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CONTROL OF PHOSPHORUS BY HARVESTING AND ALUM

Eugene B. Welch

Water Resources Series
Technical Report No.152
December 1996

Seattle, Washington
98195

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ACKNOWLEDGMENTS

The monitoring and research presented in this report were conducted by a total of 13 graduate students over the 20-year total project period, beginning in 1976. The emphasis here is on the latter portion of the period during 1988 through 1995, concentrating on the efforts and theses of Richard F. Chase, E. Bruce Kvam, Peter T. Leinenbach, Tarun Jaiswal, Michael T. Schwar, and Ingrid Wertz. The extensive contribution to the project by Professor Dimitris E. Spyridakis via supervising chemical analyses of water and sediments and advising students is greatly appreciated.

The project would not have been possible without the local funding and copperation of Kitsap County, especially Larry Cote, in maintaining the harvesting program and operation of the harvester, which was driven by George Cressman. Boat storage space provided by Mel Price was greatly appreciated.

Control of Phosphorus by Harvesting and Alum

INTRODUCTION

The primary objective of this project was to evaluate macrophyte harvesting as a control for phosphorus (P) in Long Lake, Kitsap County, Washington. Senescence of Eurasian watermilfoil (*Myriophyllum spicatum*) has been shown to account for a substantial fraction of the internal P loading in shallow lakes during summer (Carpenter, 1980; Smith and Adams, 1986) and others (Peterson et al., 1974; Wile, 1978) have calculated the potential removal of internal P loading by harvesting macrophytes before senescence occurred. Given that the maximum, whole-lake mean biomass of rooted macrophytes during summer in Long Lake has ranged between 100 and 200 g/m^2 in the past and biomass in the shallow south end usually exceeds 300 g/m^2, removal of plants by harvesting prior to senescence has been suggested as a reasonable approach to reduce internal P loading and thereby reduce algal biomass and increase water transparency (Jacoby et al., 1982). Therefore, plants were harvested in Long Lake during summers of 1988-1990 to determine if water column total P (TP) could be significantly reduced by harvesting over three successive years. While harvesting had been suggested as a possible approach to reducing internal loading and even as a means to limit the availability of sediment-P for plant uptake (Carpenter et al., 1977), to date this project is the only whole-lake test of harvesting to control lake TP.

Harvesting became effective over the three-year period, eventually resulting in the removal of 69% of the whole-lake biomass. However, TP did not decline in proportion to plant removal (Chase, 1990; Kvam, 1991; Welch et al., 1994). The probable reasons, which will be discussed, are that; 1) the dominant plant in the lake is *Egeria densa* (common aquarium plant or Brazilian elodea), which is slower to senesce during summer than watermilfoil, and 2) internal P loading in Long Lake was shown to originate largely from bottom sediments in the open water portion of the lake and that *E. densa* probably inhibited, rather than caused internal loading in areas with plants (Welch et al., 1988; Welch and Kelly, 1990; Welch et al., 1994). Others have determined that even if large releases of P occur upon senescence and decomposition of submersed aquatic plants, most of that P is sorbed by bottom sediments and is not transported to the open water (Dierberg, 1992). Nevertheless, harvesting may be effective as a deterrent to internal loading in lakes where watermilfoil is dominant. While that has never been tested in a whole-lake experiment, watermilfoil decomposition in enclosures has raised P and chlorophyll *a* concentrations (Landers, 1982).

A secondary objective of this project was to evaluate the effectiveness of a second alum treatment. Initially, the purpose of an alum treatment was to remove P from the water following a second phase of harvesting during which harvested plants were to be left in the lake to decompose. That second phase was intended to create a worst-case plant senescence and P release to the water. Unfortunately, the experiment as planned was not permitted by the Department of Ecology. Instead, a small amount of plants was held in an enclosure while water quality characteristics were observed in and outside the enclosure. Because the plant mass utilized was limited, the results observed could not be extrapolated to the whole lake and will not be presented. Nevertheless, the second alum treatment was carried out as planned

Data were sufficient to evaluate first treatments with alum in 21 U.S. lakes (Welch and Cooke, 1995), yet Long Lake was the only one to have been treated twice. The first treatment of Long Lake sediments, in September, 1980, was highly successful, reducing whole-lake TP during summer by about two thirds. That treatment was apparently still effective after nine years, although effectiveness had declined to a reduction of only about one third of the pretreatment level (Welch and Schrieve, 1994; Welch and Cooke, 1995a,b). Alum, buffered with sodium carbonate, was added to the lake at about the same dose (6.3 mg/L Al) as in the first treatment (5.5 mg/L Al). The second treatment was initially more effective than the first treatment; TP decreased to a summer mean of 19 μg/L the first summer (1992) after the September 1991 treatment. However, TP during the next spring and summer (1993) averaged 15 μg/L higher (summer mean 45 μg/L) than summer means during 1981-1984, following the first treatment.

Possible reasons for the unexpected resurge in TP will be discussed. TP declined again to less than pretreatment levels in summer 1994.

The 19 years of macrophyte data collected by UW personnel in Long Lake in the course of this and previous projects was also analyzed to evaluate factors that could have caused the large, year-to-year fluctuations observed in *E. densa* biomass. Although not initially part of the project, the uniqueness of the data set was considered worthy of such evaluation. Deliberate attempts to control plants were generally unsuccessful. Lake-level drawdown during the summer of 1979 had only a short-term effect on biomass and three successive years of harvesting macrophytes, primarily in the lake's south end, had no effect on biomass at best and at worst may have slowed a general, lake-wide decline in biomass (Wertz, 1996). Explanations are not entirely clear for two biomass reductions of *E. densa* in 1985 and 1993. They may have been a result of extended periods of ice cover or symptoms of an overall decline in *E. densa* biomass in the lake over the years of observation. Such a decline in *E. densa* has been observed in Lake Rotora, New Zealand, resulting in a virtual disappearance of the plant (Clayton and de Winton, 1994). Summer biomass and growth rate of *E. densa* in Long Lake was directly related to water transparency, but whether the plant's abundance was an effect or cause of increased light transmittance is uncertain (Wertz, 1996). While whole-lake biomass increased with increased clarity following the two alum treatments (Wertz, 1996), the magnitude of those changes were well within other year-to-year fluctuations. Moreover, its population did not reach the whole-lake pre-treatment magnitude that existed in the late 1970s.

Although *E. densa* is an exotic species and considered a nuisance, this long-term set of observations on its year-to-year abundance, response to management and largely unknown, adverse factors, and its effect on lake water quality, indicate that the plant; 1) benefits water quality, 2) can not be effectively controlled by drawdown or harvesting and 3) has shown an apparently natural long-term trend of decline and may eventually become scarce as it has in at least one other lake.

SITE DESCRIPTION AND MANAGEMENT ACTIVITY

Long Lake is a soft water, eutrophic lake located in Kitsap County, Washington (Figure 1). Its area is 137 ha and mean and maximum depths are 2 m and 4 m, respectively. Approximately 75% of the lake is less than 3 m in depth, and 40% is less than the mean depth. Consequently, Long Lake is composed of mostly littoral zone. There is one major inflow (Salmonberry Creek) and one major outflow (Curley Creek). The lake flushes at a relatively high rate (4-8/y) with most exchange occurring in winter and least in summer.

The majority of the macrophyte biomass is located in the southern-most section of the lake (the Lilies region) where lilies species and *E. densa* form dense beds, that usually restrict boat access in the summer. *E. densa* is of particular interest in Long Lake because it is an exotic and invasive species that dominates the macrophyte community. Anecdotal evidence indicates that *E. densa* first appeared *circa* 1970. The dominant species present in the lake are *E. densa, Potamogeton praelongus*, *Ceratophyllum demersum*, *Brasenia schreberi*, *Nuphar polysepalum*, and *Nymphaea odorata*.

The watershed is 2,430 ha and until recently, development had been relatively slow. In 1973, 69% of the watershed was forest, 20% agricultural and only 5% was suburban residential (Bortelson et al., 1976). However, single family residences with septic tank drainfields occupied much of the lake shoreline. Even with such a low-level of development a nutrient loading change was evident in sediment profiles of P (Welch et al., 1988b). The sedimentation rate, however, was typical for shallow lakes in the Puget Sound lowlands; from 1950 through 1978 it averaged 0.43 cm/y (Perkins et al., 1979).

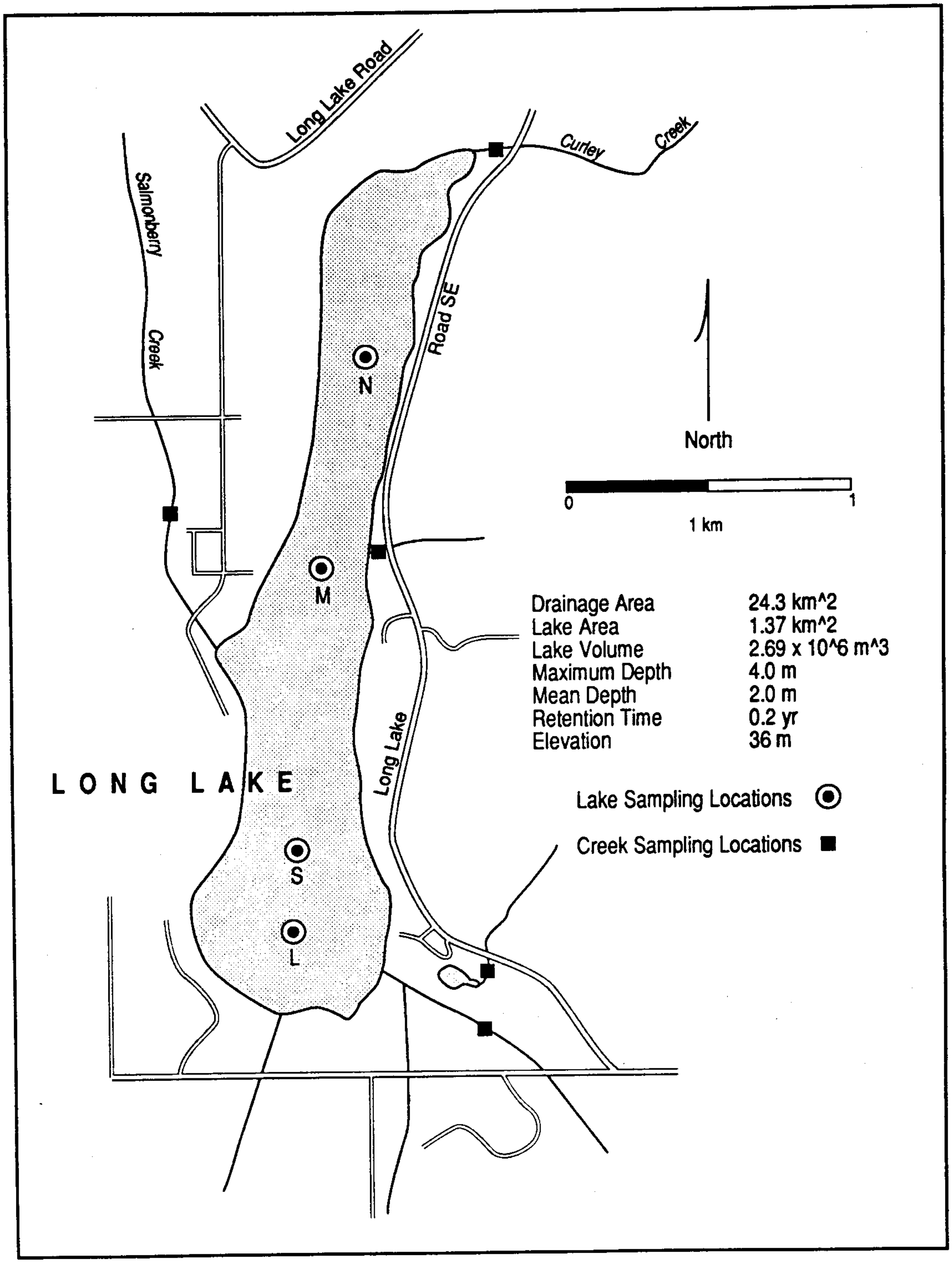

Figure 1. Long Lake sampling locations and morphometric characteristics (USGS, 1981).

The Long Lake Rehabilitation Project, funded by the U.S. Environmental Protection Agency (EPA) and Department of Ecology (DOE) in 1975, was initially aimed at macrophyte control and reduction of external nonpoint loading of nutrients. Internal nutrient loading was not addressed. However, internal P load was soon shown to be a more significant source, especially in summer (Gabrielson, 1978; Jacoby et al., 1982). A small-scale (5% of lake bottom) dredging operation in the northern region was completed in summer 1979, primarily to open the outlet area. That dredging did not have a substantial effect on internal loading and water quality because of the small area involved (Entranco, 1980).

Alum (unbuffered aluminum sulfate) was added to the lake in fall 1980 to inactivate sediment phosphorus. The most southern area of the lake (lilies) was not treated due to the uncertainty of an even alum distribution among the dense macrophytes (Entranco, 1980). Although total P (TP) decreased markedly following the drawdown, the alum treatment was considered to have been more effective than drawdown in inactivating sediment P over the long term (Jacoby et al., 1982). The alum treatment was considered highly effective in curtailing sediment P release for four years and partially effective for another six to seven years (Welch and Kelly, 1990; Welch and Schrieve, 1994). In the interim, effectiveness decreased markedly in 1985 coincident with a large decrease in macrophyte biomass, but then recovered two years later along with macrophyte biomass.

The principal emphasis of this report is on a harvesting program that was undertaken during summers 1988 to 1990 with personnel from Kitsap County. In order to maximize removal efficiency, harvesting was concentrated in the southern area (South and Lilies regions, see Figure 1) of the lake where plants were densest. The goal of the program was to reduce macrophyte biomass thereby reducing plant senescence as a source of internal P loading. Cumulative harvests in 1988, 1989, and 1990 removed 10%, 43% and 69%, respectively, of late summer whole-lake macrophyte biomass (Kvam, 1992). Boat access was improved even though regrowth was rapid. The plants simply became bushier and grew closer to the bottom producing essentially the same biomass. Macrophyte removal did not reduce lake TP content, however, indicating that their senescence was not a significant source of internal P loading. Possible reasons for that will be discussed.

The lake was treated again with alum in fall 1991. Alum was applied in all areas greater than 1.5 m depth except the Lilies region. That represented approximately 50% of the lake surface area. The lake was monitored intensively during and immediately after the treatment to determine any adverse effects of the treatment (Leinenbach, 1993). This is apparently the only thoroughly evaluated second alum treatment. In some respects the second treatment was more effective than the first, although the high level of effectiveness did not persist as long (Jaiswal, 1993).

METHODS AND MATERIALS

Sample Collection

Long Lake was sampled for chemical and biological constituents consistent with previous two decades of study. Samples for chemical and biological constituents were collected usually twice monthly from May through September and monthly the remainder of the year. Samples were collected from the surface, middle, and bottom of the lake water column at the North (N), Midlake (M), and South (S) stations (Figure 1). The southern most section of the lake has extensive macrophyte coverage, so only surface samples were collected at the Lillies (L) station. Samples from the bottom were collected 0.5 m above the sediment surface to avoid contamination. Salmonberry and Curley Creeks were sampled at the respective staff gauge locations. Except for 1982-1983 when summer samples only were collected, Long Lake has been monitored consistently in this manner from 1976 through 1994.

Temperature and dissolved oxygen (DO) profiles were determined *in situ* at 0.5 m increments at each of the four lake stations using a YSI Model 57 meter and probe. The temperature measurements were checked against a thermometer in the field. Water samples for DO analysis were also collected coincident with the *in situ* observations. These values were used to correct meter readings for DO as needed. Both temperature and DO were also determined *in situ* in the inflow and outflow streams. All samples were analyzed for pH. Transparency and depth were determined at each lake station using a Secchi disc on the shady side of the boat.

Water Sample Analysis

Water samples were analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), nitrate plus nitrite nitrogen (NO_3-N, ammonium nitrogen (NH_4-N), and alkalinity. As proposed, nitrogen forms were determined during 1988-1991 only. Samples for soluble nutrients (SRP, NO_3-N, and NH_4-N) were filtered through 0.45 µm diameter Millipore filters that were pre-soaked in distilled water overnight prior to filtration.

Samples collected from the middle of N, M, and S stations, the surface of the L station, and both creeks were analyzed for total (TAL) and dissolved aluminum (DAL) prior to and following the 1991 alum treatment. Samples for DAL were filtered through a 0.45 µm Millipore filter in the field.

Surface samples were analyzed for chlorophyll *a* (chl *a*) by filtering lake water through Gelman 25 mm (A/E) glass fiber filters. During the fall, winter, and spring 200 mL of sample were filtered. In the more productive summer months, only 50 to 100 mL were required.

TP samples were preserved with 2-3 drops of concentrated sulfuric acid, and TAL and DAL samples were preserved with 11 N nitric acid. All nutrient samples and chl *a* filters were then frozen for later analysis.

Table 1 lists the analytical techniques employed. The water used in all the above analyses was "ion and organic matter free" having passed through a 1 µm filter, activated carbon cartridge reverse osmosis ion exchange resins and final filtration through 0.22 µm. Accuracy, or percent recovery, was determined on several occasions during 1988-1992 using known standards from the EPA. Determined values for TP and SRP, the most critical nutrients, ranged from 95-105% and 100-102%, respectively. Accuracy for N forms was as follows: TN - 78%, NO_3-N - 96% and NH_4-N - 90%. Precision and accuracy for chl *a* was $\pm$ 2.6% and 87%, respectively.

Constituents were reported as whole-lake means, calculated by a volumetric weighting scheme as follows:

$$[\text{Mean lake}] = 0.67[\Sigma\, N, M)/n] + 0.33[\Sigma\, S,L)/n] \quad (1)$$

where n is the number of samples

The standard error (SE) of the whole lake means was determined by Scheaffer et al. (1990), and the formula is represented in equation 2:

$$[SE] = 0.67\ [SD(n,M)/\sqrt{n}\,] + 0.33[SD(S,L)/\ \sqrt{n}\,] \quad (2)$$

where SD is standard deviation.

Table 1. Physical characteristics and methods for chemical constituents determined in Long Lake

Characteristic	Method	Reference
TP	Persulfate digestion/ascorbic molybdate	APHA (1992)
SRP	Ascorbic molybdate	APHA (1992)
TN	Persulfate digestion/Colorimetric	Solórzano (1980)
NO_3^--N	Phenolate/Colorimetric	APHA (1992)
Total aluminum Dissolved aluminum	Inductively Coupled Argon Plasma (ICP) (ICP)	APHA (1992)
Chlorophyll *a*	Spectrophometric-Phaeophytin Corrected	APHA (1992)
pH	Beckman 10 meter and electrode	APHA (1992)
Alkalinity	Potentiometric titrations	APHA (1992)
DO	YSI probe and Winkler/Azide modified	APHA (1992)
Temperature	YSI probe and thermometer	APHA (1992)
Depth and Transparency	Secchi disc	APHA (1992)

Water and Phosphorus Budgets

Water and TP budgets for Long Lake were determined for the years 1988 through 1993. Budgets for earlier years are found in Welch et al. (1988b). A mass balance approach, based on the methodology described by Lynch (1982), was used consistently and results are reported in Appendix A.

Water budgets were determined according to the following:

Salmonberry Creek inflow + Precipitation + Ungauged inflow =

Curley Creek outflow + Evaporation + Change in lake storage (3)

Staff gauges in Salmonberry and Curley Creeks were read on each water sampling trip. Rating relationships were then used to calibrate flows from each stage measurement. The rating curves were developed from stage-discharge measurements made by DeGasperi (1987). The stage versus discharge data for both creeks were linearly related, with respective regression equations for Salmonberry and Curley Creeks as follows:

$$y = 24.450x - 86.691 \qquad r^2 = 0.94 \tag{4}$$

$$y = 17.892x - 127.79 \qquad r^2 = 0.93 \tag{5}$$

where x is the stage measurement and y is the resultant discharge measured in cubic feet per second (cfs). Flows were converted to m^3/s for computing water and P budgets.

After summer 1992, stage measurements in Salmonberry were taken from a new staff gauge located in a deeper and more uniform cross-section. Considerable filling had occurred at the original site. The relationship from the new site is as follows:

$$y = 0.906x - 7.240 \qquad r^2 = 1.000 \tag{6}$$

where x is the stage reading of the new gauge and y is the resultant discharge in m^3/s (Jaiswal, 1993). Discharge estimates from stage readings of the existing gauge (equation 4), fell within $\pm$ 3% of those calculated from stage readings of the new gauge (equation 6).

Precipitation data used were recorded at Bremerton and Wauna Weather Stations (11 km north and 13 km south, respectively, of Long Lake). Evaporation losses were determined from daily pan evaporation data obtained from Puyallup Weather Station. The values were multiplied by 0.7 (Dunne and Leopold, 1978) to estimate lake evaporation. Cumulative precipitation and evaporation values for each period were multiplied by the surface area of the lake to estimate respective input-output volumes for use in equation 3. Changes in lake storage were estimated from changes in Curley Creek stage, assuming that lake surface area remained constant.

Ungauged inflow represents the combined sources of surface and groundwater inputs and was determined for each period by solving for the residual in equation 3. Surface inputs include three minor tributaries and run-off. Partitioning the ungauged inflow into surface and groundwater components follows the following assumptions of Lynch (1982):

1. When input from the ungauged catchment is equivalent to 50% of Salmonberry Creek inflow, it is all attributed to surface water inflow. Groundwater contributions are therefore assumed to be negligible (zero).
2. During periods when input from the ungauged catchment exceeds 50% of Salmonberry Creek inflow, it is assumed that the ungauged surface input is equal to 50% of Salmonberry Creek plus one-half of the amount in excess of 50%. Groundwater is assumed to account for the other half of this excess.
3. When input from the ungauged catchment drops below an amount equivalent to 50% of Salmonberry Creek input, ungauged surface input is assumed to be equivalent to 50% of Salmonberry Creek and groundwater recharge from the lake accounts for the remainder.

The P budget was calculated using water quantities determined in the water budget. The P budget estimated the timing and magnitude of net TP flux to or from the sediments. The mass balance for P is described as follows:

Net sedimentation or Net internal loading =

[change in lake TP storage + Curley Creek TP output] -

Salmonberry TP input + ungauged surface TP input + groundwater TP input + atmospheric TP deposition + septic TP input] (7)

where a + result indicates net internal loading of P and - indicates net sedimentation of P.

Salmonberry Creek, Curley Creek, and lake TP values used in calculations were means of measured TP concentrations from successive sampling trips. Similarly, the TP content of three ungauged tributaries was estimated from the respective mean TP concentrations determined on several occasions and assumed to be constant. Groundwater inflow was assumed to contain 120 μg/L TP and outflow the mean lake TP for that period. Atmospheric deposition was assumed to be constant at 0.23 kg P/day and septic tank leachate at a rate of 0.29 kg/day (Lynch, 1982).

Macrophyte Sampling

Twenty-four macrophyte surveys were conducted between 1976 and 1994 to assess the changes in the distribution and density of aquatic macrophytes in Long Lake (Table 2). Surveys were usually conducted at the end of the growing season (August-October) to quantify peak macrophyte biomass. Eight surveys were conducted earlier in the season (March-June) to determine overwintering biomass and summer growth rates.

The macrophyte sampler consisted of one-half of a 55-gallon drum with the base removed. This provided a cylinder that enclosed an area of 0.255 m^2. Netting was attached to the upper edge of the drum forming a pouch. Lines were attached to the sides of the drum to raise and

Table 2. Summary of Macrophyte Survey Design, 1976-1994.

Survey Date	Depth Data	Drying Temp. (C)	# Sites Sampled	# Sites in Region N	M	S	L	Lake Partitioning Scheme
9/21/76 [a]	Y	105	44	14	13	10	7	Gabrielson (1977)
10/21/77 [a]	Y	105	23	7	6	4	6	"
6/28/78 [b]	Y	60	34	11	6	6	11	"
8/24/78 [b]	Y	60	34	11	6	6	11	"
3/14/79 [d]	?	?	?	?	?	?	?	?
6/26&27/80 [c]	Y	70	35	11	7	6	11	Jacoby (1981)
8/23/80 [c]	Y	70	40	11	12	6	11	"
6/23/81 [c]	Y	70	34	9	11	6	8	"
8/24/81 [c]	Y	70	34	9	11	5	9	"
9/18-20/84 [d]	Y	70	39	13	10	10	6	"
6/18&19/85 [d]	Y	70	40	14	13	8	5	"
8/5&7/85 [d]	Y	70	43	14	15	8	6	"
3/26&27/86 [d]	Y	70	40	13	13	8	6	"
9/4&5/86 [d]	Y	70	44	15	13	8	8	"
8/19/87 [e]	Y	50	42	14	14	9	5	"
8/22/88 [f]	Y	70	44	8	15	7	14	Chase (1990)
9/17/89 [f]	Y	70	44	6	18	6	14	"
9/5&6/90 [g]	Y	60	40	2	6	13	19	"
8/14&15/91 [h]	N	60	39	2	2	5	30	"
8/25&26/92 [i]	N	60	40	2	6	13	19	"
6/24&25/93 [j]	Y	103	40	2	2	8	28	"
8/16&17/93 [j]	N	103	40	2	11	4	23	"
5/7&8/94 [j]	N	103	40	9	6	5	20	"
9/15&16/94 [j]	Y	103	40	13	5	2	20	"

a - Gabrielson (1977)
b - Hufschmidt (1978)
c - unpublished data
d - de Gasperi (1987)
e - Kelly (1988)
f - Chase (1990)
g - Kvam (1992)
h - unpublished data
i - Jaiswal (1993)
j - ~~Appendix~~ Wertz (1996)

lower it from the boat. At each sampling site, the drum was lowered over the edge of the boat and a diver using SCUBA gear manually removed plants and roots within the sampler. Complete plant removal within the drum was determined by touch due to poor visibility caused by resuspended flocculent sediments. The macrophytes were secured in the net, raised to the surface, and placed in a labeled bag. Except for three years, depth was determined at the sample locations. Plant samples were washed with tap water in the laboratory to remove mud and epiphytes. With the exception of 1976-1978, samples were sorted by species. Samples were dried for a minimum of 24 hours at temperatures ranging from 50° C to 105° C and weighed (Table 2).

The number and location of sample sites varied slightly over the 19-year study period. Three methods were used to assess plant biomass. The initial method divided the lake into three regions, North, Midlake, and South (Gabrielson, 1977). The division was based on depth ranges and substrate composition. There were 44 designated sampling sites. The second method divided the lake into four regions, North, Midlake, South, and Lilies (Jacoby, 1981 and Figure 2) and sampling sites were not fixed (Chase, 1991). Neyman's Allocation (Schaeffer et al., 1990) was used in the third method to distribute 40 sampling sites among the four regions. The number of samples chosen for a specified region was proportional to the percentage of the biomass the region contained on the previous survey with no region receiving less than two sites. Locations of the sample sites within a given region were randomly determined using a grid map of the lake.

The four-region partitioning of the lake was based on substrate type and depth within each region which were observed to support a relatively homogeneous biomass of macrophtes (Jacoby, 1981). The North region represents 14% of the lake area and is characterized by a relatively steep slope and heterogeneous substratum some of which is rocky. The Midlake region represents 51% of the lake area and is the deepest region of the lake with a negligible slope and fine-grained and flocculent sediment. The South region represents 17% of the lake area and has a gentle slope. The Lilies region represents 18% of the lake area, with a large portion of the surface area covered by water lilies, *N. polysepalum* and *N. odorata*, during the summer. It is the

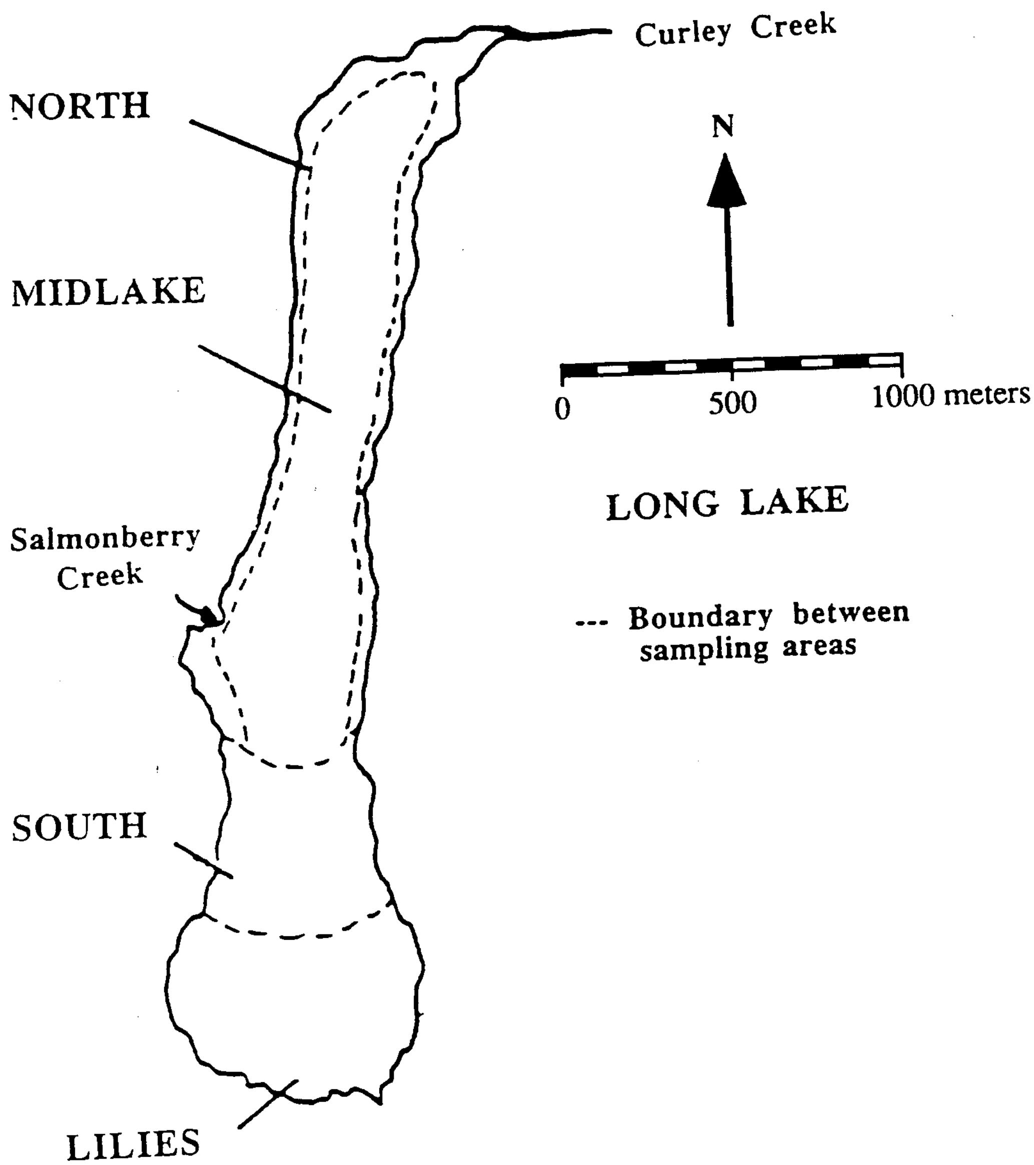

Figure 2. Macrophyte sampling regions.

shallowest region of the lake with an average depth of approximately 1 m and an average slope less than 0.3%. Both the South and Lilies regions have flocculent and peaty sediments. Whole-lake biomass was estimated by weighting the regional biomass values according to the above cited areal fractions.

Data Standardization

The nineteen years of macrophyte data were standardized in three ways to allow comparison. First, all the sampling locations were assigned to one of the four lake regions shown in Figure 2. This was done in order to compare biomass among years within each region. Data were converted to the four-region scheme because most of the surveys used this partitioning and the earlier three region surveys were easily redistributed since sampling locations were known.

Secondly, all macroalgae and lilies data were removed from total biomass calculations. Macroalgae was removed because it was unclear if it had actually been in all surveys. Lilies (*N. polysepalum* and *N. odorata)* data were not included because they had been omitted in some surveys. Lillies were represented by a large standing crop and would have greatly biased comparisons if included for some years only.

Thirdly, speciation was determined for the 1976-1978 biomass data. Raw data from these years consisted of biomass only for each sample site and a list of species present ranked according to abundance. To quantitatively distribute the sample site biomass among the species present, the following was assumed:

- In samples containing two species, the dominant species was assumed to represent 70% of the sample biomass. The other species was assumed to represent 30% of the sample biomass.
- In samples containing three species, the division of biomass was assumed to be 50%, 30%, and 20%.

These assumptions were consistent with observed species observations of sample composition from later surveys. They probably underestimated the biomass of *E. densa* while overestimating that of the less abundant species, *Ceratophyllum demersum* and *Potamogeton praelongus*. Species data from 1976-1978 was utilized primarily when evaluating the effects of the 1979 drawdown.

Macrophyte Senescence

Plant decomposition and P release were determined for *Egeria densa* and *Potamogeton praelongus* from August 1989 to January, 1990 at station L. Freshly cut shoots (25-35 g wet wt) of each species were placed in 15 Nitex bags (total 30 bags) in August and three bags with each species were removed on five occasions at 8, 21, 56, 117 and 178 days of incubation at about 0.5 m above the bottom. Dry weight of the remaining plant mass was determined for each bag. Dry weight of the initial plant mass was determined from a dry weight:wet weight ratio on six samples of each species collected prior to incubating the bags. P analysis of the remaining mass was performed in replicate according to Jackson (1958). Plant remains (0.25 g) were treated with 3 mL of alcoholic Mg $(NO_3)_2$ solution and 5 mL of deionized water and the mixture evaporated to dryness and combusted at 550^0 C for 2.5 hours. P was extracted from the ash with 10 mL of 2 N sulfuric acid and the resulting solution was filtered through 2 glass fiber filters in sequence. P was determined in the solution brought up to 100 mL after rinsing the filters twice with DI water.

Macrophyte Harvesting

Macrophytes were harvested continuously in Long Lake from May through September during 1988-1990. The harvesting crew worked 8 hours/day and five days/week. Harvesting was concentrated in the southern section of the lake, the area with the densest macrophyte biomass. Plants were removed with an Aquatics Unlimited H5-200 harvester with the cutter bar set to an approximate depth of 2.0 m below the water surface.

Harvested macrophytes were removed from the lake via a barge. The barge transported each load from the harvester to a nearby boat launch where the macrophytes were transferred to a trailer and hauled to a holding site for drying and eventual pickup for mulching.

The wet weight of harvested plants was determined by weighing the empty trailer and then the trailer containing random barge loads and calculating the difference. The number of harvested loads per day was recorded by the harvesting crew. P removed was subsequently computed from a dry:wet weight ratio and dry weight P content.

Phytoplankton

Phytoplankton samples were collected in labeled 120 mL plastic bottles from the surface at all lake stations to monitor community composition changes through the year. The collections were treated as four random samples and weighted equally. Samples were preserved with 4-6 drops of acid Lugol's iodine solution.

Algal counts were determined from 30 mL subsamples of the original samples. The subsample was centrifuged for 20 minutes, then aspirated to concentrate the sample by ten-fold. The resulting 3 mL volume was then mixed and aliquots were placed in a 0.1 mL Palmer-Malony cell for counting. The algal contents of fifty random entire Whipple Squares were identified to genus and enumerated for each 0.1 mL sample at 10X power. The enumeration method consisted of a total cell count, the counting unit being an individual cell. Approximate cell volumes were determined from the individual cell size and morphology of each genus to determine biovolume as mm^3/L. For filamentous algae, Olson (1967) was used to estimate algal cell counts.

Gleotrichia colonies are too large to be accurately enumerated by this technique. This genus was enumerated in zooplankton hauls and their biomass determined in a counting cell and expressed as colonies/L.

Zooplankton

Vertical samples were collected by hauls with a 0.5-m diameter No. 20 (76 μm) plankton net at each of the four lake stations. Hauls were from the water surface to 2.0 m in depth at N, M, and S. stations and from surface to 1.0-2.0 m in depth, depending on macrophyte density at station L. Samples were placed in labeled pint jars and preserved with 50% propanol.

At least 24 hours prior to counting, samples were stained with Eosin Y. Sample contents were concentrated for counting by passing through a 100 μm mesh filter. Large particulate organic matter was rinsed and removed from the slurry. Samples were then diluted to 0.5 or 1.0 L (depending on abundance) with tap water.

Samples were enumerated with a subsampling procedure. The diluted sample was randomly and gently stirred and a 5-10 mL subsample removed with a wide-bore pipette. The contents were then analyzed in a counting chamber. Three subsamples were enumerated from each dilution. Most Crustacea were identified to genus. Copepoda were identified to suborder and the Ostracoda to subclass. *Gleotrichia* colonies were also enumerated. Zooplankton results from the four stations are presented as no./L for the entire lake.

Sediments

Sediment cores were collected throughout the summers of 1988-1990 from the S and M stations to determine organic content in the surficial sediments. The cores were taken using a corer and core tubes 3.5 cm in internal diameter and 30 cm in length. The tubes were sealed at each end with no. 7 1/2 rubber stoppers and returned upright and undisturbed to the laboratory.

The top 2 cm of each sediment core was isolated by securing the core upright in a stand, removing the bottom stopper and extruding the core contents through the top. The top, wet 2-cm section was weighed in tared, pre-combusted aluminum dishes, dried for 24 hours at 103° C and then reweighed to determined water content and total fixed residues. Contents were next combusted at 550° C for approximately 20 minutes and reweighed to determine total volatile residues as an estimate of organic matter (Barko and Smart, 1979).

Sediment oxygen demand (SOD) was also determined on sediments collected from S and M stations in August 1988-1991. Cores were sectioned to isolate surficial 0-1 and 1-2 cm sections for this purpose. Wet 1-cm sections were weighed in tared aluminum dishes to estimate sediment density. Each section was mixed with a glass stirring rod and two, homogeneous, 0.5-gram samples were removed and placed in 300 mL BOD bottles. The BOD bottles were then filled with BOD dilution water (APHA, 1989). A static five-day BOD experiment was then performed in the dark at 20° C.

Oxygen demand was determined as mg of oxygen consumed by one gram of wet sediment in a 300 mL solution and after correction for density expressed as SOD in mg O_2/cm^3 of sediment. Final SOD results were expressed in g/m^2-day.

Sediment P release was determined in ten cores collected in August from both S and M stations. Care was taken to collect the same volume of sediment in each core tube. Cores were covered with opaque black plastic and returned undisturbed to the laboratory where rubber stoppers at the top of the cores were replaced with stoppers fitted with glass tubing. Cores were completely filled with bottom lake water, collected from the same stations, so that air space was expelled. Septums were properly placed over the exposed portion of the glass tubes and new stoppers were sealed with electrical tape.

Cores were incubated in the dark at 20° C in an anoxic chamber and sampled for TP and total soluble phosphorus (TSP) at 0, 8, 16, 32, and 64 days after incubation. Samples for TP and TSP were removed in an O_2-free atmosphere in a glove box purged 10-12 times with nitrogen gas.

Sixty mL of water was withdrawn from of two S and two M cores each sampling day with a 30 cm needle and 60 mL syringe. Water was removed a fixed distance (5 cm) from the sediment surface and stirring of sediments was avoided. Thirty mL of sample was filtered through a 0.45 μm Millipore filter, prewashed in ion-free water purged with nitrogen gas. Both filtered and unfiltered water was placed in 60 mL bottles with one drop of concentrated H_2SO_4 and frozen for later analysis.

Prior to TP and TSP analysis according to standard methods (APHA, 1989), 10 mL of sample was withdrawn from each 60 mL bottle and diluted by an appropriate factor (2-5) with ion-free water. P concentrations were multiplied by 0.15 m (water column depth in core tube) to determine P release on an areal basis and correct for the water volume inside the core tubes. The slope of the regression line between P and time was an estimate of the mean release rate over the incubation period and was expressed as mg P/m^2-day.

RESULTS

Macrophytes

Macrophyte biomass and species composition changed significantly since the project began in 1976. Management activity appeared to have little lasting effect on biomass or composition, yet there has been a net decline in biomass, especially of *Egeria*. The summer peak, whole-lake biomass decreased by 55% following the 1979 drawdown, using the 1976-1978 data as the pre-treatment base (Figure 3). However, biomass recovered quickly, approaching pre-treatment levels by 1984. Thus, the drawdown was considered unsuccessful, because it did not compact sediment as anticipated and the biomass reduction was short-lived (Jacoby et al., 1982). Exposed sediment over about 40% of the lake surface remained wet.

The largest observed change in macrophyte biomass during the 19 years occurred between 1984 and 1985 when populations declined at all sites to the minimum of 30 g/m^2 (Figure 3). Biomass recovered over the next two years to near pre-treatment levels, prior to the beginning of systematic harvesting. The abrupt decline was general at all sites in the lake (Figure 4).There were large areas of sediment in the lake's south end where *Egeria* was absent, but *Ceratophyllum* was abundant. *Egeria* had been by far the dominant species in the lake prior to the general decline, comprising about 90% of the biomass. That dropped to 60% in 1985 and in 1986, the contribution of the three major species in the lake was about equal (Figure 5). The effect of the decline on *Egeria* is more striking if its biomass were considered separately (Figure 6). It was clearly at its lowest 19-year level in both 1985 and 1986. *Egeria* recovered within two years to its previous level of dominance. The cause for that decline is unknown.

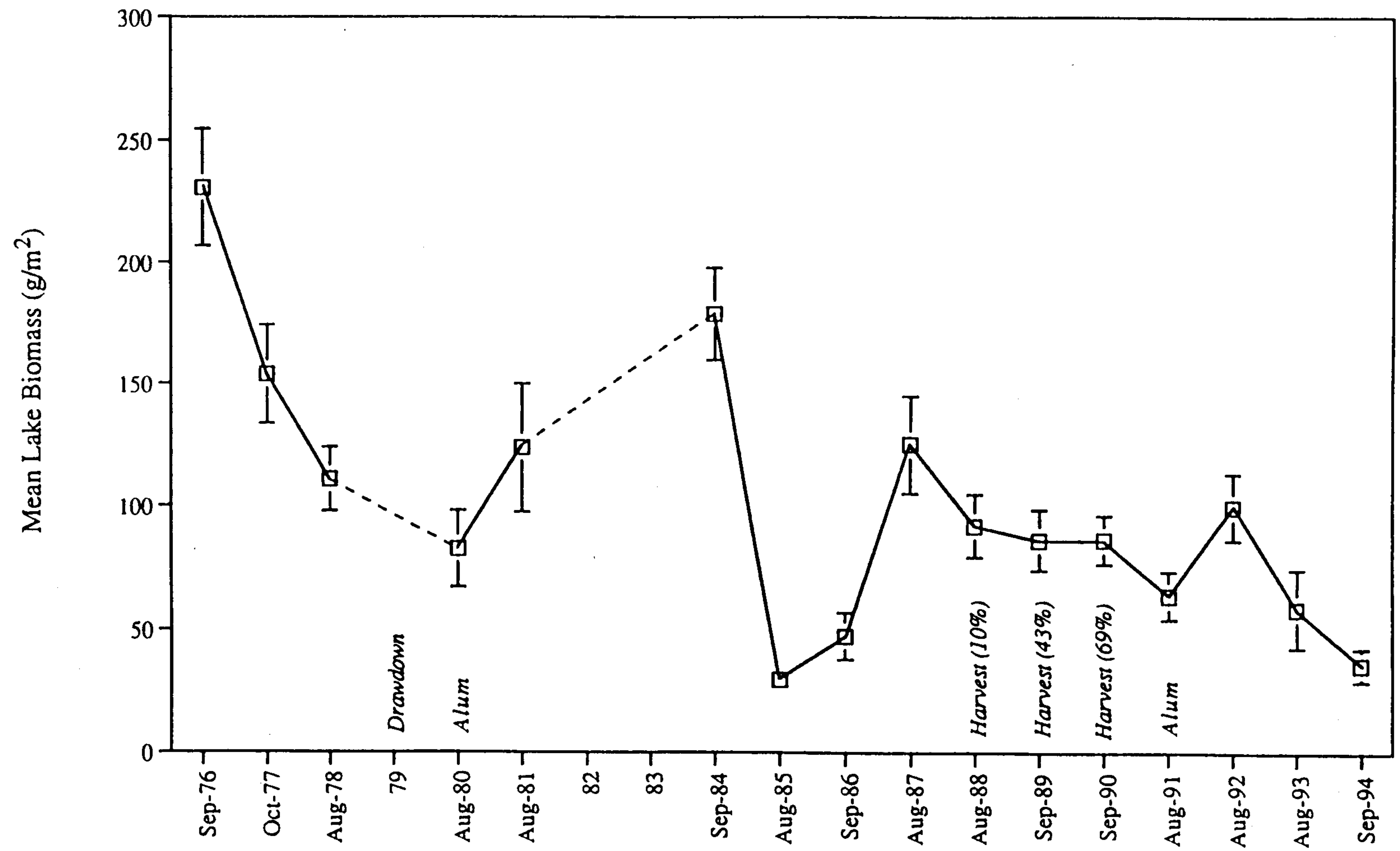

Figure 3. Mean biomass of macrophytes in Long Lake, WA from 1976 to 1994. Bars represent one standard error.

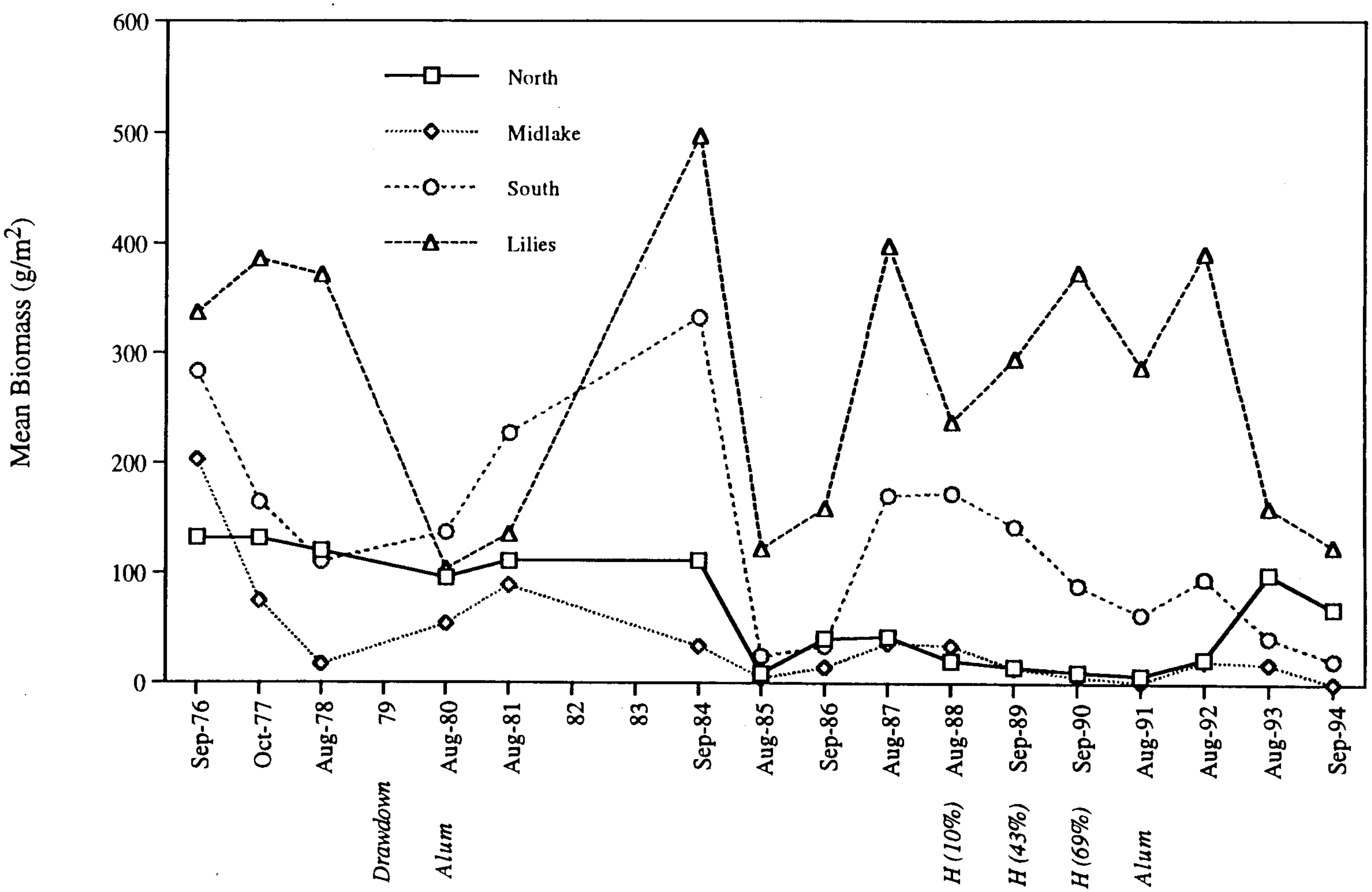

Figure 4. Mean biomass in the North, Midlake, South and Lilies Regions from 1976 to 1994.

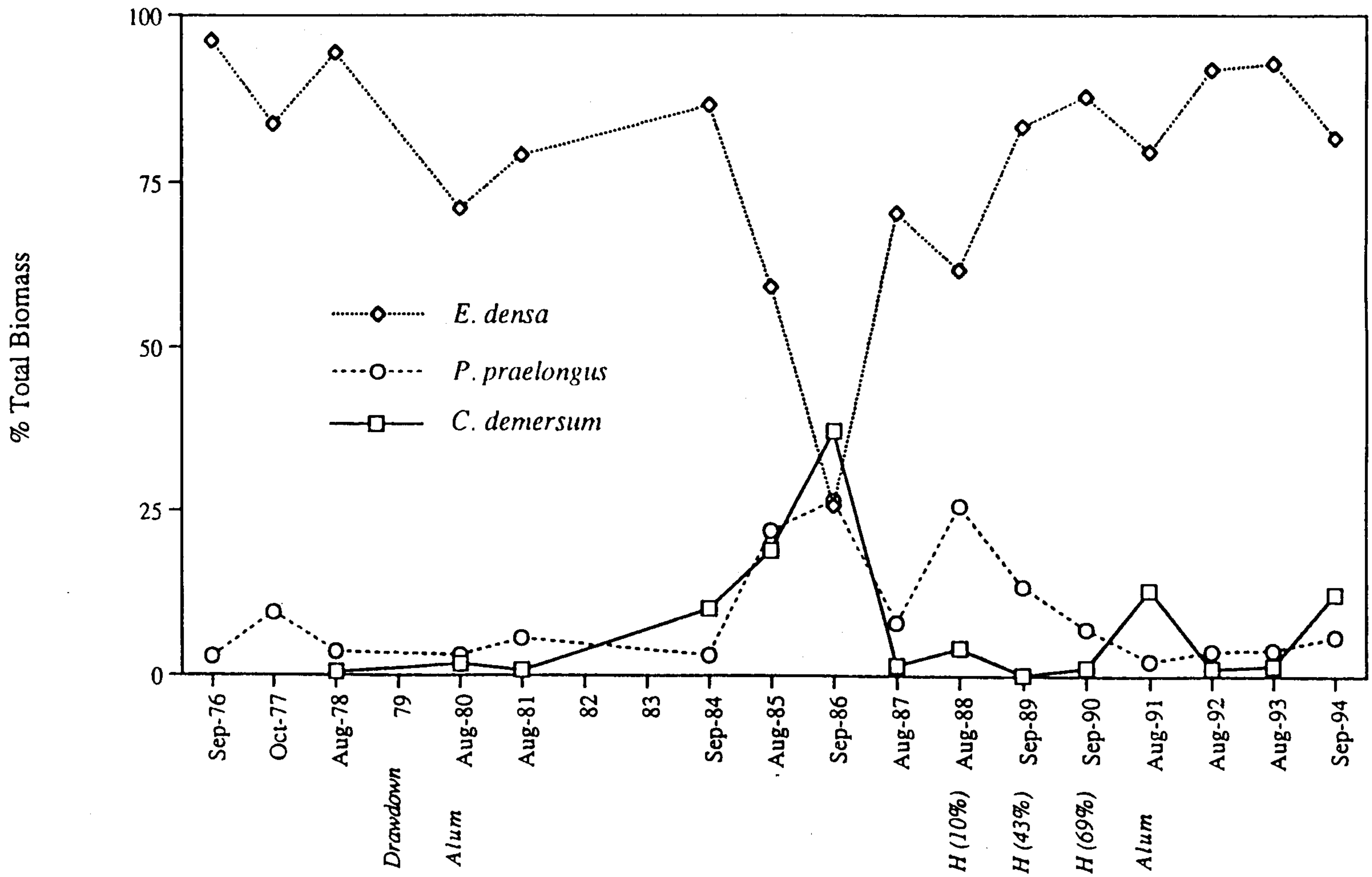

Figure 5. Percentage of total lake biomass of dominant macrophyte species in Long Lake, WA from 1976 to 1994

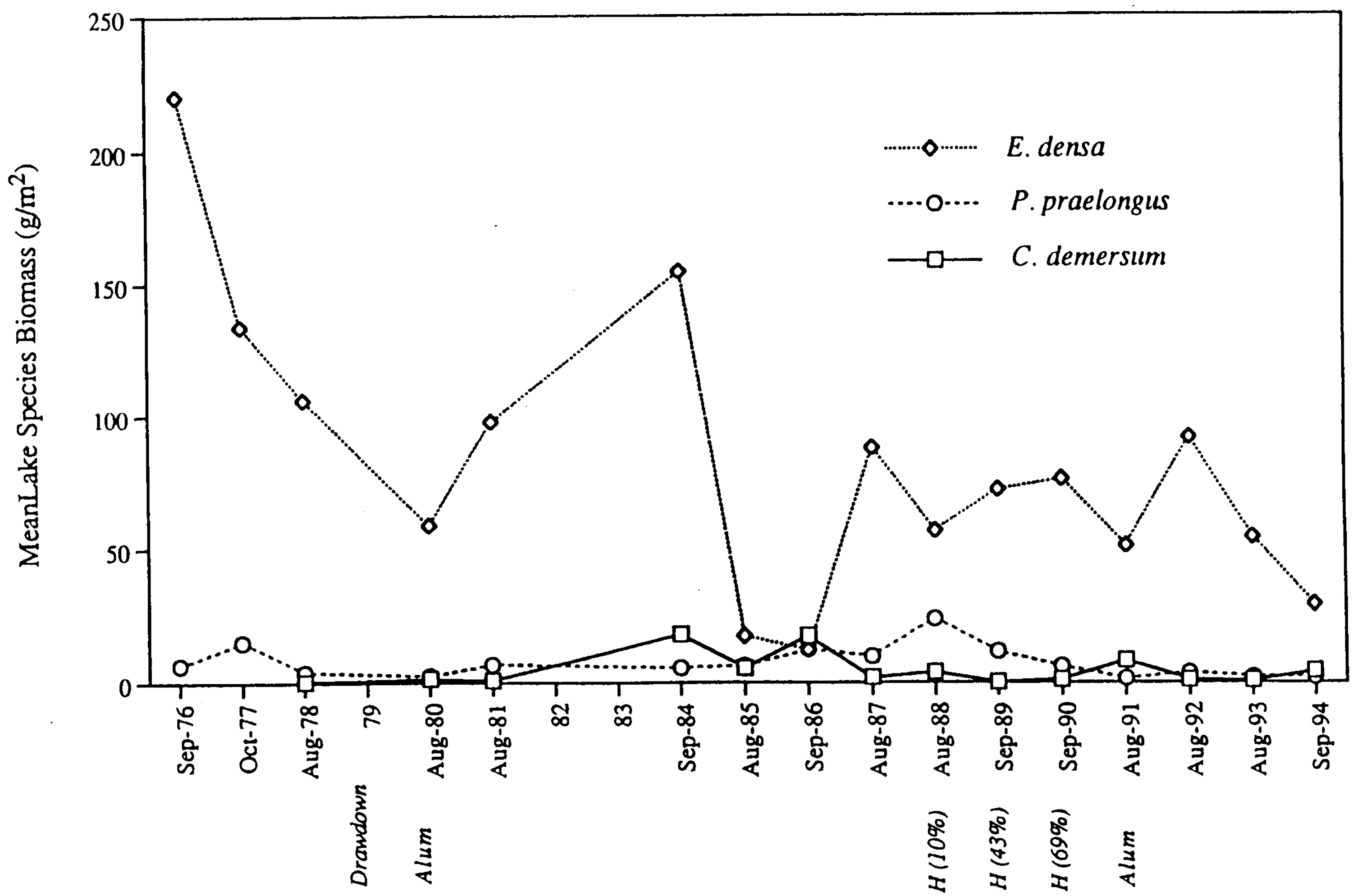

Figure 6 . Mean biomass of dominant macrophyte species in Long Lake, WA from 1976 to 1994.

During the summers of 1988-1990, harvesting removed a total of 160 metric tons (dry weight) of plant mass, largely in the South and Lilies areas (Table 3; Figure 2). Harvesting was concentrated where biomass was most dense in order to remove P as efficiently as possible in order to determine the effectiveness of harvesting at lowering lake TP content. Harvesting was more efficient in 1989 and 1990, because there were increasingly fewer mechanical problems. The harvester was accidentally overturned in 1988 requiring a complete overhaul of the motor and markedly fewer harvesting days than in the other two years.

The peak harvest in 1990 removed about 266 kg of TP , assuming that plant dry mass contained about 0.3% P (Table 3; Gabrielson, 1978). That mass represented about 20% of the external P loading to the lake in 1990. P mass removed in 1988 and 1989 represented only about 5 and 13% of external loading during those years. In spite of removing progressively larger fractions of whole-lake biomass up to a maximum of 69% in 1990, with removal concentrated in the south end, whole-lake biomass changed little (Figure 3). Harvesting simply could not keep up with regrowth. Nevertheless, plants tended to be bushier and not reach the surface during years of harvesting leaving more open water where plants did not reach the surface. Biomass did decrease slightly in the South area and increase slightly in the Lilies area during the period of harvesting, but given the error of estimate in biomass, the trends are not considered significant, especially since biomass in the South area continued to decline after harvesting had ceased (Figure 4).

Whole-lake biomass had declined to a level in 1994, the last year of sampling, similar to that in 1985 (Figure 3). Biomass had also reached a low level in the Lilies area, about equal to that during the 1985 decline and during post-drawdown when the entire Lilies area was dewatered (Figure 4). The same can be said for *Egeria*, which reached a biomass level nearly as low as during the years of general decline (Figure 6). The data clearly show that *Egeria* is less abundant in recent years than during the past. Prior to the general decline, *Egeria* biomass was less than 100 g/m^2 in 1980 only, the post-drawdown year (Figure 6). Since 1984, *Egeria* biomass has

Table 3. Summary of Long Lake macrophyte harvesting, 1988-1990.

Year	Harvester Loads	Mean Loads/Day	Total DW Removed (kg)	% of Peak DW Biomass Removed	TP Removed (kg)
1988	322	7.2	16,905	10.0	50.7
1989	732	11.1	54,695	42.8	164.1
1990	1,029	13.4	88,632	69.1	265.9

never been above that level. Moreover, *Egeria* biomass at areas N and M combined has been much reduced since the general decline in 1985 (Figure 4).

Macrophyte Senescence

Potamogeton showed the most rapid decay, losing 50% of its dry weight in about 60 days (Figure 7). In contrast, *Egeria* was more resistant to breakdown with about 90% of its mass remaining after 56. Fifty percent of its loss did not occur until the end of the incubation, January 10. The decay of *Potamogeton* biomass could be best described as exponential, but that of *Egeria* was more linear (Chase, 1990).

The loss rate of P from *Potamogeton* was double that of *Egeria* (Figure 8). After only 21 days, 50% of the P in *Potamogeton* leached or decayed away, while only 8% of the *P* in *Egeria* was lost in that time period. While 83% of the initial P in *Potamogeton* was gone by the end of the incubation, only 46% of the P in *Egeria* had been lost.

Phosphorus

Management options to control P, and hence algae, clarity and aesthetic quality in the lake included drawdown, two alum treatments and harvesting. TP remained consistently near 30 μg/L (mean 33 ± μg/L) for the four years following the first alum treatment in September, 1980, compared to the 1976-1978 pretreatment mean of 63 ± 19 μg/L, more than a 50% decrease (Figure 9, Table 4). While this four-year, consistently low TP concentration is attributed largely to the alum treatment, TP had also declined in the summer of 1980 following the 1979 all-summer drawdown.

A dramatic increase in TP (to 66 μg/L) occurred in 1985 coincident with a marked decline in macrophyte biomass, especially that of *Egeria* to the lowest two-year level during the 19-year period (Figures 3, 6). TP declined to 45 μg/L in 1986, although macrophyte biomass, including *Egeria*, remained low. TP continued to drop to the lowest level yet in 1986 (30 μg/L).

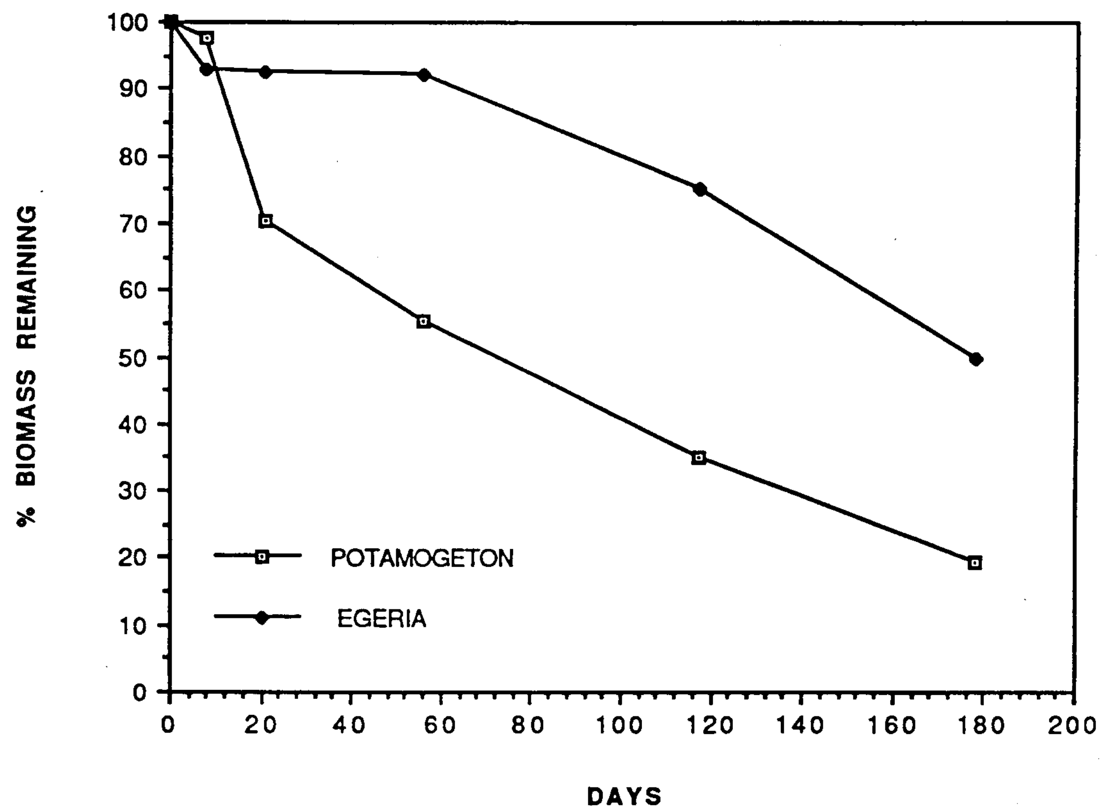

Figure 7 . Observed biomass loss of <u>Potamogeton</u> and <u>Egeria</u> in litter bags (Aug-Jan)

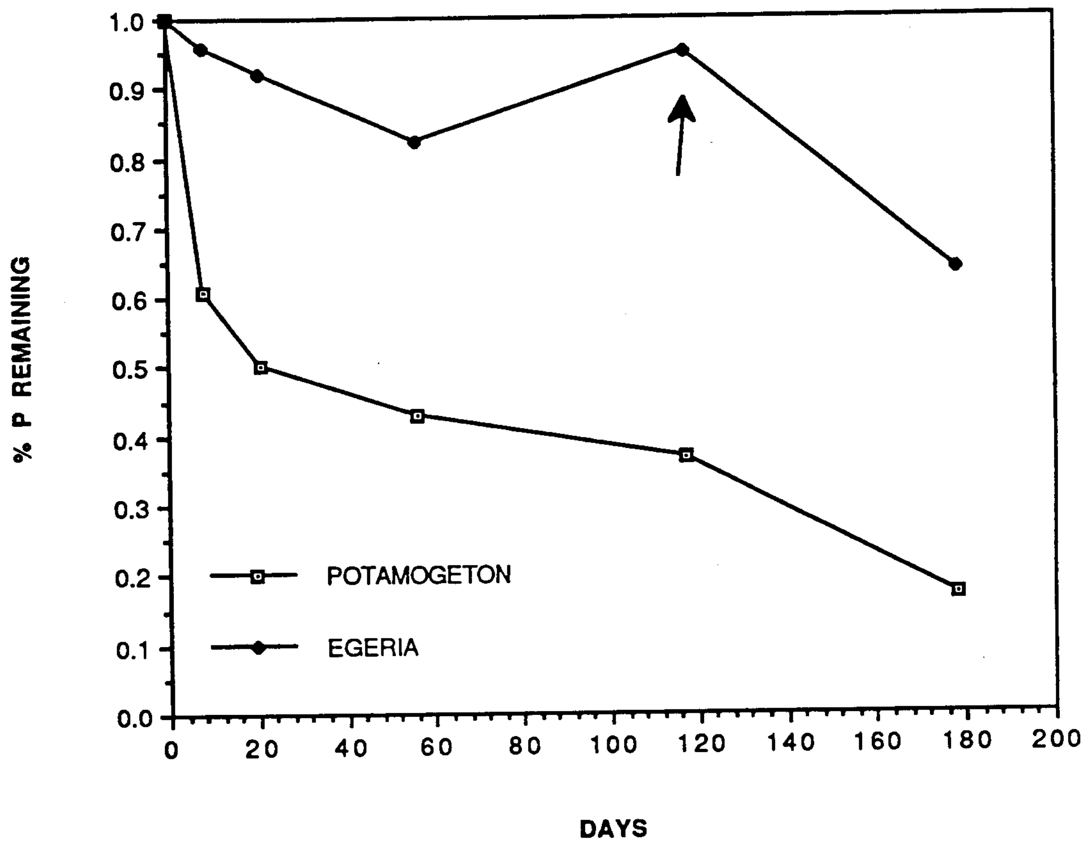

Figure 8 . Observed P loss from _Potamogeton_ and _Egeria_ in litter bags from Aug. 1989 to Jan. 1990

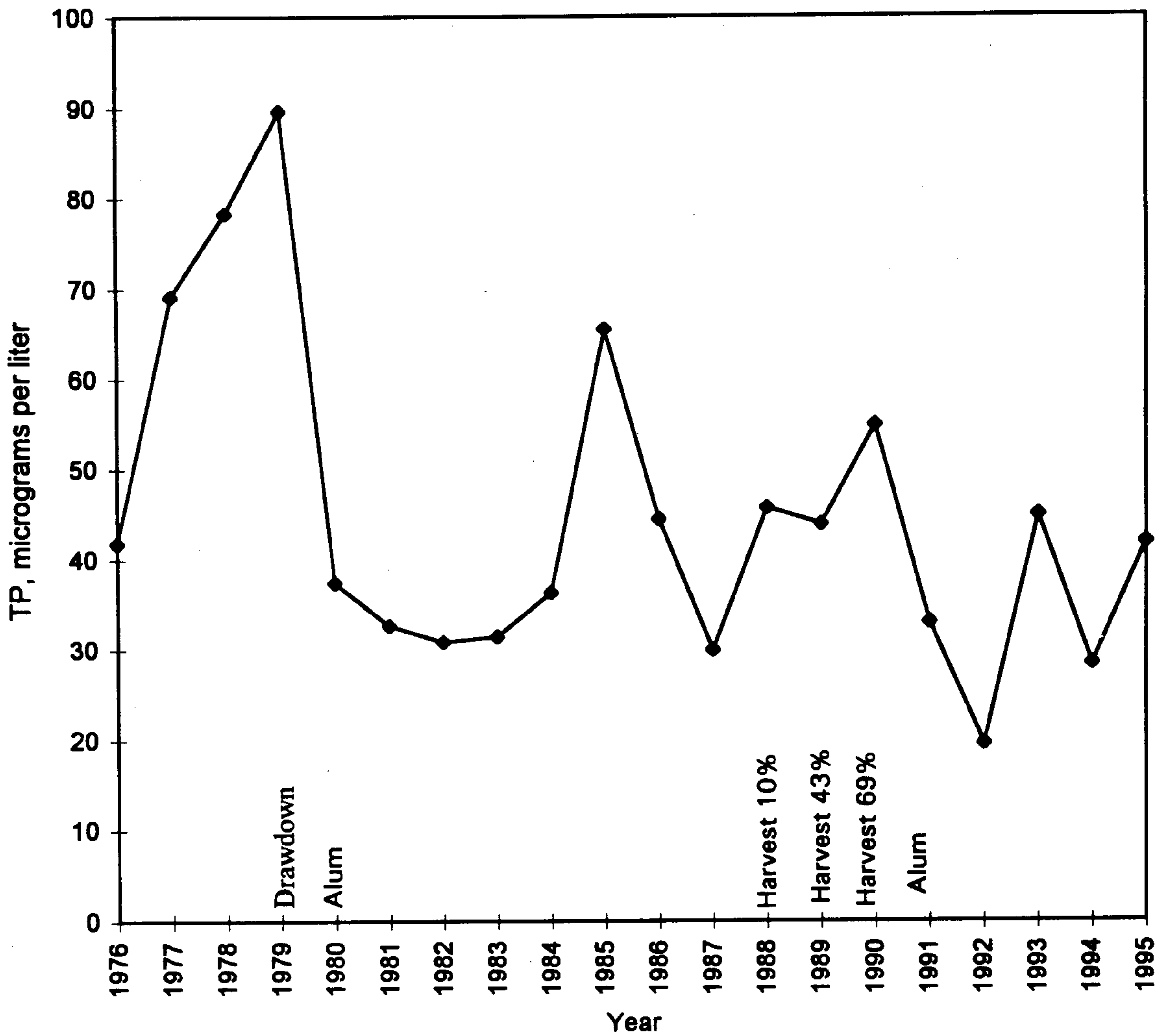

Figure 9. Volume weighted mean whole-lake TP concentrations during June-September from 1976 to 1995.

Table 4. Mean whole-lake TP, SRP, chl *a* concentrations, and Secchi depths during the summers (June-September) of 1976-1995.

Year	TP, ug/L	SRP, ug/L	chl a, ug/L	Secchi, m
1976	42	4	13	1.8
1977	69	8	29	1.4
1978	78	13	24	1.7
1979	90	11	16	1.1
1980	38	2	18	1.8
1981	33	4	16	2.2
1982	31	ND	4	3.0
1983	32	ND	11	2.1
1984	36	6	6	2.5
1985	66	5	36	1.1
1986	45	7	16	1.9
1987	30	2	11	2.1
1988	46	6	11	2.2
1989	44	5	16	1.5
1990	55	4	40	1.0
1991	33	3	12	1.3
1992	20	2	4	3.0
1993	45	4	16	1.1
1994	29	3	10	1.5
1995	42	4	10	1.9

ND= not detected

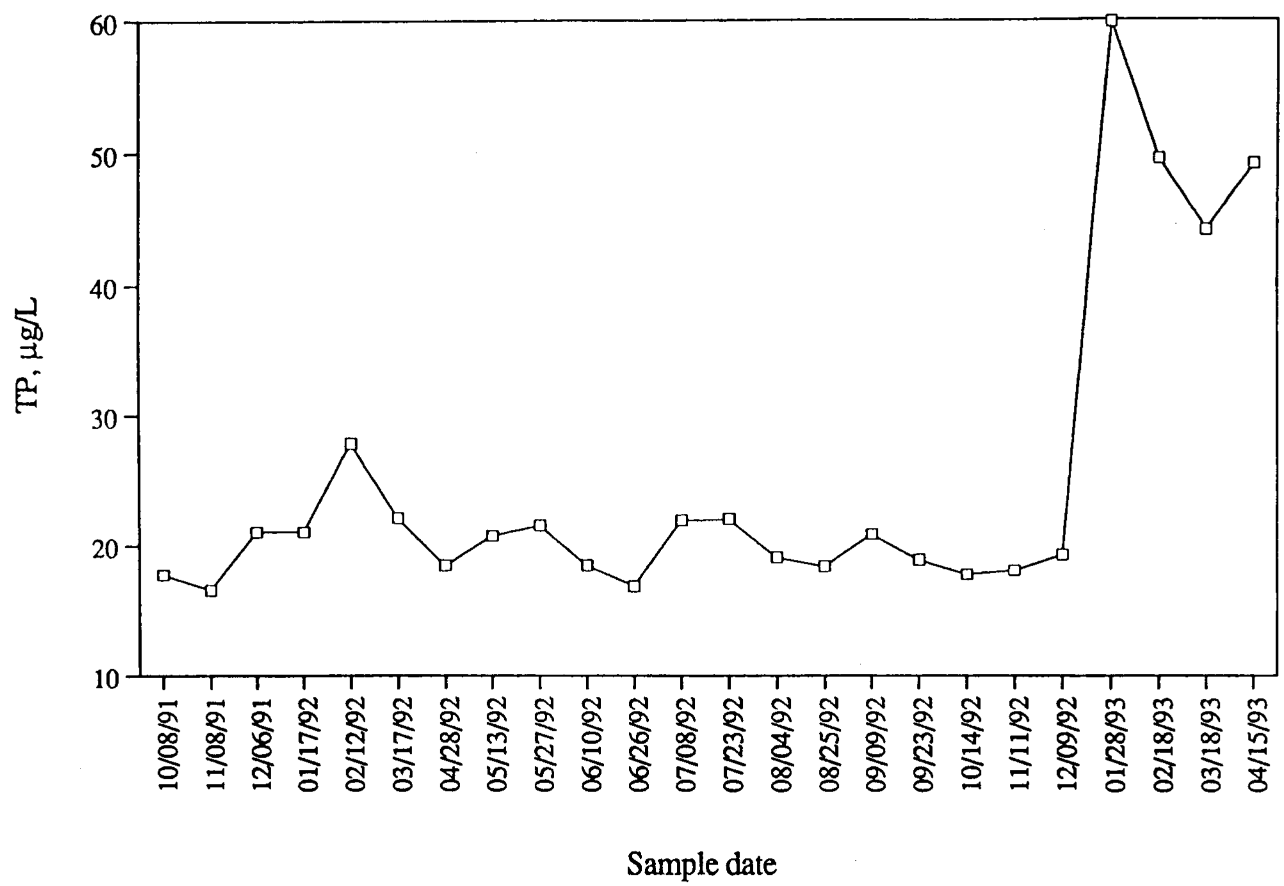

Figure 10. Volume weighted mean whole-lake TP concentrations in Long Lake after the 1991 alum treatment.

Harvesting macrophytes for three consecutive years, removing up to near 70% of the whole-lake biomass by 1990, appeared to have little effect on whole-lake TP (Figure 9). TP was highest 55 μg/L) during 1990, when most plants were removed, and declined to 33 μg/L in 1991, the year after harvesting had ceased. That response was opposite to what should have happened if plant senescence were actually contributing TP to the water and adversely affecting lake quality.

TP reached its lowest level in the 20-year record, to 20 μg/L, following the September 1991 alum treatment. However, TP returned to higher levels the next three summers (39 $\pm$ 9 μg/L). Although the 1991 alum treatment lowered TP 13 μg/L farther than the 1980 treatment, the post-treatment four-year mean was nearly the same (34 $\pm$ 12 μg/L).

Termination of low TP concentrations following the second alum treatment was apparently due to an atypical period of macrophyte senescence. Except for one observation on February 12, 1992, TP remained below 25 μg/L for over a year through December 1992 (Figure 10). However, TP suddenly increased to levels from 45-60 μg/L during the first four months of 1993. TP subsequently remained high through summer 1993 with a whole-lake mean of 45 μg/L. That phenomenon was unusual; winter (January to March) whole-lake TP mean levels between 1990 and 1992 never exceeded 34 μg/L, which is near the winter TP inflow concentration to the lake. During the same period in 1992, inflow TP was actually lower, averaging only 24 μg/L.

The lake was completely covered with ice for roughly three weeks in January 1993, which appeared to have caused die-back of macrophytes. Normally, most biomass of *Egeria*, the dominant macrophyte, tends to over-winter if the temperature and light conditions are favorable. The conditions prevalent in January, when temperatures rarely rose above 0° C and the lake was covered with a six-inch thick ice layer, were probably condusive to substantial macrophyte die-back. Observations during sampling trips indicated that the water turbidity had increased and fragments of macrophytes were floating in the water. Macrophytes that were brought to the surface with the anchor had brown leaves and appeared to be in advanced stage of decay.

Although DO profiles for January to April 1993 indicate that the lake was thoroughly mixed, concentrations at the S and L stations were consistently lower than at N and M (Figure

11). The significance of this is that the density of macrophytes is much greater at S and L, so that macrophyte decay would be expected to consume more DO there than at N and M. DO profiles in 1990, 1991 and 1992 from January to April show that the water at all stations had similar and well-saturated DO levels. Only during the period in 1993 were DO levels significantly less at S and L stations, which indicates that BOD was greater in the sourthern region, where plant mass was greater, than in the northern region. That was in spite of the shallower and, therefore, more aerated southern region.

Mean whole-lake SRP levels were also unusually high in January 1993 (27 μg/L), but quickly returned to normal levels in February 7.7 μg/L). Mean whole-lake SRP was consistently around 10% of TP during the 18 years of record (SRP was not determined in 1982-1983). SRP greater than 10 μg/L has been suggested as a criterion representing a shift from P to N limitation with levels lower than 10 being necessary to improve lake quality (Sas et al., 1989). SRP was above 10 μg/L during only one of the pretreatment years (1978) and during the summer of drawdown (Table 4).

Phosphorus Loading

Annual external TP loading was computed for 11 of the 20 year period of observation (Table 5). Total annual external loading ranged from 574 kg/year in the 1978-1979 water year to 1,480 kg/year during 1990-1991 with a mean of 1,071±337 kg/year. Detailed, two-week interval water and TP budgets for 1988-1992 are in the appendices of theses by Chase (1990), Kvam (1992), Leinenbach (1993) and Jaiswal (1993) and uncomputed data for 1993-1994 are in the appendices of Jaiswal (1993) and Wertz, (1996).

Internal loading of P from sediments and possibly macrophyte senescence during summer was found to be an important source to control early in the period of study (Jacoby et al., 1982). Estimates of net internal loading computed by mass balance for 11 years are shown in Table 6. Note that the highest internal loading rates occurred prior to drawdown and alum treatments. Internal loading was markedly reduced following those manipulations, but was quite high again in

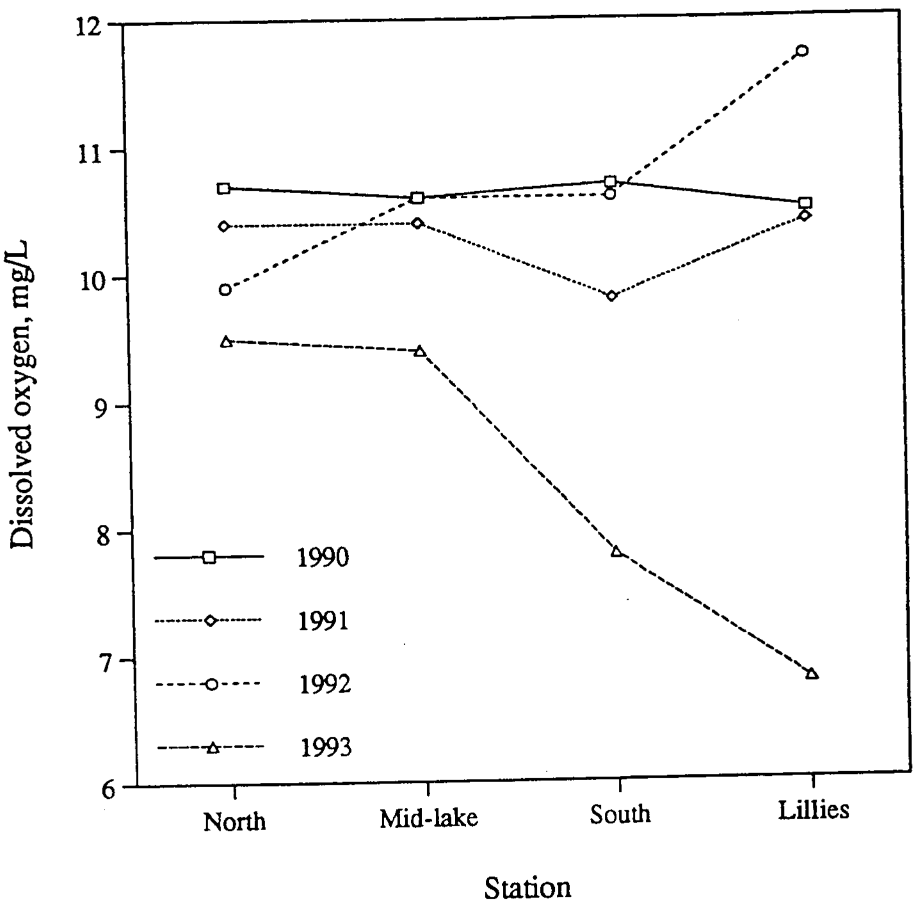

Figure 11. January to April mean surface dissolved oxygen concentrations at each station in Long Lake from 1990 to 1993.

Table 5. Summary of external TP input to and output from Long Lake during 1976 through 1992. All values are in kg/yr.

Period	Salmon-berry Ck.	Ungauged surface	Ground-water	Atmosph. and septic	Total external loading	Curley Creek losses
10/1/76-9/27/77	280	158	30	190	658	426
9/27/77-10/3/78	497	295	220	190	1,203	1,114
10/78-10/79	212	112	60	190	574	442
9/9/80-8/27/81	255	315	846	190	1,606	593
9/14/84-9/13/85	315	184	36	190	725	391
9/13/85-9/16/86	393	364	35	190	981	768
9/16/86-9/24/87	350	225	155	190	920	655
9/20/88-9/29/89	285	275	469	190	1,220	678
9/29/89-10/19/90	405	332	377	190	1,343	799
9/18/90-9/17/91	457	352	481	190	1,480	842
9/17/91-9/23/92	335	257	287	190	1,069	413

Table 6. Summer net internal P loading in Long Lake calculated from mass balance.

PERIOD	INTERNAL P LOADS, kg
06/14-09/13/77	164.7
06/09-09/19/78	189.4
06/04-08/27/81	35.7
06/14-09/13/85	127.9
06/06-09/16/86	54.2
06/18-09/10/87	94.9
06/15-09/20/88	90.6
06/12-09/29/89	13.7
06/12-09/18/90	83.2
06/05-09/30/91	53.6
06/10-09/23/92	0.0

1985, the year of the general macrophyte decline when summer TP concentration in the lake rose to pretreatment levels (Table 4). Since then, internal loading has remained below 100 kg and in 1992, following the 1991 alum treatment, it was zero (Table 6).

About one half the total loading during the summer (June-September) in Long Lake is internal loading. But that does not entirely illustrate the importance of that source in controlling algal biomass and lake quality. Prior to treatment, lake TP concentrations reached 100 μg/L or more. That is more than double the average inflow concentration in the major inflow (Salmonberry Creek), which averaged 42±10 μg/L during 1976-1992. Although external and internal loads may be similar during summer, the external flux is diluted with the inflowing water, while the internal flux enters the water column directly as a mass. That is clearly evident in Figure 12, which shows that the source of the summer's high TP is not from the input, which was rather constant at around 40 μg/L.

Algae and Transparency

Pretreatment (1976-1978) chl *a* concentrations averaged 22 ± 9 μg/L and the four-year post alum treatment means were 9 ± 5 μg/L and 10 ± 5 μg/L for the first and second treatment, respectively (Figure 13, Table 4). That reduction was well over 50% following both treatments. Chl *a* was lowest in 1992, the year after the second alum treatment.

Transparency (Secchi depth) averaged 1.6 ± 0.2 m during the three pretreatment years and 2.5 ± 0.4 and 1.9 ± 0.8 m during the two, four-year post alum treatment periods, respectively. That is more than a 50% improvement following the first treatment, but only about 20% greater following the second one. The highest transparencies (3 m) were in 1982 and 1992, subsequent to alum treatments and corresponded to the lowest chl *a* (3.5 μg/L) and lowest TP concentrations (Table 4).

The years with poorest quality, including the high TP in pretreatment years, were 1985 and 1990, following the macrophyte decline and during the largest removal of harvested macrophytes, respectively (Figure 13, Table 4). Chl *a* concentrations were 36 and 40 μg/L and

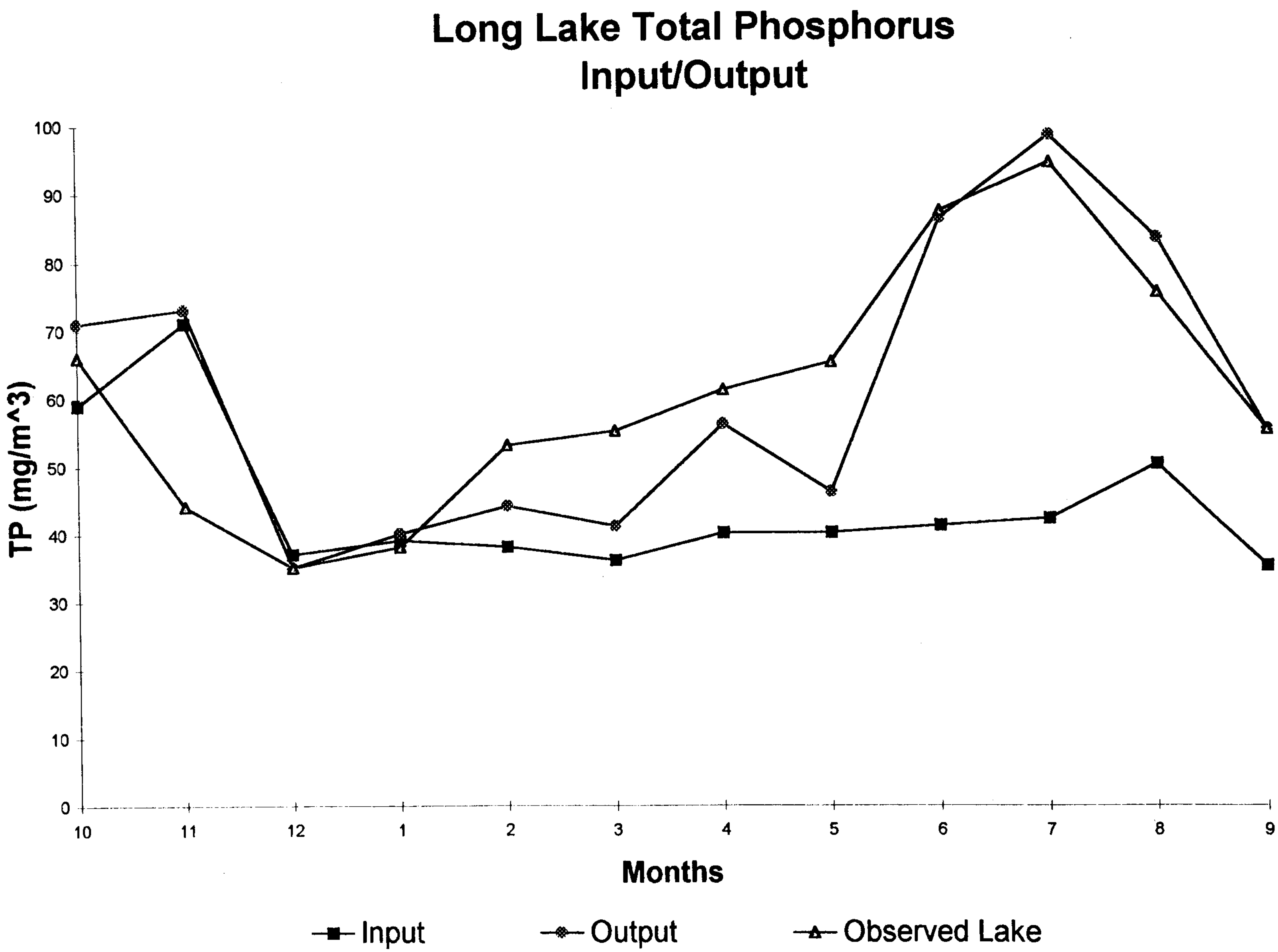

Figure 12. Inflow (Salmonberry Cr.), outflow (Curley Cr.) and lake TP concentrations in Long Lake during 1977-1978.

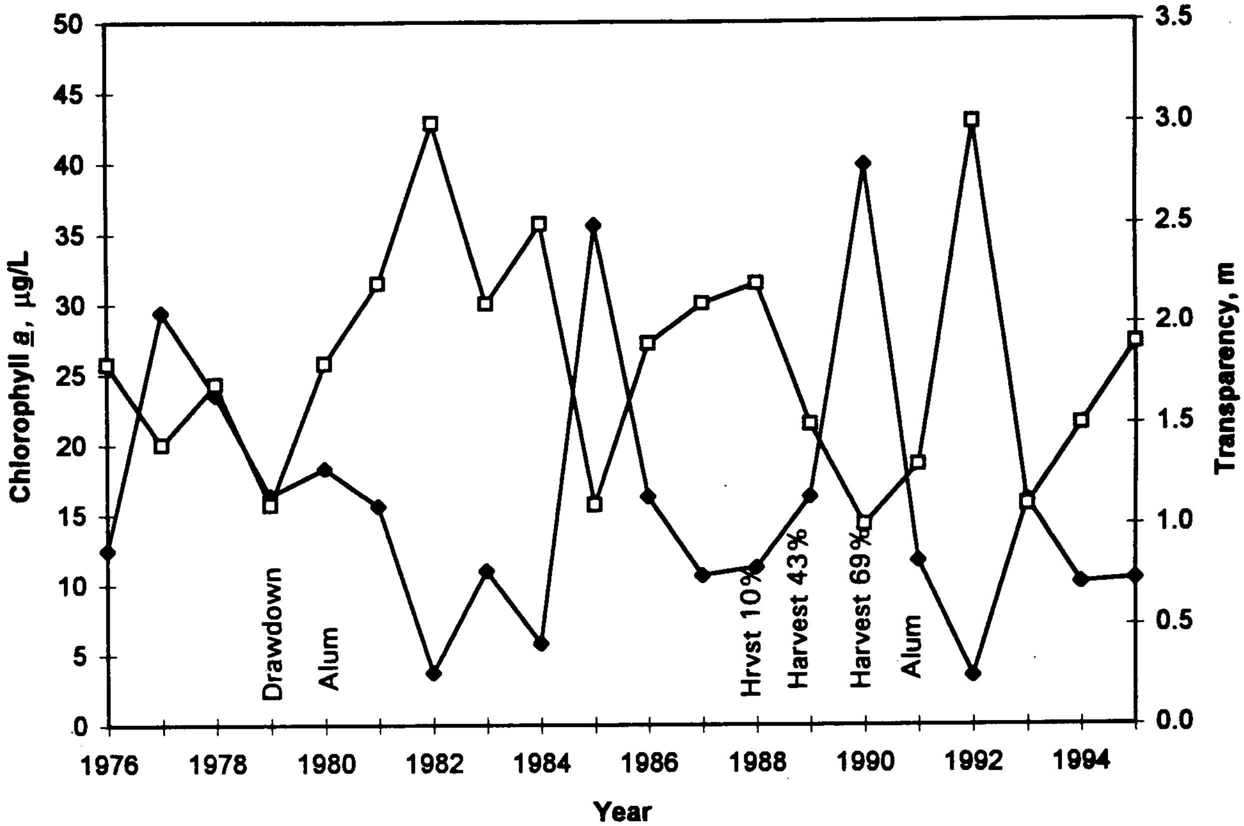

Figure 13. Lake chlorophyll *a* and transparency during June-September from 1976-1995.

transparency was only 1 m. Transparency was a low during only one other year--1979, when the lake level was lowered (Table 4).

Non-target Effects of Harvesting and Alum

Sediments: Organic content of surficial sediment at M and S stations during 1988-1990 are shown in Figure 14. Organic matter was higher at S than M, but the difference was significant ($p<0.05$) in 1989 only. The absolute difference in organic content between the two stations was greatest in 1988, decreased in 1989 and was reduced further in the summer of 1990. That trend may have resulted from less macrophyte-derived detritus occurring at the shallower S relative to the deeper, less-harvested M site during successively increasing macrophyte harvests. In support of that, organic content of S sediments was significantly less ($p<0.05$) in 1990 than in 1988 and 1989. The mean organic content of M sediments in 1990 was 27.0 ± 0.2 ($n = 9$) compared to 28.8 ± 0.5 ($n = 9$) at S.

Sediments at S had a higher and nearly identical oxygen demand (SOD) in 1988 and 1989 than sediments at M (Figure 15). SOD for M and S sediments in 1988-1989 was, respectively, 1.9 and 2.0 and 2.0 and 2.2 g O_2/m^2-day ($n = 2$). SOD in 1991 was also similar. However, SOD was greater in 1990 and sediments at M (2.6 ± 0.1 g O_2/m 2-day) consumed more oxygen than those at S (2.3 ± 0.2 g O_2/m^2-day). SOD of both sediments in 1990 was significantly greater ($p<0.05$) than values in the other three years.

The greater SOD observed in 1990 was not related with sediment organic content. Changes in organic matter determined in the sediments were probably not directly related to SOD because the active fraction may have been masked by the larger refractory fraction. The higher SOD was not due to macrophyte biomass, because more plant organic matter was removed by harvesting in 1990. On the other hand, organic matter causing the elevated SOD in 1990 could have been the remnants of a much larger algal biomass during the summer of that year. Chl *a* reached an all-time maximum during the summer of 1990.

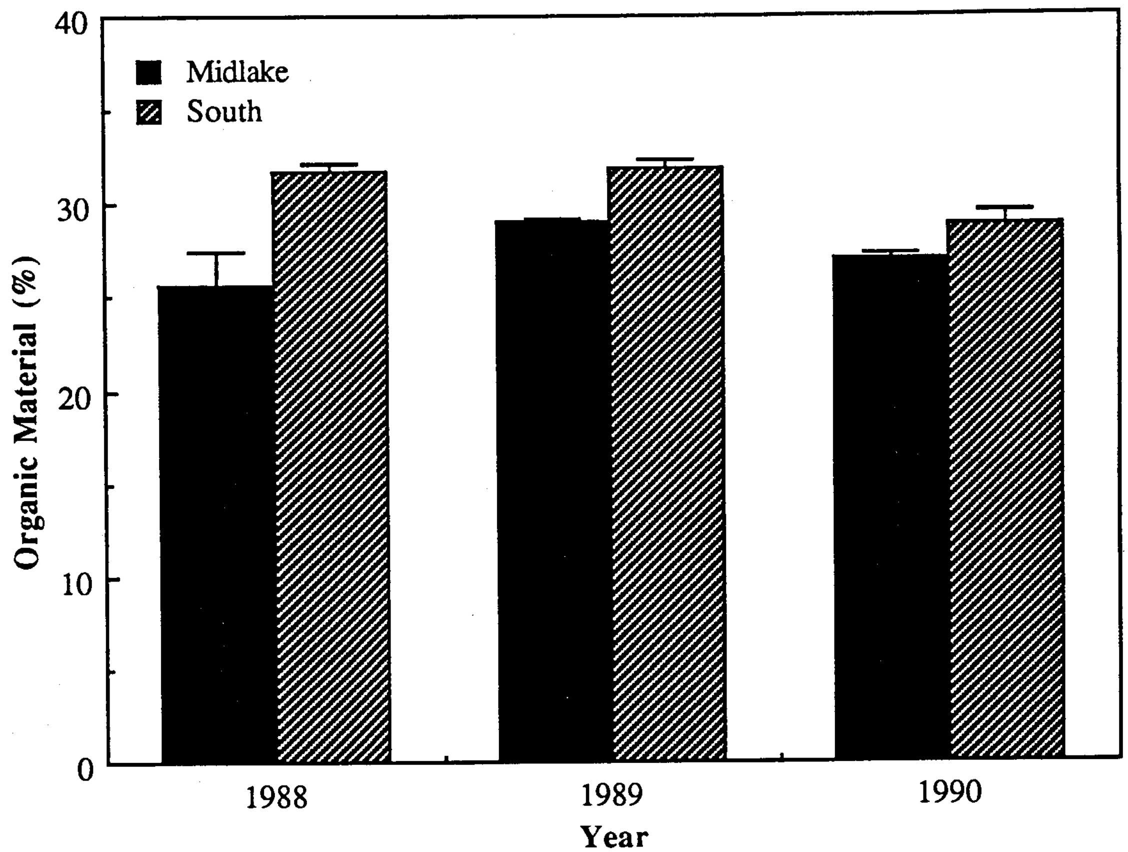

Figure 14. Sediment organic content (%) in midlake and south station sediments collected during the summer in Long Lake.

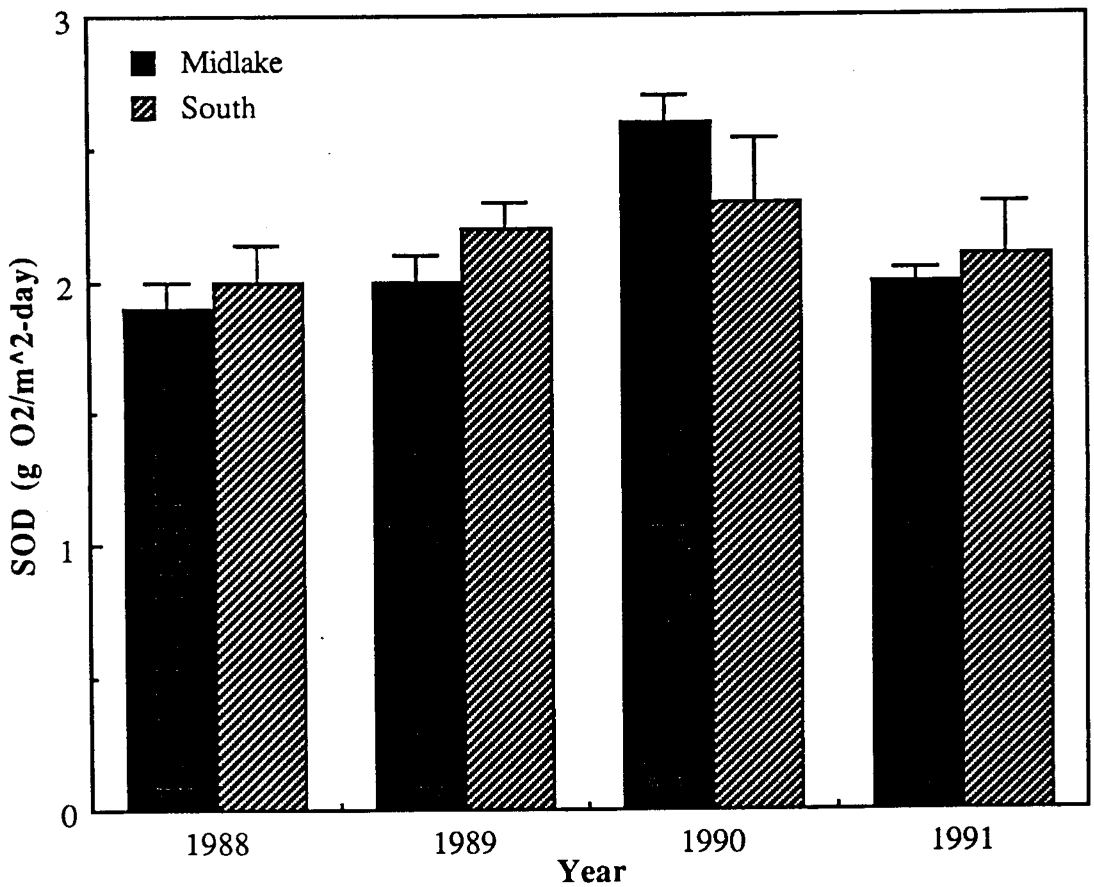

Figure 15 . Sediment oxygen demand (SOD) of midlake and south station sediments collected during the summer in Long Lake.

The higher SOD rates in 1990 were accompanied by higher anoxic sediment TSP release rates at M in 1990 than those in 1987, 1989, and 1991. TSP release from M sediments in 1987 and 1989, respectively, averaged 3.8 mg/m^2-day (between 8 and 32 days) and 1.8 mg/m^2-day (between 8 and 16 days; no results beyond 16 days). Average release rate of TSP from S sediments in 1991 was 2.5 mg/m^2-day (between 9 and 34 days) and were higher than that from M. The higher average TSP rates in 1990 from M and S, respectively were 4.0 and 4.4 mg/m^2-day.

Aluminum: Total (TAL) and dissolved aluminum (DAL) concentration determined in the lake since June 1991, show that Al increased briefly immediately after the alum treatment, but then decreased to less than pretreatment levels (Figure 16). That decrease in mean summer levels of TAL and DAL was 60% and 51%, respectively. TAL concentration peaked at 870 μg/L shortly after the alum treatment, but dropped rapidly to 107 μg/L by November 8, 1991. TAL concentrations remained fairly consistent during 1992 with an annual mean of 175 μg/L. Neither DAL or TAL exceeded 200 μg/L from April, 1993 through September, 1994, the subsequent period that was sampled regularly (mean TAL = 145 ± 50, n = 28).

Two days after the alum treatment, the ratio of DAL : TAL fell from a pretreatment level of over 1.0 to 0.69. This was probably due to the incorporation of DAL with the large aluminum hydroxide floc in the water column. The mean DAL : TAL ratio during 1992 was 0.85, consistent with the pretreatment mean ratio of 0.96.

The dramatic decrease in aluminum concentrations could have been caused by the sorption and sedimentation of humic compounds and other Al-complexed species by the aluminum hydroxide floc. Increased flushing during the winter months may also have removed some of the larger particulate Al-complexed species. However, Al did not return to pretreatment levels for up to three years after treatment and at least 10 lake renewals had occurred during that period.

Sediment cores were taken one month after the treatment and the aluminum hydroxide floc layer was not visible at the sediment surface or deeper in the core. This suggests that the floc had probably been mixed into the sediments by resuspension/sedimentation and/or animal

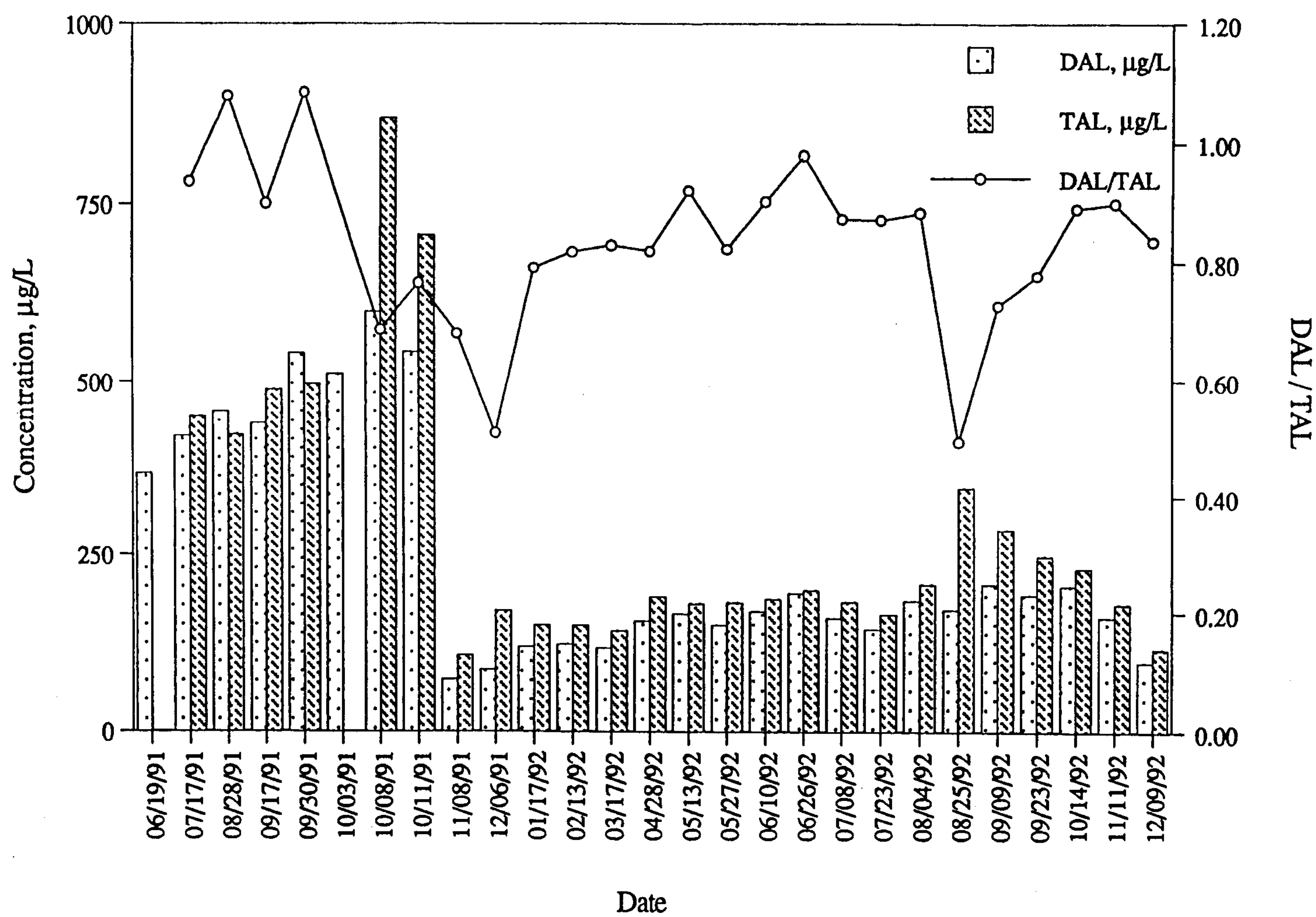

Figure 16. Volume weighted mean whole-lake total and dissolved aluminum concentrations in Long Lake and the ratio of DAL : TAL.

bioturbation and/or masked by dark brown humic substances (Leinenbach, 1993). The alum floc layer was not discernible in Long Lake cores following the 1980 treatment either.

Post treatment sediment cores from other alum-treated Washington lakes also did not clearly show the presence of a floc layer, either visually or by Al (Welch and Cooke, 1995). The aluminum hydroxide floc probably becomes well mixed into the sediments as well as being covered with fresh sediments containing relatively high background levels of aluminum. Comparison of Al concentrations in cores from treated West Twin Lake, Ohio, with nearby, untreated East Twin Lake, showed that most of the Al-floc layer redistributed to about 20 cm in 17 years. In other mid-western lakes the floc layer was clearly visible, e.g., at 8 cm after 13 years or at the sediment surface a few months after treatment (Welch and Cooke, 1995).

Benthic Invertebrates: The benthic invertebrate biomass in the lake was sampled before and after the 1991 alum treatment, as well as during 1992 and 1994, to determine if the aluminum hydroxide floc, and/or low water column pH, adversely affected benthic organisms. A comparison of mean densities of oligochaetes and chironomids is shown in Table 7.

The data show order of magnitude, year-to-year changes in mean densities, for these two dominant (> 90% abundance) organism groups. Although densities were lower immediately after than before the alum treatment, and densities did not change appreciably at the untreated L (means 23/34 and 67/45 for the two groups, before and after treatment), successive changes of greater magnitude occurred at other times as well. Moreover, the large SEs resulted in even such order of magnitude changes, as for oligochaets before and after the treatment, not being statistically significant. Greater than order of magnitude, year-to-year changes in densities also occurred at the untreated L site.

Part of the large differences in abundance at the same site, year-to-year, may be partly due to different substrata sampled. Kvam (1991) observed that larger numbers of this group were found in soft rather than coarse sediment. Variability may have been reduced had sampling been stratified according to substratum type. From the current data, however, there is no clear relationship between benthic organism densities and the alum treatment.

Table 7. Mean benthic macroinvertebrate densities in no./$m^2 \pm$ SE at the N, M and S sites in Long Lake before and after the October 4-6, 1991 alum treatment.

Date	n	Chironomidal	Oligochaeta
9/20/88	12	2,674 ± 690	19,018 ± 5,170
9/18/90	12	1,667 ± 390	915 ± 165
9/4/91	12	727 ± 187	2,007 ± 499
10/11/91	6	453 ± 122	297 ± 84
10/9-11/92	12	215 ± 46	611 ± 162
4/30/94	12	2,216 ± 1,423	1,909 ± 790
8/30/94	12	618 ± 169	2,620 ± 600

Zooplankton: Mean summer concentrations of total zooplankton were quite high during 1988 through 1991, but were much lower during 1992-1994 (Table 8). Zooplankton were not sampled prior to 1988. Although a decrease of about 50% occurred after (October), compared to before (September), the alum treatment in 1991, an even larger average decrease occurred between the same two months during 1988-1990. Thus, the alum treatment may not have caused the 1991 September-October decrease.

The large cladocerans, *Daphnia* and *Ceriodophnia*, averaged 45% of total zooplankton abundance during 1988 through 1992, but were much lower the last two years, especially for *Daphnia* in 1993. No explanation from existing information can be offered for those markedly lower levels. Without data on year class size of fish planktivores in the lake, the possibility of greater-than-usual predation can not be evaluated. Nevertheless, the highest summer mean zooplankton (and *Daphnia*) abundance occurred in 1990, the summer with the highest mean chl *a* concentration, which is the reverse of that often observed (and expected) when lakes are biomanipulated (Cooke et al., 1993). In fact, *Daphnia* abundance tended to be directly related to chl *a* among the four lake stations in 1990. *Daphnia* abundance and chl *a* concentrations were usually low at L, where macrophyte density was greatest, and highest at M and N, where macrophyte density was rather low.

DISCUSSION

Macrophytes

The hypothesis tested was that macrophyte senescence is an important process that recycles P from sediments to water during summer. If true, then removing a significant amount of macrophyte biomass should reduce lake TP concentration. The hypothesis was not confirmed, because TP concentrations actually increased, rather than decreased, as the fraction of biomass removed by harvesting increased during 1988 through 1990. Mean whole-lake TP was quite high (55 μg/L) during summer 1990 and chl *a* was the highest mean recorded during the 20-year observational period and mean transparency was only 1.0 m, which equaled the other low that

Table 8. **Mean whole-lake total zooplankton, percent Daphnia and Ceriodaphnia, and percent Daphnia, during the summers (June-September) of 1988-1994.**

YEAR	Total Zooplankton #/L	Daphnia & Ceriodaphnia %	Daphnia %
1988	151	43	43
1989	212	40	40
1990	301	45	21
1991	204	35	19
1992	77	60	60
1993	107	13	2
1994	19	26	26

occurred during drawdown. While the high TP and poorest water quality may not have been a direct effect of harvesting, the large plant removal, nevertheless, did not reduce lake TP and improve lake quality either.

Macrophyte senescence has been shown to be an important contributor to internal P loading/recycling in shallow lakes (Carpenter, 1980; Smith and Adams, 1986). However, those results were for Eurasian watermilfoil, which readily senesces during the summer. The principal plant in Long Lake is *Egeria densa*, which was shown to be rather resistant to breakdown, losing only 1/5 as much mass, over 60 days in summer, as the other dominant plant in the lake, *Potamogeton praelongus*. That loss-rate difference was also shown for P mineralization (Chase, 1990). Although *Egeria* was shown to take 85% of its P demand from sediments (Gabrielson et al., 1978), its senescence is apparently not a significant source for sediment-to-water internal loading in this lake, and harvesting would not be expected to reduce lake TP in summer.

Rather than positively contributing to internal loading of P in the lake, observations indicate that *Egeria* probably reduces internal loading of P by stabilizing and protecting sediment from wind-caused resuspension. Summers with high macrophyte biomass have tended to have low TP and visa versa, as well as internal loading having been greater during years with low versus high wind speeds (Welch and Kelly, 1990). Summer TP was inversely related to macrophyte biomass during 1976-1978, the pretreatment years. While lake TP was low for four years and macrophyte biomass had quickly recovered following drawdown and alum addition in 1979 and 1980, respectively, TP abruptly rose to the pretreatment high in 1985, apparently in response to a dramatic decline in *Egeria* biomass. As *Egeria* recovered in 1987, TP fell to a low level. That observed inverse relation between summer macrophyte biomass and lake TP is not considered due to senescence and P release from decomposing plant tissue, because plant biomass was already low in the spring before internal loading progressively raised lake TP through the summer. Rather, the absence of the plants from large areas probably exposed sediments to wind-caused resuspension of either particulate P or else a high-P anaerobic boundary layer near the sediment-water interface (Welch et al., 1988; Welch and Kelly, 1990).

The large, year-to-year shifts between high TP and algae, poor water quality and low macrophyte biomass on the one hand, and low TP, algae, good water quality and high macrophyte biomass on the other, suggests that this lake may be in a transitional stage between alternative stable states. Scheffer et al. (1993) have recognized the alternative states in shallow eutrophic lakes in Europe, where high macrophyte biomass that stabilizes sediment, protects large zooplankton and minimizes P availability to algae promoting clear-water conditions is preferred over the alternative state of high algae, turbid water and essentially no macrophytes due to light limitation. If macrophytes, and especially *Egeria*, were eliminated in Long Lake, past observations indicate that water quality would deteriorate.

Neither drawdown or harvesting was effective in controlling macrophytes, especially alternative steady state *Egeria*, in the lake. Biomass recovered within one year following drawdown and in spite of removing 69% of the whole-lake biomass in 1990, there was no significant change in biomass as a whole-lake mean or even in the south end at S and L where harvesting was concentrated. The largest reduction in 1985-1986 was apparently due to an unknown factor(s). Much of the *Egeria* biomass usually overwinters, so the very low biomass during spring-summer of 1985-1986 was thought to have been caused by extended winter ice cover. That clearly happened during the winter of 1992-1993 and biomass was quite low the following two summers. However, extensive ice cover during the winter of 1984-1985 could not be verified.

Nevertheless, this 19-year record of macrophyte biomass, which is composed of mostly *Egeria*, suggests that this exotic plant is declining naturally, although there are large year-to-year fluctuations that obscure the reliability of a definite trend. Whole-lake biomass as well as biomass at S and L were nearly as low the last two years of sampling, 1993-1994, as during the lowest biomass years in 1985-1986. This plant has undergone a "natural" decline in Lake Rotoroa, New Zealand, while going through similar boom and bust cycles (Clayton and de Winton, 1994). The most appropriate plant management option for the lake may be to simply continue observations to determine if the overall downward trend continues, given; 1) the ineffectiveness of two frequently used techniques to control *Egeria* biomass in this lake, 2) its probable positive, rather than negative, effect on lake P and water quality, and 3) the apparent trend for it to decline naturally, as it has elsewhere.

Alum Treatment Effectiveness

The second alum treatment in October, 1991 was initially more effective than the first one in September, 1980. TP was lower the following summer (20 μg/L) than during any of the 20 years of monitoring the lake. However, effectiveness did not persist as long with TP rising to a mean of 39 μg/L for the next three summers. Nevertheless, the four-year, post-treatment means following the two alum treatments were the same (34 μg/L). the cause for the failure of TP to continue at the post-treatment low was apparently an unusually long period of ice cover in winter 1992-1993 that resulted in much lower-than-normal DO in the south end where macrophytes are always more abundant. The period of undersaturated DO apparently resulted in increased P internal loading from plant decomposition, as indicated by the exceptionally high, mid-winter SRP concentrations. The persistence of high TP during the summer of 1993 was probably due to the residual from the massive winter dieoff. The lower biomass levels of *Egeria* may also have allowed greater internal P loading from sediments due to wind-mixing during summer. However, biomass of *Egeria* and other species remained low in 1994 when TP was low (29 μg/L).

This event is an example of how macrophytes in shallow lakes often compromise the effectiveness of alum treatments. While alum treatments were highly effective in shallow Washington lakes without appreciable macrophytes (e.g., Erie, Campbell, and Long-Thurston North), the presence of a broad coverage of macrophytes at high biomass in other lakes (e.g., Pattison South, Green and Wapato) resulted in less effective and short lived treatments (Welch and Cooke, 1995). Alum treatments in Long Lake-Kitsap were also effective, with effectiveness lasting about nine years (Welch and Cooke, 1995). That high treatment effectiveness/longevity was apparent in spite of high macrophyte biomass. However, biomass in this lake tends to be concentrated in the south end, while most summer internal P loading is considered to originate from the open-water sediments (M and N) as indicated by horizontal gradients of TP (Welch et al., 1988).

Non-target Effects of Harvesting and Alum

There was the possibility that plant removal by harvesting would decrease the organic matter and oxygen demand of recently deposited sediment. Results of surficial sediment analysis indicated that organic content of sediment at S, where plants were dense, was slightly greater than at M, where plants were sparse. Moreover, the organic content decreased at S, where harvesting was concentrated, as the biomass removed increased from 1988 through 1990.

SOD was also slightly higher at S than M, consistent with organic content. However, the reverse was the case in 1990, when SOD was higher at M than S and higher at both than during other years. The explanation of that inconsistency may have been related to the highest recorded algal concentration that summer. Sedimented algae would have tended to accumulate in the deeper area of the lake (M) and may have been more readily decomposable than senesced macrophytes, as indicated by the increase SOD at S.

Non-target, adverse effects of alum have always been a concern during and following treatments in lakes. Only a few cases exist where monitoring of Al concentrations and biota have continued for more than one year following treatment and usually these indices were not monitored at all (Cooke et al., 1993; Welch and Cooke, 1995). Al concentration and benthic invertebrates were monitored before and for three years after the 1991 treatment in Long Lake. Although there was a slight increase in TAL content during treatment, lake content had dropped within a month to levels less than half of those determined before the treatment. Moreover, the lower levels of both TAL and DAL had persisted for at least three years.

The marked and persistent reduction in Al was surprising; similar results have not been reported previously. Rather, higher than pretreatment levels were expected, such as observed in Lake Morey, VT (Smeltzer, 1990). One explanation for the Long Lake observations may be related to humic substances, which are known to readily sorb Al. The high concentration of Al-hydroxide flox would have sorbed the dissolved, humic-Al-complexed substances and removed them from the water column. However, given the rather high flushing rate of the lake (4-8/yr), the original equilibrium with higher humic-Al should have reestablished within a year. The fact that Al content remained low for three years suggests that the floc in sediments may continue to sorb humic substances entering the lake, or that the humic matter originated from lake sediments, which were inactivated (i.e., reduced the release of humic substances as well as P) by the alum floc. In any event, the alum treatment apparently did not pose an adverse effect from higher-than-background Al concentrations.

While marked, year-to-year changes were observed in population densities of the two most abundant benthic invertebrates, chironomid midges and oligochaete worms, there was no indication that the changes were related to the alum treatment. Except for a temporary reduction in diversity in Lake Morey, no other alum treatment has resulted in an adverse effect on benthic invertebrates (Cooke et al., 1993).

SUMMARY AND CONCLUSIONS

1. Harvesting of macrophytes over three summers, eventually removing up to 69% of whole-lake biomass, did not reduce lake TP as hypothesized to occur if macrophyte senescence were a significant source of internal P loading.
2. Lake quality, indicated by chl *a* and transparency, was actually poorest in 1990, the year of greatest plant removal, although the cause was probably not harvesting.
3. Unlike Eurasian watermilfoil and the much less-abundant *P. praelongus, Egeria* was slow (1/5 the rate) to senescence in summer and, thus, did not represent a significant fraction of internal P loading, which is highly important to water quality in this lake.
4. Rather than contributing significantly to internal P loading in this lake, *Egeria* more likely inhibits that process by protecting flocculent sediments and high P boundary layers

overlying sediment from wind-caused entrainment. The clear-water state with macrophytes is preferred for shallow lakes in Europe rather than the alternative state with no macrophytes and high turbidity. Year-to-year fluctuations in macrophyte biomass and water quality in this lake indicate that eradication of macrophytes will probably produce poor water quality.

5. A long-term, natural decline in the biomass of *Egeria* is apparently occurring in this lake, in spite of the large year-to-year fluctuations. Such a trend from nuisance levels to near absence has been evident in a New Zealand lake.

6. The second alum treatment in October 1991 was initially more effective than the first treatment in 1980, reducing lake TP an additional 13 μg/L. Longer-term effectiveness was eventually similar to that of the earlier treatment, because apparent macrophyte senescence and decomposition during and following an extensive period of ice cover had substantially raised lake P content.

7. Removal of macrophytes may have slightly reduced organic content of surficial sediment as well as SOD; however, SOD was apparently influenced more by algal- than macrophyte-derived organic matter.

8. Both total and dissolved Al content were less than one-half after, compared to before the alum treatment and the lower levels persisted for at least three years, in spite of more than ten replacements of lake volume over that period. Therefore, Al in lake water presumably did not represent a threat to the lake's biota.

9. Large, year-to-year changes were observed in the dominant invertebrates (oligochaetes and chironomids), but there was no clear association between those changes and the alum treatment. Much of the variation may have been due to non uniform bottom substrata.

10. Total zooplankton abundance was lower during the three summers after the alum treatment than the four summers before treatment. However, zooplankton biomass was more related to algal abundance than to the treatment, with the highest concentration being observed in 1990 when algal biomass was also highest. Surprisingly, the high total

zooplankton concentration (300/L), with nearly half being large cladoceran grazers, also occurred the same year.

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APPENDIX

Long Lake Water Quality Data, 1988-1989

DATE and STATION + depth	1 D.O./T	2 pH	3 ALKALINITY (mg/l)	4 SECCHI	5 CHL A (ug/l)	6 TP (ug/l)	SRP (ug/l)	7 TN (ug/l)	NO2-NO3 (ug/l)	NH4 (ug/l)
6/15/88										
N,s	10.0/19.8	7.90	38.30	2.40	6.4	12.7	4.8	NC	5	ND
N,m	9.8/18.2					17.1	2.1	NC	NEG	ND
N,b	6.0/15.5					13.9	2.4	NC	NEG	ND
M,s	- /20.2	8.05	38.85	2.40	6.4	14.5	2.1	NC	NEG	ND
M,m	- /16.1					13.9	1.6	NC	NEG	ND
M,b	- /13.9					22.3	8.6	NC	13	ND
S,s	- /21.0	8.62	37.74	2.00	7.6	10.6	2.4	NC	NEG	ND
S,m	- /17.2					13.7	2.2	NC	NEG	ND
S,b	- /13.9					38.2	23.5	NC	14	ND
L,s	- / -	8.85	32.19		8.8	19.3	1.7	NC	NEG	ND
SALMON	- / -		52.17			14.8	12.2	NC	308	ND
CURLEY	- / -		38.85			15.7	2.1	NC	7	ND
6/29/88										
N,s	9.4/19.0	7.35	38.85	1.80	12.8	45.0	5.5	424	5	ND
N,m	8.4/18.0					43.6	5.8	318	2	ND
N,b	1.5/17.7					51.7	7.9	493	3	ND
M,s	9.7/19.0	7.25	38.85	2.00	12.8	47.3	5.4	380	1	ND
M,m	8.4/17.9					46.7	7.0	439	3	74
M,b	2.8/16.5					58.2	17.4	165	17	ND
S,s	9.0/18.8	8.00	39.96	2.10	12.0	37.9	4.1	444	1	ND
S,m	8.5/17.5					47.3	4.0	245	1	ND
S,b	0.8/16.3					72.6	9.5	408	2	39
L,s	10.3/19.0	8.25	35.53		7.6	37.2	2.5	263	4	ND
SALMON	9.4/11.0	7.64	55.50			33.7	14.4	323	352	46
CURLEY	- / -		41.07			43.1	5.5	346	15	ND
7/13/88										
N,s	9.0/18.0	6.76	39.54	1.70	17.6	46.0	4.8	NC	17	77
N,m	8.4/17.8					48.2	4.8	NC	21	40
N,b	6.7/17.4					50.0	6.1	NC	15	25
M,s	8.9/17.8	7.14	38.85	1.60	19.6	50.1	4.3	NC	10	20
M,m	8.6/17.8					56.5	4.5	NC	123	21
M,b	8.4/17.8					52.2	5.3	NC	12	16
S,s	8.8/17.8	7.27	37.62	1.90	4.8	50.7	11.7	NC	216	79
S,m	8.2/17.6					54.5	12.5	NC	11	37
S,b	7.5/17.3					58.0	14.0	NC	24	44
L,s	8.9/18.2	6.78	38.12		4.4	35.9	2.5	NC	9	52
SALMON	- /12.8	7.15	55.88			43.5	13.6	NC	290	24
CURLEY	8.4/18.4		40.42			40.1	5.8	NC	59	14

STATION	D.O./T	pH	ALKALINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
7/27/88										
N,s	10.6/22.0	7.35	39.18	2.40	6.4	41.3	4.9	ND	6	43
N,m	11.2/21.8					36.4	5.4	404	3	69
N,b	3.0/19.0					49.3	6.0	364	2	64
M,s	10.7/22.8	7.55	38.66	2.70	11.2	42.3	4.1	533	2	28
M,m	10.6/22.5					67.3	4.1	477	3	64
M,b	0.3/18.4					125.2	19.1	612	3	62
S,s	12.5/23.8	8.30	37.62	2.40	8.0	12.2	2.1	374	2	35
S,m	7.2/22.8					31.1	2.8	505	1	41
S,b	0.3/18.6					77.3	14.4	541	2	73
L,s	16.0/24.2	9.00	39.18		2.0	19.4	1.1	ND	2	40
SALMON	11.0/9.5	7.70	57.48			36.1	17.2	505	333	44
CURLEY	9.2/23.1		40.76			36.9	5.2	430	10	54
8/10/88										
N,s	10.1/20.0	8.35	42.18	1.60	26.1	59.3	12.8	475	11	70
N,m	9.3/19.3					53.1	11.3	ND	6	ND
N,b	2.8/19.0					80.0	11.8	607	6	61
M,s	9.8/20.8	8.43	43.29	1.60	28.8	77.2	11.8	398	5	35
M,m	8.8/20.0					63.0	11.5	406	4	ND
M,b	1.3/19.2					149.2	15.3	349	11	77
S,s	10.1/21.6	8.64	43.29	1.40	29.3	55.7	9.2	400	2	25
S,m	10.2/20.2					54.5	6.3	328	3	ND
S,b	0.9/19.5					62.7	4.9	411	4	40
L,s	12.6/21.9	8.85	42.18		28.9	53.1	2.5	431	3	30
SALMON	10.1/13.2	7.69	58.83			39.2	14.6	225	337	53
CURLEY	9.6/20.0		43.29			53.6	8.2	395	65	68
8/24/88										
N,s	7.8/18.9	6.95	43.37	1.80	3.2	47.2	3.1	821	18	NC
N,m	5.9/18.8					33.9	2.1	647	18	NC
N,b	1.2/18.0					39.8	2.7	727	18	NC
M,s	8.0/19.4	7.58	43.00	1.90	10.4	39.0	2.7	952	10	NC
M,m	5.7/19.2					40.6	2.5	779	11	NC
M,b	2.0/18.4					51.7	3.4	1,008	15	NC
S,s	10.4/20.4	8.17	42.85	1.90	12.4	31.9	2.1	617	3	NC
S,m	8.5/19.7					32.1	2.2	888	2	NC
S,b	0.5/18.2					64.5	3.4	807	2	NC
L,s	11.2/20.8	8.59	41.28		4.0	23.6	0.5	587	4	NC
SALMON	9.6/12.5	6.92	52.77			30.5	13.0	452	322	NC
CURLEY	7.4/19.2		41.80			40.7	7.0	1,266	31	NC

STATION	D.O./T	pH	ALKALINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
9/07/88										
N,s	8.8/18.7	NT	43.89	2.40	15.5	NC	6.7	590	59	NC
N,m	7.7/18.3	NT				34.4	8.2	777	55	NC
N,b	5.5/18.7	NT				NC	6.9	584	54	NC
M,s	12.1/18.2	NT	43.36	2.50	11.6	NC	5.8	662	55	NC
M,m	10.5/18.0	NT				37.3	6.3	687	53	NC
M,b	6.3/17.7	NT				NC	8.1	ND	51	NC
S,s	12.6/19.2	NT	42.84	2.60	6.8	NC	6.7	574	27	NC
S,m	8.6/18.7	NT				33.3	5.9	643	32	NC
S,b	6.6/18.5	NT				NC	8.1	ND	35	NC
L,s	11.2/18.0	NT	40.75		1.3	18.9	0.8	436	1	NC
SALMON	11.4/10.4	NT	54.86			34.5	14.2	368	298	NC
CURLEY	8.8/17.8	NT	41.80			45.8	8.6	452	77	NC
9/20/88										
N,s	9.1/15.2	7.68	42.84	2.80	8.4	NC	2.9	404	41	15
N,m	8.6/15.1					53.3	3.2	ND	47	7
N,b	5.5/18.7					NC	3.2	445	48	8
M,s	9.4/15.2	7.88	42.84	2.90	9.6	NC	3.0	ND	30	6
M,m	9.7/13.2					60.6	3.5	453	26	8
M,b	6.5/13.0					NC	2.7	ND	23	19
S,s	9.9/14.6	8.51	41.80	2.70	14.7	NC	1.4	ND	24	19
S,m	10.5/13.5					60.5	1.5	445	17	20
S,b	7.8/13.0					NC	1.2	493	14	19
L,s	11.8/13.8	8.22	39.70		3.6	26.1	0.5	ND	1	1
SALMON	10.3/8.8	7.10	47.00			26.0	15.7	ND	400	16
CURLEY	9.8/13.5		39.70			41.7	4.7	ND	40	4
10/4/88										
N,s	9.4/12.4	8.05	41.87	2.20	8.4	26.1	4.5	NC	1	33
N,m	4.7/12.3					29.2	3.8	NC	0	18
N,b	1.5/11.5					29.6	3.5	NC	1	28
M,s	10.7/11.5	8.40	42.40	2.40	10.4	29.0	3.6	NC	3	22
M,m	10.6/12.0					38.8	4.3	NC	4	17
M,b	5.2/11.8					27.9	3.8	NC	7	19
S,s	11.0/14.8	NT	41.87	2.10	8.4	31.3	3.6	NC	4	22
S,m	11.6/14.6					33.7	6.7	NC	2	15
S,b	2.4/14.2					35.6	4.0	NC	4	16
L,s	11.0/14.6	NT	39.80		3.7	24.7	3.2	NC	1	19
SALMON	10.8/9.0	NT	50.20			24.6	16.8	NC	311	23
CURLEY	- / -		41.30			36.2	5.8	NC	16	11

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NI
10/18/88										
N,s	NT	NT	43.30	3.00	2.8	32.2	4.9	555	56	3
N,m	NT					28.1	5.9	445	55	1
N,b	NT					22.9	4.7	ND	56	3
M,s	NT	NT	41.43	2.90	4.4	29.6	6.8	323	61	3
M,m	NT					36.0	7.4	501	61	3
M,b	NT					33.9	11.5	390	61	3
S,s	NT	NT	42.54	2.70	6.8	34.5	8.4	343	62	4
S,m	NT					36.0	8.6	283	63	4
S,b	NT					45.7	9.1	481	63	5
L,s	NT	NT	40.89		2.4	24.7	7.5	737	19	20
SALMON	NT	NT	48.44			28.1	19.5	404	332	22
CURLEY	NT	NT	39.78			30.7	9.0	428	80	24
11/15/88										
N,s	10.2/6.2	7.62	34.98	2.90	1.6	60.0	10.8	NC	224	33
N,m	9.8/6.0					33.4	8.2	NC	225	30
N,b	8.3/5.9					27.5	8.3	NC	221	39
M,s	9.7/5.4	7.55	33.48	2.70	0.4	30.1	9.4	NC	290	45
M,m	9.1/5.2					33.6	8.3	NC	285	40
M,b	8.1/5.9					32.1	8.3	NC	285	41
S,s	9.9/5.0	7.62	33.25	2.50	5.2	31.1	6.8	NC	27	58
S,m	9.7/5.2					48.7	11.4	NC	345	39
S,b	8.9/5.2					64.3	9.9	NC	285	23
L,s	- / -	6.92	34.67		2.0	16.9	7.0	NC	88	41
SALMON	- / -	NT	34.67			33.4	14.4	NC	481	26
CURLEY	- / -	NT	33.68			29.3	8.3	NC	LOST	24
12/10/88										
N,s	11.2/5.0	6.56	33.92	1.90	2.8	33.9	10.3	NC	512	NC
N,m	10.5/5.0	6.63	33.21			28.0	10.4	NC	403	NC
N,b	9.0/5.0	6.65	32.86			29.6	11.4	NC	476	NC
M,s	10.4/5.2	6.67	33.49	2.00	1.2	32.8	11.5	NC	479	NC
M,m	11.4/5.0	6.71	32.86			36.4	11.5	NC	486	NC
M,b	9.2/5.2	6.73	33.40			31.7	12.1	NC	457	NC
S,s	10.0/5.8	6.73	32.86	2.10	4.4	32.0	10.4	NC	460	NC
S,m	14.4/5.4	6.75	32.67			30.6	9.8	NC	463	NC
S,b	12.4/4.9	6.70	33.12			33.6	10.1	NC	399	NC
L,s	- / -	6.60	34.98		2.0	28.6	10.0	NC	366	NC
SALMON	- / -	6.60	34.98			30.0	14.0	NC	375	NC
CURLEY	- / -	6.70	33.42			27.7	11.4	NC	304	NC

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
1/16/89										
N,s	ND	6.70	24.91	1.30	0.80	37.5	11.4	NC	582	NC
N,m	ND					36.8	10.3	NC	609	NC
N,b	ND					37.5	11.9	NC	563	NC
M,s	ND	6.80	25.44	1.40	0.80	31.0	13.6	NC	548	NC
M,m	ND					ND	ND	NC	567	NC
M,b	ND					ND	ND	NC	560	NC
S,s	ND	6.70	24.38	1.30	0.40	31.0	14.3	NC	515	NC
S,m	ND					ND	ND	NC	589	NC
S,b	ND					ND	ND	NC	615	NC
L,s	ND	6.50	24.91	1.20	0.40	26.2	11.7	NC	474	NC
SALMON	ND	6.40	21.20			44.4	11.4	NC	658	NC
CURLEY	ND	---	25.44			ND	ND	NC	542	NC
2/21/89										
N,s	ND	6.92	24.38	1.90	3.60	30.3	7.6	ND	571	7
N,m	ND		24.38			30.5	5.9	ND	545	14
N,b	ND		24.91			35.7	6.1	ND	568	11
M,s	ND	6.85	25.44	1.65	9.60	32.3	6.0	ND	839	30
M,m	ND		24.91			ND	6.1	ND	711	19
M,b	ND		24.38			32.3	8.8	ND	672	29
S,s	ND	6.71	25.42	1.65	18.80	41.2	8.3	ND	345	17
S,m	ND		25.97			35.1	7.3	ND	412	2
S,b	ND		25.97			36.2	5.3	ND	459	26
L,s	ND	6.48	26.50		8.00	33.7	7.2	ND	415	5
SALMON	ND	6.63	25.25			34.6	10.0	ND	879	31
CURLEY	ND	ND	24.38			29.7	5.0	ND	498	0
3/23/89										
N,s	ND	6.90	23.85	1.40	10.00	25.6	3.3	NC	499	28
N,m	ND					27.0	2.7	NC	485	34
N,b	ND	6.95	23.32			33.9	8.8	NC	381	48
M,s	ND	6.70	24.91	1.45	9.20	27.7	3.9	NC	488	54
M,m	ND					26.7	3.5	NC	503	38
M,b	ND	6.70	24.91			37.1	11.7	NC	492	22
S,s	ND	6.80	25.97	1.40	14.00	29.6	6.0	NC	390	19
S,m	ND					ND	4.8	NC	412	22
S,b	ND	6.80	26.50			30.9	4.7	NC	387	19
L,s	ND	6.80	26.50		11.20	44.4	12.3	NC	142	22
L,s;E	ND					27.9	5.4	NC	247	16
L,s;W	ND					26.3	4.9	NC	342	31
Salmon	ND	6.95	27.56			34.6	9.7	NC	520	24
Curley	ND	7.00	25.44			26.8	3.5	NC	230	16

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
4/13/89										
N,s	ND	6.45	26.30	1.75	9.60	13.3	2.4	NC	174	8
N,m	ND	6.75	25.44			15.9	2.2	NC	341	6
N,b	ND	6.35	25.97			15.7	2.4	NC	381	10
M,s	ND	6.55	25.54	1.90	5.60	16.4	2.0	NC	321	14
M,m	ND	6.55	25.97			20.2	2.4	NC	636	39
M,b	ND	6.60	25.54			20.6	2.3	NC	337	56
S,s	ND	6.55	25.75	2.10	3.20	15.7	2.5	NC	307	52
S,m	ND	6.60	25.54			15.7	2.4	NC	363	63
S,b	ND	6.65	26.30			14.8	4.1	NC	363	57
L,s	ND	6.83	25.97	1.90	5.60	15.0	2.0	NC	297	39
L,s;E	ND		26.50			15.1	4.2	NC	355	ND
L,s;W	ND		25.75			19.6	2.7	NC	163	ND
Salmon	ND	7.20	32.86			24.3	10.7	NC	421	19
Curley	ND		26.18			26.6	2.3	NC	217	47
5/4/89										
N,s	ND	7.13	30.32	3.00	1.00	15.0	7.6	NC	375	47
N,m	ND		29.68			18.0	8.2	NC	373	39
N,b	ND	7.20	30.21			9.4	8.3	NC	54	54
M,s	ND	7.30	30.21	3.40	1.90	20.9	7.5	NC	356	52
M,m	ND		29.15			21.8	6.7	NC	357	58
M,b	ND	7.16	30.75			26.4	14.8	NC	355	54
S,s	ND	7.45	31.23	2.60	5.00	22.5	5.7	NC	194	29
S,m	ND		30.75			24.6	6.0	NC	215	30
S,b	ND	7.20	30.95			57.6	16.9	NC	372	42
L,s	ND	7.10	30.95	NT	3.60	22.2	5.9	NC	125	22
L,s;E	ND		30.95			19.4	6.1	NC	194	ND
L,s;W	ND		32.00			18.9	3.1	NC	85	ND
Salmon	ND	7.57	46.22			23.3	13.4	NC	190	20
Curley	ND	7.46	30.95			22.8	7.6	NC	531	18
5/23/89										
N,s	9.4/16.3	6.65	32.86	1.60	11.80	25.5	7.1	475	176	NC
N,m	9.9/16.25		32.75			32.5	11.6	ND	156	NC
N,b	8.8/16.2	6.60	31.80			29.7	5.4	457	136	NC
M,s	9.2/16.0	6.75	32.02	1.70	9.20	35.2	7.3	307	159	NC
M,m	9.6/16.0		33.07			35.3	4.9	311	154	NC
M,b	9.0/16.0	7.10	32.86			24.3	5.9	483	87	NC
S,s	8.9/15.8	7.15	32.97	1.85	9.80	32.5	8.1	400	96	NC
S,m	9.4/15.8		34.45			29.7	7.3	445	121	NC
S,b	4.6/15.0	7.20	33.60			36.7	8.8	445	92	NC
L,s	8.6/16.5	7.26	33.28	NT	10.20	35.9	7.6	808	88	NC
L,s;E	8.4/16.2		31.80			20.7	4.5	ND	ND	NC
L,s;W	6.2/15.8		33.92			36.8	10.5	ND	ND	NC
Salmon	NT	7.34	48.44			23.4	14.8	525	501	NC
Curley	NT		33.60			15.9	5.3	687	202	NC

6/12/89 mostly sunny, 75' Wind: moderate, N>S

N,s	9.7/21.2	7.10	35.00	2.20	7.70	43.1	8.6	440	108	NC
N,m	9.6/20.9		33.90			31.6	10.9	709	119	NC
N,b	8.6/20.2		35.00			37.7	5.1	664	86	NC
M,s	10.3/21.5	7.45	33.90	2.00	10.60	31.6	15.3	687	127	NC
M,m	9.8/20.9		35.00			64.4	14.6	688	95	NC
M,b	1.2/17.8		35.00			37.8	5.9	977	76	NC
S,s	9.8/22.0	7.54	33.80	2.00	3.20	25.6	4.0	602	78	NC
S,m	10.4/21.2		33.80			47.4	10.7	636	48	NC
S,b	2.4/18.1		35.00			71.3	5.6	921	46	NC
L,s	9.4/22.2	7.28	35.00	NT	6.40	45.4	4.1	584	35	NC
L,s;E	NT		33.80			85.4	4.3	ND	ND	NC
L,s;W	NT		35.00			26.9	4.5	ND	ND	NC
Salmon	9.9/14.5		53.00			45.8	16.9	1,131	576	NC
Curley	9.3/22.5		33.80			75.1	5.2	828	102	NC

6/20/89 mostly sunny, 75' Wind: moderate-strong, N>S

N,s	9.8/19.0	7.45	37.10	1.80	13.40	34.4	6.3	1,042	25	32
N,m	9.4/19.0	7.40	36.04			41.4	7.3	1,269	28	28
N,b	9.0/18.5	7.40	37.10			64.6	12.2	1,358	21	19
M,s	9.4/18.9	7.40	36.04	1.50	16.40	40.0	10.1	1,157	34	17
M,m	9.3/18.8	7.45	37.10			48.5	6.7	791	31	15
M,b	9.1/18.4	7.40	36.04			44.6	6.6	677	30	31
S,s	8.6/18.8	7.60	36.04	1.40	10.60	54.1	10.4	1,398	20	20
S,m	8.4/18.4	7.55	37.10			46.5	10.5	665	19	27
S,b	7.9/18.1	7.50	37.10			49.4	10.6	799	24	23
L,s	10.4/19.0	7.55	36.04	NT	14.20	44.9	5.9	1,202	16	39
L,s;E	NT		34.98			32.3	4.2		ND	
L,s;W	NT		36.04			42.1	6.7		ND	
Salmon	NT	7.50	47.70			35.2	21.0	985	407	36
Curley	9.6/20.4	7.60	38.16			37.0	6.1	697	45	13

7/7/89 mostly sunny, 75' Wind: moderate, N>S

N,s	9.5/20.5	8.00	37.43	1.70	9.10	33.2	4.5	1,034.00	9	6
N,m	9.5/20.5	8.00	36.23			55.2	4.8	986.00	11	8
N,b	7.3/19.2	7.90	36.89			60.0	5.4	993.00	15	18
M,s	9.5/21.1	8.00	37.45	1.80	5.50	35.0	4.5	976.00	7	13
M,m	9.5/20.8	7.95	36.98			LOST	7.0	898.00	10	8
M,b	5.5/19.1	7.65	36.77			54.4	5.1	945.00	12	38
S,s	9.9/21.7	8.20	36.32	1.85	7.70	32.7	4.2	923.00	13	9
S,m	9.7/21.2	8.05	36.78			36.2	7.9	882.00	21	28
S,b	3.1/18.7	7.60	37.21			46.8	7.3	965.00	12	22
L,s	10.6/22.0	8.45	35.97	NT	8.20	44.6	4.4	673.00	8	21
L,s;E		8.20	37.56			35.0	3.6	NC	18	NC
L,s;W		8.75	35.28			34.1	6.0	NC	14	NC
Salmon		7.65	51.17			33.5	19.0	1,214.00	318	27
Curley	9.4/22.2	8.25	38.56			34.6	5.1	1,005.00	13	9

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
7/21/89										
N,s	9.4/22.5	8.05	38.16	2.15	15.80	46.5	3.5	879.00	5	NC
N,m	9.3/21.8		37.73			44.3	3.5	823.00	7	NC
N,b	8.0/21.5	7.95	37.00			65.5	5.7	912.00	12	NC
M,s	9.2/22.4	8.20	37.10	2.00	10.60	60.7	3.3	897.00	7	NC
M,m	8.5/21.5		37.42			55.4	3.4	913.00	14	NC
M,b	3.5/21.0	8.05	37.73			64.6	5.4	913.00	20	NC
S,s	10.3/22.3	8.40	37.10	2.30	7.70	44.6	4.8	816.00	9	NC
S,m	10.0/21.6		36.57			47.3	3.8	745.00	12	NC
S,b	7.0/21.0	8.15	37.10			41.1	4.5	845.00	10	NC
L,s		8.60	35.83	NT	6.40	36.4	2.6	623.00	8	NC
Salmon		7.85	53.00			38.7	18.2	784.00	378	NC
Curley	9.8/23.0	8.20	36.04			49.2	4.6	773.00	8	NC
8/4/89		calm-light, N>S								
N,s	7.9/20.0	8.10	41.64	1.50	13.70	49.4	2.6	1,186	11	NC
N,m	7.8/20.0		39.17			48.6	2.8	783	9	NC
N,b	7.5/20.0	8.15	38.91			51.2	3.6	988	6	NC
M,s	8.9/20.4	8.05	40.96	1.60	21.00	51.8	2.2	1,347	60	NC
M,m	8.7/20.4		40.96			49.8	2.2	1,309	30	NC
M,b	7.0/20.0	8.10	38.40			53.5	3.8	1,269	23	NC
S,s	9.6/20.5	8.35	40.96	1.60	29.10	59.9	2.6	1,107	26	NC
S,m	9.5/20.2		39.68			53.5	6.1	864	23	NC
S,b	6.5/19.9	8.30	40.32			57.4	5.5	1,291	39	NC
L,s	10.0/20.4	8.55	39.00	NT	9.60	42.6	3.2	766	215	NC
Salmon	9.7/15.0	8.05	55.04			40.8	18.6	1,415	713	NC
Curley	9.4/22.0	8.20	40.32			47.7	4.9	1,253	10	NC
8/18/89		moderate, N>S								
N,s	8.6/21.1	7.45	41.34	1.80	12.70	38.8	3.3	628	21	NC
N,m	8.4/20.5		41.60			44.4	3.1	631	28	NC
N,b	7.4/20.2	7.40	40.96			50.5	3.9	606	18	NC
M,s	9.9/21.6	7.95	40.32	1.50	16.80	35.2	1.8	574	18	NC
M,m	9.2/20.9		40.96			40.4	2.2	774	19	NC
M,b	3.3/20.2	7.65	40.58			42.2	5.6	838	22	NC
S,s	11.2/22.5	8.50	40.58	1.30	31.20	45.5	2.2	969	22	NC
S,m	11.4/21.5		40.70			52.2	2.3	828	28	NC
S,b	3.1/20.2	8.65	40.96			45.7	2.1	742	31	NC
L,s	11.8/22.8	8.95	39.04	NT	23.60	40.3	2.5	774	16	NC
Salmon	10.2/15.0	7.45	55.04			31.0	17.6	546	289	NC
Curley	9.7/21.6	7.30	41.60			39.8	4.7	510	18	NC

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH
9/1/89		: light-moderate, S>N								
N,s	8.5/18.9	8.40	42.88	0.90	46.80	56.9	4.5	1,173	43	NC
N,m	8.0/19.0	8.45	43.52			42.6	2.8	835	23	NC
N,b	6.1/19.0	8.40	44.16			46.1	16.1	710	34	NC
M,s	8.3/19.2	8.10	44.16	1.05	28.90	48.9	4.5	710	29	NC
M,m	8.0/19.1	7.90	44.80			48.6	3.3	755	22	NC
M,b	4-5/19.0	7.90	44.16			42.6	6.7	845	67	NC
S,s	8.1/19.3	7.85	43.77	1.00	16.40	56.3	6.2	814	48	NC
S,m	7.6/19.2	7.85	44.20			55.6	4.0	946	81	NC
S,b	6.8/19.1	7.80	44.42			65.2	9.1	888	1,104	NC
L,s	9.1/19.0	7.75	41.85	NT	5.30	26.8	3.1	557	24	NC
Salmon	9.5/13.2	7.30	57.98			29.9	13.6	474	353	NC
Curley	9.8/19.5	8.35	44.80			47.0	5.1	895	38	NC
9/13/89		moderate, N>S								
N,s	NT	8.50	43.21	1.10	33.20	17.5	3.9	1,209	32	57
N,m	NT	8.50	43.52			19.0	4.4	1,221	44	33
N,b	NT	8.45	43.97			43.8	3.2	805	62	12
M,s	NT	8.60	44.16	1.00	26.80	17.0	3.0	883	9	17
M,m	NT	8.65	44.80			21.7	3.0	1,163	8	3
M,b	NT	8.45	44.16			48.4	2.4	794	44	8
S,s	NT	9.15	43.77	1.05	23.60	16.8	2.6	937	148	4
S,m	NT	9.25	43.58			21.5	2.9	1,198	89	5
S,b	NT	8.05	44.42			59.3	6.8	1,168	39	25
L,s	NT	9.40	41.85	1.00	20.20	12.6	3.1	1,143	27	8
Salmon	NT	8.30	55.76			24.8	11.3	997	341	23
Curley	NT	8.60	45.78			22.6	3.2	1,065	37	8
9/29/89		light, N>S								
N,s	9.2/17.7	8.47	41.34	0.95	17.20	36.1	3.6	661	35	16
N,m	8.9/17.4	8.48	40.56			39.7	4.0	677	42	7
N,b	8.9/17.2	8.39	41.87			42.4	3.9	735	49	20
M,s	9.3/18.1	8.70	42.67	0.95	19.40	34.7	3.8	731	43	28
M,m	8.9/17.7	8.69	42.34			43.2	4.3	912	49	28
M,b	3.5/17.1	8.56	42.12			44.4	3.3	685	59	10
S,s	10.2/18.5	8.98	41.79	1.05	17.80	33.2	3.0	668	29	9
S,m	10.1/18.0	8.99	41.48			32.6	4.3	576	27	16
S,b	2.7/17.5	8.97	41.02			40.5	3.6	520	20	11
L,s	12.4/18.4	9.60	39.59	NT	21.10	32.7	3.1	634	17	10
Salmon	9.3/12.0	7.70	46.98			15.7	13.3	446	612	37
Curley	9.6/18.7	8.43	41.47			34.4	5.0	695	33	16

STATION	D.O./T	pH	ALKILINITY	SECCHI	CHL A	TP	SRP	TN	NO2-NO3	NH4
10/13/89	cloudy, rwind: strong, S>N									
N,s	8.5/14.3	7.35	38.23	2.00	4.80	22.6	5.4	507	34	NC
N,m	8.5/14.2		38.76			25.1	7.6		22	NC
N,b	7.5/14.1	7.48	39.04			30.9	9.2	571	13	NC
M,s	8.4/14.2	7.53	39.56	1.90	6.40	27.3	5.1	731	25	NC
M,m	8.3/14.1		38.97			29.0	8.0		35	NC
M,b	7.1/14.0	7.58	39.77			35.6	12.2		22	NC
S,s	8.6/14.3	7.65	38.83	1.90	6.80	33.2	6.5	541	41	NC
S,m	8.6/14.3		38.83			32.7	7.1		39	NC
S,b	7.4/14.1	7.83	39.56			31.1	7.3		34	NC
L,s	8.2/13.9	7.42	37.55	2.00	3.20	21.4	8.0	382	23	NC
Salmon	9.0/12.0	7.28	42.81			44.8	30.2	888	745	NC
Curley	NT	7.95	38.75			27.9	9.9	617	29	NC
11/13/89	cloudy, rwind: strong, S>N									
N,s	10.0/10.2	7.21	28.20	2.80	4.80	37.5	11.8	473	214	NC
N,m	9.8/10.2		23.08			39.4	8.7	ND	201	NC
N,b	9.5/10.0	7.10	31.08			114.0	8.6	535	115	NC
M,s	10.2/10.3	7.10	30.12	2.80	3.80	34.2	8.3	608	207	NC
M,m	9.8/10.2		25.98			44.0	10.5	ND	187	NC
M,b	9.9/9.9	7.05	32.60			146.3	9.9	ND	125	NC
S,s	9.5/9.8	7.12	33.32	2.80	1.80	23.5	6.0	622	208	NC
S,m	9.3/9.8		33.32			34.9	6.2	ND	179	NC
S,b	8.4/9.5	7.17	34.60			87.7	6.7	525	100	NC
L,s	9.6/9.8	7.24	31.23	NT	1.20	21.9	4.8	192	218	NC
Salmon	9.6/8.0	6.92	22.14			57.1	16.4	ND	1,689	NC
Curley	NT	7.10	30.12			37.3	8.8	555	211	NC
12/15/89	prtly sunwind: strong, S>N									
N,s	9.4/7.1	6.49	22.65	1.80	2.00	23.6	13.7	NC	457	NC
N,m	9.3/7.0	6.68				31.2	11.5	NC	252	NC
N,b	8.5/7.0	6.78	22.98			32.5	12.3	NC	430	NC
M,s	9.6/7.0	6.88	20.74	2.00	1.60	30.9	11.5	NC	499	NC
M,m	9.3/7.0	6.95				35.5	11.3	NC	383	NC
M,b	8.2/6.9	6.99	21.25			36.3	12.1	NC	421	NC
S,s	8.7/7.0	7.01	26.88	1.80	0.80	29.5	9.8	NC	310	NC
S,m	8.4/7.0	7.03				31.7	9.8	NC	255	NC
S,b	7.4/7.0	7.08	26.88			33.6	10.5	NC	295	NC
L,s	7.3/6.5	6.96	27.26	NT	4.40	24.9	7.3	NC	179	NC
Salmon	11.1/6.0	7.04	11.26			34.7	12.3	NC	611	NC
Curley	9.3/7.0	7.09	25.98			32.0	10.3	NC	494	NC

Water Quality, 1/10-12/17/90

1/10/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	7.5	10.8	1.3	3.1	6.7	26.7	29.6	14.5
N,m	7.5	11.0			6.9		41.5	13.0
N,b	7.4	10.6			7.0	25.0	38.9	13.3
M,s	7.7	10.8	1.2	5.0	7.0	20.8	34.6	13.7
M,m	7.7	10.8			7.0		39.1	13.3
M,b	7.5	10.6			7.1	25.6	41.9	13.1
S,s	7.5	10.6	1.8	3.5	7.1	26.9	26.8	11.2
S,m	7.3	10.7			7.1		22.9	10.4
S,b	7.2	10.2			7.2	26.9	32.2	12.2
L,s	7.1	10.0	1.4	3.0	7.1	27.3	22.1	9.7
Lake mean	7.5	10.6	1.4	3.7	8.0	25.4	33.8	12.4
Salmo. Ck.	7.0	11.7			7.0	11.2	37.2	14.3
Curley Ck.	7.4	11.5			7.0	26.0	25.1	10.7

2/24/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	5.5	13.2	1.4	9.5	7.5	21.1	30.2	4.0
N,m	5.1	12.4			7.5		32.7	5.2
N,b	5.0	12.0			7.4	21.1	26.9	5.1
M,s	5.2	12.3	1.3	13.5	7.4	21.8	34.5	6.0
M,m	5.0	12.0			7.4		29.9	5.7
M,b	5.0	12.0			7.4	22.4	22.6	6.4
S,s	6.0	12.6	1.1	11.0	7.5	21.8	47.3	6.7
S,m	5.6	12.5			7.4		31.3	6.7
S,b	4.8	11.8			7.3	21.8	27.8	10.1
L,s	6.6	12.6	1.2	8.8	7.3	23.0	30.2	6.4
Lake mean	5.3	12.3	1.2	10.7	7.4	21.8	31.1	6.1
Salmo. Ck.	7.1	11.8			7.3	25.6	31.1	11.3
Curley Ck.	5.8	12.5			7.4	23.0	23.8	4.3

3/23/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	10.6	9.9	1.2	11.5	7.2	23.7	----	----
N,m	11.0	9.9			7.2		27.9	4.0
N,b	11.0	9.9			7.3	23.5	31.2	3.3
M,s	10.8	10.2	1.1	14.0	7.3	23.7	30.3	3.0
M,m	10.7	10.1			7.4		28.5	3.0
M,b	10.5	9.5			7.3	25.6	26.3	3.4
S,s	11.5	10.7	1.0	18.5	7.5	25.6	30.6	4.2
S,m	11.2	10.9			7.5		33.3	3.3
S,b	10.9	10.4			7.4	25.6	39.7	3.9
L,s	11.5	10.5	1.1	14.0	7.5	25.6	31.2	4.9

(cont.)

3/23/90 (cont.)

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
Lake mean	10.9	10.2	1.1	14.5	7.3	24.6	30.4	3.6
Salmo. Ck.	8.9	10.4			7.3	32.0	49.1	11.3
Curley Ck.	9.6	10.0			7.3	24.4	43.6	3.3

4/16/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	16.3	8.7	1.8	4.9	7.5	29.4	30.0	3.3
N,m	14.9	8.2			7.5		29.5	3.9
N,b	13.5	4.4			7.3	29.4	44.8	3.5
M,s	15.1	9.1	1.6	2.5	7.6	29.4	23.0	2.3
M,m	15.0	8.8			7.6		23.9	2.3
M,b	13.0	5.5			7.4	30.7	26.5	4.3
S,s	15.5	8.8	1.6	2.5	7.8	29.4	21.5	1.9
S,m	15.2	8.8			7.7		23.2	2.4
S,b	13.3	4.4			7.6	31.4	23.3	3.6
L,s	15.8	8.8	1.7	---	7.7	31.4	29.0	7.2
Lake mean	15.6	7.5	1.7	3.3	7.6	30.1	27.9	3.5
Salmo. Ck.	17.5	9.6			7.6	42.2	31.2	9.7
Curley Ck.	15.0	8.5			7.5	30.7	34.4	5.0

5/2/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	15.0	9.5	2.1	---	7.0	32.0	28.6	6.3
N,m	14.9	9.4			7.1		40.0	8.5
N,b	13.5	7.6			6.9	30.7	33.7	10.7
M,s	15.1	9.5	2.1	---	7.0	32.0	29.0	5.5
M,m	15.0	9.3			7.1		35.6	5.8
M,b	13.0	7.0			6.9	32.0	----	---
S,s	15.5	9.9	2.1	---	7.1	32.0	29.5	7.6
S,m	15.2	9.6			7.3		32.0	6.8
S,b	13.3	5.2			6.7	31.4	----	---
L,s	15.8	11.5	1.5	1.0	7.7	32.0	35.3	6.5
Lake mean	14.6	8.8	2.0	1.0	7.1	31.7	33.0	7.3
Salmo. Ck.	10.6	10.1			7.1	43.5	34.1	9.9
Curley Ck.	14.5	9.6			7.0	30.7	41.9	6.7

(cont.)

5/14/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	15.8	9.7	1.9	5.0	7.2	32.0	26.7	3.8
N,m	15.7	9.4			7.1		22.5	7.9
N,b	15.3	9.2			7.0	32.0	----	---
M,s	15.8	9.7	1.9	11.4	7.2	33.3	27.5	4.9
M,m	15.5	9.3			7.2		30.2	4.4
M,b	15.2	8.5			7.1	30.7	48.3	4.9
S,s	16.0	9.4	1.5	15.1	7.6	33.3	39.8	6.7
S,m	15.2	9.4			7.6		30.7	5.7
S,b	15.0	8.7			7.2	33.3	26.1	4.9
L,s	16.2	9.6	1.4	2.1	7.1	33.3	42.5	9.8
Lake mean	15.6	9.3	1.7	8.1	7.2	32.4	28.9	5.7
Salmo. Ck.	10.8	10.6			7.6	46.1	30.8	15.8
Curley Ck.	15.0	9.7			6.4	33.3	15.9	5.3

5/31/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	16.9	9.9	1.2	---	8.2	34.9	17.8	5.3
N,m	16.9	9.7			8.2		24.0	5.0
N,b	16.9	9.7			8.1	33.8	----	---
M,s	16.9	9.9	1.3	---	8.2	33.8	23.4	4.1
M,m	16.9	9.6			8.2		30.8	5.2
M,b	16.9	9.5			8.2	36.0	25.2	4.9
S,s	16.4	9.6	1.7	17.5	8.1	34.9	26.7	7.7
S,m	16.2	9.5			8.1		31.6	6.1
S,b	16.2	9.5			8.1	36.0	30.4	8.4
L,s	16.9	10.9	1.2	5.9	8.7	33.8	24.9	6.9
Lake mean	16.7	9.8	1.4	11.7	8.2	34.7	25.6	5.7
Salmo. Ck.	11.5	9.7			7.2	33.8	62.4	13.2
Curley Ck.	16.0	9.6			7.6	33.8	30.2	5.3

6/12/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	17.1	9.8	1.1	25.9	8.2	33.8	31.7	3.5
N,m	17.0	9.6			8.2		35.0	6.7
N,b	16.8	8.8			8.3	35.2	35.1	3.2
M,s	17.5	9.7	1.1	27.6	8.2	34.4	32.7	3.9
M,m	17.0	9.4			8.3		35.3	3.9
M,b	16.8	8.6			8.0	34.9	----	---
S,s	17.0	9.8	1.2	14.5	8.2	34.8	40.5	4.8
S,m	16.7	9.6			8.2		40.0	6.1
S,b	16.4	8.8			7.9	34.8	36.3	5.1
L,s	17.0	9.6	1.5	15.5	7.6	35.2	41.7	5.6

(cont.)

6/12/90 (cont.)

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
Lake mean	16.9	9.4	1.2	20.9	8.1	34.7	31.1	4.6
Salmo. Ck.	11.9	10.4			8.0	44.1	47.3	19.0
Curley Ck.	16.1	9.6			7.4	34.8	39.1	6.5
6/26/90								
N,s	20.8	10.1	1.4	14.5	7.9	40.3	29.1	4.2
N,m	20.6	9.8			8.1		30.5	3.4
N,b	19.6	4.4			8.0	36.0	34.6	3.3
M,s	21.1	10.3	1.4	18.6	7.9	37.1	36.8	3.3
M,m	20.6	9.7			8.2		42.6	3.4
M,b	18.4	1.9			7.4	39.2	----	----
S,s	21.1	10.7	1.4	11.5	8.1	38.2	27.3	3.1
S,m	20.4	10.1			8.3		31.6	5.9
S,b	18.1	1.5			7.2	37.1	----	----
L,s	21.4	12.3	1.6	6.5	8.8	34.9	25.6	4.5
Lake mean	20.2	8.0	1.4	12.8	8.0	37.7	35.7	3.8
Salmo. Ck.	12.0	10.6			7.3	52.3	33.9	19.0
Curley Ck.	20.1	9.5			6.8	36.0	36.3	6.4
7/10/90								
N,s	23.1	13.1	0.6	48.2	9.2	39.2	48.7	3.0
N,m	22.0	11.2			9.3		64.2	3.2
N,b	20.4	1.9			8.7	40.3	46.1	9.2
M,s	23.7	12.6	0.6	58.3	9.5	39.2	43.8	3.8
M,m	21.8	8.9			9.5		60.6	3.7
M,b	19.0	0.6			7.2	41.4	----	----
S,s	25.8	13.8	0.4	70.4	9.7	38.2	51.3	5.3
S,m	23.6	13.2			9.8		55.7	4.4
S,b	18.8	0.8			8.5	37.1	53.7	5.5
L,s	28.0	14.0	0.4	20.3	10.0	37.1	40.3	2.5
Lake mean	22.4	9.4	0.5	49.3	9.1	39.2	51.9	4.5
Salmo. Ck.	14.5	10.6			7.2	54.5	26.9	19.1
Curley Ck.	20.5	10.8			8.8	39.2	60.4	4.3

(cont.)

7/24/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	23.6	7.5	0.9	46.0	6.9	40.9	65.1	10.8
N,m	23.5	7.3			7.0		54.6	5.9
N,b	23.3	6.7			7.0	42.0	60.6	4.9
M,s	23.3	7.6	0.9	56.1	7.3	41.4	56.3	8.9
M,m	23.2	7.4			7.4		64.2	13.9
M,b	20.8	0.1			6.9	42.5	67.7	20.5
S,s	22.8	6.7	1.1	49.2	6.8	42.5	58.1	6.8
S,m	22.7	6.6			---		58.0	6.9
S,b	22.3	4.9			6.9	41.4	60.1	6.5
L,s	22.7	7.7	---	9.1	7.7	38.2	34.5	5.5
Lake mean	15.6	6.2	0.9	40.1	7.1	41.4	58.5	9.4
Salmo. Ck.	14.6	8.9			6.8	56.7	26.9	18.4
Curley Ck.	21.9	8.7			7.1	41.4	48.4	3.7

8/7/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	23.5	11.0	0.9	32.1	9.2	43.6	51.6	10.9
N,m	22.8	10.5			9.2		59.4	2.0
N,b	22.4	9.1			9.0	43.1	58.7	2.7
M,s	24.4	11.3	1.0	40.1	9.2	43.1	45.6	5.6
M,m	23.2	10.2			9.1		52.9	2.4
M,b	20.8	0.9			7.8	45.2	67.3	9.8
S,s	24.6	12.0	1.0	34.1	9.1	43.6	46.3	16.5
S,m	23.8	10.9			9.1		51.3	1.9
S,b	22.0	1.0			9.0	44.1	74.1	2.0
L,s	24.3	11.2	1.5	20.0	9.1	41.4	41.7	4.1
Lake mean	23.1	9.2	1.1	31.6	9.0	43.5	55.1	5.8
Salmo. Ck.	14.0	10.9			7.6	56.7	34.2	19.6
Curley Ck.	20.8	10.0			8.7	43.6	69.1	3.8

8/21/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	22.0	10.1	0.7	72.2	8.8	46.9	61.1	2.2
N,m	22.0	9.6			9.0		58.1	2.0
N,b	21.5	7.3			8.6	46.9	62.3	3.1
M,s	22.0	9.8	0.8	78.2	9.0	47.4	60.5	1.9
M,m	22.0	9.1			9.0		58.5	1.7
M,b	21.6	7.0			8.9	47.4	69.4	2.3
S,s	22.0	10.4	0.8	68.2	9.0	46.9	59.3	2.3
S,m	21.7	6.2			9.0		60.5	2.0
S,b	20.9	1.2			7.3	48.5	76.4	6.3
L,s	21.9	9.7	1.3	47.1	7.9	46.3	34.5	1.2

(cont.)

8/21/90 (cont.)

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
Lake mean	21.8	8.1	0.9	66.4	8.7	47.2	60.3	2.1
Salmo. Ck.	15.1	9.9			7.7	56.7	46.3	22.0
Curley Ck.	18.9	9.5			8.5	44.7	53.7	2.5

9/6/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	20.9	9.8	0.9	50.1	8.6	46.9	66.7	1.6
N,m	20.4	7.8			8.4		113.3	1.5
N,b	19.2	3.8			7.2	45.8	64.1	2.2
M,s	21.0	10.3	0.9	52.1	8.6	46.9	64.0	0.9
M,m	19.7	7.0			8.3		66.1	1.9
M,b	18.9	4.7			7.6	45.8	57.6	3.1
S,s	20.9	10.7	0.8	46.1	8.8	46.3	53.4	2.2
S,m	20.3	10.2			8.8		61.0	1.2
S,b	19.2	2.3			7.5	43.6	67.7	1.2
L,s	20.8	10.2	1.5	13.0	8.9	43.6	44.6	0.8
Lake mean	20.2	8.0	1.0	40.3	8.2	45.7	66.9	1.7
Salmo. Ck.	15.2	10.0			7.7	55.6	44.4	17.5
Curley Ck.	19.0	9.8			8.1	44.1	73.3	2.3

9/18/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	18.9	8.5	1.0	34.1	7.4	44.1	75.9	1.8
N,m	18.3	7.6			7.4		77.6	1.5
N,b	18.2	5.9			7.3	43.6	74.5	1.2
M,s	19.7	10.5	0.9	52.1	8.0	45.2	84.1	1.6
M,m	18.5	8.9			8.0		85.8	1.8
M,b	18.1	5.0			7.3	45.2	74.2	2.6
S,s	20.1	10.8	0.7	78.2	8.3	45.2	91.4	1.9
S,m	19.0	9.5			8.4		97.9	1.4
S,b	18.1	3.5			7.4	46.9	63.3	1.8
L,s	19.8	10.4	0.8	66.2	8.8	46.9	77.8	2.0
Lake mean	18.7	8.1	0.9	57.7	7.8	45.1	80.0	1.8
Salmo. Ck.	11.8	10.4			7.7	57.8	39.4	12.5
Curley Ck.	16.5	8.6			7.5	44.7	62.2	2.9

(cont.)

10/19/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	12.2	9.2	1.4	27.1	7.5	39.4	47.3	3.1
N,m	12.2	8.1			7.4		56.0	1.9
N,b	12.2	7.6			7.4	38.1	53.4	2.5
M,s	12.1	8.8	1.3	29.1	7.5	41.3	112.6	1.8
M,m	12.1	8.1			7.4		58.5	2.2
M,b	12.1	7.8			7.3	40.4	51.9	3.5
S,s	11.9	9.2	1.5	25.1	7.5	40.4	50.4	2.0
S,m	11.9	8.6			7.5		59.6	1.9
S,b	11.9	8.1			7.5	40.9	43.4	2.6
L,s	11.4	9.3	1.8	---	7.4	44.2	27.1	1.7
Lake mean	11.9	8.3	1.5	27.1	7.4	40.5	57.3	2.4
Salmo. Ck.	8.2	10.4			7.3	44.2	34.2	12.5
Curley Ck.	11.6	9.4			7.1	40.4	53.8	2.6

11/16/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	10.0	10.2	1.5	3.0	7.4	34.9	33.6	4.0
N,m	10.0	8.9			7.4		37.1	4.2
N,b	10.0	8.4			7.4	33.8	33.9	3.8
M,s	10.0	9.1	1.3	8.0	7.4	33.8	36.6	4.5
M,m	10.0	8.3			7.4		35.7	4.6
M,b	10.0	8.0			7.4	33.8	42.5	5.2
S,s	10.0	9.4	1.4	11.0	7.3	33.8	33.8	4.8
S,m	10.0	7.9			7.3		32.4	4.9
S,b	9.8	7.4			7.2	33.8	31.6	4.9
L,s	10.1	8.6	1.7	7.0	7.2	37.6	26.8	4.3
Lake mean	10.0	8.6	1.5	7.3	7.4	34.4	34.8	4.5
Salmo. Ck.	8.0	10.8			7.0	26.2	99.8	99.8
Curley Ck.	10.1	10.2			7.4	34.9	32.5	3.6

12/17/90

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
N,s	5.8	10.0	1.0	0.5	7.1	21.8	34.1	12.3
N,m	5.8	10.1			7.0		30.5	10.3
N,b	5.8	---			7.0	21.8	34.9	11.2
M,s	5.8	9.5	1.0	0.0	7.6	21.8	29.9	10.7
M,m	5.8	9.8			7.3		33.2	10.7
M,b	5.8	---			7.2	24.0	29.8	10.7
S,s	5.8	9.1	1.1	1.7	7.2	23.4	30.3	10.1
S,m	5.8	9.1			7.2		28.3	10.3
S,b	5.8	9.5			7.2	25.1	21.3	9.4
L,s	5.8	8.8	1.6	2.0	7.3	26.2	21.0	7.1

(cont.)

12/17/90 (cont.)

Station	Temp. (C)	DO (mg/L)	Secchi (m)	Chl a (ug/L)	pH	Alkalinity (mgCaCO3/L	TP (ug/L)	SRP (ug/L)
Lake mean	5.8	9.6	1.2	1.1	7.2	23.2	29.8	10.4
Salmo. Ck.	6.2	13.2			6.4	23.0	46.6	12.7
Curley Ck.	5.9	12.1			5.6	23.5	39.3	11.1

Key:

Stations : N - North
M - Midlake
S - South
L - Lilies (extreme southern section of lake)

Depths : s - Surface
m - Mid-depth
b - Bottom

--- : Analysis error

Nitrogen, 1/10-9/18/90

1/10/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	1,028.0	---	42.0
N,m	1,259.7	---	48.0
N,b	1,263.5	---	43.8
M,s	1,445.8	---	36.5
M,m	1,263.5	---	35.9
M,b	1,631.9	---	29.9
S,s	693.8	---	25.1
S,m	614.0	---	23.9
S,b	860.9	---	24.5
L,s	731.7	---	34.1
Lake mean	913.7	---	35.2
Salmo. Ck.	7.0	---	---
Curley Ck.	7.4	---	---

2/24/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	1,058.3	502.0	---
N,m	846.0	571.8	---
N,b	538.0	636.2	---
M,s	1,061.7	----	---
M,m	996.7	598.6	---
M,b	1,017.2	384.0	---
S,s	969.3	469.8	---
S,m	808.4	555.7	---
S,b	965.8	545.0	---
L,s	863.2	502.0	---
Lake mean	913.7	531.8	---
Salmo. Ck.	7.1	---	---
Curley Ck.	5.8	---	---

3/23/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	996.6	349.3	177.4
N,m	835.8	324.6	51.8
N,b	815.2	344.3	28.9
M,s	825.5	317.2	4.0
M,m	801.5	329.5	2.9
M,b	832.4	314.7	0.1
S,s	777.6	285.1	0.7
S,m	818.7	277.7	1.8
S,b	716.0	282.6	1.8
L,s	736.5	228.3	17.0
Lake mean	821.8	309.6	31.4
Salmo. Ck.	8.9	10.4	---
Curley Ck.	9.6	10.0	---

4/16/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	960.1	148.0	37.1
N,m	460.4	70.0	37.1
N,b	508.3	77.5	65.4
M,s	631.5	96.7	40.8
M,m	590.5	90.3	35.3
M,b	624.7	95.6	35.9
S,s	604.2	92.4	25.7
S,m	453.5	68.9	31.3
S,b	429.6	65.2	45.5
L,s	313.2	47.0	23.3
Lake mean	570.1	87.1	38.5
Salmo. Ck.	17.5	261.0	160.3
Curley Ck.	15.0	83.4	14.3

APPENDIX

5/2/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	445.4	130.4	58.8
N,m	753.0	125.9	37.7
N,b	350.4	139.2	40.8
M,s	555.5	143.7	43.7
M,m	616.3	200.2	34.1
M,b	764.4	171.4	37.7
S,s	597.3	103.8	32.9
S,m	631.5	118.2	29.9
S,b	665.7	128.2	54.6
L,s	460.6	46.2	31.1
Lake mean	583.5	134.4	40.5
Salmo. Ck.	772.0	347.9	17.3
Curley Ck.	540.3	142.6	26.9

5/14/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	257.0	74.0	17.9
N,m	481.1	44.0	26.3
N,b	621.6	61.4	21.5
M,s	519.1	74.9	19.1
M,m	412.7	44.0	19.7
M,b	268.4	58.5	16.1
S,s	427.9	28.5	10.1
S,m	507.7	11.1	10.7
S,b	492.5	42.1	15.5
L,s	477.3	7.3	8.9
Lake mean	443.1	47.2	17.2
Salmo. Ck.	727.9	324.8	13.1
Curley Ck.	469.7	49.8	23.9

5/31/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	1,116.1	12.1	18.9
N,m	937.6	2.0	6.3
N,b	914.8	10.6	---
M,s	926.2	9.9	4.9
M,m	899.6	7.0	4.2
M,b	933.8	0.0	4.2
S,s	873.0	27.2	15.4
S,m	918.6	3.4	---
S,b	804.7	7.8	4.9
L,s	827.5	0.0	15.4
Lake mean	922.1	7.8	9.1
Salmo. Ck.	11.5	261.0	19.6
Curley Ck.	16.0	27.9	6.3

6/12/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	660.0	5.6	4.4
N,m	694.4	6.8	17.9
N,b	656.6	8.1	3.2
M,s	660.0	6.2	3.2
M,m	690.9	6.2	2.6
M,b	745.9	9.3	39.0
S,s	522.7	8.7	13.2
S,m	601.7	10.5	24.3
S,b	553.6	14.1	5.5
L,s	440.3	2.6	24.9
Lake mean	633.5	7.7	13.5
Salmo. Ck.	11.9	307.4	22.5
Curley Ck.	16.1	16.0	16.7

6/26/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	559.6	5.6	31.2
N,m	545.9	9.3	8.7
N,b	672.9	17.8	3.7
M,s	569.9	5.6	8.6
M,m	669.5	2.0	5.5
M,b	552.8	13.5	26.2
S,s	0.0	7.4	12.7
S,m	0.0	3.2	4.6
S,b	0.0	---	5.1
L,s	0.0	9.3	4.6
Lake mean	398.7	8.2	11.6
Salmo. Ck.	260.9	805.6	16.3
Curley Ck.	0.0	---	6.4

7/10/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	1,002.6	6.9	28.7
N,m	1,048.1	10.7	14.3
N,b	802.8	28.2	38.9
M,s	1,111.2	10.7	16.7
M,m	1,188.3	3.9	53.4
M,b	620.5	34.3	51.6
S,s	1,534.3	6.2	14.9
S,m	389.5	4.7	17.9
S,b	1,167.3	9.2	20.3
L,s	313.1	10.0	29.9
Lake mean	925.6	13.1	29.6
Salmo. Ck.	---	405.9	31.7
Curley Ck.	---	16.8	12.5

7/24/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	944.7	35.3	29.3
N,m	997.3	32.4	26.3
N,b	962.2	---	23.3
M,s	930.7	24.7	20.9
M,m	822.0	5.3	54.6
M,b	313.1	20.8	49.8
S,s	787.0	11.1	17.9
S,m	751.9	9.2	13.1
S,b	969.3	3.4	13.7
L,s	706.4	---	25.1
Lake mean	820.2	18.5	28.6
Salmo. Ck.	720.4	504.3	20.3
Curley Ck.	941.2	24.7	34.1

8/7/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	755.4	5.6	16.7
N,m	843.1	4.9	16.7
N,b	787.0	12.8	12.5
M,s	734.4	1.3	30.5
M,m	709.9	0.6	34.7
M,b	759.0	7.8	16.1
S,s	643.3	3.4	20.9
S,m	836.1	3.4	14.3
S,b	927.2	0.0	13.1
L,s	562.7	0.0	15.5
Lake mean	757.4	4.2	19.5
Salmo. Ck.	674.8	492.8	14.9
Curley Ck.	681.8	---	19.1

[illegible]

8/21/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	1,188.8	---	16.1
N,m	1,200.2	---	13.7
N,b	1,116.6	---	20.3
M,s	1,105.2	---	25.1
M,m	1,105.2	---	19.7
M,b	1,169.8	---	19.1
S,s	1,181.2	---	14.3
S,m	1,158.4	---	19.1
S,b	1,014.1	---	85.8
L,s	744.5	---	14.9
Lake mean	1,107.0	---	23.8
Salmo. Ck.	562.3	458.0	12.5
Curley Ck.	1,033.1	---	14.3

9/18/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	879.3	---	6.1
N,m	924.9	---	5.0
N,b	788.2	---	3.8
M,s	1,057.8	---	1.0
M,m	1,031.2	---	4.9
M,b	792.0	---	7.9
S,s	1,103.3	---	5.5
S,m	1,099.5	---	3.2
S,b	795.8	---	36.6
L,s	1,186.9	---	3.2
Lake mean	956.5	---	7.2
Salmo. Ck.	681.9	---	2.0
Curley Ck.	659.1	---	4.4

9/6/90

Station	TN (ug/L)	NO2+NO3 (ug/L)	NH4 (ug/L)
N,s	999.9	---	2.0
N,m	1,064.4	---	3.8
N,b	794.9	---	82.9
M,s	973.3	---	3.2
M,m	992.3	---	6.1
M,b	893.6	---	14.3
S,s	988.5	---	4.4
S,m	965.7	---	4.4
S,b	916.4	---	26.6
L,s	760.7	---	3.8
Lake mean	938.1	---	15.8
Salmo. Ck.	540.5	---	3.8
Curley Ck.	631.6	---	10.8

Key:

Stations : N - North
M - Midlake
S - South
L - Lilies (extreme southern section of lake)

Depths : s - Surface
m - Mid-depth
b - Bottom

--- : No data

WATER QUALITY 1/16/91 - 3/17/92

Station And Date	[1] T/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	TP (ug/L)	[6] SRP (ug/L)	TN (ug/L)	[7] NO2-NO3 (ug/L)	NH4 (ug/L)
1/16/91										
N,s	6/9.6	1.5	4.0	6.95	24.20	30.9	2.9	1,067	630	29
N,m	5.9/9.8			6.99		31.2	4.9	1,081	630	35
N,b	5.9/9.8			7.00	24.00	26.8	2.3	1,088	636	23
M,s	6.0/10.0	1.2	3.0	7.04	23.00	32.3	4.4	1,161	636	57
M,m	6.0/10.0			7.08		32.8	3.6	1,137	693	32
M,b	6.0/10.0			7.08	23.00	30.5	5.3	1,022	693	62
S,s	6.0/9.6	1.4	2.8	7.11	23.00	33.9	4.3	1,105	467	41
S,m	6.0/9.3			7.08		33.7	4.1	1,036	574	44
S,b	6.0/9.3			7.09	23.00	36.5	3.3	1,032	360	48
L,s	6.0/9.5	1.2	7.0	7.09	26.20	30.8	4.0	963	404	15
Salmon	6.4/11.8			7.03	20.70	35.0	4.3	1,420	360	41
Curley	5.8/10.7			7.10	23.90	32.8	3.3	1,158	570	50
2/15/91										
N,s	6.2/10.5	1.3	21.0	6.64	23.40	26.0	3.0	819	574	45
N,m	6.2/11.1			6.30		30.1	3.0	998	354	15
N,b	6.2/11.4			6.56	23.00	32.8	2.1	509	618	8
M,s	6.9/10.3	1.1	15.0	6.74	21.10	31.3	3.2	994	693	19
M,m	6.9/10.0			6.68		28.6	3.8	1,102	413	17
M,b	6.9/10.0			6.67	20.30	33.4	4.1	1,018	332	22
S,s	6.9/10.0	1.2	31.1	6.76	23.40	28.5	3.1	449	460	7
S,m	6.9/10.0			6.85		31.4	3.5	ND	435	9
S,b	6.9/10.0			6.91	24.50	32.3	2.1	ND	410	9
L,s	6.9/11.6	1.5	19.0	6.82	25.60	28.5	1.7	854	432	5
Salmon	6.9/12.8			6.32	13.10	34.2	7.6	865	611	37
Currley	6.2/11.9			5.51	22.30	30.7	3.3	830	467	13
3/5/91										
N,s	8.0/10.0	1.00	10.0	7.54	21.8	32.0	5.8	544	470	38
N,m	8.0/10.0					ND	ND	ND	ND	ND
N,b	8.0/10.0					ND	ND	ND	ND	ND
M,s	8.0/10.2	1.80	12.0	7.29	21.3	33.3	6.5	865	431	19
M,m	8.0/10.1					ND	ND	ND	ND	ND
M,b	8.0/10.1					ND	ND	ND	ND	ND
S,s	8.0/9.4	0.90	26.1	7.64	20.7	32.3	3.7	1,005	429	17
S,m	7.5/9.4					ND	ND	ND	ND	ND
S,b	7.5/9.1					ND	ND	ND	ND	ND
L,s	7.0/9.8	0.90	20.0	7.85	26.2	35.4	3.7	1,440	321	16
Salmon	5.0/13.1			7.38	14.7	49.1	6.7	2,090	863	48
Curley	7.5/13.2			7.14	21.3	31.6	3.3	1,500	119	6

Station And Date	[1] T/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO2+NO3 (ug/L)	NH4 (ug/L)
4/10/91										
N,s	10.2/11.5	1.1	2.0	7.58	20.1	21.6	5.0	613	192	38
N,m	10.2/11.2					ND	ND	ND	ND	ND
N,b	9.8/11.2					ND	ND	ND	ND	ND
M,s	10.2/11.0	1.0	4.0	7.46	20.7	22.3	5.6	648	352	19
M,m	9.2/10.6					ND	ND	ND	ND	ND
M,b	9.2/10.0					ND	ND	ND	ND	ND
S,s	10.7/10.0	0.9	10.0	7.57	20.7	23.7	7.8	949	316	17
S,m	10.6/9.4					ND	ND	ND	ND	ND
S,b	10.2/9.2					ND	ND	ND	ND	ND
L,s	10.2/10.5	1.3	6.0	7.46	20.7	18.7	6.9	561	332	16
Salmon	6.5/12.2			7.13	21.8	27.5	7.9	662	464	48
Curley	9.2/11.9			7.76	21.3	19.7	5.1	641	332	6
5/6/91										
N,s	15.0/9.9	1.0	11.0	9.07	25.1	39.0	5.7	830	12	33
N,m	15.2/9.9			8.81		40.9	2.8	740	11	40
N,b	15.2/9.9			8.42	26.2	44.3	3.4	ND	10	55
M,s	15.5/9.9	0.9	15.0	8.14	25.1	10.5	3.7	ND	9	21
M,m	15.3/9.8			8.05		35.8	4.0	145	9	31
M,b	15.0/9.9			8.02	25.1	46.7	2.0	516	7	23
S,s	15.0/10.3	0.8	5.0	7.94	27.3	38.7	4.5	516	7	18
S,m	15.0/10.2			8.00		36.6	4.4	606	3	27
S,b	14.9/10.2			7.99	27.3	37.2	3.7	606	6	22
L,s	15.2/10.1	0.9	24.1	8.01	25.1	35.0	3.7	624	14	20
Salmon	13.0/10.6			7.29	37.1	25.4	8.3	602	165	27
Curley	15.0/9.9			7.93	26.2	22.7	4.3	571	13	25
5/22/91										
N,s	15.0/7.8	1.40	2.0	9.00	28.3	29.1	5.6	523	4	46
N,m	15.0/8.0			8.06		21.9	3.3	471	2	33
N,b	15.0/8.5			7.80	26.1	24.3	3.6	467	12	32
M,s	15.0/7.9	1.20	6.0	7.86	27.3	22.4	3.7	471	1	33
M,m	15.0/8.0			7.48		21.5	3.5	553	6	18
M,b	14.9/7.8			7.32	27.3	18.9	3.2	586	2	32
S,s	15.0/8.5	1.30	5.0	7.53	27.3	21.3	2.8	642	4	32
S,m	15.0/8.0			7.64		22.4	4.4	534	2	21
S,b	14.2/6.9			7.44	29.4	18.6	3.4	519	7	23
L,s	15.0/6.6	1.20	10.0	7.70	27.3	25.9	4.1	553	4	21
Salmon	11.8/10.2			7.43	44.7	28.5	ND	940	210	36
Curley	16.0/8.9				28.3	18.7	3.8	381	13	38

Station And Date	[1] T/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO3+NO2 (ug/L)	NH4 (ug/L)
6/5/91										
N,s	15.5/8.3	2.0	5.0	6.62	29.4	18.6	2.6	436	0	13
N,m	15.4/8.3			6.75		18.1	2.6	373	0	15
N,b	15.1/8.0			6.82	30.5	20.7	3.4	485	0	14
M,s	15.7/8.8	1.4	3.0	4.07	29.0	21.9	3.2	478	0	16
M,m	15.5/9.4			7.20		17.9	2.5	474	0	23
M,b	15.1/9.0			7.20	32.0	23.7	2.4	452	0	24
S,s	16.1/7.2	1.4	5.0	7.26	31.0	23.1	2.7	500	0	19
S,m	16.0/9.7			7.33		27.4	2.7	404	0	14
S,b	15.4/7.5			7.40	33.0	29.1	7.7	423	0	16
L,s	16.5/9.1	1.3	13.0	7.48	33.0	35.2	3.2	600	0	17
Salmon	10.2/10.2			7.05	47.0	29.3	10.3	721	268	29
Curley	14.0/8.8			7.45	26.0	22.7	2.4	388	11	21
6/17/91										
N,s	18.0/9.0	1.4	6.0	7.35	31.4	20.3	2.1	538	1	28
N,m	17.8/9.0				30.4	15.7	2.3	627	8	7
N,b	17.2/8.6			7.51	30.4	28.5	1.9	601	1	26
M,s	18.0/9.0	1.4	9.0	7.47	31.4	14.3	2.2	571	0	8
M,m	17.0/9.0			7.54	31.4	27.7	2.4	582	7	5
M,b	16.0/6.8			7.57	26.5	25.3	1.9	571	0	4
S,s	17.2/9.0	1.1	2.0	7.61	32.4	25.9	2.2	471	0	5
S,m	17.2/9.0			7.58	32.4	27.1	2.0	571	0	19
S,b	17.0/7.1			7.54	30.4	20.2	2.4	597	1	16
L,s	18.0/9.8	0.9	14.0	7.60	31.4	29.0	2.9	582	20	20
Salmon	12.0/9.0			7.41	20.6	126.5	22.1	1,881	325	41
Curley	17.0/9.3			8.00	32.4	26.7	2.2	582	1	18
7/3/91										
N,s	21.2/8.8	1.5	4.5	7.07	32.4	22.8	1.5	569	0	10
N,m	20.8/8.9			7.24	31.4	22.8	2.0	612	0	10
N,b	20.8/6.2			7.29	32.4	44.0	2.5	696	0	10
M,s	22.4/8.9	1.6	13.5	7.59	32.4	25.3	3.3	660	0	3
M,m	21.8/8.1			7.73	31.4	28.4	2.7	624	0	6
M,b	18.8/5.6			7.63	32.4	35.2	3.4	563	0	9
S,s	22.8/10.2	1.6	12.0	7.72	31.4	27.9	2.8	533	0	10
S,m	22.8/9.4			7.91	31.4	25.7	2.1	738	0	20
S,b	19.2/7.3			7.82	35.6	36.6	2.6	599	0	8
L,s	23.9/9.0	1.5	5.0	8.15	32.4	28.5	8.9	533	0	12
Salmon	15.0/ND				50.1	54.2	2.3	913	278	24
Currley	21.0/ND				33.4	30.7	3.5	563	4	13

Station And Date	[1] T/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO3+NO2 (ug/L)	NH4 (ug/L)
7/17/91										
N,s	20.5/8.2	1.1	8.0	7.89	35.3	35.5	1.7	744	0	57
N,m	20.5/7.0			8.00	35.3	33.8	3.0	853	0	59
N,b	20.5/6.2			8.01	35.3	35.0	3.1	732	0	51
M,s	21.0/9.2	0.9	18.0	8.12	35.3	38.4	1.4	666	0	47
M,m	21.0/7.8			8.11	36.3	44.2	3.0	636	0	46
M,b	19.9/6.8			8.00	34.4	52.3	1.9	756	0	76
S,s	21.0/9.3	1.0	26.7	8.24	30.4	47.6	2.0	624	0	60
S,m	21.0/8.9			8.16	35.3	31.0	2.4	660	0	55
S,b	20.0/7.7			8.28	28.5	45.7	1.6	ND	0	54
L,s	20.4/10.6	0.9	18.0	8.71	36.3	44.3	2.8	618	0	52
Salmon	5.0/13.1			7.38	53.0	31.0	14.1	1,444	224	18
Curley	7.5/13.2			7.14	33.4	46.7	2.3	630	9	56
8/4/91										
N,s	24.1/11.0	1.3	23.1	7.50	34.4	25.5	2.2	774	6	9
N,m	23.4/13.4			8.07	34.4	24.4	4.7	696	2	4
N,b	22.5/12.0			7.93	40.2	ND	3.9	798	6	46
M,s	25.0/11.0	1.2	28.8	8.87	34.4	27.5	2.2	738	6	11
M,m	23.0/12.8			8.62	35.3	25.3	3.6	780	10	5
M,b	22.0/8.0			8.49	35.3	53.0	3.0	732	0	31
S,s	25.8/13.1	1.1	12.0	8.75	35.3	17.6	3.0	702	7	8
S,m	24.5/17.6			ND	34.4	18.0	3.3	744	21	4
S,b	22.0/7.8			9.30	34.4	ND	ND	ND	ND	ND
L,s	25.6/13.1	1.4	24.0	9.55	34.4	34.9	2.4	720	6	10
Salmon	18.1/9.8			7.18	51.0	26.0	16.7	732	305	8
Curley	19.0/10.0			7.17	34.4	48.9	4.0	587	23	18
8/14/91										
N,s	22.0/10.0	1.2	2.0	7.89	35.3	36.0	4.1	738	2	20
N,m	21.0/9.2			8.00	35.3	39.8	3.0	762	4	29
N,b	20.5/6.4			8.01	35.3	42.9	3.4	841	4	20
M,s	24.0/9.8	1.2	6.0	8.12	36.3	51.1	3.8	732	1	18
M,m	22.9/10.9			8.11	35.3	37.6	3.0	756	3	ND
M,b	20.2/11.4			8.00	35.3	41.2	3.3	738	2	28
S,s	24.5/11.8	1.2	6.0	8.24	35.3	53.1	3.5	732	0	35
S,m	23.8/12.0			8,16	33.4	36.9	4.0	756	1	26
S,b	20.1/11.7			8.28	33.4	44.3	6.0	744	0	20
L,s	25.2/11.9	0.8	16.0	8.71	35.3	32.7	3.0	762	0	20
Salmon	14.0/9.7			7.80	51.0	30.0	16.0	696	257	30
Curley	18.5/10.6			8.26	37.3	32.4	3.0	605	12	37

Station And Date	[1] T/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO3+NO2 (ug/L)	NH4 (ug/L)
8/28/91										
N,s	19.2/7.6	1.4	21.0	7.69	48.1	45.9	4.3	750	7	ND
N,m	19.2/7.6			7.77		50.1	4.6	738	9	ND
N,b	19.2/7.6			7.79	39.3	41.6	4.3	744	7	ND
M,s	19.1/7.9	1.6	8.0	7.82	39.3	44.0	4.4	666	7	ND
M,m	19.1/7.9			7.82	35.3	36.5	4.6	720	9	ND
M,b	19.1/7.9			7.75	34.4	39.9	4.7	723	11	ND
S,s	19.1/7.7	1.7	4.0	7.26	36.3	45.2	6.0	666	15	ND
S,m	19.1/7.7			7.39	38.6	42.9	4.9	654	18	ND
S,b	19.1/7.7			7.49	38.6	38.0	4.6	726	19	ND
L,s	19.8/10.6	1.4	1.0	ND	35.3	23.9	3.8	597	0	ND
Salmon	13.9/8.8			7.70	41.2	52.1	14.3	865	186	ND
Curley	16.9/8.4			7.55	38.3	38.4	6.0	768	23	ND
9/17/91										
N,s	19.0/9.1	1.2	8.0	8.64	39.3	32.1	2.3	661	0	37
N,m	19.0/9.0			8.44	40.2	32.9	2.4	679	0	37
N,b	18.0/8.5			8.45	39.3	40.4	2.4	707	0	39
M,s	19.0/9.4	1.2	6.0	8.60	38.3	36.2	2.4	807	0	39
M,m	19.0/9.6			8.66	39.3	33.7	2.1	679	0	43
M,b	18.5/4.0			8.68	35.3	19.7	2.7	679	0	35
S,s	20.0/9.6	1.3	36.0	8.81	37.3	28.5	2.6	679	0	37
S,m	19.0/10.0			8.92	40.2	38.9	ND	780	0	40
S,b	18.0/2.9			8.93	39.3	39.0	2.4	716	0	ND
L,s	20.5/12.4	1.2	14.0	9.69	40.2	30.1	2.7	643	0	16
Salmon	ND/ND				51.0	39.5	11.9	ND	264	65
Curley	16.0/9.8			8.46	38.3	30.7	2.5	679	10	83
9/30/91										
N,s	19.2/9.0	0.9	12.0	8.19	39.3	35.9	3.0	441	0	30
N,m	19.2/8.9			8.16	39.3	26.4	2.3	478	0	34
N,b	19.2/8.0			7.84	39.3	48.8	1.8	569	1	18
M,s	18.0/10.2	0.8	6.0	8.09	38.3	30.5	2.4	285	0	19
M,m	18.0/9.8			8.20	37.3	48.8	2.0	478	0	28
M,b	17.0/4.6			8.26	35.3	39.5	2.0	441	0	35
S,s	18.8/9.8	1.0	14.0	8.46	37.3	35.8	2.6	386	0	14
S,m	18.9/9.9			8,48	35.3	32.9	2.7	542	0	30
S,b	17.9/2.1			8.51	34.4	30.0	2.5	542	0	21
L,s	18.0/13.0	0.8	10.0	9.56	38.3	41.4	2.7	441	<1	21
Samon	15.7/8.2			8.45	41.2	86.0	11.6	533	220	37
Curley	17.5/9.6			9.62	38.3	32.6	4.8	514	4	35

Station and Date	[1] T/D.O.	[2] Secchi (M)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO2-NO3 (ug/L)	NH4 (ug/L)
10/8/91										
N,s	16.1/9.1	2.5	1.0	6.44	21.6	17.9	2.4	313	4	37
N,m	16.1/9.0			6.44	19.6	16.2	2.8	258	0	25
N,b	16.1/7.4			6.44	21.6	17.3	1.9	304	0	33
M,s	16.1/10.0	3.1	2.0	6.56	19.6	14.4	1.4	414	0	12
M,m	16.1/9.2			6.59	20.6	14.3	1.0	331	0	23
M,b	16.1/9.0			6.57	19.6	15.5	0.9	275	0	23
S,s	16.5/9.9	1.4	0.0	6.60	17.7	16.8	1.1	275	0	22
S,m	16.9/10.2			6.65	15.7	14.4	3.0	247	2	41
S,b	16.9/9.9			6.62	17.7	62.5	1.2	569	0	49
L,s	16.0/13.0	0.9	8.0	9.55	29.4	33.9	3.0	515	0	53
Salmon	12.2/10.1			7.63	49.1	24.5	5.4	707	279	16
Curley	16.0/10.4			8.01	37.3	34.8	9.2	432	20	46
11/8/91										
N,s	10.2/9.4	1.6	10.0	7.38	27.5	15.6	4.0	313	ND	41
N,m	10.0/9.5			7.40	28.5	14.4	1.2	350	ND	31
N,b	10.0/8.6			7.45	27.5	19.0	1.0	331	ND	37
M,s	10.0/9.6	1.6	5.0	7.52	29.5	14.4	1.4	331	ND	30
M,m	10.0/9.5			7.54	27.5	13.4	1.5	313	ND	25
M,b	10.0/9.5			7.58	29.5	16.3	1.5	340	ND	24
S,s	10.4/9.9	1.4	9.0	7.82	30.4	16.9	2.0	414	ND	33
S,m	10.2/9.8			7.83	30.4	16.6	1.9	331	ND	31
S,b	10.0/8.8			7.88	28.5	14.7	0.9	304	ND	31
L,s	11.1/11.0	0.8	1.0	8.94	28.5	27.2	1.9	322	ND	25
Salmon	12.2/8.3			7.05	40.2	30.4	23.6	652	ND	33
Curley	12.4/9.0			6.56	28.5	14.6	5.4	368	ND	33
12/6/91										
N,s	8.0/10.5	1.9	9.0	7.94	27.5	19.6	ND	560	245	49
N,m	7.9/10.4			7.78	28.6	21.0	2.5	588	228	54
N,b	7.9/8.9			7.74	28.6	19.1	2.3	606	251	30
M,s	8.0/10.2	2.0	2.0	7.56	27.5	25.6	5.7	725	304	43
M,m	7.9/10.3			7.57	26.5	26.0	4.3	569	304	51
M,b	7.9/10.3			7.47	27.5	24.9	4.9	670	282	51
S,s	8.0/10.4	1.8	16.0	7.53	25.5	17.7	3.5	514	246	42
S,m	8.0/10.4			7.52	29.6	23.8	2.6	524	228	43
S,b	8.0/10.4			7.50	27.5	18.8	2.5	441	216	42
L,s	8.0/10.2	0.8	2.0	7.46	29.6	10.9	1.9	350	17	40
Salmon	8.0/10.1			8.37	15.3	73.1	46.1	1,833	1,007	405
Curley	7.5/10.6			7.38	26.5	30.4	5.5	698	263	30

Sample and Date	[1] Temp/D.O.	[2] Secchi (m)	[3] Chl a (ug/L)	[4] pH	[5] Alkalinity (mg/L)	[6] TP (ug/L)	SRP (ug/L)	TN (ug/L)	[7] NO3-NO2 (ug/L)	NH4 (ug/L)
1/17/92										
N-S	5.3/9.8	1.4	6.0	7.36		18.8	6.0	660	351	64
N-M	5.3/9.1			7.36	24.5	21.6	4.9	698	357	37
N-B	5.2/8.2			7.36		20.0	6.0	698	333	35
M-S	6.0/9.9	1.2	6.0	7.35		23.5	5.6	725	374	62
M-M	5.9/9.8			7.36	20.4	20.6	6.8	752	357	31
M-B	5.8/9.6			7.36		24.6	5.7	624	362	33
S-S	5.5/12.0	1.4	2.0	7.39		24.8	7.2	661	304	27
S-M	5.5/12.0			7.39	20.4	19.5	6.9	551	321	44
S-B	5.5/9.2			7.32		18.8	6.8	643	304	68
L-S	5.9/10.4	0.8	1.0	7.42	23.0	17.7	6.9	514	131	66
Salmon	5.0/10.4			7.56	23.0	39.0	15.5	1,100	650	92
Curley	8.0/N.D.			8.27	28.6	23.8	4.5	707	345	59
2/12/92										
N-S	7.5/9.7	1.3	2.0	7.31		29.5	6.9	862	708	55
N-M	7.5/9.5			7.26	12.2	28.5	7.7	972	650	55
N-B	7.0/8.9			7.11		28.7	8.3	954	673	41
M-S	7.5/11.2	1.6	3.0	7.10		29.2	7.1	954	614	43
M-M	7.5/10.6			7.08	14.3	29.0	8.0	717	626	44
M-B	7.5/10.0			7.05		27.1	6.5	991	626	41
S-S	8.0/9.6	1.8	9.0	7.08		24.8	7.1	862	455	37
S-M	8.0/8.8			7.09	16.3	25.9	6.3	899	603	41
S-B	7.5/2.0			7.07		128.1	6.6	1,064	462	52
L-S	8.0/11.2	1.1	ND	7.15	ND	28.3	10.8	908	638	ND
Salmon	6.5/11.6			7.48	22.4	46.1	2.8	954	673	56
Curley	7.5/10.4			7.55	16.3	26.4	4.5	991	672	53
3/17/92										
N-S	11.0/10.2	1.6	3.0	7.76	28.6	20.8	4.5	661	321	32
N-M	11.0/9.8			7.58	28.6	21.4	4.4	661	316	26
N-B	11.0/8.8			7.42	29.6	19.2	4.7	771	321	38
M-S	11.0/10.7	1.6	1.0	7.55	28.6	17.7	7.6	633	310	25
M-M	11.0/10.6			7.39	30.6	25.5	4.7	688	310	16
M-B	10.0/10.4			7.34	29.6	21.4	5.2	542	321	42
S-S	12.0/10.1	1.4	2.0	7.34	31.6	22.9	3.8	652	292	24
S-M	11.5/9.8			7.30	31.6	31.8	4.4	688	298	21
S-B	11.0/6.8			7.27	30.6	22.4	4.3	661	298	26
L-S	12.0/13.6	0.8	5.0	8.64	28.6	21.9	4.2	670	ND	26
Salmon	7.5/11.1			7.72	30.6	45.3	14.4	359	474	28
Curley	11.0/11.1			7.68	27.6	31.2	3.9	771	368	26

WATER QUALITY (04/28/92 - 04/15/93)

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
04/28/92									
N-s	17.0	N/D	3.2	1.8	3.2	8.50	30.6	19.0	3.5
N-m	16.5	N/D				8.20	31.6	17.9	3.8
N-b	16.0	N/D				8.15	31.6	68.1*	3.2
M-s	18.0	N/D	3.8	1.6	0.0	8.25	31.6	18.2	16.6*
M-m	17.0	N/D				8.25	31.6	19.3	5.6
M-b	16.0	N/D				7.90	30.6	15.9	2.6
S-s	17.0	N/D	3.2	1.8	1.6	8.25	30.6	15.9	3.7
S-m	16.0	N/D				8.10	31.6	25.2	3.4
S-b	15.0	N/D				7.95	31.6	22.9	3.2
L-s	17.0	N/D	2.6	1.4	ND	9.05	31.6	13.1	4.2
Lake mean	**16.6**	**N/A**	**3.2**	**1.7**	**1.6**	**8.25**	**31.3**	**18.5**	**3.7**
CURLEY	17.0	12.6	N/A	N/A	N/A	7.90	30.6	23.5	3.7
SALMON	14.0	12.2	N/A	N/A	N/A	7.95	42.8	34.4	3.8
05/13/92									
N-s	17.0	9.4	3.2	2.0	0.8	7.63	31.6	16.8	2.6
N-m	16.5	9.5				7.70	33.7	21.2	2.9
N-b	16.0	N/D				7.51	32.6	20.4	2.9
M-s	17.0	9.4	3.8	1.8	4.8	7.86	32.6	16.2	2.9
M-m	16.5	9.4				7.83	32.6	23.5	3.5
M-b	16.0	N/D				7.39	33.7	19.4	3.2
S-s	17.0	N/D	3.2	1.2	2.4	7.87	33.7	17.6	3.0
S-m	17.0	9.4				7.83	32.6	20.7	3.1
S-b	16.0	N/D				7.70	32.6	37.3	3.1
L-s	17.0	12.3	2.6	0.8	1.6	8.90	31.6	17.1	2.4
Lake mean	**16.6**	**9.9**	**3.2**	**1.7**	**2.4**	**7.79**	**32.8**	**20.8**	**3.0**
CURLEY	15.0	8.3	N/A	N/A	N/A	8.11	32.6	22.2	2.9
SALMON	10.0	9.0	N/A	N/A	N/A	7.51	45.9	21.6	13.4

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
05/27/92									
N-s	20.0	8.7	3.0	2.4	3.2	7.52	34.7	19.1	2.3
N-m	19.5	8.6				7.52	34.7	18.6	2.5
N-b	19.0	N/D				7.51	34.7	20.6	2.0
M-s	20.0	8.8	3.6	2.4	1.6	7.69	35.7	20.0	2.1
M-m	19.5	8.7				7.72	33.7	17.8	2.7
M-b	19.0	8.4				7.40	35.7	18.1	1.8
S-s	20.0	9.7	3.2	2.2	2.4	8.51	33.7	19.8	2.2
S-m	19.5	8.9				8.21	33.7	19.5	1.7
S-b	19.0	N/D				7.55	34.7	53.0*	2.3
L-s	21.5	13.0	2.6	N/A	3.2	10.14	33.7	15.2	2.5
Lake mean	**19.7**	**9.3**	**3.1**	**2.3**	**2.6**	**7.90**	**34.5**	**21.6**	**2.2**
CURLEY	18.0	8.6	N/A	N/A	N/A	8.91	33.7	19.4	5.0
SALMON	12.0	9.4	N/A	N/A	N/A	8.22	52.0	21.7	15.3
06/10/92									
N-s	21.0	9.3	3.0	2.0	3.2	7.47	36.3	17.2	2.4
N-m	21.0	9.2				7.70	36.9	18.6	1.7
N-b	20.5	9.2				7.76	37.5	17.5	2.0
M-s	21.0	9.8	3.6	2.0	1.6	8.38	37.5	18.0	1.9
M-m	21.0	9.1				8.09	37.5	20.1	1.9
M-b	20.5	9.1				7.80	36.9	20.6	1.9
S-s	21.0	9.0	3.2	1.5	1.6	8.25	37.5	18.1	2.5
S-m	20.5	9.9				8.26	38.6	20.7	2.2
S-b	20.0	8.5				7.66	37.5	20.9	2.2
L-s	20.0	11.3	2.4	N/A	2.4	9.86	38.6	12.7	2.6
Lake mean	**20.7**	**9.5**	**3.1**	**1.8**	**2.2**	**8.08**	**37.4**	**18.5**	**2.1**
CURLEY	19.0	11.8	N/A	N/A	N/A	8.89	34.1	21.5	4.8
SALMON	13.0	11.8	N/A	N/A	N/A	7.80	39.7	30.2	18.3

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
06/26/92									
N-s	23.4	8.6	3.0	2.0	2.4	7.80	42.0	16.0	1.6
N-m	23.7	8.6				8.06	40.9	15.8	1.9
N-b	23.8	8.6				7.98	41.1	16.1	2.0
M-s	23.6	8.5	3.6	2.0	2.4	8.30	40.9	17.7	1.9
M-m	23.6	8.5				8.15	40.9	13.2	1.9
M-b	22.5	8.3				8.10	40.9	14.9	2.1
S-s	23.0	8.9	3.0	1.8	2.4	8.50	40.9	19.8	2.1
S-m	23.0	8.9				8.76	40.9	17.0	2.3
S-b	23.0	5.8				8.10	40.9	19.7	2.4
L-s	23.6	9.5	2.4	N/A	1.6	8.74	39.7	22.0	3.2
Lake mean	**23.3**	**8.7**	**3.0**	**1.9**	**2.2**	**8.22**	**40.9**	**16.9**	**2.1**
CURLEY	21.6	8.6	N/A	N/A	N/A	9.00	40.9	20.2	4.8
SALMON	16.0	8.0	N/A	N/A	N/A	7.65	59.0	36.3	21.5
07/08/92									
N-s	20.5	8.9	3.0	2.4	4.8	7.50	42.0	18.7	1.2
N-m	20.5	9.0				7.62	42.0	24.1	1.1
N-b	20.5	9.1				7.70	42.6	22.9	1.3
M-s	21.0	9.1	3.7	2.4	6.8	7.73	42.0	20.8	1.4
M-m	20.6	8.8				7.80	42.0	21.6	1.4
M-b	20.5	8.9				7.65	42.0	22.1	1.5
S-s	21.0	7.7	3.2	2.2	5.6	7.31	42.6	20.2	2.8
S-m	20.2	7.4				7.20	42.6	23.2	1.6
S-b	20.2	7.1				7.01	42.6	27.6	1.8
L-s	21.0	9.7	2.4	N/A	1.6	7.28	39.7	19.3	2.6
Lake mean	**20.6**	**8.6**	**3.1**	**2.3**	**4.7**	**7.51**	**42.0**	**22.0**	**1.6**
CURLEY	18.4	8.8	N/A	N/A	N/A	8.52	40.9	34.3	4.2
SALMON	14.4	9.3	N/A	N/A	N/A	7.23	48.8	71.0	16.5

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
07/23/92									
N-s	21.6	9.0	3.0	2.1	1.6	8.60	43.1	17.7	N/D
N-m	21.6	9.2				8.40	43.7	25.4	N/D
N-b	21.2	9.1				8.48	43.7	22.1	N/D
M-s	21.2	8.8	3.8	1.9	0.8	8.38	44.3	24.8	N/D
M-m	21.2	8.5				8.53	44.3	23.5	N/D
M-b	21.0	8.6				8.58	44.3	21.6	N/D
S-s	21.0	8.6	3.2	2.1	2.4	8.25	43.1	25.8	N/D
S-m	21.0	8.3				8.26	43.1	20.5	N/D
S-b	19.8	8.3				8.20	43.1	19.5	N/D
L-s	21.0	8.2	2.4	1.9	N/D	8.75	40.9	18.7	N/D
Lake mean	**21.1**	**8.7**	**3.1**	**2.0**	**1.6**	**8.45**	**43.5**	**22.1**	**N/D**
CURLEY	19.0	7.0	N/A	N/A	N/A	8.25	43.1	28.0	N/D
SALMON	14.5	8.8	N/A	N/A	N/A	7.20	57.9	47.5	N/D
08/04/92									
N-s	22.2	9.85	3.0	1.6	14.4	9.41	45.4	19.4	1.9
N-m	22.2	9.90				9.45	46.5	19.8	1.9
N-b	22.2	9.90				9.48	45.4	20.9	1.9
M-s	22.5	9.75	3.7	1.6	6.4	9.41	45.4	18.2	5.1
M-m	22.5	9.80				9.46	45.4	22.2	4.1
M-b	22.0	9.85				9.50	45.4	17.2	2.2
S-s	22.2	9.20	3.0	1.8	6.4	9.34	45.4	17.6	1.6
S-m	22.2	9.20				9.33	46.5	18.5	1.6
S-b	21.0	8.15				8.90	46.5	21.2	1.8
L-s	22.2	9.50	2.3	1.9	N/D	9.21	44.3	15.5	2.5
Lake mean	**22.1**	**9.6**	**3.0**	**1.7**	**9.1**	**9.37**	**45.6**	**19.1**	**2.5**
CURLEY	20.0	8.3	N/A	N/A	N/A	9.24	45.4	24..5	3.6
SALMON	15.0	8.5	N/A	N/A	N/A	7.91	60.2	28.9	16.6

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
08/25/92									
N-s	21.5	9.8	3.0	1.8	2.8	9.38	45.4	17.4	1.9
N-m	21.5	9.5				9.42	45.4	20.2	3.3
N-b	21.3	9.6				9.42	45.4	19.6	1.2
M-s	21.5	9.6	3.6	1.9	0.8	9.36	46.5	17.5	1.4
M-m	21.2	9.9				9.41	46.5	17.2	1.5
M-b	21.0	9.9				9.46	46.5	17.9	1.3
S-s	21.8	10.4	3.1	1.8	2.4	9.46	42.0	13.9	2.3
S-m	21.5	10.6				9.34	45.4	18.9	3.2
S-b	21.0	10.6				9.42	45.4	26.5	7.1
L-s	21.5	8.4	2.2	1.6	0.8	8.04	45.4	15.5	2.2
Lake mean	**21.4**	**9.8**	**3.0**	**1.8**	**1.7**	**9.30**	**45.5**	**18.4**	**2.4**
CURLEY	18.0	8.5	N/A	N/A	N/A	9.10	45.4	19.5	3.0
SALMON	11.5	10.0	N/A	N/A	N/A	7.31	61.3	24.5	14.7
09/09/92									
N-s	18.5	10.4	3.0	1.4	2.4	9.68	45.4	21.1	2.1
N-m	18.2	10.4				9.72	45.4	23.9	0.9
N-b	18.0	10.4				9.25	45.4	20.4	1.0
M-s	18.8	10.0	3.6	1.6	3.2	9.27	46.5	20.7	1.2
M-m	18.2	10.3				9.26	46.5	20.8	2.4
M-b	17.6	10.2				9.25	46.5	29.6	1.1
S-s	19.0	9.8	3.0	2.0	4.0	9.47	46.5	17.3	1.6
S-m	18.5	9.7				9.42	46.5	19.0	1.2
S-b	18.0	9.6				9.35	48.8	67.6*	1.9
L-s	19.0	8.1	2.2	1.2	3.2	7.98	46.5	14.8	1.3
Lake mean	**18.4**	**10.0**	**3.0**	**1.6**	**3.2**	**9.3**	**46.3**	**20.9**	**1.5**
CURLEY	16.0	9.4	N/A	N/A	N/A	8.57	45.4	20.0	3.1
SALMON	11.2	10.0	N/A	N/A	N/A	7.22	57.9	35.8	13.2

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
09/23/92									
N-s	17.8	N/D	3.0	2.7	4.0	9.26	65.7	15.9	1.2
N-m	17.8	N/D				9.42	44.5	15.2	1.3
N-b	17.5	N/D				9.40	43.9	18.1	1.4
M-s	17.8	N/D	3.8	2.2	2.4	9.29	48.5	23.5	1.3
M-m	17.5	N/D				9.35	43.8	18.3	1.6
M-b	17.0	N/D				N/D	44.2	22.2	1.6
S-s	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
S-m	N/D	N/D				N/D	N/D	N/D	N/D
S-b	N/D	N/D				N/D	N/D	N/D	N/D
L-s	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Lake mean	**17.6**	N/A	N/A	N/A	**3.2**	**9.34**	**48.4**	**18.9**	**1.4**
CURLEY	16.8	N/D	N/A	N/A	N/A	8.99	47.6	20.0	3.8
SALMON	13.0	N/D	N/A	N/A	N/A	7.07	54.8	28.7	13.1
10/14/92									
N-s	15.5	11.0	3.2	2.5	1.8	9.46	47.7	15.4	1.9
N-m	15.5	12.3				9.55	47.1	15.9	2.2
N-b	15.5	11.6				9.57	47.1	23.8	2.6
M-s	15.8	10.5	3.8	3.6	3.2	9.28	49.1	15.0	2.3
M-m	15.8	10.2				9.33	48.2	12.6	2.0
M-b	15.5	10.3				9.30	48.2	20.7	2.6
S-s	15.5	10.2	3.2	2.6	0.8	8.95	47.1	14.3	2.5
S-m	15.8	9.8				8.95	47.1	20.4	2.8
S-b	15.5	10.3				8.97	46.8	25.8	3.9
L-s	15.0	6.6	2.2	N/A	0.0	7.56	46.5	15.2	3.2
Lake mean	**15.6**	**10.4**	**3.1**	**2.9**	**1.5**	**9.15**	**47.6**	**17.8**	**2.5**
CURLEY	13.8	N/D	N/A	N/A	N/A	8.60	46.2	16.0	4.4
SALMON	9.5	N/D	N/A	N/A	N/A	7.38	56.5	24.4	12.6

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
11/11/92									
N-s	10.0	10.8	3.4	2.1	0.0	7.88	45.1	14.0	1.7
N-m	10.0	10.6				8.09	46.5	16.6	2.2
N-b	10.0	10.8				8.16	47.4	14.9	2.1
M-s	10.0	N/D	4.0	3.2	0.0	7.66	46.2	15.0	2.9
M-m	10.0	10.2				7.66	46.0	14.2	3.1
M-b	10.0	10.1				7.64	44.8	16.7	2.5
S-s	10.0	10.1	3.4	2.5	0.6	7.48	45.4	39.3	3.4
S-m	10.0	10.0				7.49	45.4	13.2	3.4
S-b	10.0	9.8				7.30	44.3	16.6	3.8
L-s	9.0	8.5	2.2	1.4	0.4	6.94	42.6	26.6	5.0
Lake mean	**9.9**	**10.2**	**3.3**	**2.3**	**0.3**	**7.67**	**45.5**	**18.1**	**2.9**
CURLEY	10.5	N/D	N/A	N/A	N/A	7.83	48.2	15.6	3.8
SALMON	8.0	N/D	N/A	N/A	N/A	7.10	38.0	22.4	20.0
12/09/92									
N-s	5.0	11.5	3.4	2.1	2.4	7.75	43.1	13.5	2.9
N-m	4.8	11.4				7.75	42.6	15.0	3.2
N-b	4.8	11.5				7.77	43.1	18.4	3.6
M-s	5.0	11.6	3.8	2.4	0.0	7.78	41.8	16.9	3.3
M-m	5.0	11.6				7.82	42.0	17.7	3.5
M-b	5.0	11.4				7.85	42.0	18.4	3.5
S-s	4.8	10.7	3.0	2.0	0.8	7.73	40.9	34.7	4.3
S-m	4.8	11.2				7.69	40.9	18.0	5.5
S-b	4.6	11.1				7.66	40.3	24.4	4.6
L-s	5.0	10.9	2.2	1.4	0.8	7.58	41.1	21.8	5.0
Lake mean	**4.9**	**11.3**	**3.1**	**2.0**	**1.0**	**7.75**	**41.9**	**19.3**	**3.8**
CURLEY	4.5	N/D	N/A	N/A	N/A	7.81	42.1	16.7	3.9
SALMON	4.0	N/D	N/A	N/A	N/A	7.06	22.7	59.4	15.4

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
01/28/93									
N-s	4.8	9.5	3.4	1.8	N/D	6.77	24.6	63.4	34.3
N-m	4.5	9.6				6.80	17.8	64.7	34.0
N-b	4.5	9.6				6.81	19.6	68.5	34.1
M-s	5.0	9.6	4.0	1.4	N/D	6.88	22.4	56.2	30.2
M-m	5.0	9.6				6.61	23.2	52.6	30.2
M-b	5.0	9.7				6.87	23.6	57.6	29.7
S-s	5.0	8.0	3.0	1.5	N/D	6.37	25.5	58.9	19.9
S-m	5.0	8.1				6.60	24.6	61.6	20.3
S-b	4.8	8.0				6.69	24.5	58.6	20.5
L-s	5.0	6.5	1.8	1.5	N/D	6.64	26.1	55.8	11.3
Lake mean	**4.8**	**8.9**	**3.1**	**1.6**	**N/D**	**6.72**	**23.0**	**59.9**	**27.4**
CURLEY	2.5	N/D	N/A	N/A	N/A	8.67	N/D	30.4	5.6
SALMON	2.0	N/D	N/A	N/A	N/A	4.76	N/D	68.1	17.7
02/18/93									
N-s	4.0	10.0	3.2	1.5	N/D	6.16	28.3	48.7	6.9
N-m	4.0	10.1				6.68	26.9	48.4	7.5
N-b	4.0	9.9				6.68	28.0	47.2	7.5
M-s	4.5	9.2	3.8	1.2	N/D	6.70	28.7	47.7	7.2
M-m	4.5	9.1				6.84	26.9	48.3	7.4
M-b	4.5	9.3				6.67	28.2	46.6	8.3
S-s	4.5	7.1	3.2	1.2	N/D	6.88	28.0	52.0	7.8
S-m	4.5	7.0				6.71	28.3	53.5	9.1
S-b	4.5	6.9				6.68	27.7	55.9	8.8
L-s	4.0	7.5	2.0	1.2	N/D	6.85	27.7	52.0	7.4
Lake mean	**4.3**	**8.8**	**3.1**	**1.3**	**N/D**	**6.67**	**27.9**	**49.6**	**7.7**
CURLEY	4.0	N/D	N/A	N/A	N/A	6.88	28.0	47.9	8.5
SALMON	0.0	N/D	N/A	N/A	N/A	6.89	30.4	29.8	10.5

Sample and date	Temp °C	DO mg/L	Secchi depth m	Transparency m	Chl *a* µg/L	pH	Alkalinity mg $CaCO_3$/L	TP µg/L	SRP µg/L
03/18/93									
N-s	11.0	9.5	3.0	1.4	4.0	6.55	30.4	43.8	4.7
N-m	11.0	9.5				6.56	29.9	41.6	4.8
N-b	11.0	9.5				6.67	30.4	42.9	5.1
M-s	11.0	9.7	4.0	1.4	6.4	6.62	30.2	43.2	4.7
M-m	11.0	9.6				6.66	30.3	46.2	5.1
M-b	11.0	9.7				6.74	30.4	41.6	5.4
S-s	11.0	8.3	3.0	1.4	3.2	6.52	30.2	45.4	4.7
S-m	11.0	8.4				6.60	31.4	47.5	6.3
S-b	11.0	8.3				6.66	30.7	51.0	6.5
L-s	11.0	7.5	2.0	1.6	---	6.45	30.3	40.6	3.9
Lake mean	**11.0**	**9.1**	**3.0**	**1.5**	**4.5**	**6.61**	**30.4**	**44.2**	**5.1**
CURLEY	10.5	N/D	N/A	N/A	N/A	7.15	30.2	50.9	6.6
SALMON	9.0	N/D	N/A	N/A	N/A	5.89	22.8	50.1	8.6
04/15/93									
N-s	12.5	9.1	3.0	1.3	0.8	6.90	28.5	42.5	5.7
N-m	12.3	9.1				6.80	27.7	42.6	5.7
N-b	12.2	8.9				6.90	28.5	43.2	6.2
M-s	12.5	9.0	3.2	1.3	---	6.90	36.3	44.1	6.2
M-m	12.5	9.0				6.80	19.6	50.9	6.2
M-b	12.2	9.2				6.80	27.7	47.2	6.1
S-s	12.0	7.9	3.0	1.3	0.4	6.90	26.9	46.3	6.6
S-m	13.0	8.1				6.80	27.7	66.8	6.9
S-b	12.4	8.1				6.80	25.3	69.3	6.9
L-s	12.0	5.8	2.2	1.2	---	6.60	27.7	47.9	6.6
Lake mean	**12.4**	**8.5**	**2.9**	**1.3**	**0.6**	**6.90**	**27.7**	**49.2**	**6.3**
CURLEY	10.5	N/D	N/A	N/A	N/A	7.34	28.1	48.5	6.8
SALMON	9.0	N/D	N/A	N/A	N/A	6.80	20.4	56.8	8.3

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
5/20/93										
N-S	21.2	ND	3.2	1.6	N/D	7.5	28.5	48.2	11.6	1
N-M	21.0	9.0				7.5	29.0	45.1	11.3	1
N-B	21.0	8.7				7.5	29.4	47.4	9.3	1
M-S	21.0	8.4	4.0	1.6	N/D	7.3	29.4	42.4	8.4	1
M-M	20.5	8.2				7.4	29.4	39.9	7.9	2
M-B	19.5	5.0				6.9	30.2	52.9	9.2	2
S-S	21.0	6.9	3.2	1.4	0.8	7.1	29.8	43.2	9.5	1
S-M	21.0	6.9				7.1	29.4	45.8	10.5	2
S-B	19.5	3.1				6.9	30.2	55.7	8.3	5
LILLIES	21.0	6.0	2.6	1.4	N/D	6.9	29.8	51.8	10.3	3
Lake mean	**20.7**	**7.2**	**3.3**	**1.5**	**0.8**	**7.2**	**29.5**	**47.0**	**9.6**	**2**
CURLEY	20.0	N/A	N/A	N/A	N/A	7.1	29.8	45.2	6.2	22
SALMON	16.0	N/A	N/A	N/A	N/A	7.1	36.7	33.8	14.7	308
6/10/93										
N-S	18.1	7.4	3.3	1.2	3.6	6.3	31.4	47.2	2.9	5
N-M	18.3	-				6.4	31.6	51.5	3.0	1
N-B	18.0	-				6.3	31.6	53.0	2.3	2
M-S	19.0	7.2	4.0	1.2	4.0	6.4	31.8	41.9	2.6	1
M-M	18.5	7.0				6.4	32.2	39.0	2.8	7
M-B	18.0	7.0				6.4	31.8	41.0	2.5	2
S-S	18.3	7.3	3.2	1.2	6.8	6.2	31.6	42.4	3.4	0
S-M	18.0	-				6.2	31.7	45.1	2.2	5
S-B	18.0	6.6				6.3	31.9	47.1	2.5	17
LILLIES	18.0	7.1	2.6	1.4	2.8	6.2	31.8	44.4	2.6	0
Lake mean	**18.2**	**7.1**	**3.3**	**1.3**	**4.3**	**6.3**	**31.7**	**45.3**	**2.7**	**4**
CURLEY	17.3	7.5	N/A	N/A	N/A	6.2	31.0	42.9	3.6	25
SALMON	13.6	8.4	N/A	N/A	N/A	6.0	26.5	63.6	20.8	320

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
6/25/93										
N-S	21.2	10.2	3.0	1.0	5.2	7.9	32.5	N/D	2.1	4
N-M	20.5	9.7				8.0	32.8	N/D	2.7	3
N-B	20.0	7.9				8.0	32.9	N/D	1.6	4
M-S	22.0	10.4	3.8	1.0	4.8	7.8	32.7	N/D	0.9	4
M-M	21.2	10.4				8.1	32.8	N/D	2.9	12
M-B	20.0	6.3				7.9	32.9	N/D	2.4	9
S-S	22.0	10.6	3.0	0.8	6.4	8.2	32.5	N/D	2.0	1
S-M	21.5	10.6				8.3	32.5	N/D	3.0	5
S-B	21.0	8.0				8.1	32.6	N/D	2.8	4
LILLIES	22.0	10.6	2.0	0.8	21.6	7.8	32.8	N/D	2.6	3
Lake mean	**21.1**	**9.4**	**3.0**	**0.9**	**9.5**	**8.0**	**32.7**	**N/A**	**2.3**	**5**
CURLEY	20.0	10.6	N/A	N/A	N/A	7.6	32.6	N/D	3.0	6
SALMON	16.5	10.2	N/A	N/A	N/A	7.7	48.0	N/D	16.1	373
7/6/93										
N-S	20.5	7.9	3.1	0.9	28.8	8.1	31.8	49.8	5.6	2
N-M	20.1	8.0				8.1	33.4	59.9	5.3	2
N-B	20.0	7.8				8.0	33.8	47.0	4.4	1
M-S	20.0	8.4	3.8	0.8	36.8	7.8	33.8	42.5	4.9	1
M-M	20.0	7.6				7.8	33.0	39.8	5.3	0
M-B	19.9	5.7				7.8	33.0	53.4	3.8	1
S-S	20.5	7.7	3.3	1.0	20.8	7.8	33.4	46.1	6.3	0
S-M	20.6	7.6				7.8	33.8	47.9	4.0	4
S-B	20.0	6.6				7.8	33.4	47.4	3.6	0
LILLIES	20.2	7.2	2.7	1.0	19.2	7.7	33.4	29.5	4.0	0
Lake mean	**20.2**	**7.4**	**3.2**	**0.9**	**26.4**	**7.9**	**33.3**	**46.8**	**4.7**	**1**
CURLEY	18.5	9.1	N/A	N/A	N/A	8.7	33.8	35.6	4.6	5
SALMON	14.7	9.2	N/A	N/A	N/A	7.8	42.8	28.6	16.0	372

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg $CaCO_3$/L	TP, µg/L	SRP, µg/L	NO_3, µg/L
7/20/93										
N-S	19.3	8.2	3.2	1.0	36.0	7.1	35.1	44.0	3.3	1
N-M	19.0	8.2				7.3	33.4	58.6	3.3	0
N-B	19.0	8.1				7.4	33.4	48.6	9.3	1
M-S	19.5	8.1	3.8	1.0	39.2	7.6	33.4	49.3	2.3	0
M-M	19.3	8.2				7.7	32.6	48.9	13.8	4
M-B	19.0	8.2				7.7	34.2	49.0	2.2	2
S-S	18.8	7.6	3.2	1.0	36.8	7.5	33.1	62.3	2.5	2
S-M	18.8	7.4				7.7	33.6	43.4	2.3	1
S-B	18.8	6.2				7.7	33.1	52.5	2.6	2
LILLIES	18.5	6.1	2.6	1.0	36.0	7.6	33.9	52.6	2.9	2
Lake mean	**19.0**	**7.7**	**3.2**	**1.0**	**37.0**	**7.5**	**33.6**	**50.7**	**4.7**	**2**
CURLEY	17.3	8.5	N/A	N/A	N/A	7.1	31.8	54.7	4.2	52
SALMON	14.0	8.4	N/A	N/A	N/A	7.7	34.2	39.6	18.6	325
8/6/93										
N-S	21.9	8.4	3.2	1.2	19.2	7.4	35.6	51.5	2.6	1
N-M	22.0	8.4				7.7	35.4	45.6	2.2	0
N-B	22.1	8.1				7.7	35.1	52.9	2.7	9
M-S	22.1	8.3	3.6	1.2	21.6	7.9	35.1	47.1	1.9	1
M-M	22.1	8.7				7.9	34.8	47.5	3.1	1
M-B	21.9	6.5				7.7	34.9	53.4	4.1	1
S-S	22.0	8.1	3.2	1.2	-7.2	7.7	35.5	56.2	2.8	1
S-M	21.9	7.7				7.7	35.1	61.6	3.1	1
S-B	21.9	4.5				7.5	35.2	68.9	2.9	7
LILLIES	22.0	6.6	2.4	1.1	4.0	7.4	35.8	59.5	2.5	1
Lake mean	**22.0**	**7.6**	**3.1**	**1.2**	**14.9**	**7.7**	**35.2**	**53.6**	**2.8**	**2**
CURLEY	17.3	7.8	N/A	N/A	N/A	7.0	28.4	39.5	3.3	24
SALMON	13.6	8.0	N/A	N/A	N/A	7.3	42.5	39.1	18.7	375

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
9/23/93										
N-S	18.0	8.3	3.2	1.2	12.0	7.3	39.1	37.9	2.8	4
N-M	17.5	7.5				7.4	38.7	48.4	2.7	4
N-B	17.0	7.1				7.3	37.5	39.0	3.0	4
M-S	17.5	8.1	3.8	1.2	8.0	7.3	40.0	44.5	2.6	0
M-M	17.5	8.1				7.4	38.3	42.6	2.7	0
M-B	17.0	7.8				7.2	39.1	48.4	3.3	1
S-S	17.5	9.1	3.2	1.0	17.6	7.4	37.5	43.9	2.5	9
S-M	17.8	9.3				7.5	39.1	40.6	8.3	1
S-B	17.1	9.2				7.5	38.7	42.6	3.2	2
LILLIES	18.0	8.6	2.4	1.0	16.8	7.1	37.9	43.1	2.7	1
Lake mean	**17.5**	**8.2**	**3.2**	**1.1**	**13.6**	**7.3**	**38.6**	**43.2**	**3.3**	**3**
CURLEY	14.2	8.7	N/A	N/A	N/A	6.7	44.4	34.6	4.3	49
SALMON	9.0	10.5	N/A	N/A	N/A	6.8	37.9	23.5	13.1	437
10/24/93										
N-S	14.0	7.9	3.2	3.2	6.4	7.3	36.3	29.3	4.1	8
N-M	14.8	7.8				7.3	34.7	31.4	4.0	10
N-B	14.0	7.4				7.2	35.5	16.6	4.3	13
M-S	14.3	8.2	3.2	2.4	5.6	7.5	35.1	28.5	3.9	8
M-M	14.3	8.0				7.5	35.3	32.3	8.1	6
M-B	14.0	7.8				7.4	35.6	30.6	3.9	11
S-S	14.0	8.3	3.7	2.6	5.6	7.5	36.0	27.6	4.5	18
S-M	14.0	7.7				7.4	35.5	43.6	4.2	10
S-B	14.0	8.0				7.3	35.5	34.4	4.4	11
LILLIES	14.0	8.2	2.3	2.2	8.8	7.2	36.1	31.9	4.2	18
Lake mean	**14.2**	**7.9**	**3.1**	**2.6**	**6.6**	**7.4**	**35.5**	**30.2**	**4.6**	**11**
CURLEY	12.5	7.9	N/A	N/A	N/A	7.1	34.4	34.2	6.6	75
SALMON	11.0	8.6	N/A	N/A	N/A	7.0	32.6	31.5	17.4	146

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
11/18/93										
N-S	7.8	8.7	3.1	3.0	1.2	5.7	33.1	30.3	3.9	43
N-M	7.9	8.6				6.4	33.4	35.7	4.1	40
N-B	8.0	8.5				6.5	33.8	-	3.3	44
M-S	8.0	8.5	3.8	3.4	4.4	6.7	33.8	24.5	5.4	50
M-M	8.0	8.6				6.5	33.5	24.5	3.7	49
M-B	8.0	8.6				6.5	33.4	24.3	4.7	52
S-S	8.0	9.2	3.2	3.0	8.4	6.6	33.8	25.7	3.1	53
S-M	8.0	9.0				6.6	33.8	27.2	2.5	52
S-B	8.0	9.1				6.6	34.0	24.0	3.6	53
LILLIES	7.5	8.9	2.4	2.4	7.6	6.6	31.6	25.5	2.7	42
Lake mean	**7.9**	**8.7**	**3.1**	**3.0**	**5.4**	**6.5**	**33.4**	**27.1**	**3.8**	**48**
CURLEY	8.0	10.3	N/A	N/A	N/A	6.7	32.7	-	4.6	33
SALMON	7.0	11.2	N/A	N/A	N/A	6.6	36.0	28.7	10.0	-
12/16/93										
N-S	6.0	9.5	3.6	2.0	ND	6.4	27.3	26.6	7.3	41
N-M	6.0	9.3				6.4	26.3	30.9	8.0	41
N-B	6.0	9.2				6.5	26.7	21.9	7.6	41
M-S	6.6	9.2	4.2	2.0	ND	6.6	24.8	-	10.9	49
M-M	6.0	9.0				6.6	24.3	30.9	9.6	50
M-B	6.3	9.1				6.6	24.2	33.6	9.8	48
S-S	6.5	9.3	3.6	2.4	ND	6.6	27.8	25.5	6.8	52
S-M	7.0	9.2				6.6	28.3	28.3	6.3	51
S-B	6.7	8.9				6.8	28.0	50.2	6.9	49
LILLIES	7.0	9.0	2.8	2.8	ND	6.7	29.8	22.0	6.6	33
Lake mean	**6.4**	**9.2**	**3.6**	**2.3**	**ND**	**6.6**	**26.5**	**29.7**	**8.1**	**45**
CURLEY	6.5	8.3	N/A	N/A	N/A	7.2	24.9	28.0	7.5	29
SALMON	6.0	10.0	N/A	N/A	N/A	6.6	18.3	42.4	15..4	410

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3-N, µg/L
1/19/94										
N-S	7.3	8.7	3.2	1.8	2.4	7.2	24.7	23.4	6.6	603
N-M	7.3	7.6				7.2	25.2	27.2	6.6	588
N-B	7.2	8.6				7.2	25.1	25.7	6.8	572
M-S	7.2	8.7	4.0	1.8	2.2	7.2	26.1	27.4	6.5	590
M-M	7.2	8.7				7.2	25.7	25.8	5.9	574
M-B	7.2	8.7				7.2	25.7	26.6	6.7	574
S-S	7.3	9.0	3.2	1.8	ND	7.2	26.1	29.8	6.1	505
S-M	7.1	9.0				7.2	25.9	28.7	6.1	483
S-B	7.2	8.8				7.2	25.9	23.9	5.7	497
LILLIES	7.3	8.0	2.4	1.6	ND	7.1	26.9	30.9	8.1	407
Lake mean	**7.2**	**8.6**	**3.2**	**1.8**	**2.3**	**7.2**	**25.7**	**26.8**	**6.5**	**547**
CURLEY	8.2	8.2	N/A	N/A	N/A	7.1	26.3	33.0	7.4	552
SALMON	6.0	10.6	N/A	N/A	N/A	7.4	29.2	39.1	17.6	ND
2/19/94										
N-S	5.8	10.6	3.4	1.6	1.2	7.3	23.2	32.4	5.2	528
N-M	5.9	10.5				7.4	21.9	37.5	5.2	472
N-B	5.9	10.4				7.4	22.8	33.6	5.3	528
M-S	6.0	10.4	4.2	1.4	ND	7.3	21.2	38.5	6.3	ND
M-M	6.0	10.4				7.3	21.6	35.7	4.9	490
M-B	6.0	10.3				7.4	32.2	42.3	5.3	ND
S-S	6.0	10.4	3.6	1.4	9.6	7.4	23.2	44.5	6.1	465
S-M	5.9	10.2				7.4	23.6	40.0	5.1	470
S-B	6.2	10.4				7.3	22.4	47.9	5.2	440
LILLIES	6.0	10.4	2.8	1.6	16.8	7.3	22.8	45.3	5.7	284
Lake mean	**6.0**	**10.4**	**3.5**	**1.5**	**9.2**	**7.4**	**23.5**	**39.2**	**5.4**	**475**
CURLEY	6.0	10.7	N/A	N/A	N/A	7.1	22.0	43.3	5.5	ND
SALMON	5.2	10.5	N/A	N/A	N/A	7.1	17.5	44.4	10.8	ND

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3-N, µg/L
3/16/94										
N-S	10.8	2.6	3.2	1.4	11.2	7.7	21.4	29.3	6.2	422
N-M	10.9	2.6				7.4	21.4	36.6	5.3	424
N-B	10.9	2.6				7.4	21.2	39.4	7.0	425
M-S	10.6	2.7	3.8	1.4	6.4	7.5	22.0	32.1	5.9	428
M-M	10.3	2.7				7.4	22.0	34.5	6.5	415
M-B	10.3	2.6				7.4	21.2	37.5	7.0	350
S-S	10.8	2.8	3.2	1.2	16.8	7.3	23.0	38.8	3.4	345
S-M	10.9	2.7				7.3	22.0	42.9	7.9	353
S-B	10.8	2.7				7.3	21.6	63.3	6.4	358
LILLIES	11.0	2.7	2.8	1.3	12.8	7.4	21.9	43.9	8.5	284
Lake mean	**10.7**	**2.7**	**3.3**	**1.3**	**11.8**	**7.4**	**21.7**	**39.0**	**6.4**	**386**
CURLEY	11.0	3.3	N/A	N/A	N/A	7.2	21.9	39.1	8.3	379
SALMON	9.5	2.7	N/A	N/A	N/A	7.4	27.2	36.9	13.6	ND
4/15/94										
N-S	ND	10.1	3.3	1.4	ND	7.2	23.8	48.7	7.3	62
N-M	ND	9.4				7.5	23.0	36.3	6.5	68
N-B	ND	9.5				7.5	23.6	42.3	5.5	71
M-S	ND	9.8	4.0	1.5	ND	7.6	23.0	38.6	7.6	75
M-M	ND	9.4				7.6	23.1	42.7	6.6	82
M-B	ND	9.3				7.5	23.5	58.5	5.9	90
S-S	ND	9.8	3.2	1.4	ND	7.4	23.6	35.9	ND	95
S-M	ND	9.7				7.5	23.0	46.7	ND	94
S-B	ND	9.4				7.5	23.2	39.1	ND	98
LILLIES	ND	10.2	2.4	1.1	ND	7.4	23.2	36.8	7.3	46
Lake mean	**ND**	**9.6**	**3.2**	**1.4**	**ND**	**7.5**	**23.3**	**42.9**	**6.8**	**77**
CURLEY	11.3	9.9	N/A	N/A	N/A	6.9	23.6	47.4	11.8	46
SALMON	ND	10.2	N/A	N/A	N/A	7.2	29.4	36.5	11.3	46

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
5/6/94										
N-S	17.6	8.8	3.0	1.6	8.4	7.7	26.1	33.4	3.3	3
N-M	17.3	8.8				7.7	25.4	33.0	3.8	256
N-B	16.4	8.0				7.9	25.7	34.8	3.3	31
M-S	17.8	9.9	3.8	1.6	6.4	8.0	25.9	28.0	4.4	7
M-M	17.8	9.6				8.0	25.0	48.7	4.3	3
M-B	17.0	9.0				7.9	25.9	38.6	4.2	9
S-S	18.3	9.8	3.2	1.8	3.2	8.1	25.2	38.8	4.8	3
S-M	18.0	9.8				8.2	25.1	32.1	3.9	3
S-B	18.0	9.8				8.2	25.0	34.5	3.5	2
LILLIES	19.2	9.8	2.2	1.6	0.8	8.2	25.5	46.7	3.6	3
Lake mean	**17.7**	**9.3**	**3.1**	**1.7**	**4.7**	**8.0**	**25.5**	**36.7**	**3.9**	**35**
CURLEY	17.4	8.9	N/A	N/A	N/A	7.6	26.3	41.5	5.6	26
SALMON	14.5	8.4	N/A	N/A	N/A	8.0	34.7	42.9	16.5	392
5/28/94										
N-S	17.0	8.0	3.0	1.7	3.2	7.6	66.9	25.4	2.3	1
N-M	17.0	8.2				7.7	66.5	24.4	3.7	2
N-B	17.0	8.2				7.7	66.8	33.2	2.0	1
M-S	17.1	7.7	3.6	1.6	3.6	7.6	62.8	26.5	1.6	1
M-M	17.0	7.7				7.6	62.9	24.8	2.1	2
M-B	17.0	7.6				7.6	61.6	26.5	2.3	3
S-S	17.0	7.1	3.2	1.6	5.6	7.4	57.8	29.1	1.8	2
S-M	16.9	7.0				7.4	57.4	34.0	1.6	2
S-B	16.9	7.1				7.4	57.5	28.1	2.7	47
LILLIES	17.0	6.7	2.4	1.6	2.4	7.2	54.6	29.4	4.6	1
Lake mean	**17.0**	**7.6**	**3.1**	**1.6**	**3.7**	**7.5**	**62.0**	**27.9**	**2.4**	**5**
CURLEY	10.2	8.5	N/A	N/A	N/A	7.2	69.2	29.7	3.2	38
SALMON	14.8	9.5	N/A	N/A	N/A	7.8	77.5	24.1	12.7	493

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
6/11/94										
N-S	19.6	9.9	3.2	1.8	9.6	8.5	28.4	20.8	3.7	3
N-M	19.4	9.8				8.5	28.0	27.8	3.2	1
N-B	19.4	9.6				8.5	28.3	32.4	3.2	1
M-S	20.1	10.1	3.8	1.8	4.8	8.6	27.8	30.6	3.2	0
M-M	20.0	10.3				8.8	27.9	25.3	2.9	2
M-B	19.0	7.8				8.2	29.0	31.0	6.2	0
S-S	20.8	10.2	3.0	1.8	8.8	8.8	28.1	24.4	4.2	1
S-M	20.9	10.1				8.8	28.5	27.8	3.2	1
S-B	20.3	8.2				8.4	28.6	29.0	3.2	1
LILLIES	21.9	10.3	2.1	1.9	6.4	8.7	28.5	21.5	3.6	2
Lake mean	**20.0**	**9.6**	**3.0**	**1.8**	**7.4**	**8.6**	**28.3**	**27.2**	**3.7**	**1**
CURLEY	16.8	9.5	N/A	N/A	N/A	8.3	29	32.6	4.8	39
SALMON	13.7	8.7	N/A	N/A	N/A	7.5	38.7	49.9	21.8	395
6/23/94										
N-S	20.6	9.0	3.0	1.9	1.2	8.2	73.2	24.5	2.8	0
N-M	20.0	9.0				8.2	73.2	25.5	2.8	0
N-B	20.0	9.0				8.3	73.5	23.1	2.2	1
M-S	19.9	8.8	3.7	1.5	10.8	8.2	71.6	27.3	2.1	0
M-M	19.8	8.6				8.2	70.4	19.3	2.5	3
M-B	19.9	8.6				8.2	69.7	26.1	2.4	0
S-S	19.0	8.4	3.2	1.5	11.6	8.1	68.7	27.4	3.1	0
S-M	19.0	8.2				8.1	66.6	23.8	3.0	0
S-B	19.0	8.3				8.0	67.7	31.1	2.7	1
LILLIES	19.1	7.7	2.1	1.3	20.4	7.8	63.1	30.1	2.4	0
Lake mean	**19.7**	**8.6**	**3.0**	**1.6**	**11.0**	**8.1**	**70.1**	**25.6**	**2.6**	**1**
CURLEY	18.8	8.2	N/A	N/A	N/A	8.4	67.0	45.0	2.9	33
SALMON	14.0	7.6	N/A	N/A	N/A	8.2	61.9	30.0	19.4	364

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg $CaCO_3$/L	TP, µg/L	SRP, µg/L	NO_3, µg/L
7/7/94										
N-S	21.8	9.2	3.1	1.3	9.6	8.4	37.1	19.1	2.8	0
N-M	21.0	8.8				8.3	37.3	31.6	2.8	0
N-B	20.4	7.0				7.9	37.2	30.0	2.2	0
M-S	22.0	9.2	3.8	1.2	9.6	8.4	36.9	21.1	2.1	0
M-M	21.5	9.4				8.4	37.4	26.8	2.5	0
M-B	20.0	8.1				8.0	36.8	34.9	2.4	0
S-S	22.2	9.3	3.2	1.3	9.2	8.5	37.3	19.6	3.1	0
S-M	22.2	9.4				8.5	37.2	20.9	3.0	1
S-B	21.2	9.2				8.3	36.8	22.9	2.7	0
LILLIES	23.2	8.8	2.1	1.5	8.8	8.3	36.6	20.8	2.4	0
Lake mean	**21.5**	**8.8**	**3.1**	**1.3**	**9.3**	**8.3**	**37.1**	**25.2**	**2.6**	**0**
CURLEY	20.9	9.0	N/A	N/A	N/A	8.3	54.4	24.2	2.9	36
SALMON	15.8	9.4	N/A	N/A	N/A	7.8	38.1	35.2	19.4	108
7/26/94										
N-S	24.2	8.2	3.0	1.5	16.8	7.7	36.6	24.6	2.6	2
N-M	24.0	7.6				7.7	36.1	30.0	2.9	2
N-B	24.0	7.4				7.6	37.6	24.7	2.5	2
M-S	24.2	7.2	3.6	1.6	16.6	7.6	37.5	27.3	2.5	2
M-M	24.0	7.4				7.9	37.6	24.0	3.0	3
M-B	23.8	6.8				7.7	34.6	25.5	23.7	3
S-S	24.0	7.2	3.0	1.5	14.4	7.4	37.7	31.9	3.2	3
S-M	24.0	7.4				7.5	37.2	27.9	3.8	3
S-B	24.0	6.9				7.5	37.5	17.4	2.5	2
LILLIES	24.3	6.9	2.1	1.4	10.0	7.1	35.9	26.4	2.1	4
Lake mean	**24.0**	**7.3**	**2.9**	**1.5**	**14.5**	**7.6**	**36.8**	**26.0**	**5.1**	**2**
CURLEY	20.5	6.9	N/A	N/A	N/A	7.6	56.3	ND	7.3	27
SALMON	15.6	8.9	N/A	N/A	N/A	7.6	65.7	36.7	14.2	156

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
8/8/94										
N-S	22.0	8.6	3.0	1.1	17.9	8.1	42.1	44.7	2.6	2
N-M	22.0	8.2				8.1	42.8	36.1	2.9	4
N-B	22.0	8.1				8.0	42.3	36.9	2.5	3
M-S	22.0	8.1	3.6	1.2	12.0	8.1	42.7	30.0	2.5	2
M-M	22.0	8.2				8.0	41.8	35.2	3.0	2
M-B	21.9	8.0				8.0	41.9	29.7	23.7	1
S-S	21.9	8.3	3.0	1.3	12.8	8.0	41.5	28.8	3.2	0
S-M	21.9	7.9				8.1	41.5	30.5	3.8	1
S-B	21.8	8.0				8.0	42.0	29.1	2.5	2
LILLIES	21.9	8.7	1.9	1.5	9.6	7.9	41.7	24.9	2.1	1
Lake mean	**21.9**	**8.2**	**2.9**	**1.3**	**13.1**	**8.0**	**42.1**	**33.1**	**5.1**	**2**
CURLEY	19.5	8.9	N/A	N/A	N/A	7.9	41.9	31.1	7.3	23
SALMON	15.8	8.1	N/A	N/A	N/A	7.8	56.2	37.5	14.2	119
8/29/94										
N-S	21.0	9.8	2.9	1.1	23.2	7.9	45.2	40.1	1.4	3
N-M	21.0	8.3				8.1	44.4	32.8	1.4	2
N-B	21.0	8.0				8.1	44.0	37.2	0.5	3
M-S	21.0	8.6	3.5	1.1	14.4	8.0	44.0	29.3	1.1	2
M-M	21.3	8.5				8.2	45.0	35.2	0.8	3
M-B	21.0	7.8				8.0	44.4	37.0	0.4	3
S-S	21.4	8.3	3.0	1.1	6.4	8.1	43.8	29.9	0.4	3
S-M	21.7	8.5				8.2	41.2	40.7	0.9	4
S-B	21.0	8.6				8.2	43.4	35.2	0.8	4
LILLIES	22.0	7.7	1.9	1.2	ND	7.7	43.3	27.5	1.1	2
Lake mean	**21.2**	**8.4**	**2.8**	**1.1**	**14.7**	**8.1**	**44.0**	**34.6**	**0.9**	**3**
CURLEY	18.0	9.1	N/A	N/A	N/A	7.2	56.9	30.0	1.0	53
SALMON	15.0	7.6	N/A	N/A	N/A	7.4	44.7	30.6	14.1	175

Sample and date	Temp, °C	DO, mg/L	Depth, m	Secchi, m	Chl a, µg/L	pH	Alkalinity mg CaCO3/L	TP, µg/L	SRP, µg/L	NO3, µg/L
9/12/94										
N-S	19.5	7.4	3.0	1.6	6.0	7.5	ND	43.0	1.3	1
N-M	19.5	7.6				7.9	ND	29.1	5.8	2
N-B	19.0	8.1				7.7	ND	38.9	1.9	2
M-S	19.9	8.1	3.6	1.8	5.0	7.8	ND	29.1	1.1	1
M-M	19.2	7.0				7.8	ND	35.8	1.7	1
M-B	19.0	6.9				7.7	ND	31.0	1.5	3
S-S	21.0	9.1	3.1	1.3	10.0	7.8	ND	26.2	1.8	1
S-M	20.0	8.5				7.8	ND	25.5	2.1	1
S-B	19.5	7.8				7.8	ND	28.5	2.3	2
LILLIES	20.1	8.8	2.2	1.3	6.8	7.8	ND	23.3	1.3	1
Lake mean	**19.6**	**7.9**	**3.0**	**1.5**	**7.0**	**7.8**	ND	**31.6**	**2.1**	**1**
CURLEY	16.2	8.4	N/A	N/A	N/A	7.5	ND	27.6	1.6	48
SALMON	13.0	8.9	N/A	N/A	N/A	7.6	ND	31.4	11.0	75
9/26/94										
N-S	20.1	8.5	3.0	1.4	4.0	7.7	44.0	29.4	0.2	0
N-M	20.3	8.5				7.6	44.7	21.2	0.0	0
N-B	19.8	8.1				7.8	44.6	22.3	0.0	0
M-S	20.5	8.1	3.8	1.5	5.6	7.8	44.5	26.7	0.9	0
M-M	20.7	8.3				7.7	44.5	24.7	0.0	0
M-B	19.7	7.6				7.7	44.2	29.0	0.4	1
S-S	21.0	8.5	3.1	1.5	5.4	8.0	44.5	25.3	1.2	1
S-M	21.0	8.4				8.0	44.5	26.5	0.3	1
S-B	20.5	8.0				7.9	46.0	22.4	0.9	1
LILLIES	21.3	10.5	2.1	1.4	1.3	8.7	44.1	20.9	0.2	1
Lake mean	**20.4**	**8.4**	**3.0**	**1.5**	**4.1**	**7.9**	44.5	**25.0**	**0.4**	**0**
CURLEY	18.2	9.0	N/A	N/A	N/A	8.2	44.4	22.0	3.3	35
SALMON	13.0	9.8	N/A	N/A	N/A	7.6	56.4	27.9	13.5	109

KEY: Stations: North (N), Midlake (M), South (S), and Lilies (L)
Depths: Surface (S), Mid-depth (M), and Bottom (B)
N/A - Not applicable ND - no data

Long Lake Water Quality, 6/7/95-9/12/95

6/7/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	4.0	75.5	1.6	21.5	6.4	7.6	33.7	6.2
NM	4.8	54.3		21.0	6.2	7.5	32.8	5.4
NB	3.8	66.3		21.0	6.5	7.5	33.6	5
MS	3.6	78.9	1.8	22.0	6.5	7.5	33.1	5.9
MM	3.4	38.5		21.0	6.5	7.4	33.6	5.3
MB	4.5	31.1		20.0	6.1	7.3	34.1	4.6
SS	3.8	36.6	1.8	23.0	6.9	7.5	34.2	6.2
SM	3.8	36.1		20.8	7.4	7.5	34.3	5.4
SB	4.2	42.6		21.0	6.8	7.4	34.1	4.9
LILLIES	3.6	37.4	1.6	22.0	7.5	7.6	33.2	5.9
CURLEY	4.1	37.2		20.5	8.9	7.6	34.2	5.8
SALMON	11.4	55.0					48.2	5.9
lake mean	**4.0**	**51.1**	**1.7**	**21.3**	**6.9**		**34.9**	**5.5**

6/19/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	3.2	13.3	1.8	21.0	8.6	7.7	35.6	6.5
NM	3.2	61.1		22.0	7.8	7.7	35.6	5.5
NB	3.2	32.1		21.5	8.9	7.6	34.7	5
MS	4.0	19.4	2.3	21.5	9.2	7.5	34.7	6.1
MM	4.4	56.8		21.0	8.1	7.6	32.8	5.6
MB	3.8	45.8		22.0	8	7.4	35.6	4.8
SS	3.8	50.5	2.1	20.0	9.1	7.4	35.6	6.3
SM	4.1	71.5		23.0	9	7.5	35.6	5.6
SB	4.7	82.1		22.5	8.9	7.5	35.6	4.5
LILLIES	5.2	56.2	2	23.5	9.4	7.8	35.6	6
CURLEY	5.7	70.7		23.5	8.5	7.7	35.6	5.9
SALMON	11.7	83.1		22.5	9	7.6	49.2	6.1
lake mean	**3.9**	**47.0**	**2.1**	**22.0**	**8.7**		**36.3**	**6.7**

7/3/95 Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	0.0	43.5	1.7	22	7.5	7.6	35.6	6.0
NM	0.4	34.4		21.5	7.3	7.5	36.5	4.0
NB	1.2	41.3		21	7.2	7.5	36.5	2.7
MS	0.1	33.0	2.1	22.5	8.3	7.7	37.4	6.0
MM	1.0	38.8		22	8.4	7.6	37.4	4.2
MB	1.5	34.7		21.5	7.5	7.5	37.4	2.3
SS	1.2	42.0	2.1	23.5	7.2	7.7	37.4	6.0
SM	3.0	41.2		22	7.2	7.4	37.4	3.5
SB	2.0	41.0		22	7	7.3	36.5	2.3
LILLIES	0.7	43.3	1.7	23	7.4	7.7	37.4	5.1
CURLEY	0.2	34.0		22.5	8.6	7.8	38.3	5.5
SALMON	16.0	31.2		23	6.6	7.6	53.8	5.7
lake mean	**1.0**	**39**	**1.9**	**22.2**	**7.5**		**38.5**	**4.0**

7/16/95								
NS	0.9	30.2	1.6	22	8.9	7.8	40.8	14.9
NM	0.1	27.9		21	6.9	7.6	41.8	7.2
NB	0.4	49.8		21	7.7	7.4	41.8	5
MS	0.2	32.2	2	21.5	8.5	7.7	40.8	16.2
MM	0.1	33.5		21	8.6	7.5	40.8	5.8
MB	4.0	36.7		21	8.1	7.4	40.8	6.1
SS	3.3	26.7	2.1	23.5	9.2	7.9	40.8	16.9
SM	0.9	34.5		22.5	9	7.7	40.8	8.9
SB	0.0	27.6		21	8.5	7.6	40.8	5.4
LILLIES	0.1	20.4	1.5	23	11.1	7.9	39.9	17.3
CURLEY	0.3	31.9		23.5	8.8	8.1	56.9	16.8
SALMON	18.6	21.3		23.5	7.3	7.8	43.7	16.7
lake mean	**1.0**	**32.5**	**1.8**	**22**	**8.6**		**42.5**	**11.5**

8/1/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	3.7	47.6	1.5	22.5	8.3	8.0	42.7	13.6
NM	4.0	36.2		22.0	8.5	7.6	42.7	10.9
NB	4.1	35.7		21.5	8.1	7.4	41.8	13.0
MS	5.4	45.0	2.1	22.0	8.4	7.8	42.7	16.0
MM	5.3	36.8		21.0	8.4	7.7	42.7	13.1
MB	6.5	34.4		21.0	8.2	7.6	42.7	12.7
SS	2.0	46.0	2.0	23.0	8.6	8.1	42.7	15.9
SM	5.9	38.1		22.5	8.5	7.7	42.7	11.9
SB	5.2	33.9		21.5	8.4	7.8	45.6	11.5
LILLIES	4.4	44.5	1.3	23.5	10.4	8.0	40.8	13.8
CURLEY	16.2	44.5		24.0	9.2	8.0	56.9	14.2
SALMON	4.0	42.9		23.5	7.2	8.1	43.7	14.9
lake mean	**5.3**	**40.5**	**1.7**	**22.3**	**8.5**		**44.0**	**13.5**

8/14/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	4.3	49.5	1.2	23.0	8.1	8.0	43.7	15.8
NM	4.6	35.2		22.5	8.2	7.7	45.6	14.9
NB	5.2	33.4		21.0	8.2	7.6	44.6	12.9
MS	4.3	48.1	1.8	23.5	8.1	8.2	44.6	16.3
MM	5.6	38.6		22.0	8.1	7.9	43.7	15.7
MB	6.9	36.3		20.5	8.1	7.4	43.7	13.9
SS	1.1	49.6	1.9	23.4	8.2	7.9	43.7	16.9
SM	5.0	40.0		23.1	8.0	7.6	43.7	13.3
SB	6.2	35.5		21.0	7.6	7.5	43.7	12.2
LILLIES	3.6	44.6	1.0	22.6	8.2	7.5	42.7	14.7
CURLEY	18.6	44.7		23.1	ND	8.1	44.6	15.0
SALMON	4.1	50.0		23.1	9.2	8.1	56.0	15.6
lake mean	**5.6**	**41.2**	**1.5**	**22.4**	**8.2**		**45.0**	**14.8**

8/30/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	4.3	47.6	1.0	23.1	8.3	7.7	45.6	14.8
NM	4.3	35.2		22.6	8.2	7.7	46.5	12.0
NB	5.6	33.4		21.1	7.9	7.6	45.6	9.6
MS	4.5	47.5	1.7	22.5	8.5	8.1	45.6	15.1
MM	5.7	36.8		22.0	8.5	8.0	45.6	13.7
MB	6.8	36.3		21.0	8.3	7.8	45.6	10.0
SS	1.2	48.8	1.7	23.6	8.6	8.1	46.5	15.5
SM	4.3	40.0		22.8	8.6	7.6	45.6	12.2
SB	6.5	35.5		21.6	8.2	7.5	45.6	9.5
LILLIES	4.6	44.6	1.0	23.4	11.1	8.2	44.6	13.0
CURLEY	18.3	44.7		22.0	8.6	8.0	45.6	13.5
SALMON	3.9	50.0		22.5	9.1	7.8	58.8	14.0
lake mean	**5.6**	**41.7**	**1.4**	**22.4**	**8.7**		**46.7**	**12.7**

9/12/95

Station	SRP, µg/L	TP, µg/L	Secchi (m)	Temp. (C)	DO (mg/L)	pH	Alkalinity mg CaCO3/L	Chl a, ug/L
NS	TP and SRP not measured		1.1	23.4	8.1	7.6	47.5	1.4
NM				22.0	8.2	7.6	47.5	11.2
NB				21.6	8.2	7.5	47.5	9.2
MS			1.5	23.8	8.1	8.1	47.5	14.3
MM				22.8	8.1	8.0	46.5	13.2
MB				21.6	8.1	7.5	47.5	10.5
SS			1.6	24.2	8.2	8.2	47.5	14.7
SM				23.1	8.2	7.9	48.4	11.9
SB				22.1	8.0	7.3	47.5	8.8
LILLIES			1.1	24.6	8.0	8.0	47.5	12.9
CURLEY				23.8	11.1	7.8	47.5	13.1
SALMON				23.9	9.3	7.7	57.9	14.0
lake mean			**1.3**	**23.1**	**8.5**		**48.3**	**12.3**