WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Water Quality Assessments of Selected Lakes within Washington State

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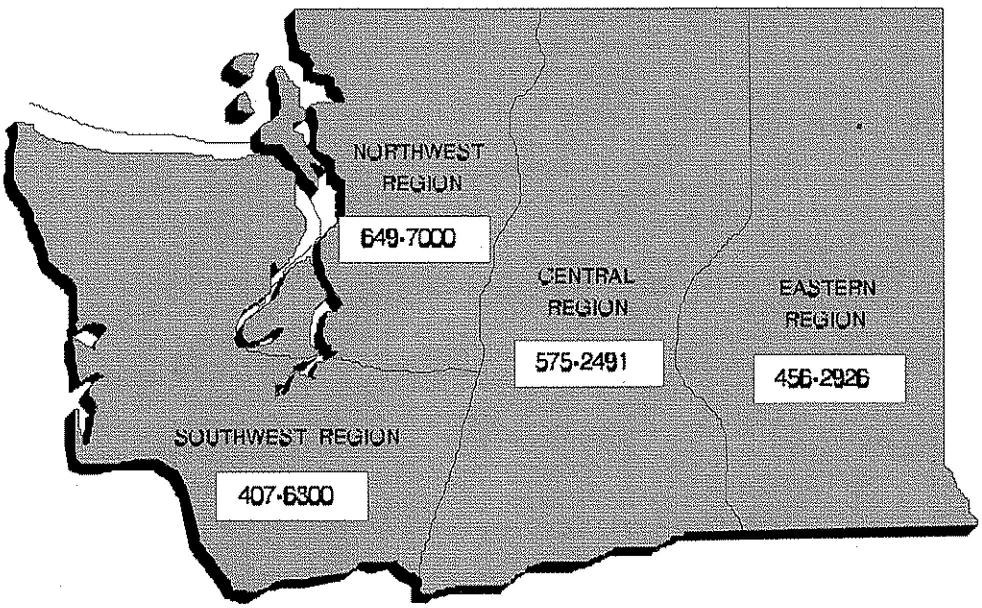

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1994

prepared by
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Olympia, Washington 98504-7710

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The success of Ecology's Lake Water Quality Assessment Program depends on volunteers to assist in the data collection process. The following people volunteered their time to collect lake data during 1994.

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Washington's Citizen Lake Monitoring Project costs approximately $120,000 annually. During 1994, approximately 29% of the project was funded by a Federal Clean Water Act 314 grant, 31% by a Federal 205 (j) grant, and 40% by matching state monies. Continued federal support of this program is greatly appreciated by Ecology staff, as well as by the volunteers who participate in the program.

Executive Summary

The objectives of Ecology's Lake Water Quality Assessment Program are to identify lakes that are exhibiting water quality problems, to assess significant publicly-owned lakes by estimating the trophic status of monitored lakes, and to promote public awareness of lake ecology and protection.

In 1994, volunteers participating in Washington's Citizen Lake Monitoring Program measured Secchi disk transparency and surface water temperature in 55 lakes; volunteers monitored their lakes bimonthly from May through October. Most volunteers also completed a questionnaire on lake and watershed uses. To supplement volunteer-collected data, Ecology staff collected water samples and profile data from all volunteer-monitored lakes, as well as 18 lakes that were not monitored by volunteers. Water samples were collected in May and August from both the epilimnion and hypolimnion of stratified lakes, and were analyzed for total phosphorus, total nitrogen, and chlorophyll *a*. Samples for total suspended solids, total nonvolatile suspended solids, and fecal coliform bacteria were also collected from selected lakes.

Carlson's Trophic State Index (1977) was calculated for volunteer-collected Secchi depth data and Ecology-collected phosphorus and chlorophyll *a* data. Trophic state estimations based on these calculations and an evaluation of other data were assigned to a total of 73 lakes: 32 lakes were oligotrophic or oligo-mesotrophic, 26 lakes were mesotrophic or meso-eutrophic, 14 lakes were eutrophic, and one lake was hyper-eutrophic.

Statistical trend in water clarity was evaluated for 29 lakes that were monitored by volunteers for at least five consecutive years. Using the seasonal Kendall test for trend, ten lakes exhibited statistically significant increasing trend in water clarity, and five lakes exhibited statistically significant decreasing trend in water clarity. For many of the monitored lakes, water clarity was better in 1994 than during previous years, which appears to be reflected in the results of trend analysis.

This report includes a compilation of the 73 lake assessments (reports) which were written in laypersons' terms and include data results from 1994.

Introduction

The purpose of this report is to describe the 1994 Lake Water Quality Assessment Program, and to present data and individual lake assessments from 73 lakes which were monitored by volunteers and/or Ecology staff in 1994. For expediency, this report is much abbreviated compared to past reports. A more thorough evaluation of the data is planned for future reports.

Program Objectives

The goal of the Lake Water Quality Assessment (LWQA) Program is to assess the current water quality of publicly-owned lakes in Washington, and to maintain a relationship with volunteers of monitored lakes for data exchange, education, and technical assistance. Specific objectives for the 1994 program were as follows:

1) determine the trophic status of monitored lakes;
2) assess water quality in lakes not evaluated in the last five years and determine the degree to which beneficial uses are supported;
3) promote public awareness of lake processes and lake protection measures and foster a conservation ethic;
4) determine trends once a sufficiently long period of record is established; and
5) establish a data set for analysis and dissemination.

History of LWQA Program

Ecology's LWQA Program was established in 1989 to gather general water quality information from significant, publicly-owned lakes. Data collected from the program are used primarily to assess each monitored lake for the state's biennial Water Quality Assessment (305 (b)) Report. Lake water quality assessments are required under Section 314 (a)(2) of the Clean Water Act, as amended by the Water Quality Act of 1987. For the purposes of reporting water quality assessments, significant, publicly-owned lakes cover at least 20 acres, have a public access, and support or have the potential to support the fishable-swimmable goals of the Clean Water Act (Ecology, 1992).

Since the program began in 1989, it has been funded from federal grants--Federal 314 Water Quality Assessment grants, and 205(j) Water Quality Management and Planning grants--as well as matching state monies. As a result, program elements have varied each year due to varying funding levels. The following reports describe program activities and results for each year of the monitoring program:

1989 Lake Water Quality Assessment Project, 1989 (Rector and Hallock, 1991).

Water Quality Survey of 25 "Citizen-Volunteer " Lakes From Washington State (Brower and Kendra, 1990).

	1989 Lakes and Reservoir Water Quality Assessment Program: Survey of Chemical Contaminants in Ten Washington Lakes (Johnson and Norton, 1990).
1990	Lake Water Quality Assessment Project, 1990 (Rector and Hallock, 1993).
	Water Quality Survey of 15 "Volunteer-Monitored" Lakes in Washington State (Coots, 1991).
1991-1992	Lake Water Quality Assessment Program, 1991-1992 (Rector, 1994).
	Survey of Chemical Contaminants in Ten Washington Lakes (Serdar *et al.*, 1994).
1993	Lake Water Quality Assessment Program, 1993 (Rector, 1996).
	1994 Statewide Water Quality Assessment Lakes Chapter, Companion Document to Washington State's 305(b) Report (Rector and Hallock, 1995).

Methods

Methods for lake selection, data collection, sample analysis, and data analysis are described below. Methods for quality assurance and quality control (QA/QC) of data collected for the program are discussed in the "QA/QC Evaluation and Results" section that follows this "Methods" section.

Volunteer Recruitment and Lake Selection

All Washington lakes that cover at least 20 acres and have a public access are eligible for inclusion in the volunteer monitoring program. Approximately 1,000 lakes in Washington meet these criteria, although the exact number is unknown (Rector and Hallock, 1995).

The main factor for selecting lakes was whether someone volunteered to monitor a lake for the program. Volunteers were recruited through press releases, or were referred to the program by Ecology staff, county offices, or from other volunteers. Potential volunteers were accepted into the program if they indicated that (1) they wanted to monitor an eligible lake, (2) they were willing and able to collect monitoring data for the six-month monitoring period, and (3) they had access to a boat to use while collecting data.

Ecology coordinated lake selection with local volunteer lake monitoring programs in King County (coordinated by METRO) and Snohomish County (coordinated by Snohomish County Department of Public Works). Some lakes were monitored by Ecology as well as King County's Small Lakes Program and Snohomish County's Volunteer Lake Monitoring Project, with the intent of comparing information for QA/QC purposes.

To support the monitoring phase of Ecology's watershed approach to water quality management, 18 lakes were sampled by Ecology staff within the Spokane, Lower Yakima, Cedar/Green, and Eastern Olympics basins.

In summary, each year of monitoring includes a group of lakes which have been monitored by volunteers over a long period (which allows for trend analysis), a group of lakes relatively new to the program whose volunteers may or may not continue over a long period, and a group of lakes monitored by Ecology staff for watershed-based permitting and planning purposes. Only the latter group of lakes are selected primarily because of a lack of data and geographical considerations.

Field Methods

There were two separate field data collection efforts for the program: (1) Volunteers measured Secchi depth and surface water temperature on a relatively frequent basis; and (2) Ecology staff collected water samples, profiles, and qualitative information on algae and macrophytes during two field visits with the volunteers. Each of these data collection efforts is described below.

Volunteer-Collected Data and Information

All volunteers measured Secchi disk transparency and surface water temperature from one lake station (the deepest site). Data were collected between 10 a.m. and 2 p.m., approximately every two weeks from mid-May through mid-October. Water clarity was measured by leaning over the shady side of a boat, lowering a 20 cm diameter limnological style Secchi disk until it was no longer visible, and then slowly raising the disk until it was just barely visible. This depth was then read from the line attached to the Secchi disk (which is marked at one-foot intervals) and recorded to the nearest 1/4 foot. The procedure was performed twice during each sampling trip. If the Secchi disk hit the lake bottom and was still visible, or was obscured by macrophyte growth, this was indicated on the data reporting card (Appendix A). The Secchi disks used by volunteers were made by Ecology staff, using methods described in Rector and Hallock (1991).

Surface water temperature was measured using red alcohol pocket thermometers. Two styles of pocket thermometers were used: a BCR model (range -40 to 50°C) and a model from Bacharach Instrument Company (range -35 to 120°F). Surface temperature was measured by holding the thermometer six to eight inches below the water surface until temperature equilibrated. The temperature was then quickly read, and recorded on the data card to the nearest 0.5 degree. Subjective assessments of weather conditions and water color were also reported on the data cards.

Each new volunteer was trained by Ecology staff at his or her monitoring site during the May surveys (see discussion below). New volunteers were provided with a summary of monitoring instructions, monitoring equipment (Secchi disk and thermometer), a bathymetric map showing the location of their monitoring site, and business-reply data cards for mailing in data. Each volunteer was also provided with a vial containing a small amount of Lugol's solution, to be used for collecting an algae sample. Collecting algae samples was optional, but having the vial readily available made it easier for volunteers to collect and preserve a sample from an algae bloom. Algae identification was provided by Ecology.

To reduce the effect of reflections and wave action on Secchi depth, volunteers were provided with viewing tubes made by Ecology staff. The materials and methods used for these tubes are shown in Appendix B. Volunteers were asked to measure Secchi depth without the viewing tube, and then with the tube, on each of their regular monitoring days. The greatest attainable depth, either with or without the tube, is considered to be closer to the true Secchi depth. It is this depth we are attempting to record for lake assessment purposes. Secchi depths measured with and without the tubes were also recorded during the onsite visits with Ecology staff, so that a determination could be made whether use of the viewing tube increased Secchi readings. Results of these evaluations are in the "QA/QC Evaluation and Results" section of this report.

All volunteers were mailed a questionnaire near the end of each monitoring season on lake and watershed uses (Appendix C). The purpose of these questionnaires was to gather additional information from the monitored lakes that may be used when assessing the lakes. Several questions required the volunteers to make additional observations around their lakes (e.g., counting the number of nearshore homes). Questionnaire results for each lake are presented with the individual lake assessments at the end of this report.

Data Collected by Ecology Staff

Ecology staff visited most of the volunteers twice in 1994; the first visit occurred during late May or early June, and the second occurred during late August or early September. The purpose of these visits was to: (1) observe the volunteer's Secchi disk reading technique and compare to the Ecology staff reading, to determine whether the volunteer needed suggestions for improving his or her technique; (2) collect profile data and water samples from the volunteers' sampling sites; (3) collect macrophyte and/or algae samples for identification; and (4) answer questions or discuss lake issues with each of the volunteers.

During each field visit, the volunteer took staff from Ecology to their monitoring site, and anchored if possible. The volunteers and Ecology staff each measured Secchi depth. Temperature, pH, dissolved oxygen, and conductivity were profiled using a Hydrolab® Surveyor II or Sonde 3/Surveyor III. Temperature profile data were used to determine whether the lakes were stratified, and if they were, to determine depths within the epilimnion and hypolimnion for collecting water samples. Weather conditions, water color, and general observations about the lake were recorded. If an obvious algal bloom was occurring, a sample was collected for later identification. Plant samples were either identified onsite, or collected for later identification. Algae and macrophyte samples were collected for qualitative purposes only, and results are not inclusive of all species present.

During each onsite visit, water samples for total phosphorus (TP), total persulfate nitrogen (TN), and chlorophyll *a* were collected using a Kemmerer style water sampler, and were composited from two to three equidistant depths within the strata (epilimnion or hypolimnion) sampled (Table 1). The epilimnion and hypolimnion are both determined by using the hydrolab profile data. The top layer of water before water temperatures begin to fall at a rate of 1° C/meter is designated as the epilimnion. The bottom layer of water where the temperature is no longer falling at 1° C/meter is designated as the hypolimnion. Lakes that were not thermally stratified were sampled from the epilimnion only. Samples for turbidity were collected from the epilimnion of the lakes at the same sites and sample depths as the nutrient samples. Lakes to be sampled for turbidity were selected, in part, by the likelihood that the turbid waters observed in the field are largely due to sedimentation as opposed to algal growth. Sedimentation would decrease Secchi depth, thereby distorting Secchi TSI values.

Table 1. Analytical methods used for samples collected for the LWQA Program.

Parameter	Strata Sampled[1]	Sample Preservation[2]	Analytical Method	Method Detection Limit	Holding Time	Analytical Lab[3]
Total Phosphorus	epilimnion, hypolimnion	H_2SO_4 to pH<2	SM 4500-P D	3 µg/L	28 days	EWU
Total Nitrogen	epilimnion, hypolimnion	H_2SO_4 to pH<2	EPA 353.2	0.010 mg/L	28 days	MEL
Chlorophyll *a*[4]	epilimnion	$MgCO_3$[5]	SM 10200H (2,B)	0.5 µg/L	28 days	EWU
Turbidity	epilimnion			1 NTU		MEL
Fecal Coliform Bacteria	nearshore grab samples (2 sites)		SM 9222D	1 colony/ 100 mL	30h	MEL

1 All samples within a strata, except fecal coliform bacteria were composited
2 All samples were kept on ice or stored at 4°C until delivery to the lab, or until filtered
3 Manchester Environmental Laboratory (MEL), or the Limnological Laboratory at Eastern Washington University (EWU)
4 Corrected for pheophytin
5 Approximately 2 mL saturated $MgCO_3$ added with last of filtrate onto filter. Packaged filters were iced, or frozen, until delivered to the lab.

Two fecal coliform bacteria samples were collected from selected lakes during May and August 1994. Samples were collected approximately 20-35 feet from shore, in areas which appeared (to the sampling staff) to have some potential source of bacteria. Fecal coliform bacteria sample bottles were filled by "scooping" water from about eight inches below the water surface, to avoid surface films.

All samples, except those for chlorophyll *a*, were transported on ice to the lab and stored at 4°C. Chlorophyll *a* samples were filtered through Whatman 4.7 cm GF/C filters as soon as possible after collection. For most samples, 1,000 mL aliquots were filtered. About 2 mL of saturated

$MgCO_3$ was added to the last of the filtrate to preserve the sample on the filter. Filters were placed in small plastic petri dishes, then wrapped in foil, and the lab number and volume of sample filtered was written on the foil. Packaged filters were bagged and stored in ice while in the field, and kept in a freezer until transported to the lab for analysis.

Sample Analysis Methods

Methods used for sample analyses are listed in Table 1. Sample preservation and analytical methods used by Manchester Environmental Laboratory (MEL) are from Huntamer and Hyre (1991).

Keys used for algal identifications were Smith (1950), Edmondson (1959), Prescott (1962; 1978), and VanLandingham (1982). Keys used for macrophyte identifications were Hitchcock and Cronquist (1973), Tarver *et al.* (1978), and Prescott (1980).

Methods Used for Estimating Trophic Status

Carlson's (1977) trophic state indices (TSI) for Secchi depth (TSI_{SD}), total phosphorus (TSI_{TP}), and chlorophyll *a* (TSI_{CHL}), tempered with some professional judgment, were used to estimate the trophic status of the monitored lakes. In general, TSIs of 40 or less indicate oligotrophy, TSIs between 40 and 50 indicate mesotrophy, and TSIs greater than 50 indicate eutrophy (Carlson, 1979). To describe lakes which appeared to be between trophic states, the terms "oligo-mesotrophic" and "meso-eutrophic" were used.

TSI_{SD} values were calculated from a time-weighted mean Secchi depth calculated from all Secchi data collected between May and October 1994. The rationale for using a time-weighted TSI_{SD} is discussed in Rector (1994). A minimum of five Secchi depth measurements separated by at least two weeks was used to calculate the TSI_{SD} for each lake. Data invalidated by the QA/QC evaluation (below) were excluded from the TSI_{SD} calculations. TSI_{TP} and TSI_{CHL} values were calculated separately for each of the May and August results.

It is not legitimate to average TSI values from different trophic state parameters, and to use that average to summarize a lake's trophic status. According to Carlson (1977), "the best indicator of trophic status may vary from lake to lake and also seasonally, so the best index to use should be chosen on pragmatic grounds." Therefore, a subjective assessment of all data collected during the monitoring season was used to determine which index to use for assigning trophic states. Then monitoring data, other available survey information[1], and information from the volunteers (e.g., information on aquatic herbicide use), were used to temper the trophic state assessment for some lakes. As a result, the trophic state estimations were not based on TSI alone, and were not

[1] sources of other information included the water quality surveys from 1989 and 1990 (Brower and Kendra, 1990; Coots, 1991), consultant reports from Ecology-funded lake restoration activities, and lake surveys conducted by universities.

necessarily based on the same parameters for all lakes. The basis for each trophic state assessment is discussed in the Comments section of the Individual Lakes Assessments at the end of this report.

QA/QC Evaluation and Results

The following section summarizes data quality evaluations of Secchi depth data collected by the volunteers, profile data measured by Ecology staff with the profiling instrument, and water chemistry results from water samples analyzed by laboratories. A more detailed discussion of QA/QC methods used for this program is in Lake Water Quality Assessment Program Quality Assurance Project Plan (Hallock, in draft). Table 2 summarizes the LWQA Program's data quality objectives. Laboratory QA/QC results for all parameters are listed in Appendix D.

Table 2. Summary of data quality objectives for the Lake Water Quality Assessment Program.

Parameter	Detection Limit	Precision	Accuracy (Bias)
Secchi Depth	--	CV <10% (daily pairs) median CV <5% (all pairs/ lake)	CV <10% (volunteer/Ecology)
Total Phosphorus	5 µg/L	median CV ≤ 7.5% (lab splits) median CV ≤ 21% (field dups)	≤ 2.5% relative bias (lab check standards) 80-120 % recovery (matrix spikes)
Total Persulfate Nitrogen	0.050 mg/L	median CV ≤ 7.5% (lab splits) median CV ≤ 30% (field dups)	≤ 5% relative bias (lab check standards)
Chlorophyll *a*	0.5 µg/L	median ≤ 10% (field splits)	≤ 2.5% relative bias (lab check standard)
Profile parameters			
Temp.	--	--	± 0.5 degree C
pH	--	--	± 0.2 SU
DO	--	--	± 0.30 mg/L
spec. cond.	--	--	± 5 µmho/cm
Fecal Coliforms	1 colony/100 mL	CV ≤ 35% (lab splits)	--
Turbidity	1 mg/L	± 0.5 NTU (lab splits)	--

Source of information: Hallock (1995, in draft)

Volunteer-Collected Secchi Data

On each sampling date, volunteers measured the Secchi depth two times. The coefficient of variation (CV) was calculated for each pair of Secchi depth readings, to evaluate the volunteers' abilities to reproduce their measurements. Although this is summarized as "precision" in Table 2, it should be apparent that the two sets of readings cannot be collected independently of each other, so the estimation of precision may be biased. Pairs which exceeded the requirements in the data quality objectives were not used in calculations of trophic state indices (TSI_{SD}).

For volunteers who measured Secchi depth using one method (*i.e.,* with tube for both or without tube for both), overall variability for each volunteer was evaluated using the median CV for all pairs of duplicate readings. Overall variability could not be evaluated for volunteers who measured Secchi depth once with and once without the view tube on each sampling day. In these cases the quality assurance evaluation relied mainly on the side by side comparisons with Ecology staff.

During the two field visits with the volunteers, Secchi depth was measured by both Ecology staff and the volunteers. The CV was calculated for Secchi depths measured during these field visits to evaluate the "accuracy" of the volunteers' measurements (assuming the Ecology staff reading was the "standard"). The Ecology staff reading is considered the standard since it is the only consistent observer from lake to lake.

Overall it was apparent that the majority of volunteers cannot see the disk as deep as Ecology staff. (This was also documented in Rector (1995 draft); Rector and Hallock (1993).) In an attempt to improve Secchi depth readings collected by volunteers, viewing tubes were made by Ecology staff and distributed to volunteers in 1993 (Rector, 1995 draft). Comparisons between volunteer-measured Secchi depths and Ecology staff-measured Secchi depths were made during the field visits. Based on improved "accuracy" using the viewing tubes, a few volunteers were asked to use a viewing tube for all their Secchi disk readings. Other volunteers use the tube as needed, indicating on the reporting card when the tube was used, or consistently report readings collected with, and without, the tube. Except for those volunteers who need to use the tube to increase "accuracy," most measurements made without tubes were used when both "with" and "without" readings were reported. This allows for readings collected before 1994 (including historical data) to be compared to readings collected for the current program. One exception is Lake Wenatchee, which is frequently choppy due to high winds in the area. The viewing tube has made it much easier for the volunteer to measure Secchi depth at this lake.

Profile Data

The Hydrolabs were pre- and postcalibrated daily for pH and dissolved oxygen. The manufacturer's instructions were followed for pH calibration, using pH 7 (low ionic strength) and pH 10 (high ionic strength) standard buffer solutions. Postcalibration readings ≤ 0.2 pH unit of the standard buffer values were considered acceptable. Dissolved oxygen of the Hydrolab Surveyor II was checked against the mean of three azide-modified Winkler titrations; dissolved oxygen concentrations from the Sonde 3/Surveyor III unit were checked against the theoretical water-saturated air method as well as field samples collected for Winkler titrations. Postcalibration results ≤0.3 mg/L of the comparison methods (Winkler or theoretical) were considered acceptable. Specific conductance, a more stable parameter on the Hydrolab, was checked periodically using the manufacturer's instructions. Potassium chloride standards used for conductivity calibration ranged from 101 to 105 µmhos/cm at 25°C (the molarity varied between individual solutions used). Postcalibration values ≤5 µmhos/cm of the standard value were considered acceptable. Temperature was also checked periodically against a National Institute of Standards and Technology (NIST) thermometer. Values within 0.5°C were considered acceptable.

Hydrolab postcalibration data were outside acceptable ranges for the following lakes and surveys:

May Survey		**August Survey**	
Dissolved Oxygen	pH	Dissolved Oxygen	pH
Byron	(none)	Wenatchee	North Pattison
Bosworth		Cortez	Phillips
Buck		Lone	Sawyer
Island		Goss	Tiger
Limerick		Cranberry	Wooten
Long (Kitsap County)		Ellen	Wye
Mason			
Nahwatzel			
Roesiger			
Stevens			
Summit			
Trails End			
Wooten			

Data for the parameters and lakes listed above are not reported here. Hydrolab post-calibration data are compiled in Appendix E.

Total Phosphorus Data

Methods used in this report for evaluating the quality of TP data (Hallock, in draft) were specified after the 1994 samples were collected. As a result, some evaluations are not complete. The following discuss laboratory quality control (QC), and total variability determined from results of field duplicates.

Laboratory QC

Total phosphorus data from both surveys were acceptable, based on results from lab blanks, lab duplicates, and lab check standards (Appendix D). However, a few high values for blanks (one total phosphorus transport blank, and a chlorophyll post-filter blank) suggest that one of the distilled water carboys was contaminated. In the future, clean containers will be used for carrying distilled water in the field.

An additional check on laboratory quality control was to submit diluted standards as "blind" samples. Results from these blind standards were compared against the 95% confidence intervals provided in the literature with the samples. However, because the standards had to be diluted

considerably to be in the expected range of lake samples, the ranges of the extrapolated confidence intervals (calculated from equations provided with the standards) were extremely wide (e.g., 6.9 µg/L to 53.8 µg/L for a known TP concentration of 15 µg/L). Results from both sets of blind standards were considered acceptable (Appendix D).

Field Variability Evaluated from Field Duplicates

Samples were collected at a second site from 10 lakes during each survey. The ten lakes were chosen according the requirements of the QAPP which essentially require the 10 lakes to represent the broad spectrum of phosphorous concentrations found in lakes throughout the state. The second site was chosen to represent a second deep site on the lake with a distance of at least 100 meters from the first site (if possible, depending on the size of the lake). These samples were collected to evaluate the representativeness of collecting epilimnetic data from a single lake station. Results from the two stations are evaluated using the median CV from all pairs.

Results in Table 3 show that the median CV value was higher during the May survey than during the August survey. Also, the median CV for the May survey exceeded the program's limit of ≤ 21% for field duplicates. As stated in the quality assurance project plan (QAPP) to achieve spatial plus analytical variability within ±5 TSI units using one sample per lake, the median CV of 10 duplicate samples must be ≤21%. The majority of the total variability in Table 3 was likely due to field variability, because lab variability was relatively small; laboratory precision, which was calculated from field duplicate samples analyzed by the lab in duplicate, was 3.1% for the May survey, and 2.8% for the August survey (Appendix D).

Table 3. Total precision of field duplicates.

Field Duplicates	n	min, max CV%	median CV%
May survey	10	10.9 - 85.7	34.4
August survey	9*	3.0 - 63.3	13.5
both surveys	20	3.0 - 85.7	29.4

* result for one lake was not used; the site one result was 103.0, and site two was 3.8; the result from the lab splits from the site two sample was 3.8 and 4.1.

A nested analysis of variance was used to evaluate the relative contribution of lake, season, and station to overall variability in TP concentrations in 1994 (Table 4). There was a significant difference in TP between lakes ($P = 0.001$), which fulfills a basic assumption of the LWQA Program. Further, within lakes that were sampled at two stations during both surveys, there was not a significant difference between stations ($P = 0.797$), but there was a significant difference between the May and August TP concentrations ($P = 0.002$).

Table 4. Variance in TP due to lake, season, and station, for lakes that were sampled at a second station during both surveys in 1994.

source of variation	df	SS	P	Significance
Lake	7	9145.165	0.001	S
site within lakes	7	250.407	0.986	NS
season within lakes	7	2328.395	0.002	S

There are not enough data available to evaluate trend in total phosphorus. However, in Rector (1995, in draft) a two-level nested Anova was used to estimate the variance components among years, among lakes, and within seasons (within years). Data were used from 31 lakes which had been sampled for the LWQA Program, during both seasons, from 1992 through 1994. From this Anova, it was apparent that the greatest source of variation was lake, and within lakes the greatest source of variation was season, followed by year.

Other Water Chemistry Data

QA/QC evaluations for total nitrogen, chlorophyll *a*, solids, and fecal coliform bacteria followed most of the methods described in Hallock (1995, in draft). All available lab QC data results are listed in Appendix D.

Total Nitrogen

Based on results from analytical blanks, the detection limit required for the LWQA Program was met during both surveys. Laboratory precision, evaluated from results of lab splits, was within acceptable limits for the LWQA Program. However, the lab did not replicate any of the field duplicate samples that were marked for lab duplication. As a result, the contribution of lab variability to total variability could not be assessed.

Unfortunately, no blind standards were submitted during the August survey. Based on the following lab QC results, the August TN data will not be used.

1) Results for the 0.15 mg/L standard were above acceptable limits for the first batch.
2) Results from a 0.608 mg/L standard were above acceptable limits for the first and second batches.

3) All second batch results were qualified by the lab because samples were not kept at 4°C until analysis (the sample cooler broke down at the lab during a weekend).
4) No results from the third analyzed batch were available.
5) Lab QC sheets for the first batch had results for lab duplicates that did not meet internal lab QC standards for precision.

Lab precision was acceptable according to limits in the LWQA Program QAPP, because the current criteria is a median CV ≤ 7.5 % for all pairs. The August data are "failed" due to unacceptable accuracy, compounded with the refrigerator problem that qualified results for the second batch of samples.)

Chlorophyll a

Total precision of chlorophyll *a* was reported as the median CV% of field duplicates. Results for both surveys exceeded the Program QAPP limit of ≤ 10% (results were 16.5% in May, 15.2% in August). This may be due, in part, to the very low concentrations in roughly half of the lakes sampled in duplicate. The critical concentration that distinguishes an oligotrophic lake from a mesotrophic lake is 2.64 µg/L, and both results for 7 of the 12 lakes sampled were well below this concentration.

As noted in Rector (1995, in draft), formal QC procedures are not available for chlorophyll *a* analysis--most labs do not run lab check standards for chlorophyll, relying instead on periodic calibration of the instrument. Also, lab splits are not possible because of the small volume of extracted sample. As shown above, results from field duplicates were highly variable, but information was not available to evaluate how much of that total variability was due to lab procedures or sample processing procedures. Until that information is available, it is premature to evaluate seasonal variation in chlorophyll data.

The problem with significant digits discussed in Rector (1995) was also a problem with the 1994 data. This affected the resolution of the test, and limited the use of absorbance ratios to evaluate sample integrity. If the spectrophotometric method is used to analyze chlorophyll samples for the LWQA Program, the cell path must be longer than 1 cm, and large sample aliquots (*i.e.,* 1000 mL) must be filtered.

Turbidity and Fecal Coliform Bacteria

All results for lab splits of turbidity samples were within the acceptable limit of ± 0.5 NTU.

Precision of fecal coliform bacteria data was evaluated using results from lab duplicates (Table 2). Results from all lab duplicates were within the acceptable limit. Although results from one lab split sample (collected in a 500 mL bottle, and split by the lab) were above the limit, the rest of the data indicated that the results were acceptable for this program.

Results and Discussion

Trophic State Assessments

Trophic states were assigned to 73 lakes (Table 5). The basis for the trophic state assessments are explained in each lake's Individual Lake Assessment (compiled at the end of this report).

Most monitored lakes were oligotrophic, oligo-mesotrophic, or mesotrophic. The number of lakes falling into each trophic state were as follows:

Oligotrophic	15
Oligo-mesotrophic	17
Mesotrophic	19
Meso-eutrophic	7
Eutrophic	14
Hyper-eutrophic	1

Statistical Trend in Water Clarity

Trend in water clarity was evaluated for 29 lakes which were monitored by volunteers for at least five consecutive years. The software package WQHYDRO (Aroner, 1994) was used for data analysis. (Sixteen of the 29 lakes had significant serial correlation.) Using the seasonal Kendall test for trend, 10 lakes exhibited significant improvements in water clarity (Table 6). For many of the monitored lakes, water clarity was better in 1994 than during previous years, which affected the trend analysis and the increase slope of Secchi depths.

Climatic variations most likely affected the lakes in 1994. The 1993 growing season was noticeably cool and cloudy, whereas the growing season in 1994 was unusually dry, clear, and warm.

Because there are gaps in the period of record for total phosphorus data (there are no total phosphorus data for the program in 1991), and because water samples are collected from lakes only two times per year, trend analysis of nutrient data do not have sufficient power to be meaningful until 1996 at the earliest.

Relationships Between Trophic State Parameters

Carlson's (1977) Trophic State Index has been very useful for evaluating data collected for the LWQA Program. Primarily the TSIs have been used by the LWQA Program to assess the trophic status of monitored lakes--TSI values less than 40 are typical of oligotrophic lakes, and TSIs greater than 50 are typical of eutrophic lakes (Carlson, 1979).

Table 5. Trophic states and trophic state indices for lakes monitored in 1994. The "assessed trophic state" is based on an evaluation of TSIs and other available data.

Lake (County)	mean SD (ft) non weighted	TSIsd non weighted	mean SD (ft) weighted	TSIsd weighted	TSItp May	TSIchl May	TSItp August	TSIchl August	Assessed Trophic State
ALICE	11.3	42.2	10.4	43.4	51.4	45.6	37.2	43.5	Mesotrophic
BIG MEADOW	12	41.6	11.7	41.7	48.3	32.1	48.1	41.9	Mesotrophic
BLACK (STEVENS)	16.4	37.1	16.4	36.8	51.0	35.4	36.0	34.8	Oligo-mesotrophic
BLACK (THURSTON)	--	--	--	--	58.8	50.0	57.9	59.4	Eutrophic
BLACKMANS	12.2	41.3	11.3	42.2	48.8	45.4	49.8	49.4	Mesotrophic
BOSWORTH	15	38.3	14.3	38.7	37.1	34.5	30.7	41.8	Oligotrophic
BUCK	8.4	46.7	8.4	46.5	57.1	46.0	50.9	41.1	Meso-eutrophic
BYRON	--	--	--	--	92.3	72.1	91.1	77.1	Hyper-eutrophic
CAIN	14	39.5	14.3	38.7	40.0	38.3	37.9	38.1	Oligo-mesotrophic
CARLISLE	3.3	62.8	2.9	61.8	77.4	73.6	65.9	48.7	Eutrophic
CHAMBERS	3.7	58.7	3.7	58.4	56.2	42.7	63.4	56.1	Eutrophic
CLEAR (SPOKANE) 1	13	40.2	12.3	40.9	51.5	35.7	46.2	47.7	Mesotrophic
CLEAR (SPOKANE) 2	13	40.3	13	40.2	60.6	37.6	49.0		
CONCONULLY	18	35.5	18.3	35.2	56.6	41.3	43.3	27.7	Oligo-mesotrophic
CORTEZ	--	--	--	--	--	--	49.8	58.2	Eutrophic
CRANBERRY	--	--	--	--	61.9	46.6	66.9	53.6	Eutrophic
CRESCENT (CLALLAM)	--	--	--	--	35.2	17.4	26.2	26.2	Oligotrophic
CURLEW	18.2	35.5	17.8	35.6	57.0	32.8	33.9	31.3	Mesotrophic
DEEP	--	--	--	--	47.3	35.5	19.5	27.1	Oligo-mesotrophic
DIAMOND	--	--	--	--	39.4	30.4	40.6		Oligotrophic
ELLEN	19.98	34.1	18.5	35	44.9	36.5	37.9		Oligo-mesotrophic
ELOIKA	6.7	50.9	6.5	50.2	58.6	38.5	62.1		Eutrophic
GOSS	--	--	--	--	46.1	26.6	40.0		Oligo-mesotrophic
GRAVELLY	26.8	30.1	26.3	30	--	--	55.4	20.5	Oligo-mesotrophic
HOWARD	19.4	34.5	19.3	34.4	50.1	37.8	34.3	41.9	Oligo-mesotrophic
ISLAND	11	43.4	9.8	44.1	57.7	37.4	40.0	45.5	Mesotrophic
JUMPOFF JOE	11.6	42	11.4	42	54.5	37.3	46.6	43.8	Mesotrophic
KETCHUM	7	50.7	6.8	50	90.3	47.1	37.2	60.4	Eutrophic
KI	24.9	30.8	24.7	30.9	--	--	42.3	53.2	Oligotrophic
KILLARNEY	8.7	46	8.6	46.1	60.6	50.4	57.7	50.0	Eutrophic
LACAMAS	7.9	47.8	7.9	47.3	55.4	47.2	55.4	34.1	Meso-eutrophic

Table 5. Continued.

Lake (County)	mean SD (ft) non weighted	TSIsd	mean SD (ft) weighted	TSIsd	TSItp May	TSIchl	TSItp August	TSIchl	Assessed Trophic State
LAWRENCE	--	--	--	--	62.4	68.9	56.2	60.1	Eutrophic
LEO	18.4	35.3	18.1	35.3	42.1	35.2	31.8	24.9	Oligo-mesotrophic
LIMERICK	10.3	43.7	10.1	43.8	48.9	29.5	36.6	43.6	Mesotrophic
LOMA	7.3	48.8	7.2	48.6	53.6	47.4	50.1	40.1	Meso-eutrophic
LONE	--	--	--	--	55.8	43.6	66.3	44.6	Eutrophic
LONG (KITSAP)	6.1	51.6	5.5	52.4	55.5	46.6	55.6	60.0	Eutrophic
LONG (THURSTON)	8.7	46.7	9.7	44.6	45.0	44.1	51.9	39.3	Mesotrophic
LOST	--	--	--	--	57.9	33.1	40.4	42.4	Oligo-mesotrophic
LAKE MARTHA	17.3	36.4	15.4	37.7	47.3	41.8	36.0	37.5	Oligo-mesotrophic
MARTHA LAKE	14.5	38.8	14.2	38.9	54.4	36.1	32.4	39.4	Oligo-mesotrophic
MASON 2	28.6	28.8	26.8	29.7	38.7	19.4	33.4	19.4	Oligotrophic
MASON 3	26.8	30	25.1	30.6	--	--	--		
MASON 4	28.6	28.8	27.5	29.3	--	--	--		
MCINTOSH	5	55.6	4.6	55.1	58.2	46.8	75.0	74.1	Eutrophic
MERWIN	--	--	--	--	37.7	35.4	--	--	Oligotrophic
NAHWATZEL	16.6	36.8	15.9	37.2	45.2	35.5	29.5	41.8	Oligotrophic
OSOYOOS	10.6	43.3	10	44	51.5	42.5	41.8	52.0	Mesotrophic
N PATTISON	11.3	43.5	11	42.6	52.6	38.3	47.2	40.2	Mesotrophic
PHILLIPS	14.8	38.3	13.6	39.5	53.3	37.3	49.3	36.2	Mesotrophic
N ROESIGER	19	34.7	19.2	34.5	51.9	38.7	23.0	33.1	Oligotrophic
S ROESIGER	18.2	35.4	18.3	35.2	--	--	--	--	
SACHEEN	--	--	--	--	46.3	41.8	53.3	30.2	Mesotrophic
E SAMISH	15.2	38.2	14.9	38.1	50.3	36.1	32.4	33.2	Oligotrophic
W SAMISH	19.9	34.1	19.5	34.3	--	--	--	--	Oligotrophic
SAWYER	15	38.4	15.3	37.8	57.8	46.9	30.0	33.8	Mesotrophic
SILVER	8.7	46	8.4	46.5	70.3	43.4	53.4	50.2	Meso-eutrophic
SPANAWAY	11.9	41.9	12	41.3	47.7	50.0	46.9	52.7	Meso-eutrophic
SPENCER	12.3	41.1	12.3	41	48.1	36.5	28.5		Oligo-mesotrophic
ST CLAIR	12.2	41.3	12.1	41.1	52.9	40.9	40.4	34.7	Mesotrophic
STEVENS	18.1	35.8	17.3	36	51.6	35.0	43.3	41.3	Oligo-mesotrophic
SULLIVAN	29	28.9	28	29.1	62.2	32.8	33.4	26.0	Oligotrophic
SUMMIT	24.8	30.9	24.7	30.9	32.8	32.8	71.0	31.6	Oligotrophic

Table 5. Continued

Lake (County)	mean SD (ft) non weighted	TSIsd	mean SD (ft) weighted	TSIsd	TSItp May	TSIchl	TSItp August	TSIchl	Assessed Trophic State
SUNDAY	--	--	--	--	74.0	77.5	54.6	39.8	Eutrophic
THOMAS	16.6	36.8	16.1	37.1	42.1	30.4	27.4	26.6	Oligo-mesotrophic
TIGER	14	39.2	13.9	39.2	42.2	37.2	38.3	33.4	Oligotrophic
TRAILS END	15.3	37.8	15.5	37.6	48.4	39.3	58.4	43.8	Mesotrophic
TWIN, BIG	--	--	--	--	47.3	17.7	42.6	41.6	Mesotrophic
WAITTS	--	--	--	--	84.3	33.2	26.5	34.4	Oligo-mesotrophic
WARD	20.8	33.5	19.9	34	48.9	36.3	46.7		Oligotrophic
WENATCHEE	26.3	30.1	26	30.1	40.8	30.6	48.1	35.3	Oligotrophic
WHITMAN	--	--	--	--	55.2	38.6	59.7	54.4	Meso-eutrophic
WILDCAT	17.7	36.5	17.5	35.9	--	--	34.9	26.8	Oligo-mesotrophic
WILLIAMS	9.8	44.8	9	45.4	54.4	48.2	60.0	38.5	Mesotrophic
WISER	--	--	--	--	63.7	48.4	74.5	54.3	Eutrophic
WOOTEN	20.3	34.1	20.2	33.8	29.8	35.1	37.9	35.1	Oligotrophic
WYE	11.7	<42.1*	12.2	<41*	60.8	36.4	39.0	41.9	Mesotrophic

* Most Secchi readings "hit bottom," so TSI_{SD} underestimates true water clarity

Table 6. Seasonal Slopes, percent annual change of Secchi depths, and probability of trend in water clarity[1] for lakes monitored by volunteers for at least five consecutive years during 1989-1994.

Lake	# years monitored	Seasonal Slope[1] (feet/year)	Average Percent Annual Change	Probability
Alice (King)	4	-0.5011	-5.0	0.3815
Big Meadow (Pend Oreille)	6	1.0568	10.7	0.0520**
Black (Stevens)	6	0.5777	3.7	0.1344*
Curlew (Ferry)	6	0.4144	2.4	0.4906
Eloika (Spokane)	6	0.1455	2.1	0.4311
Killarney (King)	6	0.2441	3.2	0.0301***
Lacamas (Clark)	6	0.6459	11.5	0.2165
Leo (Pend Oreille)	5	1.1435	6.7	0.0019****
Limerick (Mason)	5	0.0628	0.6	0.6471
Long (Kitsap)	4?	0.1774	3.7	0.6791
Long (Thurston)	6	0.1497	1.9	0.7554
L Martha (Snohomish)	5	1.14428	9.0	0.0650**
Martha L (Snohomish)	5	-0.1787	-1.1	0.3632
Mason (Mason)	6	0.4835	2.0	0.3768
Nahwatzel (Mason)	5	0.2509	1.6	0.6295
Osoyoos (Okanogan)	6	0.4983	5.5	0.1941*
Phillips (Mason)	6	0.4474	3.4	0.5603
E Samish (Whatcom)	6	0.3769	2.9	0.2207
W Samish (Whatcom)	6	1.1816	7.4	0.1072*
Spanaway (Pierce)	5	0.1557	1.5	0.9234
Spencer (Mason)	5	0.1126	0.9	0.9181
St. Clair (Thurston)	6	1.1277	13.3	0.0258***
Stevens (Snohomish)	5	-0.6025	-3.3	0.2129
Thomas (Stevens)	6	0.8563	6.0	0.0009****
Ward (Thurston)	5	0.000	0.0	1.000
Wenatchee (Chelan)	6	0.1454	0.9	1.000
Williams (Spokane)	6	-0.7718	-7.0	0.1413*
Wooten (Mason)	6	-0.3287	-1.5	0.0060

1 Based on volunteer-collected media annual Secchi depth.

1 Positive slope values (using Sen's slope estimator, Aroner, 1994) indicate increasing Secchi depths, and negative values indicate decreasing Secchi depths

* Significant at 80% level
** Significant at 90% level
*** Significant at 95% level
**** Significant at 99% level

However, for various reasons TSI values for sampled LWQA lakes do not always agree, and most trophic state assessments for the LWQA Program are tempered with professional judgment using other data and information that indicate trophic status (*i.e.*, dissolved oxygen concentrations and macrophyte coverage). These disagreements between TSI values for monitored LWQA Program lakes warrant an evaluation of the relationships between trophic state parameters, and how they compare to the relationships used in the development of Carlson's (1977) TSIs.

Comparisons of Regression Equations

Regression equations for data collected from 1989 to 1994 are listed in Table 7. Results from Carlson's regression equations are also listed for comparison.

Table 7. Regression equations using LWQA data from 1989-1994, compared to Carlson's (1977) regression equations.

LWQA[1]	Carlson (1977)
$\ln Chl = 1.025 \ln TP - 1.55$ (r^2=0.46, n=141)[2]	$\ln Chl = 1.449 \ln TP - 2.442$ (r^2=0.72,n=43)[3]
$\ln SD = 1.83 - 0.43 \ln Chl$ (r^2=0.65, n=212)[4]	$\ln SD = 2.04 - 0.68 \ln Chl$ (r^2=0.86, n=147)
	$\ln SD = 3.876 - 0.98 \ln TP$ ([5])

[1] data collected 1989-1994, August survey only
[2] using August survey data for TN:TP≥17
[3] TP data from only July and August were used
[4] Secchi depths from same day as TP and chlorophyll *a* data (*i.e.*, not mean summer values)
[5] Equation developed by combining the two other equations

Table 7 depicts the similarity of the correlations between TP, Secchi, and chlorophyll data based on LWQA Program results to those developed by Carlson (1977). The equations are fairly similar considering our data are much more local and cover a much narrower range than Carlson's, which included data from lakes all over North America. *(check the actual criteria he used...)* The relationship was poorest for chorophyll a, however, chlorophyll concentrations vary greatly with temporal changes and considering that only two samples are collected during the year, the poor correlation was not surprising. Naturally, there is also a poor coorelation between chlorophyll a TSI values and the TSI values of the other two parameters.

Factors Affecting Trophic State Relationships

It is worthwhile to explore factors that could affect Carlson's relationships between chlorophyll *a*, Secchi depth, and TP for LWQA data. Factors that could affect these relationships are included below.

1. Non-phosphorus limitation, for example, total nitrogen could be the limiting nutrient.

2. Variability in results between the May and August surveys. August surveys tend to produce results more indicative of average annual TSI values (May results were used in this analysis; August results will be used in the future).

3. Climatological variations which could affect Secchi readings by impacting the frequency and intensity of algal blooms.

4. Non-algal turbidity could consequently reduce Secchi depth and increase the corresponding Secchi TSI value.

5. Biological factors can impact Secchi depth. For example, Secchi depth is greater when the chloroplasts are concentrated in fewer large algal cells rather than many smaller cells . Additionally, zooplankton can significantly affect chlorophyll *a* concentrations. Grazing during zooplankton blooms can reduce algal biomass thereby reducing overall chlorophyll *a* concentrations and transparency. This is why some some state agencies have augmented traditional lake assessment methods to include biological measurements of zooplankton and other aquatic life such as macrophytes which may bind large quantities of phosphorus (White, 1996).

Conclusions/Recommendations

Quality Assurance

Although quality control data indicated good quality data from the laboratories, more information is needed from the laboratories in order to determine whether data quality objectives for the program are met. Based on data quality review in 1994, the following recommendations were made for the 1995 program.

1. Total nitrogen field duplicates should be split in the lab. This will enable us to evaluate the contribution of lab variability to total variability.

2. Representativeness of collecting samples from one lake station needs to be tested further, particularly since the precision limit was not met in 1993 or 1994. This happened despite an attempt in 1994 to refine the statistical method used to evaluate the data. However, as noted in this report of 1994 data, and in 1993 data (Rector 1995, in draft), the variability in TP between stations was not high compared to variability between lakes, season, or year.

3. TSI results from phosphorous, Secchi, and chlorophyll *a* data collected in the spring are not strongly correlated, suggesting spring data may not be representative of annual trophic status. Data collected in August appears to be less variable with better correlation.

Recent research has confirmed our belief that water samples collected in August are more representative of seasonal means and less variable from year to year (France *et al.*, 1995). Therefore, future assessments should be based on late summer data.

Data Analysis

1. Until lab and field variability in chlorophyll *a* results can be assessed, it is premature to refine Carlson's index using Washington's LWQA data when attempting to correlate TSI (TP) with chlorophyll *a* TSI. However, this should be considered during future years of the program.

2. The current practice of using all trophic state parameters before assessing trophic state should continue. Albeit labor-intensive, it is not appropriate to base all trophic classifications on one parameter when other trophic state information is available. Also, because August TP results have better agreement with mean Secchi depth and mean chlorophyll *a* results, more emphasis should be placed on August TP, and less on May TP.

Individual Lake Assessments

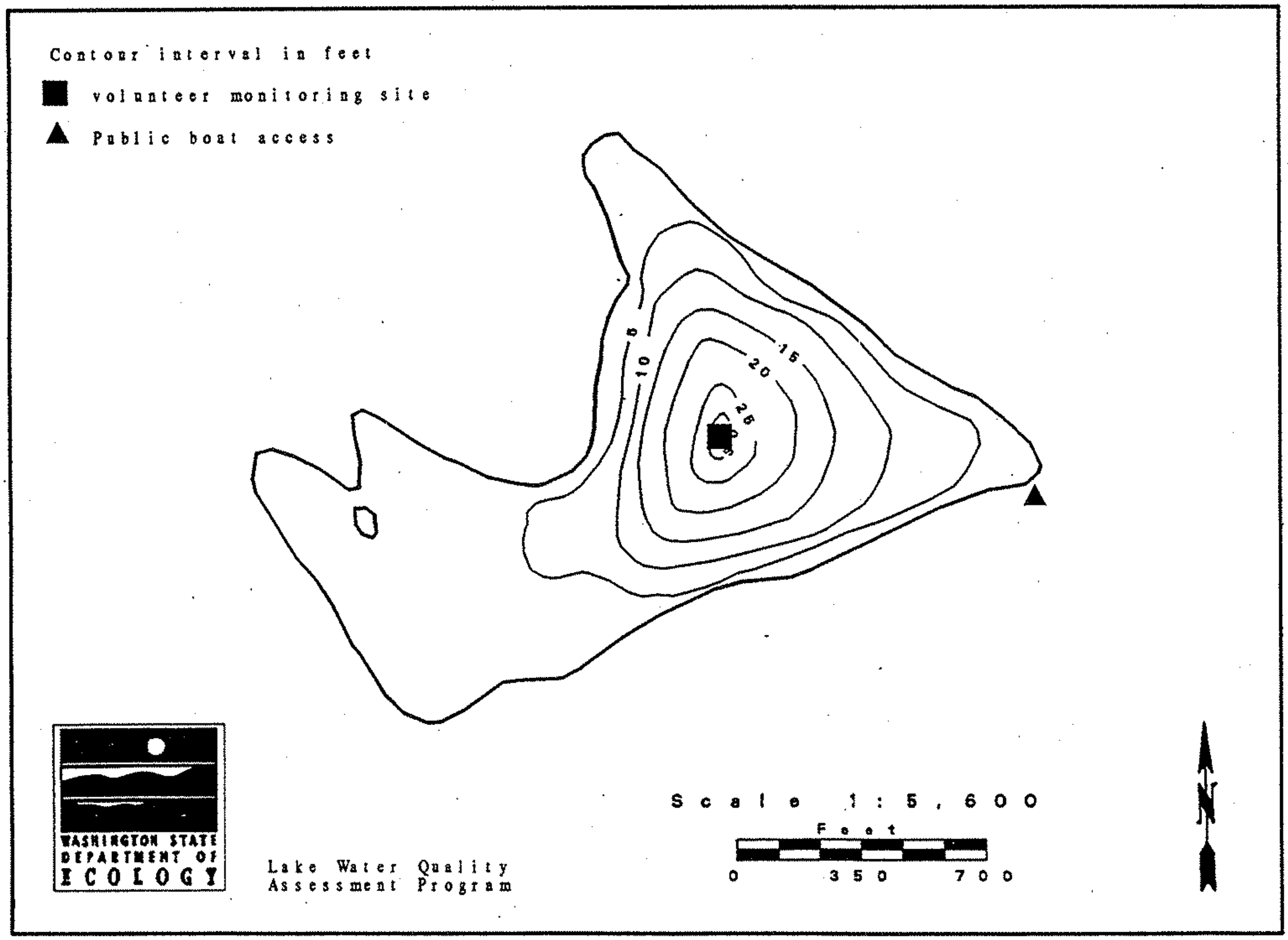
The 73 individual lake assessments presented here were written primarily for the volunteers who participated in Washington's Citizen Lake Monitoring Project. As a result, layperson's terms are used. Each volunteer received a draft of the assessment for their lake in May 1994, so that they could review the summaries of their field comments and questionnaire responses. Their comments on these individual assessments are also gratefully acknowledged for this report.

Lake Alice -- King County

Lake Alice is located 2.5 miles south of Fall City. It has no surface inlets, and drains intermittently via Icy Creek to the Raging River.

Size (acres)	32
Maximum Depth (feet)	30
Mean Depth (feet)	8
Lake Volume (acre-feet)	260
Drainage Area (miles2)	0.2
Altitude (feet)	875
Shoreline Length (miles)	1.3

Data from Bortleson *et al.* (1976)



Overall Assessment

General water quality of Lake Alice was good in 1994. Secchi depths improved in 1994 in comparison to 1993 (see graph of Secchi depth data), and there has been little change in the concentrations of total phosphorus and total nitrogen since the lake was first sampled in 1991. Mean Secchi depth in 1994 was 11.3 feet. Lake Alice was classified as mesotrophic in 1994, based on Secchi depth data and moderately high concentrations of chlorophyll *a* during both the May and August surveys. Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary.

Aquatic plants identified by Ecology staff during sampling visits include Purple loosestrife (*Lythrum salicaria*), iris (*Iris pseudacorus*), white-flowering water lily (*Nymphaea odorata*), watershield (*Brasenia schreberi*), cattails (*Typha* sp.), bulrush (*Scirpus*), quillwort (*Isoetes* sp.), water star-wort (*Callitriche* sp.), water-moss (*Fontinalis*), mint (*Labiatae*), yellow-flowering water lily (*Nuphar polysepalum*), and ribbonleaf pondweed (*Potamogeton epihydrus*). The iris appears to be spreading along the lakeshore.

The biggest threats observed at Lake Alice are the high water levels that could enter drainfields, and the Purple loosestrife (*Lythrum salicaria*) located on private property on the west shore. Although the plant had not appeared to have spread from 1993 to 1994, it should be destroyed or contained in order to preserve other shoreline plants and habitat areas around Lake Alice. The sightings in both 1993 and 1994 were reported to King County Surface Water Management and the noxious weed board.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1991 to 1994.

> Lake Alice is used for fishing, swimming, and non-motorized boating. There is one public boat ramp on the lakeshore, making about 1% of the shoreline publicly-owned. No motor boats are allowed on the lake. Trout were stocked in the lake in 1994. Currently, the watershed is used only for lakeshore development for residences. In the past, the watershed was logged and the lake was dredged.
>
> There are 76 houses on the lakeshore, and none are connected to a sewer collection system. There are no culverts which drain into the lake. There is no lake association or community association for the lake, and no aquatic plant management activities occurred in 1994. Currently, the minimum setback for lakeshore development is 50 feet for residences and 20 feet for agriculture. The

minimum lot length for residential development is 50 feet, and residential density is restricted to two houses per acre. Lake water is withdrawn for drinking and other domestic uses.

Overall, the volunteer found that Lake Alice had good water quality in 1994. Problems in the lake in 1994 were ranked as (1) high winter water level, and (2) algae. Possible sources of problems are residential development, and use of lawn fertilizers. The only change since the 1993 monitoring season was that there were fewer water lilies in 1994. In 1993, there was concern that the high water level may raise the water table above some of the drainfields around the lake.

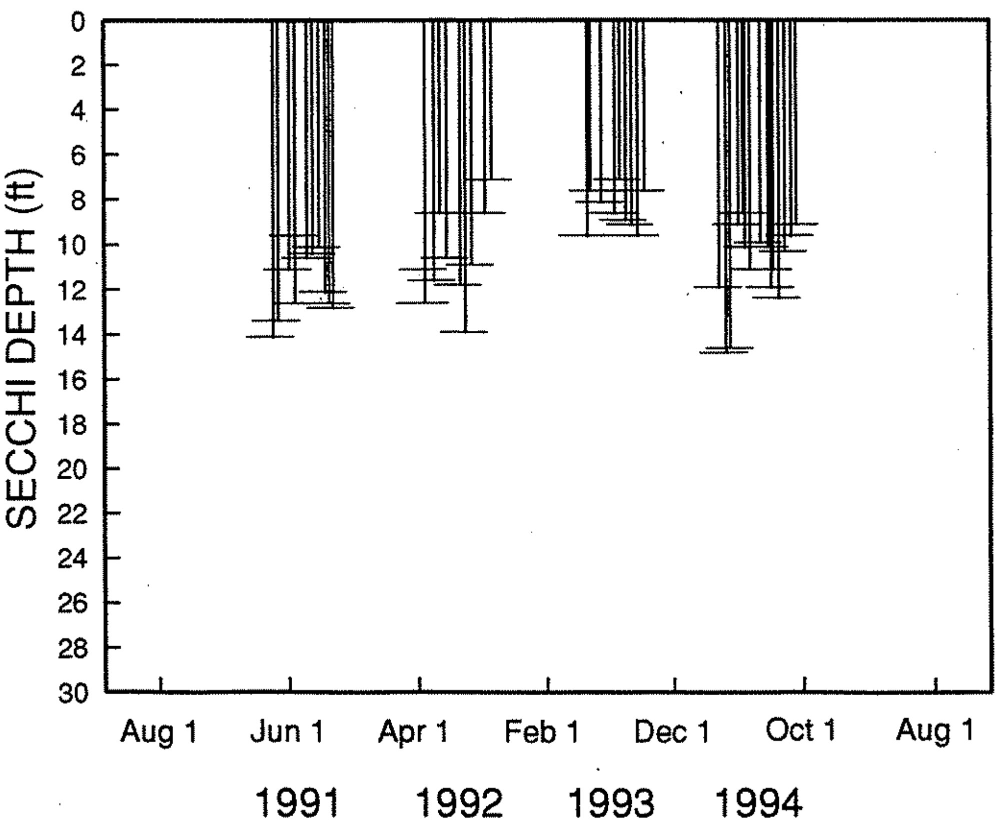
Acknowledgment

I thank Antony Johnson for volunteering his time to monitor Lake Alice from 1991 through 1994.

ALICE Lake -- KING County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/04/19	15.6	60.1	0.0		50	Trace	Light	11.3	35.0	Water color yellow-green. Water is warm for April; air temp 54 degrees.
94/05/03	15.6	60.1	0.0	Lt Green	10	Trace	Light	14.2	33.0	Second Secchi with view tube. Water very clear.
94/05/18	15.6	60.1	0.0		75	Trace	Light	14.0	32.3	Water color yellow-brown. Second Secchi with view tube.
94/06/02	16.9	62.4	0.0	Lt Green	50	Mod	Light	8.5	31.3	Second Secchi with view tube.
94/06/15	62.0	144	0.0	Lt Green	100	Heavy	Light	8.0	32.0	Second Secchi with view tube.
94/06/30	20.6	69.1	0.0	Lt Green	90	None	Light	9.5	30.0	Second Secchi with view tube.
94/07/10	21.7	71.1	0.0	Grn-brown	0	None	Light	10.5	29.5	Second Secchi with view tube.
94/07/25	24.4	75.9	0.0	Lt Green	100	Trace	Light	9.3	25.7	Second Secchi with view tube.
94/08/07	22.2	72.0	0.0	Lt Green	100	None	Calm	9.5	22.3	Second Secchi with view tube.
94/08/17	22.2	72.0	0.0	Lt Green	90	None	Breezy	10.5	0.0	Onsite visit.
94/08/20	21.7	71.1	0.0	Lt Green	75	None	Light	11.3	20.0	Second Secchi with view tube.
94/09/05	18.9	66.0	0.0	Lt Green	10	Light	Calm	11.8	18.0	Both Secchi readings with view tube.
94/09/20	20.0	68.0	0.0	Lt Green	0	None	Light	9.7	16.8	Both Secchi with view tube. Numerous white specks in the water.
94/10/05	15.6	60.1	0.0	Lt Green	10	None	Light	9.0	14.5	With view tube.
94/10/17	11.7	53.1	0.0	Lt Green	10	Light	Calm	8.5	13.5	With view tube.

LAKE ALICE (KING COUNTY)



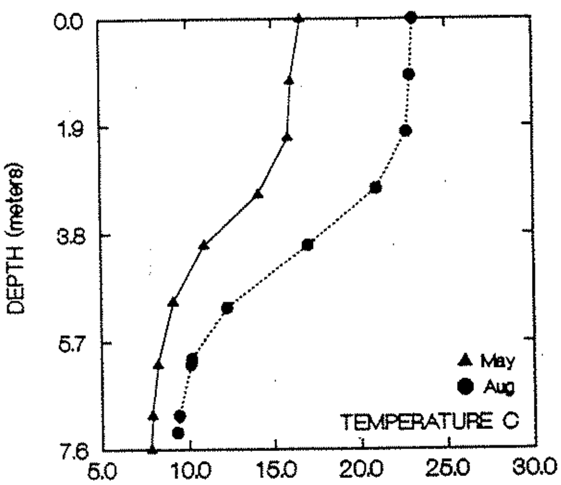
ALICE (KING) Lake -- KING County
Chemistry Data -- Station 1

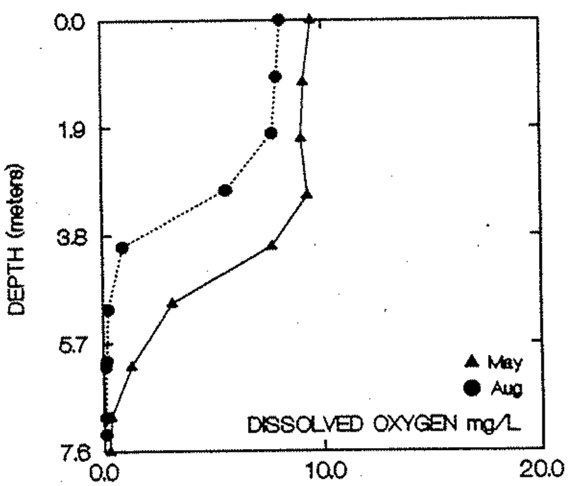
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/25		E	11			(Source: Water Supply Bulletin 43)					
91/05/24	1	E		0.23							
92/05/12	1	E	12	0.31	1.6	2	2		1	1U	25
92/08/24	1	E	14	0.38	0.5	2	1U		2	1	20
92/08/24	1	H	8	0.64							
93/05/20	1	E	23	0.34	0.5U						
93/05/20	1	H	42	0.45							
93/08/23	1	E	10	0.33	3.1						
93/08/23	1	H	43	0.54							
94/05/18	1	E	27	0.34	4.6						
94/05/18	1	H	40	0.26							
94/08/17	1	E	10	0.28J	3.7J						
94/08/17	1	H	28	0.42J							

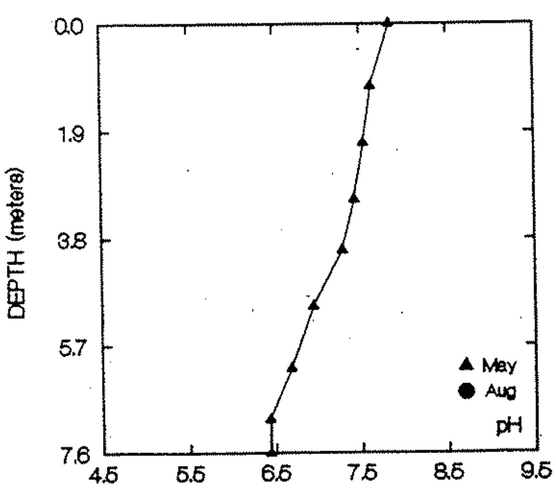
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

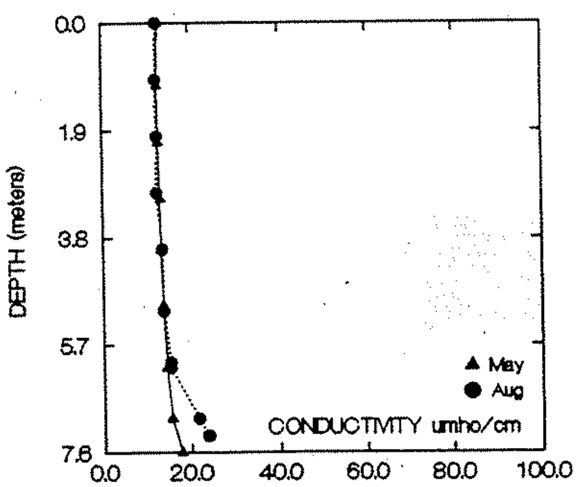
ALICE (KING) Lake -- KING County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/18	0.0	16.6	7.9	9.5	13.0	94/08/17	0.0	23.2	0.0	8.1	13.0
	1.1	16.0	7.6	9.2	13.0		1.0	23.0	0.0	7.9	12.0
	2.1	15.9	7.5	9.1	13.0		2.0	22.8	0.0	7.7	13.0
	3.1	14.2	7.4	9.3	13.0		3.0	21.0	0.0	5.7	12.0
	4.0	10.9	7.3	7.7	13.0		4.0	17.0	0.0	0.9	14.0
	5.0	9.1	7.0	3.2	14.0		5.1	12.3	0.0	0.2	14.0
	6.1	8.2	6.7	1.3	14.0		6.0	10.2	0.0	0.2	15.0
	7.0	7.9	6.4	0.4	16.0		6.1	10.1	0.0	0.1	15.0
	7.6	7.8	6.4	0.3	18.0		7.0	9.4	0.0	0.1	22.0
							7.3	9.3	0.0	0.1	24.0





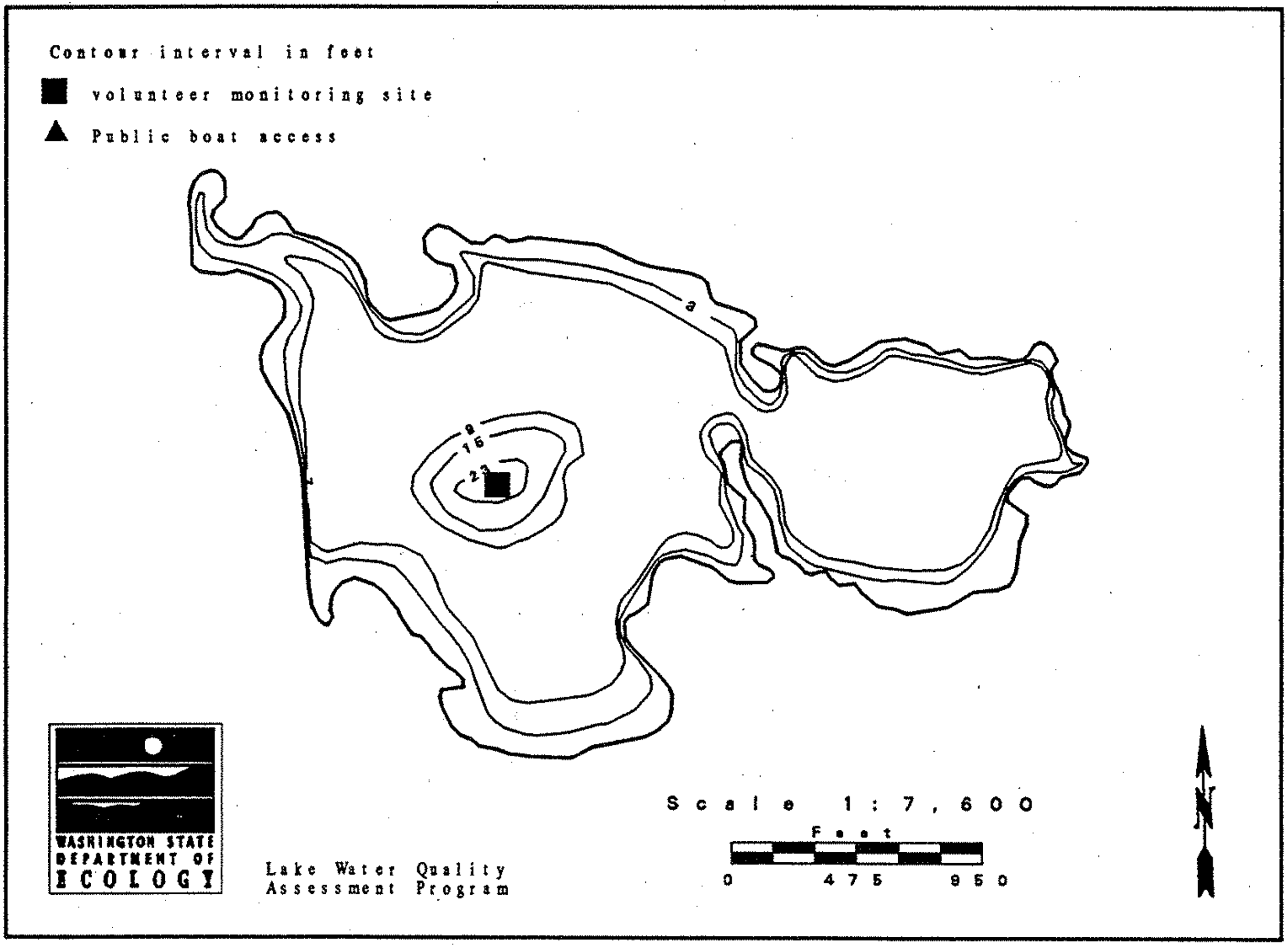




Big Meadow Lake -- Pend Oreille County

Big Meadow Lake lies in a peat area about 20 miles northeast of Colville at the head of Meadow Creek. It drains westerly to the south fork of Deep Creek and ultimately to the Columbia River. Big Meadow Creek was dammed in the mid-seventies, which enlarged the lake from its original size of about four acres to its present size of about 72 acres.

Size (acres)	72
Maximum Depth (feet)	23
Mean Depth (feet)	7.2
Lake Volume (acre-feet)	512
Drainage Area (miles^2)	2.59
Altitude (feet)	3450
Shoreline length (miles)	3.81



Overall Assessment

Water quality in Big Meadow Lake was good in 1994. From 1989 to 1994, there was a significant improving trend in water clarity (see graph of Secchi depth data). This was tested using the seasonal Kendall test for trend, and results showed an improving trend in water clarity that was significant at the 90% level ($p = 0.05$).

Concentrations of nutrients (total phosphorus and total nitrogen) and chlorophyll *a* were moderately high on both sampling dates. However these concentrations were not unusual and were similar to concentrations measured in 1990, 1992, and 1993. Turbidity measured in the lake in 1994 was low, and was likely due to algae in the water at the time of sampling. Temperature, pH, dissolved oxygen, and conductivity profile data did not appear unusual for this lake. Based on data from all three trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Big Meadow Lake was classified as mesotrophic in 1994. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary.

Plants observed by Ecology staff during field visits include sedge (*Carex* sp.), bulrush (*Scirpus* sp.), white-flowering water lily (*Nymphaea odorata*), yellow-flowering lily (*Nuphar polysepalum*), flatleaf pondweed (*Potamogeton robbinsii*), largeleaf pondweed (*Potamogeton amplifolius*), floatingleaf pondweed (*Potamogeton natans*), waterweed (*Elodea canadensis*), and bur-reed (*Sparganiaceae* family). In 1994, waterweed mats surfaced in May, which was early for the growing season

Perch were observed in the lake for the first time in 1994; they probably were introduced in the past year.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Big Meadow Lake is used for fishing, picnicking, camping, and waterfowl habitat. There is one public boat ramp, and there are no restrictions for motorboat use on the lake. There are no nearshore houses, although there is a Forest Service campground on the lakeshore; 100% of the shoreline is publicly-owned. Eastern brook trout were stocked in the lake in 1994, and spiny rays (perch and bass) were introduced into the lake.
>
> Areas flooded when the lake was enlarged were covered with submerged weeds, but the original lake area was not covered with plant growth. Open areas about seven feet deep had floating-leaved type weeds. "Floating islands" (parts of the

lake bottom which rise to the water surface and float) were common in the lake. [These islands occur when gases produced during decomposition loosen sediments they are trapped in, and eventually make a portion of the sediments buoyant.]

In January and February 1989, there was a fish kill. The Department of Wildlife installed an aeration system on August 25, 1989, to prevent the winter fish kills. The lake was aerated throughout winter 1993, but was not aerated in 1994.

Overall, the volunteer found that Big Meadow Lake had good water quality. The only problem listed for 1994 was impaired fisheries, due to the introduction of perch and bass. Excessive aquatic plant growth, which was listed as a problem in 1993, was not listed in 1994.

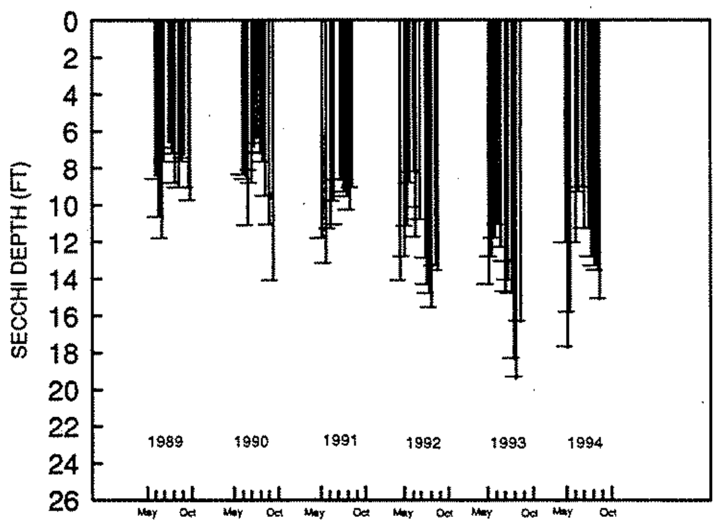
Acknowledgment

I thank Terry Williams for volunteering his time to monitor Big Meadow Lake from 1989 through 1994.

BIG MEADOW Lake -- PEND OREILLE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/08	15.0	59.0	0.0	Grn-brown	90	Heavy	Breezy	11.3	0.0	Looks like pollen in the water.
94/05/18	0.0	32.0	0.0		100		Light	16.9	0.0	Onsite visit. Elodea mats on surface early this year. Water color black.
94/05/25	19.0	66.2	0.0	Mod Green	50	None	Breezy	15.0	0.0	[Lake height first reading.] Appears to be pollen or algae in water.
94/06/22	21.0	69.8	0.0	Grn-brown	10	None	Light	11.3	-2.0	
94/07/06	20.0	68.0	0.0	Grn-brown	10	Trace	Breezy	8.5	-4.0	
94/07/20	24.0	75.2	0.0	Grn-brown	0	None	Light	8.3	-6.0	Big damsel fly hatch.
94/08/03	25.0	77.0	0.0	Grn-brown	50	None	Breezy	10.5	-8.0	Two "islands" have floated up from the bottom and have little frogs everywhere.
94/08/17	23.0	73.4	0.0	Grn-brown	15	None	Breezy	10.5	-10.0	Two islands today. Onsite visit with Dave.
94/08/31	18.5	65.3	0.0	Grn-brown	10	Light	Breezy	12.0	-12.0	
94/09/14	16.0	60.8	0.0	Grn-brown	90	Trace	Light	12.5	-16.0	
94/09/28	18.0	64.4	0.0	Grn-brown	25	None	Light	12.8	-16.0	
94/10/12	12.0	53.6	0.0	Grn-brown	0	None	Breezy	14.3	-16.0	Some algae scum on downwind end of lake.

BIG MEADOW LAKE (PEND OREILLE COUNTY)



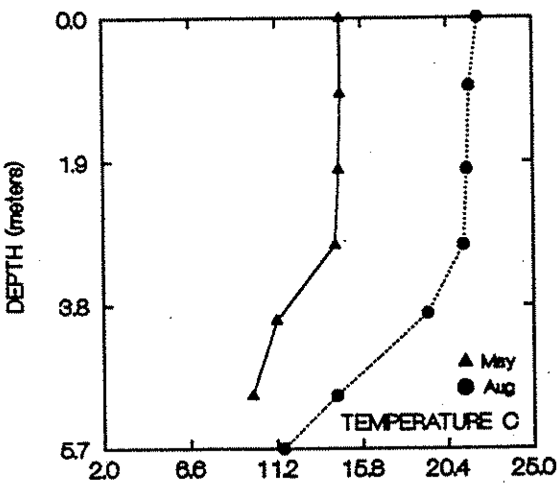
BIG MEADOW (PEND OREILLE) Lake -- PEND OREILLE County
Chemistry Data -- Station 1

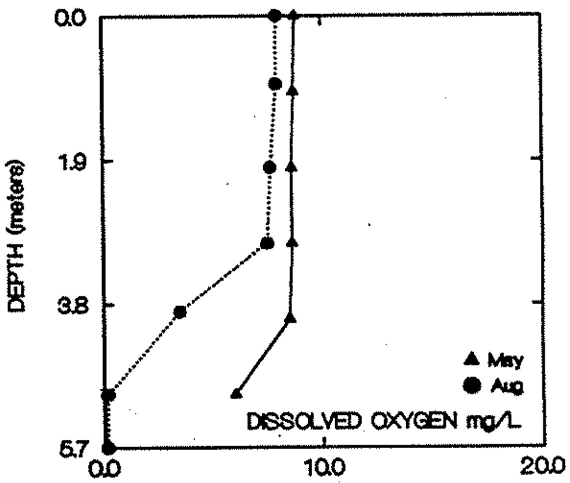
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
90/05/29	1	E	31	0.70							
90/09/12	1	E	30	0.91							
91/06/12	1	E		0.34							
92/05/19	1	E	23	0.60	1.6						
92/05/19	1	H									
92/09/01	1	E	22	0.71	3.1						
93/05/17	1	E	18	0.65	4.8						
93/05/17	1	H	36	0.44							
93/08/18	1	E	16	0.43	2.4						
93/08/18	1	H	15	0.41							
94/05/18	1	E	21	0.32	1.2			0.7			
94/05/18	1	H	24	0.22							
94/08/17	1	E	21	0.64J	3.2J			1.5			
94/08/17	1	H	27	0.58J							

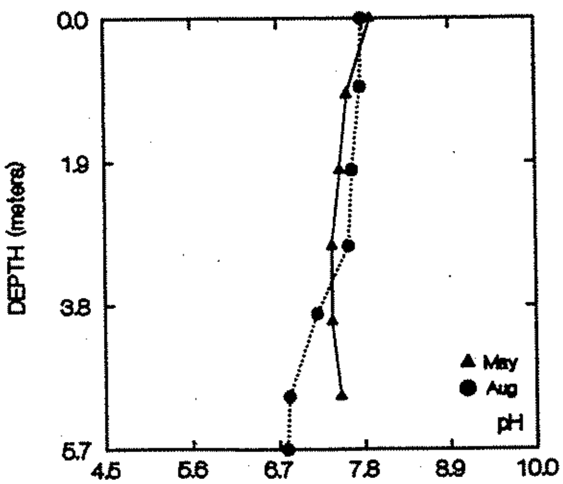
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

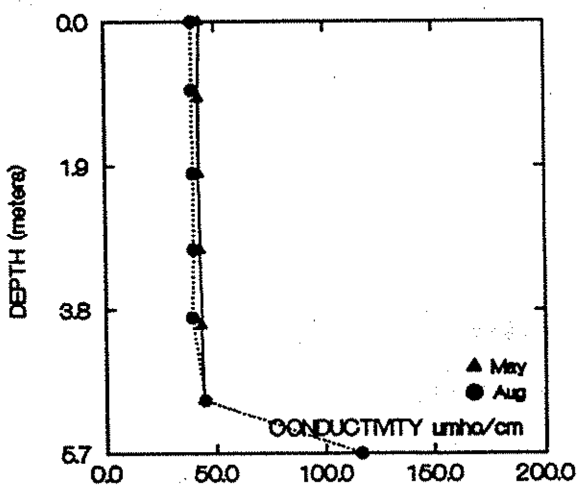
BIG MEADOW (PEND OREILLE) Lake -- PEND OREILLE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/18	0.0	14.7	7.9	8.8	43.0	94/08/17	0.0	22.1	7.8	8.0	40.0
	1.0	14.7	7.6	8.7	43.0		0.9	21.6	7.8	7.9	40.0
	2.0	14.6	7.5	8.6	43.0		2.0	21.5	7.7	7.6	40.0
	3.0	14.4	7.4	8.6	43.0		3.0	21.3	7.6	7.5	40.0
	4.0	11.2	7.4	8.5	43.0		3.9	19.3	7.2	3.5	39.0
	5.0	9.9	7.5	6.0	44.0		5.0	14.4	6.8	0.2	45.0
							5.7	11.5	6.8	0.1	117.0







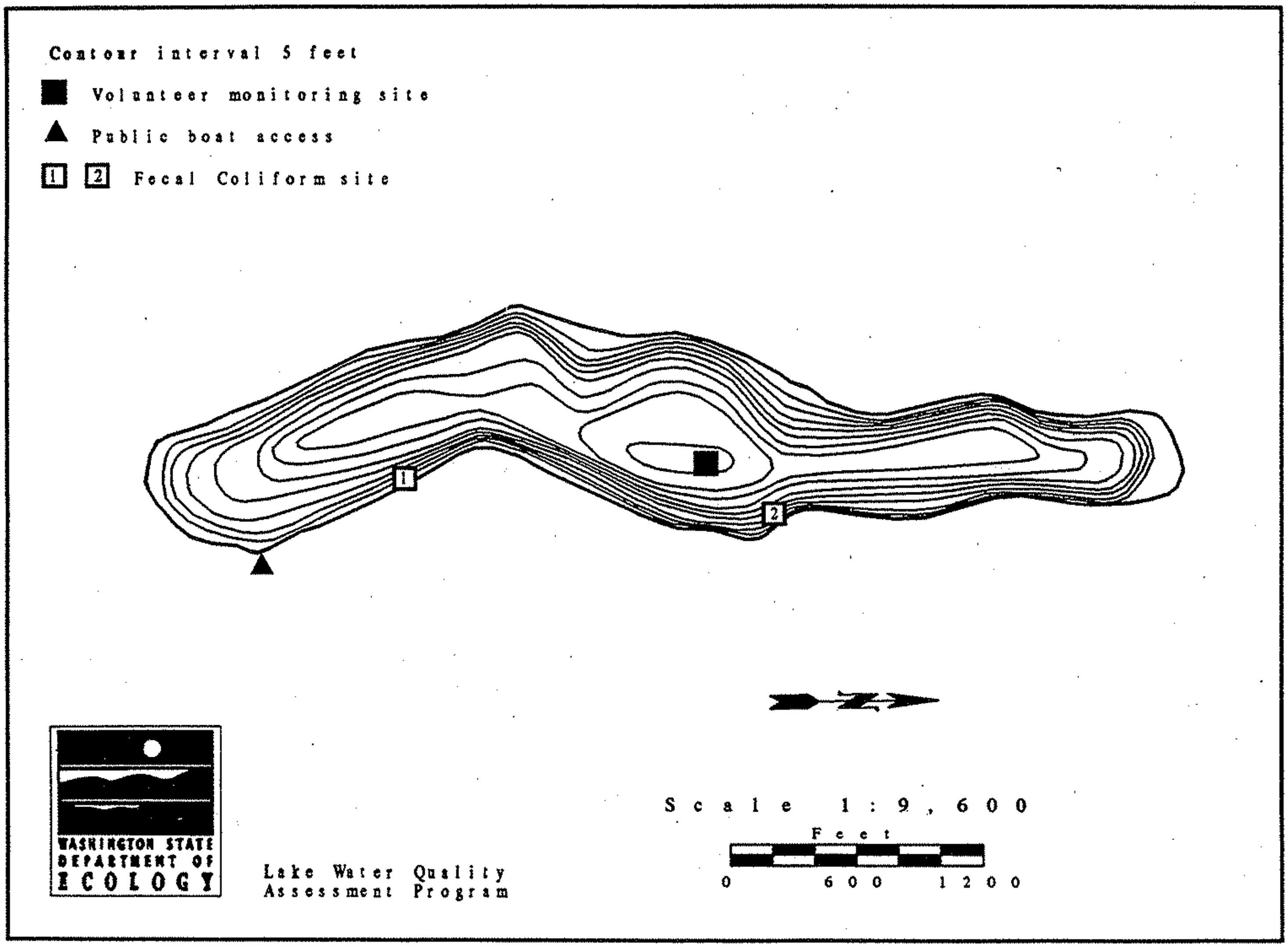


Black Lake -- Stevens County

Black Lake is located about 12.5 miles east of Colville. It is 4,800 feet long. The main inflow is intermittent into the north end of the lake, and there is a smaller inlet on the east side of the lake. Black Lake drains southeast via Gap Creek to the Little Pend Oreille River.

Size (acres)	70
Maximum Depth (feet)	45
Mean Depth (feet)	27
Lake Volume (acre-feet)	1,863
Drainage Area (miles^2)	0.9
Altitude (feet)	3,701
Shoreline Length (miles)	2.0

Data From Dion *et al.* (1976)



Overall Assessment

Water quality in Black Lake was very good in 1994. Although fewer Secchi depths were measured in 1994 than in previous years (see graph of Secchi depth data), Secchi depth data indicate that there was an improving trend in water clarity from 1989 through 1994. This was tested using the seasonal Kendall test for trend, and results showed an improving trend in water clarity that was significant at the 80% level ($p = 0.13$).

Concentrations of total phosphorus vary considerably in Black Lake, with respect to season as well as by station. Despite the wide range of phosphorus concentrations measured in the lake over the years, algae growth (indicated by chlorophyll *a* concentrations and Secchi depth measurements) remained low. Total nitrogen concentrations have been consistently low and fairly stable during the years the lake has been monitored. Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary.

Temperature, pH, dissolved oxygen, and conductivity profile data were not unusual for this lake. Although oxygen concentrations in the lower layer of water were almost depleted when the lake was sampled in August, similar profiles have been measured during previous surveys. Most likely, salmonid habitat is restricted to the thermocline during later summer months, when the concentration of dissolved oxygen below the thermocline is very low.

Plants identified by Ecology staff during field visits include largeleaf pondweed (*Potamogeton amplifolius*), waterweed (*Elodea canadensis*), yellow-flowering water lily (*Nuphar polysepalum*), ribbonleaf pondweed (*Potamogeton epihydrus*), Berchtold's pondweed (*Potamogeton berchtoldii*), muskgrass (*Chara*), water buttercup (*Ranunculus subrigidus*), slender naiad (*Najas flexilis*), bur-reed (possibly *Sparganium minumum*), and cattails (*Typha* sp.). Cinquefoil (possibly *Potentilla palustris*), was observed in 1993, but was not reported in 1994.

Black Lake was classified as oligo-mesotrophic in 1994; this assessment was based on the moderate amounts of aquatic plants in areas of the lake, as well as the low concentrations of dissolved oxygen below the thermocline in summer.

Most likely, the biggest threat to Black Lake is the presence of Eurasian watermilfoil in nearby lakes. This is a noxious aquatic plant that can be introduced into a lake from plant fragments that are usually found on boats, boat trailers, or fishing gear. Milfoil is well-established in the Little Pend Oreille chain of lakes (which include Gillette Lake, Heritage Lake, Sherry Lake, and Lake Thomas). During a thorough aquatic weed survey that was conducted in Stevens County lakes in 1994, no milfoil was found in Black Lake. This survey was conducted for the Stevens County Noxious Weed Board, and was funded by a grant from Ecology's Freshwater Aquatic Weeds Program.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

Black Lake is used for fishing, swimming, rowing, camping, and during the winter, skating and skiing. Recreational facilities on the lakeshore include a picnic area, a camping area, a beach, and one resort. There is one public boat ramp. About 4% of the shoreline is publicly-owned. Rainbow and eastern brook trout were stocked in the lake in 1994. In addition, the Department of Fish and Game planted "wild Kettle River Rainbow" in 1994 to control shiners (as opposed to using Rotenone; in the past, the lake was treated chemically to control undesirable fish species). Current watershed uses include lakeshore development for residences. In the past, the watershed was also logged and used for crop agriculture.

There are 25 houses on the lakeshore, and none of the houses are connected to a sewer. There are no culverts which drain to the lake. There is no lake association for the lake. No aquatic plant management activities occurred in 1994. Lake water is withdrawn for drinking and other domestic uses.

Overall, the volunteer found that Black Lake had excellent water quality. In 1994, there were no water quality problems in the lakes, although there is concern about excessive aquatic plant growth in areas of the lake. The volunteer would like suggestions for weed control. The only change since the 1993 monitoring season was that lake level was lower because of the dry summer.

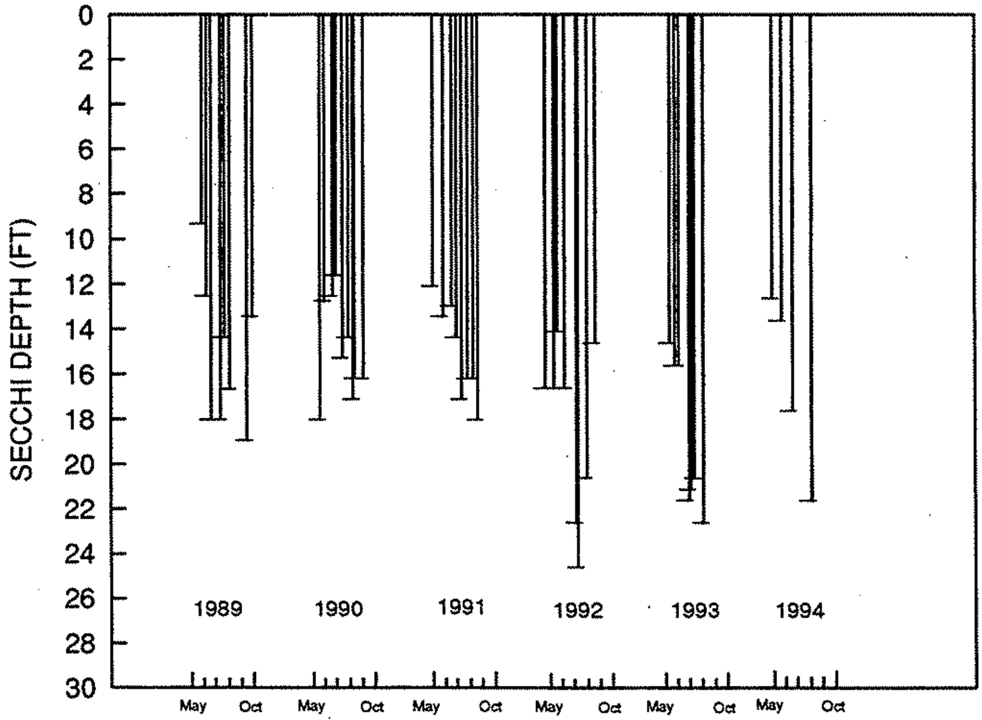
Acknowledgment

I thank Norman S. LaVigne for volunteering his time to monitor Black Lake during 1989-1994.

BLACK Lake -- STEVENS County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/17	13.9	57.0	0.0	Grn-brown	50	Heavy	Light	12.0	0.0	Onsite visit.
94/06/09	14.4	57.9	0.0		90	Mod	Breezy	13.0	-12.0	Water color clear-brownish.
94/07/15	22.2	72.0	0.0		10	None	Calm	17.0	-12.0	Water color clear-brownish. Hot and dry for several days.
94/09/15	16.7	62.1	0.0		25	Trace	Light	21.0	-19.5	Water color clear-brownish.

BLACK LAKE (STEVENS COUNTY)



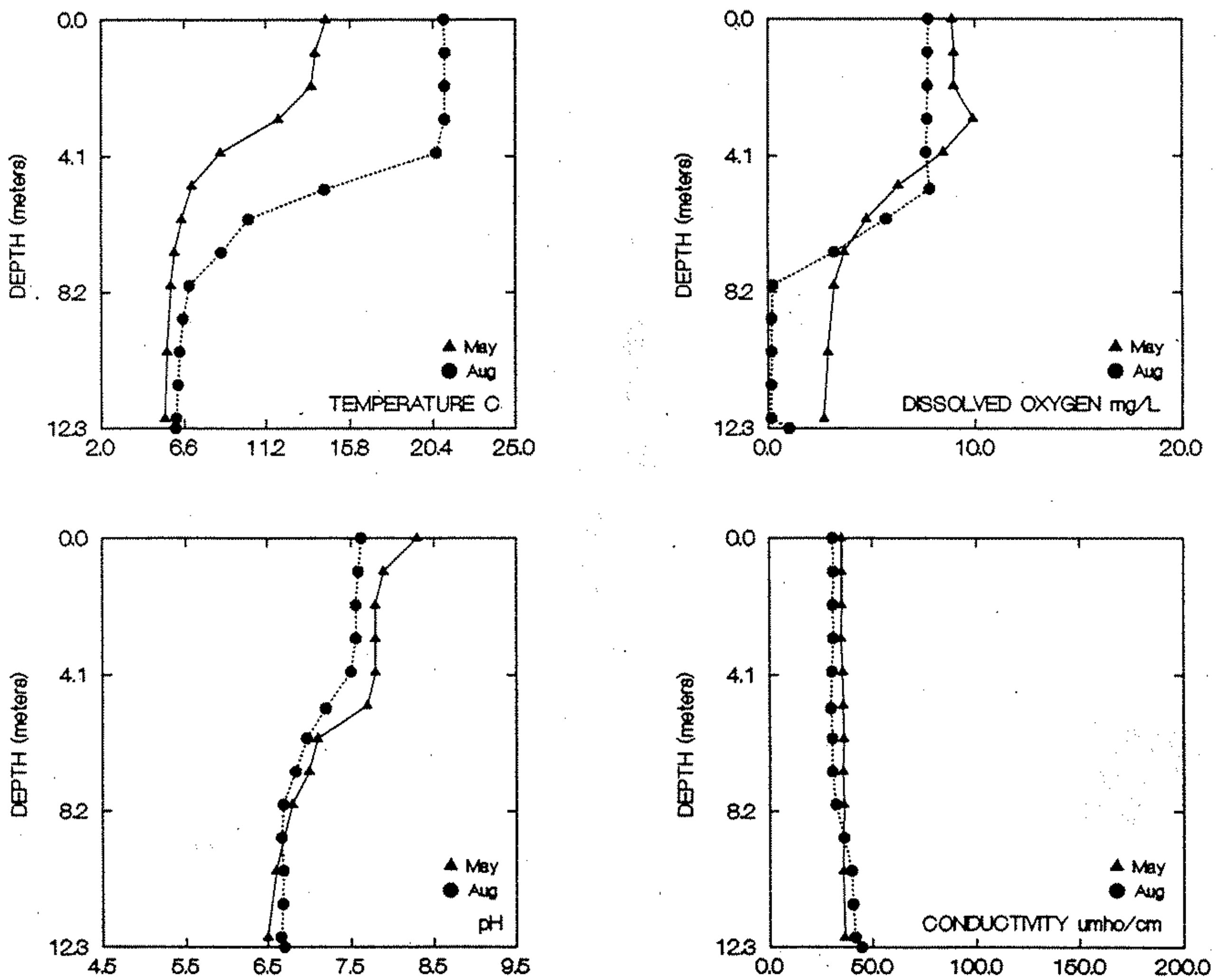
BLACK (STEVENS) Lake -- STEVENS County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/08		E	9			(Source: Water Supply Bulletin 43)					
89/06/20	1	E	11	0.28	1.6						
89/09/19	1	E	4	0.31	1.2						
90/05/29	1	E	19	0.35							
90/09/11	1	E	12	0.30							
91/06/13	1	E		0.25							
92/05/11	1	E	23	0.30	0.4	1U	1U		1	1U	25
92/05/11	2	E	12			1U			1	1U	25
92/05/11	1	H	13	0.33							
92/08/24	1	E	10	0.30	1.1	1U	1		2	1	20
92/08/24	2	E	7	0.27	1.1	1U			2	1	15
92/08/24	1	H	23	0.28							
93/05/18	1	E	7	0.39	2.2	1U	1U		1	1U	
93/05/18	2	E	42		0.5U				1	1U	
93/05/18	1	H	19	0.28							
93/08/19	1	E	8	0.24	2.4				1U	1U	
93/08/19	1	H	25	0.24							
94/05/17	1	E	26	0.18	1.7			1.7			
94/05/17	1	H	19	0.18							
94/08/16	1	E	9	0.25J	1.5J			0.6			
94/08/16	1	H	25	0.34J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

BLACK (STEVENS) Lake -- STEVENS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/17	0.0	14.5	8.3	8.9	35.0	94/08/16	0.0	21.0	7.6	7.8	31.0
	1.0	13.9	7.9	9.0	35.0		1.0	21.1	7.6	7.7	31.0
	2.0	13.7	7.8	9.0	35.0		2.0	21.1	7.6	7.7	31.0
	3.0	11.9	7.8	9.9	35.0		3.0	21.1	7.6	7.7	31.0
	4.0	8.6	7.8	8.5	36.0		4.0	20.6	7.5	7.6	30.0
	5.0	7.0	7.7	6.3	36.0		5.1	14.4	7.2	7.8	30.0
	6.0	6.4	7.1	4.8	36.0		6.0	10.2	7.0	5.7	31.0
	7.0	6.0	7.0	3.7	36.0		7.0	8.7	6.8	3.2	31.0
	8.0	5.8	6.8	3.2	36.0		8.0	6.8	6.7	0.2	32.0
	10.0	5.6	6.6	2.9	36.0		9.0	6.5	6.7	0.2	36.0
	12.0	5.5	6.5	2.7	36.0		10.0	6.3	6.7	0.2	40.0
							11.0	6.2	6.7	0.2	41.0
							12.0	6.1	6.7	0.1	42.0
							12.3	6.1	6.7	1.0	45.0

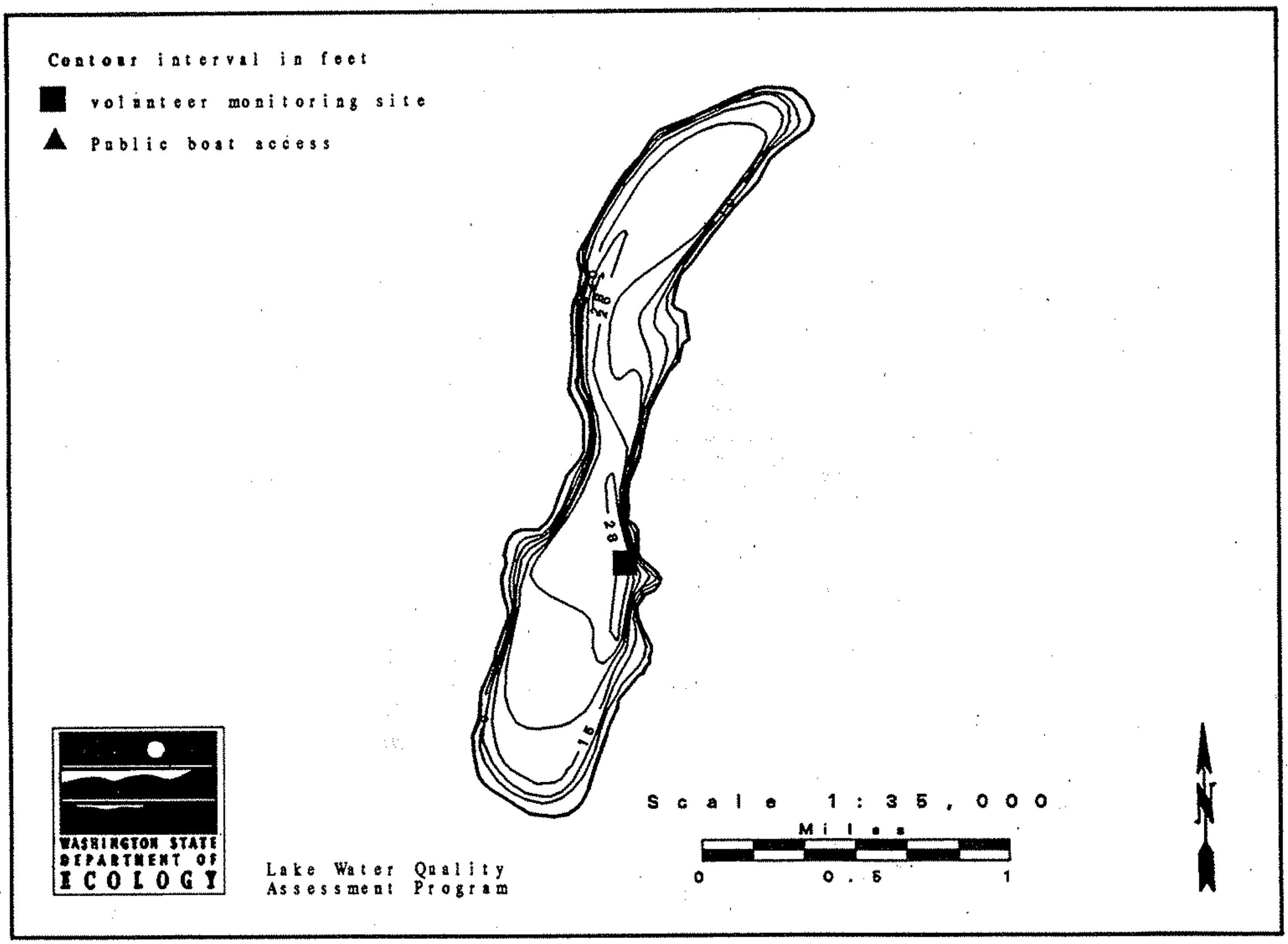


Black Lake -- Thurston County

Black Lake is located four miles southwest of Olympia. It is 2.5 miles long. The lake is fed by two unnamed perennial tributaries, and drains via Percival Creek to Budd Inlet. Black Lake was monitored by Ecology staff only.

Size (acres)	570
Maximum Depth (feet)	29
Mean Depth (feet)	19
Lake Volume (acre-feet)	11,000
Drainage Area (miles^2)	10.1
Altitude (feet)	131
Shoreline Length (miles)	6.0

Data From Bortleson *et al.* (1976)



Overall Assessment

Black Lake was sampled by Ecology staff only in 1994. The lake was monitored by a volunteer in 1993.

Water chemistry results and profile data are listed in tables at the end of this summary. Concentrations of total phosphorus and chlorophyll *a* were high during both surveys. Algae particles were visible on both sampling dates, particularly near the north end of the lake. Based on results from all trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Black Lake was classified as eutrophic in 1994. One high result for fecal coliform bacteria was from a sample collected near a mobile home park on the lakeshore. This high result was reported to Ecology's Southwest Regional Office.

Profile data indicate that the lake was stratified on both sampling dates, and that concentrations of dissolved oxygen decreased considerably below the thermocline, particularly during the August survey. The low dissolved oxygen and high conductivity near the lake bottom, as well as the high result for total phosphorus in the hypolimnion sample collected during August, suggest that phosphorus was recycled from sediments into the water column.

Aquatic plants identified by Ecology staff include curly-leaf pondweed (*Potamogeton crispus*), waterweed (*Elodea canadensis*), white-flowering water lily (*Nymphaea odorata*), naiad (*Najas guadalupensis*), iris (*Iris pseudacorus*), and watershield (*Brasenia schreberi*).

A Centennial Clean Water Fund Grant was awarded by Ecology to study the extent and sources of water quality problems in Black Lake. This grant was declined by Thurston County in 1994.

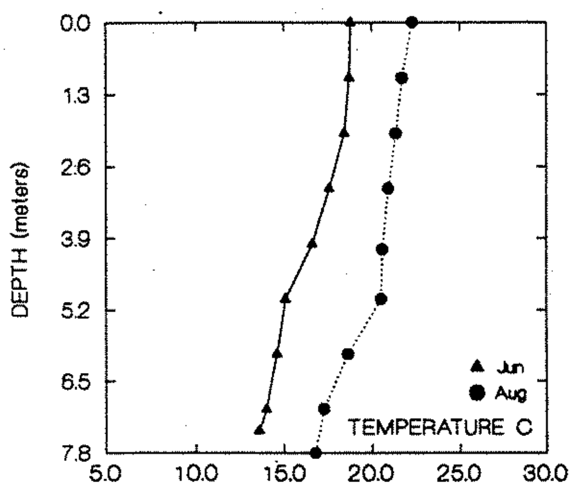
BLACK (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

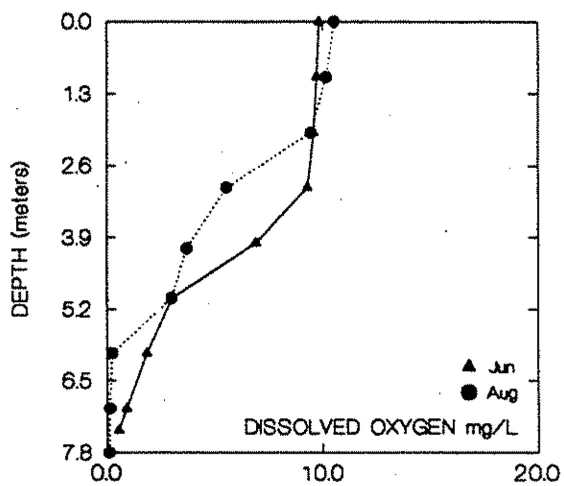
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/19		E	20			(Source: Water Supply Bulletin 43)					
81/07/21		E			9.9	(Source: Water Supply Bulletin 57)					
89/06/07	1	E	16	0.40	7.6						
89/09/05	1	E	46	0.75	56.2						
93/06/01	1	E	51	0.45	4.9	24			2	1U	
93/06/01	1	H	27	0.38							
93/08/25	1	E	55	0.67	28.1						
93/08/25	1	H	57	0.51							
94/06/03	1	E	44	0.18	7.0						
94/06/03	2	E	34	0.24							
94/06/03	1	H	52	0.21							
94/08/29	1	E	42	0.47J	19.1J	7	100	2.0			
94/08/29	2	E	27	0.45J							
94/08/29	1	H	230	0.76J							

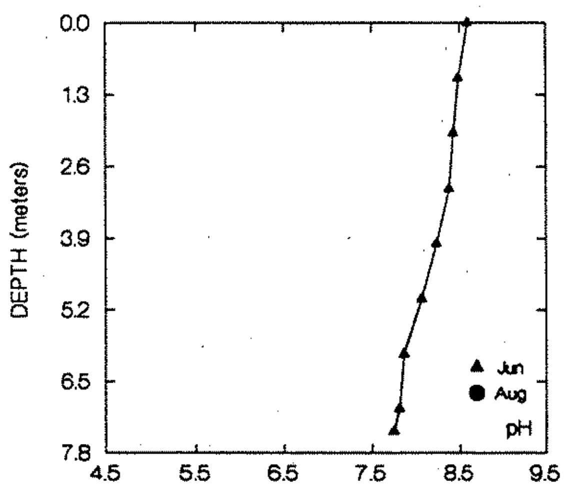
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

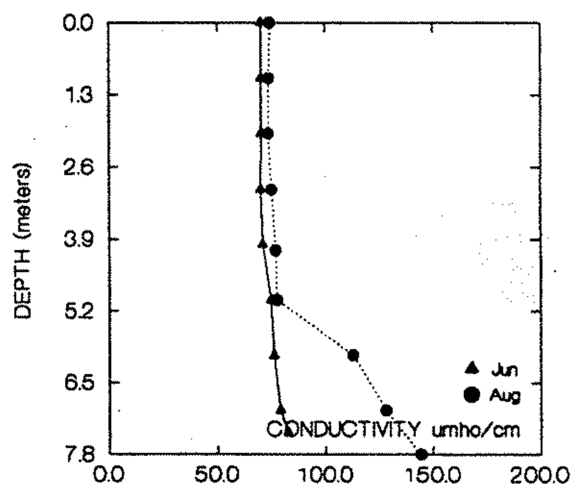
BLACK (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/03	0.0	18.8	8.6	9.9	70.0	94/08/29	0.0	22.3	0.0	10.6	74.0
	1.0	18.8	8.5	9.7	70.0		1.0	21.7	0.0	10.2	74.0
	2.0	18.5	8.4	9.6	70.0		1.0	21.7	0.0	10.2	74.0
	3.0	17.6	8.4	9.3	70.0		2.0	21.4	0.0	9.5	74.0
	4.0	16.6	8.2	6.9	71.0		3.0	21.0	0.0	5.5	75.0
	5.0	15.1	8.1	3.0	75.0		4.1	20.6	0.0	3.7	77.0
	6.0	14.6	7.9	1.8	76.0		5.0	20.5	0.0	3.0	78.0
	7.0	14.0	7.8	0.9	79.0		6.0	18.7	0.0	0.2	113.0
	7.4	13.6	7.8	0.5	82.0		7.0	17.3	0.0	0.1	129.0
							7.8	16.8	0.0	0.1	145.0







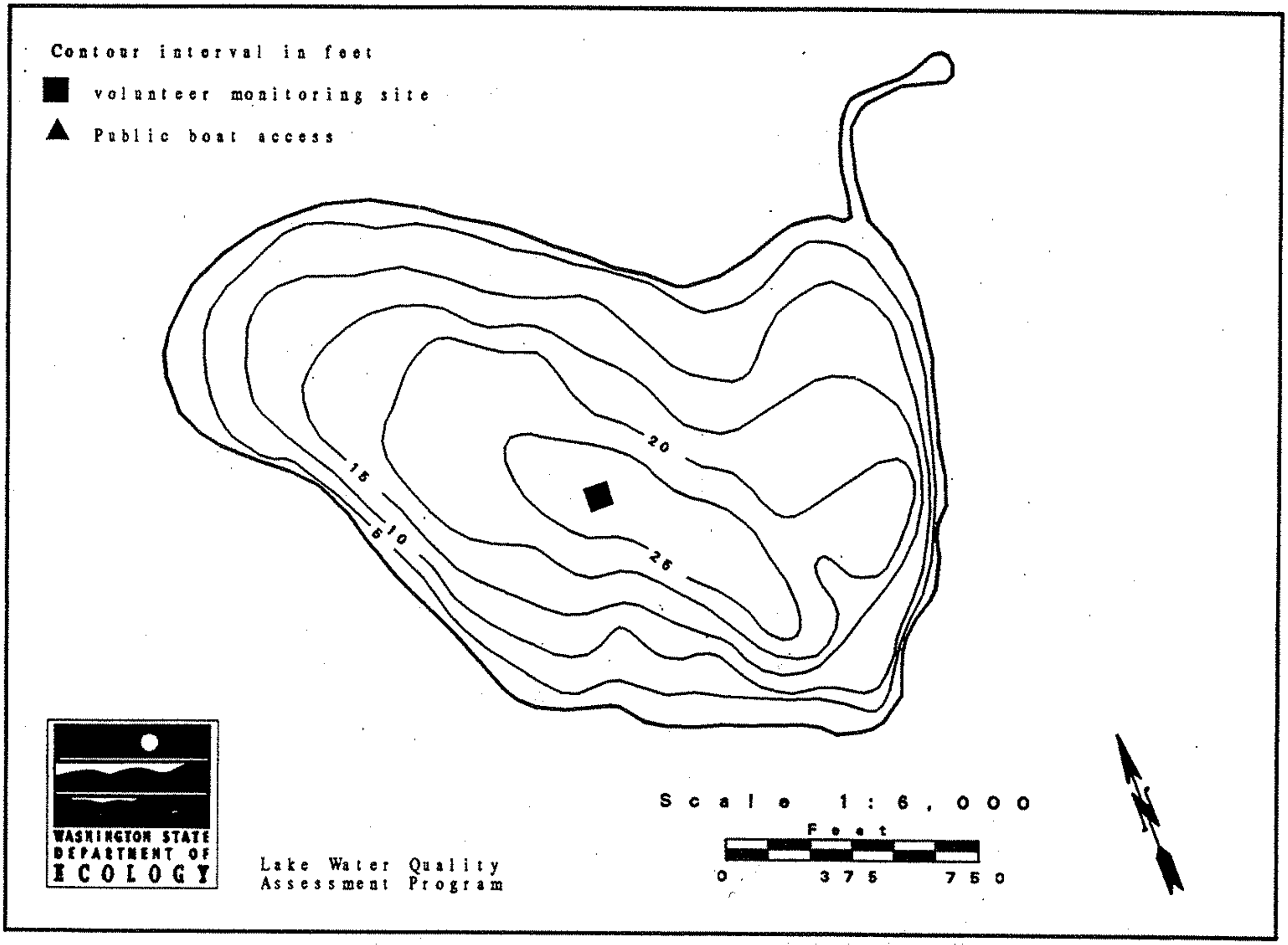


Blackmans Lake -- Snohomish County

Blackmans Lake is located one mile north of Snohomish. A perennial stream flows into the lake from the north. Blackmans Lake drains via Swifty Creek to the Snohomish River.

Size (acres)	57
Maximum Depth (feet)	29
Mean Depth (feet)	14
Lake Volume (acre-feet)	798
Drainage Area (miles^2)	0.8
Altitude (feet)	1.5
Shoreline Length (miles)	

Data From Bortleson *et al.* (1976)



Overall Assessment

Blackmans Lake has fair water clarity in 1994, although the range of values was very similar to those measured in 1993 (see graph of Secchi depth data).

Concentrations of total phosphorus were moderately high on both sampling dates, although concentrations were similar to those measured during earlier surveys on the lake. Based on results from all three trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Blackmans Lake was classified as mesotrophic in 1994. Water chemistry results are listed in a table at the end of this summary.

During the August survey, the high concentration of total phosphorus at the bottom of the lake could have resulted from phosphorus being recycled from sediments. This can happen when concentrations of dissolved oxygen are depleted near the sediment surface. Profile data show that during the August survey, concentrations of dissolved oxygen decreased considerably below the thermocline. Low dissolved oxygen concentrations can result in lakes that have moderate to heavy amounts of organic material in the water and sediments (including logs, aquatic plants, and algae), because the decomposition process removes oxygen from water.

Aquatic plants identified by Ecology staff during field visits include naiad (*Najas* sp.), yellow-flowering water lily (*Nuphar* sp.), waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), and Berchtold's pondweed (*Potamogeton berchtoldii*). In 1993, a small bryozoan colony was brought up with the aquatic plant sampler. Bryozoans are colonial invertebrates that are eaten by fish.

Other Available Information

From KCM (1994): Blackmans Lake is mesotrophic and experiences blue-green algal blooms. The majority (69%) of the lake's annual total phosphorus load is from external sources, and about 17% is from internal loading. Stormwater contributes about 28% of the total volume of water entering the lake. Watershed management and restoration measures are recommended to improve water quality. In-lake restoration recommendations include a whole-lake alum treatment and hypolimentic aeration. Watershed management recommendations include riparian area buffer zones, public education, stormwater best management practices, and improvements in practices associated with agriculture, development, and forestry. Capital improvement projects may include stream modifications, wetland enhancement, ditch improvements, and construction of a stormwater detention pond.

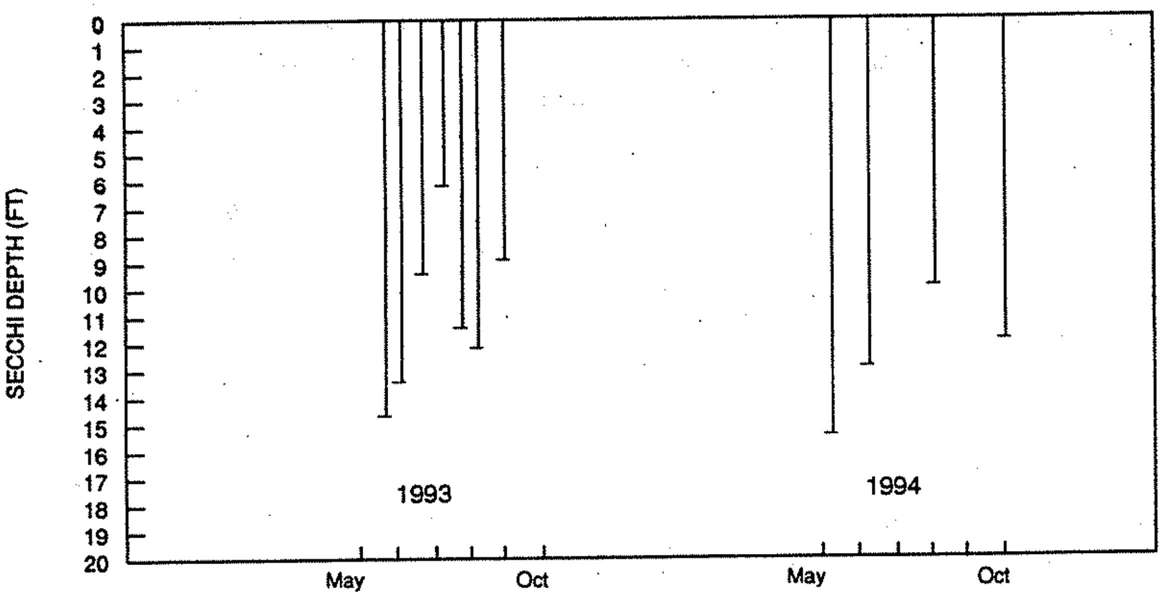
Acknowledgment

I thank Rick Hart for volunteering his time to monitor Blackmans Lake during 1993 and 1994.

BLACKMANS Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/06/04	0.0	32.0	0.0	Grn-brown	100	None	Breezy	15.0	0.0	Green algae washed up on shore.
94/07/04	20.0	68.0	7.3		0	None	Light	12.5	0.0	Water color yellow-green.
94/08/27	21.7	71.1	0.0		0	None	Breezy	9.5	29.0	
94/10/23	13.9	57.0	0.0		75	Light	Calm	11.5	0.0	Water color yellow-green. Parking lot construction underway at Hill Park.

BLACKMANS LAKE (SNOHOMISH COUNTY)



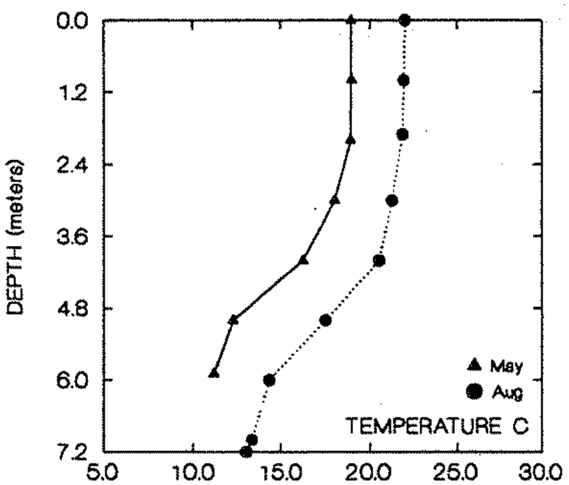
BLACKMANS (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

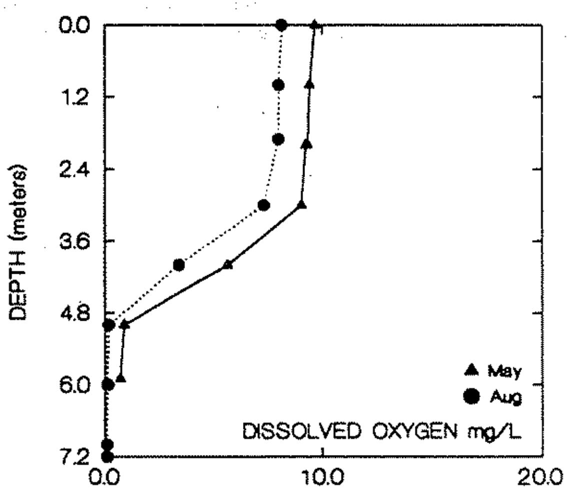
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/08/03		E	8			(Source: Water Supply Bulletin 43)					
81/07/07		E			3.8	(Source: Water Supply Bulletin 57)					
89/06/26	1	E	16	0.49	3.3						
89/09/25	1	E	22	0.44	3.9						
90/06/06	1	E	26	0.51							
93/05/23	1	E	29	0.40	3.0						
93/05/23	1	H	42	0.43							
93/08/21	1	E	13	0.40	2.8						
93/08/21	1	H	28	0.37							
94/06/04	1	E	22	0.23	4.5						
94/06/04	2	E	36	0.22	3.7						
94/06/04	1	H	45	0.21							
94/08/27	1	E	24	0.34J	6.8						
94/08/27	2	E	23	0.30J	5.1						
94/08/27	1	H	98	0.58J							

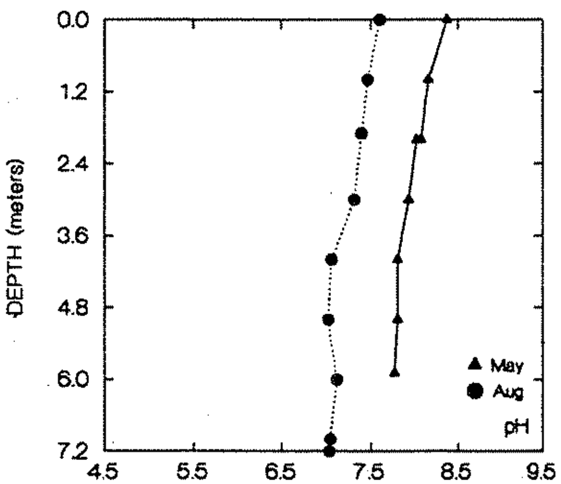
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

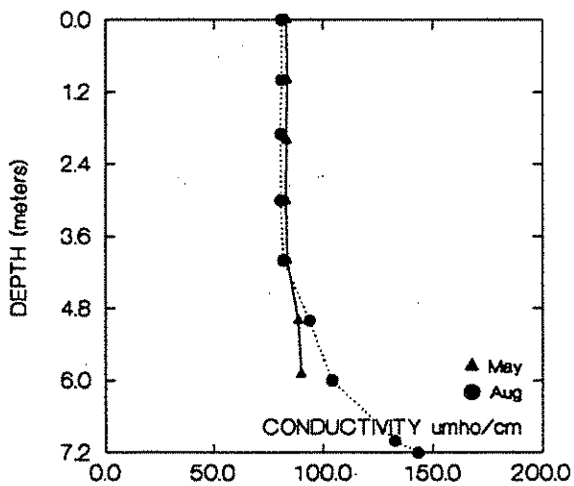
BLACKMANS (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/04	0.0	19.0	8.4	9.7	84.0	94/08/27	0.0	22.0	8.1	8.2	81.0
	1.0	19.0	8.2	9.4	84.0		1.0	22.0	8.0	8.0	81.0
	2.0	19.0	8.1	9.4	84.0		1.9	21.9	7.9	8.0	81.0
	2.0	19.0	8.0	9.3	84.0		3.0	21.3	7.8	7.3	81.0
	3.0	18.0	7.9	9.1	83.0		4.0	20.5	7.6	3.4	82.0
	4.0	16.3	7.8	5.7	84.0		5.0	17.5	7.5	0.2	94.0
	5.0	12.2	7.8	0.9	89.0		6.0	14.3	7.6	0.1	104.0
	5.9	11.2	7.8	0.7	90.0		7.0	13.3	7.5	0.1	132.0
							7.2	13.0	7.5	0.1	143.0







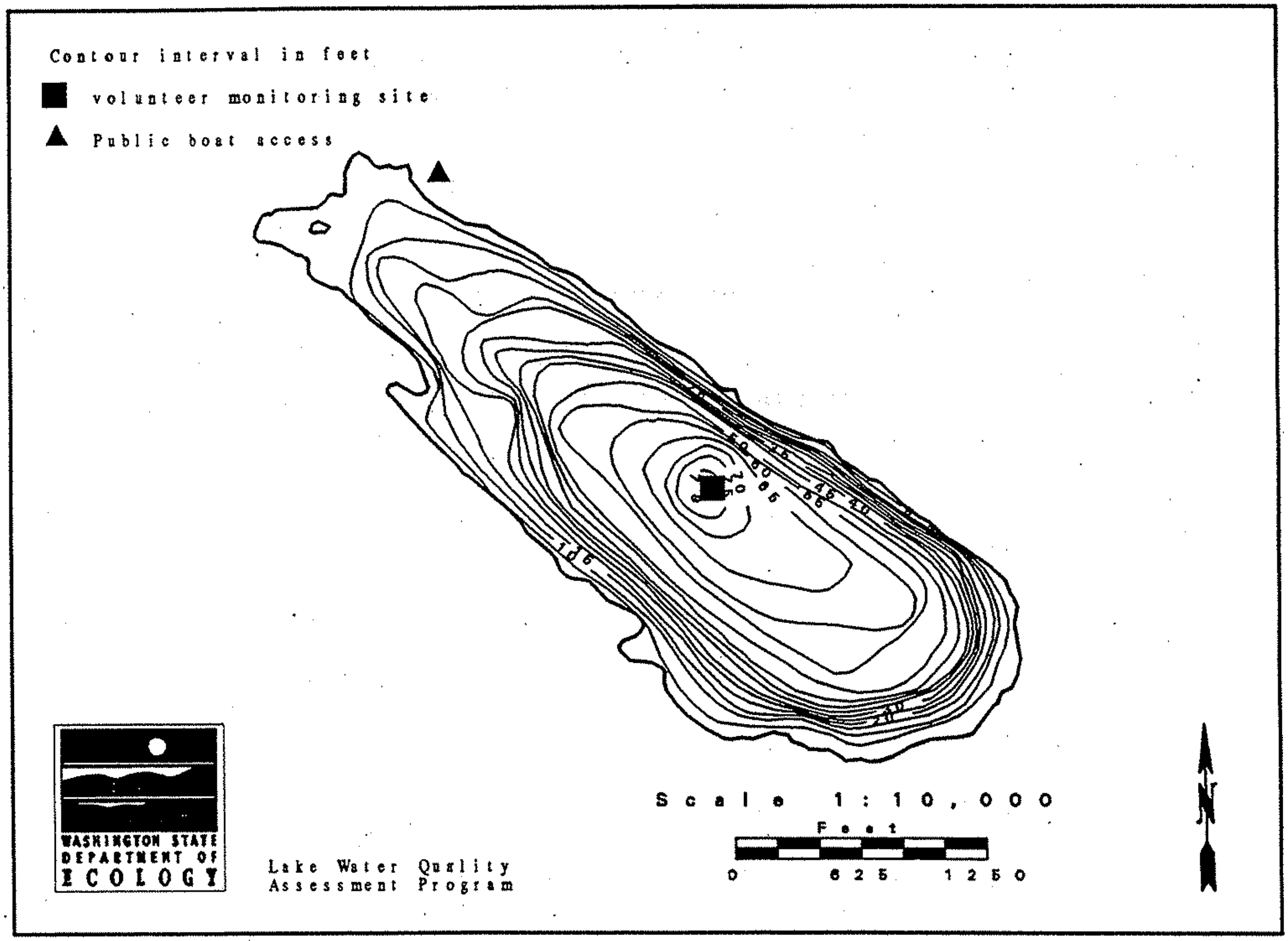


Lake Bosworth -- Snohomish County

Lake Bosworth is located 2.3 miles south of Granite Falls. It is fed by two unnamed inlets, and drains northeast to the Pilchuck River.

Size (acres)	105
Maximum Depth (feet)	79
Mean Depth (feet)	35
Lake Volume (acre-feet)	3,671
Drainage Area (miles^2)	1.4
Altitude (feet)	563
Shoreline length (miles)	2.0

Data From Bortleson *et al.* (1976)



Overall Assessment

Water quality and water clarity in Lake Bosworth was very good in 1994.

Although the seasonal Kendall test for trend indicated that there was a significant improving trend in Secchi depths from 1990 through 1994, the trend is probably due to changing volunteers between 1991 and 1992. This was shown as a step trend in data collected between the two volunteers. Statistical trend analysis of Secchi depth data will be attempted again after the 1995 monitoring season.

Concentrations of total phosphorus were low in 1994. Although concentrations of total nitrogen were moderately high, the concentrations have not changed much in the last five years. Temperature, pH, dissolved oxygen, and conductivity profile data were not unusual for this lake.

Aquatic plants were not prevalent in the lake, although iris (*Iris pseudacorus*) grew along parts of the shoreline. Other aquatic plants observed by Ecology staff include cattails (*Typha* sp.), waterweed (*Elodea candensis*), quillwort (*Isoetes* sp.), and a narrow-leaf pondweed (possibly *Potamogeton illinoensis*). Lake Bosworth was also monitored for Snohomish County's Lake Monitoring Program in 1994, which included two water sampling events and an aquatic plant survey. Results from Snohomish County's program were not available when these results were compiled.

Based on results from the three main trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Lake Bosworth was classified as oligotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Bosworth is used for fishing, swimming, and non-motorized boating. There is one public boat ramp, making about 1% of the shoreline publicly-owned. Only electric motors are allowed on the lake. Rainbow trout were stocked in the lake in 1994. Currently, the only activity in the watershed is lakeshore development for residences. In the past, the watershed was logged.
>
> There are about 112 houses on the lakeshore, and none of the houses are connected to a sewer. About six culverts/stormdrains drain into the lake. There is no homeowners association for the lake. No aquatic plant management activities occurred in 1993, although the lake was treated in the past with chemicals to control undesirable fish species. Lake water is withdrawn for drinking and other domestic uses.

Lake Bosworth -- Snohomish County

Overall, the volunteer found that Lake Bosworth had good water quality. Low water level was the worst water quality problem in 1994, followed by excessive plant growth, impaired fisheries, and swimmer's itch. The problem with the fishery may be due to low stocking rates, which were also noted in 1993 and 1992. There were no changes in the lake since the 1993 monitoring season.

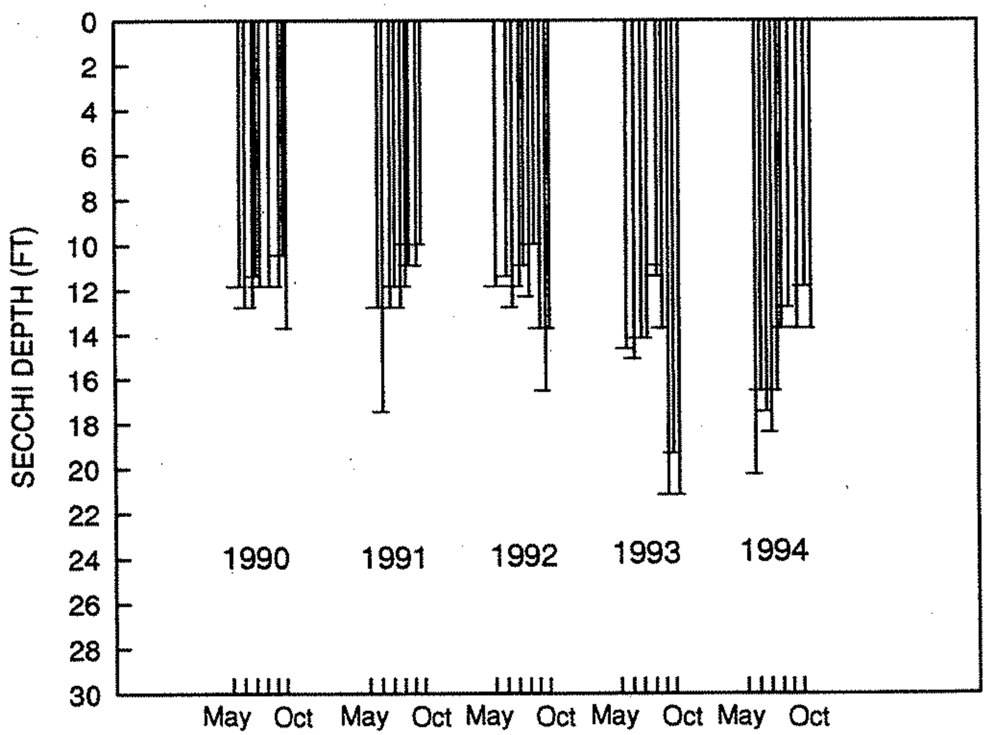
Acknowledgments

I thank Dick McFadden for volunteering his time to monitor Lake Bosworth during 1991-1994. Robert and Delores Maxwell monitored the lake during 1990-1991.

BOSWORTH Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/20	15.6	60.1	0.0	Pea-green	100	Trace	Breezy	19.6	13.5	Onsite visit.
94/06/01	16.7	62.1	0.0	Pea-green	90	Mod		15.9	14.5	Lake height in feet.
94/06/16	16.7	62.1	0.0	Pea-green	90	Mod	Light	16.8	15.0	
94/07/03	18.3	64.9	0.0	Pea-green	90	Light	Light	17.8	0.0	Lake height 13 feet.
94/07/15	21.1	70.0	0.0	Pea-green	100	None	Calm	15.9	14.0	(Lake height in inches)
94/08/01	23.9	75.0	0.0	Pea-green	0	None	Light	13.1	19.0	
94/08/15	23.3	73.9	0.0	Pea-green	50	None	Calm	12.2	24.0	
94/08/19	22.2	72.0	0.0		100	None	Breezy	12.2	0.0	Onsite visit.
94/09/01	21.1	70.0	0.0	Pea-green	90	None	Light	13.1	26.0	
94/09/15	20.0	68.0	0.0	Pea-green	50	Mod		13.1	25.0	
94/10/02	18.3	64.9	0.0	Pea-green	50	Trace	Light	11.2	26.0	
94/10/16	15.6	60.1	0.0	Pea-green	50	None	Calm	13.1	26.5	

LAKE BOSWORTH (SNOHOMISH COUNTY)



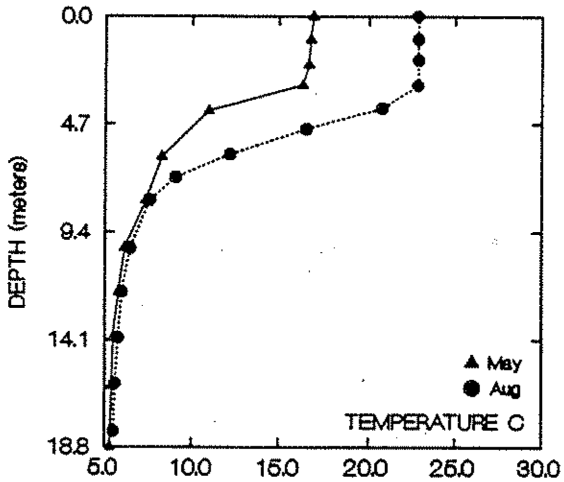
BOSWORTH (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

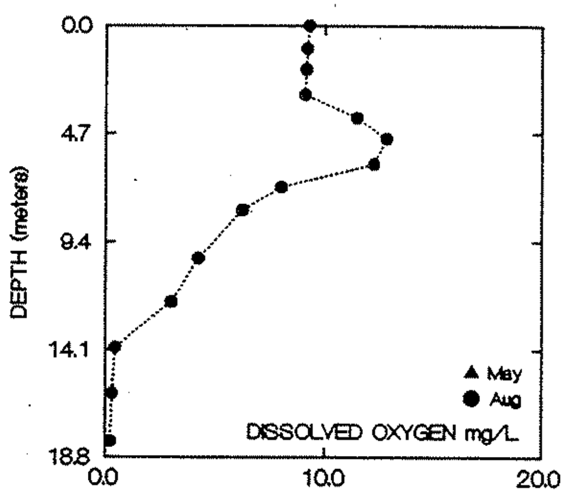
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/08/02		E	4			(Source: Water Supply Bulletin 43)					
90/06/06	1	E	7								
91/05/29	1	E		0.72							
92/05/15	1	E	10	0.67	1.5						
92/05/15	1	H	9	0.84							
92/08/21	1	E	10	0.32	2.2						
92/08/21	1	H	17	0.65							
93/05/24	1	E	21	0.62	2.4						
93/05/24	1	H	20	0.73							
93/08/18	1	E	12	0.35	5.7						
93/08/18	1	H	24	0.56							
94/05/20	1	E	10	0.73	1.5						
94/05/20	1	H	15	0.76							
94/08/19	1	E	6	0.45J	3.2J						
94/08/19	1	H	13	0.90J							

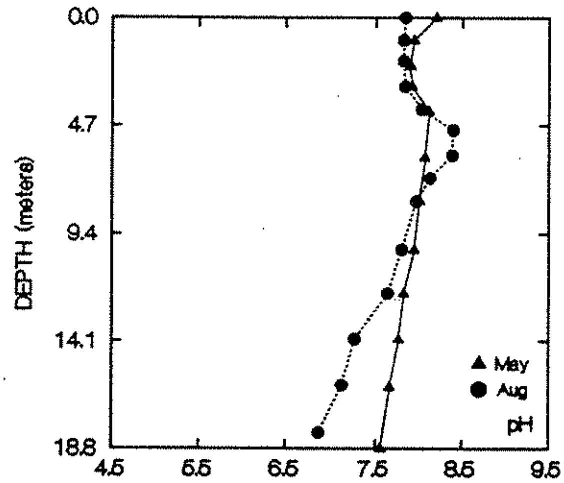
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

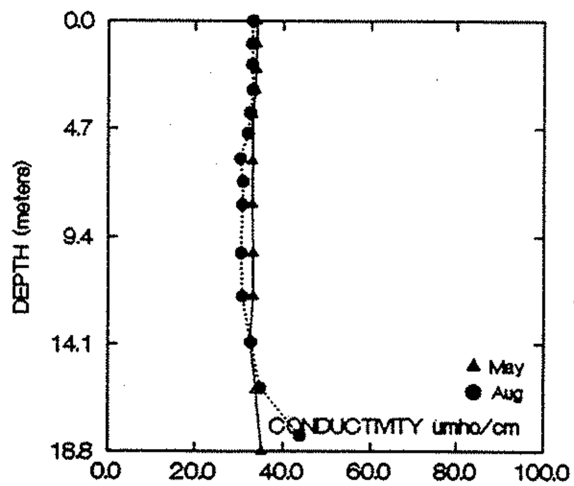
BOSWORTH (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/20	0.0	16.9	8.2	0.0	34.0	94/08/19	0.0	22.9	8.3	9.3	33.0
	1.0	16.8	7.9	0.0	34.0		1.0	22.9	8.3	9.2	33.0
	2.1	16.6	7.9	0.0	34.0		1.9	22.9	8.3	9.1	33.0
	3.0	16.3	7.9	0.0	34.0		3.0	22.9	8.3	9.1	33.0
	4.1	10.9	8.1	0.0	33.0		4.0	20.8	8.5	11.5	32.0
	6.1	8.3	8.1	0.0	33.0		4.9	16.5	8.9	12.8	32.0
	8.0	7.4	8.0	0.0	33.0		6.0	12.2	8.9	12.3	30.0
	10.1	6.1	8.0	0.0	33.0		7.0	9.0	8.6	8.0	31.0
	12.0	5.8	7.8	0.0	33.0		8.0	7.6	8.5	6.2	31.0
	14.0	5.5	7.8	0.0	33.0		10.1	6.5	8.3	4.2	30.0
	16.1	5.4	7.7	0.0	34.0		12.0	6.0	8.1	3.1	31.0
	18.8	5.3	7.6	0.0	35.0		14.0	5.8	7.8	0.5	33.0
							16.0	5.6	7.6	0.3	35.0
							18.1	5.5	7.4	0.2	44.0







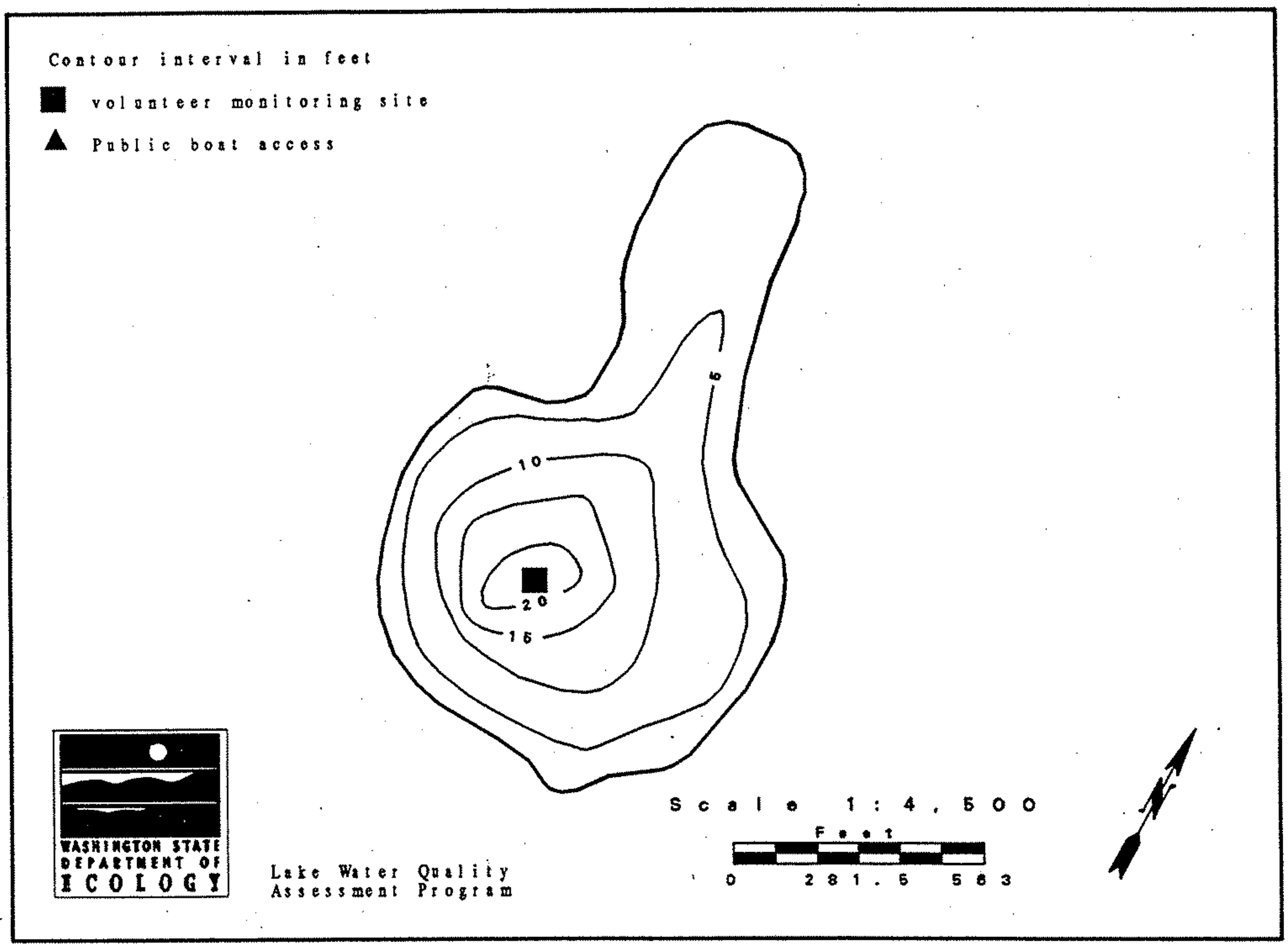


Buck Lake -- Kitsap County

Buck Lake is located 1.5 miles southwest of Hansville. It has no surface inlets, and seeps to Puget Sound.

Size (acres)	22
Maximum Depth (feet)	24
Mean Depth (feet)	7
Lake Volume (acre-feet)	157
Drainage Area (miles^2)	0.3
Altitude (feet)	130
Shoreline Length (miles)	0.9

Data From Sumioka and Dion (1985)



Overall Assessment

Water clarity in Buck Lake was fair in 1994, but was not was good as clarity in 1993 (see graph of Secchi depth data).

Despite high concentrations of total phosphorus, chlorophyll *a* concentrations and Secchi depths indicate that there was only a moderately high amount of algae in the water when the lake was sampled. Dissolved oxygen concentrations were low below the thermocline, which is not unusual for a lake with moderate to high amounts of aquatic plants. Water chemistry results and profile data are listed in tables at the end of this summary.

Aquatic plants observed by Ecology staff during field visits include yellow-flowering water lily (*Nuphar*), cattails (*Typha* sp.), coontail (*Ceratophyllum demersum*), quillwort (*Isoetes* sp.), waterweed (*Elodea canadensis*), largeleaf pondweed (*Potamogeton amplifolius*), and another pondweed that may have been *Potamogeton foliosus*. A large bryozoan colony was also observed during the August 1993 sampling visit. Bryozoans are colonial invertebrates that are often eaten by fish.

The high total phosphorus concentrations, moderately high amounts of plants and algae, and moderately low Secchi depths, indicate that Buck Lake was meso-eutrophic in 1994. Because most of Buck Lake's watershed is forested, and the only development near shore is a local park, Buck Lake is a good example of a naturally eutrophying lake. Much of Buck Lake's shore is wetlands, and the volunteers reported that the area is used by a variety of wildlife. Despite the trophic state assigned to the lake, "restoring" the lake to enhance recreational uses may not be warranted.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire on lake and watershed uses.

> Buck Lake is used for fishing, swimming, and non-motorized boating. There is one public boat ramp. Only electric motors are allowed on the lake. Rainbow trout were stocked in the lake in 1994. Currently, the only activity in the watershed is horse grazing. About two years ago, areas within the watershed were logged. There is one house on the lakeshore, which was completed in 1994.
>
> Overall, the volunteer found that Buck Lake had good water quality. The only problem in the lake is that anglers complained of poor fishing in 1994. Horses and livestock have had access to the lakeshore, and motorized boats sometimes use the lake illegally. Future

threats to the lake include development of the lakeshore. The only change at the lake since the 1993 monitoring season was the completion of the one house on the lakeshore.

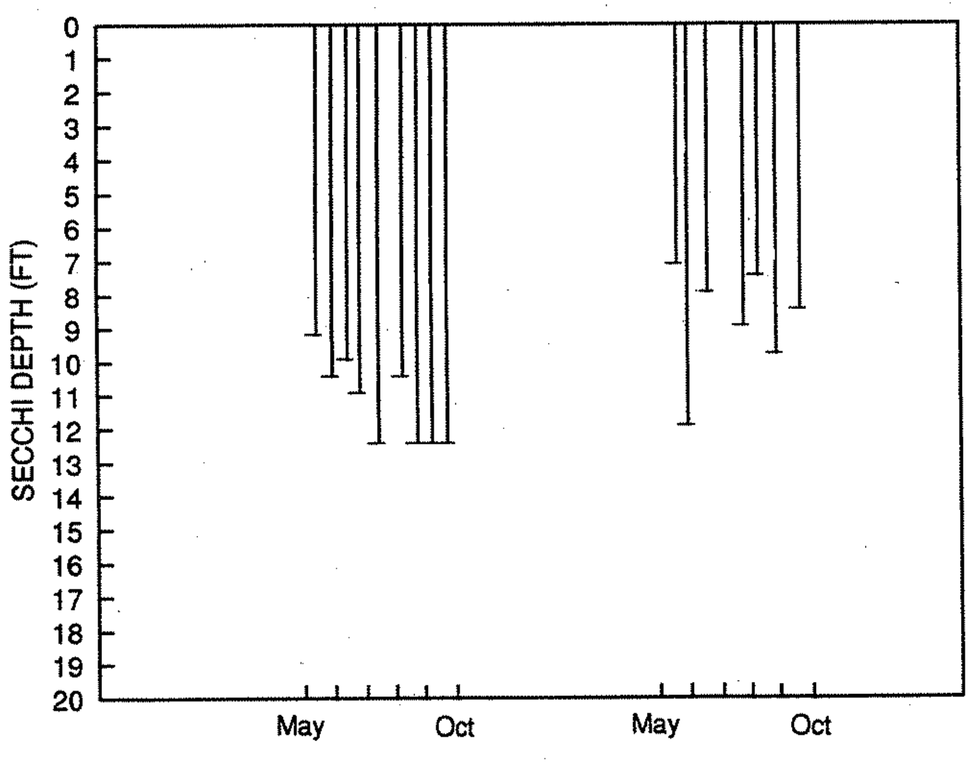
Acknowledgments

I thank Barbara Forsnier for volunteering her time to monitor Buck Lake in 1993 and 1994. Sue Koenig collected most of the 1993 monitoring data.

BUCK Lake -- KITSAP County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/23	0.0	32.0	0.0		50		Breezy	6.7	0.0	Onsite visit. Water color yellow-brown.
94/06/03	19.4	66.9	0.0		95	Light	Breezy	11.5	-3.0	Water color yellow-brown. Lake height 3" below "keep off" sign.
94/06/22	24.4	75.9	0.0		0	None	Calm	7.5	-5.0	Water color yellow with slight brown.
94/07/27	24.4	75.9	0.0		60	None	Light	8.5	0.0	Water color yellow-brown.
94/08/10	24.4	75.9	0.0		10	None	Light	7.0	-14.0	Water color slight yellow-brown.
94/08/28	22.2	72.0	0.0		0	None	Breezy	9.3	0.0	Water color yellow green.
94/09/20	20.0	68.0	0.0		0	None	Calm	8.0	0.0	Water color yellow.

BUCK LAKE (KITSAP COUNTY)



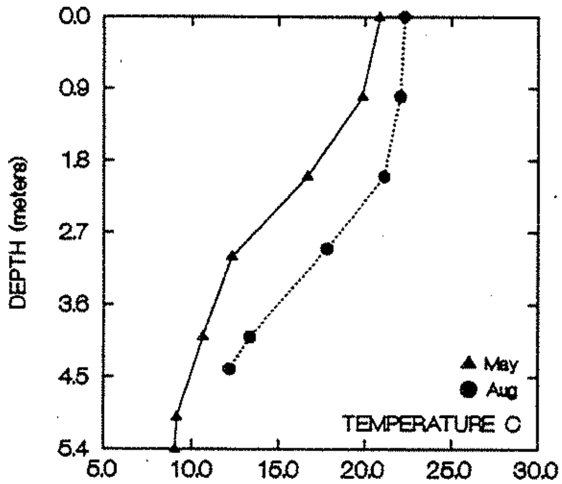
BUCK (KITSAP) Lake -- KITSAP County
Chemistry Data -- Station 1

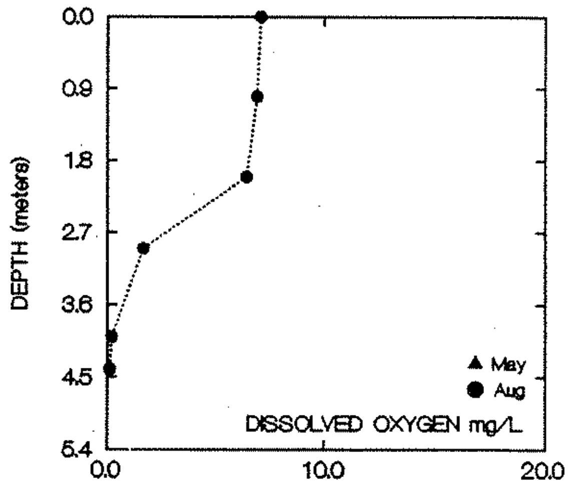
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
81/07/02		E	50		3.4	(Source: Water Supply Bulletin 57)					
93/06/07	1	E	38	0.72	9.4	5	1U		1	1	
93/06/07	1	H	114	0.82							
93/08/30	1	E	31	0.76	4.4						
94/05/23	1	E	39	0.37	4.8J						
94/05/23	1	H	71	0.44							
94/08/23	1	E	26	0.72J	2.9						
94/08/23	1	H	107	0.78J							

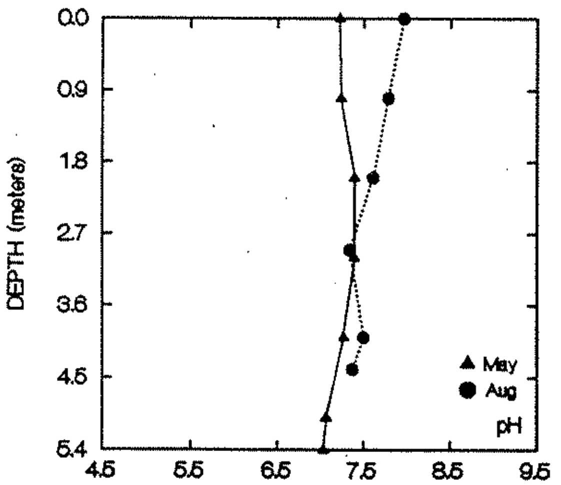
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

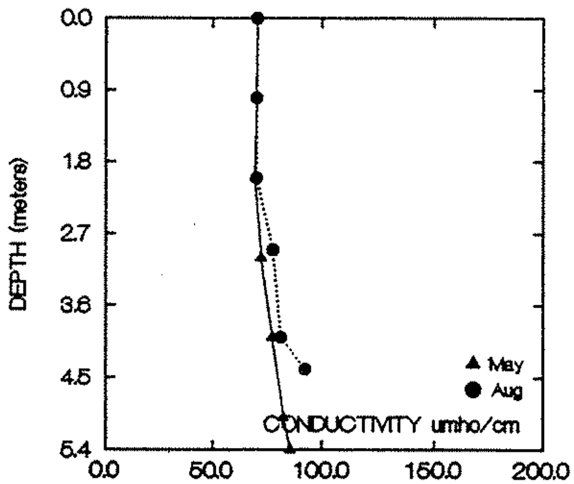
BUCK (KITSAP) Lake -- KITSAP County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/23	0.0	20.9	7.2	0.0	71.0	94/08/23	0.0	22.3	8.0	7.1	71.0
	1.0	19.9	7.2	0.0	71.0		1.0	22.1	7.8	7.0	71.0
	2.0	16.7	7.4	0.0	70.0		2.0	21.1	7.6	6.5	70.0
	3.0	12.3	7.4	0.0	73.0		2.9	17.8	7.3	1.7	78.0
	4.0	10.6	7.3	0.0	78.0		4.0	13.3	7.5	0.2	81.0
	5.0	9.1	7.1	0.0	82.0		4.4	12.1	7.4	0.1	92.0
	5.4	9.0	7.0	0.0	86.0						









Lake Byron -- Yakima County

Byron Lake is located 4.25 miles south of Grandview. It drains to the Yakima River. Byron Lake was monitored by Ecology staff only.

Size (acres)	16
Maximum Depth (feet)	6
Mean Depth (feet)	3
Lake Volume (acre-feet)	47
Drainage Area ($miles^2$)	--
Altitude (feet)	700
Shoreline Length (miles)	1.3

Data from Dion *et al.* (1976)

Map not available.

Overall Assessment

Byron Lake was sampled by Ecology staff only in 1994. A smaller pond near the upper end of Byron Lake was sampled in May, because there was no access to the main lake. The upper pond was nearly dried up in May, and there were many dead carp in the basin.

Concentrations of total phosphorus and chlorophyll *a* in both basins were very high, and based on the these results the lake was classified as hyper-eutrophic.

Aquatic plants observed by Ecology staff during the August survey include curly-leaf pondweed (*Potamogeton crispus*), milfoil (*Myriophyllum* sp.), bulrush (*Scirpus* sp.), and purple loosestrife (*Lythrum salicaria*). Only one plant of the purple loosestrife was observed.

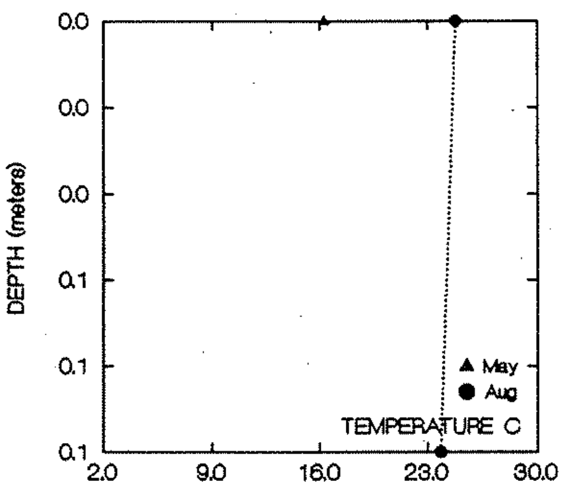
BYRON (YAKIMA) Lake -- YAKIMA County
Chemistry Data -- Station 1

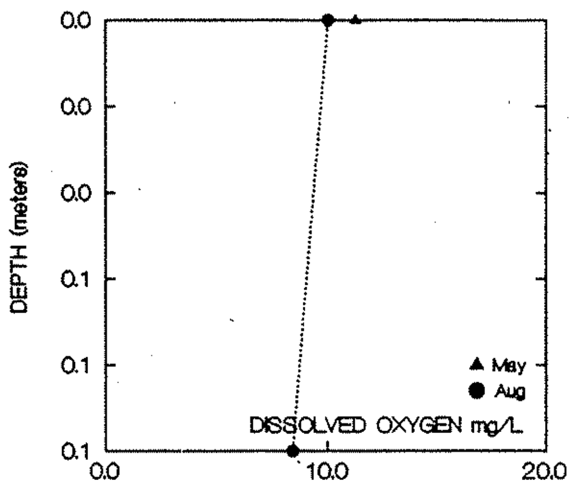
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/05/16		E	180			(Source: Water Supply Bulletin 43)					
94/05/16	1	E	451J	2.50	69.0	21	13	50.0			
94/08/15	1	E	415J	1.67J	114J			60.0			

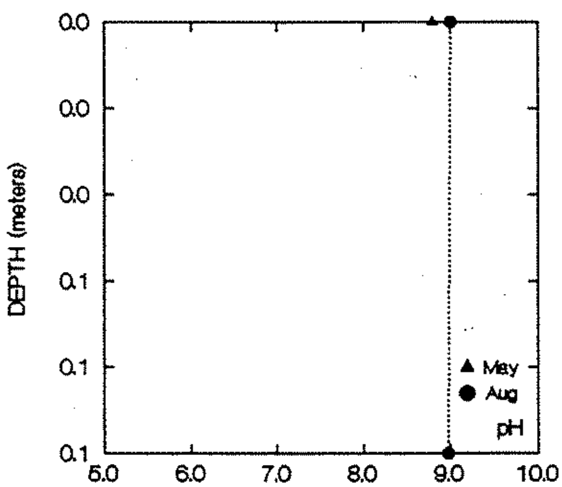
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

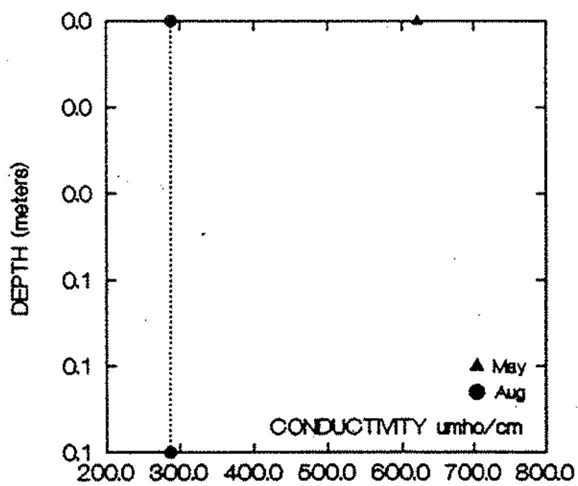
BYRON (YAKIMA) Lake -- YAKIMA County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/16	0.0	16.3	8.8	11.3	622.0	94/08/15	0.0	24.8	9.0	10.1	288.0
							0.1	23.8	9.0	8.4	287.0







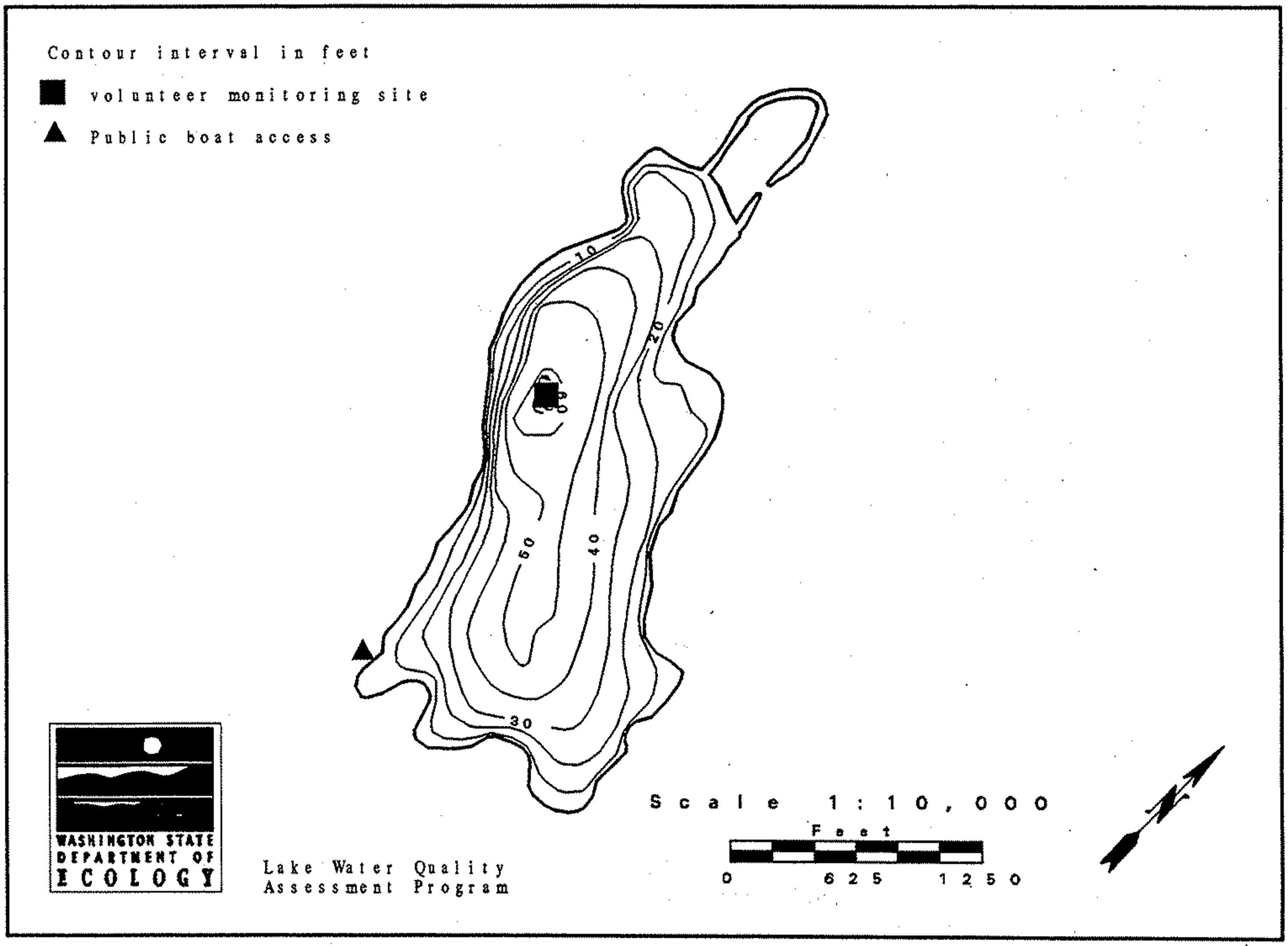


Cain Lake -- Whatcom County

Cain Lake is located 9.5 miles southeast of Bellingham. It is fed by Reed Lake, and drains via Silver Creek to the Samish River. Cain Lake is also referred to as Windemere Lake on some older maps.

Size (acres)	72
Maximum Depth (feet)	62
Mean Depth (feet)	30
Lake Volume (acre-feet)	2,200
Drainage Area (miles^2)	3.32
Altitude (feet)	391
Shoreline Length (miles)	1.7

Data From Bortleson *et al.* (1976)



Overall Assessment

Water clarity in Cain Lake was very good during most of the monitoring season.

Concentrations of total phosphorus were low on both sampling dates, yet concentrations of total nitrogen were very high. Secchi depths and chlorophyll *a* concentrations indicate that there was a low to moderate amount of algae in the water. Water chemistry results and Secchi depths are listed in tables at the end of this summary.

Temperature profile data indicate that the lake was strongly stratified on both sampling dates. Below the thermocline, concentrations of dissolved oxygen decreased considerably, which is not unusual for lakes that have a moderate amount of plant and algae growth, or are fed in part by groundwater. Salmonid habitat is probably restricted to the thermocline in late summer, when dissolved oxygen concentrations in the lower layer of water were depleted in the bottom eight meters of the lake.

Although results from fecal coliform bacteria samples were within the limits in the state water quality standards, they were a bit high in comparison to other lakes sampled for the program. One sample had 29 colonies/100 mL, and was collected near the public boat access. This is a shallow, stagnant area near the outlet of the lake. The other sample was collected at the culvert that drains from Reed Lake.

Aquatic plants observed by Ecology staff during the field visits included yellow-flowering lilies (*Nuphar* sp.) and wild celery *(Vallisneria americana)*. The latter was particularly lush in the shallow channel that separates Reed Lake from Cain Lake.

Although the results from the three main trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths) indicate that Cain Lake was oligotrophic, the low dissolved oxygen concentrations and moderate amounts of aquatic plants were more indicative of mesotrophy. Because the lake exhibited both oligotrophic and mesotrophic characteristics, the lake was classified as oligo-mesotrophic in 1994. Future study of the lake should include investigating the high nitrogen concentrations in the water.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire on lake and watershed uses.

> Cain Lake is used for fishing, swimming, and non-motorized boating. There is one public boat ramp, and boating speeds are restricted so that no wakes are produced on the lake. Rainbow trout were stocked in the lake in 1994. Currently, the

watershed is being logged and the lakeshore is being developed further for residences. Animals also graze in the watershed, and some animals have access to the lakeshore or inlets. In the past, the watershed was logged, animals grazed in the watershed, a channel was dredged between Reed and Cain Lakes, and a dam was built at the outlet of Reed Lake.

There are about 46 houses on the lakeshore, and none of the houses are connected to a sewer. There are about eight culverts/stormdrains that drain into Cain Lake, and 15 that drain into Reed Lake. There is a lake association for Cain and Reed Lakes. No aquatic plant management activities occurred in 1993. Lake water is withdrawn for drinking and other domestic uses.

Overall, the volunteer found that Cain Lake had good water quality. The worst water quality problems were ranked as (1) algae, (2) excessive plant growth, (3) decaying plants, (4) bacteria, (5) degraded water quality, (6) odor from decaying algae, (7) low water level, (8) degraded aesthetics, (9) suspended sediments, (10) shoreline erosion, (11) swimmer's itch, and (12) impaired fisheries. Potential sources of problems include too many septic systems, lack of best management practices in the watershed, and apathy by public agencies.

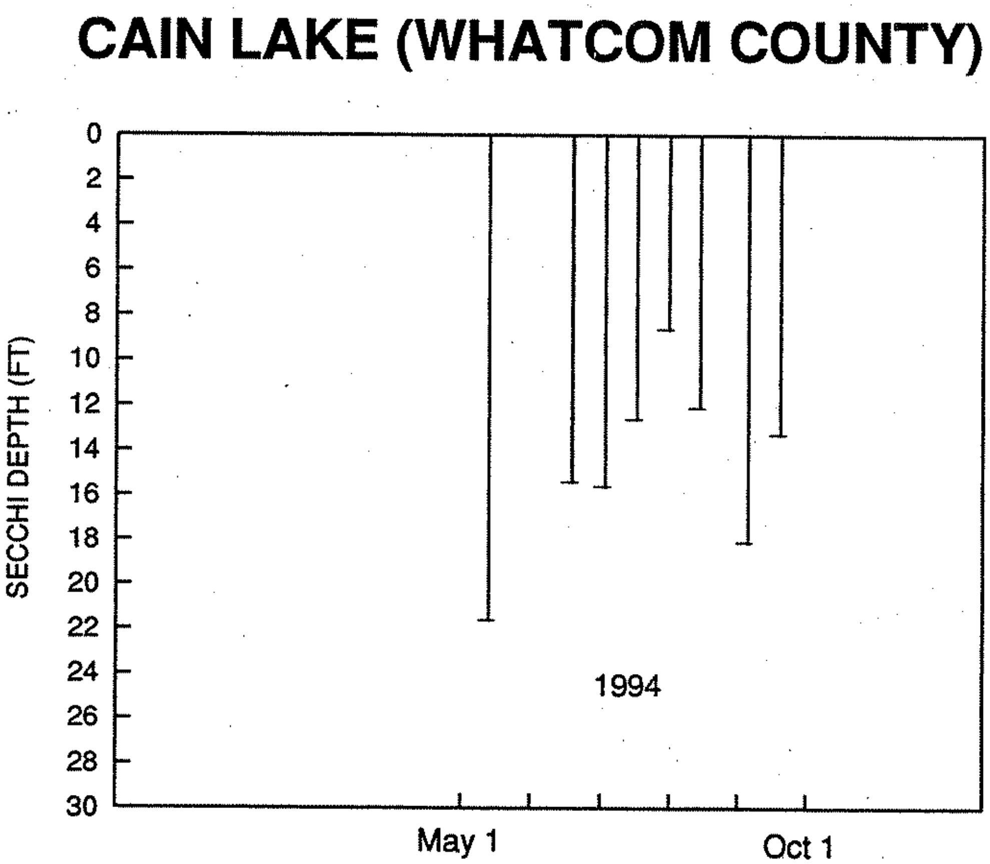
The Cain and Reed Lake Association also designed and conducted a monitoring program for Cain Lake in 1994 . Samples were collected and analyzed for total phosphorus, solids, and fecal coliform bacteria from one deep lake station and stations located at the inlets and outlet of the lake. Temperature and dissolved oxygen profiles were also measured at the deep site of the lake. Results from this monitoring program were not available when this summary was compiled. A graduate student at Western Washington University also monitored Cain Lake during summer 1994. Unusual findings include high nitrate concentrations (>1 mg/L; Harry Taggart, pers. comm.), but results from this study were not available when this summary was prepared.

Acknowledgment

I thank Harry Taggart and members of the Cain and Reed Lake Association for volunteering their time to monitor Cain Lake during 1994.

CAIN Lake -- WHATCOM County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/21	0.0	32.0	0.0		0			21.0	0.0	Onsite visit. Water color green with some brown.
94/06/26	17.2	63.0	0.0	Grn-brown	0	None	Calm	14.8	0.0	Lake height set at zero today.
94/06/26	17.2	63.0	0.0	Mod Green	0	None	Light	14.8	0.0	Lake height 0.0
94/07/10	19.4	66.9	0.0	Mod Green	0	None	Calm	15.0	-4.0	
94/07/10	19.4	66.9	0.0	Mod Green	0	None	Calm	15.0	-4.0	
94/07/24	24.4	75.9	0.0	Grn-brown	0		Light	12.0	-9.0	
94/08/07	20.0	68.0	0.0		75	None	Light	8.0	-12.0	Water color yellow green pea soup. Big algae bloom.
94/08/21	18.9	66.0	0.0		25	None	Light	11.5	-17.0	Water color medium green-yellow. Onsite visit.
94/09/11	16.7	62.1	0.0		0		Calm	17.5	-20.0	Water color yellow-green.
94/09/26	17.8	64.0	0.0	Lt Green	0	None	Calm	12.7	0.0	Robin Matthews at lake on 10/21/94. Will test until end of October, or when lake turns over. Data from IWS research in streams will be reported.



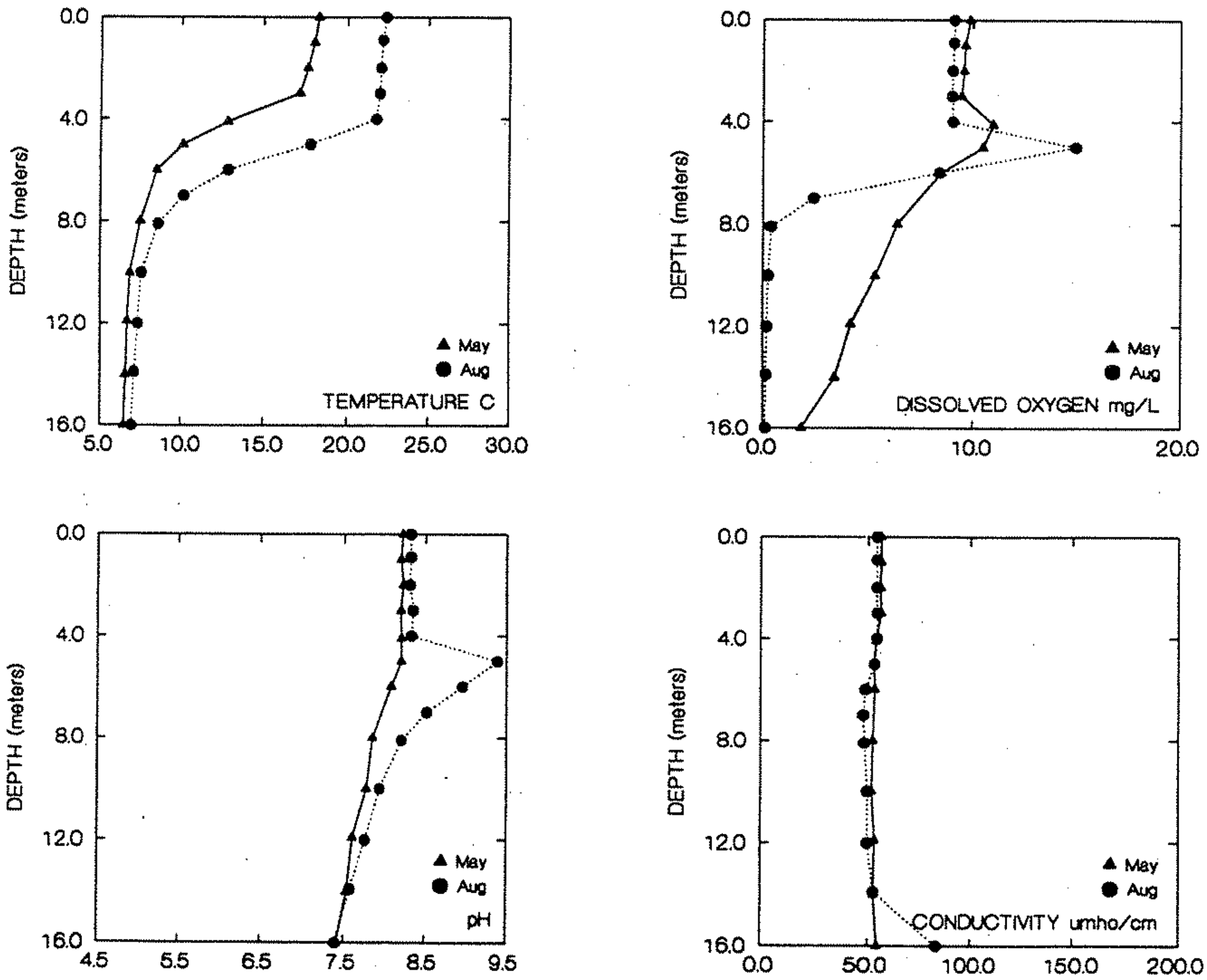
CAIN (WHATCOM) Lake -- WHATCOM County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/08/22		E	14			(Source: Water Supply Bulletin 43)					
94/05/21	1	E	12	1.60	2.2						
94/05/21	1	H	16	1.46							
94/08/21	1	E	10	1.06J	2.2J	29	11	0.8			
94/08/21	1	H	15	0.90J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

CAIN (WHATCOM) Lake -- WHATCOM County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/21	0.0	18.3	8.2	9.9	56.0	94/08/21	0.0	22.4	8.3	9.1	54.0
	1.0	18.0	8.2	9.6	56.0		0.9	22.2	8.3	9.1	54.0
	2.0	17.6	8.2	9.6	56.0		2.0	22.1	8.3	9.0	54.0
	3.0	17.1	8.2	9.4	56.0		3.0	22.0	8.4	9.0	54.0
	3.3	15.1	7.9	11.2	55.0		4.0	21.8	8.3	9.0	54.0
	4.1	12.9	8.2	11.0	54.0		5.0	17.8	9.4	15.1	53.0
	5.0	10.1	8.2	10.5	53.0		6.0	12.9	9.0	8.4	49.0
	6.0	8.5	8.1	8.5	53.0		7.0	10.1	8.5	2.4	48.0
	6.0	8.5	8.0	7.7	52.0		8.1	8.6	8.2	0.4	48.0
	8.0	7.5	7.9	6.3	52.0		10.0	7.5	7.9	0.2	50.0
	10.0	6.8	7.8	5.2	52.0		12.0	7.3	7.8	0.2	50.0
	11.9	6.6	7.6	4.1	53.0		13.9	7.1	7.6	0.1	53.0
	14.0	6.5	7.5	3.4	53.0		16.0	6.9	7.4	0.1	83.0
	16.0	6.4	7.4	1.8	54.0						

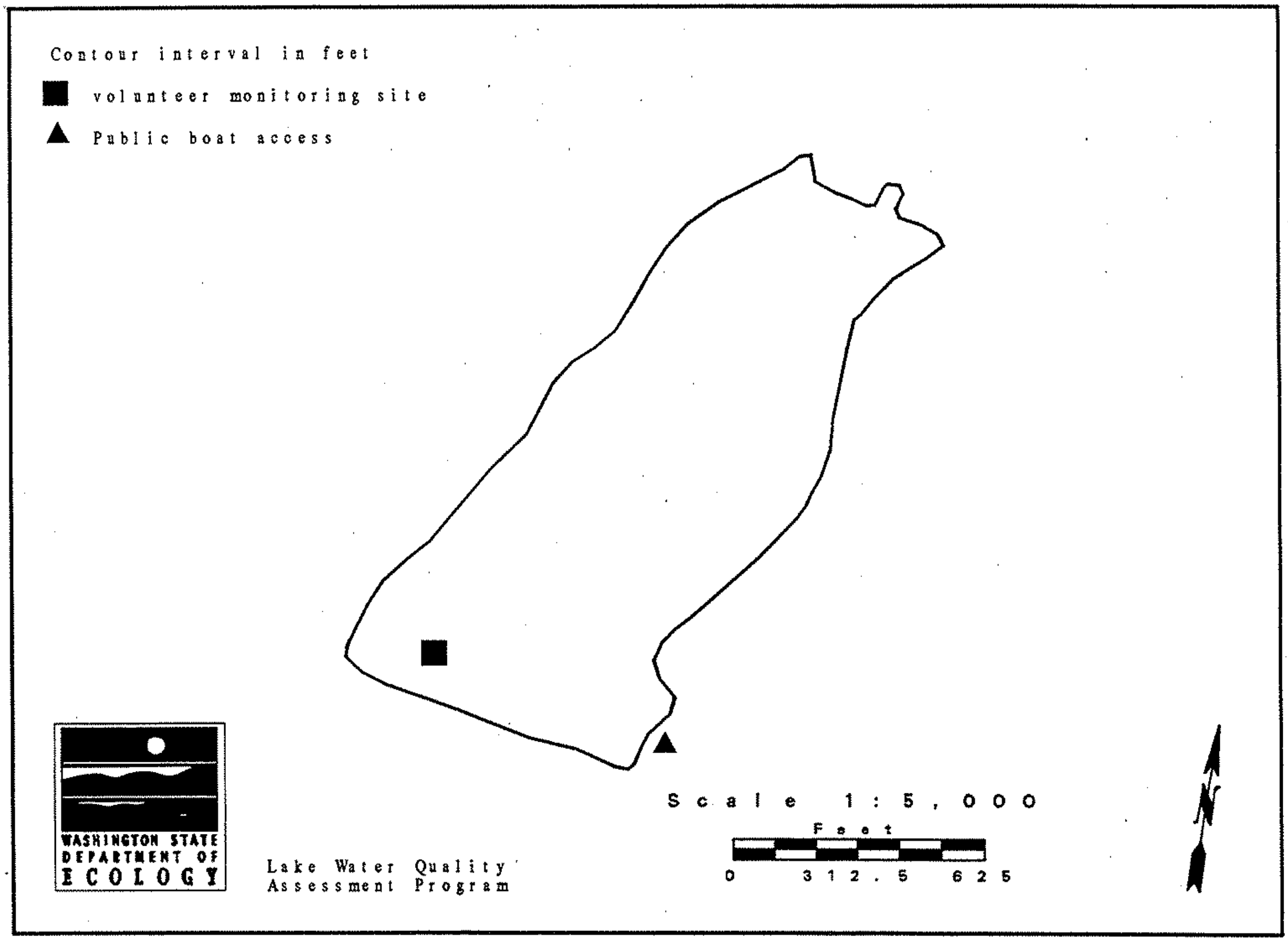


Carlisle Lake -- Lewis County

Carlisle Lake is a man-made mill pond located in Onalaska. It no longer receives mill effluent, and has been placed on Ecology's list of shoreline of the state. Carlisle Lake has no surface inlets, and drains to the south fork of the Newkaukum River.

Size (acres)	29
Maximum Depth (feet)	10
Mean Depth (feet)	3
Lake Volume (acre-feet)	85
Drainage Area (miles^2)	4.15
Altitude (feet)	506
Shoreline Length (miles)	1.1

Data from Bortleson *et al.* (1976)



Overall Assessment

Water clarity in Carlisle Lake was poor during 1994, and Secchi depths were the lowest measured for Ecology's lake monitoring program. Concentrations of total phosphorus and total nitrogen were high on both sampling dates. Algae growth in the lake was very heavy, as indicated by shallow Secchi depths and high concentrations of chlorophyll *a*. Based on results for all three main trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Carlisle Lake was classified as eutrophic in 1994. Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary.

On August 19, 1994, the lake was treated with the aquatic herbicide Sonar to control an infestation of Eurasian water milfoil (*Myriophyllum spicatum*). Following the Sonar treatment, there was an algae bloom, and the volunteer observed about 50 dead fish in the water. During the August 31, 1994 field visit, Ecology staff observed viable (*i.e.,* still green) stems of Eurasian watermilfoil. The Sonar treatment was funded by a grant from Ecology that was awarded to the Lewis County Conservation Service.

Aquatic plants observed by Ecology staff during the field visits include pondweeds (*Potamogeton* sp.), Eurasian watermilfoil (*Myriophyllum spicatum*), cattails (*Typha* sp.), yellow-flowering water lilies (*Nuphar* sp.). During the August survey, all plants were brown and necrotic due to the Sonar treatment. The pondweeds could not be identified because the leaves were not intact. Remnants of a blue-green algae bloom were apparent during the May survey.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire on lake and watershed uses.

> Carlisle Lake is used for fishing only. There is one public boat ramp, and there are no restrictions for boating on the lake. Trout were stocked in the lake in 1994. Currently, the watershed is used mainly for agriculture (both crops and animal rearing). In the past, the watershed was logged and used for agriculture, the lake was dredged, and part of the lakeshore was cleared for a park to be developed. (At present, there is no park on the lakeshore.)
>
> There are no houses on the lakeshore, no culverts that drain into the lake. The lake was treated with Sonar in 1994 to control Eurasian water milfoil.
>
> Overall, the volunteer found that Carlisle Lake had poor water quality. The worst water quality problems were ranked as (1) algae, (2) degraded aesthetics, (3) fish kill, (4) decaying plants, (5) suspended sediments, (6) degraded water quality, and

(7) impaired fisheries. A dairy farm upgradient from the lake is a potential source of nutrients to the lake. The second Sonar treatment contributed to the fish kill, because decaying plants consumed dissolved oxygen in the water. The Sonar also killed back native plants, resulting in degradation of aesthetics.

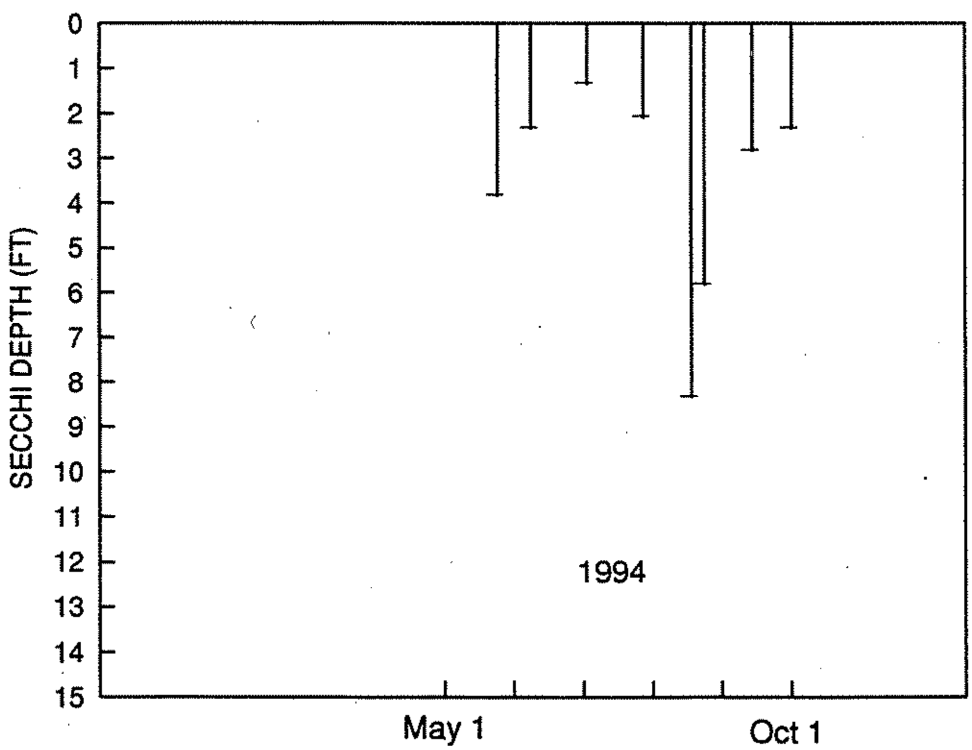
Acknowledgment

I thank Susan Moorehead for volunteering her time to monitor Carlisle Lake in 1994.

CARLISLE Lake -- LEWIS County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/06/01	0.0	32.0	0.0	Pea-green	100	Light	Calm	3.5	0.0	Onsite visit. Raining. Remnants of blue-green algae bloom--bright green floating clumps. Loud frogs.
94/06/16	17.8	64.0	0.0	Milky-grn	25	Mod	Light	2.0	0.0	
94/07/10	21.1	70.0	0.0	Pea-green	0	None	Calm	1.0	0.0	Water looks very cloudy. Four dead fish.
94/08/04	23.3	73.9	6.0	Pea-green	100	None	Calm	1.8	0.0	East shoreline littered with dead tadpoles. 11 dead tadpoles in 200+ feet, and 5-6 dead fish.
94/08/25	21.1	70.0	6.6	Grn-brown	50	None	Calm	8.0	0.0	Fish acting in distress; panting. Sonar application Aug 19. Post treatment algae bloom. 43 dead fish; all but 4 were trout.
94/08/31	0.0	32.0	0.0	Mod Green	0	None	Light	5.5	0.0	Clear for this lake. On site visit.
94/09/21	22.2	72.0	7.6	Pea-green	0	None	Calm	2.5	0.0	pH at surface
94/10/08	15.6	60.1	7.6	Pea-green	10	None	Calm	2.0	0.0	Water color very milky; more on the yellow side than green.

CARLISLE LAKE (LEWIS COUNTY)



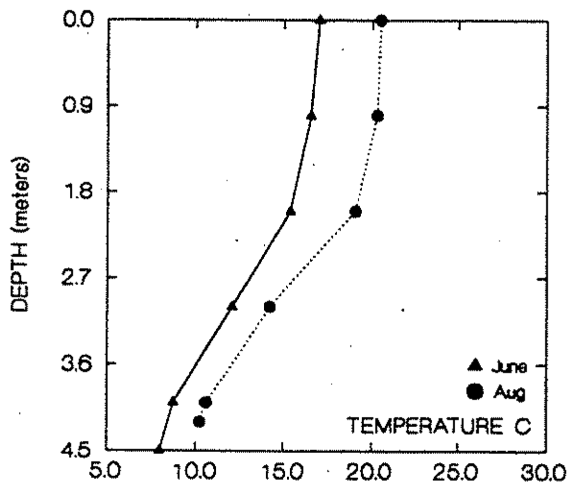
CARLISLE (LEWIS) Lake -- LEWIS County
Chemistry Data -- Station 1

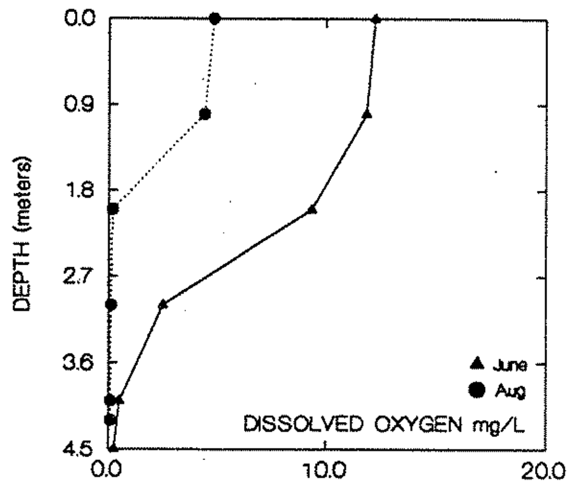
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/06/28		E	170			(Source: Water Supply Bulletin 43)					
94/06/01	1	E	160	0.34	80.6						
94/06/01	1	H	114	0.49							
94/08/31	1	E	72	0.83J	6.3J						
94/08/31	1	H	147	0.98J							

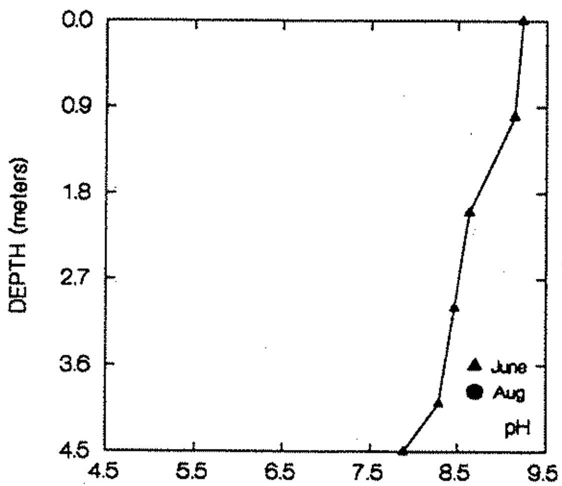
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

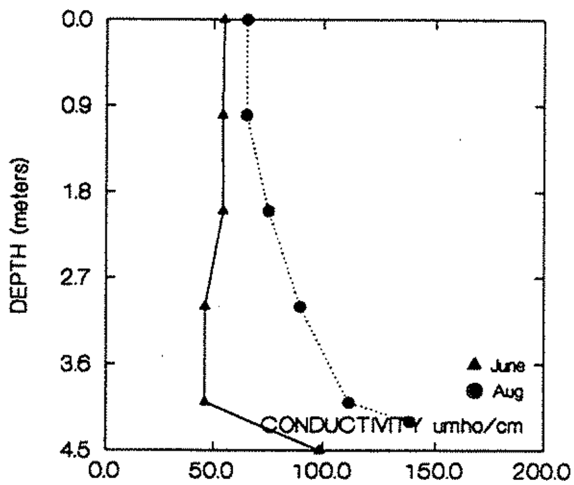
CARLISLE (LEWIS) Lake -- LEWIS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/01	0.0	17.0	9.2	12.2	55.0	94/08/31	0.0	20.5	0.0	4.9	66.0
	1.0	16.6	9.1	11.8	54.0		1.0	20.3	0.0	4.5	65.0
	2.0	15.4	8.6	9.4	54.0		2.0	19.1	0.0	0.2	76.0
	3.0	12.0	8.5	2.5	46.0		1.5	20.0	0.0	1.7	66.0
	4.0	8.7	8.3	0.5	46.0		3.0	14.2	0.0	0.1	90.0
	4.5	8.0	7.9	0.3	99.0		4.0	10.6	0.0	0.1	112.0
							4.2	10.2	0.0	0.1	139.0







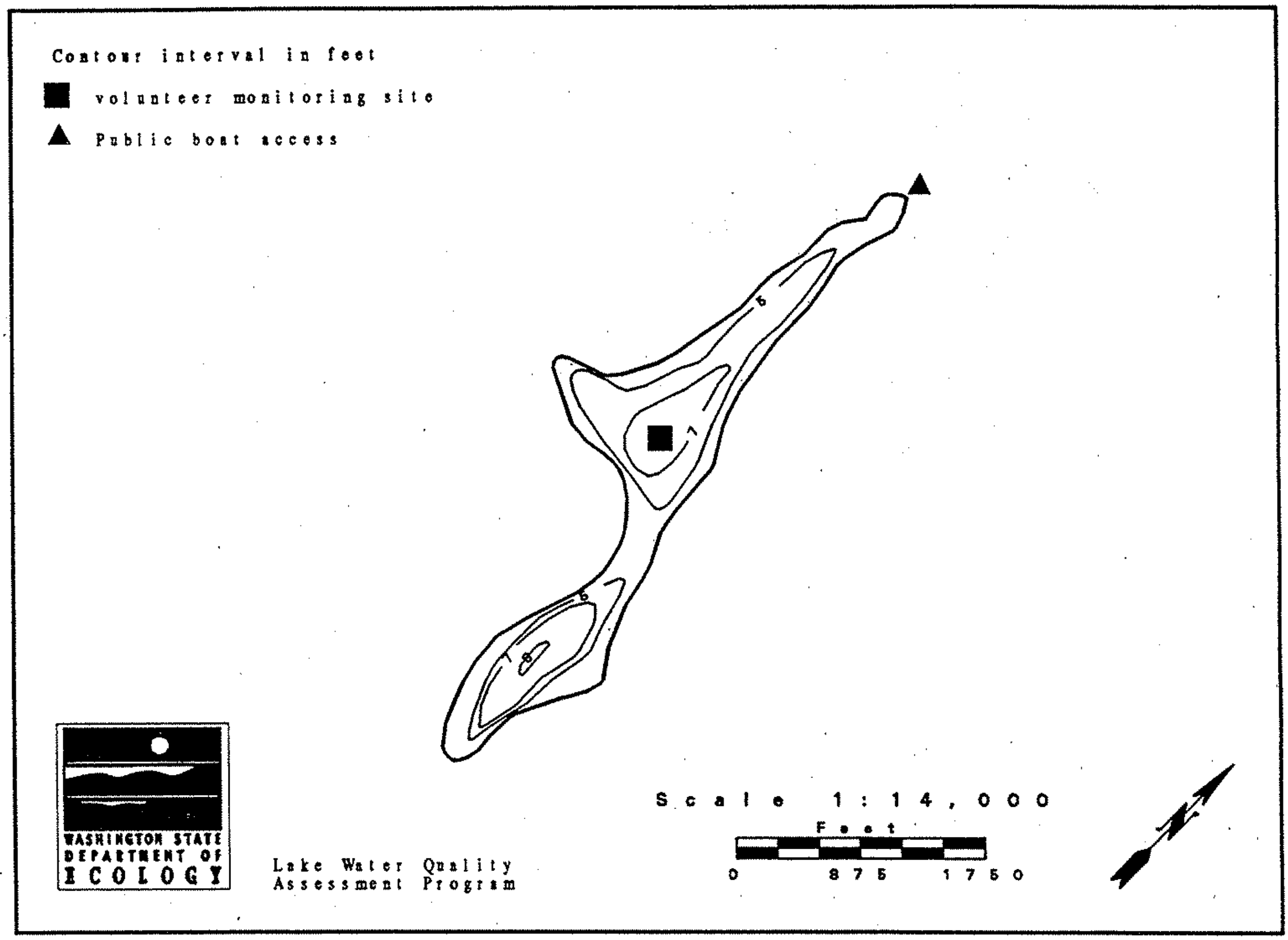


Chambers Lake -- Thurston County

Chambers Lake is located three miles southeast of Olympia. It is also known as Big Chambers Lake, and was originally known as Russell Lake. Chambers Lake has no surface inlets, but is fed by stormwater and surface runoff. As a result, it varies in size. Chambers Lake drains via Little Chambers Lake to the Deschutes River.

Size (acres)	60
Maximum Depth (feet)	8
Mean Depth (feet)	5
Lake Volume (acre-feet)	270
Drainage Area (miles^2)	0.8
Altitude (feet)	194
Shoreline Length (miles)	2.2

Data From Bortleson *et al.* (1976)



Overall Assessment

Water clarity was poor in 1994, although Secchi depths were very similar in 1993 and 1994 (see graph of Secchi depth data).

Based on all measurements made in the lake in 1994, Chambers Lake was classified as eutrophic in 1994. Algae growth was heavy, as indicated by the high concentrations of chlorophyll *a* and the low Secchi depth measurements. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary.

Because the lake is very shallow, aquatic plants can root throughout the lake bottom and much of the lake surface was covered by floating-leaved aquatic plants. Aquatic plants observed by Ecology staff during the field visits include watershield (*Brasenia schreberi*), cattails (*Typha* sp.), and a purple water lily (*Nymphaea* sp.). The latter was probably introduced into the lake. Plants observed in the lake are usually not eaten by grass carp (see other available information, below). Cattails grow along most of the shoreline, and provide habitat for a variety of birds, including swallows and blackbirds. Chambers Lake exhibits more characteristics of a wetland pond than a lake that can be used for contact recreation. Preserving the wetland characteristics of this lake should be considered if further attempts are made to restore the lake.

Other Available Information

In 1990, a four-year demonstration project on the use of grass carp was initiated by the City of Lacey, the University of Washington School of Fisheries, Ecology, and the Chambers Lake Environment and Neighborhood Association (CLEAN). Grass carp were planted in Big Chambers Lake and Little Chambers Lake to evaluate the effectiveness of grass carp on controlling floating-leaved aquatic plants, and to evaluate different stocking rates used in the two lake basins. About 3,000 fish were stocked in Little Chambers Lake, and about 12,500 were stocked in Big Chambers Lake. Two exclusion areas used to keep the fish out are still present in the wide central part of the lake. The demonstration project is still in progress.

The City of Lacey monitored several storm drains that drain into Chambers Lake. Nonpoint source controls will be implemented to reduce nutrient loading to the lake from stormwater.

Summary of Questionnaire Results and Information from the Volunteer

The 1994 survey on lake and watershed uses was not returned.

Acknowledgment

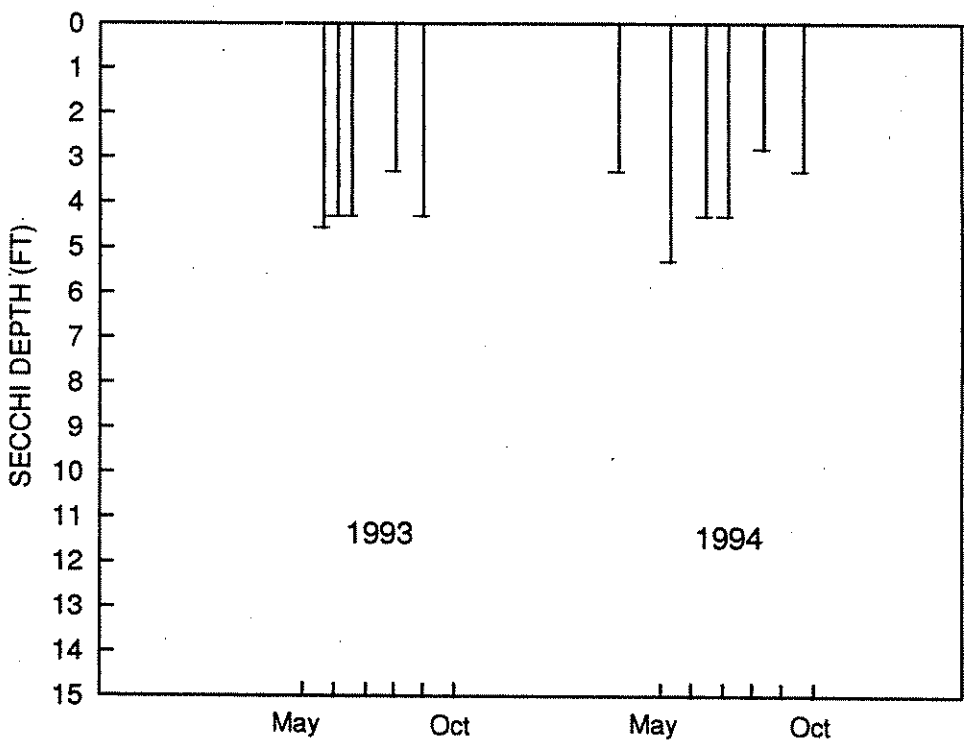
I thank Ernie Schmidt for volunteering his time to monitor Chambers Lake during 1993 and 1994.

CHAMBERS Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/03/28	15.0	59.0	0.0		0	None	Light	3.0	0.0	[Lake height first reading.] Water color yello w with brownish tint.
94/05/16	17.8	64.0	0.0		50		Light	5.0B	-5.2	Onsite visit. Water color yellow-brown.
94/06/20	18.9	66.0	0.0		0	Trace	Light	4.0	0.0	Water color reddish brown. Dead beaver on shor e; only time I've seen beaver here. Appears th ere are breeding pairs of redwing blackbirds ev ery 200-300' around the lake. Grass carp seem to congegrate near public docks.
94/07/11	26.1	79.0	0.0	Lt Brown	0	None	Light	4.0B	0.0	
94/08/15	21.7	71.1	0.0	Lt Brown	25			2.5	0.0	On site visit. Can see grass carp near surface moving lily pads.
94/09/20	21.7	71.1	0.0	Lt Brown	0	None	Breezy	3.0W	-20.2	Many 2-3" fingerlings (bass?) in the shallows.

W - Secchi disk entered weeds B - Secchi disk hit bottom

CHAMBERS LAKE (THURSTON COUNTY)



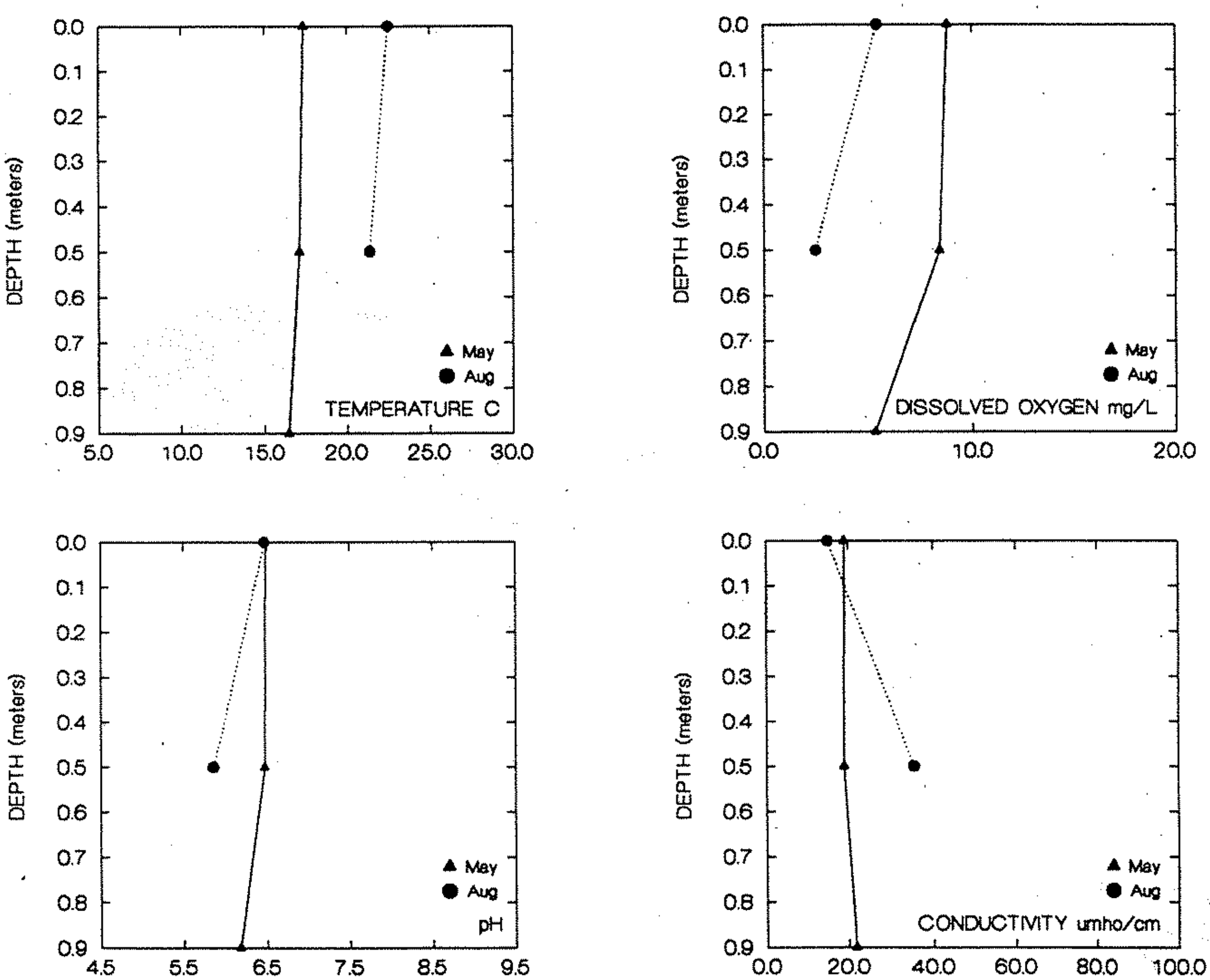
CHAMBERS (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/20		E	27			(Source: Water Supply Bulletin 43)					
93/06/01	1	E	70	0.91	39.9	1U	290		3	1U	
93/08/24	1	E	36	0.82	6.3	1	35		1U	1U	
94/05/16	1	E	37	0.43	3.5	13	9	1.1			
94/08/15	1	E	61	0.84J	13.5J	12	3	3.4			

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

CHAMBERS (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/16	0.0	17.4	6.5	8.8	19.0	94/08/15	0.0	22.5	7.0	5.5	15.0
	0.5	17.1	6.5	8.4	19.0		0.5	21.4	6.5	2.9	16.0
	0.9	16.5	6.2	5.4	22.0		0.5	21.4	6.4	2.5	36.0

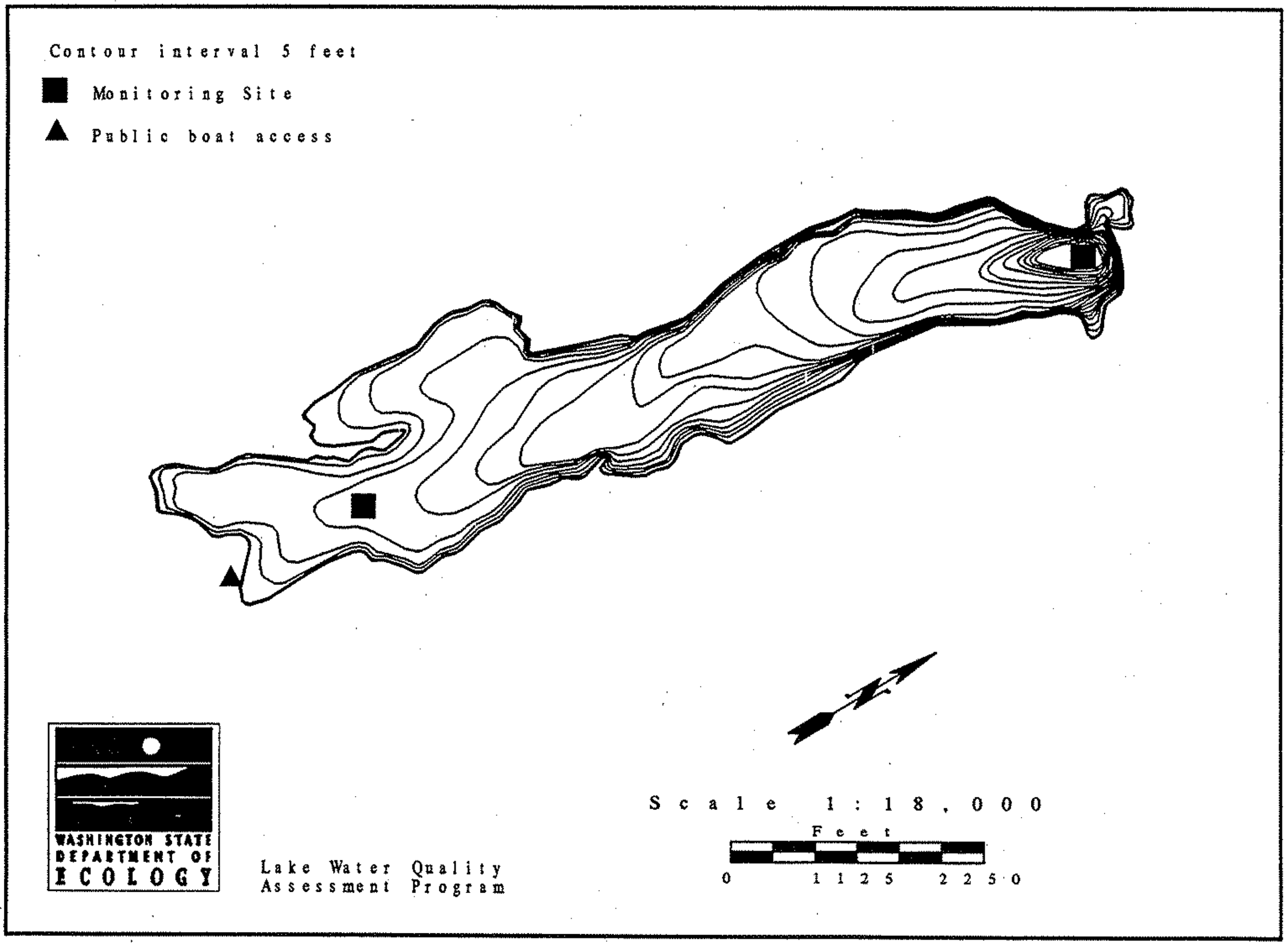


Clear Lake -- Spokane County

Clear Lake is located 2.1 miles south of the Town of Medical Lake. It has no surface inlets or outlets, and is within the Crab Creek drainage.

Size (acres)	410
Maximum Depth (feet)	110
Mean Depth (feet)	26
Lake Volume (acre-feet)	11,000
Drainage Area (miles^2)	9.5
Altitude (feet)	2,342
Shoreline Length (miles)	9.1

Data From Dion *et al.* (1976)



Overall Assessment

Volunteers measured Secchi depth at two stations in Clear Lake. The mean Secchi depth from both Stations 1 and 2 was 13.0 feet.

Water clarity was better than would be expected, given the moderately high amount of algae biomass in the water during the surveys. Algae biomass is indicated by the concentrations of chlorophyll *a*.

Concentrations of total phosphorus and total nitrogen were moderately high on both sampling dates (see the table of water chemistry results at the end of this summary). In August, concentrations of phosphorus and nitrogen were slightly higher at Station 2. Considering that Station 2 was located at a shallower area of the lake near the public boat access and a swimming dock (meaning, this area was more likely to be affected by recreational users), it is not surprising that nutrient concentrations were slightly higher at this station.

Temperature profile data indicate that the lake was strongly stratified at Station 1 on both sampling dates. Below the thermocline, concentrations of dissolved oxygen were depleted during the August survey. Low oxygen concentrations usually result from bacterial decomposition of organic material (such as algae and aquatic plants) in the bottom water and sediments. Profile data did not indicate anything unusual about the lake. Based on results for profile data, as well as results from all three major trophic state parameters (total phosphorus, total nitrogen, and chlorophyll *a*), Clear Lake was classified as mesotrophic in 1994.

Results from fecal coliform bacteria samples were low and did not indicate that there was a bacteria problem in the areas that were sampled. In August, the result for the turbidity sample was also was low, and most of the turbidity was probably due to algae in the water.

Clear Lake was surveyed for aquatic plants on August 4, 1994, for Ecology's Freshwater Aquatic Weeds Program. At the time of sampling, the dominant plant was Eurasian watermilfoil (*Myriophyllum spicatum*). Other aquatic plants observed by Ecology staff included sago pondweed (*Potamogeton pectinatus*), Richardson's pondweed (*Potamogeton richardsonii)*, coontail (*Ceratophyllum demersum*), slender pondweed (*Potamogeton pusillus*), waterweed (*Elodea canadensis*), flatstem pondweed (*Potamogeton zosteriformis*), Illinois pondweed (*Potamogeton illinoensis*), water-buttercup (*Ranunculus aquatilis*), Nuttall's waterweed (*Elodea nuttallii*), ditch-grass (*Ruppia maritima*), northern watermilfoil (*Myriophyllum sibiricum*), and muskgrass (*Chara* sp.). The sago pondweed and Richardson's pondweed were also prevalent at the time of sampling.

Eurasian watermilfoil is a noxious aquatic plant that can be easily spread to other lakes and rivers. People using Clear Lake should be advised to carefully clean their boats, jet skis, boat trailers, and fishing gear, before using them in other lakes. This precaution may prevent spreading the milfoil to other water bodies.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire on lake and watershed uses.

> Clear Lake is used for fishing, swimming, boating, jet skiing, lakeshore camping, and hunting waterfowl. There is a park on the lakeshore, three resorts, and four public boat ramps. Restrictions for motor boating include a speed limit of 5 mph at both ends of the lake, and no wake zones within 50 feet of the lakeshore. Rainbow trout and German brown trout were stocked in the lake in 1994. Currently, the watershed is being logged and used for agriculture (both crops and animal rearing), and the lakeshore is being developed for residences. In the past, the watershed was logged and used for agriculture, the lake was dredged, and the shoreline was altered for development.
>
> There are 59 houses on the lakeshore, and none are connected to a sewer system. There is no community association for the lake, although there have been attempts to start a watershed management district. There are two or three culverts that drain into the lake from wetlands. No aquatic plant management activities occurred in 1994.
>
> Overall, the volunteer found that Clear Lake had good water quality. The worst water quality problems were ranked as (1) low water level, (2) degraded water quality, (3) excessive plant growth, and (4) odor from decaying algae. Potential sources of problems include Lakeland Village pumping water from the lake (affecting the water level), and runoff from septic systems. The Department of Fish and Wildlife recently opened the lake for year-round fishing.

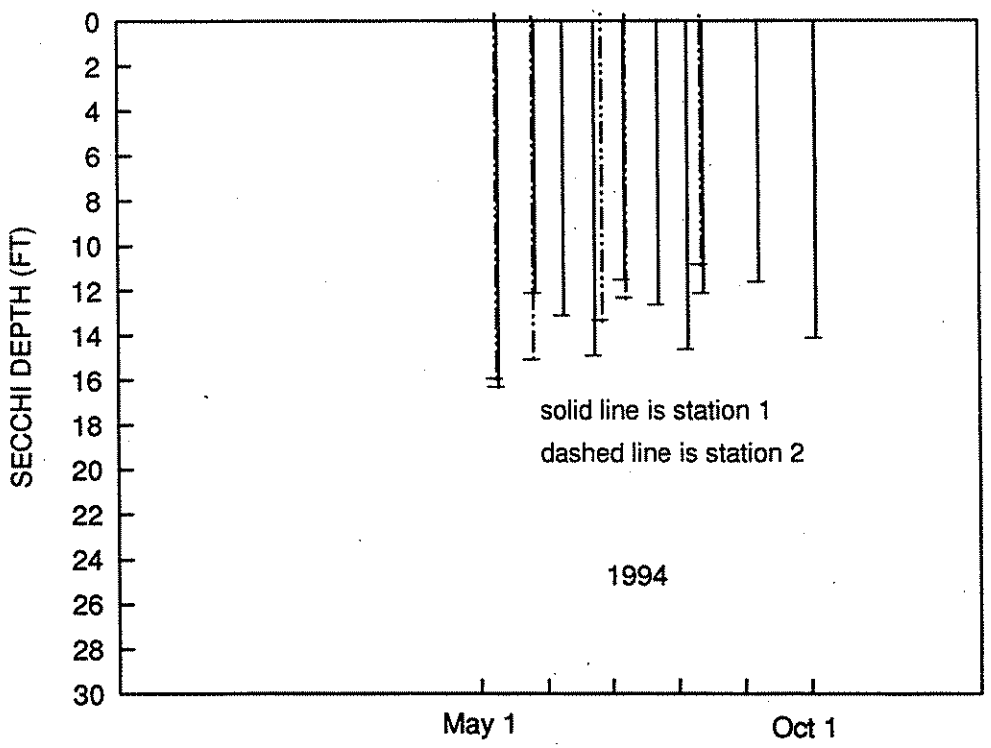
Acknowledgments

I thank Allen Johnson and Mark Stepper for volunteering their time to monitor Clear Lake in 1994.

CLEAR Lake -- SPOKANE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/25	20.0	68.0	0.0	Lt Green	10		Calm	15.7	0.0		Onsite visit.
94/06/10	16.7	62.1	0.0	Mod Green	75	Mod	Breezy	11.5	0.0		Lake is down 6-8 feet.
94/06/23	20.6	69.1	0.0	Mod Green	5	Trace		12.5	0.0		Been hot this week.
94/07/07	22.2	72.0	0.0	Mod Green	10	None	Light	14.3	0.0		Don't know lake height, but lake level dropping fast. Really low--worst the people have seen!
94/07/20	22.8	73.0	0.0	Mod Green	0	None	Light	10.9	0.0		Lake level dropping. High 80s, low 90s this week.
94/08/04	26.1	79.0	0.0	Mod Green	0	Trace		12.0	0.0		A little greener than before, but not pea-soup green. Lake is still dropping; lelve is lowest I have seen. My boat launch is a mud bank.
94/08/17	22.2	72.0	0.0	Mod Green	10	None		14.0	0.0		Level is still dropping.
94/08/24	21.1	70.0	0.0	Mod Green	15		Light	11.5	0.0		On site visit.
94/09/17	18.3	64.9	0.0	Mod Green	10	None	Calm	11.0	0.0		Lake level dropping.
94/10/12	14.4	57.9	0.0	Mod Green	10	None	Light	13.5	0.0		Last time this year.
STATION 2											
94/05/25	21.6	70.9	0.0		0			15.6	0.0		Onsite visit.
94/06/10	16.1	61.0	0.0	Lt Green	10	None	Light	14.8	0.0		
94/07/11	20.0	68.0	0.0	Mod Green	0	None	Breezy	13.0	0.0		Lake level dropping.
94/07/22	25.6	78.1	0.0	Mod Green	0	None	Light	12.0	0.0		Lake elevation down.
94/08/24	20.6	69.1	0.0	Lt Green	10	None	Light	10.5	0.0		

CLEAR LAKE (SPOKANE COUNTY)



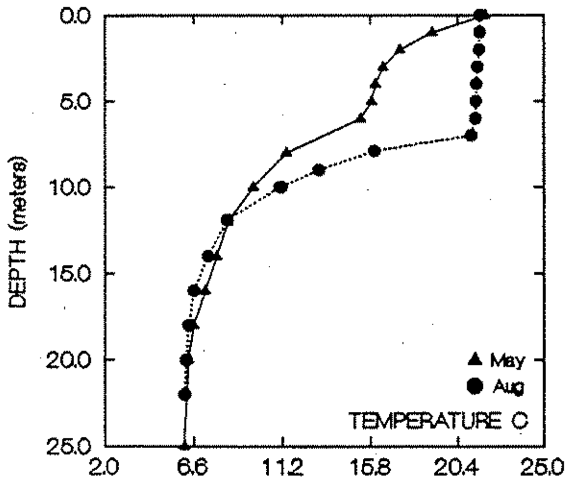
CLEAR (SPOKANE) Lake -- SPOKANE County
Chemistry Data -- Station 1

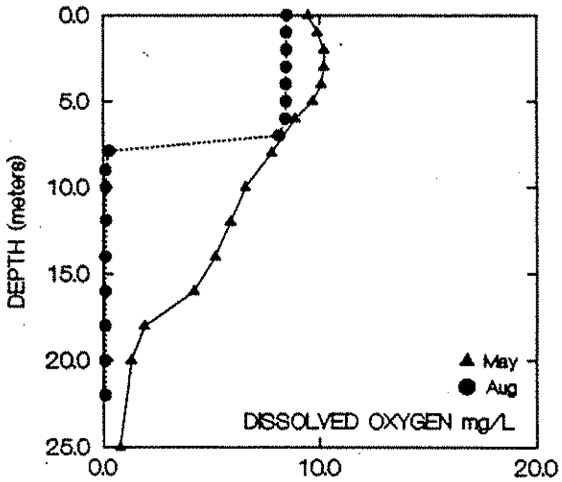
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/09		E	54			(Source: Water Supply Bulletin 43)					
90/05/23	1	E	42	1.12							
90/08/22	1	E	29	1.06							
94/05/25	1	E	27	0.58	1.7	1U		0.9			
94/05/25	2	E	50	0.54	2.1		1U				
94/05/25	1	H	44	0.74							
94/08/24	1	E	19	0.69J	5.7	3	7	1.2			
94/08/24	2	E	22	0.80J							
94/08/24	1	H	130	1.13J							

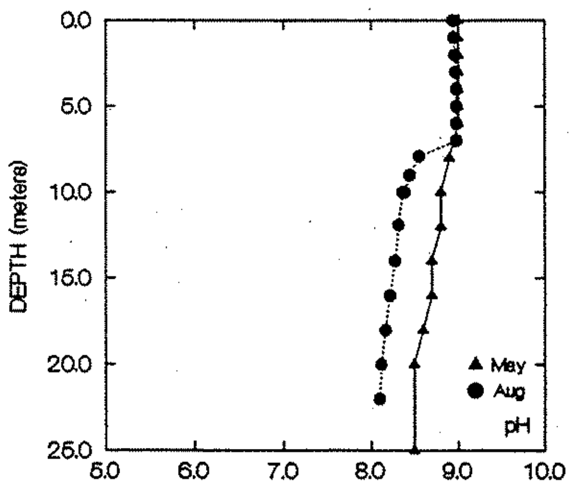
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

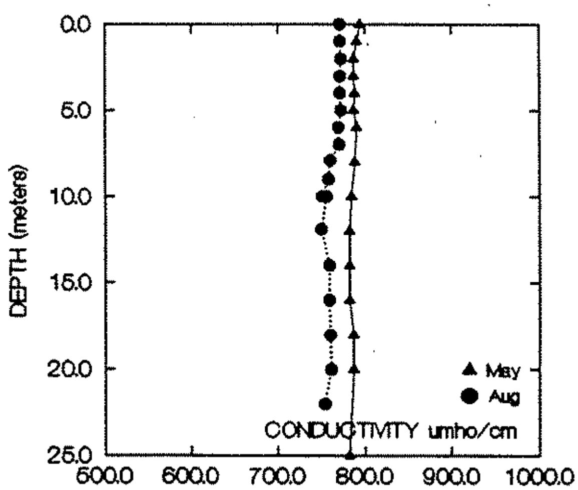
CLEAR (SPOKANE) Lake -- SPOKANE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	21.9	9.0	9.5	794.0	94/08/24	0.0	21.6	8.9	8.5	771.0
	1.0	19.1	9.0	9.9	790.0		1.0	21.6	8.9	8.5	771.0
	2.0	17.4	9.0	10.2	786.0		2.0	21.6	9.0	8.5	772.0
	3.0	16.5	9.0	10.2	786.0		3.0	21.5	9.0	8.5	771.0
	4.0	16.1	9.0	10.1	788.0		4.0	21.4	9.0	8.5	771.0
	5.0	15.9	9.0	9.7	786.0		5.0	21.4	9.0	8.5	772.0
	6.0	15.3	9.0	8.9	790.0		6.0	21.4	9.0	8.4	769.0
	8.0	11.4	8.9	7.8	788.0		7.0	21.1	9.0	8.2	770.0
	10.0	9.7	8.8	6.6	784.0		7.9	16.0	8.6	0.3	760.0
	12.0	8.4	8.8	5.9	782.0		9.0	13.1	8.4	0.1	758.0
	14.0	7.8	8.7	5.2	782.0		10.0	11.1	8.4	0.1	751.0
	16.0	7.2	8.7	4.2	782.0		10.0	11.1	8.4	0.1	756.0
	18.0	6.6	8.6	1.9	786.0		11.9	8.4	8.3	0.1	750.0
	20.0	6.3	8.5	1.3	786.0		14.0	7.3	8.3	0.1	759.0
	25.0	6.1	8.5	0.8	782.0		16.0	6.6	8.2	0.1	759.0
							18.0	6.3	8.2	0.1	760.0
							20.0	6.2	8.1	0.1	761.0
							22.0	6.1	8.1	0.1	754.0



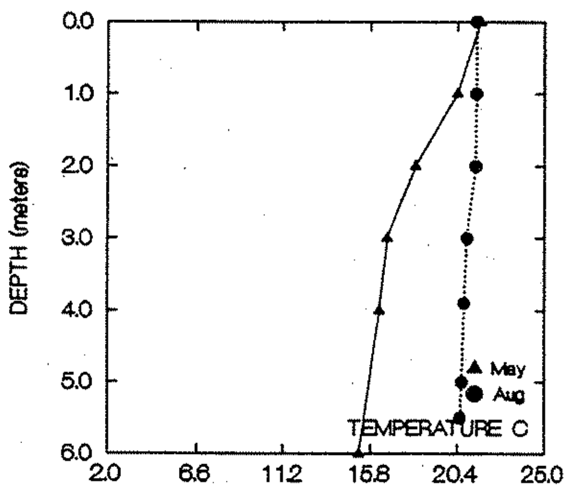


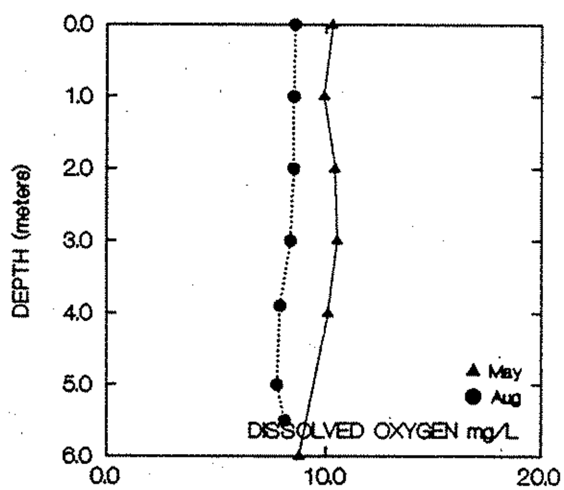


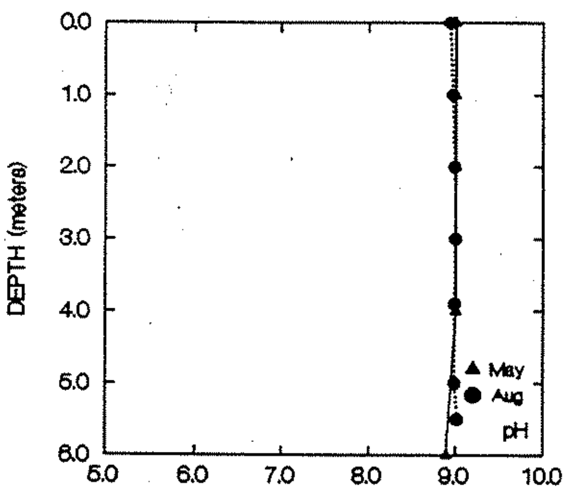


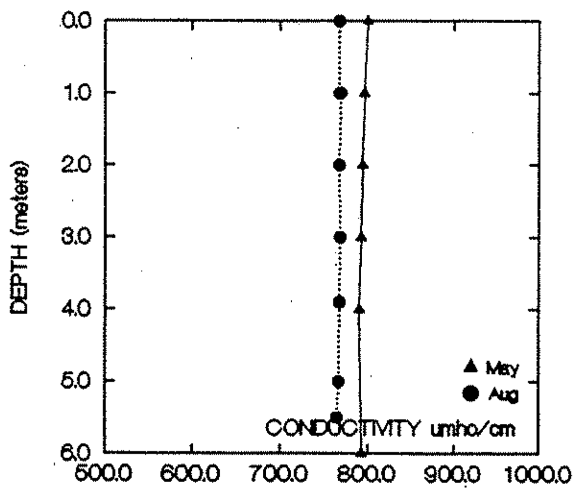
CLEAR (SPOKANE) Lake -- SPOKANE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 2											
						94/08/24	0.0	21.4	8.9	8.6	767.0
							1.0	21.4	9.0	8.5	767.0
							1.0	21.4	9.0	8.5	769.0
							2.0	21.4	9.0	8.5	767.0
							3.0	20.9	9.0	8.4	768.0
							3.9	20.8	9.0	7.9	767.0
							5.0	20.6	9.0	7.8	766.0
							5.5	20.6	9.0	8.1	764.0







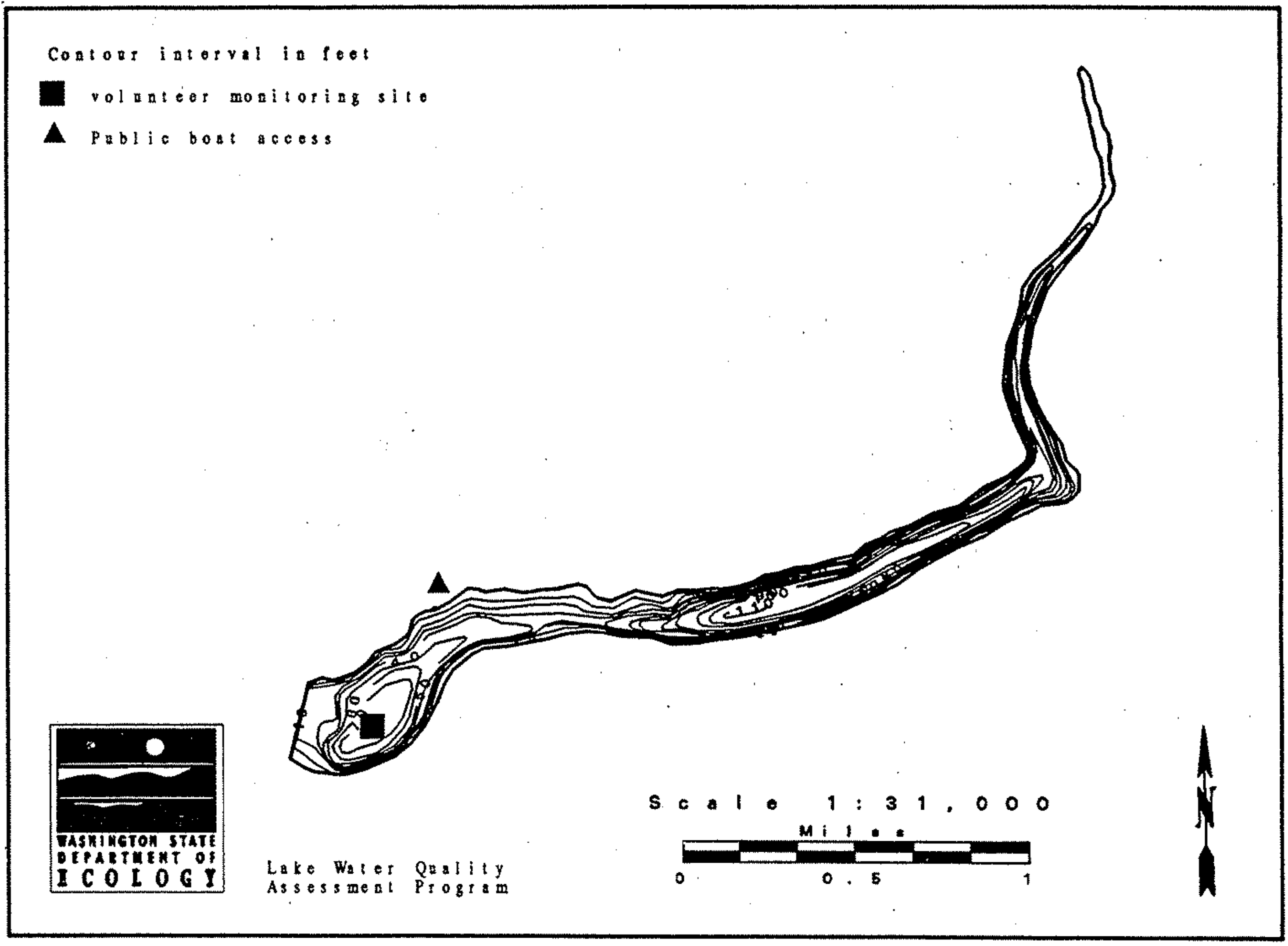


Conconully Lake -- Okanogan County

The south end of Conconully Lake is located at Conconully. It is an artificial reservoir created in 1919-1921 by damming Salmon Creek. It is fed by the North Fork of Salmon Creek, which enters Conconully Lake just above the dam. The lake drains south via Salmon Creek to Conconully Reservoir. Before Salmon Creek was dammed, the lake was known as Salmon Lake.

Size (acres)	270
Maximum Depth (feet)	110
Mean Depth (feet)	47
Lake Volume (acre-feet)	13,000
Drainage Area (miles^2)	50
Altitude (feet)	2319
Shoreline Length (miles)	6.8

Data From Dion *et al.* (1976)



Overall Assessment

Water clarity was very good in 1994, and Secchi depths were very similar to those measured in 1993 (see graph of Secchi depth data). Occasional algae blooms in the lake result from moderately high to high concentrations of phosphorus in the lake. Some of the phosphorus may be recycling from sediments during late summer, when dissolved oxygen concentrations are depleted in the lower layer of water (see profile data). Hydrogen sulfide was not detected in bottom water samples collected in 1994, although it was detected in samples collected during August 1993. Hydrogen sulfide can be produced by bacteria while decomposing organic material, and is stable only in the absence of oxygen.

Conconully Lake was classified as oligo-mesotrophic in 1994, based on the observation that the lake exhibited both oligotrophic and mesotrophic characteristics. Oligotrophic characteristics include the very good water clarity, and the moderately low amount of aquatic plants in the lake. In addition, there was less algae during the August 1994 survey than was measured during the August 1992 and August 1993 surveys. Mesotrophic characteristics were the moderately high concentrations of total phosphorus on both sampling dates, and the very low dissolved oxygen concentrations in the lower layer of water during late summer.

Conconully Lake was sampled by Ecology staff on July 26, 1995, for the Freshwater Aquatic Weeds Program. A milfoil that exhibited characteristics of both the Eurasian and the native milfoils (*Myriophyllum spicatum* and *M. sibiricum*) was widely distributed in the lake, and samples were collected for DNA analysis. That plant may be a hybrid form of milfoil, although this needs to be confirmed by the DNA analysis. Other aquatic plants observed were sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), pondweed (*Potamogeton* sp.), Illinois pondweed (*Potamogeton illinoensis*), water-buttercup (*Ranunculus aquatilis*), narrowleaf water-plantain (*Alisma gramineum*), northern watermilfoil (*Myriophyllum sibiricum*), leafy pondweed (*Potamogeton foliosus*), northern water-starwort (*Callitriche hermaphroditica*), bulrush (*Scirpus* sp.), thin leaved pondweed (*Potamogeton* sp.), stonewort (*Nitella* sp.), and muskwort (*Chara* sp.). The dominant aquatic plants in the lake were Illinois pondweed, milfoil, and coontail.

One major concern about the lake is whether or not it has the noxious aquatic plant Eurasian watermilfoil. Results of DNA analysis of a milfoil sample from Conconully Lake are still pending. In the meanwhile, people using Conconully Lake should be advised to carefully clean their boats (or jet skis), boat trailers, and fishing gear, before using them in other lakes. This precaution may prevent spreading the milfoil to other water bodies.

Summary of Questionnaire Results and Information from the Volunteer

The 1994 questionnaire on lake and watershed uses was not returned.

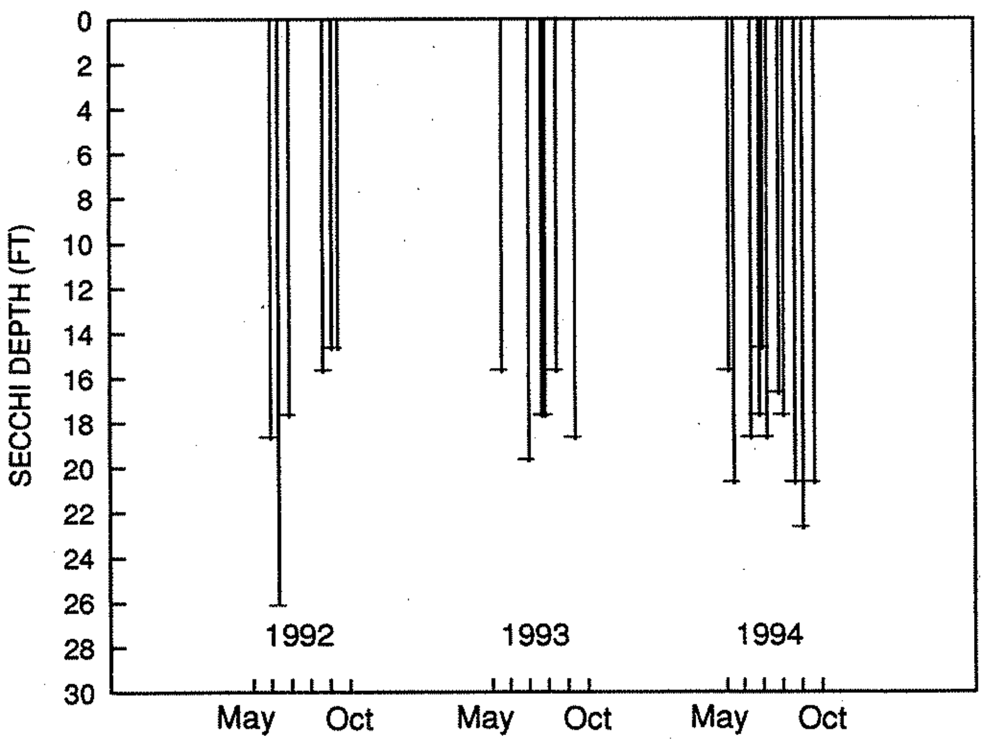
Acknowledgments

I thank Lee Moore for volunteering his time to monitor Conconully Lake during 1992-1994. I also thank Tom Pew, for allowing Lee access to the lake in order to collect monitoring data.

CONCONULLY Lake -- OKANOGAN County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/27	17.0	62.6	0.0		75	Light	Calm	15.0	99.0	Onsite visit. Water level high this year. Water color light olive.
94/06/05	17.0	62.6	0.0		100	Mod	Breezy	20.0	0.0	Water color key lime.
94/07/04	20.0	68.0	0.0		90	Trace	Light	18.0	0.0	Water color light olive.
94/07/17	28.0	82.4	0.0		10	None	Calm	17.0	0.0	Water color apple green.
94/07/23	20.0	68.0	0.0		90		Breezy	14.0	0.0	Water color key lime.
94/07/31	24.0	75.2	0.0		10	None	Breezy	18.0	0.0	Water color key lime. "Cloud cover" is smoke.
94/08/18	24.0	75.2	0.0		0	None	Calm	16.0	0.0	Water color key lime.
94/08/26	21.0	69.8	0.0		10	Light	Light	17.0	0.0	Water color apple green.
94/09/12	19.0	66.2	0.0		0	None	Calm	20.0	0.0	Water color apple green.
94/09/25	20.0	68.0	0.0		0	None	Calm	22.0	0.0	Water color apple green. Very low water level.
94/10/13	15.0	59.0	0.0		75	Trace	Breezy	20.0	0.0	Water color apple green.

CONCONULLY LAKE (OKANOGAN COUNTY)



CONCONULLY (OKANOGAN) Lake -- OKANOGAN County

Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/16		E	19			(Source: Water Supply Bulletin 43)					
92/05/18	1	E	32	0.31	0.8						
92/05/18	2	E		0.25	0.5						
92/05/18	1	H	48	0.27							
92/08/31	1	E	24	0.33	5.3						
92/08/31	1	H	146	0.39							
93/05/27	1	E	28	0.45	4.0						
93/05/27	1	H	93	0.30							
93/08/24	1	E	14	0.28	6.6						
93/08/24	1	H	96	0.45							
94/05/27	1	E	38	0.18	3.0						
94/05/27	1	H	59	0.22							
94/08/26	1	E	15	0.24J	0.8						
94/08/26	1	H	80	0.37J							

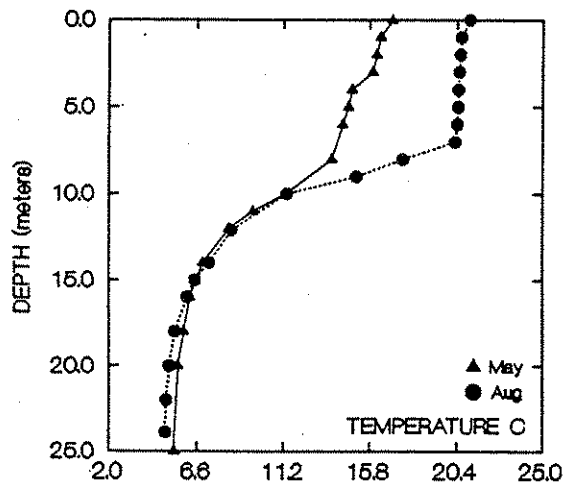
E=epilimnion composite, H=hypolimnion composite

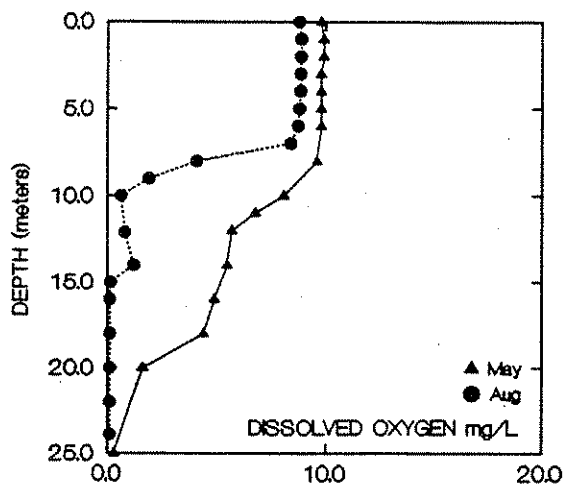
Remarks codes: U = Below detection limits; J = Estimate.

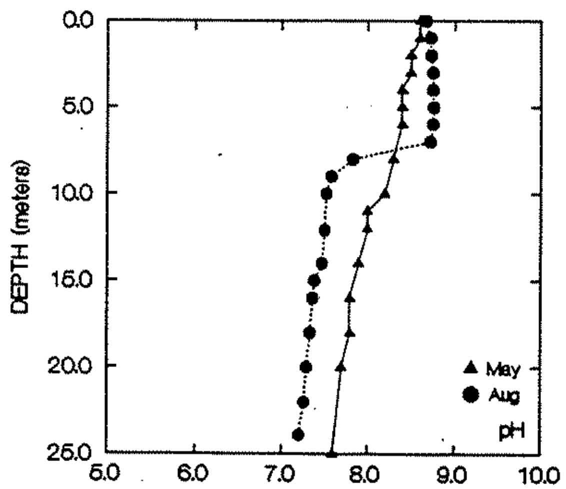
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

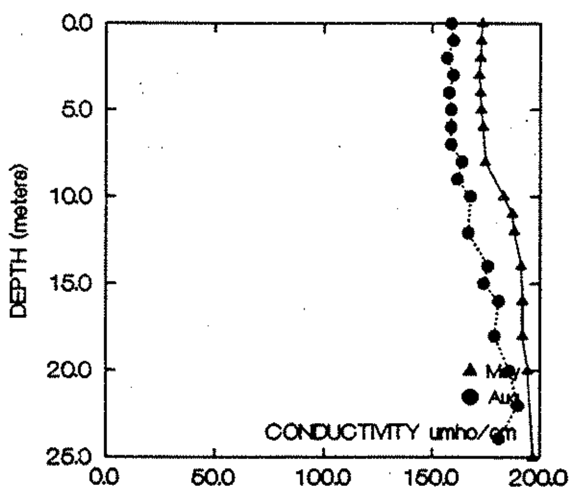
CONCONULLY (OKANOGAN) Lake -- OKANOGAN County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/27	0.0	17.0	8.6	9.8	173.0	94/08/26	0.0	21.1	8.7	8.8	159.0
	1.0	16.4	8.6	9.9	173.0		1.0	20.6	8.7	8.9	160.0
	2.0	16.2	8.5	9.9	173.0		2.0	20.6	8.7	8.9	157.0
	3.0	16.0	8.5	9.8	172.0		3.0	20.5	8.8	8.8	160.0
	4.0	14.9	8.4	9.8	173.0		4.0	20.5	8.8	8.8	158.0
	5.0	14.7	8.4	9.8	173.0		5.0	20.5	8.8	8.8	159.0
	6.0	14.4	8.4	9.8	174.0		6.0	20.4	8.8	8.7	159.0
	8.0	13.8	8.3	9.6	175.0		7.0	20.3	8.7	8.4	159.0
	10.0	11.3	8.2	8.1	183.0		8.0	17.6	7.8	4.1	164.0
	11.0	9.6	8.0	6.8	187.0		9.0	15.1	7.6	1.9	162.0
	12.0	8.3	8.0	5.7	188.0		10.0	11.4	7.5	0.6	168.0
	14.0	6.9	7.9	5.5	191.0		12.1	8.4	7.5	0.8	167.0
	16.0	6.2	7.8	4.9	192.0		14.0	7.2	7.5	1.2	176.0
	18.0	5.9	7.8	4.4	192.0		15.0	6.5	7.4	0.1	174.0
	20.0	5.6	7.7	1.6	195.0		16.0	6.1	7.4	0.1	181.0
	25.0	5.4	7.6	0.3	197.0		18.0	5.4	7.3	0.1	179.0
							20.0	5.2	7.3	0.1	186.0
							22.0	5.0	7.3	0.1	190.0
							23.9	5.0	7.2	0.1	181.0







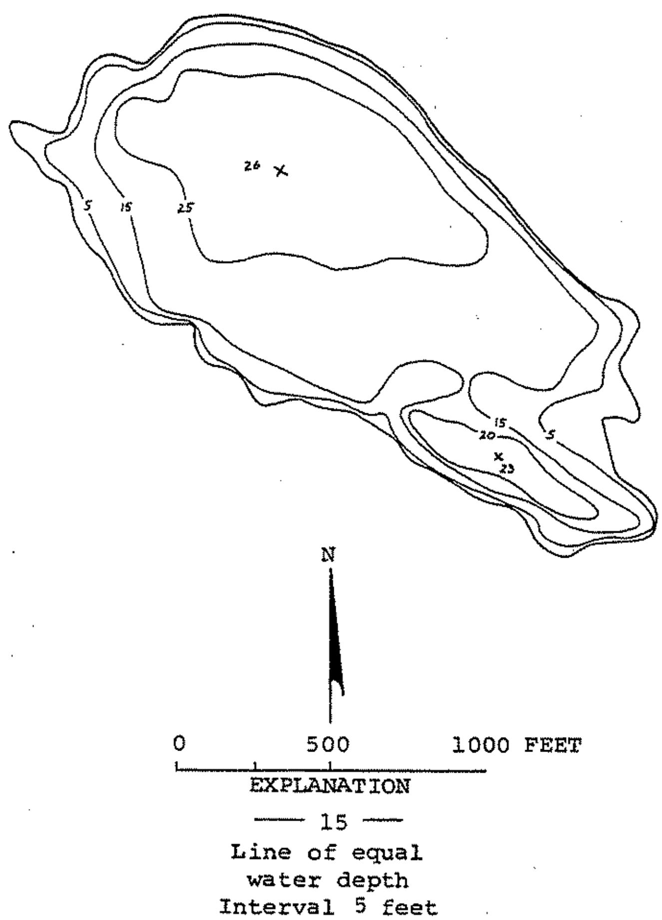


Cortez Lake -- Chelan County

Cortez Lake is located 5.7 miles southeast of Wenatchee and 1.3 miles southwest of Malaga. It is an irrigation reservoir fed by diversions from Stemilt Creek and drainage from Meadow Lake. It does not have a surface outlet, but seeps to the Columbia River. Its size varies widely with seasons. Cortez Lake is called Three Lakes Reservoir in older literature. It was monitored by Ecology staff only.

Size (acres)	44
Maximum Depth (feet)	28
Mean Depth (feet)	Z18
Lake Volume (acre-feet)	794
Drainage Area (miles^2)	0.3
Altitude (feet)	871
Shoreline Length (miles)	1.2

Data From Dion *et al.* (1976)



Overall Assessment

Cortez Lake was sampled by Ecology staff only, on August 23, 1994. Although Cortez Lake is listed as a lake constituting a shoreline of the State (Chapter 173-20 WAC), it presently does not have a public boat access.

Both total phosphorus and chlorophyll *a* concentrations were high, so Cortez Lake was classified as eutrophic in 1994. The lake was also eutrophic when it was last sampled for the program in 1990. Profile data show that although the lake was not thermally stratified, dissolved oxygen concentrations and pH both decreased considerably from surface to bottom. Low dissolved oxygen probably resulted from decomposition of organic material in lake water and sediments.

Aquatic plants observed by Ecology staff include smartweed (*Polygonum* sp.), muskgrass (*Chara* sp.), milfoil (*Myriophyllum* sp.; a sample was collected for DNA analysis to determine whether this is the noxious Eurasian variety of milfoil), sago pondweed (*Potamogeton pectinatus*), and coontail (*Ceratophyllum demersum*). Milfoil, which wasn't seen in 1990, was extensive around the littoral area in 1994.

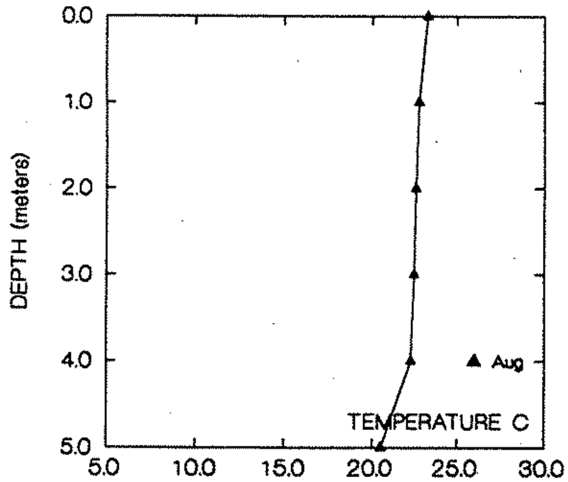
CORTEZ (THREE) (CHELAN) Lake -- CHELAN County
Chemistry Data -- Station 1

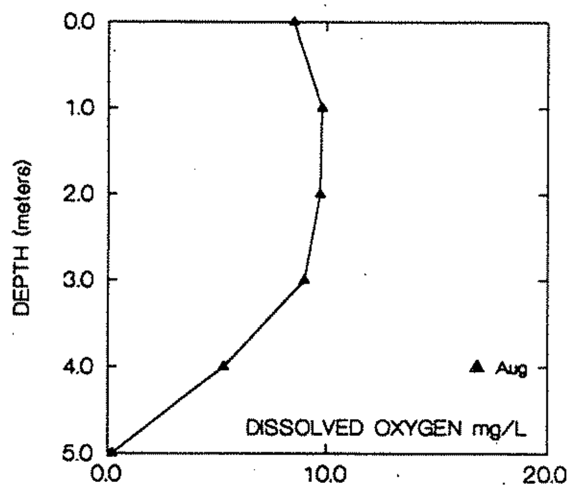
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/26		E	24			(Source: Water Supply Bulletin 43)					
90/05/21	1	E	20	0.33							
90/08/20	1	E	45	0.66							
94/08/23	1	E	24	0.40J	16.9	1	92				
94/08/23	1	H	42	0.40J							

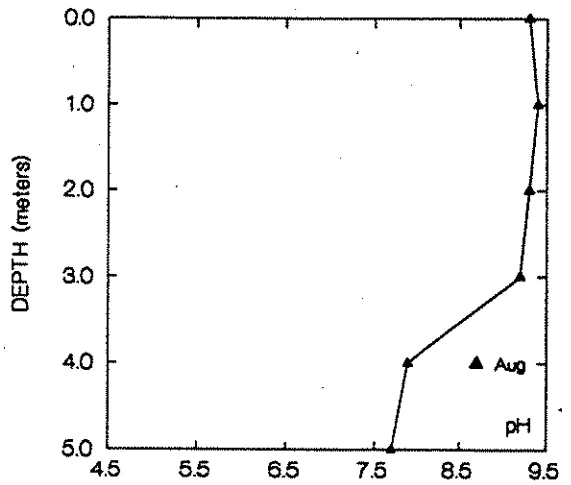
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

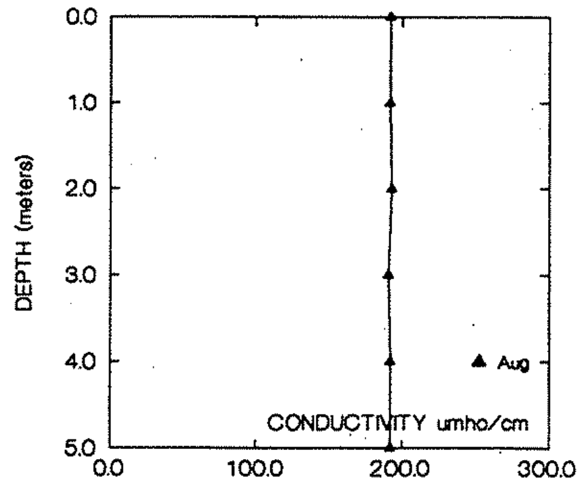
CORTEZ (THREE) (CHELAN) Lake -- CHELAN County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
						94/08/23	0.0	23.3	9.3	8.5	192.0
							1.0	22.8	9.4	9.8	193.0
							2.0	22.6	9.4	9.7	191.0
							3.0	22.5	9.3	9.0	192.0
							4.0	22.3	9.2	5.3	192.0
							5.0	20.5	7.9	0.2	225.0
							5.1	20.0	7.7	0.1	240.0







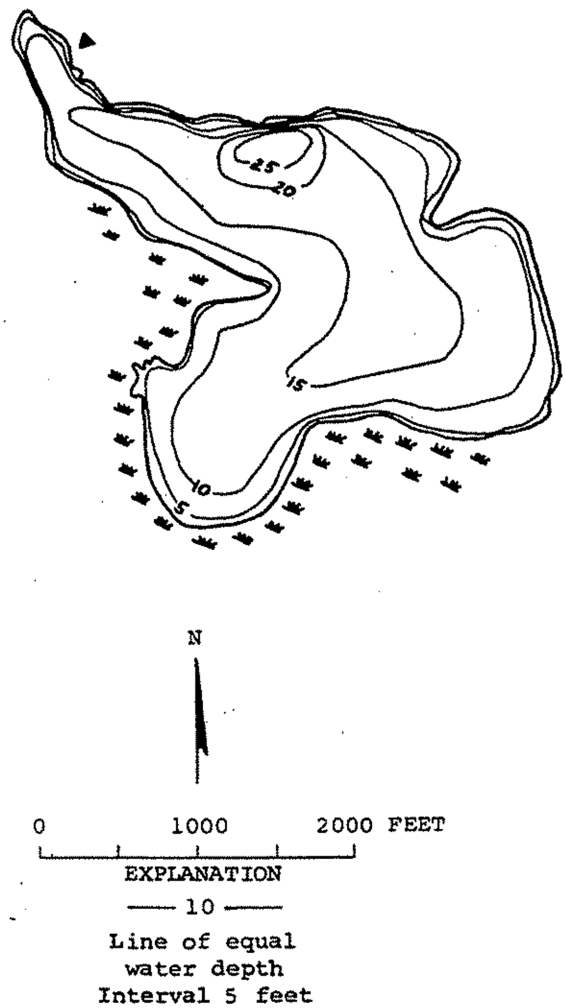


Cranberry Lake -- Island County

Cranberry Lake is located in Deception Pass State Park, at the north end of Whidbey Island. The inflow in intermittent and the lake drains to Rosario Strait. The lake level is stabilized by a dam. No motor boats are allowed on the lake. Cranberry Lake was monitored by Ecology staff only.

Size (acres)	125
Maximum Depth (feet)	25
Mean Depth (feet)	13
Lake Volume (acre-feet)	1,576
Drainage Area (miles^2)	0.6
Altitude (feet)	20
Shoreline Length (miles)	2.8

Data From Bortleson *et al.* (1976)



Overall Assessment

Cranberry Lake was sampled by Ecology staff only in 1994. It was monitored by volunteers from 1989 through 1991.

Concentrations of total phosphorus were very high on both sampling dates. Large algae particles were visible during the May survey, and could have been the blue-green alga *Gloeotrichia*. When the lake was sampled in early September, the hypolimnion sample had a very high concentration of total phosphorus, and bottom water samples smelled very strongly of hydrogen sulfide. In the absence of oxygen, hydrogen sulfide can be produced and phosphorus in sediments can be chemically reduced and released into the water column. (Dissolved oxygen profile data from the September survey are not reported due to poor post-calibration results of the profiler.)

Based on results from all three trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depth), Cranberry Lake was classified as eutrophic in 1994.

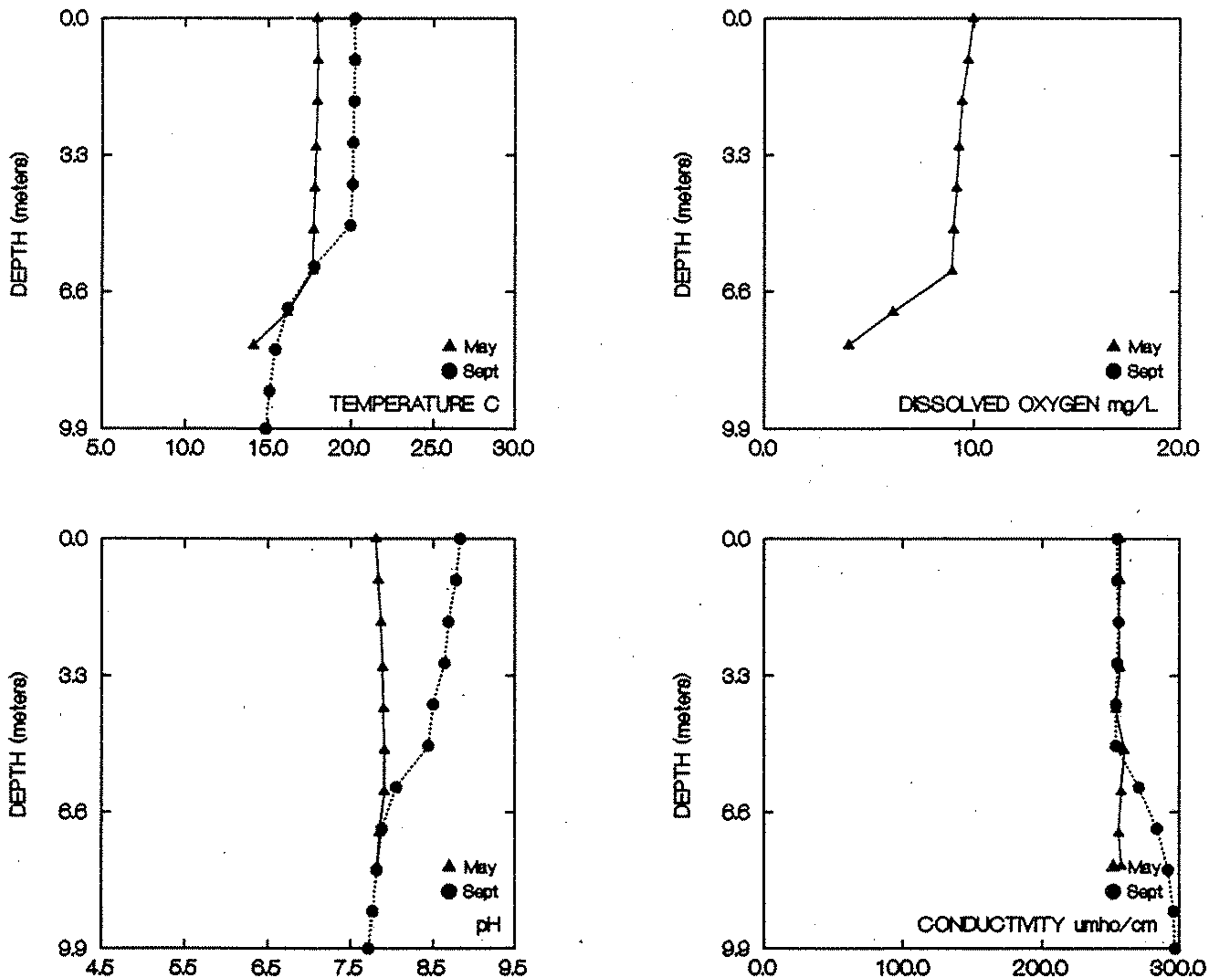
CRANBERRY (ISLAND) Lake -- ISLAND County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/09		E	35			(Source: Water Supply Bulletin 43)					
81/07/09		E	30		8.2	(Source: Water Supply Bulletin 57)					
89/06/27	1	E	59	1.15	30.0						
89/09/26	1	E	107	1.16	16.8						
90/08/14	1	E	29	0.71							
91/05/28	1	E		0.79							
93/06/11	1	E	31	0.70	15.0						
93/08/29	1	E	63	0.78	5.9	81	17				
94/05/29	1	E	55	0.35	5.1						
94/05/29	2	E	37	0.31	7.1						
94/05/29	1	H	89	0.34							
94/09/03	1	E	78	0.70J	10.4J						
94/09/03	2	E	85	0.77J	8.4J						
94/09/03	1	H	1272J	2.38J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

CRANBERRY (ISLAND) Lake -- ISLAND County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/29	0.0	18.0	7.8	10.0	257.0	94/09/03	0.0	20.3	8.8	0.0	255.0
	1.0	18.0	7.8	9.7	257.0		1.0	20.2	8.8	0.0	255.0
	2.0	17.9	7.9	9.4	256.0		2.0	20.2	8.7	0.0	256.0
	3.1	17.9	7.9	9.3	257.0		3.0	20.1	8.6	0.0	255.0
	4.1	17.8	7.9	9.2	254.0		4.0	20.1	8.5	0.0	254.0
	5.1	17.7	7.9	9.0	260.0		5.0	20.0	8.4	0.0	254.0
	6.1	17.7	7.9	9.0	258.0		6.0	17.8	8.1	0.0	271.0
	7.1	16.1	7.9	6.2	256.0		7.0	16.2	7.9	0.0	284.0
	7.9	14.1	7.8	4.1	258.0		8.0	15.4	7.8	0.0	292.0
							9.0	15.1	7.8	0.0	296.0
							9.9	14.8	7.7	0.0	297.0



Crescent Lake -- Clallam County

Crescent Lake is located 14 miles west from Port Angeles. It is 8.5 miles long. Several inlets flow into the lake, including Barnes, Smith, Aurora, Lapoel, Cross, and Eagle Creeks. Crescent Lake drains via Lyre River to the Strait of Juan de Fuca. There is a precipitous shoreline, except at both ends. It is the third largest natural lake in Western Washington. Beardslee trout are found only in Cresecent Lake.

Size (acres)	5,127
Maximum Depth (feet)	624
Mean Depth (feet)	*
Lake Volume (acre-feet)	*
Drainage Area (miles^2)	*
Altitude (feet)	580
Shoreline Length (miles)	*

Data From Dion *et al.* (1976)

* Information not available

Crescent Lake -- Clallam County

Crescent Lake is located 14 miles west from Port Angeles. It is 8.5 miles long. Several inlets flow into the lake, including Barnes, Smith, Aurora, Lapoel, Cross, and Eagle Creeks. Crescent Lake drains via Lyre River to the Strait of Juan de Fuca. There is a precipitous shoreline, except at both ends. It is the third largest natural lake in Western Washington. Beardslee trout are found only in Crescent Lake. This lake was monitored by Ecology staff only.

Size (acres)	5,127
Maximum Depth (feet)	624
Mean Depth (feet)	*
Lake Volume (acre-feet)	*
Drainage Area (miles^2)	*
Altitude (feet)	580
Shoreline Length (miles)	*

Data from Dion *et al.* (1976)

*Information not available

Map not available.

Overall Assessment

Crescent Lake was sampled by Ecology staff only in 1994, by request from the Southwest Regional Office. It was last monitored for the program in 1990 (by volunteers).

Profile data were limited by the length of the cable on the profiling instrument. On both sampling dates, the profiles show the depth of the epilimnion, but depths of the metalimnion and the hypolimnion could not be determined. Also, Secchi depth could not be determined on either sampling date, because there was only 60 feet of line attached to the disk. When the lake was last monitored for the program in 1990, Secchi depths averaged around 68 feet.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Crescent Lake was classified as oligotrophic in 1994.

CRESCENT (CLALLAM) Lake -- CLALLAM County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
94/05/28	1	E	9	0.01U	0.3						
94/09/02	1	E	5	0.01J	0.6J						
94/09/02	1	H	5	0.01J							

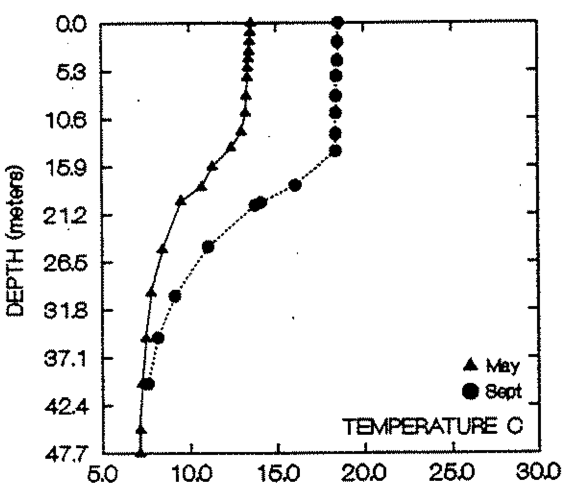
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

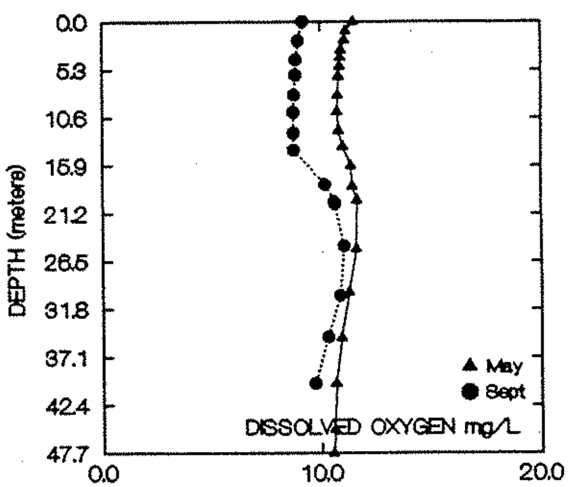
CRESCENT (CLALLAM) Lake -- CLALLAM County
1994 Profile Data

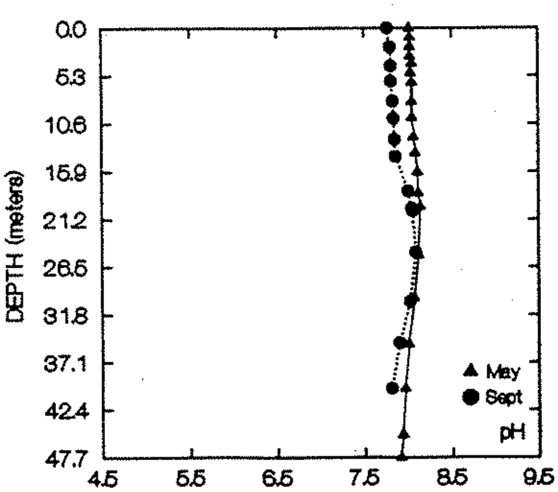
STATION 1

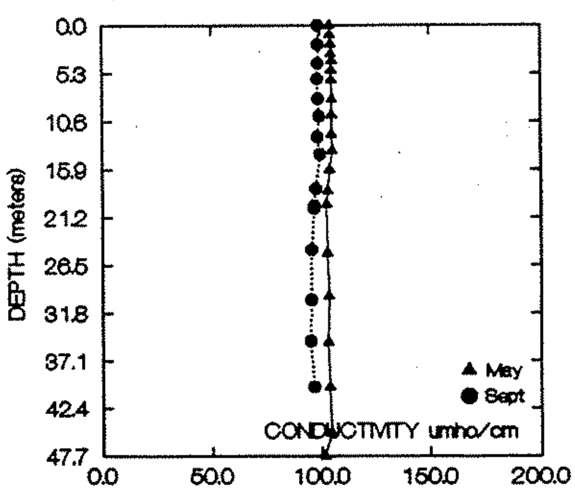
Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
94/05/28	0.0	13.6	8.0	11.5	104.0
	1.0	13.6	8.0	11.2	105.0
	2.0	13.6	8.0	11.1	105.0
	3.1	13.5	8.0	11.0	105.0
	3.9	13.5	8.1	10.9	105.0
	4.9	13.4	8.0	10.9	105.0
	6.0	13.4	8.1	10.8	105.0
	8.1	13.3	8.1	10.8	105.0
	9.9	13.3	8.1	10.8	105.0
	12.0	13.0	8.1	10.8	105.0
	13.8	12.4	8.1	11.0	105.0
	15.9	11.3	8.1	11.4	104.0
	18.2	10.7	8.1	11.5	103.0
	19.7	9.5	8.1	11.7	103.0
	25.1	8.4	8.1	11.6	103.0
	29.9	7.7	8.1	11.3	104.0
	35.0	7.4	8.0	10.9	103.0
	40.0	7.2	8.0	10.7	104.0
	45.1	7.1	7.9	10.6	104.0
	47.7	7.1	7.9	10.5	101.0

Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
94/09/02	0.0	18.6	7.8	9.2	99.0
	-0.3	18.6	7.8	9.1	99.0
	2.1	18.6	7.8	9.0	99.0
	4.2	18.6	7.8	8.9	99.0
	5.9	18.5	7.8	8.9	99.0
	8.1	18.5	7.8	8.8	99.0
	10.0	18.5	7.8	8.8	99.0
	12.3	18.4	7.9	8.8	99.0
	14.2	18.4	7.9	8.8	100.0
	18.0	16.1	8.0	10.2	98.0
	19.9	14.1	8.0	10.6	97.0
	20.2	13.8	8.1	10.6	97.0
	24.8	11.1	8.1	11.1	96.0
	30.3	9.1	8.0	10.9	96.0
	34.9	8.1	7.9	10.3	95.0
	40.0	7.5	7.8	9.7	97.0







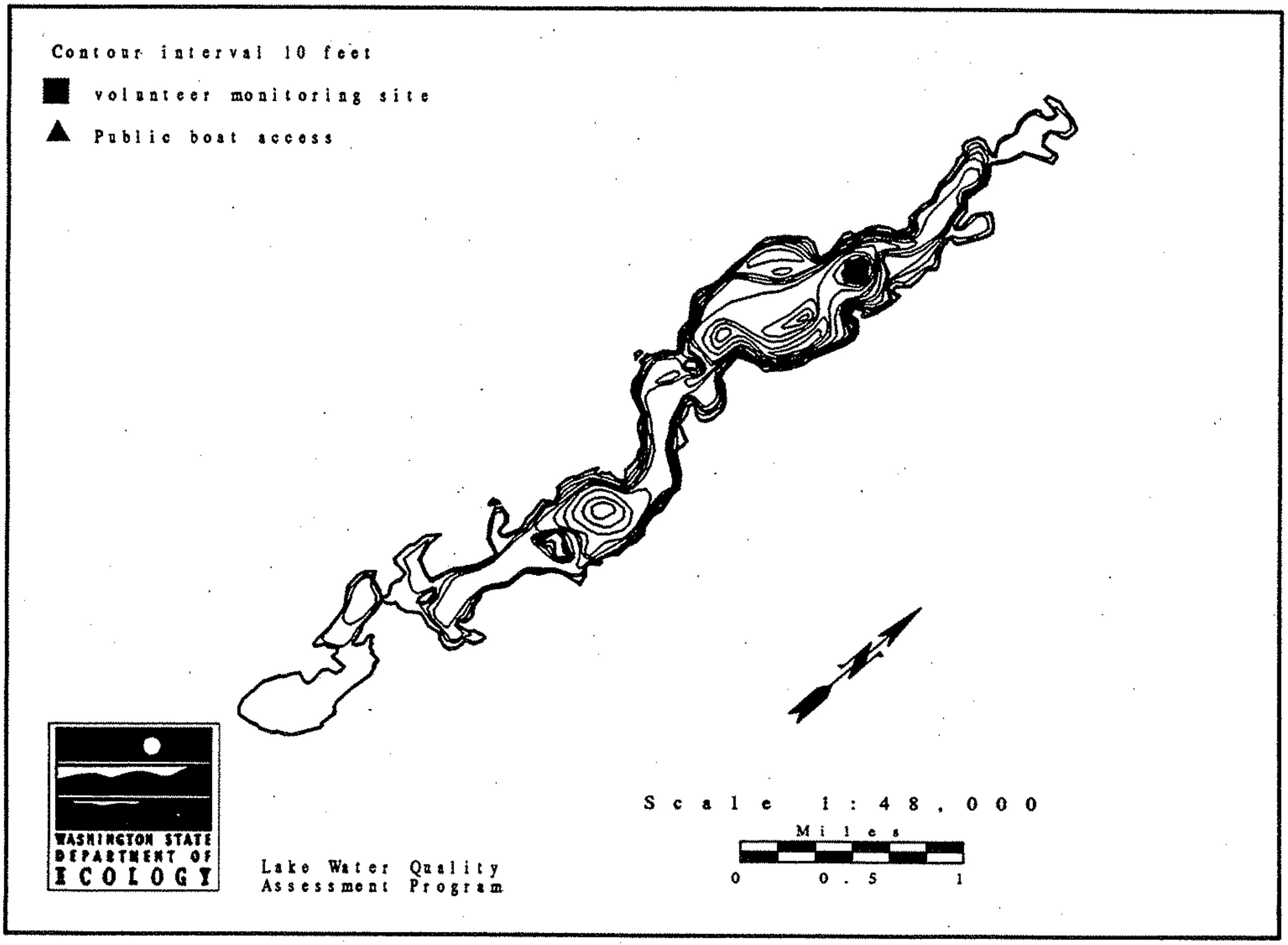


Curlew Lake -- Ferry County

Curlew Lake is located 4.8 miles northeast of Republic. It is a natural lake, and water level fluctuations are stabilized by a three foot dam built in 1926. The lake extends northerly 4.8 miles to the outlet. There are four islands, totaling 20 acres, that are not included in the reported acreage. Inlets include Herron, Mires, Barrett, and Trout Creeks.

Size (acres)	921
Maximum Depth (feet)	130
Mean Depth (feet)	43
Lake Volume (acre-feet)	39,519
Drainage Area (miles^2)	64.5
Altitude (feet)	2,333
Shoreline Length (miles)	15.8

Data From Dion *et al.* (1976)



Overall Assessment

Water clarity was very good in 1994, but there was no significant trend in water clarity from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.49$).

As during previous years, the concentration of total phosphorus in the upper layer of water was higher during the May survey than during the August survey (see water chemistry results at the end of this summary). This is not unusual. Despite the high phosphorus concentration during the May survey, water clarity was very good and algal growth was low at the time of sampling. Temperature profile data indicate that the lake was strongly stratified on both sampling dates, and dissolved oxygen concentrations were very low below the thermocline. Low dissolved oxygen concentrations usually result from bacteria which decompose organic material (including algae and aquatic plants) in the bottom water and sediments. High concentrations of total phosphorus in the lower layer may result from recycling of phosphorus from sediments, which can occur when oxygen concentrations are depleted. The smell of hydrogen sulfide was strong in water samples collected in August near the lake bottom. Hydrogen sulfide is stable only in the absence of oxygen.

Aquatic plants observed by Ecology staff during field visits include waterweed (*Elodea candensis*), coontail (*Ceratophyllum demersum*), curly-leaf pondweed (*Potamogeton crispus*), muskgrass (*Chara*--this is the dominant plant in the lake), milfoil (*Myriophyllum* sp.; although this was not the aggressive Eurasian species), and pondweeds (*Potamogeton pectinatus* and *P. richardsonii*). Blue-green algae blooms have been reported in the past.

Earlier data summaries for this lake reported that water quality problems in Curlew Lake are localized near shore, and are not reflected by Secchi depths collected from the open water area of the lake. The lake was classified as mesotrophic in 1994, based on the low dissolved oxygen in the lower layer of water, the possibility of phosphorus recycling from the sediments, and moderately heavy populations of aquatic plants in areas of the lake.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Curlew Lake is used for fishing, boating, swimming, rowing, camping, waterfowl hunting, and bird watching. Recreational facilities on the lakeshore include a picnic area, a state park, a camping area, a beach, and four resorts. There are five public boat ramps, and there are no restrictions for motorboat use on the lake. Rainbow trout were stocked in the lake in 1994. Lake water is withdrawn for irrigation.

Currently the watershed is being logged and used for animal grazing. The lakeshore is also being developed further for residences. In the past, the watershed was logged and mined, and used for animal grazing and crop agriculture. Also, the lake was dredged and the shoreline was altered.

There are 240 residences, and about 65 rental units, on the lakeshore. None of the residences are connected to a sewer. About six culverts/stormdrains drain into the lake. There is a lake association and a planning district for the lake. No aquatic plant management activities occurred in 1994. Currently, the minimum setback for lakeshore development is 50 feet, minimum lot lengths are 100 feet, and residential density is restricted to 2.5 houses per acre.

Overall, the volunteer found that Curlew Lake had good water quality. Problems in the lake in 1994 were ranked as (1) algae bloom, (2) excessive aquatic plant growth, (3) fluctuating water level, (4) shoreline erosion, (5), swimmer's itch, (6) decaying plants, (7) degraded aesthetics, (8) odor from decaying algae, and (9) degraded water quality. Highly developed areas that need improved waste disposal could be contributing to the problems. Since the 1993 monitoring season, there has been more development with complete disregard for environmental impact, that included illegal filling along the shoreline. Also, there has been a special advisory committee working with the planning department to establish the future of the Curlew Lake area.

There used to be a lumber mill at the north end of the lake, and the lake was once used as a holding pond for logs. As a result, there are many old sunken logs in the lake. The lake was dredged at the site of the old sawmill. In 1992 there was an increase in development, that included removal of lakeshore vegetation and wetlands. Also, a gold mine was being developed in the eastside watershed, less than one mile from the lake.

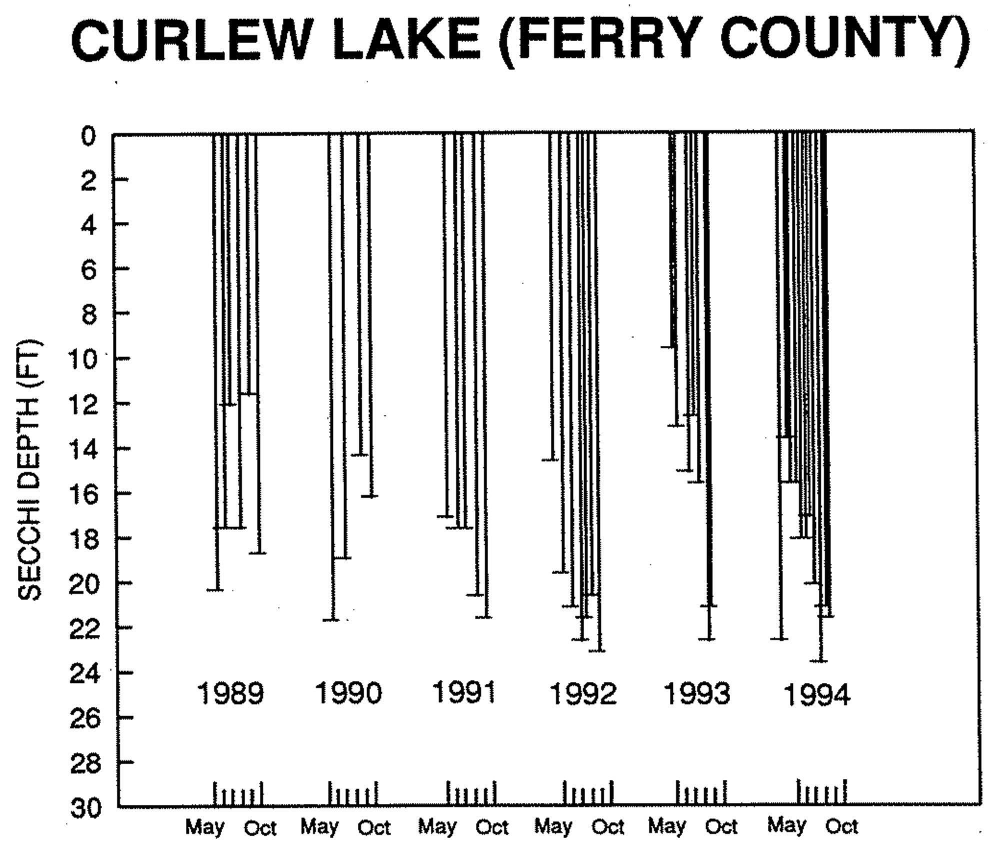
Cinquefoil (*Potentilla palustris*; identified by the County) is in one bay of the lake and appears to be replacing cattails. In the past, the lake was treated with chemicals to control aquatic plants and algae. The Washington State University Cooperative Extension Service and the Ferry County Conservation District studied the west watershed in 1990, and a grant from Ecology was allocated for a study of the east watershed beginning in 1991.

Acknowledgment

I thank Marion Dammann for volunteering her time to monitor Curlew Lake from 1989 through 1994.

CURLEW Lake -- FERRY County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/26	20.0	68.0	0.0	Pea-green	50	None	Calm	22.0	3.2	Water color more yellow green. Heavy pollen floating on surface. Lake height in feet.
94/06/18	16.7	62.1	0.0	Lt Green	75	Heavy	Light	13.0	3.0	
94/06/30	21.1	70.0	0.0	Clear	50	None	Light	15.0	2.8	Floating algae. Swimmers itch at this temperature.
94/07/14	21.7	71.1	0.0	Lt Green	0	None	Calm	15.0	2.6	
94/07/30	23.3	73.9	0.0	Lt Green	0	None	Calm	17.5	2.2	Smoke haze instead of cloud cover.
94/08/15	22.2	72.0	0.0	Lt Green	0	None	Calm	17.5	2.0	Smoke haze. Large amounts of water dipped from lake for fire suppression.
94/08/28	20.0	68.0	0.0	Lt Green	0	Trace	Breezy	16.5	1.9	Fires contained. No more debris floating.
94/09/13	17.8	64.0	0.0	Lt Green	10	None	Calm	19.5	0.0	
94/09/29	16.1	61.0	0.0	Lt Green	50	None	Calm	23.0	1.8	
94/10/13	14.4	57.9	0.0		50		Calm	20.5	0.0	Water color yellow green. Bloom particulates washing ashore.
94/10/25	11.1	52.0	0.0	Clear	10	None	Calm	21.0	0.0	Algae bloom.



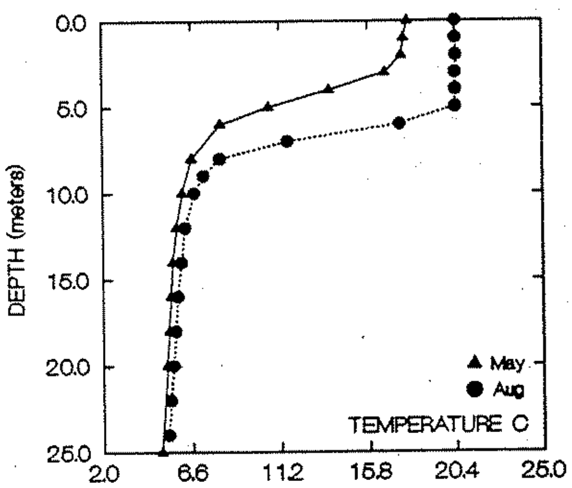
CURLEW (FERRY) Lake -- FERRY County
Chemistry Data -- Station 1

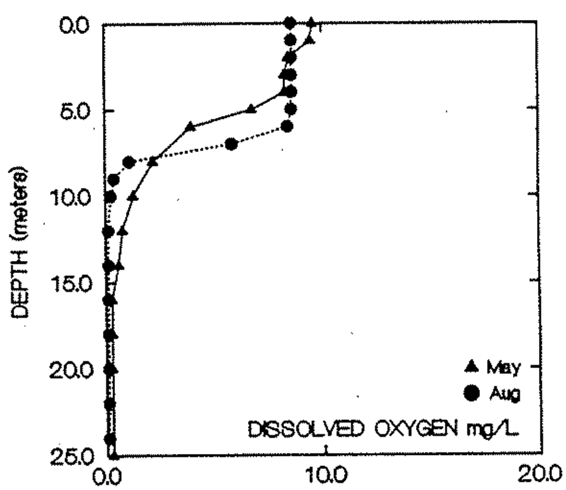
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/13		E	24			(Source: Water Supply Bulletin 43)					
81/07/15		E	20		2.4	(Source: Water Supply Bulletin 57)					
90/09/13	1	E	15	0.60							
91/06/26	1	E		0.40							
92/05/20	1	E	39	0.47	0.4	1U	1U		4	2	15
92/05/20	1	H	72	0.50							
92/09/02	1	E	13	0.44	1.1						
92/09/02	1	H	122	0.51							
93/05/24	1	E	24	0.38	3.3						
93/05/24	1	H	59	0.52							
93/08/23	1	E	11	0.43	2.1						
93/08/23	1	H	143	0.66							
94/05/26	1	E	39	0.18	1.3						
94/05/26	1	H	110	0.39	0.3						
94/08/25	1	E	8	0.33J	1.1						
94/08/25	1	H	138	0.50J							

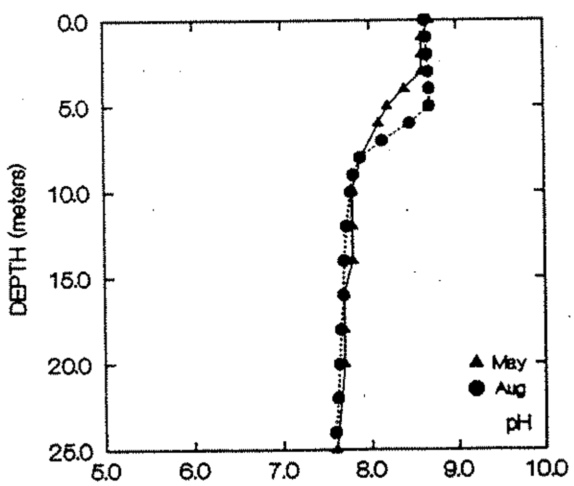
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

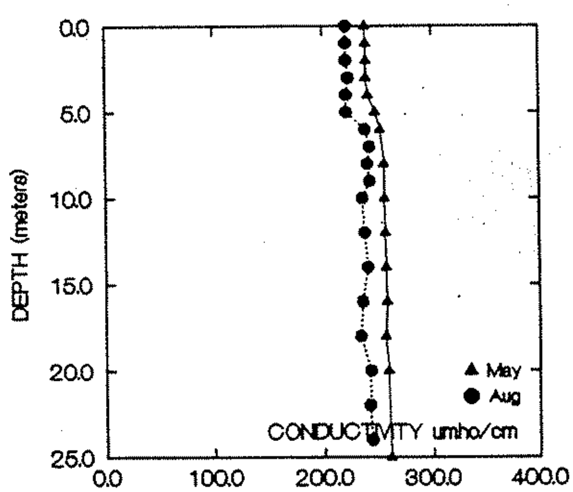
CURLEW (FERRY) Lake -- FERRY County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/26	0.0	17.9	8.7	9.6	238.0	94/08/25	0.0	20.4	8.6	8.6	221.0
	1.0	17.7	8.6	9.5	239.0		1.0	20.5	8.7	8.6	221.0
	2.0	17.6	8.6	8.5	239.0		2.0	20.5	8.7	8.6	221.0
	3.0	16.7	8.6	8.3	239.0		3.0	20.4	8.7	8.6	223.0
	4.0	13.8	8.4	8.3	241.0		4.0	20.5	8.7	8.6	221.0
	5.0	10.6	8.2	6.8	247.0		5.0	20.4	8.7	8.6	221.0
	6.0	8.1	8.1	4.0	252.0		6.0	17.5	8.5	8.4	238.0
	8.0	6.6	7.9	2.2	255.0		7.0	11.6	8.1	5.9	242.0
	10.0	6.1	7.8	1.3	256.0		8.0	8.1	7.9	1.1	240.0
	12.0	5.8	7.8	0.8	256.0		9.0	7.2	7.8	0.4	242.0
	14.0	5.6	7.8	0.6	257.0		10.0	6.7	7.8	0.3	235.0
	16.0	5.5	7.7	0.3	257.0		12.0	6.3	7.7	0.1	237.0
	18.0	5.4	7.7	0.3	256.0		14.0	6.0	7.7	0.1	240.0
	20.0	5.3	7.7	0.3	259.0		16.0	5.8	7.7	0.1	235.0
	25.0	5.0	7.6	0.3	260.0		18.0	5.7	7.7	0.1	233.0
							20.0	5.6	7.6	0.1	242.0
							22.0	5.5	7.6	0.1	241.0
							24.0	5.3	7.6	0.1	243.0







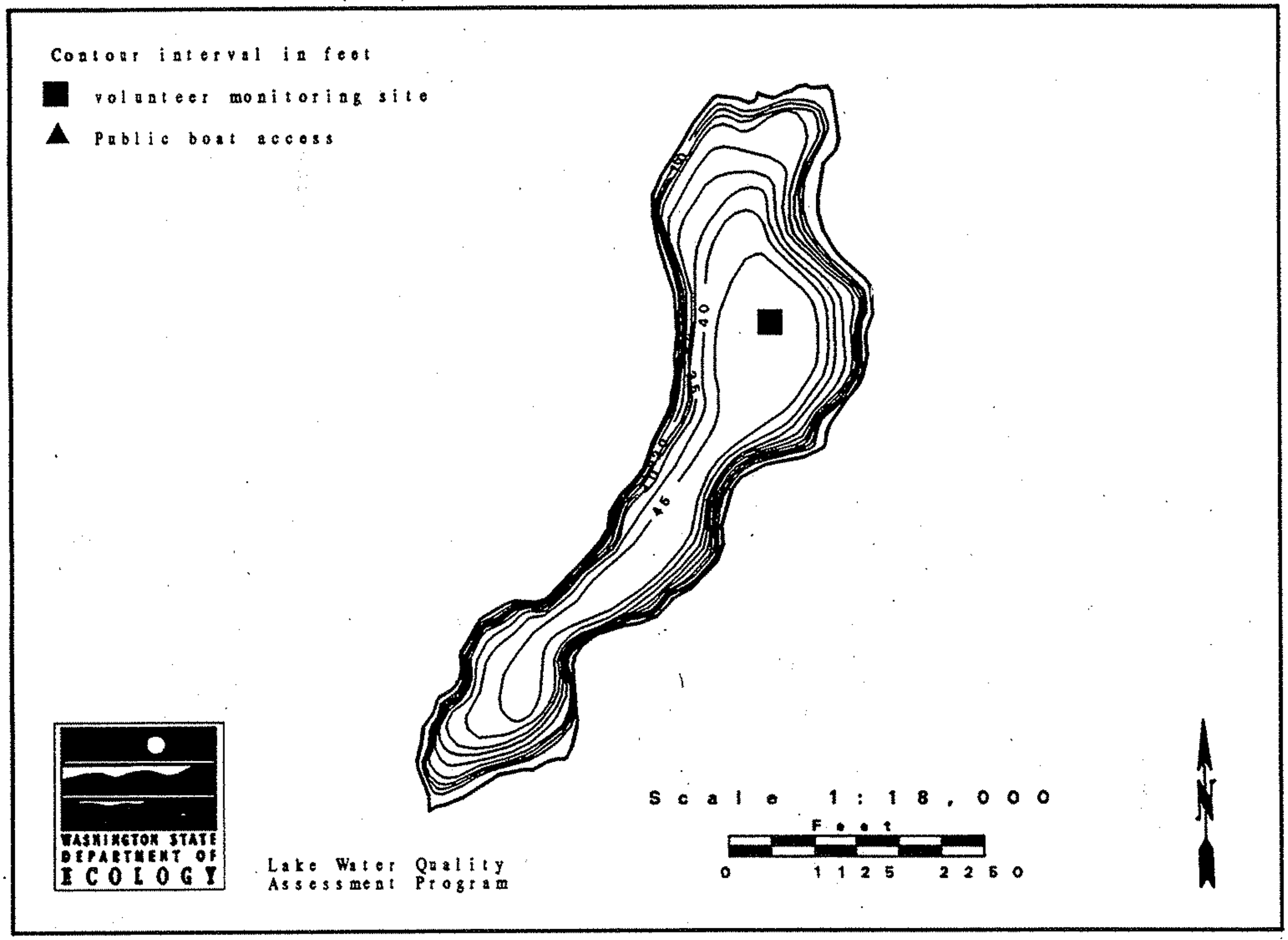


Deep Lake -- Stevens County

Deep Lake is located nine miles south of Northport, and 25 miles northeast of Colville. The lake is 1.4 miles long and the shoreline is steep. The lake is fed by the north fork of Deep Creek, and drains via Deep Creek to the Columbia River (Lake Roosevelt). This lake was monitored by Ecology staff only.

Size (acres)	210
Maximum Depth (feet)	49
Mean Depth (feet)	34
Lake Volume (acre-feet)	7,203
Drainage Area (miles^2)	48.1
Altitude (feet)	2,025
Shoreline Length (miles)	3.5

Data from Dion *et al.* (1976)



Overall Assessment

Deep Lake was sampled by Ecology staff only in 1994, but was monitored by volunteers in 1989, 1990, and 1993.

In 1994, the lake exhibited both oligotrophic and mesotrophic characteristics. Oligotrophic characteristics include the very low concentrations of chlorophyll *a* on both sampling dates, and the low concentration of total phosphorus during the August survey. Mesotrophic characteristics include the moderately high concentration of total phosphorus during the May survey, the very low concentrations of dissolved oxygen throughout the hypolimnion on both sampling dates, and the presence of hydrogen sulfide in bottom water samples collected during the August survey. Based on these, Deep Lake was classified as oligo-mesotrophic in 1994.

As noted during previous surveys, the conductivity in Deep Lake was relatively high throughout the water column. This, and mines (both active and abandoned) within the watershed, suggest that the geology within the watershed contributes to the high conductivity of the lake.

Aquatic plants observed by Ecology staff during the 1994 surveys include muskgrass (*Chara sp.*; this plant was abundant in the lake), coontail (*Ceratophyllum demersum*), sago pondweed (*Potamogeton pectinatis*), Richardson's pondweed (*Potamogeton richardsonii*), milfoil (*Myriophyllum sp.*; not suspected to be the aggressive Eurasian variety), bladderwort (*Utricularia vulgaris*), Illinois pondweed (*Potamogeton illinoensis*), floatingleaf pondweed (*Potamogeton natans*), and narrowleaf pondweed (*Potamogeton filiformis*).

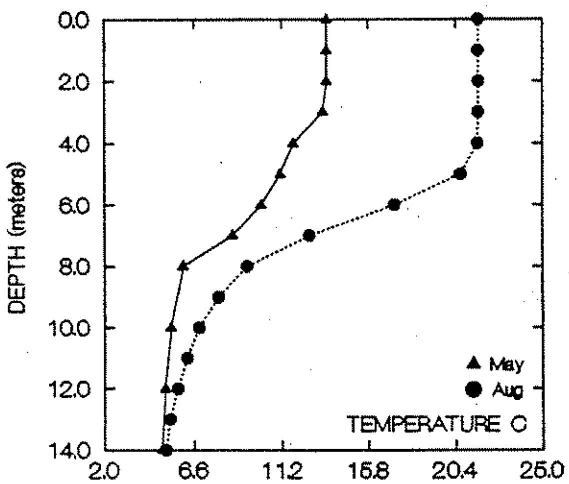
DEEP (STEVENS) Lake -- STEVENS County
Chemistry Data -- Station 1

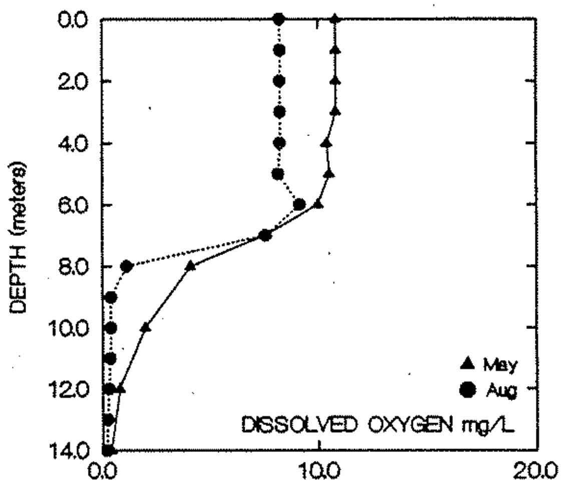
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/12		E	11			(Source: Water Supply Bulletin 43)					
89/06/20	1	E	13	0.15	2.6						
89/09/19	1	E	12	0.28	3.4						
90/05/25	1	E	31	0.31							
90/09/12	1	E	13	0.23							
91/06/14	1	E		0.13							
92/05/19	1	E	14	0.20	0.9						
92/05/19	1	H	34	0.28							
92/09/01	1	E	14	0.18	1.5						
92/09/01	2	E	16	0.17	0.8						
92/09/01	1	H	42	0.34							
93/05/17	1	E	21	0.28	3.4						
93/05/17	1	H	26	0.30							
93/08/18	1	E	6	0.14	1.6						
93/08/18	1	H	18	0.20							
94/05/21	1	E	20	0.07	1.7						
94/05/21	1	H	33	0.22							
94/08/17	1	E	3U	0.18J	0.7J						
94/08/17	1	H	39	0.27J							

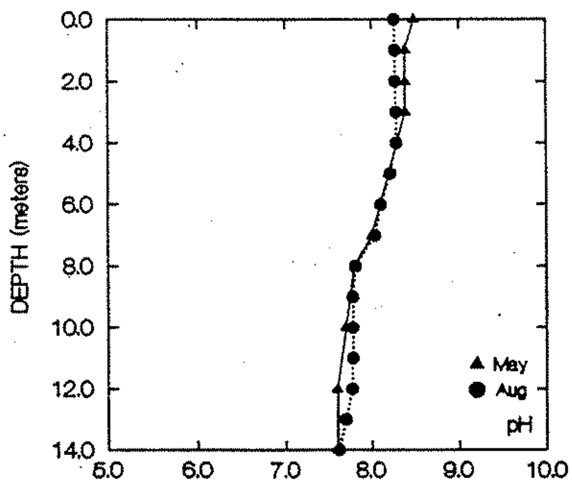
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

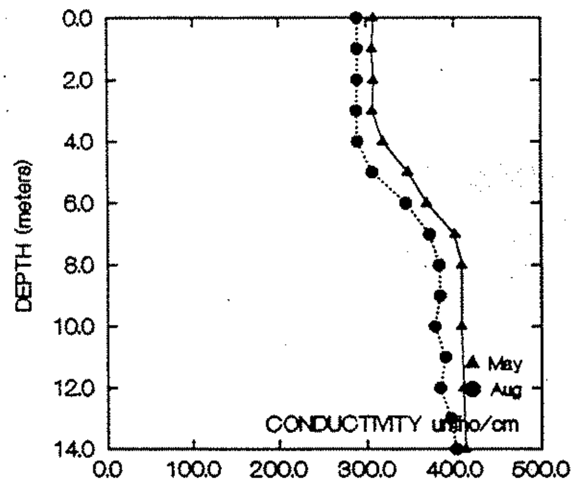
DEEP (STEVENS) Lake -- STEVENS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/21	0.0	13.6	8.5	10.8	308.0	94/08/17	0.0	21.6	8.3	8.3	289.0
	1.0	13.6	8.4	10.8	306.0		1.0	21.6	8.3	8.3	289.0
	2.0	13.6	8.4	10.8	308.0		2.0	21.6	8.3	8.3	289.0
	3.0	13.4	8.4	10.8	306.0		3.0	21.6	8.3	8.3	288.0
	4.0	11.8	8.3	10.4	318.0		4.0	21.6	8.3	8.3	289.0
	5.0	11.1	8.2	10.5	346.0		5.0	20.7	8.2	8.2	306.0
	6.0	10.1	8.1	10.0	368.0		6.0	17.2	8.1	9.2	344.0
	7.0	8.6	8.0	7.6	400.0		7.0	12.7	8.0	7.6	371.0
	8.0	6.0	7.8	4.1	408.0		8.0	9.4	7.8	1.1	382.0
	10.0	5.4	7.7	2.0	408.0		9.0	7.8	7.8	0.4	383.0
	12.0	5.1	7.6	0.8	410.0		10.0	6.8	7.8	0.4	377.0
	14.0	4.9	7.6	0.4	412.0		11.0	6.2	7.8	0.4	389.0
							12.0	5.7	7.8	0.3	383.0
							13.0	5.3	7.7	0.2	395.0
							14.0	5.1	7.6	0.2	401.0







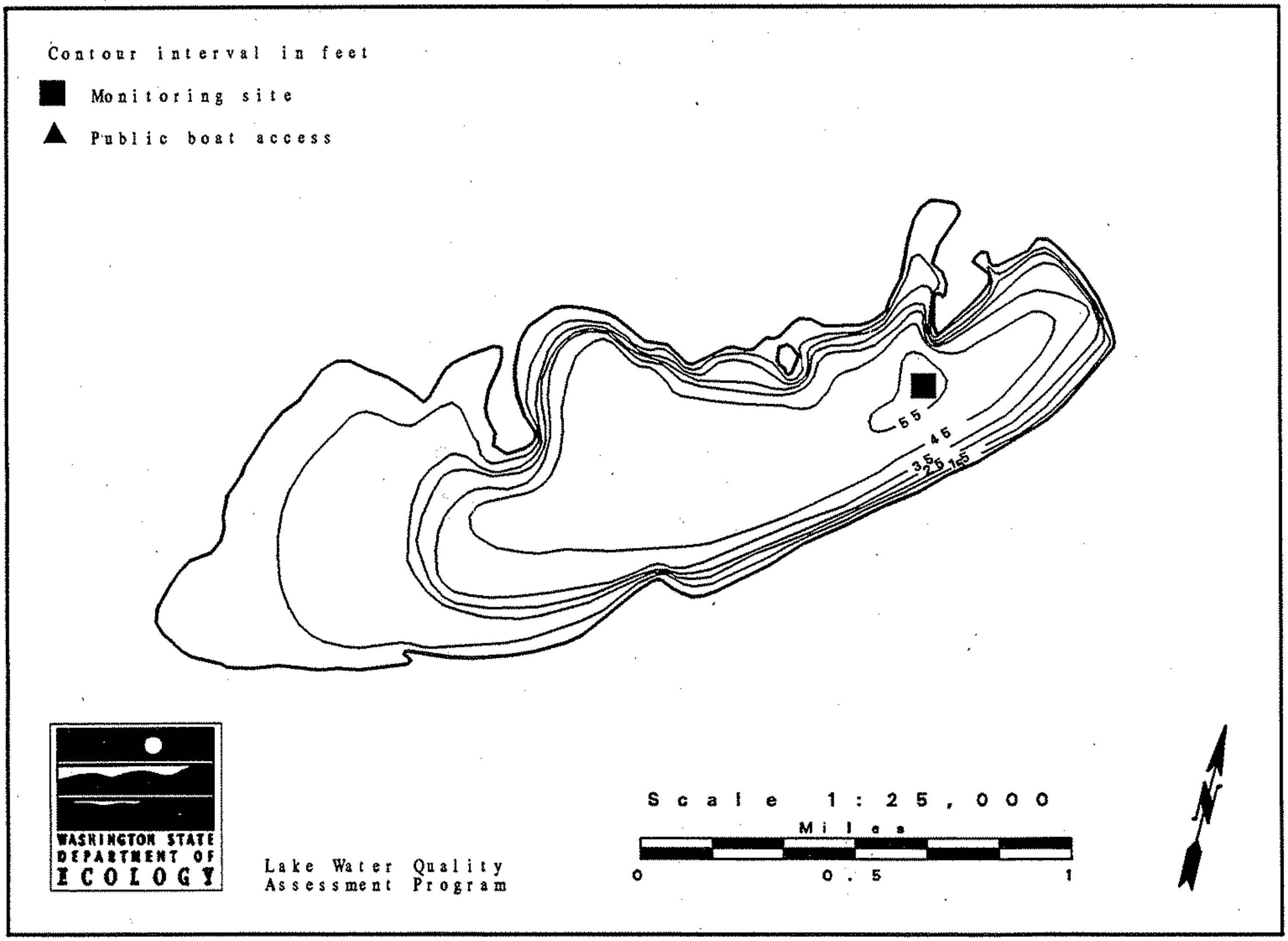


Diamond Lake -- Pend Oreille County

Diamond Lake is located about seven miles southwest of Newport, and six miles north of Camden. It has no surface inlets, and drains via Moon Creek to Sacheen Lake and the west branch of the Little Spokane River. Diamond Lake was monitored by Ecology staff only.

Size (acres)	800
Maximum Depth (feet)	58
Mean Depth (feet)	27
Lake Volume (acre-feet)	22,000
Drainage Area (miles^2)	17.4
Altitude (feet)	2,340
Shoreline Length (miles)	7.0

Data from Dion *et al.* (1976)



Overall Assessment

Diamond Lake was sampled by Ecology staff only in 1994.

Secchi depths and a chlorophyll *a* concentration indicated that algal growth was low on both sampling dates. (The August chlorophyll result is not reported here due to concern about data quality.) The only unusual result from profile data was that the thermocline was rather deep on both sampling dates, so that there was no real distinction between the metalimnion and the hypolimnion. Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Diamond Lake was classified as oligotrophic in 1994.

Aquatic plants observed by Ecology staff during the august field survey include yellow-flowering water lilies (*Nuphar sp.*), largeleaf pondweed (*Potamogeton amplifolius*), and flatleaf pondweed (*Potamogeton robbinsii*).

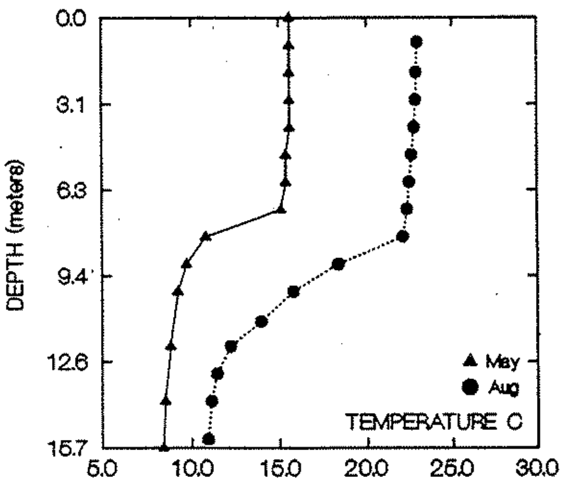
DIAMOND (PEND OREILLE) Lake -- PEND OREILLE County
Chemistry Data -- Station 1

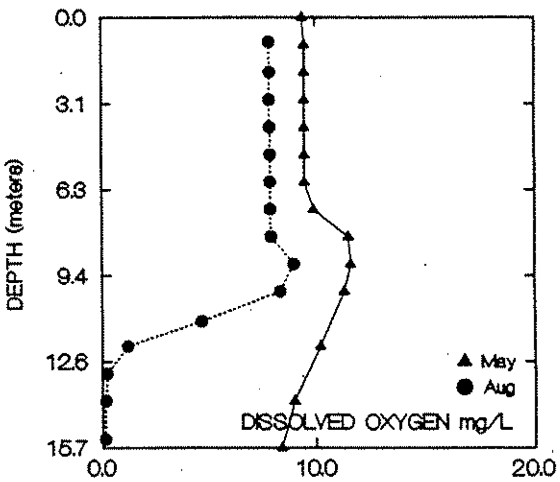
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
72/08/14		E	10			(Source: Water Supply Bulletin 43)					
81/07/13		E	10		0.6	(Source: Water Supply Bulletin 57)					
94/05/20	1	E	12	0.27	1.0						
94/05/20	1	H	12	0.23							
94/08/19	1	E	13	0.32J							
94/08/19	1	H	19	0.46J							

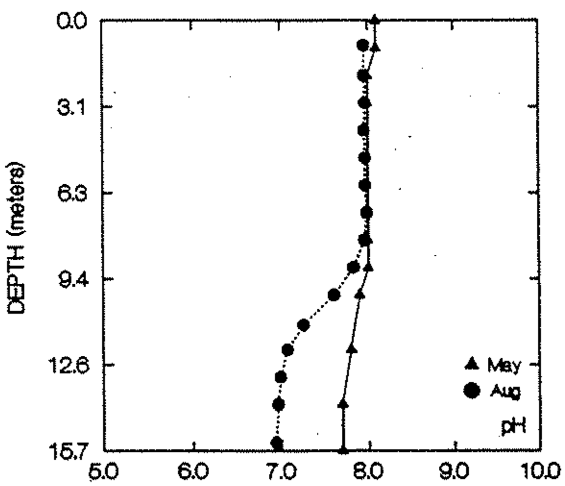
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

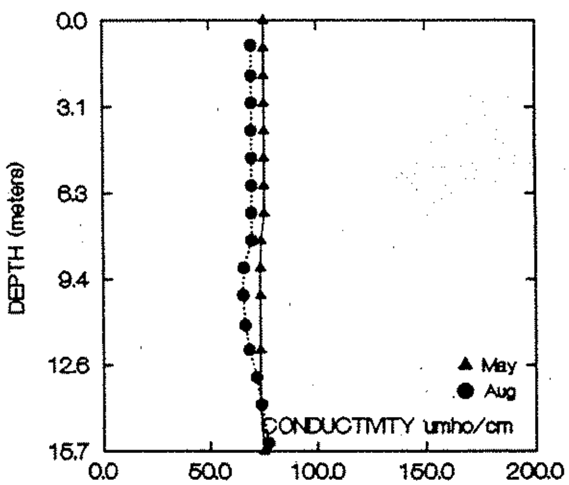
DIAMOND (PEND OREILLE) Lake -- PEND OREILLE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/20	0.0	15.6	8.1	9.4	76.0	94/08/19	-0.1	23.0	8.0	7.9	70.0
	1.0	15.6	8.1	9.5	76.0		0.9	23.0	8.0	7.9	70.0
	2.0	15.6	8.0	9.5	76.0		2.0	22.9	8.0	7.9	70.0
	3.0	15.6	8.0	9.5	76.0		3.0	22.9	8.0	7.9	70.0
	4.0	15.6	0.0	9.5	76.0		4.0	22.8	8.0	7.9	70.0
	5.0	15.4	0.0	9.5	76.0		5.0	22.7	8.0	7.9	70.0
	6.0	15.4	0.0	9.5	76.0		6.0	22.5	8.0	7.9	70.0
	7.0	15.1	8.0	9.9	76.0		7.0	22.4	8.0	7.9	70.0
	8.0	10.8	8.0	11.5	74.0		8.0	22.1	8.0	7.9	70.0
	9.0	9.7	8.0	11.6	74.0		9.0	18.4	7.8	9.0	66.0
	10.0	9.2	7.9	11.3	74.0		10.0	15.8	7.6	8.3	66.0
	12.0	8.8	7.8	10.2	74.0		11.1	13.9	7.3	4.7	67.0
	14.0	8.5	7.7	9.0	74.0		12.0	12.2	7.1	1.2	68.0
	15.7	8.4	7.7	8.4	75.0		13.0	11.4	7.0	0.2	72.0
							14.0	11.1	7.0	0.2	74.0
							15.4	10.9	6.9	0.1	77.0







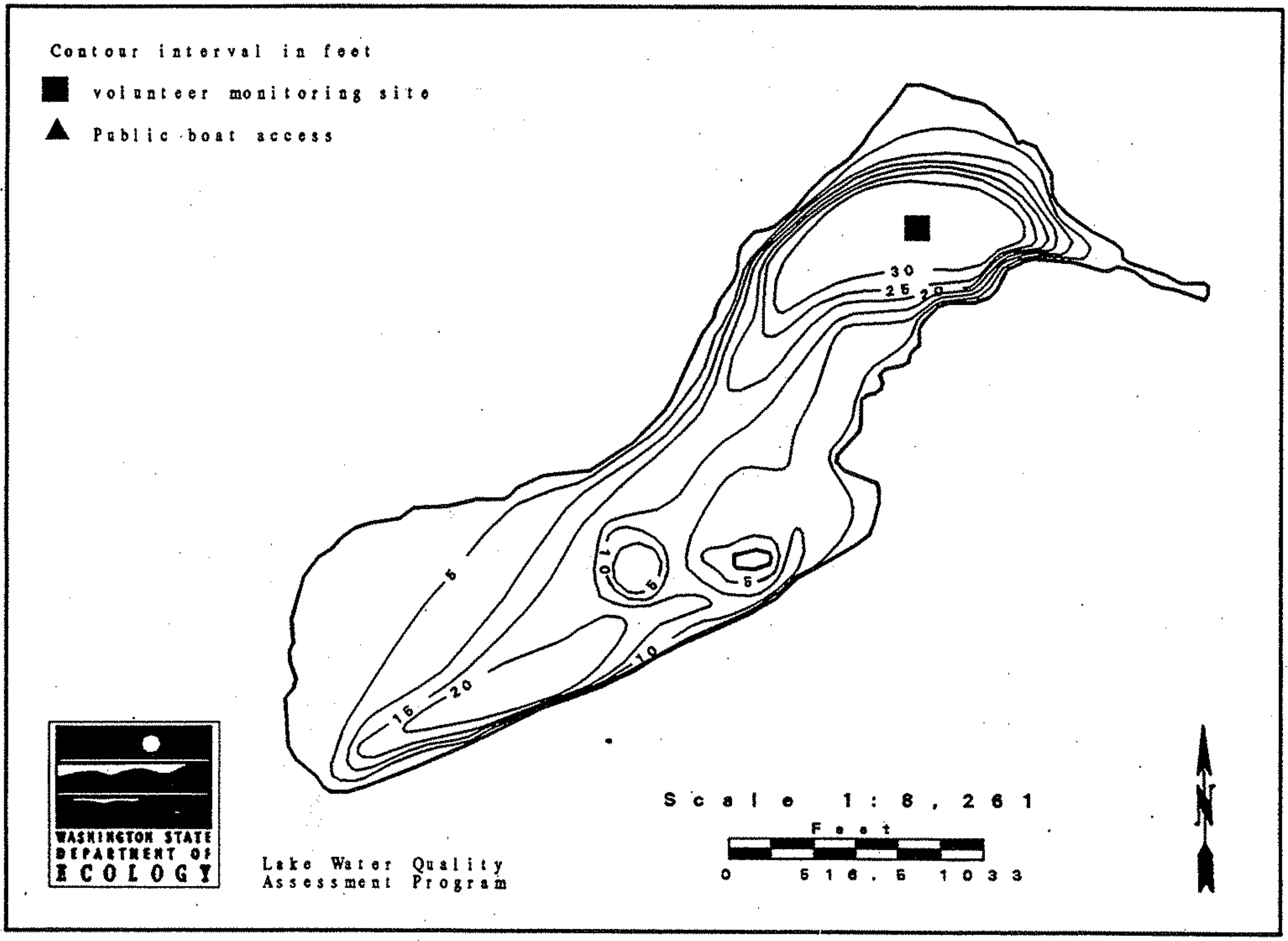


Lake Ellen -- Ferry County

Lake Ellen is located 14 miles north of Inchelium. It is fed primarily by springs.

Size (acres)	77.8
Maximum Depth (feet)	34
Mean Depth (feet)	*
Lake Volume (acre-feet)	*
Drainage Area (miles^2)	*
Altitude (feet)	2,300
Shoreline Length (miles)	*

Data from Wolcott (1973), other data not available.



Overall Assessment

Water clarity was very good in 1994. Although the concentrations of total phosphorus were moderately high in May, Secchi depths and chlorophyll *a* concentrations suggest that algae growth was low when the lake was monitored (Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary).

Dissolved oxygen profile data show that oxygen concentrations decreased considerably below the thermocline during the August survey. This is not unusual, and usually results from bacteria that decompose organic material (including algae and aquatic plants) in the water and sediments. There was a "cattail marsh" (*Typha sp.*) in a shallow embayment on the east side of the lake at the campground. Other aquatic plants identified by Ecology staff in the marshy area include white-flowering water lily (*Nymphaea odorata*), largeleaf pondweed (*Potamogeton amplifolius*), berchtold's pondweed (*Potamogeton berchtoldii*), floatingleaf pondweed (*Potamogeton natans*), slender naiad (*Najas flexilis*), smartweed (*Polygonum amphibium*), cinquefoil (*Potentilla sp.*), waterplantain (*Alisma plantago-aquatica*), and muskgrass (*Chara*). Cattails, muskgrass, and naiad were the most abundant plants in the lake.

Because of low concentrations of dissolved oxygen in the lower layer of water, and because of problems listed in the lake by the volunteer (see below), Lake Ellen was classified as oligo-mesotrophic in 1994. Smoke and haze from widespread eastern Washington fires were reported at Lake Ellen during July 1994. In 1993, the volunteer reported that livestock had direct access to the lakeshore or its inlet tributaries. To protect the lake, livestock should be fenced away from surface water.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the questionnaires from 1993 and 1994.

> Lake Ellen is used for fishing, swimming, rowing, lakeshore camping, and waterfowl hunting. There is one boat ramp on the lakeshore, and there are no restrictions for motor boat use on the lake. Trout were stocked in the lake in 1994. Currently, the watershed is being logged and used for animal grazing, and grazing animals have direct access to the lakeshore or inlet tributaries.
>
> There are no houses on the lakeshore, and no culverts which drain into the lake. There are no organizations for the lake, and no aquatic plant management activities occurred in 1994. However, the lake was scheduled to be treated with rotenone in October 1994.

Overall, the volunteer found that Lake Ellen had good water quality. The worst problems in the lake in 1994 were ranked as (1) undesirable fish species (bass), (2) excessive aquatic plants, (3) decaying plants, and (4) odor from decaying algae. No water quality problems were reported in the lake in 1993. In comparison to the 1993 monitoring season, the water level was high in spring 1994, although the dry weather brought the lake back down to its usual summer level.

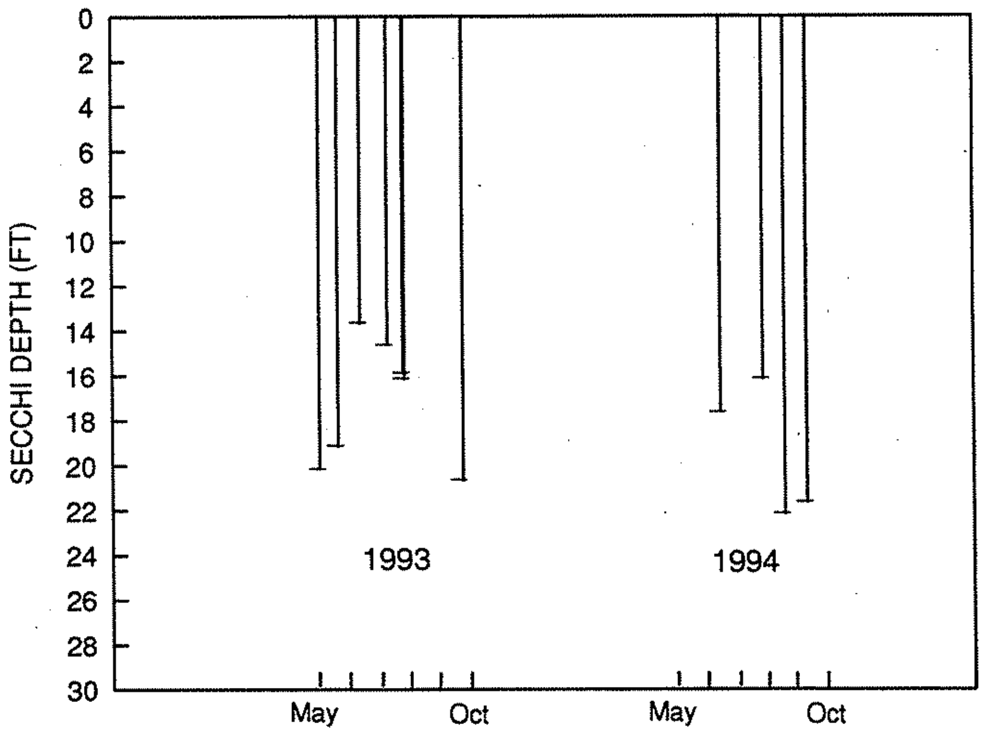
Acknowledgment

I thank David King for volunteering his time to monitor Lake Ellen during 1993 and 1994.

ELLEN Lake -- FERRY County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/15	17.8	64.0	0.0	Lt Green	100	Mod	Calm	0.0	0.0	No boat; reading (15+) taken from dock.
94/05/17	16.6	61.9	7.9	Mod Green	0	None	Calm	23.6	0.0	On-site visit; temp and pH from Hydrolab. Some pollen on surface/in water.
94/06/18	22.2	72.0	0.0	Milky-grn	50	None	Light	17.0	-4.0	Lake 23" higher than in 1993.
94/07/31	24.4	75.9	0.0	Lt Green	0	None	Breezy	15.5	-12.0	100% smoke haze from Eastern Washington fires. Level dropped 12" since last reading.
94/08/20	23.3	73.9	0.0	Lt Green	0	None	Light	21.5	0.0	Hot and dry July, and August.
94/09/11	19.4	66.9	0.0	Lt Green	50	Heavy	Breezy	21.0	0.0	

LAKE ELLEN (FERRY COUNTY)



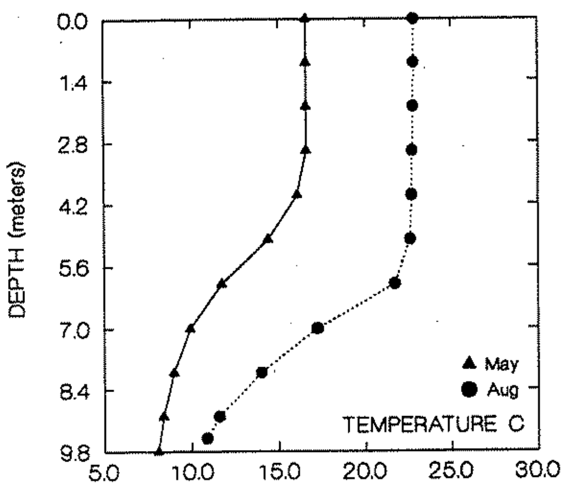
ELLEN (FERRY) Lake -- FERRY County
Chemistry Data -- Station 1

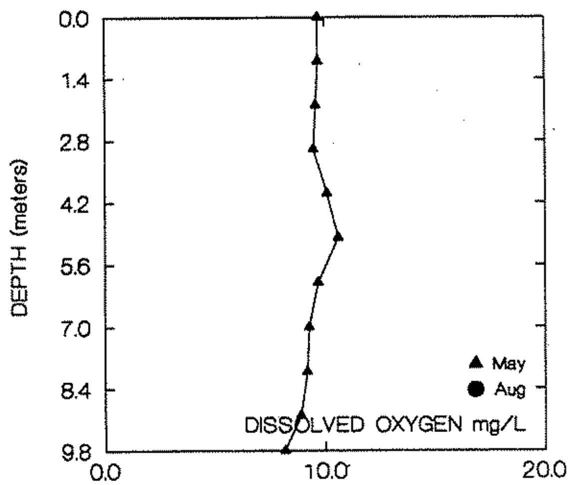
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
93/05/16	1	E	9	0.47	1.8						
93/05/16	1	H	11	0.57							
93/08/17	1	E	6	0.43	2.6						
93/08/17	1	H	27	0.75							
94/05/17	1	E	17	0.41	1.8						
94/05/17	1	H	16	0.46							
94/08/20	1	E	10	0.54J							
94/08/20	1	H	11	0.56J							

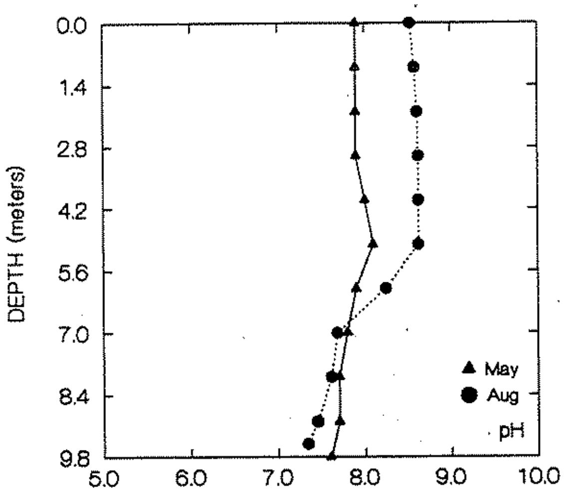
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

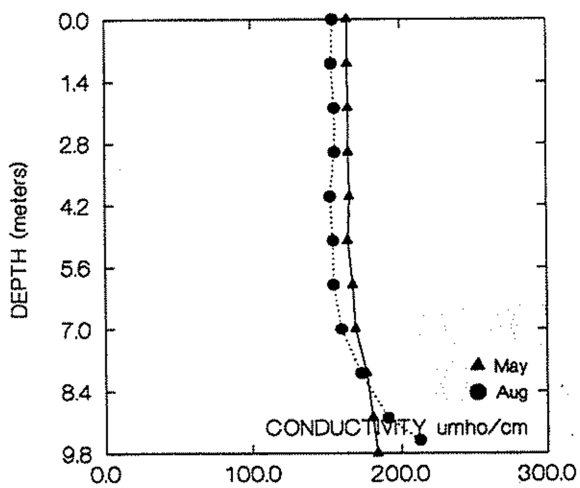
ELLEN (FERRY) Lake -- FERRY County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/17	0.0	16.6	7.9	9.7	165.0	94/08/20	0.0	22.9	8.5	7.9	155.0
	1.0	16.6	7.9	9.7	165.0		1.0	22.9	8.6	7.9	154.0
	2.0	16.6	7.9	9.6	165.0		2.0	22.8	8.6	7.9	156.0
	3.0	16.6	7.9	9.5	165.0		3.0	22.8	8.6	7.9	156.0
	4.0	16.1	8.0	10.1	166.0		4.0	22.7	8.6	7.9	153.0
	5.0	14.4	8.1	10.6	165.0		5.0	22.6	8.6	7.8	155.0
	6.0	11.7	7.9	9.7	168.0		6.0	21.7	8.3	5.2	155.0
	7.0	9.9	7.8	9.3	170.0		7.0	17.2	7.7	0.7	160.0
	8.0	9.0	7.7	9.2	177.0		8.0	14.0	7.6	0.5	173.0
	9.0	8.4	7.7	8.9	181.0		9.0	11.6	7.5	0.2	191.0
	9.8	8.1	7.6	8.2	184.0		9.5	10.8	7.3	0.1	213.0







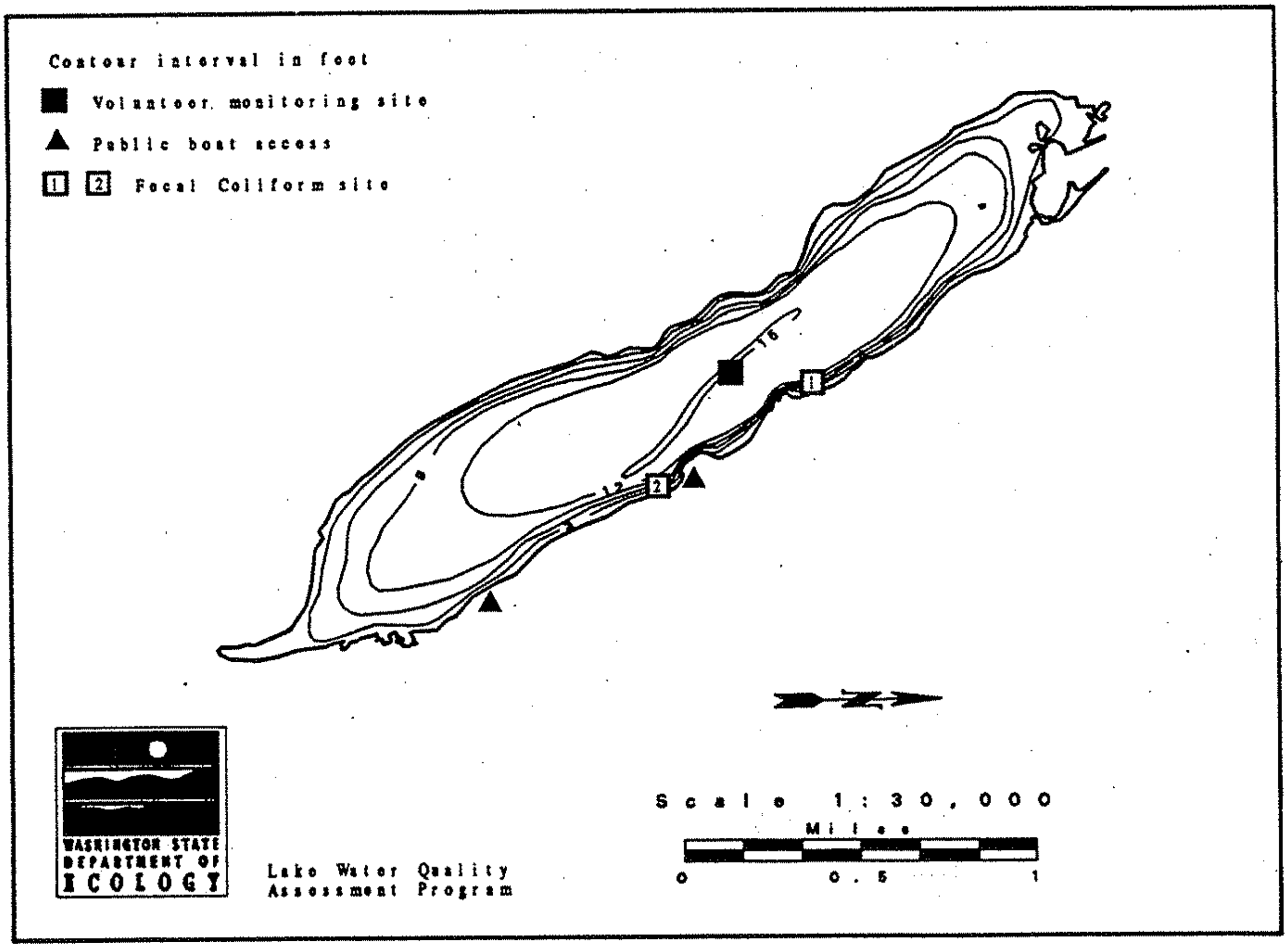


Lake Eloika -- Spokane County

Lake Eloika is located four miles west of Elk. It is three miles long and lies in a northeast/southwest direction. It is a natural lake, and is an enlargement of the west branch of the Little Spokane River. Lake Eloika extends north about 1000 feet into Pend Oreille County at high water periods.

Size (acres)	662
Maximum Depth (feet)	15
Mean Depth (feet)	9
Lake Volume (acre-feet)	6,018
Drainage Area (miles^2)	111
Altitude (feet)	1,905
Shoreline Length (miles)	5.9

Data from Dion *et al.* (1976)



Overall Assessment

Water clarity in Lake Eloika was fairly poor in 1994. However, Secchi depths measured in 1994 were similar to those measured during previous years (see graph of Secchi depth data), and there was no apparent change in Secchi depths from 1989 through 1994. This was tested using the seasonal Kendall test for trend, and results indicated that there was not a significant trend in Secchi depths from 1989 through 1994 ($p = 0.56$).

Secchi depths and a chlorophyll *a* concentration indicate that algal growth was moderately heavy to heavy when the lake was sampled. (The chlorophyll *a* concentration from August is not reported due to data quality concerns.) Total phosphorus concentrations were high on both sampling dates.

Because the volunteer alerted Ecology staff that Eurasian water milfoil was observed in the lake, Lake Eloika was surveyed by Ecology staff on August 3, 1994, for the Freshwater Aquatic Weeds Program. Aquatic plant growth was heavy to 12 feet depths. Predominant species were waterweed (*Elodea canadensis*), coontail (*Certophyllum demersum*), and Richardson's pondweed (*Potamogeton richardsonii*). Eurasian watermilfoil (*Myriophyllum spicatum*) was only observed at the boat launch. Other aquatic plants observed include slender pondweed (*Potamogeton pusillus*), fern leaf pondweed (*Potamogeton robbinsii*), flatstem pondweed (*Potamogeton zosteriformis*), great duckweed (*Spirodela polyrhiza*), watershield (*Brasenia schreberi*), northern watermilfoil (*Myriophyllum sibiricum*), and yellow water-lily (*Nuphar sp.*). Bladderwort (*Utricularia vulgaris*) was observed in extensive patches during the 1990 field survey with the volunteer, but was not reported in 1994.

Based on results for all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), as well as the heavy population of aquatic plants in the lake, Lake Eloika was classified as eutrophic in 1994. The volunteer also noted that swimming, fishing, and aesthetics in the lake are restricted during most of the year due to poor water quality.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Eloika Lake is used for fishing, rowing, camping, and waterfowl hunting. There are two resorts on the lakeshore. There is one public boat ramp, and there are no restrictions for motorboat use on the lake. About 2% of the lakeshore is publicly-owned. Currently the watershed is being logged and used for animal grazing. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for crop agriculture, the lake was dredged, and the shoreline was altered.

There are about 60 houses on the lakeshore, and many are not occupied year-round. There are six stormdrains which drain into the lake. Currently, the minimum setback for lakeshore development is 100 feet. Lake water is withdrawn for irrigation. There is a community association for the lake. No aquatic plant management activities occurred in 1994, although the lake has been treated with chemicals in the past to control aquatic plants.

Overall, the volunteer found that Lake Eloika had fair water quality. Problems in the lake in 1994 were ranked as (1) low water level, (2) suspended sediments, (3) excessive aquatic plant growth, (4) water quality gradually degraded over years, and (5) degraded aesthetics. The underwater plants thrive in the many feet of silt and decayed vegetation at the lake shallow lake bottom. In 1994, water level was lowest in local memory, and the shallow water caused more underwater weeds to grow. Also, Eurasian watermilfoil was discovered for the first time. Studies conducted by the Soil Conservation Service were completed in 1992 (for a water level control dam on the lake's outlet), the project is still in the "preliminary report" stage.

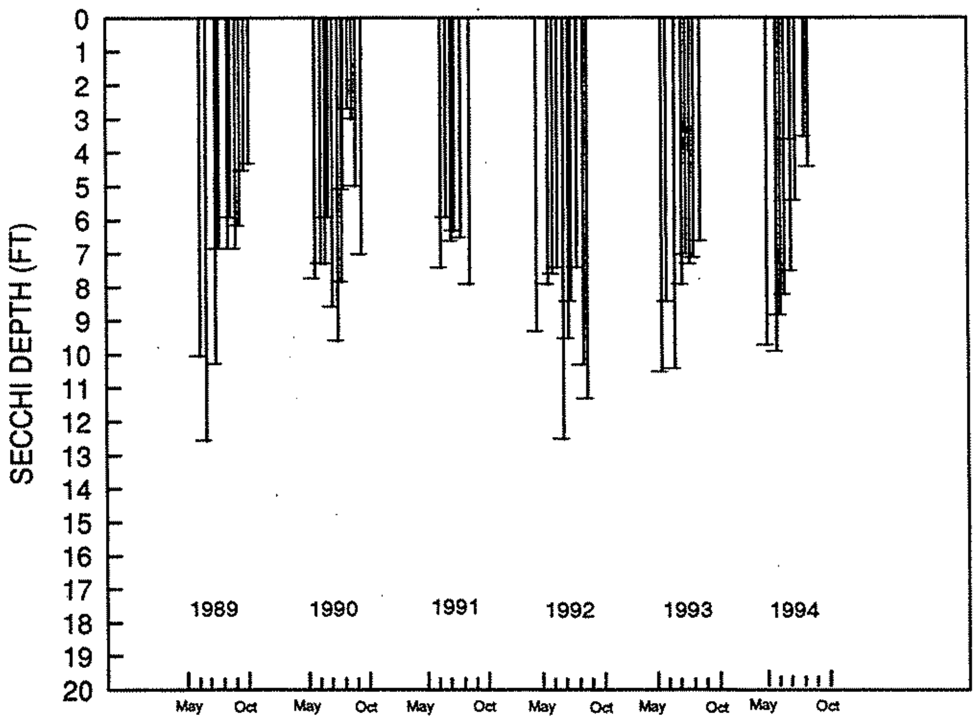
Acknowledgment

I thank Victor H. Soules for volunteering his time to monitor Eloika Lake from 1989 through 1994.

ELOIKA Lake -- SPOKANE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/19	0.0	32.0	0.0		100	Light	Breezy	9.3			Onsite visit. Water color yellow-green. Second Secchi with view tube.
94/06/17	22.0	71.6	0.0	Mod Green	10	Heavy	Calm	9.5			Lake height 1904'11". Stake may have been moved by ice. will verify later. Heavy wind and rain prevented June 1 sample.
94/07/01	23.7	74.7	0.0	Grn-brown	25	Light	Breezy	8.4			Lake height 1904'6". Second Secchi with view tube. Patches of weeds (elodea, etc.) starting to show in center of lake.
94/07/14	24.5	76.1	0.0	Grn-brown	10	None	Light	7.8			Lake height 1904'3". Weeds are bad as I have ever seen them.
94/08/01	28.0	82.4	0.0	Lt Green	10	None	Light	7.1			Second Secchi with view tube. Lake height marker dry; water level is as low as anyone remembers. Large patches of floating elodea, coontail, etc. Small areas of algae bloom near shore (bright light-green).
94/08/04	19.9	67.8	0.0	Mod Green	10	Heavy	Breezy	3.2			Lake 12.5 feet deep.
94/08/18	24.5	76.1	0.0		0	None	Calm	5.0			Water color "ima bean." Algae bloom in progress. On site visit.
94/09/16	19.0	66.2	0.0	Mod Green	10	Trace	Breezy	3.1			Second Secchi with view tube. Lake 12.0 feet deep.
94/10/01	18.0	64.4	0.0	Mod Green	10	None	Breezy	4.0			Second Secchi with view tube. Lake depth 13.0 feet at sampling site.

LAKE ELOIKA (SPOKANE COUNTY)



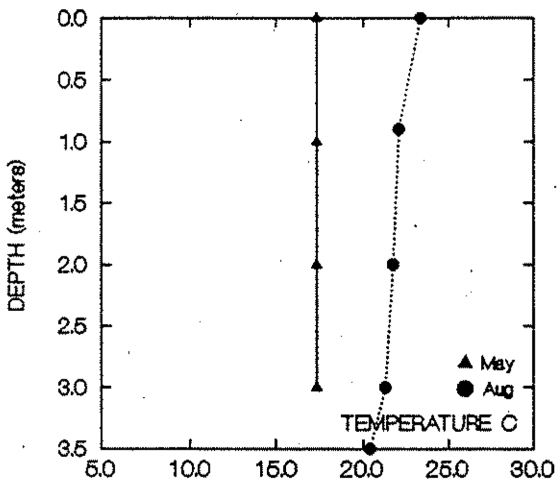
ELOIKA (SPOKANE) Lake -- SPOKANE County
Chemistry Data -- Station 1

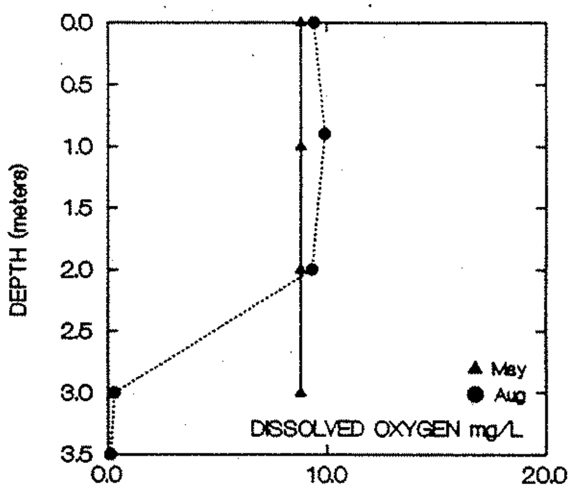
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/01		E	28			(Source: Water Supply Bulletin 43)					
81/07/13		E	20		3.7	(Source: Water Supply Bulletin 57)					
90/08/21	1	E	55	0.68							
91/06/10	1	E		0.29							
92/05/13	1	E	25	0.40	2.2	1U	1		2	1	25
92/05/13	1	H	2								
92/08/26	1	E	29	0.57	5.5	1			5	1	15
93/05/25	1	E	55	0.33	1.8	1	1U				
93/08/21	1	E	29	0.32	7.6						
94/05/19	1	E	44	0.20	2.3						
94/08/18	1	E	55	0.62J							

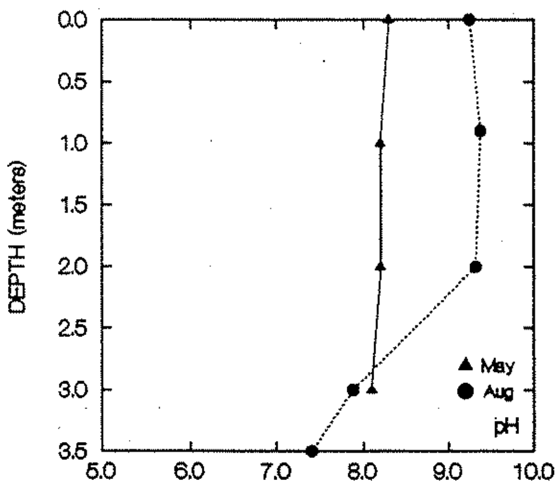
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

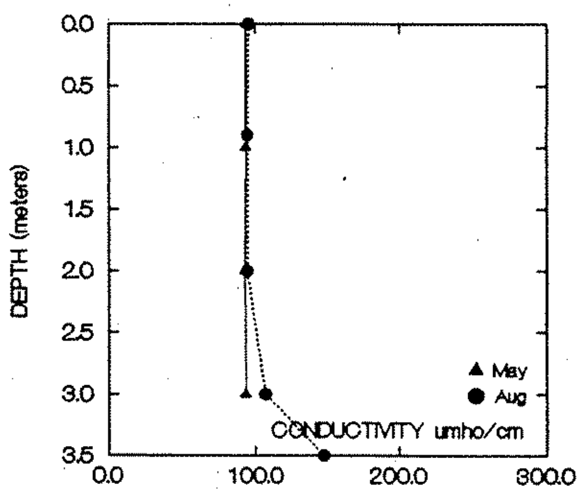
ELOIKA (SPOKANE) Lake -- SPOKANE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (μmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (μmho/cm)
STATION 1											
94/05/19	0.0	17.3	8.3	8.8	93.0	94/08/18	0.0	23.4	9.3	9.4	95.0
	1.0	17.3	8.2	8.8	93.0		0.9	22.1	9.4	9.9	94.0
	2.0	17.3	8.2	8.8	93.0		2.0	21.8	9.3	9.3	94.0
	3.0	17.3	8.1	8.8	93.0		3.0	21.3	7.9	0.3	107.0
							3.5	20.4	7.4	0.1	147.0







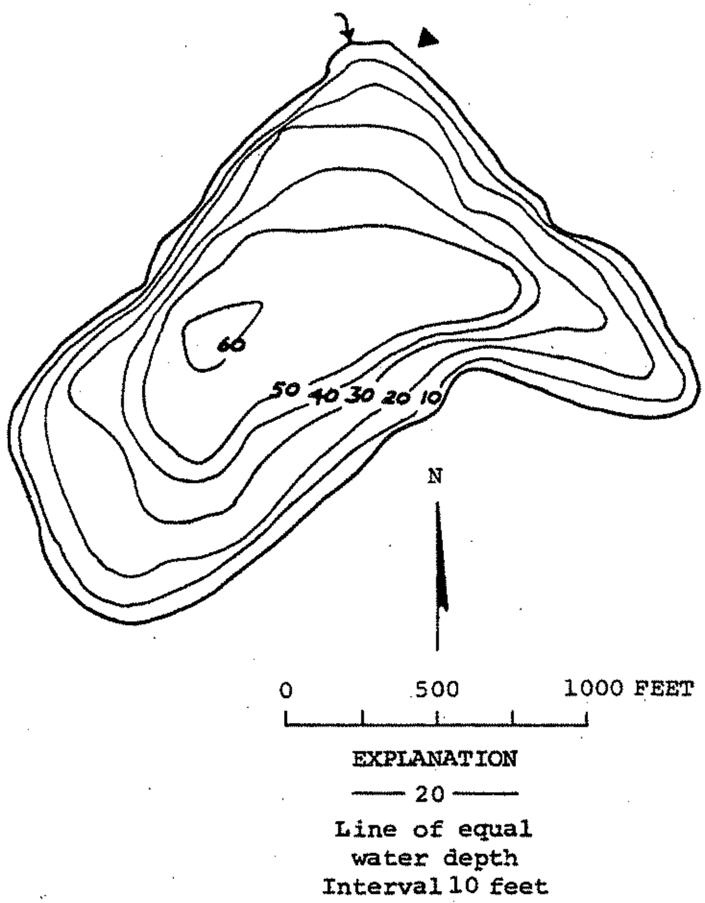


Goss Lake -- Island County

Goss Lake is located on Whidbey Island, three miles west of Langley. Three intermittent streams contribute minor inflow early in the year, but there is no surface outlet. No gasoline-powered boats are allowed on the lake. Goss Lake was monitored by Ecology staff only.

Size (acres)	47
Maximum Depth (feet)	60
Mean Depth (feet)	32
Lake Volume (acre-feet)	1,500
Drainage Area (miles^2)	1.4
Altitude (feet)	130
Shoreline Length (miles)	1.9

Data from Bortleson *et al.* (1976)



Overall Assessment

Goss Lake was monitored by Ecology staff only in 1994 and 1993. A volunteer monitored the lake during 1989 and 1990.

Although concentrations of total phosphorus were moderately high on both sampling dates, Secchi depths, and a chlorophyll *a* concentration indicated that algae growth was low at the time of sampling. (The chlorophyll *a* concentration from the September survey is not reported because of concern about data quality.) Phosphorus concentrations were higher in 1994 than during previous years of sampling, particularly in the hypolimnion. Although Goss Lake has been classified as oligotrophic during previous monitoring seasons, the lake was classified as oligo-mesotrophic in 1994 because of moderately high concentrations of total phosphorus, and increased plant growth.

The worst problem in Goss Lake was Eurasian watermilfoil (*Myriophyllum spicatum*), which was first observed at the boat launch in 1993. By 1994, the plant was found along many areas of the shoreline. A grant from Ecology's Freshwater Aquatic Weeds Program funded a Sonar treatment in Goss Lake during summer 1994. The September survey for the Lake Water Quality Assessment Program occurred after the Sonar treatment. During the survey, the smell of rotting watermilfoil was very strong, and signs were still posted around the lakeshore informing residents about the treatment. Stems of viable (*i.e.*, still green) watermilfoil were observed in patches near the public boat access. The only other aquatic plant observed during the survey was *Chara*, which is an alga that is known to flourish after systemic herbicides (that target vascular plants) are applied. Due to fluctuating water levels in the lake, watermilfoil had established its terrestrial form nearshore in lawns (Kathy Hamel, Ecology, pers. comm.). Further efforts will be needed to control the plant.

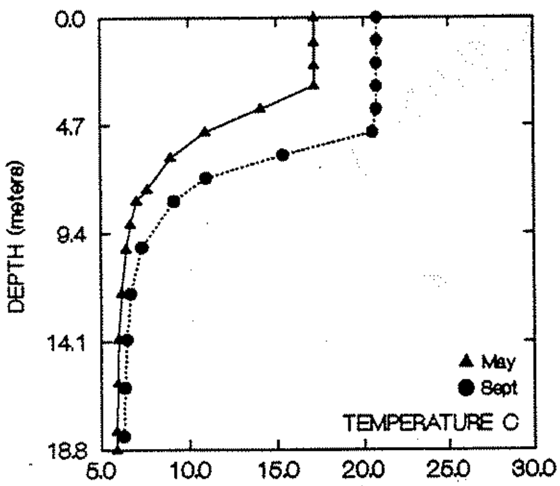
GOSS (ISLAND) Lake -- ISLAND County
Chemistry Data -- Station 1

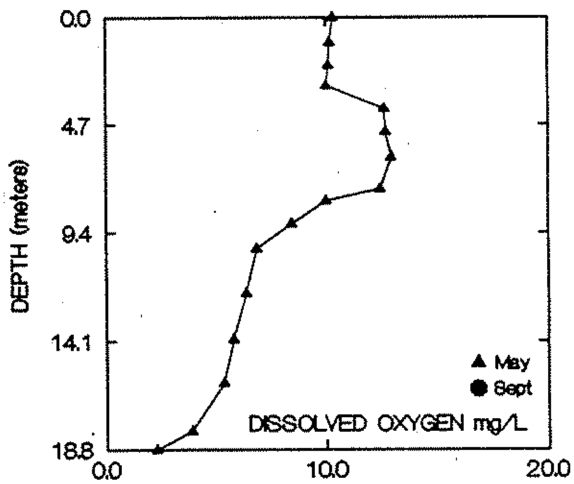
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/26		E	11			(Source: Water Supply Bulletin 43)					
89/06/26	1	E	10	0.41	2.0						
89/09/25	1	E	10	0.48	1.1						
90/06/28	1	E		0.51							
91/05/28	1	E		0.69							
93/05/29	1	E	22	0.29	0.7						
93/05/29	1	H	14	0.38							
93/08/29	1	E	3U	0.29	1.8						
93/08/29	1	H	7	0.37							
94/05/29	1	E	18	0.21	0.7						
94/05/29	1	H	25	0.28							
94/09/03	1	E	12	0.21J							
94/09/03	1	H	15	0.39J							

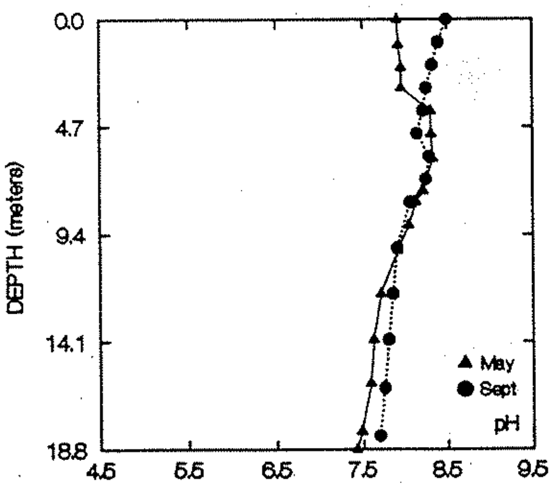
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

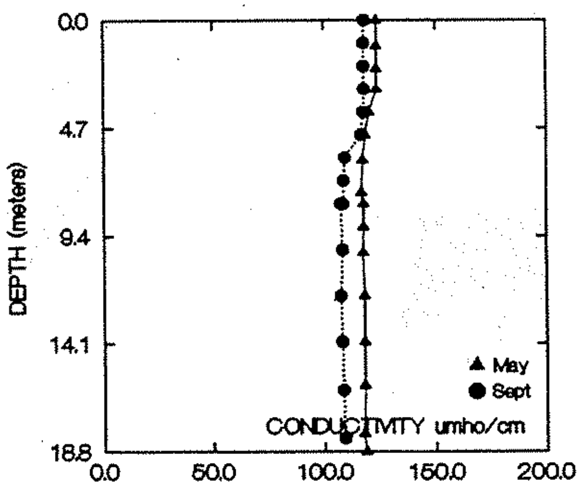
GOSS (ISLAND) Lake -- ISLAND County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/29	0.0	17.2	7.9	10.3	124.0	94/09/03	0.0	20.8	8.5	0.0	118.0
	1.1	17.2	7.9	10.2	124.0		1.0	20.8	8.4	0.0	118.0
	2.1	17.2	8.0	10.1	124.0		2.0	20.8	8.3	0.0	118.0
	3.0	17.2	8.0	10.0	124.0		3.0	20.8	8.3	0.0	118.0
	4.0	14.1	8.3	12.6	121.0		4.0	20.8	8.2	0.0	118.0
	5.0	11.0	8.3	12.7	119.0		5.0	20.6	8.2	0.0	117.0
	6.1	9.0	8.3	12.9	118.0		6.0	15.4	8.3	0.0	110.0
	7.5	7.6	8.2	12.4	117.0		7.0	11.0	8.3	0.0	109.0
	8.0	7.0	8.1	10.0	118.0		8.0	9.1	8.1	0.0	109.0
	9.0	6.7	8.1	8.5	118.0		8.0	9.1	8.1	0.0	108.0
	10.1	6.4	7.9	6.9	118.0		10.0	7.3	7.9	0.0	108.0
	12.0	6.2	7.7	6.4	118.0		12.0	6.7	7.9	0.0	108.0
	14.0	6.0	7.6	5.8	118.0		14.0	6.5	7.8	0.0	108.0
	15.9	5.9	7.6	5.4	118.0		16.1	6.4	7.8	0.0	109.0
	18.0	5.9	7.5	3.9	118.0		18.2	6.3	7.7	0.0	109.0
	18.8	5.9	7.4	2.3	119.0						







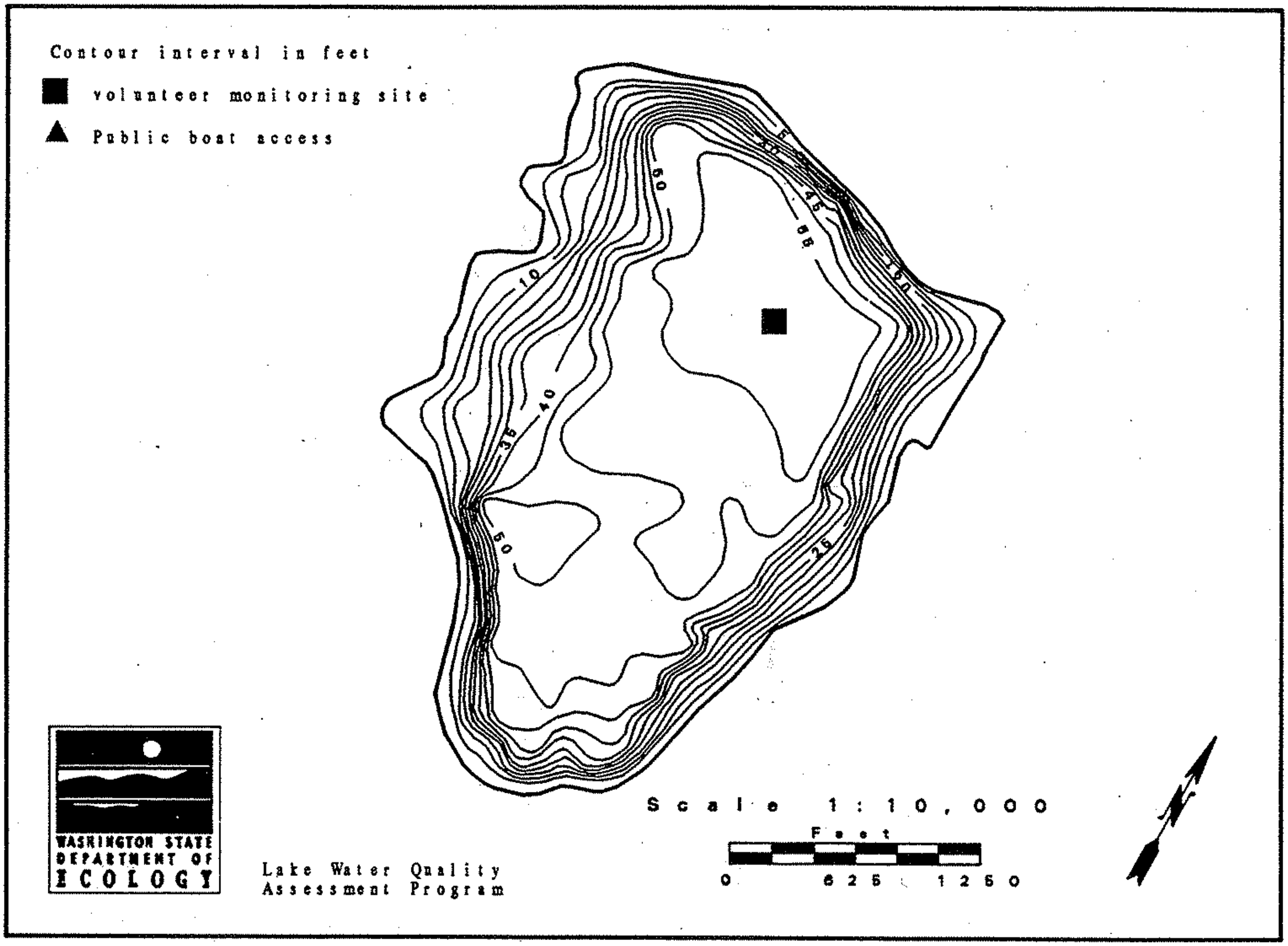


Gravelly Lake -- Pierce County

Gravelly Lake is located 0.5 mile northwest of Ponders, between American and Steilacoom Lakes. It has no surface inlets, and seeps to Puget Sound. Although Gravelly Lake is listed as a public lake in Chapter 173-20 WAC, there is no public boat access on the lake.

Size (acres)	160
Maximum Depth (feet)	55
Mean Depth (feet)	38
Lake Volume (acre-feet)	6,000
Drainage Area (miles^2)	0.7
Altitude (feet)	220
Shoreline Length (miles)	2.1

Data from Bortleson *et al.* (1976)



Overall Assessment

The water quality in Gravelly Lake was good in 1994.

Water clarity was very good in 1994, although it was better in 1993 (see graph of Secchi depth data). However, water clarity in Gravelly Lake is affected primarily by annual treatments of herbicides for controlling algae and other plants.

Secchi depths and the chlorophyll *a* concentration indicate that algal growth was low when the lake was sampled. However, dissolved oxygen profile data from August show that dissolved oxygen concentrations increased considerably at eight and nine meters; this suggests that algae growth was heavy in deeper water at the thermocline. Algicides that improve water clarity (and allow sunlight, which is needed for photosynthesis to occur, to penetrate to deeper water), and high phosphorus concentrations below the upper layer of water, probably allow this to happen. The high phosphorus concentration in the lower layer of water suggests that phosphorus was recycled from sediments into the water column. This can happen when dissolved oxygen concentrations are depleted near sediments; dissolved oxygen profile data from August show that dissolved oxygen was very low. (The pH data from August are not reported because of a problem with the probe at the time of profiling.)

Based on low dissolved oxygen concentrations in the lower layer of water, and the likelihood that phosphorus was recycled from sediments, Gravelly Lake was classified as oligo-mesotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire.

> There are 86 houses on the lakeshore. There is an improvement club for the lake that includes waterfront homeowners only. In 1994, the lake was treated with herbicides to control weeds and algae. Fish were not stocked in the lake.
>
> Overall, the volunteer found that Gravelly Lake had excellent water quality. The only problems in the lake were ranked as (1) low water level, (2) excessive aquatic plant growth, and (3) algae. Stormwater runoff may contribute to the water quality problems in the lake. In comparison to the 1993 monitoring season, there were a few more weeds and lower water level in 1994. Low water level may also have been affected by direct withdrawals for irrigating lawns.

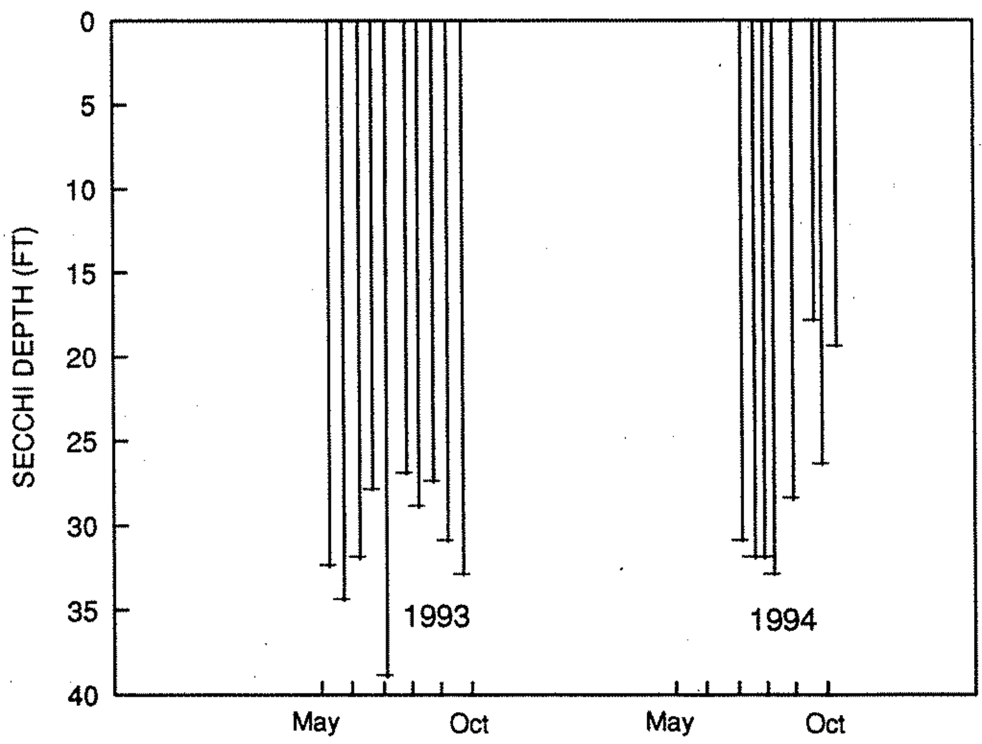
Acknowledgment

I thank Amy Perkins for volunteering her time to monitor Gravelly Lake during 1993 and 1994.

GRAVELLY Lake -- PIERCE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/07/10	22.2	72.0	0.0	Clear	0	None	Light	30.0	0.0	
94/07/20	24.4	75.9	0.0	Clear	0	None	Calm	31.0	0.0	
94/08/04	23.3	73.9	0.0	Clear	100	Trace	Light	31.0	0.0	
94/08/10	23.3	73.9	0.0	Clear	5	Mod	Calm	32.0	0.0	
94/08/29	21.1	70.0	0.0	Clear	100		Light	27.5	0.0	Onsite visit.
94/09/19	20.0	68.0	0.0		0	None	Breezy	17.0	0.0	Water color clear blue.
94/09/27	18.9	66.0	0.0		0	None	Breezy	25.5	0.0	Water color clear green. Lake level low.
94/10/11	16.7	62.1	0.0		50	None	Breezy	18.5	0.0	Water color clear dark blue.

GRAVELLY LAKE (PIERCE COUNTY)



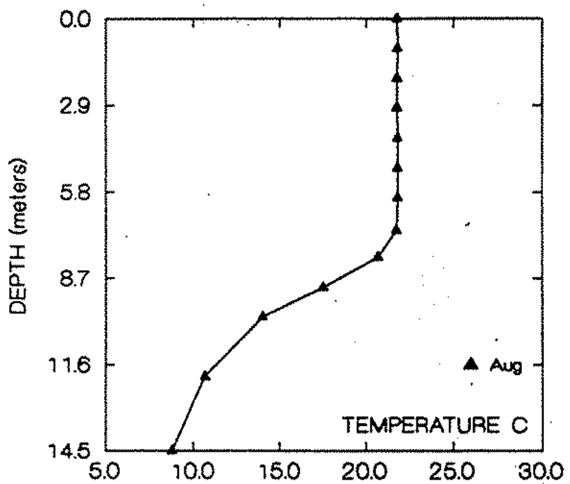
GRAVELLY (PIERCE) Lake -- PIERCE County
Chemistry Data -- Station 1

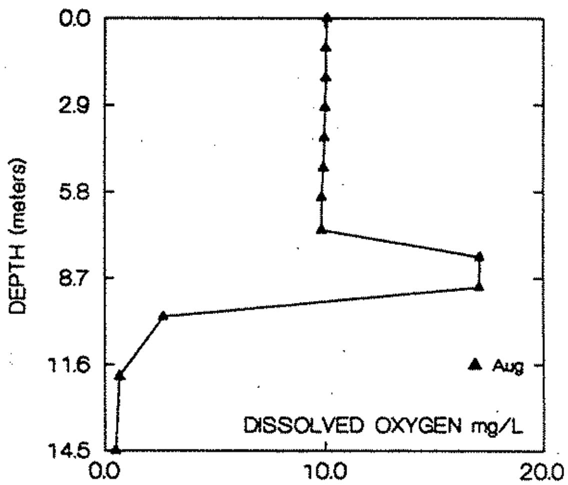
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/21		E	26			(Source: Water Supply Bulletin 43)					
93/06/04	1	E	5	0.64	1.2						
93/06/04	1	H	182	1.50							
93/08/30	1	E	7	0.61	0.5						
93/08/30	1	H	133	0.92							
94/08/29	1	E	35	0.45J	0.4J						
94/08/29	1	H	112	1.14J							

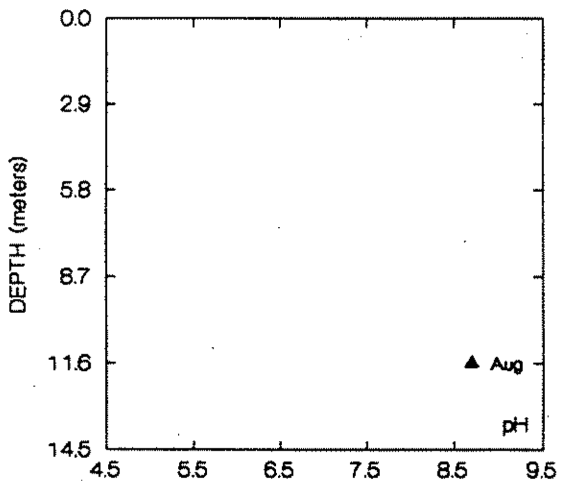
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

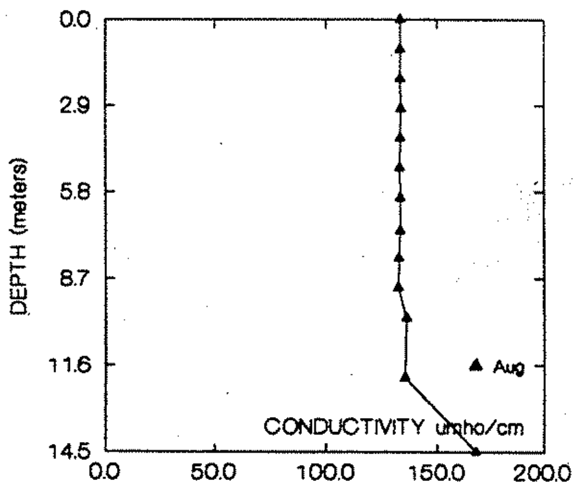
GRAVELLY (PIERCE) Lake -- PIERCE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
						94/08/29	0.0	21.8	0.0	10.1	134.0
							1.0	21.8	0.0	10.0	134.0
							2.0	21.8	0.0	10.0	134.0
							3.0	21.8	0.0	10.0	134.0
							4.0	21.8	0.0	10.0	134.0
							5.0	21.8	0.0	9.9	133.0
							6.0	21.8	0.0	9.9	134.0
							7.1	21.7	0.0	9.9	134.0
							8.0	20.7	0.0	17.1	133.0
							9.0	17.6	0.0	17.0	133.0
							10.0	14.0	0.0	2.7	136.0
							12.0	10.7	0.0	0.6	136.0
							14.5	8.8	0.0	0.5	168.0







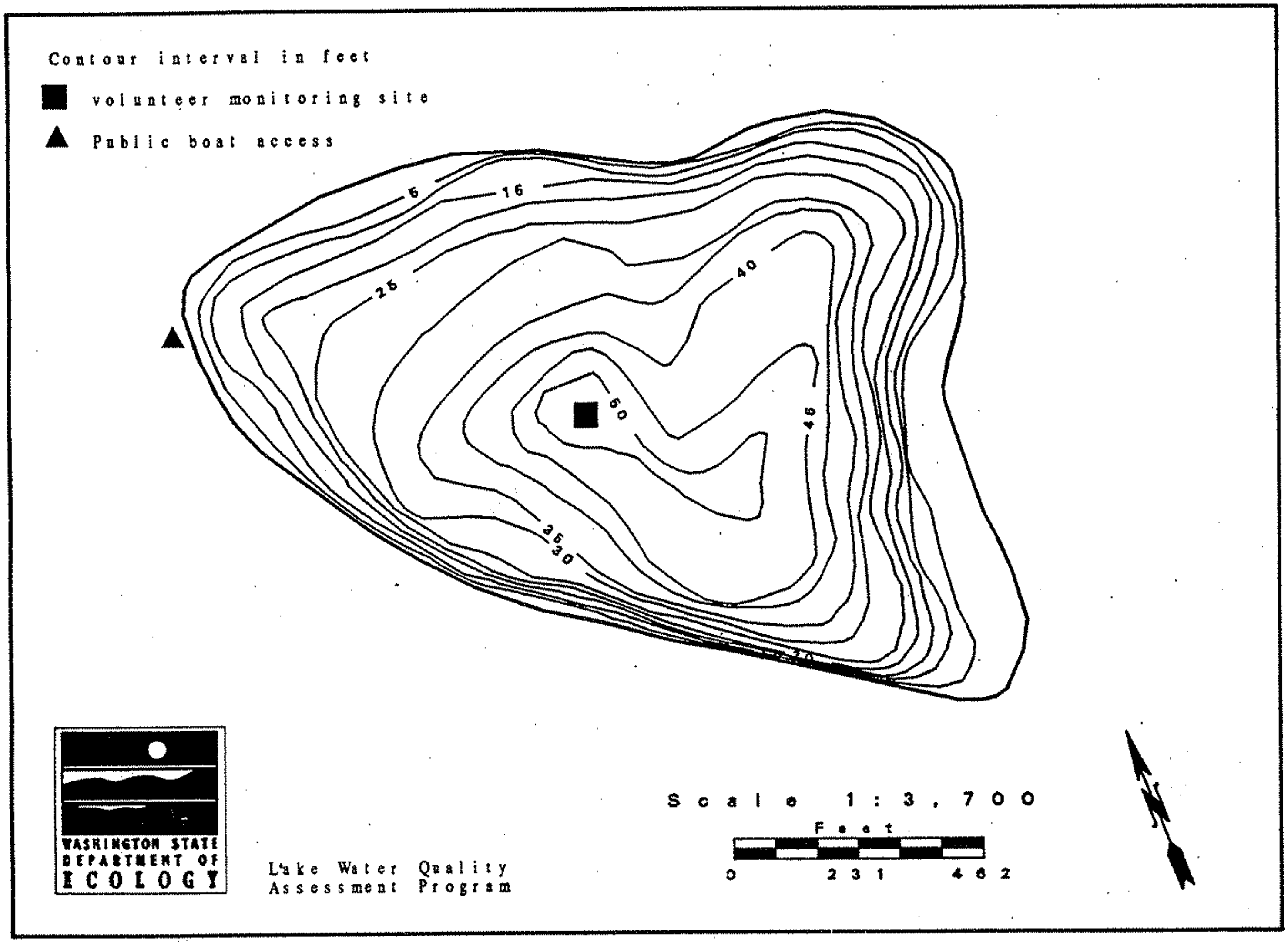


Lake Howard -- Snohomish County

Lake Howard is located 1.25 miles west of the north end of Lake Goodwin. It has no surface inlets, and drains to Lake Martha and ultimately to Port Susan.

Size (acres)	28
Maximum Depth (feet)	50
Mean Depth (feet)	29
Lake Volume (acre-feet)	790
Drainage Area (miles^2)	0.5
Altitude (feet)	238
Shoreline Length (miles)	0.9

Data from Bortleson *et al.* (1976)



Overall Assessment

Water clarity was very good in 1994, and Secchi depths were similar to those measured in 1993 (see graph of Secchi depth data). Secchi depths were better than would be expected, given the moderately high concentrations of chlorophyll *a* at the time of sampling. Concentrations of total phosphorus varied considerably in the lake during 1993 and 1994, and may be affected by the intermittent outflow, and consequently, intermittent flushing. Water chemistry results and profile data are listed in tables at the end of this summary.

Dissolved oxygen concentrations decreased considerably below the thermocline on both sampling dates, which is not unusual for a lake that is probably fed, in part, by groundwater. Bacterial decomposition of organic material (such as algae and aquatic plants) in lake water and sediments will also reduce oxygen concentrations below the thermocline. Hydrogen sulfide, which is only stable in the absence of oxygen, was smelled in water samples collected near the lake bottom during the August survey. Lake Howard was classified as oligo-mesotrophic in 1994, based on the low oxygen concentrations in the lower layer of water during late summer, and the moderately high concentration of chlorophyll *a* during the August survey.

Aquatic plants identified by Ecology staff near the public access included yellow-flowering water lily (*Nuphar sp.*), cattails (*Typha sp.*), waterweed (*Elodea canadensis*), largeleaf pondweed (*Potamogeton amplifolius*), stonewort (*Nitella*), and another pondweed that was possibly *Potamogeton foliosus*. There were very few rooted aquatic plants in 1994.

Summary of Questionnaire Results and Information from the Volunteer

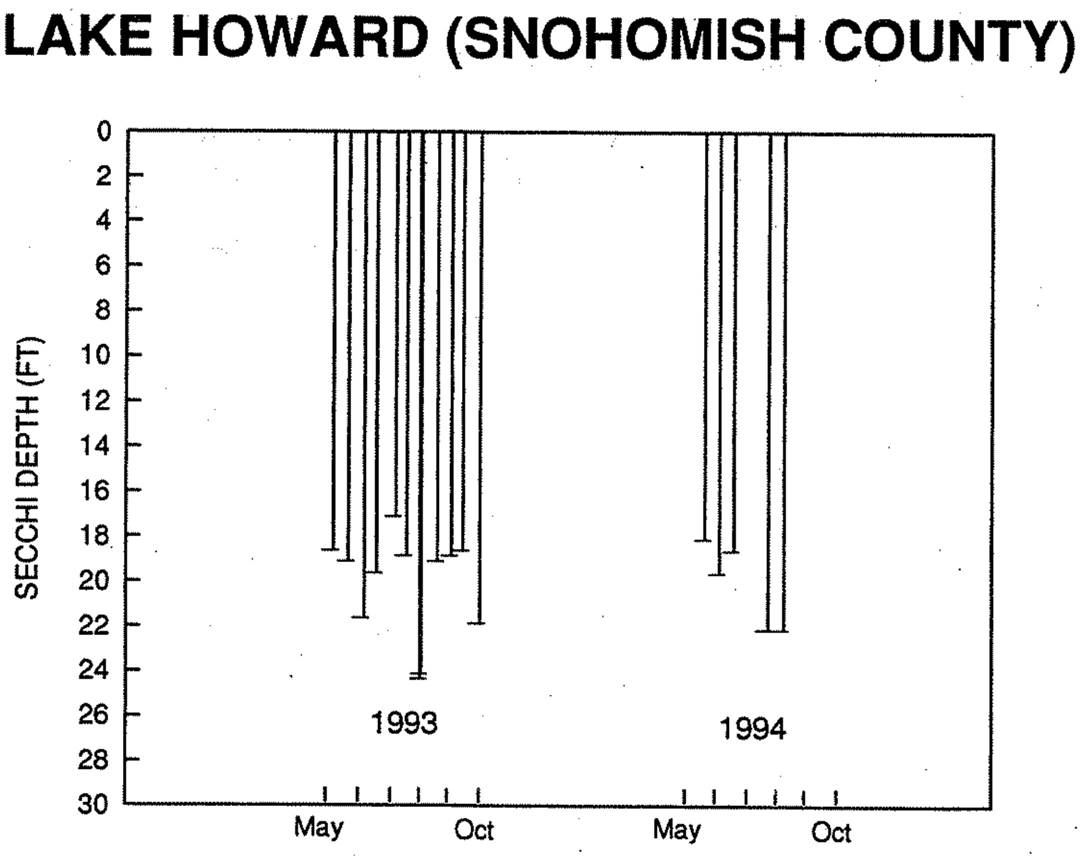
The 1994 questionnaire on lake and watershed uses was not returned.

Acknowledgment

I thank Curt Howard for volunteering his time to monitor Lake Howard during 1993 and 1994.

HOWARD Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/19	0.0	32.0	0.0	Lt Green	100	None	Light	17.5	14.5		Onsite visit. Small algae particles visible.
94/06/02	0.0	32.0	0.0	Lt Green	50	None	Light	19.0	15.8		Water almost colorless. Light algae particles.
94/06/16	17.8	64.0	0.0	Lt Green	100	None	Light	18.0	16.6		Water color almost colorless. No algae.
94/07/18	23.3	73.9	0.0	Lt Green	50	None	Light	21.5	18.6		
94/08/02	22.8	73.0	0.0	Clear	0	None	Light	21.5	21.1		



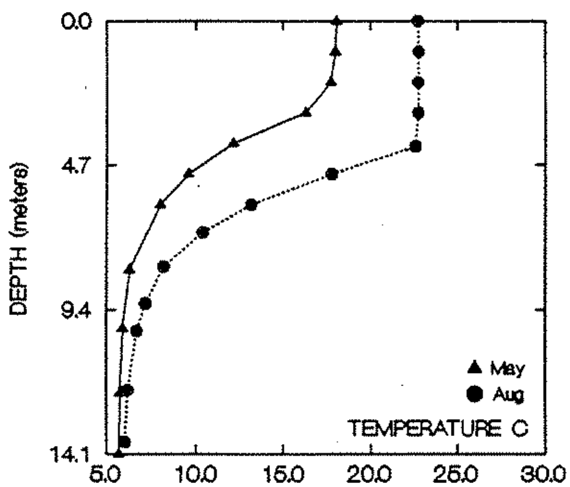
HOWARD (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

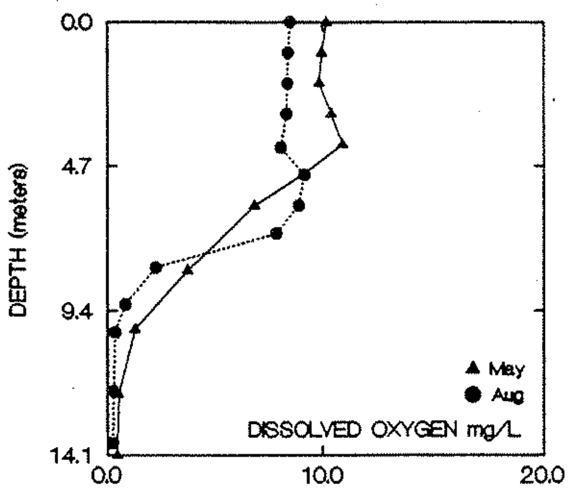
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/18		E	60			(Source: Water Supply Bulletin 43)					
81/06/30		E	20		2.3	(Source: Water Supply Bulletin 57)					
93/05/25	1	E	16	0.47	1.8						
93/05/25	1	H	33	0.69							
93/08/18	1	E	28	0.32	1.6						
93/08/18	1	H	37	0.71							
94/05/19	1	E	24	0.30	2.1						
94/05/19	1	H	71	0.73							
94/08/18	1	E	8	0.33J	3.2J						
94/08/18	1	H	66	0.81J							

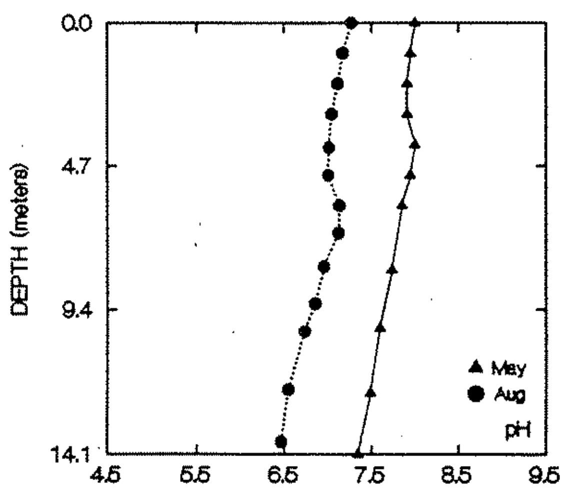
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

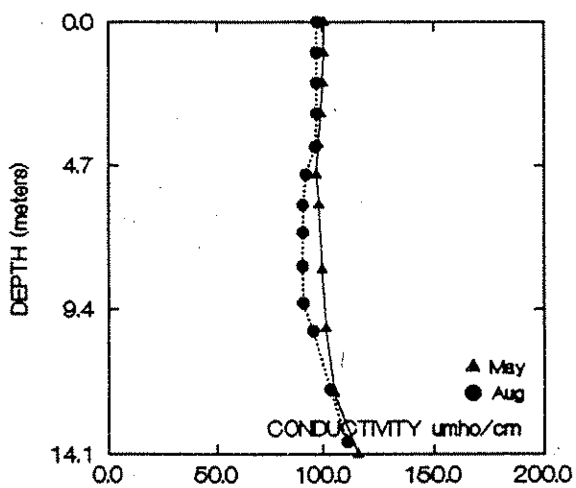
HOWARD (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	18.0	8.0	10.2	101.0	94/08/18	0.0	22.7	7.8	8.5	97.0
	1.0	18.0	8.0	10.0	100.0		1.0	22.8	7.7	8.4	97.0
	2.0	17.7	7.9	9.9	100.0		2.0	22.7	7.6	8.4	97.0
	3.0	16.3	7.9	10.4	99.0		3.0	22.8	7.5	8.3	97.0
	4.0	12.1	8.0	10.9	98.0		4.1	22.6	7.5	8.1	97.0
	5.0	9.6	8.0	9.1	97.0		5.0	17.8	7.5	9.2	92.0
	6.0	8.0	7.9	6.8	98.0		6.0	13.1	7.6	8.9	91.0
	8.1	6.3	7.7	3.7	100.0		6.9	10.4	7.6	7.8	91.0
	10.0	5.9	7.6	1.3	101.0		8.0	8.2	7.5	2.2	91.0
	12.1	5.8	7.5	0.5	105.0		9.2	7.2	7.4	0.8	91.0
	14.1	5.7	7.4	0.4	116.0		10.1	6.7	7.2	0.3	96.0
							12.0	6.2	7.0	0.3	103.0
							13.7	6.0	7.0	0.2	111.0







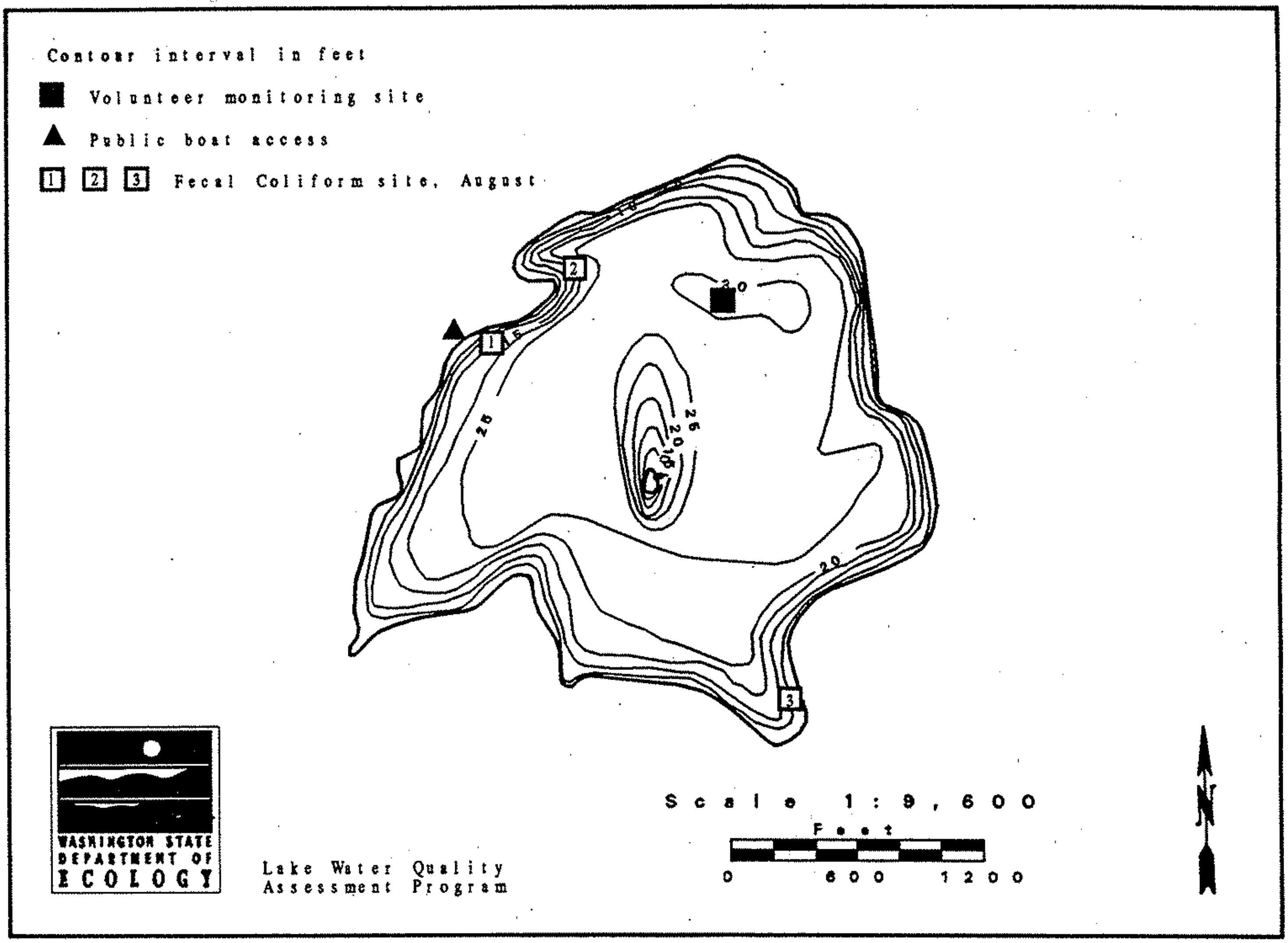


Island Lake -- Mason County

Island Lake is located two miles southwest of Keyport. It is fed primarily by groundwater, and drains via Barker Creek to Dyes Inlet. The lake has a one-acre island.

Size (acres)	108
Maximum Depth (feet)	31
Mean Depth (feet)	21
Lake Volume (acre-feet)	2,246
Drainage Area (miles^2)	0.3
Altitude (feet)	230
Shoreline Length (miles)	1.7

Data from Bortleson *et al.* (1976)



Overall Assessment

Water clarity was fairly good in 1994, although deeper Secchi depths were measured during previous years (see graph of Secchi depth data). In comparison to previous surveys of the lake, the May total phosphorus and the August chlorophyll *a* concentrations were high. During the August survey, very large algal particles were visible, and appeared to be the blue-green alga *Gloeotrichia.* The water was very murky at the time of sampling, and people on shore were heard discussing the water quality. One person said that there was "more bloom than usual" this year.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Island Lake was classified as mesotrophic in 1994. The lake was classified as oligotrophic during previous years. This apparent change in trophic status may be due to unusually dry weather in 1992 and 1994; lakes fed primarily by groundwater often have a one to two year lag time before the full effect of a drought is apparent in lake level and water quality.

Samples for fecal coliforms were collected at the public access (#1) and approximately 100 yards straight out from the access (#2). Both results were very low. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed in 1993 and 1994.

> Island Lake is used for fishing, swimming, motor boating, rowing, and jet skiing. There is one boat ramp on the lakeshore, and there are no restrictions for motor boat use on the lake. Fish (species unknown) were stocked in the lake. Currently, the lakeshore is being developed further for residences. In the past, the watershed was logged and the shoreline was altered many years ago when a small marshy area was filled.
>
> There are 87 houses on the lakeshore (no change from 1993), and none are connected to a sewer collection system. There is no organization for the lake, and no aquatic plant management activities occurred in 1994. Lake water was withdrawn for irrigation only.
>
> Overall, the volunteer found that Island Lake had good water quality. The only problem in 1994 was a severe algae bloom that lasted about one week. Possible sources of problems include septic tanks and lawn fertilizers. There were no changes in the lake since the 1993 monitoring season.

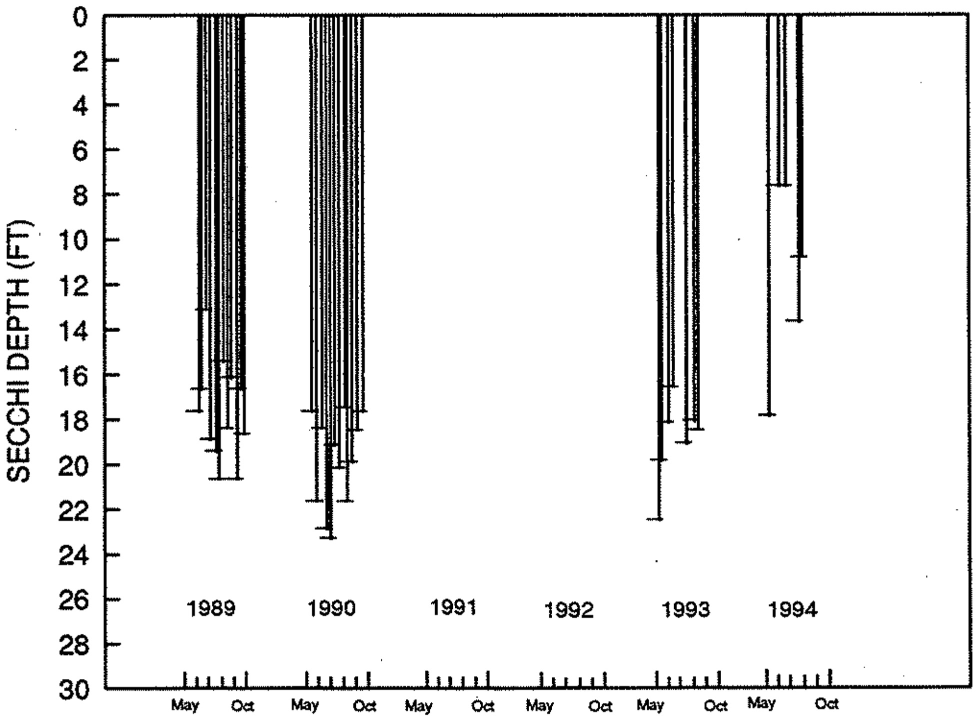
Acknowledgment

I thank Steve Whitehouse for volunteering his time to monitor Island Lake during 1993 and 1994.

ISLAND Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/25	18.9	66.0	0.0	Milky-grn	10	None	Strong	17.2	-26.0		
94/06/19	20.0	68.0	0.0	Milky-grn	0	None	Breezy	7.0	-32.0		
94/07/17	21.7	71.1	0.0	Milky-grn	100	None	Strong	7.0	-39.5		Lake is really more of a slate green color.
94/08/20	22.2	72.0	0.0	Mod Green	50		Breezy	13.0	-48.0		Lake level down four feet.
94/09/04	20.6	69.1	0.0	Mod Green	0	Heavy	Light	10.2	-48.5		Slight yellow tinge to water color.

ISLAND LAKE (MASON COUNTY)



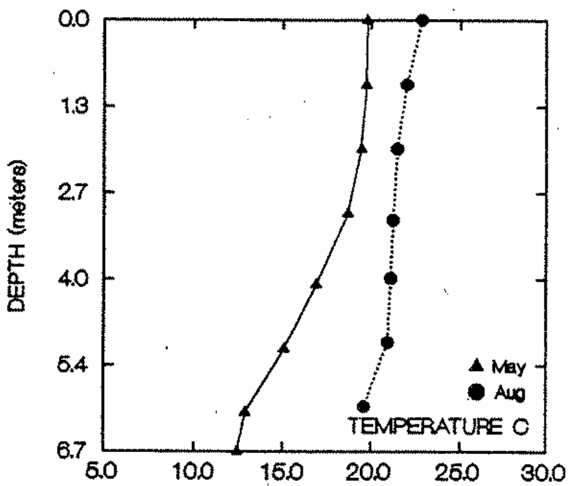
ISLAND (MASON) Lake -- MASON County
Chemistry Data -- Station 1

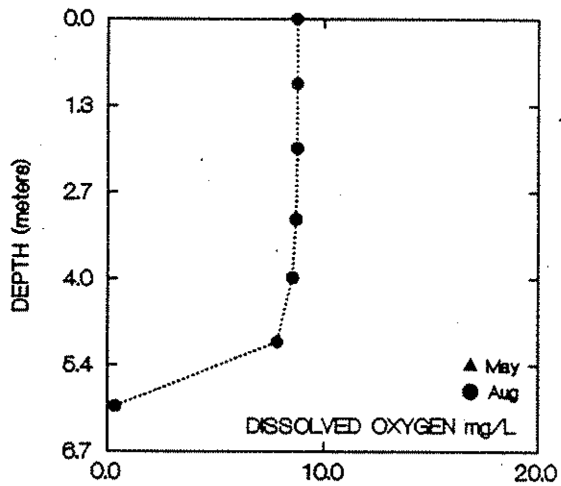
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/16		E	11			(Source: Water Supply Bulletin 43)					
81/06/10		E	30		2.0	(Source: Water Supply Bulletin 57)					
90/05/31	1	E	10	0.23							
90/08/16	1	E	11	0.27							
93/05/28	1	E	7	0.22	1.5						
93/09/01	1	E	11	0.23	2.1	6	1U				
94/05/25	1	E	41	0.20	2.0	2	1	0.7			
94/05/25	1	H	22	0.19							
94/08/30	1	E	12	0.33J	4.6J	1U	1	1.0			
94/08/30	1	H	13	0.32J							

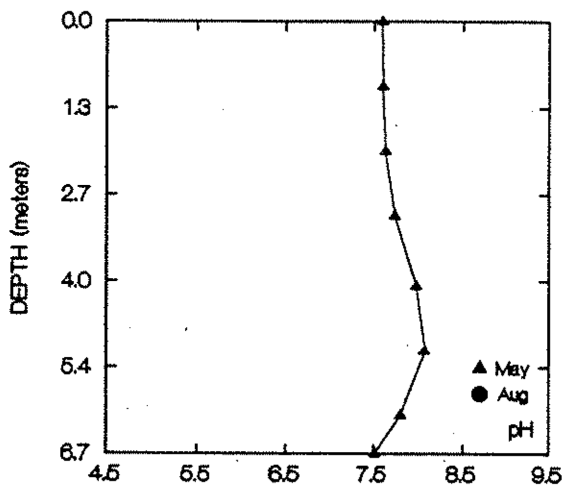
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

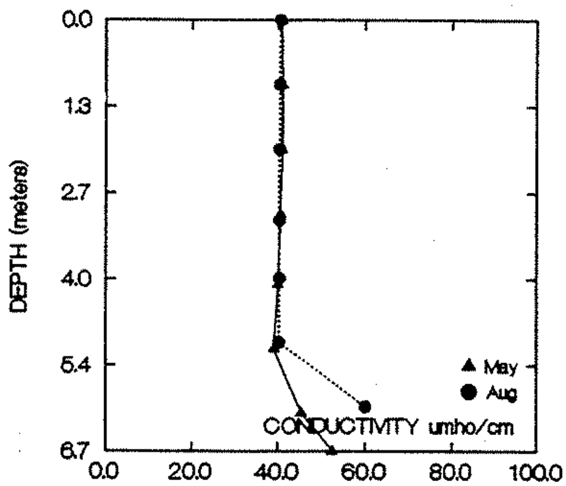
ISLAND (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	19.8	7.6	0.0	41.0	94/08/30	0.0	22.8	0.0	8.8	41.0
	1.0	19.8	7.6	0.0	41.0		1.0	22.0	0.0	8.8	40.0
	2.0	19.5	7.6	0.0	41.0		2.0	21.5	0.0	8.8	40.0
	3.0	18.7	7.7	0.0	41.0		3.1	21.3	0.0	8.7	40.0
	4.1	16.9	8.0	0.0	40.0		4.0	21.1	0.0	8.6	40.0
	5.1	15.1	8.1	0.0	39.0		5.0	21.0	0.0	7.9	40.0
	6.1	12.9	7.8	0.0	45.0		6.0	19.6	0.0	0.3	60.0
	6.7	12.5	7.5	0.0	52.0						







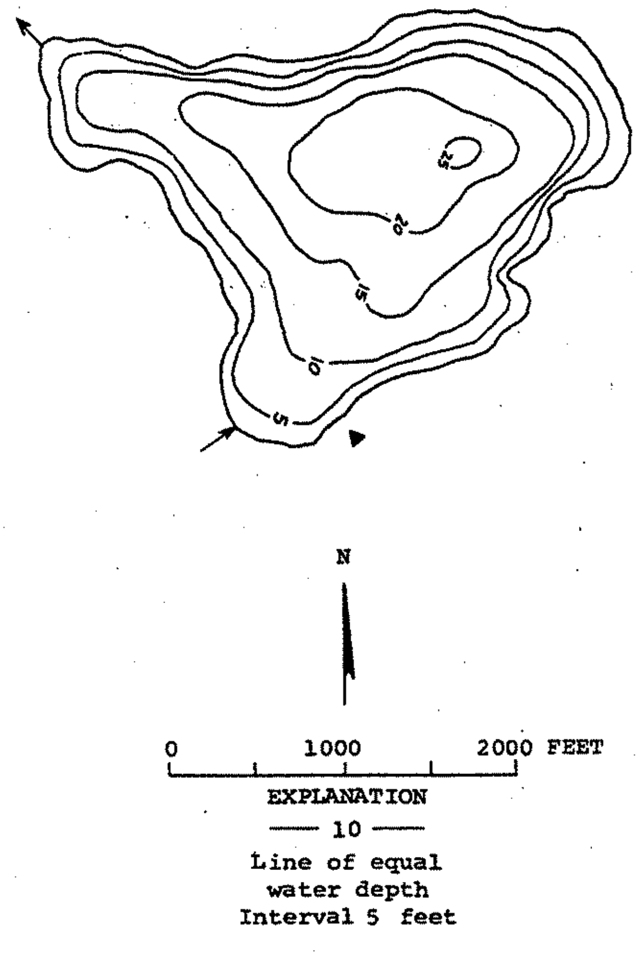


Jump Off Joe Lake -- Stevens County

Jump Off Joe Lake is located 10 miles from Chewelah and six miles northeast from Springdale. It is fed by an unnamed inlet, and drains via Jump Off Creek to the Colville River.

Size (acres)	110
Maximum Depth (feet)	25
Mean Depth (feet)	13
Lake Volume (acre-feet)	1,400
Drainage Area (miles^2)	15.3
Altitude (feet)	2,031
Shoreline Length (miles)	1.9

Data from Dion *et al.* (1976)



Overall Assessment

General water quality of Jump Off Joe Lake was good in 1994. Although concentrations of phosphorus were moderately high (see table of water chemistry data), water quality results from 1994 were similar to those from 1989. The table of 1994 profile data shows that both pH and concentrations of dissolved oxygen were high throughout the water column. This is not unusual for shallow lakes with heavy populations of aquatic plants. (During photosynthesis, plants remove carbon dioxide from the water, which results in an increase in pH, and release oxygen into the water.) Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Jump Off Joe Lake was classified as mesotrophic in 1994.

Aquatic plants observed by Ecology staff during the August field include slender naiad (*Najas flexilis*), milfoil (*Myriophyllum sp.*, although this was not the aggressive Eurasian variety), Illinois pondweed (*Potamogeton illinoensis*), waterweed (*Elodea candensis*), coontail (*Ceratophyllum demersum*), sago pondweed (*Potamogeton pectinatus*), muskgrass (*Chara*), and flatstem pondweed (*Potamogeton zosteriformis*).

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire.

> Jump Off Joe Lake is used for fishing, swimming, motor boating, lakeshore camping, and waterfowl hunting. There is a day use area, one resort, and one public boat ramp on the lakeshore. There are no restrictions for motor boating on the lake.
>
> There are 18 houses on the lakeshore, and none are connected to a sewer collection system. There is no association for the lake. German brown trout and eastern brook trout were stocked in the lake in 1994. No aquatic plant management activities occurred in 1994. Currently, the watershed is used for animal grazing and rearing, although livestock do not have access to the lake or its tributaries. The lakeshore is also being developed further for residences.
>
> Overall, the volunteer found that Jump Off Joe Lake had excellent water quality. The only problems in the lake in 1994 were algae and odor from decaying algae.

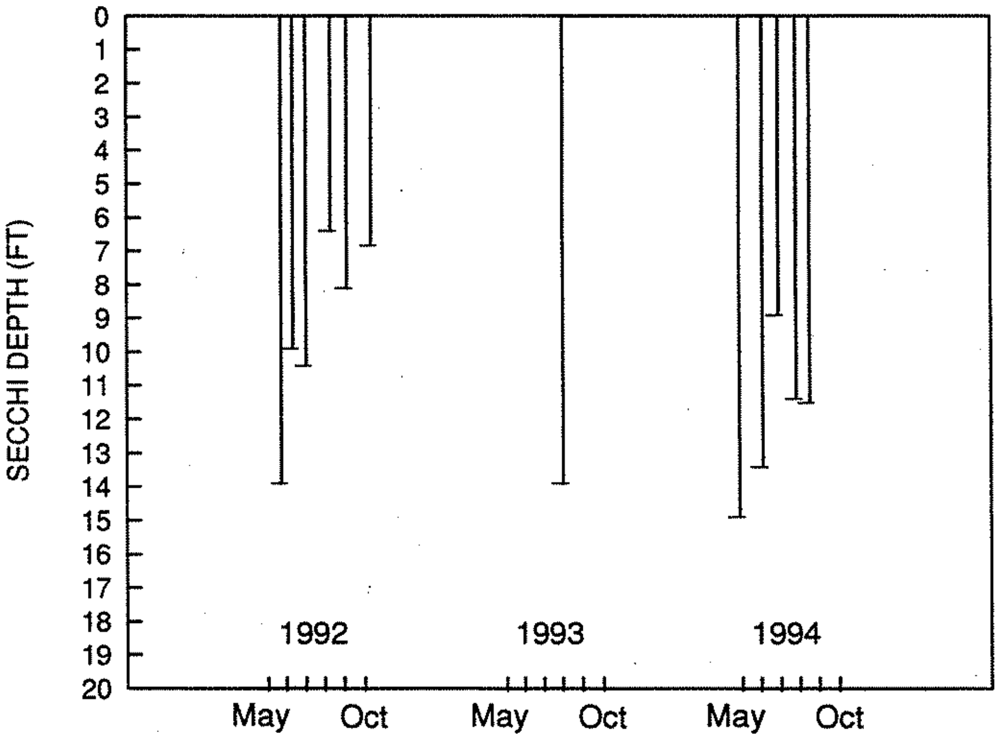
Acknowledgment

I thank LuAnn Horswill for volunteering her time to monitor Jump Off Joe Lake during 1994.

JUMPOFF JOE Lake -- STEVENS County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/19	17.8	64.0	0.0	Milky-grn	100	Trace		14.5	0.0	Onsite visit. Raining.
94/06/25	21.1	70.0	0.0	Milky-grn	0	None	Calm	13.0	0.0	Nice weather conditions last 6 days. Prior to that it was cold, rainy, windy and stormy.
94/07/18	25.6	78.1	0.0	Milky-grn	10	None	Calm	8.5	0.0	Has been in the 90s for 2 weeks.
94/08/18	22.8	73.0	0.0	Milky-grn	0	None	Light	11.0	0.0	
94/09/06	18.9	66.0	0.0	Milky-grn	0	None	Calm	11.1	0.0	Cold nights for about 2 weeks now. Heavy rains 3 days ago.

JUMP OFF JOE LAKE (STEVENS COUNTY)



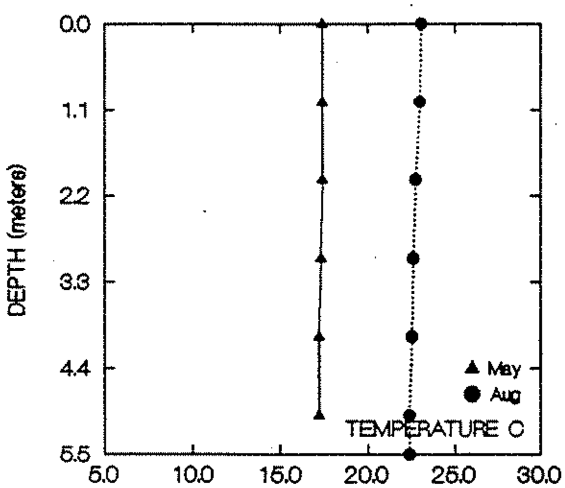
JUMPOFF JOE (STEVENS) Lake -- STEVENS County
Chemistry Data -- Station 1

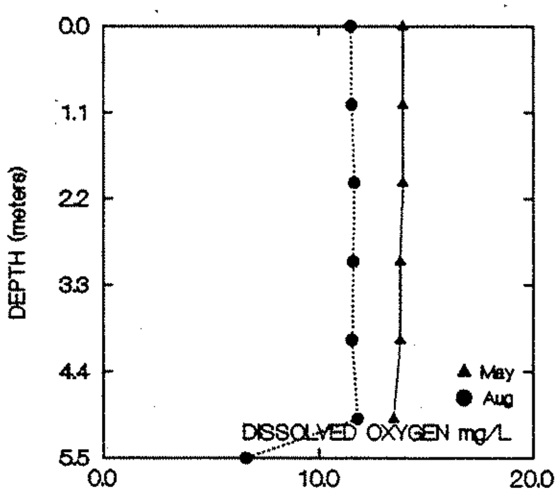
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/08		E	14			(Source: Water Supply Bulletin 43)					
89/06/20	1	E	13	0.29	2.6						
89/09/19	1	E	17	0.44	4.6						
92/05/12	1	E	10	0.26	0.8	1U	1U		2	1	20
92/05/12	1	H									
92/08/25	1	E	19	0.55	5.6	1U	1U		5	2	10
92/08/25	1	H									
93/05/19	1	E	21	0.26	2.2	4	1U				
93/05/19	1	H	24								
93/08/20	1	E	21	0.27	5.9						
94/05/19	1	E	33	0.12	2.0						
94/08/18	1	E	19	0.48J	3.8J						

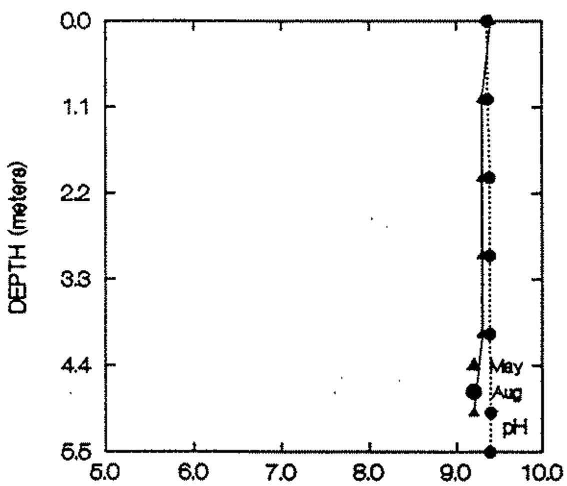
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

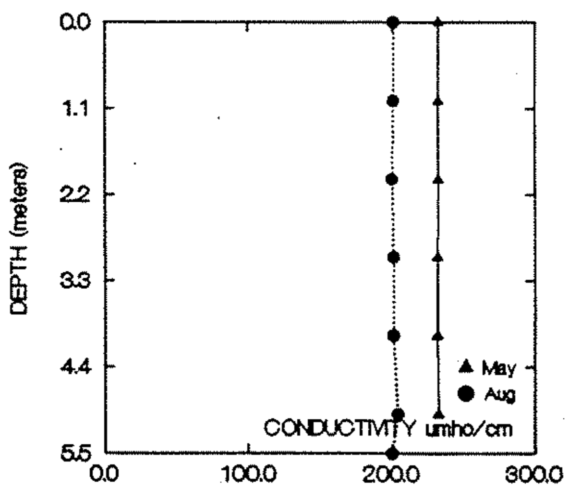
JUMPOFF JOE (STEVENS) Lake -- STEVENS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	17.4	9.4	13.9	233.0	94/08/18	0.0	23.1	9.4	11.5	201.0
	1.0	17.4	9.3	13.9	233.0		1.0	23.0	9.4	11.5	201.0
	2.0	17.4	9.3	13.9	233.0		2.0	22.8	9.4	11.6	200.0
	3.0	17.3	9.3	13.8	232.0		3.0	22.6	9.4	11.6	201.0
	4.0	17.2	9.3	13.8	232.0		4.0	22.5	9.4	11.6	201.0
	5.0	17.2	9.2	13.5	233.0		5.0	22.4	9.4	11.8	204.0
							5.5	22.4	9.4	6.7	200.0







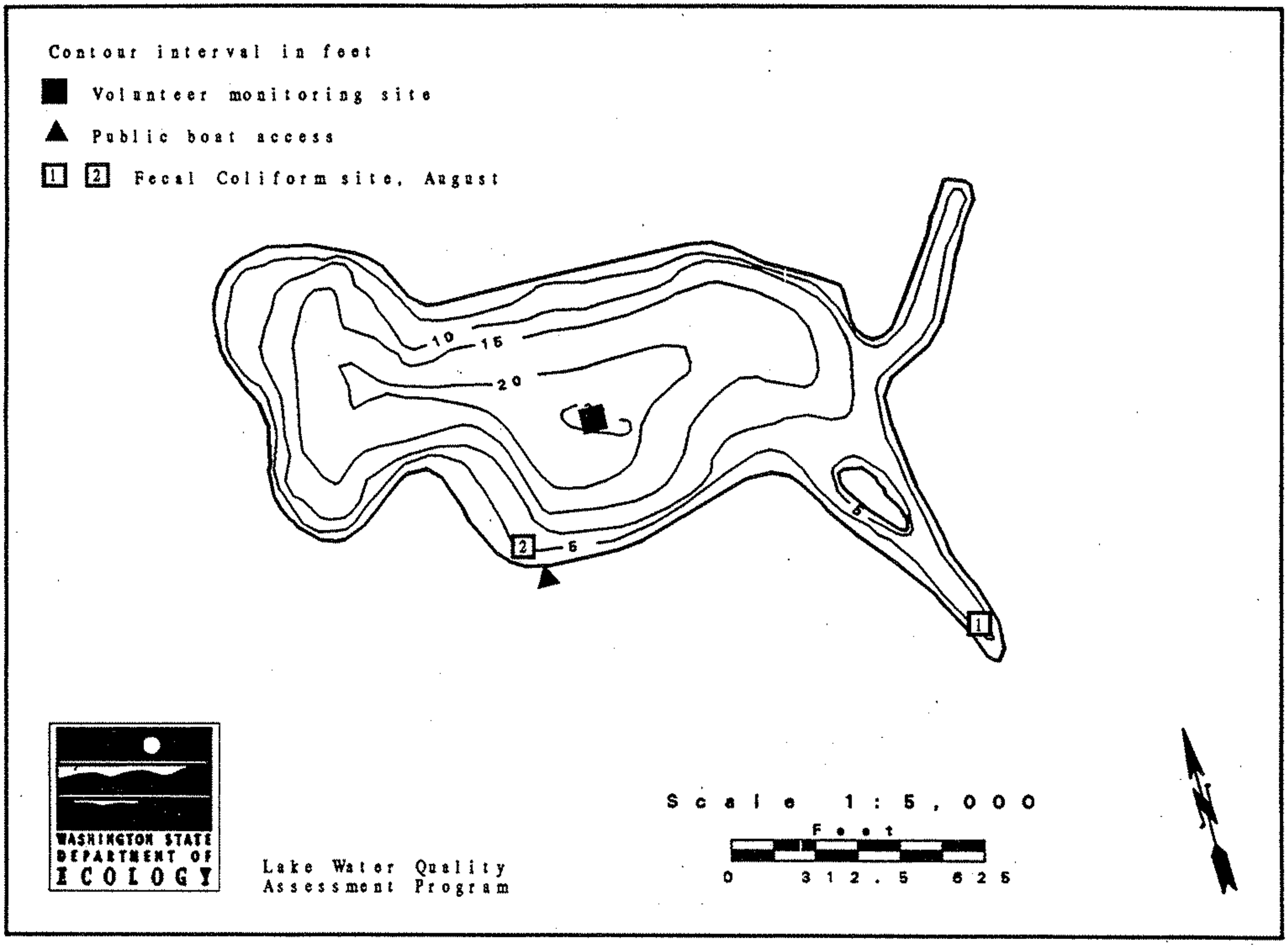


Lake Ketchum -- Snohomish County

Lake Ketchum is located three miles north of Stanwood. It is fed by two unnamed intermittent inlets, and drains via an unnamed intermittent outlet to Skagit Bay.

Size (acres)	24
Maximum Depth (feet)	21
Mean Depth (feet)	12
Lake Volume (acre-feet)	296
Drainage Area (miles^2)	0.5
Altitude (feet)	190
Shoreline Length (miles)	1.3

Data from Sumioka and Dion (1985)



Overall Assessment

Water clarity varied considerably in 1994, most likely because the lake was not treated with herbicides as in previous years. Concentrations of total phosphorus were extremely high, although concentrations were similar to those measured in 1992. High phosphorus and nitrogen concentrations fertilize the heavy growths of duckweed and algae that occurred from late August through early October. The concentration of dissolved oxygen was very low at the bottom of the lake on both sampling dates, most likely due to bacterial decomposition of organic material (algae and aquatic plants) in bottom water and sediments. Hydrogen sulfide, which is only stable in the absence of oxygen, was smelled in bottom water samples collected during the August survey.

Aquatic plants identified by Ecology staff during field visits include water net (*Hydrodictyon sp.*), duckweed (*Lemna sp.*), cattails (*Typha sp.*), stonewort (*Nitella sp.*), slender pondweed (*Potamogeton pusillus*), and yellow-flowering water lily (*Nuphar polysepalum*). Duckweed was the most dominant plant in the lake.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), as well as prolific aquatic plant populations, Lake Ketchum was classified as eutrophic in 1994. The volunteer reported that swimming, fishing, and aesthetics were affected by poor water quality in the lake.

Other Available Information

In 1993, Snohomish County was awarded a Centennial Clean Lakes Grant to study the extent of eutrophication in Lake Ketchum, and to recommend possible solutions for restoring the lake. Lake monitoring began in 1995 (GeneWilliams, Snohomish County Public Works, pers. comm.).

From Serdar *et al.* (1994): Sediment samples were collected from five sites in Lake Ketchum on February 2, 1993, and were analyzed for copper. All sites had high concentrations of copper. Samples results ranged from 260 to 600 mg/Kg dry weight, and averaged 480 mg/Kg. Concentrations above 110 mg/Kg produce severe disturbances to benthic organisms. This report recommends discontinuing copper sulfate treatments to control algae, because of high sediment copper concentrations in several areas of this small lake.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires from 1993 and 1994.

There are 52 houses on the lakeshore, and none are connected to a sewer collection system. Only 37 of the residences are occupied year-round. There is one public boat ramp on the lakeshore. There is a lake association for the lake, and in spring 1994 the lake was drawn down. Rainbow trout were stocked in the lake in 1994.

Overall, the volunteer found that Lake Ketchum had fair water quality. Problems in the lake in 1994 were ranked as (1) algae, (2) excessive aquatic plant growth, (3) degraded aesthetics, (4) long-term degradation of water quality, (5) low water level, (6) bacteria, (7) recently degraded water quality, (8) impaired fisheries, (9) decaying plants, and (10) hazardous substances. Possible sources of problems include runoff from an upstream dairy farm. The only change in the lake since the 1993 monitoring season was that the lake was not treated with herbicides in 1994.

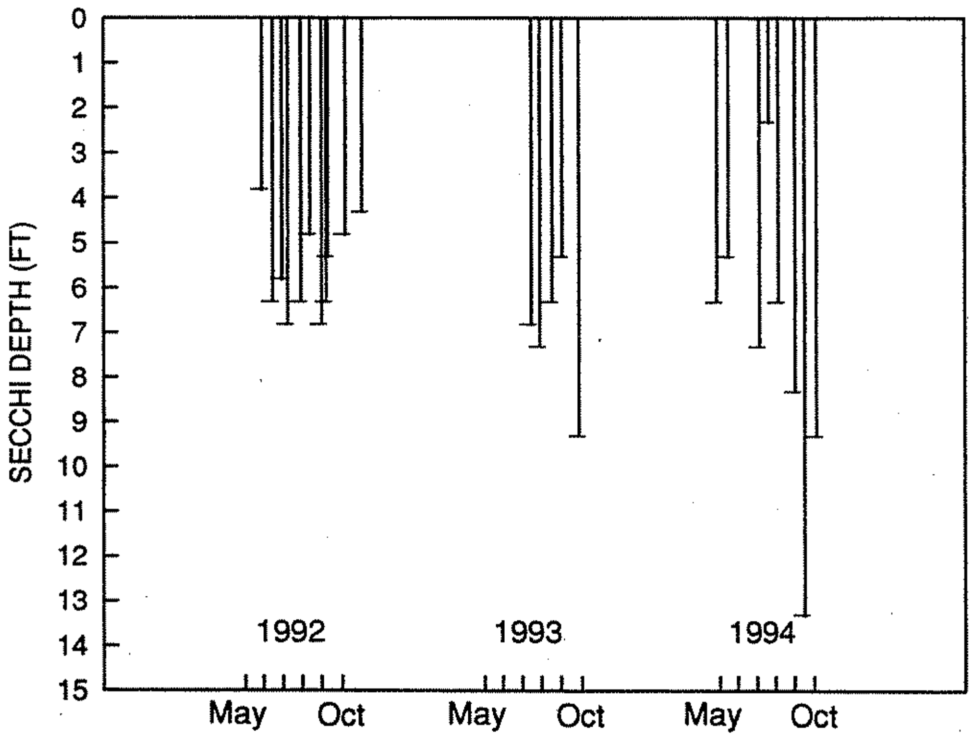
Acknowledgment

I thank Anton Ehinger for volunteering his time to monitor Lake Ketchum during 1992-1994.

KETCHUM Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/19	0.0	32.0	0.0	Lt Brown	30	None	Light	6.0	0.0	Onsite visit. Water color light brown. Some duckweed along shore. Phase I monitoring already started.
94/06/08	21.1	70.0	0.0	Lt Brown	25	Light	Breezy	5.0	23.0	Floating islands of duckweed appeared during the last two weeks. Water level very low for this time of year.
94/07/28	24.4	75.9	0.0	Lt Brown	0	None	Light	7.0	29.0	Minimal duckweed bloom. Water level very low, water is clearer than normal.
94/08/12	23.3	73.9	0.0	Pea-green	10	None	Light	2.0	32.0	Water level is lowest ever observed by this monitor. Heavy bloom of suspended plant matter. Minimal duckweed.
94/08/28	22.2	72.0	0.0	Lt Brown	90	None	Breezy	6.0	35.0	Water level very low. Significant duckweed bloom.
94/09/24	21.1	70.0	0.0	Lt Brown	0	None	Light	8.0	36.0	Large duckweed bloom. Major algae bloom from bottom. Lake level extremely low.
94/10/08	16.1	61.0	0.0	Lt Brown	10	None	Light	13.0	37.5	Deepest Secchi reading ever recorded. Lowest water level ever recorded. Duckweed bloom approaching 1992 severity.
94/10/29	11.1	52.0	0.0	Lt Brown	25	Mod	Strong	9.0	37.5	Algae, duckweed blooms diminshing. Water level still very low.

LAKE KETCHUM (SNOHOMISH COUNTY)



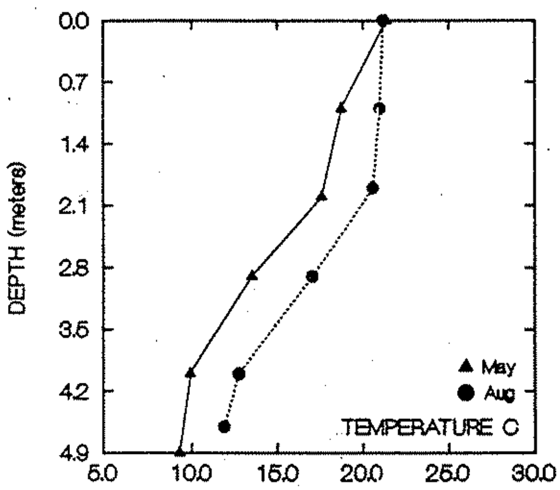
KETCHUM (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

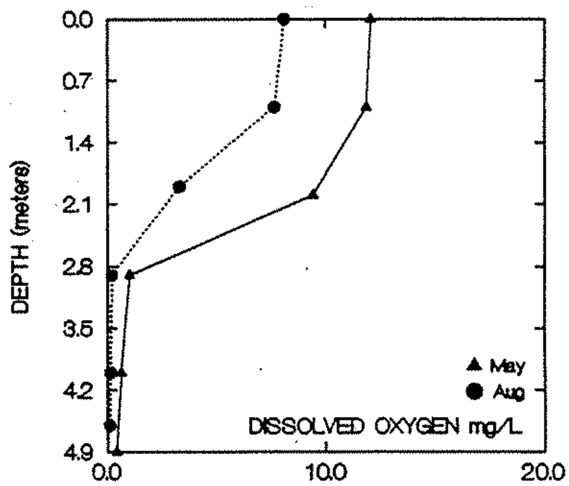
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
81/07/09		E	190		2.0	(Source: Water Supply Bulletin 57)					
92/05/18	1	E	592	1.12	9.2						
92/05/18	1	H	2342	2.44							
92/08/31	1	E	460	1.11	13.4	2	1		4	1U	60
92/08/31	1	H	3095	3.43							
94/05/19	1	E	392	0.55	5.4						
94/05/19	1	H	1956	1.21							
94/08/27	1	E	632J	1.14J	20.8						
94/08/27	1	H	2731J	2.55J							

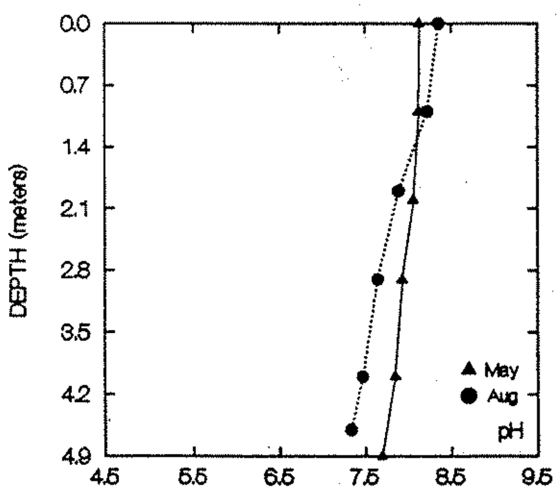
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

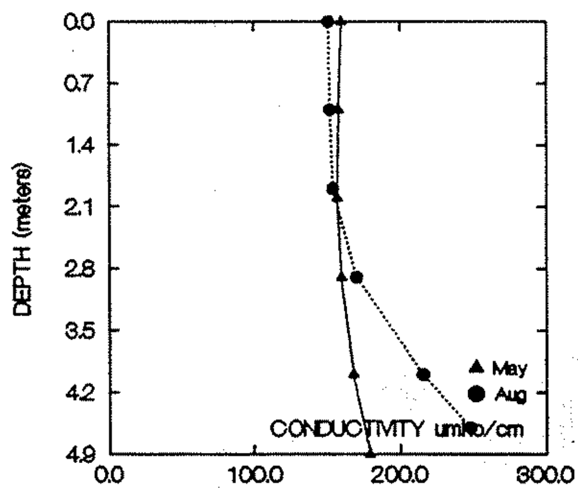
KETCHUM (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	21.4	8.1	12.1	160.0	94/08/27	0.0	21.3	8.4	8.1	151.0
	1.0	18.7	8.1	11.9	158.0		1.0	21.0	8.2	7.7	152.0
	2.0	17.6	8.1	9.4	157.0		1.9	20.6	7.9	3.3	154.0
	2.9	13.5	7.9	1.0	160.0		2.9	17.0	7.7	0.2	170.0
	4.0	9.9	7.9	0.6	168.0		4.0	12.8	7.5	0.1	216.0
	4.9	9.3	7.7	0.4	179.0		4.6	11.9	7.3	0.1	248.0







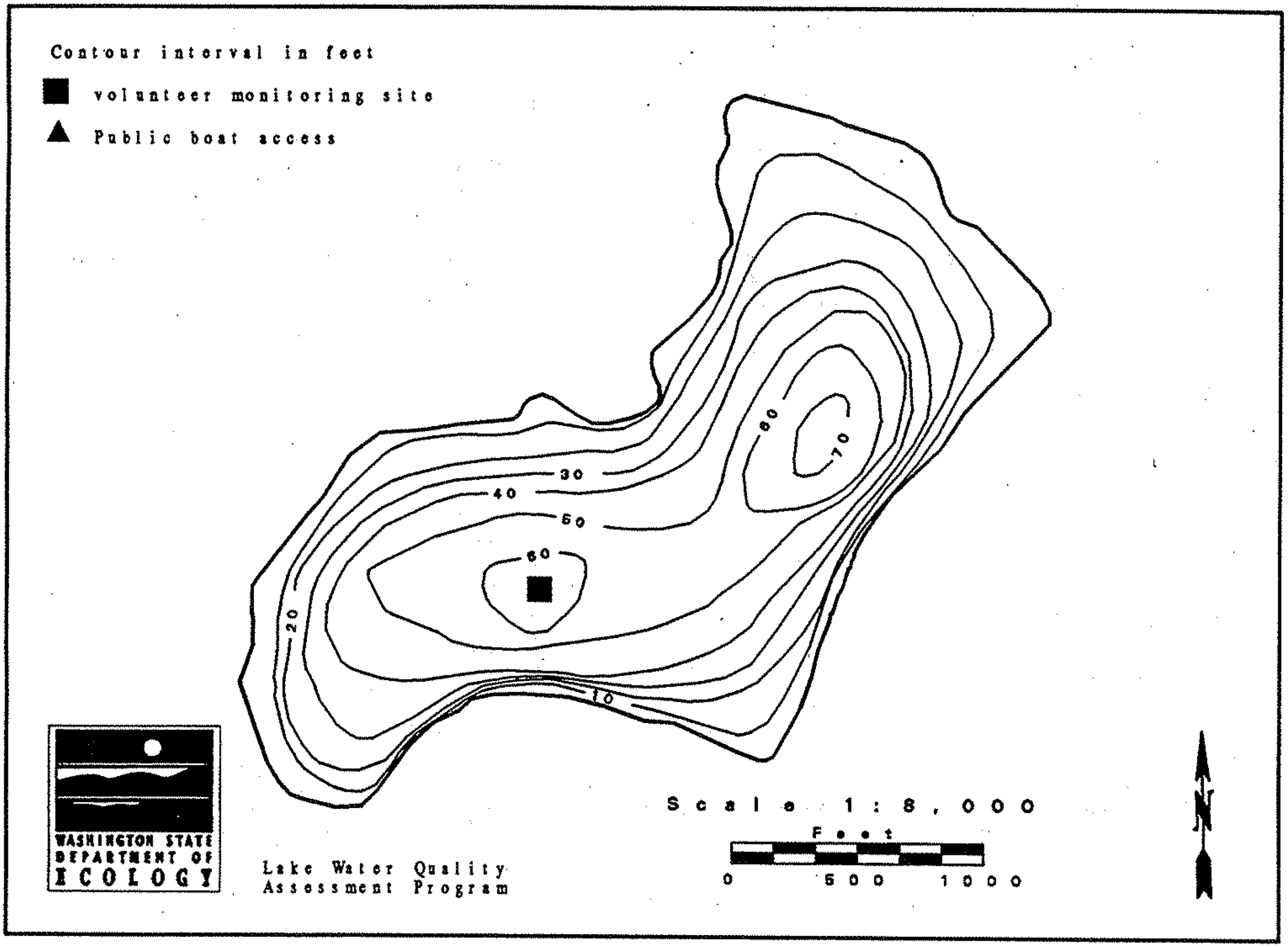


Lake Ki -- Snohomish County

Lake Ki is located 7.75 miles northwest of Marysville. It has an intermittent surface inlet at the south end, and drains via an unnamed outlet to Portage Creek and South Slough.

Size (acres)	98
Maximum Depth (feet)	70
Mean Depth (feet)	33
Lake Volume (acre-feet)	3,300
Drainage Area (miles^2)	0.7
Altitude (feet)	414
Shoreline Length (miles)	1.9

Data from Bortleson *et al.* (1976)



Overall Assessment

General water quality of Lake Ki was good in 1994. As with many other lakes in the state, lake level in 1994 was unusually low. Secchi depths were very deep throughout the monitoring season, indicating very good water clarity. Although the chlorophyll *a* concentration from August (see table of water chemistry data) suggests that algae growth was very heavy at the time of sampling, no algae particles were visible in the water. This high result may be an error. Based on very good water clarity, and a very small aquatic plant population in the lake, Lake Ki was classified as oligotrophic in 1994.

Dissolved oxygen concentrations decreased with depth below the thermocline, which is not unusual for a lake that is primarily spring-fed. However, bacterial decomposition of organic material (such as logs, or algae) in bottom water may reduce oxygen concentrations further. Hydrogen sulfide ("rotten-egg" smell) was smelled in water samples near the lake bottom during the August survey. Hydrogen sulfide is stable only in the absence of oxygen. All other profile data appeared normal for Lake Ki.

Few aquatic plants were observed in the lake. Aquatic plants observed by Ecology staff during field visits include cattails (*Typha sp.*), white-flowering water lily (*Nymphaea odorata*), and iris (*Iris pseudacorus*). Most plants were located in shallow water near the beach access on 176th Street.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires form 1993 and 1994.

> Lake Ki is used for fishing, swimming, and rowing. Public facilities on the lakeshore include a day use park and a city/county park. There is one boat ramp on the lakeshore, and restrictions for boat use on the lake include a speed limit of 8 mph and no wake within 50 feet of shore. Rainbow trout were stocked in the lake in 1994. Currently, the lakeshore is being developed further for residences. In the past, the watershed was logged.
>
> There are approximately 100 houses on the lakeshore, and none are connected to a sewer collection system. There is one culvert which drains into the lake. There is one organization for the lake, the Lake Ki Yacht Club. No aquatic plant management activities occurred in 1994. Lake water was withdrawn for irrigation only.

Lake Ki -- Snohomish County

Overall, the volunteer found that Lake Ki had excellent water quality. There were no water quality problems in the lake, although water level was a problem in 1994. The only change in the lake since the 1993 monitoring season was the low level.

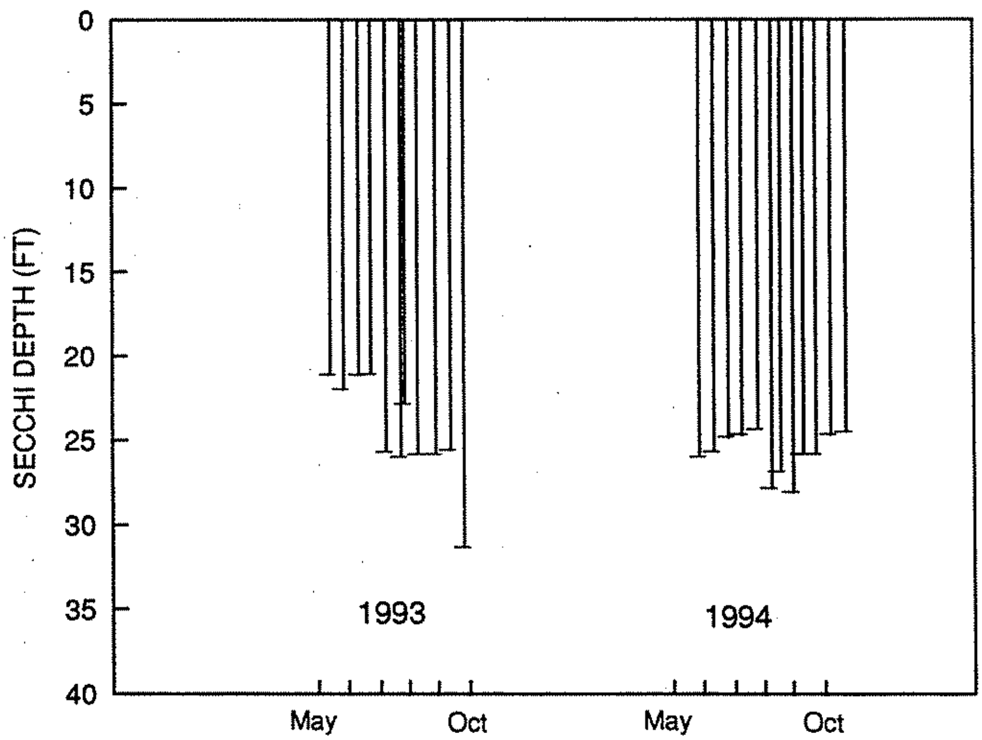
Acknowledgment

I thank Bob Freestad for volunteering his time to monitor Lake Ki during 1993 and 1994.

KI Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/06/02	16.7	62.1	0.0	Clear	0	Light	Calm	25.2	0.0	
94/06/16	16.7	62.1	0.0	Mod Green	90		Light	24.8	0.0	
94/06/30	16.7	62.1	0.0	Lt Green	25	Light	Light	24.0	0.0	
94/07/13	21.1	70.0	0.0	Lt Green	0	None	Calm	23.8	0.0	Beautiful day for testing!
94/07/28	23.3	73.9	0.0	Lt Green	100	None	Calm	23.5	0.0	Foggy this morning.
94/08/10	22.8	73.0	0.0	Lt Green	0	None	Light	27.0	0.0	
94/08/18	22.8	73.0	0.0	Lt Green	0	None	Breezy	26.0	0.0	On site visit.
94/08/31	21.1	70.0	0.0	Lt Green	0	None	Calm	27.3	0.0	Another beautiful day!
94/09/08	20.0	68.0	0.0	Lt Green	100	Mod	Light	25.0	0.0	
94/09/22	20.6	69.1	0.0	Lt Green	0	None	Calm	25.0	0.0	
94/10/06	17.8	64.0	0.0	Lt Green	50	Light	Calm	23.8	0.0	
94/10/21	13.9	57.0	0.0	Lt Green	75	Mod	Calm	23.7	0.0	Lake level is very low! Last card for this yea r.

LAKE KI (SNOHOMISH COUNTY)



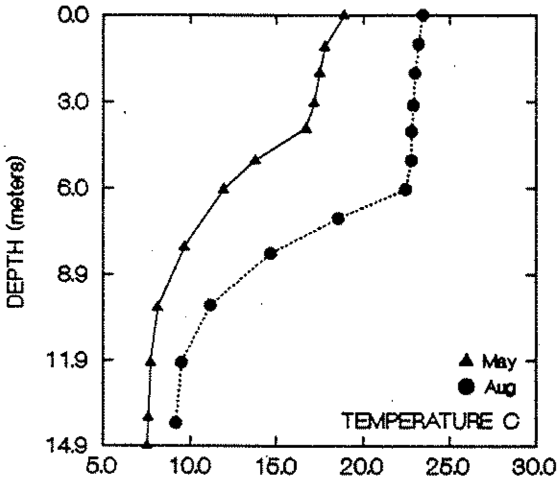
KI (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

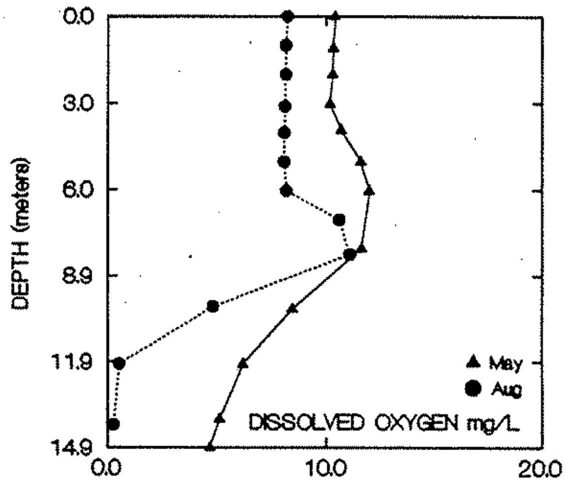
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/06/20		E	7			(Source: Water Supply Bulletin 43)					
81/07/06		E	10		2.2	(Source: Water Supply Bulletin 57)					
93/05/25	1	E	9	0.25	3.0						
93/05/25	1	H	28	0.29							
93/08/19	1	E	6	0.22	1.7						
93/08/19	1	H	19	0.23							
94/08/18	1	E	14	0.24J	10.1J						
94/08/18	1	H	17	0.19J							

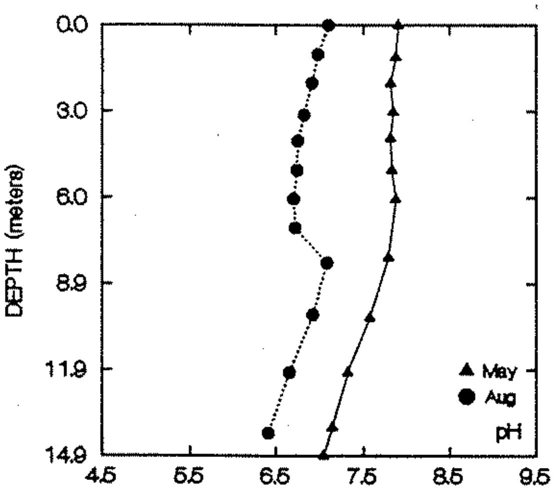
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

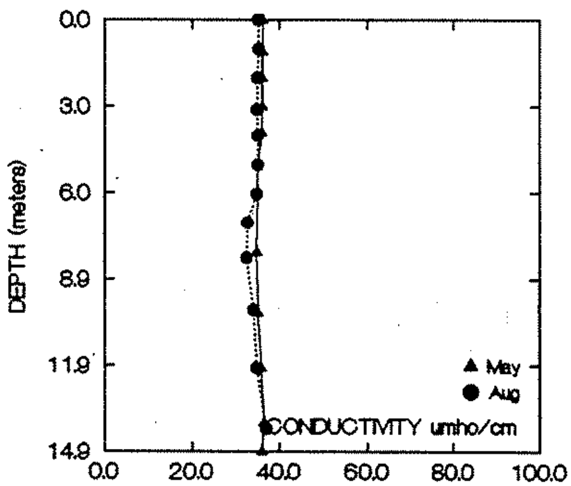
KI (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	18.9	7.9	10.4	36.0	94/08/18	0.0	23.5	7.6	8.2	35.0
	1.1	17.8	7.9	10.3	36.0		1.0	23.2	7.5	8.2	35.0
	2.0	17.5	7.8	10.3	36.0		2.0	23.0	7.4	8.2	35.0
	3.0	17.2	7.9	10.2	36.0		3.1	22.9	7.3	8.1	35.0
	3.9	16.7	7.8	10.7	36.0		4.0	22.8	7.3	8.1	35.0
	5.0	13.8	7.8	11.6	35.0		5.0	22.8	7.2	8.1	35.0
	6.0	11.9	7.9	12.0	35.0		6.0	22.5	7.2	8.2	35.0
	8.0	9.6	7.8	11.6	35.0		7.0	18.5	7.2	10.6	33.0
	10.1	8.1	7.6	8.5	35.0		8.2	14.7	7.6	11.1	32.0
	12.0	7.7	7.3	6.2	36.0		10.0	11.2	7.4	4.8	34.0
	13.9	7.6	7.1	5.1	36.0		12.0	9.5	7.2	0.5	35.0
	14.9	7.5	7.0	4.7	36.0		14.1	9.2	6.9	0.3	37.0







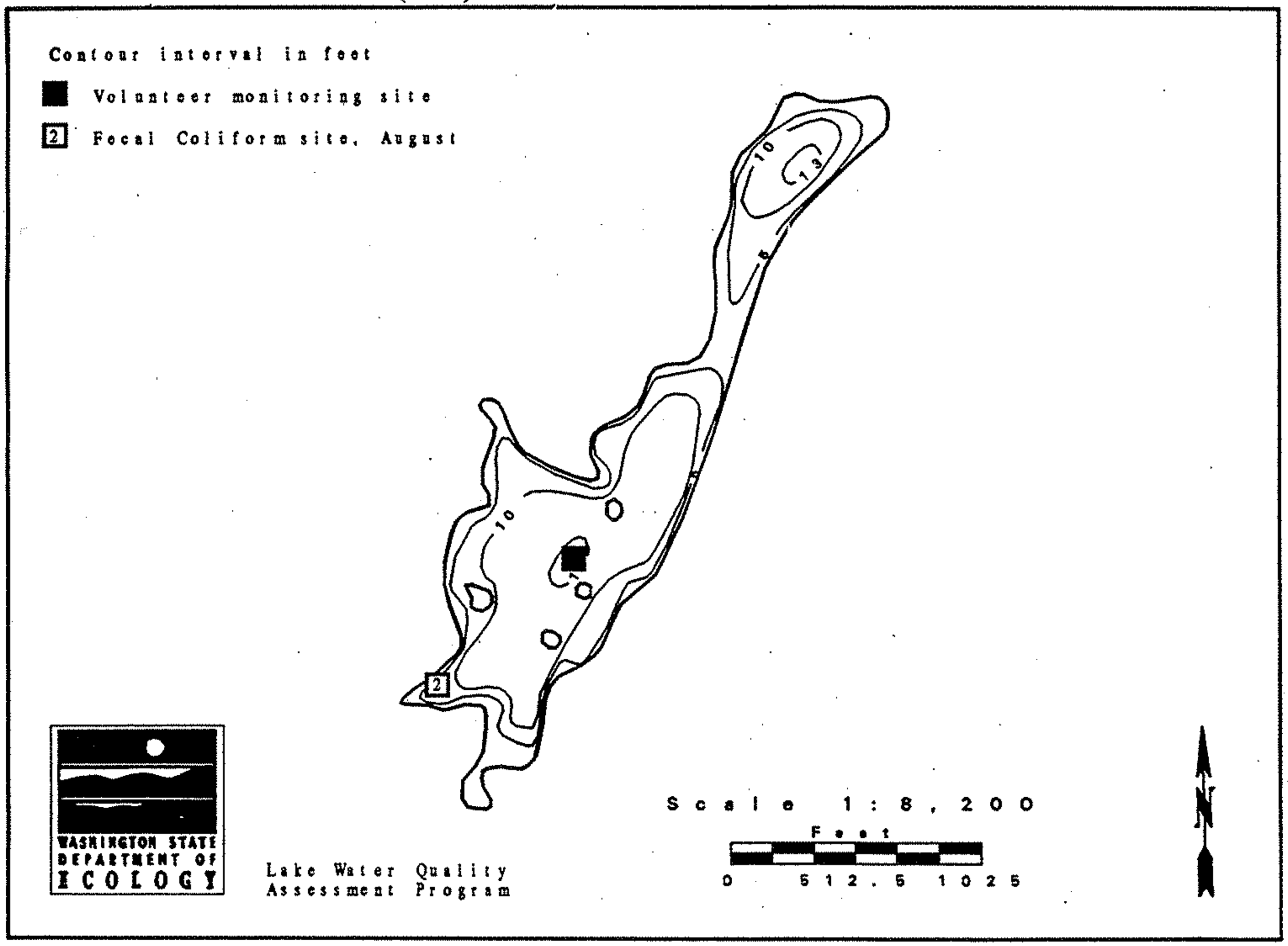


Lake Killarney -- King County

Lake Killarney is located 3.5 miles southwest of Auburn. It drains via Hylebos Creek to Commencement Bay. The volunteer monitored the south arm of the lake; the size of the south arm is 24 acres.

Size (acres)	34
Maximum Depth (feet)	15
Mean Depth (feet)	9
Lake Volume (acre-feet)	230
Drainage Area (miles^2)	0.2
Altitude (feet)	385
Shoreline Length (miles)	1.3

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Lake Killarney was fair in 1994. Secchi depths were deeper, and varied less, than in previous years (see table of volunteer-collected data, and graph of Secchi data). However, because Lake Killarney is treated with herbicides annually to control rooted plants and algae, the improved water clarity in 1994 may not necessarily be due to an improvement in water quality. Regardless of the cause, water clarity improved significantly from 1989 through 1994. This was tested using a seasonal Kendall test for trend, which was significant at the 95% level ($p = 0.03$).

Concentrations of total phosphorus were high on both sampling dates (see table of water chemistry data). As would be expected in a lake with high phosphorus concentrations, Secchi depths were moderately low and chlorophyll *a* concentrations indicated that there was a moderately high amount of algae in the lake during the surveys. Despite improved water clarity, Lake Killarney was classified as eutrophic in 1994 based on the high amounts of phosphorus, plants, and algae.

Aquatic plants observed by Ecology staff during field visits included watershield (*Brasenia schreberi*), bladderwort (*Utricularia vulgaris*), largeleaf pondweed (*Potamogeton amplifolius*), the alga *Nitella*, and leafy pondweed (*Potamogeton foliosius*). Purple loosestrife (*Lythrum salicaria*), an aggressive non-native wetland plant, was in bloom along parts of the shore in August. This sighting was reported to the King County noxious weed board and to Ecology's Freshwater Aquatic Weeds Program.

Other Available Information from the Volunteer

A new volunteer took over the Secchi depth measurements in mid-monitoring season 1994. He reported that in 1994 Lake Killarney looked the best in the 30 years he's been there. He also noted that the lake association's interest in controlling aquatic plants was initiated years ago after a young boy drowned in a bed of watershield.

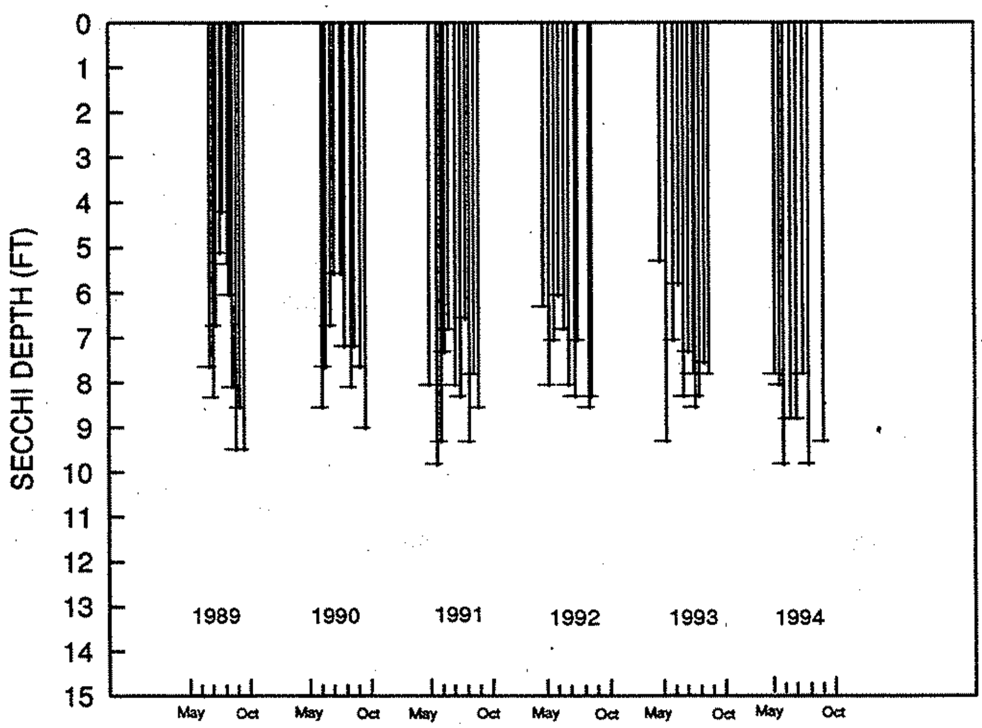
Acknowledgments

I thank George Fosberg for volunteering his time to monitor Lake Killarney in 1994. Paul DesJardin monitored the lake from 1989 though mid-season 1994.

KILLARNEY (SOUTH ARM) Lake -- KING County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/18	17.0	62.6	0.0	Lt Green	100	Mod	Calm	7.5	-7.0	Water level is 7" below high mark.
94/06/02	20.0	68.0	0.0	Grn-brown	100	Heavy	Breezy	7.8	-9.0	Secchi 9.5, 9.75 with view tube, and 7.75, 8.5 without.
94/06/15	21.0	69.8	0.0	Grn-brown	50	Mod	Light	9.5	-10.0	No sight tube used. Lake level down.
94/07/03	21.0	69.8	0.0	Lt Brown	90	Trace	Light	8.5	-13.0	Second Secchi with view tube. Turning monitori ng over to neighbor. Lake level down.
94/07/16	22.0	71.6	0.0	Lt Brown	0	None	Light	8.5	-15.5	Lake level down 1" since last measurement.
94/08/01	24.0	75.2	0.0	Lt Brown	0	None	Light	8.5	-19.0	
94/08/15	23.0	73.4	0.0	Lt Brown	75	None	Calm	7.5	-22.2	
94/09/04	19.0	66.2	0.0		100	Mod	Calm	9.5	-26.5	Water color very light brown. Freshwater spong es are growing large, with many sightings.
94/10/22	12.0	53.6	0.0	Lt Brown	50	Trace	Light	9.0	-31.5	

LAKE KILLARNEY (KING COUNTY)



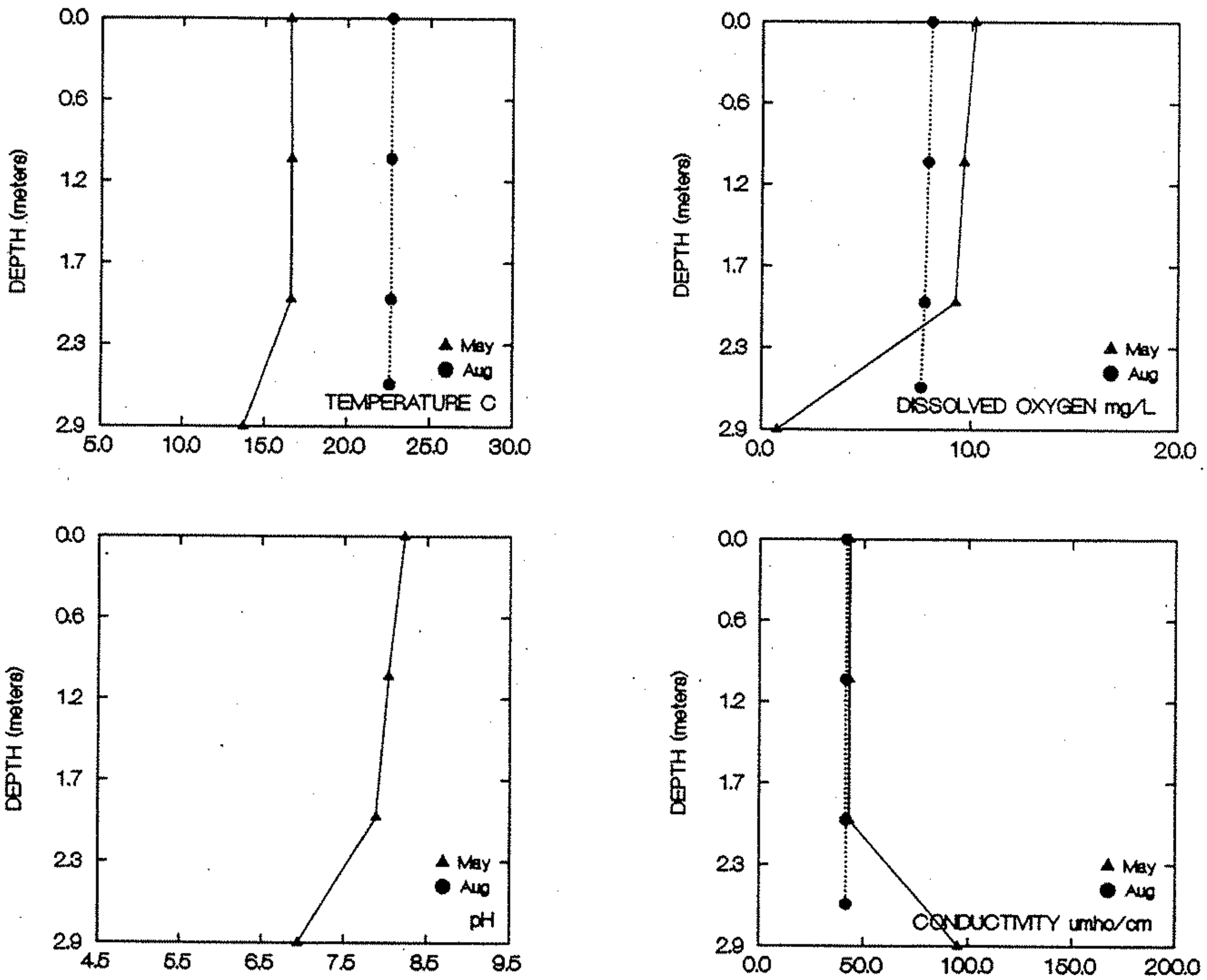
KILLARNEY (SOUTH ARM) (KING) Lake -- KING County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/05		E	22			(Source: Water Supply Bulletin 43)					
90/06/14	1	E	43	0.45							
91/05/22	1	E		0.43							
92/05/11	1	E	38	0.72	4.9						
92/08/08	1	E	39	0.52	2.5	8	6		4	2	35
92/08/08	1	H	50	0.56							
93/05/27	1	E	28	0.50	4.8						
93/08/23	1	E	33	0.47	7.4	240			1U	1U	
93/08/23	1	H	31	0.47		9					
94/05/18	1	E	50	0.33	7.5						
94/08/17	1	E	41	0.46J	7.0J						

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

KILLARNEY (SOUTH ARM) (KING) Lake -- KING County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/18	0.0	16.6	8.2	10.2	43.0	94/08/17	0.0	22.7	0.0	8.1	42.0
	1.0	16.6	8.0	9.6	43.0		1.0	22.6	0.0	7.9	42.0
	2.0	16.6	7.9	9.3	43.0		2.0	22.6	0.0	7.8	42.0
	3.0	14.3	7.1	1.0	87.0		2.6	22.6	0.0	7.6	42.0
	2.9	13.7	6.9	0.7	95.0						

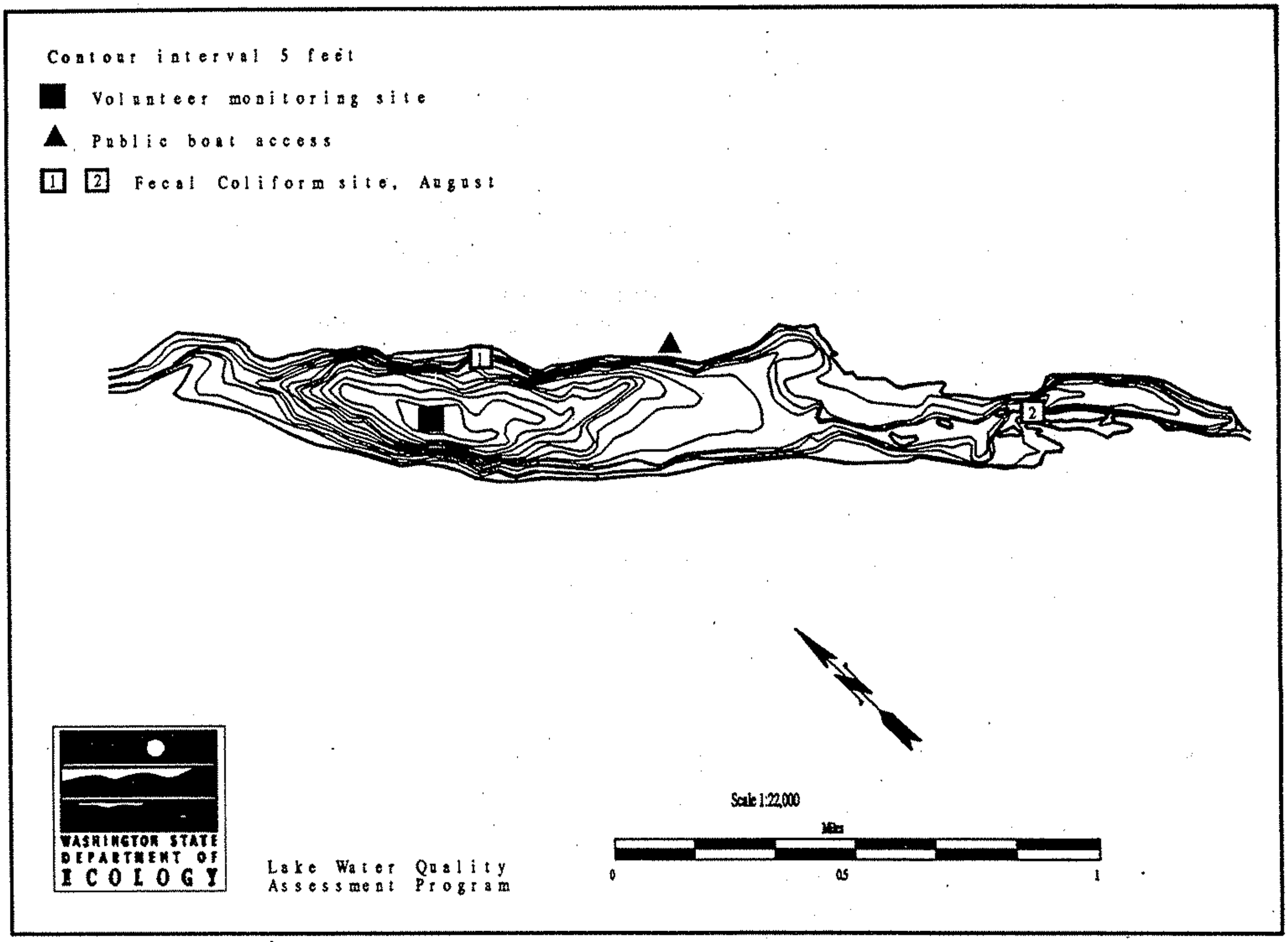


Lacamas Lake -- Clark County

Lacamas Lake is located one mile north of Camas. It is formed by two dams in Lacamas Creek. Lacamas Lake is fed by Lacamas Creek, and drains via Round Lake to Lacamas Creek and the Washougal River.

Size (acres)	315
Maximum Depth (feet)	65
Mean Depth (feet)	24
Lake Volume (acre-feet)	7,489
Drainage Area (miles^2)	64.3
Altitude (feet)	179
Shoreline Length (miles)	5.3

Data from Bortleson *et al.* (1976)



Overall Assessment

General water quality was poor in 1994. Although Secchi depths at the open water station were deeper than in previous years (see the table of volunteer-collected Secchi data), there was not a significant trend in water clarity from 1989 through 1994. This was tested using the seasonal Kendall test for trend, and results were not statistically significant at the 80% level ($p = 0.22$).

Despite high concentrations of total phosphorus on both sampling dates (see table of water chemistry data), there was less algae in the water (indicated by Secchi depths and chlorophyll *a* concentrations) during the 1994 surveys than during the 1992 and 1993 surveys. Based on 1994 data for phosphorus, chlorophyll *a*, and Secchi depths, Lacamas Lake was classified as meso-eutrophic in 1994. It was classified as eutrophic from 1989-1993. Although the water quality appeared slightly better in 1994, the volunteer reported that swimming and aesthetics were impaired by poor water quality during most of the year, and fishing was impaired by poor water quality for about a month.

Profile data were similar to data collected during previous surveys. The very low concentrations of dissolved oxygen below the thermocline are not unusual for Lacamas Lake, although these do indicate that there was a very high oxygen demand in the lower layer of water.

Aquatic plants identified by Ecology staff during field surveys visits include waterweed (*Elodea canadensis*), largeleaf pondweed (*Potamogeton amplifolius*), yellow-flowering lily (*Nuphar polysepalum*), and Brazilian elodea (*Egeria densa*). Brazilian elodea is an aggressive non-native aquatic plant, but it has not dominated the aquatic plant population in Lacamas Lake. Another plant seen in 1994 was possibly a pondweed hybrid. Staff with Ecology's Freshwater Aquatic Weeds Program noted that the plant exhibited characteristics of both largeleaf pondweed and flat leaf pondweed (*Potamogeton robbinsii*).

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Lacamas Lake is used for fishing, boating, swimming, rowing, jet skiing, waterfowl hunting, sailing, and occasional sea plane use. Recreational facilities on the lakeshore include a picnic area and four boat ramps. There are no restrictions for motorboat use on the lake. About 40% of the shoreline is publicly-owned. Brown trout were stocked in the lake in 1994. Currently the watershed is being logged, and is used for animal grazing and crop agriculture. Also, the lakeshore is being developed further for residences. In the past, the watershed was logged and used for animal grazing and crop agriculture, and the shoreline was altered.

There are about 105 houses on the lakeshore (there were 43 in 1992), and about 90% of the lakeshore is sewered. There are storm drains that empty into the lake. There is a lake association for the lake. Lake management activities in 1994 were limited to drawing down the level for about two weeks during fall. Currently, the minimum setback for lakeshore development is 100 feet. Lake water is withdrawn for industrial use.

Overall, the volunteer found that Lacamas Lake had poor water quality. Problems in the lake in 1994 were ranked as (1) water quality gradually degraded over years, (2) algae, (3) odor from decaying algae, (4) excessive aquatic plant growth, (5) decaying plants, (6) degraded aesthetics, and (7) shoreline erosion. (Aquatic plants, algae, and odor have been among the worst problems listed in the questionnaires every year since 1989.) Possible sources of problems include farm animal waste from the watershed, accumulation of decayed plants over the years, and development around the lakeshore and within the watershed. Also, regulation of development and animal rearing within the watershed is lacking. The only change in the lake since the 1993 monitoring season was that water clarity was better in 1994.

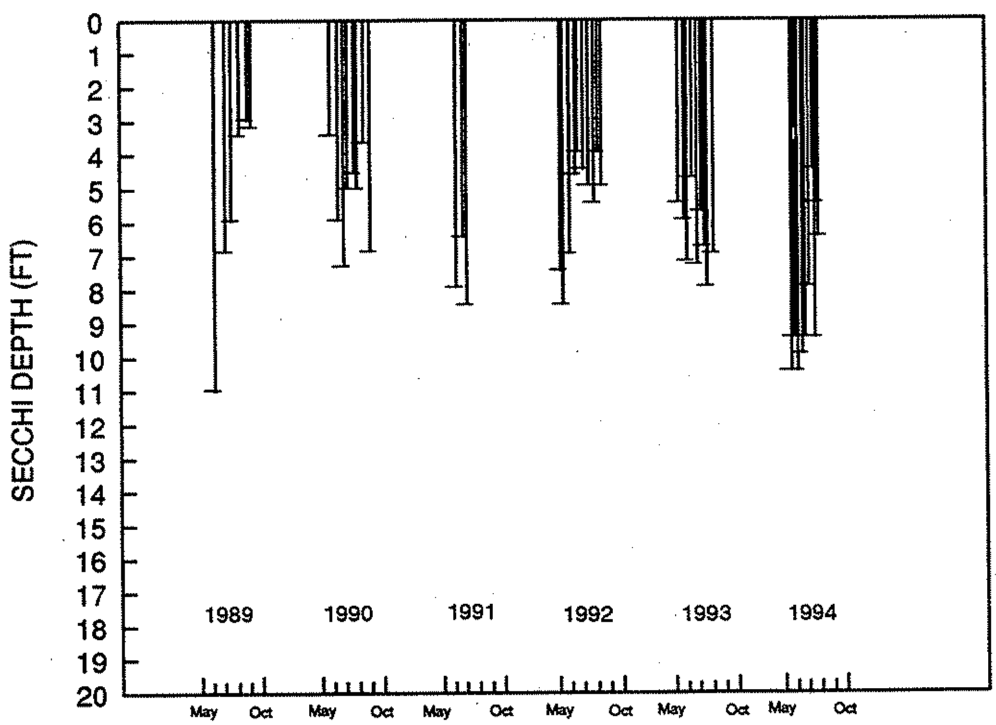
Acknowledgments

I thank Judy and Jan Baldwin for volunteering their time to monitor Lacamas Lake during 1989-1994.

LACAMAS Lake -- CLARK County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/06/01	0.0	32.0	0.0	Pea-green	0	None	Light	10.0	0.0	Onsite visit. Water color pear green/olive. P articles visible in the water.
94/06/09	17.2	63.0	0.0	Mod Green	10	None	Breezy	9.0	0.0	Large blankets of algae floating. Water smelly .
94/06/24	20.0	68.0	0.0	Mod Green	0	None	Strong	10.0	0.0	Large chunks of algae floating in water.
94/07/08	17.8	64.0	0.0	Mod Green	10	None	Breezy	9.5	0.0	Still large algae blankets.
94/07/19	21.1	70.0	0.0	Mod Green	0	None	Breezy	9.0	0.0	No algae blankets.
94/08/01	23.3	73.9	0.0	Milky-grn	0	None	Breezy	7.5	0.0	
94/08/11	23.3	73.9	0.0	Pea-green	0	None	Light	4.0	0.0	
94/08/25	21.1	70.0	0.0	Pea-green	0	None	Strong	9.0	0.0	Water level normal.
94/08/29	18.3	64.9	0.0	Pea-green	0	None	Light	5.0	0.0	
94/09/09	16.7	62.1	0.0		25	Light	Breezy	6.0	0.0	Lake level a little higher.

LACAMAS LAKE (CLARK COUNTY)



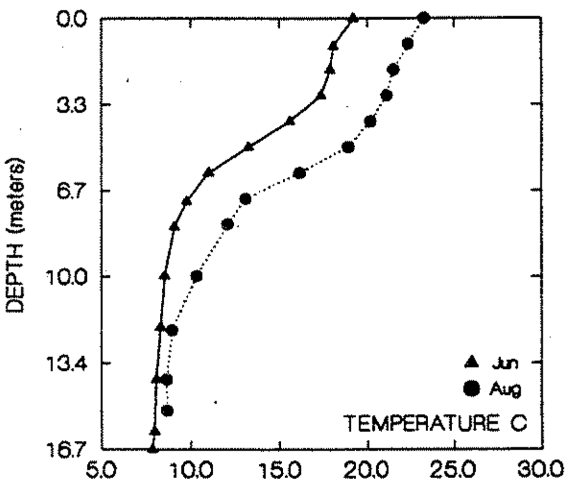
LACAMAS (CLARK) Lake -- CLARK County
Chemistry Data -- Station 1

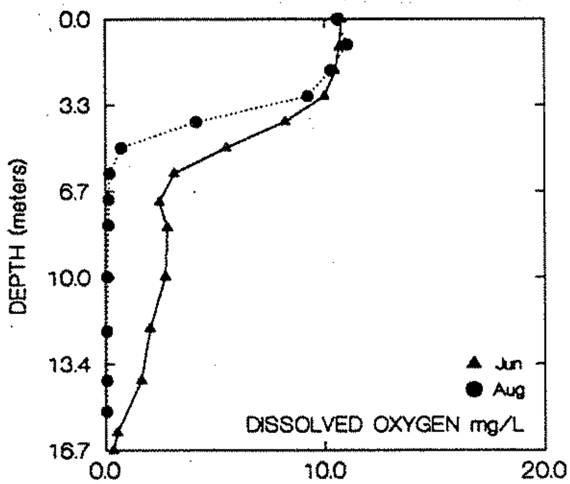
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL)		Turbidity (NTU)	Suspended Solids		Color (Pt-Co)
						Site 1	Site 2		Total (mg/L)	Non-Volatile (mg/l)	
74/06/26		E	47			(Source: Water Supply Bulletin 43)					
81/06/16		E	100		5.0	(Source: Water Supply Bulletin 57)					
90/05/26	1	E	37	3.29							
90/08/20	1	E	32	0.78							
91/06/21	1	E		0.64							
92/06/08	1	E	22	0.85	3.5	32	4		2	1U	20
92/06/08	1	H	62	0.99							
92/09/09	1	E	39	0.73	12.1	1U	1U		4	1	20
92/09/09	1	H	132	0.75							
93/06/04	1	E	61	0.96	16.7				8	6	
93/06/04	1	H	39	0.84							
93/08/31	1	E	33	0.97	11.1	3	1U		4	2	
93/08/31	1	H	56	0.81							
94/06/01	1	E	35	0.61	5.5	36	28	1.7			
94/06/01	1	H	33	0.91							
94/08/31	1	E	35	0.49J	1.4J	1U		2.9			
94/08/31	1	H	89	0.63J							

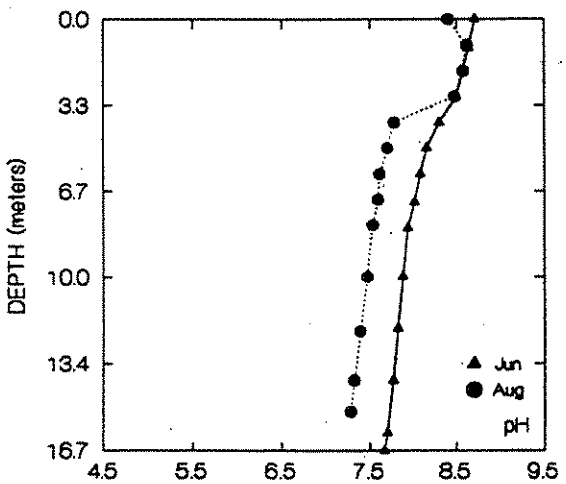
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

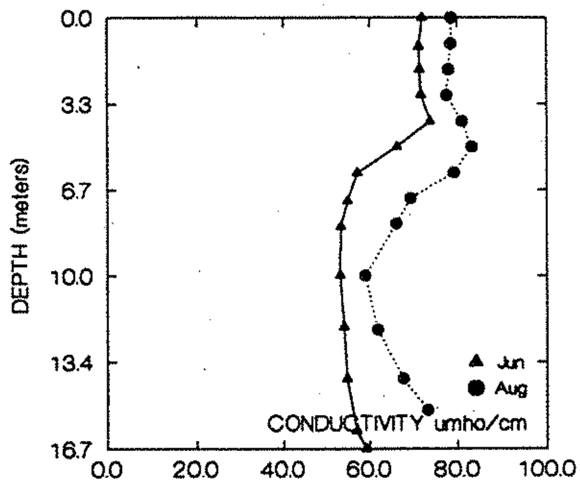
LACAMAS (CLARK) Lake -- CLARK County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/01	0.0	19.2	8.7	10.8	72.0	94/08/31	0.0	23.3	8.9	10.6	79.0
	1.1	18.1	8.6	10.7	71.0		1.0	22.4	9.1	11.1	79.0
	2.0	17.9	8.6	10.5	72.0		2.0	21.5	9.1	10.3	78.0
	3.0	17.4	8.5	10.0	72.0		3.0	21.1	9.0	9.2	78.0
	4.0	15.6	8.3	8.2	74.0		4.0	20.2	8.3	4.1	81.0
	5.0	13.2	8.2	5.5	66.0		5.0	18.9	8.2	0.7	83.0
	6.0	11.0	8.1	3.1	57.0		6.0	16.1	8.1	0.2	79.0
	7.1	9.8	8.0	2.4	55.0		7.0	13.1	8.1	0.1	69.0
	8.1	9.1	7.9	2.8	53.0		8.0	12.0	8.0	0.1	66.0
	10.0	8.5	7.9	2.7	53.0		10.0	10.3	8.0	0.1	59.0
	12.0	8.3	7.8	2.0	54.0		12.1	9.0	7.9	0.1	62.0
	14.0	8.1	7.8	1.6	55.0		14.0	8.7	7.8	0.1	68.0
	16.0	8.0	7.7	0.5	57.0		15.2	8.7	7.8	0.0	73.0
	16.7	7.9	7.7	0.3	59.0						







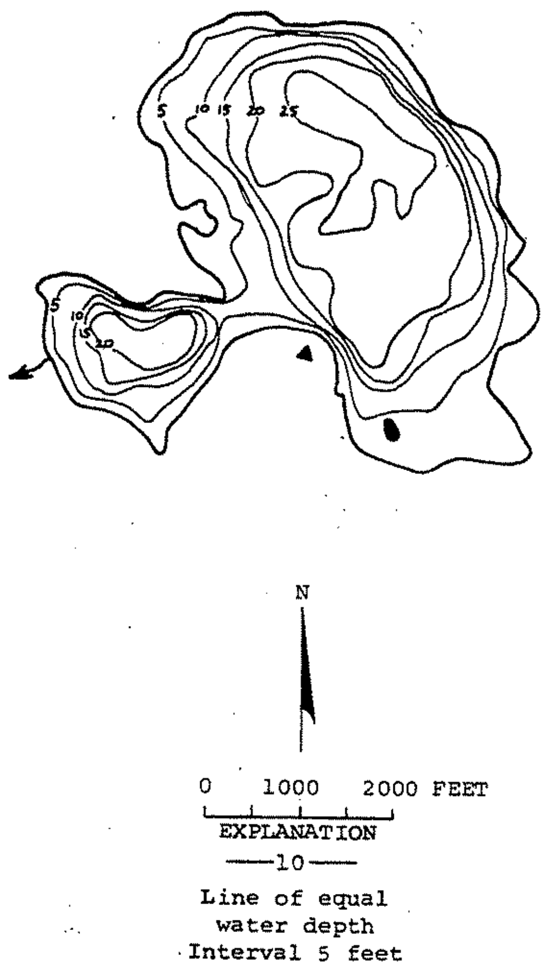


Lake Lawrence -- Thurston County

Lake Lawrence is located six miles south of Yelm, and six miles southeast of Rainier. It is fed by springs, and drains to the Deschutes River. Lawrence Lake was monitored by Ecology staff only.

Size (acre)	330
Maximum Depth (feet)	26
Mean Depth (feet)	13
Lake Volume (acre-feet)	4,400
Drainage Area (miles^2)	3.4
Altitude (feet)	421
Shoreline Length (miles)	4.0

Data from Bortleson *et al.* (1976)



Overall Assessment

Lake Lawrence was sampled by Ecology staff only in 1994, by request from Ecology's Southwest Regional Office.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Lake Lawrence was classified as eutrophic in 1994 (see table of water chemistry data).

Whitestem pondweed (*Potamogeton praelongus*) was abundant along the shore during the September survey.

The lake was awarded a Clean Lakes Grant from Ecology to investigate sources of eutrophication and to recommend options for lake restoration. An experimental process for dredging and centrifuging dredge spoils was tested in the lake in early 1995.

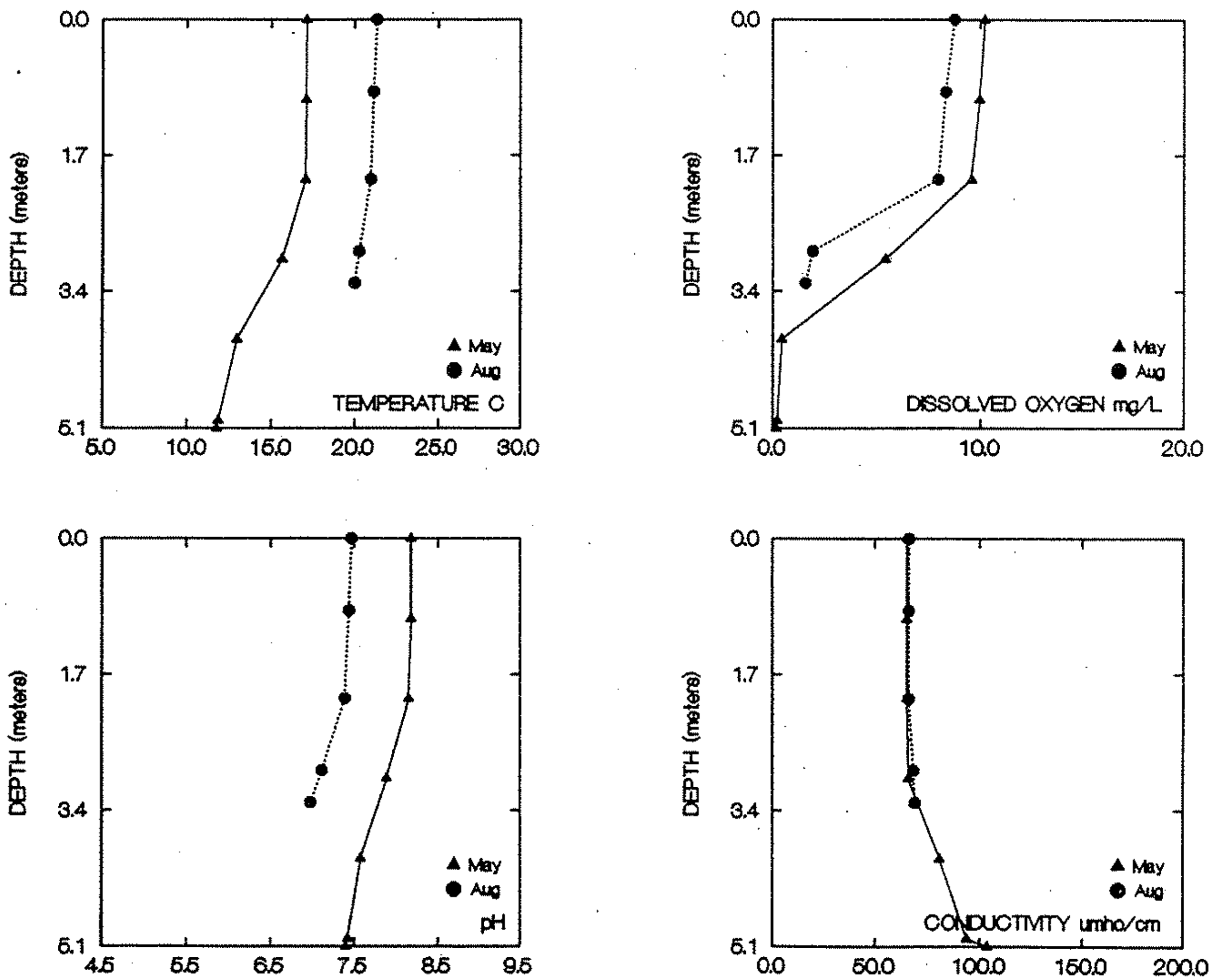
LAWRENCE (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/06/18		E	32			(Source: Water Supply Bulletin 43)					
81/06/04		E	20		5.3	(Source: Water Supply Bulletin 57)					
94/05/31	1	E	57	0.67	48.0	15	3	4.7			
94/05/31	1	H	75	0.71							
94/09/01	1	E	37	0.65J	20.3J						
94/09/01	2	E	33	0.57J							
94/09/01	1	H	34	0.68J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

LAWRENCE (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/31	0.0	17.1	8.2	10.2	65.0	94/09/01	0.0	21.3	7.5	8.8	66.0
	1.0	17.1	8.2	10.0	65.0		0.9	21.1	7.4	8.4	66.0
	2.0	17.0	8.2	9.6	65.0		2.0	21.0	7.4	8.0	66.0
	3.0	15.6	7.9	5.5	66.0		2.9	20.3	7.1	1.9	68.0
	4.0	13.0	7.6	0.4	81.0		3.3	20.0	7.0	1.6	69.0
	5.0	11.9	7.4	0.2	94.0						
	5.1	11.8	7.4	0.2	104.0						

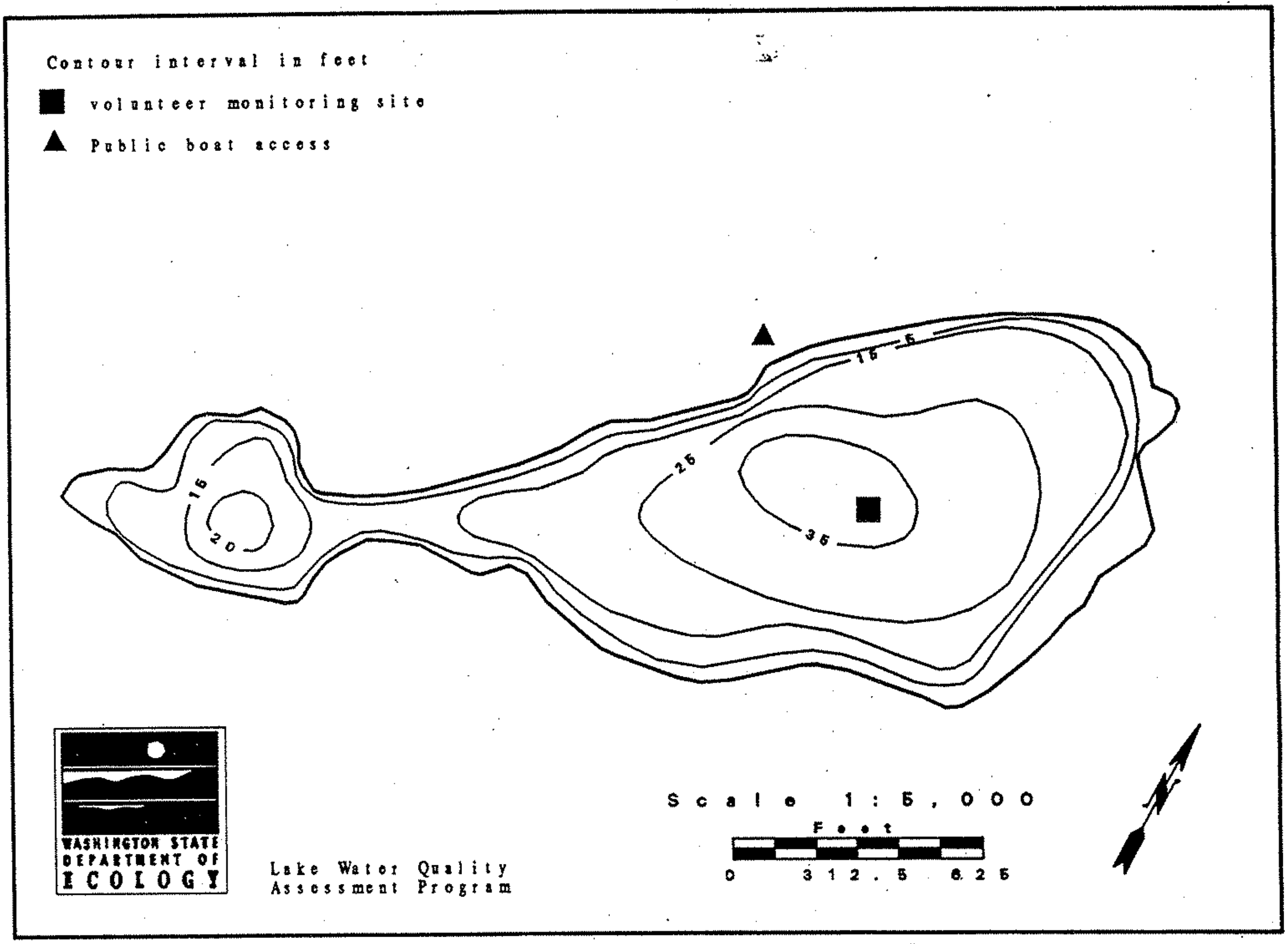


Lake Leo -- Pend Oreille County

Lake Leo is located about seven miles southwest of Ione and 0.8 miles northeast of Heritage Lake. It has an intermittent inflow, and drains via a 2.5 acre pond to Heritage Lake and the Little Pend Oreille River.

Size (acre)	43
Maximum Depth (feet)	37
Mean Depth (feet)	17
Lake Volume (acre-feet)	740
Drainage Area (miles^2)	2.9
Altitude (feet)	3,290
Shoreline Length (miles)	1.3

Data from Dion *et al.* (1976)



Overall Assessment

General water quality of Lake Leo was good in 1994. Water clarity improved significantly from 1990 through 1994. This was tested using the seasonal Kendall test for trend, and results indicated an improving trend that was statistically significant at the 99% level ($p = 0.002$).

Concentrations of total phosphorus and total nitrogen were moderate to low on both sampling dates (see table of water chemistry data). Concentrations were similar to those measured during previous surveys. Profile data were also similar to data collected during previous surveys. As in the past, concentrations of dissolved oxygen decreased considerably below the thermocline. This is not unusual for Lake Leo.

Aquatic plants observed by Ecology staff during field visits include largeleaf pondweed (*Potamogeton amplifolius*), flatleaf pondweed (*Potamogeton robbinsii*), ribbonleaf pondweed (*Potamogeton epihydrus*), waterweed (*Elodea canadensis*), tapegrass (*Vallisneria americana*), yellow-flowering water lily (*Nuphar polysepalum)*, muskgrass (*Chara*), water buttercup (*Ranunculus sp.*), and another pondweed that may have been *Potamogeton pusilus* or *Potamogeton gramineus*. Identification of this latter plant should be confirmed.

Although water chemistry results and Secchi depths in the lake are very good, there was a moderate population of aquatic plants in the lake. Because of the amount and types of aquatic plants, and the very low concentrations of dissolved oxygen in the lower layer of water, Lake Leo was classified as oligo-mesotrophic in 1994.

The biggest threat to Lake Leo is the presence of Eurasian watermilfoil (*Myriophyllum spicatum*) in the downstream lakes of the Little Pend Oreille chain of lakes. A survey conducted for the Stevens County noxious weed board in 1994 found heavy populations of water milfoil in areas of Heritage Lake, Lake Thomas, Lake Gillette, and Lake Sherry. Because Lake Leo is not in Stevens County, it was not included in this survey. Staff with Ecology's Lake Water Quality Assessment Program and Freshwater Aquatic Weeds Program will periodically check Lake Leo for the presence of Eurasian watermilfoil.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Leo is used for fishing, swimming, motor boating, and lakeshore camping. Public recreational facilities on the lakeshore include eight campsites. One hundred percent of the shoreline is publicly-owned National Forest. There are no houses on the lakeshore, and no lake association for the lake. There is one public boat ramp,

and there are no restrictions for motorboating. Currently, the watershed is being logged and used for animal grazing. No plant or algae management occurred in 1994, although the volunteer reported that the lake has been chemically treated in the past to control undesirable fish species.

Overall, the volunteer found that Lake Leo had good water quality. Problems in the lake in 1994 were ranked as (1) suspended sediments, (2) excessive aquatic plant growth, (3) decaying plants, (4) gradually degraded water quality over the years, and (5) impaired fisheries. There were no changes in the lake since the 1993 monitoring season, although fewer people used the lake in 1994. This may have resulted because fishing quality and quantity has decreased over the years. The volunteer has not seen any patterns in water clarity, pH, or aquatic plants.

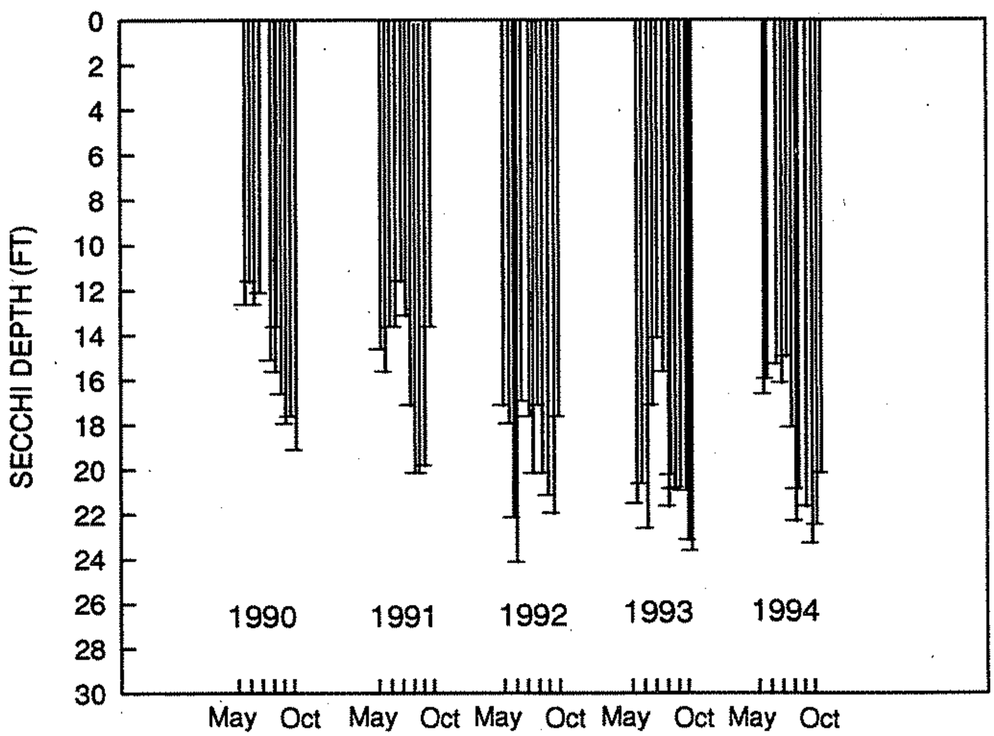
Acknowledgment

I thank Earl W. Robinson for volunteering his time to monitor Lake Leo during 1990-1994.

LEO Lake -- PEND OREILLE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/13	14.4	57.9	7.2	Grn-brown	100	None	Calm	16.0	-1.0		Water color light green-brown.
94/05/18	15.0	59.0	7.1	Lt Brown	100	Light	Light	15.3	0.0		Water color very light brown.
94/06/15	15.6	60.1	7.2	Grn-brown	100	Mod	Light	14.7	-2.0		Water color light green-brown. Record low temps during the week. Ambient temp 54 degrees.
94/06/30	21.1	70.0	7.2	Grn-brown	10	None		15.5	-2.0		Water color light green-brown.
94/07/13	22.2	72.0	7.3	Grn-brown	50	None	Calm	14.3	-3.0		Water color light greenish-brown.
94/07/27	24.4	75.9	7.4	Lt Green	0	None	Calm	17.5	-3.0		Water color light light green. No change in lake level; dropped 3" since May 18.
94/08/08	19.4	66.9	7.7	Lt Green	75	None	Breezy	21.7	-2.0		
94/08/10	21.1	70.0	7.5	Lt Green	0	None	Calm	20.3	-2.5		Water color very light green.
94/09/08	17.8	64.0	7.7	Lt Green	10	None	Light	21.0	-1.5		
94/09/22	16.7	62.1	7.8	Lt Green	0	None	Light	22.7	-2.0		
94/10/05	13.9	57.0	7.4	Lt Green	75	None	Light	21.8	-2.0		Water color very light green. Lake height unchanged. Up about one inch for the season.
94/10/19	10.0	50.0	7.4	Lt Green	100	None	Calm	19.5	-1.5		Water color very light green. Lake height up 0.5 inch, for a total of up 3.5 inches.

LAKE LEO (PEND OREILLE COUNTY)



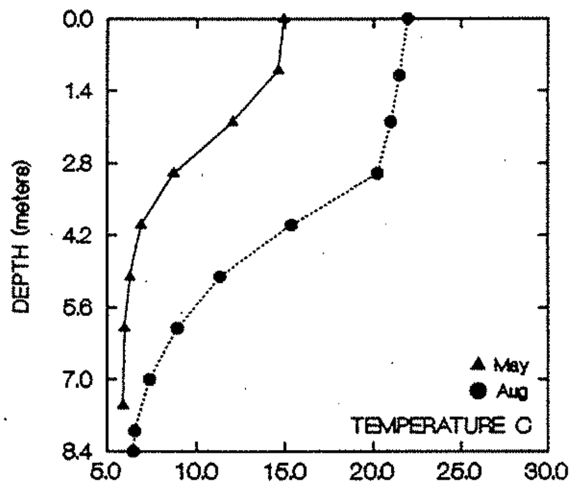
LEO (PEND OREILLE) Lake -- PEND OREILLE County
Chemistry Data -- Station 1

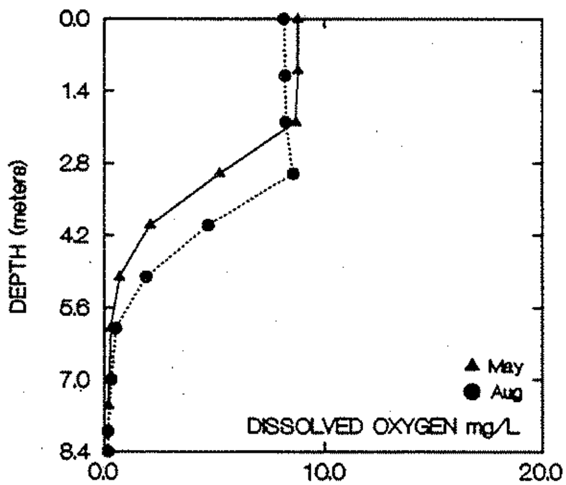
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/08/16		E	25			(Source: Water Supply Bulletin 43)					
90/05/25	1	E	12	0.27							
90/09/11	1	E	13	0.29							
91/06/13	1	E		0.21							
92/05/01	1	E	11	0.30	0.8						
92/05/01	2	E		0.26	0.4						
92/05/01	1	H	36	0.43							
92/08/07	1	E	13	0.26	2.8	1	1				
92/08/07	1	H	82	0.64							
93/05/18	1	E	18	0.31	2.9						
93/05/18	1	H	16								
93/08/19	1	E	6	0.24	1.2						
93/08/19	1	H	32	0.29							
94/05/18	1	E	14	0.18	1.6						
94/05/18	2	E	19	0.17	2.1						
94/05/18	1	H	36	0.26							
94/08/16	1	E	7	0.15J	0.6J						
94/08/16	2	E	8	0.24J	0.7J						
94/08/16	1	H	17	0.16J							

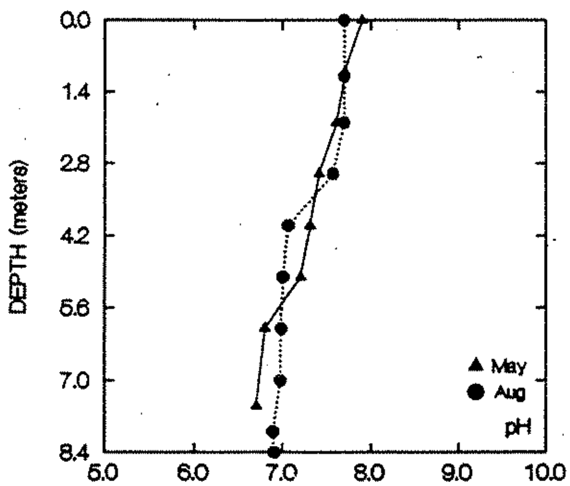
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

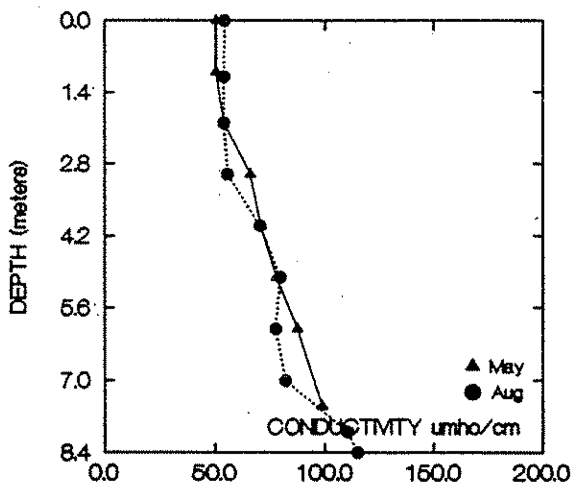
LEO (PEND OREILLE) Lake -- PEND OREILLE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/18	0.0	14.9	7.9	8.8	50.0	94/08/16	0.0	22.0	7.7	8.1	54.0
	1.0	14.6	7.7	8.8	50.0		1.1	21.5	7.7	8.2	54.0
	2.0	12.0	7.6	8.7	54.0		2.0	21.0	7.7	8.2	54.0
	3.0	8.7	7.4	5.2	66.0		3.0	20.2	7.6	8.6	56.0
	4.0	6.9	7.3	2.1	71.0		4.0	15.3	7.1	4.7	70.0
	5.0	6.3	7.2	0.7	78.0		5.0	11.3	7.0	1.9	80.0
	6.0	6.0	6.8	0.3	88.0		6.0	8.9	7.0	0.5	78.0
	7.5	5.9	6.7	0.2	99.0		7.0	7.4	7.0	0.3	82.0
							8.0	6.6	6.9	0.2	110.0
							8.4	6.5	6.9	0.2	115.0
STATION 2											
						94/08/16	0.0	22.5	7.7	8.2	54.0
							1.0	21.6	7.7	8.2	54.0
							2.0	20.9	7.8	8.5	54.0
							3.0	19.9	7.5	8.4	58.0
							4.0	16.4	7.1	6.0	68.0
							5.0	11.0	7.0	1.8	79.0







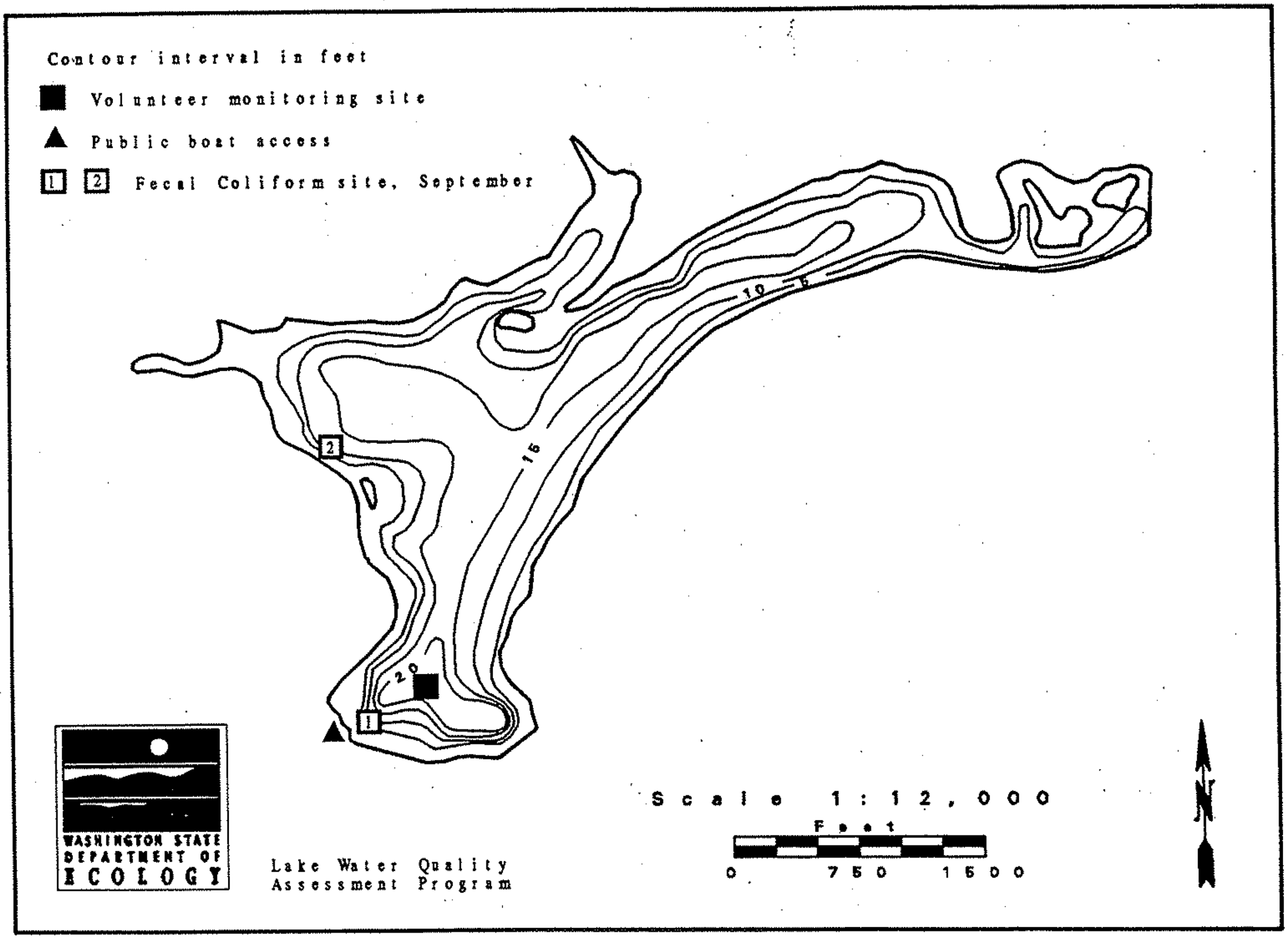


Lake Limerick -- Mason County

Lake Limerick is located about five miles northeast of Shelton. It was formed in 1966 by impoundment of Cranberry Creek. Lake Limerick is fed mainly by Cranberry Creek, as well as three other minor inlets.

Size (acre)	129
Maximum Depth (feet)	24
Mean Depth (feet)	9
Lake Volume (acre-feet)	1,210
Drainage Area (miles^2)	13
Altitude (feet)	220
Shoreline Length (miles)	4.4

Data from Bortleson *et al.* (1976)



Overall Assessment

General water quality of Lake Limerick was fair in 1994. Although the range of Secchi depths has varied between years (see graph of volunteer-collected data), there was not a trend in water clarity from 1990 through 1994. This was tested using a seasonal Kendall test for trend, and results were not statistically significant at the 80% level ($p = 0.65$).

Based on results for all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Lake Limerick was classified as mesotrophic in 1994.

During the May survey, signs posted at the public access indicated that the northeast embayment of the lake was treated with the aquatic herbicide Sonar® that day (May 25, 1994).

Aquatic plants in Lake Limerick were surveyed by Ecology staff on August 15, 1994, for the Freshwater Aquatic Weeds Program. Aquatic plants observed include Brazilian elodea (*Egeria densa*; this is an aggressive non-native plant), Dulichium (*Dulichium arundinaceum*), common elodea (*Elodea canadensis*), fern leaf pondweed (*Potamogeton robbinsii*), purple (marsh) cinquefoil (*Potentilla palustris*), needle spike-rush (*Eleocharis acicularis*), water-purslane (*Ludwigia palustris*), tapegrass (*Vallisneria spiralis*), cattail (*Typha sp.*), spike-rush (*Eleocharis sp.*), American water-plantain (*Alisma plantago-aquatica*), common smartweed (*Polygonum hydropiperoides*), common bladderwort (*Utricularia vulgaris*), large-leaf pondweed (*Potamogeton amplifolius*), watershield (*Brasenia schreberi*), ribbonleaf pondweed (*Potamogeton epihydrus*), lake quillwort (*Isoetes lacustris*), stonewort (*Nitella sp.*), yellow water-lily (*Nuphar sp.*), bur-reed (*Sparganium sp.*), rush (*Juncus sp.*), sedge (*Carex sp.*), and small duckweed (*Lemna minuscula*). Plants were not surfacing at the time of the survey, and Brazilian elodea was not healthy in some areas (probably due to the herbicide treatment). There was a heavy population of common waterweed (elodea) as well as Brazilian elodea, and there was heavy algae growth in a cove at the west end.

Because of the presence of Brazilian elodea, boaters using Lake Limerick should clean their boats, trailers, and motors very thoroughly after boating in the lake, in order to prevent the spread of this noxious plant into other lakes. The lake association is presently considering alternatives for aquatic plant management.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Limerick is used for fishing, swimming, and motor boating. There are four boat ramps on the lakeshore, although only one is for public access. There are

motorboating speed limits established for the lake. Trout were stocked in the lake in 1994. Currently, the watershed is used for crop agriculture, and the lakeshore is being developed further for residences. In the past, the watershed was logged.

There are 172 houses on the lakeshore, and none of the houses are connected to a sewer. There are culverts that drain into the lake. Lake water is withdrawn for irrigation and for firefighting. There is a community association for the lake. In 1994, lake management activities included herbicide treatments to control algae and aquatic plants, and the lake level was drawn down. Currently, the minimum setback for lakeshore development is 50 feet, minimum lot lengths are 200 feet, and residential density is restricted to one house per lot.

Overall, the volunteer found that Lake Limerick had good water quality. Problems in the lake in 1993 were listed as excessive aquatic plant growth and algae. There were no changes in the lake since the 1993 monitoring season.

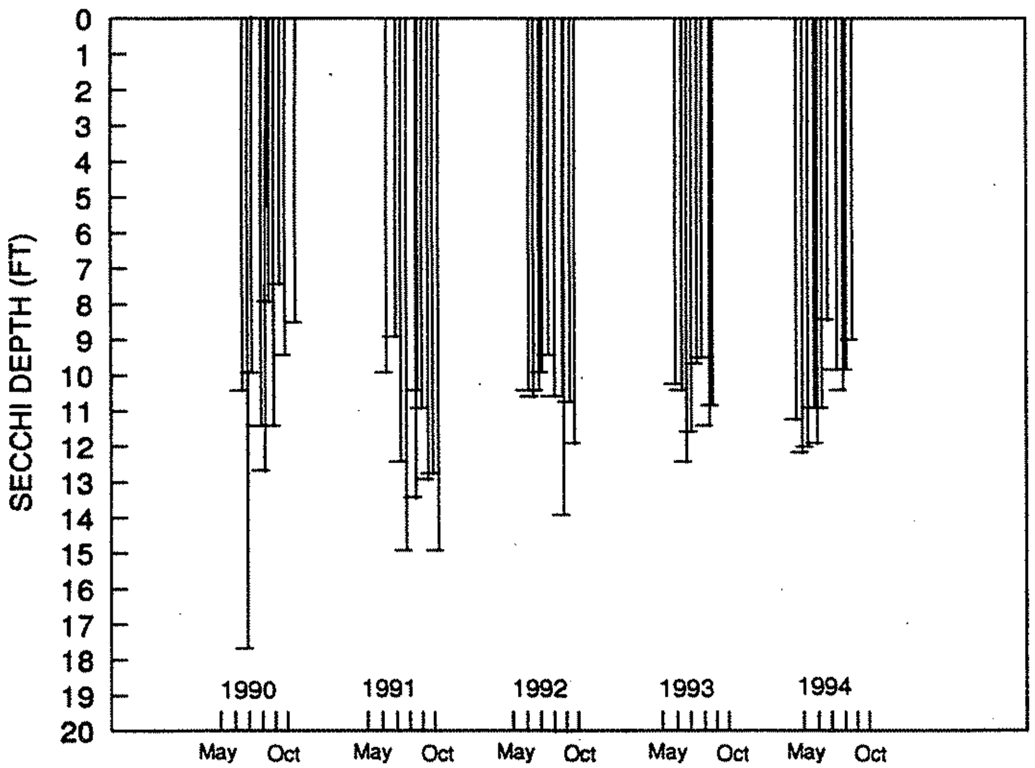
Acknowledgment

I thank Bob King and Bill Weston for volunteering their time to monitor Lake Limerick from 1992 through 1994. David Best and Bob King monitored the lake during 1990-1991.

LIMERICK Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/24	20.0	68.0	0.0		75	None	Calm	10.8	6.5	Onsite visit. Water color light yellow. At public access there was a sign from Resource Mgt, Inc. that northeast cove of lake treated with Sonar 5/24/94.
94/06/08	17.8	64.0	0.0		10	Mod	Breezy	11.8	6.3	Water color light yellow.
94/06/22	20.0	68.0	0.0		50	None	Breezy	11.6	6.0	Water color light yellow.
94/07/05	21.1	70.0	0.0		10	Light	Calm	10.5	6.0	Water color light yellow.
94/07/19	25.6	78.1	0.0		0	None	Light	11.5	4.3	Water color light yellow.
94/08/02	23.3	73.9	0.0		0	None	Light	10.5	2.5	Water color light green.
94/08/17	22.2	72.0	0.0		75	Mod	Light	8.0	2.5	Water color light yellow.
94/09/06	20.0	68.0	0.0		25	None	Calm	9.4	2.5	Water color light yellow. Lake very dirty in testing area.
94/09/20	19.4	66.9	0.0		10		Calm	10.0	4.5	Water color light yellow.
94/10/05	16.7	62.1	0.0		90	None	Calm	9.4	4.5	Water color light yellow.
94/10/18	13.9	57.0	0.0		50	Trace	Calm	8.6	0.8	

LAKE LIMERICK (MASON COUNTY)



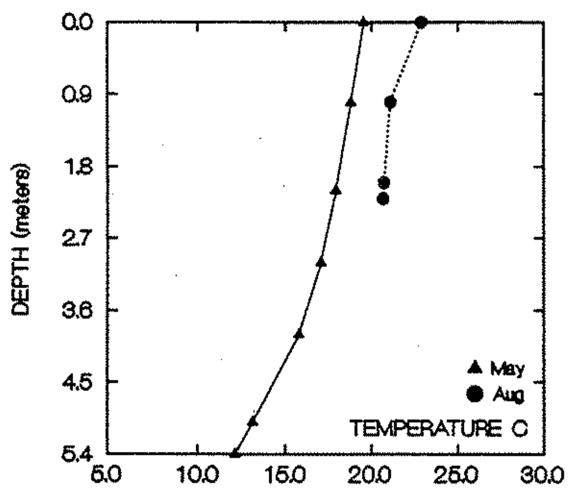
LIMERICK (MASON) Lake -- MASON County
Chemistry Data -- Station 1

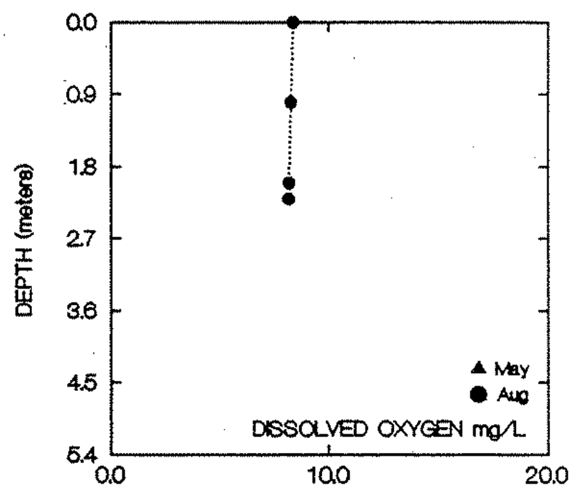
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/16		E	8			(Source: Water Supply Bulletin 43)					
90/05/24	1	E	17	0.24							
90/08/15	1	E	15	0.49							
91/05/15	1	E		0.15							
92/05/09	1	E	12	0.27	1.2						
92/05/09	1	H	37	0.33							
92/08/06	1	E	12	0.29	0.5						
92/08/06	1	H	36	0.54							
93/09/01	1	E	21	0.25	2.6	1	1				
93/09/01	1	H	19	0.32							
94/05/24	1	E	22	0.08	0.9J	29	1	0.6			
94/05/24	1	H	22	0.09							
94/08/30	1	E	10	0.31J	3.8	1U	1U	2.2			

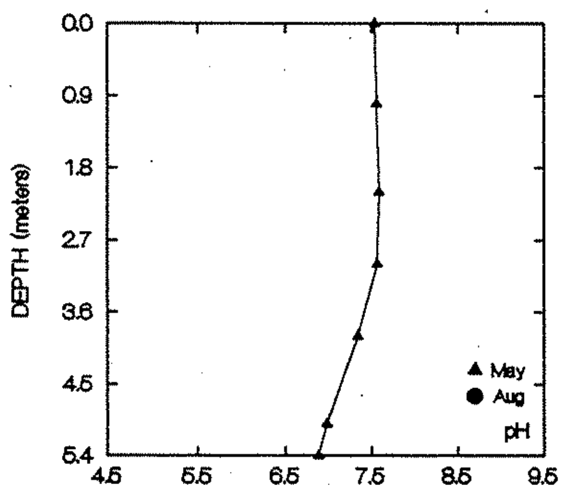
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

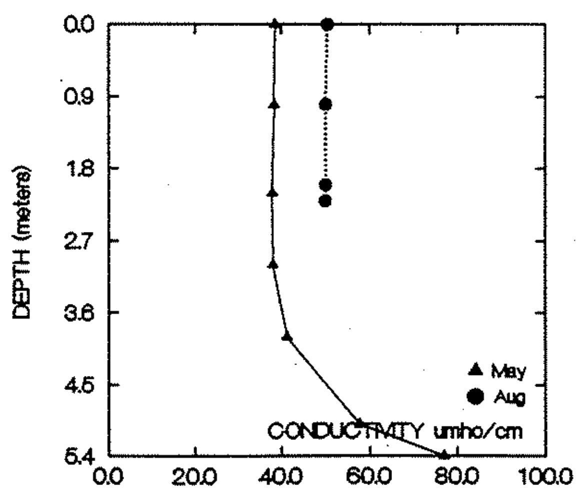
LIMERICK (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/24	0.0	19.5	7.5	0.0	39.0	94/08/30	0.0	22.9	0.0	8.4	50.0
	1.0	18.8	7.6	0.0	38.0		1.0	21.1	0.0	8.3	50.0
	2.1	17.9	7.6	0.0	38.0		2.0	20.8	0.0	8.2	50.0
	3.0	17.1	7.6	0.0	38.0		2.2	20.7	0.0	8.2	50.0
	3.9	15.8	7.3	0.0	41.0						
	5.0	13.1	7.0	0.0	58.0						
	5.4	12.1	6.9	0.0	77.0						







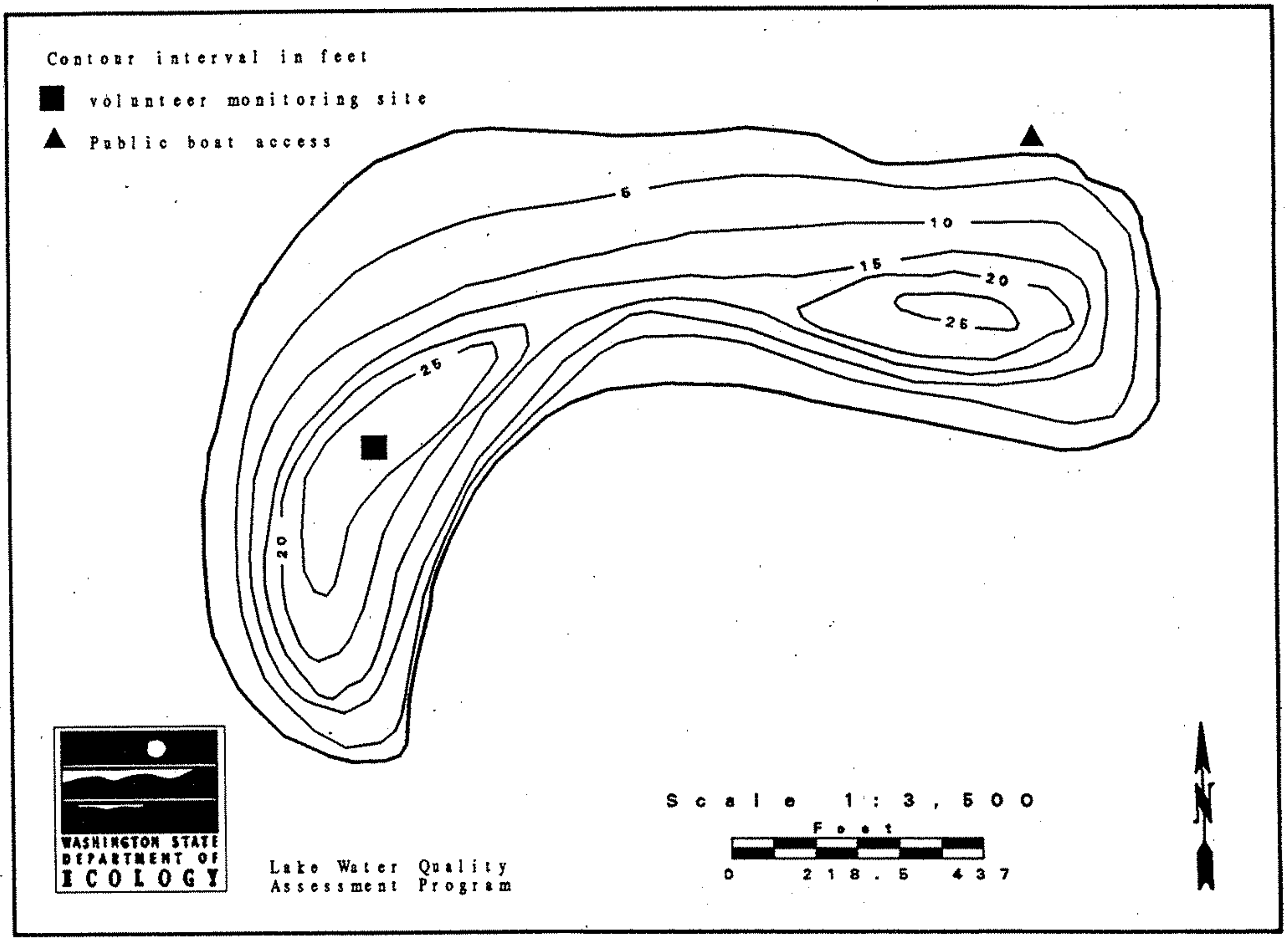


Lake Loma -- Snohomish County

Lake Loma is located 6.5 miles northwest of Marysville. It has no surface inlets, and drains via an intermittent outlet to Crabapple Lake and Tulalip Bay. Lake Loma was formerly called Cranberry Lake.

Size (acres)	21
Maximum Depth (feet)	28
Mean Depth (feet)	11
Lake Volume (acre-feet)	230
Drainage Area (miles^2)	0.2
Altitude (feet)	565
Shoreline Length (miles)	0.9

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality in Lake Loma was fair in 1994. Although there was a wider range of Secchi depths in 1994 than in 1993, the volunteer reported that the clarity in September 1994 was the best he had seen in seven years at the lake (see table of volunteer-collected data).

Although concentrations of total phosphorus were moderately high to high on both sampling dates, Secchi depths and chlorophyll *a* concentrations indicated that there was a moderate amount of algae when the lake was sampled (see table of water chemistry data). Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), as well as the heavy aquatic plant population, Lake Loma was classified as meso-eutrophic in 1994. The reddish brown color of the water results from organic material in the lake sediments and surrounding watershed, which leach tannic acids that color the water.

As in 1993, dissolved oxygen concentrations were very low below the thermocline (see table of profile data). This probably results from bacterial decomposition of organic material (including heavy populations of aquatic plants and algae) in the water and sediments, as well as from groundwater entering the lake (ground water usually carries little oxygen). In both August 1993 and August 1994, the smell of hydrogen sulfide was very strong in bottom water samples. Hydrogen sulfide is stable only in the absence of oxygen, and is usually a byproduct of decomposition.

Most of the problems in Lake Loma are related to the heavy populations of aquatic plants. Aquatic plants identified by Ecology staff during field visits include cattails (*Typha sp.*), iris (*Iris pseudacorus*), milfoil (*Myriophyllum hippuroides*; this identification was confirmed by staff with Ecology's Freshwater Aquatic Weeds Program), watershield (*Brasenia schreberi*), and yellow-flowering water lily (*Nuphar sp.*). Milfoil was the most abundant plant in the lake. The species present was not the aggressive Eurasian variety, but nonetheless has created a nuisance in the lake. Cattails grew along 50% of the shoreline.

Other Available Information

From Manasveta (1961): From 1955 to 1957, approximately 4,400 pounds of oyster shell and 13,850 pounds of hydrated lime were added to Lake Loma to raise the pH of the water and improve the lake for trout habitat. About 4,900 pounds of crab meal, 10,700 pounds of crab waste, and 400 pounds of potash were also added from 1955 to 1958 to fertilize the water and enhance the fishery.

Summary of Questionnaire Results and Information from the Volunteer

The 1994 questionnaire on lake and watershed uses was not returned.

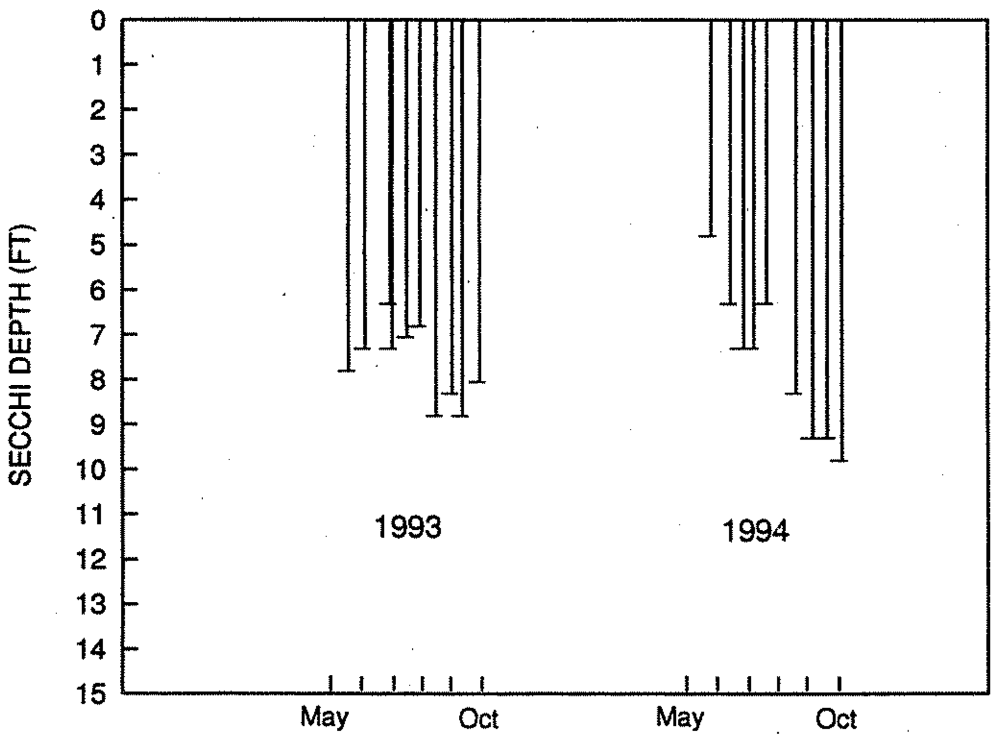
Acknowledgment

I thank Jim Brodie for volunteering his time to monitor Lake Loma during 1993 and 1994.

LOMA Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/30	0.0	32.0	0.0		25	None	Light	4.5	16.8	Onsite visit. Water color "tea." Lake level was 12" this time last year. Several anglers out today.
94/06/19	22.5	72.5	0.0		0	Trace	Breezy	6.0	-17.6	Water color red/tea. Stormy weather last week.
94/06/28	22.5	72.5	0.0		0	None	Breezy	7.0	-18.7	Water color red/tea.
94/07/10	24.0	75.2	0.0		0	None	Light	7.0	-19.6	Water color red/tea.
94/07/24	26.0	78.8	0.0		0	Trace	Calm	6.0	-22.6	Water color red/tea.
94/08/21	23.0	73.4	0.0		50	None	Light	8.0	-27.9	Water color red tea.
94/09/05	20.0	68.0	0.0		10	Mod		9.0	-29.6	Water color red/tea. This is the lowest level I've seen in the 7 years I've lived here.
94/09/21	21.0	69.8	0.0		0	None	Light	9.0	0.0	Water color red/tea.
94/10/03	16.0	60.8	0.0		0	Trace	Light	9.5	-31.5	Water color red/tea.

LAKE LOMA (SNOHOMISH COUNTY)



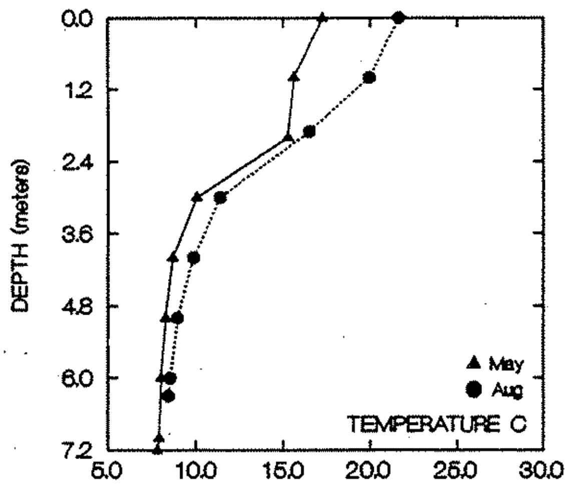
LOMA (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

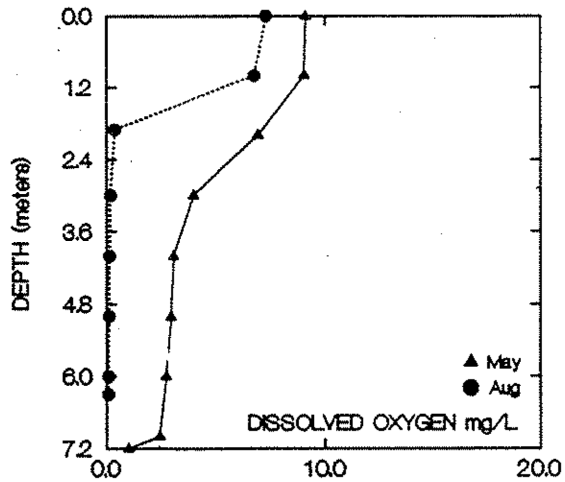
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/27		E	30			(Source: Water Supply Bulletin 43)					
81/06/30		E	40		8.0	(Source: Water Supply Bulletin 57)					
93/05/29	1	E	22	0.73	7.2						
93/05/29	1	H	33	0.70							
93/08/21	1	E	37	0.58	69.6						
93/08/21	1	H	43	0.50							
94/05/30	1	E	31	0.55	5.6	30	9	0.7			
94/05/30	1	H	96	0.67							
94/08/27	1	E	24	0.58J	2.6						
94/08/27	1	H	66	0.79J							

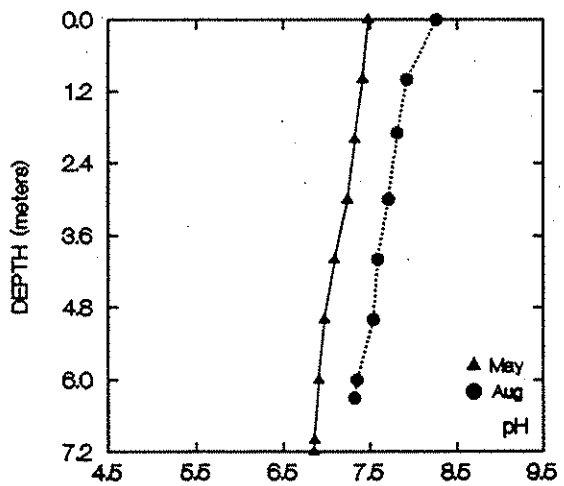
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

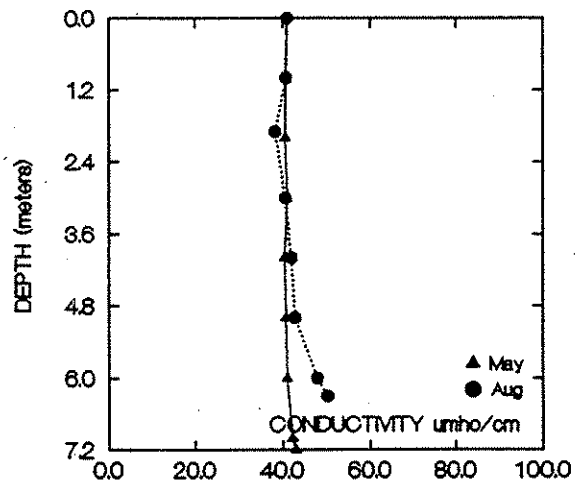
LOMA (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/30	0.0	17.3	7.5	9.1	41.0	94/08/27	0.0	21.6	8.3	7.3	41.0
	1.0	15.6	7.4	9.1	41.0		1.0	20.0	7.9	6.8	41.0
	2.0	15.3	7.3	7.0	41.0		1.9	16.5	7.8	0.4	38.0
	3.0	10.0	7.3	4.0	41.0		3.0	11.4	7.7	0.2	41.0
	4.0	8.7	7.1	3.1	40.0		4.0	9.8	7.6	0.1	42.0
	5.0	8.3	7.0	2.9	41.0		5.0	8.9	7.5	0.1	43.0
	6.0	8.0	6.9	2.7	41.0		6.0	8.5	7.4	0.1	48.0
	7.0	7.9	6.9	2.4	42.0		6.3	8.4	7.3	0.1	50.0
	7.2	7.8	6.9	1.0	43.0						







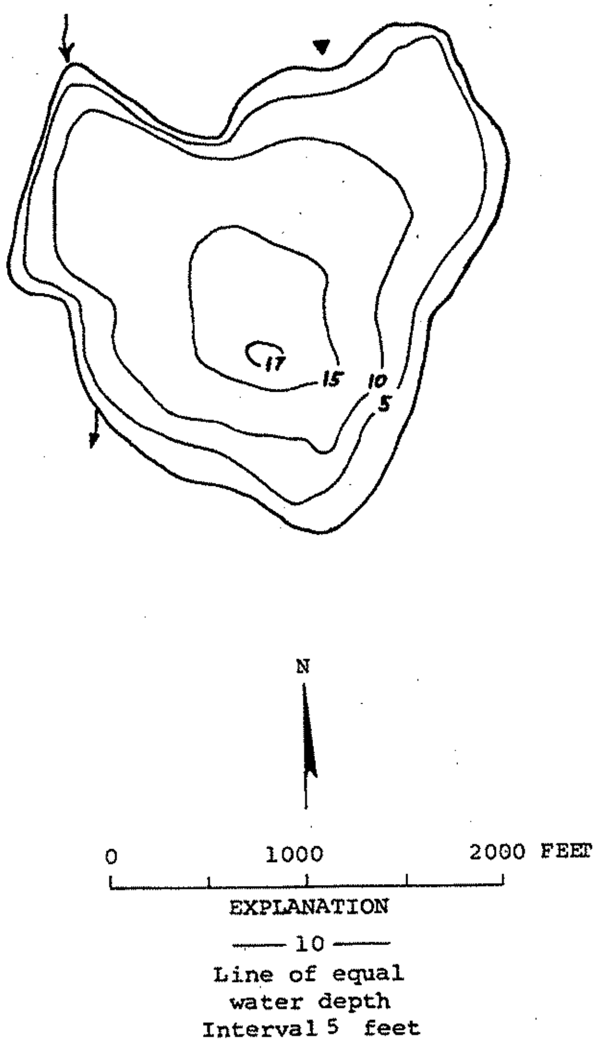


Lone Lake -- Island County

Lone Lake is located on Whidbey Island, 2.5 miles southwest of Langley, and one mile southeast from Goss Lake. It is fed by two small inlets, and drains to Useless Bay. Lone Lake was monitored by Ecology staff only.

Size (acres)	100
Maximum Depth (feet)	17
Mean Depth (feet)	9
Lake Volume (acre-feet)	920
Drainage Area (miles^2)	2.8
Altitude (feet)	17
Shoreline Length (miles)	1.6

Data from Bortleson *et al.* (1976)



Overall Assessment

Lone Lake was sampled by Ecology staff only in 1994.

Based on high concentrations of total phosphorus on both sampling dates and the very heavy population of aquatic plants, Lone Lake was classified as eutrophic in 1994. Algae growth was also heavy in the lake, but was primarily epiphytic algae associated with whitestem pondweed, therefore heavy growths would not be reflected in the concentrations of chlorophyll *a* measured in the lake.

Aquatic plants observed by Ecology staff during field visits include coontail (*Ceratophyllum demersum*), common waterweed (*Elodea canadensis*), whitestem pondweed (*Potamogeton praelongus*), muskgrass (*Chara*), bulrush (*Scirpus sp.*), yellow-flowering water lily (*Nuphar sp.*). The entire bottom of the lake was covered with whitestem pondweed, although common waterweed and coontail were the most abundant plants at the sampling site.

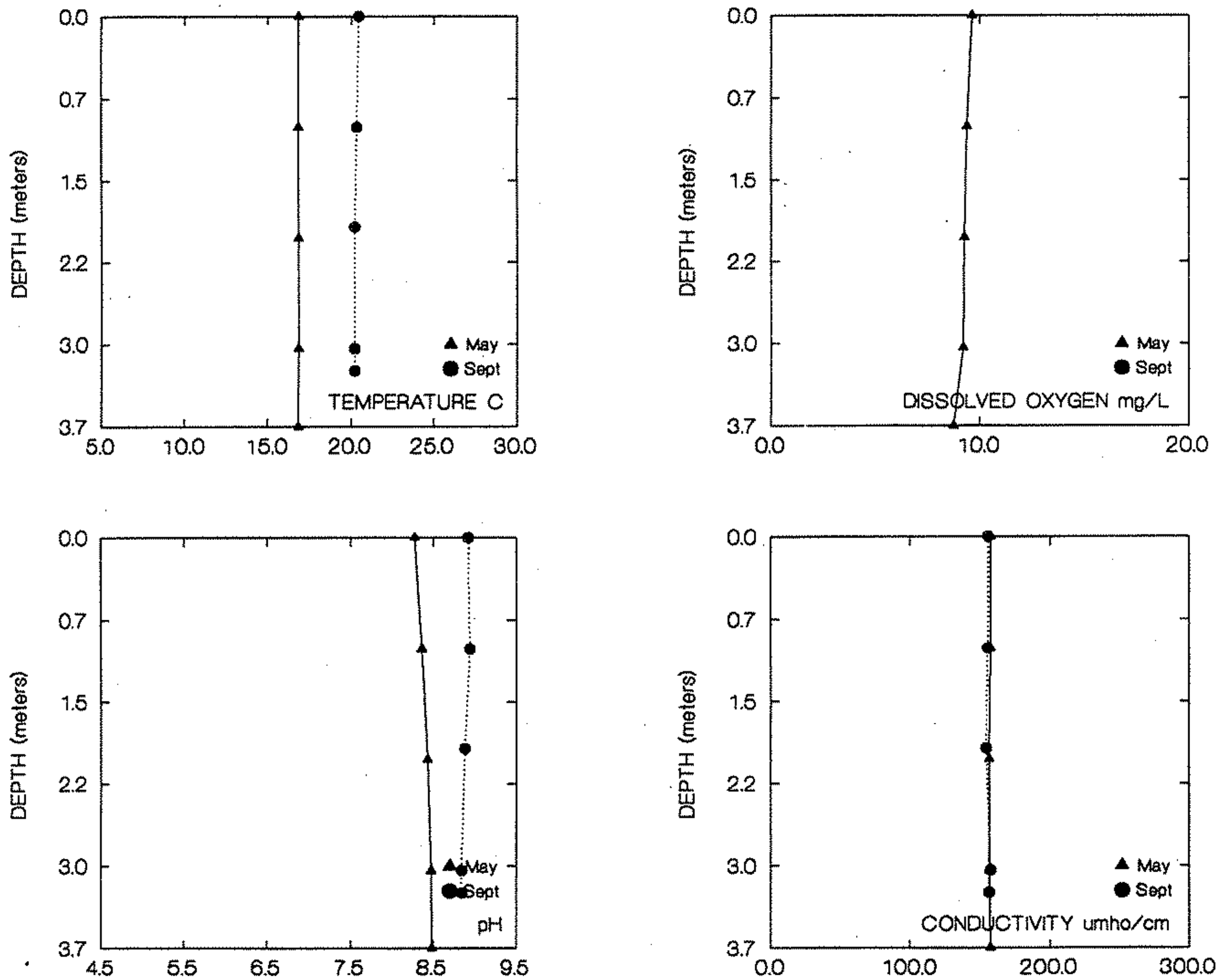
LONE (ISLAND) Lake -- ISLAND County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
74/08/05		E	75			(Source: Water Supply Bulletin 43)					
89/06/06	1	E	41	0.99	8.7						
89/09/05	1	E	61	1.07	21.3						
93/06/11	1	E	29	0.83	5.9						
93/08/29	1	E	41	0.88	4.4						
94/05/29	1	E	36	0.39	3.8						
94/09/03	1	E	75	0.69J	4.2						

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

LONE (ISLAND) Lake -- ISLAND County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/29	0.0	16.8	8.3	9.7	158.0	94/09/03	0.0	20.5	8.9	0.0	156.0
	1.0	16.8	8.4	9.4	158.0		1.0	20.4	8.9	0.0	156.0
	2.0	16.8	8.4	9.3	157.0		1.9	20.2	8.9	0.0	155.0
	3.0	16.9	8.5	9.2	157.0		3.0	20.2	8.8	0.0	158.0
	3.7	16.9	8.5	8.8	158.0		3.2	20.2	8.8	0.0	157.0

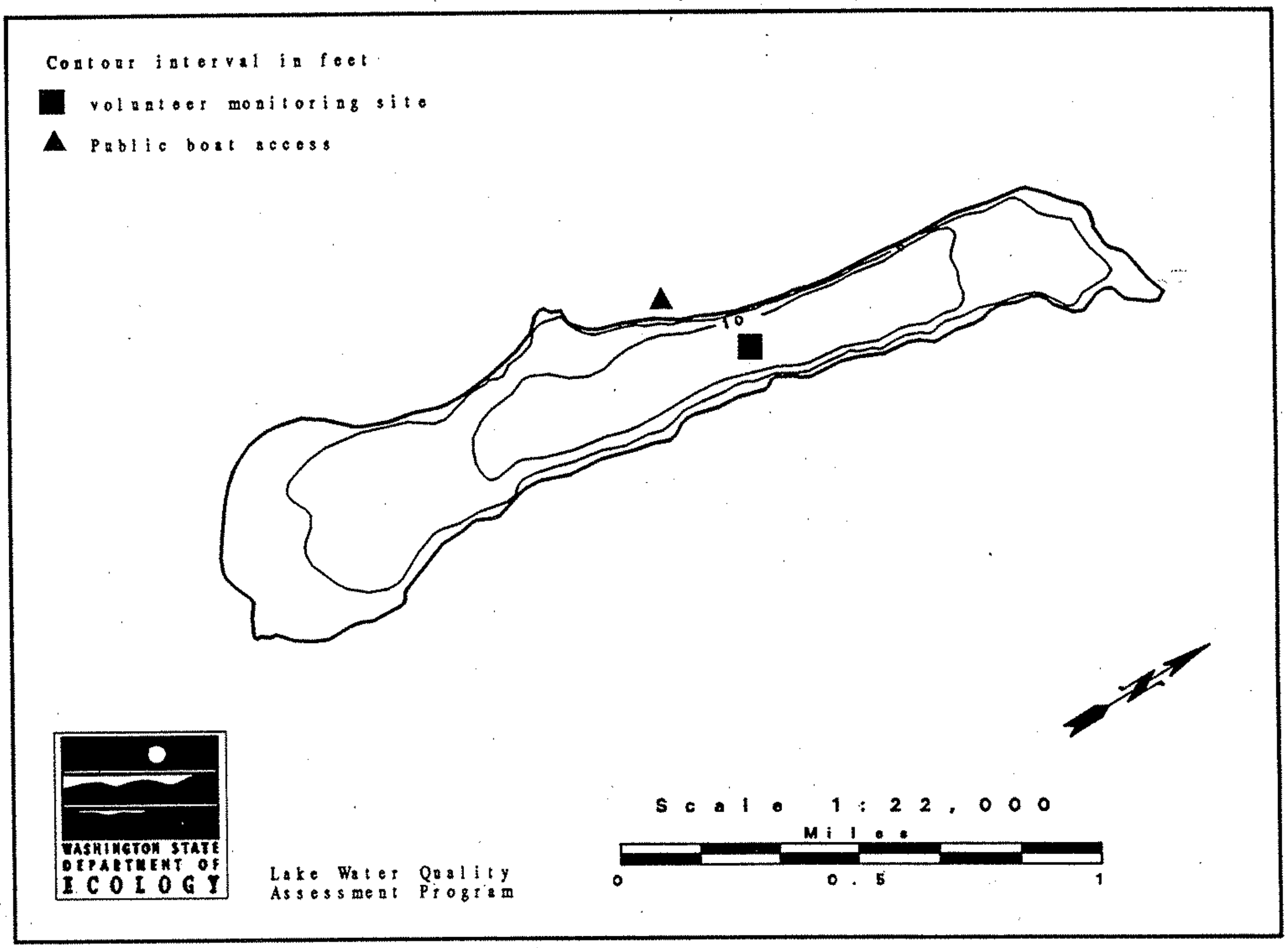


Long Lake -- Kitsap County

Long Lake is located 3.5 miles southeast of Port Orchard. It is two miles long. The lake is fed principally by Salmonberry Creek, and drains via Curley Creek to Yukon Harbor.

Size (acres)	339
Maximum Depth (feet)	12
Mean Depth (feet)	6
Lake Volume (acre-feet)	2,180
Drainage Area (miles^2)	9.4
Altitude (feet)	118
Shoreline Length (miles)	5.1

Data from Bortleson *et al.* (1976)



Overall Assessment

Compared to previous years, water quality in Long Lake was good in 1994. From 1989 through 1994, the pattern of Secchi depths shows that water clarity is generally lowest during August (see graph of Secchi depth data). However, there was no trend in water clarity from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results were not statistically significant at the 80% level ($p = 0.68$).

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Long Lake was classified as eutrophic in 1994 (see table of water chemistry data). However, concentrations of total phosphorus, total nitrogen, and chlorophyll *a* (which indicates the amount of algae in the water) were considerably lower in 1994 than in 1993. This suggests that the water quality was better in 1994 than in 1993, although it may take several years of data collection to determine if this is part of an improving trend in water quality.

Aquatic plants observed by Ecology staff during field visits include Brazilian elodea *(Egeria densa*), whitestem pondweed (*Potamogeton praelongus*), largeleaf pondweed (*Potamogeton amplifolius*), another pondweed (possibly *Potamogeton illinoensis*), coontail (*Ceratophyllum demersum*), and purple loosestrife (*Lythrum salicaria;* this is a wetland plant that grows on or near shore). Both Brazilian elodea and purple loosestrife are aggressive, non-native plants. According to staff with the Kitsap County Parks Department, purple loosestrife (even on private property) was sprayed with herbicide on August 22, 1994, in order to control the plant.

The worst problems in Long Lake are related to the presence of Brazilian elodea. This plant is an aggressive non-native plant, and is usually very abundant in the lake. This plant can easily be spread to other lakes; skiers and boaters using Long Lake should carefully clean all boat and trailer parts before entering other waterbodies, in order to prevent the spread of this noxious plant into other lakes or streams.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires from 1993 and 1994. .

> Long Lake is used for fishing, boating, swimming, rowing, jet skiing, and camping. Public recreational facilities on the lakeshore include a park, camping area, and a beach. There is one boat ramp on the lakeshore, and there is a speed restriction of 8 mph for motorboats within 300 feet of the shore, docks, and the swimming area. No fish were stocked in the lake in 1994. Currently the watershed is being logged and used for animal grazing, and grazing animals have direct access to the

lakeshore or inlet tributaries. The lakeshore is also being developed further for residences. Lake water is withdrawn for drinking and other domestic uses.

There are approximately 315 houses on the lakeshore, and none are connected to a sewer. There is a lake association for the lake. No algae or aquatic plant management activities occurred in 1994, although in the past the lake has been treated with herbicides [and alum] to control aquatic plants and algae, and aquatic plants have been mechanically harvested.

Overall, the volunteer found that Long Lake had good water quality. The worst problem in the lake in 1994 was excessive aquatic plant growth.

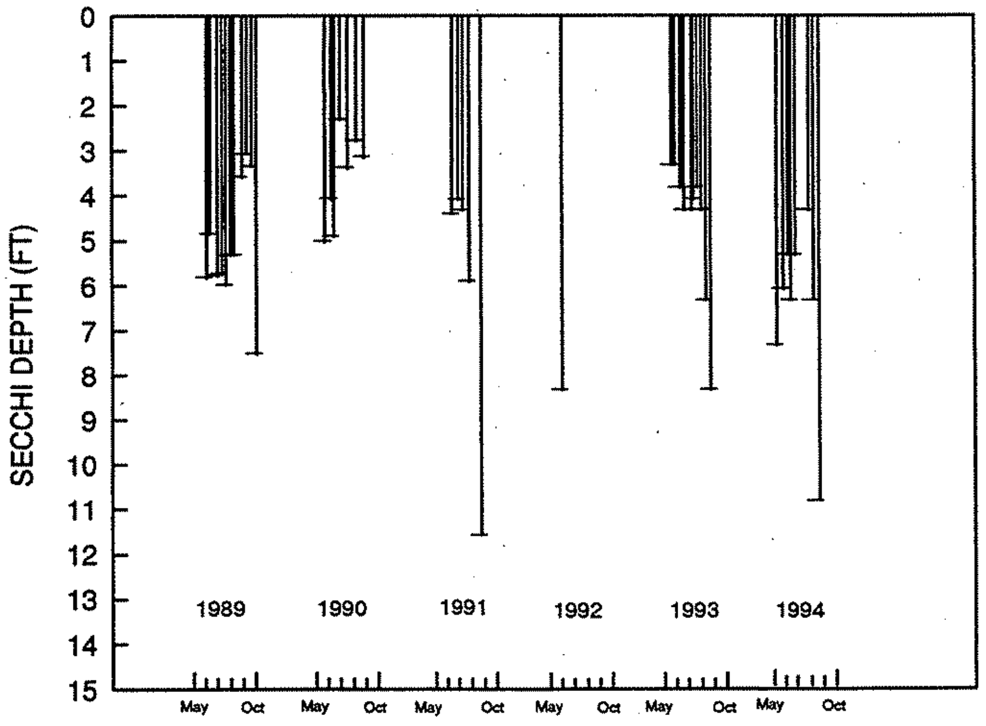
Acknowledgments

I thank Kathy Smith for volunteering her time to monitor Long Lake in 1993 and 1994. Wells Soden monitored the lake from 1989-1991.

LONG Lake -- KITSAP County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/23	0.0	32.0	0.0	Grn-brown	75	None	Breezy	7.0	0.0	Onsite visit. Changed sampling site. Water color brown-green.
94/06/12	16.7	62.1	0.0	Grn-brown	25	Light	Light	5.8	15.8	
94/06/27	19.4	66.9	0.0	Lt Brown	0	Trace	Light	5.0	15.5	
94/07/10	21.7	71.1	0.0	Lt Green	0	None	Calm	6.0	14.0	Water color light green-brown. Warm sunny days.
94/07/25	21.1	70.0	0.0	Lt Green	10	Trace	Strong	5.0	12.0	Water color light green-brown.
94/08/30	18.9	66.0	0.0	Lt Green	0	Trace	Light	4.0	13.5	Water color light green-brown.
94/09/17	17.2	63.0	0.0	Lt Brown	10	Trace	Light	6.0	13.5	No green tint to water color.
94/10/02	15.6	60.1	0.0	Clear	25	Light	Strong	10.5	12.5	Pretty clear!

LONG LAKE (KITSAP COUNTY)



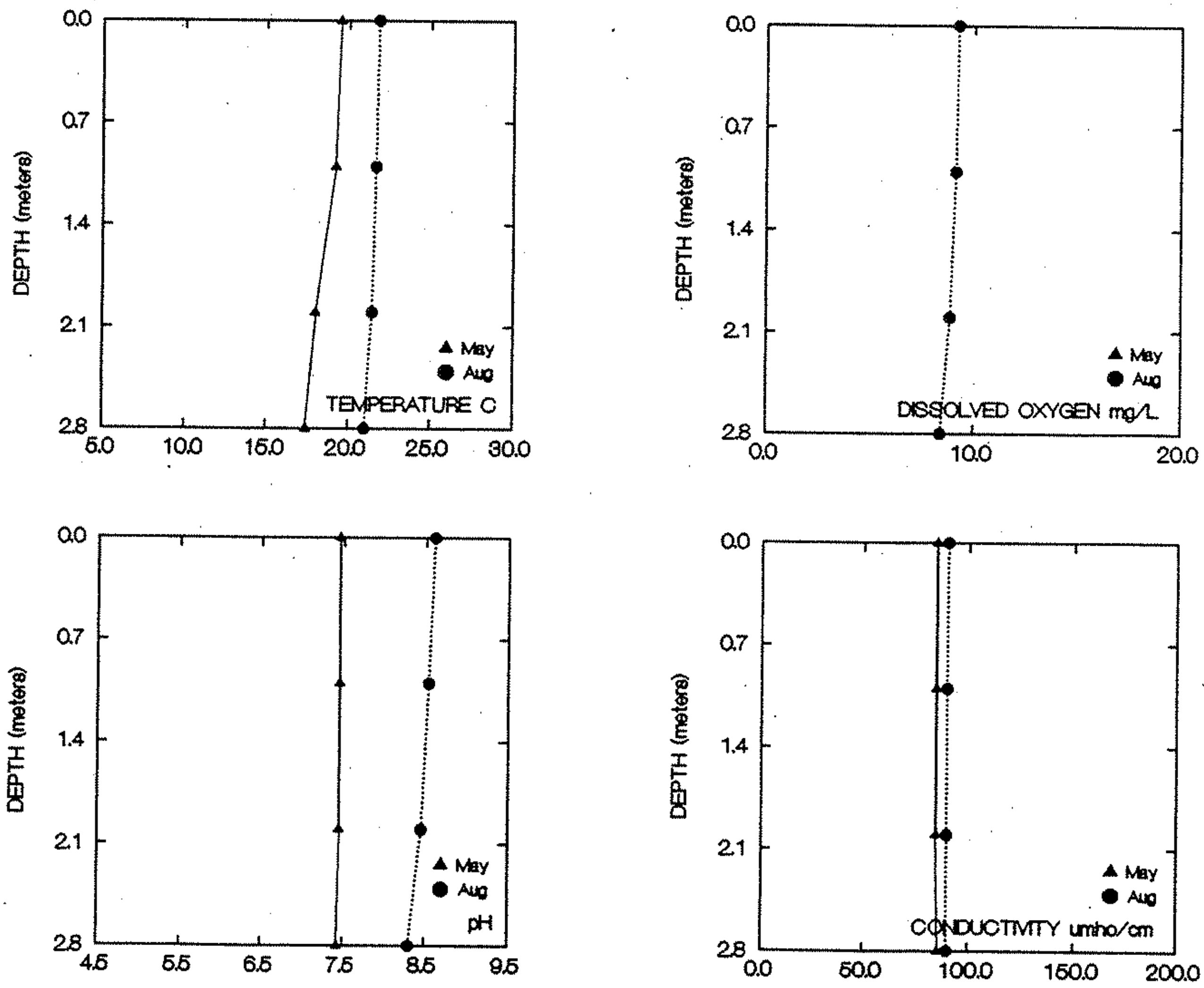
LONG (KITSAP) Lake -- KITSAP County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/22		E	41			(Source: Water Supply Bulletin 43)					
90/05/23	1	E									
90/08/14	1	E									
91/05/31	1	E		0.36							
92/08/07	1	E	22	0.41							
92/08/07	1	H									
93/06/07	1	E	62	0.69	10.8						
93/08/30	1	E	60	0.73	28.4						
94/05/23	1	E	35	0.23	5.1J						
94/08/23	1	E	35	0.49J	19.4						

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

LONG (KITSAP) Lake -- KITSAP County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/23	0.0	19.5	7.5	0.0	85.0	94/08/23	0.0	21.9	8.6	9.3	90.0
	1.0	19.2	7.5	0.0	85.0		1.0	21.7	8.5	9.2	90.0
	2.0	18.0	7.5	0.0	85.0		2.0	21.5	8.5	8.9	90.0
	2.8	17.4	7.4	0.0	86.0		2.8	21.1	8.3	8.5	90.0

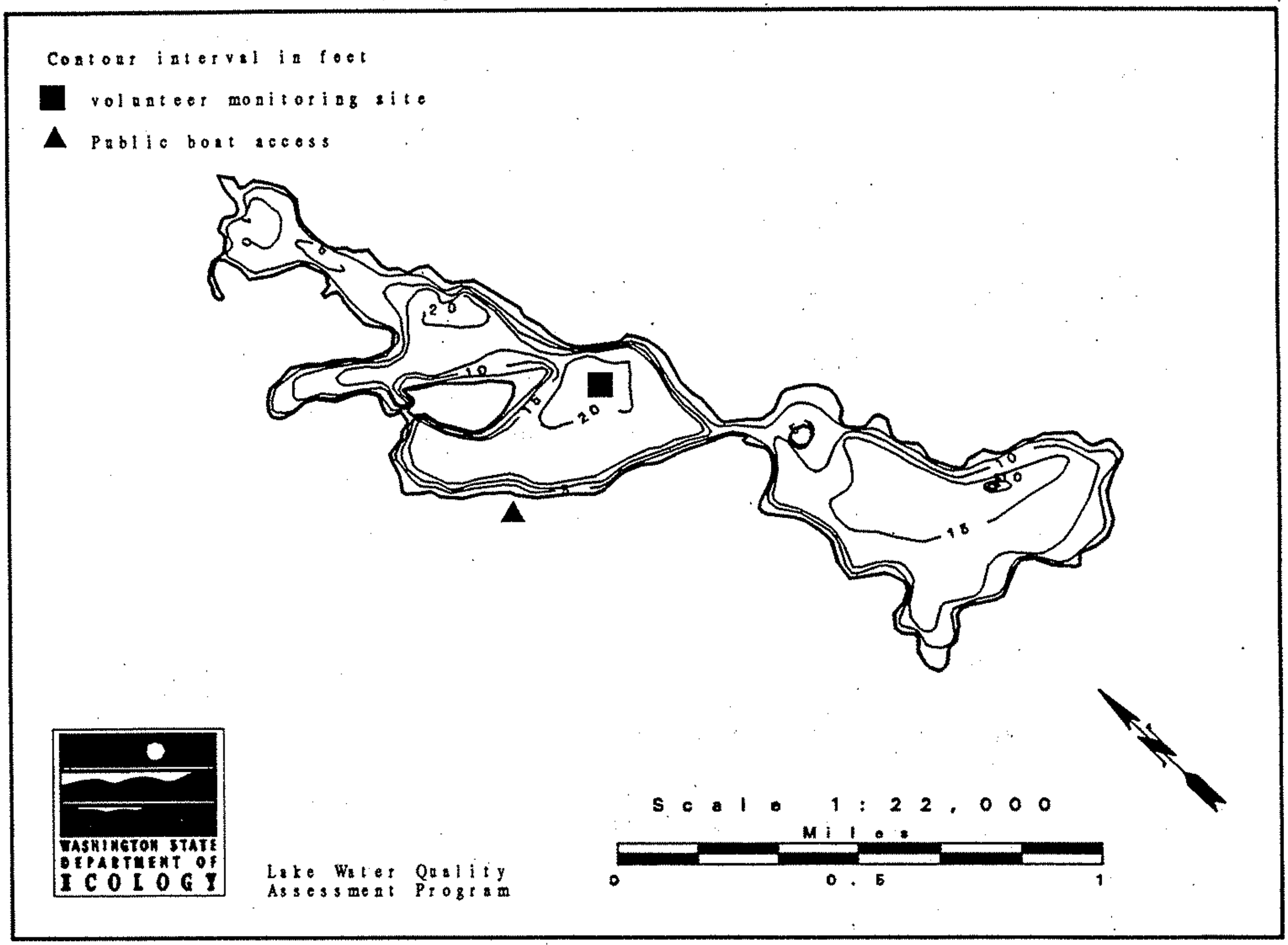


Long Lake -- Thurston County

Long Lake is located 5.5 miles east of Olympia. It consists of two basins, which are connected by a narrow neck. It is two miles long and has two islands, Holmes Island (13 acres) and Kirby Island (2.4 acres). Long Lake is fed by Pattison Lake and drains via Himes/Woodland Creek and Lois Lake to Henderson Inlet.

Size (acres)	330
Maximum Depth (feet)	21
Mean Depth (feet)	12
Lake Volume (acre-feet)	3,900
Drainage Area (miles^2)	8.3
Altitude (feet)	153
Shoreline Length (miles)	7.1

Data from Bortleson *et al.* (1976)



Overall Assessment

General water quality of Long Lake was good in 1994. There was a wide range of Secchi depths measured in 1994, which were very similar to those measured in 1989 (see graph of Secchi depth data). Overall, there was no trend in water clarity from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results were not statistically significant at the 80% level ($p = 0.76$).

Concentrations of total phosphorus were moderately high on both sampling dates, and Secchi depths and chlorophyll *a* concentrations indicate that there was a moderately high amount of algae when the lake was sampled. (Water chemistry results are listed in tables at the end of this summary.) Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Long Lake was classified as mesotrophic in 1994. This is an improvement since the 1993 monitoring season.

Although a channel was illegally cut between Lake Pattison and Long Lake in 1994 (presumably, to lower the high level in Lake Pattison), the volunteer did not notice a change in lake level at the north end of Long Lake following this action. Results from trend analysis of volunteer-collected lake level data showed that there was a statistically significant decreasing trend in lake level from 1990 to 1994 ($p = 0.02$). A decreasing trend was also detected in 1993, using data from 1990-1993.

During the August 1994 field visit, aquatic plants observed in the channel between the north and south areas of the lake include white-flowering water lily (*Nymphaea odorata*), slender naiad (*Najas flexilis*), tapegrass (*Vallisneria americana*), curly-leaf pondweed (*Potamogeton crispus*), yellow-flowering water lily (*Nuphar sp.*). At the south end of the lake, plants included tapegrass, white-flowering water lily, naiad, largeleaf pondweed (*Potamogeton amplifolius*), common waterweed (*Elodea canadensis*), slender pondweed (*Potamogeton foliosus*), whitestem pondweed (*Potamogeton praelongus*), duckweed (*Lemna sp.*),and watershield (*Brasenia schreberi*). Algae was more prevalent in this south basin, and colonies of *Gloeotrichia*, *Aphanizomenon*, and *Nitella* were visible. Overall, the plant population was more diverse, and less affected by residual herbicide (less bleaching of plants), than during the August 1993 survey.

From Thurston County (1995): Long Lake was treated with Sonar® (fluridone) during summer 1991 to control a heavy infestation of Eurasian watermilfoil (*Myriophyllum spicatum*). The lake has since been surveyed annually for Thurston County's Long Lake Management District, to evaluate the effectiveness of the whole-lake herbicide treatment and to document the progress of native plant recovery. In 1994, the survey was conducted during May and June. A total of 16 aquatic plants were observed. These were coontail, muskgrass, common elodea, spike rush (*Eleocharis sp.*), naiad, Nitella, yellow water lily, fragrant water lily, largeleaf pondweed, thinleaf pondweed (*Potamogeton berchtoldii*), curly-leaf pondweed, Richard's pondweed (*Potamogeton richardsonii*), whitestem pondweed, flatstem pondweed (*Potamogeton zosteriformis*), bladderwort (*Ultricularia vulgaris*), and tapegrass. No Eurasian watermilfoil was found. This was attributed to action following the 1992 survey, when small patches of milfoil were pulled or covered with bottom screens.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Long Lake is used for fishing, boating, swimming, rowing, jet skiing, and camping. Recreational facilities on the lakeshore include a park, a picnic area, a camping area, a beach, a resort and eight boat ramps. There is a speed restriction of 45 mph for motorboats. Less than 1% of the shoreline is publicly-owned. Brown trout were stocked in the lake in 1994. Currently the watershed is used for light industry, animal grazing and crop agriculture. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for animal grazing, the lake was dredged, and the shoreline was altered.
>
> There are about 320 houses on the lakeshore, and none of the houses are connected to a sewer. There is a lake association and lake management district for the lake. A mechanical harvester was used to control aquatic plants in the lake in 1994. Currently, the minimum setback for residential development is 50 feet. Lake water is withdrawn for irrigation.
>
> Overall, the volunteer found that Long Lake had good water quality in 1994. Problems in the lake in 1992 were ranked as (1) low water level, and (2) algae. Water level in 1994 was lowest the volunteer had seen in 14 years at the lake. Following the herbicide treatment to control Eurasian watermilfoil, the milfoil is still controlled and native plant species have recovered. Plant surveys are contracted by the lake management district as part of the milfoil control strategy.

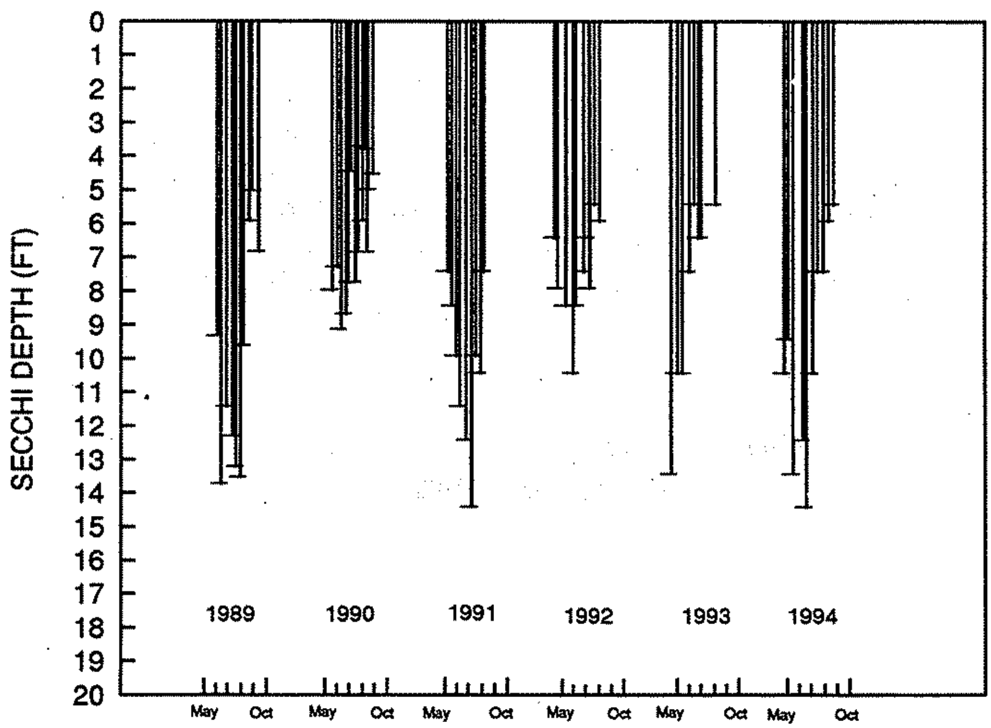
Acknowledgments

I thank Kathey Adams for volunteering her time to monitor Long Lake during 1989-1994. Sue Mauermann was the primary monitor at Long Lake during 1992.

LONG Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/16	14.4	57.9	0.0	Grn-brown	90	Mod	Breezy	10.0	20.8	Onsite visit. Second Secchi with view tube.
94/05/31	15.6	60.1	0.0	Grn-brown	100	Mod	Breezy	9.0	21.0	Second Secchi with view tube.
94/06/16	17.8	64.0	0.0	Lt Green	50	Trace	Calm	13.0	0.0	This is the best water clarity I have seen in a long time.
94/07/17	21.1	70.0	0.0	Lt Green	75	None	Breezy	12.0	0.0	Excellent visibility in the water. Never has b een better.
94/07/27	23.3	73.9	0.0	Lt Green	0	None	Breezy	14.0	0.0	Lake level is 1" lower than 8/26. If water lev el continues to drop like last year we should see an increase in native plants returning. Th is doesn't appear to be a problem anywhere exce pt in Cove at Pleasant Acres.
94/08/15	0.0	32.0	0.0	Grn-brown	90	None	Breezy	10.0	30.0	
94/08/29	0.0	32.0	0.0	Grn-brown	25	Trace	Breezy	7.0	32.5	Level dropped 11" this season so far. Alcohol in thermometer is separated--68 or 74 degrees. Lots of algae in the water.
94/09/20	0.0	32.0	0.0	Grn-brown	0	None	Light	7.0	34.0	Temp 68/72.
94/10/03	0.0	32.0	0.0	Grn-brown	0	None	Breezy	5.5	35.8	Temp 60/66
94/10/20	0.0	32.0	0.0	Grn-brown	75			5.0	36.8	Remember to check temperature--recorded 42/48 o n this card.

LONG LAKE (THURSTON COUNTY)



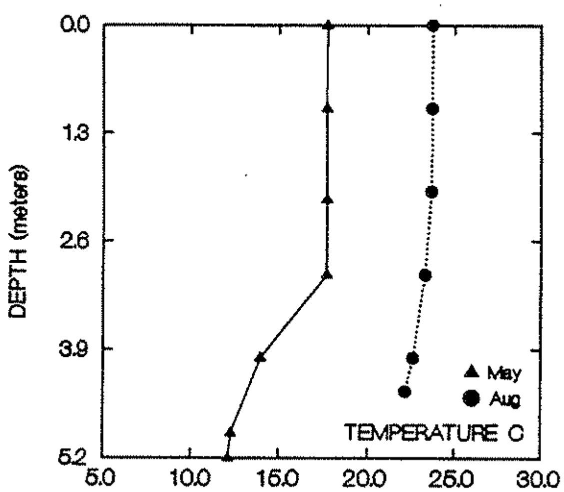
LONG (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

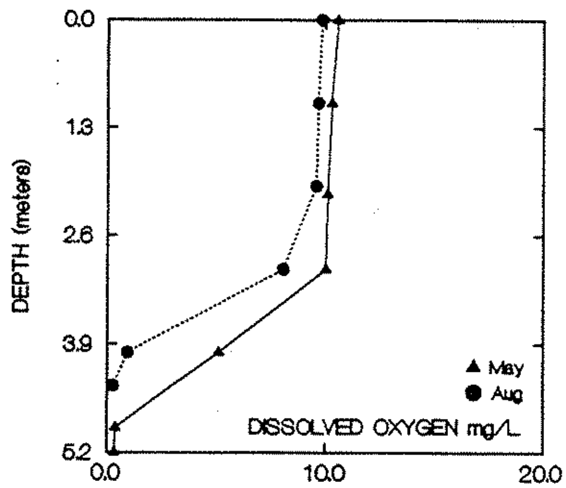
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/20		E	10			(Source: Water Supply Bulletin 43)					
90/05/29	1	E									
90/08/21	1	E									
91/06/04	1	E		0.40							
92/05/01	1	E	31	0.44	3.2						
92/05/01	1	H	54	0.45							
92/09/02	1	E	36	0.43	6.3						
92/09/02	1	H	688								
93/05/21	1	E	32	0.33	4.6						
93/08/26	1	E	45	0.56	17.8						
94/05/16	1	E	17	0.27	4.0						
94/05/16	1	H	30	0.25							
94/08/15	1	E	27	0.45	2.4						
94/08/15	1	H	69	0.36J							

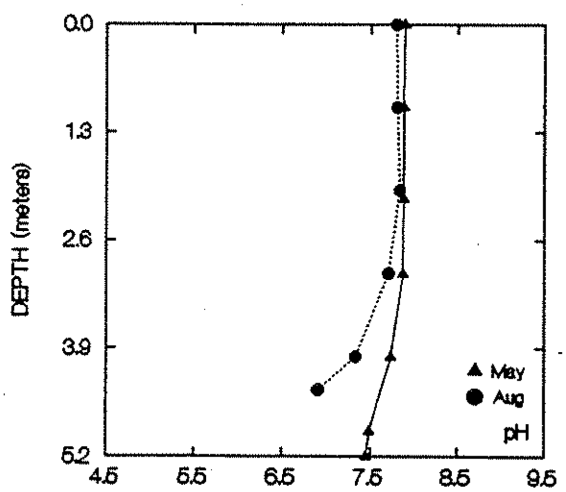
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

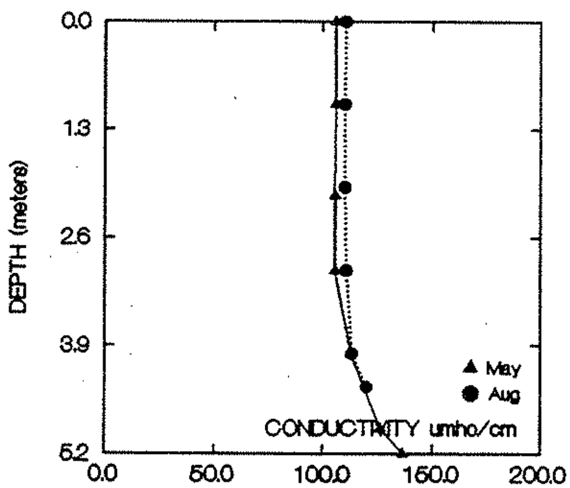
LONG (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/16	0.0	17.7	7.9	10.6	106.0	94/08/15	0.0	23.8	8.3	9.8	110.0
	1.0	17.7	7.9	10.3	106.0		-0.3	22.8	7.2	5.8	15.0
	2.1	17.7	7.9	10.1	106.0		1.0	23.7	8.3	9.7	110.0
	3.0	17.7	7.9	10.0	106.0		2.0	23.7	8.3	9.6	110.0
	4.0	14.0	7.7	5.1	113.0		3.0	23.4	8.2	8.0	111.0
	4.9	12.3	7.5	0.4	126.0		4.0	22.7	7.8	0.9	113.0
	5.2	12.1	7.5	0.3	137.0		4.4	22.2	7.4	0.3	120.0







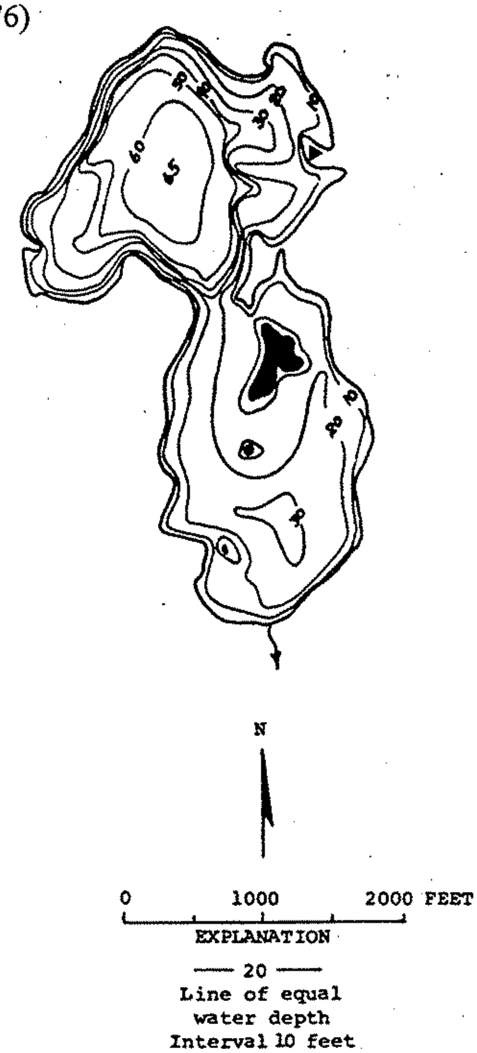


Lost Lake -- Mason County

Lost Lake is located 7.75 miles southwest of Shelton. It has no surface inlets, and drains via the south fork of Goldsborough Creek to Oakland Bay. It has a three-acre island. Lost Lake was monitored by Ecology staff only.

Size (acres)	120
Maximum Depth (feet)	65
Mean Depth (feet)	28
Lake Volume (acre-feet)	3,400
Drainage Area (miles^2)	1.08
Altitude (feet)	480
Shoreline Length (miles)	3.2

Data from Bortleson *et al.* (1976)



Lost Lake, Mason County. From Washington Department of Game, February 12, 1952.

Overall Assessment

Lost Lake was surveyed by Ecology staff only in 1994.

Although concentrations of total phosphorus were high during the May survey, concentrations were lower and similar to values from earlier surveys during the August survey. Heavy rains prior to the May survey may have contributed to the higher concentrations measured.

Based on results for all three major trophic state parameters (total phosphorus--August only, chlorophyll *a*, and Secchi depths), Lost Lake was classified as oligo-mesotrophic in 1994.

Lost Lake was surveyed by Ecology staff on August 11, 1994, for Ecology's Freshwater Aquatic Weeds Program. Aquatic plants observed include Dulichium (*Dulichium arundinaceum*), slender pondweed (*Potamogeton pusillus*), common elodea (*Elodea canadensis*), ribbonleaf pondweed (*Potamogeton epihydrus*), yellow flag (*Iris pseudacorus*), lake quillwort (*Isoetes lacustris*), stonewort (*Nitella sp.*), tapered rush (*Juncus acuminatus*), and sedge (*Carex sp.*). At the time of the survey there were few rooted plants, including only two patches of pondweeds. There is a gravel bottom at the south end of lake, and no plants. Mats of filamentous algae were on the lake bottom, from 0.5 m to approximately 8 m of water. Growths of stonewort (an alga) were fairly dense in deeper water.

Problems with epiphytic algae were reported by lakeshore residents in 1993. Localized nearshore problems may be due to wastewater and shoreline management practices along the lake.

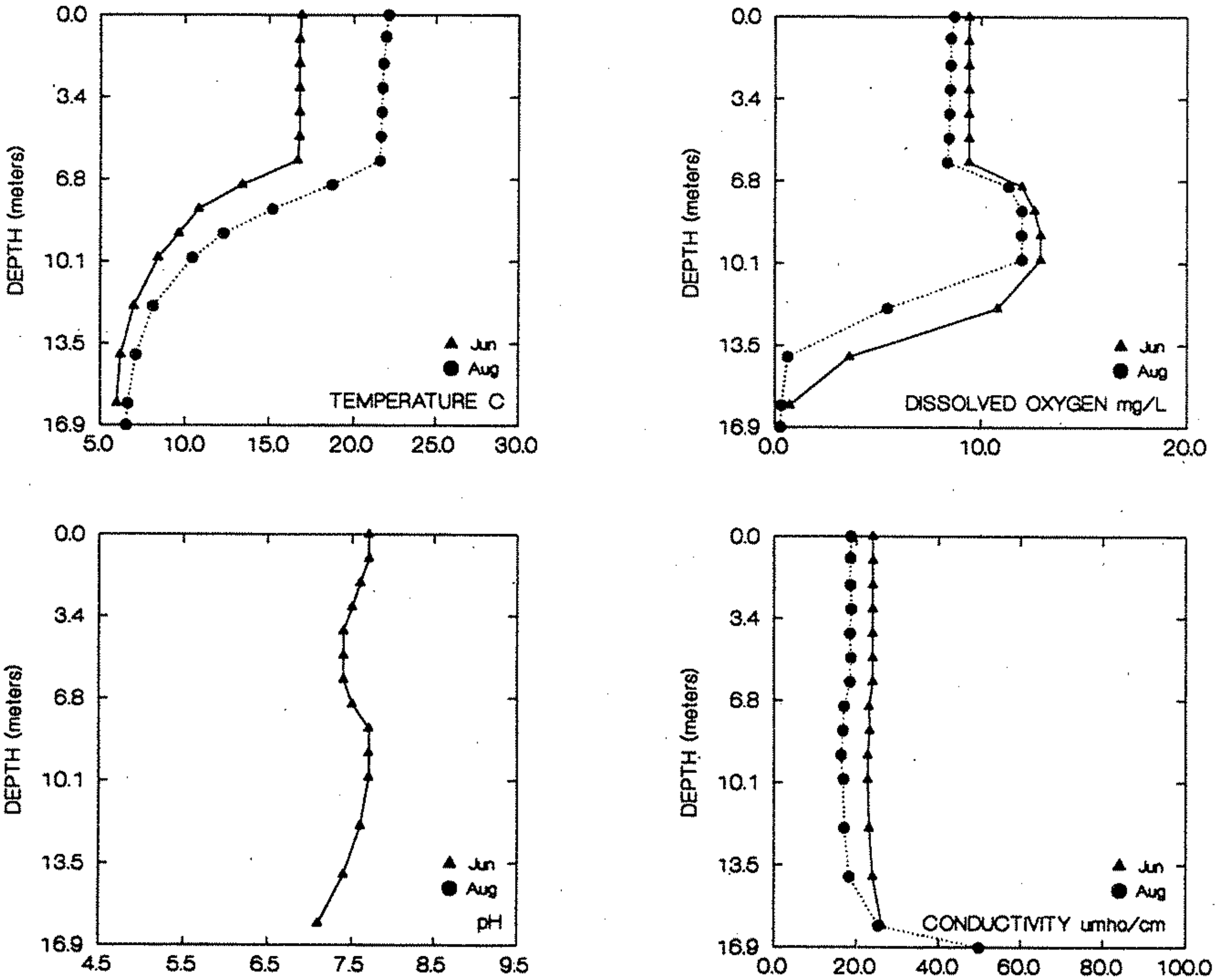
LOST (MASON) Lake -- MASON County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/21		E	16			(Source: Water Supply Bulletin 43)					
81/06/24		E	10		0.9	(Source: Water Supply Bulletin 57)					
93/05/27	1	E	12	0.17	0.6						
93/05/27	1	H	15	0.19							
93/09/02	1	E	4	0.20	0.6						
93/09/02	1	H	9	0.20							
94/06/01	1	E	41	0.12	1.3						
94/06/01	1	H	87	0.13							
94/08/24	1	E	12	0.14J	3.4						
94/08/24	1	H	29	0.22J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

LOST (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/01	0.0	16.9	7.7	9.4	24.0	94/08/24	0.0	22.1	0.0	8.7	19.0
	1.0	16.8	7.7	9.4	24.0		0.9	22.0	0.0	8.5	19.0
	2.0	16.8	7.6	9.4	24.0		2.0	21.8	0.0	8.5	19.0
	3.0	16.8	7.5	9.4	24.0		3.0	21.8	0.0	8.5	19.0
	4.0	16.8	7.4	9.4	24.0		4.0	21.7	0.0	8.5	18.0
	5.0	16.8	7.4	9.4	24.0		5.0	21.7	0.0	8.4	19.0
	6.0	16.7	7.4	9.4	24.0		6.0	21.6	0.0	8.3	18.0
	7.0	13.4	7.5	12.0	23.0		7.0	18.7	0.0	11.3	17.0
	8.0	10.8	7.7	12.6	23.0		8.0	15.2	0.0	12.0	17.0
	9.0	9.6	7.7	12.9	23.0		9.0	12.3	0.0	12.0	16.0
	10.0	8.4	7.7	12.9	23.0		10.0	10.4	0.0	12.0	17.0
	12.0	7.0	7.6	10.8	23.0		12.0	8.1	0.0	5.5	17.0
	14.0	6.2	7.4	3.6	24.0		14.0	7.1	0.0	0.6	18.0
	16.0	6.0	7.1	0.7	26.0		16.0	6.7	0.0	0.3	25.0
							16.9	6.5	0.0	0.3	50.0

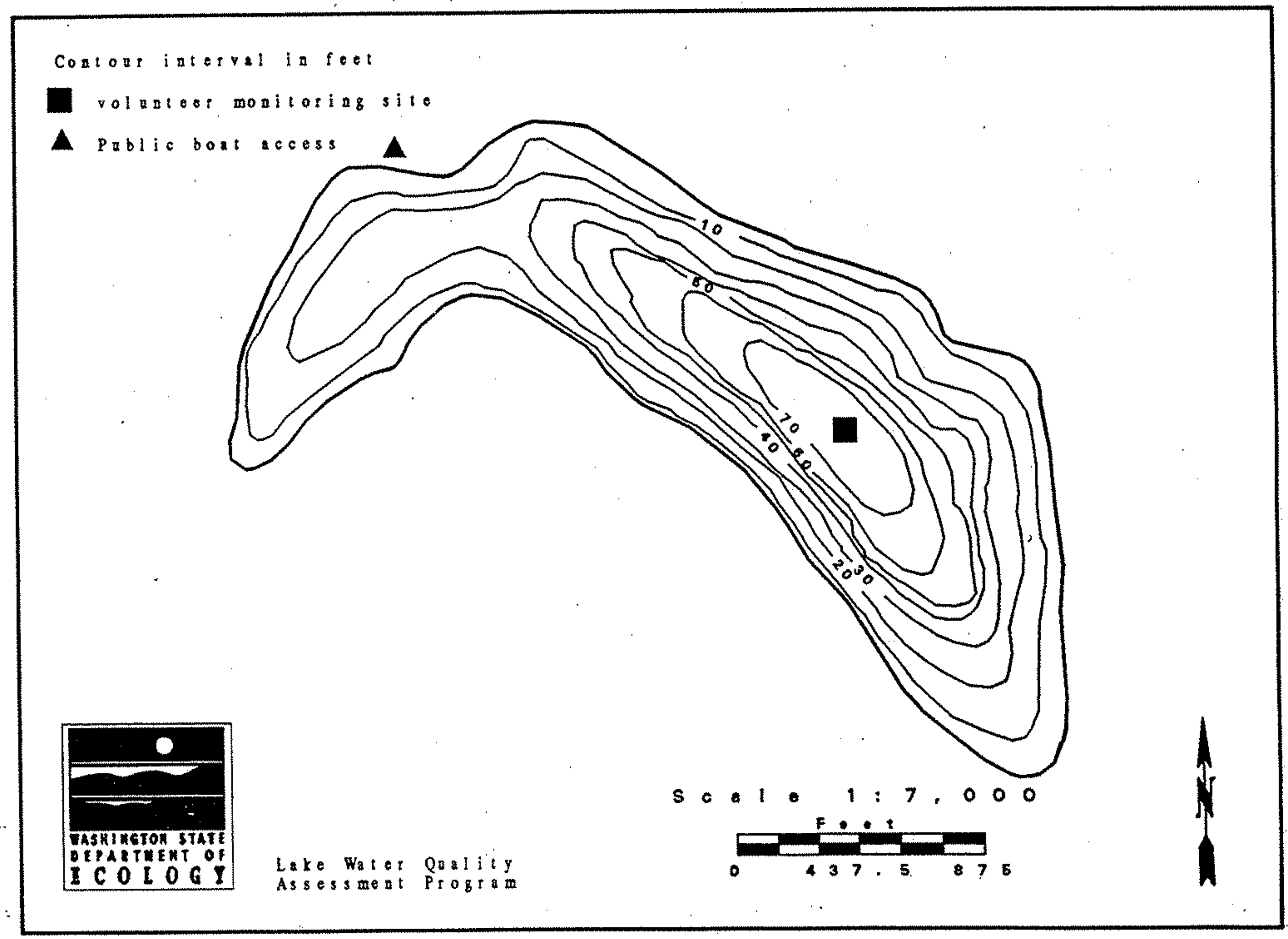


Lake Martha (near Warm Beach) -- Snohomish County

Lake Martha is located 10.5 miles northwest of Marysville, and one mile east of Warm Beach. It is fed by Lake Howard and drains to Port Susan. (There is another Lake Martha, known as Martha Lake, located near Alderwood Manor.)

Size (acres)	62
Maximum Depth (feet)	70
Mean Depth (feet)	33
Lake Volume (acre-feet)	2,034
Drainage Area (miles^2)	1.6
Altitude (feet)	186
Shoreline Length (miles)	1.8

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Lake Martha was good in 1994. Despite a moderately high concentration of total phosphorus during the May survey (see table of water chemistry data), Secchi depths and chlorophyll *a* concentrations indicated that algal growth was low when the lake was sampled.

Secchi depths improved significantly from 1990 through 1994 (see graph of Secchi depth data). This was tested using the seasonal Kendall test for trend, and results were statistically significant at the 90% level ($p = 0.07$). Concentrations of total phosphorus in the upper layer of water were lower in 1994 than in 1993, which may have contributed to the very good water clarity in 1994.

Lake Martha was classified as oligo-mesotrophic in 1994, based on Secchi depths, both chlorophyll *a* results, and the August total phosphorus concentration. The mesotrophic condition of the lake in 1993 could be due to weather patterns in 1993, which were warm and very dry. Several lakes in the Lake Water Quality Assessment Program were more eutrophic in 1993 than in previous years, most likely due to effects from weather.

Aquatic plants identified by Ecology staff during field visits include common waterweed (*Elodea canadensis*), Nuttall's waterweed (*Elodea nutalli*), coontail (*Ceratophyllum demersum*), muskgrass (*Chara*), largeleaf pondweed (*Potamogeton amplifolius*), flatleaf pondweed (*Potamogeton robbinsii*), iris (*Iris pseudacorus*), cattails (*Typha*), and yellow-flowering water lily (*Nuphar sp.*). Freshwater sponges have also been observed in the lake. Two goldfish, approximately eight inches long, were observed during the May 1994 survey. Introduced goldfish have created nuisance problems in eastern Washington lakes, and should not be introduced into any lake. Snohomish County's Lake Monitoring Program was scheduled to survey aquatic plants in Lake Martha on August 22, 1994. Results of this survey are not currently available.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Martha is used for fishing, swimming, motor boating, non-motorized boating, lakeshore camping, and birdwatching. There is one public boat ramp on the lakeshore, and the only restriction for motorboating is a speed limit of 8 mph. About 1% of the shoreline is publicly-owned. Trout were stocked in the lake in 1994. Currently, the watershed is being logged and used for animal grazing/feeding. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for crop agriculture and animal

grazing/feeding. In 1969, the lake was dredged on the east end near the inlet to create a U-shaped embayment and to extend the shoreline. Lots on this property were developed.

There are about 93 houses on the lakeshore, and none of the houses are connected to a sewer. There is a community association for education about the lake. No lake management activities occurred on the lake in 1994. Currently, the minimum setback for development is 26 feet.

Overall, the volunteer found that Lake Martha had good water quality. Problems in the lake in 1994 were low water level, and shoreline erosion. Algae, which was the worst problem in 1993, was not listed in 1994. Possible sources of shoreline problems are improper and unauthorized lot clearing, excessive use of grass as ground cover, and burning occurring too close to the lake. Guidelines should be issued with burning permits, to restrict burning near water. Since the 1993 monitoring season, two lakeshore lots were cleared, one house was built, and internal combustion engines were banned in April 1994.

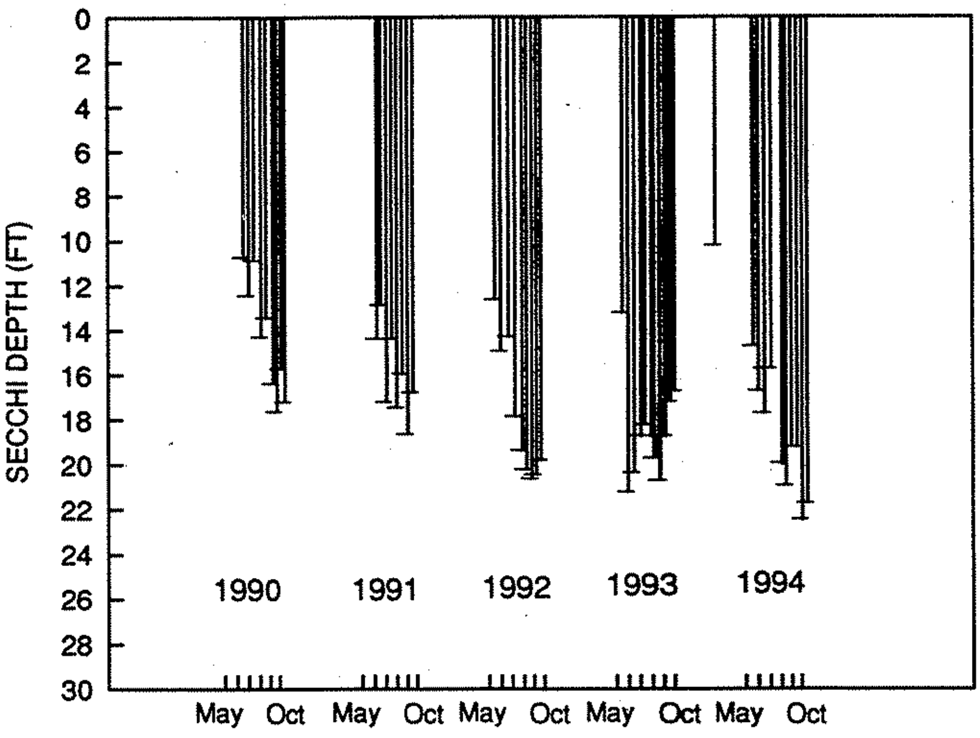
Acknowledgment

I thank Nancy Dean for volunteering her time to monitor Lake Martha during 1993 and 1994. Joan Lucas monitored the lake from 1990 through 1992.

MARTHA (NORTH; L. MARTHA) Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/02/01	39.0	102	0.0		0	None	Calm	9.6	30.0	Water color yellow against Secchi; dark green/brown just looking down. Lots of 1/4" long paricu lates shaped like fir needles, but very fine.
94/05/19	20.0	68.0	0.0		0	None	Light	14.1	33.3	Onsite visit. Water color yellow-brown/green. Small particate matter. 6 frog egg clutches around my dock. Internal combustion engines banned April, 1994. 2 8" goldfish seen. Light remnants of brownish algae nearshore.
94/06/03	20.0	68.0	0.0		10	Light	Light	16.1	35.5	Water color greenish gold. Some particulate matter. Water quite clear, even near shore.
94/06/17	20.0	68.0	0.0		0	Mod	Breezy	15.1	36.5	Water color greenish gold. 8 merganser ducklings on lake - old enough to dive. 5-6 Canada goslings getting large. Lots of frogs. Water quite clear.
94/06/17	23.3	73.9	0.0		0	None	Breezy	17.1	40.0	Water color gold.
94/07/04	20.6	69.1	0.0		100	Trace	Breezy	15.1	37.5	Water color gold. Lots of small particulate matter. Looks like an underwater sand storm. Osprey quite active on lake.
94/08/04	20.0	68.0	0.0		100	Trace	Light	19.3	43.5	Water color lime-gold. Looking good. Having lots of sunshine and quite a bit of wind. Still small particulate matter, but looks quite clear near shore.
94/08/18	23.9	75.0	0.0		0	None	Calm	20.3	45.8	Water color is lime gold. On site visit.
94/08/31	21.7	71.1	0.0		0	None	Light	18.6	48.0	Water color goldenrod. Freshwater sponge back. Elodea increasing along shoreline. Flock of about 30 geese landed on lake this a.m.
94/09/15	20.0	68.0	0.0		100	Mod	Breezy	18.6	49.0	Water color goldenrod. Monitored lake with Becky McGuire from the county on Sunday - will have lots of data from that. Water still looking quite clear.
94/10/01	63.5	146	0.0		50	Light	Light	21.8	51.0	Water color goldenrod. Lot at SE end of alke totally cleared by heavy equipment. Debris pushed into water. Stop work order posted last week, but still no silt barrier up. Debris is below high water mark. looks bad for when rain sta
94/10/15	13.3	55.9	0.0		100	Light	Light	21.1	52.5	Water color dusky gold. Everything looks good. Concerned with burning along shoreline. Evidently the fire department gives permits for burning adjacent to lake. Will investigate.

LAKE MARTHA (SNOHOMISH COUNTY)



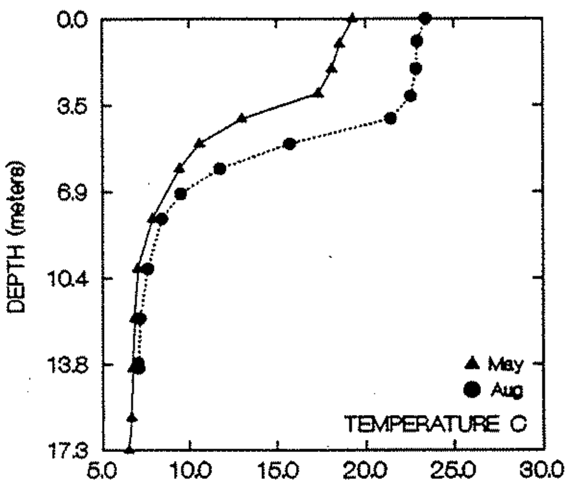
MARTHA (LAKE MARTHA) (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

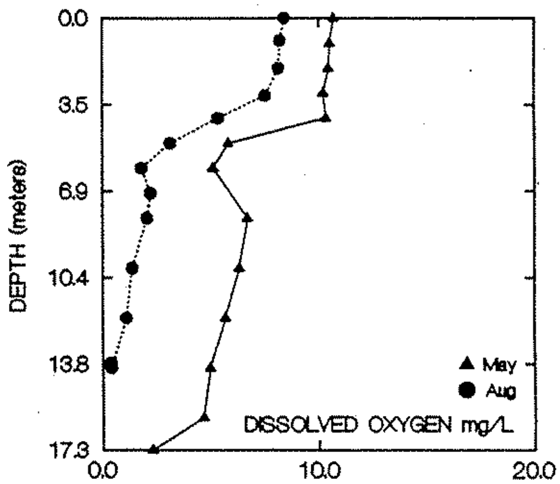
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
74/06/20		E	17			(Source: Water Supply Bulletin 43)					
81/06/30		E	10		6.0	(Source: Water Supply Bulletin 57)					
90/06/05	1	E	8	0.62							
90/08/28	1	E	12	0.46							
91/06/18	1	E		0.61							
92/06/01	1	E	12	0.46	1.9	9	5		2	1U	30
92/06/01	1	H	12	0.66							
92/08/05	1	E	12	0.38	0.6	4	1U		2	1U	20
92/08/05	1	H	17	0.63							
93/05/25	1	E	41	0.41	5.0						
93/05/25	1	H	22	0.47							
93/08/18	1	E	12	0.32	3.1						
93/08/18	1	H	29	0.44							
94/05/19	1	E	20	0.24	3.2						
94/05/19	1	H	31	0.41							
94/08/18	1	E	9	0.36J	2.0J						
94/08/18	1	H	17	0.37J							

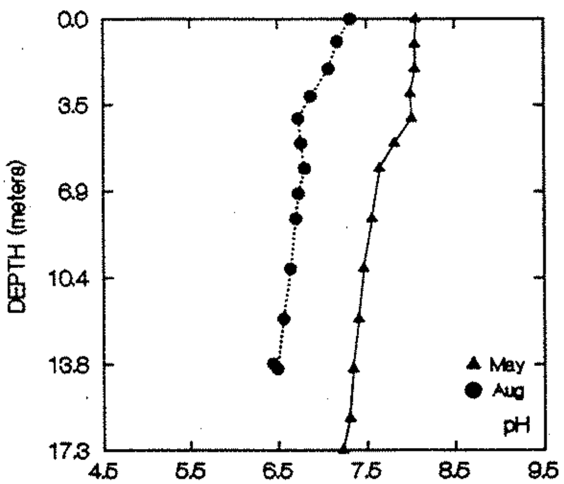
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

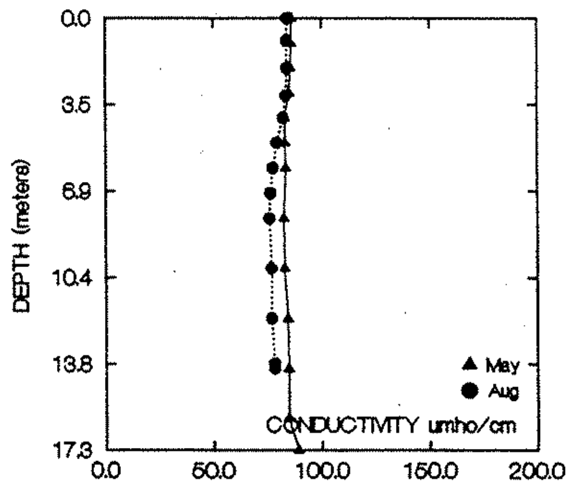
MARTHA (LAKE MARTHA) (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	19.3	8.1	10.7	87.0	94/08/18	0.0	23.5	7.8	8.4	84.0
	1.0	18.5	8.1	10.5	86.0		0.9	23.0	7.7	8.2	84.0
	2.0	18.1	8.1	10.4	86.0		2.0	22.9	7.6	8.2	84.0
	3.0	17.3	8.0	10.2	85.0		3.1	22.6	7.4	7.5	84.0
	4.0	13.0	8.0	10.3	83.0		4.0	21.5	7.2	5.3	82.0
	5.0	10.6	7.8	5.8	83.0		5.0	15.7	7.3	3.1	79.0
	6.0	9.4	7.7	5.1	83.0		6.0	11.7	7.3	1.8	77.0
	8.0	7.9	7.6	6.7	83.0		7.0	9.5	7.2	2.2	76.0
	10.0	7.0	7.5	6.3	83.0		8.0	8.4	7.2	2.0	76.0
	12.0	6.8	7.4	5.6	84.0		10.0	7.6	7.1	1.4	77.0
	14.0	6.7	7.3	5.0	85.0		12.0	7.2	7.1	1.1	77.0
	16.0	6.6	7.3	4.7	85.0		14.0	7.1	7.0	0.4	78.0
	17.3	6.5	7.2	2.3	89.0		13.8	7.0	6.9	0.4	78.0







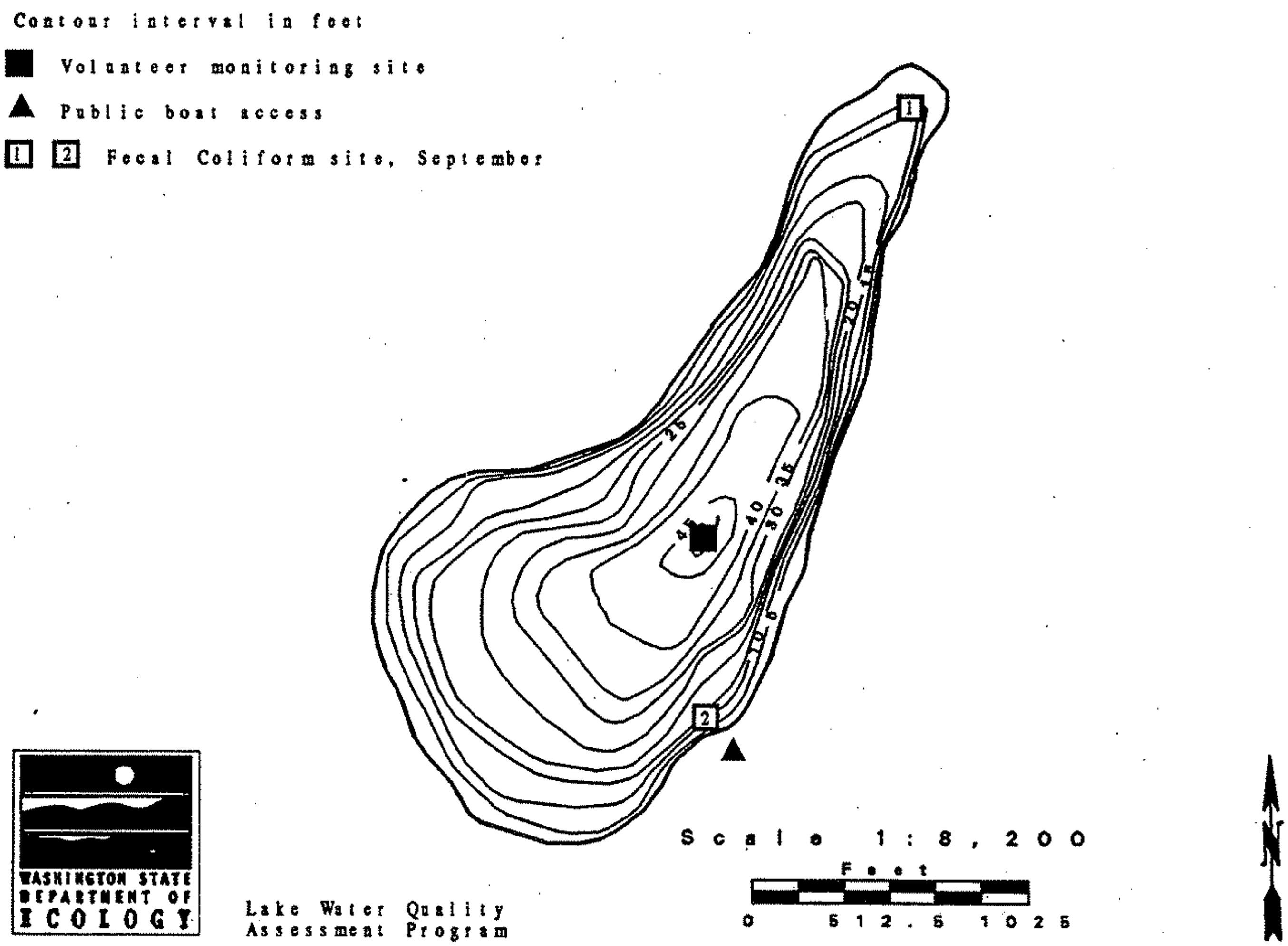


Martha Lake (near Alderwood Manor) -- Snohomish County

Martha Lake is located 2.5 miles northeast of Alderwood Manor. It was originally called Manor Lake. It has an intermittent inlet, and drains via a marsh to Swamp Creek and the Sammamish River. (There is another Martha Lake, called Lake Martha, located near Stanwood.)

Size (acres)	57
Maximum Depth (feet)	48
Mean Depth (feet)	24
Lake Volume (acre-feet)	1,346
Drainage Area (miles^2)	0.8
Altitude (feet)	450
Shoreline Length (miles)	1.4

Data from Bortleson *et al.* (1976)



Overall Assessment

The quality of Martha Lake was good in 1994. Although Secchi depths measured in 1994 were deep in comparison to Secchi depths measured during previous years (see graph of Secchi depth data), there was not trend in water clarity from 1990 through 1994. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level (p = 0.36).

Secchi depths and chlorophyll *a* concentrations indicated that algal growth was low when the lake was sampled. During the May survey there was a moderately high concentration of total phosphorus, yet a low amount of algae and low turbidity (see table of water chemistry results). This suggests that some factor other than phosphorus may have limited algae growth during the May survey.

Samples for fecal coliform bacteria were collected at the same sites that were sampled in 1993, and results were much lower and within acceptable ranges. As during previous years, dissolved oxygen decreased considerably below the thermocline. This is not unusual for Martha Lake.

All three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths) indicated that Martha Lake was borderline between oligotrophy and mesotrophy, so the lake was classified as oligo-mesotrophic in 1994.

Aquatic plants identified by Ecology staff during field visits include white-flowering water lily (*Nymphaea odorata*), yellow-flowering water lily (*Nuphar polysepalum*), iris (*Iris pseudacorus*), cattails (*Typha sp.*), common waterweed (*Elodea canadensis*), slender naiad (*Najas flexilis*), and slender pondweed (*Potamogeton pusillus*), and the alga *Nitella*.

Summary of Questionnaire Results and Information from the Volunteer

The 1994 questionnaire on lake and watershed uses was not returned.

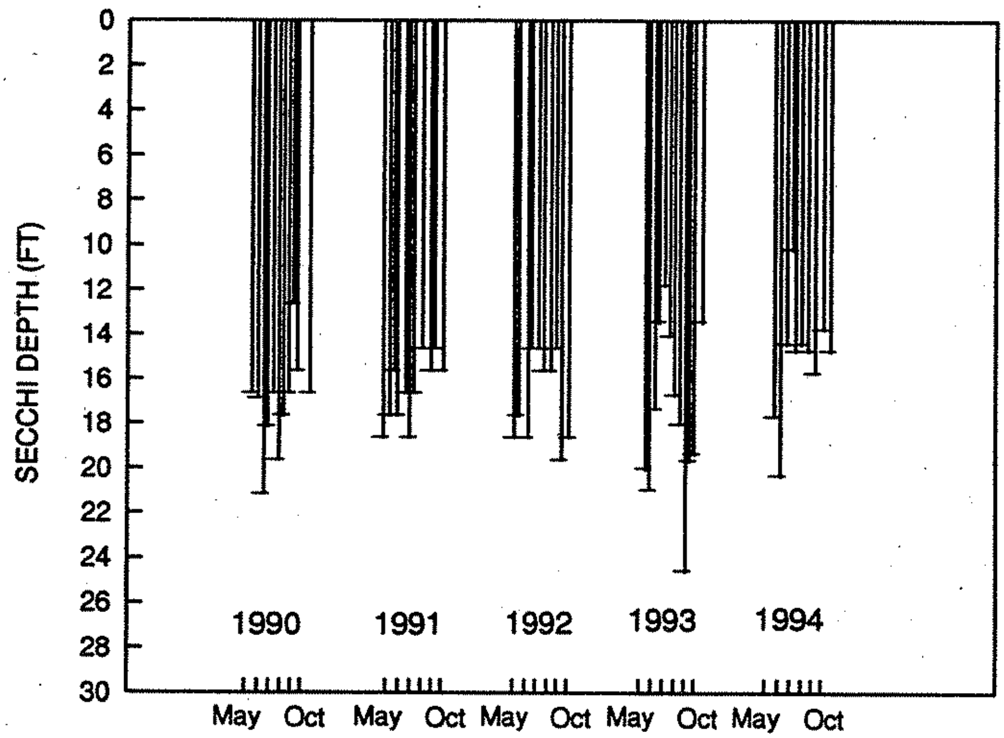
Acknowledgment

I thank both Keith Johnson for volunteering his time to monitor Martha Lake during 1993 and 1994. John W. Moore monitored Martha Lake from 1990 through 1993.

MARTHA (SOUTH; MARTHA L.) Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/22	19.0	66.2	0.0	Clear	0			17.1	0.0	
94/06/05	18.0	64.4	0.0	Lt Green	100	Mod		19.7	17.0	Significant amount of water lilies on perimeter.
94/06/21	19.0	66.2	0.0	Lt Green	0			13.8	18.0	Big storm on Saturday.
94/07/07	21.0	69.8	0.0	Lt Green	0	None		9.5	19.5	Over 100 geese.
94/07/20	27.0	80.6	0.0	Lt Green	0	None	Calm	14.1	0.0	Soap suds seen at south end, 3-4 inches high, 20 feet wide.
94/08/08	22.0	71.6	0.0	Lt Green	50	Light		13.8	26.0	
94/08/24	23.0	73.4	0.0	Lt Green	10	Trace		14.1	28.5	Canada geese have left; 20-25 remain.
94/09/10	17.0	62.6	0.0	Lt Green	50	Heavy		15.1	29.5	
94/10/03	17.0	62.6	0.0	Lt Green	0	None	Breezy	13.1	0.0	
94/10/23	13.5	56.3	0.0	Lt Green	0	Mod	Calm	14.1	0.0	

MARTHA LAKE (SNOHOMISH COUNTY)



MARTHA (MARTHA LAKE) (SNOHOMISH) Lake -- SNOHOMISH County

Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/25		E	3			(Source: Water Supply Bulletin 43)					
90/08/28	1	E	15	0.54							
91/05/30	1	E		0.81							
92/05/08	1	E	16	0.66	0.4	430	7		2	1	20
92/05/08	1	H	13	0.62							
92/08/01	1	E	11	0.41	1.1	160			1U	1U	10
92/08/01	1	H	40	0.55							
93/05/24	1	E	16	0.45	1.1						
93/05/24	1	H	33	0.56							
93/08/29	1	E	5	0.32	1.1	52	28				
93/08/29	1	H	21	0.37							
94/05/30	1	E	33	0.56	1.8	15	4	0.6			
94/05/30	1	H	18	0.55							
94/08/27	1	E	7	0.29J	2.5						
94/08/27	1	H	27	0.60J							

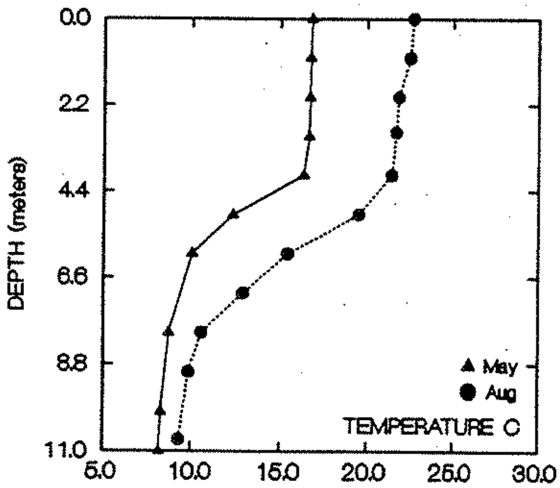
E=epilimnion composite, H=hypolimnion composite

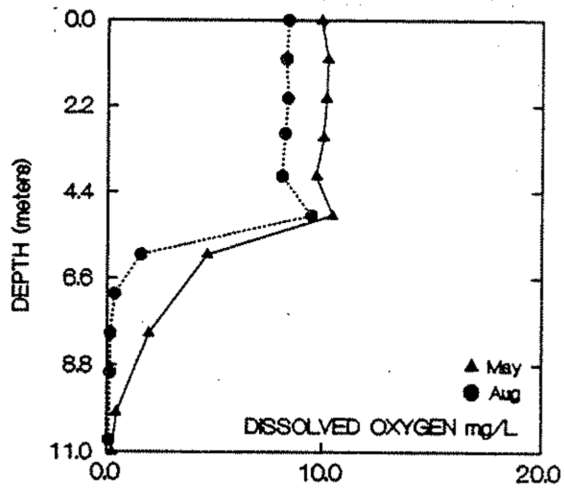
Remarks codes: U = Below detection limits; J = Estimate.

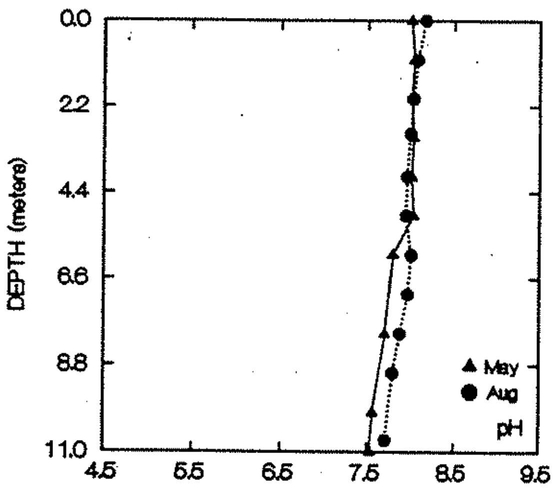
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

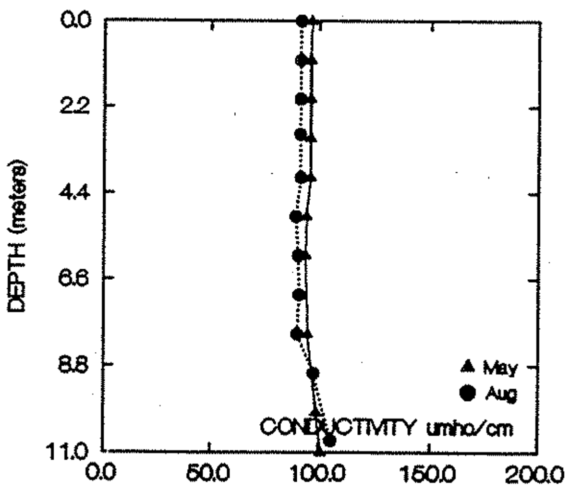
MARTHA (MARTHA LAKE) (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/30	0.0	16.8	8.0	9.9	96.0	94/08/27	0.0	22.6	8.2	8.4	92.0
	1.0	16.7	8.0	10.2	96.0		1.0	22.5	8.1	8.3	92.0
	2.0	16.7	8.0	10.2	96.0		2.0	21.8	8.0	8.4	91.0
	3.0	16.6	8.0	10.0	96.0		2.9	21.7	8.0	8.3	91.0
	4.0	16.3	8.0	9.7	96.0		4.0	21.4	8.0	8.1	92.0
	5.0	12.3	8.0	10.4	94.0		5.0	19.5	7.9	9.5	89.0
	6.0	10.0	7.8	4.7	94.0		6.0	15.4	8.0	1.5	91.0
	8.0	8.7	7.7	1.9	95.0		7.0	12.9	8.0	0.3	91.0
	10.0	8.2	7.6	0.4	99.0		8.0	10.6	7.9	0.1	90.0
	11.0	8.2	7.5	0.2	101.0		9.0	9.8	7.8	0.1	98.0
							10.7	9.3	7.7	0.1	105.0







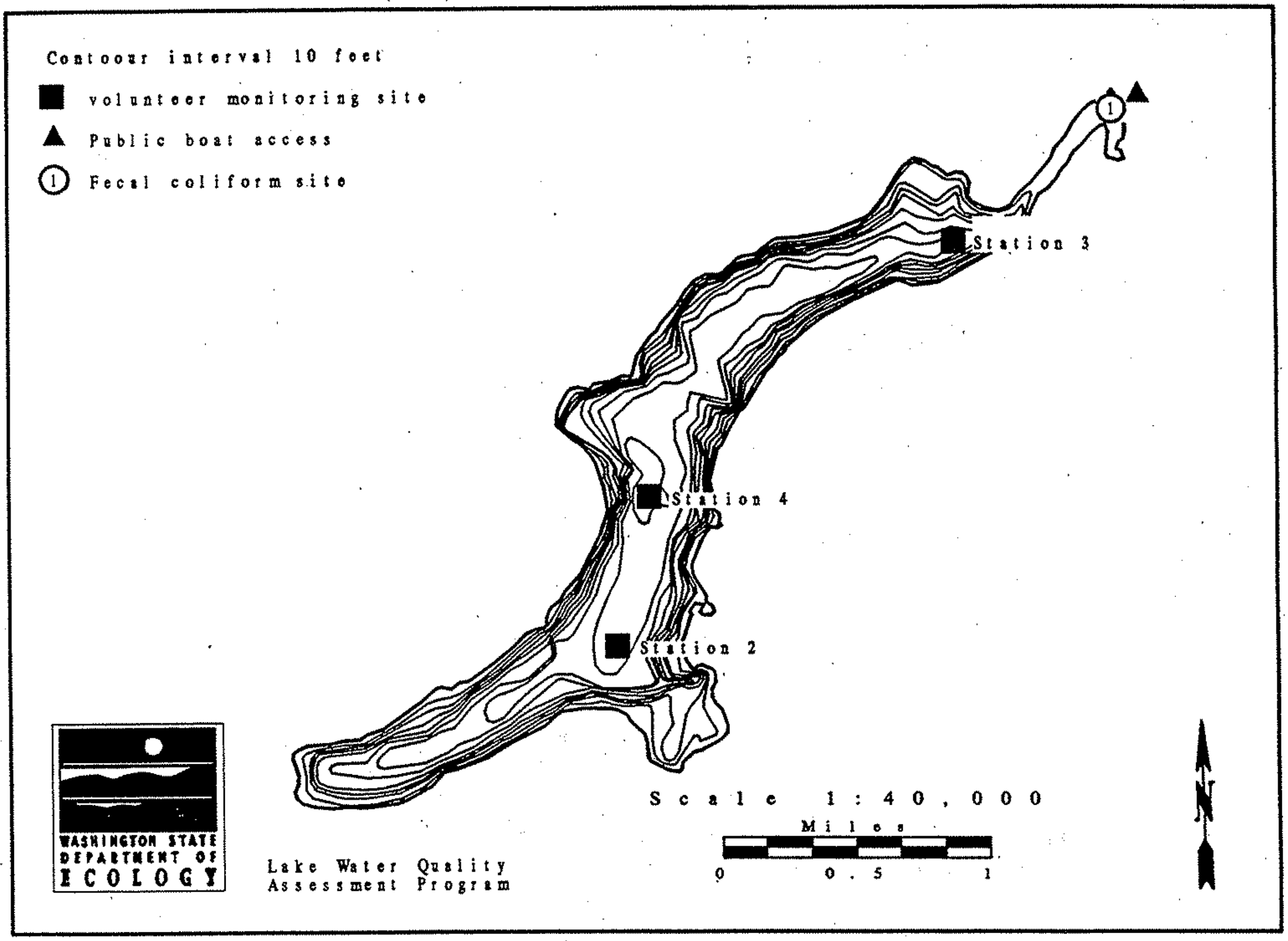


Mason Lake -- Mason County

Mason Lake is located eight miles southwest of Belfair. It is four miles long and is fed by Shumocher Creek. Mason Lake drains via Sherwood Creek to North Bay and Case Inlet. It is the largest and deepest lake in Mason County.

Size (acres)	1,000
Maximum Depth (feet)	90
Mean Depth (feet)	48
Lake Volume (acre-feet)	49,000
Drainage Area (miles^2)	20.2
Altitude (feet)	194
Shoreline Length (miles)	10.9

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Mason Lake was very good in 1994. Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Mason Lake was classified as oligotrophic in 1994. Because of problems with the dissolved oxygen probe during the May survey, no oxygen data from that survey are reported here.

Secchi depths in 1994 were very similar to those measured in 1990, despite the volunteers using a viewing tube in 1993 and 1994. Statistical trend analysis of data collected from 1989 through 1994 did not show a trend in water clarity. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.32$). Because of the frequent choppy surface of Mason Lake, and improved comparison with Ecology staff measurements during side-by-side comparisons, the volunteers at Mason Lake should continue to measure Secchi depth with the aid of the viewing tube.

In September 1993, Mason Lake had a heavy bloom of the blue-green alga *Gloeotrichia echinulata*. A health advisory was issued by the Mason County Office of Water Quality, to warn lake users about natural toxins that were produced by the algae (algal bioassays were conducted by Mike Crayton at Pacific Lutheran University). Although some blue-green algae are capable of producing toxins, problems with toxin production are rare in Washington lakes. Large colonies of *Gloeotrichia* were observed during the August 1994 survey, but no problems from the algae were reported.

Aquatic plants observed by Ecology staff during field visits include flatleaf pondweed (*Potamogeton robbinsii*), largeleaf pondweed (*P. amplifolius*), Illinois pondweed (*P. illinoensis*), common waterweed (*Elodea canadensis*), tapegrass (*Vallisneria americana*), floatingleaf pondweed (*Potamogeton natans*), variable pondweed (*Potamogeton gramineus*), water lobelia (*Lobelia dortmanna*), rush (*Juncus*), and the algae *Nitella* and muskgrass (*Chara*). The latter was sent in by a volunteer for identification in 1993.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires from 1989 through 1994.

> Mason Lake is used for fishing, boating, swimming, rowing, jet skiing, and camping. Recreational facilities on the lakeshore include a park, and a picnic area. There is one public boat ramp, and there are some restrictions for motor boating within 100 feet of shore. No fish were stocked in the lake in 1994. Currently the watershed is being logged and used for animal grazing and crop agriculture. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for animal grazing and crop agriculture.

There are about 695 houses on the lakeshore; of these, about 360 are occupied year-round. About 90% of the shoreline has been developed for residences. The lakeshore is not sewered, and there are 47 culverts all along the shore that drain into the lake. Most of the culverts are located along the southeast end and the shallow northeast end. Lake water is withdrawn for drinking and other domestic uses. There is a community club for the area. No aquatic plant management activities occurred in 1994.

Overall, the volunteer found that Mason Lake had excellent water quality. Problems in the lake in 1994 were ranked as (1) low water level at the outlet, (2) algae, and (3) odor from decyaying algae. The algae problems were noted to be normal for the lake. Possible sources of problems include lawn fertilizers and septic systems. The volunteer noted that there appears to be fewer boats on the lake since the marina was closed, but there are more jet skis.

Acknowledgments

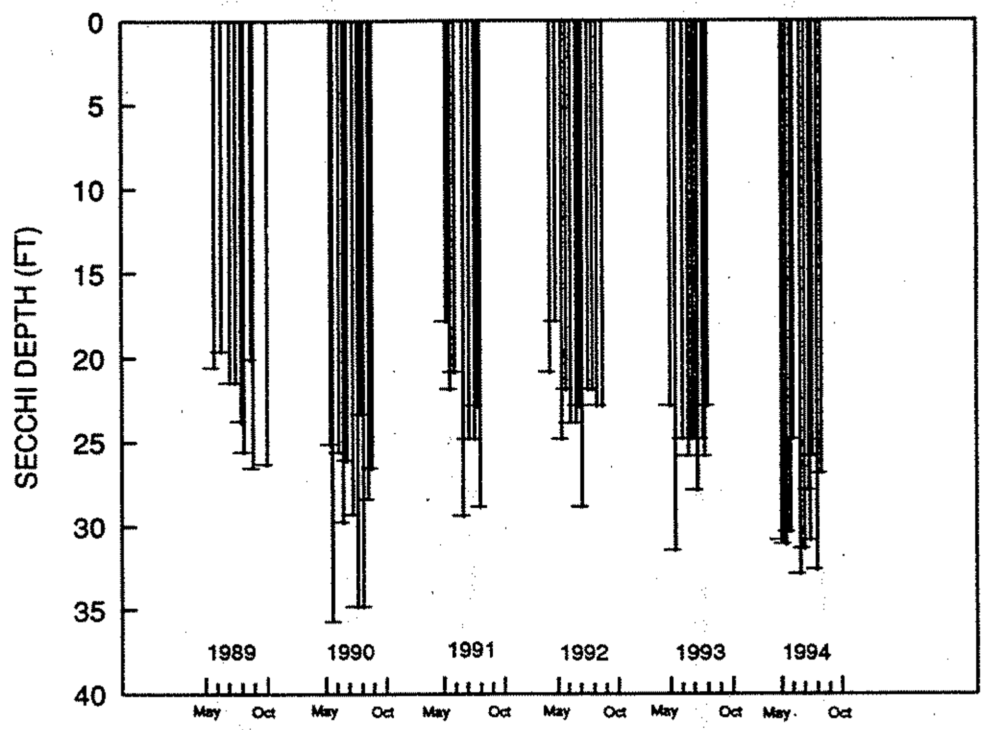
I thank the following volunteers collected data during 1994: Jerry Nelson, Al Bernhard, Harold Holm, Jim Scott, and Bud Holt. Dick Bowers monitored Station 2 from 1989 through 1993, but passed away during the monitoring season in 1994. His contribution to the program is greatly appreciated, and he is missed.

MASON Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/08/30	21.7	71.1	0.0	Mod Green	0	None	Light	29.0	0.0	On site visit. Large colonies of Gloeotrichia visible.
STATION 2										
94/05/24	18.3	64.9	5.8	Mod Green	50	None	Calm	31.0	0.0	
94/06/05	16.7	62.1	6.3	Lt Green	0			30.0	0.0	
94/06/20	15.6	60.1	6.5	Lt Green	0		Calm	28.0	0.0	Clear, no wind.
94/07/05	21.1	70.0	6.5	Lt Green	10	Mod	Calm	27.0	0.0	
94/07/18	22.2	72.0	6.0	Mod Green	90	None	Calm	27.5	0.0	
94/08/01	21.1	70.0	6.5	Lt Green	0	None	Calm	28.5	0.0	
94/08/18	23.3	73.9	6.3	Lt Green	0	None	Calm	30.0	0.0	
94/08/31	23.3	73.9	6.5	Lt Green	25	Light	Light	27.5	0.0	Sunny.
94/09/16	21.1	70.0	6.0	Lt Green	0	None	Calm	28.0	0.0	
94/10/04	18.0	64.4	6.0	Mod Green	0	Light	Light	26.0	0.0	
STATION 3										
94/06/01	20.0	68.0	0.0		50	Trace	Light	26.0	0.0	Water color blue-green.
94/06/16	20.0	68.0	6.5	Lt Green	50	Mod	Calm	28.0	0.0	
94/06/28	21.7	71.1	6.5	Lt Green	100	None	Calm	26.0	0.0	
94/07/12	25.6	78.1	6.5	Mod Green	0	None	Light	29.0	0.0	
94/07/28	24.4	75.9	6.5		0	None	Light	28.0	0.0	Water color yellow green.
94/08/15	25.6	78.1	6.5	Mod Green	75	None	Calm	23.0	0.0	
94/08/26	23.3	73.9	6.0	Lt Green	0	None	Calm	30.0	0.0	
94/09/10	23.3	73.9	6.5	Mod Green	50	Heavy	Breezy	24.0	0.0	
94/09/27	23.3	73.9	6.5	Lt Green	0	None	Calm	27.0	0.0	
94/10/10	18.3	64.9	6.5	Lt Green	50	None	Light	25.0	0.0	
STATION 4										
94/05/24	18.3	64.9	0.0	Mod Green	75	None	Calm	30.0	31.5	
94/06/10	20.0	68.0	0.0	Mod Green	10	None	Calm	30.3	31.3	
94/06/22	21.0	69.8	6.5	Mod Green	0	None	Breezy	29.5	31.0	
94/07/07	21.0	69.8	6.0	Mod Green	0	None	Calm	24.0	33.3	
94/07/26	21.0	69.8	6.5	Mod Green	0	None	Calm	32.0	35.0	
94/08/10	23.5	74.3	6.5	Mod Green	0	Light	Light	30.5	35.0	
94/08/25	21.0	69.8	6.5	Mod Green	100	None	Calm	27.0	36.0	
94/08/30	21.1	70.0	6.0	Mod Green	0			30.0	0.0	
94/09/06	20.5	68.9	6.3	Pea-green	25	None	Light	25.0	36.0	
94/09/22	21.0	69.8	6.3	Mod Green	0	None	Calm	31.8	34.5	There is an oil slick-like algae bloom in the c enter of the lake.
94/10/06	18.0	64.4	6.0	Mod Green	75	None	Light	26.0	34.5	

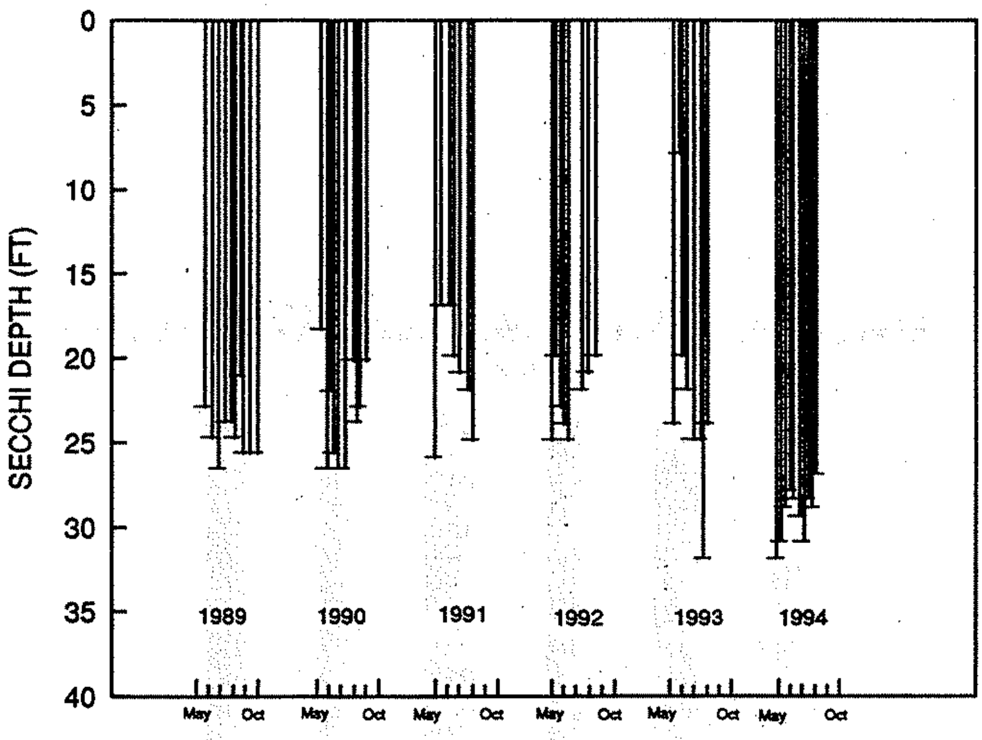
MASON LAKE (MASON COUNTY)

Station 4

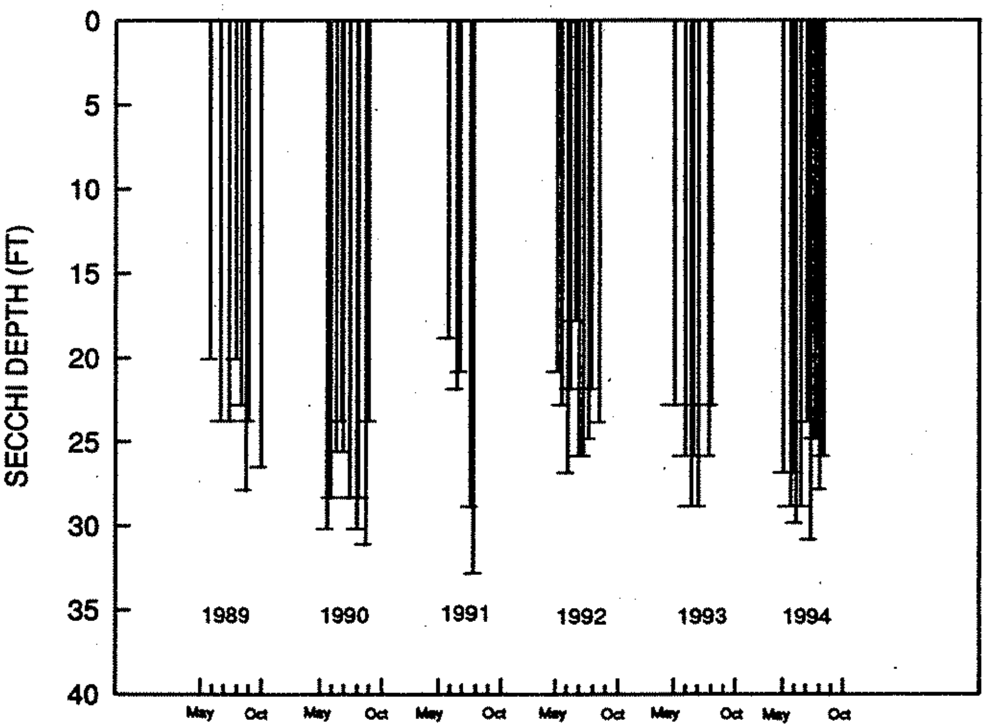


MASON LAKE (MASON COUNTY)

Station 2



Station 3



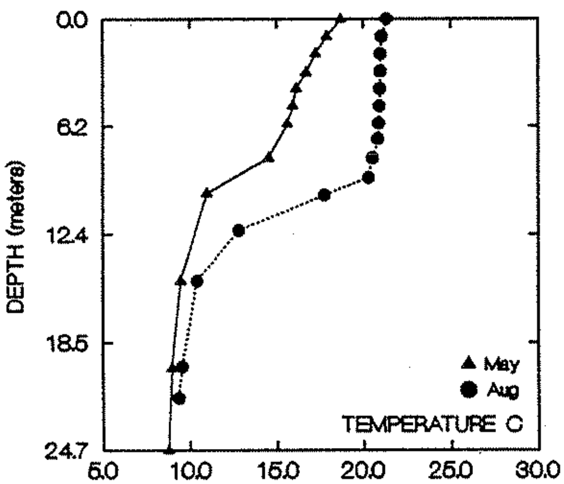
MASON (MASON) Lake -- MASON County
Chemistry Data -- Station 1

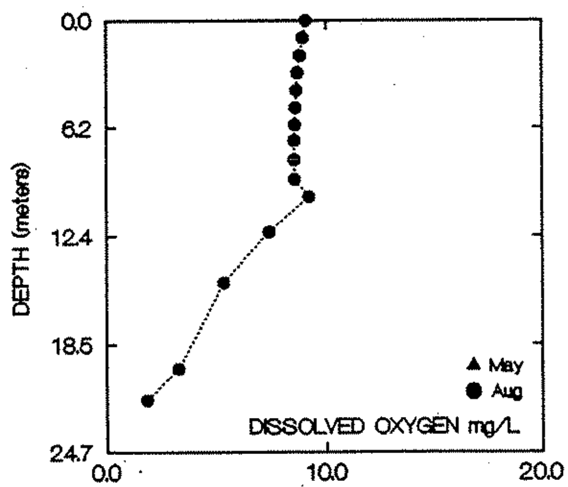
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
72/06/29		E	12			(Source: Water Supply Bulletin 43)					
81/06/12		E	20		1.5	(Source: Water Supply Bulletin 57)					
89/06/28	1	E	8	0.14	0.7						
89/09/27	1	E	9	0.19	1.0						
90/05/25	1	E	7	0.23							
90/08/16	1	E	8	0.16							
91/05/21	1	E		0.10							
92/05/09	1	E	5	0.16	1.2						
92/05/09	1	H	6	0.18							
92/08/07	1	E	4	0.14	1.1						
92/08/07	1	H	37	0.14							
93/05/28	1	E	11	0.10	1.1						
93/05/28	1	H	18	0.11							
93/09/01	1	E	6	0.12	1.0	1	7				
93/09/01	2	E	5								
93/09/01	1	H	9	0.13							
94/05/24	1	E	11	0.03	0.3U						
94/05/24	1	H		0.04							
94/08/30	1	E	8	0.10J	0.3J						
94/08/30	1	H	10	0.12J							

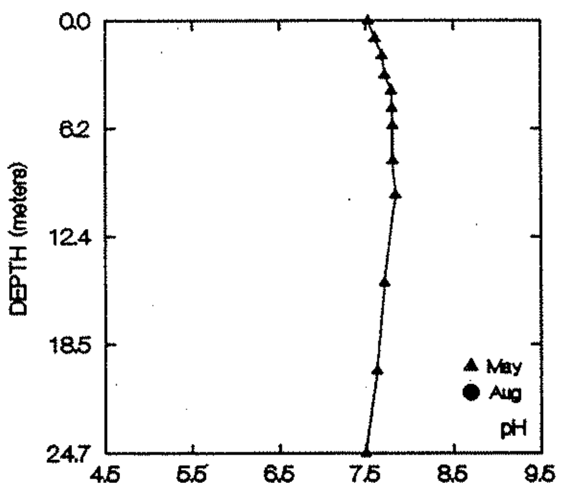
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

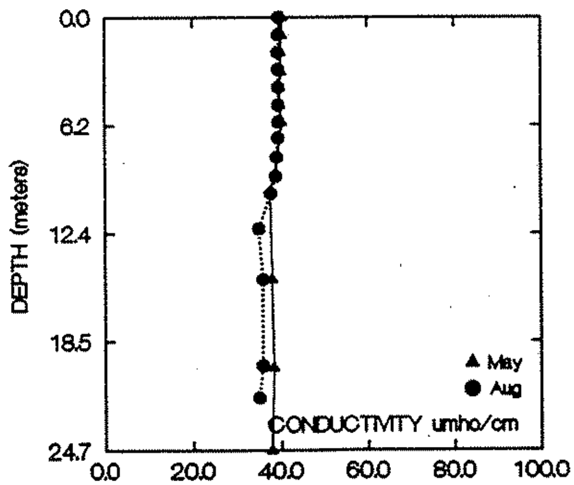
MASON (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/24	0.0	18.7	7.5	0.0	40.0	94/08/30	0.0	21.3	0.0	9.1	40.0
	1.0	17.9	7.6	0.0	40.0		1.0	21.1	0.0	8.9	40.0
	2.0	17.2	7.7	0.0	40.0		2.0	21.0	0.0	8.8	39.0
	3.1	16.7	7.7	0.0	40.0		3.0	21.0	0.0	8.7	40.0
	4.0	16.1	7.8	0.0	40.0		4.0	21.0	0.0	8.7	40.0
	5.0	15.9	7.8	0.0	40.0		5.0	20.9	0.0	8.6	40.0
	6.0	15.6	7.8	0.0	40.0		6.0	20.9	0.0	8.6	40.0
	8.0	14.5	7.8	0.0	39.0		6.9	20.8	0.0	8.6	39.0
	10.0	11.0	7.8	0.0	38.0		8.0	20.5	0.0	8.6	39.0
	15.0	9.5	7.7	0.0	38.0		9.1	20.3	0.0	8.6	39.0
	20.0	8.9	7.6	0.0	38.0		10.1	17.7	0.0	9.2	38.0
	24.7	8.7	7.5	0.0	38.0		12.1	12.9	0.0	7.4	35.0
							15.0	10.4	0.0	5.3	36.0
							19.9	9.5	0.0	3.3	36.0
							21.7	9.4	0.0	1.9	35.0







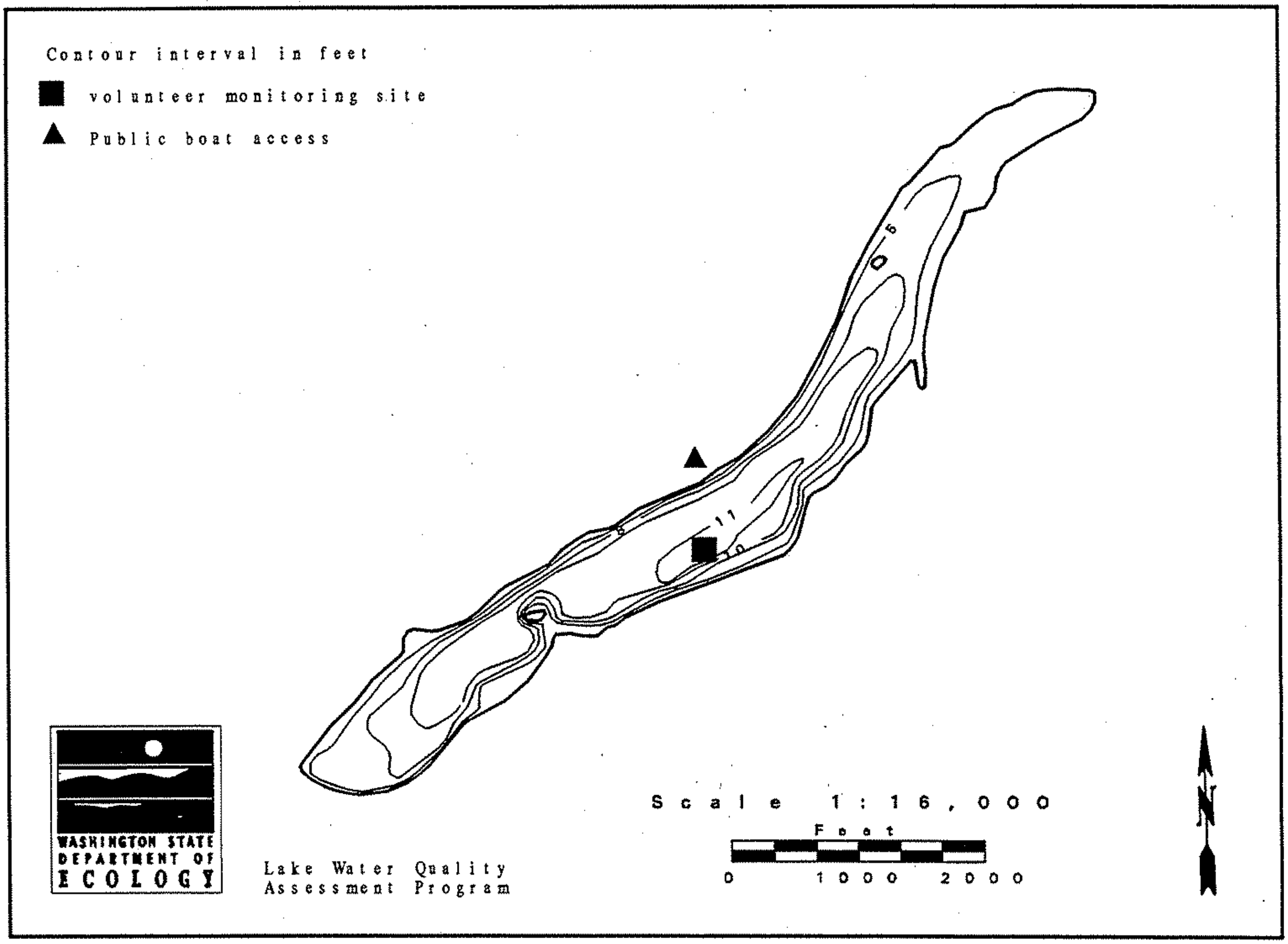


Lake McIntosh -- Thurston County

Lake McIntosh is located four miles east of Tenino. It has no surface inlets, and drains via an unnamed outlet to the Deschutes River.

Size (acres)	93
Maximum Depth (feet)	11
Mean Depth (feet)	8
Lake Volume (acre-feet)	700
Drainage Area (miles^2)	2.26
Altitude (feet)	336
Shoreline Length (miles)	2.6

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Lake McIntosh was fair in 1994. Most water quality problems were related to algae growth, which probably resulted from high phosphorus concentrations in the water. Secchi depths and volunteer observations indicate that algal growth was most severe from late August through October. The high chlorophyll *a* concentrations in August indicates that algae were in bloom proportions at the time. An algae sample contained mainly the blue-green alga *Anabaena*, and possibly was *Anabaena circinalis*. Secchi depths and water chemistry results are listed in tables at the end of this summary.

Because the lake is shallow, it is not surprising that profile data did not change much from surface to bottom. However, it was apparent that pH in the water was somewhat high (for lake water) during the August survey. This probably resulted from the algae bloom.

Results from fecal coliform bacteria samples collected during May were very low and did not indicate any problems.

Aquatic plants observed by Ecology staff during the field visits include iris (*Iris pseudacorus*), cattails (*Typha sp.*), whitestem pondweed (*Potamogeton praelongus*), common waterweed (*Elodea candensis*), and yellow-flowering water lily (*Nuphar sp.*).

Acknowledgment

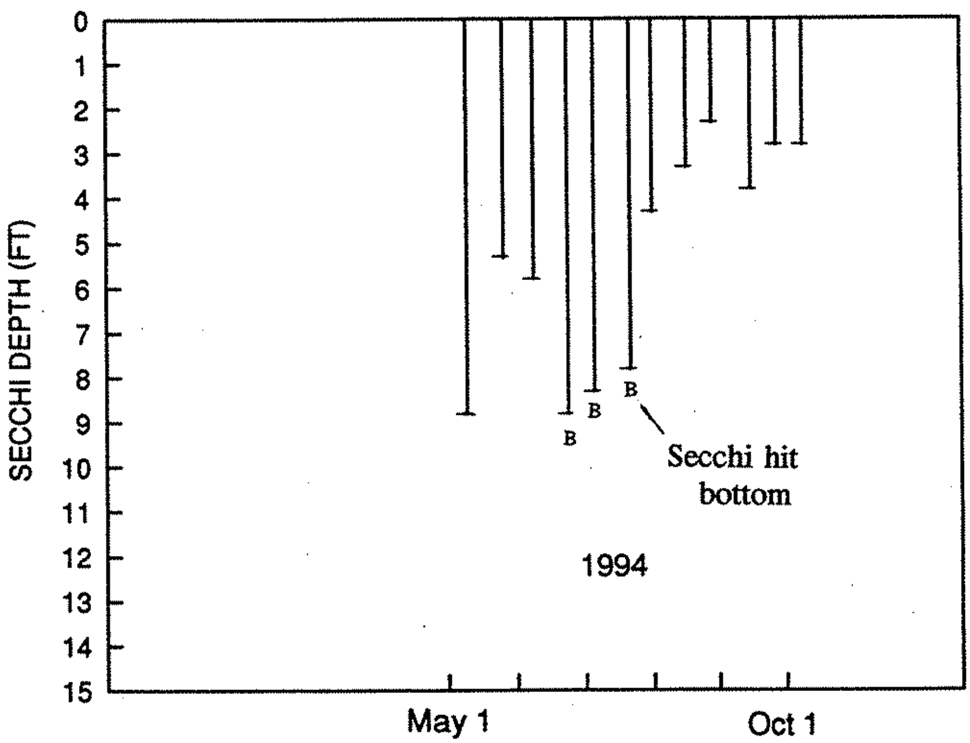
I thank Dennis Kellogg for volunteering his time to monitor Lake McIntosh during 1994.

MCINTOSH Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/17	0.0	32.0	0.0	Grn-brown	100	None	Calm	8.5B	0.0	Onsite visit.
94/06/02	20.6	69.1	0.0	Grn-brown	0		Light	5.0	0.0	Water has a grainy appearance.
94/06/16	18.3	64.9	0.0	Grn-brown	0		Light	5.5	8.5	Many days of heavy rain prior to this reading. The goose population has increased over the la st few weeks.
94/07/01	18.9	66.0	0.0	Lt Green	100	Mod	Light	8.5B	8.5	
94/07/13	23.3	73.9	0.0		0	None	Breezy	8.0B	8.0	Water color clear with light green tint.
94/07/29	22.8	73.0	0.0	Lt Green	100	None	Calm	7.5B	7.8	Fairly clear with very small granular looking p atches in water.
94/08/08	21.1	70.0	0.0	Mod Green	90	Trace	Breezy	4.0	7.5	Lake height in feet.
94/08/24	21.1	70.0	0.0	Grn-brown	10	Trace	Breezy	3.0	7.5	Green algae present. Lake hieght in feet.
94/09/05	18.9	66.0	0.0	Pea-green	0	Light	Breezy	2.0	0.0	Heavy algae bloom.
94/09/22	22.2	72.0	0.0	Grn-brown	0	None	Calm	3.5	0.0	Greenish blue film on surface in many areas - t he water itself is fairly clear.
94/10/04	16.1	61.0	0.0	Pea-green	0	None	Calm	2.5	7.0	Algae present.
94/10/16	12.2	54.0	0.0	Pea-green	0	Trace	Calm	2.5	7.0	Heavy algae bloom. Green film on water around s horeline.

B - Secchi disk hit bottom

LAKE MCINTOSH (THURSTON COUNTY)



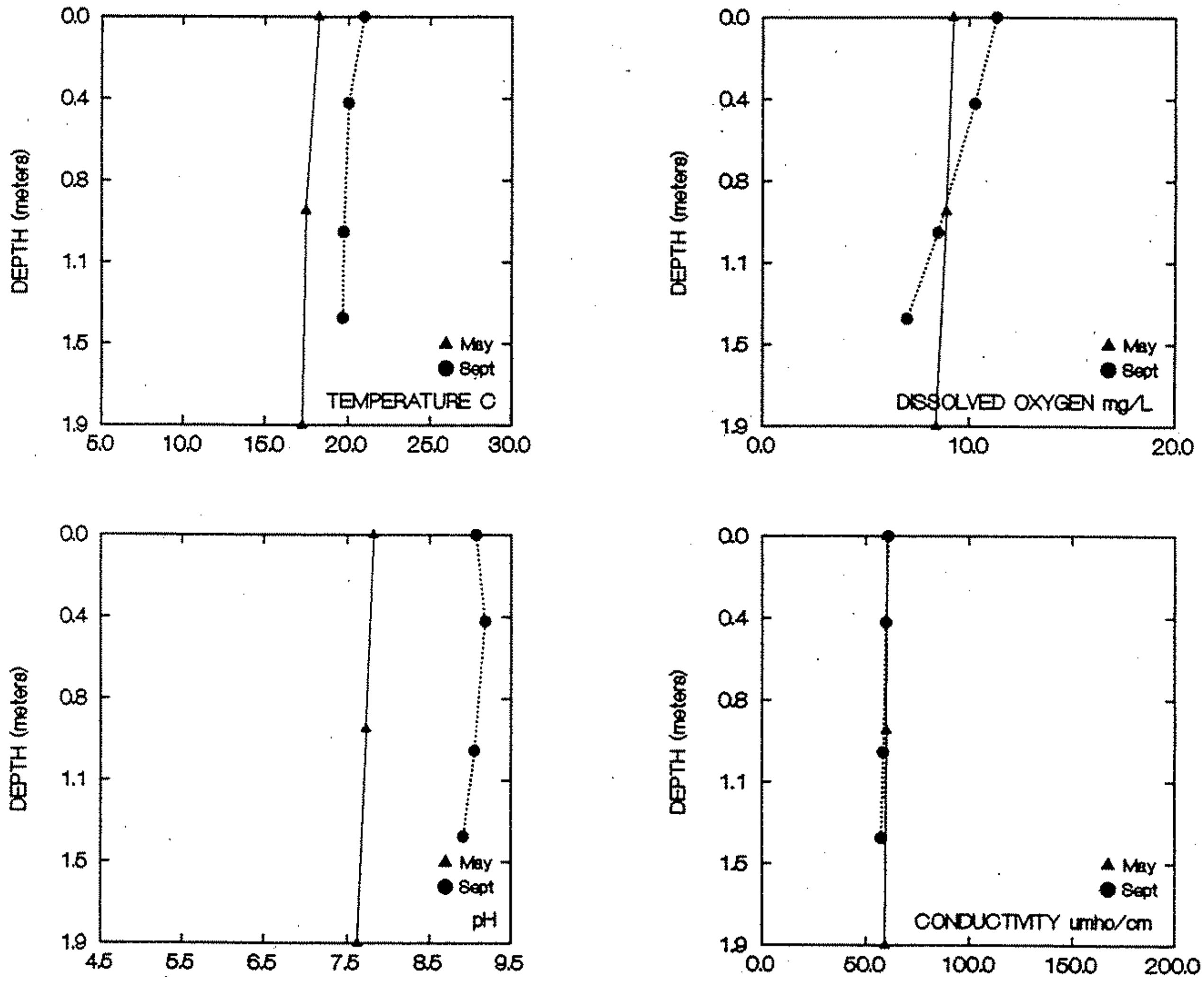
MCINTOSH (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/09/17		E	38			(Source: Water Supply Bulletin 43)					
94/05/17	1	E	42	0.23	5.2	1U	2	1.5			
94/09/01	1	E	136	0.97J	84.6J						

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

MCINTOSH (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/17	0.0	18.2	7.8	9.2	60.0	94/09/01	0.0	21.0	9.1	11.3	61.0
	0.9	17.5	7.7	8.9	60.0		0.4	20.1	9.2	10.3	60.0
	1.9	17.3	7.6	8.4	59.0		1.0	19.8	9.1	8.5	58.0
							1.4	19.7	8.9	7.0	57.0



Lake Merwin -- Clark/Cowlitz Counties

Lake Merwin is located 9.75 miles northeast of Woodland. It is an artificial reservoir in the north fork of the Lewis River below Yale Reservoir. It is 12 miles long, with 2,400 acres in Clark County, and 1,690 acres in Cowlitz County. In addition to receiving water from the north fork of the Lewis River, it is fed by Speelyai, Brooks, Rock, Canyon, Buncombe Hollow, Indian George, Jim, Cape Horn, and Marble Creeks. Lake Merwin was monitored by Ecology staff only.

Size (acres)	4,000
Maximum Depth (feet)	190
Mean Depth (feet)	100
Lake Volume (acre-feet)	420,000
Drainage Area (miles^2)	730
Altitude (feet)	239
Shoreline Length (miles)	32

Data from Bortleson *et al.* (1976)

Map not available.

Overall Assessment

Lake Merwin was sampled by Ecology staff only in May 1994. There is no bathymetric map available for the lake.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depth), Lake Merwin was classified as oligotrophic in 1994.

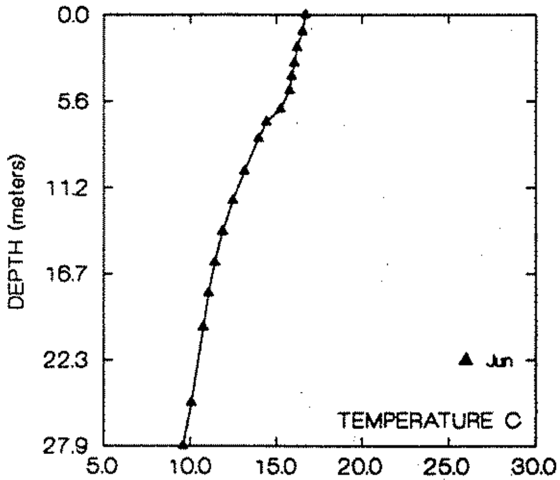
MERWIN (CLARK) Lake -- CLARK County
Chemistry Data -- Station 1

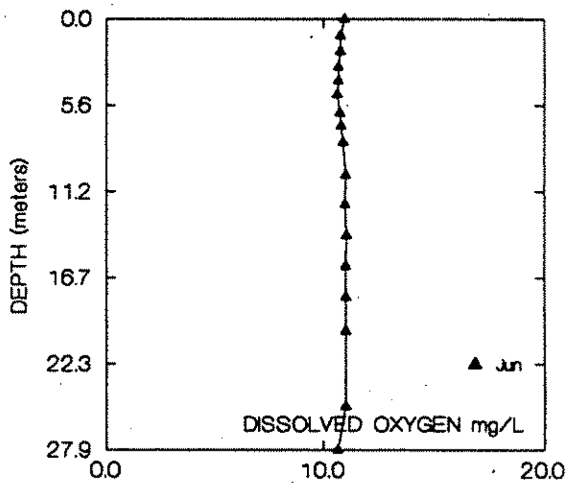
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/09/13		E	3			(Source: Water Supply Bulletin 43)					
93/06/04	1	E	10	0.11	2.0						
93/06/04	1	H	8	0.08							
93/08/30	1	E	3	0.08	2.0						
93/08/30	1	H	2U	0.07							
94/06/01	1	E	10	0.01U	1.6						
94/06/01	1	H	9	0.03							

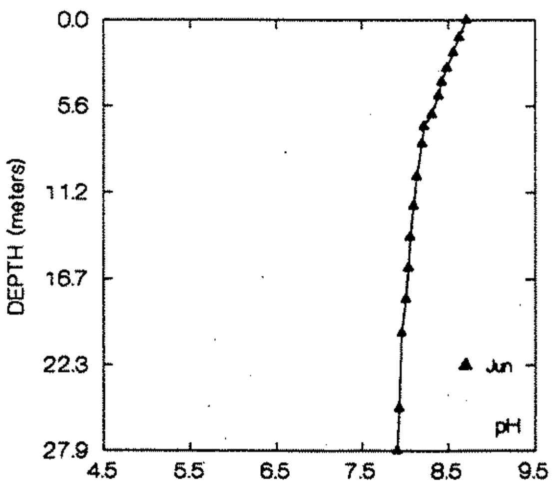
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

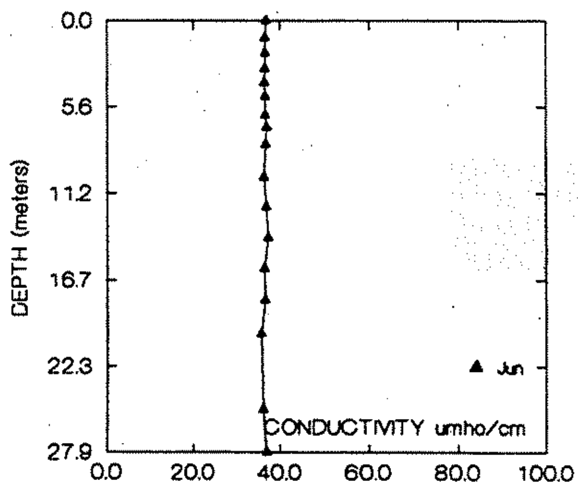
MERWIN (CLARK) Lake -- CLARK County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/01	0.0	16.8	8.7	10.9	37.0						
	1.1	16.6	8.6	10.8	37.0						
	2.1	16.3	8.6	10.8	37.0						
	3.1	16.1	8.5	10.7	37.0						
	4.0	15.9	8.4	10.7	36.0						
	4.9	15.8	8.4	10.6	37.0						
	6.1	15.2	8.3	10.7	37.0						
	6.9	14.4	8.2	10.8	37.0						
	8.0	13.9	8.2	10.9	37.0						
	10.1	13.1	8.2	11.0	36.0						
	12.0	12.4	8.1	11.0	37.0						
	14.0	11.9	8.1	11.0	37.0						
	16.0	11.4	8.1	11.0	36.0						
	18.0	11.0	8.0	11.0	37.0						
	20.2	10.7	8.0	11.0	36.0						
	25.1	10.1	7.9	11.0	36.0						
	27.9	9.6	7.9	10.6	37.0						







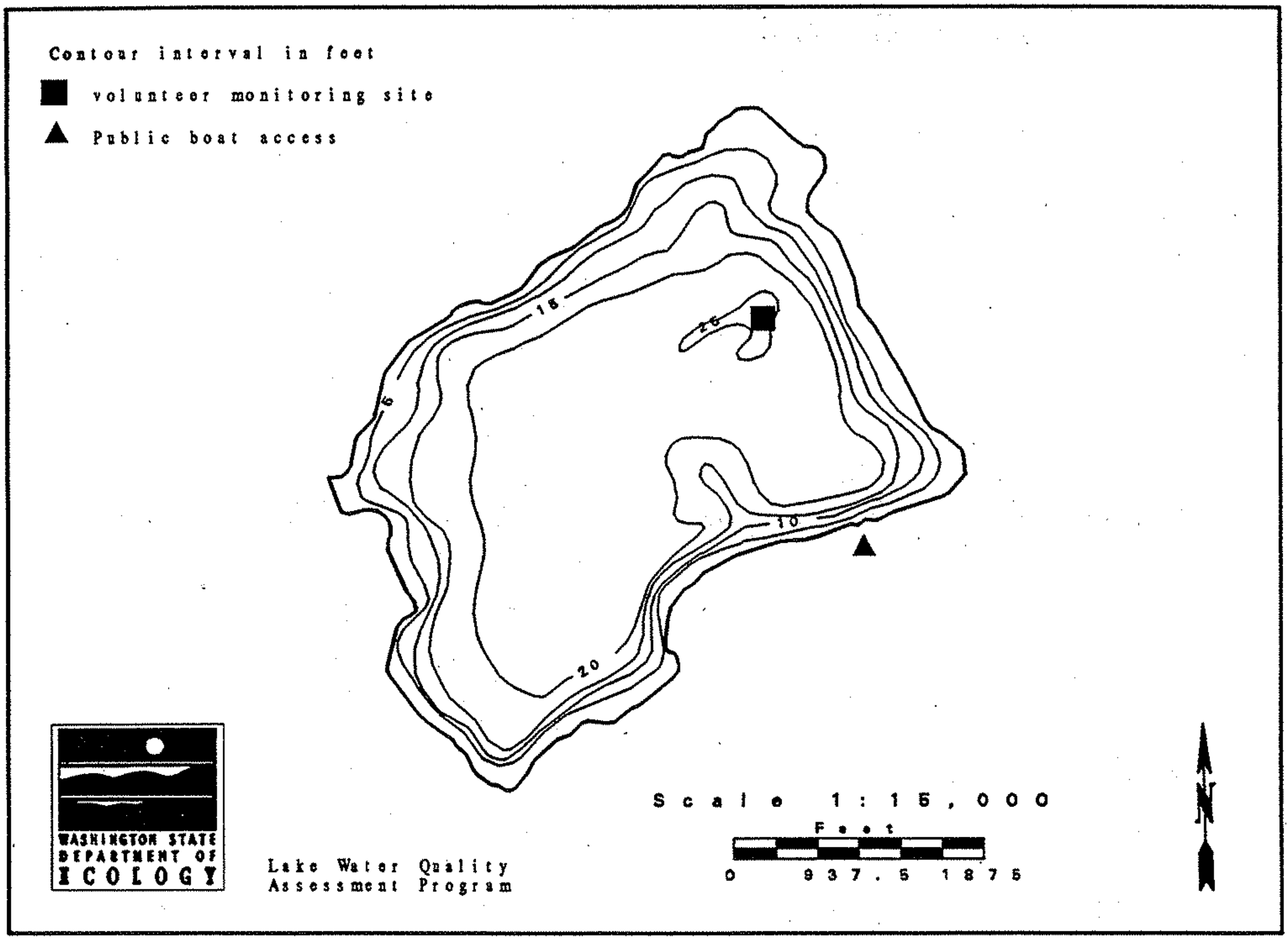


Lake Nahwatzel -- Mason County

Lake Nahwatzel is located 11 miles west of Shelton. It has two unconfirmed inlets, and drains via Outlet Creek to the East Fork of the Satsop River. The outlet seeps through a swampy area.

Size (acres)	269
Maximum Depth (feet)	25
Mean Depth (feet)	17
Lake Volume (acre-feet)	4,642
Drainage Area (miles^2)	6.2
Altitude (feet)	440
Shoreline Length (miles)	2.9

Data from Bortleson *et al.* (1976)



Overall Assessment

Lake Nahwatzel had very good water quality in 1994. Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Lake Nahwatzel was classified as oligotrophic in 1994.

Secchi depths collected since 1990 have been deep (see graph of Secchi depth data), and there was no declining trend in water clarity in the five years the lake has been monitored. This was tested using the seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.63$).

Concentrations of total phosphorus measured during the May surveys increased from 1990 through 1994; however, because of the few samples collected each year, it may take several years of monitoring to determine whether there is an increasing trend in phosphorus concentration. Concentrations were still relatively low in 1994, though. Water chemistry and profile data results are listed in tables at the end of this summary.

Aquatic plants observed by Ecology staff during field visits include sedge (*Scirpus*), common waterweed (*Elodea canadensis*), Berchtold's pondweed (*Potamogeton berchtoldii*), slender pondweed (*Potamogeton pusillis*), ribbonleaf pondweed (*Potamogeton epihydrus*), and another macrophyte that was either *Lobelia* or *Limosella*. This latter plant was located nearshore, in water up to about four feet deep. Flowers are needed for a positive identification of this plant.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Nahwatzel is used for fishing, swimming, motor boating, non-motorized boating, jet skiing, and lakeshore camping. There is one resort on the lakeshore. There is one public boat ramp, and there is a no wake restriction for motorboating within 100 feet of shore. About 1% of the shoreline is publicly-owned. Trout were stocked in the lake in 1994. Currently, the watershed is being logged, and the lakeshore is being developed further for residences. In the 1930s, the watershed was logged and there was a sawmill on the lakeshore. Numerous old pilings in the lake were removed from the lake in 1993.
>
> There are about 120 houses on the lakeshore, and none of the houses are connected to a sewer. There are no culverts or stormdrains which drain into the lake. There is no lake association for the lake, and no lake management activities

occurred on the lake in 1993. Currently, the minimum setback for lakeshore development is 25 feet (years earlier, the minimum setback was 15 feet), and there is no restriction for residential density.

Overall, the volunteer found that Lake Nahwatzel had good water quality, and there were no water quality problems in the lake. Possible sources of potential problems include septic systems and lawn fertilizers. The only changes since the 1993 monitoring season were some remodeling of lakeshore homes, and a few more residences were occupied year-round.

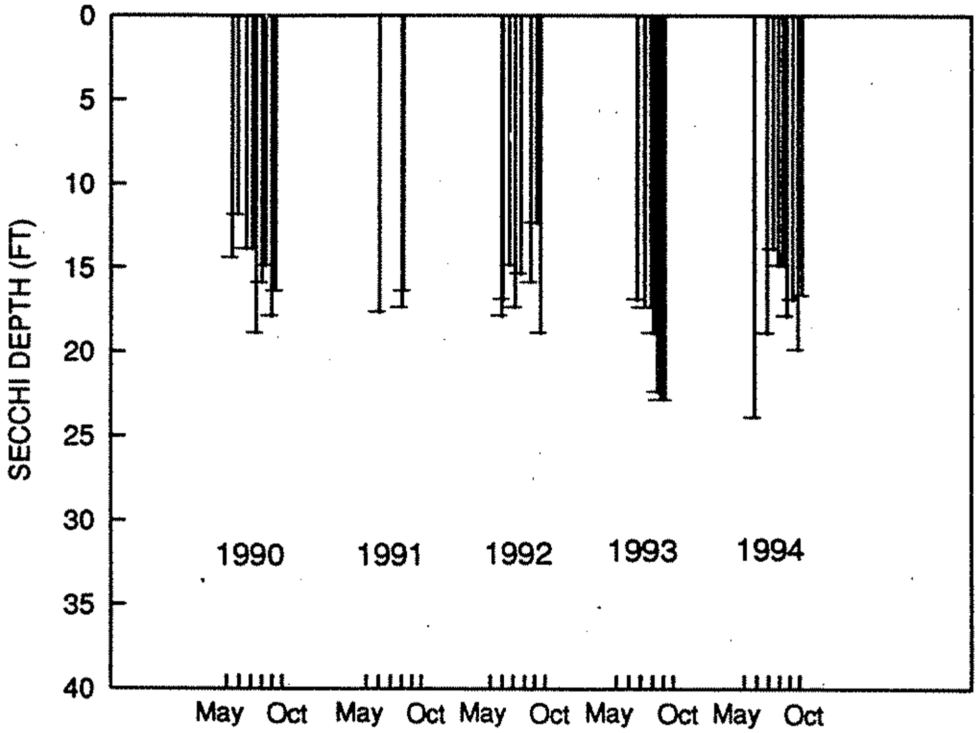
Acknowledgment

I thank Dave Fowble for volunteering his time to monitor Lake Nahwatzel from 1990 through 1994.

NAHWATZEL Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/25	0.0	32.0	0.0	Lt Green	1	None	Strong	23.0	0.0	Onsite visit. Very gusty and hard to take readings, although second Secchi hit bottom.
94/06/15	0.0	32.0	0.0	Lt Green	90	Mod	Light	0.0	2.0	
94/07/01	20.6	69.1	0.0		95	Mod	Gusty	18.0	-9.0	
94/07/17	21.1	70.0	0.0	Lt Green	100	None	Light	13.0	-14.0	
94/07/30	23.3	73.9	0.0		20	None	Light	14.0	0.0	
94/08/13	23.3	73.9	0.0	Lt Green	0	None	Calm	14.0	-19.0	
94/08/24	0.0	32.0	0.0	Lt Green	0	None	Breezy	17.0	21.0	Onsite visit.
94/09/10	20.0	68.0	0.0	Lt Green	90	Heavy	Light	16.0	0.0	
94/09/24	21.1	70.0	0.0	Lt Green	0	None	Calm	19.0	-20.0	Bright sun, 70 degrees.
94/10/08	20.0	68.0	0.0	Lt Green	0	None	Calm	15.8	0.0	Last reading for year.

LAKE NAHWATZEL (MASON COUNTY)



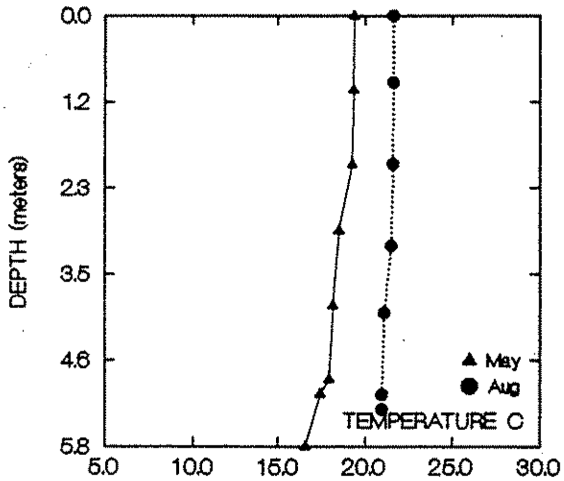
NAHWATZEL (MASON) Lake -- MASON County
Chemistry Data -- Station 1

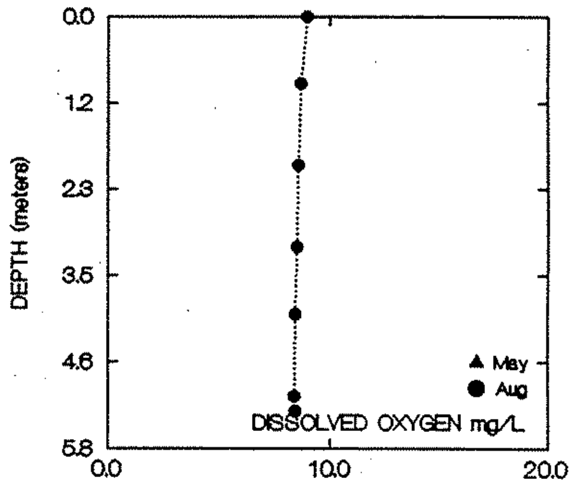
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/15		E	7			(Source: Water Supply Bulletin 43)					
81/06/10		E	40		1.5	(Source: Water Supply Bulletin 57)					
90/05/24	1	E	12	0.27							
90/06/13	1	E		0.15	2.2						
90/08/15	1	E	12	0.24							
90/09/12	1	E	10	0.21	2.2						
91/06/12	1	E		0.16							
92/05/09	1	E	9		1.2						
92/05/09	2	E	13	0.23							
92/05/09	1	H									
92/08/06	1	E	8	0.32	0.3						
92/08/06	2	E	6	0.23	0.7						
93/05/27	1	E	7	0.17	1.9						
93/05/27	2	E	11	0.23	2.4						
93/09/01	1	E	7	0.21	3.0						
94/05/25	1	E	17	0.21	1.7						
94/08/24	1	E	6	0.16J	3.2						

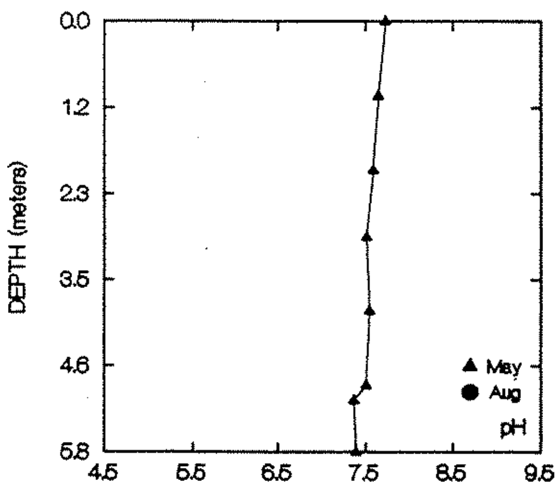
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

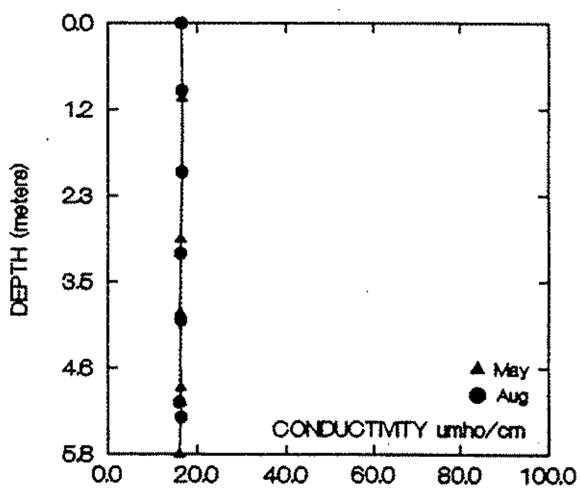
NAHWATZEL (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	19.4	7.7	0.0	16.0	94/08/24	0.0	21.7	0.0	9.0	16.0
	1.0	19.4	7.7	0.0	17.0		0.9	21.6	0.0	8.7	17.0
	2.0	19.3	7.6	0.0	17.0		2.0	21.6	0.0	8.6	17.0
	2.9	18.5	7.5	0.0	16.0		3.1	21.5	0.0	8.5	16.0
	3.9	18.2	7.6	0.0	16.0		4.0	21.1	0.0	8.4	16.0
	4.9	17.9	7.5	0.0	16.0		5.1	21.0	0.0	8.4	16.0
	5.1	17.4	7.4	0.0	16.0		5.3	21.0	0.0	8.4	16.0
	5.8	16.6	7.4	0.0	16.0						







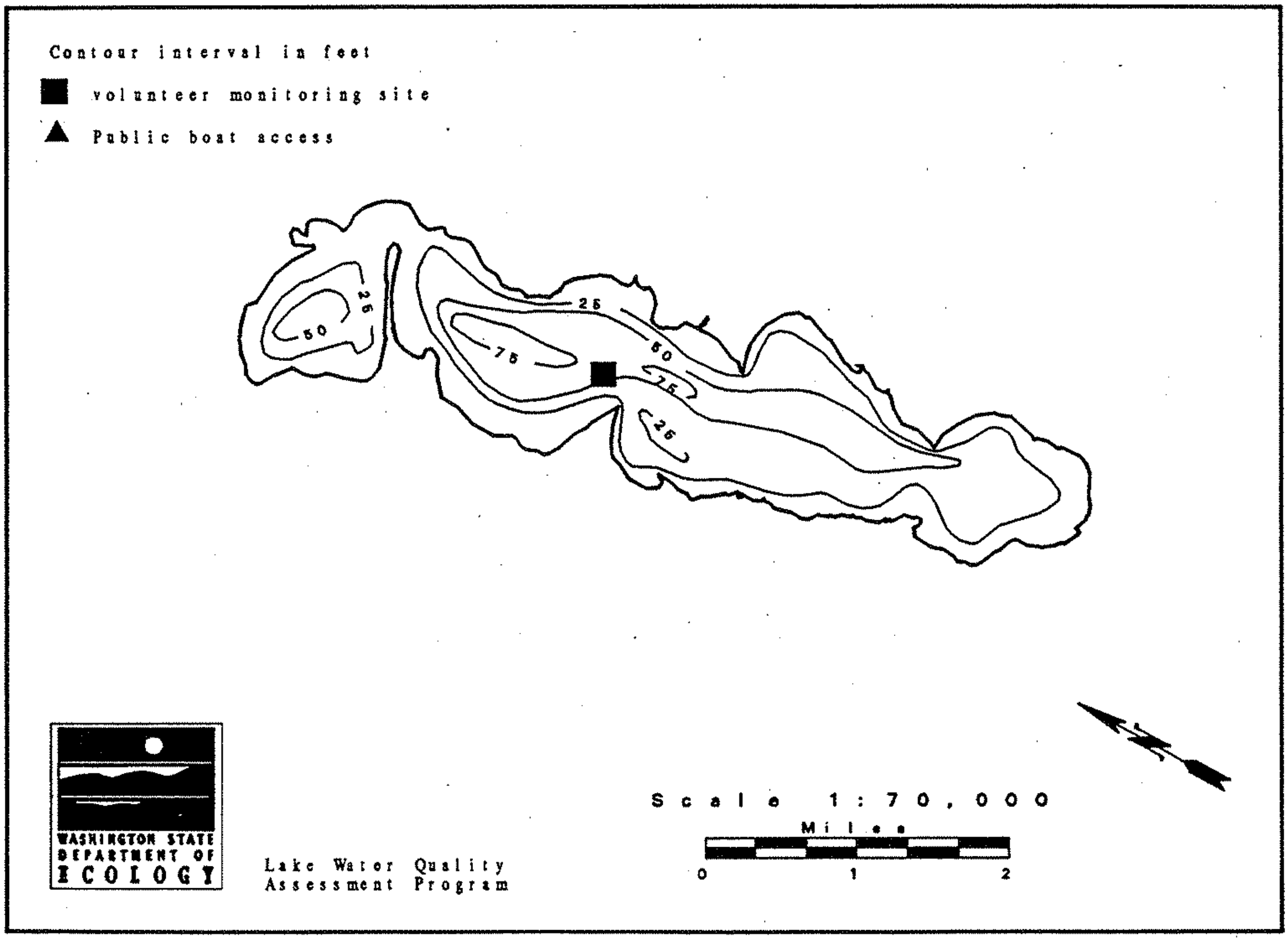


Lake Osoyoos -- Okanogan County

Lake Osoyoos is located one mile north of Oroville. It is ten miles long and extends north into Canada. The total size of the lake is 5,729 acres; 3,693 acres lie in British Columbia, Canada, and 2,036 acres lie in the U.S. Lake Osoyoos is fed principally by the Okanogan River in Canada and drains south via the Okanogan River in the U.S. to the Columbia River.

Size (acres)	5,729
Maximum Depth (feet)	208
Mean Depth (feet)	46
Lake Volume (acre-feet)	266,000
Drainage Area (miles^2)	3,150
Altitude (feet)	911
Shoreline Length (miles)	29.7

Data from Dion *et al.* (1976)



Overall Assessment

Lake Osoyoos had moderately good water quality in 1994. Despite the high concentration of total phosphorus during the May survey, and the high concentration of chlorophyll *a* during the August survey, Secchi depths in Lake Osoyoos were moderately deep.

Water clarity actually improved significantly from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results showed that there was an improving trend in Secchi depths from 1989 through 1994 that was significant at the 80 % level ($p = 0.19$).

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Lake Osoyoos was classified as mesotrophic in 1994. Secchi depths and water chemistry data are listed in tables at the end of this summary.

Aquatic plants observed by Ecology staff during field visits include Eurasian watermilfoil (*Myriophyllum spicatum*), curlyleaf pondweed (*Potamogeton crispus*), common waterweed (*Elodea canadensis*), white-flowering water lily (*Nymphaea odorata*), and purple loosestrife (*Lythrum salicaria*). The latter is a non-native, aggressive, wetland plant that is known to outcompete other wetland plants and create nuisance problems if left uncontrolled. Ecology's Freshwater Aquatic Weeds Program was notified of this sighting (see Summary of Questionnaire Responses, below).

Other Available Information

The Okanogan Water Quality Task Group was formed in 1994, with assistance from the B.C. Ministry of the Environment and Okanogan University College. The group intends to facilitate communication among the various groups that are involved with monitoring and managing water quality within Okanogan Valley, including Lake Osoyoos. Ecology's Lake Water Quality Assessment Program receives minutes from Task Group meetings, and provided Lake Osoyoos data to representatives of this group.

From Rensel (1993): To enhance the native population of sockeye salmon in Lake Osoyoos, the Douglas County Public Utility District proposed rearing juvenile salmon in small net pens in the lake. The juveniles would be released from the pens after six to eight weeks. Initial use of the net pens, and water quality monitoring at the site, began in summer 1994.

According to the volunteer, waterfowl (including loons, mergansers, and ospreys) ate well after the juvenile salmon were released from the net pens.

Eurasian water milfoil was introduced into Lake Osoyoos, and was first reported in 1975 (Gibbons *et al.*, 1984).

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994. Questionnaire responses apply to lake and watershed uses on the U.S. portion of the lake, unless otherwise indicated.

> Lake Osoyoos is used for fishing, boating, swimming, rowing, jet skiing, and camping. Recreational facilities on the lakeshore include a city park, a state park, a beach, and two boat ramps. Currently the watershed is used mainly for crop agriculture, although lakeshore development for residences is also occurring. Lake water is withdrawn for municipal, industrial and agricultural uses. In the past the watershed was used for animal grazing and crop agriculture.
>
> There are 203 houses on the U.S. side of the lakeshore. The lakeshore is not sewered on the U.S. side, although most homes on the Canadian side are sewered. There is a lake association and an inactive sewer district for the lake. The lake was drawn down during winter 1994, from approximately 912.2 feet to 908.0 feet. Aquatic plant management was restricted to mechanically harvesting aquatic plants on the Canadian side of the lake in 1994, but not on the U.S. side.
>
> Overall, the volunteer found that Lake Osoyoos had excellent water quality. Problems in the lake in 1994 were ranked as (1) excessive aquatic plant growth, (2) suspended sediments, (3) algae bloom, and (4) odor from decaying plants. There is concern about the lack of sewering on the U.S. lakeshore, and sources of funding a sewer system are being investigated. Fishing in the lake continues to be poor. Although the milfoil in the lake was not as bad in 1994 as during previous years, other plants, including purple loosestrife, were creating problems in areas. The Okanogan County Noxious Weed Board is now planning a program for eradicating the loosestrife.

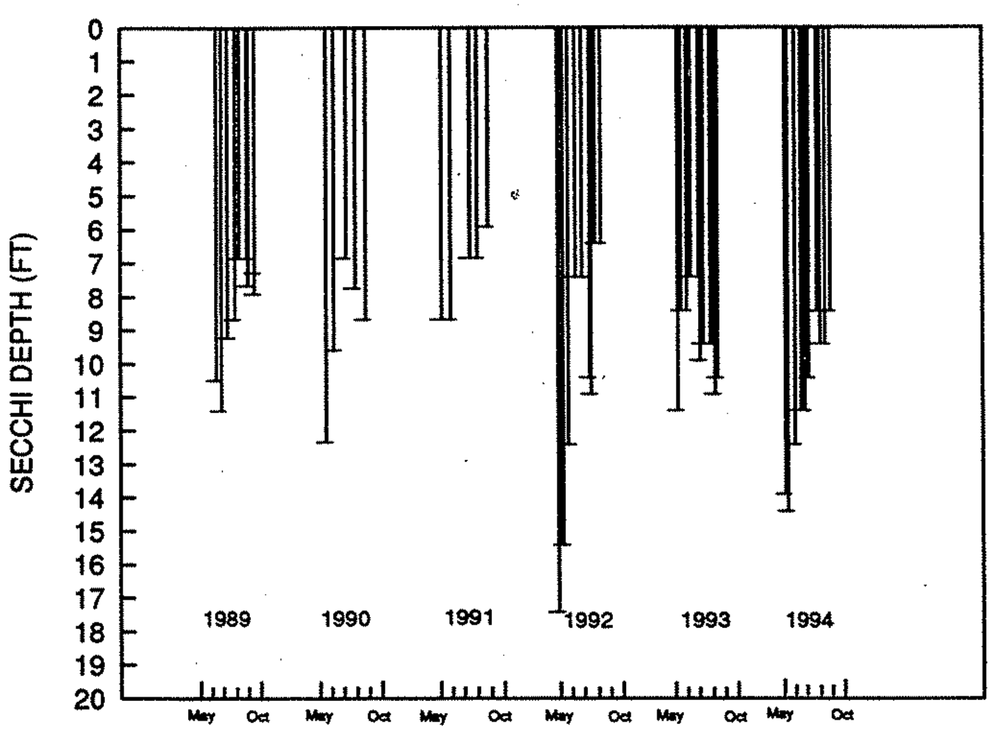
Acknowledgments

I thank Walter Ullrich for volunteering his time to monitor Lake Osoyoos from 1990 through 1994. Kathy Jones monitored the lake during 1989.

OSOYOOS Lake -- OKANOGAN County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(FT)	Abbrev.	Comments
STATION 1											
94/05/22	17.8	64.0	0.0	Lt Green	10	Mod		13.5	911.8		
94/05/27	15.6	60.1	0.0	Lt Green	10	None	Strong	14.0	911.9		Taken during Hallock's visit. Weather turned very windy and cool.
94/06/22	18.9	66.0	0.0	Lt Green	5	None	Calm	12.0	912.2		Very hot 90+ days, no wind. Lake up to summer level after a foot drop in June to release salmon.
94/07/08	23.9	75.0	0.0	Lt Green	0	None	Calm	11.0	912.3		90 degree weather after week of strong north winds, cool temps.
94/07/22	26.7	80.1	0.0	Lt Green	0	None	Light	11.0	912.3		
94/08/06	0.0	32.0	7.0	Lt Green	0		Light	10.0	912.3		Smoke from many fires in area. Now cooler temps - 90 degrees.
94/08/26	20.0	68.0	0.0	Lt Green	90	Light	Light	8.0	912.3		Onsite visit with Dave. Cool weather again. First rain in months. Lake level up 0.1 foot since last week (912.2).
94/09/15	20.0	68.0	0.0	Lt Green	0	Trace	Light	9.0	912.0		
94/09/26	20.6	69.1	0.0	Lt Green	5	None	Light	9.0	0.0		80 degrees, sunny. Summer over; no boats on lake.
94/10/13	14.4	57.9	0.0	Lt Green	75	None	Breezy	8.0	911.3		Last reading for 1994.

LAKE OSOYOOS (OKANOGAN COUNTY)



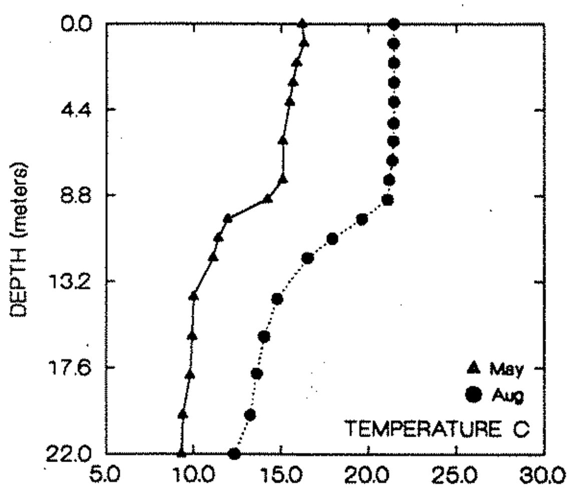
OSOYOOS (OKANOGAN) Lake -- OKANOGAN County
Chemistry Data -- Station 1

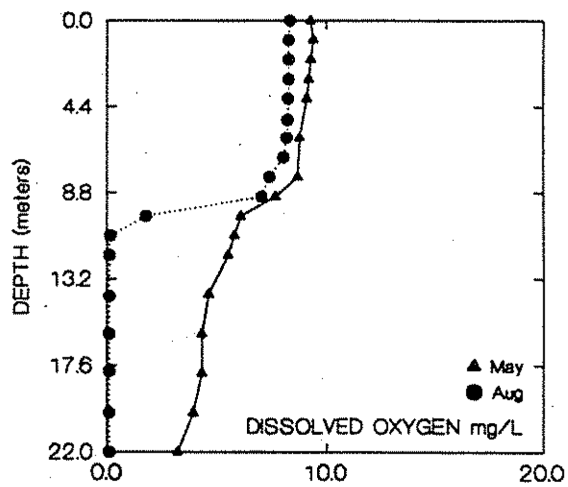
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
74/07/22		E	12			(Source: Water Supply Bulletin 43)					
81/07/15		E	20		3.3	(Source: Water Supply Bulletin 57)					
89/06/06	1	E	16	0.36	2.3						
89/09/06	1	E	21	0.31	6.0						
91/06/27	1	E		0.21							
92/05/08	1	E	12	0.34	0.8						
92/05/08	1	H	23	0.40							
92/08/01	1	E	12	0.24	1.3						
92/08/01	1	H	32	0.54							
93/05/23	1	E	15	0.29	4.7						
93/05/23	2	E	33	0.33	2.9						
93/05/23	1	H	13	0.36							
93/08/24	1	E	10	0.25	4.3						
93/08/24	2	E	12	0.29	4.8						
93/08/24	1	H	31	0.30							
94/05/27	1	E	27	0.16	3.4						
94/05/27	1	H	38	0.20							
94/08/26	1	E	14	0.37J	8.9						
94/08/26	1	H	43	0.33J							

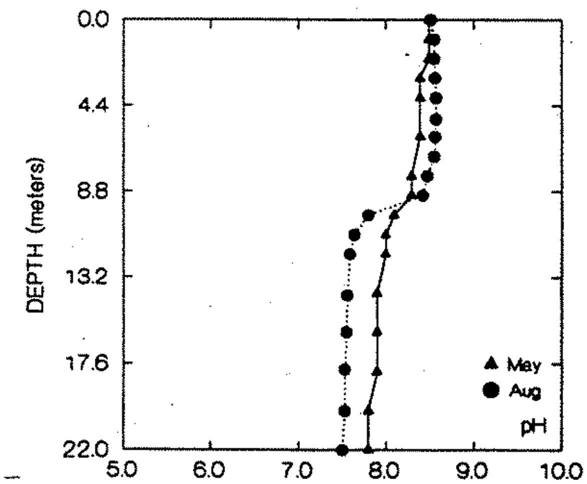
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

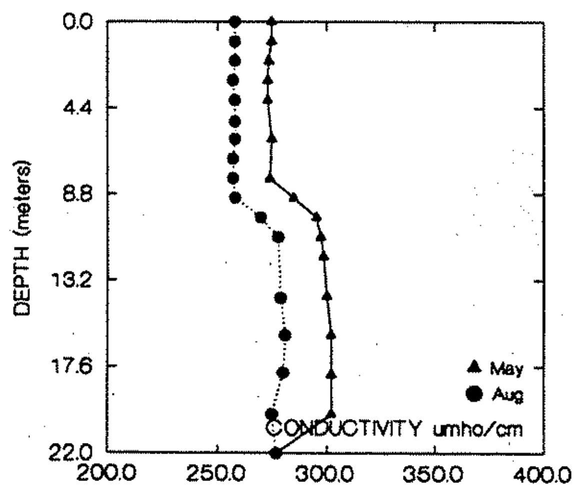
OSOYOOS (OKANOGAN) Lake -- OKANOGAN County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/27	0.0	16.2	8.5	9.3	275.0	94/08/26	0.0	21.5	8.5	8.3	258.0
	1.0	16.3	8.5	9.4	275.0		1.0	21.5	8.6	8.3	258.0
	2.0	15.9	8.5	9.3	274.0		2.0	21.5	8.6	8.3	258.0
	3.0	15.7	8.4	9.2	273.0		3.0	21.5	8.6	8.3	257.0
	4.0	15.5	8.4	9.1	273.0		4.0	21.5	8.6	8.3	258.0
	6.0	15.1	8.4	8.8	275.0		5.1	21.5	8.6	8.2	258.0
	8.0	15.1	8.3	8.7	274.0		6.0	21.5	8.6	8.2	258.0
	9.0	14.2	8.3	7.7	285.0		7.0	21.4	8.6	8.1	257.0
	10.0	11.9	8.1	6.1	295.0		8.0	21.2	8.5	7.4	257.0
	11.0	11.4	8.0	5.8	297.0		9.0	21.1	8.4	7.1	258.0
	12.0	11.1	8.0	5.5	299.0		10.0	19.6	7.8	1.7	270.0
	14.0	10.0	7.9	0.6	300.0		11.0	17.9	7.6	0.1	278.0
	16.0	9.9	7.9	4.3	302.0		12.0	16.5	7.6	0.1	266.0
	18.0	9.8	7.9	4.3	302.0		14.1	14.8	7.6	0.1	279.0
	20.0	9.4	7.8	3.9	302.0		16.0	14.0	7.5	0.1	281.0
	22.0	9.3	7.8	3.2	277.0		17.9	13.6	7.5	0.1	280.0
							20.0	13.2	7.5	0.1	275.0
							22.0	12.3	7.5	0.1	277.0
							22.0	12.3	7.5	0.2	286.0









North Pattison Lake -- Thurston County

Pattison Lake is located six miles southeast of Olympia. It consists of two basins separated by a narrow channel. The north basin covers 75 acres and the south basin covers 190 acres. The north lake is fed by Hicks Lake, drains through south Pattison Lake to Long Lake, which ultimately drains to Henderson Inlet via Himes/Woodland Creek. Pattison Lake is also listed in references as Lake.

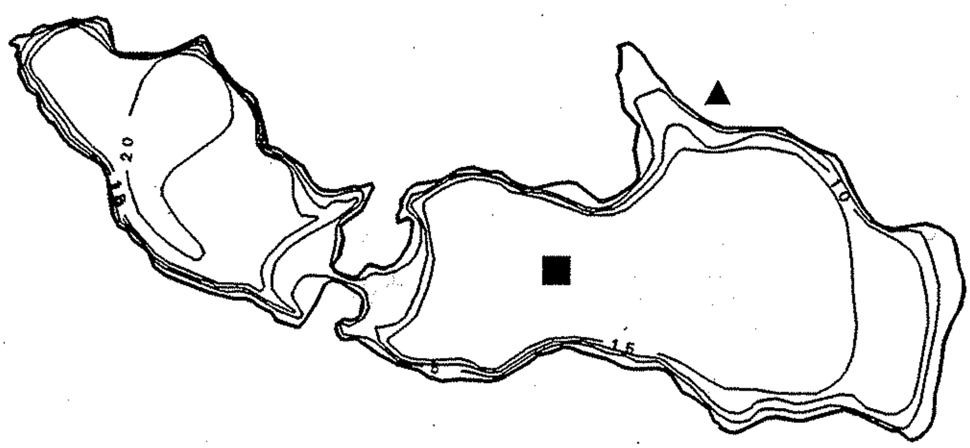
Size (acres)	75
Maximum Depth (feet)	22
Mean Depth (feet)	14
Lake Volume (acre-feet)	1,100
Drainage Area (miles^2)	2.9
Altitude (feet)	154
Shoreline Length (miles)	1.7

Data from Bortleson *et al.* (1976)

Contour interval in feet

■ volunteer monitoring site

▲ Public boat access



WASHINGTON STATE DEPARTMENT OF ECOLOGY

Lake Water Quality Assessment Program

Scale 1:18,000

Feet

0 1125 2250

Overall Assessment

North Pattison Lake had fairly good water quality in 1994. Although concentrations of total phosphorus were moderately high to high on both sampling dates, total nitrogen was relatively low (for Pattison Lake). Both nitrogen and phosphorus are nutrients used by algae. Secchi depths, and volunteer observations, indicate that algae were most prevalent during August and September (see graph of Secchi depths).

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), North Pattison Lake was classified as mesotrophic in 1994. Water chemistry data are listed in tables at the end of this summary.

Profile data were very similar to previous data collected from the lake. Low dissolved oxygen concentrations near the lake bottom usually result from bacterial decomposition of organic material (such as algae and aquatic plants) in the bottom water and sediments. Oxygen is replenished in bottom waters when the lake mixes, or "turns over" each fall.

Aquatic plants observed by Ecology staff during field visits on North Pattison Lake include yellow-flowering water lily (*Nuphar sp.*), white-flowering water lily (*Nymphaea odorata*), cattails (*Typha sp.*), tapegrass (*Vallisneria americana*), whitestem pondweed (*Potamogeton praelongus)*, common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), largeleaf pondweed (*Potamogeton amplifolius*), slender pondweed (probably *Potamogeton pusillus*, but this should be confirmed), and star duckweed (*Lemna trisulca*).

A trench between South Pattison Lake and Long Lake was dug illegally in 1994, presumably to lower the levels of Pattison Lake. In 1993, the outlet to the lake was blocked by a beaver dam, but the dam was quickly rebuilt after an attempt was made to remove it. Water level rose again in 1994. The volunteers noted that the level of North Pattison dropped three inches after the trench was dug. (However, the volunteer at Long Lake did not notice a rise in lake level after the trench was dug.)

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire on lake and watershed uses.

> North Pattison Lake is used for fishing, swimming, and non-motorized boating. There is one public boat ramp, and boat speed is restricted to 5 mph. Trout were stocked in the lake in 1994. Currently, the watershed is being developed further for residences. No algae or aquatic plant management activities occurred on the lake in 1994; this was the first year that a mechanical harvester was not used.

There are about 75 houses on the lakeshore, and there is a lake association for the lake. Lake water was withdrawn for drinking and other domestic uses.

Overall, the volunteer finds that North Pattison Lake had good water quality. Problems in the lake in 1994 were ranked as (1) low water level, (2) suspended sediments, (3) gradually degrading water quality, and (4) algae. Possible sources of problems include septic systems.

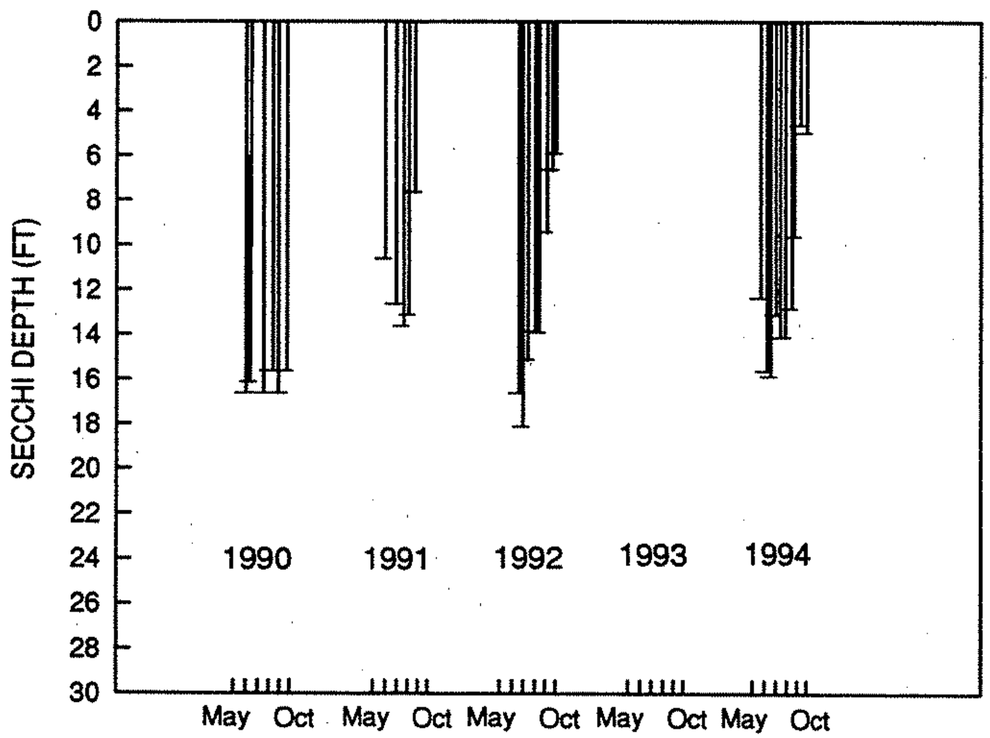
Acknowledgments

I thank Loraine Vaa for volunteering her time to monitor North Pattison Lake during 1994. Russ McMillan monitored the lake during 1991 and 1992, and David Hallock monitored the lake during 1990.

PATTISON (NORTH) Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/17	17.8	64.0	0.0	Mod Green	100	None	Calm	11.8	0.0		Onsite visit. First Secchi is Lorraine, second is Norm.
94/06/03	0.0	32.0	0.0	Lt Brown	25	Trace	Calm	15.0	0.0		
94/06/17	0.0	32.0	0.0	Grn-brown	50	Light	Light	15.3	0.0		
94/06/30	0.0	32.0	0.0	Grn-brown	75		Calm	12.5	0.0		(No water temp)
94/07/12	24.4	75.9	0.0	Mod Green	0	None	Light	13.5	0.0		Some algae floating in the water.
94/07/28	24.4	75.9	0.0	Grn-brown	0	None	Breezy	13.5	-1.0		
94/08/16	23.3	73.9	0.0	Grn-brown	50	None	Light	12.2	-4.0		Onsite visit.
94/08/25	22.2	72.0	0.0	Grn-brown	50	None	Light	9.0	-6.0		Pollen on surface. A lot of particles in water.
94/09/12	0.0	32.0	0.0	Grn-brown	0	Light	Light	4.0	-7.0		Thick tiny particles.
94/09/28	20.0	68.0	0.0	Pea-green	25	None	Calm	4.3	-9.0		

NORTH PATTISON LAKE (THURSTON COUNTY)



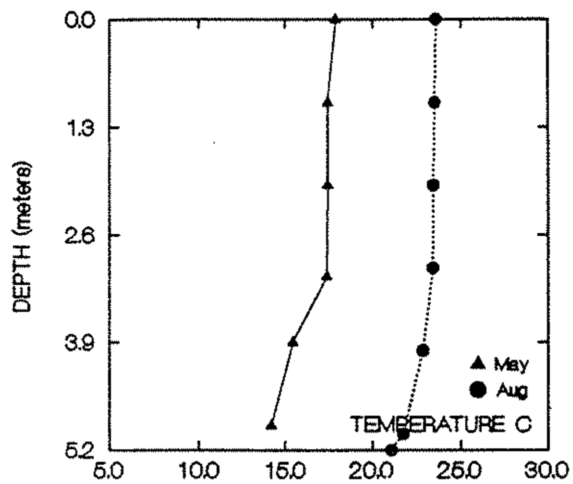
PATTERSON (NORTH ARM) (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

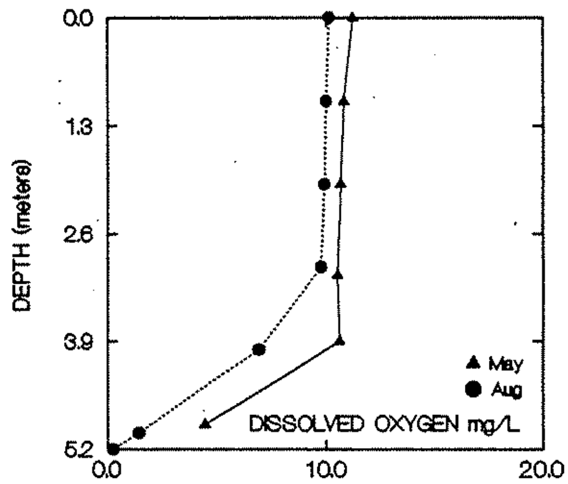
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/06/19		E	14			(Source: Water Supply Bulletin 43)					
81/07/21		E			2.9	(Source: Water Supply Bulletin 57)					
90/05/30	1	E	20	0.66							
90/08/22	1	E	15	0.95							
91/06/04	1	E		1.27							
92/08/07	1	E	23	0.61	4.0						
94/05/17	1	E	29	0.41	2.2						
94/05/17	1	H	27	0.39							
94/08/16	1	E	20	0.27J	2.7J						
94/08/16	1	H	47	0.23J							

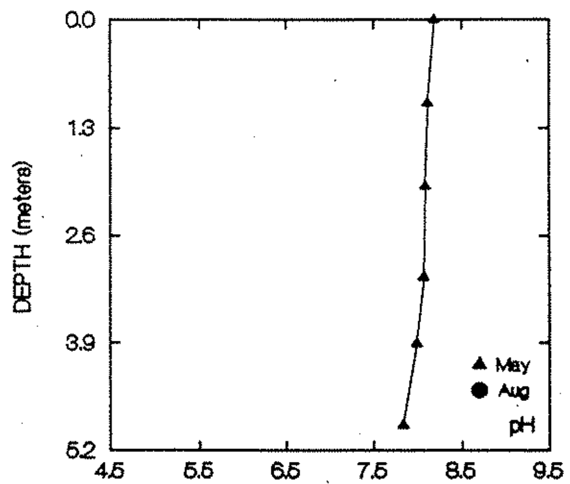
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

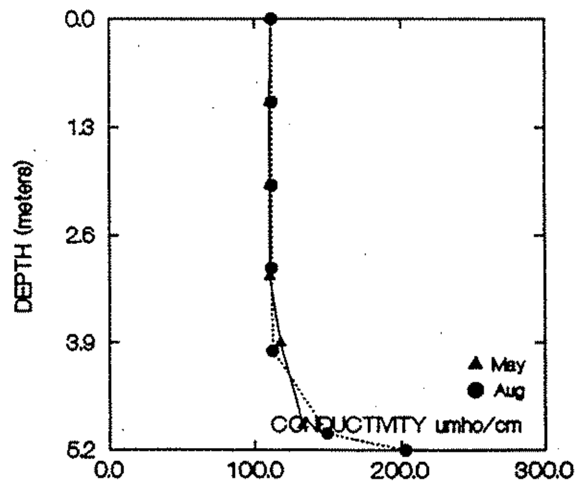
PATTERSON (NORTH ARM) (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/17	0.0	17.9	8.2	11.3	110.0	94/08/16	0.0	23.6	0.0	10.1	112.0
	1.0	17.5	8.1	10.8	110.0		1.0	23.5	0.0	10.0	111.0
	2.0	17.5	8.1	10.7	110.0		2.0	23.5	0.0	9.9	111.0
	3.1	17.4	8.1	10.5	110.0		3.0	23.4	0.0	9.8	111.0
	3.9	15.5	8.0	10.6	117.0		4.0	22.9	0.0	6.9	112.0
	4.9	14.2	7.8	4.5	132.0		5.0	21.8	0.0	1.5	149.0
							5.2	21.1	0.0	0.3	203.0







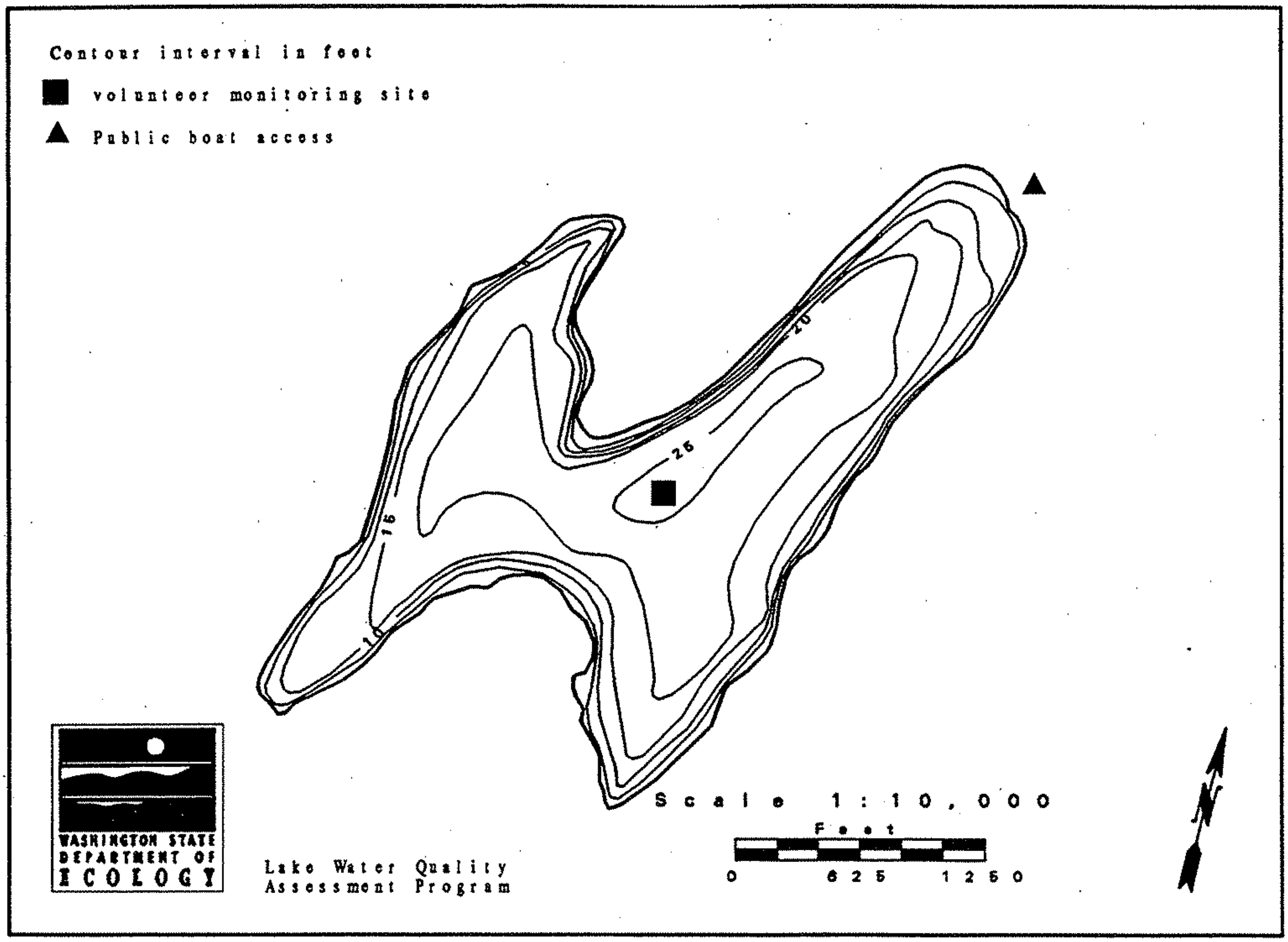


Phillips Lake -- Mason County

Phillips Lake is located seven miles north of Shelton. It has no surface inlets, and drains via Campbell Creek through a marshy area to Oakland Bay.

Size (acres)	110
Maximum Depth (feet)	25
Mean Depth (feet)	16
Lake Volume (acre-feet)	1,800
Drainage Area (miles^2)	0.5
Altitude (feet)	188
Shoreline Length (miles)	2.6

Data from Bortleson *et al.* (1976)



Overall Assessment

Phillips Lake had good water quality in 1994.

Secchi depths did not vary much during the monitoring season, and were similar to measurements from 1993 and 1990 (see graph of Secchi depth data). Statistical analysis of data collected since 1989 did not show a trend in water clarity. This was tested using a seasonal Kendall test for trend, and results were not statistically significant at the 80% level ($p = 0.56$).

Total phosphorus concentrations were moderately high to high on both sampling dates, and were higher than concentrations measured during previous years for the program (see table of water chemistry results). Despite these higher phosphorus concentrations, there was a low amount of algae (as indicated by Secchi depths and concentrations of chlorophyll *a*) when the lake was sampled.

Profile data did not change much from surface to bottom because the lake was not stratified. This is not unusual for Phillips Lake because it is very shallow. There are no pH data from the August survey in the table of profile data results, because the probe was not functioning properly at the time.

Phillips Lake was classified as mesotrophic in 1994, based primarily on the higher concentrations of total phosphorus and Secchi depths that were borderline between oligotrophy and mesotrophy. Phillips Lake has been classified as mesotrophic during previous years primarily based on moderately high amounts of algae. Resident complaints fall algal blooms have occurred almost annually since the program began.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 through 1994.

> Phillips Lake is used for fishing, swimming, boating, jet skiing, and rowing. Recreational facilities on the lakeshore include a picnic area, a beach, and one boat ramp. There are no restrictions on motor boat use on the lake. About 1% of the shoreline is publicly-owned. There are five culverts that drain into the lake. Rainbow trout were stocked in the lake in 1994. Currently the watershed is being logged, and the lakeshore is being developed further for residences. In the past, the watershed was logged and the shoreline was altered during bulkhead construction. The lake has been chemically treated in the past to control undesirable fish species.

There are about 153 houses on the lakeshore, and none of the houses are connected to a sewer. Lake water is withdrawn for drinking and other domestic uses. There is a lake association for the lake. Currently, the minimum setback for lakeshore development is 15 feet, and minimum lot size is 12,500 square feet (zoning for lot sizes depends on soil type). No lake management activities occurred in 1994.

Overall, the volunteer found that Phillips Lake had good water quality. Since the 1993 monitoring season, four new houses have been built along the lakeshore.

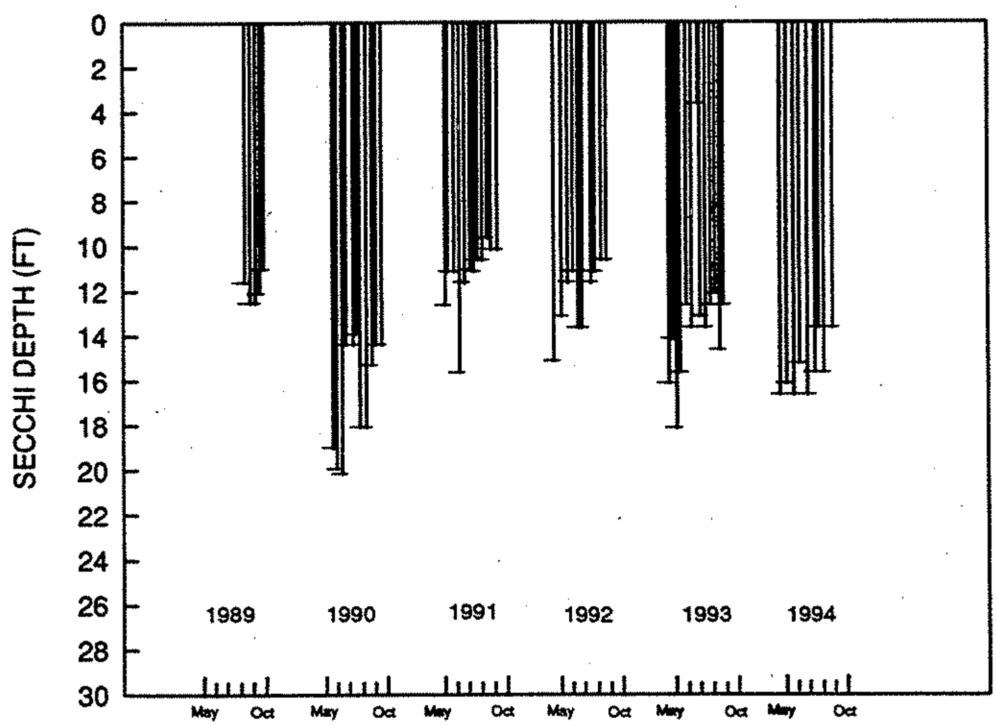
Acknowledgment

I thank James Keeley for volunteering his time to monitor Phillips Lake from 1989 through 1994.

PHILLIPS Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/02	14.4	57.9	0.0	Lt Green	10	Trace	Light	16.0	8.0	Sunny.
94/05/16	16.7	62.1	0.0	Lt Green	25	Light		15.5	9.0	
94/06/01	17.8	64.0	0.0	Lt Green	25	Trace	Light	16.0	11.0	Sunny.
94/07/02	18.9	66.0	0.0	Mod Green	80	Mod	Light	14.6	14.0	
94/07/15	22.2	72.0	0.0	Lt Green	50	None	Calm	16.0	17.0	
94/08/01	25.6	78.1	0.0	Lt Green	10	None	Calm	16.0	0.0	
94/08/15	24.4	75.9	0.0	Lt Green	25	Trace	Light	15.0	24.0	Hit bottom at 20 feet.
94/09/01	21.1	70.0	0.0	Lt Green	25	None	Breezy	13.0	26.0	
94/09/16	19.4	66.9	0.0	Lt Green	10	Trace	Light	15.0	27.0	
94/10/01	17.8	64.0	0.0	Lt Green	10	None	Light	13.0	0.0	Depth at site 19 feet.
94/10/16	14.4	57.9	0.0	Lt Green	50	Light	Light	13.0	31.5	

PHILLIPS LAKE (MASON COUNTY)



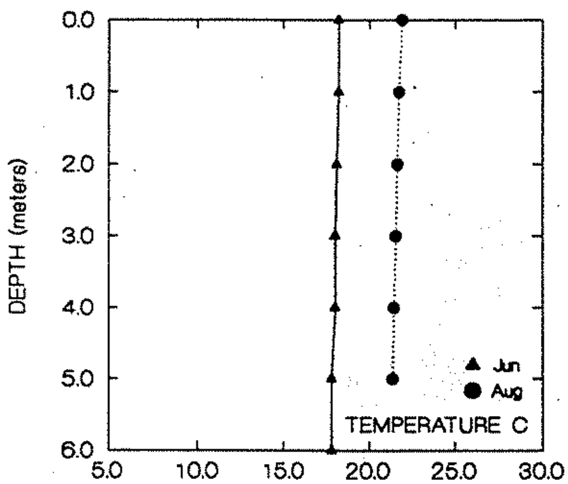
PHILLIPS (MASON) Lake -- MASON County
Chemistry Data -- Station 1

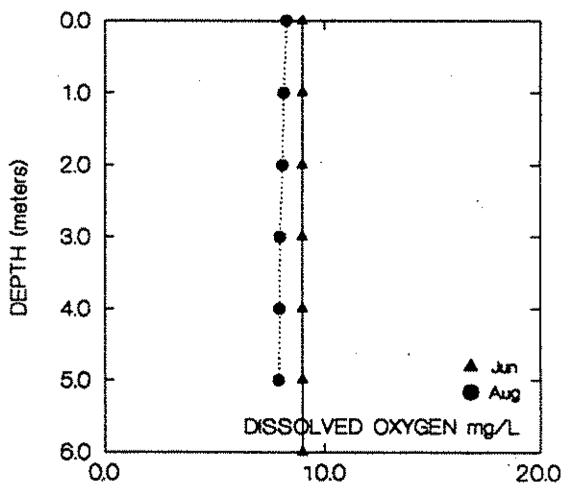
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/06/29		E	15			(Source: Water Supply Bulletin 43)					
90/05/24	1	E	13	0.30							
90/08/15	1	E	13	0.49							
91/05/21	1	E		0.28							
92/06/02	1	E	8	0.31	0.8	1U	1U		2	1U	20
92/06/02	2	E	9	0.33	1.5				2	1U	20
92/06/02	1	H	15	0.32							
92/08/26	1	E	11	0.38	1.2	1U	35		4	1	10
92/08/26	2	E				1					15J
93/05/28	1	E	21	0.31	0.6						
93/09/02	1	E	12	0.31	1.0						
94/06/01	1	E	30	0.17	2.0						
94/08/24	1	E	23	0.30J	1.8						

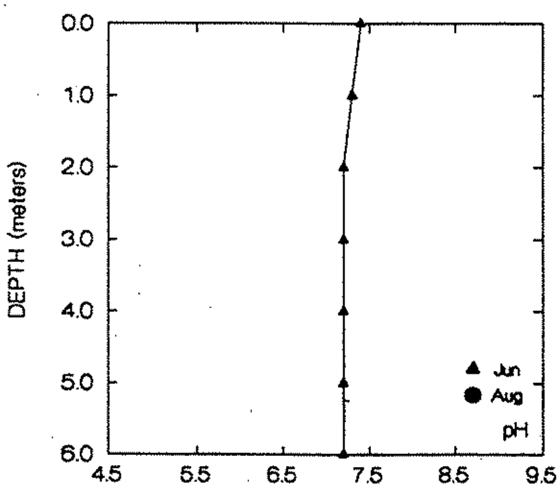
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

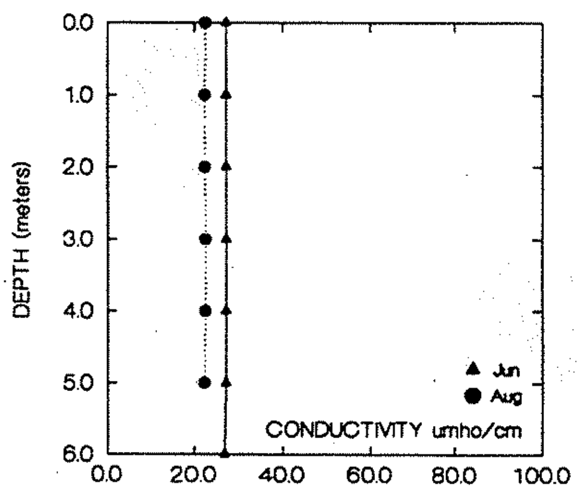
PHILLIPS (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/01	0.0	18.2	7.4	9.0	27.0	94/08/24	0.0	21.9	0.0	8.3	22.0
	0.0	18.2	7.4	9.0	27.0		1.0	21.7	0.0	8.2	22.0
	1.0	18.2	7.3	9.0	27.0		2.0	21.6	0.0	8.1	22.0
	1.0	18.2	7.3	9.0	27.0		3.0	21.6	0.0	8.0	22.0
	2.0	18.1	7.2	9.0	27.0		4.0	21.4	0.0	8.0	22.0
	2.0	18.1	7.2	9.0	27.0		5.0	21.4	0.0	7.9	22.0
	3.0	18.0	7.2	9.0	27.0						
	3.0	18.0	7.2	9.0	27.0						
	4.0	18.0	7.2	9.0	27.0						
	4.0	18.0	7.2	9.0	27.0						
	5.0	17.8	7.2	9.0	27.0						
	5.0	17.8	7.2	9.0	27.0						
	6.0	17.8	7.2	9.0	27.0						
	6.0	17.8	7.2	9.0	27.0						









Lake Roesiger -- Snohomish County

Roesiger is located 8.5 miles northeast of Monroe. The north and south basins of the lake are separated by a shallow connecting basin. The volunteer monitored both basins. The north basin of Lake Roesiger is fed by an intermittent stream, and drains southeast through the south basin of the lake via Roesiger Creek to Woods Creek and the Skykomish River.

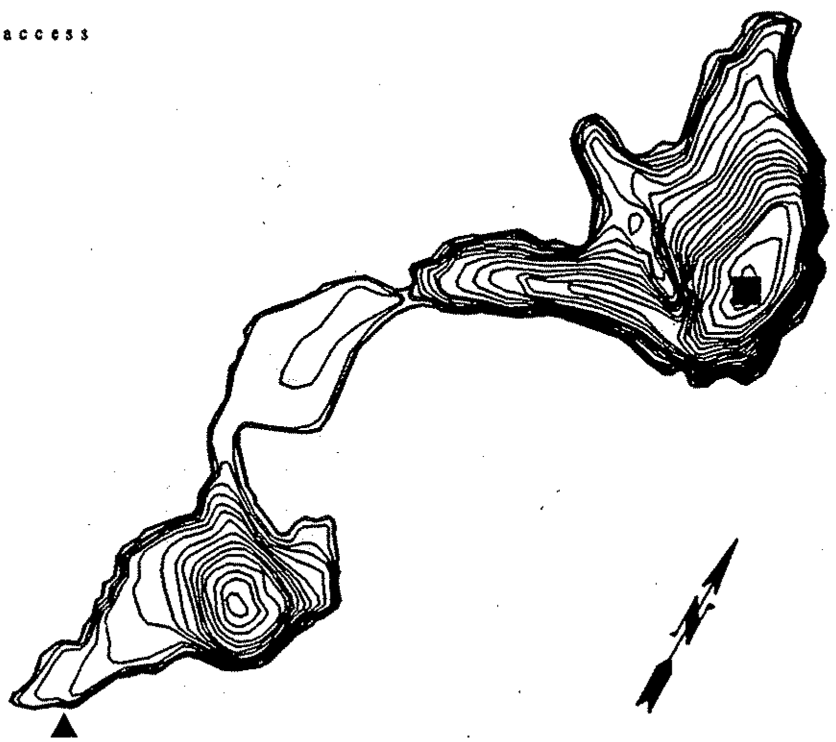
	North Basin	South Basin
Size (acres)	200	140
Maximum Depth (feet)	110	70
Mean Depth (feet)	48	22
Lake Volume (acre-feet)	9,600	3,000
Drainage Area (miles^2)	1.9	3.6
Altitude (feet)	570	570
Shoreline Length (miles)	2.9	3.0

Data from Bortleson *et al.* (1976)

Contour interval 5 feet

■ volunteer monitoring site

▲ Public boat access



Scale 1 : 25,000

Miles

0 0.5 1

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Lake Water Quality Assessment Program

Overall Assessment

Lake Roesiger had good water quality in 1994. Secchi depths in both basins were deep, although particles of algae were visible in the water during the monitoring season (see table of volunteer-collected data for the north basin).

Concentrations of total phosphorus varied considerably when the lake was sampled in 1993 and 1994 (see table of water chemistry results). As would be expected, though, higher concentrations in the epilimnion were found during the May surveys, and lower concentrations were found during the August surveys. This is typical for deeper lakes, and is consistent with findings from Lake Roesiger Resident monitoring; their 1994 results for total phosphorus in the north basin ranged from 2 to 7 µg/L, with higher concentrations during April and May. Their results, however, were considerably lower than results from Ecology's samples collected from the same depths on the same days. Reasons for these differences are unknown at this point.

Profile data showed that the lake was strongly stratified on both sampling dates. Dissolved oxygen data on both dates (May data are not reported here due to accuracy problems with the probe) showed that concentrations decreased considerably below the thermocline. Low oxygen concentrations can result from bacterial decomposition of organic material (such as logs, algae, and aquatic plants) in the bottom water sediments, from groundwater entering the lower layer of water (groundwater carries no oxygen), and possibly from incomplete mixing during lake turnover. The latter is particularly a consideration, because of the unusual cone-shaped morphometry of the two basins of the lake, and appears to be supported by data collected by a local monitoring program (see Summary of Questionnaire Results and Information from the Volunteer). Hydrogen sulfide, which is only stable in the absence of oxygen, was smelled in water samples collected at 24 meters and 28 meters during the August survey. It is been smelled in samples collected during previous years of the program, as well as by volunteers who have collected samples for the Lake Roesiger Residents Monitoring Program.

As in earlier years, Lake Roesiger exhibited both oligotrophic and mesotrophic characteristics. Oligotrophic characteristics include the low concentrations of chlorophyll *a* on both sampling dates, and the low August concentration of total phosphorus. Mesotrophic characteristics include the very low concentrations of dissolved oxygen below the thermocline, the moderately high concentrations of total phosphorus during the May survey, and an increasing population of aquatic plants that is moderately heavy in areas. Because the lake exhibited both oligotrophic and mesotrophic characteristics, Lake Roesiger was classified as oligo-mesotrophic in 1994.

There has been a long term disagreement between the Snohomish County PUD, Ecology, and resident homeowners regarding the benefits of aerating Lake Roesiger. At issue is the low dissolved oxygen concentrations in the hypolimnion, and phosphorus recycling from sediments as a result of low oxygen concentrations. Monitoring dissolved oxygen, oxidation-reduction potential, and phosphorus in transects along both basins of Lake Roesiger, from late summer through early winter, may be beneficial in resolving some of this dispute. Ecology recently awarded a grant to the Snohomish County PUD for monitoring the effectiveness of best management practices in the Lake Roesiger watershed; monitoring has not yet commenced.

Other Available Information

The Association of Lake Roesiger Property Owners began monitoring both basins in 1992. Data and samples were collected monthly from November through April, and bimonthly from May through October. Temperature and dissolved oxygen profiles were measured using a YSI meter. Secchi depth was also measured. Epilimnion samples were composited from water collected at 1, 2, and 3 meter depths. These samples were analyzed for total phosphorus and chlorophyll *a*. Hypolimnion samples were composited from water collected at 16, 22, and 28 meter depths. These samples were analyzed for total phosphorus. Additional samples were collected at discrete depths from both basins in April and November. Metalimnion samples were collected for chlorophyll analysis and algae identification and enumeration. Bottom samples were collected for TP, iron, alkalinity, and conductivity. All water samples were analyzed using an Ecology-accredited laboratory.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires from 1990 through 1994.

> Lake Roesiger is used for fishing, boating, swimming, rowing, jet skiing, camping, and bird watching. Public recreational facilities on the lake include a county park, a picnic area, and a beach. There is one public boat ramp, and there is a speed restriction of 8 mph for motorboating and "no wake" allowed before 10:30 a.m. and after 5:30 p.m., or in the middle basin. Water skiing is restricted between September 26 and May 24. Rainbow and cutthroat trout were stocked in the lake in 1994. Less than 5% of the shoreline is publicly-owned. The watershed is being logged and is used for horse grazing. The lakeshore is also being developed further for residences. In the past, the watershed was logged, and the shoreline was altered (prior to 1960, trees and fallen timber in the Gemmer Road area were pushed into the lake during lot clearing). Also, prior to 1960, a wetland on the east side of the middle basin was filled in.
>
> There are about 350 houses on the lakeshore (but 454 lakefront lots). Except for the county park area, there are residences all along the shore of the south basin. The lakeshore is not sewered. Currently, the minimum setback for lakeshore development is 25 feet, and residential density is restricted to two houses per acre. Lake water is withdrawn for drinking, irrigation, and to fill fire district tankers.

There are 48 culverts which drain into the lake. There is a lake association, and two community clubs for the lake. No aquatic plant or algae control occurred in 1994.

Overall, the volunteer found that Lake Roesiger had excellent water quality. Low water level was the worst problem in 1994, which primarily affected the middle basin. Excessive aquatic plants and shoreline erosion were also problems, but were not severe. Surface runoff from property could be reduced through landscaping for less lawn area, and more mixed vegetation.

Data from the Lake Roesiger Residents Monitoring Program showed that dissolved oxygen was depleted in the north basin throughout the year. Total nitrogen and iron concentrations were higher in hypolimnion samples. Eplimnetic samples had low concentrations of total phosphorus and chlorophyll *a*. Monitoring results indicated very good water quality.

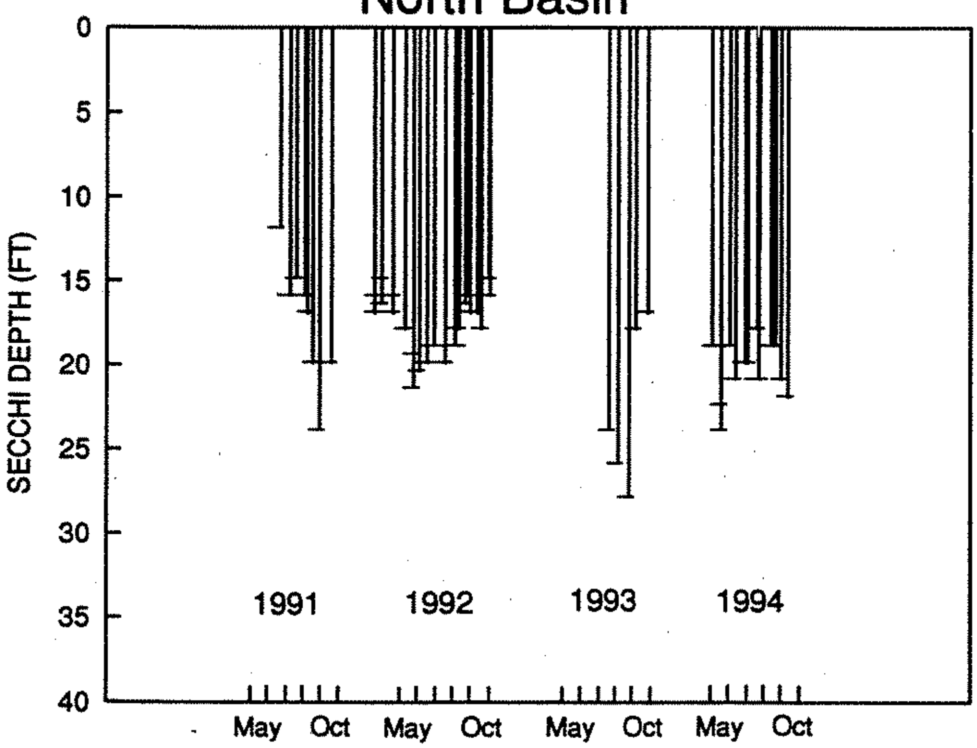
Acknowledgments

I thank the following volunteer monitors at Lake Roesiger: Elsie Sorgenfrei, Mitch and Clarissa Sazawa, Robert and Jo Miller, and Mary and Cam Standish. These volunteers collected data from Lake Roesiger in 1994 and 1993. Andy Loch monitored both basins during 1992, and Elsie Sorgenfrei and Frank Stegmeier monitored the south basin during 1991.

ROESIGER Lake -- County
1994 Volunteer-collected Data

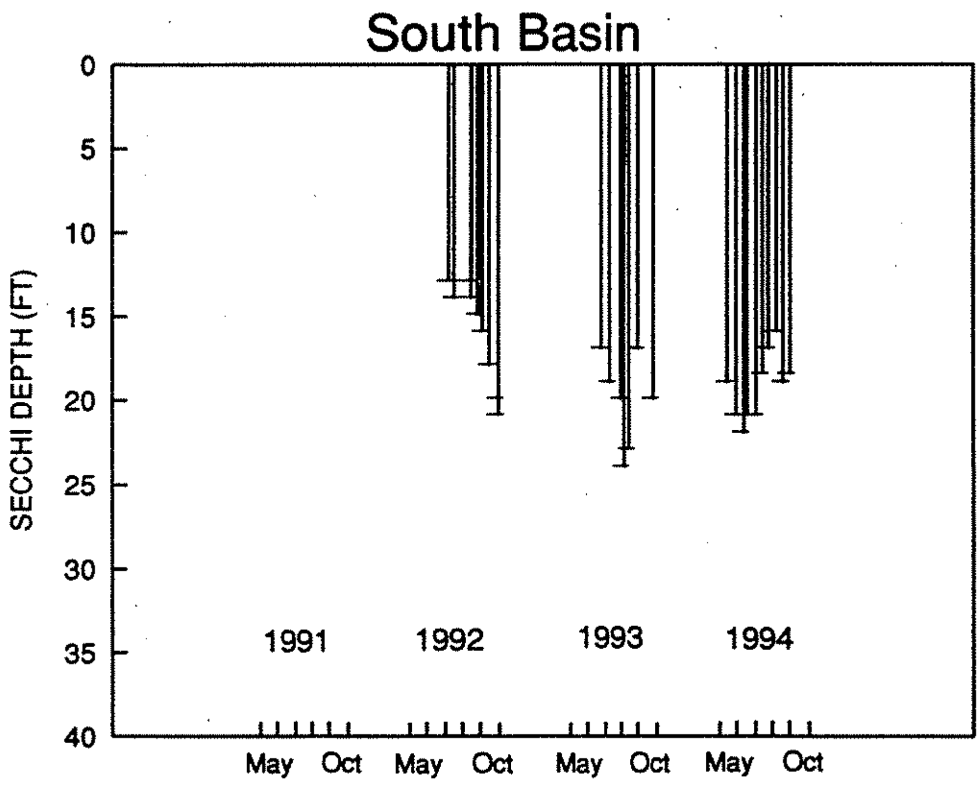
Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/04/30	14.4	57.9	0.0	Lt Green	90	Light		18.0	0.0		
94/05/20	16.0	60.8	0.0	Lt Green	75	Mod	Calm	21.5	0.0		White particles among green algae.
94/06/11	21.0	69.8	7.5	Lt Green	10	None	Calm	18.0	17.0		
94/06/24	20.0	68.0	0.0	Lt Green	0			20.0	16.0		
94/07/15	24.0	75.2	0.0	Lt Green	10	None	Calm	19.0	17.5		
94/07/29	24.0	75.2	0.0	Lt Green	90	Trace	Calm	19.0	19.0		3 weeks of no rain, temps to 100 degrees. DO at 29.5 m: 1 mg/L Winkler, 0.05 mg/L YSI. Fine ribbons of algae film in deep lake areas only. None near. shore.
94/08/13	22.5	72.5	0.0	Mod Green	0	None	Calm	20.0	20.5		Dandelion and other seed puffs on water surface gave a white coat to some areas near lake middle.
94/08/19	23.5	74.3	0.0	Mod Green	50	Trace		17.0	22.0		
94/08/27	22.0	71.6	0.0	Mod Green	0	None	Calm	20.0	22.5		Some dabs of foam towards middle of lake.
94/09/16	20.8	69.4	0.0	Mod Green	25	Mod	Calm	18.0	21.5		Fireweed seed floc on water.
94/09/30	20.0	68.0	0.0	Mod Green	90	None	Breezy	18.0	21.0		
94/10/14	15.5	59.9	0.0	Mod Green	90	Mod	Breezy	20.0	23.0		
94/10/28	13.0	55.4	0.0	Lt Green	75	Mod		21.0	19.5		Inshore water very clear to bottom.

LAKE ROESIGER (SNOHOMISH COUNTY)
North Basin



ROESIGER Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 3											
94/05/20	17.5	63.5	0.0	Lt Green	100	Mod	Calm	18.0	14.5		Raining.
94/06/10	19.2	66.6	7.5	Lt Green	0	None	Light	20.0	22.5		
94/06/30	20.5	68.9	0.0	Lt Green	90	None	Light	21.0	22.5		
94/07/19	22.0	71.6	0.0	Lt Green	0	None	Calm	20.0	25.0		
94/08/01	24.0	75.2	0.0	Lt Green	0	None	Calm	20.0	0.0		Floating plant parts.
94/08/15	23.0	73.4	0.0	Mod Green	75	None	Calm	17.5	27.0		No odor at 21 meter sample.
94/08/29	21.5	70.7	0.0	Mod Green	100	Trace	Light	16.0	28.0		Lake level lowest in three years.
94/09/16	19.9	67.8	0.0	Mod Green	0	Mod	Calm	15.0	0.0		Water level "low", but no measurement.
94/10/03	18.5	65.3	0.0	Mod Green	0	Trace		18.0	28.0		Light leaf and pollen debris floating on inshor e waters.
94/10/17	15.0	59.0	0.0	Mod Green	75	Heavy	Calm	17.5	28.0		



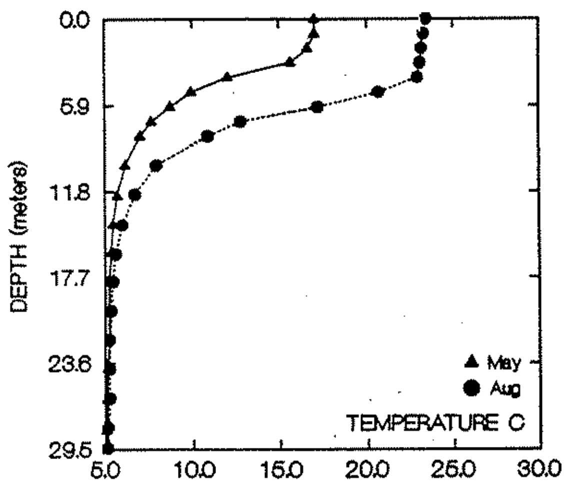
ROESIGER (NORTH ARM) (SNOHOMISH) Lake -- County
Chemistry Data -- Station 1

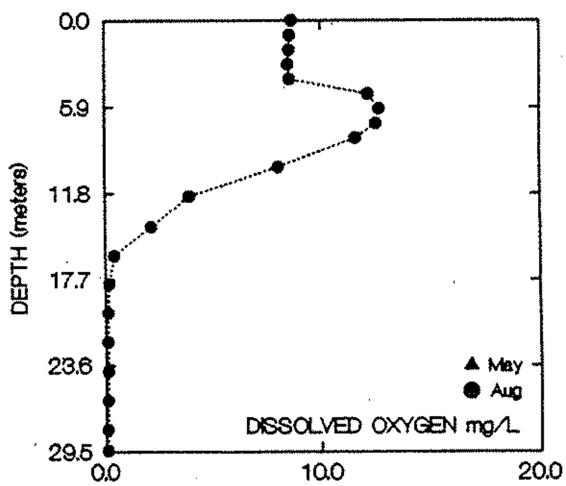
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/07/25		E	29			(Source: Water Supply Bulletin 43)					
81/07/06		E	10		2.3	(Source: Water Supply Bulletin 57)					
92/05/05	1	E	5	0.48	0.5						
93/05/24	1	E	112	0.36	1.3						
93/05/24	1	H	20	0.53							
93/08/20	1	E	4	0.20	2.3						
93/08/20	1	H	8	0.36							
94/05/20	1	E	27	0.26	2.3						
94/05/20	2	E	17	0.25							
94/05/20	1	H	12	0.31							
94/08/19	1	E	4	0.13J	1.3J						
94/08/19	2	E	10	0.17J							
94/08/19	1	H	21	0.55J							

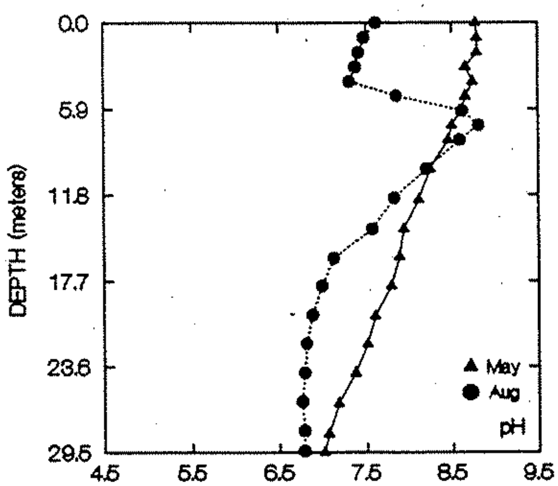
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

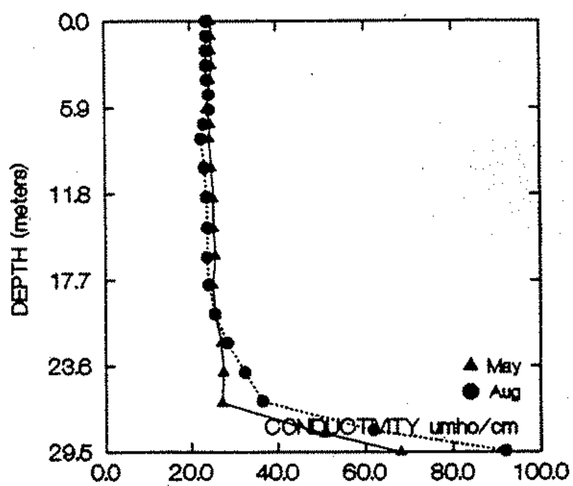
ROESIGER (NORTH ARM) (SNOHOMISH) Lake -- County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/20	0.0	17.0	8.8	0.0	25.0	94/08/19	0.0	23.5	7.6	8.7	24.0
	1.0	17.0	8.8	0.0	25.0		1.0	23.3	7.5	8.6	24.0
	2.0	16.6	8.8	0.0	25.0		2.0	23.2	7.4	8.6	24.0
	3.0	15.6	8.7	0.0	25.0		3.0	23.1	7.4	8.5	24.0
	4.0	12.0	8.7	0.0	25.0		4.0	23.0	7.3	8.6	24.0
	5.0	9.9	8.7	0.0	24.0		5.0	20.7	7.9	12.2	24.0
	6.0	8.7	8.6	0.0	24.0		6.0	17.2	8.6	12.7	24.0
	7.0	7.7	8.5	0.0	25.0		7.0	12.8	8.8	12.5	23.0
	8.0	7.0	8.5	0.0	24.0		8.0	10.9	8.6	11.6	22.0
	10.0	6.2	8.3	0.0	25.0		10.0	7.9	8.2	8.1	23.0
	12.1	5.7	8.1	0.0	25.0		12.0	6.7	7.8	3.9	24.0
	14.1	5.5	7.9	0.0	25.0		14.1	6.0	7.6	2.2	24.0
	16.0	5.4	7.9	0.0	26.0		16.1	5.6	7.1	0.4	24.0
	18.0	5.3	7.8	0.0	25.0		18.0	5.5	7.0	0.2	24.0
	20.1	5.2	7.6	0.0	26.0		20.0	5.4	6.9	0.1	25.0
	22.0	5.2	7.5	0.0	27.0		22.0	5.3	6.8	0.1	28.0
	24.0	5.2	7.4	0.0	27.0		24.0	5.3	6.8	0.1	32.0
	26.1	5.1	7.2	0.0	27.0		26.0	5.3	6.8	0.1	37.0
	28.2	5.1	7.1	0.0	51.0		28.0	5.2	6.8	0.1	62.0
	29.5	5.1	7.0	0.0	68.0		29.4	5.1	6.8	0.1	92.0







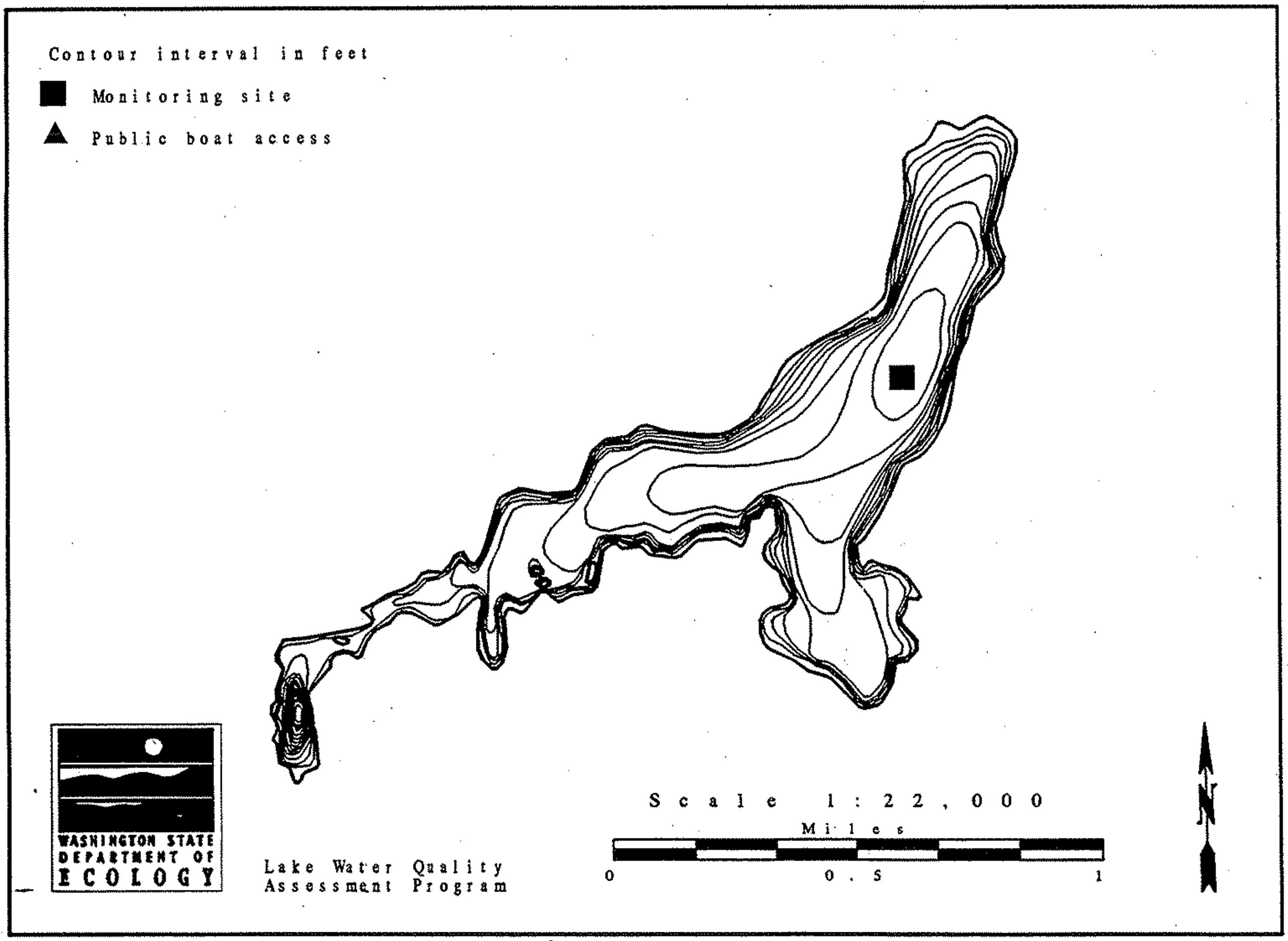


Lake Sacheen -- Pend Oreille County

Lake Sacheen is located about 34 miles north of Spokane, and 12 miles west of Northport. It is two miles long. Principal inlets include Moon and Star Creeks. It drains via the West Branch of the Little Spokane River. There is a low dam at the outlet, built in 1922. Lake Sacheen was monitored by Ecology staff only.

Size (acres)	317
Maximum Depth (feet)	40
Mean Depth (feet)	24
Lake Volume (acre-feet)	7,615
Drainage Area (miles^2)	42.8
Altitude (feet)	2,234
Shoreline Length (miles)	6.3

Data from Dion *et al.* (1976)



Overall Assessment

Lake Sacheen was sampled by Ecology staff only in 1994. It was last monitored by a volunteer in 1990.

Lake Sacheen was classified as mesotrophic in 1994, based on moderately high to high concentrations of total phosphorus on both sampling dates, very low concentrations of dissolved oxygen below the thermocline, and the presence of Eurasian water milfoil (*Myriophyllum spicatum*).

Ecology staff surveyed aquatic plants in Lake Sacheen on August 2, 1994, for the Freshwater Aquatic Weeds Program. The survey covered most of the shallow areas of the lake. Aquatic plants observed include coontail (*Ceratophyllum demersum*), Eurasian water-milfoil (*Myriophyllum spicatum*), slender pondweed (*Potamogeton pusillus*), common elodea (*Elodea canadensis*), fern leaf pondweed *(Potamogeton robbinsii*), eel-grass pondweed (*Potamogeton zosteriformis*), small grass-like plants (*Juncus sp.* or *Eleocharis sp.*), Illinois pondweed (*Potamogeton illinoensis*), purple loosestrife (*Lythrum salicaria*), cattail (*Typha sp.*), large-leaf pondweed (*Potamogeton amplifolius*), watershield (*Brasenia schreberi*), snailseed pondweed, diverse leaf pondweed (*Potamogeton diversifolius*), yellow-flowering water lily (*Nuphar sp.*), and muskwort (*Chara sp.*). Thick patches of Eurasian watermilfoil and pondweeds were found throughout the littoral zone. Milfoil beetles and Chironomidae (midge) larvae were found on a few plants which had not been harvested. Much of the *M. spicatum* had a strange growth form, reportedly the result of harvesting activity.

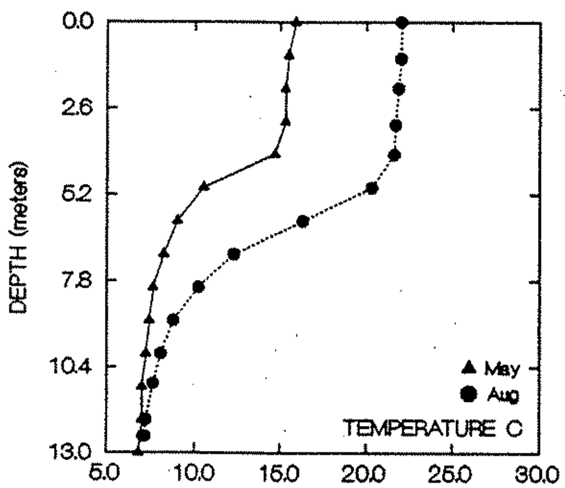
SACHEEN (PEND OREILLE) Lake -- PEND OREILLE County
Chemistry Data -- Station 1

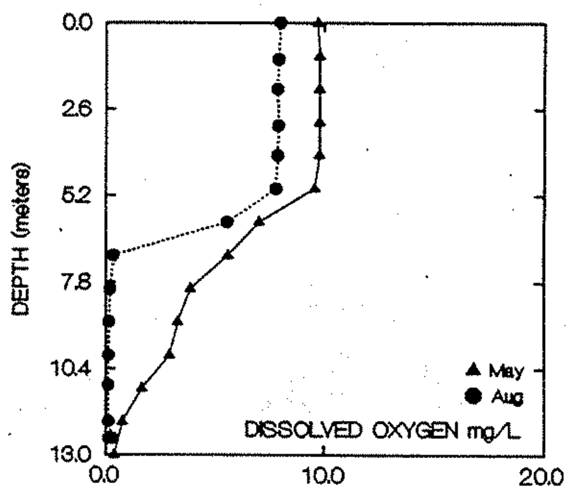
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
74/07/02		E	17			(Source: Water Supply Bulletin 43)					
81/07/14		E	20		9.1	(Source: Water Supply Bulletin 57)					
90/05/30	1	E	18	0.43							
90/08/21	1	E	25	0.44							
94/05/20	1	E	19	0.16	3.1						
94/05/20	1	H	50	0.21							
94/08/19	1	E	30	0.25J	1.0J						
94/08/19	1	H	82	0.41J							

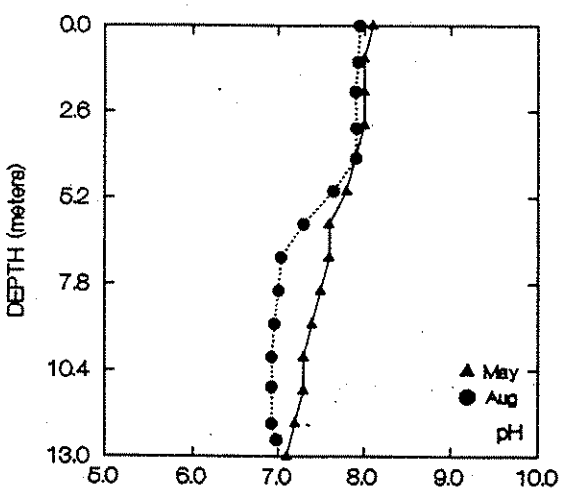
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

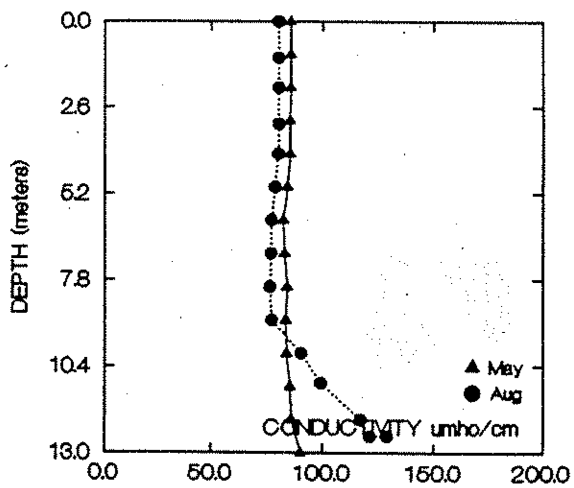
SACHEEN (PEND OREILLE) Lake -- PEND OREILLE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/20	0.0	15.9	8.1	9.7	86.0	94/08/19	0.0	22.0	8.0	8.0	81.0
	1.0	15.5	8.0	9.8	86.0		1.1	22.0	7.9	8.0	80.0
	2.0	15.3	8.0	9.8	86.0		2.0	21.9	7.9	7.9	80.0
	3.0	15.3	8.0	9.8	86.0		3.1	21.7	7.9	8.0	81.0
	4.0	14.7	7.9	9.8	86.0		4.0	21.6	7.9	7.9	80.0
	5.0	10.5	7.8	9.6	84.0		5.0	20.3	7.7	7.9	79.0
	6.0	9.0	7.6	7.1	83.0		6.0	16.4	7.3	5.7	77.0
	7.0	8.2	7.6	5.7	83.0		7.0	12.3	7.0	0.4	77.0
	8.0	7.6	7.5	4.0	84.0		8.0	10.2	7.0	0.2	77.0
	9.0	7.4	7.4	3.4	84.0		9.0	8.8	7.0	0.1	77.0
	10.0	7.2	7.3	3.0	84.0		10.0	8.0	6.9	0.1	91.0
	11.0	7.0	7.3	1.7	85.0		10.9	7.6	6.9	0.1	99.0
	12.0	7.0	7.2	0.8	86.0		12.0	7.2	6.9	0.1	117.0
	13.0	6.8	7.1	0.4	90.0		12.5	7.1	7.0	0.3	121.0
							12.5	7.1	7.0	0.1	129.0







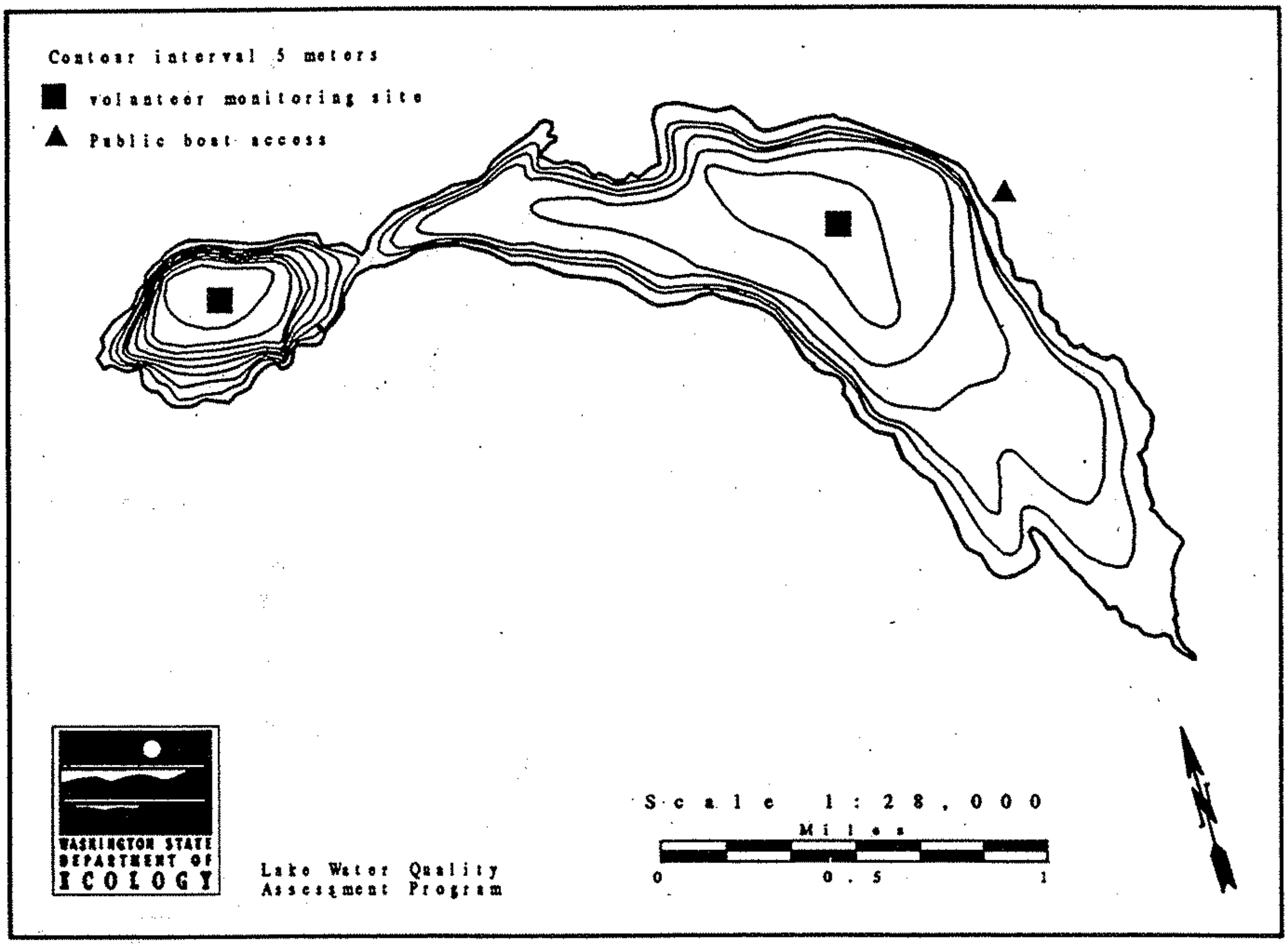


Lake Samish -- Whatcom County

Lake Samish is located 6.5 miles southeast of Bellingham. It is comprised of two basins which are connected by a narrow strait. The west arm is a small deep bay, and the east arm is a larger shallow bay. There are several small inlets that flow into the lake, including Lake Creek and Barnes Creek. Lake Samish drains via Friday Creek to the Samish River.

	East Arm	West Arm
Size (acres)	680	130
Maximum Depth (feet)	75	140
Mean Depth (feet)	31	71
Lake Volume (acre-feet)	24,000	9,100
Drainage Area (miles^2)	9.2	3.7
Altitude (feet)	273	273
Shoreline Length (miles)	6.3	1.8

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Lake Samish was good in 1994. Except for one high concentration of total phosphorus measured during the May survey, all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths) indicated very good water quality. Secchi depths, water chemistry results, and profile data results are listed in tables at the end of this summary.

Profile data were similar to data collected during previous surveys. The only thing of note is that pH was somewhat high (for a western Washington lake) on both sampling dates. Most likely the lake has naturally low buffering capacity, so that even small amounts of algae can raise the pH of the water. Although low buffering capacity is usually found in higher elevation lakes in western Washington, it is also found in nearby Lake Whatcom.

Since 1989, Secchi depths have been more variable in the west basin than in the east basin (see graph of Secchi depth data). However, values for both basins were similar each year. To determine whether there was a trend in water clarity, a statistical trend test was applied to data collected since 1989. A seasonal Kendall test for trend showed that there was no significant trend in either basin. Results were not significant at the 80% level for both basins ($p = 0.22$ for the east basin, and $p = 0.11$ for the west basin).

Aquatic plants observed by Ecology staff during field visits include tapegrass (also known as wild celery; *Vallisneria americana*), coontail (*Ceratophyllum demersum*), watershield (*Brasenia schreberi*), duckweed (*Lemna minor*), Nuttall's waterweed (*Elodea nuttali*), white-flowering lily (*Nymphaea odorata*), slender pondweed (possibly *Potamogeton berchtoldii*) and water buttercup (*Ranunculus sp.*). Tapegrass is usually the most abundant plant in shallow areas of the lake.

Lake Samish exhibited both oligotrophic and mesotrophic characteristics in 1994, and as a result, was classified as oligo-mesotrophic. Oligotrophic characteristics include the low chlorophyll *a* concentrations on both sampling dates, the low August concentration of total phosphorus, and the good water clarity in both basins. Mesotrophic characteristics include the moderately high concentration of total phosphorus during the May survey, the increasing amounts of aquatic plants in the lake that is heavy in areas, as well as the low concentrations of dissolved oxygen near the lake bottom.

Summary of Questionnaire Results and Information From the Volunteers

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

> Lake Samish is used for fishing, boating, water skiing, swimming, rowing, and jet skiing. Public recreational facilities on the lakeshore include a park, a picnic area,

a beach, and one boat ramp. About 5% of the shoreline is publicly-owned. Currently the watershed is being logged, and the lakeshore is being developed further for residences. In the past, the watershed was logged and used for animal grazing, and the lake was dredged. In 1990 there were about 60 culverts or stormdrains that drained into the lake.

There are 301 residences on the lakeshore (of roughly 530 residences in the Lake Samish basin). Lake water is withdrawn for drinking and other domestic uses. The lakeshore is fully sewered. There is a lake management district and a community association for the lake.

No fish were stocked in the lake in 1994. No aquatic plant or algae control activities occurred in 1994, but the outlet channel was cleared to the county line for flood control. A dam is now being built at the outlet, to stabilize stream flow during the dry season.

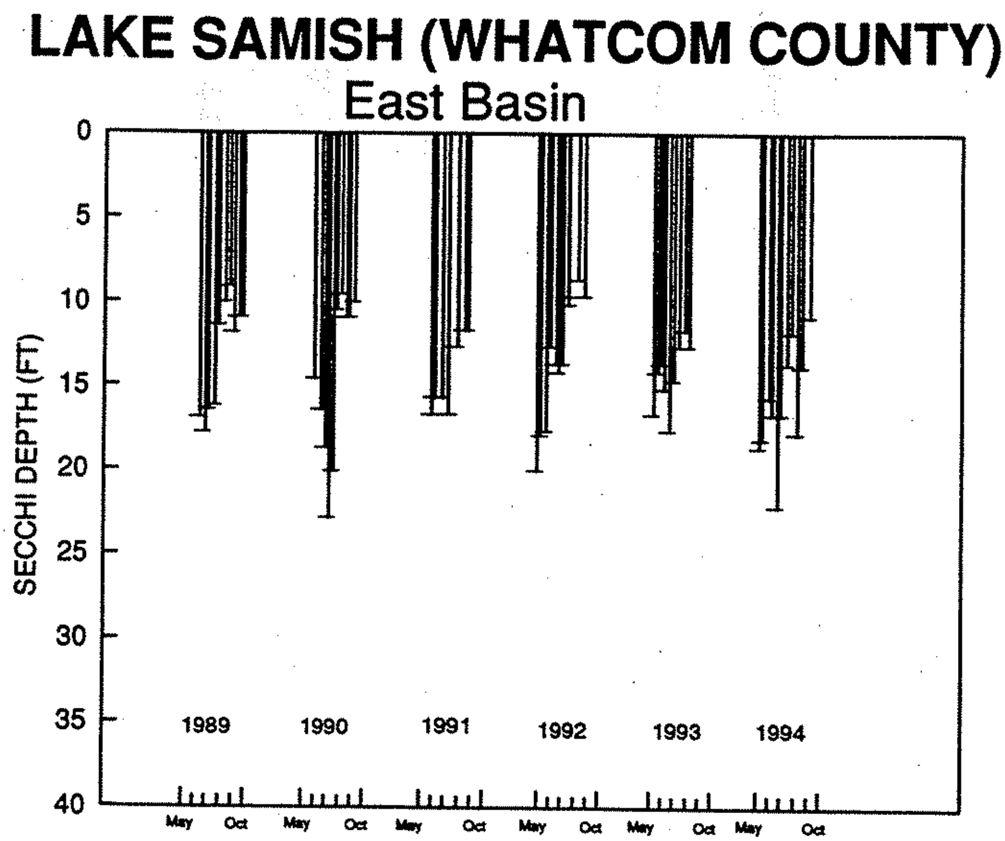
Overall, the volunteers found that Lake Samish had excellent water quality. The worst water quality problems in 1994 were ranked as (1) excessive aquatic plant growth, and (2) algae. The plants spread more each year, creating more problems.

Acknowledgments

I thank A.B. Davis and J. David Jenkins for volunteering their time to monitor the east and west basins of Lake Samish, respectively, from 1989 through 1994.

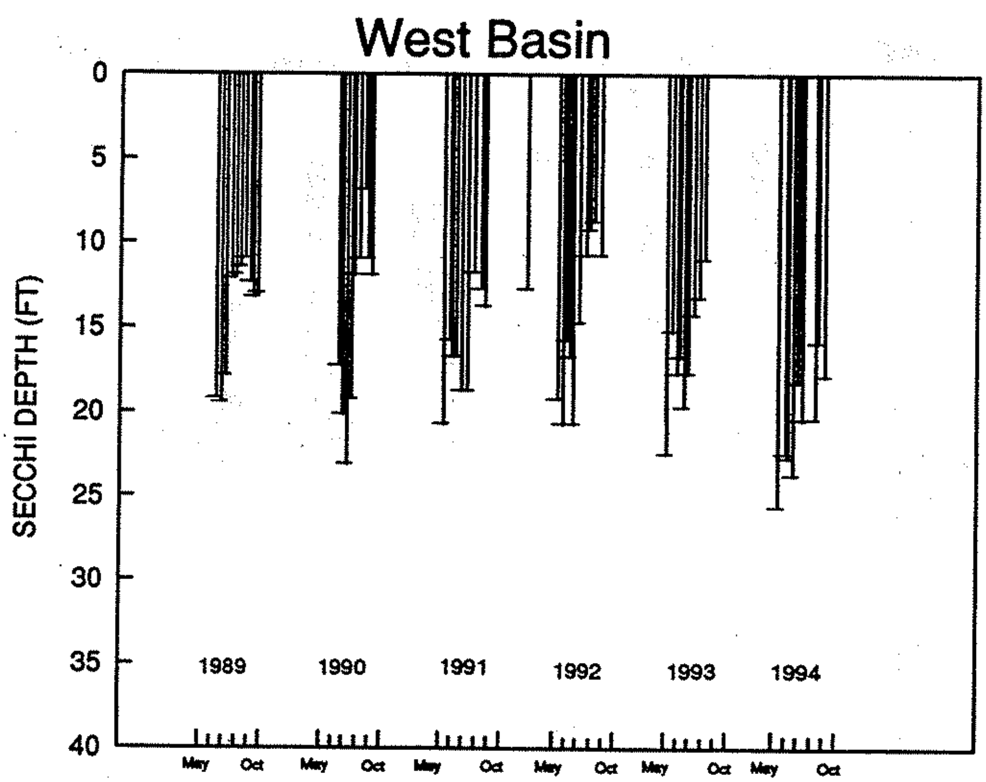
SAMISH (EAST ARM) Lake -- WHATCOM County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/21	18.0	64.4	0.0		100	None	Breezy	17.8	268.1	On site visit.
94/06/01	18.8	65.8	0.0	Lt Green	50	Mod	Calm	17.3	0.0	
94/06/21	20.0	68.0	0.0	Lt Green	0	None	Light	14.8	267.4	
94/06/30	20.0	68.0	0.0	Lt Green	90	None	Breezy	15.8	268.3	
94/07/18	22.0	71.6	0.0	Lt Green	0	Trace	Light	21.3	267.1	
94/08/01	25.0	77.0	0.0	Lt Green	0	None	Light	15.8	267.6	
94/08/16	23.0	73.4	0.0	Lt Green	75	None	Calm	12.8	267.7	
94/09/01	22.0	71.6	0.0	Lt Green	25	None	Breezy	11.0	267.4	Reading taken at SE corner due to blustering wind.
94/09/19	22.0	71.6	0.0	Lt Green	0	None	Breezy	17.0	267.7	
94/10/04	19.5	67.1	0.0	Lt Green	0	None	Light	13.0	267.7	Yellow greenish scum along beach in cove.
94/10/29	15.0	59.0	0.0	Lt Green	10	Light	Calm	10.0	267.9	



SAMISH (WEST ARM) Lake -- WHATCOM County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/07/18	22.0	71.6	0.0	Lt Green	0	Trace	Light	22.8	267.1	
94/08/16	23.0	73.4	0.0	Lt Green	75	None	Calm	19.6	267.7	
STATION 2										
94/06/01	19.3	66.7	0.0	Lt Green	50	Mod	Calm	24.7	267.9	Second Secchi with view tube.
94/06/21	21.0	69.8	0.0	Lt Green	0	None	Light	21.6	267.4	Second Secchi with view tube.
94/06/30	20.5	68.9	0.0	Lt Green	90	None	Breezy	21.8	268.3	Second Secchi with view tube.
94/08/01	24.5	76.1	0.0	Lt Green	0	None	Light	17.3	267.6	Second Secchi with view tube.
94/09/01	25.0	77.0	0.0	Lt Green	25	None	Breezy	19.5	267.4	Due to breeze - sampled at calmer location than usual. Second Secchi with view tube.
94/09/19	22.0	71.6	0.0	Lt Green	0	None	Breezy	19.5	266.7	Thick algae. Second Secchi with view tube.
94/10/04	19.5	67.1	0.0	Lt Green	0	None	Light	15.0	267.7	Second Secchi with view tube.
94/10/29	14.0	57.2	0.0	Lt Green	10	Light	Calm	17.0	267.9	Second Secchi with view tube. Lots of drift visible with view scope.



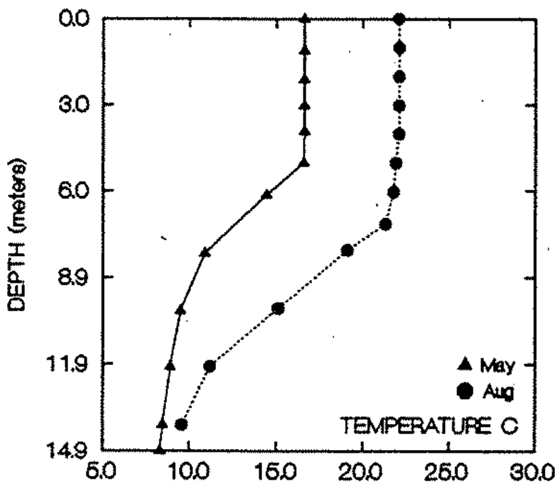
SAMISH (EAST ARM) (WHATCOM) Lake -- WHATCOM County
Chemistry Data -- Station 1

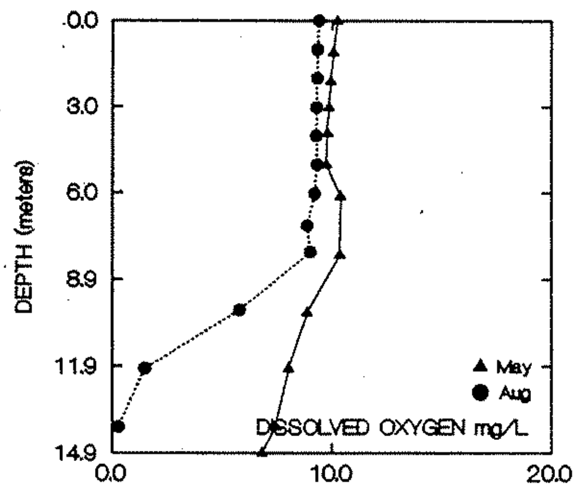
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/24		E				(Source: Water Supply Bulletin 43)					
89/06/27	1	E	6	0.62	2.7						
89/09/26	1	E	12	0.40	6.3						
90/06/04	1	E	13								
90/08/15	1	E	10	0.36							
91/05/28	1	E		0.58							
92/05/01	1	E	4	0.66	1.2						
92/05/01	2	E	6		1.5						
92/05/01	1	H	12	0.69							
92/08/04	1	E	10	0.25	1.3						
92/08/04	2	E	10	0.23	3.9						
92/08/04	1	H	12	0.53							
93/05/22	1	E	22	0.57	1.2						
93/05/22	1	H	18	0.59							
93/08/16	1	E	8	0.32	3.0						
93/08/16	2	E	6								
93/08/16	1	H	12	0.54							
94/05/21	1	E	25	0.64	1.8						
94/05/21	1	E			1.4						
94/05/21	1	H	31	0.65							
94/08/20	1	E	7	0.48J	1.3J						
94/08/20	1	H	25	0.57J							

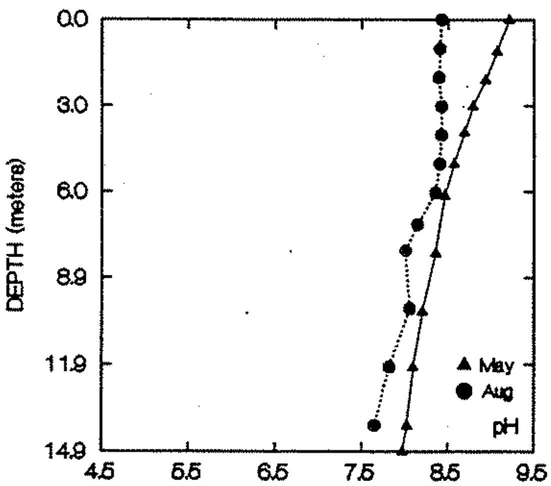
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

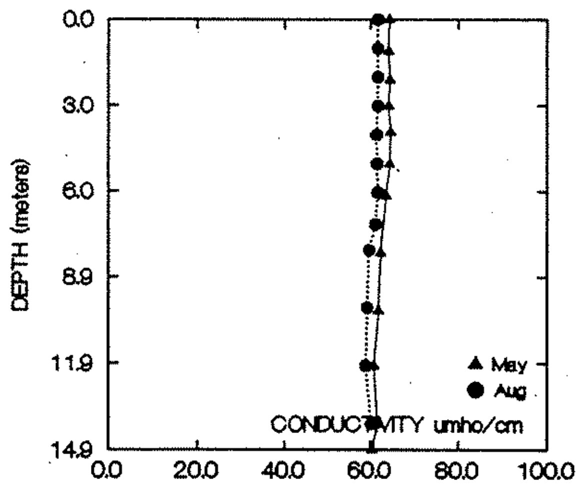
SAMISH (EAST ARM) (WHATCOM) Lake -- WHATCOM County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/21	0.0	16.6	9.2	10.2	64.0	94/08/20	0.0	22.1	8.4	9.4	62.0
	1.1	16.6	9.1	10.1	64.0		1.0	22.1	8.4	9.3	62.0
	2.1	16.6	9.0	9.9	64.0		2.0	22.1	8.4	9.3	62.0
	3.0	16.6	8.8	9.8	64.0		3.0	22.1	8.4	9.3	62.0
	3.9	16.6	8.7	9.8	65.0		4.0	22.1	8.4	9.3	61.0
	5.0	16.5	8.6	9.7	64.0		5.0	21.9	8.4	9.3	61.0
	6.1	14.4	8.5	10.4	64.0		6.0	21.8	8.4	9.2	62.0
	8.1	10.9	8.4	10.4	62.0		7.1	21.3	8.2	8.9	61.0
	10.1	9.5	8.2	8.9	62.0		8.0	19.1	8.0	9.0	60.0
	12.0	8.9	8.1	8.0	61.0		10.0	15.1	8.1	5.7	59.0
	14.0	8.4	8.0	7.4	62.0		12.0	11.2	7.8	1.4	59.0
	14.9	8.3	8.0	6.7	60.0		14.0	9.6	7.7	0.3	60.0







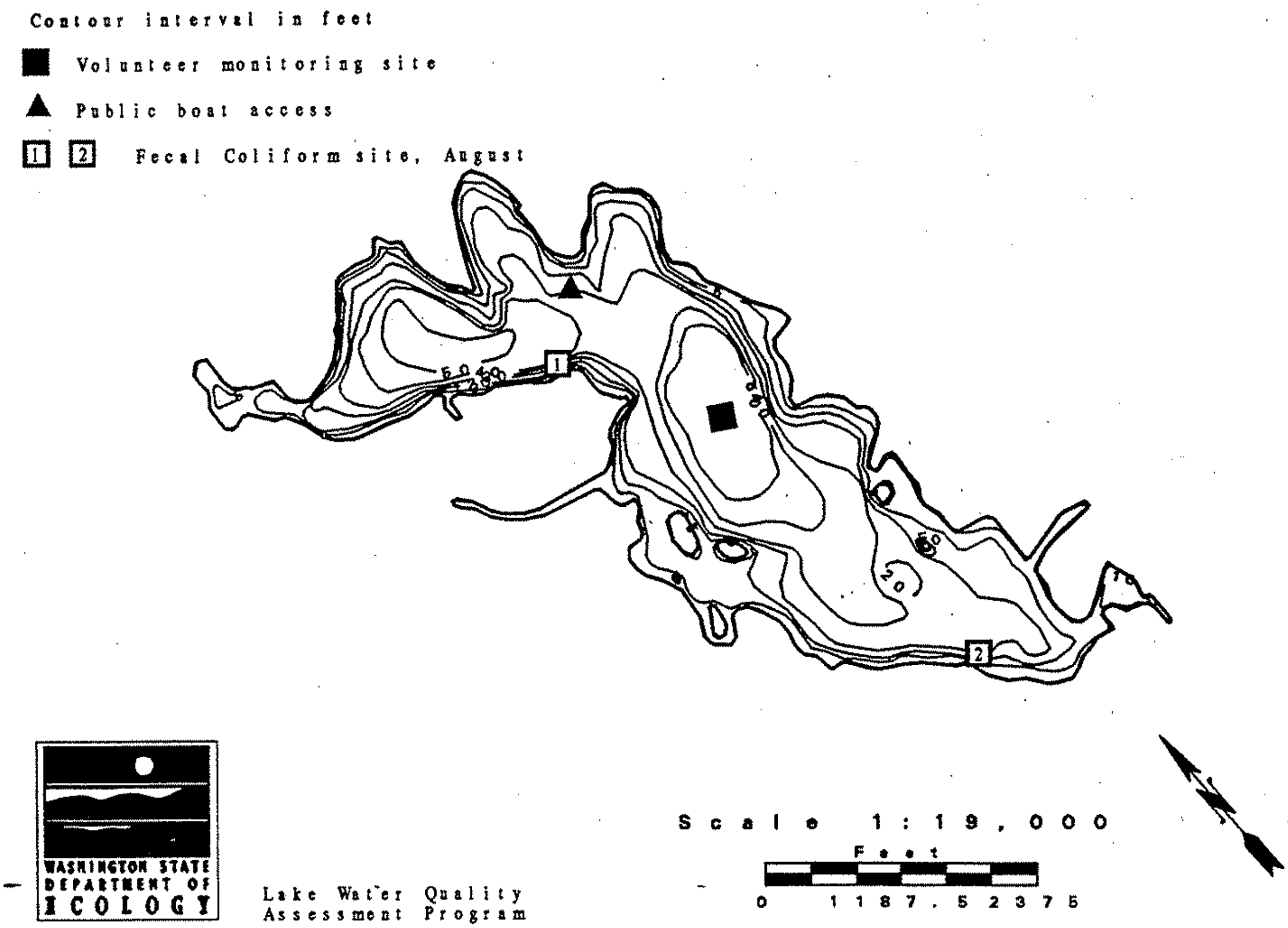


Lake Sawyer -- King County

Lake Sawyer is located two miles northwest of Black Diamond. It has four small islands. It is fed at the south end of the lake by Rock Creek, Ravensdale Creek, and an extensive wetland. The lake drains via Covington Creek to the Green River. Lake level is controlled by a concrete weir which was constructed in 1952. Wastewater effluent from the City of Black Diamond has been discharged since 1983 to a natural wetland that drains to Lake Sawyer.

Size (acres)	300
Maximum Depth (feet)	58
Mean Depth (feet)	26
Lake Volume (acre-feet)	7,700
Drainage Area (miles^2)	13.0
Altitude (feet)	512
Shoreline Length (miles)	7.0

Data from Bortleson *et al.* (1976)



Overall Assessment

The water quality of Lake Sawyer was fairly good in 1994. Secchi depths were deeper than they were in 1993 (see graph of Secchi depth data). Also, concentrations of both total phosphorus and total nitrogen in the upper layer of water, during the August survey, were lower than all concentrations measured during 1992 and 1993. Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary.

Profile Data from 1994 were similar to data collected during previous years. Dissolved oxygen concentrations were low throughout the lower layer of water during the August survey. As a result of these low oxygen concentrations, it is likely that phosphorus was recycled from sediments into the water column during late summer, resulting in the high concentration of total phosphorus in the hypolimnion during August.

Aquatic plants observed by Ecology staff during field visits include yellow-flowering water lily (*Nuphar polysepalum*), duckweed (*Lemna sp.*), cattails (*Typha sp.*), coontail (*Ceratophyllum demersum*), Eurasian milfoil (*Myriophyllum spicatum*), largeleaf pondweed (*Potamogeton amplifolius*), curlyleaf pondweed (*Potamogeton crispus*), flatstem pondweed (*P. zosteriformis*), another pondweed (possibly *P. gramineas*), and white-flowering water lily (*Nymphaea odorata*).

Based on low hypolimnetic dissolved oxygen concentrations, recycling of phosphorus from sediments, and a moderately heavy population of aquatic plants, Lake Sawyer was classified as mesotrophic in 1994.

One of the major goals of diverting Black Diamond wastewater away from Lake Sawyer was to return the lake to a mesotrophic condition. Although it is still too soon to evaluate statistical trend in water quality, it does appear that there has been a short-term improvement. However, Ecology's report on the lake stipulated that stormwater and residential runoff must also be controlled in order to achieve long-term improvements in water quality. Continued education of homeowners, and cooperation with county regulations, should help Lake Sawyer. Long-term monitoring may be able to determine the long-term effectiveness of efforts to improve the quality of the lake.

Summary of Questionnaire Results and Information From the Volunteer

The 1994 questionnaire on lake and watershed uses was not returned.

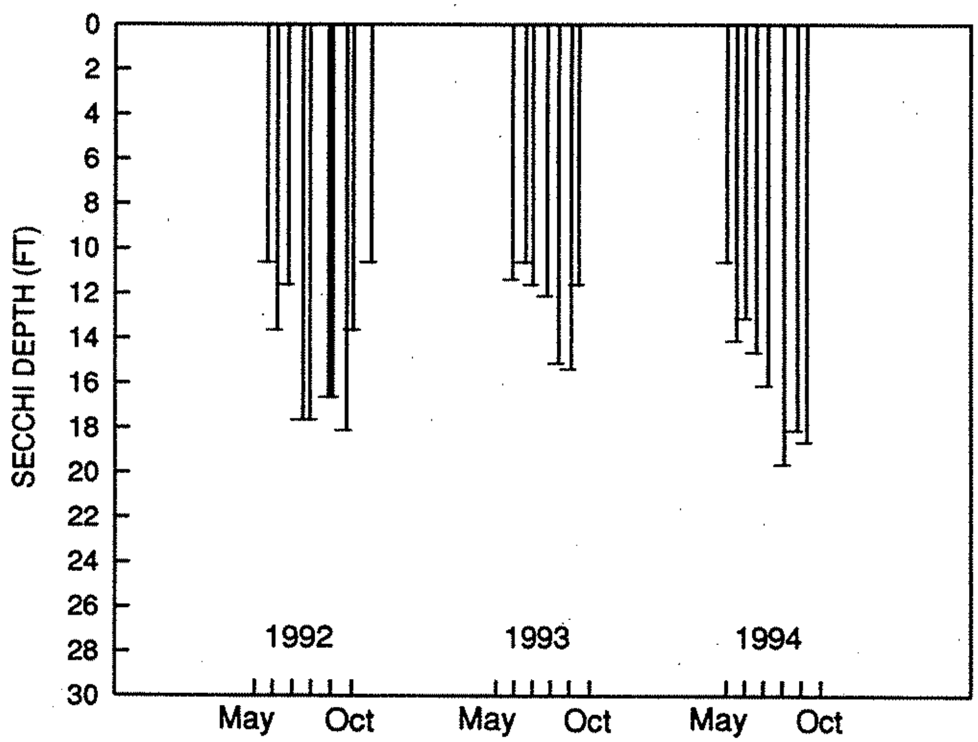
Acknowledgment

I thank Doug Geiger for volunteering his time to monitor Lake Sawyer from 1992 through 1994.

SAWYER Lake -- KING County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/24	17.8	64.0	0.0	Grn-brown	75	None	Light	10.0	-4.2	
94/06/09	17.8	64.0	0.0	Grn-brown	10	Mod	Light	13.5	-4.2	
94/06/24	20.6	69.1	0.0	Mod Green	75	Trace	Light	12.5	-5.0	Thermometer is fixed. No apparent correction needed.
94/07/11	22.2	72.0	0.0	Lt Green	0	None	Breezy	14.0	-5.7	Water clear at shore in morning - cloudy after boat activity. Four warm days - lots of boating.
94/07/28	25.0	77.0	0.0	Lt Green	0	None	Calm	15.5	-10.2	Record high temp at SeaTac 1 week ago-101 F followed by many hot days.
94/08/17	0.0	32.0	0.0		0	Trace	Breezy	0.0	-16.5	Onsite visit; no disk on boat.
94/08/27	22.2	72.0	0.0	Lt Green	0	None	Calm	19.0	-20.0	
94/09/16	21.1	70.0	0.0	Lt Green	10	Heavy	Calm	17.5	-24.5	
94/10/01	18.9	66.0	0.0	Lt Green	50	Light	Breezy	18.0	-28.5	

LAKE SAWYER (KING COUNTY)



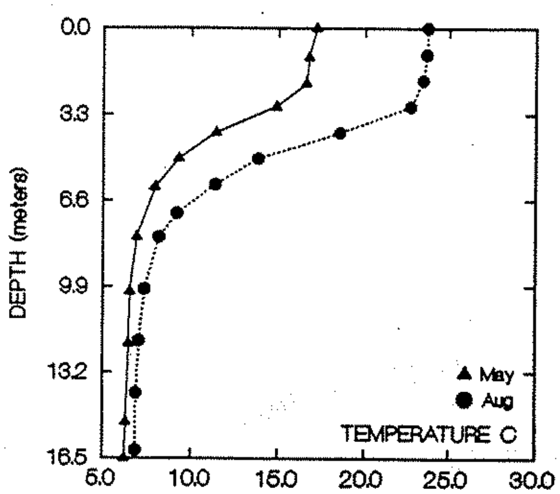
SAWYER (KING) Lake -- KING County
Chemistry Data -- Station 1

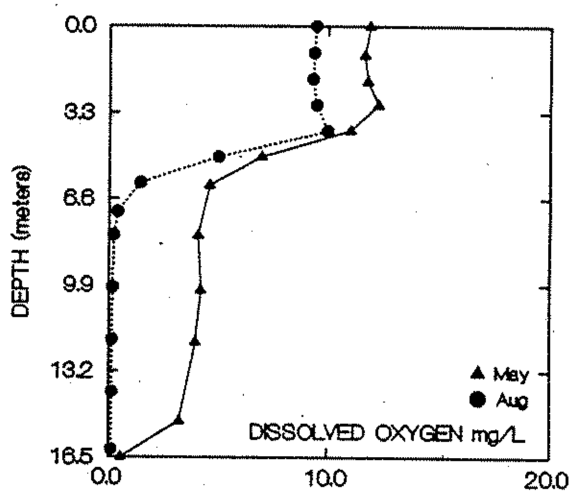
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/25		E	22			(Source: Water Supply Bulletin 43)					
92/05/02	1	E	19	0.32	3.2	1	2				
92/05/02	1	H	30	0.56							
92/08/04	1	E	14	0.27	1.5	1	1		3	1	15
92/08/04	1	H	272	0.57							
93/05/20	1	E	34	0.32	8.7						
93/05/20	1	H	28	0.45							
93/08/23	1	E	11	0.23	4.2	11	8		1U	1U	
93/08/23	1	H	138	0.48							
94/05/18	1	E	41	0.36	5.3						
94/05/18	1	H	29	0.66							
94/08/17	1	E	6	0.21J	1.4J						
94/08/17	1	H	116	0.54J							

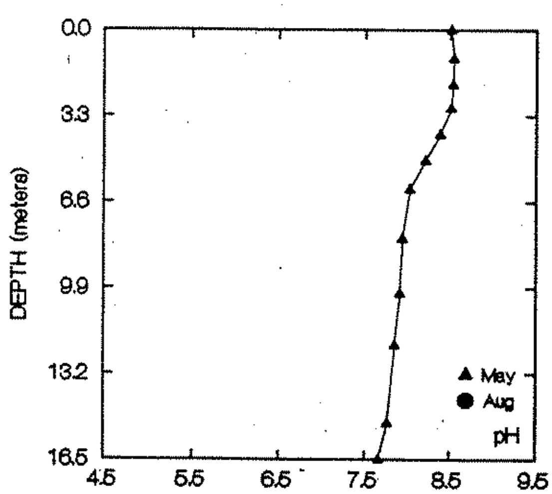
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

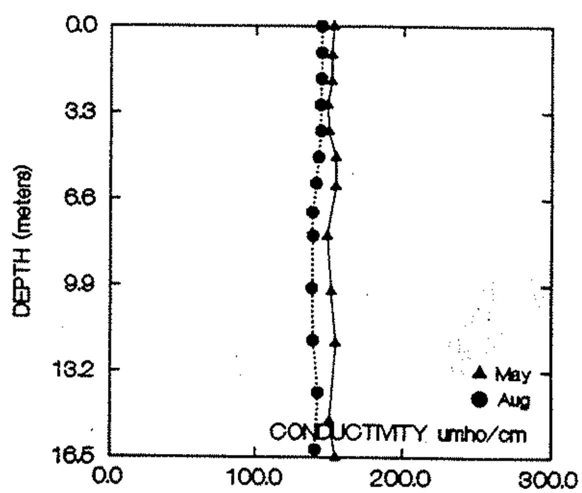
SAWYER (KING) Lake -- KING County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/18	0.0	17.2	8.5	11.9	153.0	94/08/17	0.0	23.8	0.0	9.5	145.0
	1.1	16.7	8.6	11.7	152.0		1.0	23.7	0.0	9.4	145.0
	2.1	16.6	8.5	11.8	152.0		2.0	23.5	0.0	9.3	145.0
	3.0	14.9	8.5	12.3	149.0		3.0	22.8	0.0	9.5	144.0
	4.0	11.4	8.4	11.0	150.0		4.0	18.6	0.0	10.0	145.0
	5.0	9.3	8.2	7.0	155.0		5.0	13.9	0.0	5.0	143.0
	6.1	7.9	8.0	4.6	155.0		6.0	11.4	0.0	1.5	141.0
	8.0	6.9	8.0	4.1	149.0		7.1	9.2	0.0	0.4	139.0
	10.1	6.6	7.9	4.2	152.0		8.0	8.2	0.0	0.2	139.0
	12.1	6.5	7.9	4.0	155.0		10.0	7.4	0.0	0.2	139.0
	15.1	6.3	7.8	3.2	151.0		12.0	7.1	0.0	0.1	140.0
	16.5	6.2	7.7	0.5	155.0		14.0	6.9	0.0	0.1	143.0
							16.2	6.9	0.0	0.1	141.0







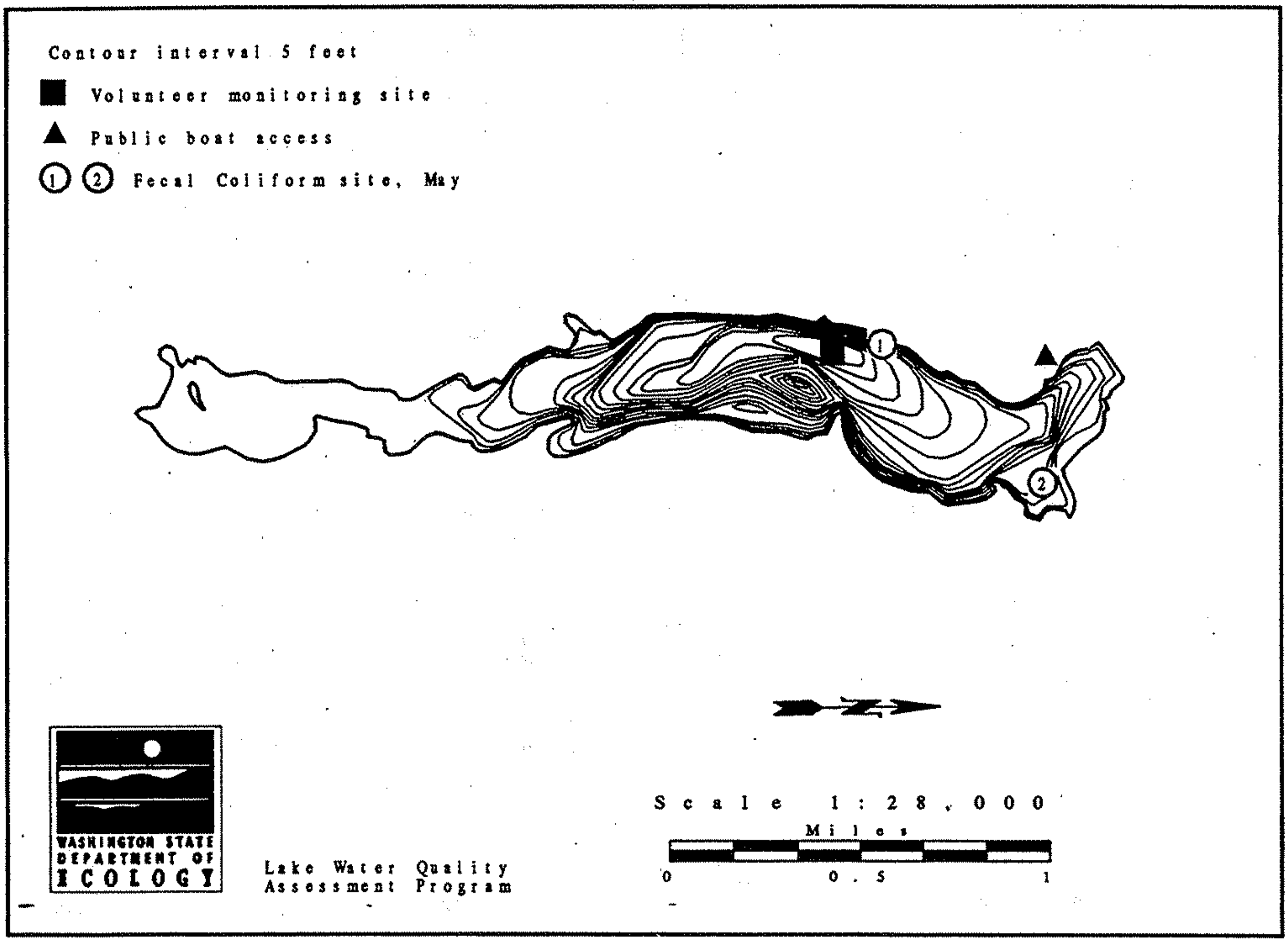


Silver Lake -- Spokane County

Silver Lake is located 1.1 miles due east of the Town of Medical Lake. It is within the Crab Creek watershed.

Size (acres)	490
Maximum Depth (feet)	80
Mean Depth (feet)	30
Lake Volume (acre-feet)	14,000
Drainage Area ($miles^2$)	19
Altitude (feet)	2,341
Shoreline Length (miles)	8.7

Data from Dion *et al.* (1976)



Overall Assessment

Silver Lake had fair water quality in 1994. It is a productive lake, meaning that it contains enough nutrients to support a large plant community, which in turn can support fish and other wildlife. However, Silver Lake had better water clarity (Secchi depths) than would be expected, given the high concentrations of total phosphorus and moderately high amounts of algae.

Profile data were somewhat unusual, in that the lake had very high conductivity and moderately high pH. Both can result from mineralization of rock within the lake's watershed, since most chemical constituents of lake water come from leachate and runoff from the watershed. Although this is probably not unusual for Silver Lake, in comparison to most other lakes monitored for the program, the conductivity in Silver Lake was high.

Based on the phosphorus and chlorophyll concentrations, and the very low concentrations of dissolved oxygen below the thermocline, Silver Lake was classified as meso-eutrophic in 1994. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary.

Aquatic plants observed by Ecology staff during the field visits included smartweed (*Polygonum sp.*), slender pondweed (*Potamogeton filiformis*), milfoil (*Myriophyllum sp.*; but not the aggressive Eurasian variety), water plantain (*Alisma sp.*), water buttercup (*Ranunculus* sp.) two types of muskgrass (*Chara*), sago pondweed (*Potamogeton pectinatus*), rush (*Juncus sp.*), and another plant that was possibly horned pondweed (*Zannichellia palustris*). Native milfoil was the most abundant plant observed.

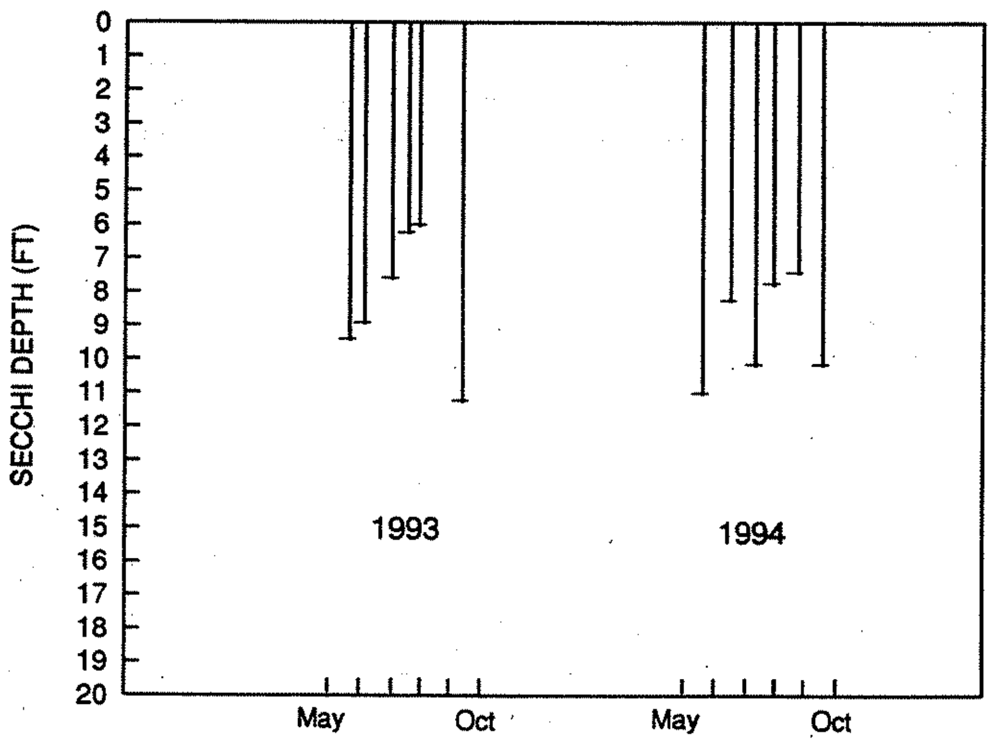
Acknowledgment

I thank Kristen Stewart for volunteering her time to monitor Silver Lake in 1993 and 1994.

SILVER Lake -- SPOKANE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/25	18.9	66.0	0.0	Mod Green	0	Trace	Calm	10.6	0.0	Onsite visit.
94/06/21	21.1	70.0	0.0	Grn-brown	0	None	Light	7.8	-3.0	
94/07/16	22.8	73.0	0.0	Lt Green	0	Trace	Light	9.8	-7.0	
94/08/02	25.0	77.0	0.0	Lt Green	50	None	Calm	7.3	-6.0	Some clouds; could be smoke from central Washin gton fires. Use of lake by fishermen and skier s down this year.
94/08/24	21.1	70.0	0.0	Lt Green	75	None	Breezy	7.0	0.0	
94/09/18	20.6	69.1	0.0	Lt Green	0	None	Calm	9.8	0.0	Still turtles out sunning; not usual for mid-Se ptember. Snag used to measure lake height is h igh and dry--no measurement.

SILVER LAKE (SPOKANE COUNTY)



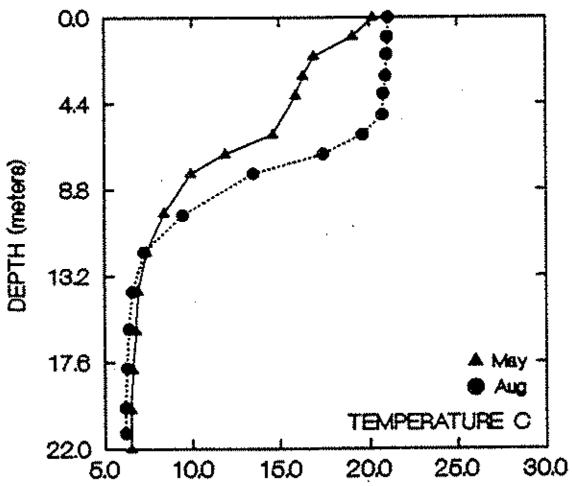
SILVER (SPOKANE) Lake -- SPOKANE County
Chemistry Data -- Station 1

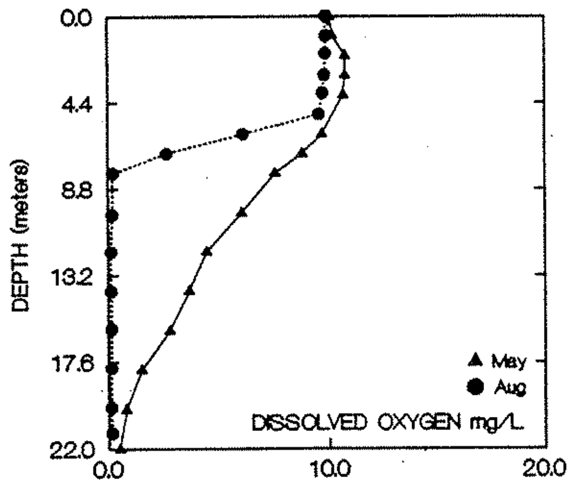
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/06/24		E	32			(Source: Water Supply Bulletin 43)					
93/05/26	1	E	64	1.19	4.8	1U	3		3	1	
93/05/26	1	H	41	1.41							
93/08/22	1	E	20	0.78	6.5						
93/08/22	1	H	70	1.52							
94/05/25	1	E	98	0.70	3.7			1.4			
94/05/25	1	H	52	0.90J							
94/08/24	1	E	30	1.28J	7.4			2.5			
94/08/24	1	H	72	1.56J							

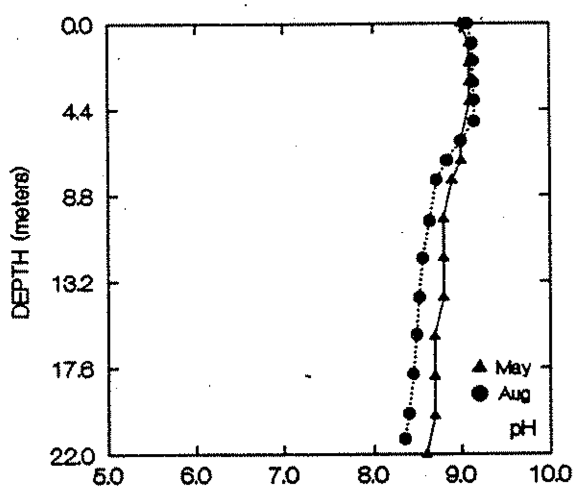
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

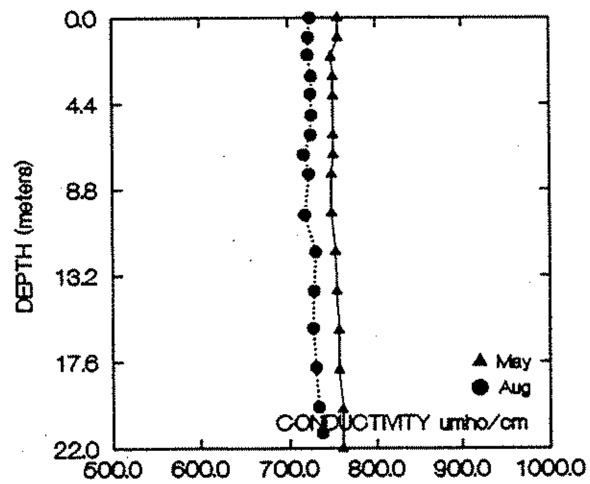
SILVER (SPOKANE) Lake -- SPOKANE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	20.2	9.0	10.1	756.0	94/08/24	0.0	21.1	9.1	9.9	724.0
	1.0	19.1	9.1	10.2	756.0		1.0	21.0	9.1	9.9	722.0
	2.0	16.9	9.1	10.8	748.0		1.9	21.0	9.1	9.9	721.0
	3.0	16.3	9.1	10.8	690.0		3.0	20.9	9.1	9.8	725.0
	4.0	15.9	9.1	10.7	750.0		3.9	20.8	9.2	9.7	724.0
	6.0	14.6	9.0	9.7	750.0		5.0	20.7	9.2	9.6	725.0
	7.0	11.9	9.0	8.8	750.0		6.0	19.6	9.0	6.2	724.0
	8.0	9.9	8.9	7.6	748.0		7.0	17.4	8.8	2.7	716.0
	10.0	8.4	8.8	6.1	748.0		8.0	13.5	8.7	0.2	722.0
	12.0	7.4	8.8	4.5	752.0		10.1	9.4	8.6	0.2	717.0
	14.0	6.9	8.8	3.7	754.0		12.0	7.3	8.6	0.1	729.0
	16.0	6.8	8.7	0.8	756.0		14.0	6.6	8.5	0.1	727.0
	18.0	6.6	8.7	1.5	756.0		15.9	6.4	8.5	0.1	726.0
	20.0	6.5	8.7	0.8	760.0		17.9	6.3	8.4	0.1	729.0
	22.0	6.5	8.6	0.5	760.0		19.9	6.2	8.4	0.1	732.0
							21.2	6.2	8.3	0.1	736.0







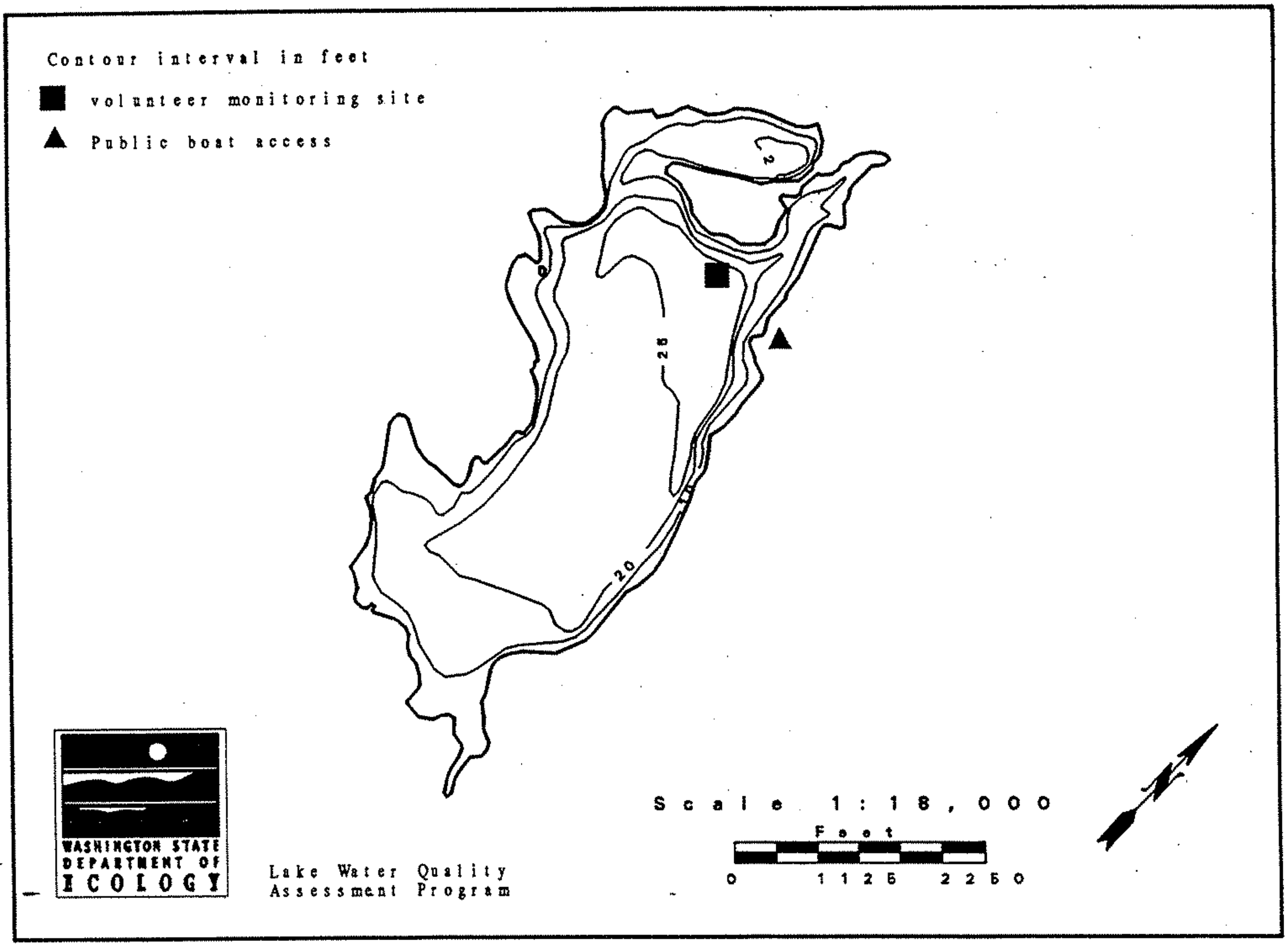


Lake Spanaway -- Pierce County

Lake Spanaway is located ten miles south of Tacoma, and 0.5 mile west of Spanaway. It is fed by drainage from a swampy area, and drains via Spanaway Creek to Clover Creek and Lake Steilacoom. Daron Island lies in the north portion of the lake.

Size (acres)	280
Maximum Depth (feet)	28
Mean Depth (feet)	16
Lake Volume (acre-feet)	4,600
Drainage Area (miles^2)	17.0
Altitude (feet)	320
Shoreline Length (miles)	4.4

Data from Bortleson *et al.* (1976)



Overall Assessment

Lake Spanaway had fair water quality in 1994. Secchi depths were deeper in 1993 than in 1994 (see graph of Secchi depth data). However, results from a statistical trend analysis did not show a significant trend in water clarity from 1990 through 1994. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.92$).

Secchi depths in Lake Spanaway were better than would be expected, given the moderately high nutrient concentrations, and high amounts of algae (indicated by chlorophyll *a* concentrations) on both sampling dates. Nutrient concentrations were particularly high in the bottom water sample collected during the August survey; very low concentrations of dissolved oxygen below the thermocline on both sampling dates suggest that phosphorus may have been recycled from lake sediments into the water column. In Lake Spanaway, it is possible that the major source of phosphorus in the lake is lake sediments.

Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary. Based on high nutrient and chlorophyll concentrations, and a moderately heavy aquatic plant population, Lake Spanaway was classified as meso-eutrophic in 1994.

Aquatic plants observed by Ecology staff and the volunteer during field visits include whitestem pondweed (*Potamogeton praelongus*), largeleaf pondweed (*Potamogeton amplifolius*), Richardson pondweed *(Potamogeton richardsonii)*, slender pondweed *(Potamogeton berchtoldii)*, *Nitella* (a macro-algae), coontail (*Ceratophyllum demersum*), clubmoss, cattails (*Typha sp.*), yellow-flowering water lily (*Nuphar sp.*), and common waterweed (*Elodea canadensis*). Pondweeds were the dominant plants in the lake. Water net (*Hydrodictyon sp.*), a filamentous alga, was seen in the south cove of the lake during the August 1994 survey. Additional substances collected during the August 1994 survey were freshwater sponge, black masses of detritus which was held together by the blue-green algae *Spirulina* and *Oscillatoria*, and round blue-green gelatinous balls that were colonies of the alga *Aphanothece castagnei*.

Other Available Information

From Serdar *et al.*(1994): Sediment samples were collected from five lake sites on January 26, 1993, and were analyzed for copper. The shallow bay at the south end of the lake, and the center of the lake, had low copper concentrations in sediments (89.1 and 106 mg/Kg). Three sites in developed areas, the small bay on the west side of the lake, at the outlet, and off the public bathing beach, had high copper concentrations that ranged from 173 to 308 mg/Kg. Higher copper levels were attributed to copper sulfate treatments used to control algal growth.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Spanaway is used for fishing, swimming, motor boating, non-motorized boating, and jet skiing. Public recreational facilities on the lakeshore include a city/county park, and one public boat ramp. Motorboating is restricted to no wake within 200 feet of shore. Rainbow trout, and some coho and kokanee trout, were stocked in the lake in 1994. Currently, the main activity in the watershed is lakeshore development for residences. In the past, the watershed was logged and used for animal grazing/feeding, the lake was dredged, and the shoreline was altered by vegetation removal and fill.
>
> There are about 177 houses on the lakeshore, as well as one condominium with 56 units, and a trailer park with 39 mobile homes. None of the houses are connected to a sewer. About three culverts/stormdrains drain into the lake, and there is a possibility that these may be diverted from the lake. There is no lake association for the lake. Currently, the minimum setback for lakeshore development is 100 feet. No lake management activities occurred on the lake in 1994. In 1991, parts of the lake were treated with chemicals to control algae and aquatic plants. The lake has also been chemically treated in the past to control undesirable fish species.
>
> Overall, the volunteer found that Lake Spanaway had fairly good water quality. (In 1993, the lake had poor water quality.) Problems in the lake in 1994 were ranked as (1) swimmer's itch, (2) algae, (3) excessive amounts of resident waterfowl, (4) suspended sediments, (5) eye/skin problems after swimming, (6) excessive aquatic plant growth, (7) decaying plants, (8) bacteria, (9) degraded aesthestics, (10) odor from decaying algae, (11) gradually degrading water quality, (12) shoreline erosion, (13) fluctuating water level, and (14) recently degraded water quality. Possible sources of problems include runoff (from septic systems and roads) and the year-round waterfowl population. There were no changes in the lake since the 1993 monitoring season. Problems reported in 1994 were very similar to those from previous surveys, although aquatic plants were not ranked as high of a problem in 1994. The volunteer notes that the residents may just be getting used to all the plant growth.

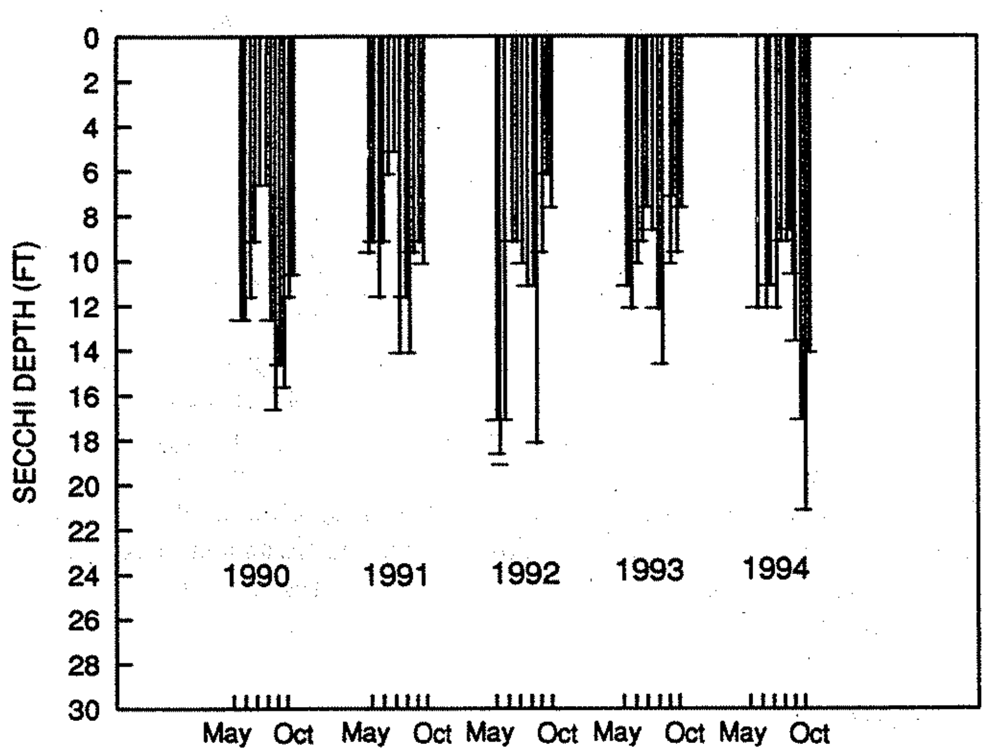
Acknowledgment

I thank Sue Thompson for volunteering her time to monitor Lake Spanaway from 1990 through 1994.

SPANAWAY Lake -- PIERCE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/16	17.8	64.0	0.0	Mod Green	100	None	Light	11.5	-0.5		
94/05/31	17.2	63.0	0.0	Mod Green	10	Heavy	Light	11.5	-1.0		
94/06/12	20.0	68.0	0.0	Mod Green	100	Light	Breezy	11.5	-1.7		
94/06/26	19.4	66.9	0.0	Mod Green	0	None	Light	10.5	-2.5		
94/07/10	21.4	70.5	0.0	Mod Green	0	None	Calm	11.5	-3.0		
94/07/23	22.8	73.0	0.0	Grn-brown	50	None	Light	8.5	-3.5		
94/08/07	22.8	73.0	0.0	Mod Green	0	None	Calm	8.5	-4.5		Lake has had a lot of use, warm temps., and a lot of snails and algae.
94/08/21	21.4	70.5	0.0	Mod Green	90	Trace	Breezy	8.0	-4.7		Still more dead snails washing up on to shore.
94/08/26	22.2	72.0	0.0	Mod Green	0	None	Calm	10.0	0.0		On site visit.
94/09/03	20.6	69.1	0.0	Mod Green	100	Light	Breezy	13.0	-4.5		A lot of algae, and decrease in lake level.
94/09/17	20.6	69.1	0.0	Lt Green	10	Trace	Light	16.5	-5.0		
94/10/01	18.9	66.0	0.0	Lt Green	0	Trace	Breezy	20.5	-5.5		Lake fairly quiet.
94/10/16	15.0	59.0	0.0	Grn-brown	10	None	Calm	13.5	-5.2		Very few skiers, jetskiers. Mostly anglers. Water greenish-brown, almost milky.

LAKE SPANAWAY (PIERCE COUNTY)



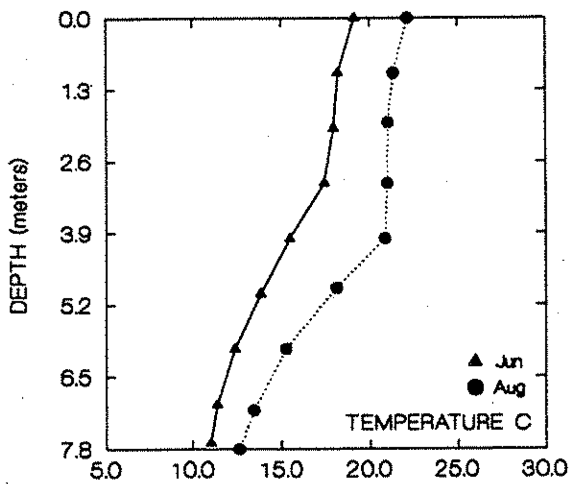
SPANAWAY (PIERCE) Lake -- PIERCE County
Chemistry Data -- Station 1

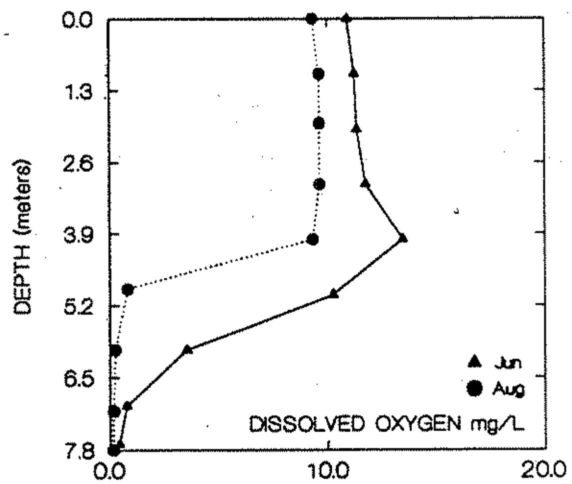
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/18		E	28			(Source: Water Supply Bulletin 43)					
81/06/11		E			1.6	(Source: Water Supply Bulletin 57)					
90/06/01	1	E	22	1.01							
90/08/24	1	E	15	0.68							
91/05/24	1	E		1.21							
92/05/02	1	E	8	1.17	1.2						
92/05/02	1	H	27	0.96							
92/09/04	1	E	17	0.30	3.3						
92/09/04	2	E	22	0.34	2.6						
92/09/04	1	H		3.66							
93/06/04	1	E	13	1.09	7.9						
93/06/04	1	H	47	1.19							
93/08/27	1	E	14	0.62	9.3						
93/08/27	1	H	103	1.58							
94/06/03	1	E	20	1.00	7.2						
94/06/03	2	E	35	1.00	6.7						
94/06/03	1	H	58	1.06							
94/08/26	1	E	19	0.36J	9.6						
94/08/26	1	H	477J	3.89J							

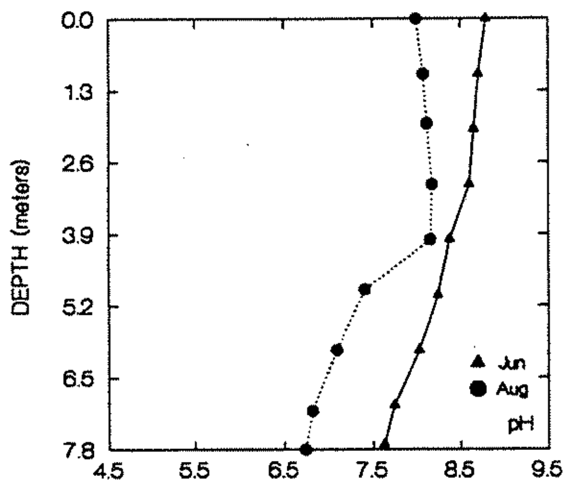
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

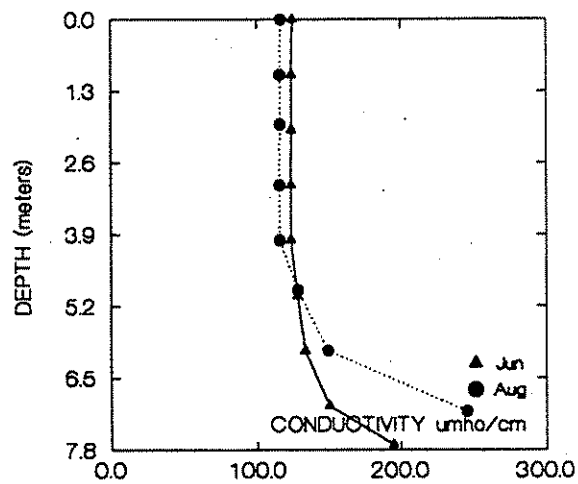
SPANAWAY (PIERCE) Lake -- PIERCE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/03	0.0	19.2	8.8	10.9	125.0	94/08/26	0.0	22.1	8.5	9.3	116.0
	-0.2	19.1	8.8	10.9	125.0		1.0	21.3	8.6	9.6	116.0
	1.0	18.2	8.7	11.3	124.0		1.9	21.0	8.6	9.7	116.0
	2.0	18.0	8.7	11.4	124.0		3.0	21.0	8.7	9.7	115.0
	3.0	17.5	8.6	11.8	123.0		4.0	20.8	8.7	9.3	115.0
	4.0	15.5	8.4	13.5	123.0		4.9	18.1	7.9	0.8	128.0
	5.0	13.8	8.2	10.3	128.0		6.0	15.3	7.6	0.2	149.0
	6.0	12.4	8.0	3.6	133.0		7.1	13.4	7.3	0.2	246.0
	7.0	11.4	7.7	0.7	150.0		7.8	12.6	7.2	0.1	317.0
	7.7	11.0	7.6	0.4	195.0						







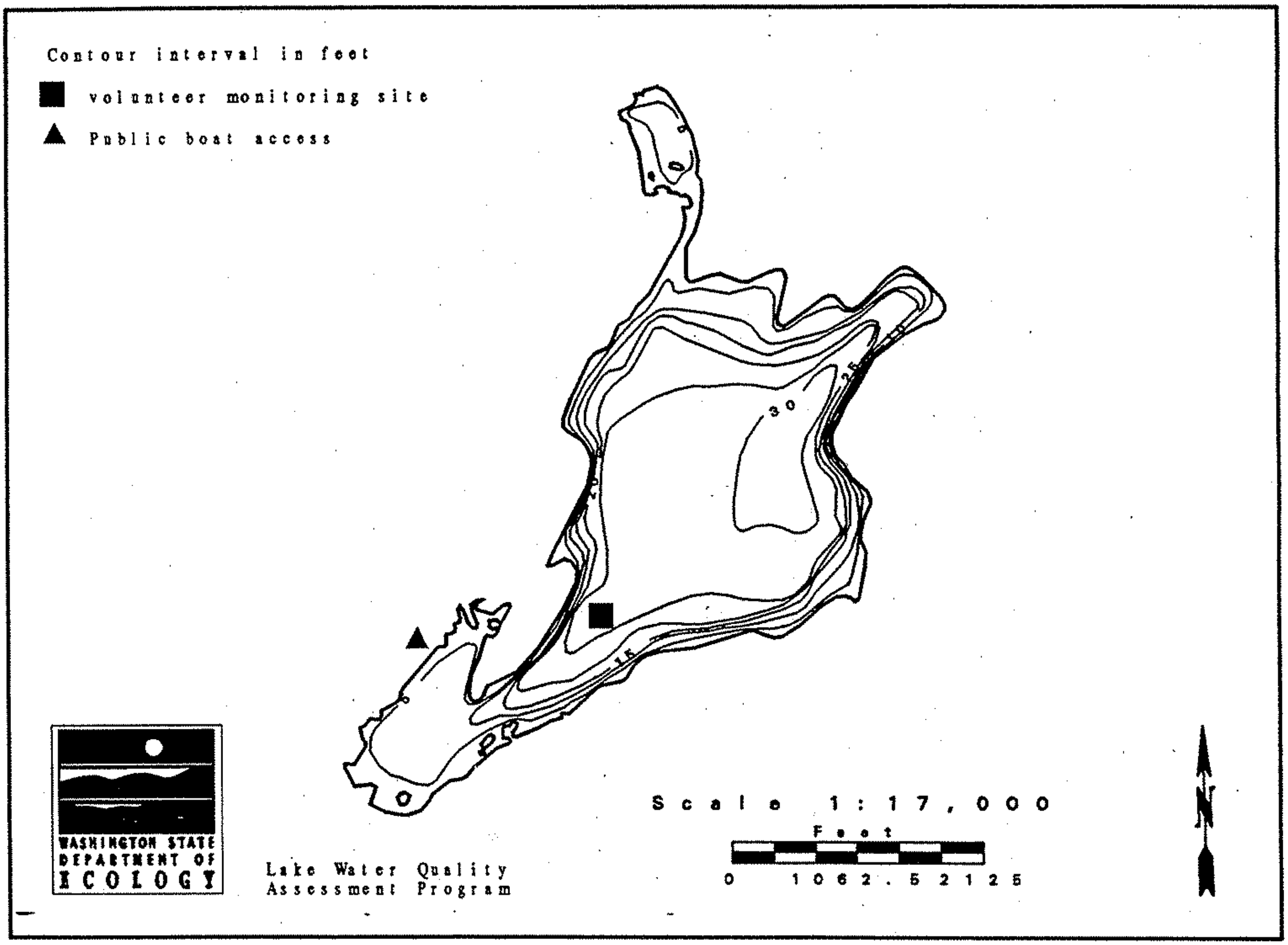


Spencer Lake -- Mason County

Spencer Lake is located seven miles northeast of Shelton. It has no inlets, and drains via Malaney Creek to Oakland Bay.

Size (acres)	230
Maximum Depth (feet)	36
Mean Depth (feet)	22
Lake Volume (acre-feet)	5,152
Drainage Area (miles^2)	1.7
Altitude (feet)	170
Shoreline Length (miles)	4.3

Data from Bortleson *et al.* (1976)



Overall Assessment

Spencer Lake had good water quality in 1994. Despite a moderately high concentration of total phosphorus during the May survey, both Secchi depths and chlorophyll *a* concentrations indicate that there was a low amount of algae when the lake was sampled. Concentrations of total nitrogen were low and similar to concentrations measured during previous surveys (see table of water chemistry results).

The pattern of Secchi depths measured in 1994 was similar to the pattern from 1992, although Secchi depths were deeper in 1994 (see graph of Secchi depths data). There was no significant trend in water clarity since 1990. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.92$).

Profile data were very similar to data measured during previous surveys, and did not indicate any problems. (Dissolved oxygen Data from May, and pH Data from August, are not reported here due to accuracy problems with the probe.)

Results from fecal coliform bacteria and turbidity samples collected during the May survey were very low, and did not indicate any problems in the areas that were sampled.

Spencer Lake was surveyed by Ecology staff on August 15, 1994, for the Freshwater Aquatic Weeds Program. Not many plants were observed in the lake due to the rocky substrate, although there large patches of lilies. Areas with prevalent aquatic plant growth were dominated by common waterweed, white-flowering water lily, and largeleaf pondweed. Purple loosestrife, a non-native aggressive wetland plant, was observed in one location. Seed heads were removed from the plant during the survey. Aquatic plants observed include water-milfoil (*Myriophyllum sp.*; but not the aggressive Eurasian variety), slender pondweed (*Potamogeton pusillus*), common elodea (*Elodea canadensis*), white-flowering water lily (*Nymphaea sp.*), water lobelia (*Lobelia dortmanna)*, purple (marsh) cinquefoil (*Potentilla palustris*), purple loosestrife (*Lythrum salicari*a), cattail (*Typha sp.*), common bladderwort (*Utricularia vulgaris*), largeleaf pondweed (*Potamogeton amplifolius*), yellow flag (*Iris pseudacorus*), common naiad (*Najas flexilis*), quillwort (*Isoetes sp.*), stonewort (*Nitella sp.*), bulrush (*Scirpus sp.*), yellow water-lily (*Nuphar sp.*), fescue scolochloa (*Scirpus subterminalis*), rush (*Juncus sp.*), and wool-grass (*Scirpus cyperinus*).

Based on low concentrations of chlorophyll *a*, fairly deep Secchi depths, and low amounts of aquatic plants, Spencer Lake was classified as oligo-mesotrophic in 1994. The only problem of concern is the presence of purple loosestrife on the shoreline. Although Ecology staff removed the seed heads, ideally the plant should be destroyed to prevent it from spreading. The infestation was reported to the Mason County Cooperative Extension Office (Mason County does not have a noxious weed board), and Ecology staff will check the plants during the May 1995 survey to see if more action is required.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 through 1994.

Spencer Lake is used for fishing, swimming, motor boating, non-motorized boating, jet skiing, lakeshore camping, and waterfowl hunting. Many springs feed the lake. There is one resort on the lakeshore, and two public boat ramps. About 1% of the shoreline is publicly-owned. Rainbow trout were stocked in the lake in 1994. Currently, the watershed is used for crop agriculture, animal grazing/feeding, and lakeshore development for residences. In the past, the watershed was logged and used for crop agriculture and animal grazing/feeding. The lake was also used as a log storage pond 50-60 years ago. The shoreline was altered in the past when beaches were cleaned at individual residences. A dike was built in 1950, and the weir was taken out around 1988. Wildlife in the area include raccoon, otter, mink, muskrat, and geese (both wild and domestic).

There are about 100 houses on the lakeshore, and none of the houses are connected to a sewer. One culvert drains into the lake. There is no lake association for the lake. Currently, the minimum setback for lakeshore development is 15 feet, and minimum lot lengths are 50 feet. Septic systems are restricted within 100 feet of individual wells, and there is a minimum lot size of 12,500 square feet per residence which use community wells. No lake management activities occurred on the lake in 1994, although the lake level was drawn down for a short time during spring so that debris could be cleared near the old weir.

Overall, the volunteer found that Spencer Lake had good water quality and there were no water quality problems in the lake in 1994. However, water quality has gradually degraded over the years. The only change since the 1993 monitoring season was additional expansion of an RV park on the east end of the lake. This park keeps expanding each year, and there is some concern about possible affects on lake water quality.

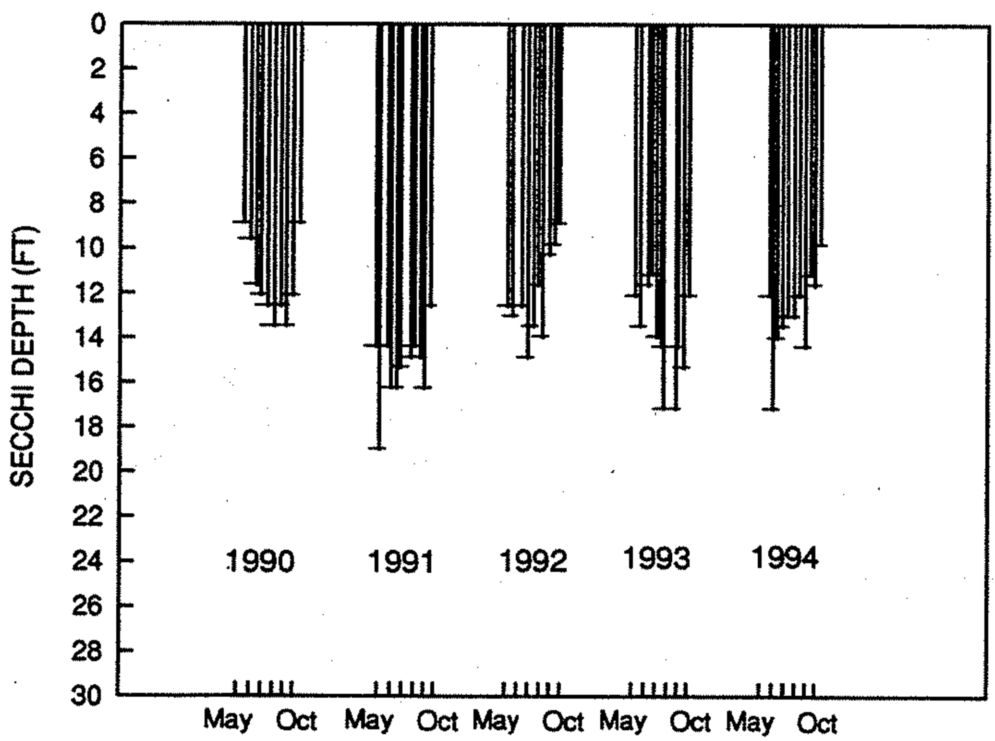
Acknowledgment

I thank Virginia Charrier for volunteering her time to monitor Spencer Lake from 1990 through 1994.

SPENCER Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/24	17.2	63.0	0.0	Lt Green	10	None	Light	11.5	-7.0	Onsite visit. This time last year level was 10 " below winter high level; lake unusually high all winter.
94/06/02	16.7	62.1	0.0	Lt Green	25	None	Breezy	16.5	0.0	Have no idea why it was so much clearer.
94/06/15	17.8	64.0	0.0	Lt Green	25	Heavy	Breezy	13.4	-10.0	Lake height measured below winter high.
94/06/30	18.3	64.9	0.0		25	None	Light	12.8	0.0	Water color light yellow green.
94/07/14	21.1	70.0	0.0		50	None	Light	12.4	-14.0	Water color light yellow green.
94/07/28	22.8	73.0	0.0		25	None	Breezy	12.4	0.0	Water color ligth yellow green. In the last 2 weeks the state did some dredging by the weir. Lake has gone down.
94/08/15	21.7	71.1	0.0	Lt Green	50	None	Light	11.5	-19.0	
94/08/30	21.1	70.0	0.0		0	None	Calm	13.8	-22.0	Water color light yellow green.
94/09/15	20.0	68.0	0.0		90	Mod	Breezy	10.6	-21.0	Water color light yellow green.
94/09/30	20.0	68.0	0.0	Lt Green	50	None	Breezy	11.0	-23.0	
94/10/15	15.6	60.1	0.0	Lt Green	50	Light	Calm	9.2	-25.0	

SPENCER LAKE (MASON COUNTY)



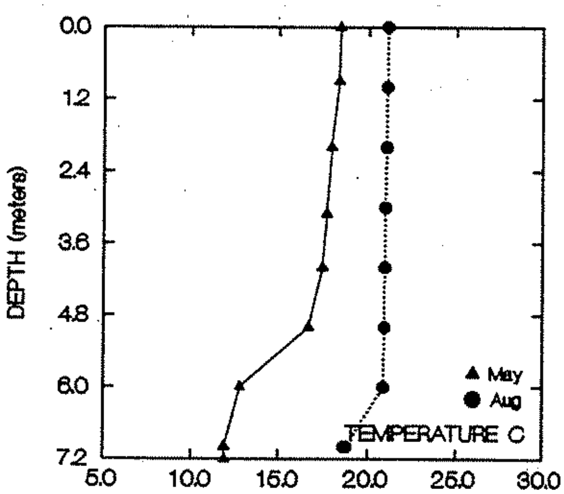
SPENCER (MASON) Lake -- MASON County
Chemistry Data -- Station 1

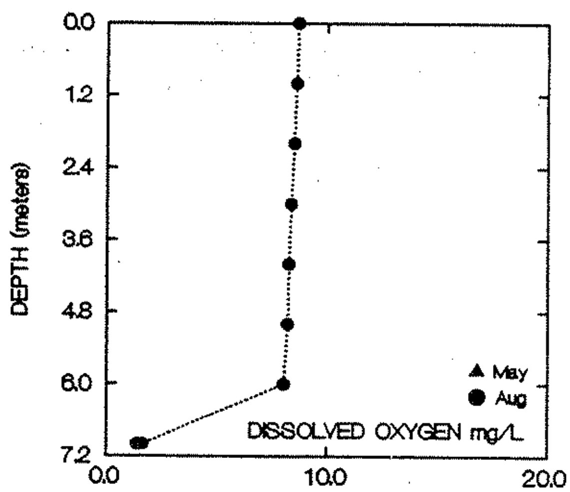
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/20		E	9			(Source: Water Supply Bulletin 43)					
90/05/24	1	E	9	0.27							
90/08/15	1	E	13	0.35							
91/05/21	1	E		0.22							
92/05/09	1	E	10	0.29	1.3						
92/05/09	2	E	18								
92/05/09	1	H	21	0.33							
92/08/06	1	E	7	0.33	1.1						
92/08/06	1	H	6	0.30							
93/05/28	1	E	51	0.26	4.0						
93/05/28	1	H	15	0.28							
93/09/02	1	E	8	0.26	2.3						
93/09/02	1	H	15	0.28							
94/05/24	1	E	21	0.10	1.8J	2	1	0.5U			
94/05/24	1	H	20	0.11							
94/08/30	1	E	5	0.21J							
94/08/30	1	H	10	0.27J							

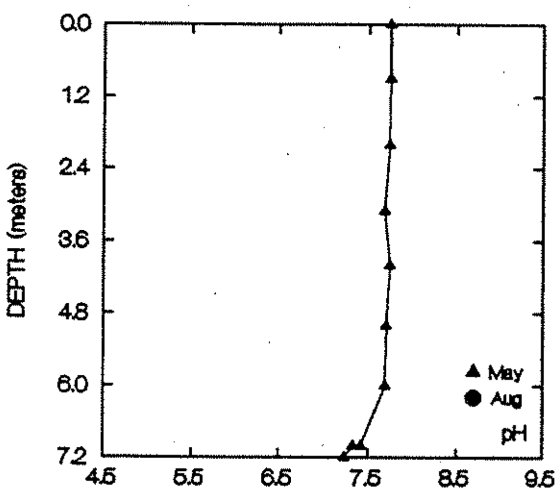
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

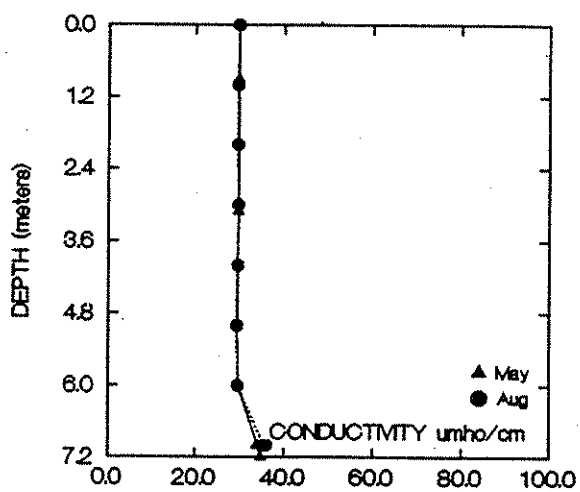
SPENCER (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/24	0.0	18.4	7.7	0.0	30.0	94/08/30	0.0	21.1	0.0	8.7	30.0
	0.9	18.4	7.7	0.0	30.0		1.0	21.0	0.0	8.6	30.0
	2.0	18.0	7.7	0.0	30.0		2.0	21.0	0.0	8.5	30.0
	3.1	17.7	7.7	0.0	30.0		3.0	21.0	0.0	8.4	30.0
	4.0	17.5	7.7	0.0	30.0		4.0	20.9	0.0	8.3	30.0
	5.0	16.7	7.7	0.0	30.0		5.0	20.9	0.0	8.2	29.0
	6.0	12.8	7.7	0.0	30.0		6.0	20.9	0.0	8.1	30.0
	7.0	11.9	7.4	0.0	34.0		7.0	18.8	0.0	1.6	36.0
	7.0	11.9	7.3	0.0	34.0		7.0	18.7	0.0	1.4	36.0
	7.2	11.9	7.2	0.0	35.0						









Lake St. Clair -- Thurston County

Lake St. Clair is located 6.5 miles northwest of Yelm. It is an irregularly shaped lake with steep sides, numerous narrow arms and four small islands. The lake is fed by Eaton Creek, drains to the Nisqually River, and seeps to McAllister Springs. The south arm of Lake St. Clair is a deep conical-shaped depression.

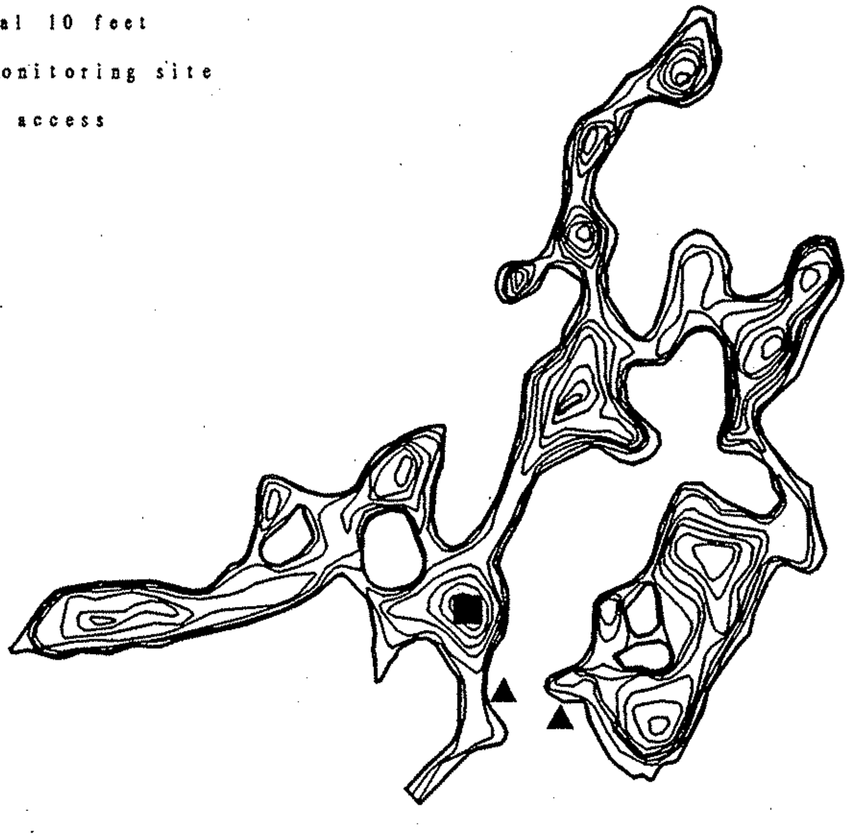
	North Arm	South Arm
Size (acres)	180	88
Maximum Depth (feet)	70	110
Mean Depth (feet)	28	40
Lake Volume (acre-feet)	5,100	3,600
Drainage Area (miles^2)	6.4	14.5
Altitude (feet)	73	73
Shoreline Length (miles)	7.5	2.9

Data from Bortleson *et al.* (1976)

Contour interval 10 feet

■ volunteer monitoring site

▲ Public boat access



WASHINGTON STATE DEPARTMENT OF ECOLOGY

Lake Water Quality Assessment Program

Scale 1:16,000

Feet

0 1000 2000

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Overall Assessment

Water quality of Lake St. Clair was better in 1994 than in previous years of monitoring. In particular, Secchi depths were unusually deep in 1994 (see graph of Secchi depth data). Water clarity seemed to improve as water color became clearer; rather than being reddish brown. The water was mostly reddish during 1994 (see table of volunteer-collected data). There was a statistically significant improving trend in water clarity from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results were significant at the 95% level ($p = 0.03$).

Nutrient concentrations and profile data were very similar to results from 1993, and did not indicate any problems in the lake. Based on good Secchi depths, moderate concentrations of nutrients and algae, and a moderately heavy population of aquatic plants in areas of the lake, Lake St. Clair was classified as mesotrophic in 1994. This is an improvement from previous years, when the lake was classified as meso-eutrophic.

Aquatic plants observed by Ecology staff during field visits include slender naiad (*Najas flexilis*), watershield (*Brasenia schreberi*), tapegrass (*Vallisneria americana*), flatleaf pondweed (*Potamogeton robbinsii*), yellow-flowering water lily (*Nuphar sp.*), white-flowering lily (*Nymphaea odorata*), the alga *Nitella*, cattail (*Typha latifolia*), iris (*Iris pseudacorus*), waterweed (*Elodea canadensis*), large-leaf pondweed (*Potamogeton amplifolius*), flatstem pondweed (*Potamogeton zosteriformis*), slender pondweed (*Potamogeton pusillus*), sedge (*Scirpus*), and coontail (*Ceratophyllum demersum*).

In 1994, the main concern about the lake was the considerable drop in water level. In Lake St. Clair, lake level started 19.5 inches lower than usual in 1994, and dropped 32.5 inches from May through October. The decrease in 1994 was the greatest since 1990 (when level measurements began for this program). Although many other lakes in western Washington had lower levels in 1994, the lakes fed primarily by groundwater were most affected. However, Lake St. Clair seeps to groundwater and feeds the aquifer that is the main source of water for the City of Olympia. Quite possibly the level of Lake St. Clair in recent years has been affected by water withdrawal from the McAllister springs aquifer. This is conjecture, but may be worth investigating.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 through 1994.

> Lake St. Clair is used for fishing, boating, swimming, rowing, and jet skiing. There are two boat ramps on the lakeshore, and with the exception of the deep basin in the south arm, there is a speed restriction of 5 mph for motorboats. About

2% of the shoreline is publicly-owned. Trout (Rainbow and kokanee) were stocked in the lake in 1994. Currently the watershed is being logged and used for animal grazing and crop agriculture. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for animal grazing and crop agriculture. Also, the channel under the bridge was dredged in 1990.

There are 319 houses on the lakeshore, and none of the houses are connected to a sewer. Two storm drains empty into the lake. Lake water is withdrawn for drinking and other domestic uses. There is a community association for the lake, the Lake St. Clair Organization, and a volunteer lake monitoring group for the lake. Currently, the minimum setback for lakeshore development is 30 feet. No lake management activities occurred on the lake in 1994. Currently there are plans to improve fish access to Eaton Creek (for spawning) which involve the Department of Fish and Wildlife and the lake organization. The channel is currently blocked, and a fish ladder may be installed to improve access.

Overall, the volunteer found that Lake St. Clair had good water quality. Problems in the lake in 1994 were ranked as (1) low water level, (2) excessive aquatic plant growth, (3) impaired fishery, (4) algae, (5) fluctuating water level, (6) suspended sediments, (7) shoreline erosion, (8) gradually degraded water quality over the years, and (9) decaying maple leaves in the water. In comparison to the 1993 monitoring season, water level was excessively low, and water was more clear during fall.

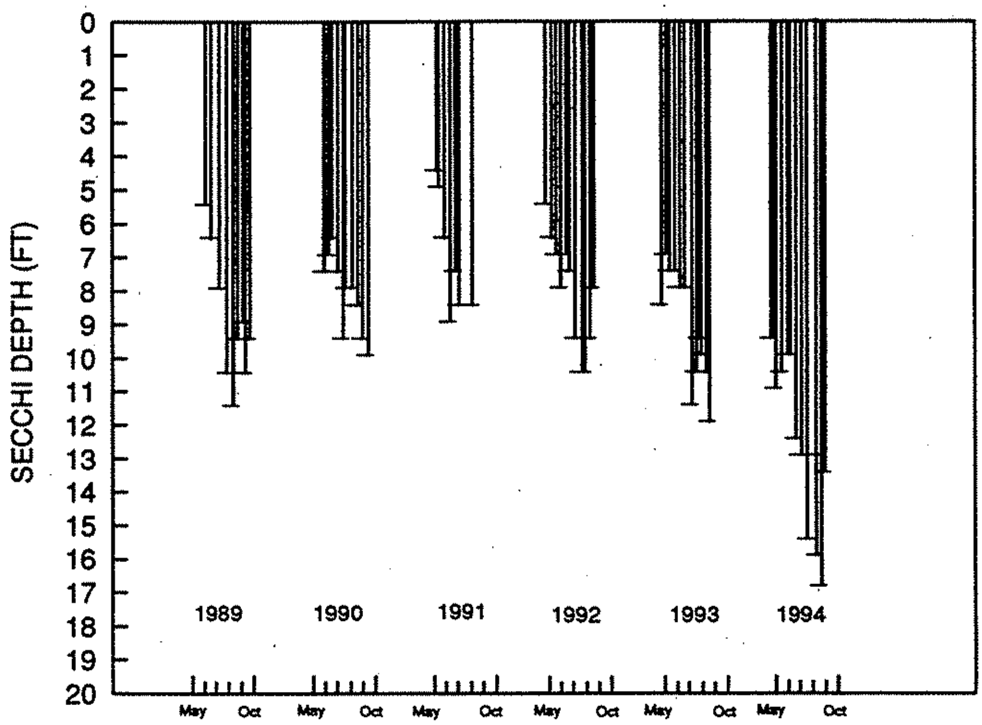
Acknowledgment

I thank M.E. Christopherson for volunteering his time to monitor Lake St. Clair from 1989 through 1994.

ST. CLAIR Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/02	15.0	59.0	0.0		50	Trace	Light	9.0	0.0	Water color reddish brown. Lake level is start ing 19.5" below the usual level on previous May 1 dates!
94/05/18	18.0	64.4	0.0		90	Light	Light	10.5	-3.0	Water color reddish brown. Lake level dropped 3" since 2 May reading, approx 20" lower than t he average for this time of year.
94/06/05	19.0	66.2	0.0		100	Light		10.0	-5.5	Water color reddish brown.. Lake level dropped 2.5" since last reading.
94/06/20	21.0	69.8	0.0		90	Trace	Light	9.5	-7.2	Water color reddish brown. Lake level dropped 1.75". Less reddish brown color.
94/07/03	21.0	69.8	0.0		90	Light	Light	9.5	-9.2	Water color reddish brown.
94/07/18	25.0	77.0	0.0		10	None	Breezy	12.0	-13.0	Water color quite clear, some red-brown. Lake dropped 3.75", approximately 31" below average 1 May level.
94/08/01	25.0	77.0	0.0		0	None	Light	12.5	-17.5	Lake dropped 4.5" (severe drop). Lowest level ever.
94/08/13	25.0	77.0	0.0		0	None	Light	12.5	-20.5	Water color reddish. Due to beginning low wate r level lake is about 40" below 1 May level ave rage.
94/08/26	25.0	77.0	0.0		0	Trace	Light	15.0	-24.0	Water color reddish brown, but more clear than usual. Lake is dropping at about the usual sum mer rate. However lake is approximately 43.5 " below average 1 May level.
94/09/14	21.0	69.8	0.0		75	Mod	Light	12.5	-25.0	Water color reddish. Level dropped 1"; 44.5 be low average May 1 level. Lowest level ever obs erved. Water is still very clear; this was a d ark day with no sun.
94/09/24	21.0	69.8	0.0		0	None	Light	15.5	-27.5	Water quite clear. Lake very low, lower than a nyone remembers.
94/10/08	18.0	64.4	0.0	Clear	10	None	Light	16.4	-31.5	Less color, water much clearer than usual. Lak e level dropped 31.5" since 1 May. However, 1 May level was 19.5" below average level (total drop 51").
94/10/24	15.0	59.0	0.0	Grn-brown	0	None	Calm	13.0	-32.5	Water color clear greenish brown; less red colo r. Light algae bloom floating on surface, brig ht green color. Total level drop 32.5" since 1 May, 52" for season.

LAKE ST. CLAIR (THURSTON COUNTY)



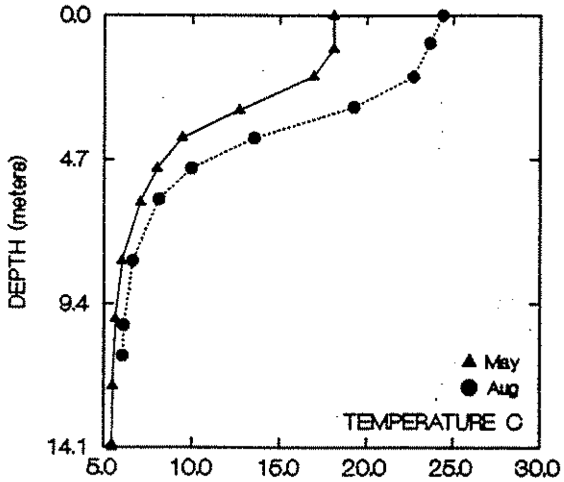
ST. CLAIR (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

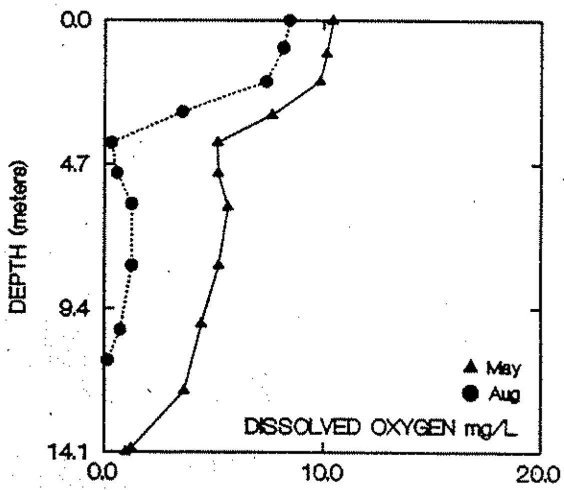
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
90/05/30	1	E	35	0.53							
90/06/11	1	E		0.63	11.6						
90/08/22	1	E	24	0.53							
90/09/19	1	E	25	0.66	10.1						
91/05/31	1	E		0.63							
92/05/01	1	E	32	0.61	5.9	5	3		5	1	250
92/05/01	2	E		0.84	5.5				4	1	250
92/05/01	1	H	59	0.81							
92/09/02	1	E	25	0.38	1.0	1	1U		1U	1U	50
92/09/02	2	E	21	0.32	1.9						
92/09/02	1	H	114	0.62							
93/05/19	1	E	29	0.41	2.0						
93/05/19	1	H	52	0.57							
93/09/07	1	E	18	0.48	4.5						
93/09/07	1	H	63	0.60							
94/05/31	1	E	29	0.20	2.9						
94/05/31	1	H	68	0.45							
94/08/15	1	E	12	0.31J	1.5J						
94/08/15	1	H	51	0.59J							

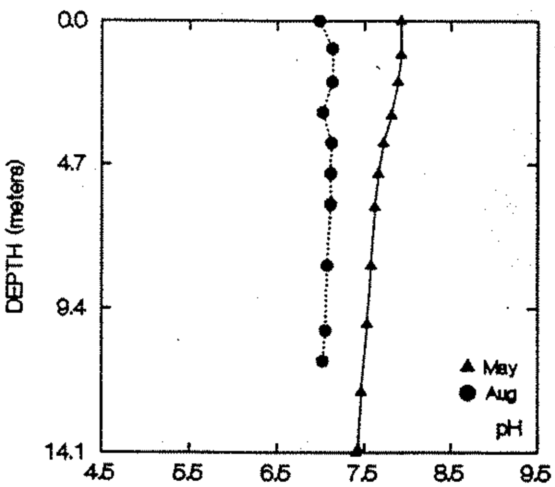
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

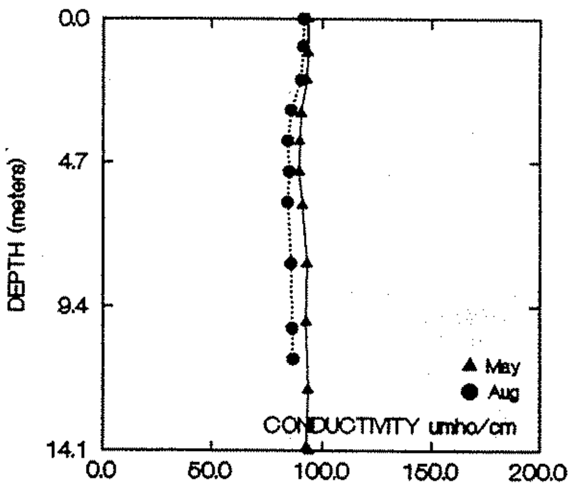
ST. CLAIR (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/31	0.0	18.1	7.9	10.4	94.0	94/08/15	0.0	24.4	7.0	8.4	91.0
	1.1	18.1	7.9	10.2	94.0		0.9	23.7	7.1	8.2	91.0
	2.0	16.9	7.9	9.9	93.0		2.0	22.7	7.1	7.4	90.0
	3.1	12.7	7.8	7.7	90.0		3.0	19.3	7.0	3.6	86.0
	4.0	9.4	7.7	5.2	90.0		4.0	13.5	7.1	0.3	84.0
	5.0	8.0	7.7	5.3	89.0		5.0	10.0	7.1	0.6	85.0
	6.1	7.1	7.6	5.7	91.0		6.0	8.1	7.1	1.3	84.0
	8.0	6.0	7.6	5.3	93.0		8.0	6.6	7.1	1.3	86.0
	9.9	5.7	7.5	4.5	93.0		10.1	6.1	7.1	0.7	86.0
	12.1	5.5	7.5	3.7	94.0		11.1	6.1	7.0	0.2	87.0
	14.0	5.5	7.4	1.3	93.0						
	14.1	5.5	7.4	1.0	94.0						







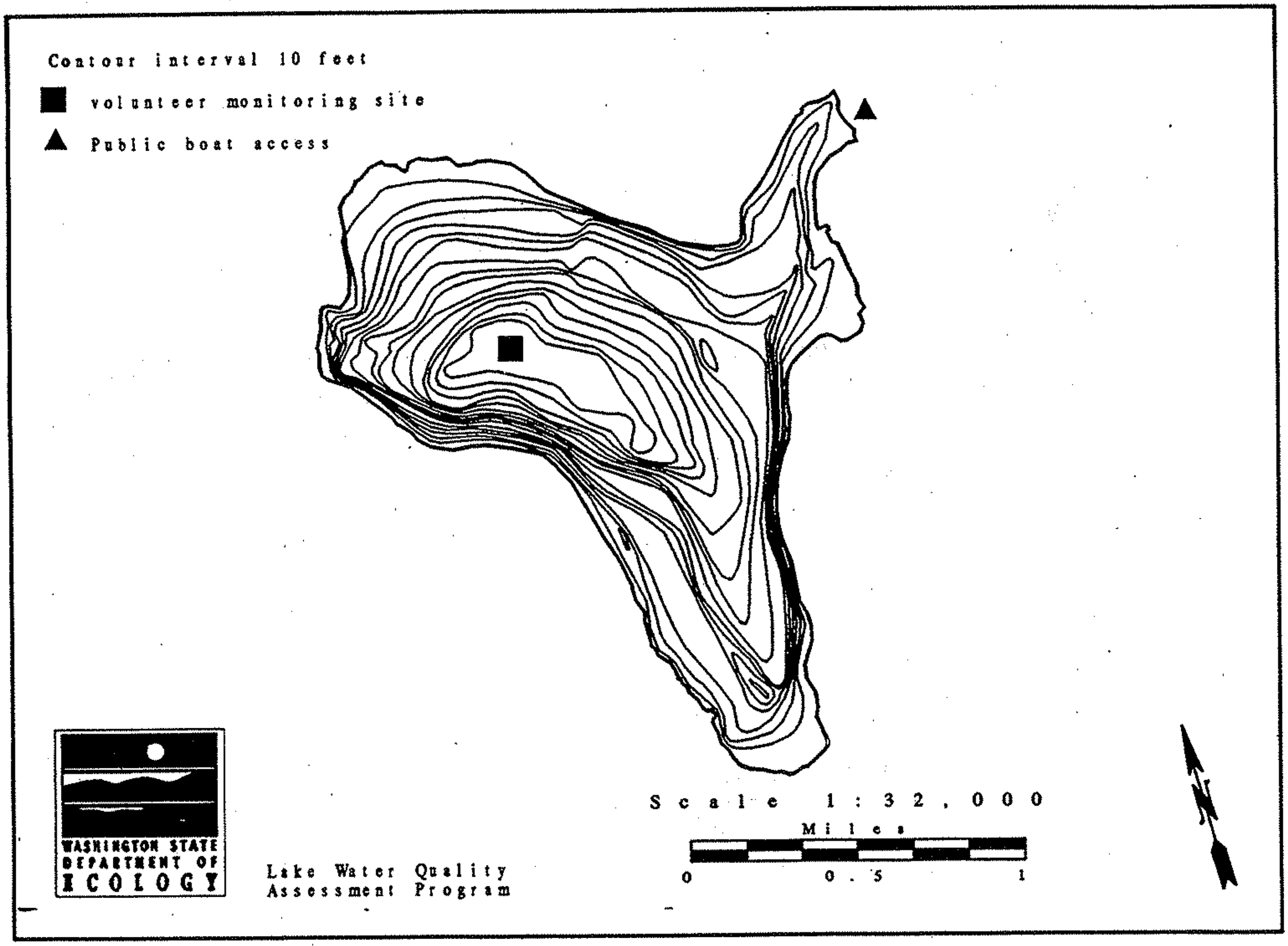


Lake Stevens -- Snohomish County

Lake Stevens is located 5.5 miles east of Everett. It has several small inlets and drains via Lake Stevens Creek to Little Pilchuk Creek and the Pilchuk River.

Size (acres)	1,000
Maximum Depth (feet)	155
Mean Depth (feet)	63
Lake Volume (acre-feet)	65,000
Drainage Area (miles^2)	6.8
Altitude (feet)	210
Shoreline Length (miles)	7.1

Data from Bortleson *et al.* (1976)



Overall Assessment

Water quality of Lake Stevens was good in 1994. Secchi depth data, water chemistry results, and profile data are listed in tables at the end of this summary.

There was a wide range in Secchi depths, and in May the deepest reading in five years was measured (see graphs of Secchi data). Secchi depths from 1989 through 1994 were analyzed for trend in water clarity, but there was not a significant trend. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 0.21$).

As a result of four partial lift hypolimnetic aerators operating near the sampling site, dissolved oxygen concentrations increased in the bottom 15 meters of the lake. During previous surveys, dissolved oxygen concentrations decreased with depth below the thermocline. These aerators began operating in May 1994, as part of a lake management effort to prevent phosphorus from being recycled from sediments. These apparently had the desired effect, as the lower layer of water had higher concentrations of oxygen, and lower concentrations of total phosphorus, than during earlier surveys for this program. However, concentrations of total phosphorus in the upper layer of water were moderately high to high, and were higher in 1994 than during previous surveys. Despite this, the volunteer noted that there were fewer algae and other aquatic plants in 1994.

Because Lake Stevens exhibited both oligotrophic and mesotrophic characteristics in 1994, it was classified as oligo-mesotrophic. Oligotrophic characteristics include the good water clarity, the higher concentrations of dissolved oxygen throughout the water column, and the low chlorophyll concentration during the May survey. Mesotrophic characteristics were the moderately high concentrations of total phosphorus on both sampling dates, and the moderately high concentration of chlorophyll *a* during the August survey.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 to 1994.

> Lake Stevens is used for fishing, swimming, motor boating, non-motorized boating, and jet skiing. There is a park on the lakeshore, and about 3% of the shoreline is publicly-owned. There are two public boat ramps, and there is a speed limit of 35 mph for motorboating. Currently, the watershed is being logged and is used for crop agriculture, animal grazing/feeding, and industry. The lakeshore is also being developed further for residences. In the past, the watershed was logged and used for crop agriculture and animal grazing/feeding, the lake was dredged, and the shoreline was altered (filled wetlands).

There are 285 houses on the lakeshore, and all houses are connected to a sewer. About six culverts/stormdrains drain into the lake. There is a lake management district and a sewer district for the lake. Hypolimentic aeration began in May 1994 as part of a lake restoration and lake management effort.

Overall, the volunteer found that Lake Stevens had good water quality. The only problem in 1994 was low water level. The only change in the lake since the 1993 monitoring season was the installation and operation of the four aerators, and the lake has been colder since the aeration began.

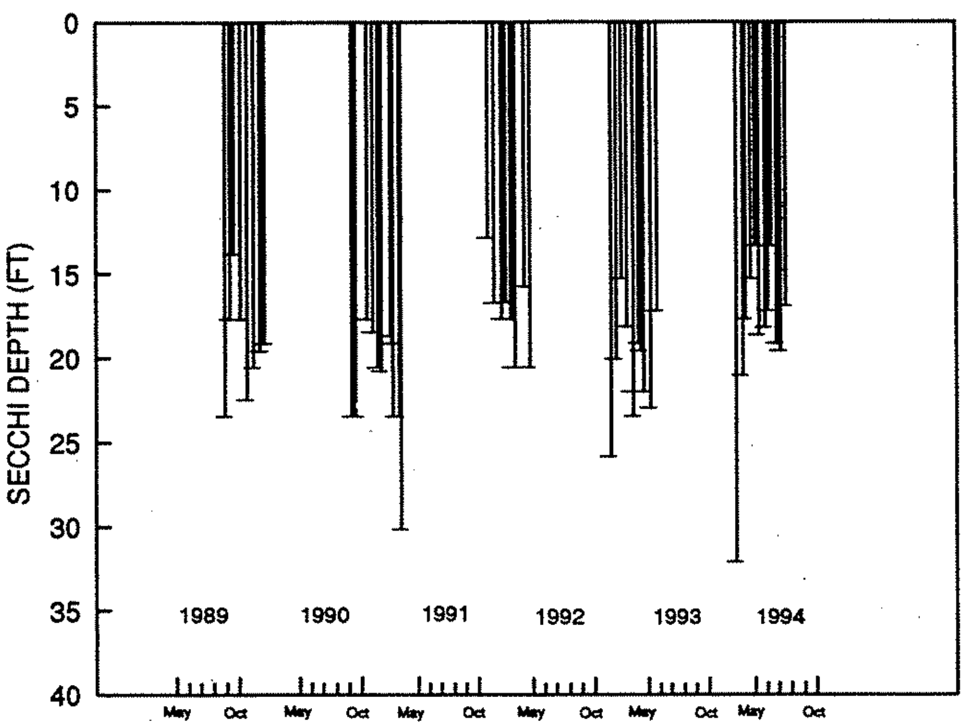
Acknowledgment

I thank Mark McCullough for volunteering his time to monitor Lake Stevens from 1990 through 1994.

STEVENS Lake -- SNOHOMISH County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/20	0.0	32.0	0.0	Mod Green	100	None	Light	31.3	0.0	Onsite visit. Lost yet another messenger. Four aerators installed and running in last 2 weeks.
94/06/07	17.2	63.0	0.0	Mod Green	75	Light	Breezy	20.2	-4.0	Aeration has been going on for 3-4 weeks now.
94/06/15	17.8	64.0	0.0	Milky-grn	75	Trace	Breezy	16.8	-12.0	Aeration going. Water temp is low for this time of year.
94/07/01	19.4	66.9	0.0	Pea-green	25	None	Breezy	14.4	-14.0	
94/07/11	20.6	69.1	0.0	Pea-green	0	None	Light	12.5	-15.0	
94/07/24	23.3	73.9	0.0	Mod Green	0	None	Calm	17.8	-17.0	Free-floating algae.
94/08/12	21.7	71.1	0.0	Mod Green	10	None	Breezy	17.3	-24.0	Lake level dropping.
94/08/18	23.0	73.4	0.0	Mod Green	10		Light	16.4	-24.0	
94/08/30	20.6	69.1	0.0	Mod Green	0	None	Light	12.5	24.0	
94/09/13	18.9	66.0	0.0	Grn-brown	80	None	Calm	18.3	-28.0	Lots of algae floating under water. Lake is extremely low.
94/09/23	19.4	66.9	0.0	Grn-brown	0		Light	18.8	-29.0	Lake level still dropping.
94/10/08	16.7	62.1	0.0	Grn-brown	10	None	Light	16.0	-36.0	Lake lowest it's been in years. Water cooling down fast.

LAKE STEVENS (SNOHOMISH COUNTY)



STEVENS (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/07/27		E	5			(Source: Water Supply Bulletin 43)					
90/06/06	1	E	9	0.36							
90/08/30	1	E	12	0.35							
91/06/18	1	E		0.37							
92/08/01	1	E	12	0.33	2.2						
92/08/01	2	E	9	0.31	1.5						
92/08/01	1	H	45	0.60							
93/05/25	1	E	7	0.36	4.0						
93/05/25	1	H	32	0.50							
93/08/18	1	E	10	0.24	3.0						
93/08/18	1	H	11	0.44							
94/05/20	1	E	27	0.32	1.6						
94/05/20	1	H	10	0.40							
94/08/18	1	E	15	0.29J	3.0J						
94/08/18	1	H	9	0.56J							

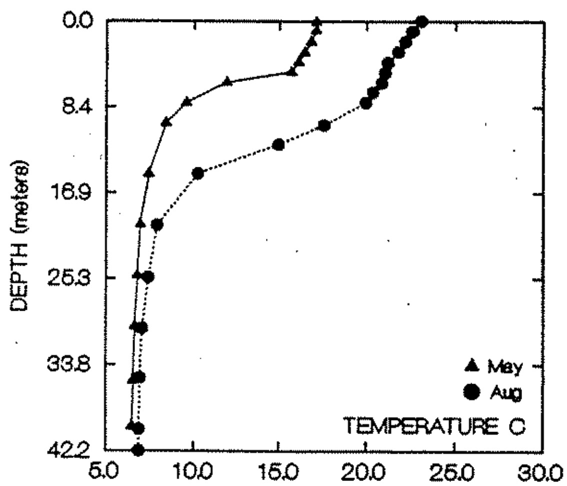
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

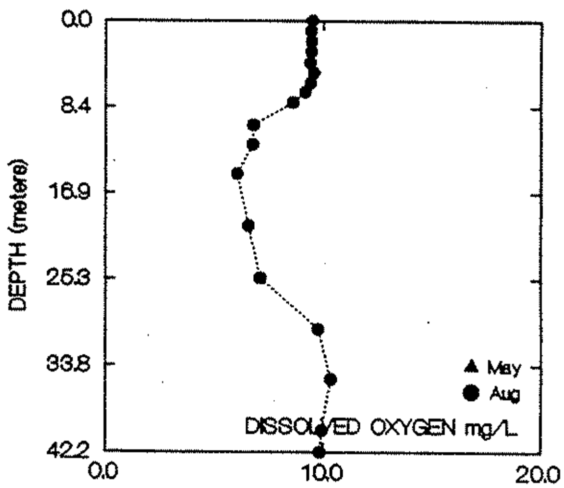
STEVENS (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

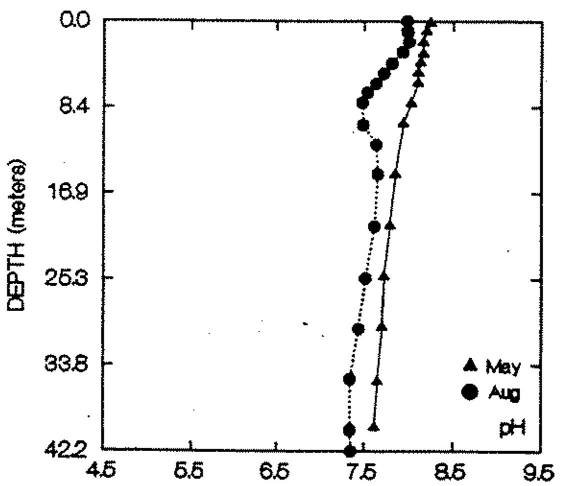
STATION 1

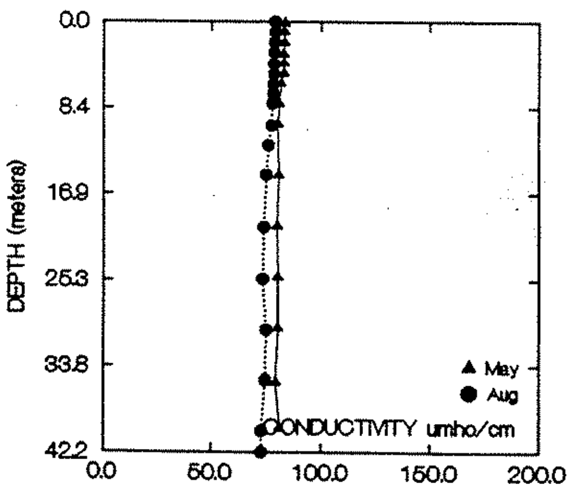
Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
94/05/20	0.1	17.1	8.3	0.0	83.0
	0.9	17.1	8.2	0.0	83.0
	2.0	16.8	8.2	0.0	83.0
	3.1	16.4	8.2	0.0	83.0
	4.0	16.1	8.1	0.0	83.0
	5.0	15.7	8.1	0.0	83.0
	6.0	11.9	8.1	0.0	82.0
	8.0	9.5	8.0	0.0	81.0
	10.0	8.4	8.0	0.0	80.0
	15.0	7.4	7.9	0.0	81.0
	20.0	6.9	7.8	0.0	80.0
	25.0	6.8	7.7	0.0	80.0
	30.0	6.6	7.7	0.0	80.0
	35.3	6.5	7.7	0.0	79.0
	39.8	6.5	7.6	0.0	81.0

Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
94/08/18	0.0	23.1	8.0	9.5	79.0
	1.0	22.6	8.0	9.4	79.0
	1.0	22.6	8.0	9.4	79.0
	2.0	22.2	8.0	9.4	79.0
	3.0	21.8	7.9	9.4	79.0
	4.1	21.3	7.8	9.4	78.0
	5.1	21.1	7.7	9.6	78.0
	6.1	20.9	7.6	9.4	78.0
	7.0	20.4	7.5	9.2	78.0
	8.0	20.0	7.5	8.6	78.0
	10.2	17.6	7.5	6.8	77.0
	12.1	15.0	7.6	6.8	76.0
	15.0	10.2	7.7	6.1	75.0
	20.1	7.9	7.6	6.6	74.0
	25.2	7.4	7.5	7.1	73.0
	30.2	7.0	7.4	9.8	75.0
	35.1	6.9	7.3	10.4	75.0
	40.1	6.9	7.3	9.9	73.0
	42.2	6.9	7.4	9.9	73.0







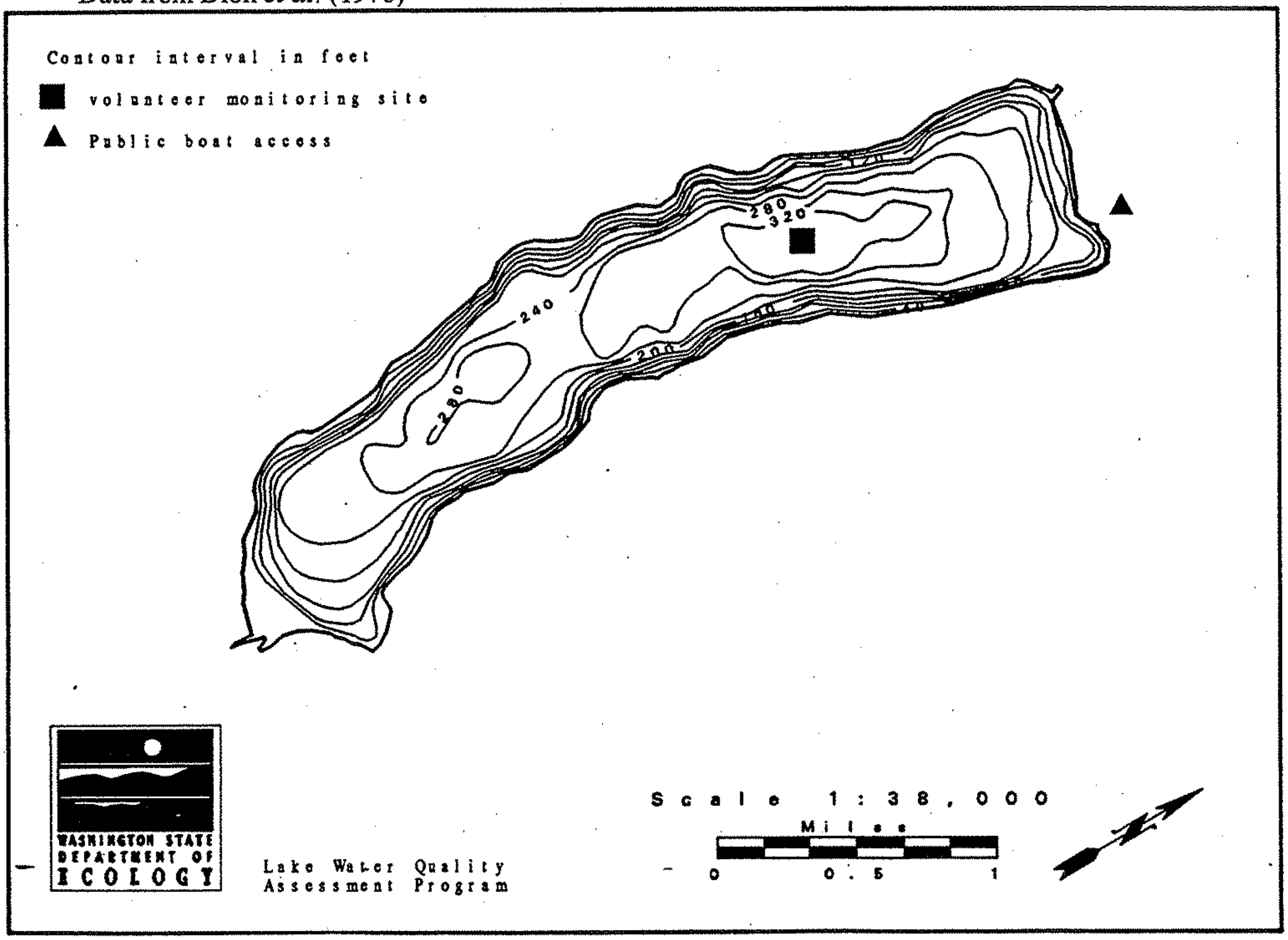


Sullivan Lake -- Pend Oreille County

Sullivan Lake is located 4.3 miles southeast of Metaline Falls. It is a natural lake that was enlarged by a dam built in Harvey Creek in 1931. The lake is 3.6 miles long and averages 0.6 miles in width. Sullivan Lake drains to Sullivan Creek and the Pend Oreille River. There are campgrounds at both the north and south ends of the lake.

Size (acres)	1,380
Maximum Depth (feet)	332
Mean Depth (feet)	193
Lake Volume (acre-feet)	267,000
Drainage Area (miles^2)	51.2
Altitude (feet)	2,583
Shoreline Length (miles)	8.9

Data from Dion *et al.* (1976)



Overall Assessment

Lake Sullivan had very good water quality in 1994. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary.

Based on results from all three major trophic state parameters (Secchi depths, chlorophyll *a*, and August total phosphorus), Sullivan Lake was classified as oligotrophic in 1994. Concentrations of total nitrogen and chlorophyll *a* were among the lowest of the lakes monitored in 1994.

It is not unusual for higher elevation lakes to have higher phosphorus concentrations in spring after lake thaw and snowmelt. This can happen because suspended sediments often carry adsorbed phosphorus that would be measured in the water samples, but would not be in a form available for algae to use. Therefore, these occasional high values do not affect the current water quality of the lake.

Profile data show that concentrations of dissolved oxygen remained high throughout the upper and middle layers of water. (The probe's cable was not long enough to collect data though the entire water column during either survey.) There was nothing unusual about the profile data.

Aquatic plants observed by Ecology staff during field visits include common waterweed (*Elodea canadensis*), Richard's pondweed (*Potamogeton richardsonii*), water buttercup (*Ranunculus sp.*), and the alga *Nitella*.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of volunteer's remarks and responses to questionnaires from 1990, 1993, and 1994.

> Sullivan Lake is used for fishing, boating, swimming, rowing, jet skiing, camping, scuba diving, and bird watching. Public recreational facilities on the lakeshore include a picnic area, a camping area, a beach, and two boat ramps. There are campgrounds located at the north and south ends of the lake. There is a speed restriction of 35 mph for motorboats.
>
> There are two houses on the lakeshore. Currently the watershed is being logged and used for animal grazing. Grazing animals have direct access to the lakeshore or inlet tributaries. The lakeshore is also being developed further for residences. In the past, the watershed was logged and mined, and the shoreline was altered when the lake was dammed in 1931. There is a PUD for the lake, but no lake user's organization. Every year the lake level is drawn down for hydroelectric use from October 1 through April 15.

Overall, the volunteer found that Sullivan Lake had excellent water quality. Problems in the lake in 1994 were ranked as (1) impaired fisheries, (2) low water level in winter, and (3) fluctuating water level. Problems were mainly due to drawdown of the lake during winter, which affected fishing. The only change in the lake since the 1993 monitoring season was replacement of the dam.

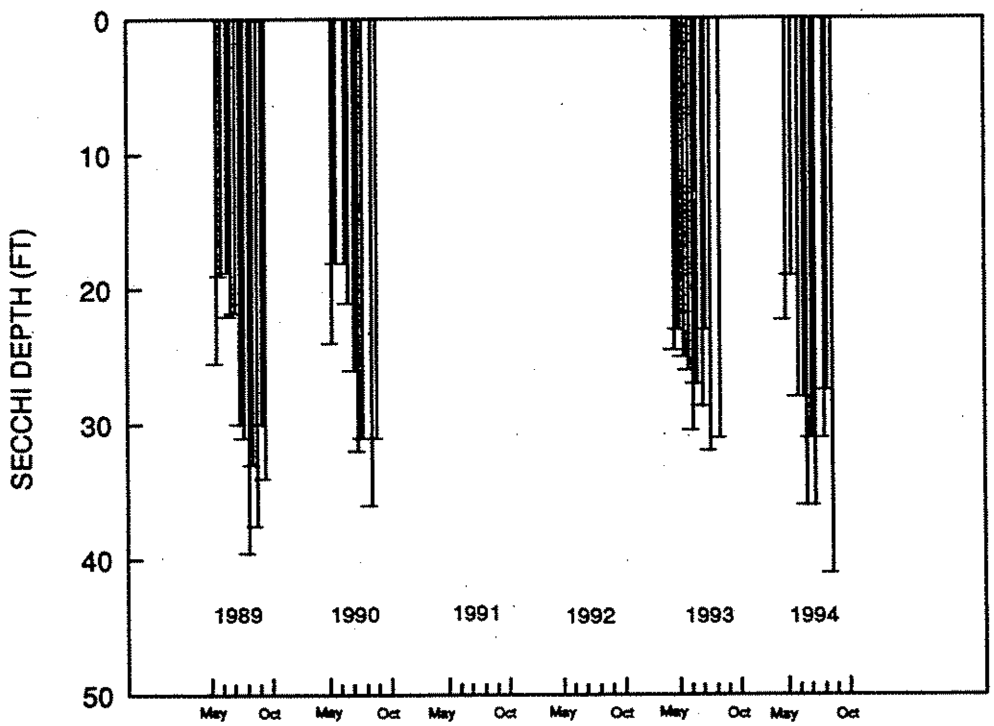
Acknowledgments

I thank John Riley for volunteering his time to monitor Sullivan Lake during 1993 and 1994. Dick Vogel monitored the lake in 1990, and Terry Williams monitored the lake in 1989.

SULLIVAN Lake -- PEND OREILLE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/20	11.7	53.1	0.0	Mod Green	100	Light	Calm	21.3	0.0		Lake level 2581.62'.
94/06/07	13.9	57.0	0.0	Mod Green	98	Heavy	Light	18.0	0.0		Lake level 2586.6. Small amount of pine pollen near shore.
94/06/30	18.9	66.0	0.0	Lt Green	50	None	Breezy	27.0	0.0		Lake level 2587.7.
94/07/14	22.5	72.5	0.0	Lt Green	50	None	Breezy	27.0	0.0		Lake level 2587.26.
94/07/27	24.4	75.9	0.0	Lt Green	90	None	Calm	35.0	0.0		Lake level 2587.
94/08/10	22.2	72.0	0.0	Lt Green	0	None	Calm	30.0	0.0		Lake level 2586.7 feet.
94/08/19	21.7	71.1	0.0	Lt Green	0	None	Calm	35.0	0.0		Lake height 2586.2 feet. Onsite visit with Dave.
94/09/02	18.9	66.0	0.0	Lt Green	75	None	Calm	30.0	0.0		Lake height 2586 feet.
94/09/16	18.3	64.9	0.0	Lt Green	10	None	Calm	30.0	0.0		Lake height 2586 feet.
94/09/30	16.7	62.1	0.0	Mod Green	100	None	Breezy	26.5	0.0		Lake height 2585.
94/10/16	13.3	55.9	0.0	Lt Green	0	Light	Calm	40.0	0.0		Lake height 2582.48.

SULLIVAN LAKE (PEND OREILLE COUNTY)



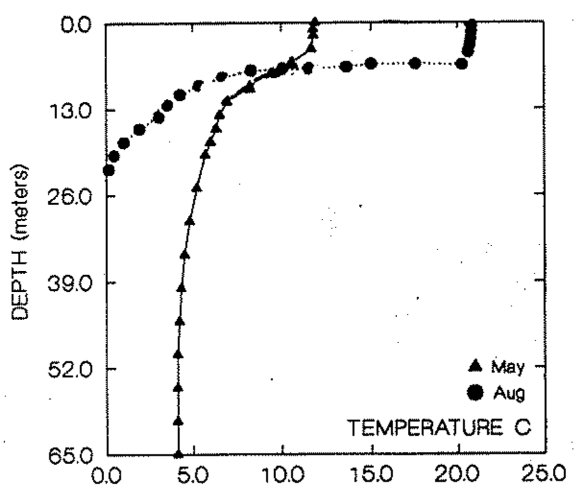
SULLIVAN (PEND OREILLE) Lake -- PEND OREILLE County
Chemistry Data -- Station 1

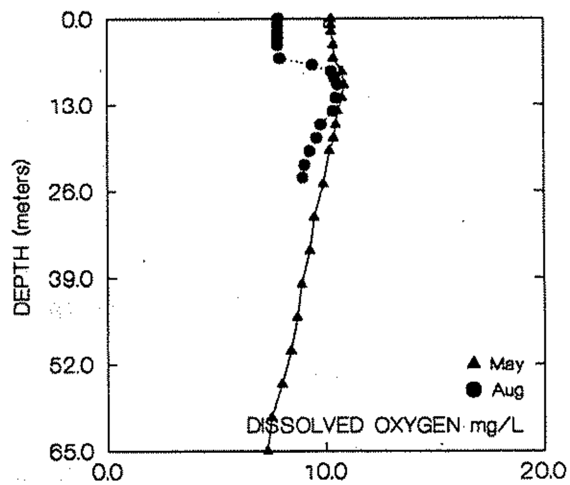
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/12		E	7			(Source: Water Supply Bulletin 43)					
93/05/25	1	E	17	0.07	0.9						
93/05/25	2	E	36								
93/05/25	1	H	9	0.05							
93/08/21	1	E	7	0.06	1.3						
93/08/21	2	E	3U								
93/08/21	1	H	11	0.06							
94/05/20	1	E	56	0.03	1.3						
94/05/20	2	E	14								
94/05/20	1	H	4	0.01							
94/08/19	1	E	8	0.21J	0.6J						
94/08/19	2	E	1U	0.37J							
94/08/19	1	H	14	0.08J							

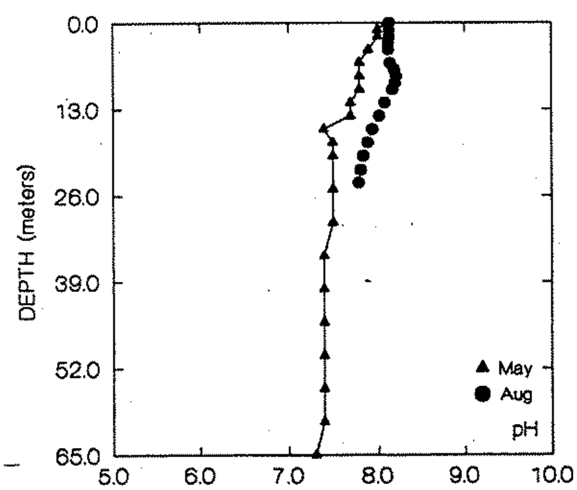
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

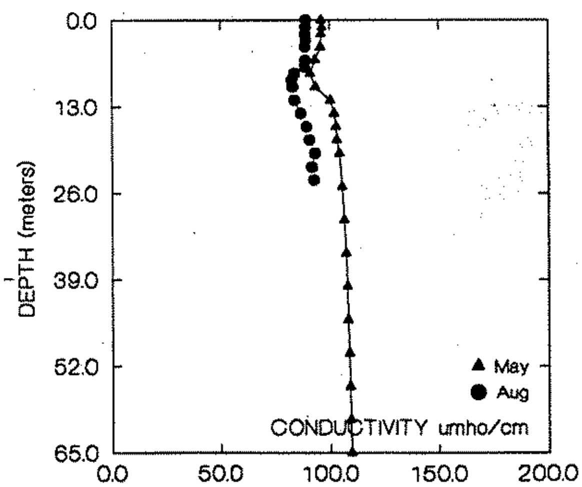
SULLIVAN (PEND OREILLE) Lake -- PEND OREILLE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/20	0.0	11.9	8.1	10.3	96.0	94/08/19	0.0	21.5	8.1	7.9	89.0
	1.0	11.8	8.0	10.3	37.0		1.0	21.6	8.1	7.8	89.0
	2.0	11.8	8.0	10.3	96.0		2.1	21.6	8.1	7.8	89.0
	4.0	11.7	7.9	10.4	96.0		3.0	21.6	8.1	7.8	89.0
	6.0	10.6	7.8	10.4	94.0		4.0	21.6	8.1	7.8	89.0
	8.0	8.7	7.8	10.8	91.0		6.0	21.3	8.1	7.9	89.0
	10.0	8.2	7.8	10.9	93.0		7.0	18.6	8.2	9.4	89.0
	12.0	6.9	7.7	10.8	100.0		8.0	16.1	8.2	10.3	84.0
	14.0	6.5	7.7	10.6	102.0		9.0	14.8	8.2	10.4	83.0
	16.0	6.3	7.4	10.5	103.0		10.0	12.7	8.2	10.6	83.0
	18.0	6.0	7.5	10.4	103.0		12.0	9.5	8.1	10.5	84.0
	20.0	5.7	7.5	10.2	104.0		14.0	8.1	8.0	10.4	87.0
	25.0	5.2	7.5	9.9	106.0		16.0	6.9	7.9	9.8	89.0
	30.0	4.8	7.5	9.5	107.0		18.0	6.0	7.9	9.6	91.0
	35.0	4.5	7.4	9.3	107.0		20.0	5.4	7.8	9.3	93.0
	40.0	4.3	7.4	8.9	108.0		22.1	5.1	7.8	9.1	92.0
	45.0	4.2	7.4	8.7	108.0		24.0	4.8	7.8	9.0	93.0
	50.0	4.1	7.4	8.4	109.0						
	55.0	4.1	7.4	8.0	109.0						
	60.0	4.1	7.4	7.5	109.0						
	65.0	4.1	7.3	7.3	110.0						







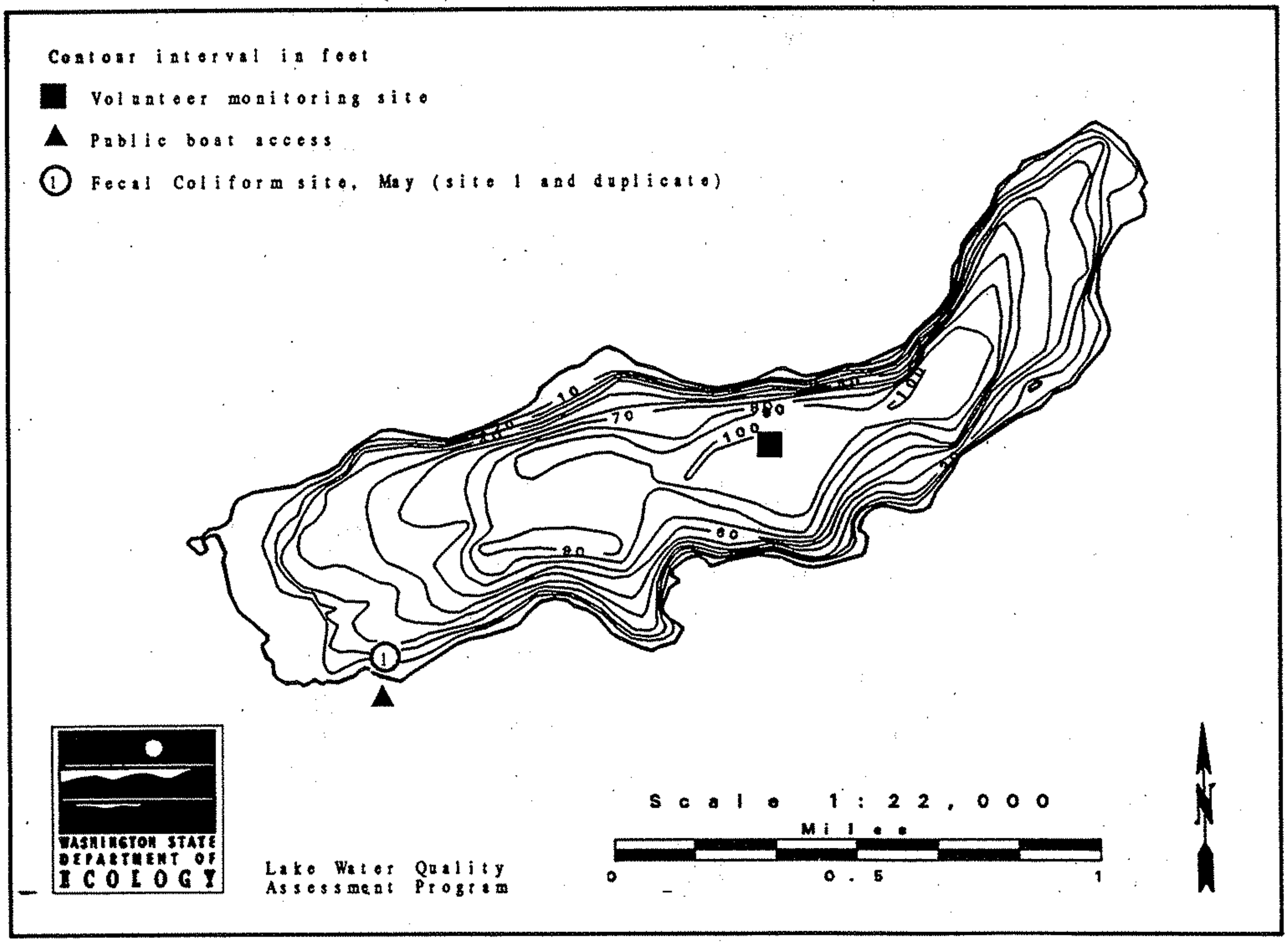


Summit Lake -- Thurston County

Summit Lake is located in a steep forested valley nine miles west of Olympia. It is two miles long. Summit Lake is fed by intermittent streams, seeps, and springs, and drains via Kennedy Creek to Oyster Bay in Totten Inlet.

Size (acres)	530
Maximum Depth (feet)	100
Mean Depth (feet)	53
Lake Volume (acre-feet)	28,000
Drainage Area (miles^2)	2.8
Altitude (feet)	500
Shoreline Length (miles)	5.6

Data from Bortleson *et al.* (1976)



Overall Assessment

Summit Lake had very good water quality in 1994. Secchi depths were all very deep, and profile data were similar to data collected during previous surveys, and did not indicate anything unusual about the lake. Secchi depths, water chemistry results, and profile data are listed in tables at the end of this summary. The one high phosphorus concentration from August is probably an error, since a sample collected from a second site on the same date had a very low concentration.

Based on results from all three major trophic state parameters (Secchi depths, chlorophyll *a*, and May total phosphorus), Summit Lake was classified as oligotrophic in 1994.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of volunteer's remarks and responses to questionnaires from 1989 and 1994.

> Summit Lake is used for fishing, boating, swimming, jet skiing, picnicking, camping, and hiking. There are two boat ramps on the lakeshore, and there are speed restrictions and time restrictions for motor boating. Rainbow trout were stocked in the lake in 1994. Lake water is withdrawn for drinking and other domestic uses, and for irrigation. Currently the watershed is being logged ad used for animal grazing. In the past, the watershed was logged, and the shoreline was altered.
>
> There are over 250 houses on the lakeshore, and none are connected to a sewer. There is a community association for the lake. In 1994, septic systems around the lake were tested as part of a lake management effort. In the past, the lake has been chemically treated to control undesirable fish species.
>
> Overall, the volunteer found that Summit Lake had excellent water quality. Water quality problems in 1994 were ranked as (1) gradually degraded water quality over the years, (2) bacteria, (3) high water level, and (4) low water level. Possible sources of bacteria problems are failing septic systems, pet and animal wastes, and lake uses involving lake access. Since the lake was last monitored for the program, numerous septic systems have been repaired. The volunteer also notes that septic system monitoring and repair should be an ongoing program for Summit Lake.

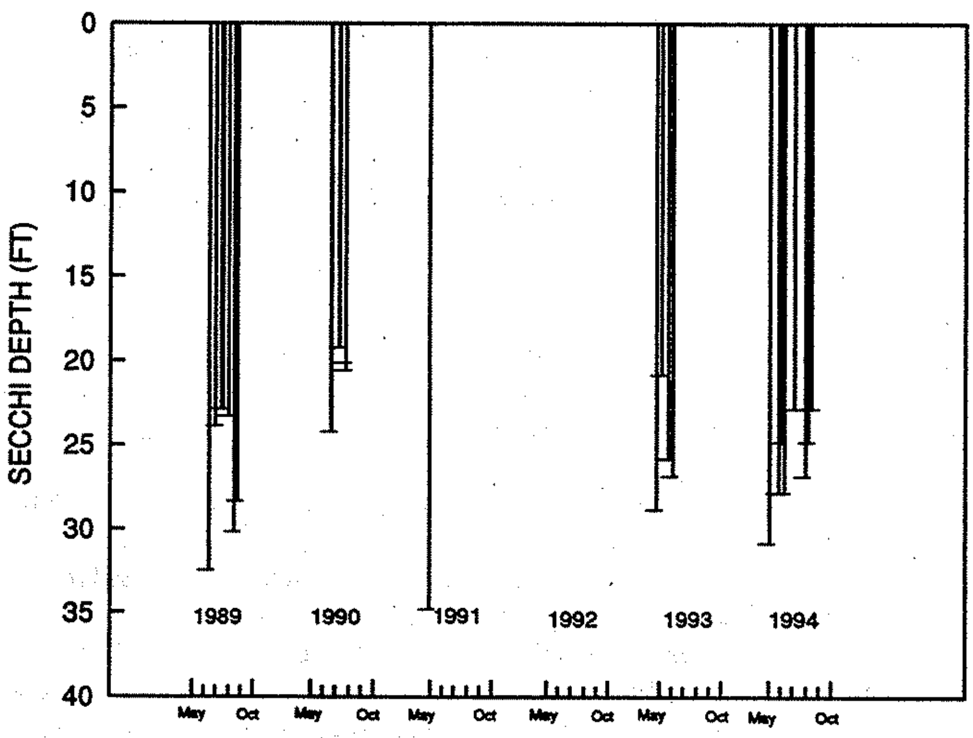
Acknowledgments

I thank Larry Davis for volunteering his time to monitor Summit Lake during 1994, 1990, and 1989. Bill Champion monitored Summit Lake during 1993.

SUMMIT Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/26	0.0	32.0	0.0	Mod Green	100		Light	30.0	0.0	Onsite visit. New rope on Secchi. Dropped some Hypo TP sample into Epi TP sample, in case there are some weird results.
94/06/22	16.7	62.1	0.0	Lt Green	50	None	Light	27.0	0.0	
94/07/04	16.7	62.1	0.0	Mod Green	100	None	Light	24.0	0.0	Deep site 84 feet.
94/07/17	17.8	64.0	0.0	Lt Green	0	None	Light	27.0	0.0	High thin clouds.
94/08/13	20.0	68.0	0.0	Lt Green	0	None	Light	22.0	0.0	Lake depth 82 feet.
94/09/05	17.8	64.0	0.0	Mod Green	0	Light	Light	22.0	0.0	
94/09/18	17.8	64.0	0.0	Mod Green	0	None	Calm	26.0	0.0	
94/10/02	16.7	62.1	0.0	Mod Green	10	Trace	Light	24.0	0.0	
94/10/16	13.3	55.9	0.0	Lt Green	10	None	Light	22.0	0.0	

SUMMIT LAKE (THURSTON COUNTY)



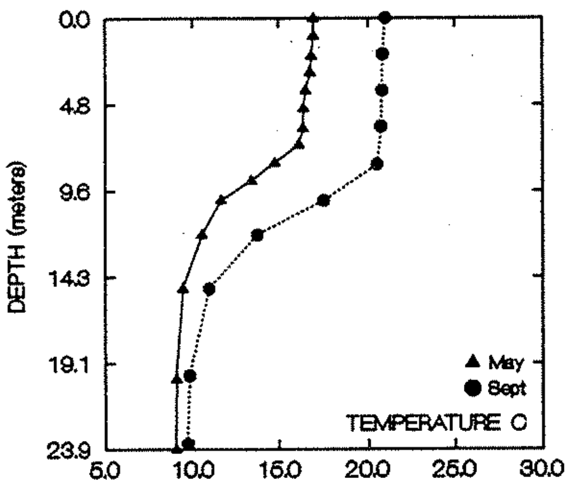
SUMMIT (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

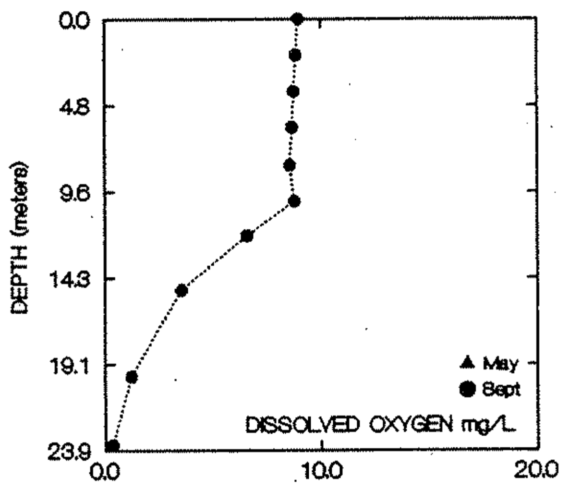
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/19		E	10			(Source: Water Supply Bulletin 43)					
89/06/07	1	E	7	0.16	1.5						
89/09/05	1	E	6	0.15	1.5						
90/05/31	1	E	5	0.17							
90/08/23	1	E	15	0.21							
91/05/23	1	E		0.13							
93/05/19	1	E	19	0.17	3.1	2	1		1U	1U	
93/05/19	2	E	9								
93/05/19	1	H	10	0.18							
93/09/07	1	E	8	0.17	1.2						
93/09/07	1	H	12	0.17							
94/05/26	1	E	7	0.09	1.3						
94/05/26	1	H	27	0.14							
94/09/01	1	E	103	0.12J	1.1J						
94/09/01	2	E	4								
94/09/01	1	H	13	0.18J							

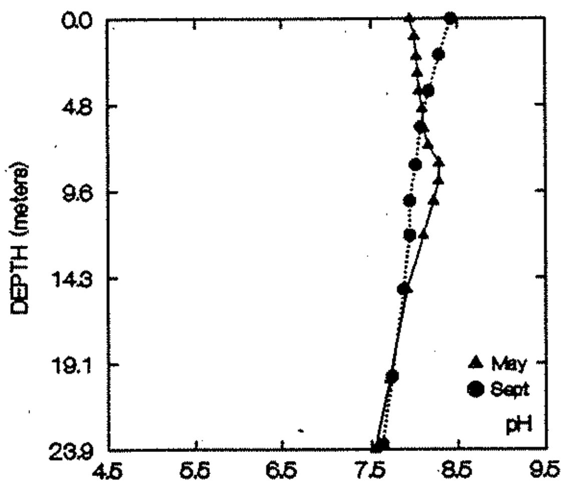
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

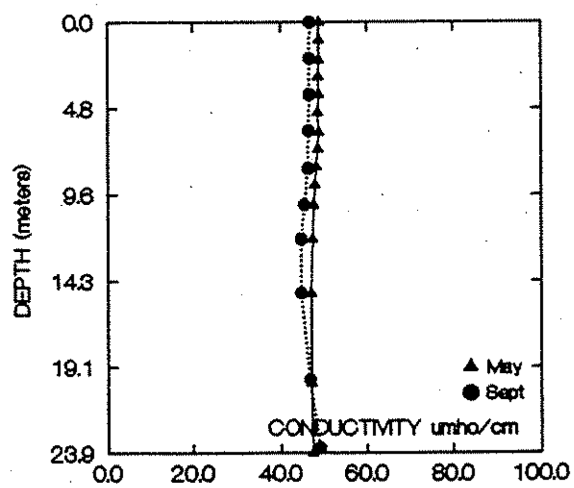
SUMMIT (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/26	0.0	17.0	8.0	0.0	49.0	94/09/01	0.0	21.0	8.4	9.0	47.0
	1.0	17.0	8.0	0.0	49.0		2.0	20.9	8.3	8.8	47.0
	2.1	16.9	8.0	0.0	49.0		4.0	20.8	8.2	8.7	47.0
	3.0	16.8	8.0	0.0	49.0		6.0	20.8	8.1	8.7	46.0
	4.0	16.5	8.1	0.0	49.0		8.1	20.5	8.0	8.6	46.0
	5.0	16.4	8.1	0.0	49.0		10.1	17.5	7.9	8.8	45.0
	6.1	16.4	8.1	0.0	49.0		12.0	13.8	7.9	6.6	45.0
	7.0	16.1	8.2	0.0	49.0		15.0	10.9	7.9	3.6	45.0
	8.0	14.8	8.3	0.0	48.0		19.8	9.8	7.7	1.2	47.0
	9.0	13.4	8.3	0.0	48.0		23.6	9.7	7.6	0.3	49.0
	10.1	11.6	8.2	0.0	48.0						
	12.0	10.5	8.1	0.0	47.0						
	15.0	9.4	7.9	0.0	47.0						
	20.0	9.1	7.7	0.0	47.0						
	23.9	9.0	7.6	0.0	47.0						







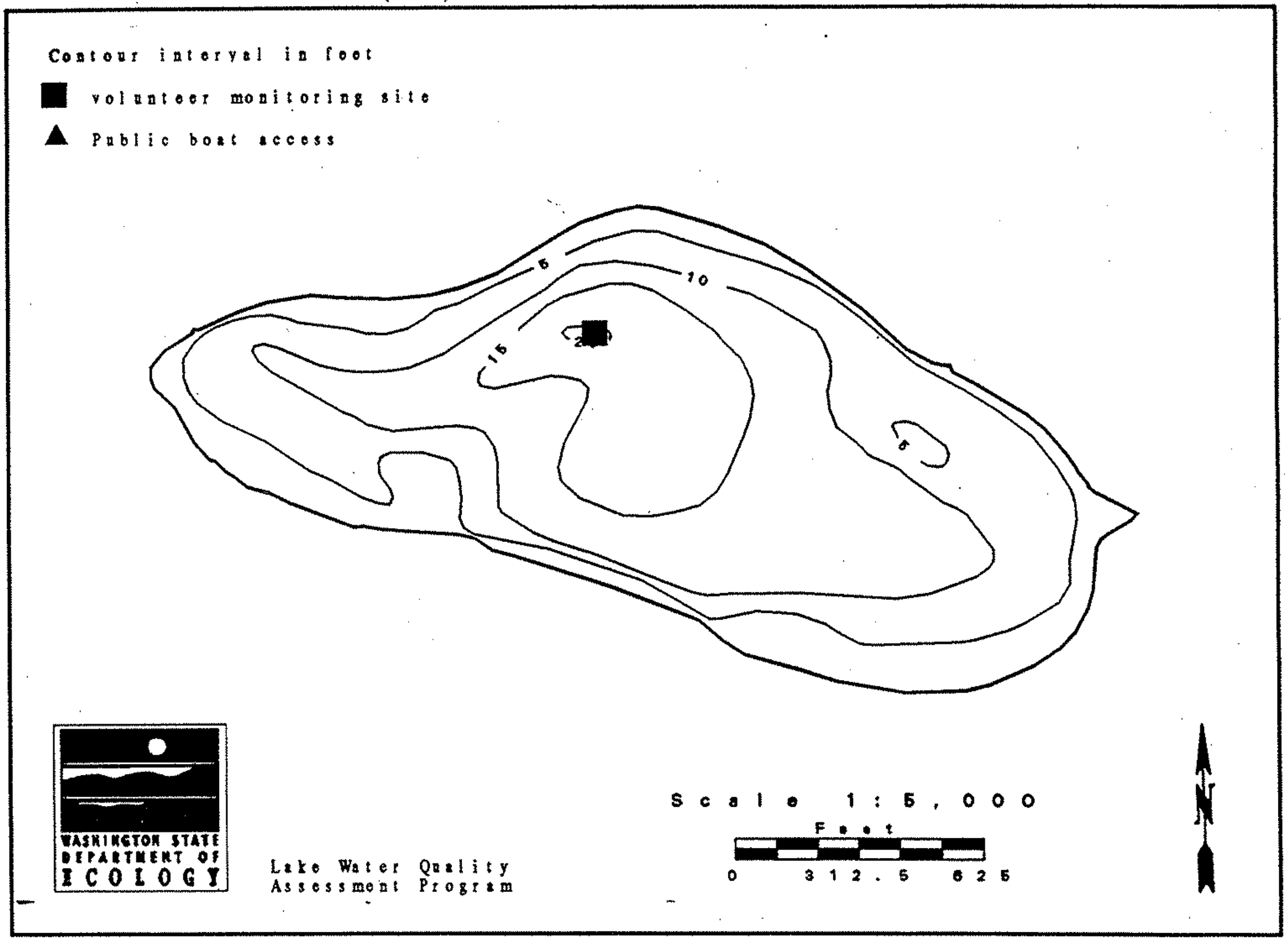


Sunday Lake -- Snohomish County

Sunday Lake is located five miles east of Stanwood. It drains southeast to the lower Stillaguamish River via Jackson Gulch. It has a marshy shoreline. Sunday Lake was monitored by Ecology staff only.

Size (acres)	46
Maximum Depth (feet)	20
Mean Depth (feet)	8
Lake Volume (acre-feet)	365
Drainage Area (miles^2)	1.7
Altitude (feet)	211
Shoreline Length (miles)	1.3

Data from Bortleson *et al.* (1976)



Overall Assessment

Sunday Lake was monitored by Ecology staff only in 1994. A volunteer measured Secchi depths in the lake from 1990 through 1993.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depth), Sunday Lake was classified as eutrophic in 1994. The chlorophyll result from the August survey was among the highest measured for this program.

Aquatic plants observed by Ecology during field visits include yellow-flowering water lily (*Nuphar sp.*), cattails (*Typha sp.*), largeleaf pondweed (*Potamogeton amplifolius*; there was a lot of epiphytic algae on the plants), common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), slender pondweed (either *Potamogeton pusillus* or *P. foliosus*), and hornwort (the alga *Nitella*).

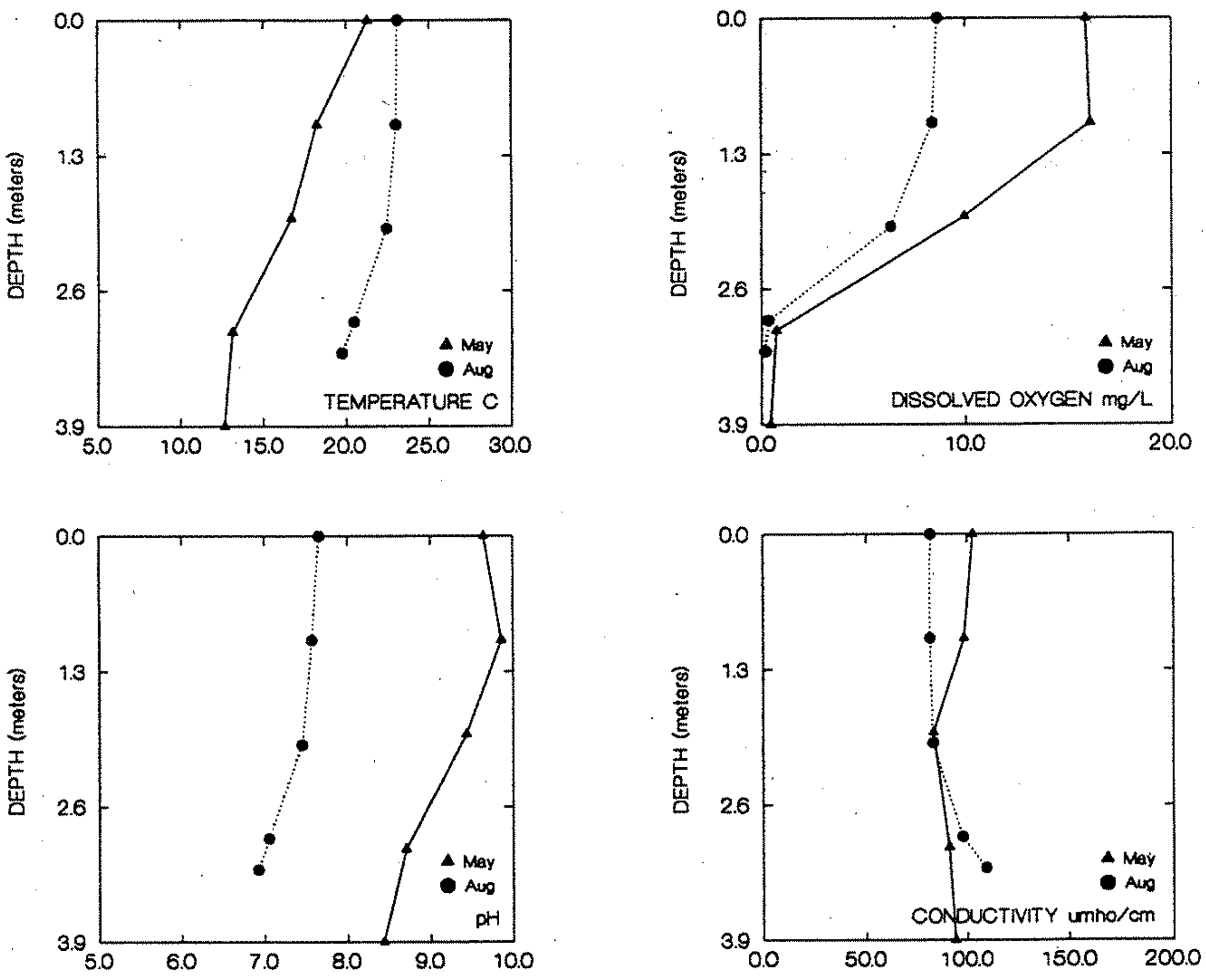
SUNDAY (SNOHOMISH) Lake -- SNOHOMISH County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/26		E	18			(Source: Water Supply Bulletin 43)					
90/06/05	1	E	151								
90/08/28	1	E	71	0.93							
91/05/29	1	E		0.61							
92/05/18	1	E	54	0.96	7.8	1U	1U		7	1	60
92/05/18	1	H	51	0.78							
92/08/25	1	E	44	0.74	4.3	1U	1U		4	1	40
92/08/25	1	H	189	1.20							
93/05/25	1	E	72	1.61	56.9						
93/08/18	1	E	44	0.86	4.8						
93/08/18	1	H	67	1.06							
94/05/19	1	E	127	1.41	120						
94/05/19	1	H	124	0.57							
94/08/19	1	E	33	0.60J	2.6J						
94/08/19	1	H	57	0.62J							

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

SUNDAY (SNOHOMISH) Lake -- SNOHOMISH County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	21.3	9.7	15.9	103.0	94/08/19	0.0	23.1	7.7	8.6	82.0
	1.0	18.3	9.9	16.1	99.0		0.9	23.0	7.6	8.5	82.0
	1.9	16.7	9.4	9.9	83.0		1.0	23.0	7.6	8.4	82.0
	3.0	13.0	8.8	0.9	91.0		2.0	22.4	7.5	6.3	83.0
	3.0	13.1	8.7	0.7	91.0		2.9	20.5	7.1	0.3	98.0
	3.9	12.7	8.4	0.4	94.0		3.2	19.7	6.9	0.2	109.0

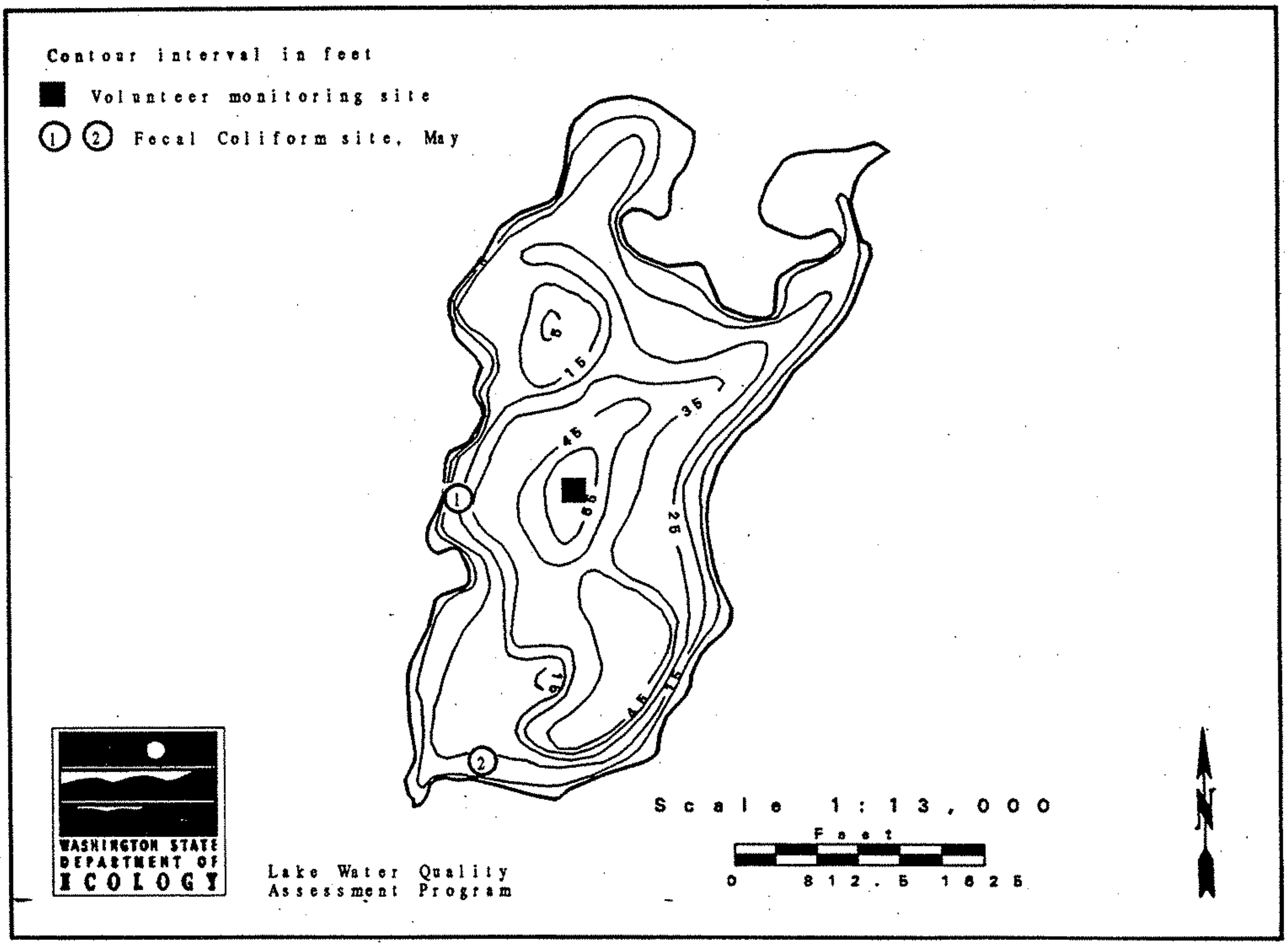


Lake Thomas -- Stevens County

Lake Thomas is located 17 miles northeast of Colville, and is in the Little Pend Oreille chain of lakes. It is fed by Heritage Lake via a narrow channel, and drains south to Gillette Lake and ultimately to the Little Pend Oreille River. There is no boat ramp on the lake, but it is accessible from the other lakes in the Little Pend Oreille chain.

Size (acres)	170
Maximum Depth (feet)	55
Mean Depth (feet)	23
Lake Volume (acre-feet)	4,000
Altitude (feet)	3,147
Drainage Area (miles^2)	12.7
Shoreline Length (miles)	3.3

Data from Dion *et al.* (1976)



Overall Assessment

Lake Thomas had good water quality in 1994. Also, Secchi depths improved significantly from 1989 through 1994 (see graph of Secchi depth data). This improving trend was tested using a seasonal Kendall test for trend, and results were significant at the 99% level ($p = 0.0009$).

Although the May concentration of total phosphorus was moderately high, Secchi depths and chlorophyll concentrations showed that there was a low amount of algae when the lake was sampled. Turbidity samples collected during both surveys were very low. Although concentrations of dissolved oxygen were very low below the thermocline on both sampling dates, profile data were very similar to data collected during previous surveys. Water chemistry results and profile data are listed in tables at the end of this summary.

Aquatic plants in Lake Thomas were surveyed during summer 1994, as part of a project to survey and map aquatic plants in 28 Stevens County lakes. This project was funded by a grant from Ecology's Freshwater Aquatic Weeds Program, which was awarded to the Stevens County Noxious Weed Board. Application for this grant was prompted, in part, over concern about Eurasian watermilfoil in the Little Pend Oreille chain of lakes. Aquatic plants observed in Lakes Heritage, Thomas, Sherry, and Gillette were all reported together for the little Pend Oreille chain. Aquatic plants observed in these lakes were Eurasian watermilfoil (*Myriophyllum spicatum*), watershield (*Brasenia schreberi*), yellow-flowering water lily (*Nuphar sp.*), white-flowering water lily (*Nymphaea sp.*), stonewort (*Nitella*), coontail (*Ceratophyllum demersum*), common elodea (*Elodea canadensis*), tapegrass (*Vallisneria americana*), largeleaf pondweed (*Potamogeton amplifolius*), slender pondweed (*Potamogeton graminus*), floatingleaf pondweed (*Potamogeton natans*), fernleaf pondweed (*Potamogeton robinsii*), and flatstem pondweed (*Potamogeton zosteriformis*).

Aquatic plants observed by Ecology staff during field visits include visits included Eurasian water milfoil (*Myriophyllum spicatum*), flatleaf pondweed (*Potamogeon robbinsii)*, yellow-flowering water lily (*Nuphar polysepalum*), muskgrass (*Chara*), whitestem pondweed (*Potamogeton praelongus*), white-flowering water lily (*Nymphaea odorata.*), stonewort (*Nitella)*, largeleaf pondweed *(Potamogeton amplifolius)*, and lake quillwort (*Isoetes sp.)*.

Freshwater jellyfish (*Craspedacusta sowerbii*) were seen during the sampling visits in August 1992 and September 1990. The volunteer also reported seeing them on August 5, 1994, and during September 1991. Jellyfish were not reported in 1993. Freshwater jellyfish are relatively rare, and have unpredictable life cycles. Lake Thomas is the only volunteer-monitored lake in which they have been seen.

Based on low hypolimnetic oxygen concentrations, the moderate population of aquatic plants, and water quality problems from the infestation of Eurasian watermilfoil (see the volunteer's questionnaire responses, below), Lake Thomas was classified as oligo-mesotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 through 1994.

> Lake Thomas is used for fishing, boating, swimming, rowing, jet skiing, and camping. There is a U.S. Forest Service campground on the lakeshore. There are no restrictions for motorboat use on the lake. About 3% of the shoreline is publicly-owned. Cutthroat and rainbow trout were stocked in the lake in 1994. Perch, crappie, and bass were also introduced, albeit illegally.
>
> There are 72 houses on the lakeshore, and none of the houses are connected to a sewer. There is now a lake association for the lake. Currently the watershed is being logged, and the lakeshore is being developed further for residences. In the past, the watershed was logged and mined, and the shoreline was altered. No aquatic plant or algae control activities occurred in 1994, but the lake has been treated with chemicals in the past to control undesirable fish species.
>
> Overall, the volunteer found that Lake Thomas had fair water quality. Problems in the lake in 1994 were ranked as (1) low water level, (2) excessive aquatic plant growth, (3) shoreline erosion, and (4) degraded aesthetics. Problems with plants and aesthetics were due to milfoil in the lake. There were no changes in the lake since the 1993 monitoring season.

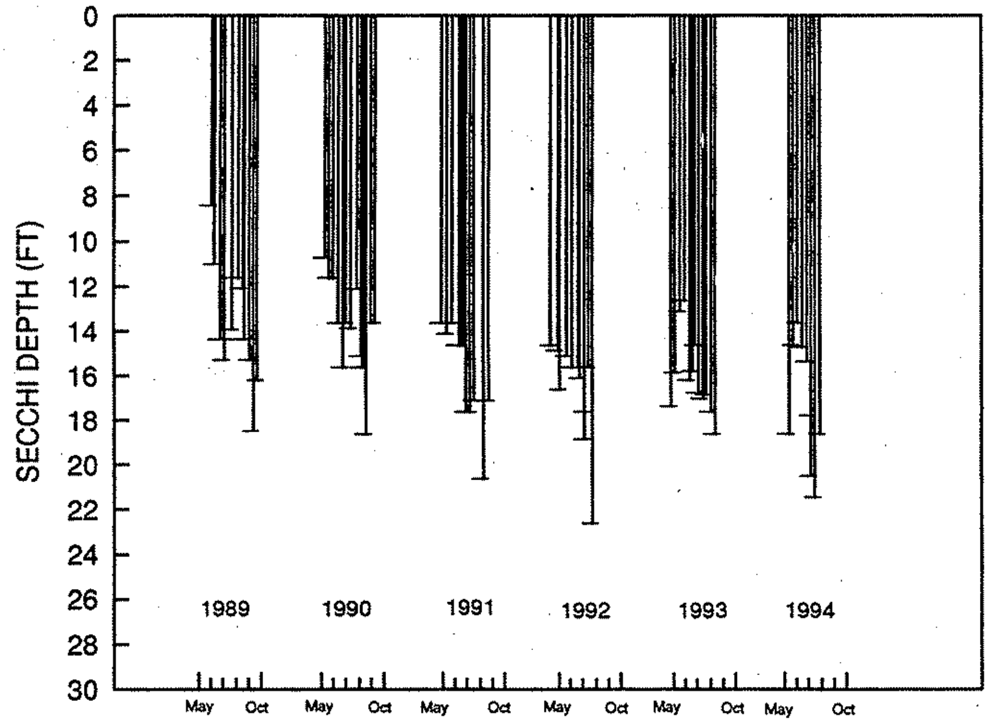
Acknowledgments

I thank Ray Hawk and Robert Strauss for volunteering their time to monitor Lake Thomas from 1989 through 1994.

THOMAS Lake -- STEVENS County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/06/10	17.2	63.0	0.0		75	Trace		18.0	5.0	Water color yellow-green. View tube used.
94/06/24	20.0	68.0	0.0		10	None	Breezy	14.0	5.0	Water color yellow-green. Used view tube.
94/07/08	21.1	70.0	0.0		25	None	Breezy	13.0	1.8	Water color yellow-green.
94/07/22	25.6	78.1	0.0		0	None	Light	14.1	1.5	yellow-green.
94/08/05	24.4	75.9	0.0		10	Light	Light	14.8	-3.2	Water color yellow-green. Dollar fish profuse.
94/08/16	70.5	159	0.0		0	None	Light	17.2	0.0	Water color evergreen. On site visit.
94/08/19	22.5	72.5	0.0		0	None	Light	19.9	-4.7	Water color yellow-green. Moderate smoke in ai r. "Dollar" fish reported two weeks ago--were jellyfish!
94/09/02	19.4	66.9	0.0		50	None	Breezy	20.8	-7.5	Water color yellow-green.
94/09/16	17.8	64.0	0.0		0	Light	Light	18.0	-9.0	Water color yellow-green.

LAKE THOMAS (STEVENS COUNTY)



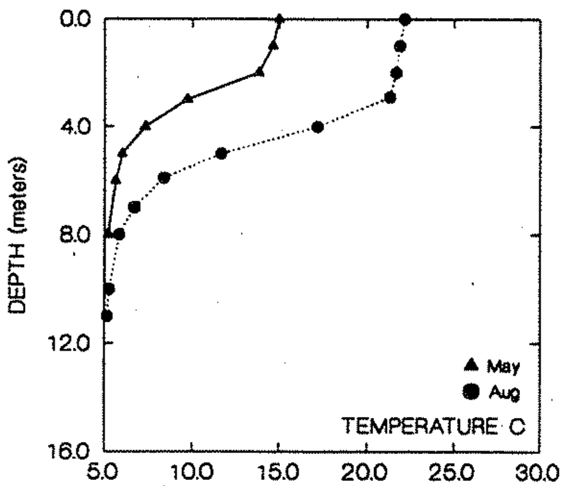
THOMAS (STEVENS) Lake -- STEVENS County
Chemistry Data -- Station 1

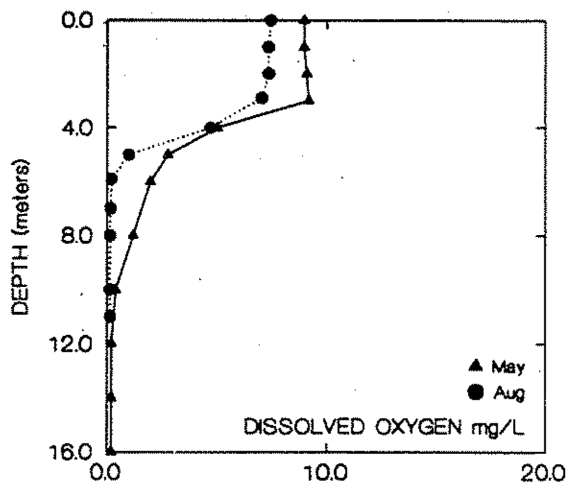
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
72/08/16		E	27			(Source: Water Supply Bulletin 43)					
81/07/15		E	20		3.0	(Source: Water Supply Bulletin 57)					
90/05/25	1	E	11	0.29							
90/09/10	1	E	7	0.27							
91/06/13	1	E		0.21							
92/05/01	1	E	13	0.33	3.1	1	1U		2	1U	25
92/05/01	1	H	16	0.30							
92/08/07	1	E	5	0.28	1.1	1	1U		1		20
92/08/07	1	H	36	0.33							
93/05/18	1	E	12	0.22	1.5	1	1				
93/05/18	1	H	33								
93/08/19	1	E	11	0.18	1.4						
93/08/19	1	H	38	0.33							
94/05/17	1	E	14	0.23	1.0			0.6			
94/05/17	1	H	21	0.23							
94/08/16	1	E	5	0.23J	0.7J			0.5U			
94/08/16	1	H	26	0.26J							

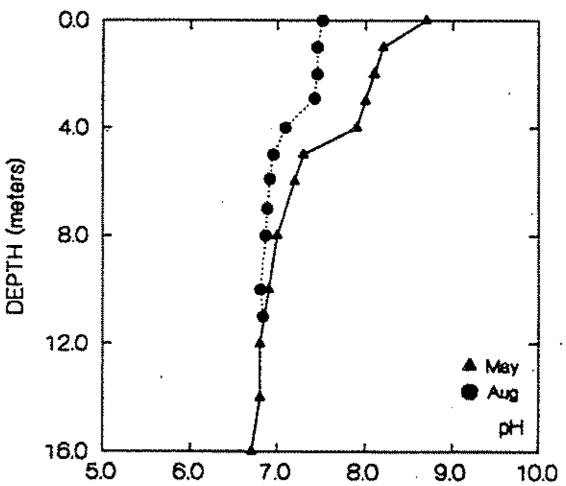
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

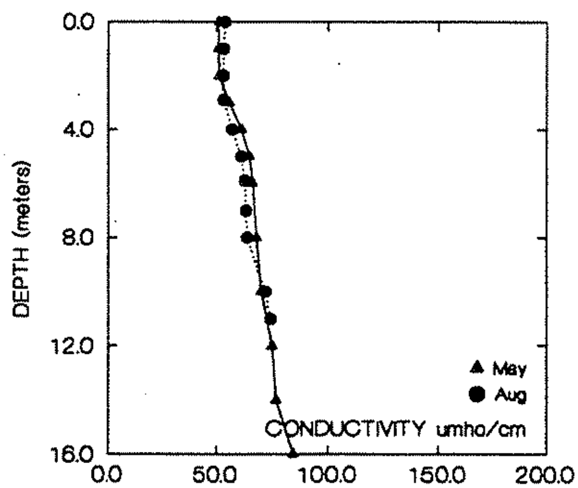
THOMAS (STEVENS) Lake -- STEVENS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/17	0.0	15.0	8.7	9.0	51.0	94/08/16	-0.1	22.2	7.5	7.5	54.0
	1.0	14.6	8.2	9.0	51.0		1.0	21.9	7.5	7.4	53.0
	2.0	13.8	8.1	9.1	51.0		2.0	21.7	7.5	7.4	53.0
	3.0	9.7	8.0	9.2	56.0		2.9	21.3	7.4	7.1	53.0
	4.0	7.3	7.9	5.1	62.0		4.0	17.2	7.1	4.8	57.0
	5.0	6.0	7.3	2.8	65.0		5.0	11.6	7.0	1.0	61.0
	6.0	5.6	7.2	2.0	67.0		5.9	8.4	6.9	0.2	63.0
	8.0	5.2	7.0	1.2	68.0		7.0	6.7	6.9	0.2	64.0
	10.0	4.9	6.9	0.4	70.0		8.0	5.8	6.9	0.1	64.0
	12.0	4.8	6.8	0.2	75.0		10.0	5.3	6.8	0.1	72.0
	14.0	4.7	6.8	0.2	77.0		11.0	5.1	6.8	0.1	75.0
	16.0	4.7	6.7	0.2	85.0						







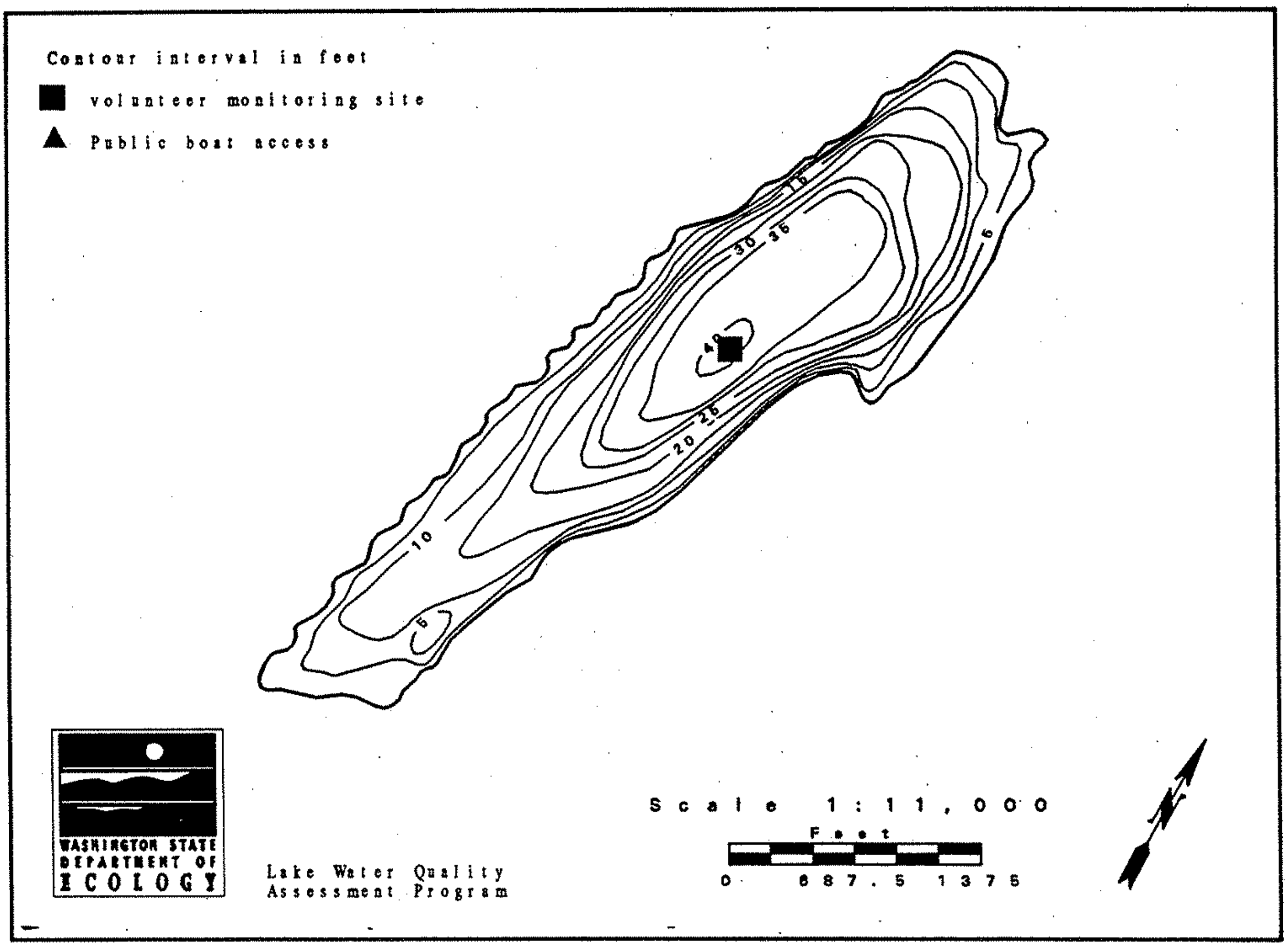


Tiger Lake -- Kitsap/Mason Counties

Tiger Lake is located 9.5 miles southwest of Bremerton. Most of the lake (102.8 acres) is in Mason County, and the northern tip of the lake (6.3 acres) is in Kitsap County. Tiger Lake has no surface inlets, and drains via Mission Creek to Hood Canal.

Size (acres)	110
Maximum Depth (feet)	40
Mean Depth (feet)	19
Lake Volume (acre-feet)	2,100
Drainage Area (miles^2)	0.7
Altitude (feet)	296
Shoreline Length (miles)	2.5

Data from Bortleson *et al.* (1976)



Overall Assessment

The water quality of Tiger Lake was good in 1994. Secchi depths were somewhat deeper in 1994 than in 1993 (see graph of Secchi depth data).

Despite a moderately high concentration of total phosphorus during the May survey, Secchi depths and chlorophyll concentrations indicate that there was a low amount of algae when the lake was sampled (see table of water chemistry results at the end of this summary). Total nitrogen concentrations were very low. Based on low nutrient concentrations, low algal growth, and good water clarity, Tiger Lake was classified as oligotrophic in 1994.

The graph of profile data shows that concentrations of dissolved oxygen decreased near the lake bottom. This can result from the lake being fed primarily by groundwater (groundwater does not carry dissolved oxygen), as well as from bacterial composition of organic material (such as logs, algae, and aquatic plants) in the bottom lake water and sediments. When the lake mixes ("turns over") each fall, oxygen from the upper layer of water will replenish oxygen concentrations at the lake bottom.

Aquatic plants observed by Ecology staff during field visits include yellow-flowering water lily (*Nuphar polysepalum*), and cattails (*Typha sp.*). Some of the aquatic plant problems noted by the volunteer (see questionnaire responses, below) may be partially due to the low water level in 1994; low water levels allows more floating-leaf plants, such as lilies, to reach the water surface. Several lakes in the program that are fed primarily by groundwater were also very low in 1994; it is possible that when groundwater recharges and the level of Tiger Lake rises again, the plant problems may lessen.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires from 1993 and 1994.

> Tiger Lake is used for fishing, swimming, motor boating, rowing, and jet skiing. There is one boat ramp on the lakeshore, and there are no restrictions for motor boat use on the lake. Trout were stocked in the lake in 1994. Currently the watershed is being logged and used for crop agriculture. The lakeshore is also being developed further for residences. In the past, the watershed was logged.
>
> There are approximately 100 houses on the lakeshore, and none are connected to a sewer collection system. There is a lake association for the lake. No lake management activities occurred on the lake in 1994. Lake water was withdrawn for drinking and other domestic uses.

Overall, the volunteer found that Tiger Lake had good water quality. Problems in the lake in 1994 were ranked as (1) shoreline erosion, and (2) excessive aquatic plant growth, (3) low water level, (4) suspended sediments, (5) gradually degraded water quality over the years, (6) recently degraded water quality, and (7) decaying plants. Possible sources of problems include excessive boat traffic (erosion problems) and urbanization. Aquatic plant problems are from lily pads which are spreading in the south end of the lake, and a green slime that was visible on the lake bottom. Residents are also concerned that different species of fish were caught in 1994, and there were leeches in the lake. County commissioners banned ski courses from the lake, which may reduce some of the boat traffic. Residents may next attempt to ban jet skis from the lake. Water level dropped 19 inches from May through August.

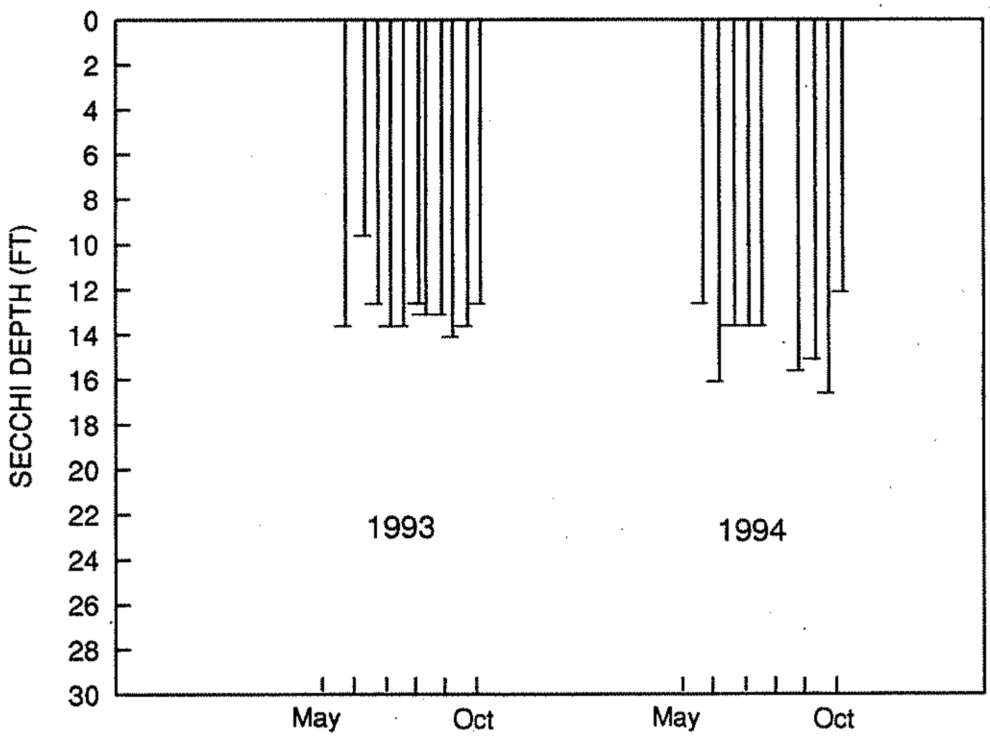
Acknowledgment

I thank Don Olson for volunteering his time to monitor Tiger Lake during 1993 and 1994.

TIGER Lake -- KITSAP/MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/26	0.0	32.0	0.0	Mod Green	100	Trace	Calm	12.0	0.0	Onsite visit. Drizzle during sampling. Second Secchi with view tube.
94/06/10	21.1	70.0	0.0	Lt Green	50		Breezy	15.5	32.5	
94/06/24	21.1	70.0	0.0	Lt Green	100	Trace	Light	13.0	30.0	
94/07/08	22.2	72.0	0.0	Lt Green	10	None	Calm	13.0	-6.0	
94/07/21	25.6	78.1	0.0	Lt Green	0	None	Calm	13.0	-9.5	
94/08/25	23.3	73.9	0.0	Lt Green	95	None	Light	15.0	51.5	Water level dropped 19" since June.
94/09/10	21.1	70.0	0.0	Lt Green	50	Heavy	Breezy	14.5	-21.0	
94/09/23	22.2	72.0	0.0	Lt Green	0	None	Calm	16.0	0.0	Much green "slime" on fishing gear.
94/10/07	17.8	64.0	0.0	Pea-green	0		Light	11.5	-25.5	

TIGER LAKE (KITSAP/MASON COUNTIES)



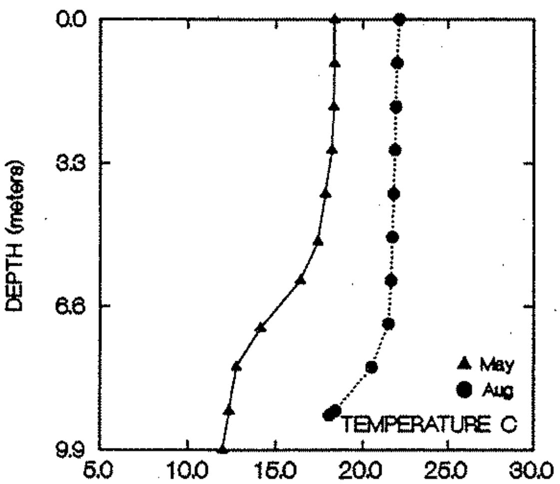
TIGER (KITSAP/MASON) Lake -- KITSAP/MASON County
Chemistry Data -- Station 1

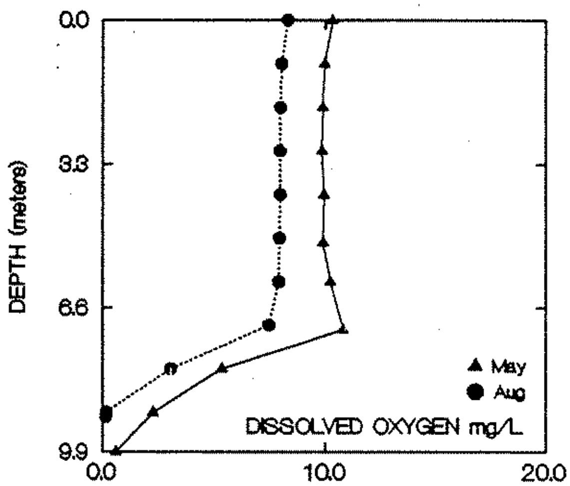
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/06/20		E	4			(Source: Water Supply Bulletin 43)					
89/06/28	1	E	8	0.28	1.5						
89/09/27	1	E	13	0.27	1.6						
93/06/03	1	E	8	0.23	1.7						
93/06/03	1	H	11	0.24							
93/08/31	1	E	8	0.25	1.0						
93/08/31	1	H	9	0.23							
94/05/26	1	E	14	0.16	2.0						
94/05/26	1	H	11	0.15							
94/08/25	1	E	11	0.15J	1.3						
94/08/25	1	H	12	0.18J							

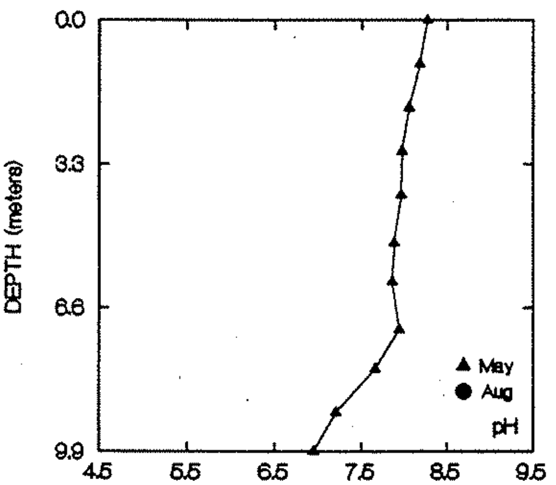
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

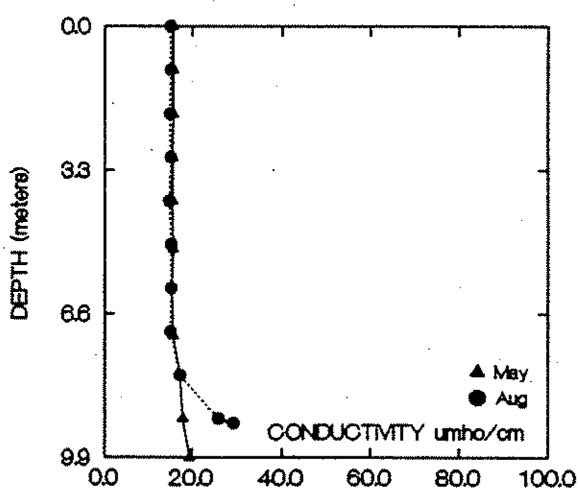
TIGER (KITSAP/MASON) Lake -- KITSAP/MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/26	0.0	18.4	8.3	10.3	16.0	94/08/25	0.0	22.1	0.0	8.3	15.0
	1.0	18.4	8.2	10.0	16.0		1.0	22.0	0.0	8.1	15.0
	2.0	18.3	8.1	9.9	16.0		2.0	21.9	0.0	8.0	15.0
	3.0	18.2	8.0	9.9	16.0		3.0	21.9	0.0	8.0	15.0
	4.0	17.9	8.0	9.9	16.0		4.0	21.8	0.0	8.0	15.0
	5.1	17.4	7.9	9.9	16.0		5.0	21.7	0.0	8.0	15.0
	6.0	16.4	7.9	10.2	15.0		6.0	21.7	0.0	7.9	15.0
	7.1	14.1	7.9	10.8	16.0		7.0	21.5	0.0	7.5	15.0
	8.0	12.8	7.7	5.4	17.0		8.0	20.5	0.0	3.1	17.0
	9.0	12.3	7.2	2.3	18.0		9.0	18.4	0.0	0.2	26.0
	9.9	12.0	6.9	0.6	19.0		9.1	18.1	0.0	0.1	29.0







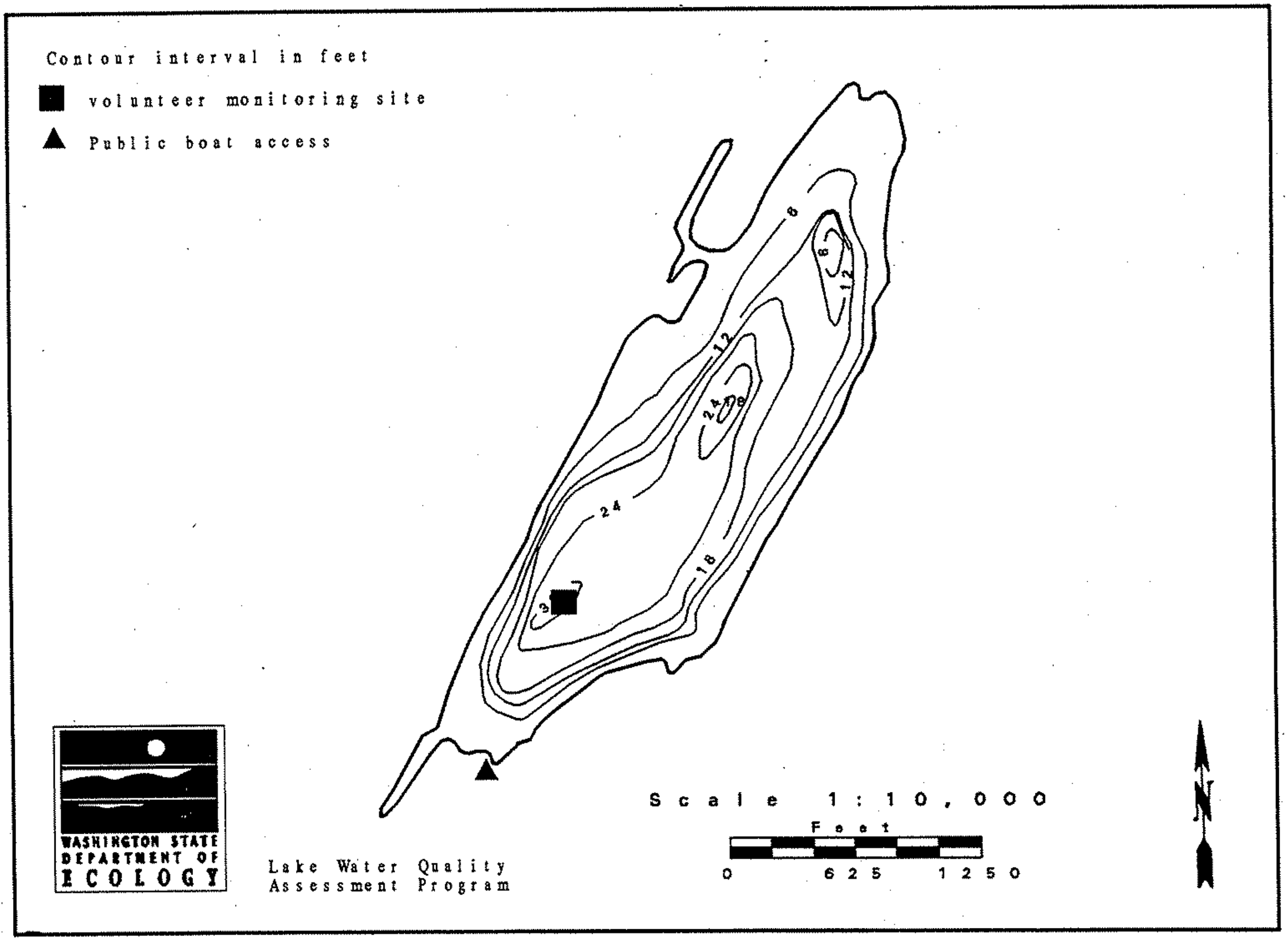


Trails End Lake -- Mason County

Trails End Lake is located 5.5 miles southwest of Belfair. It has no surface inlets, and drains via Sherwood Creek to North Bay. Trails End Lake is also referred to as Prickett Lake.

Size (acres)	74
Maximum Depth (feet)	30
Mean Depth (feet)	13
Lake Volume (acre-feet)	990
Drainage Area (miles^2)	0.39
Altitude (feet)	301
Shoreline Length (miles)	1.7

Data from Bortleson *et al.* (1976)



Overall Assessment

The water quality of Trails End Lake was fairly good in 1994. Although there was a moderately high amount of algae during the May and August surveys (indicated by the high concentrations of chlorophyll *a*), Secchi depths were relatively deep throughout the monitoring season and indicated very good water clarity. Algae growth was probably due to moderately high concentrations of total phosphorus in the water.

Because the lake is very shallow, profile data results did not change much from surface to bottom. This is not unusual. The only thing noteworthy about the profile data is that pH was somewhat high for a Mason County lake, and probably resulted from the large amounts of algae in the water. Usually, pH increases when algae growth increases, because algae remove carbon dioxide from the water. This is a common occurrence in lakes.

Aquatic plants observed by Ecology staff during the field visits include bladderwort (*Utricularia vulgaris*), watershield (*Brasenia schreberi*), and purple loosestrife (*Lythrum salicaria*). The latter is a noxious wetland plant, and was observed at the public boat access. Ecology staff and the volunteer removed and bagged flowers from the plant, to lessen seed production. Ideally, the plant should be dug up, bagged, and taken to a landfill, to prevent it from spreading throughout the area. Because there is no noxious weed board in Mason County, the sighting was reported to Ecology's Freshwater Aquatic Weeds Program. Ecology staff will check the plant during the 1995 field surveys, to determine whether additional action is needed.

Based on the moderately high amounts of phosphorus and algae in the water, and areas with heavy populations of aquatic plants, Trails End Lake was classified as mesotrophic in 1994. Considering the amount phosphorus in the water and the shallow depth of the lake, Trails End Lake had fairly good water quality. This lake could be susceptible to more algae and plant problems, though, if care is not taken to limit the amount of runoff and sediments entering the lake.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire.

> Trails End Lake is used for fishing, swimming, non-motorized boating, and lakeshore camping. There is one public boat ramp. Rainbow trout were stocked in the lake in 1994.
>
> There are about 62 houses on the lakeshore, and none are connected to a sewer. There is community club for the area, although lake issues are a low priority. No lake management activities occurred in 1994.

Overall, the volunteer found that Trails End Lake had fair water quality. The worst problems in the lake in 1994 were ranked as (1) excessive mud in south end of lake, (2) excessive aquatic plant growth, (3) low water level, and (4) high water level. Low water level and mud makes swimming difficult in the south end of the lake. Potential sources of problems include old septic systems that are up to 30 years old, storm drains that drain into the lake, and gradually increasing plant growth. There were more aquatic plants in the lake in 1994 than in 1993. Other concerns include need for more silt barriers when lots are cleared, and need for cleared areas to be revegetated instead of being left bare.

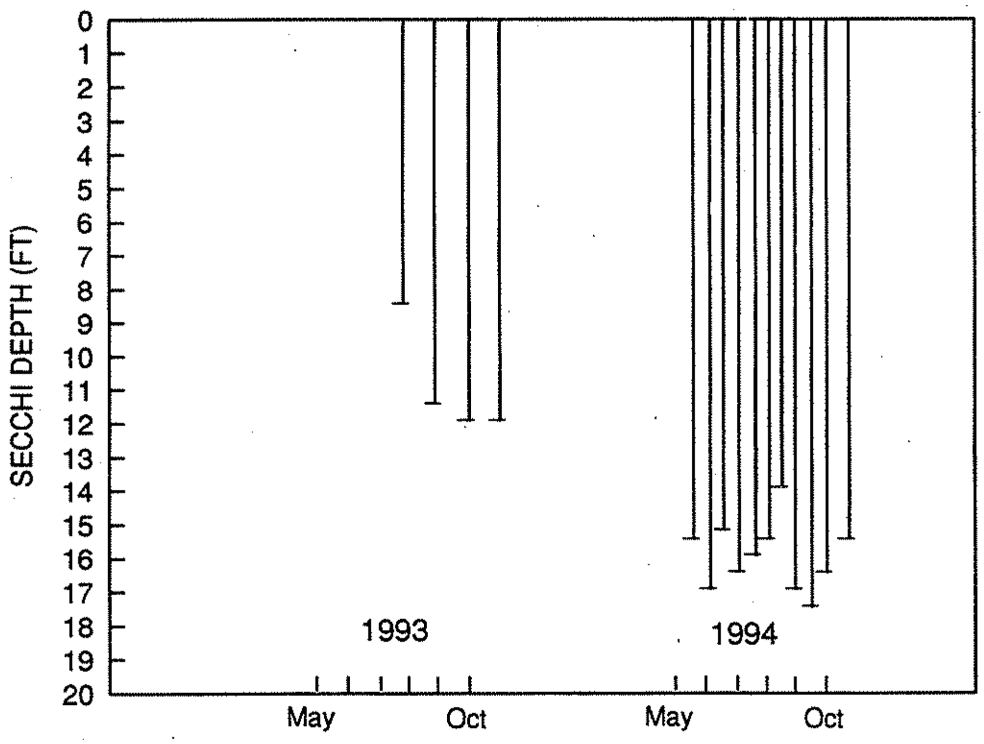
Acknowledgments

I thank Lyle S. Smith for volunteering his time to monitor Trails End Lake during 1994.

TRAILS END Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/25	18.0	64.4	0.0	Clear	100	None	Light	15.0	13.5	Overcast. Second Secchi hit bottom. [training session with Julie--drafted to more shallow area for #2 reading.]
94/06/10	16.0	60.8	0.0	Lt Green	0	None	Calm	16.5	0.0	
94/06/24	15.0	59.0	0.0	Clear	100	Trace	Calm	14.8	14.9	
94/07/08	20.0	68.0	0.0	Clear	10	None	Light	16.0	17.0	
94/07/24	22.0	71.6	0.0	Clear	50	None	Breezy	15.5	20.3	
94/08/06	20.0	68.0	0.0	Clear	10	None	Calm	15.0	23.0	
94/08/18	19.0	66.2	0.0	Lt Green	10	None	Calm	13.5	24.8	
94/09/01	17.0	62.6	0.0		90		Light	16.5	27.0	Second Secchi hot bottom. Water color light green-brown.
94/09/17	19.5	67.1	0.0	Lt Green	10		Light	17.0	26.9	
94/10/01	16.0	60.8	0.0	Clear	90	Trace	Light	16.0	0.0	
94/10/23	10.0	50.0	0.0	Clear	25	Light	Calm	15.0	29.5	

TRAILS END LAKE (MASON COUNTY)



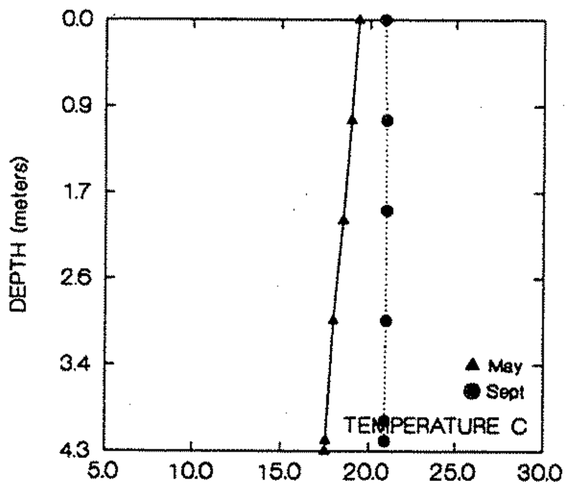
TRAILS END (MASON) Lake -- MASON County
Chemistry Data -- Station 1

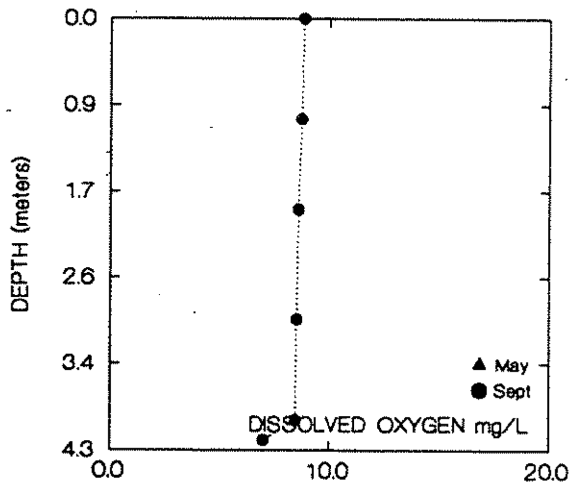
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/08/27		E	9			(Source: Water Supply Bulletin 43)					
94/05/25	1	E	22	0.15	2.4						
94/09/01	1	E	43	0.26J	3.8J						

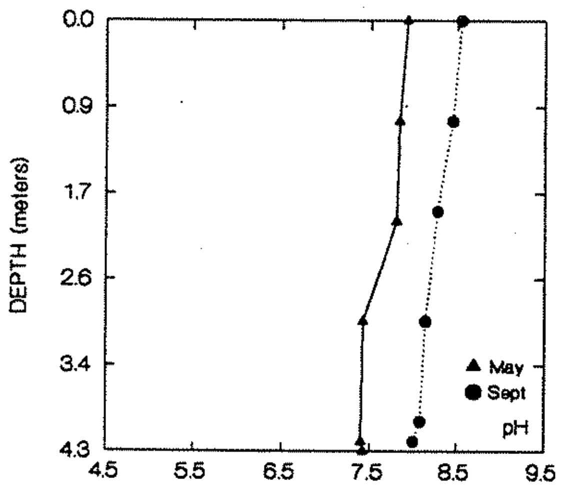
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

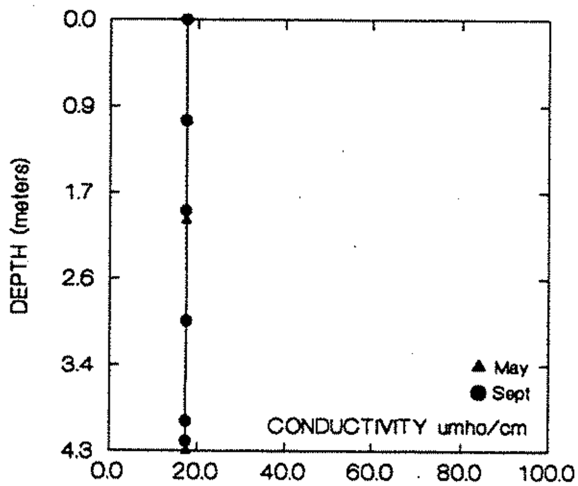
TRAILS END (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	19.4	7.9	0.0	18.0	94/09/01	0.0	20.9	8.6	8.8	17.0
	1.0	19.0	7.8	0.0	18.0		1.0	21.0	8.5	8.7	17.0
	2.0	18.5	7.8	0.0	17.0		1.9	21.0	8.3	8.6	17.0
	3.0	18.1	7.7	0.0	17.0		3.0	21.0	8.1	8.5	17.0
	3.0	18.0	7.4	0.0	17.0		4.0	20.9	8.1	8.5	17.0
	4.2	17.6	7.4	0.0	17.0		4.2	20.9	8.0	7.0	17.0
	4.3	17.5	7.4	0.0	17.0						







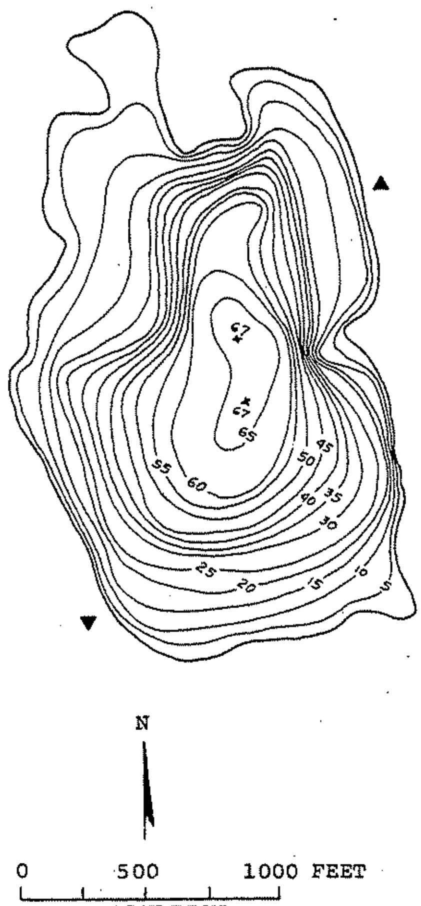


Big Twin Lake -- Okanogan County

Big Twin Lake is located two miles south of Winthrop. It has no surface inlets or outlet. It is located within the Methow River watershed. Big Twin Lake was monitored by Ecology staff only.

Size (acres)	79
Maximum Depth (feet)	70
Mean Depth (feet)	24
Lake Volume (acre-feet)	1,900
Drainage Area (miles^2)	1.4
Altitude (feet)	1,799
Shoreline Length (miles)	1.5

Data from Dion *et al.* (1976)



EXPLANATION

—— 10 ——

Line of equal water depth
Interval 5 feet

Overall Assessment

Big Twin Lake was monitored by Ecology staff only in 1994.

Big Twin Lake was classified as mesotrophic in 1994. This assessment is based on moderately high concentrations of total phosphorus on both sampling dates, low concentrations of dissolved oxygen below the thermocline, a moderately high concentration of chlorophyll *a* during the August survey, and the possibility that phosphorus was recycled from sediments into the water column.

Water samples collected from 13 m smelled strongly of hydrogen sulfide; this is stable only in the absence of oxygen.

Aquatic plants observed by Ecology staff during field visits include sago pondweed (*Potamogeton pectinatus*), muskgrass (*Chara sp.*), slender naiad (*Najas flexilis*), variable pondweed (*Potamogeton gramineus*), and another pondweed (*Potamogeton alpinus*).

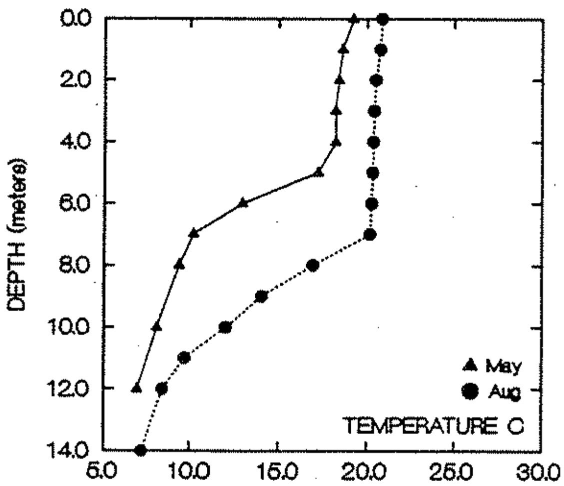
TWIN, BIG (OKANOGAN) Lake -- OKANOGAN County
Chemistry Data -- Station 1

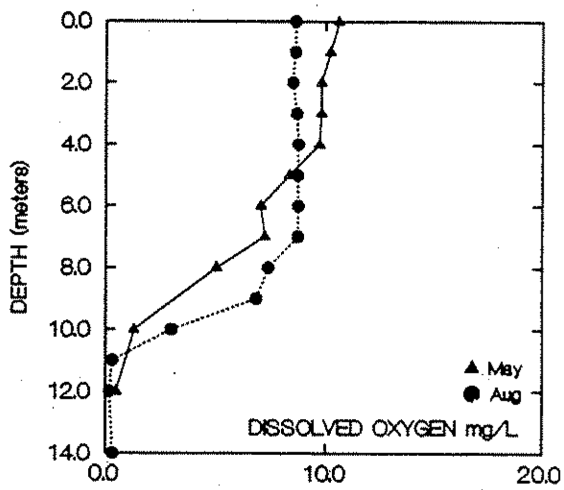
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/16		E	20			(Source: Water Supply Bulletin 43)					
93/05/23	1	E	12	0.72	1.4						
93/05/23	1	H	17	1.10							
93/08/24	1	E	15	0.70	2.0						
93/08/24	1	H	47	1.48							
94/05/26	1	E	20	0.37	0.3						
94/05/26	1	H	67	0.58							
94/08/25	1	E	14	0.62J	3.1						
94/08/25	1	H	41	0.99J							

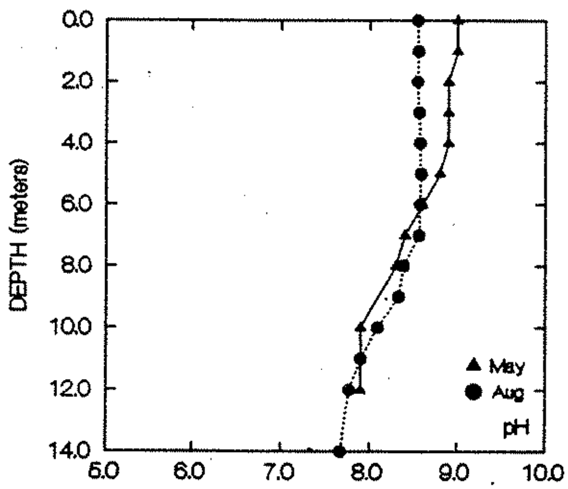
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

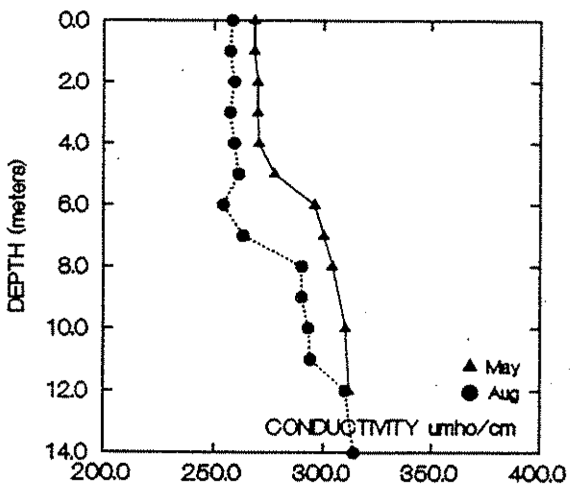
TWIN, BIG (OKANOGAN) Lake -- OKANOGAN County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/26	0.0	19.2	9.0	10.6	268.0	94/08/25	0.0	20.8	8.5	8.6	258.0
	1.0	18.6	9.0	10.2	268.0		1.0	20.7	8.6	8.6	257.0
	2.0	18.4	8.9	9.8	270.0		2.0	20.5	8.5	8.5	259.0
	3.0	18.2	8.9	9.8	270.0		3.0	20.4	8.6	8.7	257.0
	4.0	18.2	8.9	9.7	270.0		4.0	20.4	8.6	8.7	259.0
	5.0	17.2	8.8	8.3	277.0		5.0	20.3	8.6	8.7	261.0
	6.0	12.9	8.6	7.0	296.0		6.0	20.3	8.6	8.7	254.0
	7.0	10.2	8.4	7.2	300.0		7.0	20.2	8.6	8.7	263.0
	8.0	9.4	8.3	5.0	304.0		8.0	16.9	8.4	7.3	290.0
	10.0	8.1	7.9	1.3	310.0		9.0	14.0	8.3	6.8	290.0
	12.0	6.9	7.9	0.5	312.0		10.0	12.0	8.1	3.0	293.0
							11.0	9.7	7.9	0.3	294.0
							12.0	8.4	7.8	0.2	310.0
							14.0	7.2	7.7	0.3	314.0







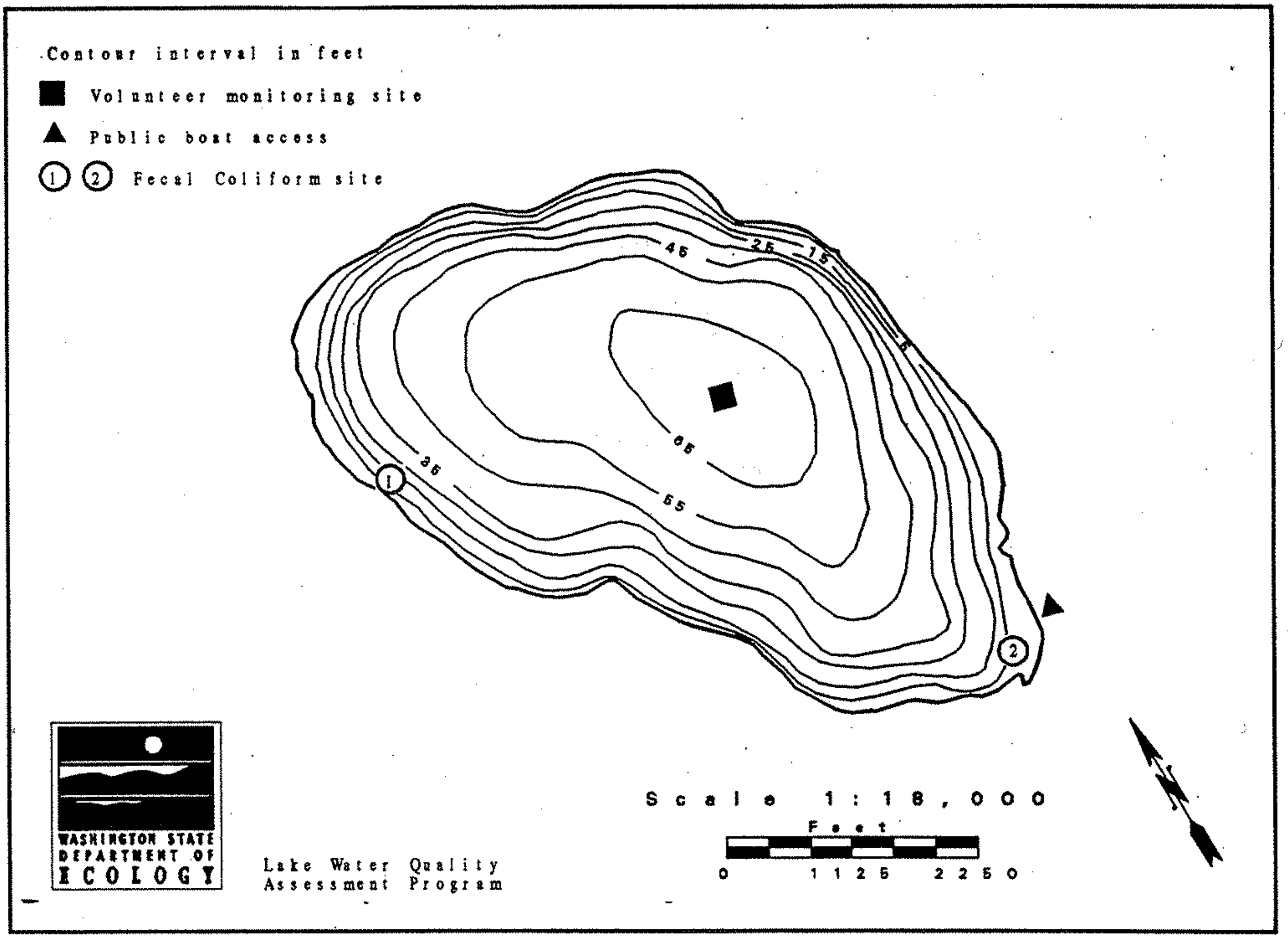


Waitts Lake -- Stevens County

Waitts Lake is located seven miles south of Chewelah, and 2.5 miles west of Valley. It is a reservoir stabilized by a low dam built in 1927. It is fed by two creeks and drains east via an unnamed creek to the Colville River. Waitts Lake was monitored by Ecology staff only.

Size (acres)	472
Maximum Depth (feet)	68
Mean Depth (feet)	40
Lake Volume (acre-feet)	18,784
Drainage Area (miles^2)	11.7
Altitude (feet)	1,946
Shoreline Length (miles)	3.3

Data from Dion *et al.* (1976)



Overall Assessment

Waitts Lake was monitored by Ecology staff only in 1994. It was monitored by a volunteer for the Lake Water Quality Assessment Program from 1990 through 1993. The volunteer resumed monitoring in 1995.

Although the May concentration of total phosphorus was very high (and may be an error), the August results was low, as were the concentrations of chlorophyll *a* on both sampling dates. Concentrations of dissolved oxygen were very low below the thermocline, but profile data were similar to data collected during previous years.

Waitts Lake exhibited both oligotrophic and mesotrophic characteristics, so it was classified as oligo-mesotrophic in 1994. Oligotrophic characteristics were the low concentrations of chlorophyll *a* on both sampling dates, and the low concentration of total phosphorus during the August survey. Mesotrophic characteristics were the high concentration of phosphorus during the May survey, and the moderately heavy population of macrophytes.

Aquatic plants observed by Ecology staff during field visits include purple loosestrife (*Lythrum salicaria*), Illinois pondweed *(Potamogeton illinoensis*), muskgrass (*Chara sp.*), cattails (*Typha sp.*)

Aquatic plants in Waitts Lake were surveyed during summer 1994 for a project undertaken by the Stevens County Noxious Weed Board. The project to survey and map aquatic plants in Stevens County lakes was paid for by a grant from Ecology through the Freshwater Aquatic Weeds Program. Aquatic plants observed in Waitts Lake include *Lythrum salicaria, Chara, Ceratophyllum demersum, Elodea sp., Myriophyllum sibiricum*, and *Potamogeton illinoensis.*

In 1994, the Stevens County PUD began working on a proposal to sewer the lakeshore of Waitts Lake. Data collected for the Lake Water Quality Assessment Program were provided to the Stevens County PUD for their proposal.

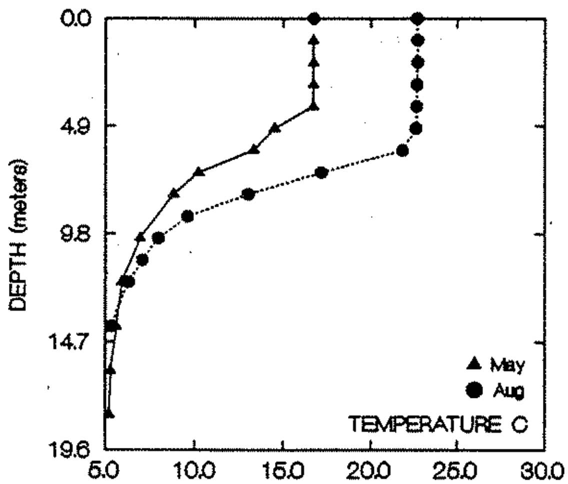
WAITTS (STEVENS) Lake -- STEVENS County
Chemistry Data -- Station 1

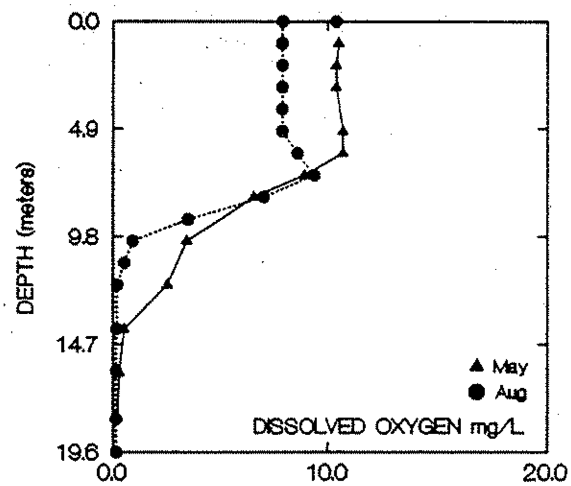
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
74/07/08		E	17			(Source: Water Supply Bulletin 43)					
81/07/14		E	20		1.5	(Source: Water Supply Bulletin 57)					
90/06/26	1	E	10	0.41	1.7						
90/08/09	1	E	16	0.47							
90/09/25	1	E	8	0.40	1.5						
91/06/10	1	E		0.40							
92/05/03	2	E	14								
92/05/12	1	E	16	0.48	0.8	1U	1U		2	1	20
92/05/12	1	H	28	0.48							
92/08/05	1	E	10	0.46	2.1	1	2		2	1U	10
92/08/05	2	E	10	0.47	2.3						
92/08/05	1	H	34	0.65							
93/05/19	1	E	20	0.47	1.6	1	1				
93/05/19	1	H	24	0.50							
93/08/20	1	E	10	0.40	1.6						
93/08/20	1	H	27	0.44							
94/05/19	1	E	258	0.38	1.3						
94/05/19	1	H	30	0.38							
94/08/18	1	E	5	0.39J	1.5J						
94/08/18	1	H	38	0.43J							

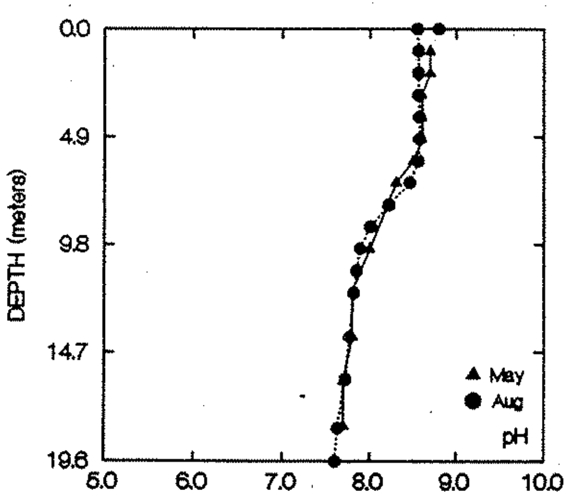
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

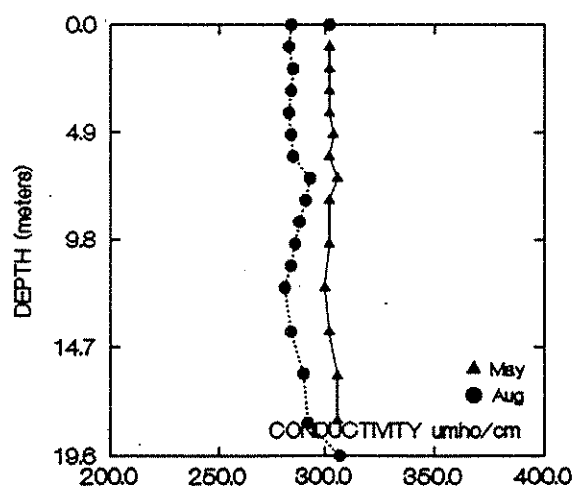
WAITTS (STEVENS) Lake -- STEVENS County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/19	0.0	16.7	8.8	10.4	302.0	94/08/18	0.0	22.7	8.6	7.9	284.0
	1.0	16.7	8.7	10.5	302.0		1.0	22.7	8.6	7.9	283.0
	2.0	16.7	8.7	10.4	302.0		2.0	22.7	8.6	7.9	285.0
	3.0	16.7	8.6	10.4	302.0		3.0	22.7	8.6	7.9	284.0
	4.0	16.7	8.6	40.5	302.0		4.0	22.7	8.6	7.9	283.0
	5.0	14.5	8.6	10.7	304.0		5.0	22.6	8.6	7.9	284.0
	6.0	13.3	8.5	10.7	302.0		6.0	21.8	8.6	8.6	285.0
	7.0	10.2	8.3	8.9	306.0		7.0	17.1	8.5	9.4	293.0
	8.0	8.8	8.2	6.5	302.0		8.0	13.0	8.2	7.0	291.0
	10.0	6.9	8.0	3.4	302.0		9.0	9.6	8.0	3.5	288.0
	12.0	5.9	7.8	2.5	300.0		10.0	8.0	7.9	0.9	286.0
	14.0	5.6	7.8	0.5	302.0		11.0	7.0	7.8	0.5	284.0
	16.0	5.3	7.7	0.3	306.0		12.0	6.3	7.8	0.2	281.0
	18.0	5.2	7.7	0.2	306.0		14.0	5.3	7.8	0.2	284.0
							15.9	4.9	7.7	0.1	290.0
							18.1	4.8	7.6	0.1	292.0
							19.6	4.7	7.6	0.1	307.0







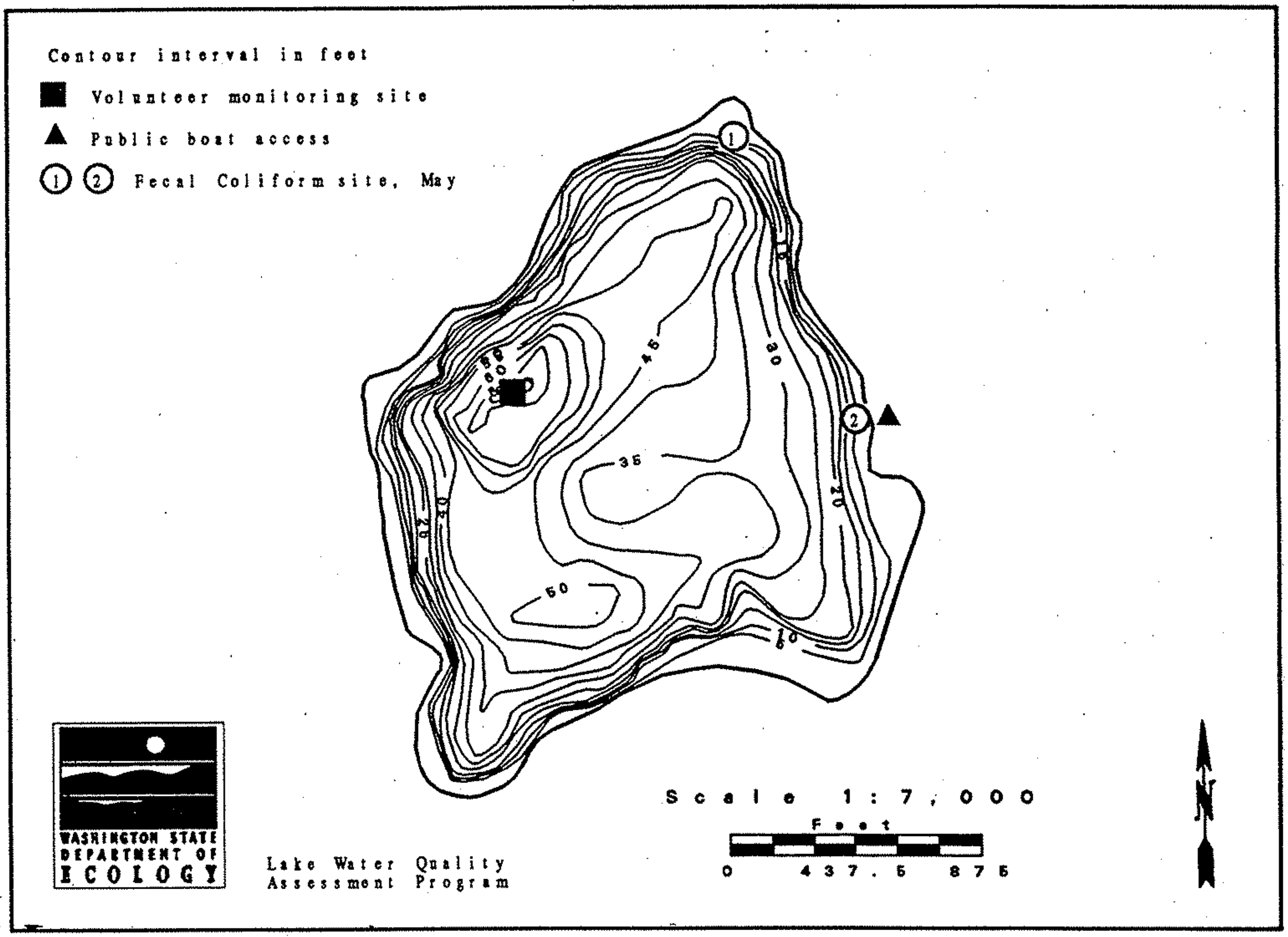


Ward Lake -- Thurston County

Ward Lake is located 2.5 miles south of Olympia, in a kettle depression. It is spring-fed, and has no surface outlets. It is within the Deschutes River watershed.

Size (acres)	65
Maximum Depth (feet)	67
Mean Depth (feet)	33
Lake Volume (acre-feet)	2,100
Drainage Area (miles^2)	1.0
Altitude (feet)	123
Shoreline Length (miles)	1.4

Data from Bortleson *et al.* (1976)



Overall Assessment

The pattern of Secchi depths varied each year the lake has been monitored (see graph of Secchi depth data). Except for data collected in 1993, Secchi depths tended to be lowest during late summer. Secchi depth data collected since 1990 were analyzed for trend in water clarity using a seasonal Kendall test for trend. Results were not significant at the 80% level ($p = 1.00$). From August through October 1994, volunteer comments about heavy construction near the lake coincided with milky gray water color that was not observed and reported during previous years. Data collected during the 1995 monitoring season should indicate whether water color resumes its normal light green color. Also, on October 14, 1994, there was a spill of white paint about 200 yards away from the lake, which entered the lake through a storm drain. (The Department of Emergency Services responded to the spill.) According to the volunteer, this is not the first spill that has entered the lake (see Summary of Questionnaire Results and Information from the Volunteer, below).

Despite moderately high concentrations of total phosphorus on both sampling dates, Secchi depths and chlorophyll *a* concentrations indicate that there was a low amount of algae when the lake was sampled. Profile data show that dissolved oxygen concentrations were very low below the thermocline, which can result from groundwater inflow (groundwater does not carry oxygen), as well as from bacterial decomposition of organic material (such as logs, algae, and aquatic plants) in the bottom water and sediments. Hydrogen sulfide, which is only stable in the absence of oxygen, was smelled in water samples collected from 14 and 16 meters during the August survey. Profile Data from 1994 were similar to data collected during previous surveys.

Aquatic plants identified by Ecology staff during field visits include white-flowering water lily (*Nymphaea odorata*) cattails (*Typha sp.*), stonewort (Nitella), and water-starwort (*Callitriche sp.*). Only about 50% of the shoreline had emergent plants, likely due to the many bulkheads, docks, and artificial beaches put in by lakeshore residents. Very few submerged plants have been observed in the lake.

From Serdar *et al.*(1994): Bottom sediment and fish tissue samples were collected from Ward Lake on June 10, 1992. Samples were analyzed for persistent organic compounds and trace metals. Arsenic concentrations from both sediment sampling sites were high (34 and 41 mg/Kg) and exceeded the recommended sediment quality guideline of 33 mg/Kg. Rainbow trout muscle tissue had PCB concentrations of 8 μg/L, which exceeds the EPA human health criterion of 1.4 μg/L. Concentrations of all other chemical contaminants were within acceptable ranges.

Based on the PCB concentrations found in Rainbow trout muscle tissue, Ward Lake was listed on Ecology's 1994 "water quality limited" list. This list identifies waterbodies that do not meet water quality standards. All waterbodies on this list will be evaluated to address the source(s) of water quality violations.

Ward Lake -- Thurston County

In 1994, Ward Lake had very good water clarity, and low amounts of algae and aquatic plants, so Ward Lake was classified as oligotrophic. However, the milky green water color in 1994 most likely resulted from runoff from nearby heavy construction, and historical runoff probably caused the elevated levels of arsenic in sediments and PCBs in fish tissue that were found in 1992. Ward Lake needs to be protected from further contamination from runoff.

Summary of Questionnaire Results and Information From the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1990 through 1994.

> Ward Lake is used for fishing, swimming, and boating. There is one public boat ramp, making about 2% of the shoreline publicly-owned. Sometimes it is difficult to use the public boat launch due to heavy use of the area by swimmers. Rainbow trout and kokanee were stocked in the lake in 1994. Currently, the watershed is used for crop agriculture, animal grazing/feeding, and the lakeshore is being developed further for residences. In the past, the watershed was logged and used for crop agriculture and animal grazing/feeding. The lake has been dredged, and the shoreline was altered with dredging and fill. (The Game Department filled about one acre in 1949 when the access was built, and old sawdust and shavings from the north end were dredged in the 1960's for landscaping at Holiday Hills.) There was a sawmill on the lakeshore prior to 1900, so the lake is full of sunken logs.
>
> There are 49 houses on the lakeshore, and about one or two of the houses are connected to a sewer. At least 5 culverts/stormdrains drain into the lake. There is no resident's organization for the lake, and no algae or aquatic plant management activities occurred in 1994.
>
> Overall, the volunteer found that Ward Lake had excellent water quality. Problems in 1994 were ranked as (1) runoff from storm and street drains, (2) geese, and (3) gradually degrading water quality. Since the 1993 monitoring season, new houses were built on the west side of the lake, and a new access was built in this area. In addition to the spill of white paint that entered the lake on October 14, 1995, there was another spill about two years ago (substance not identified), and several years ago the lake was closed for a few days after raw sewage entered the lake from a failed sewer pump.

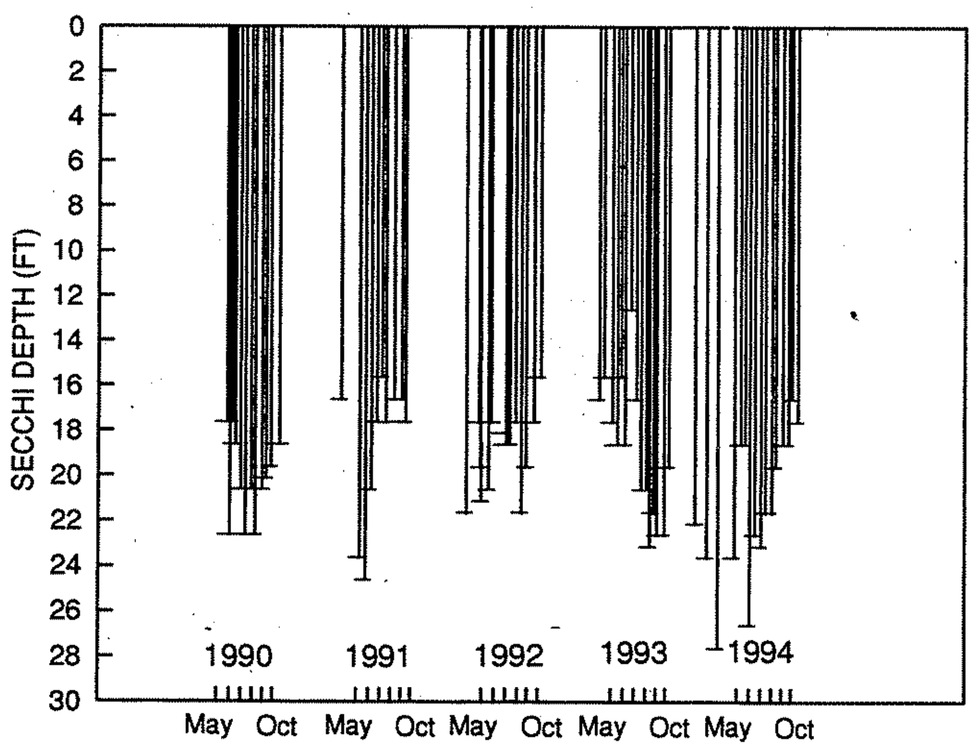
Acknowledgments

I thank Kit Weaver for volunteering his time to monitor Ward Lake from 1990 through 1994.

WARD Lake -- THURSTON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/01/01	0.0	32.0	0.0		0			21.5	0.0		
94/02/01	4.4	39.9	0.0		0			23.0	0.0		
94/03/01	5.6	42.1	0.0		0			27.0	0.0		
94/04/02	10.0	50.0	0.0		0			31.5	0.0		
94/04/17	15.6	60.1	0.0		0	None	Calm	23.0	30.0		Water color light green.
94/05/04	15.0	59.0	0.0		25	Mod	Calm	18.0	28.0		Water color clear green. Lots of boat traffic and lots of debris.
94/05/16	15.6	60.1	0.0	Clear	90	Mod	Breezy	18.0	25.5		Onsite visit. Water color clear green. Lots o f zooplankton in Site #2 sample. Second Secchi with view tube.
94/06/01	15.6	60.1	0.0	Lt Green	25	Mod	Light	26.0	0.0		
94/06/16	15.6	60.1	0.0	Lt Green	100	Light	Breezy	22.0	25.0		
94/07/03	17.8	64.0	0.0	Lt Green	75	Light	Light	22.5	21.5		Too windy and rough July 1-2.
94/07/16	21.1	70.0	0.0	Lt Green	10	None	Light	21.0	19.5		
94/08/01	23.3	73.9	0.0		0	None	Calm	21.0	15.0		Water color dirty gray. Heavy equipment workin g 300 yards east of lake.
94/08/15	23.3	73.9	0.0	Lt Green	80	None	Light	19.0	12.0		No construction near lake.
94/09/01	21.1	70.0	0.0		100	None	Calm	18.0	8.0		Water color cloudy light green.
94/09/16	20.0	68.0	0.0	Milky-grn	0	Trace	Breezy	18.0	1.0		Water color gray green. Heavy machinery workin g east of lake on Boulevard Rd.
94/10/01	17.8	64.0	0.0	Milky-grn	0	Trace	Strong	16.0	4.0		Water color gray green. 4-5" waves during samp ling. The lake has been 10" lower on this date .
94/10/15	20.0	68.0	0.0		75	Light	Calm	17.0	3.0		Water color milky green/gray.

WARD LAKE (THURSTON COUNTY)



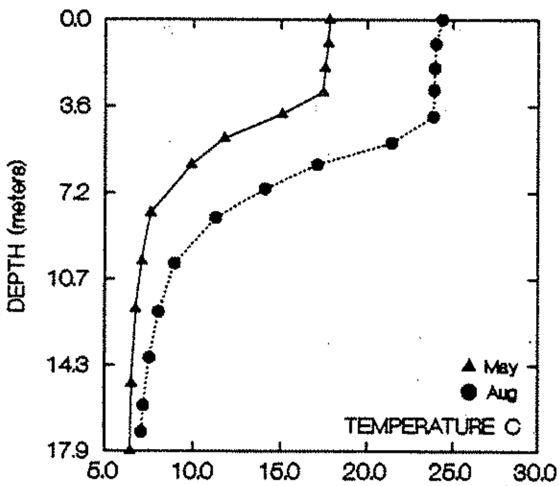
WARD (THURSTON) Lake -- THURSTON County
Chemistry Data -- Station 1

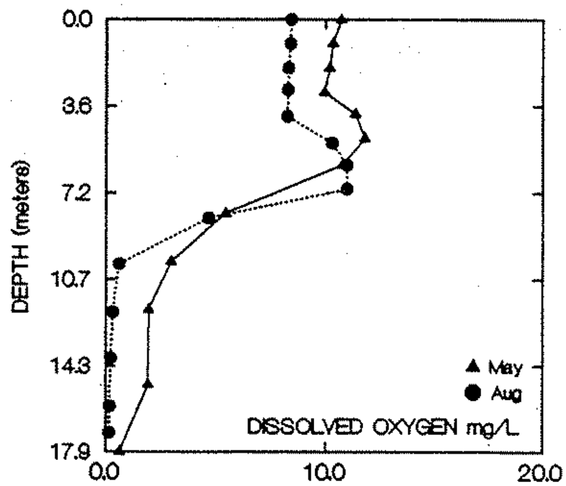
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/06/27		E	10			(Source: Water Supply Bulletin 43)					
90/05/29	1	E	10	0.26							
90/08/21	1	E	12	0.27							
91/06/19	1	E		0.19							
92/05/01	1	E	12	0.28							
92/05/01	2	E	12								
92/05/01	1	H	40	0.39							
92/09/09	1	E	8	0.27	0.6						
92/09/09	1	H	207	0.60							
93/05/19	1	E	21	0.23	0.6	1U	3				
93/05/19	1	H	45	0.37							
93/08/25	1	E	5	0.20	0.6U						
93/08/25	2	E	7								
93/08/25	1	H	130	0.53							
94/05/16	1	E	22	0.15	1.8						
94/05/16	2	E	19								
94/05/16	1	H	18	0.27							
94/08/15	1	E	10	0.20J	0.9J						
94/08/15	2	E	16								
94/08/15	1	H	107	0.36J							

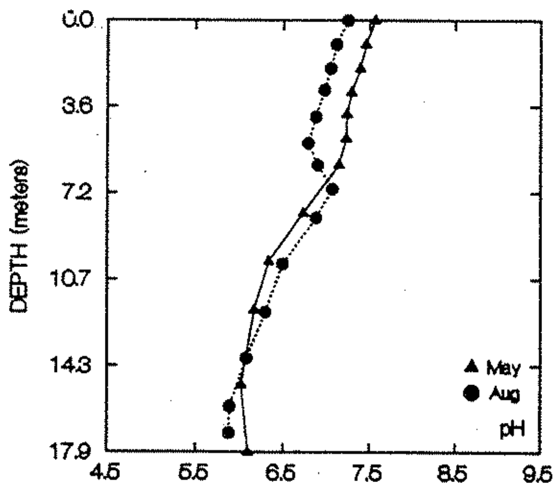
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

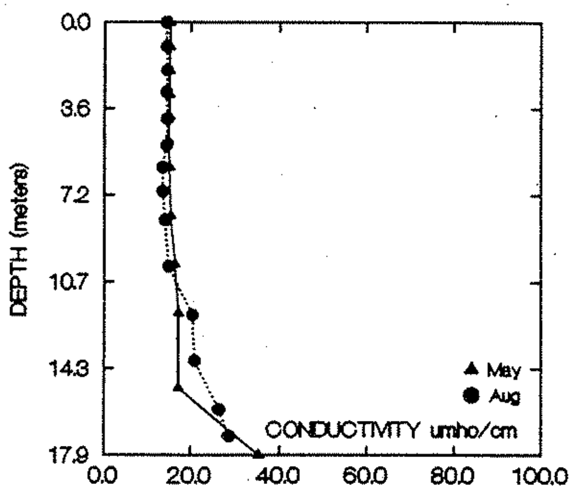
WARD (THURSTON) Lake -- THURSTON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/16	0.0	17.8	7.6	10.7	15.0	94/08/15	0.0	24.4	7.8	8.4	14.0
	1.0	17.8	7.5	10.3	15.0		1.0	24.0	7.6	8.4	14.0
	2.0	17.6	7.4	10.2	15.0		2.0	24.0	7.6	8.3	15.0
	3.0	17.5	7.3	10.0	15.0		2.9	23.9	7.5	8.3	14.0
	3.9	15.0	7.2	11.4	15.0		4.0	23.9	7.4	8.3	15.0
	4.9	11.8	7.2	11.8	15.0		5.1	21.4	7.3	10.3	14.0
	6.0	9.9	7.2	10.8	15.0		6.0	17.1	7.4	11.0	13.0
	8.0	7.6	6.7	5.5	15.0		7.0	14.1	7.6	11.0	14.0
	10.0	7.1	6.3	3.0	16.0		8.2	11.3	7.4	4.7	14.0
	12.0	6.7	6.2	2.0	17.0		10.1	8.9	7.0	0.6	15.0
	15.1	6.5	6.0	1.9	17.0		12.1	8.0	6.8	0.3	20.0
	17.9	6.4	6.1	0.6	35.0		14.0	7.5	6.6	0.2	21.0
							16.0	7.2	6.4	0.2	26.0
							17.1	7.1	6.4	0.1	29.0







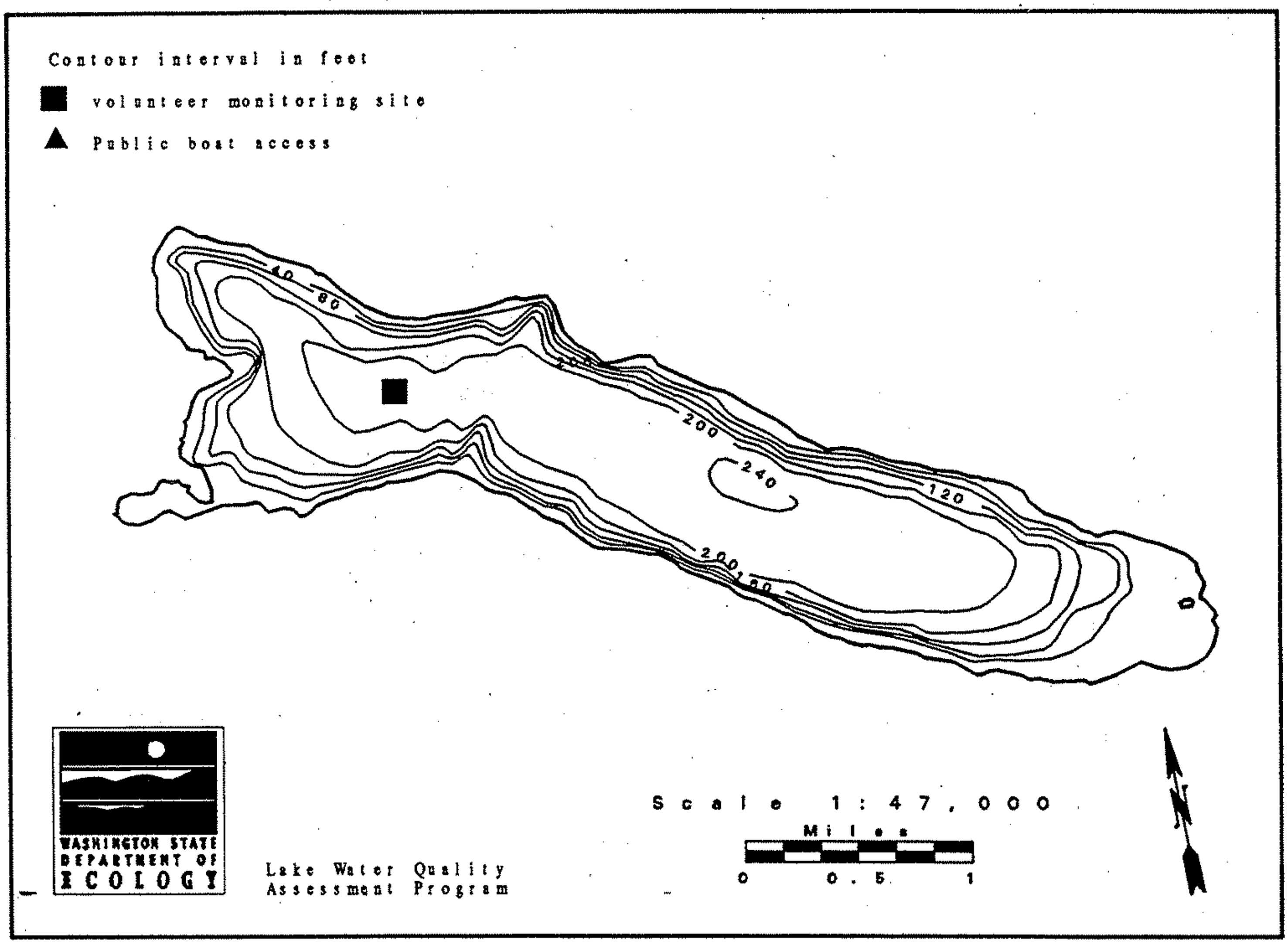


Lake Wenatchee -- Chelan County

Lake Wenatchee is a large, steep-sided lake located 15 miles north of Leavenworth in the Wenatchee National Forest. It is fed principally by the Little Wenatchee River and the White River, and drains to the Wenatchee River. There is a large wetland at the northeast end of the lake.

Size (acres)	2,480
Maximum Depth (feet)	244
Mean Depth (feet)	147
Lake Volume (acre-feet)	360,000
Drainage Area (miles^2)	273
Altitude (feet)	1,875
Shoreline Length (miles)	13.3

Data from Dion *et al.* (1976)



Overall Assessment

Water clarity was very good in 1994, despite smoke in the area during the August wild fires. Although Secchi depths were unusually deep in 1994 in comparison to previous years (see graph of Secchi depth), there as not a significant trend in water clarity from 1989 through 1994. This was tested using a seasonal Kendall test for trend, and results were not significant at the 80% level ($p = 1.00$).

Despite moderately high concentrations of total phosphorus on both sampling dates, Secchi depths and chlorophyll *a* concentrations indicate that there was a low amount of algae when the lake was sampled. The phosphorus concentration for August 1994 was the highest summer concentration measured for the program since 1989 (see table of water chemistry results). Runoff combined with fallout from the eastern Washington fires (the area was very smoky from the nearby fires), may have contributed to the higher phosphorus concentrations in 1994. Nitrogen concentrations in the lake remained low.

Profile data were very similar to data collected during previous years. Based on good water clarity and low plant and algae populations, Lake Wenatchee was classified as oligotrophic in 1994.

Aquatic plants observed by Ecology staff during field visits include milfoil (*Myriophyllum sp.*, but not the aggressive Eurasian variety), spikerush (*Eleocharis sp.*), waterweed (*Elodea sp.*), quillwort (*Isoetes sp.*), stonewort (*Nitella*), ribbon leaf pondweed (*Potamogeton robbinsii*), water buttercup (*Ranunculus aquatilus*), and Nuttall's waterweed (*Elodea nuttalli*).

Ecology staff with the Freshwater Aquatic Weeds Program surveyed aquatic plants in Lake Wenatchee on September 1, 1994. Areas surveyed were the entire western shore (by boat), and part of the eastern shore (on foot). Aquatic plants observed include water-milfoil (*Myriophyllum sp.*), narrowleaf bur-reed (*Sparganium angustifolium*), whitestem pondweed (*Potamogeton praelongus*), common elodea (*Elodea canadensis*), fern leaf pondweed (*Potamogeton robbinsii*), small grass-like plants (*Juncus sp.* or *Eleocharis sp.*), water-buttercup (*Ranunculus aquatilis*), horse tail (*Equisetum sp.*), ribbonleaf pondweed (*Potamogeton epihydrus*), quillwort (*Isoetes sp.*;), stonewort (*Nitella sp.*), and yellow water-lily (*Nuphar sp.*). Dense growth of quillwort were found in shallows in the western end of the lake. The most prevalent submersed macrophyte was *Myriophyllum sp.* (not surfacing).

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1994.

Lake Wenatchee is used for fishing, boating, swimming, rowing, jet skiing and camping. Recreational facilities on the lakeshore include a park, a picnic area, a state park, a camping area, a beach and one resort. About 50% of the shoreline is publicly-owned Natural Forest. There are two boat ramps on the lakeshore, and there are no restrictions for motorboat use on the lake. Kokanee were raised in rearing pens in the lake in 1994. Currently the watershed is being logged and used for animal grazing, and the lakeshore is being developed further for residences. In the past the watershed was logged and used for crop agriculture. No lake management activities occurred in 1994.

There are about 165 houses on the lakeshore; of these, 10 are occupied year-round. The lakeshore is not sewered (although some facilities provide their own wastewater collection and treatment), and there are culverts that empty into the lake. There is a sewer district for the lake. Currently, the minimum setback for lakeshore development is 20 feet, minimum lot lengths are 100 feet, and residential density is restricted to a 50 foot frontage minimum. Lake water is withdrawn for drinking and other domestic uses.

Overall, the volunteer found that Lake Wenatchee had excellent water quality in 1994. Some problems were from algae and weeds--plants grew in water up to five feet deep, and there was a scum on the lake. Possible sources of problems are fish pens.

Runoff, containing glacial silt from Glacier Peak, enters the lake via the White River. The "plume" where the silt enters the lake is very distinct because the water color is milky. This plume area is near the volunteers' monitoring site, so he avoids taking Secchi readings in the silt "plume". Two fish pens were located on the west end of the lake just north of where the White River enters the lake; one is a holding pond for brood stock and the other is a rearing pond. Reeds and waterlilies grow in the cove just south of the Wenatchee River outlet. Algae blooms have also occurred in this area.

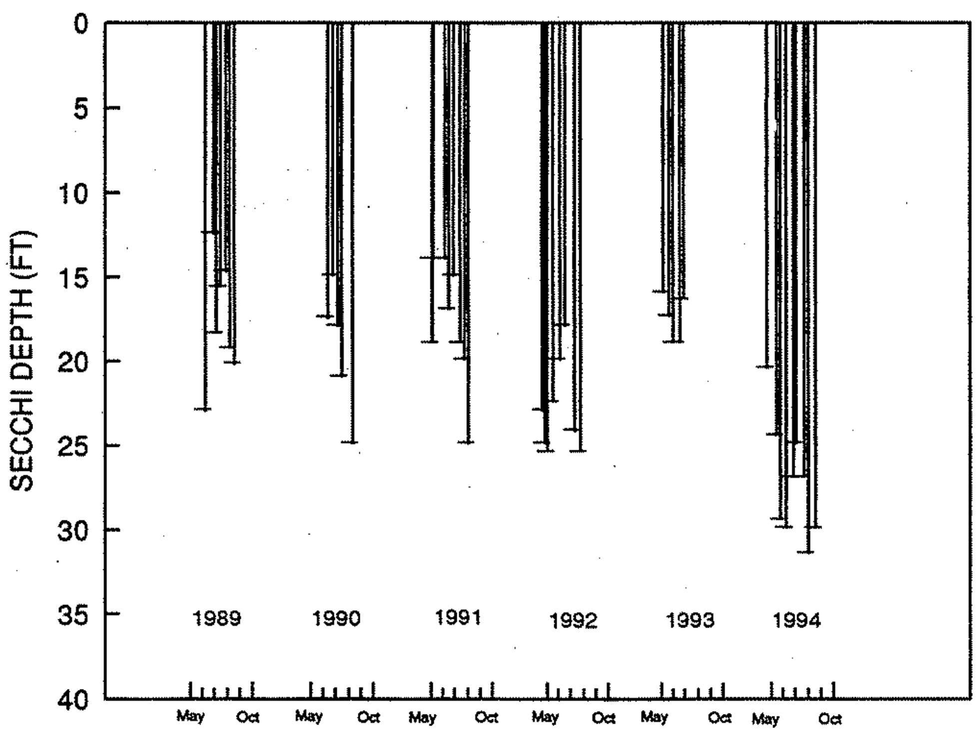
Acknowledgment

I thank Gary Craig for volunteering his time to monitor Lake Wenatchee from 1989 through 1994.

WENATCHEE Lake -- CHELAN County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/14	11.1	52.0	0.0	Lt Green	10	Trace	Strong	19.5	0.0		On-off high winds stir up waves and temp.
94/06/14	11.7	53.1	0.0	Lt Green	10	Light	Breezy	23.5	0.0		On-off rain and wind.
94/06/27	12.8	55.0	0.0	Lt Green	0	None	Calm	28.5	0.0		Perfect conditions last 2 days. Lake is very c lear.
94/07/14	11.7	53.1	0.0	Lt Green	5	None	Calm	29.0	0.0		Calm in morning - windy each afternoon.
94/08/01	21.1	70.0	0.0	Lt Green	0	None	Calm	26.0	0.0		Very smoky -- fire. Sun and sky smoke shaded.
94/08/15	17.8	64.0	0.0		0	None	Strong	24.0	0.0		Water color milky-brown from rains. Very wind y last few days - glacial melt; poor visibility .
94/09/08	17.8	64.0	0.0	Lt Green	10	Mod	Light	26.0	0.0		Medium-heavy rain plus high winds during previo us days.
94/09/22	17.2	63.0	0.0	Lt Green	0	None	Calm	30.5	0.0		Very calm past 3 days. Light wind in late afte rnoon.
94/10/16	15.6	60.1	0.0	Lt Green	10	Mod		29.0	0.0		Wind and Rain on Thursday.

LAKE WENATCHEE (CHELAN COUNTY)



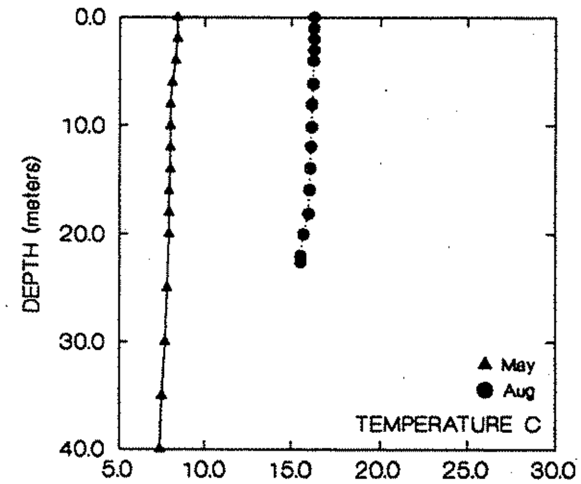
WENATCHEE (CHELAN) Lake -- CHELAN County
Chemistry Data -- Station 1

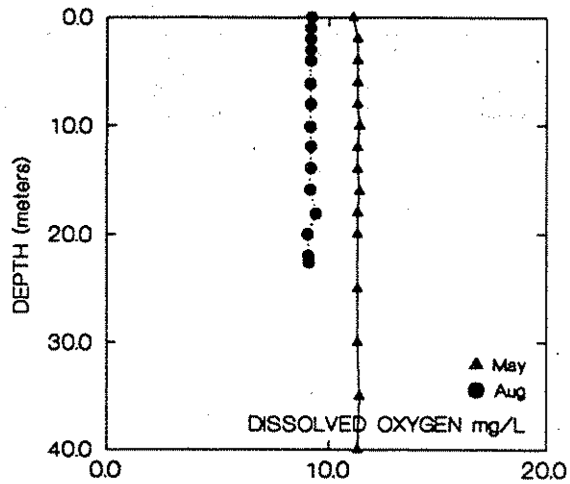
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/07/18		E	4			(Source: Water Supply Bulletin 43)					
89/06/06	1	E	6	0.16	0.7						
89/09/06	1	E	7	0.07	1.4						
90/06/04	1	E	8	0.11							
90/08/20	1	E	12	0.17							
91/06/05	1	E		0.11							
92/05/21	1	E	3	0.21	0.2	1U	1U		1	1	10
92/05/21	2	E	2						1U	1	5
92/05/21	1	H	3	0.13							
92/09/03	1	E	3	0.07	1.2	1U	1U		1	1	5
92/09/03	2	E	3	0.05	1.0	1U			1	1	5
92/09/03	1	H	3	0.11							
93/05/28	1	E	50	0.13	0.6						
93/05/28	2	E	20								
93/05/28	1	H	14	0.13							
93/08/26	1	E	3U	0.09	2.9						
93/08/26	2	E	3U								
93/08/26	1	H	3U	0.14							
94/05/28	1	E	13	0.26	1.0						
94/05/28	1	H	8	0.09							
94/08/23	1	E	21	0.05J	1.6						
94/08/23	1	H		0.20J							

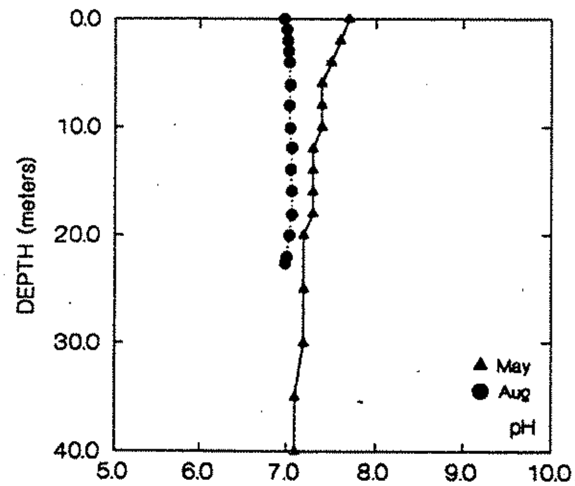
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

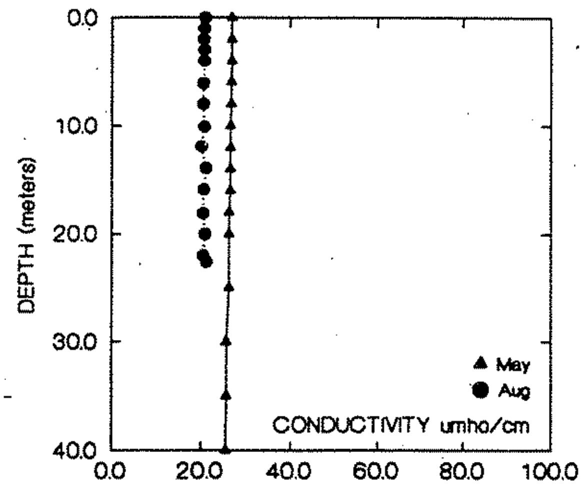
WENATCHEE (CHELAN) Lake -- CHELAN County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/28	0.0	8.4	7.7	11.1	27.0	94/08/23	0.0	16.3	7.0	9.2	21.0
	2.0	8.4	7.6	11.3	27.0		1.0	16.3	7.0	9.2	21.0
	4.0	8.3	7.5	11.3	27.0		2.0	16.3	7.0	9.2	21.0
	6.0	8.1	7.4	11.3	27.0		3.0	16.3	7.0	9.2	21.0
	8.0	8.0	7.4	11.3	27.0		4.0	16.3	7.0	9.2	21.0
	10.0	8.0	7.4	11.4	26.0		6.1	16.3	7.0	9.2	20.0
	12.0	8.0	7.3	11.3	26.0		8.0	16.2	7.0	9.2	20.0
	14.0	8.0	7.3	11.3	26.0		10.1	16.2	7.0	9.2	21.0
	16.0	7.9	7.3	11.4	26.0		11.9	16.1	7.1	9.2	20.0
	18.0	7.9	7.3	11.3	26.0		13.9	16.1	7.0	9.2	21.0
	20.0	7.9	7.2	11.3	26.0		15.9	16.1	7.1	9.2	21.0
	25.0	7.8	7.2	11.3	26.0		18.1	16.0	7.1	9.4	20.0
	30.0	7.7	7.2	11.3	26.0		20.0	15.7	7.0	9.0	21.0
	35.0	7.5	7.1	11.4	26.0		22.0	15.6	7.0	9.1	20.0
	40.0	7.4	7.1	11.3	25.0		22.6	15.6	7.0	9.1	21.0







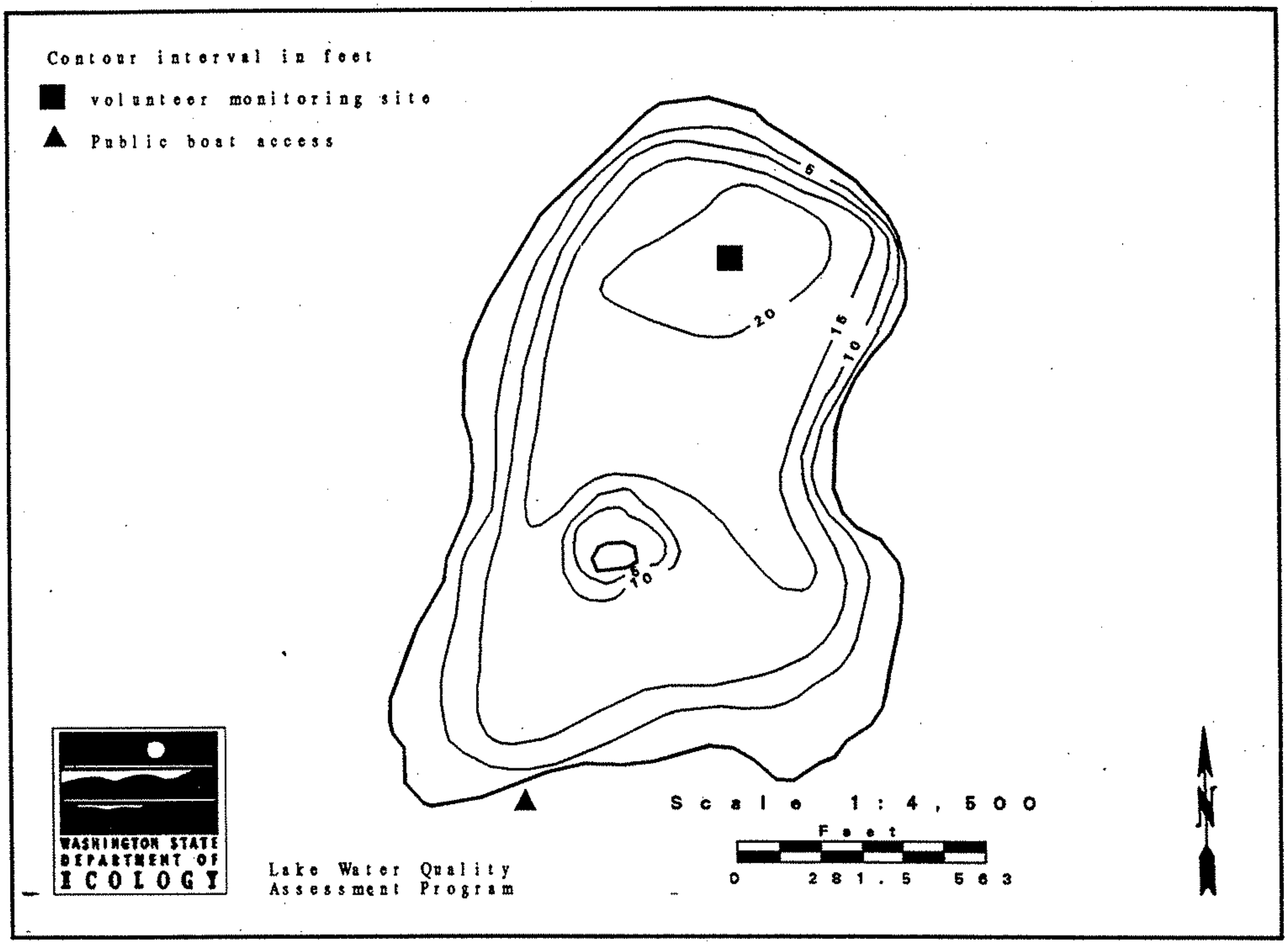


Lake Whitman -- Pierce County

Lake Whitman is located 6.5 miles north of Eatonville. It is the largest of the Benbow group of lakes. It is fed by Twin Lakes, and drains to Tanwax Creek and the Nisqually River. Lake Whitman was monitored by Ecology staff only.

Size (acres)	30
Maximum Depth (feet)	20
Mean Depth (feet)	12
Lake Volume (acre-feet)	350
Drainage Area (miles^2)	1.0
Altitude (feet)	601
Shoreline Length (miles)	1.0

Data from Bortleson *et al.* (1976)



Overall Assessment

Lake Whitman was sampled by Ecology staff only in 1994. The lake was monitored by volunteers in 1990 and 1993.

Based on high concentrations of total phosphorus on both sampling dates, a high concentration of chlorophyll *a* during the August survey, a moderately heavy population of aquatic plants, yet moderately deep Secchi depths, Lake Whitman was classified as meso-eutrophic in 1994.

Aquatic plants observed by Ecology staff during field visits include white-flowering water lily (*Nymphaea odorata*), tapegrass (*Vallisneria americana*), watershield (*Brasenia schreberi*), common waterweed (*Elodea canadensis*), Nuttall's waterweed (*Elodea nuttalli*), coontail (*Ceratophyllum demersum*), whitestem pondweed (*Potamogeton praelongus*), and cattails (*Typha sp.*). Coontail and common waterweed were the most abundant plants in areas of the lake.

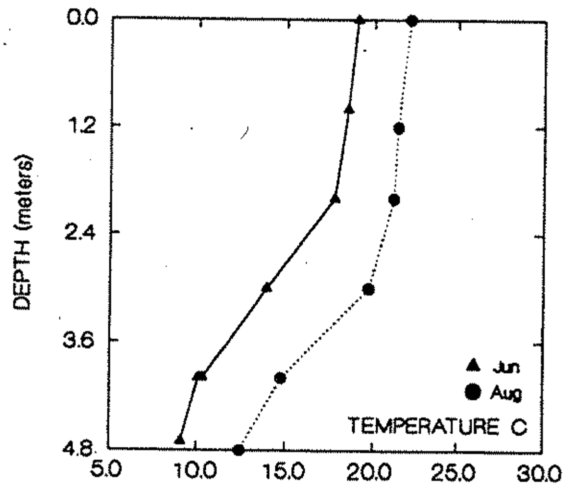
WHITMAN (PIERCE) Lake -- PIERCE County
Chemistry Data -- Station 1

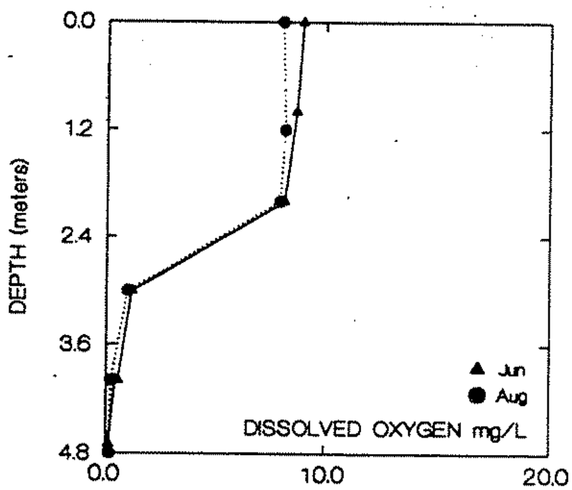
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/08/10		E	13			(Source: Water Supply Bulletin 43)					
81/06/23		E	40		4.6	(Source: Water Supply Bulletin 57)					
90/05/31	1	E	26	0.42							
90/08/23	1	E	33	0.50							
93/06/04	1	E	23	0.48	7.0						
93/06/04	2	E	45	0.51							
93/06/04	1	H	32	0.48							
93/08/27	1	E	18	0.48	5.1						
93/08/27	2	E	20								
93/08/27	1	H	132	0.65							
94/06/03	1	E	34	0.19	2.3						
94/06/03	1	H	35	0.18							
94/08/26	1	E	47	0.49J	11.3						
94/08/26	1	H	101	0.47J							

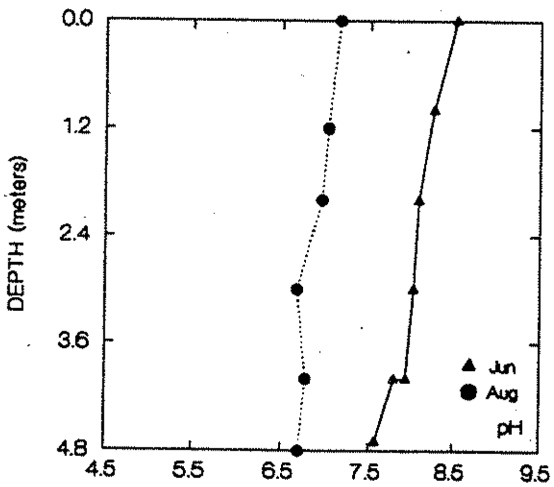
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

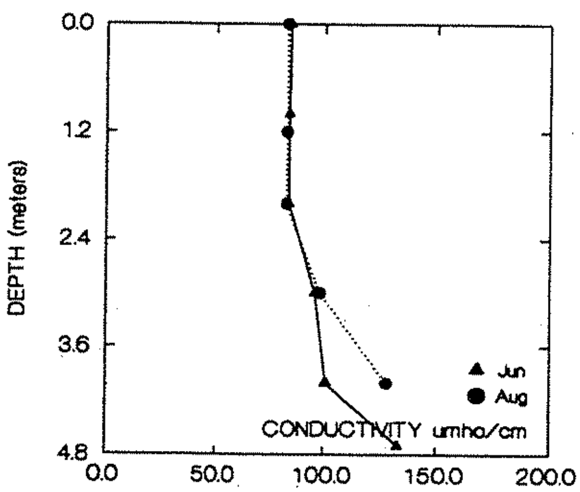
WHITMAN (PIERCE) Lake -- PIERCE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/03	0.0	19.1	8.5	9.0	84.0	94/08/26	0.0	22.2	7.7	8.0	83.0
	1.0	18.5	8.3	8.7	84.0		1.2	21.4	7.5	8.1	83.0
	2.0	17.8	8.1	8.1	84.0		2.0	21.2	7.5	7.9	83.0
	3.0	13.9	8.0	1.1	96.0		3.0	19.7	7.2	0.9	98.0
	4.0	10.2	8.0	0.5	100.0		4.0	14.7	7.3	0.2	128.0
	4.0	10.3	7.9	0.5	101.0		4.8	12.4	7.2	0.1	243.0
	4.0	10.2	7.8	0.4	101.0						
	4.0	10.1	7.8	0.4	101.0						
	4.7	9.1	7.6	0.1	133.0						







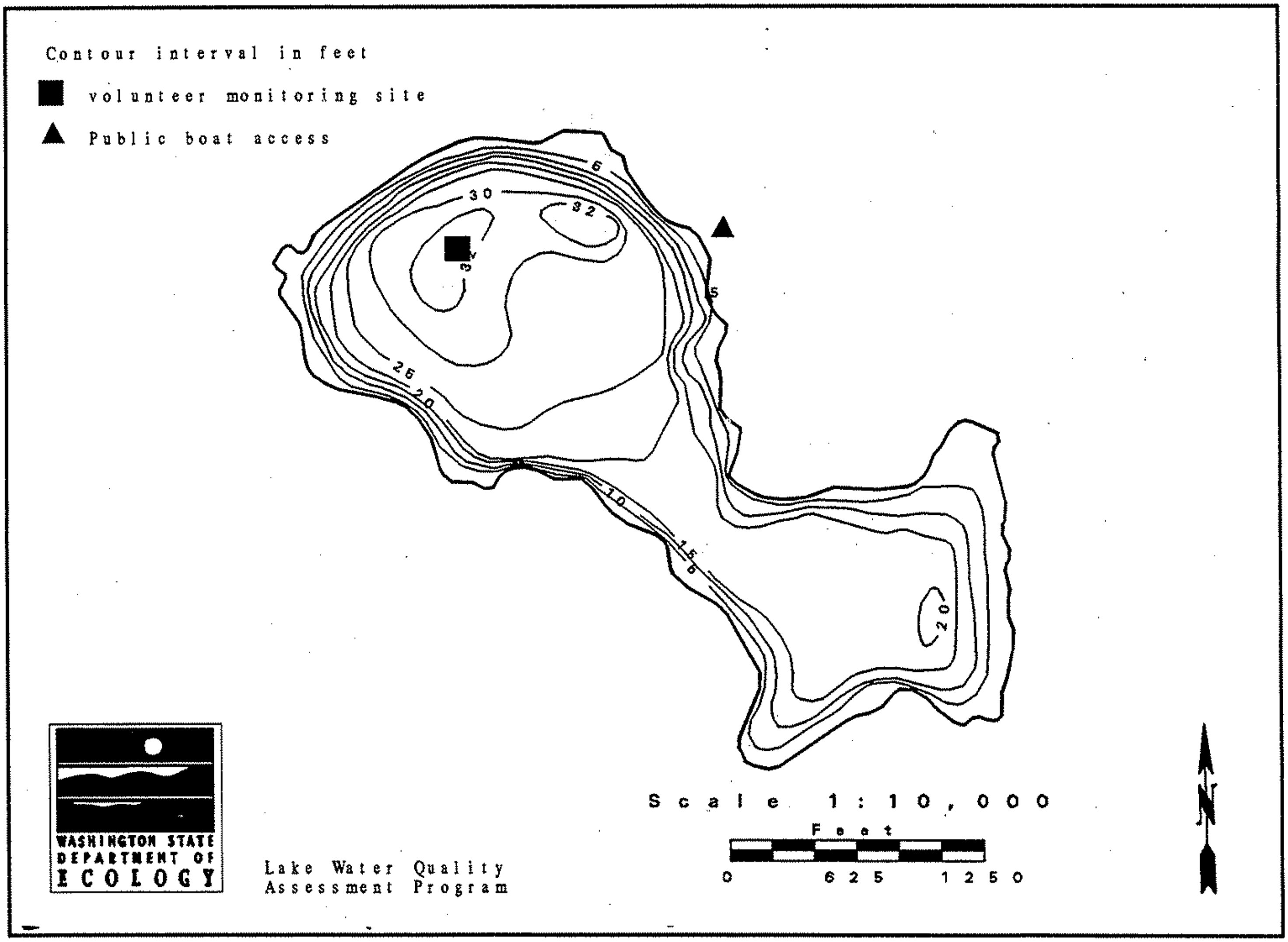


Wildcat Lake -- Kitsap County

Wildcat Lake is located six miles northwest of Bremerton. It is fed by two inlets, and drains via Wildcat Creek to Dyes Inlet.

Size (acres)	120
Maximum Depth (feet)	33
Mean Depth (feet)	18
Lake Volume (acre-feet)	2,200
Drainage Area (miles^2)	2.5
Altitude (feet)	377
Shoreline Length (miles)	2.2

Data from Bortleson *et al.* (1976)



Overall Assessment

Wildcat Lake had good water quality in 1994.

Secchi depths were deep, indicating good water clarity (see graph of Secchi depth data). Concentrations of total phosphorus and total nitrogen were low when the lake was sampled in August. The concentration of chlorophyll *a*, which indicates the amount of algae in the water, was also low in the area that was sampled. Water chemistry results are listed in a table at the end of this summary.

Profile data show that concentrations of dissolved oxygen were very low below the thermocline. Low oxygen concentrations near the lake bottom is not unusual for most lakes; algae and aquatic plants decompose near the lake bottom, and the decomposition process removes oxygen from the water. However, the dissolved oxygen concentrations in Wildcat were very low throughout the entire lower layer of water. When the lake was last sampled in 1974, oxygen concentrations were also very low, so this probably has occurred for many years in Wildcat Lake.

Aquatic plants observed by Ecology staff during the field visit include white-flowering water lily (*Nymphaea odorata*), cattails (*Typha sp.*), and a thinleaf pondweed (possibly *Potamogeton pusillus*). An algae sample was collected near shore between the sampling site and the public access; however, no algae particles were visible in the sample.

Based on good water clarity, low nutrient concentrations, a moderate amount of aquatic plants yet very low hypolimnetic oxygen concentrations, Wildcat Lake was classified as oligo-mesotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1994 questionnaire.

> Wildcat Lake is used for swimming, fishing, and non-motorized boating. There is a county park and a church camp on the lakeshore, and one public boat ramp. There is a speed restriction for boating on the lake. Trout were stocked in the lake in 1994. Currently the watershed is being logged and used for agricultural uses (both animal grazing and small Christmas tree farms). A few horses have direct access to the lakeshore. The lakeshore is also being developed further for residences. In the past the watershed was logged, and the shoreline was altered during residential development.
>
> There are 87 houses on the lakeshore, and none of the houses are connected to a sewer. One home is currently under construction. There is a community

association for the lake (The Wildcat Community Club). Lake water is withdrawn for drinking and other domestic uses. There are two culverts that drain into the lake.

Overall, the volunteer found that Wildcat Lake had fair water quality. Problems in the lake in 1994 were ranked as (1) swimmer's itch, (2) excessive aquatic plant growth, and (3) algae. Possible sources of problems include septic systems.

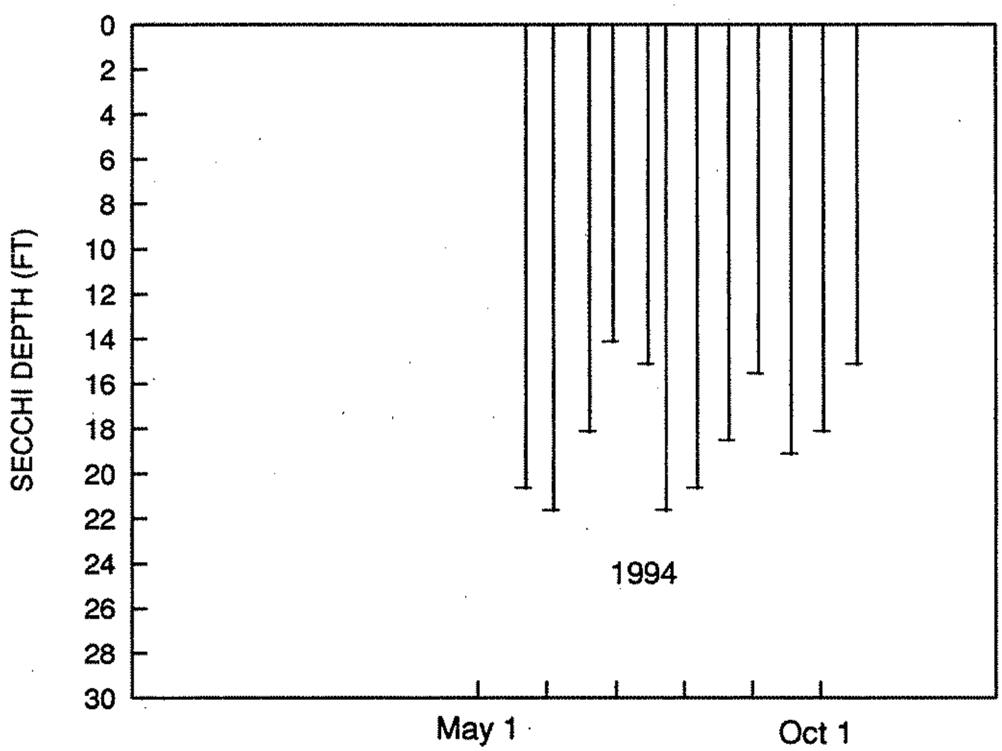
Acknowledgment

I thank Geoff and Joshua Keeler for volunteering their time to monitor Wildcat Lake during 1994.

WILDCAT Lake -- KITSAP County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev.	Comments
STATION 1											
94/05/30	17.2	63.0	0.0		0	Light	Light	20.0	0.0		Water color light yellow.
94/06/11	18.3	64.9	0.0		50	None	Breezy	21.0	-15.2		Water color light yellow.
94/06/27	18.9	66.0	0.0		10	None	Light	17.5	-15.7		Water color light yellow.
94/07/07	21.1	70.0	0.0		0	None	Breezy	13.5	-16.0		Water color light yellow-green.
94/07/23	24.4	75.9	0.0		100	None	Breezy	14.5	-17.0		Water color pale yellow.
94/07/31	22.2	72.0	0.0		0	None	Light	21.0	-18.0		Water color pale yellow. Change in sampling schedule.
94/08/14	22.2	72.0	0.0		0	None	Light	20.0	-18.7		Water color pale yellow.
94/08/28	20.6	69.1	0.0		90	Light	Breezy	17.9	-19.7		Water color pale yellow green. Algae sample taken by J. Rector.
94/09/10	18.3	64.9	0.0		25	Mod	Light	14.9	0.0		Water color pale yellow green. Substantial algae particles.
94/09/25	18.9	66.0	0.0		10	None	Light	18.5	-19.0		Water color pale yellow-green.
94/10/09	15.6	60.1	0.0		100	None	Calm	17.5	-19.5		Water color pale yellow-green.
94/10/23	12.2	54.0	0.0		25	Light	Breezy	14.5	-18.0		Water color pale yelllow-green. End of year observations.

WILDCAT LAKE (KITSAP COUNTY)



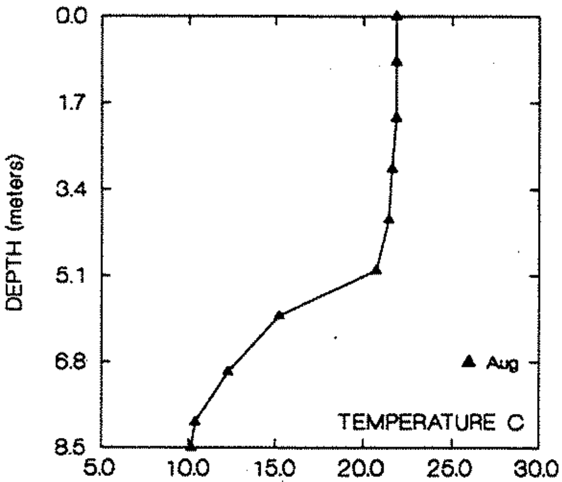
WILDCAT (KITSAP) Lake -- KITSAP County
Chemistry Data -- Station 1

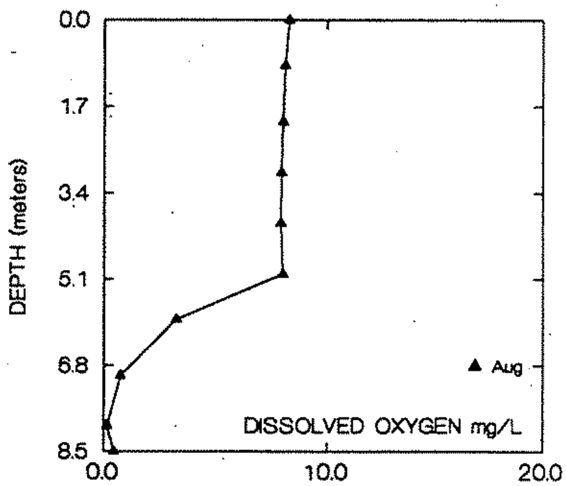
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
74/09/05		E	10			(Source: Water Supply Bulletin 43)					
94/08/28	1	E	8	0.14J	0.7						
94/08/28	1	H	17	0.16J							

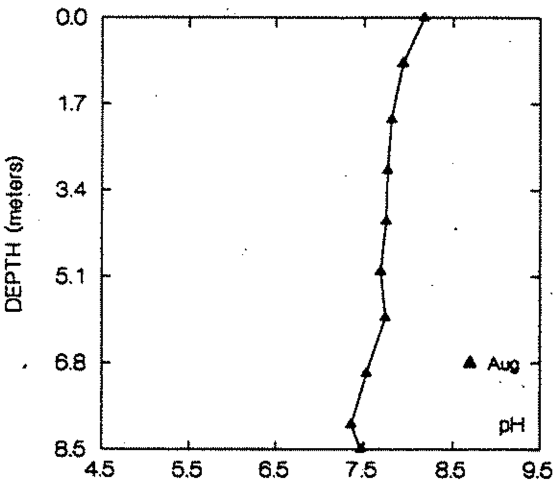
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

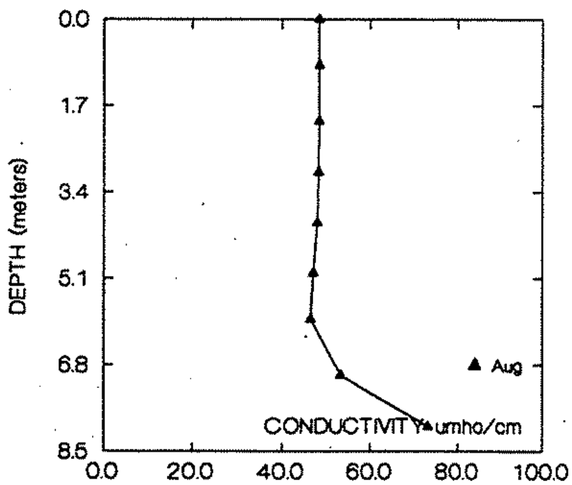
WILDCAT (KITSAP) Lake -- KITSAP County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
						94/08/28	0.0	21.8	8.2	8.3	48.0
							0.9	21.8	7.9	8.1	48.0
							2.0	21.8	7.8	8.0	48.0
							3.0	21.6	7.8	8.0	48.0
							4.0	21.4	7.8	7.9	48.0
							5.0	20.7	7.7	8.0	47.0
							5.9	15.2	7.7	3.3	46.0
							7.0	12.2	7.5	0.7	53.0
							8.0	10.4	7.4	0.1	73.0
							8.5	10.1	7.5	0.4	117.0







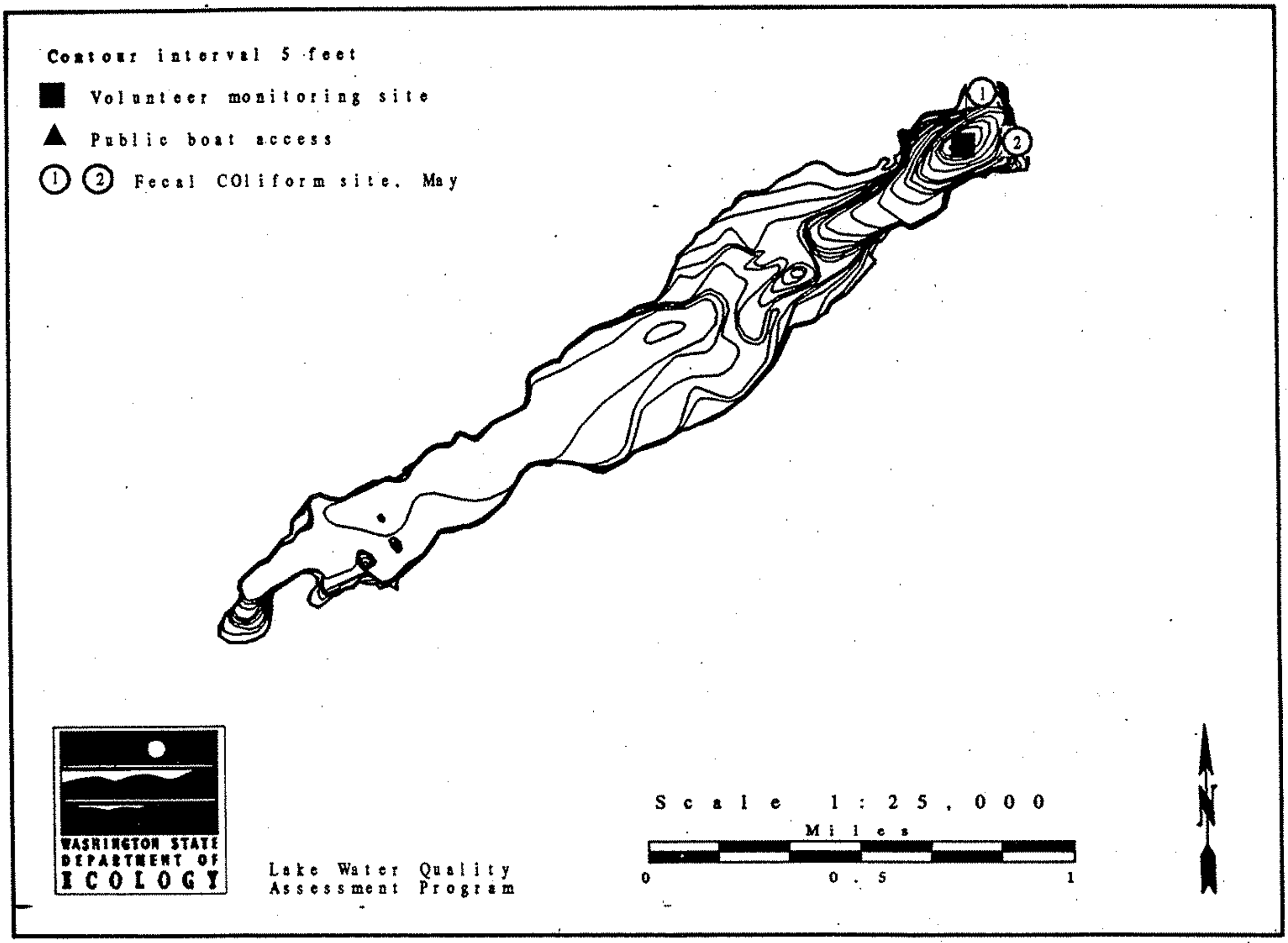


Williams Lake -- Spokane County

Williams Lake is located 11.5 miles southwest of Cheney and 12.5 miles east of Sprague. The inflow is intermittent. The outlet, which flows only during high water, drains to Downs Lake and the Palouse River.

Size (acres)	320
Maximum Depth (feet)	120
Mean Depth (feet)	37
Lake Volume (acre-feet)	12,000
Drainage Area (miles^2)	21.8
Altitude (feet)	2,052
Shoreline Length (miles)	5.3

Data from Dion *et al.* (1976)



Overall Assessment

Williams Lake had fair water quality in 1994. Concentrations of total phosphorus were high on both sampling dates. Also, Secchi depths decreased significantly from 1989 through 1994, showing that there was a decreasing trend in water clarity (see graph of Secchi depth data). This was tested using a seasonal Kendall test for trend, and results were significant at the 80% level ($p = 0.14$).

Samples were collected during both the May and August surveys for fecal coliform bacteria and turbidity. Turbidity results were low on both sampling dates. Only one of three bacteria samples showed some bacteria; this sample was collected in May at the northeast end of the lake, in an area densely packed with homes. The bacteria level was not high enough to indicate a health problem. Water chemistry results and profile data are listed in tables at the end of this summary.

Profile data were similar to data collected during previous surveys. Concentrations of dissolved oxygen decreased considerably below the thermocline. By August, oxygen was completely depleted throughout the lower layer of water. Some of this is probably from the lake being fed by groundwater, because groundwater usually does not carry dissolved oxygen. Also, bacterial decomposition of organic material (such as logs, algae, and aquatic plants) will reduce oxygen concentrations in the lower layer of water. Like other groundwater-fed lakes in Washington, Williams Lake had low water level in 1994, due to drought conditions that considerably reduced the recharging of groundwater aquifers.

Aquatic plants identified by Ecology staff during field visits include largeleaf pondweed (*Potamogeton amplifolius*), common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), milfoil (*Myriophyllum verticillatum*), muskgrass (*Chara*), and watermeal (*Wolffia sp.*).

A more thorough survey of aquatic plants was made by Ecology staff on August 5, 1994, for the Freshwater Aquatic Weeds Program. Only a few patches of plants were found due to rocky substrate in many areas. The most extensive patch of plants was at the south end, and was dominated by common waterweed, but the pondweeds and northern watermilfoil were also common. Aquatic plants observed included sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), common elodea (*Elodea canadensis*), flatstem pondweed (*Potamogeton zosteriformis*), reed canarygrass (*Phalaris arundinacea*), Illinois pondweed (*Potamogeton illinoensis*), water-buttercup (*Ranunculus aquatilis*), cattail (*Typha sp.*), northern watermilfoil (*Myriophyllum sibiricum*), leafy pondweed (*Potamogeton foliosus*), stonewort (*Nitella sp.*), floating leaf pondweed (*Potamogeton natans*), and hardstem bulrush (*Scirpus acutus*).

Based on moderately deep Secchi depths and moderately high amounts of algae and other aquatic plants, as well as low hypolimnetic concentrations of dissolved oxygen, Williams Lake was classified as mesotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 though 1994.

Williams Lake is used for fishing, boating, swimming, rowing, jet skiing, camping, and waterfowl hunting. There are two resorts on the lakeshore. There is one boat ramp, and there is a speed restriction set by Spokane County of 50 mph for motorboats. About 1% of the shoreline is publicly-owned. Currently the watershed is used primarily for animal grazing and crop agriculture. The lakeshore is also being developed further for residences. In the past the watershed was used for animal grazing and crop agriculture.

There are more than 30 houses on the lakeshore. At the northeast end of the lake there are about 125 permanent trailers which use septic tanks, and 55 lots used seasonally by RVs that all use holding tanks. The resort on the west end of the lake was sewered in 1976 (treatment uses a lagoon system) and serves 75 trailers. There are two culverts that empty into the lake. Lake water is withdrawn for drinking and irrigation. Currently, the minimum setback for lakeshore development is 50 feet. There is a lake association for the lake. No lake management activities occurred on the lake in 1994.

Overall, the volunteer found that Williams Lake had poor water quality. Problems in the lake in 1994 were gradually degrading water quality, low water level, and suspended sediments. Possible sources of problems include inadequate septic systems on the northeast end of the lake.

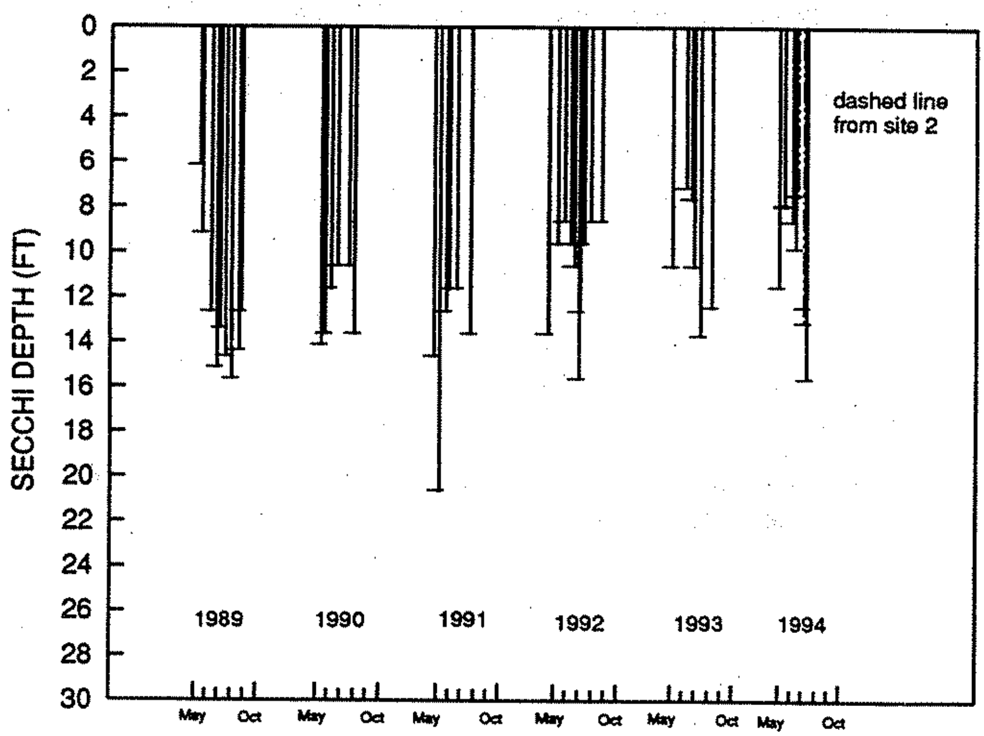
Acknowledgment

I thank L.O. Kerlee for volunteering his time to monitor Williams Lake in 1993 and 1994. Brad McHenry monitored the lake from 1989 to 1993.

WILLIAMS Lake -- SPOKANE County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/25	19.0	66.2	0.0		0	Heavy	Light	10.9	0.0	Onsite visit.
94/06/11	19.0	66.2	0.0	Mod Green	100	None	Breezy	7.3	1.6	Site 1.
94/07/04	19.0	66.2	0.0	Mod Green	25	None	Breezy	8.0	0.0	
94/07/23	25.0	77.0	0.0	Mod Green	0	None	Breezy	6.8	1.1	
94/08/17	23.0	73.4	0.0	Mod Green	0	None	Light	11.8	0.6	
94/08/24	21.0	69.8	0.0	Mod Green	50	None	Calm	15.0	0.5	
STATION 2										
94/06/11	17.0	62.6	0.0	Mod Green	90	None	Breezy	7.3	1.6	Site 2
94/07/04	18.0	64.4	0.0	Mod Green	25	None	Breezy	8.0	0.0	
94/07/23	25.0	77.0	0.0	Mod Green	0	None	Breezy	9.2	1.1	
94/08/17	24.0	75.2	0.0	Mod Green	0	None	Light	12.5	0.6	

WILLIAMS LAKE (SPOKANE COUNTY)



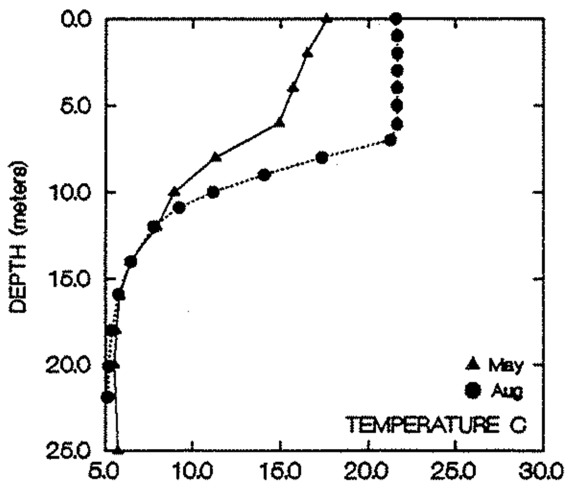
WILLIAMS (SPOKANE) Lake -- SPOKANE County
Chemistry Data -- Station 1

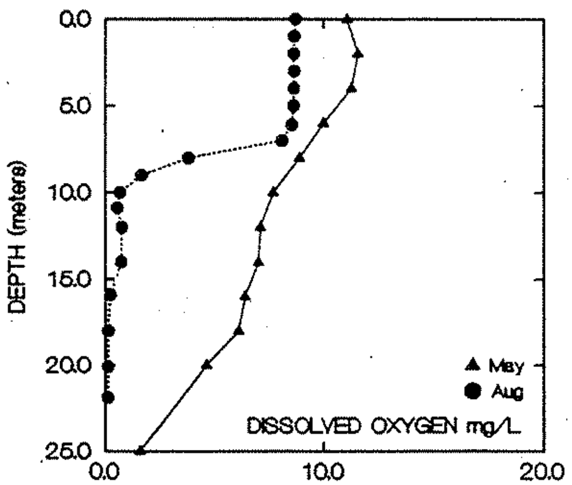
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turb-idity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
73/07/10		E	27			(Source: Water Supply Bulletin 43)					
89/06/21	1	E	18	0.45	2.4						
89/09/20	1	E	15	0.74	2.6						
90/05/23	1	E	19	0.49							
90/08/10	1	E	17	0.52							
91/06/10	1	E		0.42							
92/05/13	1	E	18	0.57	2.0	1U	1U		3	1	25
92/05/13	1	H	21	0.70							
92/08/26	1	E	15	0.52	2.0	1U	1U		4	2	15
92/08/26	2	E	13	0.51	2.5						
92/08/26	1	H	18	0.54							
93/05/26	1	E	30	0.56	5.1	1	1U				
93/05/26	2	E	33	0.55	5.0						
93/05/26	1	H	68	0.84							
93/08/22	1	E	12	0.43	6.2						
93/08/22	2	E	20	0.41	8.7						
93/08/22	1	H	75	0.64							
94/05/25	1	E	33		6.0	1	13	1.8			
94/05/25	1	H	35	0.46							
94/08/24	1	E	48	0.34J	2.3	1U	1U	1.5			
94/08/24	1	H	1U	0.56J							

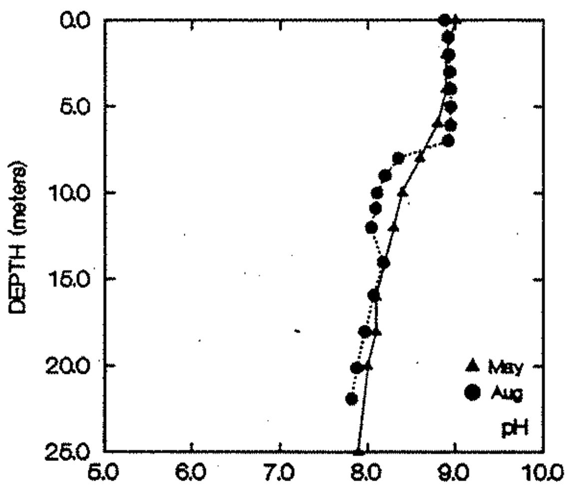
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

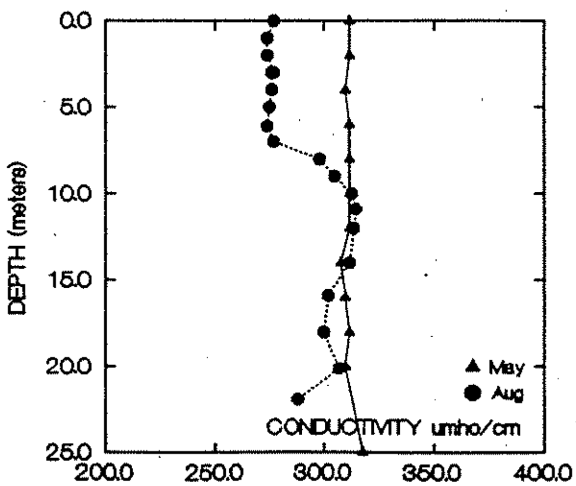
WILLIAMS (SPOKANE) Lake -- SPOKANE County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/25	0.0	17.6	9.0	11.1	312.0	94/08/24	0.0	21.6	8.9	8.7	277.0
	2.0	16.5	8.9	11.6	312.0		1.0	21.7	8.9	8.7	274.0
	4.0	15.7	8.9	11.3	310.0		2.0	21.7	8.9	8.7	274.0
	6.0	14.9	8.8	10.0	312.0		3.0	21.7	8.9	8.7	277.0
	8.0	11.3	8.6	8.9	312.0		3.0	21.7	8.9	8.7	276.0
	10.0	8.9	8.4	7.7	312.0		4.0	21.7	8.9	8.7	276.0
	12.0	7.9	8.3	7.1	312.0		5.0	21.7	8.9	8.6	275.0
	14.0	6.4	8.2	7.0	308.0		6.1	21.7	8.9	8.6	274.0
	16.0	5.8	8.1	6.4	310.0		7.0	21.3	8.9	8.1	277.0
	18.0	5.6	8.1	6.1	312.0		8.0	17.4	8.3	3.8	298.0
	20.0	5.5	8.0	4.6	310.0		9.0	14.0	8.2	1.7	305.0
	25.0	5.7	7.9	1.6	318.0		10.0	11.2	8.1	0.7	313.0
							10.9	9.2	8.1	0.5	315.0
							12.0	7.7	8.0	0.8	314.0
							14.0	6.4	8.2	0.7	312.0
							15.9	5.7	8.1	0.2	302.0
							18.0	5.3	8.0	0.1	300.0
							20.1	5.2	7.9	0.1	307.0
							21.9	5.1	7.8	0.1	288.0







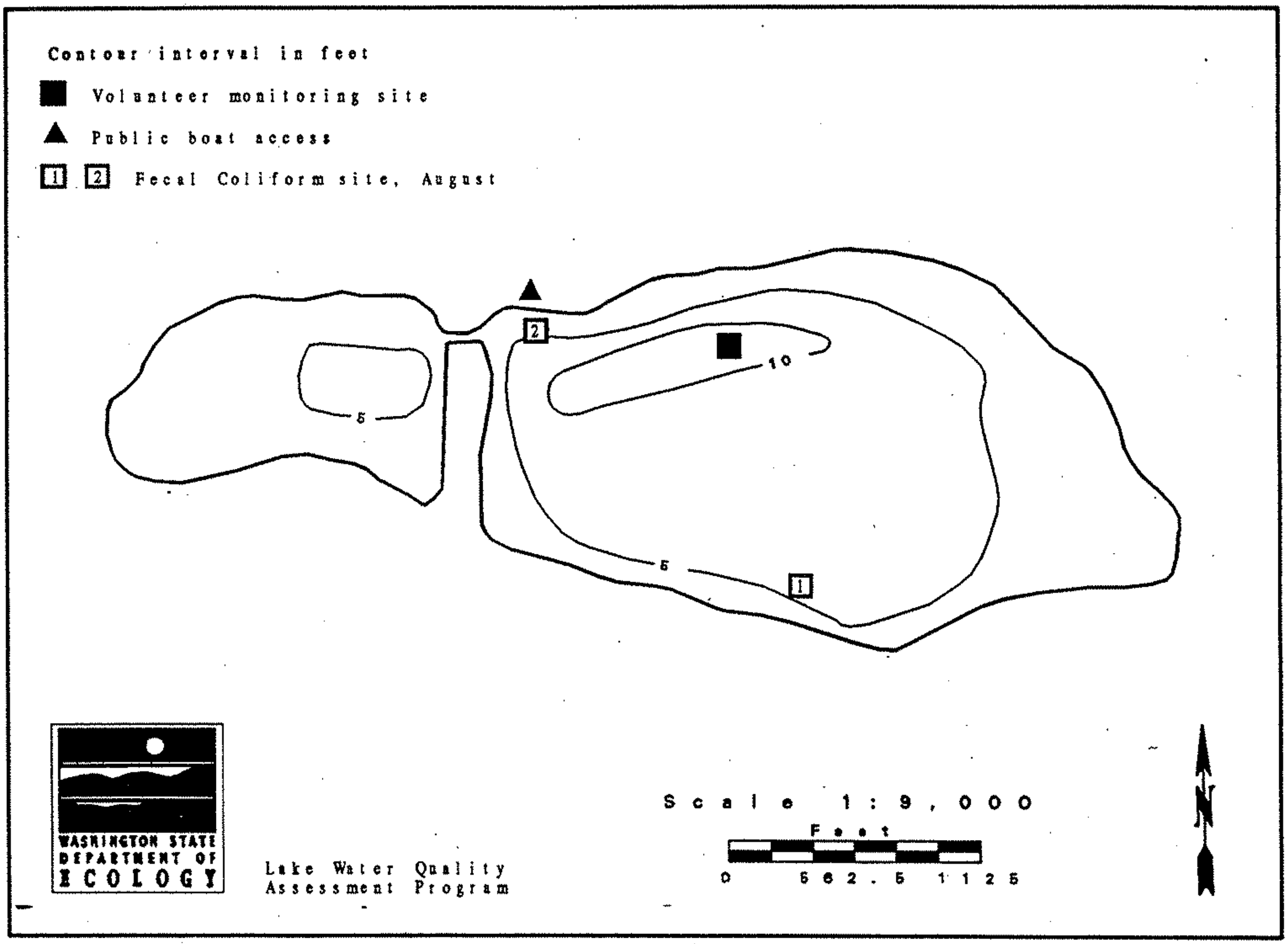


Wiser Lake -- Whatcom County

Wiser Lake is located three miles southwest of Lynden. It consists of two basin, connected by a narrow isthmus, which is crossed by Meridian Road. The lake has no surface inlets, and drains via Wiser Lake Creek to the Nooksack River. Wiser Lake was monitored by Ecology staff only.

Size (acres)	100
Maximum Depth (feet)	11
Mean Depth (feet)	6
Lake Volume (acre-feet)	610
Drainage Area ($miles^2$)	3.8
Altitude (feet)	50
Shoreline Length (miles)	2.3

Data from Bortleson *et al.* (1976)



Overall Assessment

Wiser Lake was monitored by Ecology staff only in 1994. The lake was briefly monitored by a volunteer in 1993.

Large particles of algae, including large colonies of the blue-green alga *Aphanizomenon*, were visible on both sampling dates. An algae sample collected during August also contained abundant amounts of *Ceratium* and *Anabaena*.

Aquatic plants observed by Ecology staff during field visits include coontail (*Ceratophyllum demersum*), Richard's pondweed (*Potamogeton richardsonii*), common waterweed (*Elodea canadensis*), Nuttall's waterweed (*Elodea nuttalli*), slender naiad (*Najas flexilis*), curly-leaf pondweed (*Potamogeton crispus*), whitestem pondweed (*Potamogeton praelongus*), and a small leaf pondweed (possibly *Potamogeton foliosus* or *P. pusilllus*). Floating mats of Nuttall's waterweed were abundant in the lake.

Wiser Lake was classified as eutrophic in 1994, based on high nutrient concentrations and heavy populations of algae and aquatic plants.

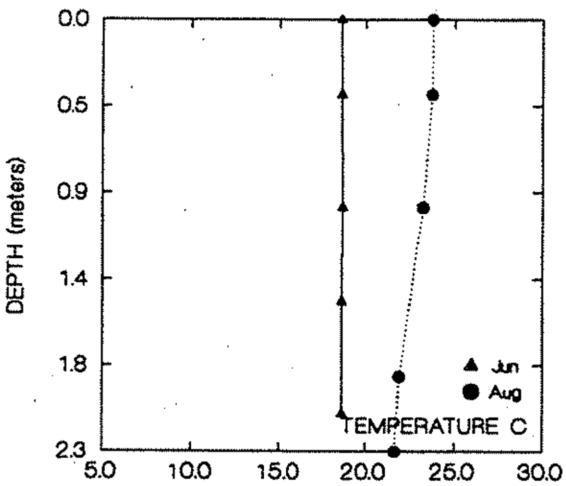
WISER (WHATCOM) Lake -- WHATCOM County
Chemistry Data -- Station 1

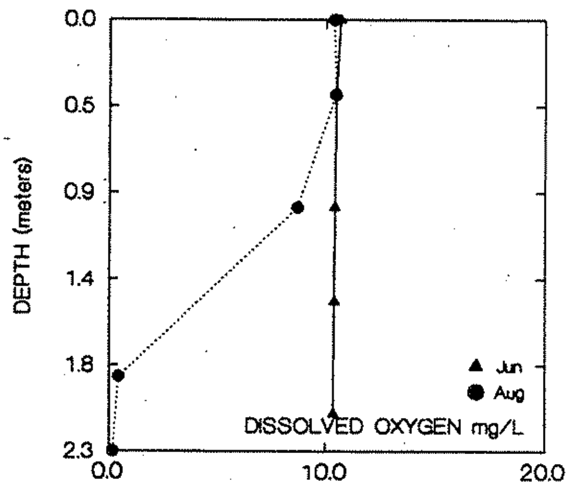
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Fecal Col. Bacteria (colonies/100 mL) Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Suspended Solids Non-Volatile (mg/l)	Color (Pt-Co)
73/08/23		E	41			(Source: Water Supply Bulletin 43)					
93/08/17	1	E	165	0.85	30.8	7	77				
93/08/17	2	E									
94/06/04	1	E	62	0.38	6.2						
94/08/20	1	E	131	0.71J	11.3J						

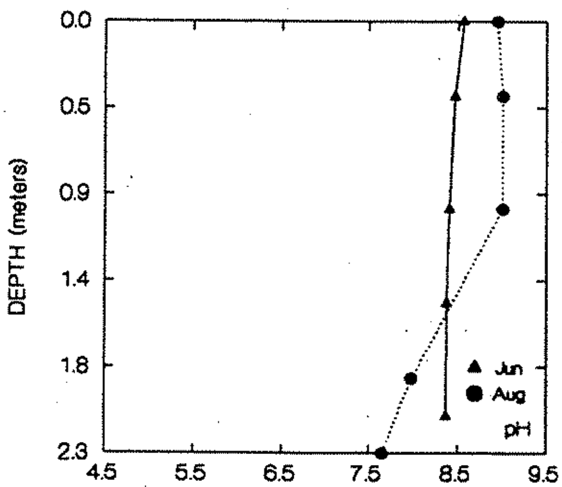
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

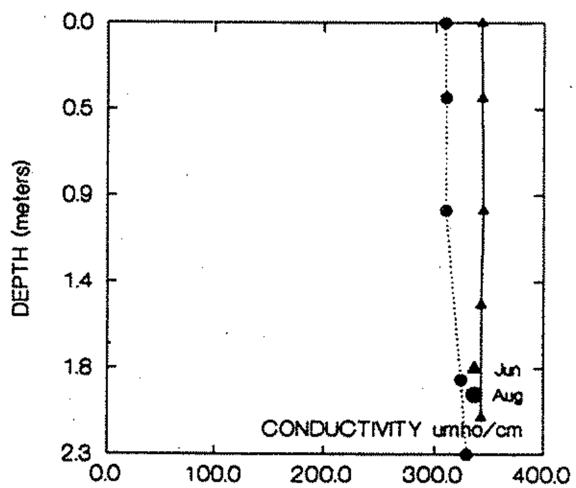
WISER (WHATCOM) Lake -- WHATCOM County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/06/04	0.0	18.6	8.6	10.6	342.0	94/08/20	0.0	23.8	9.5	10.4	309.0
	0.4	18.7	8.5	10.4	343.0		0.4	23.7	9.5	10.4	310.0
	1.0	18.7	8.4	10.4	344.0		1.0	23.2	9.5	8.7	310.0
	1.5	18.7	8.4	10.4	342.0		1.9	21.9	8.5	0.4	324.0
	2.1	18.6	8.4	10.4	342.0		2.3	21.7	8.2	0.2	329.0







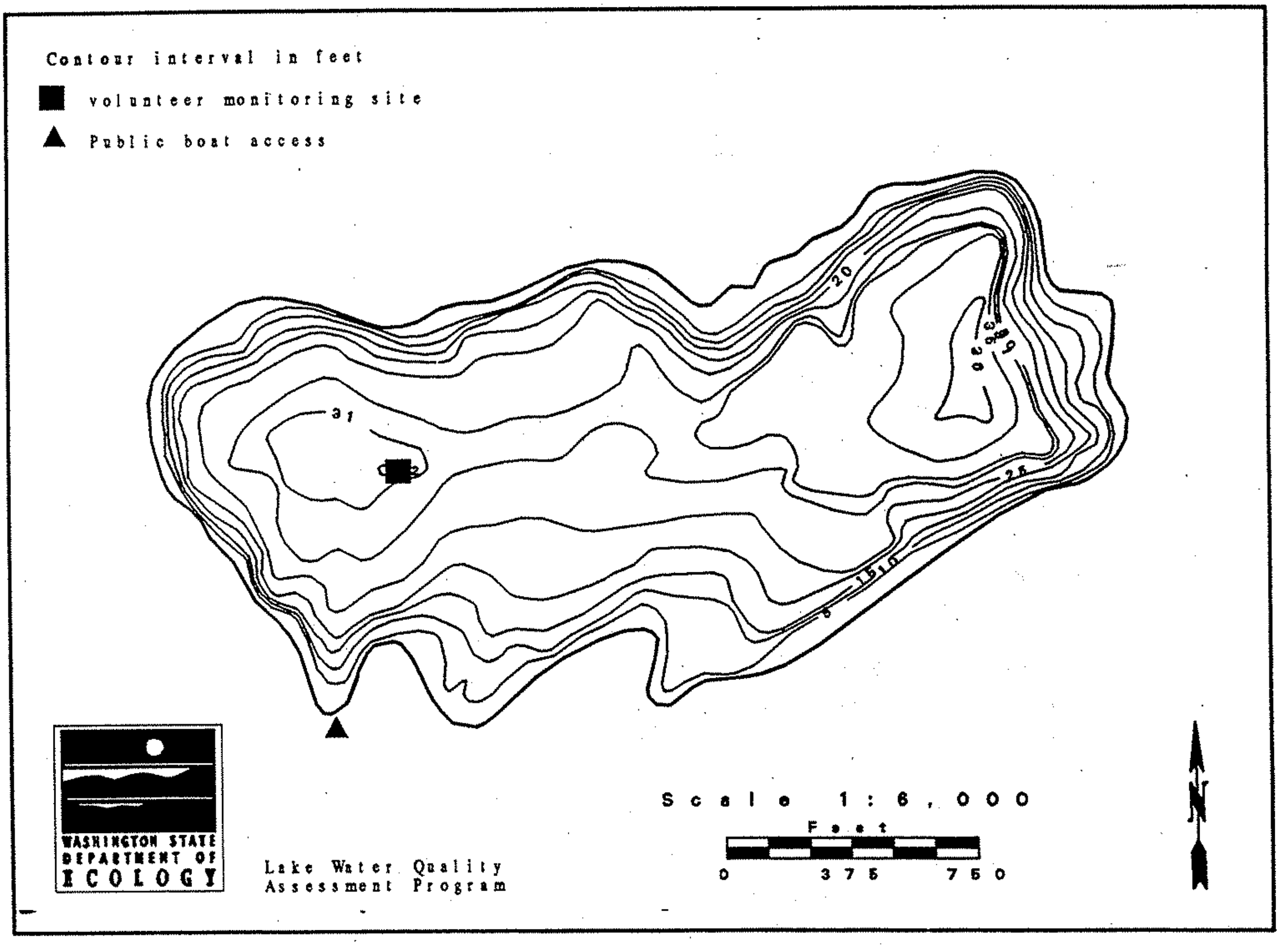


Lake Wooten -- Mason County

Lake Wooten is located seven miles west of Belfair. The lake has no inlet and drains to Haven Lake and the Tahuya River.

Size (acres)	68
Maximum Depth (feet)	36
Mean Depth (feet)	23
Lake Volume (acre-feet)	1,530
Drainage Area ($miles^2$)	0.3
Altitude (feet)	407
Shoreline Length (miles)	1.5

Data from Bortleson *et al.* (1976)



Overall Assessment

Secchi depths have been measured in Lake Wooten each year since 1989. During most years, the Secchi depths decreased gradually from May through October (see graph of Secchi depth data). Lake Wooten is the only lake in the program that consistently showed this pattern. Although Secchi depths decreased an average of 1.5% annually since 1989, this was not statistically significant at the 80% level using the seasonal Kendall test for trend ($p = 0.94$).

The only aquatic plant observed by Ecology staff during field visits was false loosestrife (*Ludwigia palustris*); this plant was first observed in 1992. No other submerged macrophytes were observed. Large algal colonies (which appeared to be *Gloeotrichia*) were visible mid-lake during the August survey. *Gloeotrichia* colonies have been observed in the lake during several surveys.

Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), as well as a sparse community of aquatic plants, Lake Wooten was classified as oligotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 through 1994.

> Lake Wooten is used for fishing, boating, swimming, rowing and jet skiing. There are is one public boat ramp, and there are no restrictions for motorboat use on the lake. About 1% of the shoreline publicly-owned. Rainbow and cutthroat trout were stocked in the lake in 1994. In the past the watershed was logged, and the shoreline was altered.
>
> There are 57 houses on the lakeshore, and none of the houses are connected to a sewer. There are four culverts that drain into the lake. Lake water is withdrawn for drinking and irrigation. There is no resident's organization for the lake. Currently, the minimum setback for lakeshore development is 15 feet, and there are no minimum lot lengths or restrictions on residential density. No lake management activities occurred on the lake in 1994.
>
> Overall, the volunteer found that Lake Wooten had excellent water quality. The worst problem in the lake in 1994 was algae. Possible sources of problems include older septic systems which need to be updated. There were no changes in the lake since the 1993 monitoring season. The volunteer noted in 1992 that Western Pond Turtle were spotted in the lake by another resident.

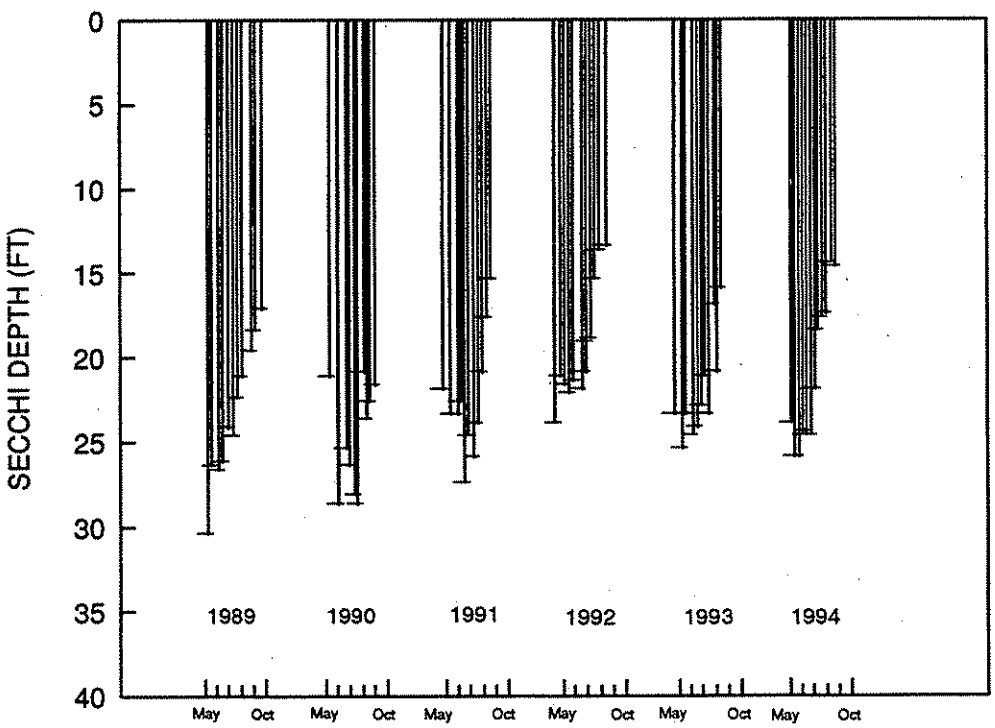
Acknowledgment

I thank Rusty Kidrick for volunteering her time to monitor Lake Wooten from 1989 through 1994.

WOOTEN Lake -- MASON County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/26	0.0	32.0	0.0	Lt Green	100	None	Light	23.0	0.0	Onsite visit. Water color clear green.
94/06/09	18.0	64.4	0.0	Lt Green	0	Trace	Light	25.0	23.5	
94/06/21	20.0	68.0	0.0	Lt Green	0	None	Breezy	25.0	22.8	
94/07/07	21.0	69.8	0.0	Lt Green	0	None	Light	23.8	22.0	Water color very light green.
94/07/21	23.0	73.4	0.0	Lt Green	0	None	Calm	23.5	21.0	
94/08/02	23.0	73.4	0.0	Lt Green	100	Trace	Calm	23.8	18.3	No algae bloom yet this year.
94/08/17	23.5	74.3	0.0	Lt Green	50	None	Light	21.0	16.3	There has been several turtle sightings on the lake. I have not seen one.
94/08/25	21.0	69.8	0.0	Lt Green	98	None	Calm	17.5	0.0	On site visit.
94/09/07	21.0	69.8	0.0	Lt Green	90	None	Strong	16.8	14.3	Small amount of algae.
94/09/22	20.5	68.9	0.0	Lt Green	0	None	Light	16.5	13.8	
94/10/05	17.0	62.6	0.0	Lt Green	75	None	Calm	13.5	12.0	Lots of suspended particulate in the lake now. Lowest level several years.
94/10/21	14.0	57.2	0.0	Lt Green	0	Heavy	Light	13.8	0.0	

LAKE WOOTEN (MASON COUNTY)



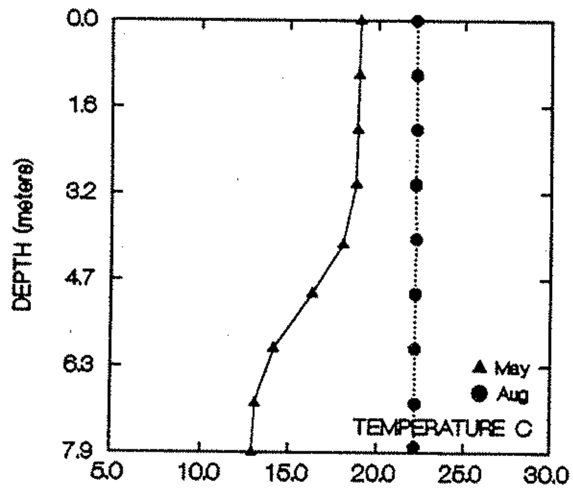
WOOTEN (MASON) Lake -- MASON County
Chemistry Data -- Station 1

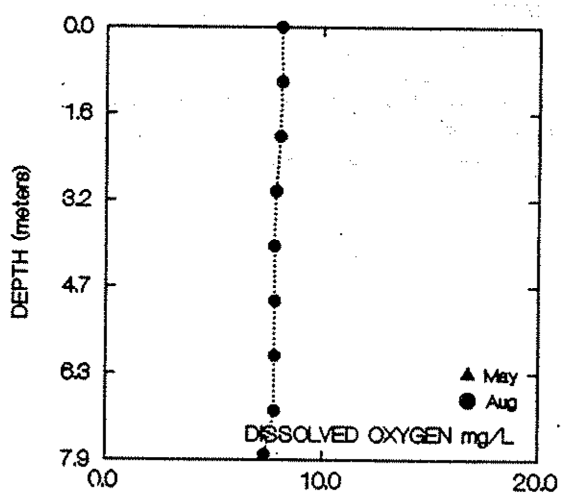
Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL)		Turbidity (NTU)	Suspended Solids		Color (Pt-Co)
						Site 1	Site 2		Total (mg/L)	Non-Volatile (mg/l)	
74/08/22		E	5			(Source: Water Supply Bulletin 43)					
89/06/28	1	E	3		0.9						
89/09/27	1	E	10		9.7						
90/08/14	1	E	15	0.64							
91/05/20	1	E		0.13							
92/05/13	1	E	6	0.26	1.1	1U	1U		1	1	25
92/05/13	1	H	33	0.32							
92/08/09	1	E	8	0.21	1.7	4			1	1U	5
92/08/09	2	E	6	0.20	1.9	3	2		2	1U	5
92/08/09	1	H	12	0.27							
93/06/03	1	E	4	0.17	1.1						
93/06/03	1	H	18	0.26							
93/08/31	1	E	5	0.18	1.8						
94/05/26	1	E	11	0.08	0.8						
94/05/26	2	E	6		1.0						
94/05/26	1	H	16	0.17							
94/08/25	1	E	10	0.12J	1.6						
94/08/25	2	E	5								

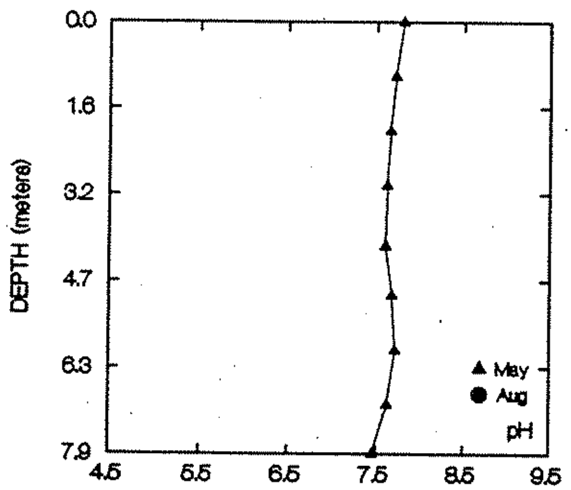
E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

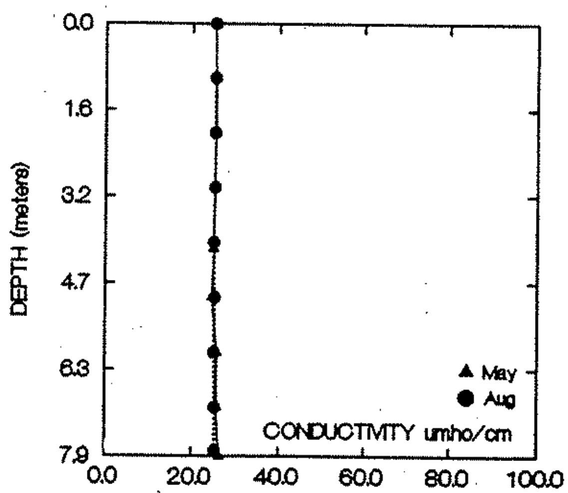
WOOTEN (MASON) Lake -- MASON County
1994 Profile Data

Date Spring	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)	Date Summer	Depth (M)	Temp (°C)	pH	Diss. Oxygen (mg/L)	Cond (µmho/cm)
STATION 1											
94/05/26	0.0	19.0	7.8	0.0	25.0	94/08/25	0.0	22.2	0.0	8.0	25.0
	1.0	18.9	7.7	0.0	26.0		1.0	22.2	0.0	8.0	25.0
	2.0	18.8	7.7	0.0	26.0		2.0	22.3	0.0	8.0	25.0
	3.0	18.8	7.6	0.0	25.0		3.0	22.2	0.0	7.8	25.0
	4.1	18.0	7.6	0.0	25.0		4.0	22.2	0.0	7.7	25.0
	5.0	16.3	7.7	0.0	25.0		5.0	22.2	0.0	7.8	25.0
	6.0	14.1	7.7	0.0	26.0		6.0	22.2	0.0	7.8	25.0
	7.0	13.1	7.6	0.0	26.0		7.0	22.2	0.0	7.8	25.0
	7.9	12.9	7.5	0.0	27.0		7.8	22.2	0.0	7.3	25.0







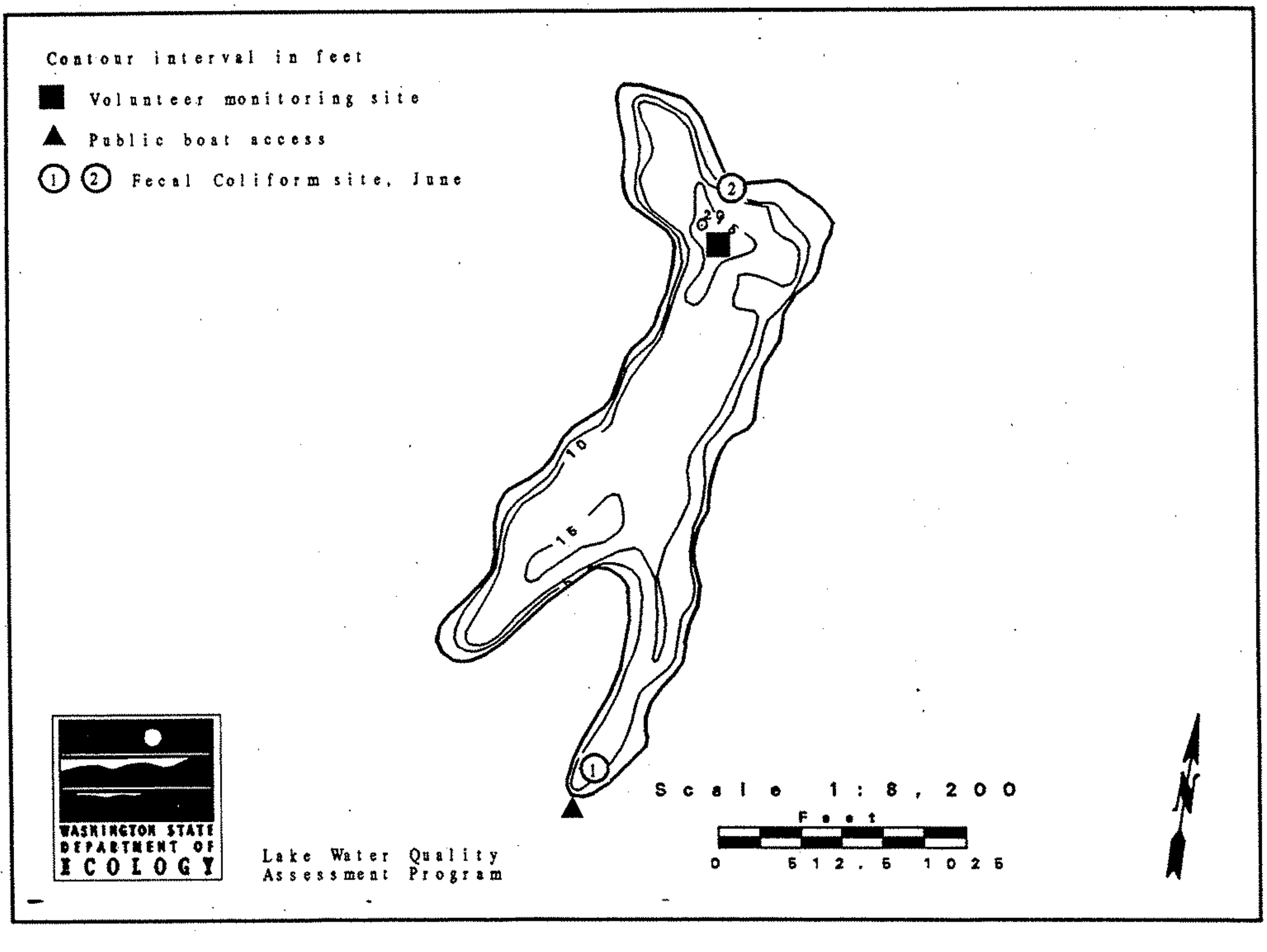


Wye Lake -- Kitsap County

Wye Lake is located 3.5 miles southeast of Belfair. It is fed by about six intermittent inlets, and drains via an unnamed creek to Fern Lake, Rocky Creek and ultimately to Case Inlet.

Size (acres)	39
Maximum Depth (feet)	15
Mean Depth (feet)	10
Lake Volume (acre-feet)	370
Drainage Area (miles^2)	1.1
Altitude (feet)	300
Shoreline Length (miles)	1.7

Data from Bortleson *et al.* (1976)



Overall Assessment

Wye Lake had good water quality in 1994, despite its shallow depth and high concentrations of total phosphorus. Water clarity was very good, and the lake bottom could be seen throughout most of the monitoring season (see table of volunteer-collected data).

Profile data did not change much from surface to bottom, because the lake is so shallow. Both volunteer-collected data and profile data collected during the field surveys show that water temperature in 1994 was very warm.

Few aquatic plants were observed along shore, but one plant observed during field visits was false loosestrife *(Ludwigia palustris)*.

Based on good water clarity, low algal concentrations and moderately low populations of aquatic plants, Wye Lake was classified as mesotrophic in 1994.

Summary of Questionnaire Results and Information from the Volunteer

The following is a summary of the volunteer's remarks and responses to the 1993 and 1994 questionnaires.

> Wye Lake is used for fishing, swimming, rowing, and lakeshore camping. Public facilities on the lakeshore include a day use park and one boat ramp. No motor boats are allowed on the lake. Rainbow trout were stocked in the lake in April 1994. Currently, the watershed is being used for tree farms, and the lakeshore is being developed further for residences. In the past, the watershed was logged and used for crop agriculture, and the shoreline was altered with bulkheads.
>
> There are 111 houses on the lakeshore (one more than in 1993), and none are connected to a sewer collection system. No culverts drain into the lake. There is a community association for the lake. Lake water was withdrawn for drinking and other domestic uses. No lake management activities occurred on the lake in 1994.
>
> Overall, the volunteer found that Wye Lake had good water quality. The worst problem in the lake in 1994 swimmer's itch, and eye/skin problems after swimming. Swimmer's itch problems are affected by the people who feed ducks and geese [ed. note: the swimmer's itch parasite is carried by waterfowl and snails]. Other potential sources of problems include the high amount of logging around the lake, and the conversion of seasonal homes to year-round residences without upgrades to the septic systems. Since the 1993 monitoring season, fishing

was opened year-round, resulting in more anglers using the lake, and more garbage being found in the lake.

Acknowledgment

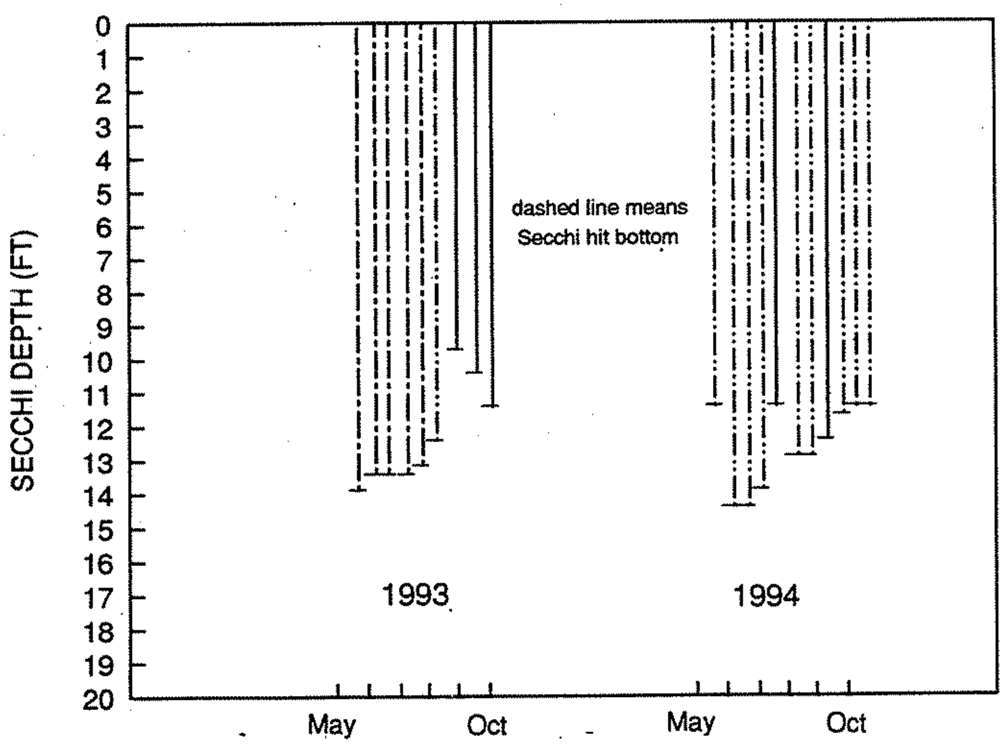
I thank Sandra Gold for volunteering her time to monitor Wye Lake during 1993 and 1994.

WYE Lake -- KITSAP County
1994 Volunteer-collected Data

Date 1994	Temperature (°C)	(°F)	pH	Water Color	%Cloud Cover	Recent Rain	Wind	Secchi (ft)	Lake Ht(in)	Abbrev. Comments
STATION 1										
94/05/26	20.0	68.0	0.0	Mod Green	100	None	Light	11.0B	0.0	Onsite visit. Water color clear light green. New thermometer this year.
94/06/10	23.0	73.4	0.0	Lt Green	90	None	Calm	14.0B	-4.0	Very humid.
94/06/26	22.5	72.5	0.0	Milky-grn	50	Mod	Strong	14.0B	-3.0	Extremely heavy rain about a week ago washed a great deal of silt into lake. It is just start ing to settle out.
94/07/10	25.0	77.0	0.0	Lt Green	0	None	Light	13.5B	-10.0	Hot dry weather last 5-6 days. Air temp 24C at this time. Water feels warm when you get in.
94/07/25	26.5	79.7	0.0	Pea-green	0	Trace	Breezy	11.0	-15.0	Really hot! Feels like bath water.
94/08/11	26.0	78.8	0.0	Lt Green	0	Trace	Light	12.5B	-19.5	Water feels cooler. Water is much clearer.
94/08/25	23.0	73.4	0.0	Lt Green	50	None	Light	12.5B	-23.5	Found a spot which appears to be 4-6" deeper. Still hitting bottom with disk.
94/09/11	21.0	69.8	0.0	Lt Green	10	Mod	Breezy	12.0	-26.0	Rain last 4 days has been steady. No real runo ff into lake yet.
94/09/27	21.0	69.8	0.0	Lt Green	0	None	Light	11.3B	-29.5	
94/10/09	17.0	62.6	0.0	Clear	0	None	Calm	11.0B	0.0	Almost clear.
94/10/23	13.0	55.4	0.0	Clear	50	Light	Breezy	11.0B	-33.5	

B - Secchi disk hit bottom

WYE LAKE (KITSAP COUNTY)



WYE (KITSAP) Lake -- KITSAP County
Chemistry Data -- Station 1

Date	Sta.	Strata	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll (µg/L)	Fecal Col. Bacteria (colonies/100 mL) Site 1	Site 2	Turbidity (NTU)	Suspended Solids Total (mg/L)	Non-Volatile (mg/l)	Color (Pt-Co)
72/06/29		E	10			(Source: Water Supply Bulletin 43)					
93/06/07	1	E	28	0.27	15.0	13	18				
93/06/07	1	H									
93/08/31	1	E	15	0.37	2.8						
94/05/26	1	E	51	0.18	1.8						
94/08/25	1	E	11	0.24J	3.2						

E=epilimnion composite, H=hypolimnion composite
Remarks codes: U = Below detection limits; J = Estimate.
Unless source is specified, data are from Ecology's Lake Water Quality Assessment Program

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Appendix A

Data Reporting Cards Used by Volunteers

Appendix A. Data Reporting Cards Used by Volunteers

WASHINGTON'S CITIZEN LAKE MONITORING PROJECT

Your Name ____________________ Sample Date__________

Lake/County ____________________ Sample Time __________

1st Secchi Reading __________ feet 2nd Secchi Reading __________ feet

Did the Secchi disk: ☐ hit bottom ☐ enter weeds ☐ N/A

Surface Water Temperature __________ degrees

Percent Cloud Cover: 0% 10% 25% 50% 75% 90% 100%

Rain Within Last 2 Days: None Trace Light Moderate Heavy

Wind: Calm Light Breezy Strong Gusty Lake Height __________ ft/in

Water Color:

Light Green	Moderately Green	Pea-Soup Green	Other: __________
Light Brown	Dark Brown	Greenish-Brown	
Black	Milky Green	Clear	

Field Observations/Questions/Comments

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 433, OLYMPIA, WA

POSTAGE WILL BE PAID BY ADDRESSEE

ATT: JULIE RECTOR
DEPARTMENT OF ECOLOGY
PO BOX 47600
OLYMPIA WA 98599-7600

Appendix B

Materials and Methods Used to Build Viewing Tubes

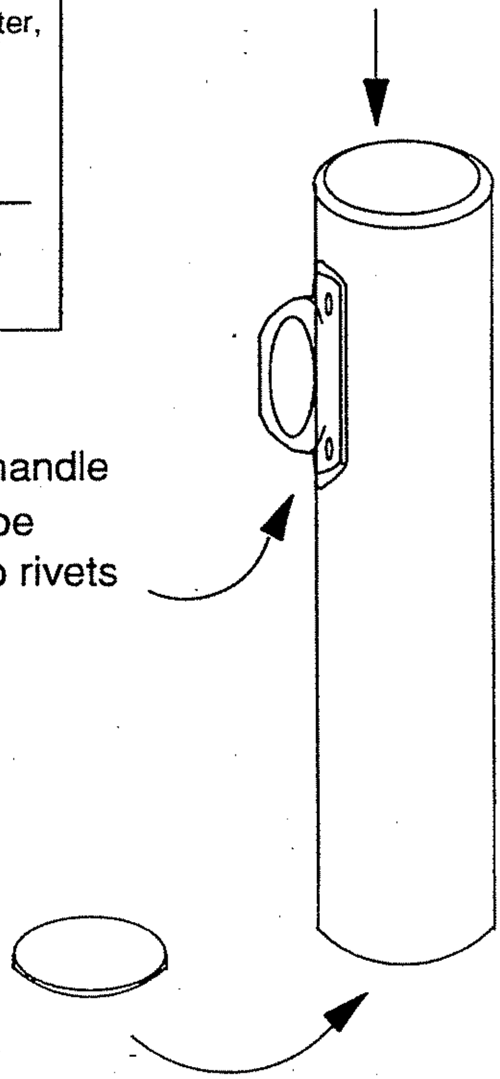
Materials and Methods Used to Make View Tubes

MATERIALS

1. 4" diameter black PVC pipe*
   cut into 28" lengths
2. drawer pulls with holes for rivets
3. pop rivets (to fit holes in handles)
   and rivet gun
4. sandpaper
5. 1/4" clear plastic disks, 3 15/16" diameter,
   edge unfinished (order from plastic
   supply store)
6. silicone caulk and caulking gun

---

* if white PVC is used, paint inside of tube
  evenly with flat black paint.



Appendix C

1994 Questionnaire on Lake and Watershed Uses

WASHINGTON'S CITIZEN LAKE MONITORING PROJECT
1994 QUESTIONNAIRE

Your Name ______________________________ Date ____________________
Lake/County ______________________________

Note: The purpose of this survey is to gather information that will help us understand more fully the current water quality of your lake, and possible changes that have occurred over time. This will involve documenting your perception of your lake's water quality, as well as recent changes in land uses and lake management. As a result, I usually repeat questions from previous surveys. The only new question this year is #19.

- Please complete and return this questionnaire by October 31, 1994.
- Remember to continue collecting Secchi data, every two weeks, until mid-October
- If you aren't sure how to answer a question, contact Julie Rector at (206) 407-6680.
- **Thanks for your time spent on this!**

General Lake Information

1. How many houses are there on the shoreline? (The exact number is best; please estimate the number if you are monitoring a very large lake.)
   - ☐ Exactly ______________________________
   - ☐ Estimated ______________________________

2. Was the lake treated with any chemicals this year?
   - ☐ Yes, for weed control
   - ☐ Yes, for algae control
   - ☐ Yes, for eliminating non-game fish
   - ☐ No
   - ☐ Don't Know

3. Did any lake management activities occur on your lake this year?
   - ☐ Yes, a mechanical harvester has been used
   - ☐ Yes, the lake has been chemically treated
   - ☐ Yes, the lake has been dredged this year
   - ☐ Yes, the lake was drawn down last winter
   - ☐ Yes, the lake was aerated
   - ☐ No management activities were pursued this year

4. Were fish stocked in the lake this year?
   - ☐ Yes (What species? ______________________________)
   - ☐ No
   - ☐ Don't know

Lake Water Quality

5. Were there days when you would not swim in your lake because of poor water quality?
   - ☐ Yes (About how many days out of the year? ______________________)
     Was the lake officially closed for swimming? ☐ Yes ☐ No
   - ☐ No

6. Were there days when fishing was difficult because of poor water quality (for example, because of excessive plants or algae)?
   - ☐ Yes (About how many days out of the year? ______________________)
     Was the lake officially closed to fishing? ☐ Yes ☐ No
   - ☐ No

7. Were there days when the lake had poor aesthetics?
   - ☐ Yes (About how many days out of the year? ______________________)
   - ☐ No

8. Overall, how would you evaluate the recreational quality on your lake with respect to swimming, fishing, and boating?
   - ☐ Excellent
   - ☐ Good--no uses are restricted because of poor water quality
   - ☐ Fair--some uses are restricted because of water quality or excessive plant growth
   - ☐ Poor--would not swim in this lake most days of the year, even when the temperature was warm enough

9. What have been the worst water quality problems on your lake in 1994? Please rank the problems in order of their importance, with No. 1 being the worst problem and No. 2 being the next worse problem, etc. Use "0" to indicate if any of the below were not an important problem in your lake.

____	Algae bloom	____	High water level
____	Odor from decaying algae	____	Low water level
____	Aesthetics degraded	____	Fluctuating water level
____	Excessive aquatic plant growth	____	Suspended sediments
____	Decaying plants	____	Shoreline erosion
____	Bacteria	____	Water quality gradually degraded over years
____	Hazardous substance	____	Recently degraded water quality
____	Eye/skin problems after swimming	____	Fish kill
____	Swimmer's itch	____	Impaired fisheries
____	Beach closure		
____	Other ______________________________		

10. What do you see as the predominant source(s) of actual or potential water quality problems in your lake (if a problem or potential problem exists)? Use the back of Page 3 if you need more room.

    ____

    ____

    ____

11. Have there been any changes in your lake since last year's monitoring season?

    ____

    ____

    ____

12. Is there any other information that you would like to pass on about your lake?

____

____

____

Lake Organizations

13. Are there any lake groups for your lake?
- ☐ Lake Association
- ☐ Lake Management District
- ☐ Sewer District
- ☐ Community Association
- ☐ Other(s) ______________________

Monitoring/Training

14. How many times did you take a Secchi reading? ______________
(This is to make sure we've received as many data cards as you've mailed)

15. Did you enjoy participating in this project? (Please comment.)

____

____

16. Would you volunteer again for next summer?
- ☐ Yes
- ☐ No, I'll return the disk and thermometer at the end of the sampling season so another volunteer can use them next year.
- ☐ No, but I know someone who may want to monitor next year:
  Name ______________________
  Address ______________________
  Phone ______________________

17. Suggestions for improving the program for the 1995 sampling season:

____

____

18. Each year, we get requests from local reporters, county agencies, and other volunteers who want to talk to some of the volunteers in this program. May we have your permission to provide your name and phone number to these people?
- ☐ Yes
- ☐ No

19. Reports prepared for each lake are generally 8-10 pages long, and the drafts are sent to volunteers the following May. I am thinking of using a different format, so that the reports are shorter and simpler, in order to get the reports completed sooner. Would a quicker, though less detailed, report be acceptable to you? (please comment)

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE!

The following questions are asked during a volunteer's first year in the program, to gather some background information on lake and watershed uses.

Please mark all that apply. Thank you!

Watershed and Lake Uses

20. What are the recreational uses of the lake?
- ☐ Swimming
- ☐ Fishing
- ☐ Motor Boating (including water skiing)
- ☐ Non-motorized boating (rowing, sailing, wind surfing)
- ☐ Jet skiing
- ☐ Lakeshore camping
- ☐ Waterfowl hunting
- ☐ Other ____________________

21. What public recreational facilities are there on the lakeshore?
- ☐ Day use area (picnic area, beach...)
- ☐ State Park
- ☐ County/City Park
- ☐ Resorts (How many? ________)
- ☐ Boat Ramps (How many? ____________)
- ☐ Other ____________________

22. Are there restrictions for motor boat use on the lake?
- ☐ No motor boating allowed
- ☐ Speed limits for motor boats ____________ mph
- ☐ No wake zones within ____________ feet of lakeshore
- ☐ Other restrictions (please list ____________________)
- ☐ No restrctions on motor boat use

23. What are the uses of the lake water?
- ☐ Direct withdrawal -- drinking and other domestic uses
- ☐ Municipal water supply
- ☐ Industrial water supply
- ☐ Irrigation
- ☐ Other ____________________
- ☐ Don't Know

Lake/Watershed Activities and Development

24. **Currently**, what kinds of activities are there within the watershed? (A watershed is all land that drains eventually into a lake, and includes land that drains into streams that flow into the lake.) Please note if one activity is especially dominant.
- ☐ Logging
- ☐ Agriculture -- crops, orchards, tree farms...
- ☐ Agriculture -- animal grazing and animal feeding operations
  Do livestock have direct access to the lakeshore or inlet tributaries? ☐ Yes ☐ No
- ☐ Industrial development
- ☐ Lakeshore development for residences
- ☐ Other ____________________

25. **Historically**, what kinds of activities occurred within the watershed?

- ☐ Logging
- ☐ Agriculture -- crops
- ☐ Agriculture -- animal grazing
- ☐ Mining
- ☐ Dredging (lake or wetlands? ________________________________)
- ☐ Shoreline alteration (such as vegetation removal or filling in the shoreline. Please explain.) ________________________________
- ☐ Other________________________________

26. Is the lakeshore area sewered?

- ☐ Yes -- Fully
- ☐ Yes -- Partially (_____ % of the shoreline, or _____% of the homes served)
- ☐ No
- ☐ Don't Know

27. Are there any storm drains that drain into the lake? (Storm drains usually appear as concrete or metal pipes that drain into a lake from ditches or under roads.)

☐ Yes (How many? _________) ☐ No

Appendix D

Laboratory Quality Assurance/ Quality Control Data for 1994

Appendix D. Hydrolab postcalibration data for quality assurance.

Date 1994	Parameter	Comparison Value	Hydrolab Value	Postcalibration for the following lakes
05/16	DO	9.4 mg/L	9.6 mg/L	Long (Thurston), Ward, Chambers
	pH	7.0	6.9	
	pH	10.0	9.9	
05/17	DO	9.4 mg/L	9.3 mg/L	North Pattison, McIntosh
	DO[f]	10.6 mg/L	10.8 mg/L	North Pattison, 1 m
	pH	7.0	7.09	
	pH	10.0	9.9	
05/17	DO	7.2 mg/L	7.7 mg/L*	Byron
	pH	7.0	6.94	
	pH	10.1	10.2	
05/18	DO	9.3 mg/L	9.4 mg/L	Killarney, Sawyer, Alice
	pH	7.0	7.0	
	pH	10.0	9.9	
05/18	DO	8.4mg/L	8.2 mg/L	Ellen, Thomas, Black
	DO[f]	9.1 mg/L	9.0 mg/L	Thomas, 0.5 m
	pH	7.0	6.9	
	pH	10.1	10.2	
05/19	DO	10.0 mg/L	10.1 mg/L	Big Meadow, Leo
	DO[f]	8.8 mg/L	8.9 mg/L	Leo, 0.5 m
	pH	7.0	7.3	
	pH	10.1	10.2	
05/20	DO	9.6 mg/L	9.9 mg/L	Howard, Ki, L. Martha, Sunday, Ketchum
	pH	7.0	7.0	
	pH	10.0	10.0	
05/20	DO	10.1 mg/L	10.2 mg/L	Waitts, Jumpoff Joe, Eloika
	DO[f]	14.1 mg/L	13.9 mg/L	Jumpoff Joe, 1 m
	pH	7.0	7.0	
	pH	10.1	10.2	
05/21	DO	12.3 mg/L	13.1 mg/L*	Bosworth, Roesiger, Stevens
	pH	7.0	6.9	
	pH	10.0	9.9	
05/21	DO	10.3 mg/L	10.5 mg/L	Sullivan, Sacheen, Diamond
	DO[f]	9.3 mg/L	9.5 mg/L	Diamond, 1.0 m
	pH	7.0	7.1	
	pH	10.1	10.1	
05/22	DO	9.4 mg/L	9.3 mg/L	Samish, Cain
	pH	7.0	7.0	
	pH	10.0	9.9	
05/24	DO	10.51 mg/L	11.04 mg/L*	Long (Kitsap), Buck
	DO	8.55 mg/L	8.00 mg/L*	Spencer, Mason, Limerick
	pH	7.0	6.91	
	pH	10.0	10.19	
	cond	104 µmho/cm	102 µmho/cm	
05/24	DO	9.3 mg/L	9.5 mg/L	Deep
	pH	7.0	7.1	
	pH	10.0	10.1	
05/26	DO	9.3 mg/L	8.5 mg/L*	Wooten, Summit, Island, Prickett, Nahwatzel
	pH	7.0	7.0	
	pH	10.0	10.1	
05/26	DO	9.5 mg/L	9.5 mg/L	Williams (Spokane), Silver, Clear
	DO[f]	10.1 mg/L	10.5 mg/L	Silver, 1 m
	pH	7.0	7.1	
	pH	10.1	9.9	

Methods:

DO	Azide-modified dissolved oxygen titration
DO[f]	Azide-modified dissolved oxygen titration of field sample
pH 7	standard pH 7 buffer
pH 10	standard pH 10 buffer
pH 4	standard pH 4 buffer
cond	standard KCL conductivity solution, 107 µmho/cm
*	Postcalibration data exceeded acceptable QA limits. Data for this parameter or flagged, or not reported

Appendix D. Continued.

Date 1994	Parameter	Comparison Value	Hydrolab Value	Postcalibration for the following lakes
05/27	DO	9.1 mg/L	9.1 mg/L	Curlew, Twin
	DO[f]	9.9 mg/L	9.8 mg/L	Twin, 1.0 m
	pH	7.0	7.0	
	pH	10.1	10.2	
05/28	DO	9.4 mg/L	9.2 mg/L	Tiger, Wye
	pH	7.0	7.0	
	pH	10.0	10.1	
05/28	DO	10.8 mg/L	10.7 mg/L	Osoyoos, Conconully
	DO[f]	9.9 mg/L	9.8 mg/L	Conconully, 3 m
	pH	7.0	7.0	
	pH	10.1	10.2	
05/29	DO	9.9 mg/L	9.7 mg/L	Crescent
	DO[f]	10.8 mg/L	10.8 mg/L	Crescent, 10 m
	pH	7.0	7.0	
	pH	10.0	10.0	
05/30	DO	9.5 mg/L	9.3 mg/L	Goss, Lone, Cranberry
	pH	7.0	7.0	
	pH	10.0	10.0	
06/01	DO	10.7 mg/L	11.0 mg/L	Martha L., Loma, St. Clair, Lawrence
	pH	7.0	7.0	
	pH	10.0	10.0	
06/01	DO	9.5 mg/L	9.7 mg/L	Wenatchee
	pH	7.0	6.9	
	pH	10.1	10.1	
	cond	104.2 µmho/cm	100.7 µmho/cm	
06/03	DO	9.6 mg/L	9.6 mg/L	Lacamas, Carlisle, Merwin
	pH	7.0	7.2	
	pH	10.0	9.6	
06/03	DO	8.3 mg/L	8.1 mg/L	Lost, Phillips
	DO[f]	9.0 mg/L	9.0 mg/L	Phillips, 3 m
	pH	7.0	7.1	
	pH	10.0	10.0	
	cond	104.2 µmho/cm	110.2 µmho/cm	
06/06	DO	10.04 mg/L	9.6 mg/L	Black (Thurston), Spanaway, Whitman
	pH	7.0	7.0	
	pH	10.0	10.0	
08/16	DO	9.3 mg/L	9.1 mg/L	Long (Th), Chambers, Ward, St. Clair
	DO[f]	9.6 mg/L	9.9	Ward, 2m
	pH	7.0	7.0	
	pH	10.0	10.0	
08/16	DO	8.7 mg/L	9.0 mg/L	Byron
	pH	7.0	7.0	
	pH	10.0	10.1	
08/17	DO	9.7 mg/L	9.9 mg/L	N Pattison
	pH	7.0	6.6*	
	pH	10.0	10.1	
08/17	DO	9.1 mg/L	9.1 mg/L	Black(Stevens), Thomas, Leo
	pH	7.0	7.0	
	pH	10.0	10.1	
08/18	DO	9.9 mg/L	10.2 mg/L	Killarney, Alice, Sawyer
	DO[f]	9.2 mg/L	9.5 mg/L	Sawyer, 0.1 m
	pH	7.0	7.6*	
	pH	10.0	9.5*	

Methods:

DO	Azide-modified dissolved oxygen titration
DO[f]	Azide-modified dissolved oxygen titration of field sample
pH 7	standard pH 7 buffer
pH 10	standard pH 10 buffer
pH 4	standard pH 4 buffer
cond	standard KCL conductivity solution, 107 µmho/cm
*	Postcalibration data exceeded acceptable QA limits. Data for this parameter or flagged, or not reported

Appendix D. Continued.

Date 1994	Parameter	Comparison Value	Hydrolab Value	Postcalibration for the following lakes
08/18	DO	9.2 mg/L	9.3 mg/L	Deep, Big Meadow
	pH	7.0	7.02	
	pH	10.0	9.9	
08/19	DO	9.2 mg/L	9.2 mg/L	L Martha, Howard, Ki, Stevens
	DO[f]	8.6 mg/L	8.2 mg/L	Ki, surface
	pH	7.0	7.3	
	pH	10.0	10.1	
08/19	DO	9.5 mg/L	9.6 mg/L	Waitts, Jumpoff Joe, Eloika
	pH	7.0	7.10	
	pH	10.0	10.01	
08/20	DO	9.2 mg/L	9.1 mg/L	Bosworth, Roesiger, Sunday
	DO[f]	8.6 mg/L	8.7 mg/L	Roesiger, surface
	pH	7.0	7.0	
	pH	10.0	10.3	
08/20	DO	8.6 mg/L	8.6 mg/L	Sullivan, Sacheen, Diamond
	pH	7.0	7.0	
	pH	10.0	9.9	
08/21	DO	9.6 mg/L	9.7 mg/L	Samish, Wiser
	DO[f]	10.0 mg/L	10.4 mg/L	Wiser, surface
	pH	7.0	7.0	
	pH	10.0	10.3	
08/23	DO	10.0 mg/L	10.0 mg/L	Toad, Cain
	DO[f]	8.6 mg/L	9.0 mg/L	Cain, 3.3 m
	pH	7.0	7.0	
	pH	10.0	10.1	
08/23	DO	9.3 mg/L	8.9 mg/L*	Ellen
	pH	7.0	7.2	
	pH	10.0	9.9	
08/24	DO	9.9 mg/L	10.0 mg/L	Long (Kitsap), Buck
	pH	7.0	7.3	
	pH	10.0	10.1	
08/24	DO	9.6 mg/L	10.1* mg/L	Wenatchee, Cortez
	pH	7.0	7.0	
	pH	10.0	9.9	
08/25	DO	9.8 mg/L	10.0 mg/L	Lost, Phillips, Nahwatzel
	pH	7.0	7.4*	
	pH	10.0	9.4*	
08/25	DO	10.0 mg/L	9.8 mg/L	Williams, Silver, Clear
	pH	7.0	7.0	
	pH	10.0	9.9	
08/26	DO	9.0 mg/L	9.2 mg/L	Wooten, Tiger, Wye
	pH	7.0	7.4*	
	pH	10.0	10.2	
08/26	DO	9.7 mg/L	9.6 mg/L	Curlew, Twin
	pH	7.0	7.1	
	pH	10.0	10.0	
08/27	DO	9.6 mg/L	9.8 mg/L	Spanaway, Whitman
	pH	7.0	6.8	
	pH	10.0	10.2	
08/28	DO	9.6 mg/L	9.5 mg/L	Ketchum, Loma, Blackmans, Martha L, Wildcat
	pH	7.0	7.2	
	pH	10.0	9.9	

'Methods:

DO	Azide-modified dissolved oxygen titration
DO[f]	Azide-modified dissolved oxygen titration of field sample
pH 7	standard pH 7 buffer
pH 10	standard pH 10 buffer
pH 4	standard pH 4 buffer
cond	standard KCL conductivity solution, 107 μmho/cm
*	Postcalibration data exceeded acceptable QA limits. Data for this parameter or flagged, or not reported

Appendix D. Continued.

Date 1994	Parameter	Comparison Value	Hydrolab Value	Postcalibration for the following lakes
08/31	DO	8.4 mg/L	8.6 mg/L	Gravelly, Black (Th), Spencer, Mason, Island, Limerick, Carlisle
	pH	7.0	6.5*	
	pH	10.0	10.0	
	cond	104.2 µmho/cm	100.7 µmho/cm	
09/01	DO	9.2 mg/L	9.2 mg/L	Lacamas
	pH	7.0	7.3	
	pH	10.0	9.9	
09/03	DO	10.1 mg/L	10.0 mg/L	Crescent, Summit, Trails End, McIntosh, Lawrence
	pH	7.0	6.8	
	pH	10.0	10.0	
09/04	DO	9.5 mg/L	10.1 mg/L*	Lone, Goss, Cranberry
	pH	7.0	7.2	
	pH	10.0	9.9	

Methods:

DO	Azide-modified dissolved oxygen titration
DO^f	Azide-modified dissolved oxygen titration of field sample
pH 7	standard pH 7 buffer
pH 10	standard pH 10 buffer
pH 4	standard pH 4 buffer
cond	standard KCL conductivity solution, 107 µmho/cm
*	Postcalibration data exceeded acceptable QA limits. Data for this parameter or flagged, or not reported

Appendix E

Hydrolab Postcalibration Data for 1994

Appendix E. Laboratory quality assurance/quality control data for 1994.

1994 Total Phosphorus Data

May Total Phosphorus Lab Splits

Lab Number	Results		CV%
208209	19.1	19.9	2.9
208236	16.7	18.3	6.5
218226	5.9	6.5	6.8
218239	37.1	36.3	1.5
228229	34.7	36.3	3.2
228236	36.3	36.6	0.6
208288	13.9	13.1	4.2
208298	55.9	55.6	0.4
218280	26.6	25.5	3.0
228232	34.4	37.4	5.9

Lab Precision median CV = 3.1%
Acceptable level ≤ 7.5%

August Total Phosphorus Lab Splits

Lab Number	Results		CV%
338497	15.9	15.9	0.0
338499	9.7	9.1	4.5
348498	5.2	5.0	2.8
358499	27.3	29.0	4.3
358424	3.8	4.1	5.4
358426	33.4	33.9	1.1
358436	85.4	84.3	2.9
348512	22.4	22.4	0.0
338508	7.8	8.1	2.7

Lab Precision median CV = 2.8%
Acceptable level ≤7.5%

May Total Phosphorus Field Duplicates

Lake	Site 1	Site 2	CV%
Ward	22.3	19.1	10.9
Roesiger	27.4	16.7	34.3
Wooten	11.0	5.9	42.7
Cranberry	54.6	37.1	27.0
Spanaway	20.4	34.7	36.7
Blackmans	22.1	36.3	34.4
Leo	13.9	18.6	20.5
Sullivan	55.9	13.7	85.7
Clear	26.6	49.9	43.0
Black (Thurston)	44.1	34.4	17.5

Total Precision median CV = 34.4 %
median CV 34.3 % without Sullivan)
Acceptable level ≤ 21%

August Total Phosphorus Field Duplicates

Lake	Site1	Site 2	CV%
Ward	9.9	15.9	32.9
Roesiger	3.7	9.7	63.3
Wooten	10.4	5.2	47.1
Cranberry	77.7	85.4	6.7
Summit	103.0	3.8	131.4
Blackmans	24.0	23.0	3.0
Leo	6.8	6.8	9.9
Sullivan	7.6	1.3U	--
Clear	18.5	22.4	13.5
Black (Thurston)	41.6	27.3	29.4
Lawrence	36.9	33.4	7.0

Total Precision median CV = 21.5%
(median CV 13.3% without Summit Lake)
Acceptable level ≤ 21%

May Total Phosphorus Lab Check Standard Results

Standard value	4.9 µg/L	19.6 µg/L	40.8 µg/L
Batch 1 Results	4.9	20.2	40.5
	4.7	19.7	40.5
	4.9	19.7	41.1
	4.7	19.9	41.3
		20.2	41.3
	Relative error=-2.0%	Relative error=1.7%	Relative error=0.3%
	Acceptable level=<2.5%	Acceptable level=<2.5%	Acceptable level=<2.5%
	Accuracy=98.0%	Accuracy=101.8%	Accuracy=100.3%
	(95.9%-100%)	(100.5%-103.1%)	(99.3%-101.2%)

Standard value	4.9 µg/L	19.6 µg/L	40.8 µg/L
Batch 2 Results	4.9	19.9	40.4
	4.9	20.2	41.7
	4.9	20.5	42.3
	Relative error=0%	Relative error=3.1%	Relative error=1.6%
	Acceptable level=<2.5%	Acceptable level=<2.5%	Acceptable level=<2.5%
	Accuracy=100%	Accuracy=103.1%	Accuracy=101.7%
		(101.5%-104.6%)	(99.0%-103.7%)

Appendix E. Continued.

August Total Phosphorus Lab Check Standard Results

Standard value	4.9 µg/L	19.6 µg/L	40.8 µg/L
Batch 1 Results	4.7	19.5	41.1
	5.2	19.5	40.6
	4.5	20.0	40.3
	4.5	20.0	40.9
	4.7	19.5	40.1
	4.7	20.6	39.8
	Relative error=-3.7%	Relative error=1.3%	Relative error=-0.8%
	Acceptable level=<2.5%	Acceptable level=<2.5%	Acceptable level=<2.5%
	Accuracy=96.2%	Accuracy=101.3%	Accuracy=99.2%
	(91.8% - 106.1%)	(99.5% - 105.1%)	(97.5% - 100.7%)
Standard value	4.9 µg/L	19.6 µg/L	40.8 µg/L
Batch 2 Results	5.0	18.8	40.9
	5.0	19.3	40.1
	5.0	20.6	40.1
	4.5	20.6	39.8
	4.5	20.3	39.8
	4.1	19.1	40.8
	4.3	18.8	41.0
	4.3	18.6	40.8
	Relative error=-6.4%	Relative error=-0.4%	Relative error=-0.9%
	Acceptable level=<2.5%	Acceptable level=<2.5%	Acceptable level=<2.5%
	Accuracy=92.7%	Accuracy=99.6%	Accuracy=99.0%
	(83.7% - 98.0%)	(94.9% - 105.1%)	(97.5% - 100.5%)

Total Phosphorus Field Check Standards

Expected Concentration (µg/L)	Lab Result (µg/L)	95% CI From Literature (µg/L)
15.0	22.3	6.9 - 53.8
30.0	45.5	19.3 - 70.8
150.0	161.1	118.4 - 206.2

Acceptable level=Within 95% CI.

Total Phosphorus Lab Blank Results

May 1994
-0.2683, -0.2683, 0.2683, 0.2683, 0.5365, 0.000, -0.2683, 0.2683, 0.2711, 0.5422, 0.5422, 0.2711, 0.5422, 0.2711, 0.5422
Detection limit=1.6 µg/L

August 1994
0.520, 0.260, -0.520, 0.780, 0.780, -1.04, -0.781, 0.0, 0.520, -0.781, -1.041, -1.041, 0.771, -0.514, -0.771
Detection limit=3.5 µg/L (LWQA Program requires a detection limit of <5µg/L, although 3 µg/L is recommended)

May 1994 Transport Blanks	August 1994 Transport Blanks
3.2 µg/L, 5.5 µg/L	0. 8 µg/L, 0.0 µg/L, 2.6 µg/L

Appendix E. Continued.

1994 Total Persulfate Nitrogen – Lab Duplicates

May 1994

Lab Number	Result 1	Result 2	CV%
218280	0.5760	0.5323	5.6
228205	0.5639	0.5857	2.7
228278	0.1711	0.1661	2.1
218284	0.1840	0.1918	2.9
228214	0.6681	0.6487	2.1
228220	0.9136	0.9101	0.3
228227	0.9961	1.0353	2.7
208298	0.0323U	0.0297*	--
208276	2.5042	2.5624	1.6
208288	0.1750	0.1791	1.6

Lab Precision median CV =2.1 %
Acceptable level ≤ 7.5%

August 1994

Lab Number	Result 1	Result 2	CV%
338407	0.5939	0.5731	2.5
338414	0.2128	0.2165	1.2
338421	0.1928	0.1806	4.6
338428	0.1335	0.1449	5.8
338434	0.7109	0.8081	9.0
338500	1.6699	1.7881	4.8
338502	0.2529	0.2352	5.1
338515	0.4291	0.4705	6.5
338510	0.1776	0.1690	3.5
338520	0.2087	0.2226	4.6
338499	0.1670	0.2131	17.2
348403	0.7746	0.7067	6.5
348412	0.1516	0.1767	10.8
348422	1.1394	1.1536	0.9
348430	0.1363	0.1537	8.5
348518	0.3690	0.3755	1.2
348496	0.3007	0.3254	5.6
348506	0.3349	0.3395	1.0
348500	0.0457U	0.0584	--

Lab Precision median CV =5.0 %
Acceptable level ≤ 5%

Total Persulfate Nitrogen – Field Duplicates

May 1994

Lake	Result 1	Result 2	CV%
Roesiger	0.256	0.248	2.2
Cranberry	0.347	0.312	7.5
Spanaway	0.996	0.996	0.0
Blackmans	0.234	0.220	4.4
Black (Th)	0.180	0.244	21.3
Leo	0.175	0.167	3.3
Clear	0.576	0.536	5.1

Total Precision median CV =4.8 %
Acceptable level ≤30%

August 1994

Lake	Result 1	Result 2	CV%
Roesiger	0.134	0.167	15.5
Cranberry	0.704	0.770	6.3
Lawrence	0.653	0.633	2.2
Black (Th)	0.468	0.375	15.6
Leo	0.150	0.242	60.6
Clear	0.693J	0.800J	10.1

Total Precision median CV = 12.8 %
Acceptable level ≤ 30%

Appendix E. Continued.

Total Persulfate Nitrogen-- 0.196 mg/L Matrix Spikes

May 1994 % Recoveries

51.7%, 96.0%, 100.9%, 99.4%, 95.8%, 97.7
Range = 51.7 - 100.9%
Mean = 90.3%

August 1994 % Recoveries

10.2.2%, 91.9%, 94.8%, 113.0%, 113.7%, 110.0%
Range=91.9-113.0%
Mean=104.3%

Total Persulfate Nitrogen -- Lab check Standards
Note: QAPP states that lab check standards should be between 0.050 mg/L - 0.50 mg/L, and standards of 0.075, 0.40, and 1.0 mg/L are suggested. Majority of sample results are from 0.30 - 0.60 mg/L.

May 1994 Std Value	1.0 mg/L	0.15 mg/L
Batch 1	1.0350 1.0206 0.9994 Relative error=1.8% Acceptable limit ≤ 5% Accuracy=102% (99.9% - 103.5%)	0.1357 0.1475 0.1070 Relative error=-13.3% Acceptable limit ≤ 5% Accuracy=86.7% (71.3% - 98.3%)
Batch 2	0.9402 1.0350 Relative error=-1.2% Acceptable limit ≤ 5% Accuracy=98.8% (94.0% - 103.5%)	0.1556 0.1357 Relative error=-2.9% Acceptable limit ≤ 5% Accuracy=97.1% (90.5% - 103.7%)

August 1994 Std Value	1.0 mg/L	0.15 mg/L	0.608 mg/L
Batch 1	1.0463 1.0708 1.1169 0.9037 Relative error=3.4% Acceptable limit ≤5% Accuracy=103.4% (90.4% - 111.7%)	0.1847 0.1343 Relative error=6.3% Acceptable limit ≤ 5% Accuracy=106.3% (89.5% - 123.1%)	0.5776 0.5600 Relative error=-6.4% Acceptable limit ≤ 5% Accuracy=93.6% (92.1% - 95.0%)
Batch 2*	1.0174 0.9815 1.0251 Relative error=0.8% Acceptable limit ≤ 5% Accuracy=100.8 (98.2% - 102.5%)	0.1448 0.1649 Relative error=3.2% Acceptable limit ≤ 5% Accuracy=103.2% (96.5% = 109.9%)	0.6340 0.6516 Relative error=5.7% Acceptable limit ≤ 5% Accuracy=105.8% (104.3% - 107.2%)

*Note: No QC for Batch 3 were reported. All Batch 2 TPN results were qualified by the lab as estimates ("J" code) because samples were not kept at 4°C until analysis (refrigerator failure).

Appendix E. Continued.

Total Nitrogen Field Check Standards--May survey only

Expected Concentration (mg/L)	Lab Result (mg/L)	CV%	95% CI From Literature (mg/L)
0.050	0.032	31*	-0.219 - 0.490
0.250	0.232	5.3	-0.057 - 0.716
0.500	0.455	6.7	-0.040 - 0.998

Acceptable level ≤15% CV between values, and within 95% CI
* possibly due to dilution error

Total Persulfate Nitrogen -- Lab Blanks

May 1994
Results in mg/L: -0.0194, -0.0194, -0.0138, -0.0138, -0.0149, -0.0149, -0.0225, -0.0225
Detection Limit = 0.020 mg/L

August 1994
Results in mg/L: -0.0053, -0.0053, -0.0163, -0.0163, -0.0265, -0.0265, -0.0249, -0.0118
Detection limit =0.047 mg/L

Acceptable detection limit is ≤ 0.050 mg/L

Chlorophyll *a*

May 1994 Chlorophyll *a* Field Duplicates

Lake	µg/L	µg/L	CV
Samish	1.76	1.37	17.6
Wooten	0.82	0.98	12.6
Cranberry	5.14	7.06	22.3
Spanaway	7.16	6.73	4.4
Blackmans	4.54	3.66	15.2
Leo	1.61	2.07	17.7
Clear	1.69	2.05	13.6
Curlew	1.26	0.26	93.0

Total precision median CV = 16.5%
(15.2% without Curlew)
Acceptable level ≤10%

August 1994 Chlorophyll *a* Field Duplicates

Lake	µg/L	µg/L	CV
Samish	1.31	1.53	11.0
Martha L	6.80	5.11	20.1
Cranberry	10.42	8.35	15.6
Leo	0.56	0.69	14.7

Total precision median CV =15.1%
Acceptable level ≤ 10%

May 1994 Chlorophyll a filter blanks

pre-	post-
0.0	0.0

August 1994 Chlorophyll a filter blanks

pre-	post-
0.0	0.0
0.0	0.65
	0.0

Appendix E. Continued.

Fecal Coliform Bacteria

May 1994 FC Lab Duplicates

Lab #	colony/ 100 mL	dup	CV
228220	28	32	9.4
208277	13	20	30.6
208214	<1	<1	--
218210	1	1	0

Acceptable level <35%

August 1994 FC Lab Duplicates

Lab #	colony/ 100 mL	dup	CV
348512	7	11	31.4
348502	1	1	0
348439	11	8	22.3
358414	<1	<1	--
358403	103	92	8.0
358411	1	<1	--

Acceptable level <35%

May 1994 FC Field Duplicates

Lake	colony/ 100 mL	dup	CV%
Martha L. #1	15	19	16.6
Martha L. #2	4	4	0

Acceptable level <35%

August 1994 Lab Splits

Lake	colony/ 100 mL	dup	CV%
Chambers #1	12	8	28.2
Chambers #2	3	9	70.7

Acceptable level <35%

Turbidity

May 1994 Turbidity Lab Duplicates

Lab #	NTU	dup	difference
208286	0.67	0.75	0.08
208276	51.6	51.7	0.10
208214	1.47	1.53	0.06
218209	0.562	0.574	0.012
218280	0.853	0.814	0.039
228219	1.72	1.73	0.01
228297	0.65	0.64	0.01
228214	4.74	4.49	0.25

Acceptable level = +/- 0.5 NTU

August 1994 Turbidity Lab Duplicates

Lab #	NTU	dup	difference
338402	3.35	3.38	0.03
338512	1.486	1.513	0.027
338500	60.5	59.8	0.7
338438	0.818	0.787	0.31
358410	1.047	1.085	0.038
358414	2.91	2.95	0.04
358402	2.02	2.05	0.03

Acceptable level = +/- 0.5 NTU

May 1994 Turbidity Check Standards

	Std value (NTU)		
	1.213 NTU	13.97 NTU	161.3 NTU
Results	1.308	14.58	161.3
	1.305	14.53	
	1.312	14.61	
	1.311	14.67	
	1.302	14.62	
	1.317		
	1.314		
	1.312		
Relative error	7.7%	4.5%	0%

August 1994 Turbidity Check Standards

	Std value (NTU)		
	1.335 NTU	14.88 NTU	165.5 NTU
Results	1.338	15.03	165.7
	1.338	15.04	
	1.335	15.04	
	1.345	14.96	
	1.345	15.06	
	1.347	15.13	
		15.11	
Relative error	0.5%	1.2%	0.1%