.0 μg $FeCl_3$ + 2.13 g EDTA
6 = 320.0 μg $FeCl_3$ + 2.13 g EDTA

GROUP = ALGAL GROUP WHERE;
1 = CYANOPHYTA 2 = CHLOROPHYTA
3 = RHODOPHYTA 4 = CHRYSOPHYTA
5 = PHYROPHYTA 6 = DIATOMS

TAXON = ALGAE ID - SEE LIST BELOW;

NAME	ALGAE	NAME	ALGAE
SPEC1	ANABAENA SP.	SPEC33	SELENASTRUM MINUTUM
SPEC2	ANACYSTIS SP.	SPEC34	SPYROGYRA SP.
SPEC3	ANKISTRODESMUS FALCATUS	SPEC35	TETRAEDRON MINIMUM
SPEC4	ANKISTRODESMUS FRACTUS	SPEC36	TETRAEDRON TRIGONUM
SPEC5	ANKISTRODESMUS SPIRALIS	SPEC37	TOLYPOTHRIX DISTORTA
SPEC6	APHANOCAPSA RIVULARIS	SPEC38	PENNATE DIATOMS
SPEC7	BOTRYOCOCCUS BRAUNII	SPEC39	CENTRIC DIATOMS
SPEC8	CHLAMYDAMONAS GLOBOSA	SPEC40	UNKNOWN CYANOPHYTA
SPEC9	CHLORELLA ELLIPSOIDEA	SPEC41	UNKNOWN CHLOROPHYTA
SPEC10	CHROOCOCCUS LIMNETICUS VAR. DISTANS	SPEC42	PLEUROTAENIUM NODOSUM
SPEC11	CHROOCOCCUS LIMNETICUS		
SPEC12	CLOSTERIOPSIS LONGISSIMA		
SPEC13	CLOSTERIUM MONILIFERUM		
SPEC14	COSMARIUM SP. #1		
SPEC15	CRUCIGENIA IRREGULARIS		
SPEC16	DINOBRYON SOCIALE		
SPEC17	ELAKATOTHRIX GELATINOSA		
SPEC18	ELAKATOTHRIX VIRIDIS		
SPEC19	GLOEOCYSTIS GIGAS		
SPEC20	GLOEOTHECE LINEARIS		
SPEC21	MOUGEOTIA SP.		
SPEC22	OEODOGONIUM SP.		
SPEC23	OOCYSTIS SOLITARIA		
SPEC24	OSCILLATORIA SP.		
SPEC25	PEDIASTRUM BORYANUM		
SPEC26	PERIDINIUM CINCTUM		
SPEC27	PERIDINIUM PUSILLUM		
SPEC28	PLANKTOSPHAERIA GELATINOSA		
SPEC29	QUADRIGULA CLOSTERIOIDES		
SPEC30	RHODOMONAS LACUSTRIS		
SPEC31	SCENEDESMUS QUADRICAUDA		
SPEC32	SELENASTRUM GRACILE		

TAXA CELL COUNT DATA

TEST OBS	TEST REPLICATE TAXON	GROUP	1 1	1 2	1 3	1 4	2 1	2 2	2 3	2 4	3 1	3 2	3 3
3	SPEC1	1	21	0	3	22	0	11	0	0	11	15	4
4	SPEC2	1	0	6	0	0	0	0	0	0	0	0	0
5	SPEC3	2	25	126	82	32	33	15	17	18	21	24	22
6	SPEC4	2	11	16	26	3	9	9	12	3	3	7	2
7	SPEC5	2	0	0	0	0	0	0	0	0	0	0	0
8	SPEC6	1	12	0	0	51	0	0	0	0	0	0	0
9	SPEC7	3	0	0	0	0	0	25	0	0	0	0	0
10	SPEC8	2	0	3	7	0	28	26	18	0	21	8	43
11	SPEC9	2	42	73	43	44	60	38	49	36	75	57	35
12	SPEC10	1	0	7	7	0	7	0	0	9	0	10	0
13	SPEC11	1	8	16	12	6	16	4	4	0	44	16	6
14	SPEC12	2	13	12	9	0	0	10	7	8	13	7	0
15	SPEC13	2	0	0	0	0	0	0	0	0	0	0	0
16	SPEC14	2	0	0	2	0	0	0	0	0	0	0	0
17	SPEC15	2	0	0	0	0	0	0	0	0	0	0	0
18	SPEC16	4	48	87	102	36	119	172	83	43	81	59	71
19	SPEC17	2	8	4	12	4	10	8	6	6	10	2	12
20	SPEC18	2	45	44	79	19	27	29	21	13	27	37	39
21	SPEC19	2	2	0	0	0	0	0	4	1	0	0	0
22	SPEC20	1	0	0	0	0	0	0	0	8	0	0	0
23	SPEC21	2	0	0	0	0	0	0	0	0	0	6	0
24	SPEC22	2	0	0	0	0	0	0	0	0	7	0	0
25	SPEC23	2	0	0	1	0	0	0	0	0	0	0	2
26	SPEC24	1	3	0	0	0	0	0	0	0	7	0	0
27	SPEC25	2	0	1	0	0	1	0	0	0	0	0	0
28	SPEC26	5	0	0	0	0	0	0	0	0	4	0	0
29	SPEC27	5	6	11	7	6	5	10	6	6	12	5	3
30	SPEC28	2	0	0	0	0	23	0	70	0	0	12	0
31	SPEC29	2	0	0	0	0	0	0	0	0	0	0	0
32	SPEC30	5	11	25	30	5	94	113	83	22	168	95	117
33	SPEC31	2	0	0	0	0	0	0	0	0	0	0	1
34	SPEC32	2	0	1	0	0	0	0	0	0	0	0	0
35	SPEC33	2	17	22	6	12	9	8	15	13	6	8	11
36	SPEC34	2	0	3	0	1	1	1	0	0	0	5	1
37	SPEC35	2	0	0	0	0	0	1	0	0	0	0	0
38	SPEC36	2	0	0	0	1	0	0	1	0	0	0	0
39	SPEC37	1	1	0	0	0	0	0	0	0	0	0	0
40	SPEC38	6	103	488	248	126	102	161	102	67	193	232	97
41	SPEC39	6	20	16	24	22	14	21	18	15	21	17	31
42	SPEC40	1	36	81	56	20	28	32	59	40	79	98	107
43	SPEC41	2	18	25	38	12	10	23	88	18	21	63	10
44	SPEC42	2	0	0	0	0	0	0	0	0	0	0	1

TEST	3	4	4	4	4	5	5	5	5	6	6	6	6
REP.	4	1	2	3	4	1	2	3	4	1	2	3	4
OBS													
3	27	0	0	0	21	0	0	0	18	11	4	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	8
5	22	13	10	351	26	8	13	14	11	12	6	11	9
6	0	0	0	188	23	0	4	7	5	0	0	7	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	15	0	0	0	22	0	6	6	5	0	3	15	6
11	52	57	59	26	70	32	52	52	71	58	46	45	33
12	0	0	0	9	0	5	15	2	8	0	0	0	0
13	0	2	12	4	10	14	0	0	4	6	6	0	4
14	12	7	5	98	18	4	5	5	11	9	4	6	2
15	0	0	0	111	0	0	0	0	0	1	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	16	0	0	0	0	0	0	0	0	0
18	40	25	44	27	182	24	53	29	132	31	28	20	6
19	14	0	0	4	20	0	2	0	4	2	0	0	0
20	30	14	6	10	35	3	0	7	12	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	8	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1	0	0	0	0	0	0	0	0	0	0	0
28	3	3	1	0	0	3	1	0	4	2	0	9	5
29	15	10	11	0	3	0	3	4	14	12	0	20	0
30	100	17	30	0	28	0	0	15	17	0	0	37	0
31	0	0	0	4	0	0	0	0	0	0	0	0	0
32	82	24	9	14	63	9	0	9	12	10	5	32	2
33	0	0	0	4	31	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	11	30	17	1	9	16	17	11	24	8	18	11	13
36	0	0	0	0	0	1	0	0	1	1	0	2	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	18	0
40	154	91	168	4772	521	47	96	107	526	105	70	68	81
41	24	21	13	9	7	23	7	17	30	17	11	15	14
42	45	7	24	14	183	8	23	12	124	11	6	14	19
43	11	6	29	0	37	5	21	22	58	12	6	11	16
44	0	0	0	0	0	0	0	0	0	0	0	0	0

LAKE CRESCENT
ARTIFICIAL SUBSTRATE ALGAE - NON DIATOM TAXA
1987 COLLECTIONS

VARIABLE LIST: TYPE = ALGAL GROUP WHERE;
1 = CYANOPHYTA 2 = CHRYSOPHYTA
3 = PHYROPHYTA 4 = CHLOROPHYTA
ID = TAXON NAME - SEE LIST BELOW;

ID#	TAXON
1	ANABAENA #1
2	ANABAENA #2
3	ANABAENA #3
4	APHANOCAPSA
5	APHANOTHECE
6	APHANOTHECE #2
7	CALOTHRIX
8	CHROOCOCCUS
9	DICHOTHRIX
10	GLOEOCAPSA
11	GLOEOTHECE
12	GLOEOCHAETE
13	GOMOPHOSPHAERIA
14	LYNGBIA #1
15	LYNGBIA #2
16	MERISMOPEDIA
17	MICROCYSTIS
18	NOSTOC
19	OSCILLATORIA #1
20	OSCILLATORIA #2
21	SCHIZOTHRIX
22	SCYTONEMA
24	SPIRULINA
25	SYNECHOCOCCUS
26	TOLYPOTHRIX
501	MALLAMONAS
502	SYNURA
503	TRIBONEMA
601	GLENODINIUM
602	GYMNODINIUM
101	ANKISTRODESMUS
102	BOTRYOCOCCUS
103	BULBOCHAETAE
104	CHAETOPHORA
105	CHAETOSPHERIDIUM
106	CHALMYDAMONAS
107	CLOSTERIOPSIS
108	CLOSTERIUM
109	COELASTRUM
110	COSMARIUM #1
111	COSMARIUM #2
112	COSMARIUM #3
113	CYLENDROCAPSA
114	DESMIDIUM
115	DICTYOSPHAERIUM
116	ELAKATOTHRIX
117	EREMOSPHORA
118	EUASTRUM
119	GEMINELLA
120	GLOEOCYSTIS
121	GONATOZYGON
122	MICROSPORA #1
123	MICROSPORA #2
124	MOUGEOTIA #1
125	MOUGEOTIA #2
126	NEPHROCYTIUM
127	OEODOGONIUM #1
128	OEODOGONIUM #2
129	OOCYSTIS
130	PALMELLA
131	PANDORINA
132	PEDIASTRUM #1
133	PEDIASTRUM #2
134	PLANKTOSPAERIA
135	PLEUROTAENIUM
136	SCENEDESMUS #1
137	SCENEDESMUS #2
138	SCENEDESMUS #3
139	SELENASTRUM
140	SPHAEROCYSITIS
141	SPYROGYRA
142	STAURASTRUM #1
143	STAURASTRUM #2
144	STARUASTRUM #3
145	STIGEOCLONIUM
146	ULOTHRIX
147	GREEN BALLS
148	GREEN FILAMENTS
149	ZYGNEMA #1
150	ZYGNEMA #2

VARIABLE LIST CONTINUED:

FHO1 = FAIRHOLM SITE SUBSTRATE #1
FHO2 = FAIRHOLM SITE SUBSTRATE #2
LOG1 = LOG CABIN SITE SUBSTRATE #1
LOG2 = LOG CABIN SITE SUBSTRATE #2
LAP1 = LAPOEL SITE SUBSTRATE #1
BPT1 = BARNES POINT SITE SUBSTRATE #1
BPT2 = BARNES POINT SITE SUBSTRATE #2
PBT1 = PUNCHBOWL TUNNEL SITE SUBSTRATE #1
PBT2 = PUNCHBOWL TUNNEL SITE SUBSTRATE #2

TAXA CELL COUNT DATA

		FHO1	FHO1	FHO2	LOG1	LOG1	LOG2	LAP1	BPT1	BPT2	PBT1	PBT1	PBT2
REPLICATE		1	2	1	2	1	1	1	1	1	1	2	1
GROUP	ID#												
1	1	385	525	1430	1130	1123	3205	3430	2045	2315	2450	2293	194
1	2	120	180	136	170	0	3250	3307	1400	2217	570	42	0
1	3	0	170	0	0	0	0	0	0	252	0	0	0
1	4	0	50	96	429	0	230	100	114	268	150	244	50
1	5	140	0	39	250	100	16	40	30	34	40	83	34
1	6	0	0	0	0	17	0	0	0	0	0	0	0
1	7	1	0	0	0	0	0	0	0	0	0	0	0
1	8	30	14	39	80	111	50	28	81	49	22	82	37
1	9	0	0	0	0	24	0	0	0	0	0	0	0
1	10	0	0	0	175	215	0	0	3	0	0	0	0
1	11	0	0	6	9	0	6	38	0	0	0	0	0
1	12	0	0	20	0	50	100	0	0	11	0	52	0
1	13	80	0	0	0	110	0	0	0	0	0	0	0
1	14	0	83	0	0	0	30	0	0	0	30	204	0
1	15	0	0	0	0	100	0	0	0	0	0	0	0
1	16	0	21	31	42	21	80	60	44	12	0	26	0
1	17	0	100	0	0	102	20	0	0	70	68	130	0
1	18	0	0	0	170	30	0	0	0	0	0	0	0
1	19	176	114	186	90	0	411	160	30	0	60	0	60
1	20	20	0	0	0	0	0	0	0	0	0	0	0
1	21	0	0	3	0	0	0	0	230	0	0	0	1
1	22	0	3	0	0	0	0	0	0	0	0	0	60
1	24	0	0	0	0	0	0	0	0	0	0	0	4
1	25	0	0	0	0	6	0	0	0	0	0	0	0
1	26	0	25	28	173	0	76	6	4	14	5	2	0
2	501	12	14	42	13	0	4	44	41	47	55	47	14
2	502	0	0	4	53	100	33	0	0	0	10	16	0
2	503	22	38	0	0	1	10	31	0	0	0	0	0
3	601	108	134	266	12	6	20	228	47	52	49	52	47
3	602	0	0	0	0	0	0	0	0	0	1	0	0
4	101	124	183	491	329	273	374	708	605	603	255	211	423
4	102	0	0	0	0	40	0	40	0	30	50	0	160
4	103	3	3	21	7	4	20	8	25	7	10	1	7
4	104	0	0	0	30	302	0	0	0	0	0	0	0

		FHO1	FHO1	FHO2	LOG1	LOG1	LOG2	LAP1	BPT1	BPT2	PBT1	PBT1	PBT2
REPLICATE		1	2	1	2	1	1	1	1	1	1	2	1
GROUP	ID#												
4	105	0	0	0	0	0	0	0	0	0	0	4	0
4	106	6	3	26	45	32	26	672	153	98	51	68	8
4	107	0	0	0	0	0	1	4	11	6	1	0	0
4	108	0	0	0	0	0	0	0	2	0	5	11	0
4	109	1	0	0	0	0	0	0	0	0	0	0	0
4	110	1	0	6	5	1	6	5	8	6	1	4	5
4	111	0	0	0	0	2	0	0	2	0	0	0	0
4	112	1	3	4	13	19	6	1	8	18	9	8	0
4	113	0	95	0	0	0	0	0	0	0	0	157	0
4	114	2	0	0	0	0	0	0	0	0	0	0	0
4	115	50	180	30	0	78	14	0	54	138	10	30	0
4	116	0	0	40	0	0	26	13	49	42	6	9	53
4	117	10	10	0	0	0	0	0	0	0	0	0	0
4	118	3	0	0	3	0	0	0	0	0	0	0	0
4	119	0	0	20	0	35	0	10	45	0	84	16	0
4	120	6	11	14	39	31	60	23	29	46	85	24	9
4	121	0	0	0	0	0	0	0	0	6	0	1	1
4	122	332	403	56	0	0	0	0	0	0	0	0	0
4	123	5	0	0	0	0	0	0	0	0	0	0	0
4	124	0	44	68	45	62	56	1066	201	266	141	136	21
4	125	0	7	0	2	0	0	38	0	42	0	0	4
4	126	0	0	60	116	94	47	33	60	59	50	86	15
4	127	253	625	206	795	1064	980	874	367	668	775	991	216
4	128	34	62	48	35	43	24	53	13	11	30	46	13
4	129	10	9	48	7	17	26	51	25	52	13	21	91
4	130	0	0	146	0	0	23	417	106	81	26	94	131
4	131	0	0	0	0	0	13	15	30	0	40	0	0
4	132	3	0	3	4	3	0	1	2	1	2	3	3
4	133	0	0	0	0	3	0	0	0	0	0	0	0
4	134	0	0	0	0	0	0	0	0	0	0	0	138
4	135	0	0	0	0	0	0	0	0	0	3	0	0
4	136	8	5	2	26	23	12	1	10	14	4	2	4
4	137	0	4	0	11	13	6	1	4	0	7	6	3
4	138	0	0	0	0	0	0	0	0	0	4	0	0
4	139	0	0	0	11	16	0	0	0	0	7	0	0
4	140	0	0	103	0	0	39	118	96	116	0	0	103
4	141	70	118	133	63	69	84	356	35	257	110	124	26
4	142	2	4	0	0	2	0	0	0	0	0	0	0
4	143	0	0	2	0	0	0	0	0	0	0	0	0
4	144	0	0	5	0	0	1	6	5	12	0	6	6
4	145	0	30	24	0	0	0	0	0	0	0	0	0
4	146	0	0	22	40	0	30	0	30	16	74	0	0
4	147	19	18	0	40	41	0	0	0	0	34	13	83
4	148	269	428	90	155	192	95	257	54	192	108	72	10
4	149	53	29	43	23	47	18	18	31	41	133	56	27
4	150	0	0	0	7	0	0	0	0	0	0	0	0

LAKE CRESCENT
ARTIFICIAL SUBSTRATE ALGAE - DIATOM TAXA
1987 COLLECTIONS

VARIABLE LIST:
BPT2 = BARNES POINT SITE SUBSTRATE #2
BPT1 = BARNES POINT SITE SUBSTRATE #1
FHO2 = FAIRHOLM SITE SUBSTRATE #2
LOG1 = LOG CABIN SITE SUBSTRATE #1
LOG2 = LOG CABIN SITE SUBSTRATE #2
LAP1 = LAPOEL SITE SUBSTRATE #1
PBT1 = PUNCHBOWL TUNNEL SITE SUBSTRATE #1
PBT2 = PUNCHBOWL TUNNEL SITE SUBSTRATE #2
FHO1 = FAIRHOLM SITE SUBSTRATE #1

AREA = THE TOTAL AREA OF THE MICROSCOPE SLIDE OBSERVED TO COUNT 600 DIATOM FRUSTULES FOR DENSITY CALCULATIONS

TAXA AND CELL COUNT DATA

TAXON	ID	BPT2	BPT1	FHO2	LOG1	LOG2	LAP1	PBT1	PBT2	FHO1
AREA IN mm2		5.53	4.46	8.60	5.47	3.80	3.88	4.95	12.18	7.16
Achnanthes affinis var. affinis	1	6	24	5	4	0	0	8	0	0
Achnanthes clevei var. clevei	2	2	0	3	2	1	3	4	15	1
Achnanthes exigua var. exigua	3	0	0	0	2	0	0	0	7	0
Achnanthes hauckiana var. hauckiana	4	0	0	0	2	0	4	2	6	0
Achnanthes hustedtii var. hustedtii	144	0	0	0	7	0	0	0	0	0
Achnanthes kryophila var. kryophila	5	0	5	4	3	0	0	0	0	0
Achnanthes lanceolata var. dubia	6	0	1	1	0	8	0	5	12	5
Achnanthes lanceolata var. lanceolata	7	0	0	6	0	0	0	0	1	0
Achnanthes lauenburgiana var. lauenburgiana	8	0	0	0	0	0	0	0	0	2
Achnanthes levanderi var. helvetica	9	0	0	0	0	0	0	0	8	0
Achnanthes levanderi var. levanderi	10	3	0	8	11	1	0	10	0	8
Achnanthes linearis var. curta	11	0	0	7	15	0	2	10	0	0
Achnanthes linearis var. linearis	12	0	0	4	0	0	0	0	4	4
Achnanthes linearis var. microcephala	13	0	0	0	0	0	0	0	0	11
Achnanthes microcephala var. microcephala	14	7	24	1	11	2	10	11	0	1
Achnanthes minutissima var. minutissima	15	32	75	52	30	37	84	39	7	25
Achnanthes paragalli var. parvula	16	0	0	0	2	0	0	0	0	0
Achnanthes species #1	17	0	0	0	0	0	0	0	0	6
Achnanthes sublaevis var. crassa	18	0	0	0	2	0	0	2	1	0
Achnanthes sublaevis var. subleavis	19	2	0	0	0	0	0	0	0	0
Amphipleura pellucida var. pellucida	20	94	28	54	10	53	3	89	26	31
Amphora ovalis var. affinis	21	16	4	13	4	0	3	2	6	0
Amphora perpusilla var. perpusilla	22	11	6	9	11	15	3	10	21	17
Anonoeoneis vitrea var. vitrea	23	1	3	2	3	0	2	2	6	0
Asterionella formosa var. formosa	24	0	0	0	0	0	0	0	1	0
Caloneis alpestris var. alpestris	25	0	0	0	0	1	0	0	0	0
Caloneis oregonica var. quadrilineata	26	0	0	0	0	1	0	0	0	0
Caloneis species #1	27	6	2	2	2	0	0	0	3	1
Cocconeis disculus var. diminuta	28	15	5	4	3	10	1	3	14	8
Cocconeis disculus var. disculus	29	0	0	0	2	0	0	0	0	0
Cocconeis placentula var. placentula	30	3	3	2	2	3	6	3	5	13
Cyclotella stelligera var. stelligera	31	1	0	0	2	0	2	1	0	0
Cymbella angustata var. angustata	32	19	24	17	5	19	15	30	14	28
Cymbella aspera var. aspera	33	0	0	5	0	2	0	0	0	2

TAXON	ID	BPT2	BPT1	FHO2	LOG1	LOG2	LAP1	PBT1	PBT2	FHO1
Cymbella cesatii var. cesatii	34	0	0	0	0	0	1	4	1	0
Cymbella cymbiformis var. cymbiformis	35	0	1	0	0	0	5	1	2	0
Cymbella hustedtii var. hustedtii	36	3	0	0	0	0	1	0	1	0
Cymbella mexicana var. mexicana	37	0	0	1	0	0	0	0	0	0
Cymbella microcephala var. microcephala	38	8	7	3	4	13	13	1	0	3
Cymbella minuta var. minuta	39	3	0	2	0	1	0	4	2	0
Cymbella muelleri var. muelleri	40	0	0	0	0	0	0	0	1	0
Cymbella norvegica var. norvegica	41	0	0	0	0	0	0	0	0	4
Cymbella sinuata var. sinuata	42	3	0	0	0	2	0	0	0	3
Cymbella thumensis var. thumensis	43	3	0	2	0	4	0	0	3	0
Diploneis marginstriata var. marginstriata	44	5	5	5	0	3	0	2	3	1
Diploneis ovalis var. oblongella	45	0	0	0	0	0	2	0	0	0
Epithemia adnata var. minor	46	0	0	0	0	2	0	0	0	0
Epithemia adnata var. saxonica	47	0	0	0	0	0	0	0	1	0
Epithemia argus var. alpestris	48	21	11	11	4	19	12	16	15	30
Epithemia argus var. argus	49	6	0	0	4	0	0	0	0	0
Epithemia argus var. protracta	50	0	0	0	0	0	0	0	0	1
Epithemia smithii var. smithii	51	0	0	3	0	0	0	0	0	0
Epithemia sorex var. sorex	52	7	9	9	8	4	0	6	12	16
Epithemia turgida var. granulata	53	0	0	0	2	0	0	0	0	0
Epithemia turgida var. turgida	54	2	0	0	0	0	0	0	0	4
Epithemia turgida var. westermannii	55	8	9	6	6	4	3	4	1	8
Eunotia pseudopectinalis var. pseudopectinalis	56	0	0	0	0	0	0	0	1	0
Fragilaria binodis var. binodis	57	0	0	0	0	0	0	0	4	0
Fragilaria brevistriata var. brevistriata	58	23	0	63	40	7	17	23	78	19
Fragilaria brevistriata var. subcapitata	144	0	0	0	0	0	0	0	2	0
Fragilaria capucina var. capucina	59	0	16	0	0	0	108	0	0	0
Fragilaria construens var. construens	60	10	0	34	45	7	0	0	18	4
Fragilaria construens var. venter	61	51	23	26	40	46	9	20	100	67
Fragilaria crotonensis var. crotonensis	62	0	21	0	5	0	5	0	0	0
Fragilaria lapponica var. lapponica	63	4	0	12	0	7	5	0	8	6
Fragilaria pinnata var. intercedens	64	0	0	0	14	0	0	0	0	0
Fragilaria pinnata var. pinnata	65	16	3	4	69	67	0	43	40	54
Fragilaria species #1	66	0	0	0	0	0	0	0	0	4
Fragilaria vaucheriae var. vaucheriae	67	0	0	9	14	0	0	0	3	2
Frustulia rhomboides var. amphipleuroides	68	0	0	0	0	6	0	0	0	0
Frustulia vulgaris var. vulgaris	69	0	0	2	0	0	0	0	0	0
Gomphonema acuminatum var. acuminatum	70	0	0	0	0	0	0	0	3	6
Gomphonema affine var. insigne	71	0	0	0	3	0	0	0	0	0
Gomphonema gracile var. gracile	72	4	13	0	2	7	0	0	5	13
Gomphonema intricatum var. intricatum	73	0	0	0	0	0	0	0	1	0
Gomphonema intricatum var. vibrio	74	0	0	0	0	0	0	7	0	0
Gomphonema olivaceum var. olivaceum	75	0	0	0	0	0	6	0	0	0
Gomphonema scapha var. scapha	76	0	0	0	0	0	0	0	1	0
Gomphonema subtile var. subtile	77	0	0	0	2	0	0	0	0	0
Gomphonema tenellum var. tenellum	78	0	0	0	0	0	0	0	0	3
Gomphonema truncatum var. truncatum	79	0	0	0	0	0	0	0	0	3
Gyrosigma acuminatum var. acuminatum	80	2	1	0	0	0	1	1	1	1
Gyrosigma sciotense var. sciotense	81	0	0	0	0	0	0	0	2	0
Mastogolia greville var. greville	82	22	3	7	6	15	4	16	6	12
Mastogloia smithii var. lacustris	83	1	2	3	4	0	1	2	1	2
Melosira italica var. subarctica	84	2	1	1	1	3	1	0	0	9
Navicula bryophila var. bryophila	85	0	0	0	0	0	0	0	1	0
Navicula cinta var. cinta	86	0	0	0	0	0	0	0	1	0
Navicula cocconeiformis var. cocconeiformis	87	1	0	1	1	3	0	0	0	1
Navicula cryptocephala var. veneta	88	0	0	0	0	0	0	0	2	0
Navicula exigua var. capitata	89	0	0	0	0	0	0	3	0	0
Navicula exigua var. exigua	90	1	0	0	0	0	0	0	0	0
Navicula fluviatilis var. fluviatilis	91	0	0	0	0	0	0	0	1	0
Navicula globosa var. globosa	92	0	4	1	1	6	0	0	0	0
Navicula graciloides var. graciloides	93	2	0	0	0	0	0	0	0	0
Navicula heufleri var. heufleri	94	0	0	0	1	0	0	0	0	0
Navicula lapidosa var. lapidosa	95	0	0	0	0	1	0	0	0	0
Navicula laterostrata var. laterostrata	96	0	0	0	0	0	0	1	0	0
Navicula menisculus var. upsaliensis	97	0	0	0	0	0	0	1	0	2

TAXON	ID	BPT2	BPT1	FHO2	LOG1	LOG2	LAP1	PBT1	PBT2	FHO1
Navicula notha var. notha	98	0	0	0	0	0	0	0	0	9
Navicula minima var. minima	99	3	0	6	16	20	2	4	4	15
Navicula pseudoscutiformis var. pseudoscutiformis	100	5	2	0	0	3	2	0	4	1
Navicula pupula var. mutata	101	2	0	0	0	0	0	0	0	0
Navicula pupula var. pupula	102	0	1	0	0	0	1	0	1	0
Navicula pupula var. rectangularis	103	0	0	0	0	0	0	1	0	2
Navicula radiosa var. radiosa	104	7	4	3	6	2	0	3	2	0
Navicula radiosa var. tenella	105	2	4	11	0	4	8	0	9	0
Navicula rotunda var. rotunda	106	0	0	0	1	0	0	0	0	0
Navicula seminuloides var. seminuloides	107	0	0	0	0	0	0	0	0	3
Navicula seminulum var. intermedia	108	0	0	0	0	0	0	0	4	5
Navicula seminulum var. radiosa	109	1	0	0	7	0	0	0	1	4
Navicula seminulum var. seminulum	110	17	4	16	8	20	16	12	36	0
Navicula subatomiodes var. subatomoides	111	0	0	0	0	3	2	4	3	2
Navicula subocculta var. subocculta	112	0	0	0	0	0	0	0	0	1
Navicula symmetrica var. symmetrica	113	0	0	0	0	0	0	0	5	0
Navicula tantula var. tantula	114	0	0	0	0	2	0	0	0	0
Navicula vitabunda var. vitabunda	115	0	0	0	0	0	0	0	1	0
Neidium bisulcatum var. bisulcatum	116	0	0	0	0	1	0	0	0	0
Nitzschia denticula var. denticula	117	0	0	0	1	0	0	0	0	2
Nitzschia dissipata var. dissipata	118	1	1	8	0	1	4	3	3	1
Nitzschia fonticola var. fonticola	119	13	31	19	19	25	11	27	2	19
Nitzschia frustulum var. frustulum	120	9	12	18	26	0	5	9	8	0
Nitzschia gracilis var. gracilis	121	7	13	14	7	27	23	19	4	0
Nitzschia lanceolata var. lanceolata	122	0	0	0	0	0	0	2	0	0
Nitzschia linearis var. linearis	123	0	0	0	0	0	0	0	2	1
Nitzschia subtilis var. subtilis	124	0	0	0	0	0	3	0	0	0
Pinularia abaujensis var. rostrata	125	0	0	0	0	0	0	0	1	0
Rhopalodia gibba var. gibba	126	49	7	27	13	39	5	25	11	13
Rhopalodia gibba var. ventricosa	127	6	0	3	2	11	0	1	0	0
Rhopalodia parallela var. parallela	128	2	3	4	0	17	0	2	0	16
Stauroneis smithii var. smithii	129	0	2	0	0	0	0	0	1	0
Stephanodiscus carconensis var. carconensis	130	1	1	2	1	0	1	1	3	3
Surirella delicatissima var. delicatissima	131	6	5	12	11	11	8	10	0	14
Synedra acus var. acus	132	0	0	0	0	0	1	0	0	0
Synedra acus var. radians	133	2	4	0	1	0	7	0	5	8
Synedra capitata var. capitata	134	0	0	0	0	1	0	0	0	4
Synedra delicatissima var. delicatissima	135	8	0	16	11	21	4	7	3	33
Synedra incisa var. incisa	136	0	0	0	0	2	0	0	0	0
Synedra minuscule var. minuscule	137	11	38	2	12	0	1	9	0	0
Synedra parasitica var. parasitica	138	2	3	0	0	0	0	0	1	0
Synedra radians var. radians	139	0	15	0	0	0	0	0	0	0
Synedra rumpens var. familiaris	140	15	101	28	33	11	111	65	0	4
Synedra rumpens var. rumpens	141	0	13	0	0	0	3	7	0	0
Synedra ulna var. chaseana	142	4	5	2	3	0	21	0	0	1
Synedra ulna var. ulna	143	0	0	0	0	0	0	2	5	0

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-219 December 1991