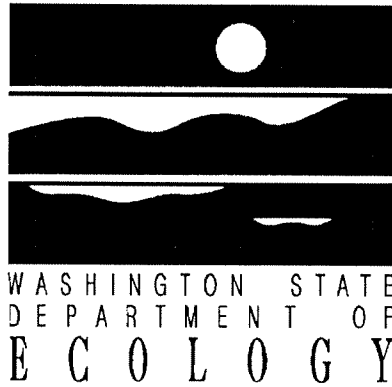


**WATER QUALITY SURVEY OF
25 "CITIZEN-VOLUNTEER" LAKES
FROM WASHINGTON STATE**

March 1990



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25 "CITIZEN-VOLUNTEER" LAKES
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ABSTRACT

A subset of 25 "citizen volunteer" lakes were sampled for conventional water quality parameters to determine their current trophic status and provide a data base for statewide assessment. Carlson's trophic state index (TSI) was used to classify each lake.

This classification system yielded TSI values ranging from 29 to 70, 21 to 80, and -8 to 72 when based on Secchi-disc transparency, total phosphorus concentration and chlorophyll-a concentration, respectively. The degree of eutrophication increases as the numerical value increases. Most lakes demonstrated like TSI values based upon each of the three parameters. The chlorophyll-a parameter was given priority when they were not similar. Ten lakes were considered oligotrophic, eight lakes were mesotrophic, and seven lakes eutrophic.

INTRODUCTION

Many of the 7,800 lakes in the State of Washington face constant demands by a growing population. These include water supply demands for agricultural, municipal and industrial needs, as well as recreational and residential development. With these increased demands a potential exists for cultural eutrophication and water quality deterioration. Restoring the water quality of a lake is sometimes possible, but is often a slow and costly process.

In 1989, the Washington State Lakes and Reservoir Water Quality Assessment Program was developed by the Ambient Monitoring Section of the Department of Ecology. This program consists of three components: a "citizens-volunteer" study, an intensive water quality study, and a toxics study.

This study was designed to fulfill the intensive water quality component through sampling and analysis of conventional parameters at 25 "citizen-volunteer" lakes. Program funding was provided through the Lakes Water Quality Assessment Grant from the Environmental Protection Agency.

OBJECTIVES

The objectives of this study were to:

- Determine the trophic state of 25 publicly owned lakes.
- Assess the water quality of each lake.
- Provide assessment information needed to prioritize lakes proposed for restoration.
- Provide assessment information for lakes not adequately addressed under the Statewide Water Quality Assessment (305(b)) Report.

LAKE SELECTION

Lakes were selected for a balance of size, altitude, depth, geographic distribution (ecoregion), development, and trophic class. Priority was given to lakes that fit the following criteria:

- Had not been previously studied or assessed within the last five years.
- Recreational importance.
- Organized public interest groups, such as lake associations, citizen volunteers, etc.
- Proximity to acid rain monitoring sites.
- Need for additional information for restoration and statewide assessment reports.

METHODS

Samples were collected once in June just prior to summer stratification or as soon after stratification as possible and again in September before turnover. Lakes were accessed by boat or float plane.

Water column sampling occurred over the point of maximum depth, which was confirmed by echo-sounding when possible. An exception was Blue Lake which was sampled in the northeast corner because of high winds. Parametric coverage and methodology are outlined in Table 1. Samples were collected from representative depths of the epilimnion and hypolimnion down to 50 meters and composited individually using a Kemmerer bottle. Transparency of the water was determined by Secchi-disc. Water color and weather conditions were noted.

A cursory survey of aquatic macrophytes was made in the vicinity of each boat launch and sampling area in June. Samples were bagged and refrigerated prior to identification. Hitchcock and Cronquist (1973), Tarver *et al.*, (1978), and Prescott (1980) were used to identify macrophytes. Results are qualitative only and not necessarily inclusive of all forms present. Lakes sampled by plane were not surveyed for macrophytes, although significant populations may have existed. Macrophyte data was supplemented with information from citizen volunteers.

Algal samples were collected when blooms were visible or when suspected by dissolved oxygen monitoring. Samples were iced until they could be identified. Smith (1950), Edmondson (1959), and Prescott (1962 and 1978) were used to identify algae. Results are qualitative only and not necessarily inclusive of all forms present. Identification of aquatic macrophytes and algae was made by Dave Hallock of the Ambient Monitoring Section of Ecology.

Samples for analysis were transported to the Turnbull Ecological Laboratory at Eastern Washington University in Cheney, Washington within 24 hours of collection. All sampling protocols were followed according to standardized procedures and methods (EPA 1983; APHA 1985).

QUALITY ASSURANCE

Twelve percent of samples at each lake were replicated to assess sampling and analytical variability. Similarity of each replicate pair was measured by calculating the relative percent difference (RPD), defined as the difference between two replicates divided by their mean. Results were expressed using box plots (Figure 1).

Box plots graphically depict the distribution of a series of data points (McGill *et al.*, 1978). The line within the box represents the median (the middle value of a series of values arranged in order of magnitude). The box itself represents the interquartile range (the 25th and 75th percentiles of the ranked data set). Vertical lines project above and below the box to the maximum and minimum values, respectively. Outlying points are values that occurred beyond 1.5 times the interquartile range.

Table 1. Parametric coverage, analytical methodology, and target precision for conventional water quality monitoring in 25 lakes.

Location	Target Parameter	Method*	Precision
Surface -to- Bottom Profile	Temperature	Hydrolab	-
	pH	"	-
	Conductivity	"	-
	Dissolved oxygen	"	-
	Light transmission	Irradiameter	-
Surface Grab	Fecal coliform bacteria	SM-909C	-
Epilimnion Composite	Chlorophyll <u>a</u>	SM-1002G	0.5 ug/L
	Turbidity	SM-214A	
Epilimnion and Hypolimnion Composites	Ammonia-N	SM-417C**	5.0 ug/L
	Nitrate + nitrite-N	SM-418C	5.0 ug/L
	Total nitrogen-N	D'Elia <i>et al.</i> 1977	10.0 ug/L
	Ortho-phosphate-P	SM-424F	1.0 ug/L
	Total phosphorus-P	EPA-365.3	2.0 ug/L
	Alkalinity***	SM-403	0.2 mg/L
	Sulfate***	SM-429	0.05 mg/L

* EPA: EPA (1983). SM: APHA (1985).

** SM-417C was used to analyze for ammonia in June. Solarzano (1969) was used to analyze for ammonia in September.

***Only at four lakes located near acid rain monitoring sites. Sulfate ion chromatography was performed by Ecology's Manchester Lab.

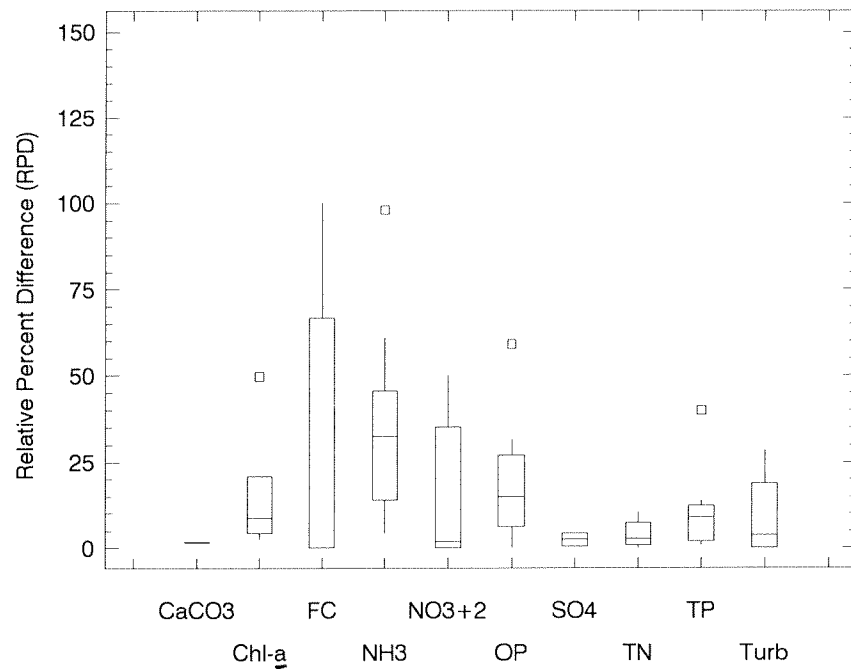


Figure 1. Comparison of replicate samples taken from 25 lakes in June and September, 1989. Parameter codes are: CaCO₃ - alkalinity; Chl-a - chlorophyll-a; FC - fecal coliform; NH₃ - ammonia; NO₃+2 - nitrate + nitrite; OP - orthophosphorus; SO₄ - sulfate; TN - nitrogen; TP - total phosphorus; Turb - turbidity. Each box plot represents 12 sample replicates, except FC, Chl-a, Turb (with 6 each), and CaCO₃ and SO₄ (with 2 each).

Water quality variables fell within acceptable limits. Five parameters showed some variation. The high RPDs for fecal coliform and total phosphorus are of little significance since they occurred at lower ranges of detection (e.g. replicate values of 1 and 2 yield an RPD of 67%). High variability in one chlorophyll-*a* sample was attributed to the patchy concentration of algae in the particular lake sampled. Ammonia and orthophosphorus occasionally exhibited higher variation; data for these parameters should be regarded as less accurate.

Analysis of RPDs for lab duplicates, matrix spikes, method spikes, filtration blanks and lab blanks fell within acceptable limits. Values for these checks are provided in Appendix A. Laboratory quality assurance was checked by submitting external reference standards provided by EPA. All recoveries were within quality control limits.

RPD was also used to assess the consistency of field equipment. Equipment was calibrated at the beginning and end of a week of sampling. Daily calibration checks were made in the field. All RPDs for dissolved oxygen, temperature, specific conductivity, and light transmission had acceptable precision. pH values varied up to 0.4 unit; results are flagged to denote they are estimated values only.

SUMMARY

Summary of Trophic State Index

The broad nature of the traditional classification categories of oligotrophic, mesotrophic, and eutrophic makes them inadequate for all but the most general of uses (Sumioka and Dion, 1985). Shapiro (1975) argued that in order to: properly identify and manage lakes, estimate their recreational potential, estimate their sensitivity to degradation, and restore them efficiently; the lakes should be classified with quantitative trophic indices. Shapiro further suggested that what limnology needed was an objective, numerical classification system similar to the Richter scale used to describe earthquakes.

As part of this investigation all lakes were classified using trophic state indices (TSI's) (Carlson, 1977). The TSI is both absolute and univariate, and can be calculated using any one of three variables. Because of this, the method could actually be multivariate by averaging the three TSI's (Reckhow, 1979). However, if one TSI diverged significantly from the other two, it would be difficult to detect the divergence in the average value (Carlson, 1979).

Carlson's TSI was developed by first assigning a TSI range of 0 - 100 to the largest range of Secchi-disc depth that could reasonably be expected (0 - 210 feet), such that a halving or doubling of the Secchi-disc depth corresponded to a change of 10 units in TSI. Regression equations were then used to relate the TSI to concentrations of total phosphorus and chlorophyll-*a*. Because of this regression approach, values of TSI greater than 100 are not uncommon for trophic determinations based on total phosphorus. The completed scale and its associated parameters are shown in Table 2.

Table 2. Trophic state index (TSI) and its associated parameters (Carlson, 1977).

TSI	Secchi-disc (m)	Epilimnetic phosphorus (ug/L)	Chlorophyll- <u>a</u> (ug/L)
0	64	0.75	0.04
10	32	1.5	0.12
20	16	3	0.34
30	8	6	0.94
40	4	12	2.6
50	2	24	6.4
60	1	48	20
70	0.5	96	56
80	0.25	192	154
90	0.12	384	427
100	0.062	768	1,183

TSI values are calculated from Secchi-disc depth and concentrations of total phosphorus and chlorophyll-a as follows:

$$TSI_{(SD)} = 10 \left(6 - \frac{\ln SD}{0.693} \right)$$

$$TSI_{(TP)} = 10 \left(6 - \frac{\ln \frac{48}{TP}}{0.693} \right)$$

$$TSI_{(Chl)} = 10 \left(6 - \frac{2.04 - 0.68 \ln Chl}{0.693} \right)$$

where

SD = Secchi-disc depth, in meters

TP = total phosphorus concentration of epilimnion, in ug-P/L (micrograms of phosphorus per liter), and

Chl = chlorophyll-a concentration, in ug chl-a/L.

The three parameters do not always indicate the same trophic state for each lake. Carlson (1977) suggested that for purposes of classification in summer, priority should be given to the chlorophyll-a index. In spring, autumn, and winter, when algal growth may be limited by factors other than phosphorus, priority should be given to the total phosphorus index. These priorities would result in about the same TSI during any season of the year.

TSI values for the 25 lakes sampled in this study are given in Table 3 and the individual lake data sheets (see Results and Discussion section). Lakes with higher TSI values are considered more "eutrophic" than lakes with lower values.

For comparison with traditional methods of classifying lakes, Carlson (1979) suggested limits of TSI values that correspond to the traditional terms "oligotrophic" and "eutrophic." He found that a mean TSI value of 41 (with a standard deviation of 5.8) was the upper limit of oligotrophy, and a mean TSI value of 51 (s.d. = 7.6) was the lower limit of eutrophy. Although these suggested guidelines are of limited use when applied to the median value of a large number of lakes, they are of considerable use in estimating the likely trophic levels of the individual lakes in this study.

General Summary

All chemical parameters, excluding dissolved oxygen, temperature, pH, and percent light transmission, were ranked for comparison. The ranking is relative only and serves as a way to compare individual lakes to other lakes surveyed. Tables 4a and 4b rank June and September data, respectively. Lakes that were not thermally stratified were ranked using epilimnetic values only. Three orthophosphorus values were eliminated from the ranking because they exceeded corresponding total phosphorus values. The highest value is given a rank of one, second highest two, etc. Significant features of these rank comparisons are discussed later under individual lake results.

Physical characteristics influence the trophic status of lakes. Physical data for all lakes is presented in the individual lake data sheets. This monitoring effort was designed to include lakes of various sizes, depths, altitudes, and ecoregion. Lake size ranged from 47 acres (Goss Lake) to 5,800 acres (Osoyoos Lake). Nineteen of the lakes were within 50 to 600 acres.

Altitudes ranged from 10 feet (Duck Lake) to 3,701 feet (Black Lake - Stevens County). Elevations for lakes on the east side of the Cascades were generally higher than those on the west. Two exceptions were Packwood Lake at 2,858 feet on the west side and Osoyoos Lake at 910 feet on the east side. Sixty-four percent of the lakes were below 1,000 feet.

Mean depths ranged from nine feet in Lone Lake to 150 feet in Lake Wenatchee. Mean depths of 10 lakes were below 20 feet. Eight lakes had mean depths of 20 to 50 feet and five were from 50 to 110 feet.

Land use along the shoreline and within a drainage basin can also affect the trophic status of lakes. Data related to development was obtained from Ecology publications by Dion *et al.* (1976a,b,c) and Bortleson *et al.* (1976a,b,c,d). This data gives a general indication of the potential for nutrient loading to a lake. Data were not available for Osoyoos or Blue Lakes. Residential development of the shoreline area varied from lakes having less than one percent (Cranberry, Packwood and Sprague Lakes) to those whose shorelines were completely developed (Steilacoom and Tiger Lakes). A summary follows: six lakes - 0 to 25 percent, three lakes - 26 to 50 percent, four lakes - 51 to 75 percent, and six lakes - 76 to 99 percent residentially developed around their shorelines.

Table 3. Trophic State Index (TSI) values for 25 Washington lakes.

Lake (County)	Spring			Fall			Trophic State
	TSI SD	TSI TP	TSI Chl	TSI SD	TSI TP	TSI Chl	
American (Pierce)	37	40	40	34	40	33	Mesotrophic
Black (Stevens)	42	39	35	36	24	32	Oligotrophic
Black (Thurston)	48	44	50	62	59	70	Eutrophic
Blackmans (Snohomish)	45	44	42	41	49	44	Mesotrophic
Blue (Grant)	43	57	44	43	47	45	Mesotrophic
Cle Elum (Kittitas)	30	27	31	32	80	31	Oligotrophic
Clear (Thurston)	33	56	38	51	79	63	Eutrophic
Cranberry (Island)	59	63	64	55	72	58	Eutrophic
Deep (Stevens)	37	41	40	35	40	43	Mesotrophic
Duck (Grays Harbor)	70	68	67	70	69	64	Eutrophic
Goss (Island)	37	37	37	29	37	31	Oligotrophic
Jumpoff Joe (Stevens)	46	41	40	49	45	46	Mesotrophic
Lone (Island)	46	58	52	40	63	61	Eutrophic
Mason (Mason)	31	34	27	33	36	30	Oligotrophic
Osoyoos (Okanogan)	42	44	39	49	48	48	Mesotrophic
Packwood (Lewis)	54	40	25	32	36	-8	Oligotrophic
Samish (Whatcom)	39	30	40	42	40	49	Mesotrophic
Sprague (Adams)	40	59	49	67	87	72	Eutrophic
Steilacoom (Pierce)	51	51	54	67	64	62	Eutrophic
Summit (Thurston)	32	32	34	32	30	34	Oligotrophic
Sutherland (Clallam)	36	37	30	32	37	26	Oligotrophic
Tiger (Tiger)	45	34	35	43	41	35	Oligotrophic
Wenatchee (Chelan)	42	30	27	32	32	34	Oligotrophic
Williams (Spokane)	37	46	39	35	43	40	Mesotrophic
Wooten (Mason)	33	21	29	39	37	53	Oligotrophic

Table 4a. Comparative ranking of chemical parameters for 25 lakes. Highest value is ranked one. Values with the same rank are equal.

June 1989															
Lake (County)	Total Nitrogen		Orthophos-phorus-P		Total Phosphorus		Nitrate + Nitrite-N		Ammonia-N		Turbidity	Chlorophyll-a	Fecal Coliform (Surface)	Secchi Disc	Specific Conductivity
	E	H	E	H	E	H	E	H	E	H					
American (Pierce)	16	7	15	10	15	9	8	7	10	4	12	10	7	9	13
Black (Stevens)	14	13	17	8	16	11	11	-	8	10	18	17	5	14	22
Black (Thurston)	10	10	4	6	10	10	3	4	21	6	4	5	8	21	17
Blackmans (Snohomish)	7	11	19	18	9	8	6	8	15	14	16	8	1	18	14
Blue (Grant)	11	9	16	9	5	7	9	13	5	8	17	7	7	16	1
Cle Elum (Kittitas)	24	18	-	-	24	19	14	11	12	18	19	20	8	1	20
Clear (Thurston)	17	14	2	1	6	4	14	15	1	12	25	15	8	5	15
Cranberry (Island)	1	2	10	3	2	1	14	15	16	2	5	2	2	24	5
Deep (Stevens)	20	5	6	5	12	5	10	6	9	1	20	12	-	7	3
Duck (Grays Harbor)	2	4	1	4	1	3	14	15	3	5	1	1	4	25	8
Goss (Island)	9	8	21	11	18	12	5	3	21	9	22	16	6	10	12
Jumpoff Joe (Stevens)	13	-	12	-	13	-	12	-	4	-	7	11	8	19	7
Lone (Island)	4	-	9	-	4	-	14	-	14	-	3	4	7	20	9
Mason (Mason)	21	17	7	13	20	16	14	15	21	17	23	24	8	2	19
Osoyoos (Okanogan)	12	12	20	15	11	14	14	9	13	7	9	14	8	13	4
Packwood (Lewis)	25	19	8	13	14	18	14	10	18	13	2	25	8	23	18
Samish (Whatcom)	6	6	22	16	23	17	3	1	19	16	21	9	8	11	16
Sprague (Adams)	5	-	3	-	3	-	7	-	2	-	9	6	3	12	2
Steilacoom (Pierce)	3	1	5	7	7	6	2	2	7	11	6	3	6	22	11
Summit (Thurston)	18	15	-	14	21	15	14	12	20	3	13	19	7	3	21
Sutherland (Clallam)	22	16	13	17	17	13	14	14	11	15	10	21	8	6	10
Tiger (Mason)	15	-	18	-	19	-	14	-	17	-	14	18	6	17	25
Wenatchee (Chelan)	19	-	14	-	22	-	4	-	21	-	11	23	8	15	24
Williams (Spokane)	8	3	23	2	8	2	13	5	6	19	15	13	8	8	6
Wooten (Mason)	23	-	11	-	25	-	14	-	23	-	24	22	6	4	23

"-" no data

"E" epilimnion composite

"H" hypolimnion composite

Table 4b. Comparative ranking of chemical parameters for 25 lakes. Highest value is ranked one. Values with the same rank are equal.

September 1989															
Lake (County)	Total Nitrogen-N		Orthophos-phorus-P		Total Phosphorus		Nitrate + Nitrite-N		Ammonia-N		Turbidity	Chlorophyll-a	Fecal Coliform (Surface)	Secchi-Disc	Specific Conductivity
	E	H	E	H	E	H	E	H	E	H					
American (Pierce)	18	7	21	8	16	9	2	3	7	4	13	19	5	8	13
Black (Stevens)	15	13	9	10	25	11	2	10	11	9	21	20	4	11	22
Black (Thurston)	5	10	8	6	8	6	2	10	22	6	1	2	4	22	16
Blackmans (Snohomish)	11	11	10	20	9	13	2	10	4	14	9	13	1	14	14
Blue (Grant)	10	8	-	7	11	10	2	10	2	5	15	12	5	17	1
Cle Elum (Kittitas)	23	21	12	16	2	7	1	8	18	18	24	22	5	2	21
Clear (Thurston)	7	5	2	4	3	3	2	7	1	3	5	4	4	20	15
Cranberry (Island)	2	1	4	1	4	1	2	10	3	1	4	7	3	21	4
Deep (Stevens)	16	4	6	5	15	5	2	10	13	2	14	14	4	9	3
Duck (Grays Harbor)	4	-	7	-	5	-	2	-	23	-	3	3	3	25	8
Goss (Island)	9	15	18	14	20	19	2	4	12	13	17	21	5	1	12
Jumpoff Joe (Stevens)	12	-	5	-	12	-	2	-	10	-	10	11	4	18	7
Lone (Island)	3	-	3	-	7	-	2	-	5	-	8	6	5	13	9
Mason (Mason)	20	18	14	13	22	14	2	10	16	12	12	23	5	7	18
Osoyoos (Okanogan)	14	14	22	19	10	15	2	10	9	19	7	10	4	19	6
Packwood (Lewis)	25	20	16	12	21	18	2	1	24	16	19	25	5	3	20
Samish (Whatcom)	13	9	24	21	17	17	2	2	14	8	11	9	5	15	17
Sprague (Adams)	1	2	1	3	1	2	2	10	17	17	2	1	2	23	2
Steilacoom (Pierce)	8	6	13	11	6	8	2	5	25	7	6	5	5	24	11
Summit (Thurston)	21	17	20	18	24	20	2	9	19	20	22	17	5	6	19
Sutherland (Clallam)	22	16	15	9	18	12	2	10	20	10	23	24	5	4	10
Tiger (Mason)	17	12	19	17	14	16	2	10	21	11	18	16	2	16	24
Wenatchee (Chelan)	24	19	17	15	23	21	2	6	6	15	25	18	5	5	25
Williams (Spokane)	6	3	11	2	13	4	2	10	15	25	20	15	5	10	5
Wooten (Mason)	19	-	23	-	19	-	2	-	8	-	16	8	4	12	23

"-" no data

"E" epilimnion composite

"H" hypolimnion composite

Steilacoom and American Lakes had the highest residential development within their drainage basins (55% and 38%, respectively). Ten lakes were less than 1 percent, eight had between 1 and 10 percent, and four lakes had between 10 to 40 percent development.

Only eleven lakes had agriculture present within their watersheds and in half of these, agriculture covered less than 5 percent of their respective areas. Sprague, Williams, and Blackmans Lakes had the highest percentage of agriculture at 89, 77, and 69 percent, respectively. They also had the lowest percentage of forest of all lakes. Over half of all the lakes were 75 percent forest. Another ten watersheds were 25 to 75 percent forested.

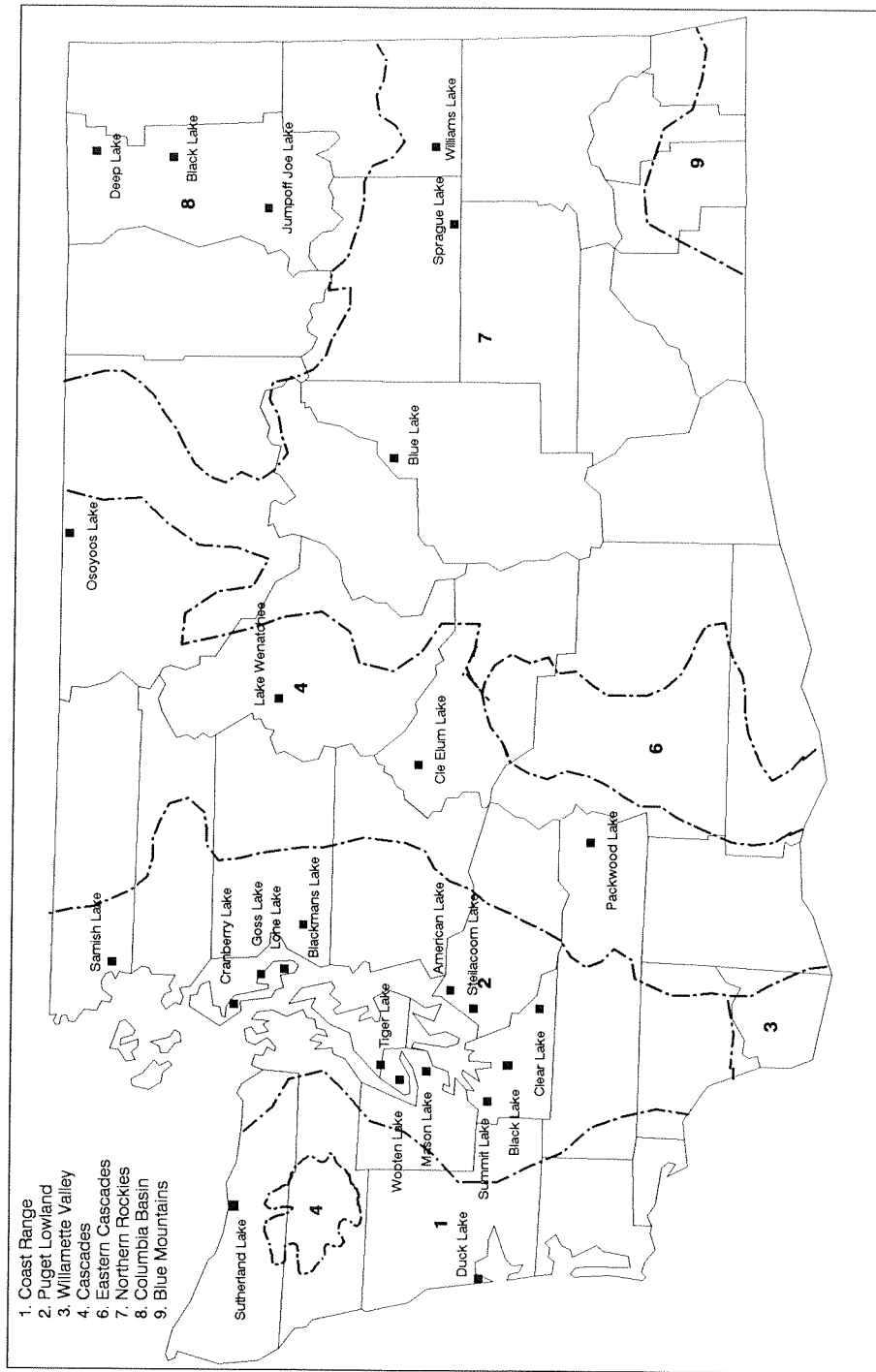
Figure 2 shows the distribution of the lakes by ecoregion (Omernik, 1986). Of the eight ecoregions that have been identified in Washington State, five were represented in this study.

Lake Specific Summaries

Most of the following lake reports contain four graphs representing water column data for temperature, dissolved oxygen, pH, and percent light transmission for both sampling dates (tabulated values for water column data can be found in Appendix B). An aerial photograph accompanies all lakes. Photos are from the early 70's and were obtained from the United States Geological Survey in Tacoma and the United States Forest Service in Packwood, Washington.

A table on the opposing page provides water quality data for epilimnion and hypolimnion parameters and includes lake trophic classification. A brief narrative summary accompanies each lake report.

Figure 2. Distribution of 25 Washington lakes by ecoregion.



RESULTS AND DISCUSSION

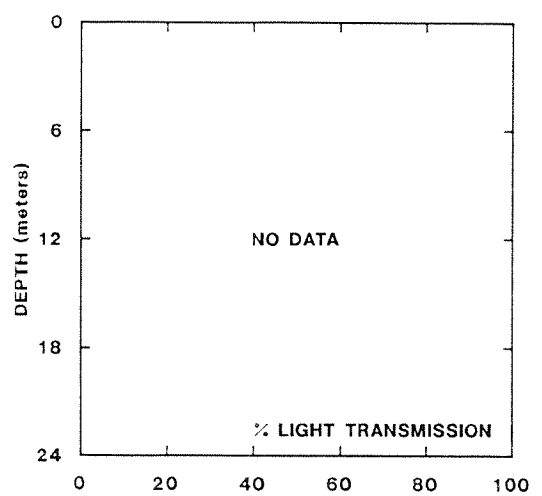
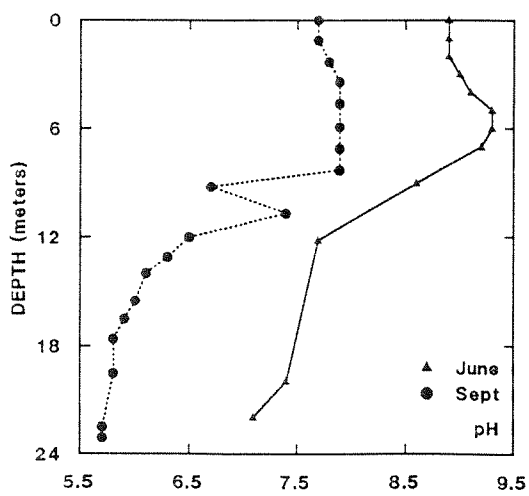
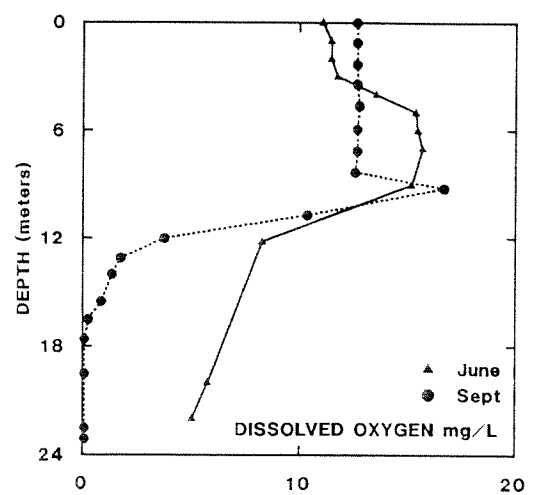
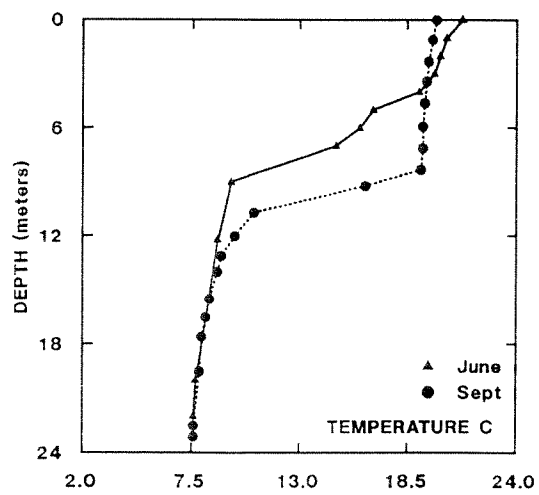
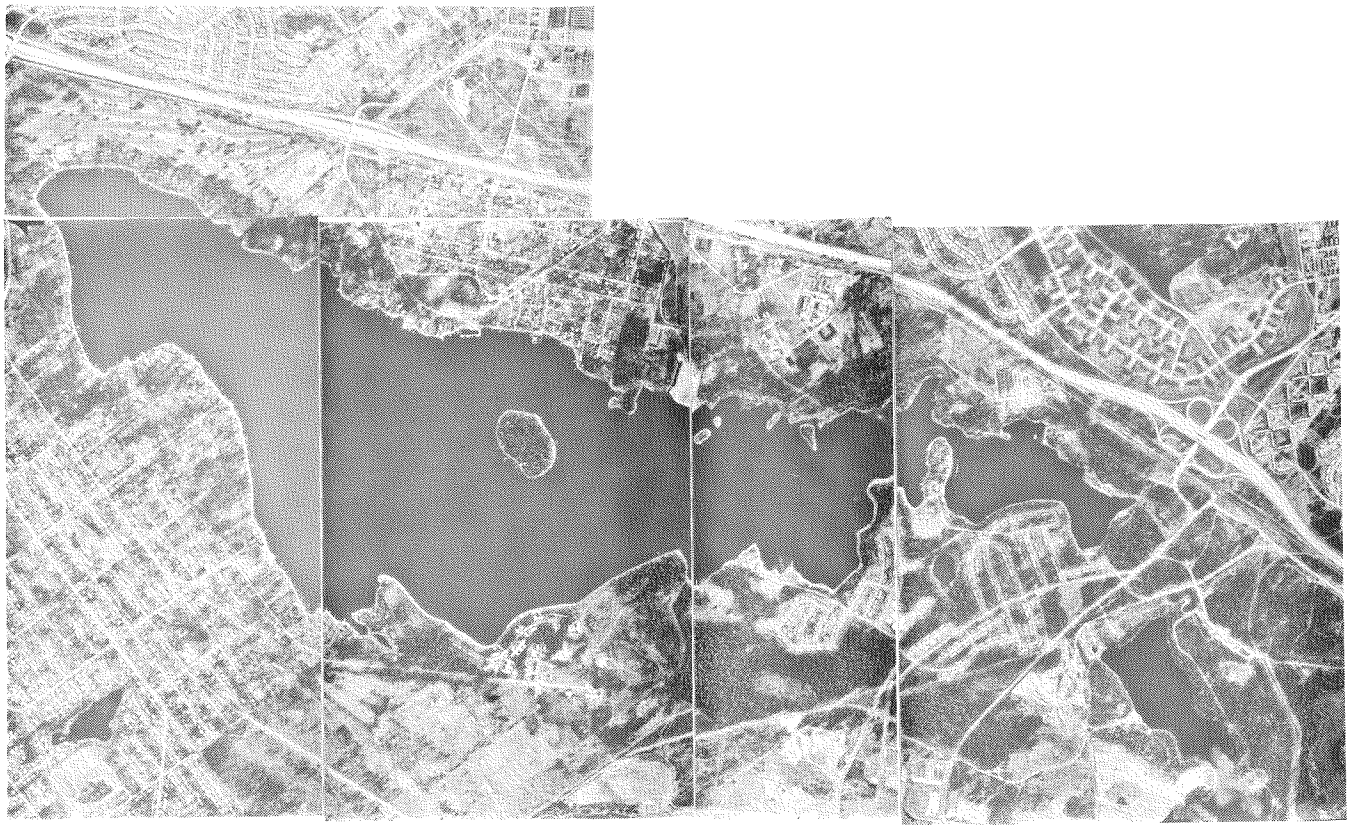
AMERICAN LAKE - PIERCE COUNTY

American Lake is the largest lake in Pierce County. It is 3.5 miles long, covers 1,100 acres, and drains 25.4 square miles. The lake has a maximum depth of 90 feet and a mean depth of 53 feet. About 53 percent of the shoreline had been developed for residential use by 1971 (Bortleson *et al.*, 1976c). Murray Creek, the main inflow, drains through the Fort Lewis Military Reservation which borders part of the lake. Because no natural outlet exists a box culvert was installed in 1956 which overflows to Sequallitchew Creek.

Most trophic parameters indicate that American Lake is mesotrophic. The chlorophyll-*a* level for September was low. However, if the sample had been taken where the bloom occurred (9.2 meters) this parameter would have been higher, suggesting a lesser degree of water quality. The bloom algae (*Anabaena*) was later believed responsible for a toxic blue-green bloom that occurred in November and December of 1989. Lake color was blue-green. Compared to other lakes, water quality values for American Lake were mid-range. High residential development and drainage from a largely urbanized area will bear on the future water quality of this lake.

AMERICAN LAKE - PIERCE COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 7		Sept 5	
	E	H	E	H
Depth (m) (composite sample)	0,2,4	15,18,21	0,4,6	16,20,23
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.110	0.097	0.003	0.192
Ammonia (NH ₃ -N)	0.014	0.172	0.011	0.248
Total Nitrogen (TN)	0.264	0.574	0.270	0.700
Orthophosphorus (PO ₄ -P)	0.005	0.010	0.004	0.032
Total Phosphorus (TP)	0.012	0.026	0.012	0.053
Nitrogen/Phosphorus ratio (TN/TP)	22.0	22.1	22.5	13.2
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductivity (umhos/cm)	107	109	105	108
Turbidity (NTU)	0.8	-	1.3	-
Chlorophyll-a (ug/L)	2.6	-	1.3	-
Secchi-disc (m)		5.0		6.1
Fecal Coliform (#/100 mL)		1		0
Predominant Algae		-	<i>Anabaena</i> , <i>Aphanocapsa</i> , <i>Microcystis</i> , <i>Cyclotella</i> , <i>Scenedesmus</i> , <i>Oocystis</i> (9.2 m)	
Macrophytes present	not sampled			
Trophic State Index				
TSISD		37		34
TSITP		40		40
TSIChl		40		33



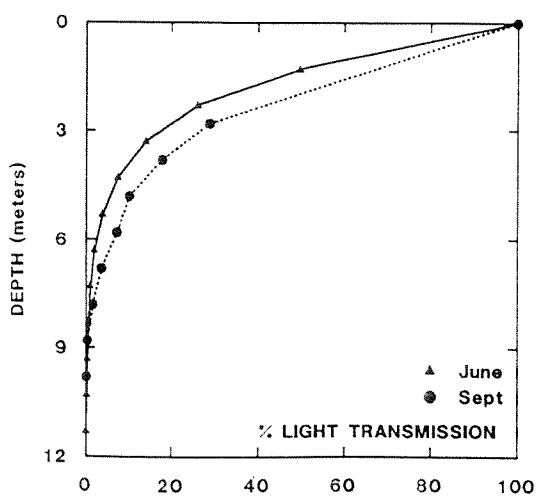
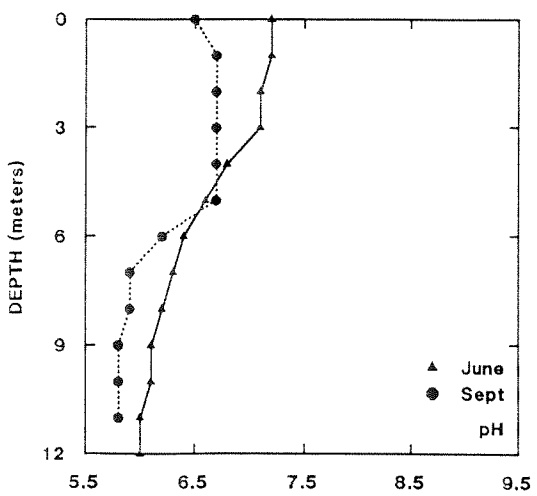
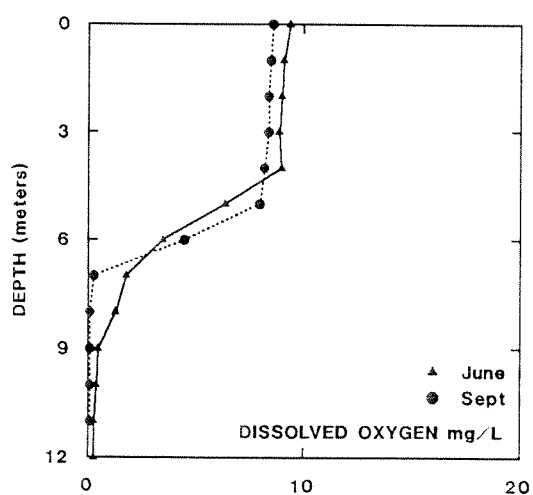
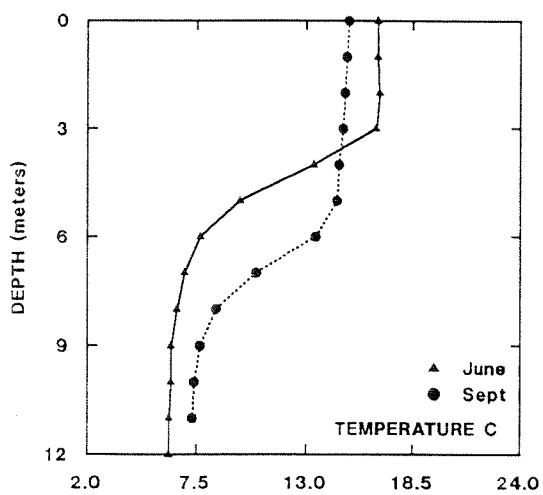
BLACK LAKE - STEVENS COUNTY

Black Lake is located 12.5 miles east of Colville, Washington. This lake covers 70 acres, drains 0.9 square mile, has a maximum depth of 45 feet and a mean depth of 27 feet. In 1974, 34 percent of the shoreline had been developed for residential use while the drainage basin remained largely forested (Dion *et al.*, 1976c). Logging and lakeshore development have increased since that time. The main inflow is from the north end of the lake.

Most trophic parameters indicate that Black Lake is oligotrophic. It was stratified and anoxic in the hypolimnion on both sampling dates. Compared to other lakes, Black Lake had low nutrient levels. Macrophytes covered 90 - 95 percent of the shoreline with scattered patches offshore. In June, the water was tea colored, presumably from humic substances in the watershed. An olive color was noted in September.

BLACK LAKE - STEVENS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 20		Sept 19	
	E	H	E	H
Depth (m) (composite sample)	0.5,1.5,2.5	9.5,10.5,11.5	1,3,5	9,10,11
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.007	-	0.003	0.003
Ammonia (NH ₃ -N)	0.017	0.035	0.008	0.052
Total Nitrogen (TN)	0.280	0.312	0.310	0.360
Orthophosphorus (P ₀₄ -P)	0.005	0.016	-	0.018
Total Phosphorus (TP)	0.011	0.019	0.004	0.044
Nitrogen/Phosphorus ratio (TN/TP)	25.4	16.4	77.5	8.2
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductivity (umhos/cm)	38	42	39	52
Turbidity (NTU)	0.7	-	0.8	-
Chlorophyll- <i>a</i> (ug/L)	1.6	-	1.2	-
Secchi-disc (m)		3.5		5.1
Fecal Coliform (#/100 mL)		3		1
Predominant algae		-		-
Macrophytes present		<i>Elodea canadensis</i> , <i>Nitella</i> , <i>Potamogeton</i> , <i>Carex</i> , <i>Nuphar</i> , <i>Typha</i> , <i>Eleocharis</i> , <i>Equisetum</i>		
Trophic State Index				
TSISD	42		36	
TSITP	39		24	
TSIChl	35		32	



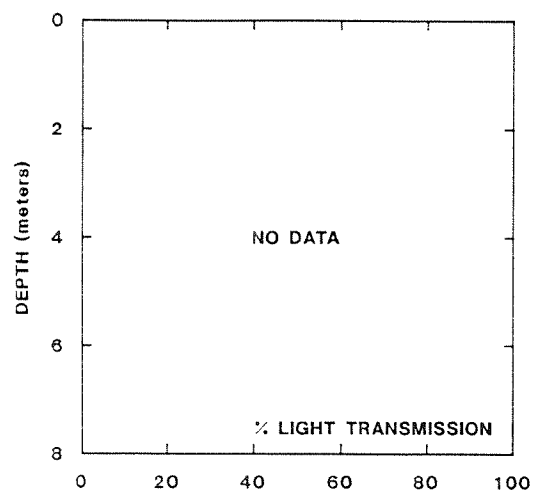
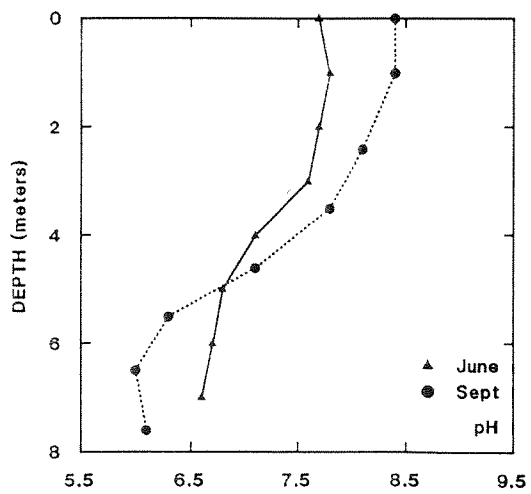
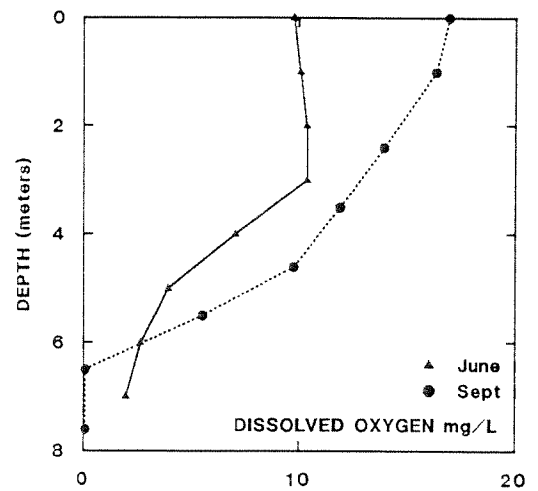
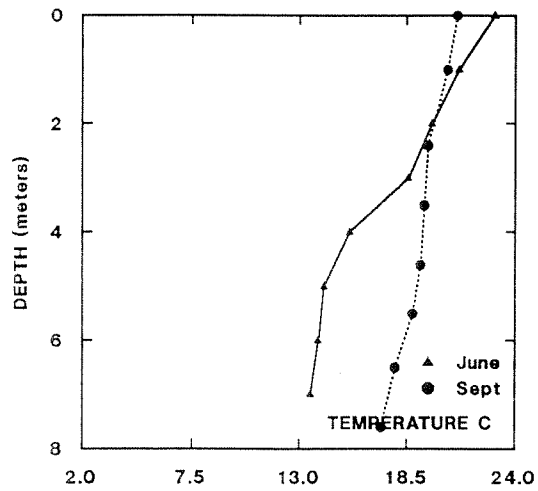
BLACK LAKE - THURSTON COUNTY

Black Lake is located approximately four miles south of Olympia, Washington. It covers 570 acres, drains 10.1 square miles, has a maximum depth of 29 feet and a mean depth of 19 feet. In 1981, lakeshore development was 85 percent and the drainage basin was 55 percent forested and 33 percent agricultural (Sumioka and Dion, 1985). The lake is fed by three tributaries, two of which drain a wetland at the southeast end.

In 1971 and 1981, Black Lake was classified as a meso-eutrophic lake (Bortleson *et al.*, 1976d; Sumioka and Dion, 1985). Increases in total nitrogen and total phosphorus since that time indicate that Black Lake may now be eutrophic. However, June TSI values for Secchi-disc and total phosphorus are inconsistent with this rating. Still, Carlson (1977) suggests giving priority to biological parameters when determining trophic status, especially the chlorophyll-*a* index. Compared to other lakes, Black Lake had the second highest chlorophyll-*a* level and the highest turbidity in September. Private septic systems, high residential development and high recreational use may be possible sources of nutrients. Lake color was brown and "pea-green" for June and September, respectively. Historically, water has been "tea" colored, likely from humic substances in the basin.

BLACK LAKE - THURSTON COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 7		Sept 5	
	E	H	E	H
Depth (m) (composite sample)	0,0.5,1	6.5,7,7.5	1,2,3	6,7
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.104	0.153	0.003	0.003
Ammonia (NH ₃ -N)	0.003	0.065	0.005	0.168
Total Nitrogen (TN)	0.400	0.457	0.750	0.490
Orthophosphorus (PO ₄ -P)	0.012	0.020	0.011	0.075
Total Phosphorus (TP)	0.016	0.021	0.046	0.146
Nitrogen/Phosphorus ratio (TN/TP)	25.0	21.7	16.3	3.4
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	73	80	83	115
Turbidity (NTU)	1.7	-	12.5	-
Chlorophyll- <i>a</i> (ug/L)	7.6	-	56.2	-
Secchi-disc (m)	2.3		0.9	
Fecal Coliform (#/100 mL)	0		1	
Predominant Algae	<i>Sphaerocystis</i> , <i>Synedra</i>		<i>Anabaena</i> , <i>Tabellaria</i> (surface bloom)	
Macrophytes present	not sampled			
Trophic State Index				
TSISD	48		62	
TSITP	44		59	
TSIChl	50		70	



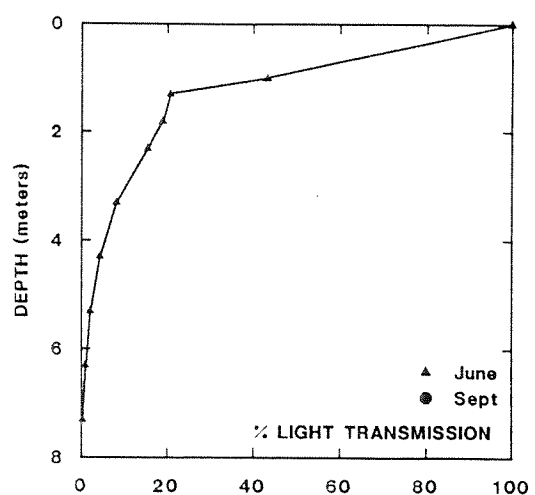
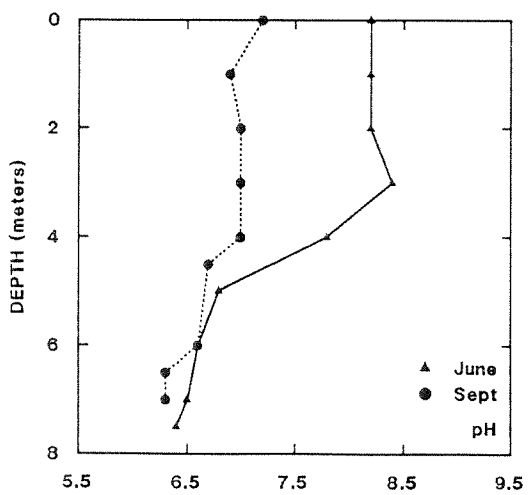
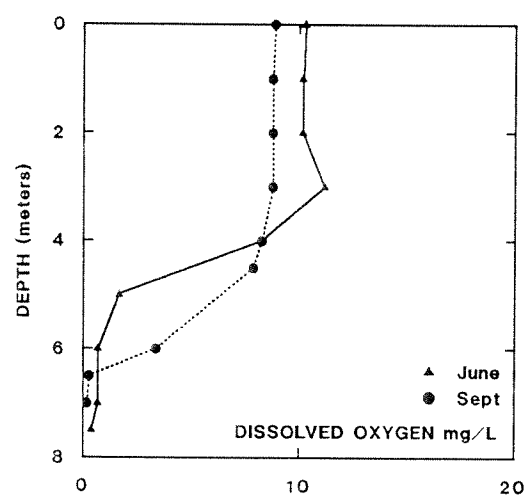
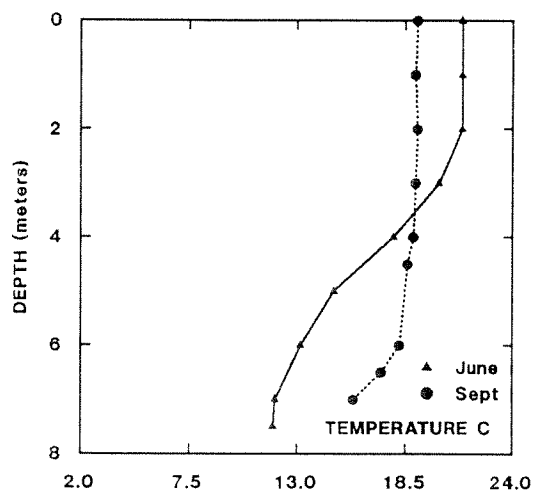
BLACKMANS LAKE - SNOHOMISH COUNTY

Blackmans Lake is located one mile north of Snohomish, Washington. It covers 57 acres, drains 0.8 square miles, has a maximum depth of 29 feet and mean depth of 14 feet. In 1981, 55 percent of the shoreline was residentially developed and 69 percent of the drainage basin was agricultural (Sumioka and Dion, 1985). A perennial stream flows into the lake from the north.

All trophic indicators show that Blackmans Lake is mesotrophic. Blackmans Lake was stratified and had anoxic conditions in the hypolimnion in both June and September. Likewise, Blackmans Lake consistently had the highest fecal coliform count of all lakes surveyed. Macrophytes cover 25 percent of the shoreline. *Nymphaea* species occur along the southeast corner and the northern perimeter. Water color was greenish-brown.

BLACKMANS LAKE - SNOHOMISH COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 26		Sept 25	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	7,7.5	0,2,4	6,6.5,7
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.036	0.048	0.003	0.003
Total Ammonia (NH ₃ -N)	0.005	0.009	0.018	0.009
Total Nitrogen (TN)	0.488	0.450	0.440	0.420
Orthophosphorus (PO ₄ -P)	0.004	0.004	0.009	0.004
Total Phosphorus (TP)	0.016	0.029	0.022	0.035
Nitrogen/Phosphorus ratio (TN/TP)	30.5	15.5	20.0	12.0
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	89	105	89	109
Turbidity (NTU)	0.7	-	1.6	-
Chlorophyll-a (ug/L)	3.3	-	3.9	-
Secchi-disc (m)	2.9		3.7	
Fecal Coliform (#/100 mL)	36		37	
Predominant Algae	-		-	
Macrophytes present	<i>Juncus</i> , <i>Nymphaea odorata</i> , <i>Potamogeton friesii</i> , <i>Nymphaea</i> sp.			
Trophic State Index				
TSISD	45		41	
TSITP	44		49	
TSIChl	42		44	



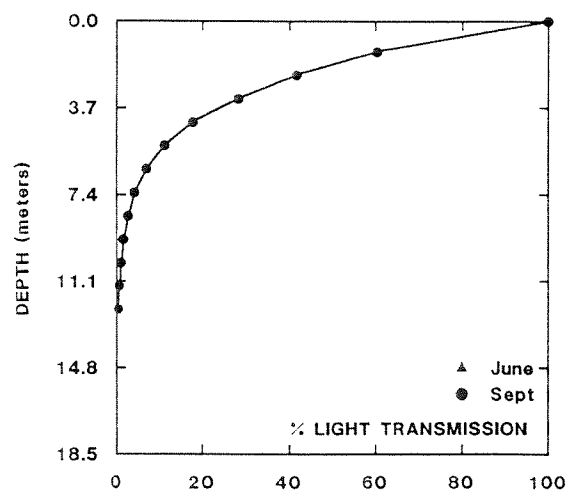
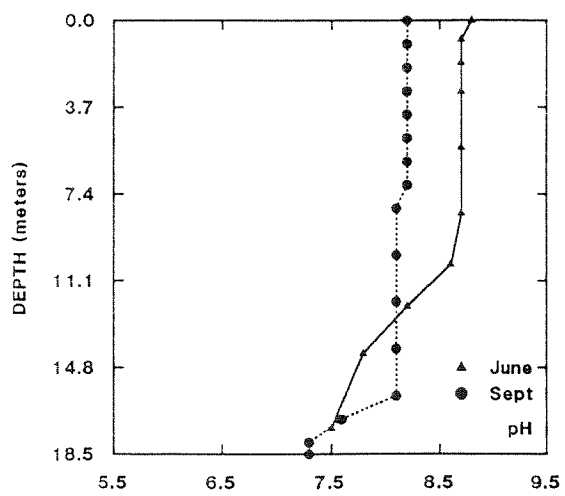
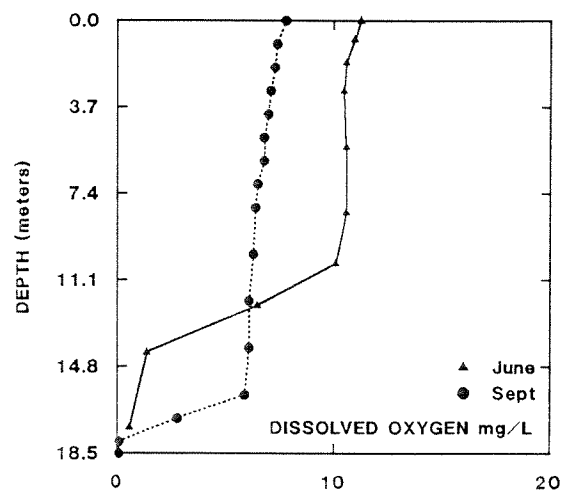
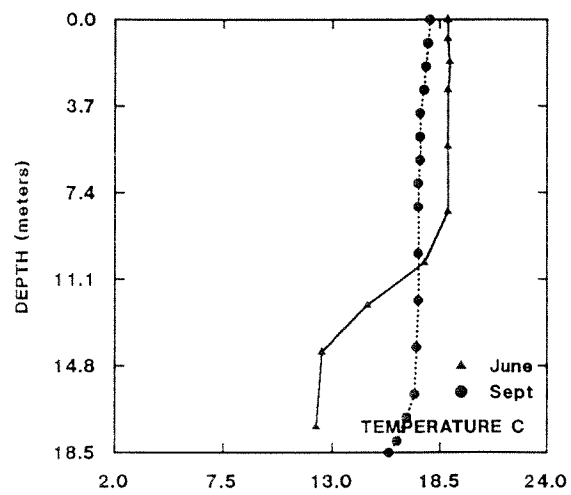
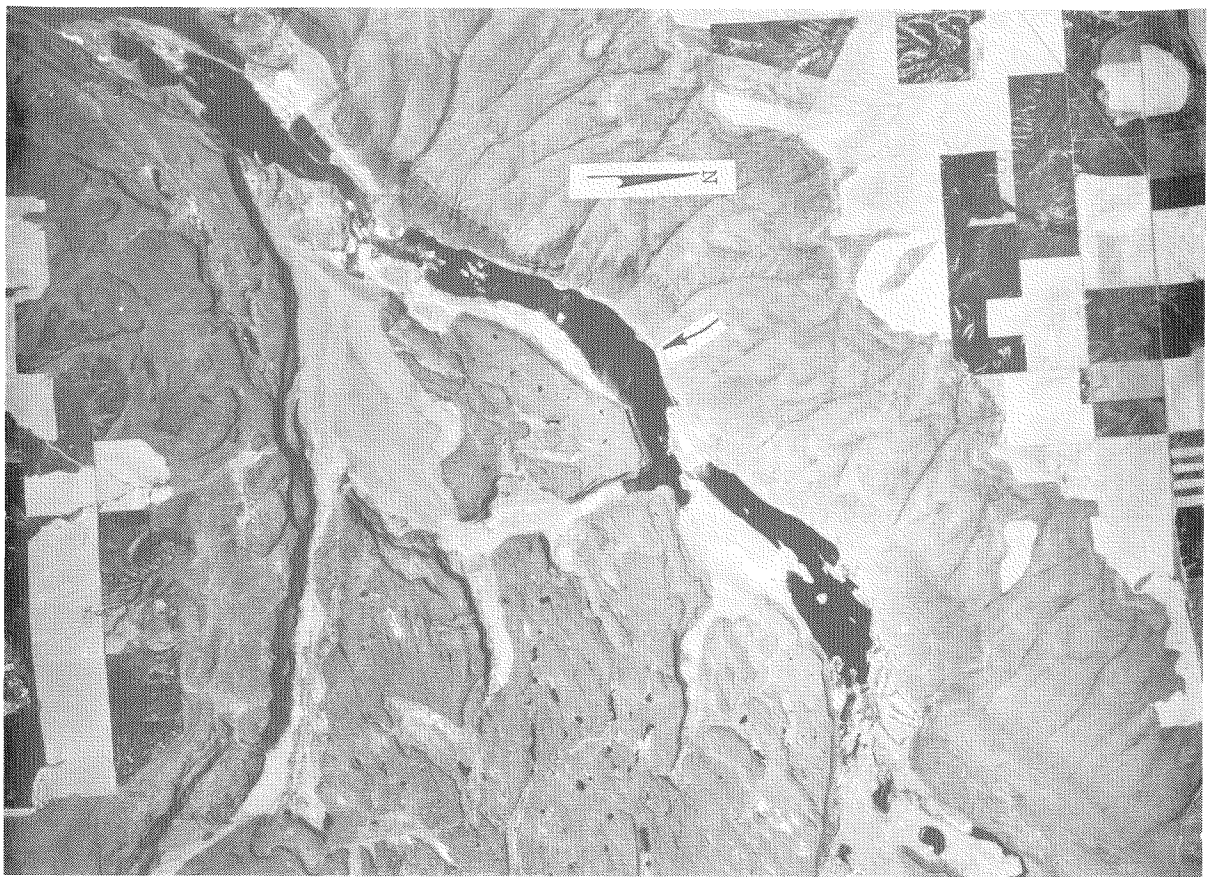
BLUE LAKE - GRANT COUNTY

Blue Lake is a natural lake in the lower Grand Coulee about 11 miles north of Soap Lake, Washington. It covers 530 acres and drains 334 square miles. It has a maximum depth of 69 feet and mean depth of 40 feet. It is fed by Park Lake via Park Lake Creek. In 1974, residences occupied 14 percent of shoreline (Dion *et al.*, 1976b). Land use information is not available.

Most parameters used to classify trophic status show that Blue Lake is mesotrophic. Blue Lake had anoxic conditions near the bottom waters in June and September. Compared to other lakes, Blue Lake had the second highest ammonia concentration (epilimnion). It also had the highest specific conductance in both June and September. A wetland exists at the south end of the lake. Animal grazing, shoreline development, high recreational use, and runoff from Highway 17 are possible sources of nutrients.

BLUE LAKE - GRANT COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 19		Sept 18	
	E	H	E	H
Depth (m) (composite sample)	1,4,7	14,16	1,7,14	16,17,18
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.009	0.007	0.003	0.003
Ammonia (NH ₃ -N)	0.029	0.045	0.049	0.224
Total Nitrogen (TN)	0.381	0.458	0.460	0.670
Orthophosphorus (PO ₄ -P)	0.005	0.011	-	-
Total Phosphorus (TP)	0.038	0.047	0.020	0.046
Nitrogen/Phosphorus ratio (TN/TP)	10.0	9.7	23.0	14.6
Alkalinity (CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	436	434	412	420
Turbidity (NTU's)	0.7	-	1.2	-
Chlorophyll-a (ug/L)	3.9		4.2	
Secchi-disc (m)		3.3		3.2
Fecal Coliform (#/100 mL)		1		0
Predominant Algae		-		-
Macrophytes present		<i>Iris pseudacorus</i>		
Trophic State Index				
TSISD		43		43
TSITP		57		47
TSIChl		44		45



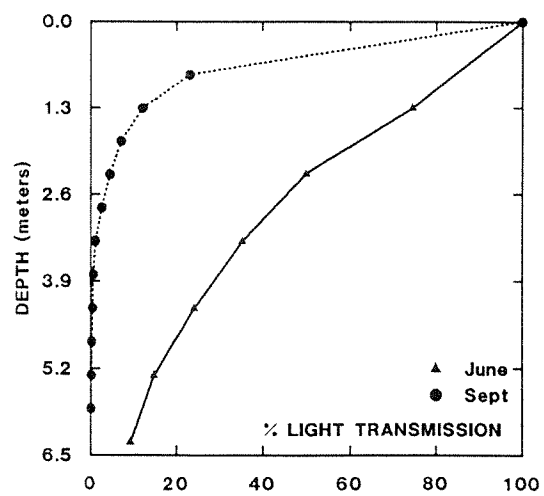
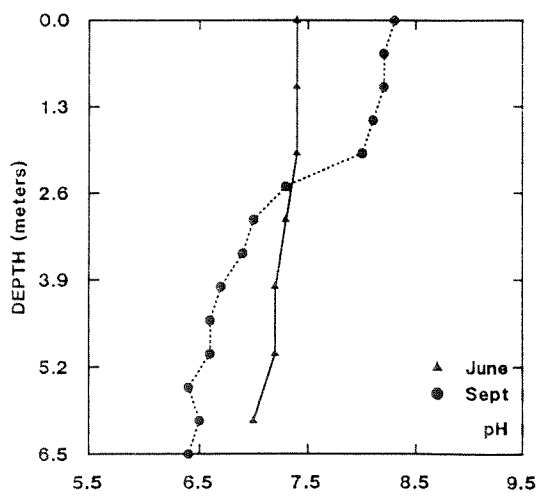
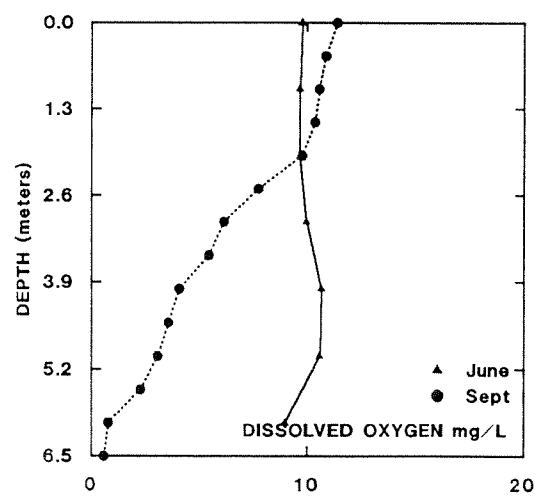
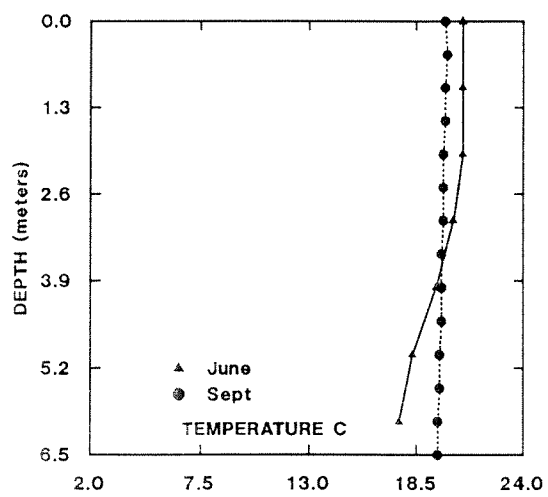
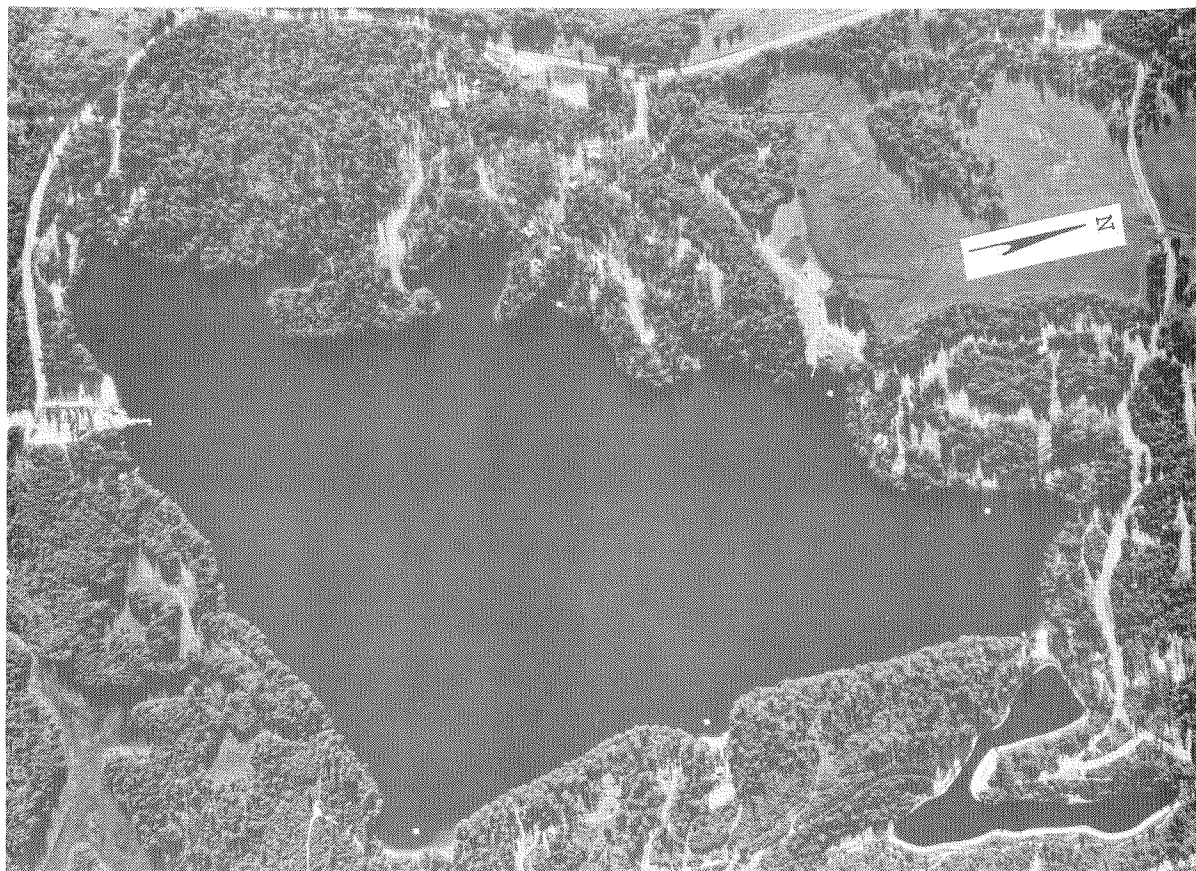
CLEAR LAKE - THURSTON COUNTY

Clear Lake is located in a forested basin ten miles southeast of Yelm, Washington. The lake covers 170 acres and drains 2.4 square miles. It has a maximum depth of 25 feet and a mean depth of 19 feet. The basin was relatively undeveloped (87%) in 1971, and only 16 percent of the shoreline was residentially developed (Bortleson *et al.*, 1976d).

Current data suggests that Clear Lake is eutrophic. All nutrients increased dramatically over the summer and anoxic conditions existed in the fall. Compared to other lakes, Clear Lake had some of the highest orthophosphorus and ammonia levels on both sampling dates. Sediment loading from logging and runoff from tree farms are possible sources of nutrients. Macrophytes are sparse. Chemical control of algae and macrophytes has occurred since the late 1960s.

CLEAR LAKE - THURSTON COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 14		Sept 13	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	5,6	0.5,2.5,4	5,6,6.5
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.003	0.029	0.064
Ammonia (NH ₃ -N)	0.059	0.020	0.059	0.306
Total Nitrogen (TN)	0.222	0.218	0.740	0.810
Orthophosphorus (P ₀₄ -P)	0.031	0.059	0.085	0.144
Total Phosphorus (TP)	0.037	0.061	0.173	0.251
Nitrogen/Phosphorus ratio (TN/TP)	6.0	3.6	4.3	3.2
Alkalinity (as CaCO ₃)	33.1	32.5	36.0	37.3
Sulfate (SO ₄)	1.9	2.0	1.4	1.3
Specific Conductance (umhos/cm)	81	81	84	88
Turbidity (NTU)	0.3	-	2.6	-
Chlorophyll-a (ug/L)	2.1	-	27.7	-
Secchi-disc (m)	6.5		1.9	
Fecal Coliform (#/100 mL)	0		1	
Predominant Algae	-		<i>Anabaena</i> (surface)	
Macrophytes present	<i>Elodea</i> , <i>Potamogeton praelongus</i> , <i>Iris pseudacorus</i>			
Trophic State Index				
TSISD	33		51	
TSITP	56		79	
TSIChl	38		63	



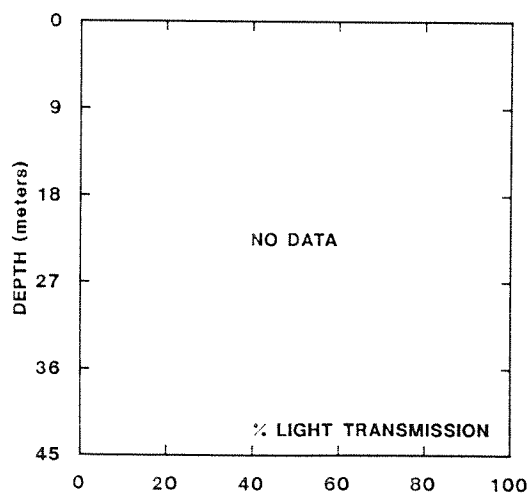
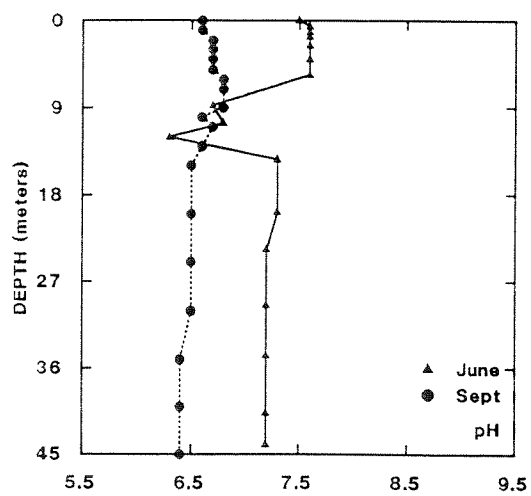
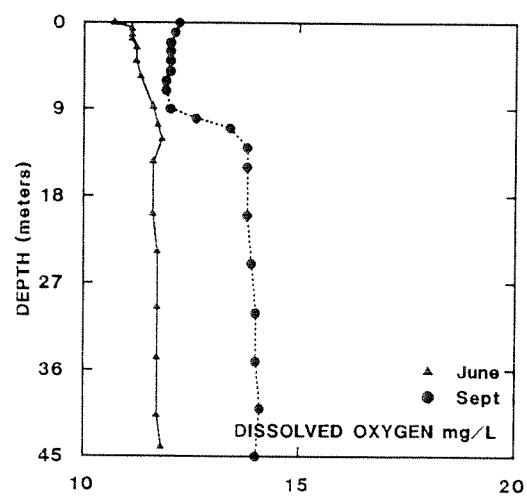
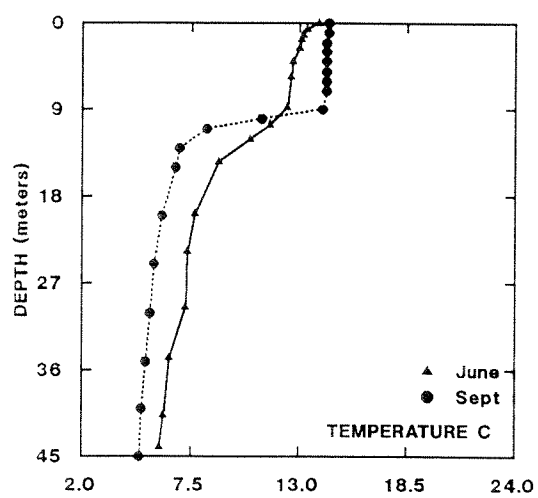
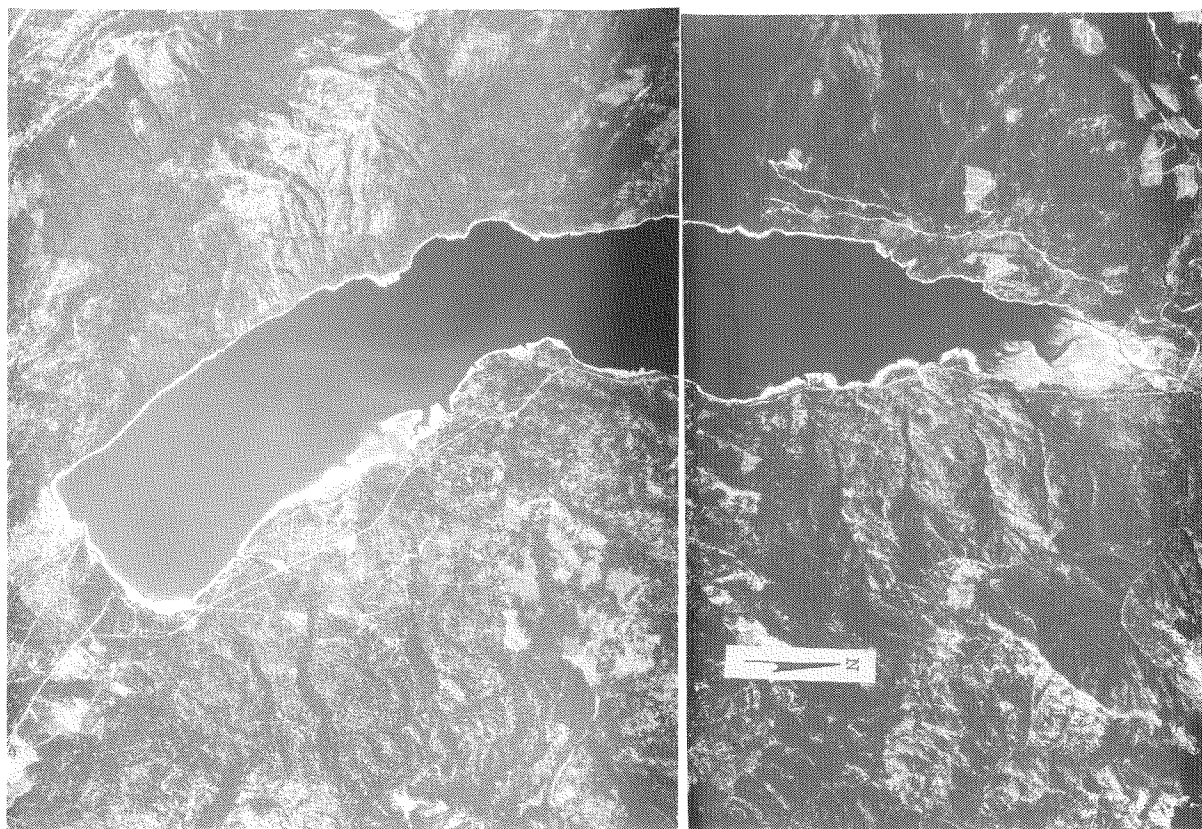
CLE ELUM LAKE - KITTITAS COUNTY

Cle Elum Lake is an artificial reservoir used for irrigation and is located 7.3 miles northwest of Cle Elum, Washington. It covers approximately 4,800 acres and drains 203 square miles. It has a maximum depth of 260 feet and a mean depth of 110 feet. As of 1974, there was little shoreline development and 96 percent of the basin was forested (Dion *et al.*, 1976a).

Cle Elum Lake is oligotrophic, yet it had a high phosphorus concentration. This lake experienced a significant increase in total phosphorus (epilimnion) from June to September, ranking second lowest in June and second highest in September. Sediment loading is a likely source of phosphorus; a fresh clearcut northeast of the lake inlet, floating wood chips, and silt from erosion were observed. Dissolved oxygen levels in June and September were supersaturated and oxygen distribution in the epilimnion in fall was largely a function of temperature. Water color was yellow-brown in June and green in September. Recreational use is high.

CLE ELUM LAKE - KITTITAS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 6		Sept 6	
	E	H	E	H
Depth (m) (composite sample)	1,4,6	25,30,35	1,4,8	15,30,45
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.014	0.003	0.039
Ammonia (NH ₃ -N)	0.012	0.003	0.006	0.007
Total Nitrogen (TN)	0.062	0.091	0.070	0.090
Orthophosphorus (PO ₄ -P)	0.007	0.006	0.008	0.006
Total Phosphorus (TP)	0.005	0.002	0.197	0.094
Nitrogen/Phosphorus ration (TN/TP)	12.4	45.5	0.4	1.0
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	51	49	50	52
Turbidity (NTU)	0.6	-	0.6	-
Chlorophyll-a (ug/L)	1.0	-	1.1	-
Secchi-disc (m)		7.8		7.2
Fecal Coliform (#/100 mL)		0		0
Predominant Algae	<i>Dinobryon</i> , <i>Synedra</i> , <i>Asterionella</i> (surface)		-	
Macrophytes present	not sampled			
Trophic State Index				
TSISD	30		32	
TSITP	27		80	
TSIChl	31		31	



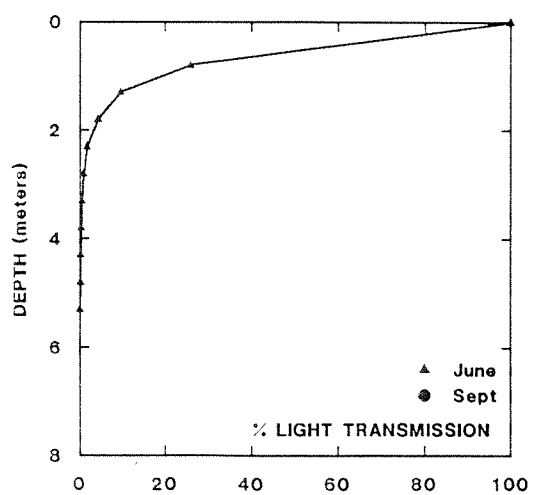
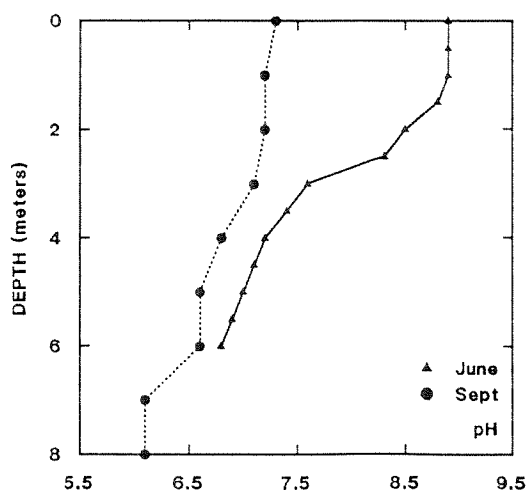
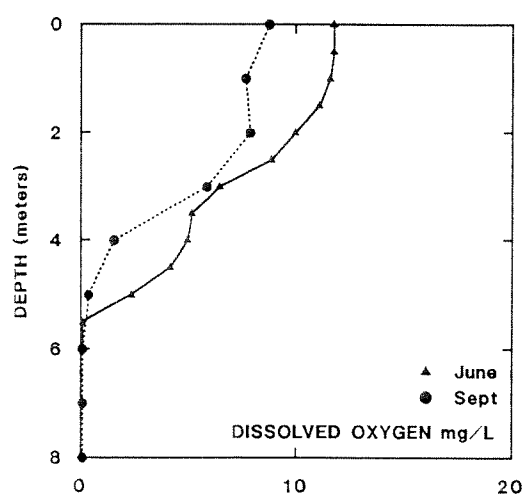
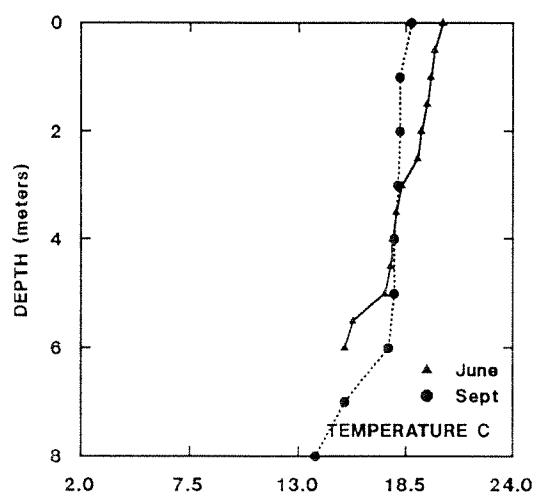
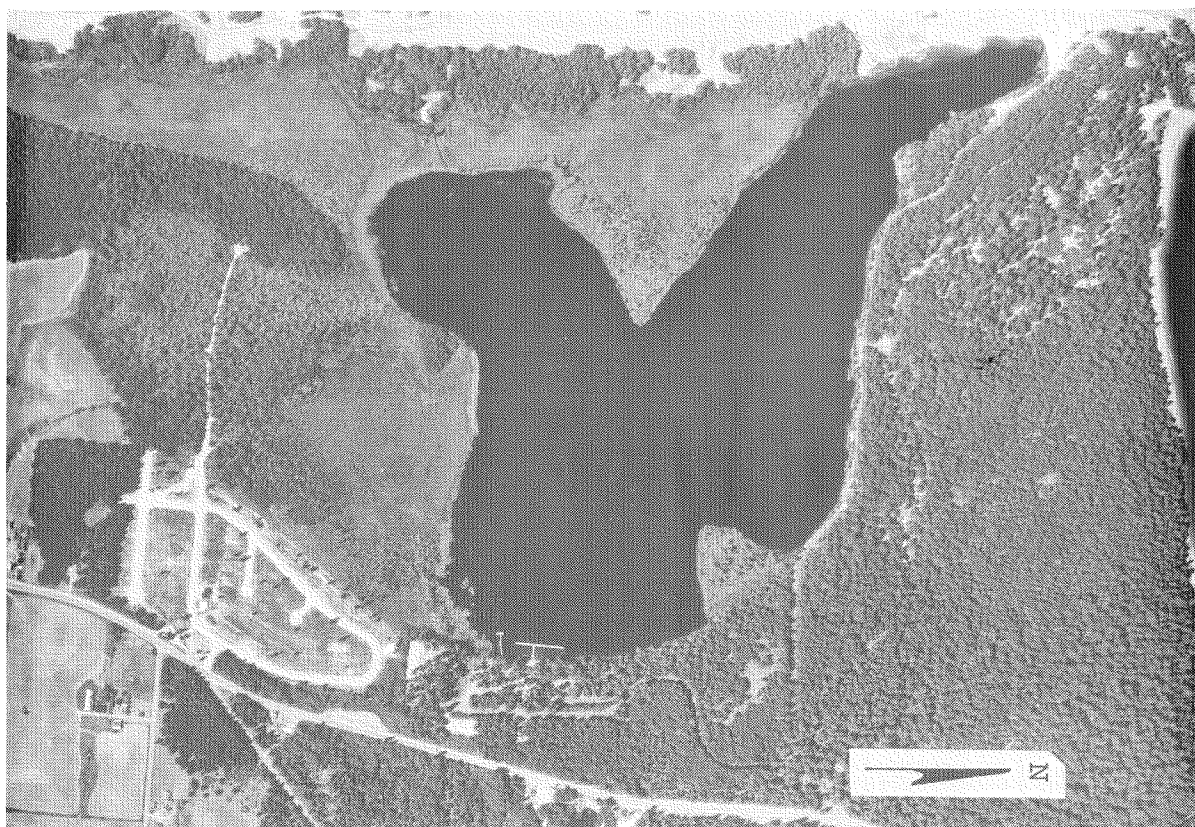
CRANBERRY LAKE - ISLAND COUNTY

Cranberry Lake is located at the north end of Whidbey Island and lies within Deception Pass State Park. It covers 130 acres and was one of the shallowest lakes studied with a maximum depth of 25 feet and a mean depth of 13 feet. As of 1981, there was no development within the drainage basin which is forested (Bortleson *et al.*, 1976a). Inflow occurs from a stream at the southwest end of the lake.

All conventional parameters indicate that Cranberry Lake is well within the eutrophic classification. June and September data show that Cranberry Lake ranked high in nutrients when compared to other lakes surveyed. Secchi-disc ranked second lowest in June and large clumps of surface algae were observed. In September a "rotting hay" odor was noted, water color was yellow-brown due to organics, and anoxic conditions occurred below four meters. A large wetland exists on the southern half of Cranberry Lake. Water lilies line the northern perimeter. This lake typifies the condition of a lake in the advanced stages of natural eutrophication, although human impacts may be accelerating this process. Compared to total nitrogen and phosphorus levels from a 1981 study (Sumioka and Dion, 1985), water quality in Cranberry Lake appears to be deteriorating.

CRANBERRY LAKE - ISLAND COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 27		Sept 26	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	5.5,6	1,3,6	7,8
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.003	0.003	0.003
Ammonia (NH ₃ -N)	0.005	0.204	0.035	3.272
Total Nitrogen (TN)	1.154	1.081	1.160	5.915
Orthophosphorus (PO ₄ -P)	0.007	0.051	0.021	1.210
Total Phosphorus (TP)	0.059	0.131	0.107	1.362
Nitrogen/Phosphorus ratio (TN/TP)	19.6	18.3	10.8	4.3
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	281	287	282	346
Turbidity (NTU)	1.6		-	6.4
Chlorophyll-a (ug/L)	30.0		-	16.8
Secchi-disc (m)		1.1		1.4
Fecal Coliform (#/100 mL)		7		2
Predominant Algae	Cladophora, Rhizoclonium , Aphanizomenon , Lyngbia , Fragillaria (surface)		-	
Macrophytes present	Eleocharis, Juncus, Myriophyllum exalbescens			
Trophic State Index				
TSISD	59		55	
TSITP	63		72	
TSICl	64		58	



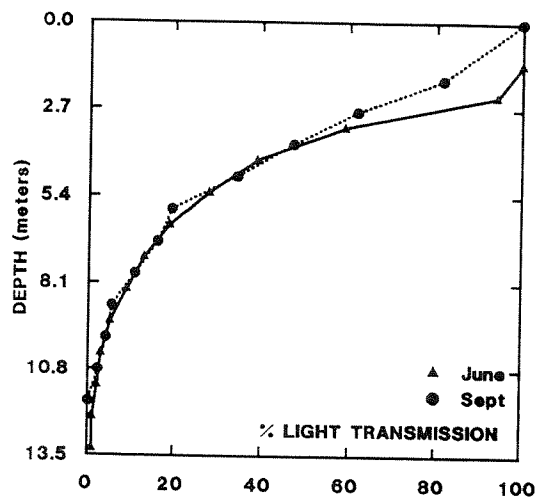
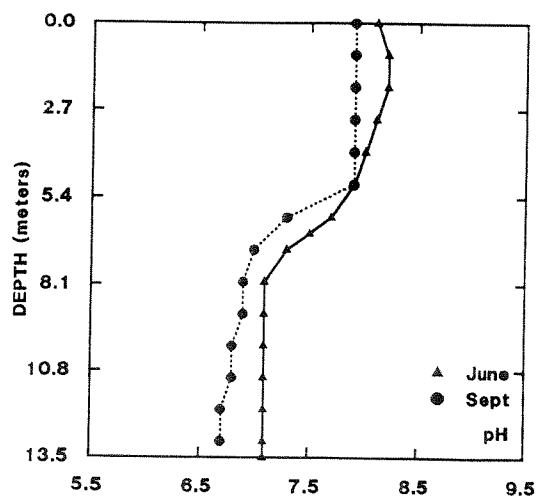
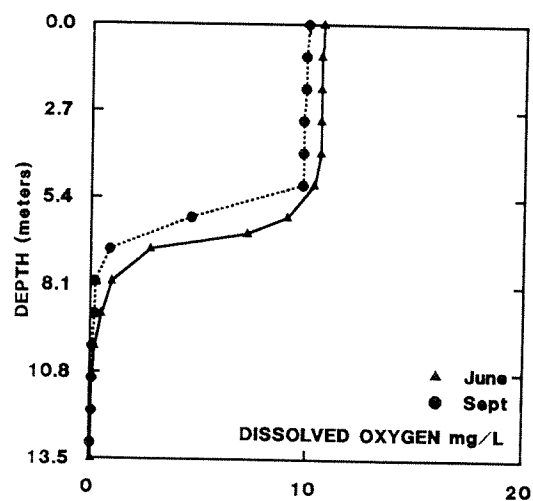
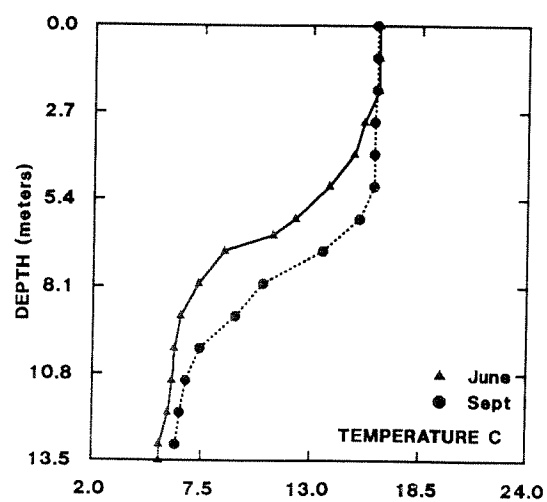
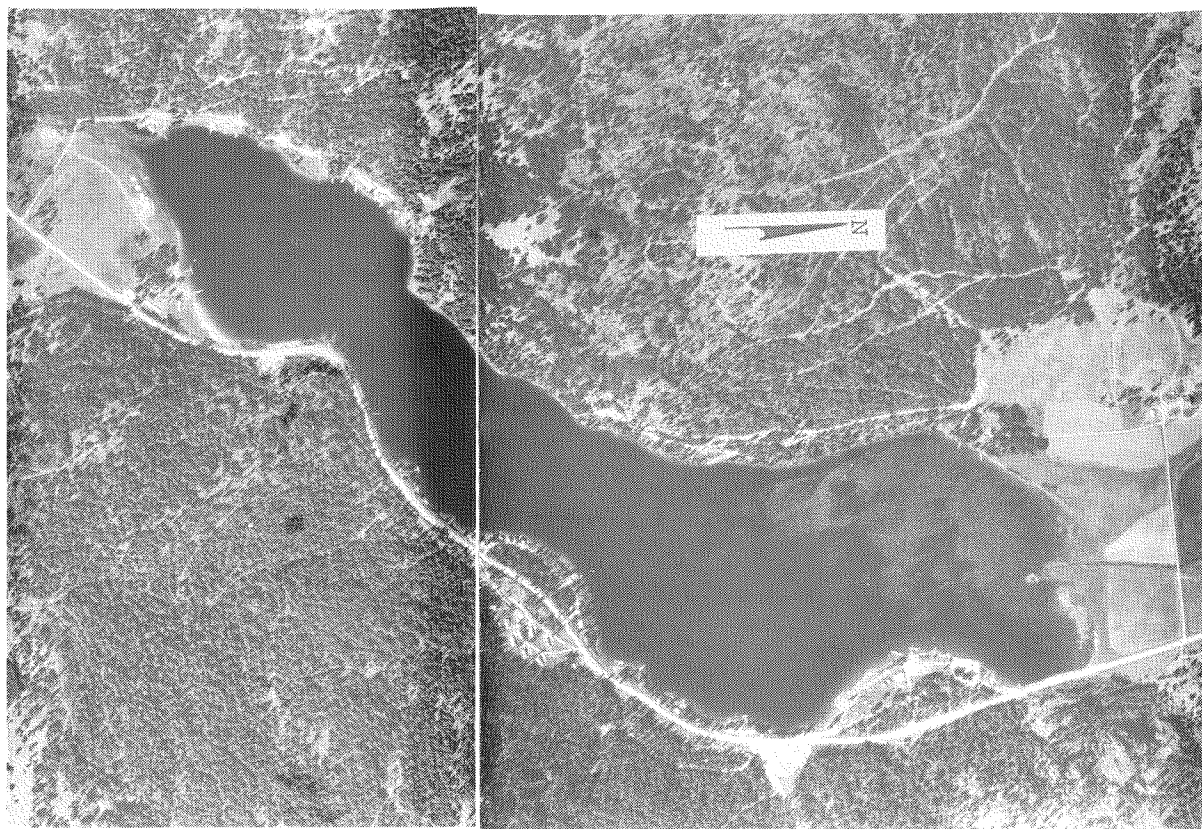
DEEP LAKE - STEVENS COUNTY

Deep Lake is an enlargement of North Fork Deep Creek and is located 25 miles northeast of Colville, Washington. It covers 210 acres, drains 48.1 square miles, has a maximum depth of 49 feet and a mean depth of 34 feet. As of 1974, 48 percent of the shoreline was residentially developed, with 96 percent of the basin forested and 3 percent agricultural (Dion *et al.*, 1976c).

Biological trophic parameters indicate that Deep Lake is mesotrophic. Although secchi-disc readings were in the oligotrophic range, chlorophyll-*a* values are more accurate indicators of trophic status in summer months (Carlson, 1977). Compared to other lakes, it had the widest range in surface to bottom specific conductance. Cation and anion samples were collected in the fall to ascertain the ionic source of increased conductivity. Values are listed in Appendix C. All anions except chloride increased from 20 to 100 percent from epilimnion to hypolimnion. Cation data cannot be interpreted due to lack of hypolimnetic data. Deep Lake had the first and second highest ammonia level (hypolimnion) in spring and fall, respectively. Anoxia occurred in the hypolimnion in June and September and the smell of hydrogen sulfide was detected in the fall. A surface bloom of *Anabaena* was observed in September.

DEEP LAKE - STEVENS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 20		Sept 19	
	E	H	E	H
Depth (m) (composite sample)	0,2,4	10,11.5,13	1,3,5	11,12,13
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.009	0.105	0.003	0.003
Ammonia (NH ₃ -N)	0.014	0.215	0.008	0.338
Total Nitrogen (TN)	0.151	0.773	0.280	1.000
Orthophosphorus (PO ₄ -P)	0.008	0.043	0.012	0.136
Total Phosphorus (TP)	0.013	0.056	0.012	0.175
Nitrogen/Phosphorus ratio (TN/TP)	11.6	13.8	23.3	5.7
Alkalinity (as CaCO ₃)	-	-	147	186
Sulfate (SO ₄)	-	-	16.3	31.8
Specific Conductance (umhos/cm)	294	396	284	379
Turbidity (NTU)	0.6	-	1.3	-
Chlorophyll-a (ug/L)	2.6	-	3.4	-
Secchi-disc (m)		5.0		5.5
Fecal Coliform (#/100 mL)		-		1
Predominant Algae		-	<i>Anabaena</i> , <i>Dinobryon</i> , <i>Asterionella</i> (surface)	
Macrophytes present		<i>Lemna trisulca</i> , <i>Scirpus</i> , <i>Equisetum</i> , <i>Potamogeton nodosus</i> , <i>Myriophyllum exalbescens</i> , <i>Ranunculus subrigidus</i> , <i>Chara</i>		
Trophic State Index				
TSISD		37		35
TSITP		41		40
TSIChl		40		43



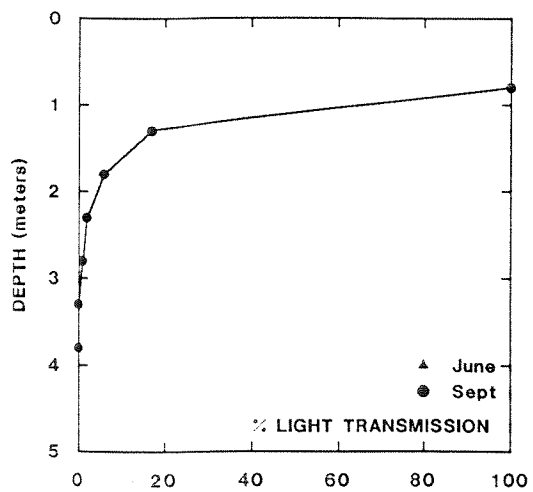
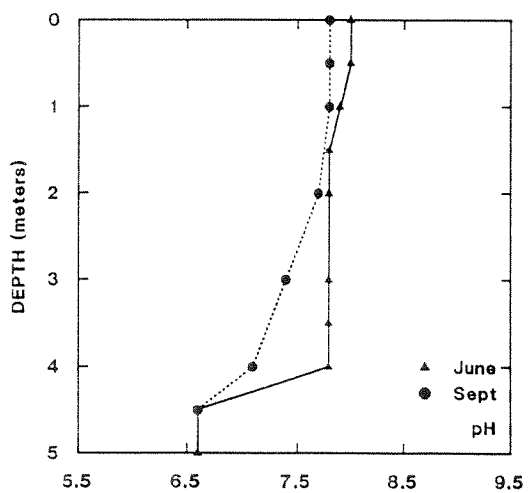
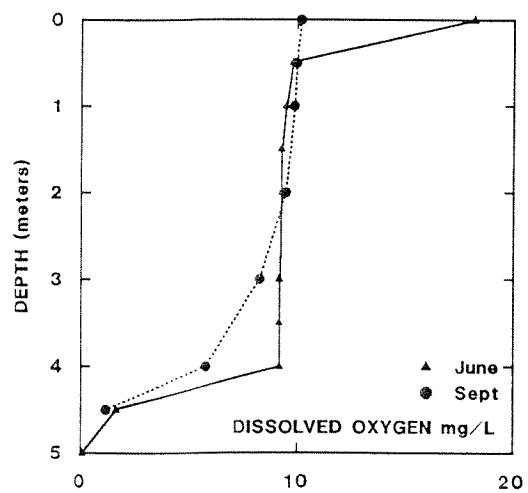
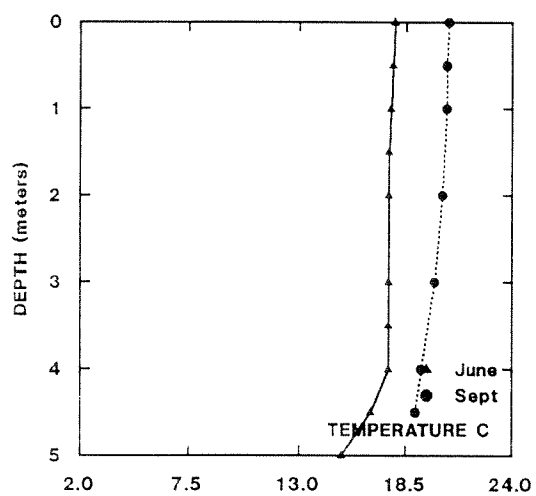
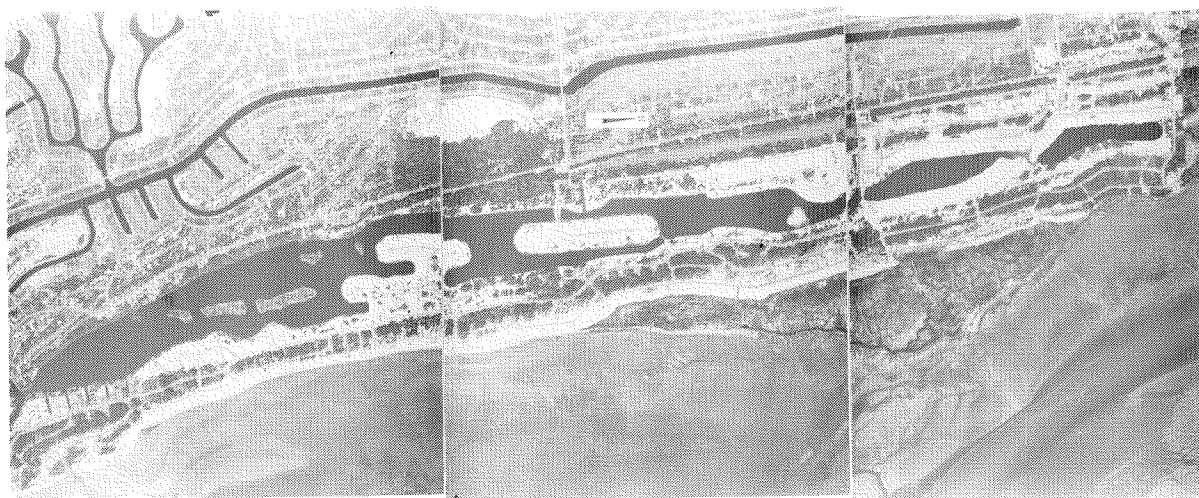
DUCK LAKE - GRAYS HARBOR COUNTY

Duck Lake is located on a peninsula directly southeast of Ocean Shores, Washington. Once a wetland, the lake has been extensively dredged and filled for residential and recreational development. This lake covers 280 acres, drains 1.4 square miles and has numerous islands and peninsulas (Bortleson *et al.*, 1976d). Although it is a relatively large lake, the maximum depth is only 30 feet and the mean depth is 11 feet. It is 10 feet above sea level. The shoreline is approximately 45 percent residentially developed.

All parameters fell within the eutrophic classification for Duck Lake. Compared to other lakes, Duck Lake had some of the highest nutrient concentrations and had the lowest Secchi-disc readings. Dense algal blooms at the surface coincided with anoxic conditions near the bottom during both months. Nuphar covers much of the shoreline. Chemicals have been used for the last three years to control macrophytes. Once a naturally eutrophic lake, it remains eutrophic despite treatment. High development, lack of public sewers, sandy soils, and dense macrophyte coverage suggest septic systems and runoff as possible sources of nutrient loading.

DUCK LAKE - GRAYS HARBOR COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 14		Sept 13	
	E	H	E	H
Depth (m) (composite sample)	0,1.5,3	4.5,5	1,2.5,4	-
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.003	0.003	-
Ammonia (NH ₃ -N)	0.050	0.111	0.004	-
Total Nitrogen (TN)	1.071	1.032	0.970	-
Orthophosphorus (PO ₄ -P)	0.040	0.049	0.012	-
Total Phosphorus (TP)	0.081	0.081	0.091	-
Nitrogen/Phosphorus ratio (TN/TP)	13.2	12.7	10.6	
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	177	217	181	-
Turbidity (NTU)	9.0	-	8.9	
Chlorophyll-a (ug/L)	42.7		30.2	
Secchi-disc (m)		0.5		0.5
Fecal Coliform (#/100 mL)		4		2
Predominant Algae	<i>Oscillatoria</i> , <i>Anabaena</i> , <i>Melosira</i> , <i>Pandorina</i> , <i>Lyngbia</i> , <i>Euglena</i>		<i>Oscillatoria</i> , <i>Anabaena</i> (surface)	
Macrophytes present	<i>Nuphar polysepalum</i> , <i>Potamogeton</i>			
Trophic State Index				
TSISD	70		70	
TSITP	68		69	
TSIChl	67		64	



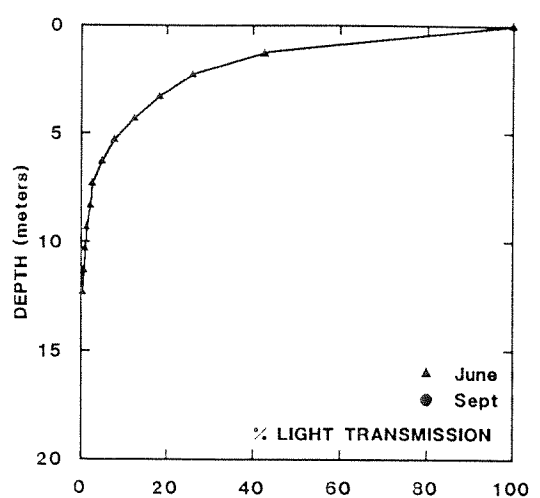
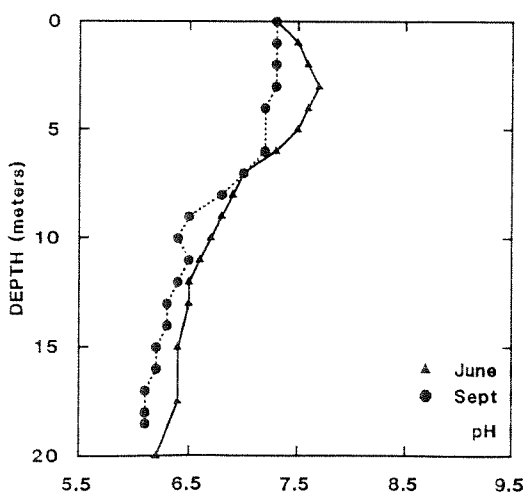
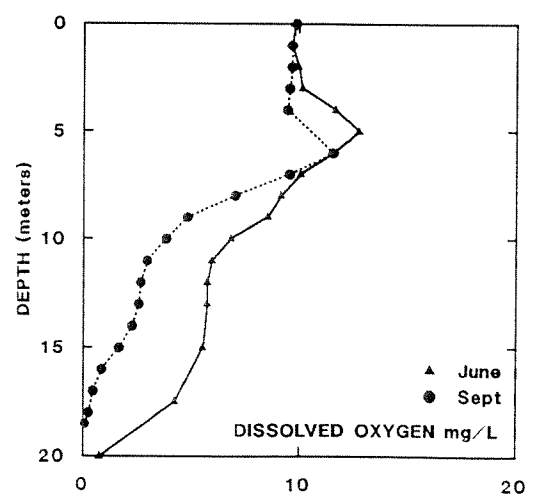
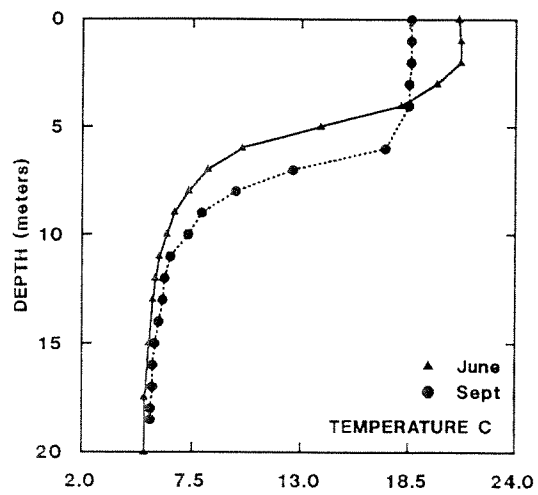
GOSS LAKE - ISLAND COUNTY

Goss Lake is located on Whidbey Island, three miles west of Langley, Washington. It was the smallest lake studied, covering only 47 acres and draining 1.4 square miles. It has a maximum depth of 60 feet and a mean depth of 32 feet. Over 90 percent of the shoreline is currently residentially developed. In 1973, 90 percent of the drainage basin was forested (Sumioka and Dion, 1985). Three intermittent streams contribute minor inflow early in the year. There is no outlet.

All trophic parameters indicate that Goss Lake is oligotrophic. Goss stratified and had reached anoxic conditions in the hypolimnion in June. Compared to other lakes, Goss Lake had the highest transparency in the fall. Dissolved oxygen pulses in June and September were likely the result of algal photosynthesis. Sparse patches of *Typha* occurred on east and west ends of the lake; *Potamogeton* occurred on the north end. The water was "tea" colored, probably from humic materials.

GOSS LAKE - ISLAND COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 26		Sept 25	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	15,17,5,20	0,2,4	12,15,18
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.075	0.215	0.003	0.167
Ammonia (NH ₃ -N)	0.004	0.036	0.008	0.011
Total Nitrogen (TN)	0.412	0.554	0.480	0.280
Orthophosphorus (PO ₄ -P)	0.004	0.008	0.005	0.009
Total Phosphorus (TP)	0.010	0.016	0.010	0.014
Nitrogen/Phosphorus ratio (N/P)	41.2	34.6	48.0	20.0
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	132	129	129	123
Turbidity (NTU)	0.5	-	1.1	-
Chlorophyll- <i>a</i> (ug/L)	2.0	-	1.1	-
Secchi-disc (m)		4.9		8.4
Fecal Coliform (#/100 mL)		2		0
Predominant Algae	<i>Microcystis</i> , <i>Dinobryon</i> , <i>Pandorina</i> , <i>Oocystis</i> , <i>Gloeocystis</i> , <i>Quadrigula</i> (5.5m)			-
Macrophytes present	<i>Polygonum amphibium</i> , <i>Typha</i>			
Trophic State Index				
TSISD		37		29
TSITP		37		37
TSIChl		37		31



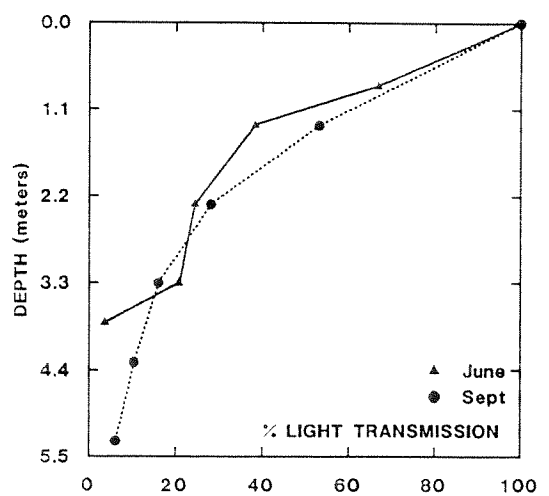
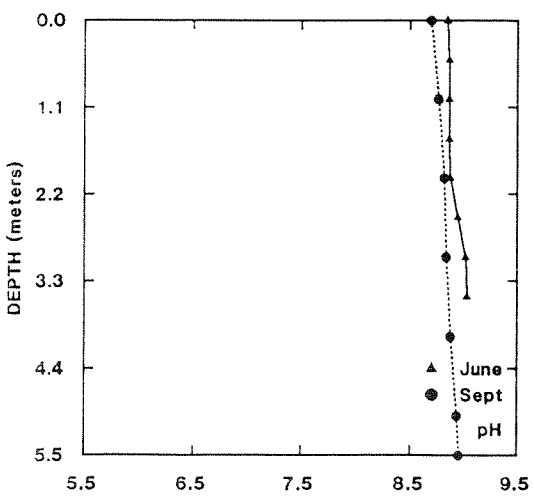
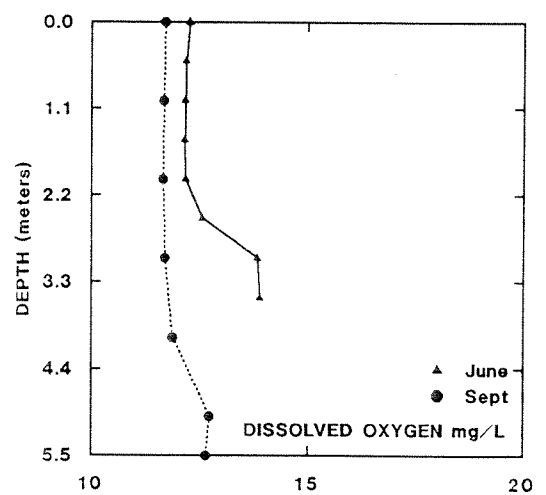
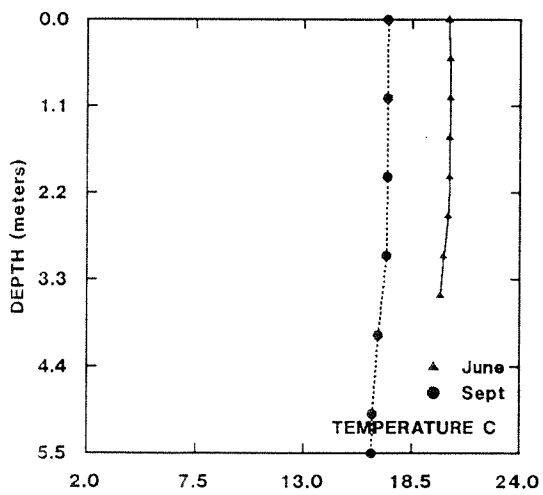
JUMPOFF JOE LAKE - STEVENS COUNTY

Jumpoff Joe Lake is located 32 miles northwest of Spokane. It covers 110 acres and drains 15.3 square miles. It is shallow for its size with a maximum depth of 25 feet and a mean depth of 13 feet. In 1974, approximately 19 percent of the shoreline was developed (Dion *et al.*, 1976c). The drainage basin was 90 percent forested and eight percent was agricultural. Perennial inflow occurs at the southern end of the lake.

All trophic parameters identify Jumpoff Joe Lake as mesotrophic. In both June and September the lake was homothermal. Compared to other lakes, all parameters fell within the middle range. The lake bottom was dominated by a dense growth of submersed macrophytes, as indicated by near-bottom dissolved oxygen pulses. *Typha* dominated 90 percent of the shoreline. Dominance of macrophytes in and around the lake suggests that Jumpoff Joe Lake could be approaching a more eutrophic state. Water color was green and recreational use is heavy.

JUMPOFF JOE LAKE - STEVENS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 20		Sept 19	
	E	H	E	H
Depth (m) (composite sample)	0,1,5,3	-	1,3,5	-
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.006	-	0.003	-
Ammonia (NH ₃ -N)	0.029	-	0.009	-
Total Nitrogen (TN)	0.289	-	0.440	-
Orthophosphorus (PO ₄ -P)	0.006	-	0.014	-
Total Phosphorus (TP)	0.013	-	0.017	-
Nitrogen/Phosphorus ratio (TN/TP)	22.2	-	25.9	-
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	209	-	197	-
Turbidity (NTU)	1.4	-	1.5	-
Chlorophyll-a (ug/L)	2.6	-	4.6	-
Secchi-disc (m)	2.6		2.2	
Fecal Coliform (#/100 mL)	0		1	
Predominant Algae	Cyclotella , Fragillaria , Asterionella (surface)		-	
Macrophytes present	Typha, Myriophyllum verticillatum, Ceratophyllum demersum, Chara, Scirpus, Potamogeton pectinatus, P. zosteriformis			
Trophic State Index				
TSISD	46		49	
TSITP	41		45	
TSIChl	40		46	



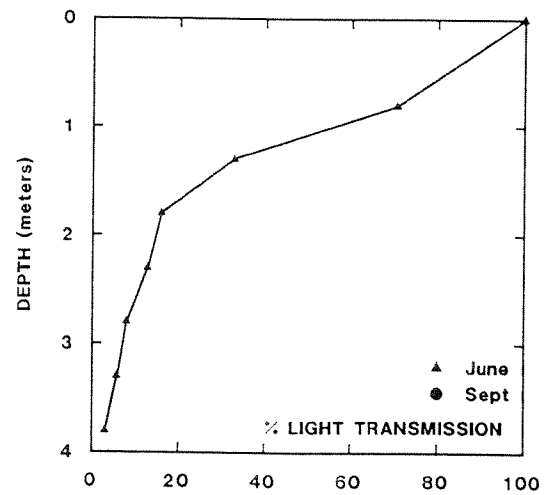
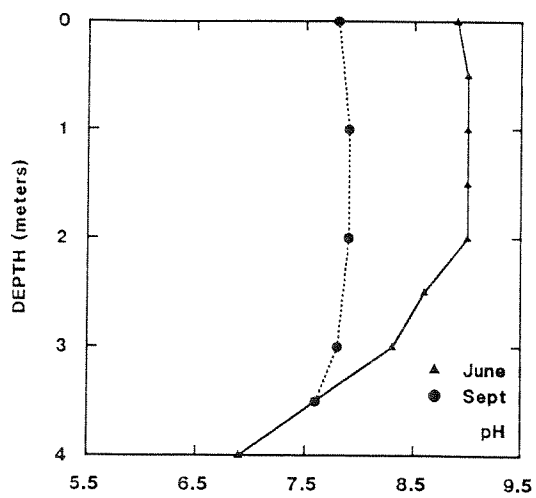
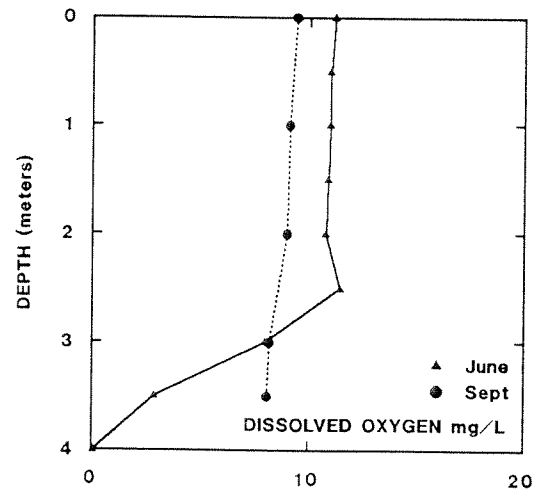
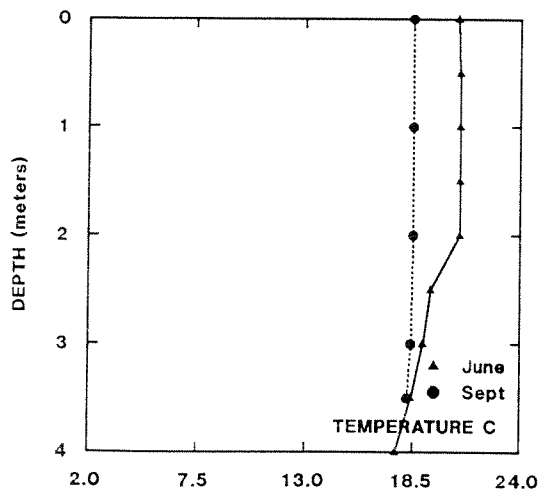
LONE LAKE - ISLAND COUNTY

Lone Lake is located on Whidbey Island, three miles southwest of Langley, Washington. It covers 100 acres and drains 2.8 square miles. It was the shallowest lake studied with a maximum depth of 17 feet and a mean depth of nine feet. In 1978, 28 percent of the shoreline was developed and the drainage basin was 77 percent forested and 17 percent agricultural (Bortleson *et al.*, 1976a). In 1989, the shoreline was 60 percent developed. Two streams flow into the lake from the northwest and northeast corners.

Based on high chlorophyll-*a* and total phosphorus values, Lone Lake falls into an eutrophic classification. Lone Lake was stratified only in June, when near-bottom waters were anoxic and a surface algal bloom was noted. Compared to other lakes, Lone Lake had the third highest total nitrogen and turbidity values in June. Water color was greenish-brown in September. Rushes dominated the northern perimeter and Nuphar the southern perimeter. Submersed macrophytes occurred around most of the shoreline and throughout other parts of the lake.

LONE LAKE - ISLAND COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 26		Sept. 25	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	-	1,2,2.5	-
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	-	0.003	-
Ammonia (NH ₃ -N)	0.009	-	0.013	-
Total Nitrogen (TN)	0.989	-	1.070	-
Orthophosphorus (P0 ₄ -P)	0.007	-	0.022	-
Total Phosphorus (TP)	0.041	-	0.061	-
Nitrogen/Phosphorus ratio (TN/TP)	24.1	-	17.5	-
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	170	-	168	-
Turbidity (NTU)	1.7	-	1.8	-
Chlorophyll-a (ug/L)	8.7	-	21.3	-
Secchi-disc (m)	2.6		4.1	
Fecal Coliform (#/100 mL)	1		0	
Predominant Algae	Aphanizomenon , Gloeocystis , Pandorina, Staurastrum , Quadrigula, Ceratium		Spirogyra	
Macrophytes present	Eleocharis, Scirpus, Nuphar polysepalum, Elodea canadensis, Ceratophyllum demersum, Potamogeton zosteriformis, P. praelongus			
Trophic State Index				
TSISD	46		40	
TSITP	58		63	
TSIChl	52		61	



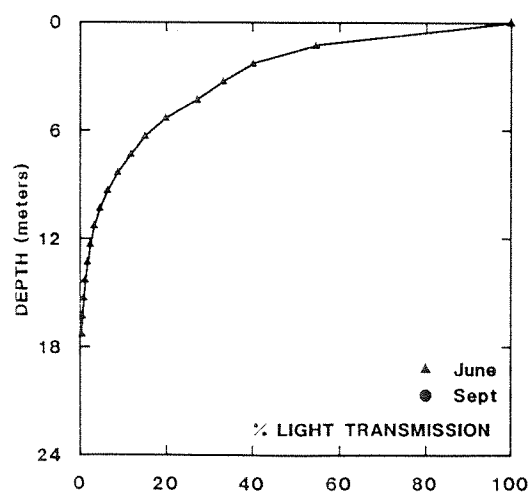
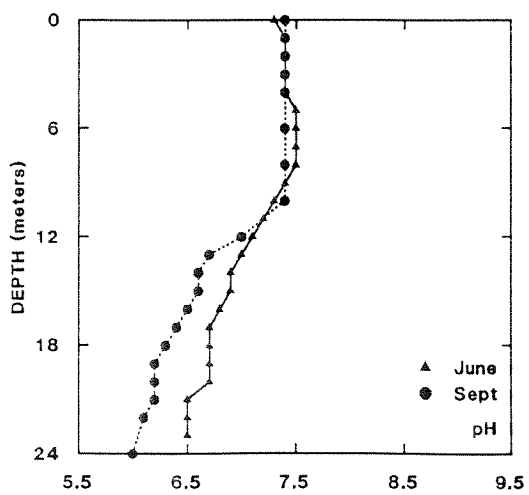
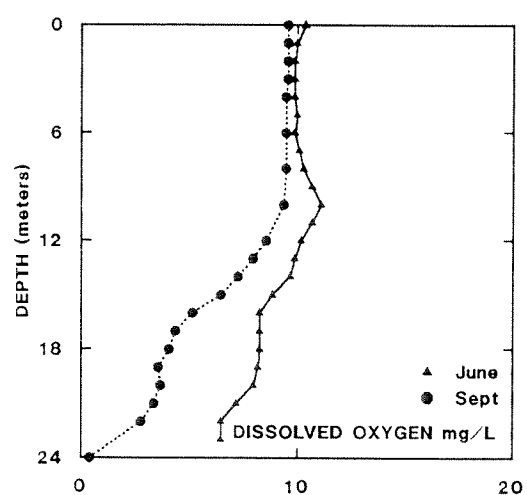
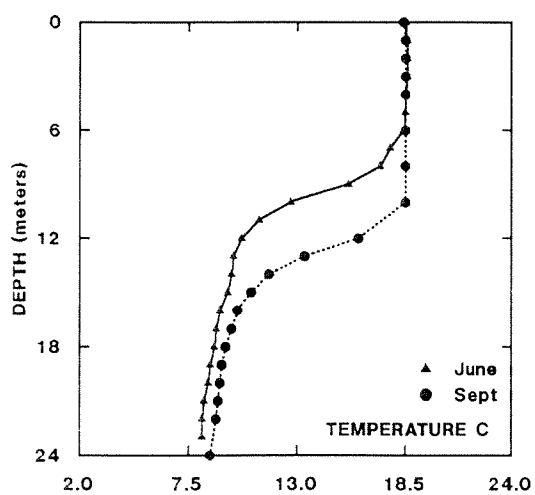
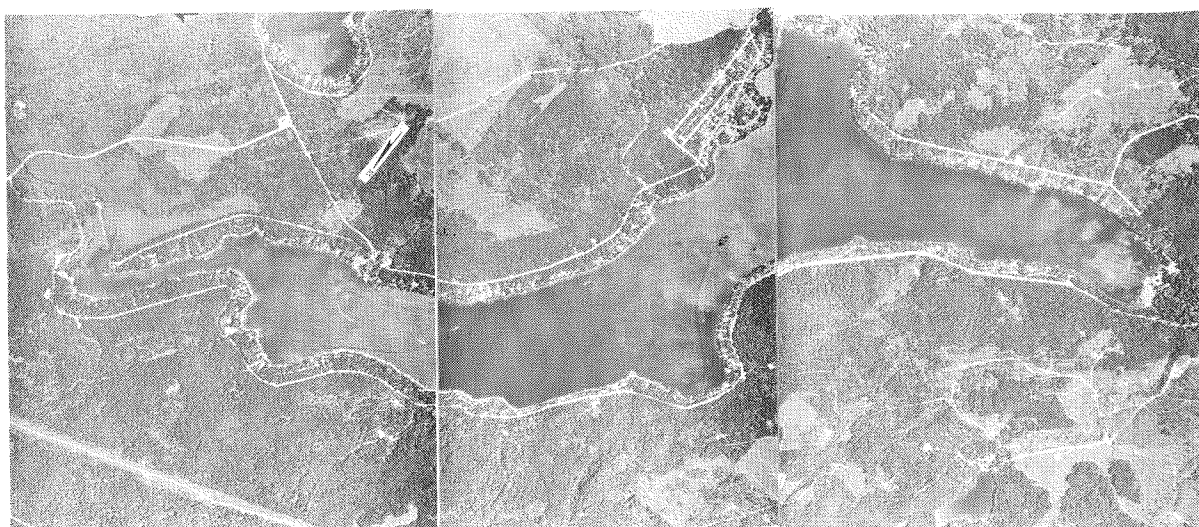
MASON LAKE - MASON COUNTY

Mason Lake, the largest and deepest lake in Mason County, is located eight miles southwest of Belfair, Washington. It covers 1,000 acres, drains 20.2 square miles, has a maximum depth of 90 feet, and a mean depth of 48 feet. The main inflow is from Shumacher Creek, which is perennial. The shoreline is 95 percent developed with approximately 640 nearshore homes. In 1981, the drainage basin was 89 percent forested and three percent was residential (Sumioka and Dion, 1985).

Based on trophic parameters, Mason Lake can be considered oligotrophic. Dissolved oxygen levels were high in the spring and anoxia occurred only in the fall. Chlorophyll-*a* levels were among the lowest observed in both the spring and fall. It also had the second lowest turbidity and second highest transparency in the spring. Macrophytes were dense around the shoreline and concentrated near development in the northern arm of the lake. Recreational use was heavy. Considering that homes are not sewered and soils are sandy, Mason Lake should continue to be monitored for signs of nutrient loading.

MASON LAKE - MASON COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 28		Sept. 27	
	E	H	E	H
Depth (m) (composite sample)	0,2.5,5	20,21.5,5	1,4,10	17,20,23.5
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.003	0.003	0.003
Ammonia (NH ₃ -N)	0.003	0.007	0.009	0.014
Total Nitrogen (TN)	0.136	0.113	0.190	0.140
Orthophosphorus (P ₀₄ -P)	0.008	0.007	0.007	0.010
Total Phosphorus (TP)	0.008	0.008	0.009	0.029
Nitrogen/Phosphorus ratio (TN/TP)	17.0	14.0	21.1	4.8
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	52	49	54	52
Turbidity (NTU's)	0.4	-	1.4	-
Chlorophyll- <i>a</i> (ug/L)	0.7	-	1.0	-
Secchi-disc (m)		7.4		6.6
Fecal Coliform (#/100 mL)		0		0
Predominant Algae		-		-
Macrophytes present		<i>Elodea canadensis</i> , <i>Potamogeton natans</i> , <i>P. gramineus</i> , <i>P. amplifolius</i> , <i>Lobelia dortmanna</i> , <i>Juncus</i> , <i>Elodea</i> <i>canadensis</i> , <i>Nitella</i> , <i>Vallesneria americana</i>		
Trophic State Index				
TSISD		31		33
TSITP		34		36
TSIChl		27		30



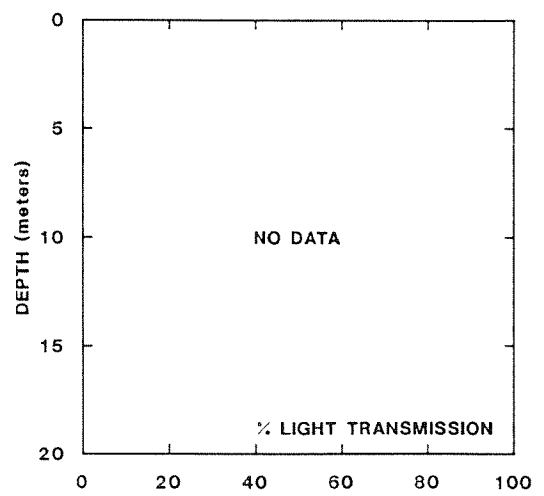
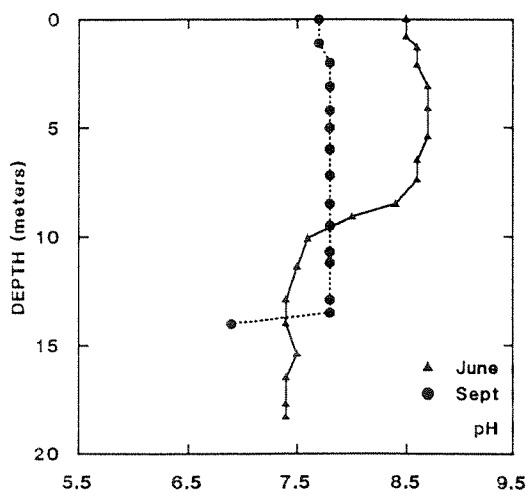
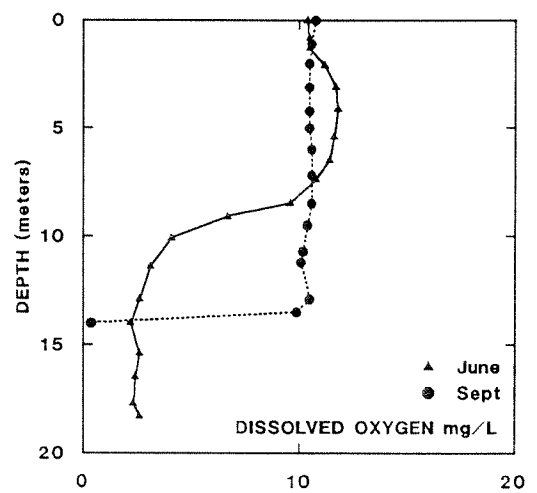
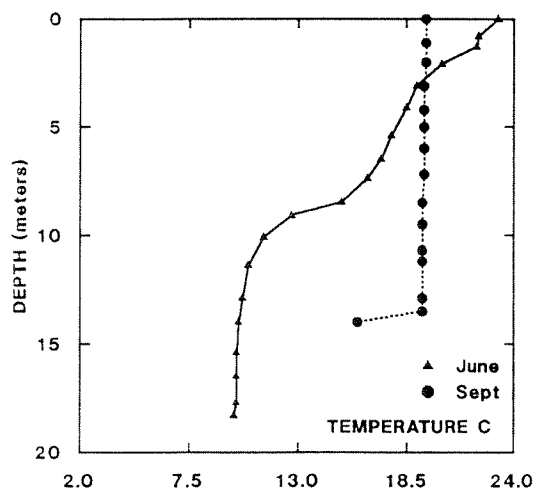
OSOYOOS LAKE - OKANOGAN COUNTY

Osoyoos Lake is located one mile north of Oroville, Washington. Sixty-five percent of Osoyoos Lake lies in Canada and 35 percent in the United States. It was the largest lake studied and covers 5,800 acres and drains 3,150 square miles. Maximum depth is 210 feet and mean depth is 86 feet (Dion *et al.*, 1976a). It is fed principally by the Okanogan River in Canada. Drainage basin land use information is not available.

Current data suggests that Osoyoos Lake is mesotrophic. A mild algal bloom occurred in the epilimnion in June. Osoyoos had begun to turn over by September, although near-bottom waters were still anoxic. Compared to all lakes, Osoyoos had the second lowest epilimnetic orthophosphorus level in the fall. All other parameters were mid-range. Approximately 60 percent of the shoreline was covered by immersed macrophytes. Fruit orchards surround the lake on the American side. Water color was green and recreational use is high. Compared to a 1981 study, total nitrogen has decreased while total phosphorus has basically stayed the same (Sumioka and Dion, 1985).

OSOYOOS LAKE - OKANOGAN COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 6		Sept. 6	
	E	H	E	H
Depth (m) (composite sample)	1,4,8	12,15,17	1,6,12	14,14.5
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.020	0.003	0.003
Ammonia (NH ₃ -N)	0.009	0.051	0.008	0.006
Total Nitrogen (TN)	0.364	0.329	0.310	0.340
Orthophosphorus (P ₀₄ -P)	0.004	0.006	0.004	0.004
Total Phosphorus (TP)	0.016	0.014	0.021	0.023
Nitrogen/Phosphorus ratio (TN/TP)	22.8	23.5	14.8	14.8
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	286	308	260	293
Turbidity (NTU)	1.2	-	2.1	-
Chlorophyll-a (ug/L)	2.3	-	6.0	-
Secchi-disc (m)		3.6		2.1
Fecal Coliform (#/100 mL)		0		0
Predominant Algae	Fragillaria , Asterionella , Dinobryon , Mougeotia Tabellaria , Gloeocystis (surface)		-	
Macrophytes present	Myriophyllum			
Trophic State Index				
TSISD	42		49	
TSITP	44		48	
TSIChl	39		48	



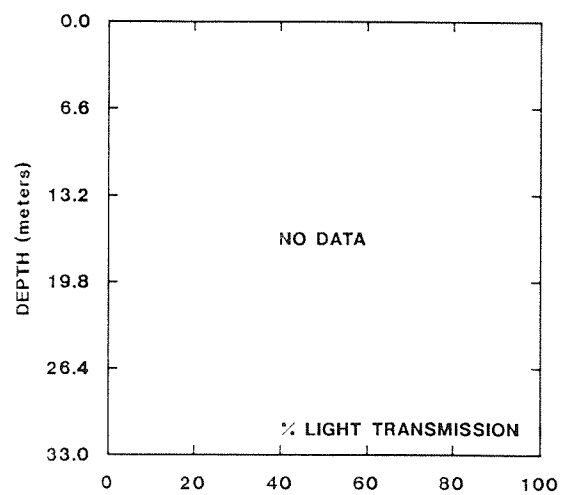
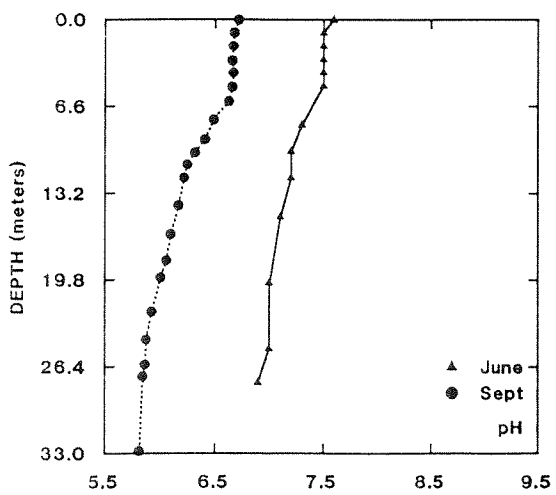
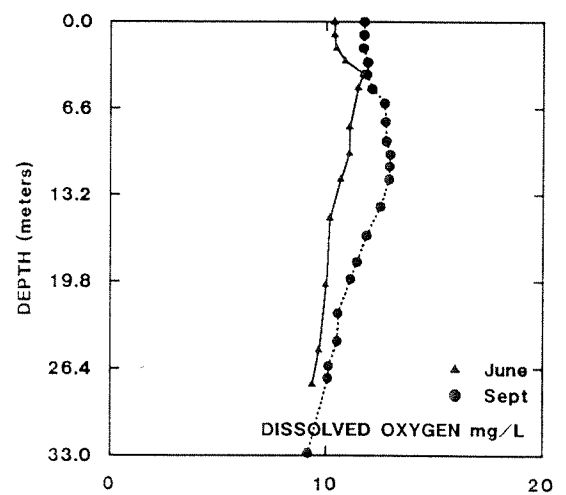
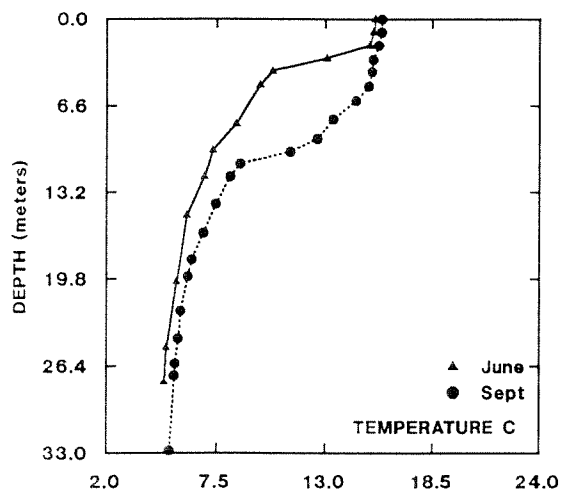
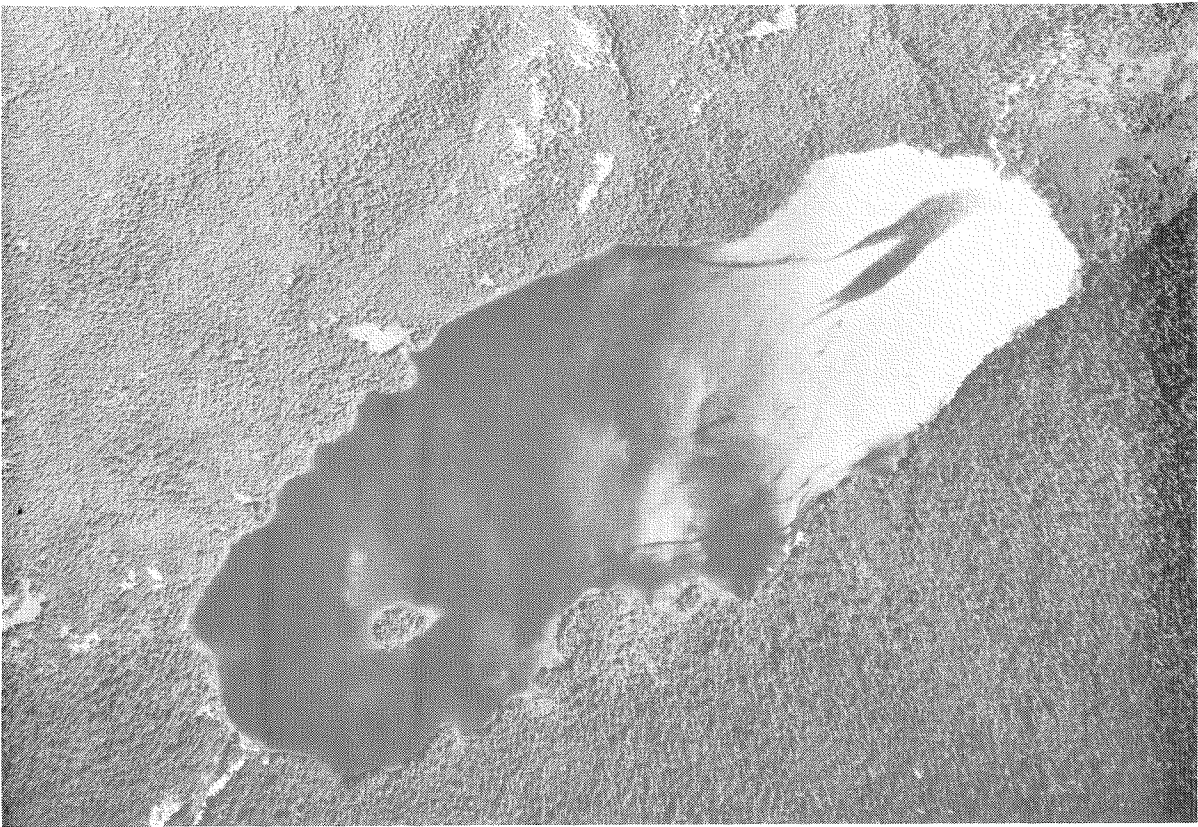
PACKWOOD LAKE - LEWIS COUNTY

Packwood Lake is located in the Gifford Pinchot National Forest due east of Packwood, Washington. It is a natural lake that has been stabilized by a dam at the outlet. It covers 400 acres, drains 19.2 square miles, has a maximum depth of 120 feet, and a mean depth of 71 feet (Bortleson *et al.*, 1976d). The main inlet, Lake Creek, enters at the southeast corner of the lake. The drainage basin is forested and has been protected by wilderness status since 1984.

Almost all trophic parameters indicated that Packwood Lake is oligotrophic. An exception was the June Secchi-disc measurement, which was estimated because of heavy winds and glacial runoff. Packwood had the second highest turbidity among all lakes due to the suspension of glacial silt, which caused the water color to be green. Compared to other lakes, Packwood Lake had some of the lowest nutrient levels throughout the summer. Increased dissolved oxygen levels in the metalimnion in both June and September may be a function of temperature stratification.

PACKWOOD LAKE - LEWIS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 7		Sept. 5	
	E	H	E	H
Depth (m) (composite sample)	1,2,3	20,25,28	0,3,5	23,27,31
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.048	0.003	-
Ammonia (NH ₃ -N)	0.004	0.014	0.004	0.008
Total Nitrogen (TN)	0.046	0.077	0.020	0.110
Orthophosphorus (P ₀₄ -P)	.007	.007	0.006	0.011
Total Phosphorus (TP)	0.012	0.008	0.009	0.014
Nitrogen/Phosphorus ratio (TN/TP)	3.8	9.6	2.2	7.9
Alkalinity (as CaCO ₃)	19.6	22.3	19.3	23.0
Sulfate (SO ₄)	3.5	3.6	3.8	3.6
Specific Conductance (umhos/cm)	52	56	51	58
Turbidity (NTU)	2.3	-	1.0	-
Chlorophyll-a (ug/L)	0.6	-	0.0	-
Secchi-disc (m)	1.5		7.1	
Fecal Coliform (#/100 mL)	0		0	
Predominant Algae	-		-	
Macrophytes present	not sampled			
Trophic State Index				
TSISD	54		32	
TSITP	40		36	
TSIChl	25		-8	



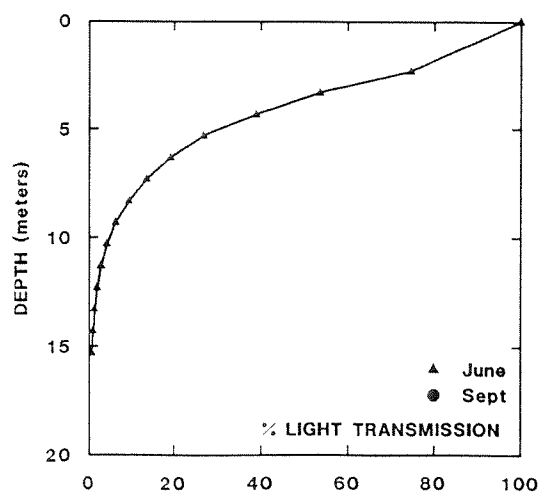
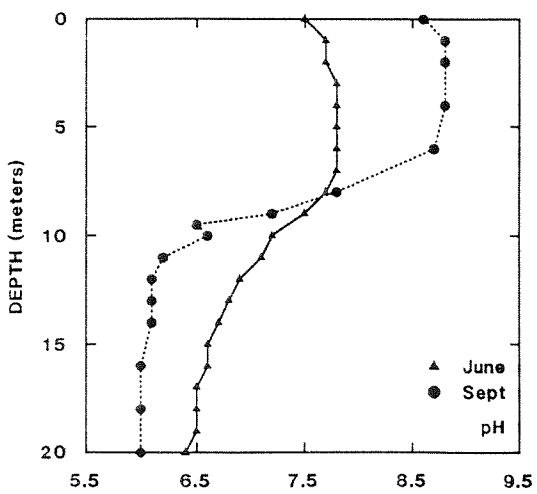
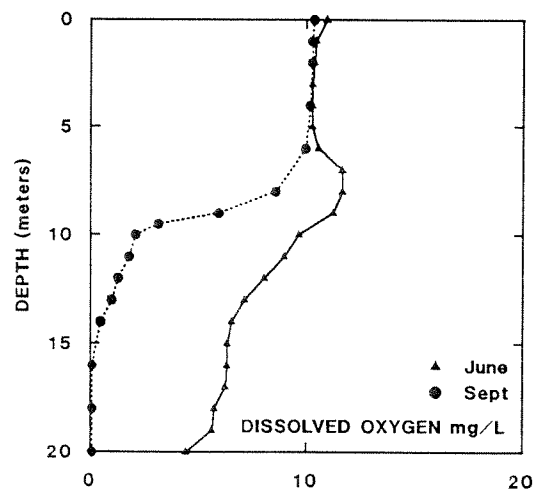
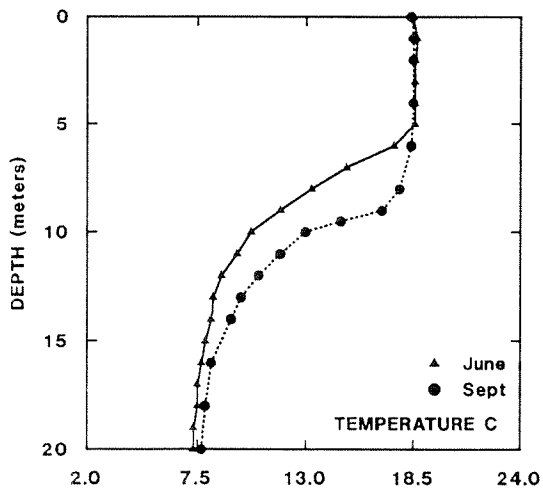
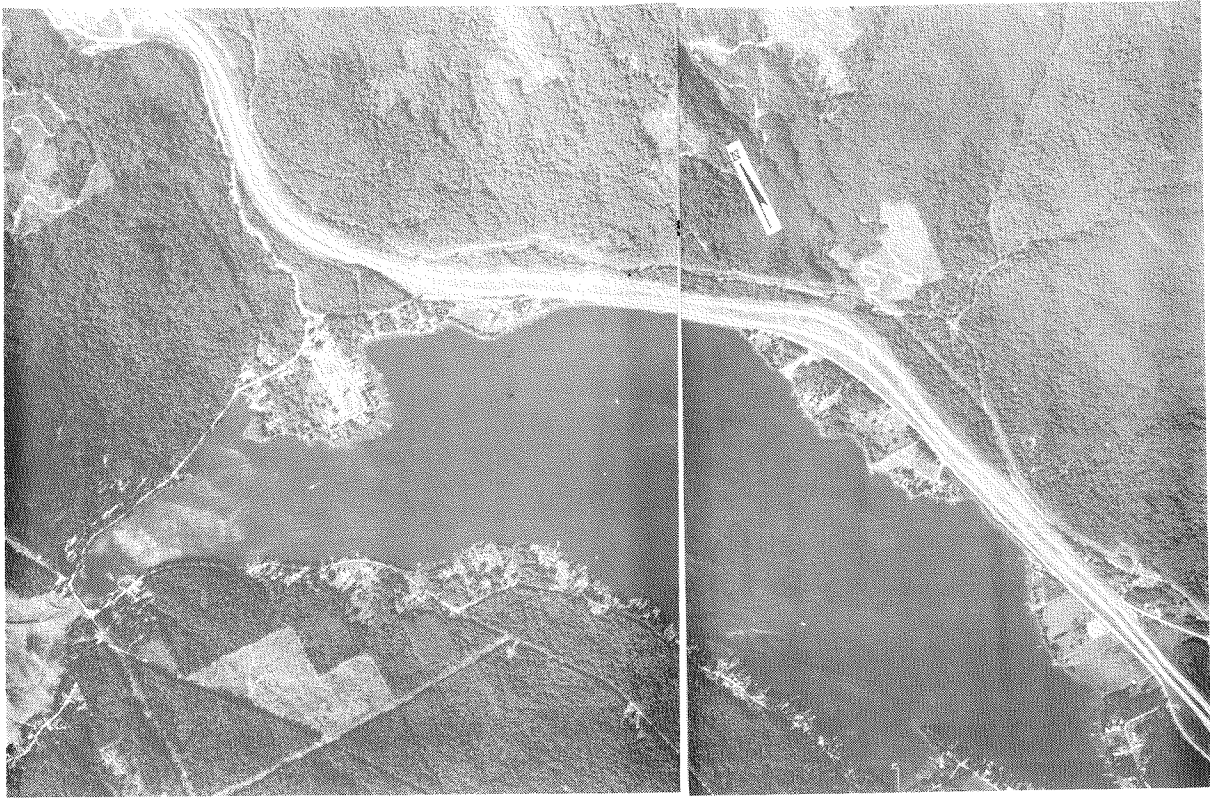
SAMISH LAKE - WHATCOM COUNTY

Lake Samish, located about eight miles south of Bellingham, appears as two lakes connected by a narrow passage. The west arm is a small deep bay; the east arm is larger and shallower. For this survey, only the east arm was sampled. The east arm covers 680 acres, drains 9.2 square miles, has a maximum depth of 75 feet, and a mean depth of 31 feet. The shoreline is approximately 90 percent residentially developed (Bortleson *et al.*, 1976a). The main inlet, Lake Creek, occurs at the north end. A wetland occurs at the outlet.

Current data indicates that Lake Samish is mesotrophic. Chlorophyll-*a* values show algal blooms occurred on both sampling dates. Lake color was blue-green and green, respectively. Compared with other lakes, Lake Samish had among the highest nitrate levels and lowest orthophosphorus levels for both spring and fall. Logging, residential development, and runoff from I-5 could be possible sources of nutrient loading. Macrophyte coverage in Lake Samish appears to be increasing; approximately 90 percent of the shoreline is covered by *Vallisneria americana*.

SAMISH LAKE - WHATCOM COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 27		Sept. 26	
	E	H	E	H
Depth (m) (composite sample)	0,2.5,5	15,17.5,20	0,4,6	16,18,20
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.412	0.583	0.003	0.341
Ammonia (NH ₃ -N)	0.004	0.008	0.008	0.057
Total Nitrogen (TN)	0.618	0.680	0.400	0.560
Orthophosphorus (PO ₄ -P)	0.003	0.004	0.002	0.003
Total Phosphorus (TP)	0.006	0.007	0.012	0.014
Nitrogen/Phosphorus ratio (TN/TP)	103.0	97.1	33.3	40.0
Alkalinity (as CaCO ₃)	17.6	17.6	19.2	20.5
Sulfate (SO ₄)	4.7	4.5	4.7	4.4
Specific Conductance (umhos/cm)	74	75	75	77
Turbidity (NTU)	0.6	-	1.4	-
Chlorophyll-a (ug/L)	2.7	-	6.3	-
Secchi-disc (m)	4.2		3.6	
Fecal Coliform (#/100 mL)	0		0	
Predominant Algae	Lyngbia , Anabaena, Dimorphococcus (8.0 m)		-	
Macrophytes present	Vallisneria americana, Ceratophyllum demersum, Eleocharis, Potamogeton, Elodea canadensis, Scirpus, Nymphaea odorata, Brasenia schreberi, Nuphar polysepalum			
Trophic State Index				
TSISD	39		42	
TSITP	30		40	
TSIChl	40		49	



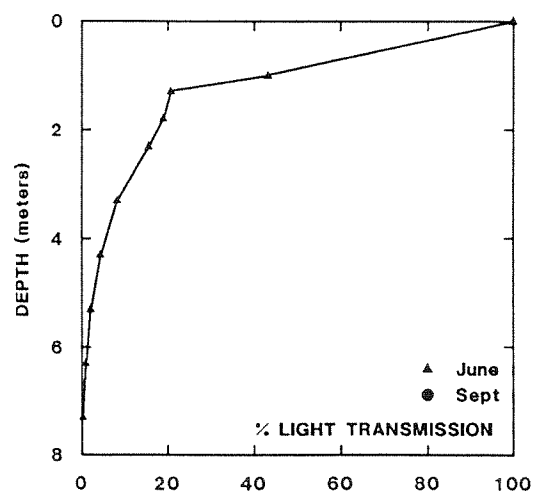
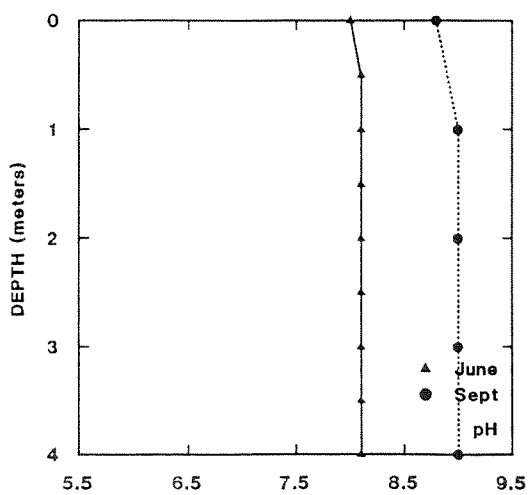
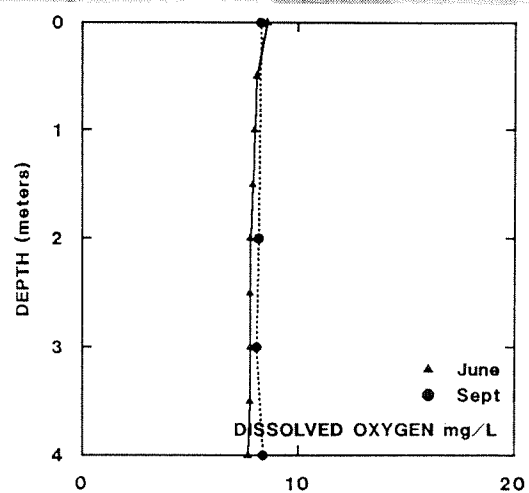
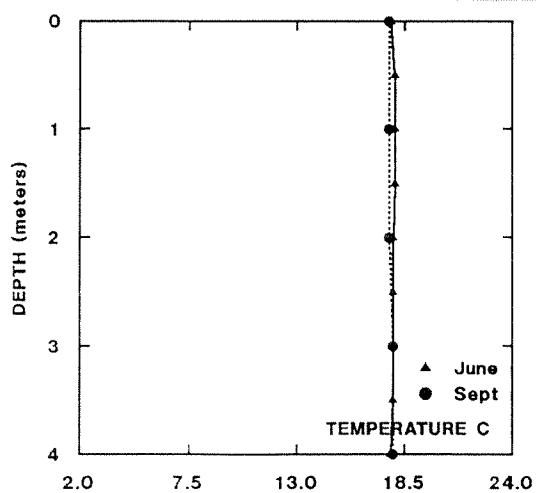
SPRAGUE LAKE - ADAMS COUNTY

Sprague Lake is located 38 miles southwest of Spokane, Washington. It covers 1,800 acres and drains 288 square miles. Although its area is large, it is relatively shallow with a maximum depth of 20 feet and a mean depth of 11 feet. Negro Creek at the northeast end provides the main surface inflow. Lake levels are regulated by a small dam at the outlet. In 1975, 89 percent of the drainage basin was agricultural, nine percent was forested and less than one percent was residential (Dion *et al.*, 1976b). A large wetland occurs at the outlet.

All trophic parameters show that Sprague Lake is eutrophic. Because it is shallow and exposed to frequent winds, thermal stratification did not occur. Compared to other lakes, it ranked high in nutrients and dissolved salts on both sampling dates. An algal bloom occurred in June and water color was "pea-green." Macrophytes were dense; *Scirpus* dominated 75 percent of the shoreline and submersed macrophytes occurred down to a depth of two meters. Rotenone was applied in 1985 as part of a fishery enhancement project. Significantly increased phosphorus levels have been documented since that time (Willms, 1989).

SPRAGUE LAKE - ADAMS COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 21		Sept. 20	
	E	H	E	H
Depth (m) (composite sample)	0,2,4	-	0,1,2	3,4
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.023	-	0.003	0.003
Ammonia (NH ₃ -N)	0.056	-	0.007	0.008
Total Nitrogen (TN)	0.823	-	1.690	1.750
Orthophosphorus (P ₀₄ -P)	0.016	-	0.178	0.180
Total Phosphorus (TP)	0.044	-	0.313	0.314
Nitrogen/Phosphorus ratio (TN/TP)	51.4	-	5.4	5.6
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	378	-	380	-
Turbidity (NTU)	1.2	-	12.0	-
Chlorophyll- <i>a</i> (ug/L)	6.8	-	69.9	-
Secchi-disc (m)		3.9		0.6
Fecal Coliform (#/100 mL)		5		2
Predominant Algae	<i>Aphanizomenon</i> , <i>Fragillaria</i> , <i>Microcystis</i> , <i>Pediastrum</i> , <i>Gloeocystis</i>		-	
Macrophytes present	<i>Nuphar</i> , <i>Myriophyllum exalbescens</i> , <i>Scirpus</i> , <i>Potamogeton filiformis</i>			
Trophic State Index				
TSISD	40		67	
TSITP	59		87	
TSIChl	49		72	



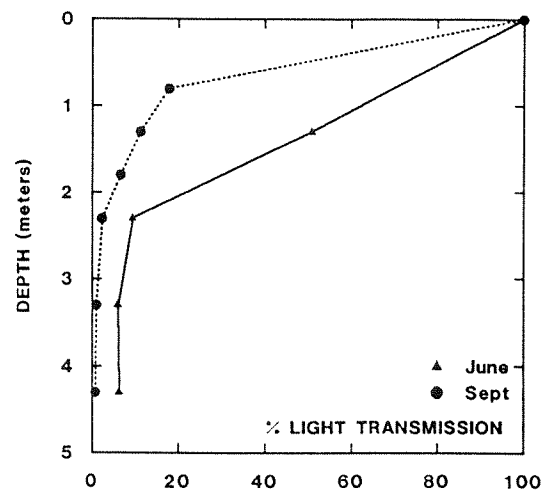
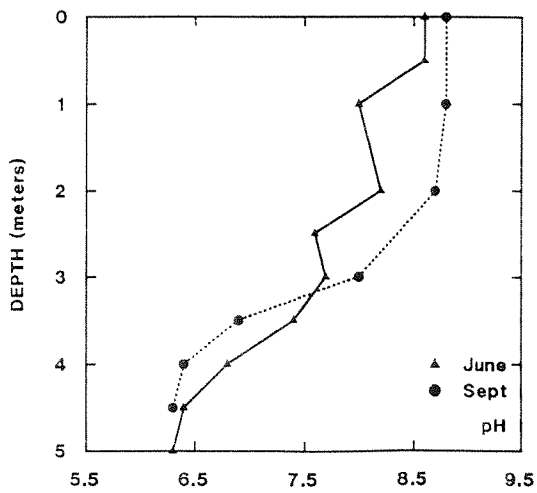
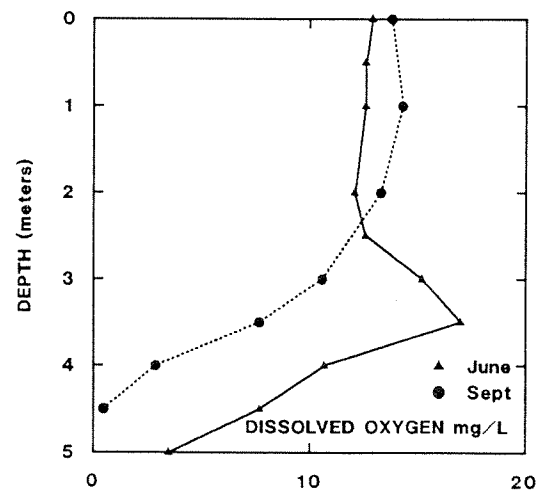
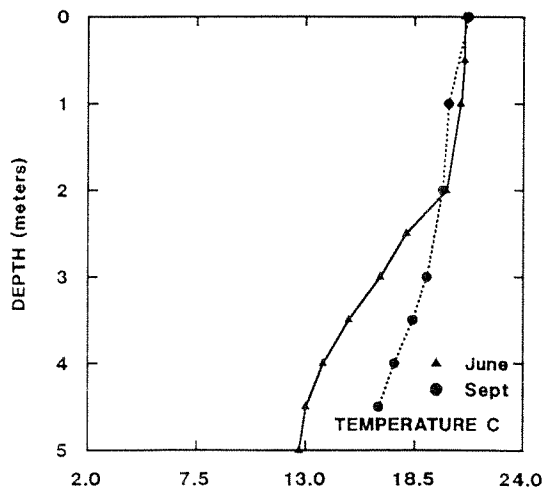
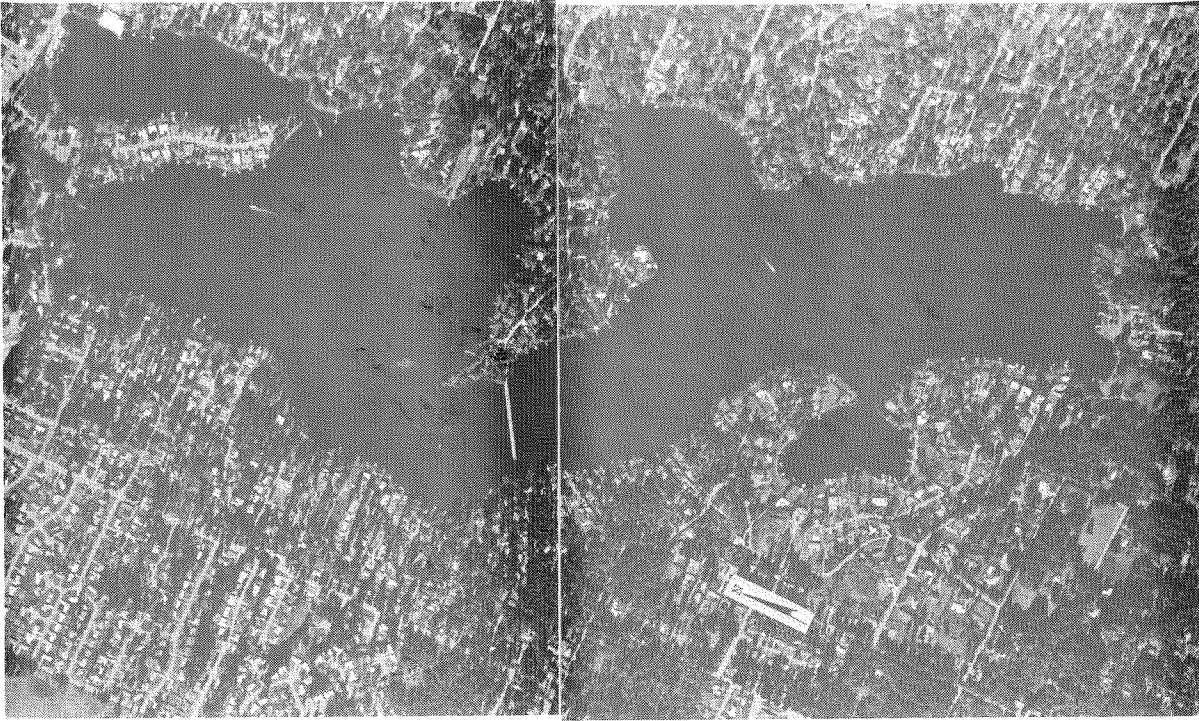
STEILACOOM LAKE - PIERCE COUNTY

Steilacoom Lake is an urban lake that lies three miles east of Steilacoom, Washington. It was one of the shallowest lakes studied with a maximum depth of 20 feet and a mean depth of 11 feet. It covers 320 acres and drains 89.4 square miles. The shoreline is 100 percent residentially developed. By 1981, the drainage basin was 55 percent residential, 42 percent forest and two percent agricultural (Sumioka and Dion, 1985). Two inlets are present at the south and southeast ends of the lake.

All trophic parameters indicate that Steilacoom Lake is eutrophic. Steilacoom Lake had high concentrations of total nitrogen and nitrates which declined over the summer, while levels of chlorophyll-*a* and total phosphorus approximately doubled. Compared to studies in the early '70s and '80s, nutrient levels were similarly high. In June, a dissolved oxygen pulse at 3-4 meters indicated an algal bloom. Water color was green and anoxic conditions existed in the hypolimnion in September. The lake has been treated chemically since 1955 to control aquatic flora; copper sulfate is currently being used to control algae. Runoff from a largely urbanized drainage basin is a likely source of nutrients.

STEILACOOM LAKE - PIERCE COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 14		Sept. 13	
	E	H	E	H
Depth (m) (composite sample)	0,1,2	4,5	0.5,2,3	3.5,4.0,4.5
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.757	0.555	0.003	0.183
Ammonia (NH ₃ -N)	0.022	0.027	0.005	0.096
Total Nitrogen (TN)	1.061	1.129	0.590	0.810
Orthophosphorus (PO ₄ -P)	0.011	0.017	0.008	0.016
Total Phosphorus (TP)	0.025	0.051	0.062	0.089
Nitrogen/Phosphorus ratio (TN/TP)	42.4	22.1	9.5	9.1
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	138	155	135	143
Turbidity (NTU)	1.4	-	2.1	-
Chlorophyll-a (ug/L)	11.4	-	24.1	-
Secchi-disc (m)	1.9		0.6	
Fecal Coliform (#/100 mL)	2		0	
Predominant Algae	Oscillatoria , Fragillaria, Asterionella, Pandorina, Stephanodiscus, Tabellaria			-
Macrophytes present	-			
Trophic State Index				
TSISD	51		67	
TSITP	51		64	
TSIchI	54		62	



SUMMIT LAKE - THURSTON COUNTY

Summit Lake is located in a steep forested valley nine miles west of Olympia, Washington. It is two miles long, covers 530 acres, and drains 2.8 square miles. The maximum depth is 200 feet and mean depth is 53 feet. Inflow is from intermittent streams, seeps, and springs. Outflow is through Kennedy Creek which drains a wetland on the west side. Residential development occupies 93 percent of the shoreline area and the surrounding basin is forested (Bortleson *et al.*, 1976d).

All trophic parameters indicate that Summit Lake is oligotrophic. Compared to other lakes, it had high transparency and low nutrient levels. Increases in dissolved oxygen and pH from 5 to 11 meters in June suggest some algal activity. Near-bottom waters were hypoxic in September. Water color was blue-green and recreational use is high.

SUMMIT LAKE - THURSTON COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 7		Sept. 5	
	E	H	E	H
Depth (m) (composite sample)	1,2,4	16,18,22	1,4,8	17,19,21
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.009	0.003	0.010
Ammonia (NH ₃ -N)	0.004	-	0.005	0.005
Total Nitrogen (TN)	0.159	0.165	0.150	0.170
Orthophosphorus (PO ₄ -P)	0.008	0.006	0.005	0.005
Total Phosphorus (TP)	0.007	0.009	0.006	0.012
Nitrogen/Phosphorus ratio (TN/TP)	22.7	18.3	25.0	14.2
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	52	54	53	56
Turbidity (NTU)	0.8	-	0.7	-
Chlorophyll- <i>a</i> (ug/L)	1.5	-	1.5	-
Secchi-disc (m)		7.0		6.8
Fecal Coliform (#/100 mL)		1		0
Predominant Algae		-		-
Macrophytes present		not sampled		
Trophic State Index				
TSISD		32		32
TSITP		32		30
TSIChl		34		34

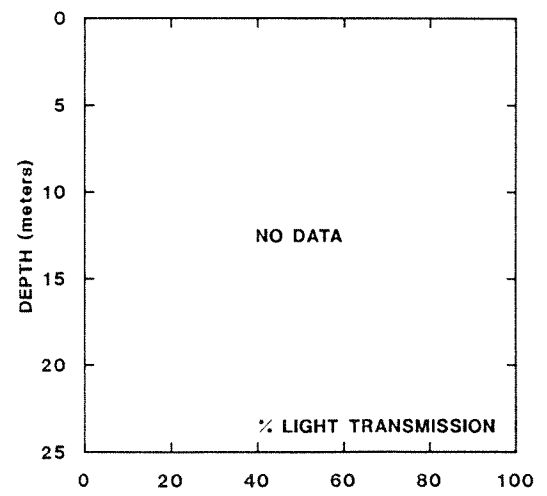
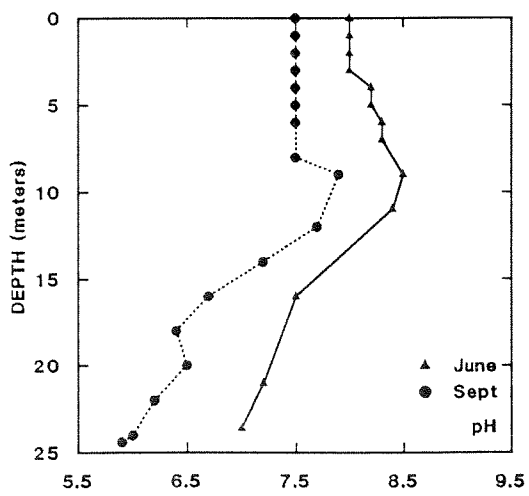
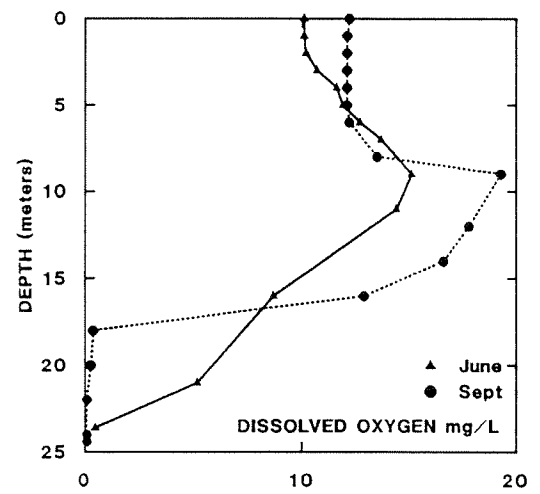
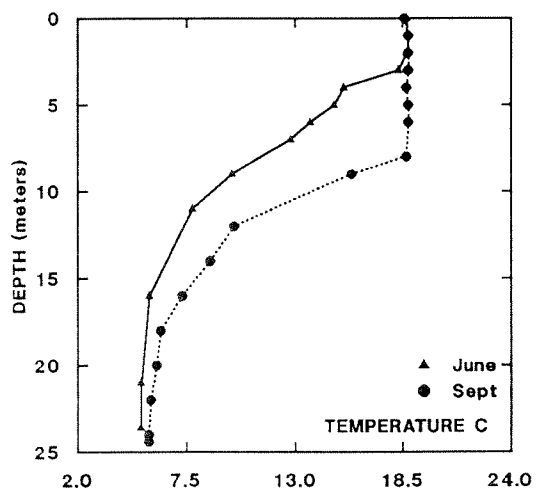
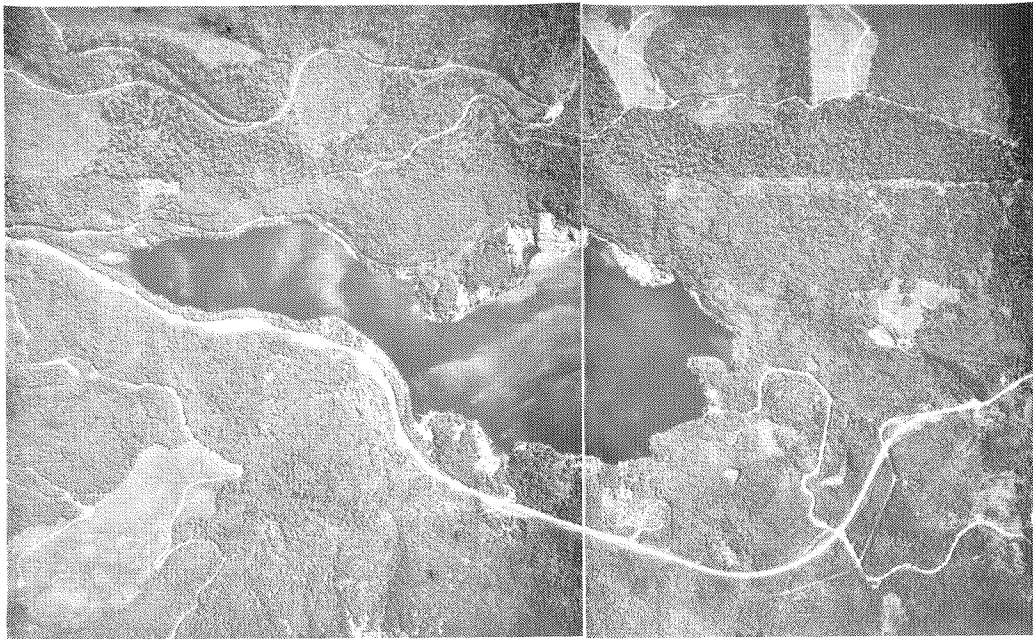
SUTHERLAND LAKE - CLALLAM COUNTY

Sutherland Lake is located 12 miles west of Port Angeles, Washington along Highway 101. It covers 370 acres and drains eight square miles of which 91 percent was still forested in 1974 (Bortleson *et al.*, 1976a). It has a maximum depth of 86 feet and a mean depth of 57 feet. Residential development presently occupies 90 percent of the shoreline area and continues to expand. The principal inlet is Falls Creek.

Current data shows that Sutherland Lake is oligotrophic. On both sampling dates, dramatic increases in dissolved oxygen and pH at mid-depth were observed, suggesting photosynthesis; however, no algal blooms were evident. Sutherland is fed by many small springs and streams on the north and south shores. Water color was blue. Compared to other lakes, Sutherland ranked low in nutrients and had the second lowest chlorophyll-*a* level in September.

SUTHERLAND LAKE - CLALLAM COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 7		Sept. 5	
	E	H	E	H
Depth (m) (composite sample)	1,4,6	16,18,22	1,3,6	16,20,24
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	0.003	0.003	0.003
Ammonia (NH ₃ -N)	0.012	0.008	0.005	0.031
Total Nitrogen (TN)	0.129	0.114	0.100	0.200
Orthophosphorus (PO ₄ -P)	0.006	0.004	0.006	0.025
Total Phosphorus (TP)	0.010	0.014	0.010	0.043
Nitrogen/Phosphorus ratio (TN/TP)	12.9	0.1	10.0	4.7
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	139	141	142	147
Turbidity (NTU)	0.9	-	0.7	-
Chlorophyll-a (ug/L)	1.0	-	0.6	-
Secchi-disc (m)		5.3		6.9
Fecal Coliform (#/100 mL)		0		0
Predominant Algae		-	<i>Fragillaria, Chroococcus</i> <i>Ankistrodesmus</i>	
Macrophytes present	not sampled			
Trophic State Index				
TSISD		36		32
TSITP		37		37
TSIChl		30		26



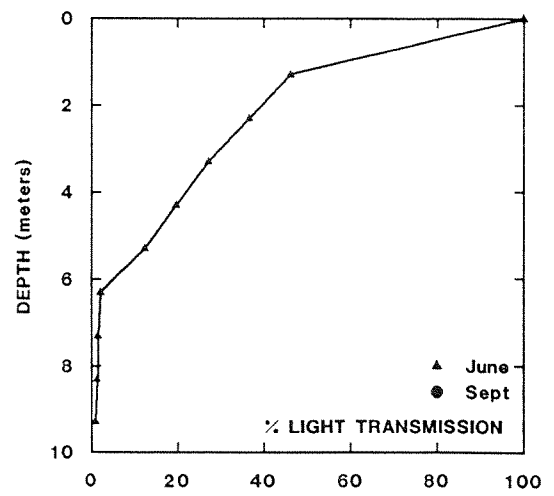
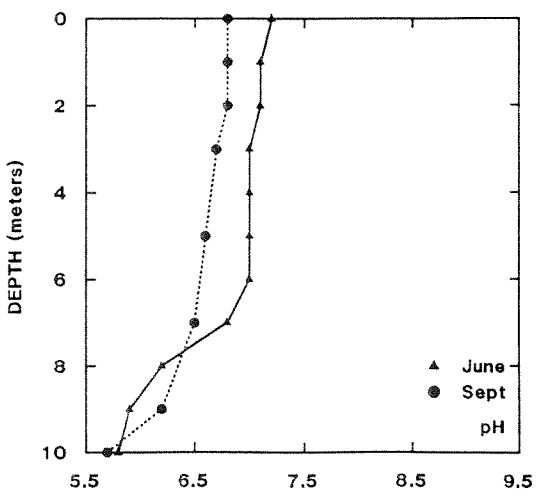
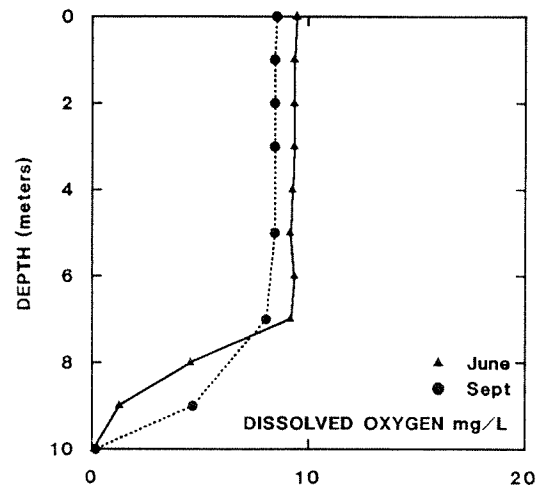
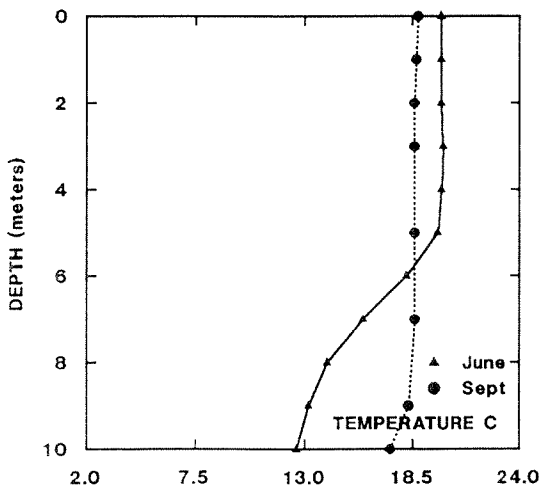
TIGER LAKE - MASON COUNTY

Tiger Lake is located 9.5 miles southwest of Bremerton, Washington. It covers 110 acres, drains 0.7 square miles, has a maximum depth of 40 feet and a mean depth of 19 feet. Residential development occupies 100 percent of the shoreline area, and the drainage basin is 14 percent residentially developed and 61 percent forested (Bortleson *et al.*, 1976c).

All trophic parameters, with the exception of Secchi-disc transparency, indicate Tiger Lake may be oligotrophic. Windy conditions on both sampling dates probably distorted transparency readings. Compared to other surveyed lakes, Tiger had the lowest and second lowest specific conductance in June and September, respectively. Anoxic conditions existed near the bottom on both dates. Water color was green and emergent macrophytes occurred only in sparse patches. Recreational use is high.

TIGER LAKE - MASON COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 28		Sept. 27	
	E	H	E	H
Depth (m) (composite sample)	0,2.5,5	-	1,5,9	10
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	-	0.003	0.003
Ammonia (NH ₃ -N)	0.004	-	0.005	0.021
Total Nitrogen (TN)	0.280	-	0.270	0.390
Orthophosphorus (PO ₄ -P)	0.004	-	0.005	0.006
Total Phosphorus (TP)	0.008	-	0.013	0.020
Nitrogen/Phosphorus ratio (TN/TP)	35.0	-	20.8	19.5
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	24	-	28	33
Turbidity (NTU)	0.7	-	1.0	-
Chlorophyll- <i>a</i> (ug/L)	1.5	-	1.6	-
Secchi-disc (m)	2.9		3.3	
Fecal Coliform (#/100 mL)	2		3	
Predominant Algae	-		-	
Macrophytes present	<i>Typha latifolia</i> , <i>Nuphar</i>			
Trophic State Index				
TSISD	45		43	
TSITP	34		41	
TSIChl	35		35	



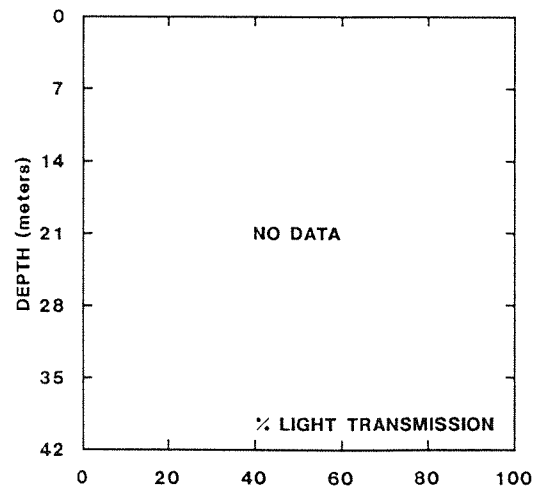
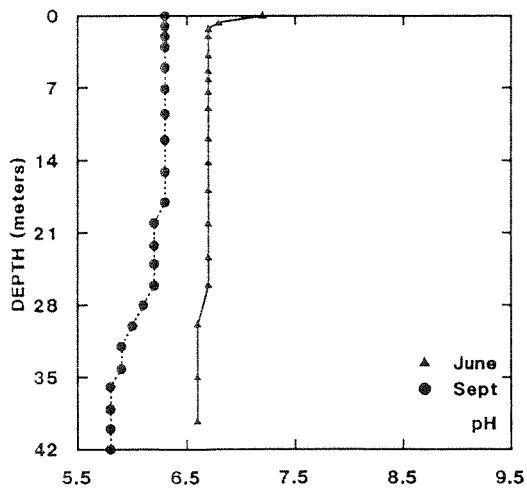
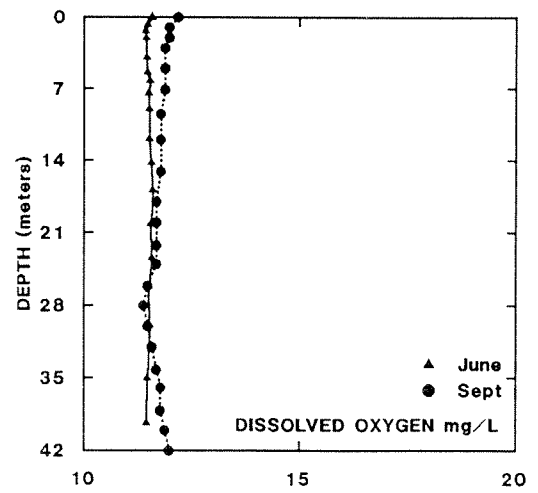
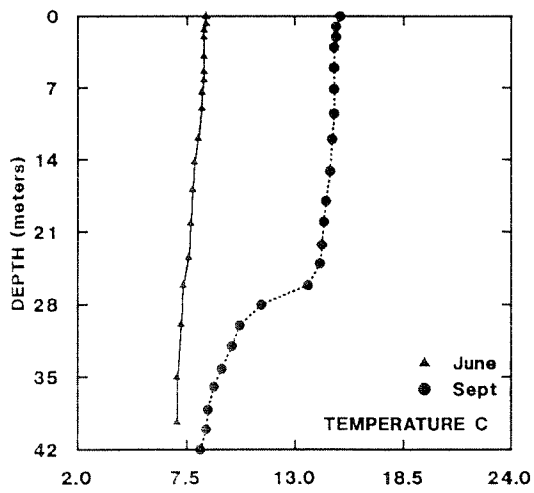
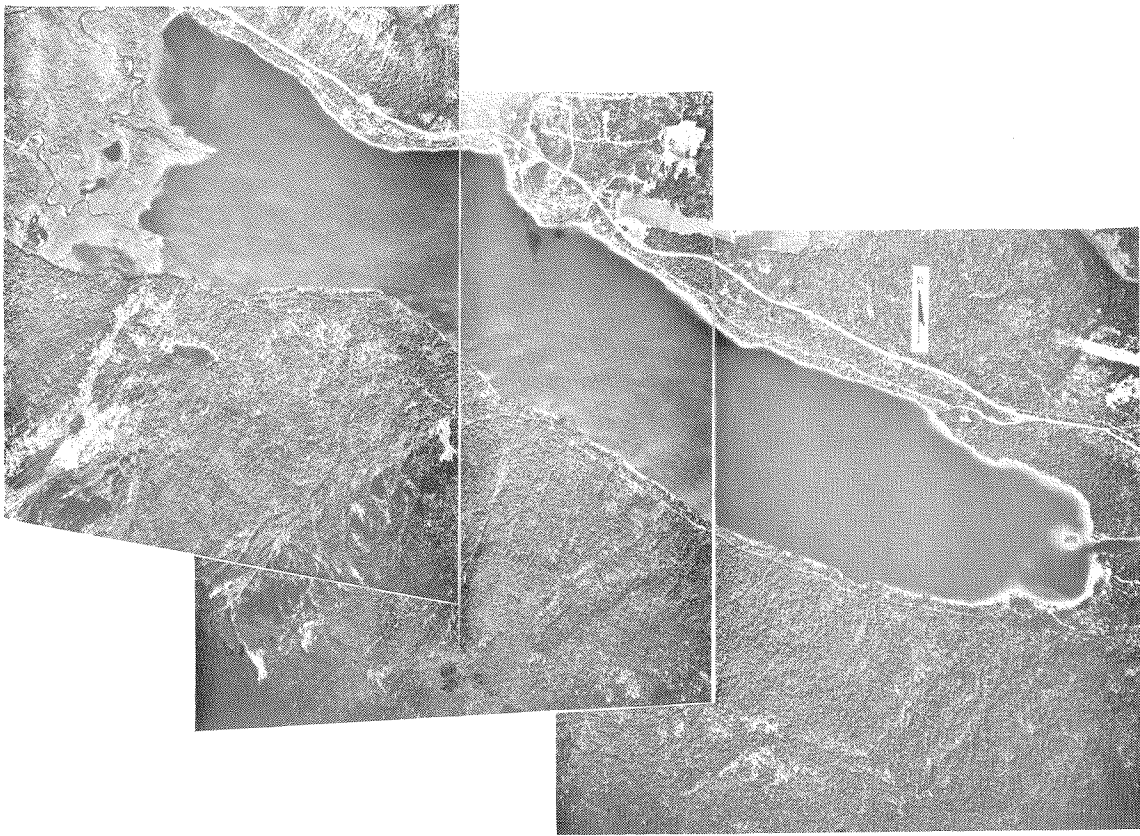
WENATCHEE LAKE - CHELAN COUNTY

Lake Wenatchee is a large, steep-sided lake located in the Wenatchee National Forest. It covers 2,500 acres and drains 273 square miles. It was the deepest natural lake sampled with a maximum depth of 240 feet and a mean depth of 150 feet. In 1974, 59 percent of the shoreline was residentially developed and the basin was 98 percent forested (Dion *et al.*, 1976a). Inflow is from the Little Wenatchee and White Rivers. A large wetland occupies the northeast end of the lake.

Trophic parameters indicate Lake Wenatchee is oligotrophic. The June Secchi-disc readings is the exception, but it was probably distorted by wind. Although Lake Wenatchee was one of the most biologically unproductive lakes studied, current activities within the watershed (such as logging, lakeshore development, and animal grazing) could alter this status.

LAKE WENATCHEE - CHELAN COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 6		Sept. 6	
	E	H	E	H
Depth (m) (composite sample)	1,15,35	-	0,4,8	30,35,40
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.100	-	0.003	0.071
Ammonia (NH ₃ -N)	0.003	-	0.012	0.008
Total Nitrogen (TN)	0.157	-	0.070	0.110
Orthophosphorus (PO ₄ -P)	0.006	-	0.006	-
Total Phosphorus (TP)	0.006	-	0.007	0.006
Nitrogen/Phosphorus ratio (TN/TP)	26.2	-	10.0	18.3
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	27	-	27	26
Turbidity (NTU)	0.8	-	0.5	-
Chlorophyll- <i>a</i> (ug/L)	0.7	-	1.4	-
Secchi-disc (m)	3.5		6.9	
Fecal Coliform (#/100 mL)	0		0	
Predominant Algae	-		-	
Macrophytes present	not sampled			
Trophic State Index				
TSISD	42		32	
TSITP	30		32	
TSIChl	27		34	



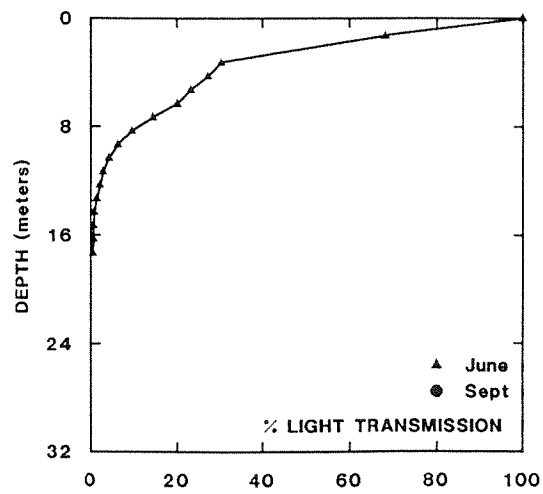
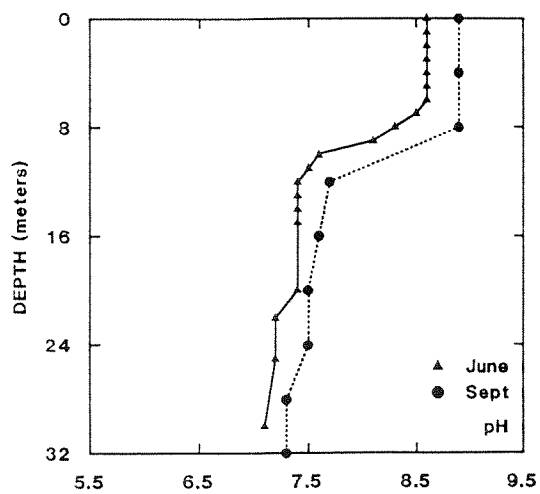
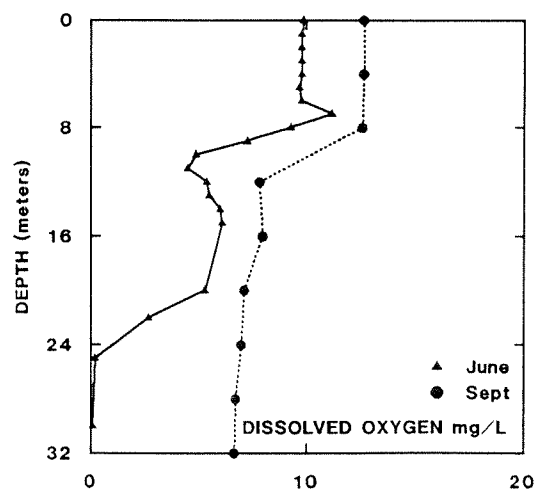
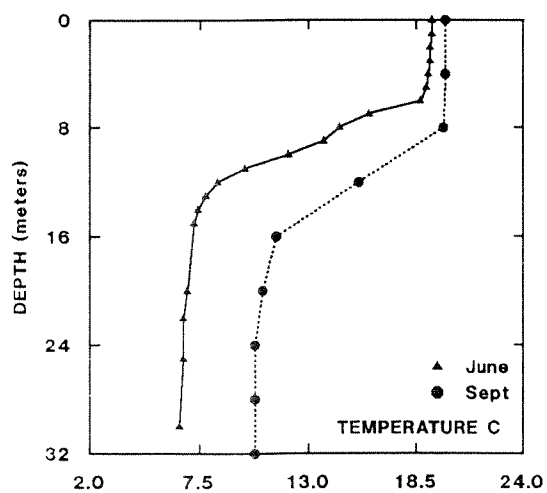
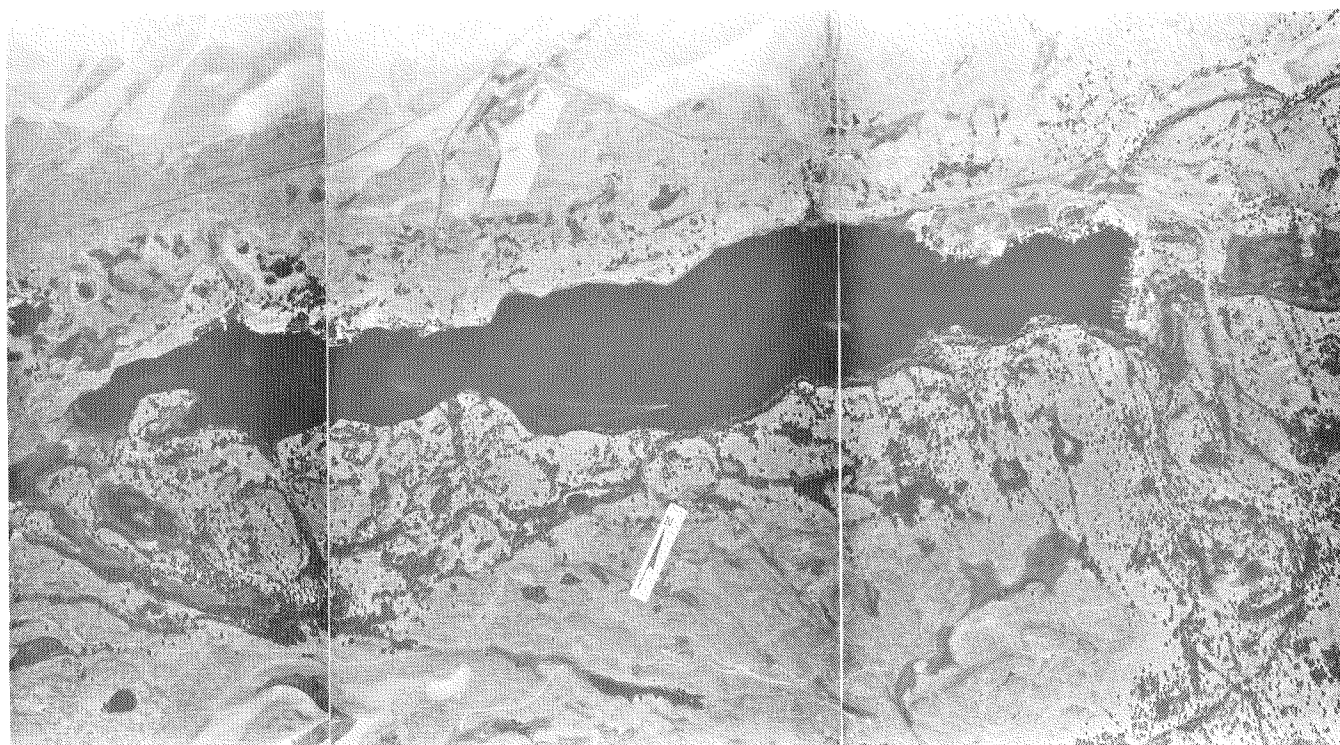
WILLIAMS LAKE - SPOKANE COUNTY

Williams Lake is located 27 miles southwest of Spokane, Washington. It covers 320 acres, drains 21.8 square miles, has a maximum depth of 120 feet, and a mean depth of 37 feet. Lakeshore residences occupy about 25 percent of the shoreline. Land use in the drainage basin is divided between agriculture (77%) and forest land (21%) (Dion *et al.*, 1976c). Inflow is intermittent.

Trophic indices are split between oligotrophic and mesotrophic classifications for Williams Lake. In June, an algal bloom at seven meters was dominated by *Fragillaria*. The bloom depth was not included in composite sampling for chlorophyll-*a*. Anoxic conditions were observed on both sampling dates and the smell of hydrogen sulfide was detected in the hypolimnion. Macrophytes were concentrated at the north and south ends of the lake. Considering the visual and chemical characteristics of Williams Lake, a mesotrophic classification seems appropriate. Unsewered homes, livestock, agricultural runoff, and heavy recreation are possible sources of nutrient loading.

WILLIAMS LAKE - SPOKANE COUNTY 1989 WATER QUALITY DATA

Parameter (mg/L unless noted)	June 21		Sept. 20	
	E	H	E	H
Depth (m) (composite sample)	0,2,4	25,27.5,30	0,4,8	24,28,32
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.005	0.141	0.003	0.003
Ammonia (NH ₃ -N)	0.026	0.394	0.008	-
Total Nitrogen (TN)	0.449	1.060	0.740	1.020
Orthophosphorus (PO ₄ -P)	0.001	0.057	0.008	0.191
Total Phosphorus (TP)	0.018	0.085	0.015	0.200
Nitrogen/Phosphorus ratio (TN/TP)	24.9	12.5	49.3	5.1
Alkalinity (as CaCO ₃)	123.8	127.1	123.9	134.0
Sulfate (SO ₄)	6.7	5.8	7.2	5.1
Specific Conductance (umhos/cm)	279	283	272	292
Turbidity (NTU)	0.7	-	0.8	-
Chlorophyll-a (ug/L)	2.4	-	2.6	-
Secchi-disc (m)		5.0		5.5
Fecal Coliform (#/100 mL)		0		0
Predominant Algae	<i>Fragillaria</i> , <i>Gloeocystis</i> <i>Tabellaria</i> , <i>Ankistrodesmus</i> , <i>Dinobryon</i> , <i>Golenkinia</i> (7 m)			-
Macrophytes present	<i>Ceratophyllum demersum</i> , <i>Potamogeton pectinatus</i> , <i>P. zosteriformis</i> , <i>Elodea canadensis</i> , <i>Nitella</i> , <i>Scirpus</i>			
Trophic State Index				
TSISD	37		35	
TSITP	46		43	
TSIChl	39		40	



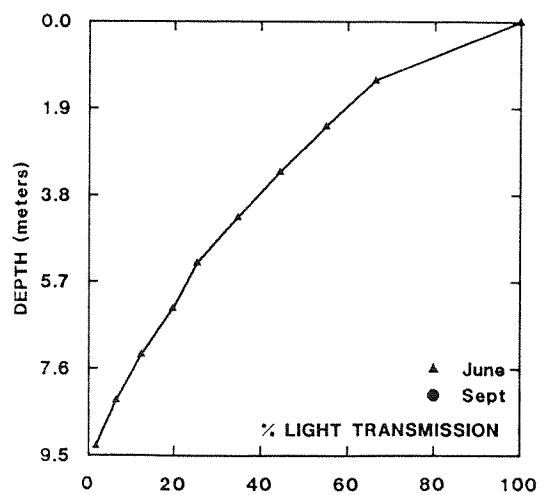
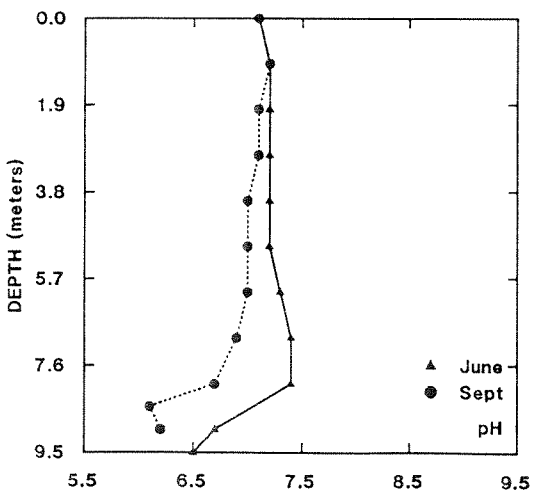
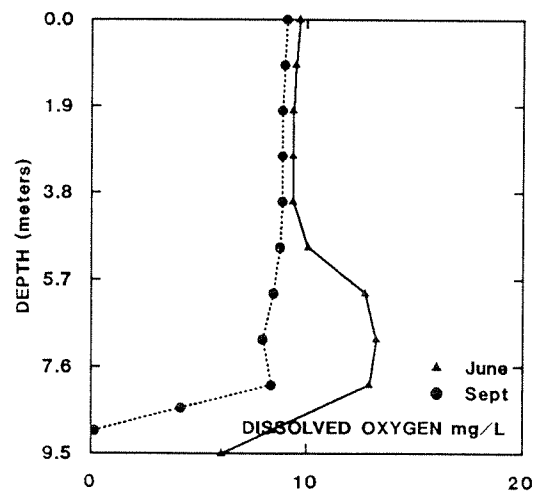
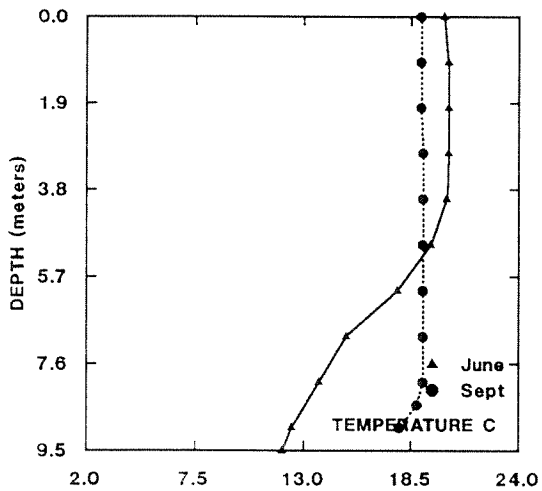
WOOTEN LAKE - MASON COUNTY

Wooten Lake, 15 miles southwest of Bremerton, had the smallest drainage basin (0.3 square miles) of all lakes surveyed. This lake covers 68 acres, which accounts for a third of the basin's area. Forest (42%) and residential development (25%) account for the rest (Bortleson *et al.*, 1976c). Nearshore residential development is approximately 75 percent. The maximum depth is 36 feet and the mean depth is 23 feet. No inflowing streams are present.

Most trophic parameters indicate Wooten Lake is oligotrophic. The fall chlorophyll-*a* is the exception, with a surface algal bloom of *Gloeotrichia*. A bloom also occurred in June at 7 meters. The water quality in Wooten Lake appeared to worsen over the summer when compared to other lakes; Wooten ranked low in nutrients for June but ranked mid-range in September. Intermittent patches of *Carex* and *Juncus* were observed. Algal blooms have been increasing in recent years; lakeshore development, old septic systems, and logging within the watershed are likely sources of nutrient loading.

WOOTEN LAKE - MASON COUNTY 1989 WATER QUALITY DATA

Parameters (mg/L unless noted)	June 28		Sept. 27	
	E	H	E	H
Depth (m) (composite sample)	0,2,4	-	0,4,8	-
Nitrate + Nitrite (NO ₃ + NO ₂ -N)	0.003	-	0.003	-
Ammonia (NH ₃ -N)	0.003	-	0.009	-
Total Nitrogen (TN)	0.128	-	0.200	-
Orthophosphorus (PO ₄ -P)	0.006	-	0.005	-
Total Phosphorus (TP)	0.003	-	0.010	-
Nitrogen/Phosphorus ratio (TN/TP)	42.7	-	20.0	-
Alkalinity (as CaCO ₃)	-	-	-	-
Sulfate (SO ₄)	-	-	-	-
Specific Conductance (umhos/cm)	35	-	36	-
Turbidity (NTU)	0.4	-	1.1	-
Chlorophyll-a (ug/L)	0.9	-	9.7	-
Secchi-disc (m)		6.7		4.3
Fecal Coliform (#/100 mL)		2		1
Predominant Algae	<i>Aphanocapsa</i> (?), <i>Sphaerocystis</i> , <i>Cyclotella</i> , <i>Dinobryon</i> (7m)		<i>Gloeotrichia</i> (Surface)	
Macrophytes present	<i>Carex</i> , <i>Juncus</i>			
Trophic State Index				
TSISD		33		39
TSITP		21		37
TSIChl		29		53



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APPENDICES

APPENDIX A. Values for field replicates, lab duplicates, matrix spikes, methods spikes, filtration blanks and lab blanks. Matrix spikes are field samples that have been spiked; values shown are minus the field value. Method spikes are lab blanks that have been spiked.

Parameter	Field Replicate		Lab Duplicate	Matrix Spikes		Method Spikes		Filtration Blanks		Lab Blanks		
				measured	actual	measured	actual	measured	actual	measured	actual	
Alkalinity	33.1	32.6	32.6	32.5								
(CaCO ₃) (mg/L)	19.0	19.3	22.1	22.5								
			134.0	133.2								
Ammonia (NH ₃ -N)	58.2	19.9	-1.1	-1.1	64.6	75.1	76.5	75.1	5.9	0.0	2.6	0.0
(ug/L)	34.2	18.3	112.0	110.5	71.4	75.1	73.8	75.1	3.6	0.0	8.9	0.0
	3.9	6.5	57.3	56.0	72.3	75.1	76.8	75.1			0.5	0.0
	30.6	43.7	7.6	6.8	76.8	75.1					0.2	0.0
	3.5	3.6	13.6	13.6							1.4	0.0
	8.5	6.1	7.0	8.2							3.7	0.0
	3.7	4.4									3.7	0.0
	110.5	82.7										
	7.8	5.1										
	7.0	7.8										
	29.7	41.1										
	3139.0	3404.5										
Chlorophyll-a	2.35	2.41										
(ug/L)	2.85	2.31										
	2.64	2.76										
	66.26	73.54										
	24.08	25.85										
	12.57	20.93										
Fecal Coliform	0	0	0	0							0	0
(#/100 mL)	0	0	0	0							0	0
	0	0	0	0							0	0
	0	0	35	37							0	0
	2	1	6	8								
	1	3	1	3								
Nitrate + Nitrite	0.000	0.001	0.140	0.166	.429	0.400	0.379	0.400	-0.006	0.000	-0.019	0.000
(NO ₃ -N + NO ₂ -N)	0.006	0.004	0.006	0.005	0.406	0.400	0.400	0.404	-0.007	0.000	-0.001	0.000
(mg/L)	-0.005	-0.005	-0.007	-0.010			0.400	0.372			-0.007	0.000
	0.217	0.213	-0.009	-0.007			0.400	0.395			-0.007	0.000
	0.412	0.412	-0.004	-0.004							-0.003	0.000
	0.566	0.600	-0.002	-0.002							-0.003	0.000
	0.001	0.001										
	0.156	0.209										
	-0.005	-0.005										
	-0.003	-0.005										
	-0.007	-0.010										
	-0.008	-0.008										
Orthophosphorus	27.9	28.4	7.9	6.9	50.4	50.0	52.4	50.0	4.1	0.0	-0.1	0.0
(PO ₄ -P) (ug/L)	0.8	1.1	27.9	28.4	51.2	50.0	50.6	50.0	3.3	0.0	3.0	0.0
	7.4	9.5	9.7	6.9			49.7	50.0			2.8	0.0
	2.6	2.6	3.8	3.6			50.5	50.0			2.8	0.0
	3.6	3.8	4.3	3.8			51.5	50.0			5.6	0.0
	7.1	7.6	11.7	11.5							2.8	0.0
	6.9	8.4									3.2	0.0
	20.6	11.2										
	186.8	168.9										
	172.2	187.6										
	19.1	23.8										
	1177.0	1244.0										

Appendix A. (continued)

Parameter	Field Replicate		Lab Duplicate	Matrix Spikes		Method Spikes		Filtration Blanks		Lab Blanks	
				measured	actual	measured	actual	measured	actual	measured	actual
Sulfates (SO ₄) (mg/L)	4.71	4.73	1.86	2.03							
	1.94	1.86									
Total Nitrogen (TN) (mg/L)	0.22	0.23	0.41	0.39	0.34	0.33		-0.02	0.00	-0.01	0.00
	0.59	0.65	0.75	0.79	0.35	0.33				-0.03	0.00
	0.68	0.68	1.13	1.03	0.34	0.33				-0.03	0.00
	0.11	0.12	0.16	0.14						-0.01	0.00
	0.45	0.45	0.44	0.44						0.34	0.33
	0.55	0.56	0.32	0.35						0.31	0.33
	0.61	0.57	0.75	0.74						0.36	0.33
	0.80	0.82	0.14	0.14							
	1.69	1.69									
	1.73	1.77									
	1.22	1.10									
	6.21	5.62									
Total Phosphorus (TP) (ug/L)	34.9	39.6	24.2	27.2	46.8	50.0	56.6	50.0		0.8	0.0
	17.8	18.1	11.1	15.8	48.7	50.0				1.0	0.0
	8.2	8.4	53.5	53.0	48.4	50.0				0.6	0.0
	16.7	14.8	175.8	169.5						-1.4	0.0
	7.5	5.0	14.4	11.6						2.2	0.0
	6.7	7.7									
	62.0	62.5									
	93.8	83.3									
	310.5	314.6									
	311.2	317.6									
	102.5	110.7									
	1432.0	1293.0									
Turbidity (NTU)	0.4	0.3	0.9	0.9							
	0.7	0.7	0.3	0.3							
	0.6	0.5	0.5	0.6							
	2.3	2.2	0.5	0.5							
	12.0	12.0	0.4	0.4							
	6.3	6.5	9.0	8.8							

Negative values are those values found at less than the contract required detection limit.

APPENDIX B

Vertical column data for 25 lakes (K-specific conductivity, D.O.-dissolved oxygen, pH, temperature and % light transmission). The asterisks indicate that all pH values are estimates. The compensation depth is where oxygen production by algae is in equilibrium with algal respiration (Goldman and Horne, 1983). It is calculated as one percent of the total light transmission at the surface.

AMERICAN LAKE (PIERCE)**JUNE 7, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	107	11.1	8.9	21.3
1.0	107	11.5	8.9	20.5
2.0	107	11.5	8.9	20.2
3.0	107	11.8	9.0	19.9
4.0	107	13.6	9.1	19.1
5.0	108	15.4	9.3	16.8
6.0	108	15.5	9.3	16.1
7.0	108	15.7	9.2	14.9
9.0	106	15.2	8.6	9.5
12.2	107	8.3	7.7	8.8
20.0	109	5.8	7.4	7.7
22.0	109	5.1	7.1	7.6

AMERICAN LAKE (PIERCE)**SEPT. 5, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	104	12.7	7.7	20.0
1.1	104	12.7	7.7	19.8
2.3	105	12.7	7.8	19.6
3.4	106	12.7	7.9	19.5
4.6	106	12.8	7.9	19.4
5.9	106	12.7	7.9	19.3
7.1	106	12.7	7.9	19.3
8.3	107	12.6	7.9	19.2
9.2	108	16.7	6.7	16.4
10.7	107	10.4	7.4	10.7
12.0	108	3.8	6.5	9.7
13.1	107	1.8	6.3	9.0
14.0	106	1.4	6.1	8.8
15.5	106	0.9	6.0	8.4
16.5	105	0.3	5.9	8.2
17.6	105	0.1	5.8	8.0
19.5	107	0.1	5.8	7.9
22.5	110	0.1	5.7	7.6
23.1	111	0.1	5.7	7.6

BLACK LAKE (STEVENS)**JUNE 20, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	39	9.4	7.2	16.7
1.0	38	9.1	7.2	16.8
2.0	38	9.0	7.1	16.8
3.0	39	8.9	7.1	16.6
4.0	38	9.0	6.8	13.4
5.0	41	6.4	6.6	9.7
6.0	40	3.5	6.4	7.7
7.0	41	1.8	6.3	6.9
8.0	41	1.3	6.2	6.5
9.0	42	0.5	6.1	6.2
1.0	42	0.4	6.1	6.2
11.0	42	0.3	6.0	6.1
12.0	42	0.3	6.0	6.1

BLACK LAKE (STEVENS)**SEPT. 19, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	39	8.6	6.5	15.2
1.0	39	8.5	6.7	15.1
2.0	39	8.4	6.7	15.0
3.0	39	8.4	6.7	14.9
4.0	39	8.2	6.7	14.7
5.0	40	8.0	6.7	14.6
6.0	40	4.5	6.2	13.5
7.0	43	0.3	5.9	10.5
8.0	44	0.1	5.9	8.5
9.0	50	0.1	5.8	7.7
10.0	52	0.1	5.8	7.4
11.0	53	0.1	5.8	7.3

BLACK LAKE (STEVENS)**JUNE 20, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	7.5
1.3	49.8	
2.3	26.0	
3.3	14.1	
4.3	7.5	
5.3	4.0	
6.3	2.1	
7.3	1.1	
8.3	0.6	
9.3	0.3	
10.3	0.1	
11.3	0.0	

BLACK LAKE (STEVENS)**SEPT.19, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	8.9
2.3	51.6	
3.3	28.9	
4.3	17.9	
5.3	10.3	
6.3	7.4	
7.3	3.8	
8.3	1.8	
9.3	0.4	
10.3	0.1	

BLACK LAKE (THURSTON)**JUNE 7, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	73	9.8	7.7	23.0
1.0	73	10.1	7.8	21.2
2.0	73	10.4	7.7	19.8
3.0	72	10.4	7.6	18.6
4.0	73	7.1	7.1	15.6
5.0	77	4.0	6.8	14.3
6.0	79	2.7	6.7	14.0
7.0	81	2.0	6.6	13.6

BLACK LAKE (THURSTON)**SEPT. 7, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	83	16.9	8.4	21.1
1.0	83	16.3	8.4	20.6
2.4	81	13.9	8.1	19.6
3.5	82	11.9	7.8	19.4
4.6	82	9.8	7.1	19.2
5.5	85	5.6	6.3	18.8
6.5	104	0.1	6.0	17.9
7.6	126	0.1	6.1	17.2

BLACKMANS LAKE (SNOHOMISH)**JUNE 26, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	89	10.3	8.2	21.4
1.0	89	10.2	8.2	21.4
2.0	89	10.2	8.2	21.4
3.0	89	11.2	8.4	20.2
4.0	89	8.3	7.8	17.9
5.0	95	1.7	6.8	14.9
6.0	102	0.7	6.6	13.2
7.0	103	0.7	6.5	11.9
7.5	106	0.4	6.4	11.8

BLACKMANS LAKE (SNOHOMISH)**SEPT.25, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	88	8.9	7.2	19.1
1.0	89	8.8	6.9	19.0
2.0	89	8.8	7.0	19.1
3.0	90	8.8	7.0	19.0
4.0	90	8.3	7.0	18.9
4.5	90	7.9	6.7	18.7
6.0	92	3.4	6.6	18.2
6.5	102	0.3	6.3	17.3
7.0	126	0.2	6.3	15.9

BLACKMANS LAKE (SNOHOMISH)**JUNE 26, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	6.4
0.8	43.2	
1.3	20.7	
1.8	19.0	
2.3	15.6	
3.3	8.3	
4.3	4.4	
5.3	2.2	
6.3	1.1	
7.3	0.3	
8.3	0.1	

BLUE LAKE (GRANT)**JUNE 19, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	435	11.3	8.8	18.9
0.8	436	11.0	8.7	18.9
1.8	436	10.6	8.7	19.0
3.0	436	10.5	8.7	18.9
5.4	438	10.6	8.7	18.9
8.2	438	10.6	8.7	18.9
10.4	434	10.1	8.6	17.7
12.2	423	6.5	8.2	14.8
14.2	450	1.4	7.8	12.5
17.4	445	0.6	7.5	12.2

BLUE LAKE (GRANT)**SEPT. 18, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	410	7.8	8.2	18.0
1.0	410	7.4	8.2	17.9
2.0	410	7.3	8.2	17.8
3.0	411	7.1	8.2	17.7
4.0	411	7.0	8.2	17.5
5.0	412	6.8	8.2	17.5
6.0	412	6.8	8.2	17.5
7.0	413	6.5	8.2	17.4
8.0	413	6.4	8.1	17.4
10.0	413	6.3	8.1	17.4
12.0	414	6.1	8.1	17.4
14.0	413	6.1	8.1	17.3
16.0	412	5.9	8.1	17.2
17.0	427	2.8	7.6	16.8
18.0	420	0.1	7.3	16.3
18.5	431	0.1	7.3	15.9

BLUE LAKE (GRANT)**SEPT. 19, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	10.7
1.3	60.4	
2.3	41.7	
3.3	28.3	
4.3	17.8	
5.3	11.3	
6.3	7.1	
7.3	4.3	
8.3	2.8	
9.3	1.7	
10.3	1.2	
11.3	0.7	
12.3	0.5	

CLEAR LAKE (THURSTON)

JUNE 14, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	81	9.8	7.4	20.9
1.0	80	9.7	7.4	20.9
2.0	81	9.7	7.4	20.9
3.0	81	10.0	7.3	20.4
4.0	80	10.7	7.2	19.5
5.0	80	10.6	7.2	18.3
6.0	82	9.0	7.0	17.6

CLEAR LAKE (THURSTON)

SEPT. 13, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	83	11.4	8.3	20.0
0.5	83	10.9	8.2	20.1
1.0	83	10.6	8.2	20.0
1.5	83	10.4	8.1	20.0
2.0	83	9.8	8.0	19.9
2.5	84	7.8	7.3	19.9
3.0	85	6.2	7.0	19.9
3.5	85	5.5	6.9	19.8
4.0	86	4.1	6.7	19.8
4.5	87	3.6	6.6	19.8
5.0	86	3.1	6.6	19.7
5.5	87	2.3	6.4	19.7
6.0	88	0.8	6.5	19.6
6.5	90	0.6	6.4	19.6

CLEAR LAKE (THURSTON)**JUNE 14, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	-
1.3	74.5	
2.3	50.1	
3.3	35.4	
4.3	24.1	
5.3	14.8	
6.3	9.3	

CLEAR LAKE (THURSTON)**SEPT. 13, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	3.5
0.8	23.2	
1.3	12.2	
1.8	7.2	
2.3	4.6	
2.8	2.7	
3.3	1.2	
3.8	0.7	
4.3	0.5	
4.8	0.3	
5.3	0.2	
5.8	0.1	

CLE ELUM LAKE (KITITAS)

JUNE 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	0	10.7	7.5	14.0
0.6	52	11.1	7.6	13.4
1.2	52	11.1	7.6	13.2
1.7	51	11.1	7.6	13.1
2.6	51	11.2	7.6	13.0
4.0	51	11.2	7.6	12.7
5.6	51	11.3	7.6	12.6
8.8	51	11.6	6.7	12.4
10.6	51	11.7	6.8	11.5
12.1	51	11.8	6.3	10.5
14.4	53	11.6	7.3	8.9
19.8	50	11.6	7.3	7.7
23.7	50	11.7	7.2	7.3
29.5	49	11.7	7.2	7.2
34.7	48	11.7	7.2	6.4
40.7	50	11.7	7.2	6.1
44.0	50	11.8	7.2	5.9

CLE ELUM LAKE (KITITAS)

SEPT. 6, 1986

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	48	12.2	6.6	14.5
1.0	48	12.1	6.6	14.5
2.1	50	12.0	6.7	14.4
3.0	50	12.0	6.7	14.4
4.0	50	12.0	6.7	14.4
5.1	51	12.0	6.7	14.4
6.1	51	11.9	6.8	14.4
7.1	51	11.9	6.8	14.4
9.0	51	12.0	6.8	14.2
10.0	50	12.6	6.6	11.1
11.0	52	13.4	6.7	8.3
13.0	51	13.8	6.6	6.9
15.0	51	13.8	6.5	6.7
20.0	52	13.8	6.5	6.0
25.0	53	13.9	6.5	5.6
30.1	52	14.0	6.5	5.4
35.1	52	14.0	6.4	5.2
40.0	52	14.1	6.4	5.0
45.0	52	14.0	6.4	4.9

CRANBERRY LAKE (ISLAND)**JUNE 27, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	281	11.8	8.9	20.4
0.5	280	11.8	8.9	20.0
1.0	281	11.6	8.9	19.8
1.5	281	11.1	8.8	19.6
2.0	281	10.0	8.5	19.3
2.5	282	8.9	8.3	19.1
3.0	282	6.5	7.6	18.3
3.5	283	5.2	7.4	18.0
4.0	284	5.0	7.2	17.8
4.5	285	4.2	7.1	17.7
5.0	285	2.4	7.0	17.4
5.5	285	0.1	6.9	15.8
6.0	288	0.1	6.8	15.4

CRANBERRY LAKE (ISLAND)**SEPT. 26, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	279	8.8	7.3	18.8
1.0	279	7.7	7.2	18.2
2.0	280	7.9	7.2	18.2
3.0	280	5.9	7.1	18.1
4.0	284	1.6	6.8	17.9
5.0	286	0.4	6.6	17.9
6.0	287	0.1	6.6	17.6
7.0	334	0.1	6.1	15.4
8.0	357	0.1	6.1	13.9

CRANBERRY LAKE (ISLAND)**JUNE 27, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	2.7
0.8	25.9	
1.3	9.7	
1.8	4.4	
2.3	1.8	
2.8	0.9	
3.3	0.5	
3.8	0.3	
4.3	0.1	
4.8	0.1	
5.3	0.0	

DEEP LAKE (STEVENS)**JUNE 30, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	288	10.7	8.1	16.3
1.0	290	10.6	8.2	16.3
2.0	291	10.6	8.2	16.3
3.0	297	10.6	8.1	15.6
4.0	302	10.6	8.0	15.1
5.0	315	10.3	7.9	13.9
6.0	338	9.1	7.7	12.2
6.5	346	7.3	7.5	11.1
7.0	375	2.8	7.3	8.6
8.0	388	1.0	7.1	7.3
9.0	395	0.5	7.1	6.4
10.0	395	0.2	7.1	6.1
11.0	394	0.1	7.1	6.0
12.0	396	0.1	7.1	5.8
13.0	400	0.1	7.1	5.4
13.5	400	0.1	7.1	5.4

DEEP LAKE (STEVENS)**SEPT. 19, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	282	10.0	7.9	16.2
1.0	283	9.9	7.9	16.2
2.0	284	9.9	7.9	16.2
3.0	284	9.8	7.9	16.1
4.0	284	9.8	7.9	16.1
5.0	284	9.8	7.9	16.1
6.0	320	4.7	7.3	15.4
7.0	345	0.9	7.0	13.6
8.0	365	0.2	6.9	10.6
9.0	370	0.2	6.9	9.2
10.0	375	0.1	6.8	7.4
11.0	377	0.1	6.8	6.7
12.0	379	0.1	6.7	6.4
13.0	380	0.1	6.7	6.2

DEEP LAKE (STEVENS)**JUNE 20, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	12.9
3.3	68.7	
4.3	44.9	
5.3	32.1	
6.3	21.6	
7.3	15.1	
8.3	10.2	
9.3	5.2	
10.3	3.1	
11.3	2.0	
12.3	1.3	
13.3	0.8	

DEEP LAKE (STEVENS)**SEPT. 19, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	10.9
1.3	81.6	
2.3	61.9	
3.3	47.3	
4.3	34.5	
5.3	19.5	
6.3	16.3	
7.3	11.0	
8.3	5.5	
9.3	4.1	
10.3	2.3	
11.3	0.1	

DUCK LAKE (GRAYS HARBOR)**JUNE 14, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	177	18.2	8.0	17.9
0.5	177	9.8	8.0	17.8
1.0	177	9.5	7.9	17.7
1.5	177	9.3	7.8	17.6
2.0	177	9.3	7.8	17.6
3.5	177	9.2	7.8	17.6
3.0	177	9.2	7.8	17.6
4.0	178	9.2	7.8	17.6
4.5	195	1.7	6.6	16.7
5.0	238	0.1	6.6	15.2

DUCK LAKE (GRAYS HARBOR)**SEPT. 13, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	181	10.2	7.8	20.7
0.5	180	10.0	7.8	20.6
1.0	181	9.9	7.8	20.6
2.0	180	9.5	7.7	20.4
3.0	181	8.3	7.4	20.0
4.0	182	5.8	7.1	19.3
4.5	183	1.2	6.6	19.0

DUCK LAKE (GRAYS HARBOR)**SEPT. 13, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.8	100.0	2.7
1.3	17.2	
1.8	6.5	
2.3	1.9	
2.8	0.7	
3.3	0.2	
3.8	0.0	

WAVES AT SURFACE

GOSS LAKE (ISLAND)**JUNE 26, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	131	9.8	7.3	21.1
1.0	132	9.7	7.5	21.2
2.0	132	10.0	7.6	21.2
3.0	131	10.2	7.7	20.0
4.0	130	11.7	7.6	18.1
5.0	130	12.7	7.5	14.0
6.0	127	11.6	7.3	10.0
7.0	128	10.1	7.0	8.3
8.0	127	9.2	6.9	7.3
9.0	126	8.6	6.8	6.6
10.0	126	6.9	6.7	6.2
11.0	127	6.0	6.6	5.8
12.0	127	5.8	6.5	5.6
13.0	127	5.8	6.5	5.5
15.0	127	5.6	6.4	5.3
17.5	127	4.3	6.4	5.1
20.0	129	0.8	6.2	5.1

GOSS LAKE (ISLAND)**SEPT. 25, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	128	9.9	7.3	18.6
1.0	128	9.7	7.3	18.6
2.0	129	9.7	7.3	18.6
3.0	129	9.6	7.3	18.5
4.0	128	9.5	7.2	18.5
6.0	126	11.6	7.2	17.3
7.0	125	9.6	7.0	12.6
8.0	121	7.1	6.8	9.7
9.0	122	4.9	6.5	8.0
10.0	122	3.9	6.4	7.3
11.0	122	3.0	6.5	6.4
12.0	124	2.7	6.4	6.1
13.0	123	2.6	6.3	6.0
14.0	123	2.3	6.3	5.8
15.0	123	1.7	6.2	5.6
16.0	123	0.9	6.2	5.5
17.0	123	0.5	6.1	5.5
18.0	123	0.3	6.1	5.4
18.5	124	0.1	6.1	5.4

GOSS LAKE (ISLAND)**JUNE 26, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	10.3
1.3	42.7	
2.3	26.0	
3.3	18.4	
4.3	12.4	
5.3	7.9	
6.3	5.0	
7.3	2.8	
8.3	2.3	
9.3	1.4	
10.3	1.0	
11.3	0.7	
12.3	0.4	

JUMPOFF JOE LAKE (STEVENS)**JUNE 20, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	210	12.3	8.8	20.4
0.5	210	12.2	8.9	20.4
1.0	211	12.2	8.9	20.4
1.5	211	12.1	8.9	20.4
2.0	212	12.2	8.9	20.4
2.5	211	12.6	8.9	20.3
3.0	207	13.8	9.0	20.1
3.5	206	13.9	9.0	19.9

JUMPOFF JOE LAKE (STEVENS)**SEPT. 19, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	196	11.7	8.7	17.3
1.0	197	11.7	8.8	17.3
2.0	197	11.7	8.8	17.3
3.0	198	11.7	8.8	17.2
4.0	197	11.9	8.9	16.8
5.0	197	12.7	8.9	16.5
5.5	198	12.7	9.0	16.5

JUMPOFF JOE LAKE (STEVENS)**JUNE 20, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	-
0.8	66.7	
1.3	38.3	
2.3	24.5	
3.3	20.7	
3.8	3.9	

JUMPOFF JOE LAKE (STEVENS)**SEPT 19, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	-
1.3	53.2	
2.3	28.2	
3.3	16.1	
4.3	10.5	
5.3	6.3	

LONE LAKE (ISLAND)**JUNE 26, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	169	11.2	8.9	20.8
0.5	170	11.0	9.0	20.9
1.0	170	11.0	9.0	20.9
1.5	170	10.9	9.0	20.9
2.0	170	10.8	9.0	20.9
2.5	169	11.5	8.6	19.4
3.0	170	8.0	8.3	19.0
3.5	175	2.9	7.6	18.4
4.0	193	0.1	6.9	17.6

LONE LAKE (ISLAND)**SEPT. 25, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	167	9.4	7.8	18.5
1.0	168	9.1	7.9	18.5
2.0	168	9.0	7.9	18.5
3.0	168	8.2	7.8	18.4
3.5	169	8.1	7.6	18.2

LONE LAKE (ISLAND)**JUNE 26, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	-
0.8	70.7	
1.3	32.7	
1.8	16.0	
2.3	12.9	
2.8	8.1	
3.3	5.9	
3.8	3.3	
4.3	2.3	

MASON LAKE (MASON)
JUNE 28, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	52	10.4	7.3	18.5
1.0	52	10.0	7.4	18.6
2.0	52	9.9	7.4	18.6
3.0	52	9.9	7.4	18.6
4.0	52	9.9	7.4	18.6
5.0	52	10.0	7.5	18.5
6.0	52	9.9	7.5	18.4
7.0	52	10.1	7.5	17.7
8.0	52	10.3	7.5	17.2
9.0	51	10.7	7.4	15.6
10.0	50	11.1	7.3	12.7
11.0	50	10.7	7.2	11.1
12.0	50	10.2	7.1	10.2
13.0	49	9.9	7.0	9.8
14.0	49	9.7	6.9	9.7
15.0	50	8.9	6.9	9.5
16.0	50	8.3	6.8	9.1
17.0	49	8.3	6.7	8.9
18.0	49	8.3	6.7	8.8
19.0	49	8.2	6.7	8.6
20.0	49	8.0	6.7	8.5
21.0	49	7.2	6.5	8.3
22.0	49	6.5	6.5	8.2
23.0	48	6.5	6.5	8.2

MASON LAKE (MASON)
SEPT. 27, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	54	9.6	7.4	18.4
1.0	54	9.6	7.4	18.5
2.0	54	9.6	7.4	18.5
3.0	54	9.6	7.4	18.5
4.0	54	9.5	7.4	18.5
6.0	54	9.5	7.4	18.5
8.0	54	9.5	7.4	18.5
10.0	54	9.4	7.4	18.5
12.0	53	8.6	7.0	16.1
13.0	51	8.0	6.7	13.4
14.0	51	7.3	6.6	11.6
15.0	51	6.5	6.6	10.7
16.0	51	5.2	6.5	10.0
17.0	51	4.4	6.4	9.7
18.0	51	4.1	6.3	9.4
19.0	51	3.6	6.2	9.2
20.0	52	3.7	6.2	9.1
21.0	52	3.4	6.2	9.0
22.0	52	2.8	6.1	8.9
24.0	54	0.4	6.0	8.6

MASON LAKE (MASON)**JUNE 28, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	15.0
1.3	54.5	
2.3	40.1	
3.3	33.2	
4.3	27.1	
5.3	19.8	
6.3	15.1	
7.3	11.8	
8.3	8.7	
9.3	6.3	
10.3	4.6	
11.3	3.3	
12.3	2.3	
13.3	1.7	
14.3	1.2	
15.3	0.9	
16.3	0.6	
17.3	0.4	

OSOYOOS LAKE (OKANOAGAN)

JUNE 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	280	10.4	8.5	23.2
0.8	279	10.5	8.5	22.2
1.3	279	10.5	8.6	22.1
2.1	278	11.2	8.6	20.3
3.1	286	11.7	8.7	19.0
4.1	286	11.8	8.7	18.5
5.4	285	11.6	8.7	17.7
6.5	286	11.4	8.6	17.2
7.4	286	10.8	8.6	16.5
8.5	293	9.6	8.4	15.2
9.1	301	6.7	8.0	12.7
10.1	305	4.1	7.6	11.3
11.4	308	3.1	7.5	10.5
12.9	308	2.6	7.4	10.2
14.0	308	2.2	7.4	10.0
15.4	308	2.6	7.5	9.9
16.5	308	2.4	7.4	9.9
17.7	309	2.3	7.4	9.9
18.3	309	2.6	7.4	9.8

OSOYOOS LAKE (OKANOAGAN)

SEPT. 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	258	10.8	7.7	19.5
1.1	258	10.6	7.7	19.5
2.0	258	10.5	7.8	19.5
3.1	259	10.5	7.8	19.4
4.2	260	10.5	7.8	19.4
5.0	260	10.5	7.8	19.4
6.0	260	10.6	7.8	19.4
7.2	260	10.6	7.8	19.4
8.5	260	10.6	7.8	19.3
9.5	260	10.4	7.8	19.3
10.7	260	10.2	7.8	19.3
11.2	261	10.1	7.8	19.3
12.9	261	10.5	7.8	19.3
13.5	268	9.9	7.8	19.3
14.0	293	0.4	6.9	16.0

PACKWOOD LAKE (LEWIS)**JUNE 7, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	51	10.4	7.6	15.6
1.0	52	10.4	7.5	15.5
2.0	52	10.5	7.5	15.3
3.0	51	10.9	7.5	13.1
4.0	51	11.7	7.5	10.3
5.0	50	11.5	7.5	9.7
8.0	50	11.1	7.3	8.5
10.0	53	11.1	7.2	7.3
12.0	55	10.7	7.2	6.9
15.0	56	10.2	7.1	6.0
20.0	56	10.0	7.0	5.5
25.0	57	9.7	7.0	5.0
27.6	56	9.4	6.9	4.9

PACKWOOD LAKE (LEWIS)**SEPT. 5, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	50	11.8	6.7	15.9
1.0	51	11.8	6.7	15.9
2.0	51	11.7	6.7	15.8
3.1	51	11.9	6.7	15.5
4.0	52	11.9	6.7	15.4
5.1	52	12.1	6.7	15.3
6.2	53	12.7	6.6	14.6
7.6	54	12.7	6.5	13.4
9.1	53	12.8	6.4	12.6
10.1	54	12.9	6.3	11.2
11.0	57	12.9	6.3	8.7
12.0	58	12.9	6.2	8.2
14.1	58	12.5	6.2	7.5
16.3	57	11.9	6.1	6.9
18.3	57	11.5	6.1	6.3
19.6	58	11.2	6.0	6.1
22.2	58	10.6	5.9	5.7
24.3	58	10.6	5.9	5.6
26.2	57	10.1	5.9	5.4
27.1	58	10.1	5.9	5.4
32.8	58	9.2	5.8	5.2

SAMISH LAKE (WHATCOM)

JUNE 27, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	74	11.0	7.5	18.5
1.0	74	10.5	7.7	18.7
2.0	74	10.4	7.7	18.6
3.0	74	10.3	7.8	18.6
4.0	74	10.3	7.8	18.6
5.0	74	10.3	7.8	18.6
6.0	74	10.6	7.8	17.5
7.0	74	11.7	7.8	15.1
8.0	74	11.7	7.7	13.3
9.0	73	11.3	7.5	11.7
10.0	74	9.7	7.2	10.2
11.0	73	9.0	7.1	9.5
12.0	74	8.1	6.9	8.7
13.0	74	7.2	6.8	8.3
14.0	74	6.6	6.7	8.2
15.0	74	6.4	6.6	7.9
16.0	75	6.4	6.6	7.7
17.0	75	6.3	6.5	7.5
18.0	74	5.8	6.5	7.5
19.0	74	5.7	6.5	7.3
20.0	74	4.5	6.4	7.3

SAMISH LAKE (WHATCOM)

SEPT. 26, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	74	10.4	8.6	18.4
1.0	74	10.3	8.8	18.5
2.0	74	10.3	8.8	18.5
4.0	75	10.2	8.8	18.5
6.0	75	10.0	8.7	18.4
8.0	75	8.6	7.8	17.8
9.0	74	6.0	7.2	16.9
9.5	74	3.2	6.5	14.8
10.0	75	2.1	6.6	13.0
11.0	76	1.8	6.2	11.7
12.0	75	1.3	6.1	10.6
13.0	75	1.0	6.1	9.7
14.0	75	0.5	6.1	9.2
16.0	75	0.1	6.0	8.2
18.0	77	0.1	6.0	7.9
20.0	79	0.1	6.0	7.7

SAMISH LAKE (WHATCOM)**JUNE 27, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	14.3
2.3	74.7	
3.3	53.6	
4.3	38.9	
5.3	26.8	
6.3	19.3	
7.3	13.6	
8.3	9.4	
9.3	6.3	
10.3	4.3	
11.3	3.0	
12.3	2.0	
13.3	1.4	
14.3	1.0	
15.3	0.7	

SPRAGUE LAKE (ADAMS)**JUNE 21, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	376	8.6	8.0	17.8
0.5	378	8.1	8.1	18.0
1.0	377	8.0	8.1	18.0
1.5	378	7.9	8.1	18.0
2.0	378	7.8	8.1	17.9
2.5	378	7.8	8.1	17.9
3.0	378	7.8	8.1	17.9
3.5	378	7.8	8.1	17.9
4.0	378	7.7	8.1	17.8

SPRAGUE LAKE (ADAMS)**SEPT. 20, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	378	8.30	8.8	17.7
1.0	380	-	9.0	17.7
2.0	380	8.20	9.0	17.7
3.0	380	8.10	9.0	17.9
4.0	380	8.40	9.0	17.9

SPRAGUE LAKE (ADAMS)**JUNE 21, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	-
0.8	67.5	
1.3	45.0	
1.8	36.0	
2.3	22.5	
3.3	17.7	
3.8	12.6	
4.3	8.7	
4.8	6.6	

STEILACOOM LAKE (PIERCE)**JUNE 14, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	138	12.9	8.6	21.0
0.5	138	12.6	8.6	21.0
1.0	138	12.6	8.0	20.8
2.0	138	12.1	8.2	20.1
2.5	139	12.6	7.6	18.1
3.0	140	15.2	7.7	16.8
3.5	150	17.0	7.4	15.2
4.0	154	10.7	6.8	13.9
4.5	153	7.7	6.4	13.0
5.0	155	3.5	6.3	12.7

STEILACOOM LAKE (PIERCE)**SEPT. 13, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	137	13.8	8.8	21.2
1.0	136	14.3	8.8	20.2
2.0	136	13.3	8.7	19.9
3.0	138	10.6	8.0	19.1
3.5	138	7.7	6.9	18.4
4.0	142	2.9	6.4	17.5
4.5	144	0.5	6.3	16.7

STEILACOOM LAKE (PIERCE)**JUNE 14, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	
1.3	50.8	
2.3	9.4	
3.3	6.1	
4.3	6.3	
5.3	3.9	

STEILACOOM LAKE (PIERCE)**SEPT. 13, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	3.6
0.8	17.9	
1.3	11.3	
1.8	6.7	
2.3	2.4	
3.3	1.1	
4.3	0.8	
5.8	0.0	

SUMMIT LAKE (THURSTON)

JUNE 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	52	9.9	7.7	19.7
1.0	52	10.0	7.8	19.2
2.0	51	10.1	7.8	18.8
3.0	52	10.4	8.0	18.4
4.0	52	10.4	8.0	18.2
5.0	52	11.2	8.4	16.3
6.0	52	11.2	8.5	15.4
7.0	52	11.2	8.5	15.2
9.0	52	12.1	7.8	11.9
11.0	53	12.5	7.7	9.7
13.0	53	11.0	7.4	8.7
16.0	53	8.8	7.1	7.9
20.0	54	7.2	6.9	7.5
24.0	54	6.3	6.8	7.5

SUMMIT LAKE (THURSTON)

SEPT.5, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	52	11.8	6.9	20.0
1.0	53	11.6	6.9	19.8
2.0	53	11.9	6.9	19.6
3.0	53	11.8	7.0	19.5
4.3	53	11.9	7.0	19.4
5.2	53	11.9	7.0	19.4
6.6	53	11.8	7.0	19.2
7.8	53	11.8	6.9	19.1
8.9	53	11.4	6.8	18.9
10.6	53	11.8	6.5	16.7
12.3	52	9.3	6.1	12.6
14.2	54	5.5	5.9	9.7
16.0	54	4.2	5.8	8.9
18.2	55	3.1	5.7	8.3
20.3	56	2.0	5.6	8.2
21.0	56	1.6	5.5	8.0

SUTHERLAND LAKE (CLALLAM)**JUNE 7, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	139	10.1	8.0	18.7
1.0	139	10.1	8.0	18.8
2.0	139	10.2	8.0	18.7
3.0	139	10.7	8.0	18.3
4.0	139	11.6	8.2	15.5
5.0	139	11.9	8.2	15.0
6.0	141	12.7	8.3	13.8
7.0	141	13.7	8.3	12.8
9.0	141	15.1	8.5	9.8
11.0	141	14.4	8.4	7.8
16.0	140	8.7	7.5	5.6
21.0	141	5.2	7.2	5.2
23.6	147	0.5	7.0	5.2

SUTHERLAND LAKE (CLALLAM)**SEPT.5, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	142	12.2	7.5	18.6
1.0	142	12.1	7.5	18.8
2.0	142	12.1	7.5	18.8
3.0	142	12.1	7.5	18.8
4.0	142	12.1	7.5	18.7
5.0	142	12.1	7.5	18.8
6.0	142	12.2	7.5	18.8
8.0	142	13.5	7.5	18.7
9.0	144	19.3	7.9	15.9
12.0	141	17.8	7.7	9.9
14.0	143	16.6	7.2	8.7
16.0	143	12.9	6.7	7.3
18.0	143	0.4	6.4	6.2
20.0	145	0.3	6.5	6.0
22.0	147	0.1	6.2	5.7
24.0	154	0.1	6.0	5.6
24.4	159	0.1	5.9	5.6

TIGER LAKE (MASON)**JUNE 28, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	24	9.5	7.2	20.0
1.0	24	9.4	7.1	20.0
2.0	24	9.4	7.1	20.0
3.0	24	9.4	7.0	20.1
4.0	24	9.3	7.0	20.0
5.0	24	9.2	7.0	19.8
6.0	24	9.4	7.0	18.2
7.0	25	9.2	6.8	16.0
8.0	28	4.6	6.2	14.2
9.0	30	1.3	5.9	13.2
10.0	31	0.1	5.8	12.6

TIGER LAKE (MASON)**SEPT. 27, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	28	8.6	6.8	18.8
1.0	28	8.5	6.8	18.7
2.0	28	8.5	6.8	18.6
3.0	28	8.5	6.7	18.6
5.0	28	8.5	6.6	18.6
7.0	27	8.1	6.5	18.6
9.0	28	4.7	6.2	18.3
10.0	33	0.2	5.7	17.4

TIGER LAKE (MASON)**JUNE 28, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	9.3
1.3	46.2	
2.3	36.7	
3.3	27.3	
4.3	19.7	
5.3	12.4	
6.3	2.2	
7.3	1.6	
8.3	1.4	
9.3	1.0	
10.3	0.7	

WENATCHEE LAKE (CHELAN)

JUNE 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	27	11.6	7.2	8.5
0.7	27	11.5	6.8	8.5
1.3	26	11.5	6.7	8.4
2.0	26	11.5	6.7	8.4
3.9	26	11.5	6.7	8.4
5.4	27	11.5	6.7	8.4
6.2	27	11.6	6.7	8.4
7.4	27	11.5	6.7	8.3
9.0	27	12.5	6.7	8.3
11.9	27	11.5	6.7	8.1
14.2	27	11.6	6.7	8.0
16.9	27	11.6	6.7	7.8
20.1	27	11.6	6.7	7.7
23.4	27	11.6	6.7	7.7
26.1	26	11.5	6.7	7.3
29.9	26	11.6	6.7	7.2
35.0	26	11.5	6.6	7.1
39.3	26	11.5	6.6	7.0
44.4	26	11.5	6.6	6.9

WENATCHEE LAKE (CHELAN)

SEPT. 6, 1989

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	26	12.2	6.3	15.3
1.0	26	12.0	6.3	15.1
2.0	26	12.0	6.3	15.1
3.0	27	11.9	6.3	15.0
5.0	26	11.9	6.3	15.0
7.1	27	11.9	6.3	15.0
9.5	27	11.8	6.3	15.0
12.0	27	11.8	6.3	14.9
15.1	27	11.8	6.3	14.8
18.0	27	11.7	6.3	14.6
20.0	27	11.7	6.2	14.5
22.2	27	11.7	6.2	14.4
24.0	27	11.7	6.2	14.3
26.1	27	11.5	6.2	13.7
28.0	25	11.4	6.1	11.3
30.0	25	11.5	6.0	10.2
32.0	26	11.6	5.9	9.8
34.2	26	11.7	5.9	9.3
35.9	26	11.8	5.8	8.9
38.1	26	11.7	5.8	8.6
40.0	26	11.9	5.8	8.5
42.0	25	12.0	5.8	8.2

WILLIAMS LAKE (SPOKANE)**JUNE 21, 1989**

DEPTH	K	D.O.	pH*	TEMP
(m)	(umhos/cm)	(mg/L)	(S.U.)	(°C)
0.0	277	9.9	8.6	19.3
1.0	278	9.8	8.6	19.3
2.0	279	9.8	8.6	19.2
3.0	279	9.8	8.6	19.2
4.0	279	9.8	8.6	19.1
5.0	279	9.7	8.6	19.0
6.0	279	9.8	8.6	18.7
7.0	282	11.2	8.5	16.1
8.0	281	9.3	8.3	14.6
9.0	278	7.3	8.1	13.8
10.0	278	4.9	7.6	12.0
11.0	278	4.5	7.5	9.8
12.0	279	5.4	7.4	8.4
13.0	277	5.5	7.4	7.8
14.0	278	6.0	7.4	7.4
15.0	276	6.1	7.4	7.2
20.0	278	5.3	7.4	6.9
22.0	278	2.7	7.2	6.7
25.0	278	0.2	7.2	6.7
30.0	288	0.1	7.1	6.5

WILLIAMS LAKE (SPOKANE)**SEPT. 20, 1989**

DEPTH	K	D.O.	pH*	TEMP
(m)	(umhos/cm)	(mg/L)	(S.U.)	(°C)
0.0	275	9.0	8.9	20.0
4.0	270	9.0	8.9	20.0
8.0	268	8.9	8.9	19.9
12.0	279	1.8	7.7	15.6
16.0	280	2.0	7.6	11.4
20.0	280	0.7	7.5	10.7
24.0	285	0.5	7.5	10.3
28.0	291	0.1	7.3	10.3
32.0	300	0.0	7.3	10.3

WILLIAMS LAKE (SPOKANE)**JUNE 21, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	14.1
1.3	68.3	
3.3	30.4	
4.3	27.3	
5.3	23.2	
6.3	20.1	
7.3	14.5	
8.3	9.6	
9.3	6.4	
10.3	4.3	
11.3	3.0	
12.3	2.2	
13.3	1.5	
14.3	0.9	
15.3	0.8	
16.3	0.7	
17.3	0.6	

WOOTEN LAKE (MASON)**JUNE 28, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	36	9.7	7.1	20.2
1.0	35	9.5	7.2	20.4
2.0	34	9.4	7.2	20.4
3.0	35	9.4	7.2	20.4
4.0	34	9.4	7.2	20.3
5.0	34	10.1	7.2	19.5
6.0	34	12.7	7.3	17.8
7.0	33	13.2	7.4	15.2
8.0	33	12.9	7.4	13.8
9.0	35	8.4	6.7	12.4
9.5	36	6.1	6.5	11.9

WOOTEN LAKE (MASON)**SEPT. 27, 1989**

DEPTH (m)	K (umhos/cm)	D.O. (mg/L)	pH* (S.U.)	TEMP (°C)
0.0	36	9.1	7.1	19.0
1.0	36	9.0	7.2	19.0
2.0	36	8.9	7.1	19.0
3.0	36	8.9	7.1	19.1
4.0	36	8.9	7.0	19.1
5.0	36	8.8	7.0	19.1
6.0	36	8.5	7.0	19.1
7.0	37	8.0	6.9	19.1
8.0	37	8.4	6.7	19.1
8.5	42	4.2	6.1	18.8
9.0	42	0.2	6.2	17.9

WOOTEN LAKE (MASON)**JUNE 28, 1989**

DEPTH(m)	PERCENT TRANSMISSION	COMPENSATION DEPTH
0.0	100.0	
1.3	66.4	
2.3	55.1	
3.3	44.4	
4.3	34.7	
5.4	25.3	
6.3	19.7	
7.3	12.5	
8.3	6.7	
9.3	1.9	

APPENDIX C. Major cations and anions in Deep Lake on
September 19, 1989.

Major Cations	Epilimnion	Hypolimnion
Ca	48.9	-
Mg	13.5	-
K	0.82	-
Na	2.08	-
Major Anions		
SO ₄	16.3	31.8
Cl	0.57	0.76
HCO ₃	147	186
CO ₃	<1	<1

"-" hypolimnion sample was lost due to lab error.