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# Water Quality Assessments of Selected Lakes Within Washington State

## 1998

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# Water Quality Assessments of Selected Lakes Within Washington State

## 1998

by
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# List of Individual Lake Assessments

**Lake (County)**

Crescent (Clallam)
Crocker (Jefferson)
Horseshoe (Pend Oreille)
Island (Mason)
Leland (Jefferson)
Liberty (Spokane)
Limerick (Mason)
Long (Kitsap)
Mason (Mason)
Medical (Spokane)
West Medical (Spokane)
Moses (Grant)
Offutt (Thurston)
Phillips (Mason)
Potholes (Grant)
Spanaway (Pierce)
Sutherland (Clallam)
William Symington (Kitsap)
Ward (Thurston)
Wildcat (Kitsap)

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# Abstract

In 1998 the Washington State Department of Ecology (Ecology) embarked on a different approach to assessing lake water quality. Recent methods in lake monitoring focused on general assessments and long-term trends in water clarity. Although trend data are crucial in the documentation of declining or improving water quality through time, they provide little information as to whether or not beneficial uses of a lake are impaired. The original intent of the Federal Clean Water Act was to protect the beneficial uses (e.g., swimable, drinkable, fishable) of our waters. The new approach in 1998 is an attempt to evaluate the condition of the beneficial uses on certain lakes throughout the state and to recommend lake-specific nutrient criteria for those lakes in order to protect or restore the uses.

New methodology was developed to evaluate various parameters on some of our monitored lakes. Monitoring concentrated on assessing habitat, fish, wildlife, zooplankton, aquatic plants, watershed, water chemistry, and user perception. Beneficial uses were determined by evaluating the user perception surveys and talking with conservation district representatives and the Washington State Department of Fish & Wildlife biologists. A lake-specific criterion was then recommended to protect or improve conditions on the lake. Lake specific criteria were determined using procedures outlined in Washington's Water Quality Standards (WAC 173-201A). If proposed criteria are codified into the WAC, then, should they ever be exceeded in a particular lake, measures could be taken either to reduce nutrient concentrations or to conduct a more detailed study in order to refine the criteria.

# Introduction

The purpose of this report is to describe the portion of the Lake Water Quality Assessment Program that deals with lake-specific studies conducted on 20 selected lakes throughout the state.

## Program Objectives

The objectives of the lake-specific studies portion of the program are as follows:

- ◊ Establish protocols for lake-specific studies.
- ◊ Recommend nutrient criteria, if possible, for each studied lake as per WAC 173-201A-030(6) "Establishing lake nutrient criteria".
- ◊ Establish an integrated approach to lake assessment with Washington State Department of Fish & Wildlife officials, local government officials, and citizen volunteers.

Specific goals for 1998 include:

- ◊ Selecting and sampling 20 lakes according to requests from within Ecology, the Washington State Department of Fish & Wildlife, and local government.
- ◊ Refining methodology for effective assessment of beneficial uses (including methods for habitat assessment), zooplankton indices, watershed assessment, and user perception surveys.
- ◊ Developing a new Y2k compliant database that integrates all the tables created for the different parameters described in the preceding goal, and that is also able to interface with the Ecology Aquatic Plant database.

# 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.

## Lake Selection

Lakes were selected according to the needs described in the Ecology Water Quality Program appraisal for 1998 and by requests from state fish and wildlife biologists. Additional input was sought from local governments when dealing with particular lakes in Thurston, Pierce, and Jefferson counties. The U.S. Park Service was consulted before Crescent Lake was sampled and a sampling permit was obtained for sampling within the national park. Every reasonable attempt was made to recruit volunteers on all selected lakes, however, many lakes were selected for sampling too late in the year to recruit volunteers.

## Field Methods

Many of the field methods implemented in 1998 were adopted from methods utilized or developed outside of Washington State, which were then customized for the program's needs.

### Sample Collection

Ecology staff visited selected lakes for special study monthly from June through September. The purpose of these visits was to (1) collect Hydrolab® profile data and sample for chemical parameters from the deep site of lakes once each month; (2) conduct habitat assessments once during the season; (3) conduct watershed assessments in September; (4) collect zooplankton samples in June and August; (5) distribute user perception surveys; (6) do Secchi depth quality assurance evaluations with volunteer monitors on selected lakes.

During each field visit, the volunteer (on lakes with volunteers) escorted Ecology personnel to their monitoring site, and anchored if possible. The volunteer and Ecology staff each measured Secchi depth. Temperature, pH, dissolved oxygen, and conductivity were profiled using a Hydrolab® Surveyor III and Reporter. 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 at the surface or at depth (as indicated by a large change in dissolved oxygen with no concurrent decrease in temperature), 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 necessarily inclusive of all species present.

During each onsite visit, water samples for total phosphorous (TP), total persulfate nitrogen (TN), turbidity, and chlorophyll *a* were collected using a Kemmerer water sampler, and were composited from two to three equidistant depths within the strata (epilimnion or hypolimnion) sampled (Table 1).

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

| Parameter | Strata Sampled[1] | Sample Preservation[2] | Analytical Method[3] | Method Detection Limit | Holding Time | Analytical Lab[4] |
|---|---|---|---|---|---|---|
| Total Phosphorus | epilimnion, hypolimnion | $H_2SO_4$ to pH < 2 | SM[5] 4500-P D | 3 µg/L | 28 days | MEL |
| Total Nitrogen | epilimnion, hypolimnion | $H_2 SO_4$ to pH < 2 | EPA 353.2 | 10 µg/L | 28 days | MEL |
| Chloro-phyll a[6] | epilimnion | $MgCO_3$[7] | SM 10200H (2,B) | 0.5 µg/L | 28 days | MEL |
| Turbidity | epilimnion | | SM 2540D,E | 1 NTU | 7 days | MEL |
| Fecal Coliform Bacteria | nearshore grab samples (2 sites) | | SM 9222D | 1 colony/ 100 mL | 30 hours | MEL |

1 All samples except fecal coliform bacteria were composited.
2 All samples kept on ice or stored at 4°C until delivery to the lab, or until filtered.
3 Huntamer and Hyre, 1991
4 Manchester Environmental Laboratory (MEL)
5 Standard Method (SM)
6 Corrected for pheophytin.
7 Approximately 2 mL saturated $MgCO_3$ added with last of filtrate onto filter. Filters were iced, or frozen, until delivered to lab.

Fecal coliform 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, 500 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 10 ml of 90% acetone, then stored in the dark and on ice or refrigerated until transported to the lab for analysis.

## Sampling Protocols for Zooplankton

The new approach to measure uses on a given lake includes a need to evaluate the health of a fishery. A widely utilized tool on the east coast of the United States is the measuring of zooplankton as a cost effective surrogate to collecting and measuring fish. An index has been developed in order to determine the predator/prey balance in the fish communities within a given lake (Mills and Schavone, 1982). In a study of 18 natural lakes in upstate New York, Mills and Schavone (1982) demonstrated a strong correlation between mean length of cladocerans and planktivore weight ($r^2 = .70$; $P<0.05$). In other words, the presence of large zooplankton indicate predator fish are keeping prey species in balance. Dominance of smaller zooplankton suggests an ineffective amount of predators to suppress planktivore density.

A standard approach to sampling zooplankton was followed in the field. Methods for collecting, storage, and enumeration are patterned after the "Zooplankton Workshop Reference Guide" prepared by BSA Environmental Services, Inc. (Beaver, 1997).

### Sampling Period

Five vertical tows were pulled in June and five were pulled in August from the deep site of each selected lake. Tows were composited into one 125ml sample bottle. Five tows were not necessary if there were an abundance of zooplankton in the first few tows. Duplicate samples (again, five tows if necessary) were taken at duplicate TP sample sites.

### Field Procedure

The Wisconsin net was pulled from a depth of one meter off the bottom or 20 meters, whichever was less. The depth was rounded to the most conservative meter to ensure bottom sediments weren't disturbed. Nets were retrieved at a rate of one meter per three seconds.

Upon retrieval of the sample, a squirt bottle filled with tap or distilled water was used to dislodge any zooplankton that may have been clinging to the mesh. Samples were discharged into a 125 mL amber, Lugol-treated sample container and preserved with approximately 15 mls of Lugol's solution.

### Sample Analysis

Samples were analyzed for relative abundance of cladocerans and copepods and their mean length. Relative abundance was determined using a Sedgewick-Rafter counting chamber and a compound microscope. Subsamples were analyzed to estimate mean length of the zooplankton using a compound microscope and an ocular equipped with a reticle. Measurements were recorded to the nearest 0.2mm. Results were tabulated as the ratio of total cladocerans:total copepeods.

Data Interpretation

Due to time constraints in 1998, it was not possible to fully analyze the collected samples of zooplankton but the following provides possibilities for future data interpretation. A subset of lakes sampled by Ecology in 1998 were also surveyed by the Washington State Department of Fish and Wildlife. Zooplankton mean length data should be compared to fish length-frequency distributions to evaluate whether there is a particular mean zooplankton length that could be used as a pivot indicator of a balanced predator/prey fish population in a given lake (e.g. 1.0 mm is used in some states). An index with a range of mean lengths within given categories may be the most effective use of the zooplankton data. For example, mean zooplankton lengths between 0.9 mm and 1.0 mm may be rated as "fair" for predator/prey populations and mean lengths between 1.0 mm and 1.1 mm may rate "good" and above 1.1 mm rated as "fair," etc. A fair rating or worse could then be used to demonstrate impairment of a beneficial use.

Relative zooplankton abundance data may be correlated with nutrient and Secchi data. It is uncertain at this time whether or not zooplankton abundance is a good indicator of predator/prey balance. However, correlations with traditional water chemistry data and additional fish population data may demonstrate whether or not trophic cascade effects are present in Washington lakes (Brett and Goldman, 1996). Zooplankton data may also explain differences between total phosphorus concentrations and expected correlated values for chlorophyll *a*/Secchi measurements.

## Habitat Characterization

Details of the habitat survey and methodology are covered at length in the EPA publication EPA/620/R-97/001 entitled *Surface Waters, Field Operations Manual for Lakes*, Section 5 (Kaufmann and Whittier, 1997). In order to do a whole lake assessment, an evaluation of the riparian and littoral zones is important. The new methodology published in the EPA manual provides an excellent approach to evaluating these zones. It allows for the evaluation of physical structure, aquatic vegetation and human impacts, all of which may contribute to the protection or degradation of lake water quality.

## Watershed Survey

A cursory "windshield" survey of the watershed was implemented as part of the new approach to assessing lakes because knowledge of the watershed may contribute to understanding attributes of the water quality in the lake. For instance, if agriculture is predominant in the watershed, livestock or fertilizers may be impacting the lake's tributaries. Also, many poor management practices can be seen from the windshield of a vehicle. Due to the lack of time and funds, a more thorough watershed assessment was not practical. A copy of the survey form used in the field is located in Appendix A.

## User Perception Questionnaire

The idea of implementing user perception surveys originated after reviewing research conducted by University of Maine's Water Research Institute. Maine's research demonstrated relationships between water clarity and property values and other socio-economic factors within the lake community (Boyle et al., 1997). WAC 173-201A-030(6) calls for public input before setting a nutrient criterion in a lake. The surveys conducted in Maine were modified and edited for Washington State then distributed, on a limited basis, to most of the lake communities studied in 1998.

The questionnaires were designed primarily to help investigators of lake water quality determine the following:

1) Primary recreational uses and their relative importance.
2) Lake user's perception of the quality of those uses.
3) Socio-economic value of the resource.

In 1998, however, efforts were focused primarily on objective #1 while objectives #2 and #3 were experimented with.

Questionnaire data was not collected rigorously and it has been cautiously interpreted. Although an effort was made to widely distribute the questionnaires, only a small fraction were returned. Returns were greatest where volunteers were available to hand-distribute the questionnaire.

Two types of questionnaires were developed, one for visitors and one for residents, though most questions were common to both. The resident questionnaire, located in Appendix A, is followed by a brief synopsis of why each question was asked.

## 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 described in 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 Tarver *et al*. (1978), Prescott (1980), and others (see Parsons, 1999).

## 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 professional judgment, were used to estimate the trophic status of the monitored lakes. In general, TSIs of 40 or less indicate oligotrophy, TSIs greater than 40 indicate mesotrophy, and TSIs greater than 50 indicate eutrophy (Carlson, 1979).

To describe lakes that 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 mid-May and mid-October 1998. A minimum of five Secchi depth measurements separated by at least two weeks were used to calculate the $TSI_{SD}$ for each lake. Those $TSI_{SD}$ values failing the five measurement minimum are qualified with the letter ‘N.’ Data invalidated by the QA/QC evaluation (below) were excluded from the $TSI_{SD}$ calculations. $TSI_{TP}$ and $TSI_{CHL}$ values were similarly calculated from time-weighted mean total phosphorous and chlorophyll values, respectively.

It is not valid 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.” 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 (short term lake surveys conducted by Ecology or universities, and consultant reports from Ecology-funded lake restoration activities), and information from the volunteers (e.g. on aquatic herbicide use) were used to temper the trophic state assessment for most lakes. As a result, the trophic state estimations were not based on TSI alone, and were not necessarily based on the same parameters for all lakes. The basis for each trophic state assessment is discussed in the “Summary” section of the individual lake assessments in Appendix B.

## Overall Lake Assessments and Setting Criteria

Water Quality Standards (WAC 173-201A (6)) suggest total phosphorus criteria for lakes (also referred to as “action values”) based on ecoregion and trophic state. If measured concentrations are below the action value, a criterion may be proposed at or below the action value, or a lake-specific study may be conducted. Measured concentrations above the action value or where no action value is provided require a lake-specific study. The characteristics monitored in the LWQA Program are similar to examples included in the Water Quality Standards for lake-specific studies.

An evaluation of the primary beneficial uses on each lake is one of the purposes of the lake-specific study. These were determined from the user perception surveys, observations during sampling, and discussions with volunteer monitors. Determining whether or not the water quality in the lake supports the beneficial uses required best professional judgment. The types of uses were considered and water quality was subsequently determined sufficient or insufficient to support those uses. The results of the questionnaires were reviewed to determine how the users perceive the water quality. Additionally, local governments, fish and wildlife officials, and other lake studies were consulted. Results from the habitat survey provided information on aquatic vegetation, which may impact the quality of swimming, fishing, and boating, as well as fish reproduction and wildlife habitat suitability.

If beneficial uses were supported, then the nutrient criterion recommended for the lake was generally the mean total phosphorus concentration plus an adjustment for interannual variation (described further, below) or the action value. The final recommendation also depended on best professional judgment as to whether current nutrient concentrations are higher due to anthropogenic sources.

If uses were not supported due to being adversely impacted by artificially high nutrient concentrations, then further study may be necessary to determine what nutrient concentrations are needed to support the beneficial uses. Alternatively, if uses were not supported because of habitat modifications, or other non-nutrient related attributes, then recommendations were made on how to improve conditions in order to support those uses. Recommendations can be based on the results from water quality, habitat, watershed, user perception, zooplankton, and Hydrolab® surveys. One benefit of this new approach to lake assessment is the potential to use all the information for management purposes.

The lake-specific nutrient criteria proposed in this report were selected using information compiled through the seasonal sampling. As previously discussed, the criterion was usually recommended as either the action value, or the mean total phosphorus concentration plus an adjustment to allow for natural interannual variation. This adjustment was calculated as the median interannual standard deviation of all lakes monitored by the LWQA program for more than two years with similar phosphorus concentrations to the lake being evaluated (Table 2). For example, if the seasonal mean value for phosphorus in a given lake was 18.3 ug/L, a recommendation of a nutrient criterion of 18.3 + 4.1 = 22.4 ug/L total phosphorus was made. However, if that lake were in the Puget Lowlands and was assessed as lower mesotrophic, the action value of 20 ug/L may be recommended because the action value is more protective yet is still above the mean measured concentration.

Table 2. Median inter-annual standard deviations based on historical data as a function of mean total phosphorus concentrations.

| Mean Phosphorus Concentration of sampled lake | Median Inter-annual Standard Deviation (of all lakes) | Number of Lakes |
|---|---|---|
| Less than or equal to 10 | 3.0 | 19 |
| >10 through 20 | 4.1 | 43 |
| >20 through 30 | 5.1 | 17 |
| >30 through 40 | 8.0 | 16 |
| >40 through 60 | 15.0 | 7 |
| >60 through 80 | 27.8 | 2 |
| Greater than 100 | 70.6 | 8 |

The intent of recommended criteria is to be protective but not overly sensitive—criteria should be sensitive enough to identify lakes that may be degraded or degrading; yet they should not be so sensitive as to be meaningless as a management tool. These criteria should be considered preliminary. Once a lake has exceeded a criterion, a more detailed study should be conducted, particularly a nutrient loading analysis, the first objective of which should be an evaluation and refinement of the criterion.

# Results

Individual lake assessments and proposed criteria are in Appendix B. Table 3 below, summarizes the trophic state, mean total phosphorous values, and proposed criteria for each lake.

Table 3. Summary of individual lake assessments.

| Lake Name | County | Assessed Trophic State | Mean TP Concentration (ug/L) | Proposed TP Criterion (ug/L) |
|---|---|---|---|---|
| Crescent | Clallam | Oligotrophic | 3.0 U[a] | 4 |
| Crocker | Jefferson | Eutrophic | 58 | 73 |
| Horseshoe | Pend Oreille | Mesoeutrophic | 20.3 | 25.4 |
| Island | Mason | Oligotrophic | 8.1 | 10 |
| Leland | Jefferson | Mesoeutrophic | 18.3 | 20 |
| Liberty | Spokane | Oligomestrophic | 13.3 | 17.4 |
| Limerick | Mason | Mesotrophic | 9.0 | 10 |
| Long | Kitsap | Eutrophic | 29.6 | 34.7 |
| Mason | Mason | Oligotrophic | 4.3 | 7.3 |
| Medical | Spokane | Eutrophic | 29.4 | None[b] |
| Medical, West | Spokane | Eutrophic | Nitrogen = 1.20 mg/L[c] | Nitrogen = 1.36 mg/L[c] |
| Moses | Grant | Eutrophic | 79.2 | None[d] |
| Offutt | Thurston | Mesotrophic | 19.2 | 20 |
| Phillips | Mason | Oligotrophic | 7.6 | 10 |
| Potholes | Grant | Eutrophic | 36 | 44 |
| Spanaway | Pierce | Mesoeutrophic | 16.6 | 20 |
| Sutherland | Clallam | Oligotrophic | 4.7 | 7.7 |
| William Symington | Kitsap | Mesotrophic | 11.3 | 20 |
| Ward | Thurston | Oligomesotrophic | 8.8 | 10 |
| Wildcat | Kitsap | Oligotrophic | 7.7 | 10 |

[a] Phosphorus results qualified with a "U" indicate the analyte was not detected at or above the reported result.

[b] A criterion was not proposed for Medical Lake due to artificial maintenance of water quality (by aeration) and a need for further study.

[c] For lakes in which nitrogen, rather than phosphorous, is the limiting nutrient, a nitrogen criterion is recommended.

[d] A criterion for Moses Lake was not established since that was not the objective of the intensive study of this lake.

# Quality Assurance and Quality Control Evaluation

All data collected for the LWQA Program were evaluated to determine whether data quality objectives for the program (Table 4) were met. Methods used for data quality evaluations are described in *Lake Water Quality Assessment Program Quality Assurance Project Plan* (Hallock, 1995-draft). QA/QC analysis for all parameters is listed in Appendix C.

Table 4. Summary of data quality objectives for the LWQA Program.

| Parameter | Detection Limit | Precision | Accuracy (Bias) |
|---|---|---|---|
| Secchi Depth | -- | < 10% CV[a] (daily pairs)<br>< 5% median CV (all pairs/lake) | < 10% CV[b] (volunteer/ Ecology) |
| Total Phosphorus | 5 µg/L | < 7.5% CV (10 lab splits) | < 2.5% relative bias (lab check standards) |
| Total Persulfate Nitrogen | 0.050 mg/L | < 5% CV (lab splits) | < 5% relative bias (lab check standards) |
| Chlorophyll *a* | 0.5 µg/L | < 10% CV (field dups)<br>< 45% CV (May/August) | < 2.5% relative bias (lab check standards) |
| Profile parameters | | | |
| Temp. | -- | -- | ± 1.0°C |
| pH | -- | -- | ± 0.2 SU |
| D.O. | -- | -- | ± 0.50 mg/L |
| spec. cond. | -- | -- | ± 5 µmho/cm |
| Fecal Coliforms | 1 colony/100 mL | < 35% CV (lab splits) | -- |

[a] Coefficient of Variation

[b] In the case of Secchi depth, this isn't truly "accuracy" but rather a comparison between volunteer and Ecology staff collected readings.

## Profile Data

The Hydrolabs® were pre- and post-calibrated daily for pH and dissolved oxygen. The manufacturer's instructions were followed for pH calibration, using pH 7 (low ionic strength) and pH 10 (standard ionic strength) standard buffer solutions. Post-calibration readings within 0.2 pH units of the standard buffer values were considered acceptable. Two post-calibration readings out of 42 taken did not meet quality assurance requirements. The dissolved oxygen

sensor was calibrated against theoretical water-saturated air, in accordance with manufacturer's instructions. Daily field samples were collected for Winkler titrations and check standards. Post-calibration results within 0.5 mg/L were considered acceptable. Five post-calibration readings out of 38 taken failed quality assurance requirements. Three field checks of 13 taken failed quality assurance requirements. 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 147 µmhos/cm at 25°C (the molarity varied between individual solutions used). Post-calibration values within 5 µmhos/cm of the standard value were considered acceptable. One post-calibration reading out of four calibration checks taken did not meet quality assurance requirements. Temperature was also checked periodically against a National Bureau of Standards (NBS) mercury thermometer. Values within 1.0°C were considered acceptable. All four post-calibration results met quality assurance requirements. Post-calibration results are listed in Appendix D.

Additionally, two duplicate Hydrolab® profiles were collected on each survey. "Nonsequential" duplicates were collected from a separate station, the same station as the nutrient duplicate sample. "Sequential" duplicates were collected by retrieving the Hydrolab® and immediately repeating the measurements at the same station and depths as previously measured. The precision of duplicate readings was calculated as the median of CV%s of data pairs from the same depths. Although no specific quality assurance standards were set for duplicate Hydrolab® data, all median CV%s were under four percent, indicating good precision. As expected, nonsequential duplicates are generally slightly more variable than sequential duplicates. Median CV%s are listed below in Table 5. Additionally, profile quality assurance results are listed in Appendix D.

Table 5. Summary of Quality Assurance/Quality Control data for Hydrolab® profiles.

| **DISSOLVED OXYGEN** | | | | **PH** | | | |
|---|---|---|---|---|---|---|---|
| **Nonsequential Duplicates** | | **Sequential Duplicates** | | **Nonsequential Duplicates** | | **Sequential Duplicates** | |
| Date | Median CV% | Date | Median CV% | Date | Median CV% | Date | Median CV% |
| June | 2.56 | June | 3.04 | June | 2.38 | June | 0.5 |
| July | 3.29 | July | 1.72 | July | 0.00 | July | 0.85 |
| August | 1.89 | August | 0.94 | August | 0.82 | August | 0.00 |
| September | 3.78 | September | 1.28 | September | 0.00 | September | 0.00 |

| **TEMPERATURE** | | | | **CONDUCTIVITY** | | | |
|---|---|---|---|---|---|---|---|
| **Nonsequential Duplicates** | | **Sequential Duplicates** | | **Nonsequential Duplicates** | | **Sequential Duplicates** | |
| Date | Median CV% | Date | Median CV% | Date | Median CV% | Date | Median CV% |
| June | 0.71 | June | 0.22 | June | 0.17 | June | 0.17 |
| July | 1.15 | July | 0.31 | July | 0.17 | July | 0.09 |
| August | 0.31 | August | 0.00 | August | 0.00 | August | 0.00 |
| September | 0.34 | September | 2.40 | September | 0.16 | September | 0.00 |

# Laboratory Quality Assurance

Laboratory QC requirements include the use of check standards, reference materials, matrix spikes, blanks, and lab split samples (duplicates). Lab splits are discussed below. For the most part, data quality for this project met all lab quality assurance and quality control criteria as determined and evaluated by the Manchester Environmental Laboratory. Exceptions, which caused results to be qualified as estimates include the following: sixteen turbidity samples and seven chlorophyll a samples exceeded holding times due to a shipping problem and subsequent late arrival at the lab; ten turbidity samples were qualified due to high algae concentrations; one total phosphorous sample was qualified due to spike recovery exceeding the acceptance limit; and ten total phosphorous samples were qualified due to the calibration check standard being outside of control limits. Additionally, several results were qualified as containing the analyte below the method's limit of detection. These qualifiers were noted and taken into consideration when assessing lake water quality and recommending nutrient criteria.

# Field Quality Assurance

## Total Phosphorous Data

Lab precision was calculated by pooling the coefficients for all pairs of lab splits. Results (Appendix C) were all under the acceptable median CV% of 7.5 percent (Table 6).

Total phosphorous samples were collected at a second site from ten lakes during the course of the survey. These duplicate samples were collected to evaluate the representativeness of collecting epilimnetic data from a single lake station. The Quality Assurance Project Plan (QAPP) for the LWQA Program (Hallock, 1995) states that the total precision of these nonsequential duplicates should be evaluated by pooling the CV%s for each pair and, if the median CV% exceeds 21 percent, then collecting from a single lake station is generally not representative of lakewide epilimnetic phosphorous. Results (Appendix C) show that the median CV% did not exceed 21 percent; therefore, sampling at one site is generally representative (Table 6).

In addition to nonsequential duplicates, sequential duplicates were collected by immediately repeating the sample collection at the nonsequential site. Although no specific quality assurance standards were set for sequential duplicate total phosphorous data, all median CV%s indicate little variance (Table 6).

## Other Water Chemistry Data

QA/QC evaluations for total nitrogen, chlorophyll *a*, solids, and fecal coliform bacteria followed the methods described in Hallock (1995). All available lab QC data results are listed in Appendix C and summarized below in Table 6.

Total Nitrogen

All median CV%s for total nitrogen lab splits fell below the QAPP standard of 7.5 percent. Similarly, all nonsequential duplicate median CV%s were well under the QAPP standard of 30 percent.

Chlorophyll a

All median CV%s for chlorophyll a lab splits fell below the QAPP standard of 10 percent. However, sequential duplicate results exceeded QAPP standards for both June and July indicating difficulty in collecting consistent composite samples. However, the mean variance was high largely due to two samples with concentrations less than one, where even a small absolute difference between results can yield a large CV% (Appendix C). August and September sequential duplicate median CV%s were under the QAPP standard of 10 percent.

Fecal Coliform Bacteria

It is not possible to conduct quality assurance calculations on fecal coliform data due to the wide variability in fecal concentrations expected in the field. We do not consider a single fecal bacteria sample to be representative lakewide. These samples were generally used to assess high risk or potential source areas such as swimming beaches, heavily developed embayments, etc.

Turbidity

All turbidity readings were within 0.5 NTUs, the acceptable range set forth by the QAPP.

Table 6. Summary of Quality Assurance/Quality Control Data for 1998.

**TOTAL PHOSPHOROUS**

| **Lab Splits (QAPP standard ≤7.5%)** | | **Nonsequential Duplicates (standard ≤21%)** | | **Sequential Duplicates (no standard)** | |
|---|---|---|---|---|---|
| Date | Median CV% | Date | Median CV% | Date | Median CV% |
| June | 3.4 | June | 8.8 | June | Not avail. |
| July | 3.8 | July | 19.0 | July | 2.4 |
| August | 2.3 | August | 5.0 | August | 5.4 |
| September | 0.8 | September | 8.8 | September | 25.9 |

**TOTAL NITROGEN**

| **Lab Splits (QAPP standard ≤5%)** | | **Nonsequential Duplicates (standard ≤30%)** | | **Sequential Duplicates (no standard)** | |
|---|---|---|---|---|---|
| Date | Median CV% | Date | Median CV% | Date | Median CV% |
| June | 0.3 | June | 1.9 | June | Not avail. |
| July | 2.7 | July | 7.7 | July | 4.1 |
| August | 1.2 | August | 5.4 | August | 1.6 |
| September | 2.2 | September | 2.5 | September | 0.0 |

**CHLOROPHYLL A**

| **Lab Splits (QAPP standard ≤10%)** | | **Nonsequential Duplicates (no standard)** | | **Sequential Duplicates (standard ≤10%)** | |
|---|---|---|---|---|---|
| Date | Median CV% | Date | Median CV% | Date | Median CV% |
| June | 5.0 | June | 9.9 | June | **24.7** |
| July | 3.7 | July | 10.5 | July | **10.9** |
| August | 2.7 | August | 19.8 | August | 6.1 |
| September | 2.7 | September | 11.6 | September | 10.0 |

**TURBIDITY**

| **Lab Splits (QAPP standard within 0.5NTU)** | | **Nonsequential Duplicates (no standard)** | | **No turbidity sequential duplicates were collected** |
|---|---|---|---|---|
| Date | Max. Difference | Date | Median CV% | |
| June | 0.2 | June | 6.7 | |
| July | 0.1 | July | Not Available | |
| August | 0.2 | August | 0.0 | |
| September | 0.4 | September | 0.0 | |

# Recommendations

- ◊ The questionnaires provided useful supporting information for the lake assessments. A more rigorous methodology for collecting and evaluating the user surveys should be developed for future use. The habitat surveys may be much harder to summarize because different habitat attributes may be more important on one lake than another; looking at results for individual metrics may be more useful than a summary. The watershed survey would be difficult to summarize and is very useful in its present form as a general overview of the watershed.

- ◊ The zooplankton index should be further tested as an indicator of fish predator/prey balance, as intended, and developed further to help elucidate the trophic cascade relationships in Washington lakes.

- ◊ An acceptable protocol is needed to recommend nutrient criteria in lakes where the water quality does not support the beneficial uses. Setting values with very little knowledge of nutrient loading conditions could be problematic.

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# Appendix A

**Survey Forms**

## Watershed Survey

# Date: Name of Lake:

1. In reference to the watershed in general, note types of land use
   -Agriculture (commercial, not hobby)
   -Residential
   -Commercial, Industrial
   -Major transportation
   -Park, forest or natural

On a relative scale, rank the above land uses from most prominent to least in respect to how it may have the most adverse impact on the lake. (Example: A lake watershed may be 90% forest land but none of that may be under harvest at the time of survey but I-5 may transit just 200 meters from the lake with runoff from the highway going directly to the lake. Forest land may be most prominent in area but major transportation would have the most adverse impact on the lake.)

2. Impervious surfaces (Roads and parking areas)
   -Mostly curbed with storm drains (>75%)
   -About half of the surfaces are curbed (35-75%)
   -Partially curbed
   -No curbs

3. BMPs evident (Y or N)
   -Give examples of BMPs and/or lack of

4. Odors from septics or agriculture detectable?
   -If yes, please note where

5. Cattle, ducks or geese in the water? If so, where?

6. Fertilizers and weed killers appear to be used in residential or agriculture areas (Y or N). If so, where?

7. Buffer zones around steams and wetlands noticed? If lacking, where?

8. Are there any irrigation withdrawals noted from lake or tributaries of the lake? Is so, where?

9. Approximately what portion of the watershed did you survey?

## Lake Survey for Residents

# Date: Name of Lake:

## Introduction:

The Department of Ecology is conducting a study on this lake. We are attempting to obtain information from people who are visiting the lake. Information provided will be used in conjunction with scientific measurements in an effort to adequately assess the lake and its uses. If you have already filled out this survey this summer then you may do so again if the conditions on the lake have changed to the point where your answers have changed. Attempt to answer the questions based on your experience at the time you were last recreating on the lake or lake shore and ensure that the date written above matches the date of the visit. If you have any questions, please call Kirk Smith at 360-407-6680.

## General:

Are you a seasonal or permanent resident of the Lake?

☐ Seasonal Resident

☐ *Permanent Resident (if permanent, go to question 2)*

1. Where is your permanent residence?

   _____

   City/Town State

2. Including this year, how many years have you lived or come to stay at the lake?
   _____years

3. Do you own or rent this property?
   ☐ *Own*

   ☐ *Rent*

4. What is the **primary** activity you took part in when recreating on the lake today? (**<u>check one only</u>**)

   ☐ canoeing/kayaking
   ☐ fishing
   ☐ personal watercraft
   ☐ motor boating
   ☐ sailing
   ☐ swimming/wading
   ☐ watching birds/wildlife
   ☐ water skiing
   ☐ wind surfing
   ☐ relaxing on the shore
   ☐ other_____

The following question asks about your decision to recreate on this lake.

5. Of the following attributes, which added to or detracted from your enjoyment? **Please mark in the "Qualifiers" column when applicable** or use the blank in that column to briefly comment on that attribute.

| | Added to | No Effect | Detracted from | Qualifiers (X=yes) |
|---|---|---|---|---|
| types of water craft allowed | ☐ | ☐ | ☐ | ☐ Restricted use (5mph, etc.) |
| public access | ☐ | ☐ | ☐ | ☐ Available? |
| water clarity | ☐ | ☐ | ☐ | |
| fishing quality | ☐ | ☐ | ☐ | |
| scenic views | ☐ | ☐ | ☐ | |
| having a swimming beach | ☐ | ☐ | ☐ | ☐ Available? |
| water quality for swimming | ☐ | ☐ | ☐ | |
| having plants in the water | ☐ | ☐ | ☐ | |
| distance traveled to lake | ☐ | ☐ | ☐ | Miles (one way)?_____ |
| Canada geese | ☐ | ☐ | ☐ | ☐ N/A |

6. On the scale of 1 to 5, how would you rate the quality of the water clarity today? 1 being poor and 5 being excellent. _____

7. When deciding to (purchase/rent) this residence, did you consider the clarity of the water?

☐ No
☐ Yes

8. Have you noticed a change in water clarity at the lake over the years?

☐ *diminished (approximately what year did the change begin?)* _____
☐ no change
☐ *enhanced (approximately what year did the change begin?)*
☐ Don't know

9. If it wasn't possible to have both, would you rather have (a) better fishing and more natural habitat or (b) clearer water? _____

10. If it wasn't possible to have both, would you rather have (a) better fishing and more natural habitat or (b) few aquatic plants? _____

11. If it wasn't possible to have both, would you rather have (a) clearer water or (b) few aquatic plants? _____

12. Please rate how important each of the following lake characteristic is to you.

**(CIRCLE ONE NUMBER FOR EACH CHARACTERISTIC)**

| | Very Undesirable | Undesirable | Neither | Desirable | Very Desirable |
|---|---|---|---|---|---|
| Restricted watercraft use | 1 | 2 | 3 | 4 | 5 |
| Plant growth in the water | 1 | 2 | 3 | 4 | 5 |
| More natural shoreline | 1 | 2 | 3 | 4 | 5 |
| No water odor | 1 | 2 | 3 | 4 | 5 |
| Good trout/salmon fishing | 1 | 2 | 3 | 4 | 5 |
| Good bass/perch fishing | 1 | 2 | 3 | 4 | 5 |
| Good swimming | 1 | 2 | 3 | 4 | 5 |
| Less algae | 1 | 2 | 3 | 4 | 5 |
| Public access | 1 | 2 | 3 | 4 | 5 |
| Clear water | 1 | 2 | 3 | 4 | 5 |
| Views of natural scenery | 1 | 2 | 3 | 4 | 5 |
| Public beach | 1 | 2 | 3 | 4 | 5 |
| Canada geese | 1 | 2 | 3 | 4 | 5 |
| Other, please explain | 1 | 2 | 3 | 4 | 5 |

This concludes the survey. Thank you very much for your time and cooperation. Your help is very much appreciated.

## --Did you put the date and the name of the lake at the top of the survey?

**Summary of Resident's Survey**: The survey for day visitors is very similar to the to the survey for residents. The main exception is that more questions pertaining to socio-economics are not included. (Changes in lake quality have been shown to impact property values in addition to the enjoyment of the resource (Boyle et al., 1997)). With one exception, all of the questions below will be used to meet objective #3.

1. Helps establish where seasonal residents reside permanently. For instance, it may be important to know that most of the seasonal residents on Lake X come from the Seattle area vs. other metro areas or that more of the seasonal residents on Lake Y are from Seattle compared to Lake X even though Lake X is closer to Seattle. Investigators may then want to look at why Lake Y appears to be more popular.

2. Aids in determining whether or not the respondent has a historical perspective. A person who has been coming to the lake every summer for the last 12 years may provide more valuable information than someone who has just starting to vacation on the lake.

3. Establishes whether or not the resident is an owner of the property in which case he or she may have more of an interest in the quality of the lake.

4. Helps discern what the primary human uses are for that particular lake (part one of objective #1). The question will help narrow the scope of the data analysis by guiding the evaluation of uses.

5. Helps discern conflicts between uses and whether or not uses are impaired. For instance, high-speed water craft may impair overall scenic beauty for someone who has primarily come to the lake to relax on the shore. Also, the closeness to home question adds a component that helps evaluate the overall socio-economic importance of that water body. Lakes where users are willing to travel great distances to recreate may be said to have a greater user value. An index could be developed to show the lake value based on miles willing to travel to get to the lake. (objectives #1 part 2, #2, #3).

6. Attempts to match user perception of water clarity with Secchi readings taken for that day. Hypothetically, a percentage (40%?) indicating water clarity is poor could be set as a threshold before acceptable nutrient concentrations are exceeded for that lake. A nutrient criterion could then be established for that threshold using interpolated LWQA historical data compiled for similar lakes or some other model. This would only apply if it was determined that impaired primary recreational uses were linked to water clarity. For example: Water skiing is determined to be the primary recreational use of a lake but the use is impaired by quality of water for swimming and water clarity (questions #4 and #5). Management for water clarity may then be warranted for that particular lake (objective #2). If 56% of respondents in August indicate poor water quality for Lake X, then the beneficial uses of the lake are said to be impaired and a nutrient criterion should be set at concentrations below present levels. On the other hand, if the lake is primarily used for fishing, wildlife habitat, and scenery and there is little primary contact, then beneficial uses of the lake may not be impaired even if there are more than 40% of the respondents replying with a “yes” response. This may be also be true for lakes which habitat and watershed surveys suggest is at or near a natural condition.

7. Attempts to establish a direct relationship between water clarity and willingness to rent/buy. This question could also be used to determine if owners are more concerned about water clarity than renters.

8. Generates historical knowledge on possible trends in water quality. The answers could be difficult to interpret, especially if there was no overwhelming response for any of the choices. However, where a majority (over 50 %) of responses indicate a consistent change in clarity, results from this question may support an evaluation of historical data. Also, this question would be of particular importance when assessing lakes that have undergone some type of restoration. If restored lakes don't indicate an overwhelming perception of improved water clarity then there may be reason to believe that beneficial uses are still impaired despite restoration efforts. (objective #2)

9 – 11. Helps those being surveyed resolve in their minds what is more important, human or non-human uses. Answers to these questions may be particularly important if there are conflicting uses on the lake. For instance, if bird watching, relaxing on shore and swimming were the top beneficial uses on a lake, it may be important to determine if the survey respondents believe saving wildlife habitat is more important for that particular lake even at the expense of having clear and/or weedless water for swimming. These questions could be pivotal for some lakes (Lake Limerick in Mason County may be a good test for these questions). (objective #1)

12. Determines whether or not there is a need for protecting a use on the lake. Allows respondents to place values on the uses of the lake relative to other uses for the lake. Weighted answers could help accentuate the need or importance of some uses to be managed more than others. An example would be an extraordinarily high number of "Very Desirable" rating for "Few problem waterfowl." Such a response may direct the need for habitat management and suggest lake specific criteria be set for habitat as well as other criteria (e. g., fecal coliform bacteria). This question also demonstrates the socio-economic importance of each lake attribute. The general public may feel that water clarity has detracted from their enjoyment on the lake in question #3 but may not value that quality as much as few problem waterfowl, views of natural scenery, public access, and no water odor. Weighted answers are important to help set priorities for lake specific criteria by adding values to the uses. (objectives #1 and #3)

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# Appendix B

**Individual Lake Assessments**

# CRESCENT

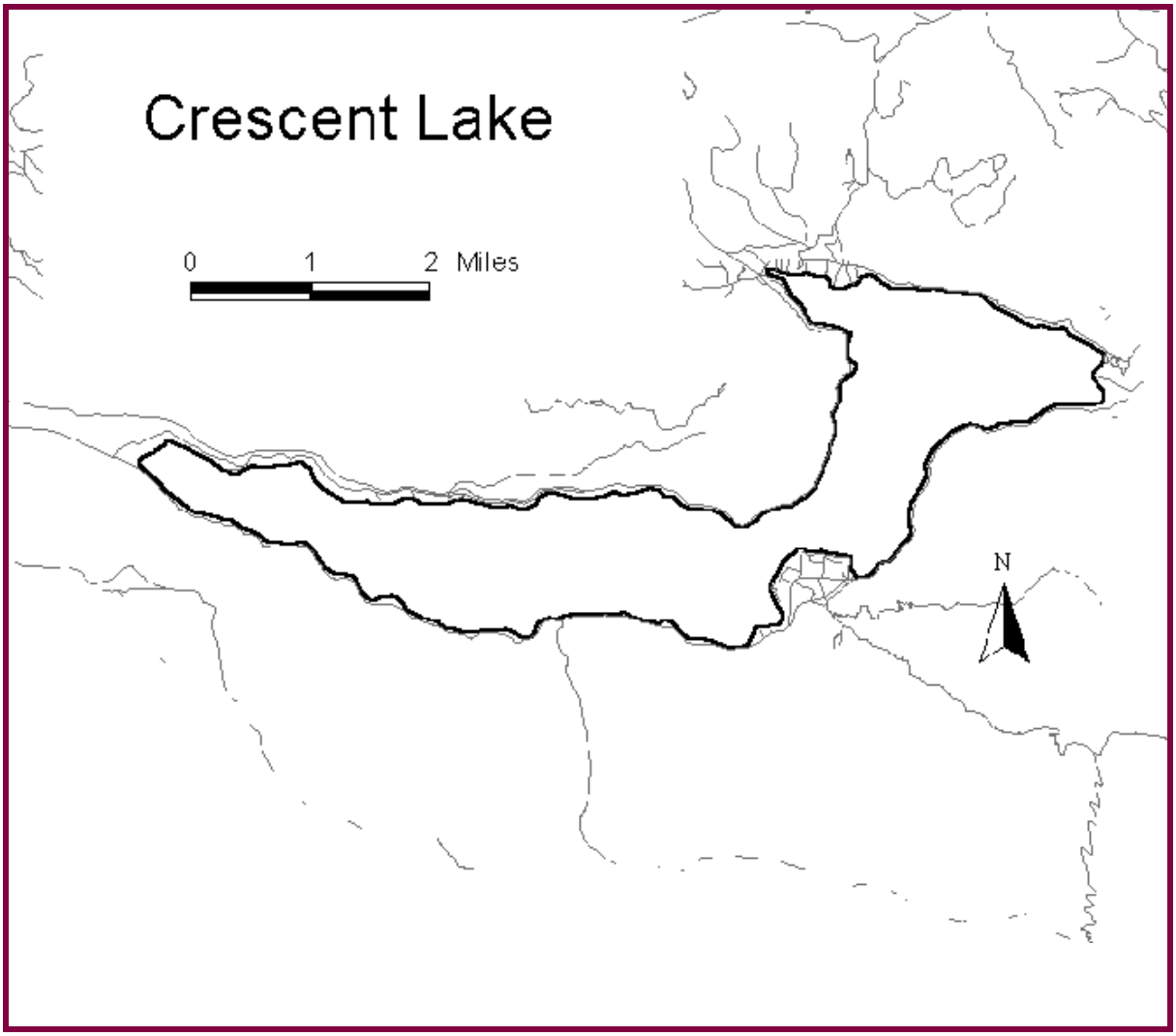
CLALLAM County

*Lake ID:* CRECL1

*Ecoregion:* 1

Crescent Lake is 14 miles west of 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 the 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.

| Area (acres) | Maximum Depth (ft) | Mean Depth (ft) | Drainage (sq mi) | |
|---|---|---|---|---|
| 5127 | 624 | | | |
| **Volume (ac-ft)** | **Shoreline (miles)** | **Altitude (ft abv msl)** | **Latitude** | **Longitude** |
| | | 580 | 48 05 41. | 123 48 14. |



## Station Information

CRECL1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 48 04 58.4 | longitude: 123 46 62.4 |
| | Description: | In east end of lake approximately midway between eastern shore and outlet (Lyre River) | |
| Secondary Station | Station # 2 | latitude: 48 03 33.3 | longitude: 123 49 51.5 |
| | Description: | Approximately in middle of lake midway between Lake Crescent Lodge to the east and a picnic area to the west | |

## Trophic State Assessment for 1998

CRESCENT

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | | |
| TSI_Phos: | 20 | J |
| TSI_Chl: | 24 | J |
| Narrative TSI:[a] | O | |

Crescent Lake is an ultra-oligotrophic lake nestled in the Olympic Mountain range within the boundary of the Olympic National Park. Our Secchi line was not long enough to measure the true Secchi depth, nor were we able to accurately measure total phosphorus or chlorophyll a because our detection limits were not adequate for such low concentrations. Because Crescent is clearly pristine, we recommend a total phosphorus criterion be set at the Cascades ecoregion/ultra-oligotrophic action value of 4 ug/L pending additional studies with lower detection levels. However, Crescent Lake may be nitrogen limited, and all anthropogenic nutrient sources should be limited and controlled in this national resource.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

CRESCENT

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | |
| 6/8/1998 | | E | 3 U | .01 U | 3 | .5 U | | 53.3 | 16800 | .7 |
| 7/30/1998 | | E | 3 U | .01 U | 3 | .5 U | | | | |
| 9/15/1998 | | E | 3 U | .022 | 7 | .5 U | | | | .5 U |
| **Station 2** | | | | | | | | | | |
| 6/8/1998 | | E | 8.2 | .01 U | 1 | .5 U | | | | |
| 7/30/1998 | | E | 3 U | .018 | 6 | | | | | |
| 8/13/1998 | | E | 3 U | .041 | 14 | .5 U | | | | .5 U |
| 9/15/1998 | | E | 3 U | .01 U | 3 | .52 J | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

# Watershed Survey

CRESCENT

**Survey Date:** 9/15/1998

## Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | | **Residential** |
| | **Commercial, Industrial** | 2 | **Park, forest or natural** |
| 1 | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

## Observations (check mark denotes presence)

**BMP's** ☐

Lake shore is kept at or near natural conditions. The vast majority of the watershed is a nattional park.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☑

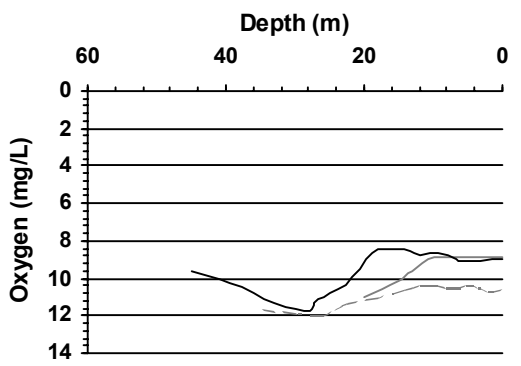
Buffer zones in place around most of the lake--very little development.

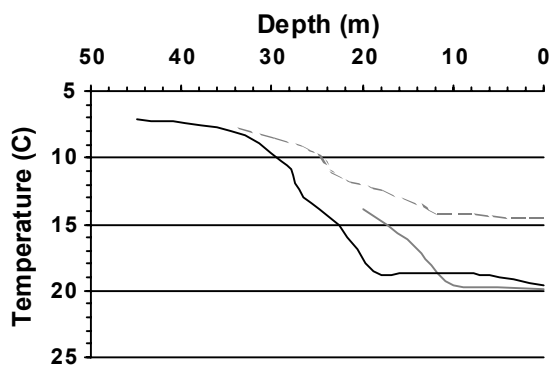
**Irrigation** ☐

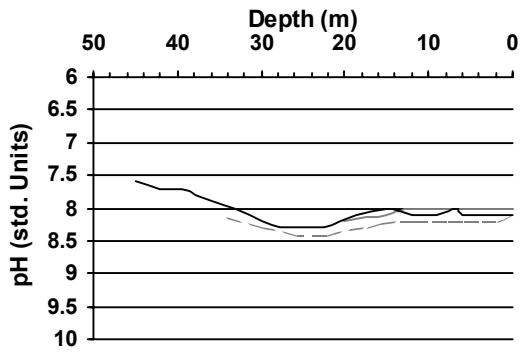
**Survey Id:** 90

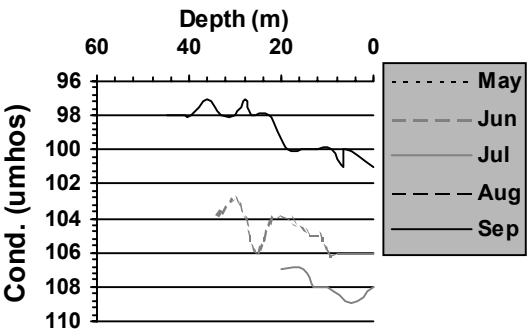
# Secchi Depth and Profile Graphics

**Station:** 1 CRECL1



# Secchi Data and Field Observations

CRESCENT

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/8/1998 | | | | 1 | 50 | 4 | | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | WATER WAS A TORQUOISE BLUE. WATER WAS TOO CLEAR AND DEEP FOR A SECCHI READING | | | | | | | | |
| 7/31/1998 | | | | 1 | 80 | 1 | | 5 | 5 | 7 | 1 | 1 | 1 |
| | Sampler: | SMITH | | Remarks: | WATER WAS EXTREMELY CLEAR, TOO CLEAR FOR A SECCHI READING. DO TAKEN AT 5 METERS | | | | | | | | |
| 8/13/1998 | | | | 1 | 0 | | | 5 | 5 | 0 | 0 | 1 | 3 |
| | Sampler: | SMITH | | Remarks: | WATER WAS TOO CLEAR AND TOO DEEP FOR A SECCHI READING. | | | | | | | | |
| 9/15/1998 | | | | 1 | 50 | | | 5 | 5 | 4 | 5 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | WATER WAS TOO CLEAR AND TOO DEEP FOR A SECCHI READING. The Conductivity and oxygen results are qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |

# CROCKER

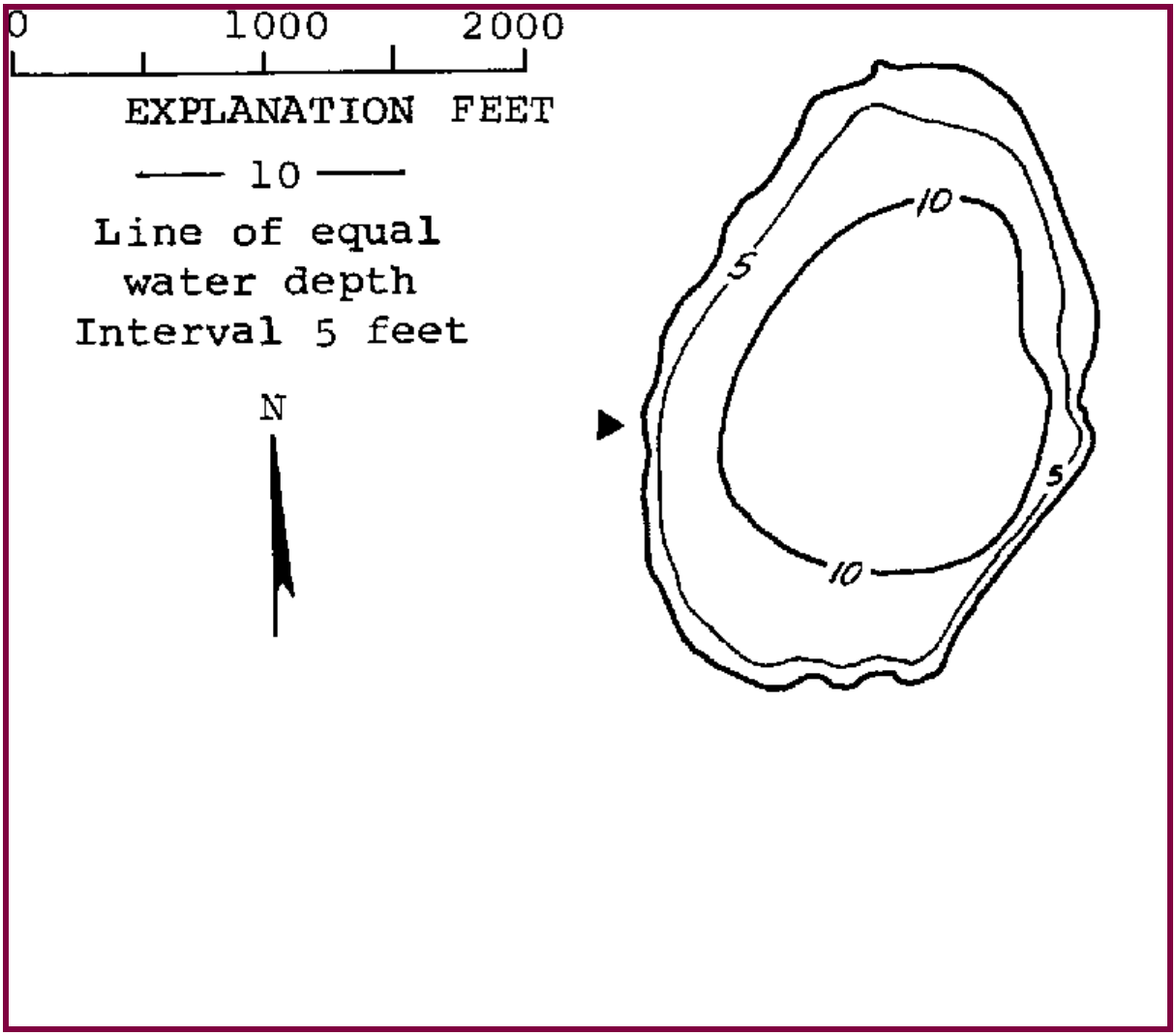
JEFFERSON County

*Lake ID:* CROJE1

*Ecoregion:* 2

Crocker Lake is one of the most visible lakes on the Olympic Penninsula for those driving from the Seattle suburbs to Port Angeles along Highway 104. The lake is easily seen from the highway as you're heading west just before the intersection with Highway 101. This small eutrophic lake is abundant with natural aquatic vegetation yet, as of 1998, Crocker Lake lacks the invasive Egeria densa (Brazilian elodea) of its neighbor lake, Lake Leland.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* | |
|---|---|---|---|---|
| 76 | 13 | 9 | 3 | |
| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
| 663 | 1.29 | 190 | 47 56 22. | 122 52 45. |



## Station Information

CROJE1

Primary Station Station # 1 latitude: 47 56 03.9 longitude: 122 53 01.7

Description: Deep part of lake, mid lake directly east of boat launch

## Trophic State Assessment for 1998

CROCKER

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 54 | N |
| TSI_Phos: | 66 | |
| TSI_Chl: | 58 | J |
| Narrative TSI:[a] | E | |

Crocker is a shallow lake with abundant nutrients and macrophyte growth. It is a typical naturally eutrophic lake. The watershed is largely undisturbed with some agriculture and tree cutting in the area. The water quality appears to support both the human and non-human uses in the lake. Zooplankton were quite large, which can be indicative of a large fish predator base. In fact, Crocker was treated on 8 July 1998 with rotenone by the Washington Department of Fish and Wildlife to remove illegally stocked northern pike. High late summer TP could be from nutrient release from anoxic sediments (although the lake was not thermally stratified at the time of sampling, there was an oxycline most months) or possibly from decomposing fish, left in the lake after the rotenone treatment. The lake may have been phosphorous limited during the first half of the summer, becoming nitrogen limited later as phosphorus concentrations rose. However, the very dark colored water may also diminish light penetration into the water column thereby limiting primary production. One fecal sample, collected near the boat launch in August, was unusually high for lakes (140 colonies/100mL).

In our judgement, uses are being supported and the eutrophic state of the lake is natural. We recommend that a total phosphorus criterion be established at 73 ug/L, the seasonal mean of our 1998 samples with an adjustment to account for inter-annual variability (mean of 58 ug/L total phosphorus plus std. dev. of 15 ug/L). However, because of the rotenone treatment our mean could be biased high, and this should be considered an interim criterion pending further TP sampling.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

CROCKER

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 8/12/1998 | | L | | | | | 140 | | | |
| **Station 1** | | | | | | | | | | |
| 6/5/1998 | | E | 18.4 | .397 | 22 | 10.3 | | 25 | 5820 | 3 J |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7/30/1998 | E | 50.3 | 1.1 | 22 | 42.8 | | |
| 8/12/1998 | E | 60.6 | .854 | 14 | 21.8 | | 3.9 |
| 9/14/1998 | E | 103 | .755 | 7 | 3.9 J | | 3.1 J |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

CROCKER

**Survey Date:** 9/14/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| 2 | **Agriculture(commercial, not hobby)** | | **Residential** |
| | **Commercial, Industrial** | 1 | **Park, forest or natural** |
| 3 | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☑

Select cutting at a near-by forest.

**Odors** ☑

Yes, a farm one-mile from lake with a strong manure odor.

**Cattle** ☐ **Ducks** ☐ **Geese** ☑

3 domestic geese by the boat ramp

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☑

**Irrigation** ☐

**Survey Id:** 70

## Habitat Survey Summary Report

CROCKER

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 9/3/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 3.0 | **Number of stations with canopy:** | 4 |
| **Understory Avg:** | 2.9 | **Number of stations with understory:** | 7 |

### Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 0.5 |

| | | |
|---|---|---|
| | **trees< 0.3 m DBH** | 1.0 |
| **Understory:** | **woody shrubs saplings** | 1.9 |
| | **tall herbs, forbs grasses** | 2.7 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.0 |
| | **herbs, forbs, grasses** | 1.3 |
| | **standing water or inundated veg** | 1.0 |
| | **barren or buildings** | 0.3 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 0.2 |
| | **loose sand** | 0.5 |
| | **other fine soil/sediment** | 0.3 |
| | **vegetated** | 3.6 |
| | **other** | 0.5 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.0 |
| | **vertical dist (M from wtrln to high wt):** | 0.3 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.3 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 0.1 |
| **walls, dikes, or revetments** | 0.0 |
| **litter, trash dump, or landfill** | 0.2 |
| **roads or railroad** | 0.4 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.2 |
| **orchard** | 0.0 |
| **lawn** | 0.2 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 0.9 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.1 |
| **gravel** | 0.4 |
| **sand** | 1.2 |
| **silt** | 2.7 |
| **woody debris** | 0.6 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 3.2 |
| **emergent** | 1.5 |
| **floating** | 1.7 |
| **total weed cover** | 3.6 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.8 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.8 |
| **snags** | 0.6 |
| **brush or woody debris** | 0.4 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.2 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 0.2 |

---

## Zooplankton Report

CROJE1

Date 6/5/1998 Station: 1
Sample ID 12

Only large predators present, Northern Pike, so no known planktivores or very few planktivores present; 1 mL analyzed.

Number of organisms measured: 64

| Group | Percent |
|---|---|
| Cladoceran | 50.0% |
| Copepod | 50.0% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 25.0% |
| Large >= 1mm | 75.0% |
| Ratio of large to Small: | 3.00 |
| Average size (mm): | 1.06 |

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## Aquatic Plant Data

CROCKER

Sampler: Parsons, Bell-McKinnon Survey Date: 9/3/1998

Max depth of growth (M): 2

Comments Sunny, wind. Did vegetation survey form for Kirk Smith. Bare sediment in shallows with patchy E. canadensis. Nuphar dying back. The lake was treated with rotenone to remove Pike several weeks ago. Water very muddy brown. Emergent stems of the Sagittaria rigida grazed off through much of the lake. Many ducks, newt.

SPECIES LIST

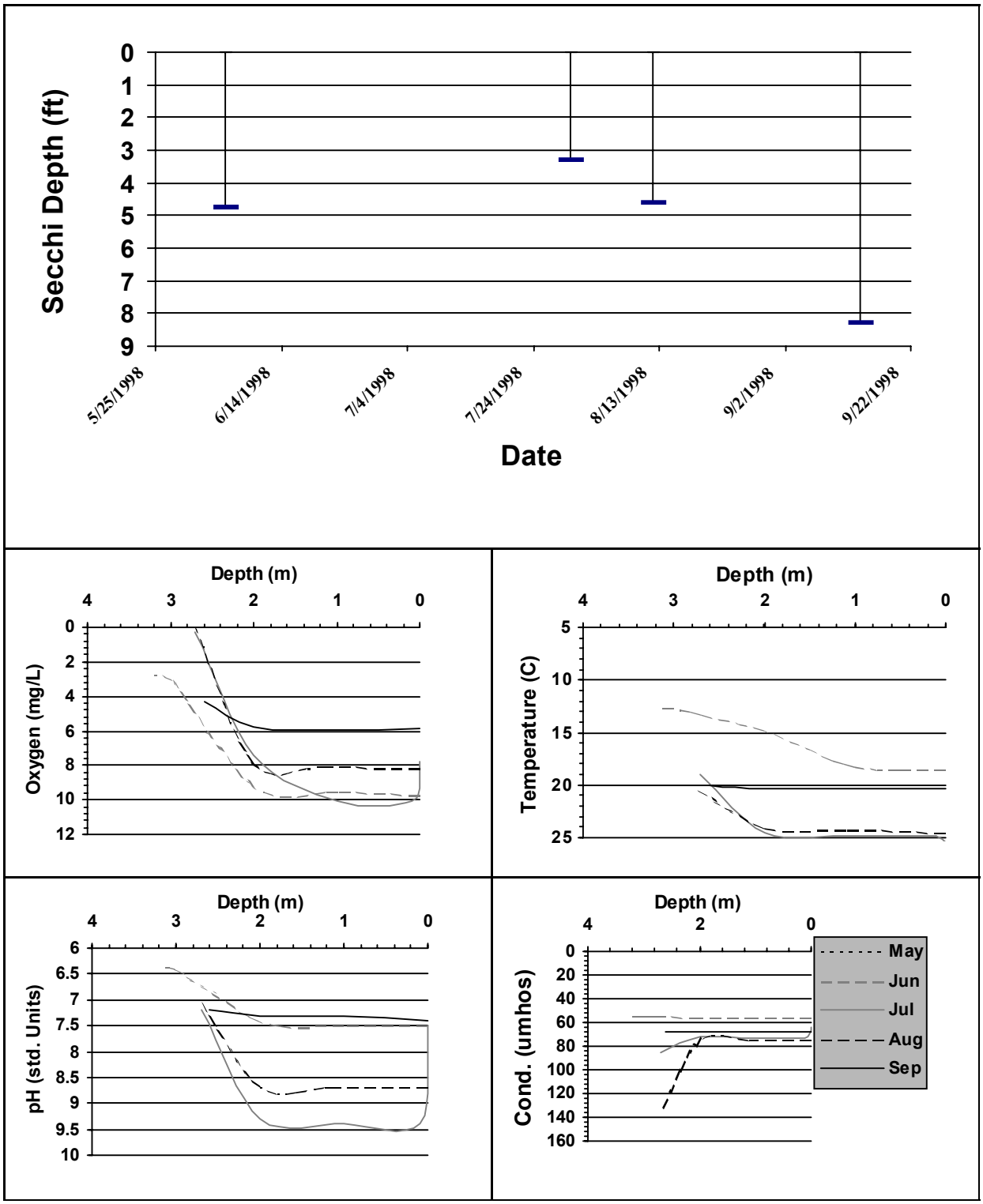
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Ceratophyllum demersum* | Coontail; hornwort | 2 | |
| *Chara sp.* | muskwort | 2 | |
| *Elodea canadensis* | common elodea | 4 | very dense in shallows |
| *Najas flexilis* | common naiad | 2 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 3 | |

| | | | |
|---|---|---|---|
| *Potamogeton obtusifolius* | bluntleaf pondweed | 1 | on east side |
| *Potamogeton praelongus* | whitestem pondweed | 2 | |
| *Potamogeton pusillus* | slender pondweed | 1 | at north end |
| *Sagittaria rigida* | bur arrowhead | 2 | mostly at south end |
| *Scirpus sp.* | bulrush | 2 | |
| *Typha latifolia* | common cat-tail | 2 | |
| *Utricularia sp.* | bladderwort | 1 | |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 CROJE1



# Secchi Data and Field Observations

CROCKER

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/5/1998 | | | 4.75 | 8 | 100 | | | 5 | 2 | 23 | 5 | 1 | 0 |
| | Sampler: | SMITH | | Remarks: | 3 METERS FOR ZOOPLANKTON TOW. | | | | | | | | |
| 7/30/1998 | | | 3.3 | 7 | 100 | 2 | | 3 | 2 | 9 | 18 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | WATER WAS POISONED WITH ROTENONE ON 7/8/98. MUCH LOGGING AND CLEAR-CUTTING IN THE AREA. FEW RESIDENTIAL HOMES. | | | | | | | | |
| 8/12/1998 | | | 4.62 | 8 | 0 | 2 | | 2 | 2 | 3 | 33 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FIELD VISIT | | | | | | | | |
| 9/14/1998 | | | 8.25 | 9 | 0 | | | 4 | 3 | 38 | 23 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | NEW BOAT LAUNCH INSTALLED. The Conductivity and Oxygen results are qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |

# HORSESHOE

PEND OREILLE County

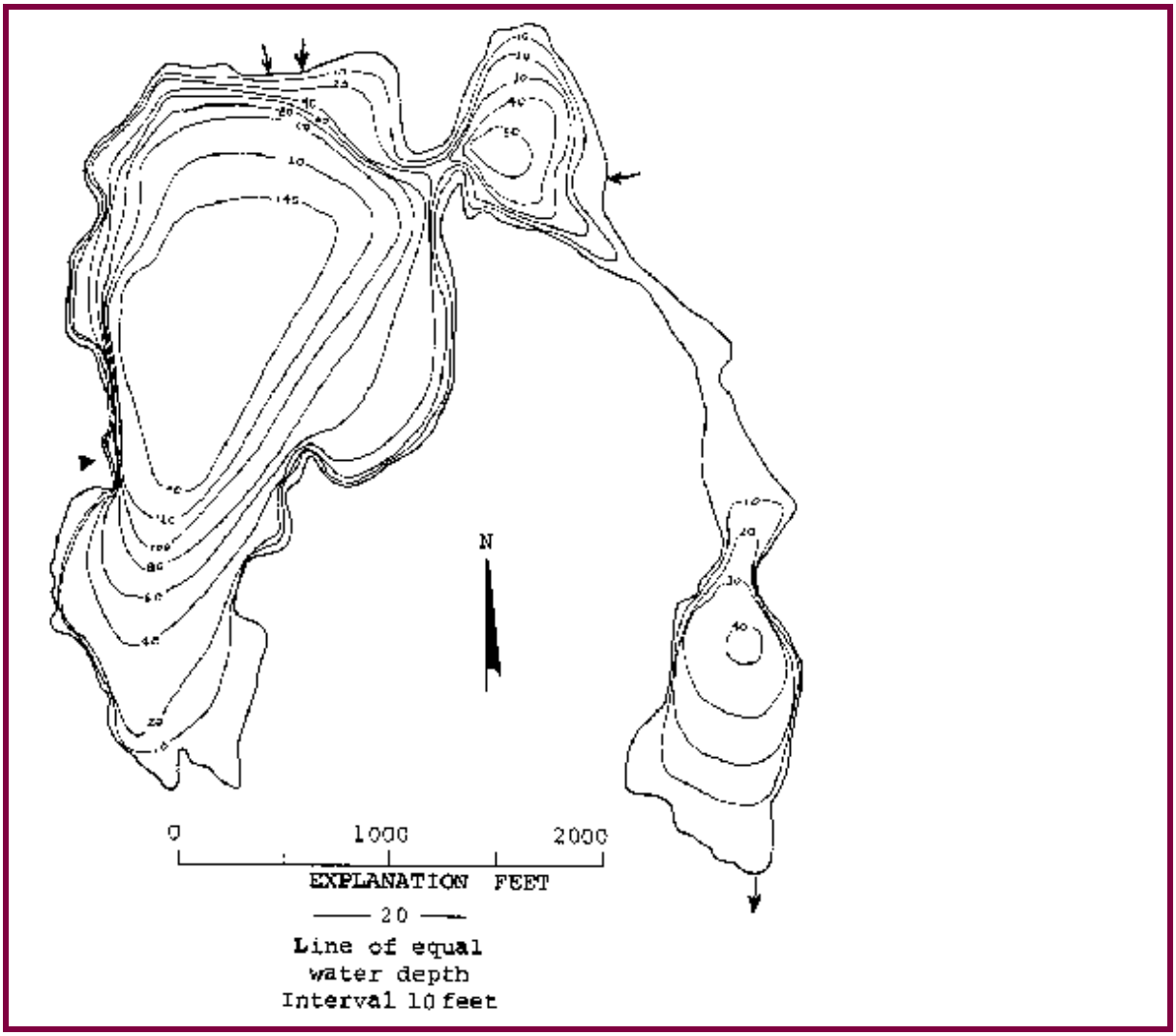
***Lake ID:*** *HORPE1*

***Ecoregion:*** 8

Horseshoe Lake is approximately 25 miles northwest of Spokane located near the corner where three counties (Spokane, Pend Oreille and Stevens) meet. It is fed by Heel and Buck Creeks and drains to the Little Spokane River through Eloika Lake.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 141 | 150 | 64 | 80 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 9002 | 3.84 | 1975 | 48 06 19. | 117 24 28. |



## Station Information

HORPE1

Primary Station Station # 1 latitude: 48 06 41.0 longitude: 117 25 10.0

Description: Deep part of lake, directly north of boat launch

## Trophic State Assessment for 1998

HORSESHOE

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 47 | N |
| TSI_Phos: | 45 | |
| TSI_Chl: | 62 | |
| Narrative TSI:[a] | ME | |

The trophic state of Horseshoe Lake is probably near natural conditions. Results from the watershed and habitat surveys suggest there is relatively little anthropogenic disturbance and the meso-eutrophic state of the lake should be acceptable in supporting the uses of the lake. Questionnaires indicated a strong desire among respondents to restrict motorboat use as well as an appreciation for the scenery. Whether to restrict motorboat use is largely an aesthetic decision; the shoreline is not particularly susceptible to erosion from motorboats. The lake should support an excellent coldwater fishery. It is productive yet retains a very cold and mostly oxygenated hypolimnion. There was only slight evidence of internal phosphorus loading (in August). Average chlorophyll concentrations were higher than would be expected given phosphorus and transparency averages. Our early June chlorophyll reading was highest; this could have been the tail end of a spring response to under-ice nutrient release from senescing macrophytes.

Because uses are being supported and the trophic state of the lake is natural, a total phosphorus criterion may be set at the seasonal mean that was established during 1998 sampling, adjusted for interannual variability. Therefore, a nutrient criterion for the lake of 25.4 ug/L total phosphorus (mean 20.3 ug/L plus std. dev. of 5.1 ug/L) is recommended..

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

HORSESHOE

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 7/13/1998 | | L | | | | | 1 J | | | |
| | | L | | | | | 1 U | | | |
| 8/10/1998 | | L | | | | | 3 | | | |
| | | L | | | | | 1 U | | | |
| 9/14/1998 | | L | | | | | 2 | | | |

**Station 1**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6/15/1998 | E | 29.7 | .178 | 6 | 33.5 | | 19 | 3.3 J |
| | H | 20.1 | | | | | | |
| 7/13/1998 | E | 20.5 | .414 | 20 | 13.8 | | | 2.5 |
| | H | 23.9 | .192 | 8 | | | | |
| 8/10/1998 | E | 18.4 | .517 | 28 | 24.2 | | | 2.1 |
| | H | 62.8 | .399 | 6 | | | | |
| 9/14/1998 | E | 11.7 | .229 | 20 | 4.2 | | | .7 |
| | H | 14.4 | .247 | 17 | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

HORSESHOE

**Survey Date:** 9/14/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [2] **Residential**
- [1] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Probably not too degraded from natural conditions and not too suceptible provided good forest practices. Shoreline is cobble/broken shale and probably not susceptible to erosion. 17 homes on lake--probably not many more in watershed.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☐

**Irrigation** ☐

**Survey Id:**

## Habitat Survey Summary Report

HORSESHOE

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/13/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.2 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.4 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.8 |
| | **trees< 0.3 m DBH** | 0.7 |
| **Understory:** | **woody shrubs saplings** | 2.0 |
| | **tall herbs, forbs grasses** | 1.8 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.6 |
| | **herbs, forbs, grasses** | 1.2 |
| | **standing water or inundated veg** | 0.5 |
| | **barren or buildings** | 1.6 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.3 |
| | **boulders** | 0.4 |
| | **cobble/gravel** | 1.8 |
| | **loose sand** | 0.8 |
| | **other fine soil/sediment** | 0.4 |
| | **vegetated** | 2.5 |
| | **other** | 0.2 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.8 |
| | **vertical dist (M from wtrln to high wt):** | 0.1 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.6 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 0.7 |
| **walls, dikes, or revetments** | 0.0 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.3 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.0 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 4.5 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.4 |

| | |
|---|---|
| **boulders** | 0.2 |
| **cobble** | 1.1 |
| **gravel** | 2.4 |
| **sand** | 0.9 |
| **silt** | 0.8 |
| **woody debris** | 0.6 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.5 |
| **emergent** | 1.0 |
| **floating** | 0.0 |
| **total weed cover** | 1.7 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.3 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.2 |
| **snags** | 0.1 |
| **brush or woody debris** | 0.9 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.4 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.2 |
| **human structures** | 0.3 |

---

# Questionnaire

HORSESHOE

**Results compiled from** 6 **Surveys.** **Average time (years) respondents spent on lake:** 7.33

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.2 | View: | 1.0 | Distance to Lake: | 0.5 |
| Public Access: | -0.3 | Swim Beach: | 0.5 | Canada Geese: | 0.7 |
| Water Clarity: | 0.2 | Water Qual. for Swim: | 0.0 | | |
| Fishing Quality: | 0.5 | Aquatic Plants: | -0.2 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **3.5**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.2 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.3 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.3 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.7 | Good Warmwtr Fishing: | 4.0 | Natural Scenery: | 5.0 |
| Plant Growth: | 3.2 | Good Swimming: | 4.3 | Public Beach: | 2.2 |
| Natural Shoreline: | 4.2 | Less Algae: | 3.8 | Canada Geese: | 4.3 |
| No Odors: | 4.2 | Public Access: | 2.2 | | |
| Good Coldwtr Fishing: | 4.0 | Clear Water: | 4.0 | | |

Good Coldwtr Fishing: No Clear Water: No

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 47 | 12/31/1998 | Visitor | | | SEVERAL OF THE A | ☐ | Unknown | |
| 60 | 8/10/1998 | Resident | Permanent | Rent | several of the above | ☑ | Worse | 5 to 10 year |
| | It is very desirable that the public launch be managed better because swimmers are using the launch at the same time people are attempting to launch boats. It would help to have gas motors banned. | | | | | | | |
| 71 | 8/17/1998 | Resident | Permanent | Rent | 7 | ☐ | Worse | 1996 |
| 82 | 8/15/1998 | Resident | Permanent | Rent | run a business | ☐ | No | |
| 84 | 12/31/1998 | Visitor | | | 4 | ☐ | No | |
| 85 | 8/8/1998 | Resident | Permanent | Rent | run a business | ☐ | No | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

HORPE1

Date 6/15/1998 Station: 1 Sample ID 5

Anabaena prevalent, 4 mLs observed

Number of organisms measured: 35

| Group | Percent |
|---|---|
| Cladoceran | 20.0% |
| Copepod | 80.0% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 57.1% |
| Large >= 1mm | 42.9% |
| Ratio of large to Small: | 0.75 |
| Average size (mm): | 0.84 |

## Aquatic Plant Data

HORSESHOE

Sampler: Parsons, O'Neal

Survey Date: 7/13/1998

Max depth of growth (M): variable ~3.5

Comments gusty wind, breeze, partly cloudy. Goose family, ducks, bullfrog, osprey nest on SE shore. Productive lake! Water greenish, heavy algae growth on most submersed plants. Dense plant growth in protected areas. Most places max depth of plant growth about 3 m.

SPECIES LIST

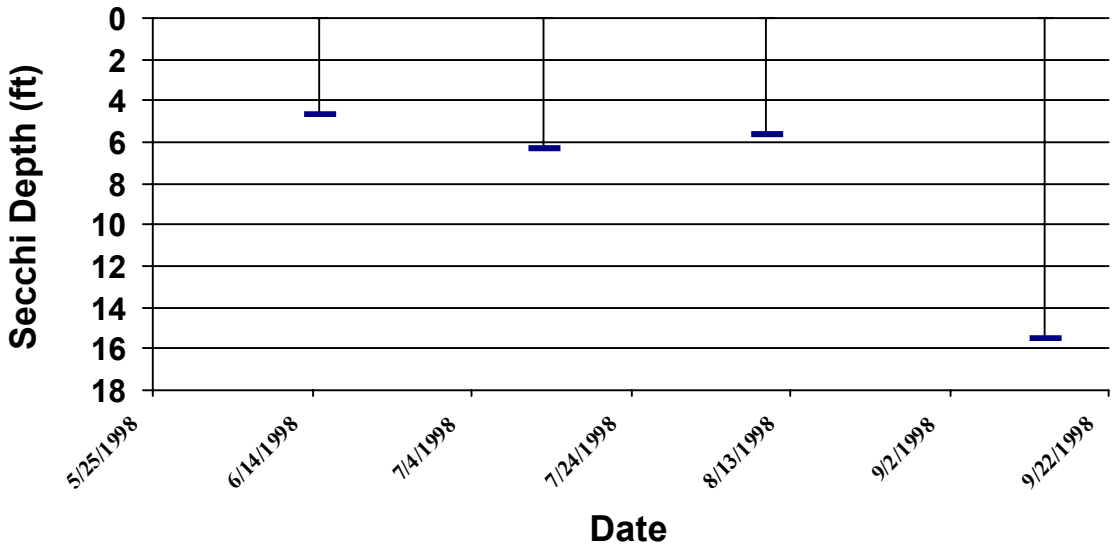
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 2 | patches, never dense |
| *Carex sp.* | sedge | 2 | shoreline |
| *Ceratophyllum demersum* | Coontail; hornwort | 2 | |
| *Eleocharis sp.* | spike-rush | 2 | shoreline |
| *Elodea canadensis* | common elodea | 3 | sometimes very dense, blooming |
| *Juncus sp.* | rush | 2 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | at south end |
| *Phalaris arundinacia* | reed canarygrass | 2 | |
| *Potamogeton amplifolius* | large-leaf pondweed | 2 | |
| *Potamogeton epihydrus* | ribbonleaf pondweed | 2 | |

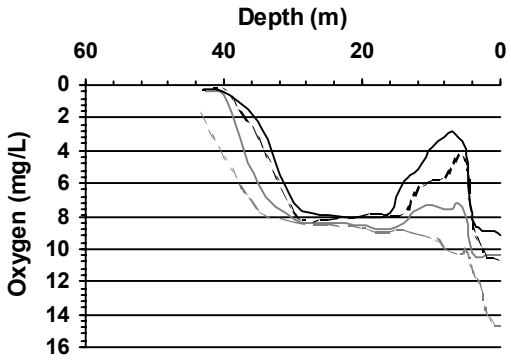
| | | | |
|---|---|---|---|
| *Potamogeton robbinsii* | fern leaf pondweed | 3 | few dense areas in deeper water |
| *Scirpus sp.* | bulrush | 2 | |
| *Typha sp.* | cat-tail | 2 | |

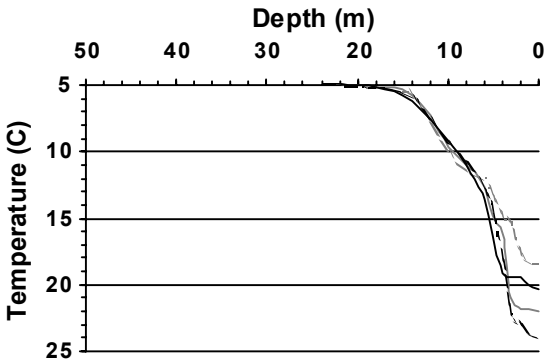
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

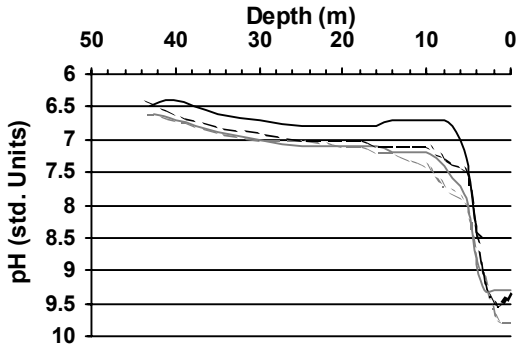
# Secchi Depth and Profile Graphics

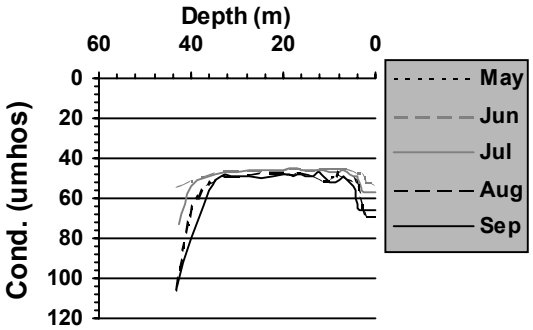
**Station:** 1 HORPE1



# Secchi Data and Field Observations

HORSESHOE

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/15/1998 | | | 4.62 | 3 | 50 | 2 | 2 | 4 | 3 | 8 | 1 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | APPROX. 20 HOMES SCATTERED AROUND SHORE. TIMBERED SLOPES, LOTS OF BEDROCK OUTCROPS AND CLIFFS. 1 RESORT. LOTS OF BLUE-GREEN IN THE WATER. | | | | | | | | |
| 7/13/1998 | | | 6.27 | 3 | 50 | 3 | | 3 | 2 | 8 | 1 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | AESTHETICS ARE FAIR BUT GOOD HABITAT FOR WILDLIFE. SMALL ALGAL COLONIES ABUNDANT. PEOPLE SWIMMING AT RESORT AND JUMPING OFF CLIFFS. | | | | | | | | |
| 8/10/1998 | | | 5.61 | 6 | 0 | 1 | | 3 | 3 | 0 | 0 | 3 | 0 |
| | Sampler: HALLOCK | | | Remarks: | H2S @ 40 M BUT NOT AT 10 OR 25 M. SOME BIRDS WADING AT ACCESS, ONE PERSON FISHING. | | | | | | | | |
| 9/14/1998 | | | 15.51 | 6 | 0 | 1 | | 4 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | | | | | | | | | |

# ISLAND

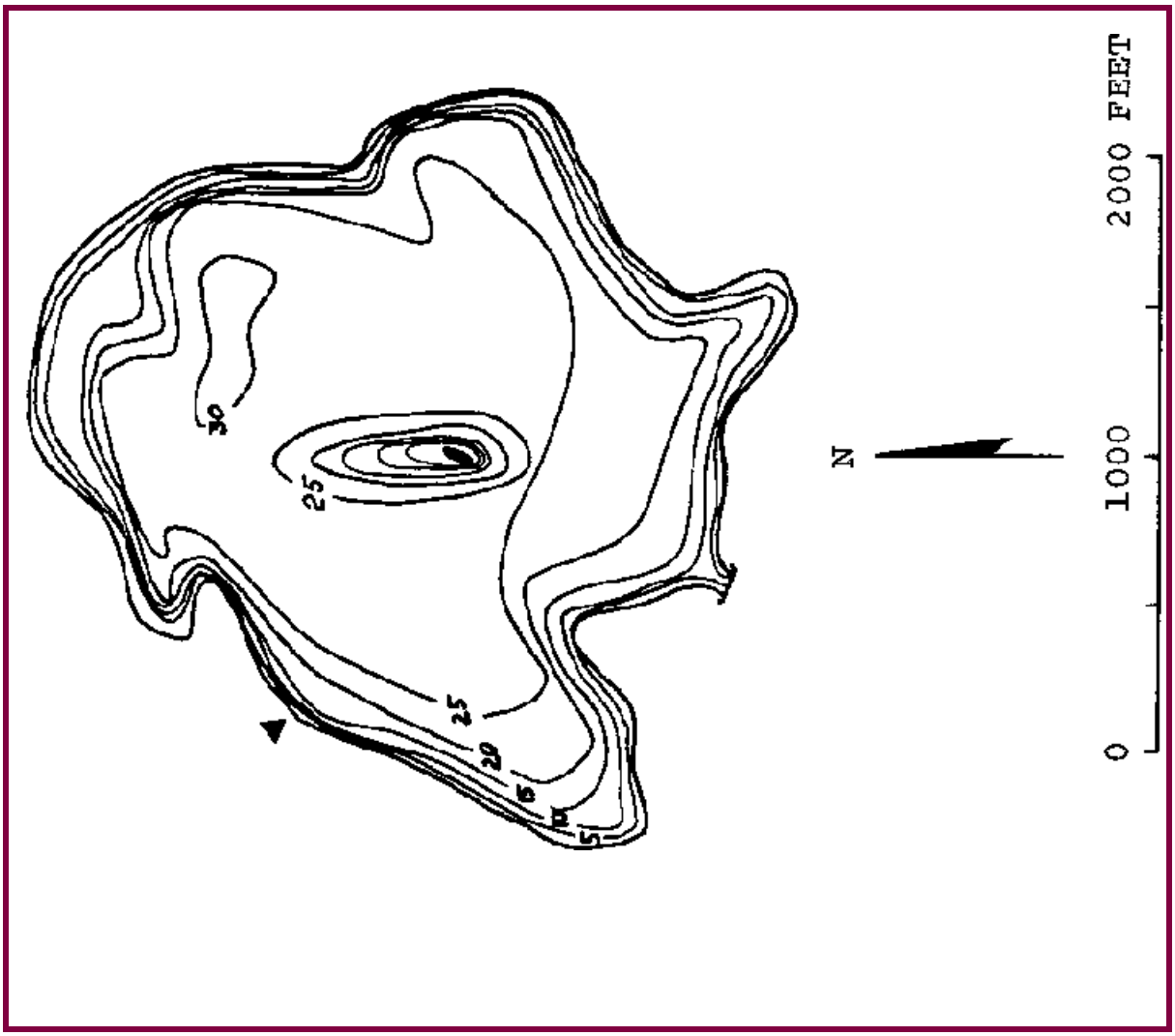
MASON County

***Lake ID:*** *ISLMA1*

***Ecoregion:*** 2

Island Lake is located 2.5 miles north of Shelton. It drains via a swamp to Goldsborough Creek and Oakland Bay.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* | |
|---|---|---|---|---|
| 108 | 31 | 21 | | |
| ***Volume (ac-ft)*** | ***Shoreline (miles)*** | ***Altitude (ft abv msl)*** | ***Latitude*** | ***Longitude*** |
| 2246 | 1.74 | 230 | 47 14 44. | 123 06 40. |



## Station Information

ISLMA1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 14 51.7 | longitude: 123 06 45.2 |
| | Description: | Deep part of lake, directly east of first cove north of boat luanch, approximately 500 feet west of eastern shore | |
| Secondary Station | Station # 2 | latitude: 47 14 55.3 | longitude: 123 06 59.8 |
| | Description: | Approximately midway between boat launch and first major point south of boat launch (point between large cove to the west and culvert leading to swamp to the east) | |

## Trophic State Assessment for 1998

ISLAND

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 36 |
| TSI_Phos: | 35 |
| TSI_Chl: | 43 |
| Narrative TSI:[a] | O |

Island Lake is an oligotrophic lake in a suburban setting. The shoreline is about 60% natural vegetation, though about 70% of the shoreline is developed residential. There was a Sonar application for Eurasian water milfoil on 14 August 98. The excellent water quality and water clarity in the lake is surprising considering how developed the shoreline is. Eurasian milfoil was the dominant aquatic plant in 1998, growing in nearly monospecific patches. Milfoil remains the biggest threat to the beneficial uses on the lake.

We recommend that a nutrient criterion be set at 10 ug/L total phosphorus, the action value for Puget Lowland oligotrophic lakes.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

ISLAND

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | |
| 6/2/1998 | | E | 8.7 | .216 | 25 | 3.7 | | 18.5 | 4460 | .8 |
| 7/25/1998 | | E | 5.2 | .199 | 38 | 3.4 | | | | .7 J |
| 8/17/1998 | | E | 9.6 | .199 | 21 | 4.2 | | | | .9 |
| 9/17/1998 | | E | 8.7 | .193 | 22 | 2.5 | | | | .8 |
| **Station 2** | | | | | | | | | | |
| 6/2/1998 | | E | 9.6 | .191 | 20 | 2.6 | | | | |
| 7/25/1998 | | E | 10.1 | .178 | 18 | 3 | | | | |
| 8/17/1998 | | E | 9.2 | .18 | 20 | 4.4 | | | | |
| **Station 3** | | | | | | | | | | |

| | | |
|---|---|---|
| 6/2/1998 | L | 1 |
| | L | 1 |
| 9/17/1998 | L | 3 |
| | L | 1 |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

ISLAND

**Survey Date:** 9/17/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | 1 | **Residential** |
| | **Commercial, Industrial** | 2 | **Park, forest or natural** |
| 3 | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Lack of shoreline errosion control where a new home was being built.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Lots of green lawns/landscaping on lakeshore properties.

**Buffer zones around streams and wetlands** ☐

Buffer zones absent on lakeshore property. Forrested areas appeared OK. Natural vegetation was rare.

**Irrigation** ☑

2 separate locations

**Survey Id:**

## Habitat Survey Summary Report

ISLAND

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/9/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | | **Number of stations with canopy:** | 0 |
| **Understory Avg:** | | **Number of stations with understory:** | 0 |

### Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.7 |
| | **trees< 0.3 m DBH** | 0.6 |
| **Understory:** | **woody shrubs saplings** | 1.9 |
| | **tall herbs, forbs grasses** | 0.7 |
| **Ground Cover:** | **woody shrubs seedlings** | 0.9 |
| | **herbs, forbs, grasses** | 2.1 |
| | **standing water or inundated veg** | 0.6 |
| | **barren or buildings** | 1.5 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 1.5 |
| | **loose sand** | 0.4 |
| | **other fine soil/sediment** | 0.5 |
| | **vegetated** | 2.8 |
| | **other** | 0.8 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | |
| | **vertical dist (M from wtrln to high wt):** | 0.1 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence

**(0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)**

| | |
|---|---|
| **buildings** | 1.2 |
| **commercial** | 0.0 |
| **park facilities** | 0.0 |
| **docks/boats** | 1.4 |
| **walls, dikes, or revetments** | 1.2 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.4 |
| **other** | 0.2 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 3.2 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 1.5 |
| **gravel** | 1.9 |
| **sand** | 0.3 |
| **silt** | 2.5 |

| | |
|---|---|
| **woody debris** | 0.8 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 2.5 |
| **emergent** | 0.6 |
| **floating** | 1.5 |
| **total weed cover** | 3.1 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.4 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.8 |
| **snags** | 0.1 |
| **brush or woody debris** | 1.0 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 1.2 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 1.1 |

---

## Zooplankton Report

ISLMA1

Date 6/2/1998 Station: 1 Sample ID 19 — 2 mLs measured

Number of organisms measured: 98

| Group | Percent |
|---|---|
| Cladoceran | 25.5% |
| Copepod | 74.5% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 98.0% |
| Large >= 1mm | 2.0% |
| Ratio of large to Small: | 0.02 |
| Average size (mm): | 0.46 |

Date 6/2/1998 Station: 2 Sample ID 7 — Cyclopoid Copepods with very long term. Setae, ~75% of body length; 1 mL observed

Number of organisms measured: 76

| Group | Percent |
|---|---|
| Cladoceran | 53.9% |
| Copepod | 46.1% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 71.1% |
| Large >= 1mm | 28.9% |
| Ratio of large to Small: | 0.41 |
| Average size (mm): | 0.77 |

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## Aquatic Plant Data

ISLAND

Sampler: Parsons, O'Neal — Survey Date: 7/9/1998

Max depth of growth (M): 4

Comments Calm, partly cloudy. Lake treated with sonar June 24, 1998 - plants starting to show some

bleaching, especially the Najas. Milfoil mostly still not showing signs, a little bright green. Milfoil very dense in many areas, mostly near the boat launch and to the north. East side still just individual plants with occasional dense patches. Bullfrogs heard. Conducted habitat survey for Kirk Smith.

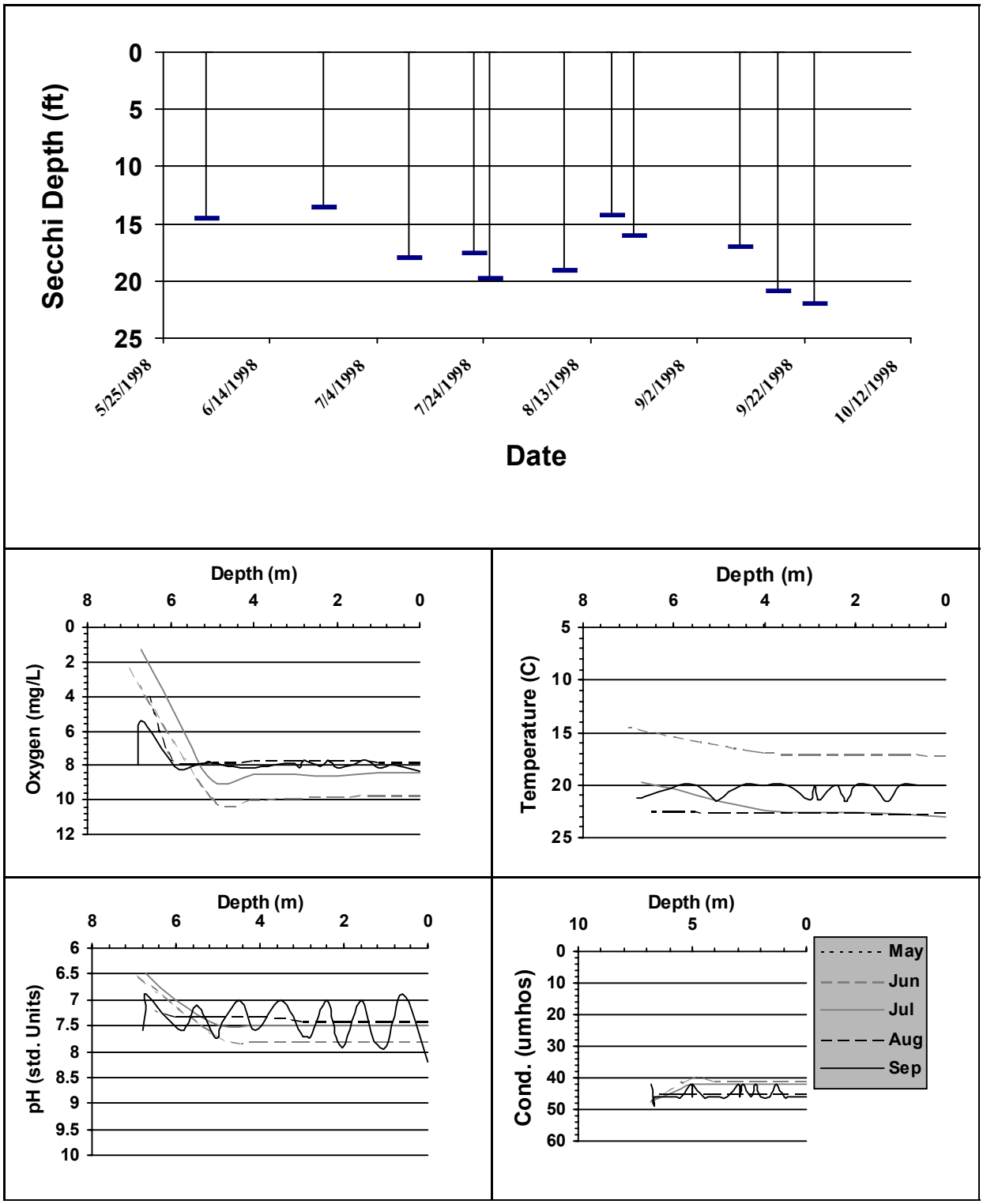
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 3 | some dense patches, esp along south shore |
| *Eleocharis sp.* | spike-rush | 1 | |
| *Elodea canadensis* | common elodea | 2 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Myriophyllum spicatum* | Eurasian water-milfoil | 4 | to 4 m deep |
| *Najas flexilis* | common naiad | 2 | |
| *Nitella sp.* | stonewort | 2 | |
| *Nymphaea odorata* | fragrant waterlily | 1 | one or 2 patches, east shore |
| *Potamogeton amplifolius* | large-leaf pondweed | 2 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 1 | |
| *Scirpus sp.* | bulrush | 2 | |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 ISLMA1



# Secchi Data and Field Observations

ISLAND

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/2/1998 | | | 14.5 | 2 | 100 | | 2 | 4 | 1 | 3 | 0 | 0 | 0 |
| | Sampler: SMITH | | | Remarks: | AQUATIC HERBICIDE ADDED | | | | | | | | |
| 6/24/1998 | | 18 | 13.5 | 2 | 75 | 3 | 3 | 5 | 5 | 30 | 0 | 1 | 0 |
| | Sampler: YOUNG | | | Remarks: | LAKE WAS RECEIVING A HERBICIDE (SONAR) TREATMENT. | | | | | | | | |
| 7/10/1998 | | 20.5 | 18 | 2 | 0 | 3 | 1 | 4 | 4 | 25 | 0 | 0 | 0 |
| | Sampler: YOUNG | | | Remarks: | | | | | | | | | |
| 7/22/1998 | | 23 | 17.5 | 2 | 0 | 1 | 1 | 5 | 5 | 8 | 0 | 2 | 1 |
| | Sampler: YOUNG | | | Remarks: | WARM DAY - MANY SHORE SWIMMERS (EST. 25). | | | | | | | | |
| 7/25/1998 | | | 19.8 | 2 | 0 | | | 5 | 5 | 0 | 2 | 0 | 1 |
| | Sampler: SMITH | | | Remarks: | 70% OF THE SHORELINE DEVELOPED. CONSTRUCTION ALONG SHORELINE NEAR SITE #2 WITH NO SILT SCREENS. SLIGHT BLUE-GREEN BLOOM. 5 SWIMMERS. | | | | | | | | |
| 8/8/1998 | | 23 | 19 | 2 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 2 | 0 |
| | Sampler: YOUNG | | | Remarks: | | | | | | | | | |
| 8/17/1998 | | | 14.2 | 3 | 90 | 1 | | 4 | 2 | 1 | 0 | 0 | 2 |
| | Sampler: SMITH | | | Remarks: | 8-14-98 SONAR TREATMENT FOR MILFOIL. SLIGHT BLUE-GREEN BLOOM. | | | | | | | | |
| 8/21/1998 | | 22 | 16 | 2 | 50 | 2 | 1 | 5 | 5 | 3 | 0 | 1 | 0 |
| | Sampler: YOUNG | | | Remarks: | | | | | | | | | |
| 9/10/1998 | | 22 | 17 | 2 | 0 | 1 | 1 | 5 | 5 | 0 | | 0 | 0 |
| | Sampler: YOUNG | | | Remarks: | MILFOIL DEPRESSED. | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/17/1998 | | | 20.79 | 2 | 60 | | | 5 | 5 | 2 | 2 | 0 | 0 |
| | Sampler: SMITH | | | Remarks: FEC #1 TAKEN AT ISLAND SIDE FACING BOAT RAMP. The Conductivity result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | | |
| 9/24/1998 | | 19.5 | 22 | 2 | 75 | 3 | 2 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: YOUNG | | | Remarks: | | | | | | | | | |
| 9/24/1998 | | | 22 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: BELL-MCKINNON | | | Remarks: | | | | | | | | | |

# LELAND

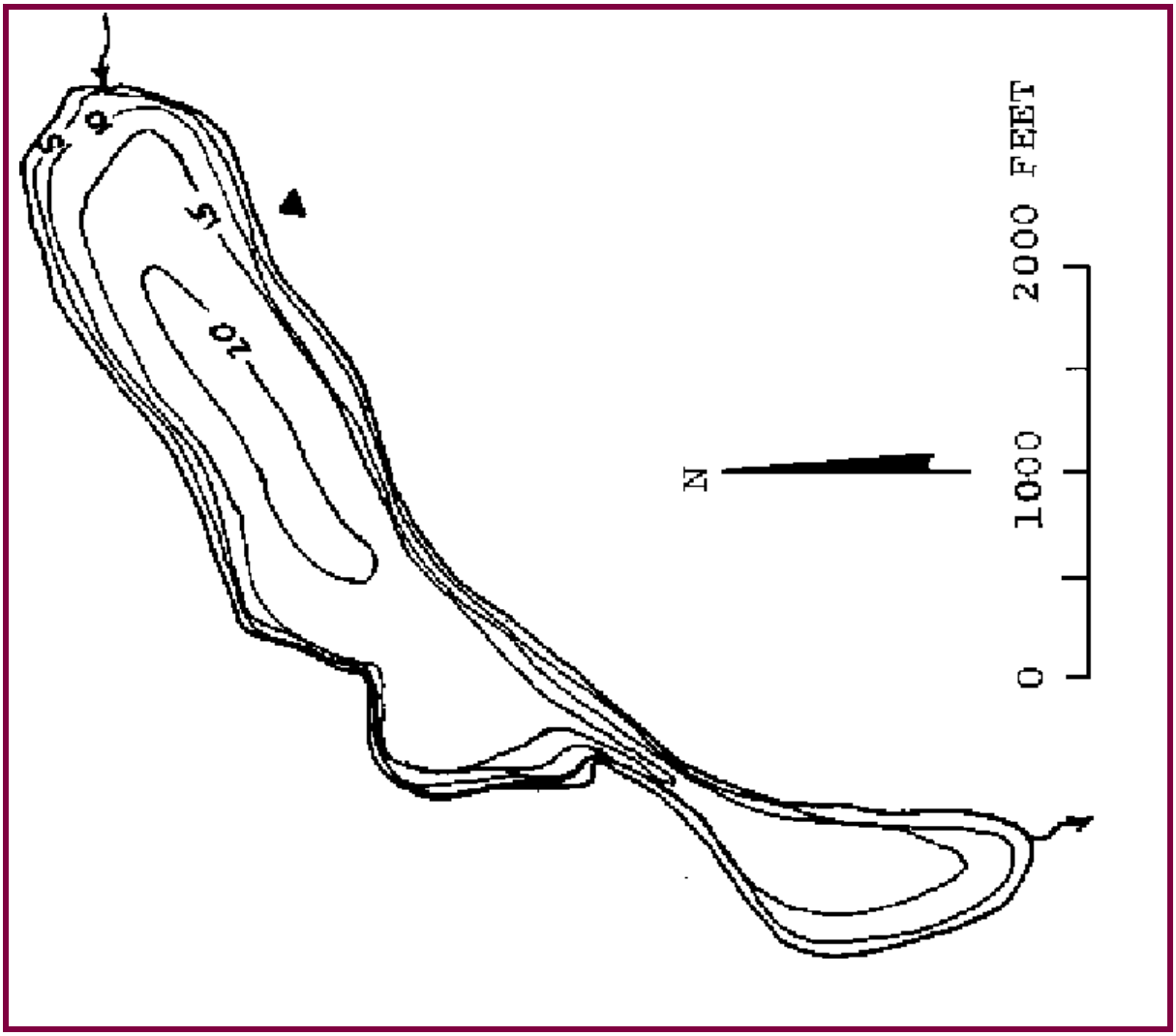
JEFFERSON County

***Lake ID:*** *LELJE1*

***Ecoregion:*** 2

Leland Lake is a prime fishing lake nestled on the eastern slopes of the Olympics. The lake is located approximately 5 miles north of Quilcene, just west of Highway 101. Leland Lake's outlet is Leland Creek which flows into the Little Quilcene River

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* | |
|---|---|---|---|---|
| 107 | 20 | 13 | 6 | |
| ***Volume (ac-ft)*** | ***Shoreline (miles)*** | ***Altitude (ft abv msl)*** | ***Latitude*** | ***Longitude*** |
| 1415 | 2.75 | 190 | 47 53 12. | 122 53 05. |



## Station Information

LELJE1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 56 47.3 | longitude: 122 52 50.5 |
| | Description: Deep part of lake, directly west from boat launch | | |
| Secondary Station | Station # 2 | latitude: 47 53 16.8 | longitude: 122 53 18.4 |
| | Description: Approximate center of southernmost arm of lake | | |

## Trophic State Assessment for 1998

LELAND

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 47 | |
| TSI_Phos: | 48 | |
| TSI_Chl: | 51 | J |
| Narrative TSI:[a] | ME | |

Lake Leland is a productive shallow lake which has been infested with the non-native aquatic plant, Brazilian elodea (Egeria densa). Questionnaire results from residents indicate the primary use on the lake is most likely swimming/wading and the secondary use appears to be enjoyment of the view/watching wildlife. Survey respondents indicated a desire for more restrictive motorboat regulations. The survey suggests that water clarity may be impairing the water quality for swimming. Historic data suggests that there may be even fewer nutrients now than before and swimming conditions may be as good as could reasonably be expected. The lake supports a good bass fishery and water quality parameters suggests the lake could be very productive for a warmwater fishery but somewhat limiting for a coldwater fishery due to the substantial decrease in hypolimnetic oxygen in the summer.

Our mean measured total phosphorus concentration was 18.3 ug/L. We recommend the nutrient criterion for Lake Leland be set at 20ug/L total phosphorus, the action value for Puget Lowlands lower mesotrophic lakes.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

LELAND

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 8/12/1998 | | L | | | | | 54 | | | |
| **Station 1** | | | | | | | | | | |
| 6/5/1998 | | E | 17.2 | .416 | 24 | 4.3 | | 25 | 5590 | 1 J |
| | | H | 32.6 | .784 | 24 | | | | | |
| 7/30/1998 | | E | 15.7 | .371 | 24 | 4.6 | | | | |
| | | H | 330 | 1.07 | 3 | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8/12/1998 | E | 18.2 | .384 | 21 | 4.8 | 1.3 |
| | H | 254 | .813 | 3 | | |
| 9/14/1998 | E | 22.1 | .56 | 25 | 17.5 J | 2.1 J |
| | H | 273 | .725 | 3 | | |
| **Station 2** | | | | | | |
| 6/5/1998 | E | 14.8 | .415 | 28 | | 1.1 J |
| 7/30/1998 | E | 22 | .437 | 20 | 4.4 | |
| 8/12/1998 | E | 20.1 | .386 | 19 | 6.8 | 1.3 |
| 9/14/1998 | E | 28.8 | .57 | 20 | 19.4 J | 2.1 J |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

LELAND

**Survey Date:** 9/14/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [2] **Residential**
- [1] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Lots of natural shoreline on the lake.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☑

**Irrigation** ☐

**Survey Id:** 50

## Habitat Survey Summary Report

LELAND

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 9/3/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.6 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.5 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.7 |
| | **trees< 0.3 m DBH** | 1.2 |
| **Understory:** | **woody shrubs saplings** | 1.6 |
| | **tall herbs, forbs grasses** | 1.8 |
| **Ground Cover:** | **woody shrubs seedlings** | 0.7 |
| | **herbs, forbs, grasses** | 1.4 |
| | **standing water or inundated veg** | 1.5 |
| | **barren or buildings** | 0.5 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.1 |
| | **cobble/gravel** | 0.3 |
| | **loose sand** | 0.1 |
| | **other fine soil/sediment** | 0.3 |
| | **vegetated** | 3.6 |
| | **other** | 0.6 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.3 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.8 |
| **commercial** | 0.0 |
| **park facilities** | 0.2 |
| **docks/boats** | 1.0 |
| **walls, dikes, or revetments** | 0.0 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.1 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.2 |
| **orchard** | 0.0 |
| **lawn** | 0.8 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.9 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |

| | |
|---|---|
| **boulders** | 0.0 |
| **cobble** | 0.2 |
| **gravel** | 0.9 |
| **sand** | 1.1 |
| **silt** | 3.0 |
| **woody debris** | 0.4 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 3.1 |
| **emergent** | 1.5 |
| **floating** | 1.0 |
| **total weed cover** | 3.4 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.4 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 2.0 |
| **snags** | 0.5 |
| **brush or woody debris** | 0.2 |
| **inundated live trees** | 0.3 |
| **overhanging vegetation** | 0.9 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 0.3 |

---

# Questionnaire

LELAND

**Results compiled from** 15 **Surveys.** **Average time (years) respondents spent on lake:** 15.09

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.3 | View: | 0.9 | Distance to Lake: | 0.2 |
| Public Access: | -0.2 | Swim Beach: | 0.2 | Canada Geese: | 0.1 |
| Water Clarity: | -0.1 | Water Qual. for Swim: | -0.1 | | |
| Fishing Quality: | 0.1 | Aquatic Plants: | -0.3 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **2.4**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.4 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.3 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.3 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.4 | Good Warmwtr Fishing: | 3.5 | Natural Scenery: | 4.8 |
| Plant Growth: | 2.8 | Good Swimming: | 4.3 | Public Beach: | 3.1 |
| Natural Shoreline: | 3.9 | Less Algae: | 4.3 | Canada Geese: | 3.4 |
| No Odors: | 4.3 | Public Access: | 3.0 | | |
| Good Coldwtr Fishing: | 4.1 | Clear Water: | 4.4 | | |

Good Coldwtr Fishing: ... Clear Water: ...

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 4 | 12/31/1998 | Visitor | | | 2 | ☐ | Unknown | |
| | Bass fishing catch and release only. Campers harvest too many bass. | | | | | | | |
| 7 | 7/7/1998 | Resident | Permanent | Rent | 6 | ☐ | Unknown | |
| 8 | 9/13/1998 | Resident | Seasonal | Rent | 2 | ☐ | Unknown | |
| 9 | 8/24/1998 | Resident | Permanent | Rent | 1 | ☐ | Worse | |
| 10 | 7/11/1998 | Resident | Permanent | Rent | 7 | ☐ | Worse | early 90s |
| | too much shoreline vegetation | | | | | | | |
| 11 | 9/13/1998 | Resident | Permanent | Rent | 10 | ☐ | No | |
| 65 | 8/23/1998 | Resident | Permanent | Rent | 10 | ☐ | No | |
| 66 | 8/25/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 1997 |
| | In order to encourage the conservation of this little lake, we need to knock out the elodia noxious weed through non-chemical means and remove gas motors from the lake. | | | | | | | |
| 67 | 9/29/1998 | Resident | Seasonal | Rent | 6 | ☑ | Unknown | |
| | good water quality--fecals, nitrates, etc. | | | | | | | |
| 68 | 8/26/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 10 to 15 yea |
| 70 | 8/23/1998 | Resident | Permanent | Rent | 7 | ☐ | Unknown | |
| 74 | 8/23/1998 | Resident | Permanent | Rent | | ☐ | No | |
| 77 | 8/23/1998 | Resident | Permanent | Rent | 6 | ☐ | No | |
| 78 | 8/22/1998 | Resident | Permanent | Rent | 6 | ☑ | No | |
| 79 | 8/27/1998 | Resident | Permanent | Rent | 2 | ☐ | No | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

# Zooplankton Report

LELJE1

## Date 6/5/1998

Station: 1
Sample ID 22

Sample full of Aphonizomenon; 9 mLs measured

Number of organisms measured: 55

| Group | Percent |
|---|---|
| Cladoceran | 21.8% |
| Copepod | 78.2% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 81.8% |
| Large >= 1mm | 18.2% |
| Ratio of large to Small: | 0.22 |
| Average size (mm): | 0.57 |

## Date 6/5/1998

Station: 2
Sample ID 18

Lots of Aphanizominon; 6 mLs observed

Number of organisms measured: 62

| Group | Percent |
|---|---|
| Cladoceran | 19.4% |
| Copepod | 80.6% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 64.5% |
| Large >= 1mm | 35.5% |
| Ratio of large to Small: | 0.55 |
| Average size (mm): | 0.73 |

Date 8/12/1998 Station: 1
Sample ID 29

Date may be wrong--difficult label to read; LOTS of algae in sample (mostly nostoc, and something else, single-celled).

Number of organisms measured: 145

| Group | Percent |
|---|---|
| Cladoceran | 17.2% |
| Copepod | 82.8% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 77.2% |
| Large >= 1mm | 22.8% |
| Ratio of large to Small: | 0.29 |
| Average size (mm): | 0.48 |

## Aquatic Plant Data

LELAND

Sampler: Parsons, Bell-McKinnon

Survey Date: 9/3/1998

Max depth of growth (M): 3

Comments Sunny, calm. Visited to do vegetation survey for Kirk Smith. Egeria still patchy in main part of lake, though well distributed. Also plentiful P. praelongus and P. robbinsii. Egeria not at surface in most of lake, though dense below surface at the west end.

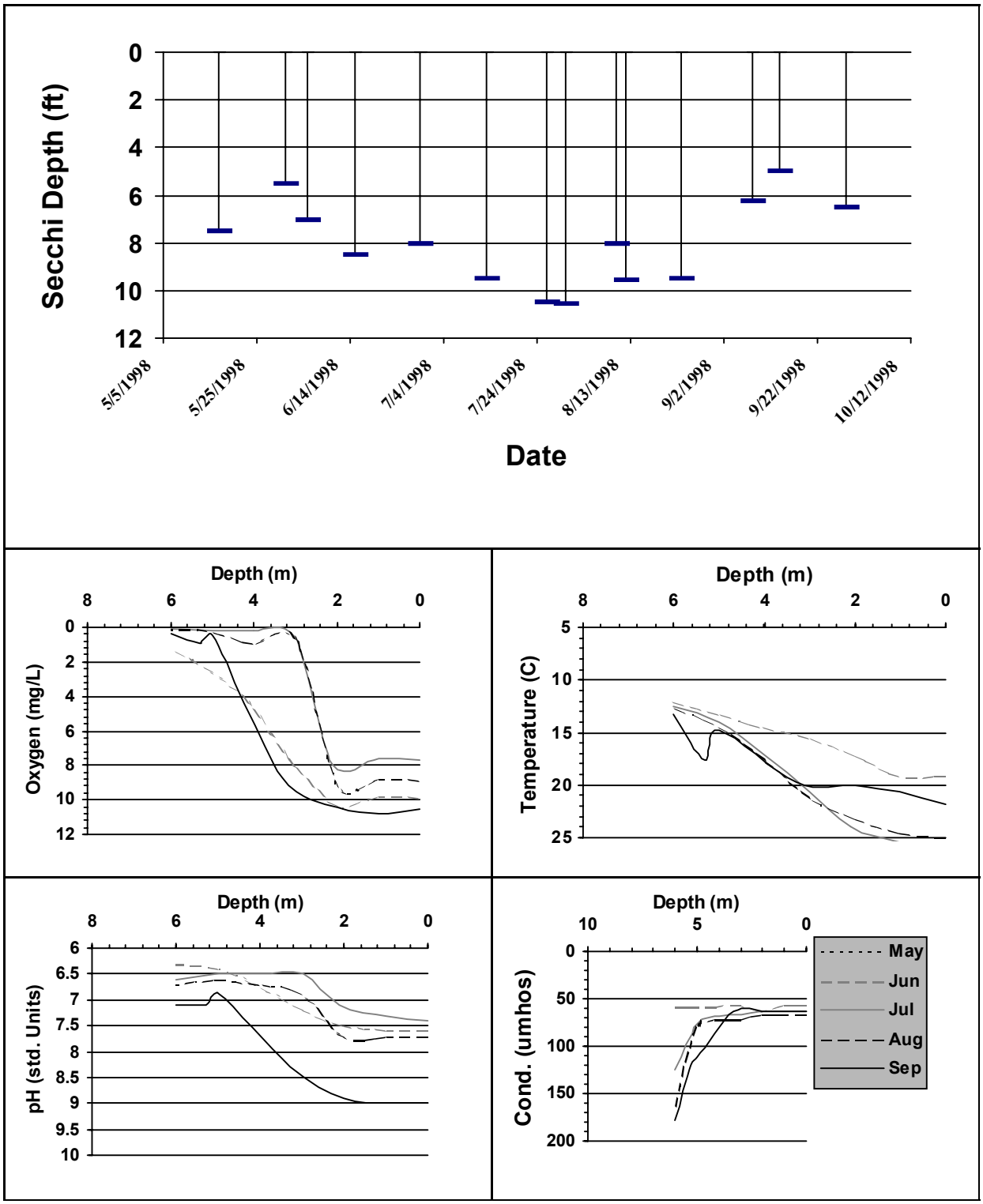
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Ceratophyllum demersum* | Coontail; hornwort | 2 | |
| *Egeria densa* | Brazilian elodea | 4 | flowering toward SW end, heavy epiphytic growth |
| *Elodea canadensis* | common elodea | 2 | |
| *Iris pseudacorus* | yellow flag | 3 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | |
| *Nymphaea odorata* | fragrant waterlily | 1 | one patch seen on S shore |
| *Phalaris arundinacia* | reed canarygrass | 2 | |
| *Potentilla palustris* | purple (marsh) cinquefoil | 2 | |
| *Potamogeton praelongus* | whitestem pondweed | 3 | |
| *Potamogeton robbinsii* | fern leaf pondweed | 3 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 1 | |
| *Sagittaria sp.* | arrowhead | 1 | vicinity of Don Case's house |
| *Utricularia sp.* | bladderwort | 1 | in wetland at NE end |
| *Zizania aquatica* | wild rice | 2 | |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 LELJE1



# Secchi Data and Field Observations

LELAND

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 5/17/1998 | | 15.6 | 7.5 | 7 | 100 | 1 | 2 | 5 | 5 | 4 | | 3 | 0 |
| | Sampler: | CASE | | Remarks: | NEW STAFF GAUGE - NEW = 2.25, OLD =14.00. | | | | | | | | |
| 5/31/1998 | | 20 | 5.5 | 9 | 50 | 1 | 2 | 5 | 5 | 0 | 0 | 6 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 6/5/1998 | | | 7 | 9 | 100 | | | 4 | 2 | 0 | 0 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | RESIDENT SUSPECTS LOGGING IN AREA HAS CONTRIBUTED TO HIGH WATER LEVELS OVER THE LAS FEW YEARS. | | | | | | | | |
| 6/15/1998 | | 19.4 | 8.5 | 8 | 50 | 2 | 2 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 6/29/1998 | | 22.8 | 8 | 8 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 2 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 7/13/1998 | | 21.1 | 9.5 | 8 | 50 | 2 | 3 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 7/26/1998 | | 24.4 | 10.5 | 7 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 4 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 7/30/1998 | | | 10.56 | 9 | 100 | 1 | | | | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | MUCH LESS BLUE-GREEN ALGAE THAN USE TO SEEING IN THE LAKE. VERY DARK WATER! 2 OSPREY | | | | | | | | |
| 8/10/1998 | | 22.2 | 8 | 8 | 25 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 8/12/1998 | | | 9.57 | | 0 | 1 | | 4 | 3 | 0 | 3 | 1 | 0 |
| | Sampler: | SMITH | | Remarks: | STRONG H2S IN HYPOLIMNION | | | | | | | | |
| 8/24/1998 | | 22.2 | 9.5 | 7 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/8/1998 | | 21.7 | 6.25 | 7 | 75 | 1 | 3 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |
| 9/14/1998 | | | 4.95 | 2 | 0 | | | 3 | 3 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | The conductivity and dissolved oxygen results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 9/28/1998 | | 17.8 | 6.5 | 7 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: | CASE | | Remarks: | | | | | | | | | |

# LIBERTY

SPOKANE County

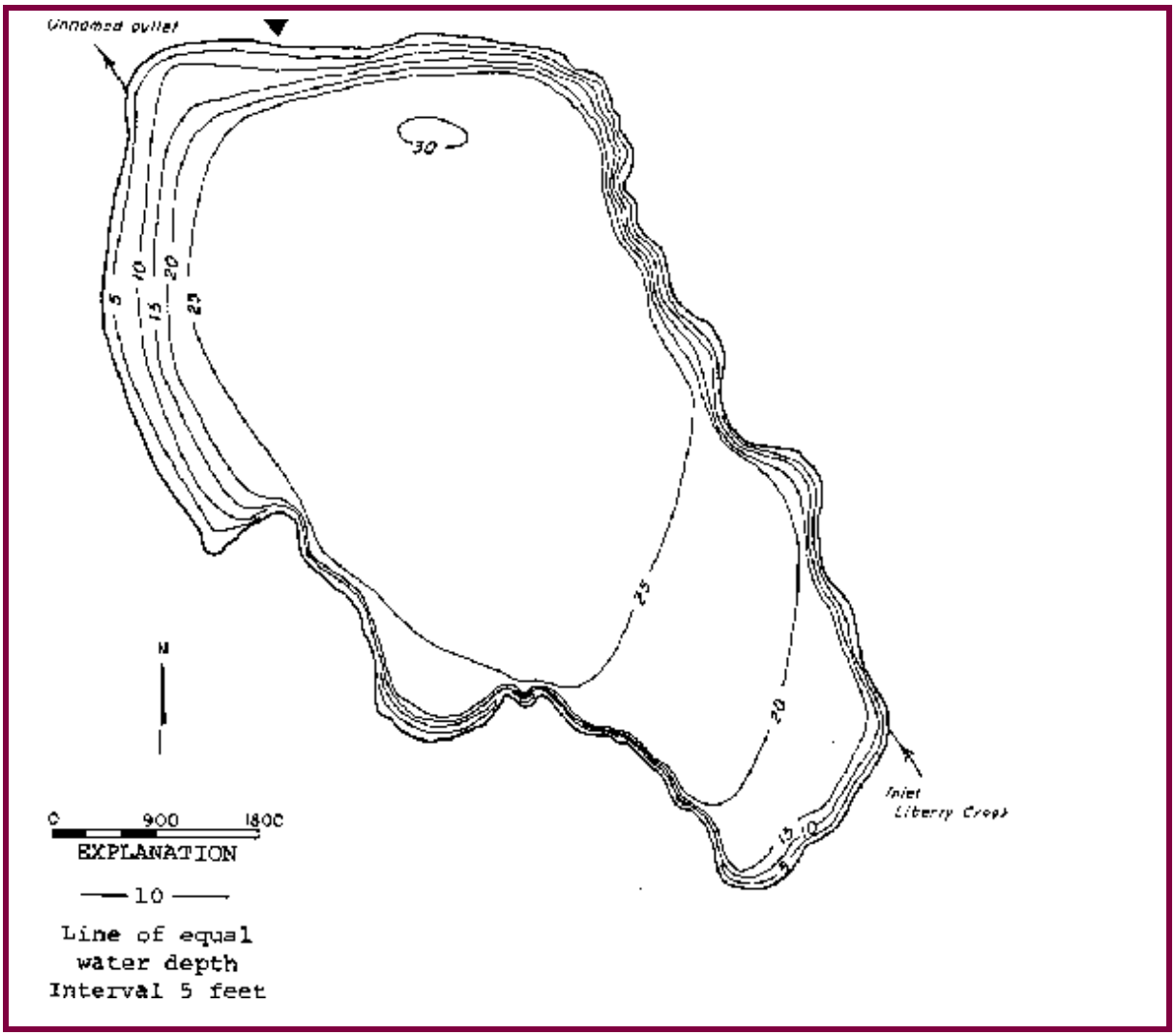
***Lake ID:*** *LIBSP1*

***Ecoregion:*** 7

Liberty Lake is a popular lake just outside the Spokane city limits to the west. Its shores are only a mile from the Idaho border. The inlet for Liberty Lake is Liberty Creek and the outlet is an unnamed creek.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 710 | 30 | 23 | 13 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 16000 | 4.77 | 2053 | 47 39 09. | 117 05 20. |



## Station Information

LIBSP1

Primary Station Station # 1 latitude: 47 39 01.0 longitude: 117 04 33.0

Description: Lake's deep site, several hundred meters from shore, SW of public access.

## Trophic State Assessment for 1998

LIBERTY

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 38 |
| TSI_Phos: | 42 |
| TSI_Chl: | 39 |
| Narrative TSI:[a] | OM |

Liberty Lake has a well developed shoreline but the watershed appears to be mostly undeveloped with abundant timber and some timber harvest. The residential area around the lake is partially curbed; however, many roads run perpendicular to the lake so runoff could enter directly into the lake. The lake has undergone recent restoration efforts and is currently being monitored by both residents and by the Liberty Lake Sewer District. Dr. Funk (Washington State University) has been actively monitoring the lake for many years in conjunction with the sewer district.

Some lakeside landscaping appeared to include the use of lawn chemicals. Zooplankton samples collected in the spring suggest a healthy zooplankton population with large daphnia to support a sport fishery. Water quality measurements suggest the lake is oligo-mesotrophic; our seasonal mean TP was 13.3 ug/L. The vast majority of the user surveys were answered by lakeside residents who were primarily interested in maintaining water clarity. Several respondents reported seagulls to be a nuisance.

Dr. Funk considers nutrient deposition from wild fowl to be a threat to the water quality of the lake. He also recommends the repair of the dike separating the marsh from the lake (Funk, W. H. 2000. Water quality annual report for Liberty Lake, Washington. Submitted to Liberty Lake Sewer District).

The total phosphorus action value for Liberty Lake is 20 ug/L; however, we recommend a criterion be set at current TP levels (plus an adjustment to account for inter-annual variation) in order to protect present uses. Therefore, the recommended nutrient criterion for Liberty Lake is (13.3 + 4.1=) 17.4 ug/L total phosphorus.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

LIBERTY

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 7/13/1998 | | L | | | | | 1 U | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | L | | | | | 3 J | | |
| 8/10/1998 | L | | | | | 1 | | |
| | L | | | | | 2 | | |
| 9/14/1998 | L | | | | | 8 | | |
| | L | | | | | 9 | | |
| **Station 1** | | | | | | | | |
| 6/15/1998 | E | 11 | .225 | 20 | 1.5 | | 14.7 | .6 J |
| | H | 21.5 | .225 | 10 | | | | |
| 7/13/1998 | E | 12.9 | .236 | 18 | 2.5 | | | .8 |
| | H | 14 | .236 | 17 | | | | |
| 8/10/1998 | E | 12.9 | .251 | 19 | 2.3 | | | .6 |
| | H | 25.9 | .289 | 11 | | | | |
| 9/14/1998 | E | 16.3 | .25 | 15 | 4.8 | | | 1 |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

LIBERTY

**Survey Date:** 9/14/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [1] **Residential**
- [2] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** Partially Curbed

### Observations (check mark denotes presence)

**BMP's** ☑

Sediment screen at base of Clark Ave. (which is perpendicular to the lake, separated by steep straight path to lake). Selective thinning approx. 200 yds from the water. Rds perpendicular to the lake, directly upslope have berms in poor shape.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☑

A couple of geese at private park west of outlet.

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Many lawns are green and groomed, some extending to bulkhead.

**Buffer zones around streams and wetlands** ☐

No development around inlet stream or wetland @ S. end. Overall assessment of lake--little improvement needed.

**Irrigation** ☐

**Survey Id:** 100

# Habitat Survey Summary Report

LIBERTY

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/13/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.6 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.2 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.5 |
| | **trees< 0.3 m DBH** | 0.8 |
| **Understory:** | **woody shrubs saplings** | 1.6 |
| | **tall herbs, forbs grasses** | 0.7 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.6 |
| | **herbs, forbs, grasses** | 2.7 |
| | **standing water or inundated veg** | 0.2 |
| | **barren or buildings** | 1.8 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.7 |
| | **boulders** | 0.8 |
| | **cobble/gravel** | 0.7 |
| | **loose sand** | 2.3 |
| | **other fine soil/sediment** | 0.4 |
| | **vegetated** | 1.5 |
| | **other** | 0.6 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.4 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.2 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.4 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 1.6 |
| **walls, dikes, or revetments** | 1.6 |
| **litter, trash dump, or landfill** | 0.2 |
| **roads or railroad** | 0.1 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.4 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.7 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.3 |
| **boulders** | 0.4 |
| **cobble** | 0.8 |
| **gravel** | 1.5 |
| **sand** | 2.3 |
| **silt** | 1.3 |
| **woody debris** | 0.1 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.5 |
| **emergent** | 0.2 |
| **floating** | 0.1 |
| **total weed cover** | 1.6 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -1.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.3 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.0 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.5 |
| **rock ledges or sharp dropoffs** | 0.2 |
| **boulders** | 0.4 |
| **human structures** | 1.4 |

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# Questionnaire

LIBERTY

**Results compiled from** 21 **Surveys.** **Average time (years) respondents spent on lake:** 26.05

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.6 | View: | 0.8 | Distance to Lake: | 0.5 |
| Public Access: | -0.2 | Swim Beach: | 0.5 | Canada Geese: | -0.2 |
| Water Clarity: | 0.4 | Water Qual. for Swim: | 0.4 | | |
| Fishing Quality: | 0.3 | Aquatic Plants: | -0.6 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **3.5**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.8 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.4 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.2 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.1 | Good Warmwtr Fishing: | 3.4 | Natural Scenery: | 4.6 |
| Plant Growth: | 2.6 | Good Swimming: | 4.8 | Public Beach: | 2.9 |
| Natural Shoreline: | 3.6 | Less Algae: | 4.5 | Canada Geese: | 3.0 |
| No Odors: | 4.0 | Public Access: | 2.6 | | |
| Good Coldwtr Fishing: | 3.1 | Clear Water: | 4.8 | | |

**Tabulated Results**

| Survey ID | Date | ----------Residency---------- | | Rent or Own | Primary Activity* | ----------Water Clarity---------- Purchase Factor? | Has it Changed? | When? |
|---|---|---|---|---|---|---|---|---|
| 5 | 9/28/1998 | Visitor | | | 2 | ☐ | Unknown | |
| | Would like more shoreline access. Should have questions about fishing access. | | | | | | | |
| 6 | 9/28/1998 | Resident | Permanent | Rent | 6 | ☑ | Better | |
| | We have too many ducks--they do not add to the clarity of the water. | | | | | | | |
| 12 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☑ | No | |
| 13 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☑ | Unknown | |
| | Personal watercraft are irritating and at times dangerous on this small, crowded lake (ski-dos, wave-runners, etc.) | | | | | | | |
| 14 | 9/28/1998 | Resident | Permanent | Rent | 6 | ☑ | Better | early 90s |
| 15 | 9/28/1998 | Resident | Permanent | Rent | living | ☐ | Worse | after first po |
| 16 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☑ | Worse | 1994-1995 |
| | Remove swimmer's itch--goes with getting rid of plants and snails. Plants were not introduced naturally and should be removed. | | | | | | | |
| 17 | 9/28/1998 | Resident | Permanent | Rent | 7 | ☑ | Better | 1990 |
| 18 | 9/28/1998 | Resident | Permanent | Rent | 1 | ☐ | Better | 1998 |
| 19 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☑ | Better | |
| | Would like to see the ducks, seagulls and geese eliminated. They are causing more pollution problems than anything else. | | | | | | | |
| 20 | 9/28/1998 | Resident | Permanent | Rent | 4 | ☑ | Better | |
| 21 | 9/28/1998 | Resident | Permanent | Rent | 7 | ☑ | No | |
| 22 | 9/28/1998 | Resident | Permanent | Rent | 7 | ☑ | Better | When sewer |
| 23 | 9/28/1998 | Resident | | Rent | 4 | ☑ | Better | since the 70 |
| | Seagulls are a nuisance | | | | | | | |
| 24 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☐ | Worse | |
| 25 | 9/28/1998 | Resident | Permanent | Rent | 4 | ☑ | No | |
| 26 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☐ | Better | 80s after the |
| | Manage a control public access. Remove it from high residential area and restrict it to current county park including boater access. | | | | | | | |
| 27 | 9/28/1998 | Resident | Permanent | Rent | none | ☐ | No | |
| | I was born here 82 years ago. I remember good fishing (no trout), algae and a great pleasure lake. Now it is almost a closed lake for the very few. How sad. | | | | | | | |
| 28 | 9/28/1998 | Resident | Permanent | Rent | many of the above | ☑ | Unknown | clarity very |
| 29 | 12/31/1998 | Resident | | Rent | | ☐ | Unknown | |
| 87 | 9/28/1998 | Resident | Permanent | Rent | 10 | ☑ | Better | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

LIBSP1

Date 6/15/1998 Station: 1

Sample ID 15

Number of organisms measured: 116

| Group | Percent | Group | Percent |
|---|---|---|---|
| Cladoceran | 25.9% | Small < 1mm | 77.6% |
| Copepod | 74.1% | Large >= 1mm | 22.4% |
| Other | | Ratio of large to Small: | 0.29 |
| | | Average size (mm): | 0.56 |

Date 8/10/1998 Station: 1 Lots of large rotifers
Sample ID 9

Number of organisms measured: 119

| Group | Percent | Group | Percent |
|---|---|---|---|
| Cladoceran | 7.6% | Small < 1mm | 77.3% |
| Copepod | 92.4% | Large >= 1mm | 22.7% |
| Other | | Ratio of large to Small: | 0.29 |
| | | Average size (mm): | 0.53 |

## Aquatic Plant Data

LIBERTY

Sampler: Parsons, O'Neal Survey Date: 7/13/1998

Max depth of growth (M): 6.5

Comments Breezy, partly cloudy. Nice plant community. Few plants in water less than 1.5 m deep, deeper water with plants approaching surface to 3 m deep. Deep water with Elodea, P. pusillus and Chara. Mergansers, greebes, osprey. Did habitat survey for Kirk Smith.

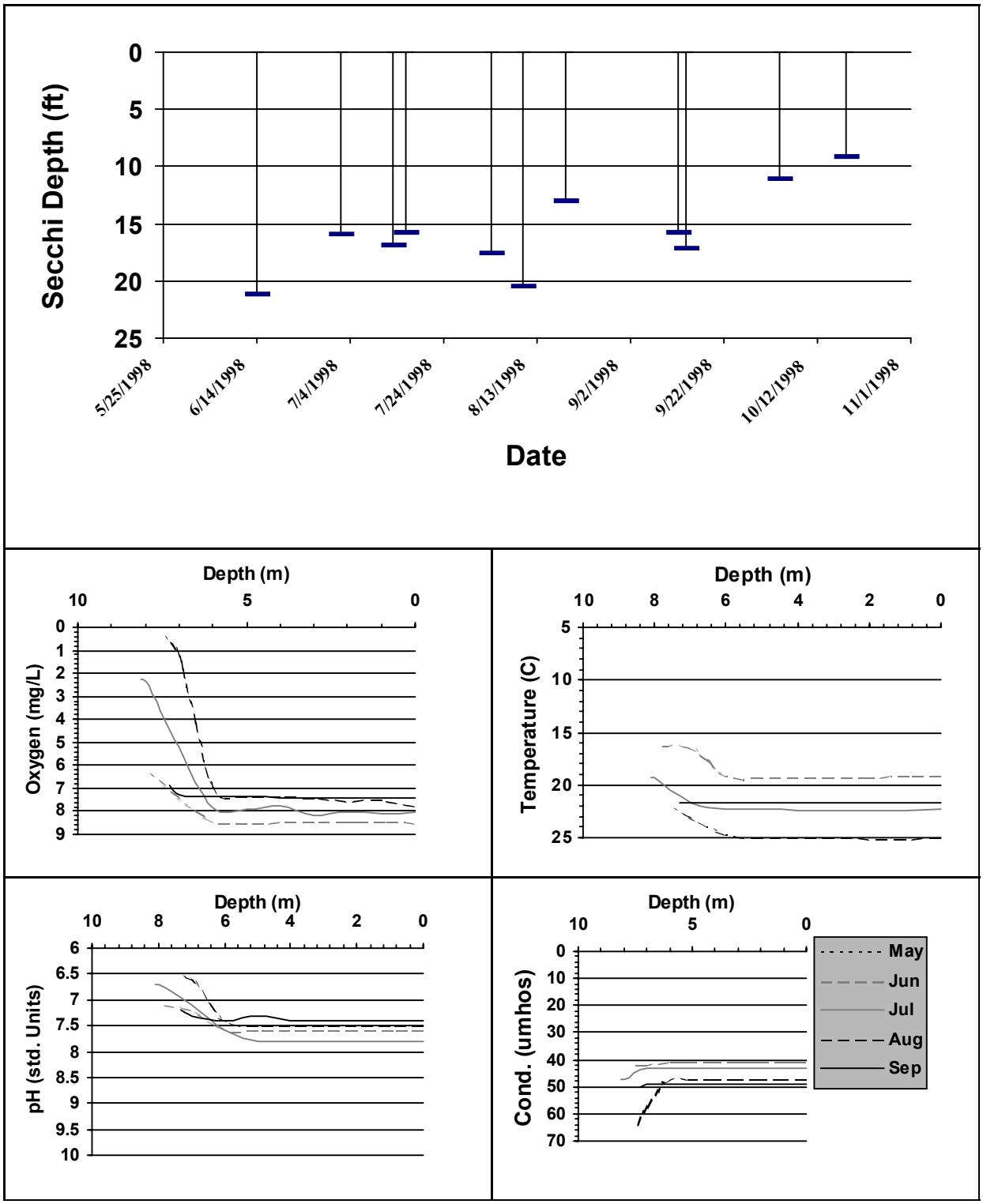
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Chara sp.* | muskwort | 2 | in shallow to deep water |
| *Elodea canadensis* | common elodea | 3 | blooming |
| *Myriophyllum spicatum* | Eurasian water-milfoil | 1 | seen at wetland, south end, several plants (also known from north end) |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | |
| *Phalaris arundinacia* | reed canarygrass | 2 | most in wetland, south end |
| *Phragmites communis* | common reed | 1 | |
| *Potamogeton amplifolius* | large-leaf pondweed | 3 | |
| *Potamogeton pusillus* | slender pondweed | 2 | |
| *Potamogeton robbinsii* | fern leaf pondweed | 3 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 2 | may also be P. pusillus, in deep water |
| *Scirpus sp.* | bulrush | 2 | bulrush, south end |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 LIBSP1



# Secchi Data and Field Observations

LIBERTY

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/14/1998 | | 19.5 | 21.2 | 6 | 50 | 3 | 3 | 5 | 5 | 0 | 0 | 2 | 3 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |
| 6/14/1998 | | 19.5 | 21.2 | 6 | 100 | 1 | | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | HALLOCK | | Remarks: | 2 PARTIES BANK FISHING AT ACCESS. MOSTLY TIMBER IN WSHED. SHORELINE DEVELOPED HEAVILY IN SOME AREAS. ALL SEWERED. | | | | | | | | |
| 7/2/1998 | | 22.2 | 15.83 | 6 | 0 | 3 | 2 | 5 | 5 | 0 | 0 | 0 | 1 |
| | Sampler: | KLAPP | | Remarks: | FORGOT THE VIEW TUBE THIS TIME BUT EXPECT TO USE IT REGULARLY. | | | | | | | | |
| 7/13/1998 | | | 16.8 | 6 | 20 | 3 | | 5 | 5 | 0 | 25 | 3 | 1 |
| | Sampler: | HALLOCK | | Remarks: | ONE TRAILER AT ACCESS. TWO OTHERS FISHING AT ACCESS | | | | | | | | |
| 7/16/1998 | | 25 | 15.7 | 6 | 0 | 1 | 1 | 5 | 5 | 0 | 1 | 2 | 2 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |
| 8/3/1998 | | 27 | 17.6 | 6 | 0 | 2 | 2 | 5 | 5 | 0 | 3 | 1 | 2 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |
| 8/10/1998 | | | 20.46 | 6 | 0 | | | | | 0 | 9 | 2 | 2 |
| | Sampler: | HALLOCK | | Remarks: | VOL HASN'T SEEN GEESE ON THE LAKE SINCE GOLF COURSE OPENED. GLEOTRICHIA IN WATER COLUMN. | | | | | | | | |
| 8/19/1998 | | 23.8 | 13 | 6 | 0 | 2 | 1 | 5 | 5 | 0 | 5 | 0 | 2 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |
| 9/12/1998 | | 23 | 15.7 | 6 | 0 | 1 | 2 | 5 | 5 | 0 | 4 | 0 | 2 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |
| 9/14/1998 | | | 17.16 | 6 | 0 | | | 4 | 4 | 2 | 0 | 1 | 0 |
| | Sampler: | HALLOCK | | Remarks: | GLEOTRICHIA PRESENT IN WATER COLUMN. COUNTY PARK IS ACCESSIBLE BY ROAD. | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/4/1998 | | 16.2 | 11.1 | 6 | 50 | 2 | 1 | 5 | 5 | 0 | 5 | 0 | 0 |
| | Sampler: | KLAPP | | Remarks: | "PECTINATELLA" NOTED 9/12/98. | | | | | | | | |
| 10/18/1998 | | 12.3 | 9.1 | 6 | 0 | 1 | 3 | 5 | 3 | 0 | 2 | 0 | 0 |
| | Sampler: | KLAPP | | Remarks: | | | | | | | | | |

# LIMERICK

MASON County

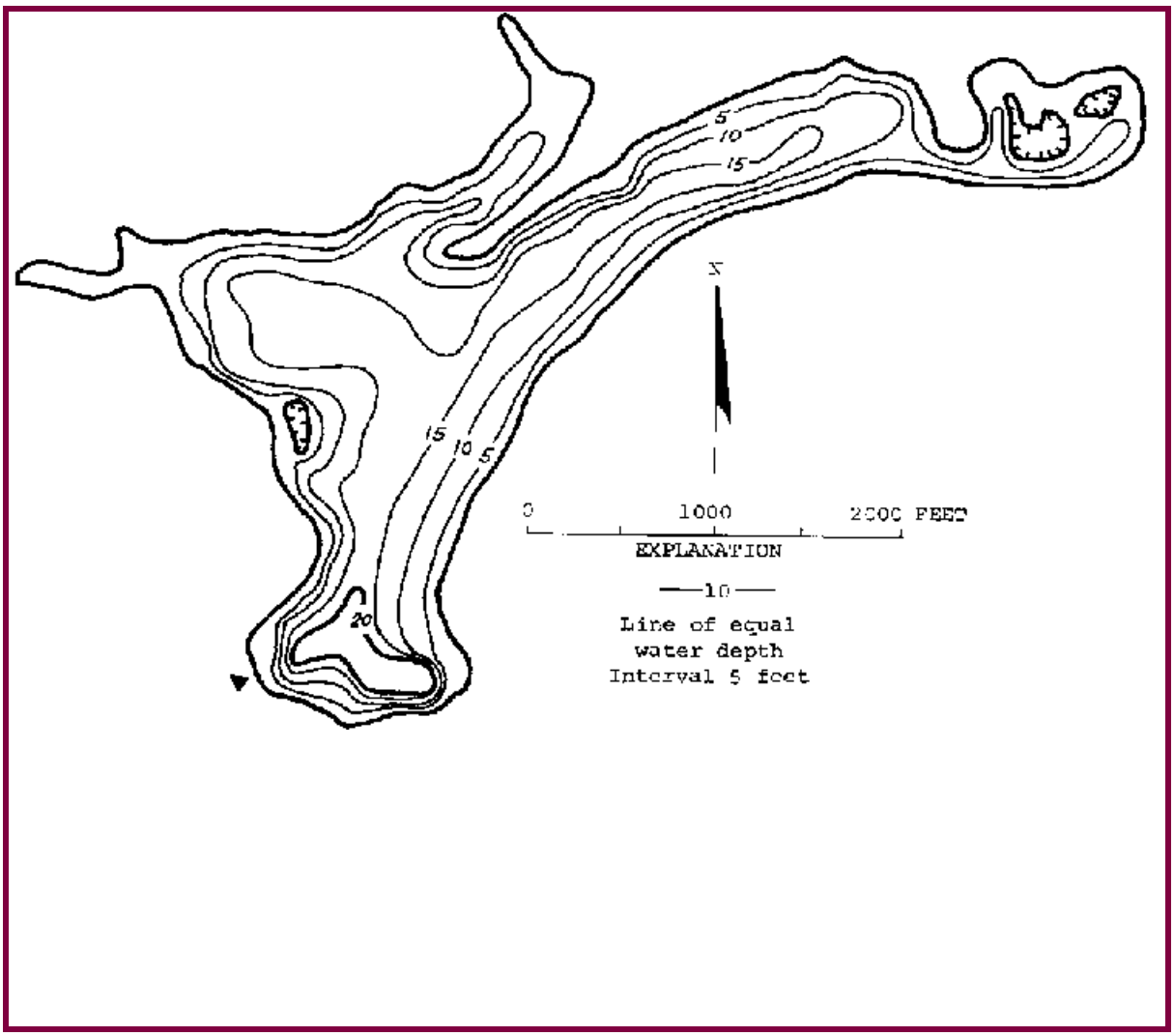
*Lake ID:* LIMMA1

*Ecoregion:* 2

Lake Limerick is located about five miles northeast of Shelton. It was formed in 1966 by the impoundment of Cranberry Creek. Lake Limerick is fed mainly by Cranberry Creek, as well as three other minor inlets. The lake level is stabilized by a control weir at its outlet to Cranberry Creek.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 129 | 24 | 9 | 13 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 1210 | 4.39 | 220 | 47 16 59. | 123 02 51. |



## Station Information

LIMMA1

Primary Station Station # 1 latitude: 47 16 48.8 longitude: 123 02 45.7

Description: Deep part of lake in approximate center of southernmost cove

## Trophic State Assessment for 1998

LIMERICK

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 43 |
| TSI_Phos: | 36 |
| TSI_Chl: | 42 |
| Narrative TSI:[a] | M |

Lake Limerick is relatively low in nutrients (mean total phosphorus was 9.0 ug/L) but rich in aquatic macrophytes. It is surprising more nutrients are not showing up in the water column considering Cranberry Lake (a bog-like wetland with considerably higher nutrient concentrations) drains into Lake Limerick. It is possible that much of the total phosphorus is bound to sediment particles or accumulated in macrophyte biomass. The abundant aquatic plants appear to impair the beneficial uses of the lake more than the nutrient concentrations. Limiting the nutrients, however, will not necessarily reduce the aquatic macrophyte biomass because those nutrients typically come from sediment and not from the water column.

We recommend the ecoregional action value for oligotrophic Puget Lowland lakes (10 ug/L) be set as a total phosphorus criterion for Lake Limmerick.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

LIMERICK

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 7/27/1998 | | L | | | | | 6 | | | |
| | | L | | | | | 7 | | | |
| 8/18/1998 | | L | | | | | 5 | | | |
| | | L | | | | | 30 | | | |
| **Station 1** | | | | | | | | | | |
| 6/4/1998 | | E | 8.8 | .186 | 21 | 2.8 | | 21.4 | 4890 | .9 |
| 7/27/1998 | | E | 7.4 | .247 | 33 | 2.4 | | | | 1.3 |
| | | H | 16.3 | .269 | 17 | | | | | |
| 8/18/1998 | | E | 9.6 | .335 | 35 | 3.8 | | | | 2 |
| 9/18/1998 | | E | 10.4 | .283 | 27 | 4.3 | | | | .8 J |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than, G=Greater than.

## Watershed Survey

LIMERICK

**Survey Date:** 9/18/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | 1 | **Residential** |
| | **Commercial, Industrial** | 2 | **Park, forest or natural** |
| | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Lawns were mowed right down to the lake

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☑

Many geese use the lake. Volunteer has mentioned that geese have just recently produced offspring on the lake.

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

On the neighborhood golf course and lakeside lawns

**Buffer zones around streams and wetlands** ☐

lacking on the inlet stream where homes are built and the stream is treated more like a canal than a stream

**Irrigation** ☑

at boat launch near the dam

**Survey Id:** 30

## Habitat Survey Summary Report

LIMERICK

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/8/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.2 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.4 | **Number of stations with understory:** | 10 |

### Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 2.4 |
| | **trees< 0.3 m DBH** | 0.7 |
| **Understory:** | **woody shrubs saplings** | 1.9 |

| | | |
|---|---|---|
| | **tall herbs, forbs grasses** | 0.5 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.5 |
| | **herbs, forbs, grasses** | 2.2 |
| | **standing water or inundated veg** | 0.2 |
| | **barren or buildings** | 1.9 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.2 |
| | **cobble/gravel** | 1.4 |
| | **loose sand** | 0.0 |
| | **other fine soil/sediment** | 0.4 |
| | **vegetated** | 3.1 |
| | **other** | 0.5 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.1 |
| **commercial** | 0.0 |
| **park facilities** | 0.0 |
| **docks/boats** | 1.3 |
| **walls, dikes, or revetments** | 0.9 |
| **litter, trash dump, or landfill** | 0.2 |
| **roads or railroad** | 0.4 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.3 |
| **other** | 0.1 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.6 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.4 |
| **gravel** | 1.3 |
| **sand** | 0.6 |
| **silt** | 3.0 |
| **woody debris** | 0.1 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.7 |

| | |
|---|---|
| **emergent** | 0.6 |
| **floating** | 0.0 |
| **total weed cover** | 1.7 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -1.0 |

**Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)**

| | |
|---|---|
| **aquatic weeds** | 1.4 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.2 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.7 |
| **rock ledges or sharp dropoffs** | 0.1 |
| **boulders** | 0.0 |
| **human structures** | 1.1 |

## Zooplankton Report

LIMMA1

Date 6/4/1998 Station: 1 Sample ID 32

Lots of rotifers in sample.

Number of organisms measured: 180

| Group | Percent |
|---|---|
| Cladoceran | 31.7% |
| Copepod | 68.3% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 91.7% |
| Large >= 1mm | 8.3% |
| Ratio of large to Small: | 0.09 |
| Average size (mm): | 0.48 |

Date 8/18/1998 Station: 1 Sample ID 28

Lots of rotifers, nostic and worms (!) in sample.

Number of organisms measured: 104

| Group | Percent |
|---|---|
| Cladoceran | 23.1% |
| Copepod | 76.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 92.3% |
| Large >= 1mm | 7.7% |
| Ratio of large to Small: | 0.08 |
| Average size (mm): | 0.39 |

## Aquatic Plant Data

LIMERICK

Sampler: Parsons, O'Neal Survey Date: 7/8/1998

Max depth of growth (M): 2.5

Comments Partly cloudy, calm. Vegetation survey done for Kirk Smith. Bullfrog. Did not survey whole shoreline carefully. Patches of dense P. amplifolius, thin leaved pondweed, many aeas with much algae and few plants. Egeria densa found during snorkling at launch in water ~ 2 m deep, widely scattered small plants, at islands patchy, some dense growth

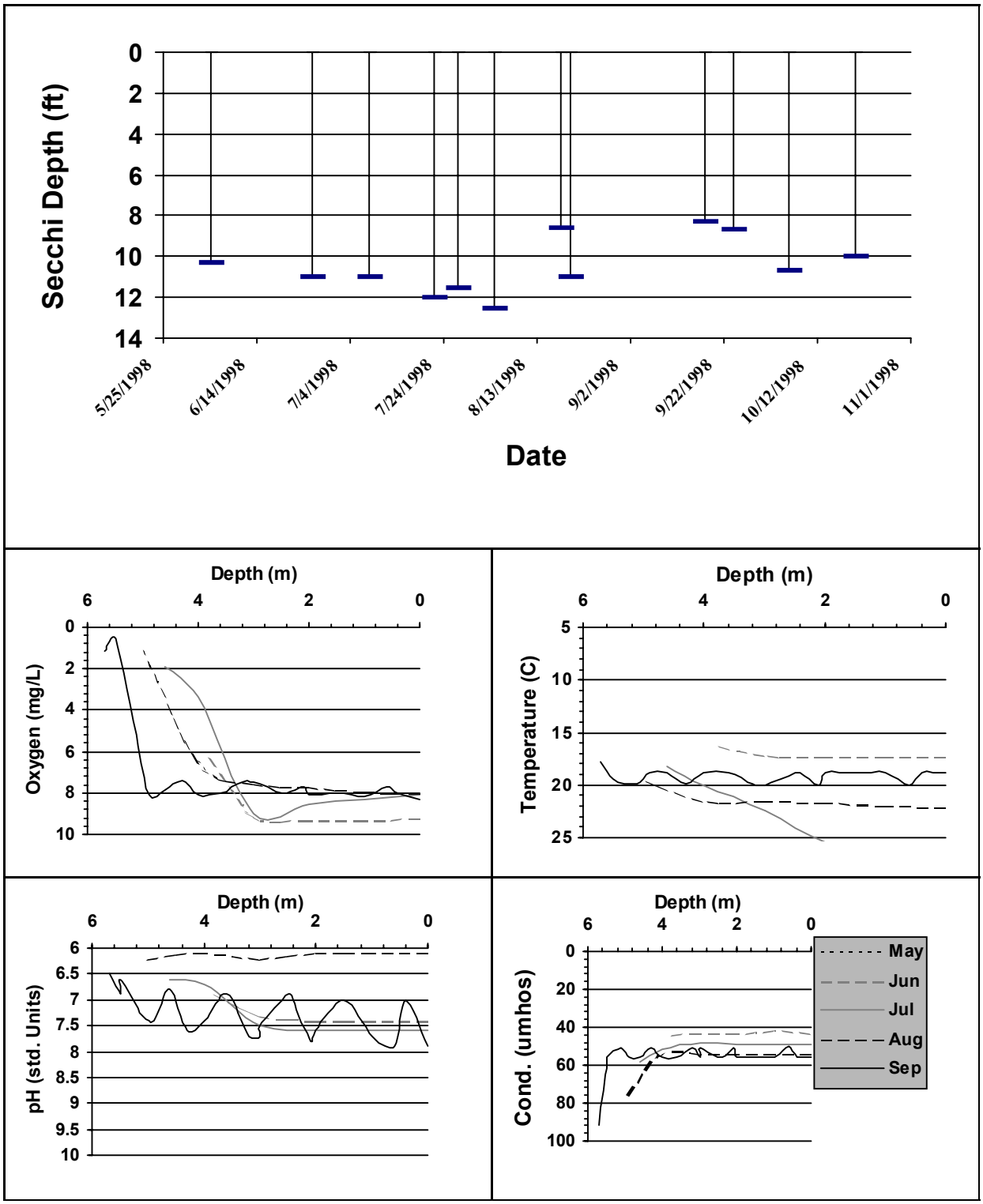
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 1 | |
| *Callitriche stagnalis* | pond water-starwort | 1 | at one site |
| *Carex sp.* | sedge | 2 | on shore |
| *Chara sp.* | muskwort | 3 | shallow to deep water |
| *Dulichium arundinaceum* | Dulichium | 1 | near islands |
| *Egeria densa* | Brazilian elodea | 1 | patch around islands, and deeper water near launch |
| *Elodea canadensis* | common elodea | 2 | |
| *Equisetum sp.* | horse tail | 1 | |
| *Juncus sp. or Eleocharis sp.* | small grass-like plants | 1 | shallow gravelly areas |
| *Juncus sp.* | rush | 2 | on shore |
| *Ludwigia palustris* | water-purslane | 2 | on shore near inflow |
| *Myriophyllum sp.* | water-milfoil | 2 | near islands, probably M. hippuroides |
| *Nitella sp.* | stonewort | 2 | shallow to deep water |
| *Potamogeton amplifolius* | large-leaf pondweed | 3 | |
| *Potamogeton gramineus* | grass-leaved pondweed | 1 | 1 patch seen |
| *Potamogeton natans* | floating leaf pondweed | 2 | |
| *Potentilla palustris* | purple (marsh) cinquefoil | 2 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 3 | is P. pusillus |
| *Sparganium sp.* | bur-reed | 2 | |
| *Utricularia inflata* | big floating bladderwort | 3 | few blooming, much on the bottom |
| *Vallisneria americana* | water celery | 1 | in inflow area |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 LIMMA1



# Secchi Data and Field Observations

LIMERICK

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/4/1998 | | 16.6667 | 10.25 | 7 | 100 | 1 | 1 | 5 | 5 | 30 | 16 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FIRST TIME VOL HAS SEEN GOSLINGS ON LAKE. BLADDERWORT NOTICED, GREEN ALGAL MATS. MOSTLY TIMBER LAND IN WSHED. The Oxygen result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 6/26/1998 | | 17.8 | 11 | 7 | 75 | 2 | 4 | 5 | 5 | 0 | 0 | 2 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 7/8/1998 | | 20.6 | 11 | 6 | 100 | 2 | 1 | 5 | 5 | 0 | 6 | 1 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 7/22/1998 | | 24.4 | 12 | 6 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 7/27/1998 | | | 11.55 | | 0 | | | 3 | 2 | 15 | 5 | 0 | 2 |
| | Sampler: | SMITH | | Remarks: | WATER UNUSUALLY CLEAR FOR LIMERICK. DEAD PLANTS IN WATER FROM HERB TREATMENT--MAKES FOR BORDERLINE SWIMMING CONDITIONS | | | | | | | | |
| 8/4/1998 | | 23.3 | 12.5 | 6 | 0 | 1 | 1 | 5 | 5 | 15 | 6 | 0 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 8/18/1998 | | | 8.58 | 6 | 100 | | | 4 | 3 | 5 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FEC#1 AT OUTFALL NEAR BOAT LAUNCH. FEC#2 AT COMMUNITY CENTER DOCK. The pH results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 8/20/1998 | | 22.2 | 11 | 6 | 25 | 1 | 1 | 5 | 5 | 0 | | 1 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 9/18/1998 | | | 8.25 | 6 | 90 | 1 | | 4 | 3 | 2 | 1 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | The conductivity result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 9/24/1998 | | 18.9 | 8.66 | 8 | 100 | 3 | 1 | 5 | 5 | | | 0 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 9/24/1998 | | | 8.66 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/6/1998 | | 15.6 | 10.66 | 6 | 25 | 1 | 1 | 5 | 5 | | 8 | 0 | 0 |
| | Sampler: | WESTON | | Remarks: | | | | | | | | | |
| 10/20/1998 | | 13.9 | 10 | 7 | 0 | 1 | 1 | 5 | 3 | 0 | 102 | 0 | 0 |
| | Sampler: | WESTON | | Remarks: | LAKE HEIGHT AT THIS TIME YEAR DUE TO REMOVAL OF BOARDS IN THE DAM TO HELP THE SALMON RUN. I COUNTED AT LEAST THREE SALMON IN BEAVER CREEK. | | | | | | | | |

# LONG

KITSAP County

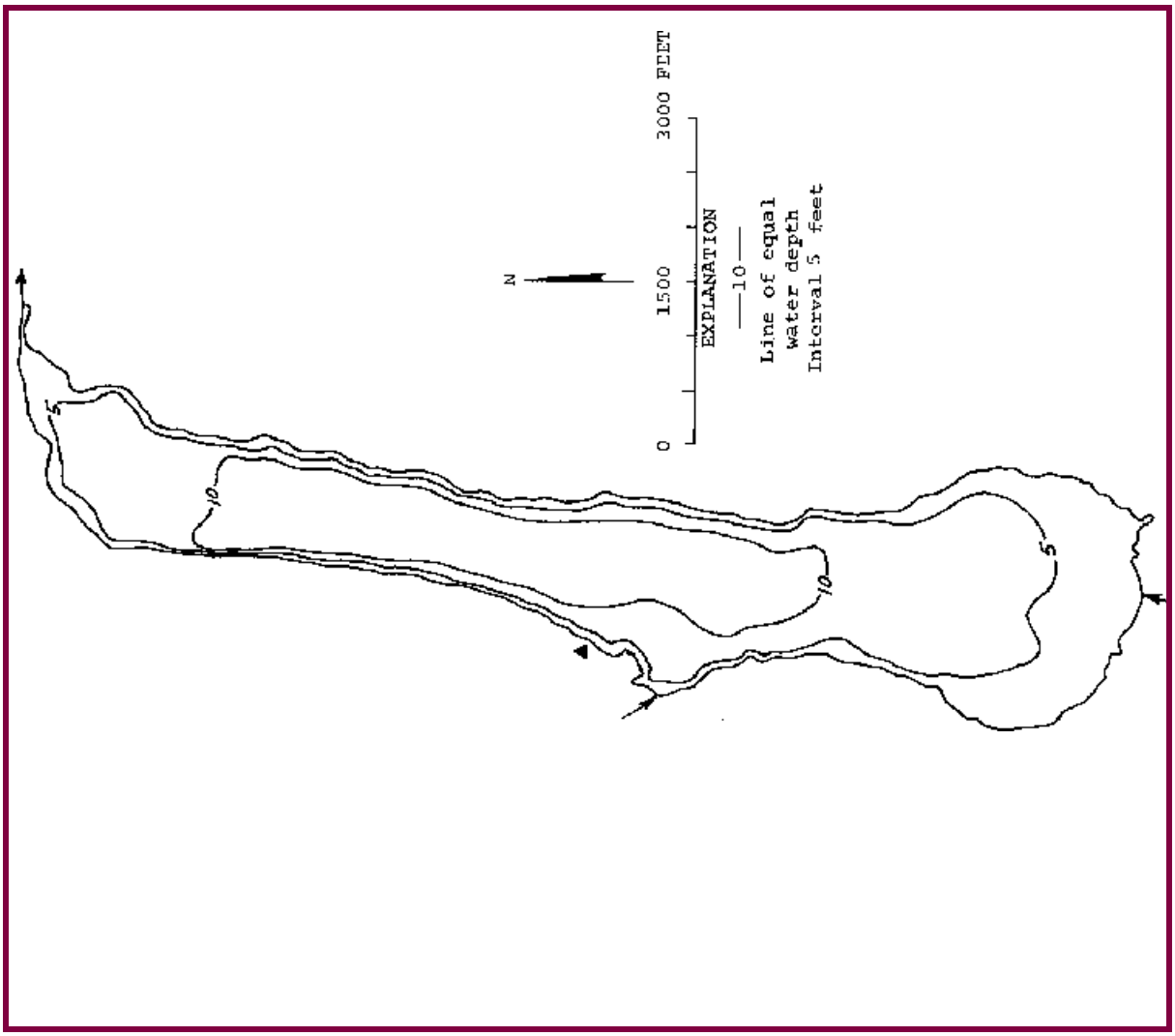
***Lake ID:*** LONKI1

***Ecoregion:*** 2

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.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 339 | 12 | 6 | 9 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 2180 | 5.07 | 118 | 47 28 58. | 122 35 12. |



## Station Information

LONKI1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 29 26.6 | longitude: 122 35 17.4 |
| | Description: | In approximate middle of lake, about 1000 feet northeast of launch | |
| Secondary Station | Station # 2 | latitude: 47 28 39.5 | longitude: 122 35 36.4 |
| | Description: | In horizontal middle of lake approximately 2000 feet south of northern shore | |

## Trophic State Assessment for 1998

LONG

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 53 | N |
| TSI_Phos: | 54 | |
| TSI_Chl: | 53 | |
| Narrative TSI:[a] | E | |

Long Lake in Kitsap County is a shallow, naturally eutrophic lake. Historically, Long Lake has been subjected to intensive studies and restoration efforts but we suspect that Long Lake is naturally eutrophic and will always be rich in nutrients without unreasonably extensive and expensive management. All the chlorophyll samples for the lake were well within the eutrophic range with the exception of the June sample. There were no user surveys distributed around Long Lake but the county closed the public swimming beach for a short time due to fecal contamination which they attributed to human sources (presumably swimmers). Fecal bacteria concentration from this study were unusually high for lakes. Also, the lake is notorious for its abundant macrophyte growth and algal blooms both of which have adversely affected primary contact uses in the past. Our habitat survey also confirmed the abundant macrophyte growth in the lake. The lake does have two noxious weeds, Brazilian elodea (Egeria densa) and Eurasian water milfoil (Myriophyllum spicatum). Zooplankton had a relatively large average size with cladocerans dominant. The abundant macrophyte growth may impair foraging by the large fish predators while at the same time enhancing the protective cover for salmon smolts. Historical data from 1973 suggests TP concentrations to be similar or perhaps even higher than concentrations detected in this study.

In summary, Long Lake appears to be naturally eutrophic. Beneficial uses do not appear to be impacted from the abundant nutrients considering the eutrophic state of the lake. Uses may suffer impacts from excessive aquatic plant growth although that growth may provide a protective nursery for coho salmon smolts. Also, reducing nutrients in the lake most likely would not reduce the plant biomass and may actually increase biomass should the decrease in algal concentrations allow for greater light penetration. Therefore, we recommend that the nutrient criterion be set at 34.7 ug/L, the mean total phosphorus concentration from this study plus an adjustment for inter-annual variability (mean = 29.6 ug/L + std. dev. = 5.1 ug/L).

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

LONG

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 8/19/1998 | | L | | | | | 71 | | | |
| | | L | | | | | 27 | | | |
| 9/23/1998 | | L | | | | | 160 | | | |
| | | L | | | | | 88 | | | |
| **Station 1** | | | | | | | | | | |
| 6/10/1998 | | E | 21.4 | .367 | 17 | 5.7 | | 40.3 | 8100 | 1.7 |
| 7/24/1998 | | E | 28.3 | .487 | 17 | 8.2 | | | | 2.4 J |
| 8/19/1998 | | E | 39.3 | .559 | 14 | 26.6 | | | | 3.9 |
| 9/23/1998 | | E | 28.1 | .44 | 16 | 9.5 | | | | 2.1 |
| **Station 2** | | | | | | | | | | |
| 8/19/1998 | | E | 35 | | | | | | | |
| 9/23/1998 | | E | 26.3 | .45 | 17 | 11.2 | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

LONG

**Survey Date:** 9/23/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [2] **Major transportation**
- [1] **Residential**
- [ ] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

None needed at this time.

**Odors** ☐

None detected

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

None

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Some fertilizers appear to be used on lawns around the lake.

**Buffer zones around streams and wetlands** ☑

**Irrigation** ☐

**Survey Id:** 90

# Habitat Survey Summary Report

LONG

**Data are averages of** ***10*** **Stations Surveyed** **Date of Visit:** 8/19/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.8 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.4 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.7 |
| | **trees< 0.3 m DBH** | 1.1 |
| **Understory:** | **woody shrubs saplings** | 1.9 |
| | **tall herbs, forbs grasses** | 0.5 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.5 |
| | **herbs, forbs, grasses** | 1.3 |
| | **standing water or inundated veg** | 0.8 |
| | **barren or buildings** | 0.9 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.6 |
| | **cobble/gravel** | 1.0 |
| | **loose sand** | 2.0 |
| | **other fine soil/sediment** | 0.8 |
| | **vegetated** | 2.6 |
| | **other** | 0.0 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.3 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.9 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.8 |
| **commercial** | 0.0 |
| **park facilities** | 0.2 |
| **docks/boats** | 0.9 |
| **walls, dikes, or revetments** | 0.7 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.4 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.2 |

| | |
|---|---|
| **orchard** | 0.0 |
| **lawn** | 1.1 |
| **other** | 0.2 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.4 |

### Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.0 |
| **gravel** | 1.0 |
| **sand** | 1.6 |
| **silt** | 2.8 |
| **woody debris** | 0.2 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 2.6 |
| **emergent** | 0.7 |
| **floating** | 1.0 |
| **total weed cover** | 2.9 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -1.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.9 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.8 |
| **inundated live trees** | 0.3 |
| **overhanging vegetation** | 1.0 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 1.1 |

---

# Zooplankton Report

LONKI1

Date 6/10/1998 Station: 1
Sample ID 25

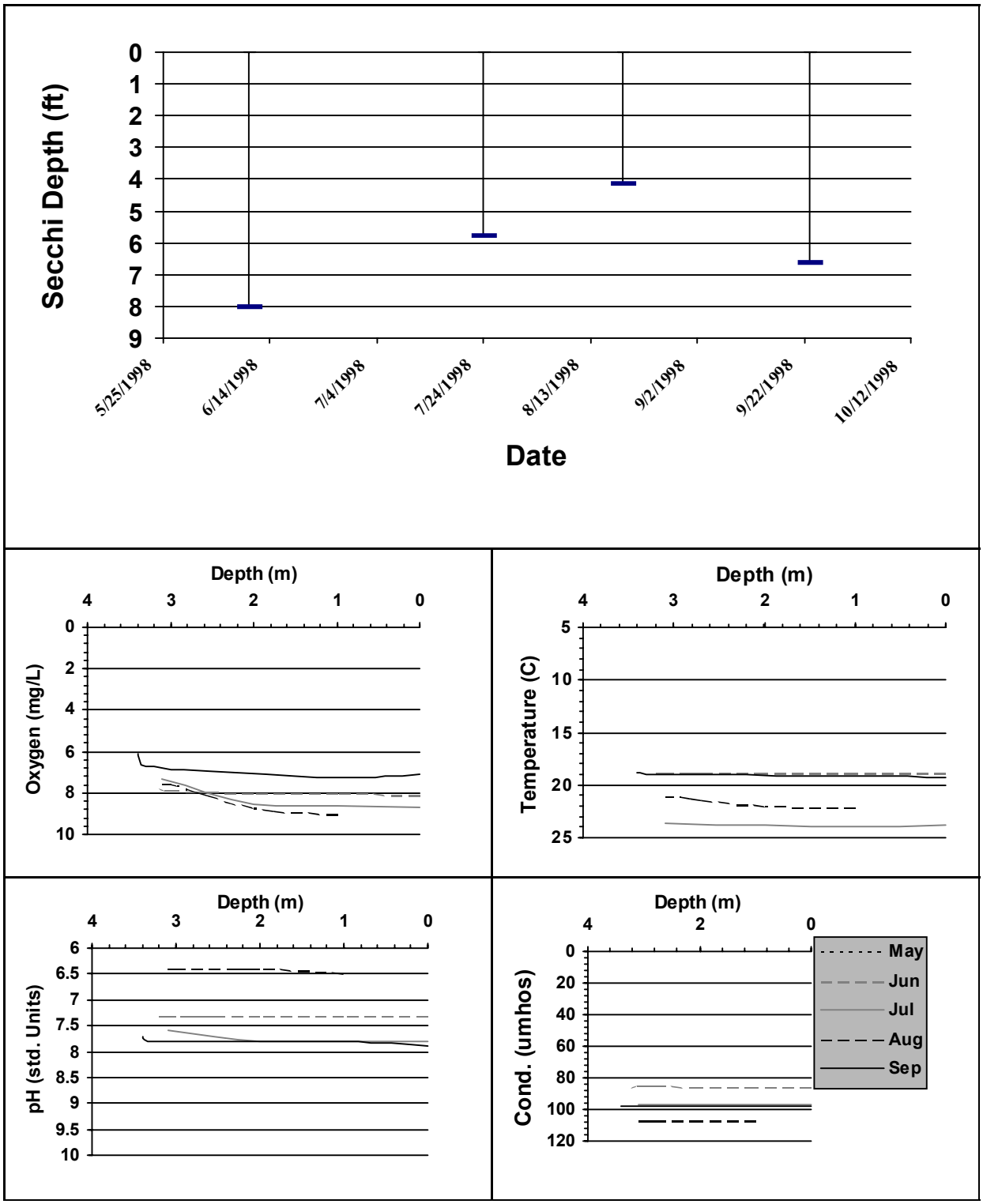
Number of organisms measured: 59

| Group | Percent |
|---|---|
| Cladoceran | 83.1% |
| Copepod | 16.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 72.9% |
| Large >= 1mm | 27.1% |
| Ratio of large to Small: | 0.37 |
| Average size (mm): | 0.75 |

# Secchi Depth and Profile Graphics

**Station:** 1 LONKI1



# Secchi Data and Field Observations

LONG

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/10/1998 | | | 8 | 8 | 100 | | | 3 | 3 | 0 | 0 | 0 | 1 |
| | Sampler: | SMITH | | Remarks: | SECCHI DIPS CONDUCTED WITH KITSAP COUNTY HEALTH FOR QC PURPOSES. 229 HOMES ON LAKE. WSHED 15% LOGGING, 85% RESIDENTIAL; SHORELINE 35% NATURAL VEGETATION | | | | | | | | |
| 7/24/1998 | | | 5.78 | 6 | 100 | | | 2 | 1 | 17 | 5 | 1 | 0 |
| | Sampler: | SMITH | | Remarks: | 1 EAGLE OBSERVED. 2 PEOPLE FISHING AT BOAT LAUNCH. MANY NEW HOMES ALONG SHORELINE. The Oxygen result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 8/19/1998 | | | 4.13 | 3 | 0 | 2 | | 3 | 2 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | ABUNDANT ALGAL BLOOM. APPEARS TO BE APHANIZOMENON. BRAZILIAN ELODEA THROUGHOUT BOTTOM FROM SHORE TO SHORE | | | | | | | | |
| 9/23/1998 | | | 6.6 | 2 | 0 | 1 | | 3 | 2 | 58 | 165 | 0 | 2 |
| | Sampler: | SMITH | | Remarks: | FEC#1 AT PUB SWIM BEACH, #2 AT BOAT LAUNCH. ONE BALD EAGLE OBSERVED. The Conductivity and Oxygen results are qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |

# MASON

MASON County

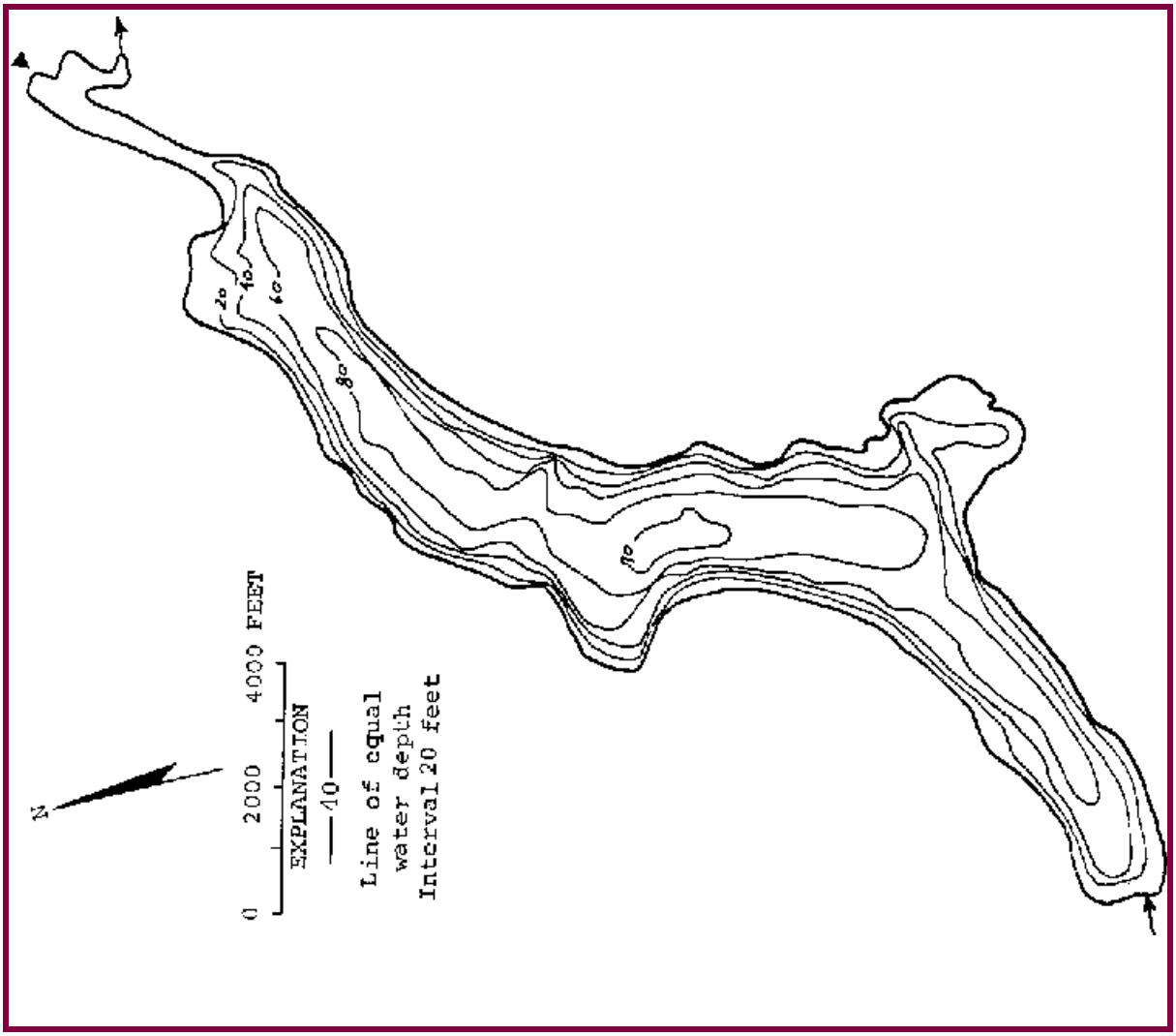
***Lake ID:*** *MASMA1*

***Ecoregion:*** 2

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.

| ***Area (acres)*** | ***Maximum Depth (ft)*** | ***Mean Depth (ft)*** | ***Drainage (sq mi)*** |
|---|---|---|---|
| 1000 | 90 | 48 | 20 |

| ***Volume (ac-ft)*** | ***Shoreline (miles)*** | ***Altitude (ft abv msl)*** | ***Latitude*** | ***Longitude*** |
|---|---|---|---|---|
| 49000 | 10.9 | 194 | 47 21 14. | 122 55 17. |



## Station Information

MASMA1

| | | | |
|---|---|---|---|
| Secondary Station | Station # 1 | latitude: | longitude: |
| | Description: | Located approximately 3500 feet up from the inlet at the southern end of the lake. The station is midway between the east and west shorelines at a spot where the water is about 60 feet in depth. | |
| Secondary Station | Station # 2 | latitude: | longitude: |
| | Description: | Located at the far southern end of the 80 foot contour line (see bathymetric map) midway between both shorelines. Station is directly across from a concrete boathouse on the western shore and a brown house on the eastern shore. | |
| Secondary Station | Station # 3 | latitude: 47 19 38.7 | longitude: 122 56 17.0 |
| | Description: | Located at the northern end of the 60 foot contour line, midway between both shorelines (see bathymetric map). The station is directly across from a red boathouse on the western shore and a yellow boathouse on the eastern shore. | |
| Primary Station | Station # 4 | latitude: 47 20 16.0 | longitude: 122 57 18.1 |
| | Description: | Located in the deepest part of the lake in the middle of the 90 foot contour line (see the bathymetric map). The station is in the approximate center of a line extending from the southern edge of a large cove on the western shore to a smaller cove on the east shore. | |
| Secondary Station | Station # 5 | latitude: | longitude: |
| | Description: | Located approximately 2 miles south of the boat launch. The station is midway between the east and west shorelines and where the water depth is about 80 feet. | |

## Trophic State Assessment for 1998

MASON

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 32 |
| TSI_Phos: | 24 |
| TSI_Chl: | 31 |
| Narrative TSI:[a] | O |

Mason Lake is an oligotrophic lake in the Puget Lowlands ecoregion. Mason Lake remains relatively clear despite the densely developed shoreline. The watershed is mostly timber and some of it has been clear-cut within the last decade. This disturbance in the watershed has not shown any apparent impact on lake nutrient concentrations; Ecology records do not indicate an increase in total phosphorus concentrations throughout the decade. Although water clarity is very good, blooms of blue-green algae (Gleotrichia sp.) are apparent in mid and late summer. The first invasion of Eurasian milfoil (Myriophyllum spicatum) on Mason Lake was observed in 1998 along the east shore, midlake. Although the watershed appeared fairly stable (even in the clear-cut areas), it was rare to see any natural habitat along the shoreline. The habitat survey revealed considerable human disturbance in the riparian and littoral zones. These disturbances could adversely impact fish

populations. The results of the user survey suggests the water clarity is sufficient to support primary contact uses--although only 3 surveys were returned. Our 1998 sampling found a mean total phosphorus concentration of 4.3 ug/L. Although there may be reason to suspect impairment to habitat from human disturbance and there is a potential for increased phosphorus loading from the recent milfoil introduction, there is not enough information to conclude that there is currently any impairment to the uses of the lake. Milfoil most likely offers the biggest threat to beneficial uses in the near future.

The phosphorus criterion for Mason Lake could be set at 10 ug/L, the action value in the water quality regulations for Puget Lowlands Oligotrophic lakes; however, to protect this valuable resource from degradation, we recommend a criterion be set at 7.3 ug/L, the current total phosphorus concentration plus an adjustment for inter-annual variability.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

MASON

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 7/26/1998 | | L | | | | | 4 | | | |
| | | L | | | | | 1 U | | | |
| 8/18/1998 | | L | | | | | 22 | | | |
| | | L | | | | | 1 | | | |
| **Station 3** | | | | | | | | | | |
| 6/4/1998 | | E | 5.8 | .104 | 18 | | | | | |
| 7/26/1998 | | E | 3.8 | .081 | 21 | .73 | | | | |
| 9/18/1998 | | E | 4.3 | | | | | | | |
| **Station 4** | | | | | | | | | | |
| 6/4/1998 | | E | 5.3 | .121 | 23 | 1.2 | | 19.8 | 4560 | .5 U |
| | | H | 6.1 J | .081 | 13 | | | | | |
| 7/26/1998 | | E | 3.1 | .09 | 29 | .5 U | | | | .5 U |
| | | H | 5 | .068 | 14 | | | | | |
| 8/18/1998 | | E | 3.7 | .087 | 24 | 1.1 | | | | .5 U |
| | | H | 8.5 | .066 | 8 | | | | | |
| 9/18/1998 | | E | 5.2 | .066 | 13 | 1.2 | | | | .5 U |
| | | H | 14 | .04 | 3 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

MASON

**Survey Date:** 9/18/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | 1 | **Residential** |
| | **Commercial, Industrial** | 2 | **Park, forest or natural** |
| | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Extensive clear cutting on the hill at the west side of the lake. The cutting looked recent, perhaps within the last 5 - 8 years.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Fertilizers and weed killer appear to be in use on lakeshore property.

**Buffer zones around streams and wetlands** ☑

There is one small patch of buffer zone along lakeshore. This appears to be Simpson property at the very northwest end of the lake.

**Irrigation** ☐

**Survey Id:** 50

## Habitat Survey Summary Report

MASON

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 9/14/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.4 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.1 | **Number of stations with understory:** | 10 |

### Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 2.3 |
| | **trees< 0.3 m DBH** | 1.0 |
| **Understory:** | **woody shrubs saplings** | 2.4 |

| | | |
|---|---|---|
| | **tall herbs, forbs grasses** | 1.1 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.7 |
| | **herbs, forbs, grasses** | 3.2 |
| | **standing water or inundated veg** | 0.3 |
| | **barren or buildings** | 1.6 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 3.1 |
| | **loose sand** | 0.6 |
| | **other fine soil/sediment** | 1.2 |
| | **vegetated** | 1.0 |
| | **other** | 0.4 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.2 |
| | **vertical dist (M from wtrln to high wt):** | 0.3 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.2 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.5 |
| **commercial** | 0.0 |
| **park facilities** | 0.0 |
| **docks/boats** | 1.5 |
| **walls, dikes, or revetments** | 1.3 |
| **litter, trash dump, or landfill** | 0.4 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.6 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.5 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.1 |
| **boulders** | 0.1 |
| **cobble** | 1.1 |
| **gravel** | 2.3 |
| **sand** | 2.2 |
| **silt** | 1.5 |
| **woody debris** | 0.8 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.3 |

| | |
|---|---|
| **emergent** | 0.3 |
| **floating** | 0.1 |
| **total weed cover** | 1.3 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -1.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.3 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.4 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.2 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.1 |
| **human structures** | 1.3 |

# Questionnaire

MASON

**Results compiled from** 3 **Surveys.** **Average time (years) respondents spent on lake:** 24.33

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.3 | View: | 0.3 | Distance to Lake: | 0.0 |
| Public Access: | -0.3 | Swim Beach: | 0.7 | Canada Geese: | -1.0 |
| Water Clarity: | 0.3 | Water Qual. for Swim: | 0.3 | | |
| Fishing Quality: | 0.0 | Aquatic Plants: | -0.7 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **4.3**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.7 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.3 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.3 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.0 | Good Warmwtr Fishing: | 4.0 | Natural Scenery: | 4.0 |
| Plant Growth: | 1.7 | Good Swimming: | 4.3 | Public Beach: | 1.3 |
| Natural Shoreline: | 3.3 | Less Algae: | 4.7 | Canada Geese: | 2.3 |
| No Odors: | 4.0 | Public Access: | 1.3 | | |
| Good Coldwtr Fishing: | 4.0 | Clear Water: | 4.3 | | |

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 42 | 9/7/1998 | Resident | Permanent | Rent | several of the above | ☑ | Worse | 1985 |
| | No more public access. Get rid of Canada geese and ducks. | | | | | | | |
| 51 | 8/29/1998 | Resident | Seasonal | Rent | 10 | ☑ | No | |
| | Better or more enforcement of state boating regulations | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 59 | 8/29/1998 | Resident | Seasonal | Rent | 10 | ☐ | No |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

MASMA1

Date 8/18/1998 Station: 1
Sample ID 27

Number of organisms measured: 174

| Group | Percent |
|---|---|
| Cladoceran | 12.1% |
| Copepod | 87.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 98.3% |
| Large >= 1mm | 1.7% |
| Ratio of large to Small: | 0.02 |
| Average size (mm): | 0.46 |

## Aquatic Plant Data

MASON

Sampler: Parsons, O'Neal

Survey Date: 9/14/1998

Max depth of growth (M): >6

Comments Sunny, calm. Surveyed entire shoreline, did habitat survey for Kirk Smith. Plants patchy, occasional dense areas of P. amplifolius, but many areas with open sediment. Much tiny ball-like algae suspended in water. M. spicatum only seen in Paradise Estates launch area. Observed a loon at south end, herons, few mallards, fish, osprey, heard frogs (didn't sound like adult bullfrogs).

SPECIES LIST

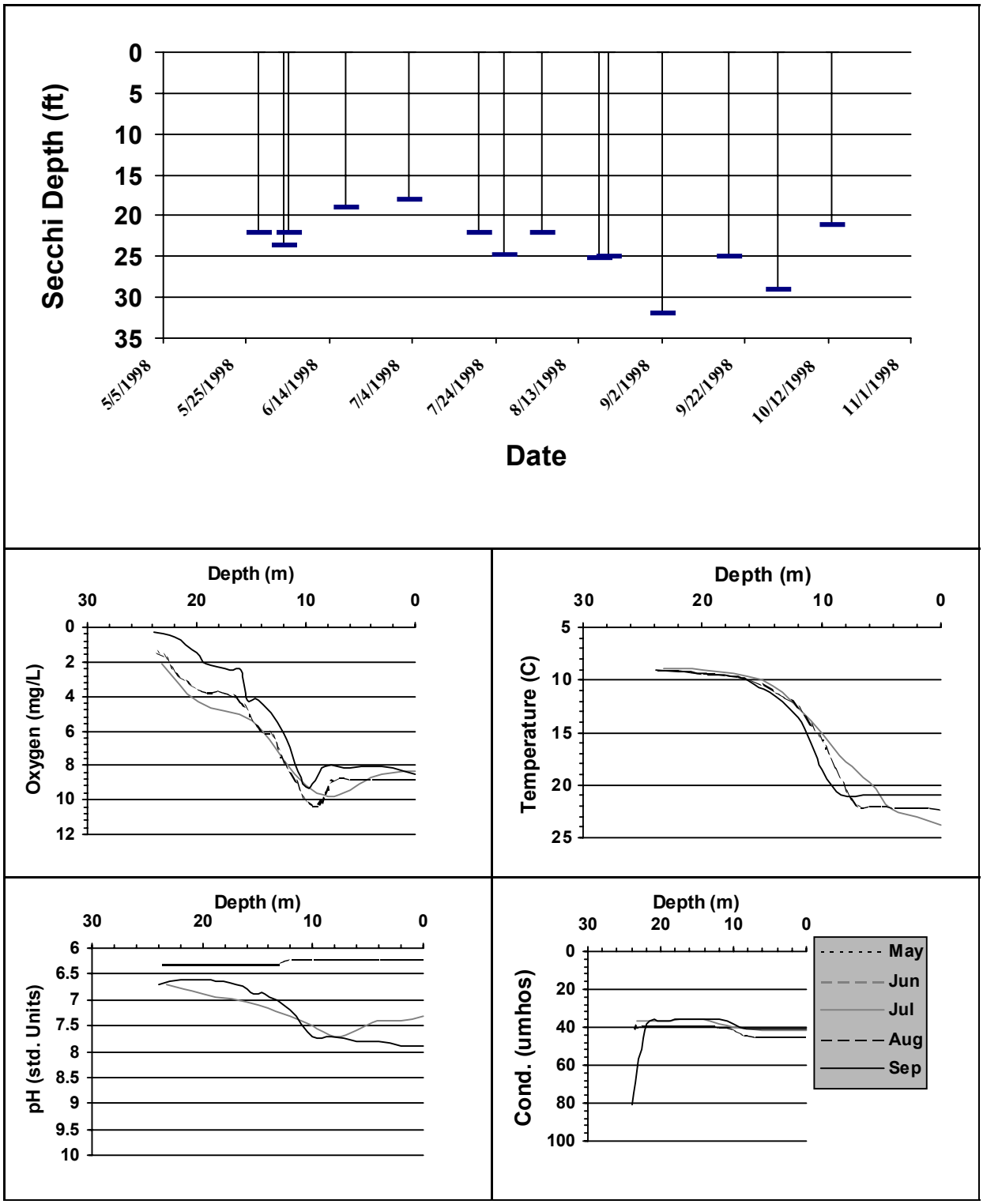
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 1 | |
| *Carex sp.* | sedge | 1 | |
| *Elodea canadensis* | common elodea | 2 | |
| *Hippuris vulgaris* | common marestail | 1 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Isoetes sp.* | quillwort | 3 | |
| *Juncus sp.* | rush | 2 | |
| *Lilaeopsis occidentalis* | lilaeopsis | 1 | shallows and shoreline at SW end |
| *Lobelia dortmanna* | water gladiole; water lobelia | 2 | |
| *Myriophyllum sp.* | water-milfoil | 1 | looks like M. hippuroides |
| *Myriophyllum spicatum* | Eurasian water-milfoil | 1 | only found in the area of Paradise Estates boat launch |
| *Nitella sp.* | stonewort | 2 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 1 | only a couple of patches |
| *Potamogeton amplifolius* | large-leaf pondweed | 3 | |
| *Potamogeton epihydrus* | ribbonleaf pondweed | 1 | |
| *Potamogeton gramineus* | grass-leaved pondweed | 2 | also may be a hybrid |
| *Potamogeton robbinsii* | fern leaf pondweed | 2 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 1 | low growing, no achenes |
| *Ranunculus aquatilis* | water-buttercup | 2 | |
| *Sagittaria graminea* | slender arrowhead | 1 | dense around private launch, NE end of lake |

| | | | |
|---|---|---|---|
| *Utricularia sp.* | bladderwort | 1 | may be U. inflata, very small winter buds |
| *Vallisneria americana* | water celery | 2 | |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 4 MASMA1



# Secchi Data and Field Observations

MASON

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 2** | | | | | | | | | | | | | |
| 5/30/1998 | | 14.4 | 22 | 2 | 75 | 2 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 6/13/1998 | | 17.8 | 19 | 2 | 100 | 2 | 3 | 5 | 5 | 2 | 0 | 1 | 1 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 6/30/1998 | | 20 | 17 | 2 | 75 | 2 | 1 | 5 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 7/16/1998 | | 21.1 | 22 | 2 | 0 | | 4 | 5 | 5 | 0 | 0 | 0 | 1 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 7/31/1998 | | 24.4 | 21 | 2 | 100 | 1 | 3 | 5 | 4 | 0 | 0 | 0 | 1 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 8/13/1998 | | 25 | 26 | 2 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 1 | 3 |
| | Sampler: | HOLM | | Remarks: | BEAUTIFUL DAY. | | | | | | | | |
| 8/27/1998 | | 23 | 25 | 2 | 0 | | | 5 | 5 | 0 | 0 | 0 | 1 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 9/11/1998 | | 23 | 27 | 2 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 9/27/1998 | | 20 | 29 | 2 | 0 | 1 | 3 | 5 | 5 | 0 | 0 | 0 | 1 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| 10/13/1998 | | 17 | 23 | 2 | 100 | 3 | 5 | 1 | 1 | 0 | 0 | 0 | 0 |
| | Sampler: | HOLM | | Remarks: | | | | | | | | | |
| **Station 3** | | | | | | | | | | | | | |
| 5/28/1998 | | 15 | 22 | 2 | 0 | 3 | 2 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | SCOTT | | Remarks: | LATE WITH TESTING DUE TO WEATHER. | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/10/1998 | | 20 | 19 | 2 | 75 | 1 | 4 | 4 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 6/22/1998 | | 19 | 17 | 2 | 25 | 3 | 1 | 4 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 7/9/1998 | | 22 | 17 | 2 | 75 | 1 | 1 | 4 | 4 | 0 | 0 | 0 | 2 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 7/24/1998 | | 28 | 20 | 2 | 100 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 1 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 8/8/1998 | | 24 | 25 | 2 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 2 |
| | Sampler: | SCOTT | | Remarks: | SATURDAY. | | | | | | | | |
| 8/24/1998 | | 22 | 21 | 2 | 100 | 1 | 1 | 4 | 4 | 2 | 0 | 0 | 2 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 9/8/1998 | | 23 | 25 | | 100 | 1 | 1 | 4 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: | SCOTT | | Remarks: | | | | | | | | | |
| 9/20/1998 | | 23 | 27 | 2 | 0 | 1 | 2 | 3 | 3 | 0 | 0 | 0 | 0 |
| | Sampler: | SCOTT | | Remarks: | SUNDAY. | | | | | | | | |
| **Station 4** | | | | | | | | | | | | | |
| 5/28/1998 | | 15 | 22 | 2 | 0 | 3 | 2 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | LATE GETTING STARTED DUE TO BAD WEATHER. | | | | | | | | |
| 6/3/1998 | | 17 | 23.5 | 2 | 100 | 2 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 6/4/1998 | | | 22 | 2 | 100 | 4 | 1 | 5 | 4 | 0 | 1 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | VERY WINDY DAY. EXTREMELY DIFFICULT FOR SAMPLING. DRIFTING TOO MUCH FOR ZOO TOW. WSHED 100% TIMBER, SHORELINE ALL RESIDENTIAL (~400 HOMES). NO RESTRICTED USES. The Oxygen result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/18/1998 | | 16.7 | 19 | 2 | 100 | 3 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 7/3/1998 | | 18 | 18 | 2 | 75 | 3 | 3 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 7/20/1998 | | 23 | 22 | 2 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 1 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 7/26/1998 | | | 24.7 | 6 | 0 | | | 3 | 5 | 6 | 9 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |
| 8/4/1998 | | 23 | 22 | 6 | 100 | 2 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 8/18/1998 | | | 25.08 | 2 | 90 | | | 5 | 5 | 0 | 13 | 1 | 4 |
| | Sampler: | SMITH | | Remarks: | WATER REALLY SHALLOW AT BOAT RAMP. VERY SLIGHT BLUE-GREEN BLOOM. The pH results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 8/20/1998 | | 25 | 25 | 2 | 0 | 2 | 1 | | | | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 9/2/1998 | | 23.9 | 32 | 2 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 9/18/1998 | | 21.1 | 25 | 2 | 100 | 1 | 2 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 9/18/1998 | | | 24.75 | 2 | 80 | 1 | | 5 | 5 | 0 | 7 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |
| 9/30/1998 | | 20 | 29 | 2 | 0 | 2 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 10/13/1998 | | 17 | 21 | 2 | 100 | 3 | 5 | 1 | 1 | 0 | 0 | 0 | 0 |
| | Sampler: | NELSON | | Remarks: | | | | | | | | | |
| 10/13/1998 | | | 21 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |

# MEDICAL

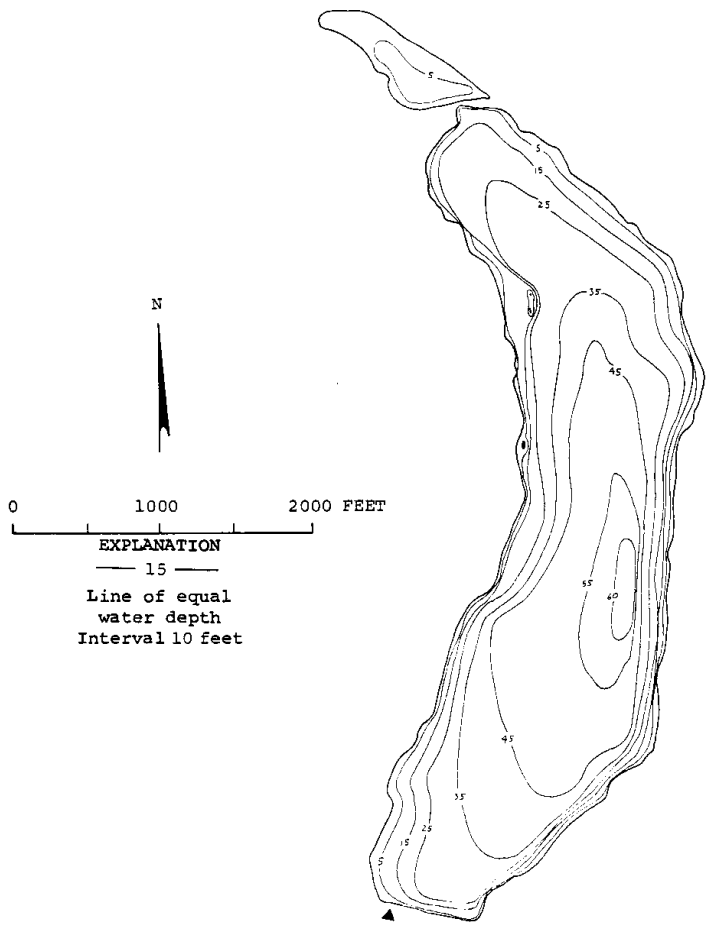
SPOKANE County

*Lake ID:* MEDSP1

*Ecoregion:* 7

Medical Lake is located approximately 10 miles southwest of Spokane. The City of Medical Lake lies along its eastern shore. The west shore is mostly undeveloped, with Consolidated Support Services set back from the lake to the west. Residential homes line much of the eastern shore. There is a city park on the north shore and a walking/biking trail around lake. Medical Lake's water quality is improved with the help of an aerator. The lake is a popular recreational lake and supports a variety of uses despite the rich eutrophic conditions. Motors are prohibited on the lake.

| Area (acres) | Maximum Depth (ft) | Mean Depth (ft) | Drainage (sq mi) | |
|---|---|---|---|---|
| 160 | 60 | 32 | 1.35 | |
| **Volume (ac-ft)** | **Shoreline (miles)** | **Altitude (ft abv msl)** | **Latitude** | **Longitude** |
| 5000 | 3.14 | 2394 | 47 33 48. | 117 41 21. |




Medical Lake, Spokane County. From Washington Department of Game, February 12, 1955.

## Station Information

MEDSP1

| Primary Station | Station # 1 | latitude: 47 34 18.8 | longitude: 117 41 16.0 |
|---|---|---|---|
| | Description: Site is 50' south of S. aerator | | |

## Trophic State Assessment for 1998

MEDICAL

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 53 | N |
| TSI_Phos: | 53 | |
| TSI_Chl: | 44 | |
| Narrative TSI:[a] | E | |

Medical lake is probably naturally eutrophic. Kemmerer reported eutrophic conditions there in 1924. The lake was treated with alum in 1977 and an aerator has been operated in the lake since 1987 (see Soltero, et al., 1994, Partial and full lift hypolimnetic aeration of Medical Lake, WA to improve water quality, Wat. Res. 28(11):2297-2308). Despite the aeration, however, in 1998 the hypolimnion remained nearly anoxic through most of the summer and internal nutrient loading was pronounced.

The lake supports multiple uses including fishing, swimming, and wildlife. The zooplankton community appears to be healthy enough to support a good sport fishery; however, the low hypolimnetic dissolved oxygen and warm surface temperatures are not ideal for a trout fishery. If the lake is to be managed as a coldwater fishery, increased aeration may be desirable. Only five user surveys were returned; two of the respondents believed the water quality had improved in the lake. Two others believed the water quality had deteriorated while one person did not know.

Fecal bacteria concentrations were extremely high at the city park at the north end of the lake. Geese were almost certainly the source and control options should be considered to keep geese out of the park. Soils on the east shore were eroding and might benefit from management such as planting of native shrubs.

It is difficult to set nutrient criteria in a lake that has been altered in a restoration effort and where the trophic state and other parameters are artificially maintained. The beneficial uses appear to be supported, at present, through the use of the aerator. We cannot recommend a criterion for Medical Lake without further study. We recommend continued use of the aerator and continued efforts to tune aeration volume to reduce internal nutrient loading.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

MEDICAL

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/16/1998 | | L | | | | | 3 | | | |
| | | L | | | | | 25 | | | |
| 7/14/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 4 | | | |
| 8/11/1998 | | L | | | | | 1000 G | | | |
| | | L | | | | | 2 | | | |
| 9/15/1998 | | L | | | | | 84 | | | |
| | | L | | | | | 100 | | | |
| **Station 1** | | | | | | | | | | |
| 6/16/1998 | | E | 42.2 | .822 | 19 | 5.7 | | 142 | | 5.4 |
| | | H | 121 J | 1.09 | 9 | | | | | |
| 7/14/1998 | | E | 37 | 1.02 | 28 | 1.7 | | | | 4.8 |
| | | H | 152 | 1.77 | 12 | | | | | |
| 8/11/1998 | | E | 25.7 | 1.19 | 46 | 2.5 | | | | 3.9 |
| | | H | 122 | 1.53 | 13 | | | | | |
| 9/15/1998 | | E | 25.5 | .982 | 39 | 2.9 | | | | 3.5 |
| | | H | 145 | 1.65 | 11 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than, G=Greater than.

## Watershed Survey

MEDICAL

**Survey Date:** 9/15/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [2] **Agriculture(commercial, not hobby)**
- [1] **Residential**
- [3] **Commercial, Industrial**
- [4] **Park, forest or natural**
- [ ] **Major transportation**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☑

Geese at N. end of the city park (Peper Park--high fecs there too).

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

CSS lawns, Med. Lake residents lawns, wheat fields to west of CSS.

**Buffer zones around streams and wetlands** ☑

Shoreline is mostly natural and rocky--not particularly susceptible to erosion in most place (however, see aquatic plant surve). Overall watershed assessment--no clear major impacts.

**Irrigation** ☐

**Survey Id:** 75

---

# Habitat Survey Summary Report

MEDICAL

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/14/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.2 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.6 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.1 |
| | **trees< 0.3 m DBH** | 0.9 |
| **Understory:** | **woody shrubs saplings** | 1.4 |
| | **tall herbs, forbs grasses** | 1.6 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.2 |
| | **herbs, forbs, grasses** | 1.5 |
| | **standing water or inundated veg** | 0.2 |
| | **barren or buildings** | 1.1 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.7 |
| | **boulders** | 1.4 |
| | **cobble/gravel** | 1.0 |
| | **loose sand** | 0.0 |
| | **other fine soil/sediment** | 0.5 |
| | **vegetated** | 2.4 |
| | **other** | 0.2 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.7 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.6 |

| | |
|---|---|
| **commercial** | 0.0 |
| **park facilities** | 0.2 |
| **docks/boats** | 0.3 |
| **walls, dikes, or revetments** | 0.6 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.2 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.3 |
| **other** | 0.3 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 3.4 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.6 |
| **boulders** | 1.1 |
| **cobble** | 1.5 |
| **gravel** | 0.3 |
| **sand** | 0.0 |
| **silt** | 2.5 |
| **woody debris** | 0.1 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 2.7 |
| **emergent** | 0.5 |
| **floating** | 0.0 |
| **total weed cover** | 2.7 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.7 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.7 |
| **snags** | 0.5 |
| **brush or woody debris** | 0.6 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.5 |
| **rock ledges or sharp dropoffs** | 0.1 |
| **boulders** | 0.7 |
| **human structures** | 0.1 |

---

## Questionnaire

MEDICAL

**Results compiled from** 5 **Surveys.** **Average time (years) respondents spent on lake:** 9.60

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | 0.8 | View: | 1.0 | Distance to Lake: | 0.3 |
| Public Access: | 0.8 | Swim Beach: | 0.2 | Canada Geese: | -0.2 |
| Water Clarity: | -0.4 | Water Qual. for Swim: | -0.4 | | |
| Fishing Quality: | -0.2 | Aquatic Plants: | -0.2 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **2.2**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.8 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.4 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.0 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 5.0 | Good Warmwtr Fishing: | 3.8 | Natural Scenery: | 4.6 |
| Plant Growth: | 2.2 | Good Swimming: | 5.0 | Public Beach: | 3.8 |
| Natural Shoreline: | 4.2 | Less Algae: | 4.6 | Canada Geese: | 3.6 |
| No Odors: | 5.0 | Public Access: | 3.0 | | |
| Good Coldwtr Fishing: | 3.6 | Clear Water: | 4.8 | | |

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 30 | 8/11/1998 | Resident | Seasonal | Own | 10 | ☐ | Better | compared to |
| 31 | 8/11/1998 | Resident | Permanent | Own | 6 | ☐ | Worse | 1996 |
| | Good beach access. Smells, especially @ spring turnover. Quality is horrible. | | | | | | | |
| 35 | 8/14/1998 | Resident | Permanent | Rent | 7 | ☐ | Better | |
| 80 | 8/26/1998 | Resident | Permanent | Rent | 6 | ☐ | Unknown | |
| 81 | 8/14/1998 | Resident | Permanent | Rent | 10 | ☑ | Worse | |
| | Since no power boats are allowed, the lake environment is, for the most part, quiet and peaceful. Lots of ducks and geese which I like. Walking path around the lake is excellent. | | | | | | | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

# Zooplankton Report

MEDSP1

Date 6/16/1998 Station: 1 Sample ID 30

Date difficult to read on label, may be incorrect.

Number of organisms measured: 302

| Group | Percent |
|---|---|
| Cladoceran | 26.2% |
| Copepod | 73.8% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 93.0% |
| Large >= 1mm | 7.0% |
| Ratio of large to Small: | 0.07 |
| Average size (mm): | 0.46 |

Date 8/11/1998 Station: 1 Sample ID 31

Number of organisms measured: 356

| Group | Percent |
|---|---|
| Cladoceran | 84.8% |
| Copepod | 15.2% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 98.9% |
| Large >= 1mm | 1.1% |
| Ratio of large to Small: | 0.01 |
| Average size (mm): | 0.48 |

## Aquatic Plant Data

MEDICAL

Sampler: Parsons, O'Neal

Survey Date: 7/14/1998

Max depth of growth (M): ~ 4

Comments Water color blue-green and opaque. Paved bike path circles lake on west shore, homes along most of east shore. Soils on east shore erroding, some shrub plantings might help. Popular recreational lake. Much algae in water - forming mats along west, south and north and parts of east shore, much periphyton on plants. Did habitat survey for Kirk Smith

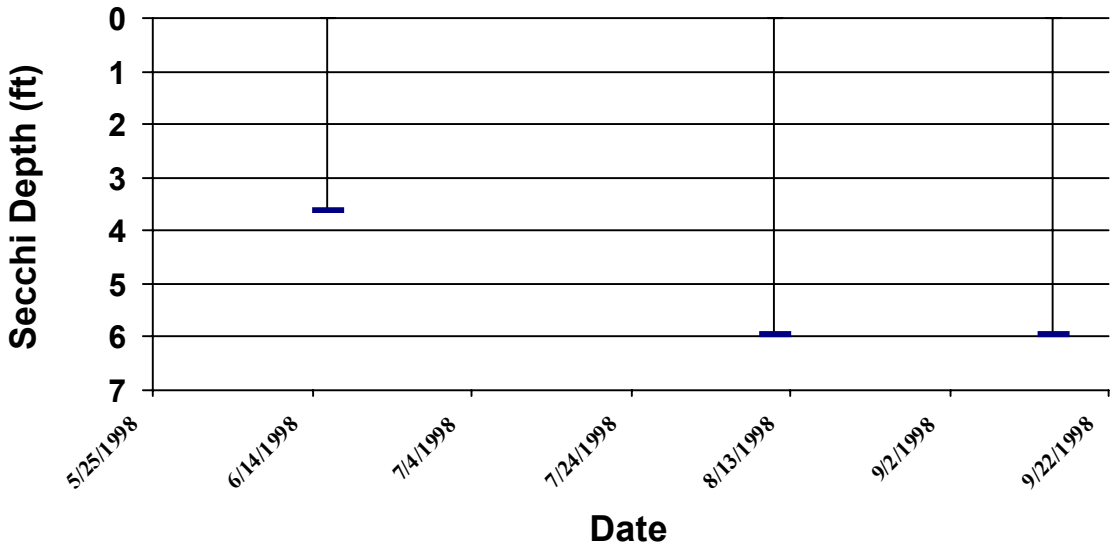
SPECIES LIST

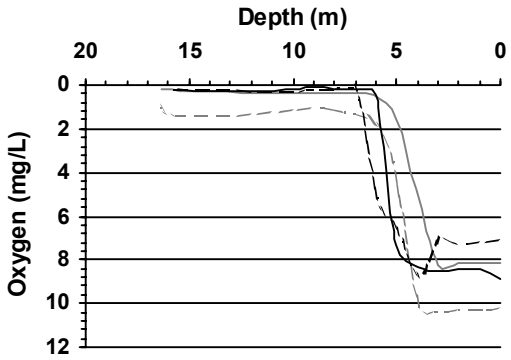
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Myriophyllum sibiricum* | northern watermilfoil | 2 | blooming |
| *Phalaris arundinacia* | reed canarygrass | 3 | |
| *Potamogeton pectinatus* | sago pondweed | 3 | with fruit |
| *Ranunculus aquatilis* | water-buttercup | 2 | blooming |
| *Ruppia maritima* | ditch-grass | 4 | blooming |
| *Scirpus sp.* | bulrush | 2 | |
| *Typha latifolia* | common cat-tail | 2 | blooming |

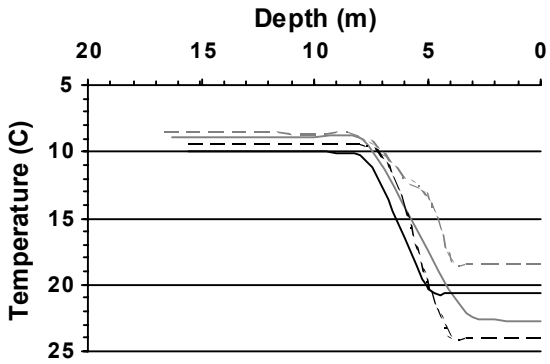
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

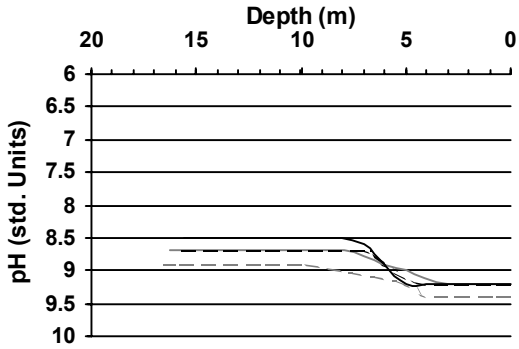
# Secchi Depth and Profile Graphics

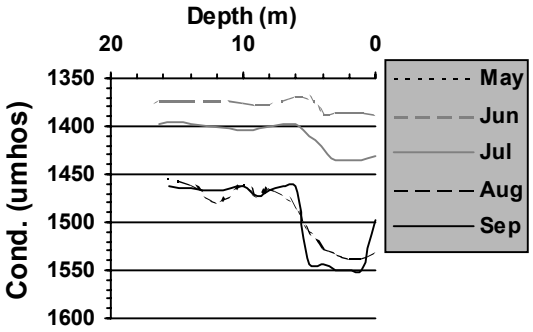
**Station:** 1 MEDSP1



# Secchi Data and Field Observations

MEDICAL

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/16/1998 | | | 3.63 | 2 | 100 | 1 | 1 | 3 | 3 | 30 | 3 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | | | | | | | | | |
| 7/14/1998 | | | | | 80 | 1 | | 2 | 2 | 30 | 11 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | CLOUDY GREEN. OCCASIONAL CLUMPS OF FIBROUS, TAN ALGAE; SAMPLE TAKEN | | | | | | | | |
| 8/11/1998 | | | 5.94 | 2 | 0 | 1 | | 2 | 3 | 100 | 25 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | LOTS OF ZOOPLANKTON, INCLUDING A FEW LARGE DAPHNIA. MILD ANOXIC SMELL @ 10 AND 15M BUT NOT H2S. APPROX 40 HOMES ON EAST SHORE. | | | | | | | | |
| 9/15/1998 | | | 5.94 | 6 | 0 | 1 | | 3 | 3 | 20 | 0 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: | NO COLONIAL ALGAE VISIBLE. HYPOLIMNION ALMOST ENTIRELY ANOXIC. THE USUAL BUBBLES (NEAR SHORELINE) FROM AERATOR ARE VISIBLE. HYPO SAMPLES ARE SLIGHTLY BLACK. 15M SAMPLE, SLIGHT H2S SMELL. | | | | | | | | |

# MEDICAL, WEST

SPOKANE County

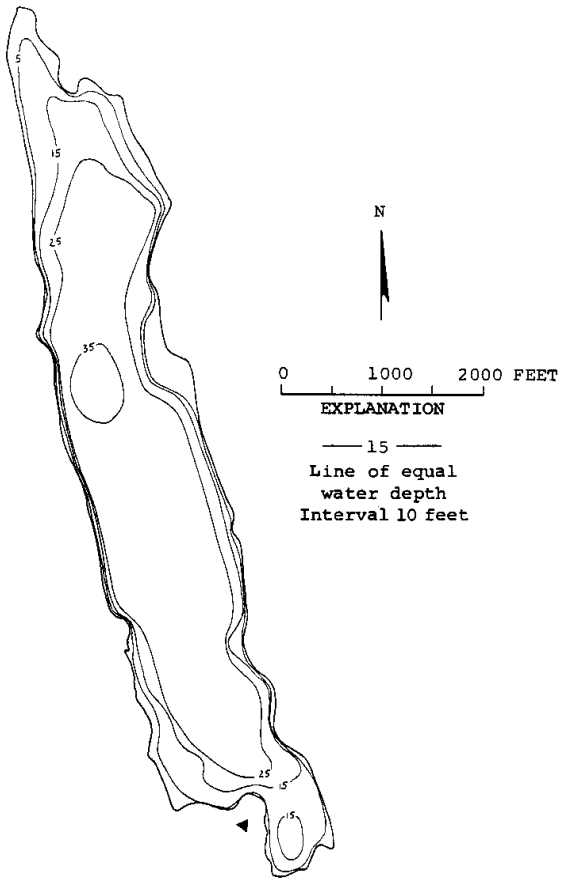
***Lake ID:*** *MEDSP2*

***Ecoregion:*** 7

West Medical lake is a very eutrophic lake located approximately 30 miles southwest of Spokane. It is one of the few lakes in the state with a permitted waste water discharge.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 220 | 35 | 22 | 2 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 4900 | 3.98 | 2423 | 47 33 42. | 117 42 06. |




Medical, West Lake, Spokane County. From
Washington Department of Game, February 3, 1955.

## Station Information

MEDSP2

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 34 28.6 | longitude: 117 42 33.4 |
| | Description: | Deep part of lake approximately 500 feet east of a white slumped bank on west shore | |
| Secondary Station | Station # 3 | latitude: 47 34 11.9 | longitude: 117 42 28.1 |
| | Description: | Approximately 750 feet west of east shore hospital access | |
| Secondary Station | Station # 2 | latitude: 47 34 44.9 | longitude: 117 42 40.3 |
| | Description: | Northern end of lake in approximate center of a line extending from the east shore to the west shore about 2500 feet south of northern tip of lake | |

## Trophic State Assessment for 1998

MEDICAL, WEST

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI Secchi: [a] | 38 | N |
| TSI Phos: | 120 | |
| TSI Chl: | 53 | |
| Narrative TSI: [b] | E | |

West Medical Lake is one of the few lakes in Washington State which receives a waste treatment plant discharge. Because of this, the lake is unusually high in nutrients. The lake shoreline is mostly natural and the watershed is mostly agriculture with large wheat fields close by. The west shore is undeveloped with wheat fields some 200 meters back from the lake. The east shore is undeveloped except for a picnic access. There is a boat rental place/fishing dock and a large public access on the south end; there is a pumphouse on the north end. The lake has a 50 mph speed limit but we seldom saw boats exceed trolling speed during our sampling visits. The lake is a popular fishing lake and the zooplankton population appears to be healthy and supportive of a good sport fishery. Aquatic plants were thick in places; coontail (Ceratophyllum demersum) was dominant. The water clarity was surprisingly good considering the sizeable nutrient load within the lake. Wildlife were diverse and abundant. Unlike Medical Lake, a mile to the east, West Medical Lake is not typically used for primary contact recreation, though we do not know what uses would be if water quality were better. The abundant vegetation and nutrients do not appear to greatly interfere with current uses, though too much vegetation may interfere with forage by predator fish or be so thick that it is impenetrable even by the smaller prey fish. It can also potentially interfere with fishing. Hydrogen sulfide odor was observed very deep in the water column (8 meters) and there were many blue-green colonies (probably Mycrocystis) but again, these typical indicators of poor water quality do not appear to impact the current uses of the lake. An aerator has been operated in the lake in the past.

In 1992, Willms, R. and G. Pelletier reported high fecal bacteria near the treatment plant outfall, mean TPs of 2.35 mg/L (max 2.8), and mean TN of 1.68 (Impacts of Eastern State Hospital and Lakeland Village Wastewater discharges on the quality of

West Medical Lake, Washington State Department of Ecology, 36 pp.). In 1998, we found no high fecal bacteria concentrations, much higher TP concentrations (epilimnion mean 3.03, whole lake max 4.91) and a similar TN concentration (1.36). Willms and Pelletier reported evidence of significant internal nutrient loading; internal loading was even more pronounced during our study, perhaps because thermal stratification was greater.

There are plans to redirect the treatment plant outfall out of the lake in the near future.

West Medical Lake is almost certainly nitrogen limited with TN/TP ratios below 2. (Nitrogen limitation would also explain why the mean Secchi and chlorophyll concentrations were so much lower than mean TP concentrations would indicate.) Pending a more thorough study, we recommend that a nitrogen criterion for West Medical Lake be set at current levels plus a correction for inter-annual variability: 1.36 mg/L (= mean 1.20 mg/L + std. dev. 0.16).

[a] TSI Qualifiers: B or W-Secchi Disk hit bottow or entered weeds; J-Estimate; N-Fewer than the required number of samples

[b] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

MEDICAL, WEST

| Date | Time | Strata | Tot P (ug/L | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/16/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 1 U | | | |
| 7/14/1998 | | L | | | | | 19 | | | |
| | | L | | | | | 1 U | | | |
| 8/11/1998 | | L | | | | | 1 | | | |
| | | L | | | | | 1 U | | | |
| 9/15/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 1 U | | | |
| **Station 1** | | | | | | | | | | |
| 6/16/1998 | | E | 3310 J | .912 | 0 | 7.3 | | 164 | | 1 |
| | | H | 3590 J | .99 | 0 | | | | | |
| 7/14/1998 | | E | 3000 | 1.36 | 0 | 12.3 | | | | .8 J |
| | | H | 4000 | 1.78 | 0 | | | | | |
| 8/11/1998 | | E | 2750 | 1.42 | 1 | 16.4 | | | | 1.4 J |
| | | H | 4330 | 1.83 | 0 | | | | | |
| 9/15/1998 | | E | 3050 | 1.13 | 0 | 12.4 | | | | .8 |

| | | | | | |
|---|---|---|---|---|---|
| | H | 4910 | 2.86 | 1 | |
| **Station 2** | | | | | |
| 7/14/1998 | E | 2900 | 1.33 | 0 | 10.6 |
| 9/15/1998 | E | 2680 | 1.12 | 0 | 11.3 |
| **Station 3** | | | | | |
| 8/11/1998 | E | 2840 | 1.28 | 0 | 13.2 |
| | H | 2630 | 1.31 | 0 | 13.8 |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than, G=Greater than.

## Watershed Survey

MEDICAL, WEST

**Survey Date:** 9/15/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

2 **Agriculture(commercial, not hobby)**

1 **Commercial, Industrial**

**Major transportation**

**Residential**

**Park, forest or natural**

**Impervious surfaces (Roads and parking area)** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Cattle and horses have access to low-lying areas but not sure if the areas are upstream or down.

**Odors** ☐

**Cattle** ☐ **Ducks** ☑ **Geese** ☐

Ducks are all over.

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Wheat fields and at prison

**Buffer zones around streams and wetlands** ☐

**Irrigation** ☑

north end of lake

**Survey Id:** 75

## Habitat Survey Summary Report

MEDICAL, WEST

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/14/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

**Canopy Layer Avg:** 1.2 **Number of stations with canopy:** 6

| | | | |
|---|---|---|---|
| **Understory Avg:** | 2.3 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.3 |
| | **trees< 0.3 m DBH** | 0.6 |
| **Understory:** | **woody shrubs saplings** | 1.3 |
| | **tall herbs, forbs grasses** | 2.3 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.5 |
| | **herbs, forbs, grasses** | 2.8 |
| | **standing water or inundated veg** | 0.7 |
| | **barren or buildings** | 0.5 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.7 |
| | **boulders** | 0.4 |
| | **cobble/gravel** | 0.4 |
| | **loose sand** | 0.0 |
| | **other fine soil/sediment** | 0.9 |
| | **vegetated** | 3.4 |
| | **other** | 0.0 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.7 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.2 |
| **commercial** | 0.0 |
| **park facilities** | 0.0 |
| **docks/boats** | 0.1 |
| **walls, dikes, or revetments** | 0.0 |
| **litter, trash dump, or landfill** | 0.7 |
| **roads or railroad** | 0.4 |
| **row crops** | 0.1 |
| **pasture or hayfield** | 0.7 |
| **orchard** | 0.0 |
| **lawn** | 0.0 |
| **other** | 0.1 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.4 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.3 |
| **boulders** | 0.3 |
| **cobble** | 0.0 |

| | |
|---|---|
| **gravel** | 0.0 |
| **sand** | 0.0 |
| **silt** | 3.3 |
| **woody debris** | 0.6 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 3.2 |
| **emergent** | 1.4 |
| **floating** | 0.2 |
| **total weed cover** | 3.3 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.8 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.9 |
| **snags** | 0.3 |
| **brush or woody debris** | 0.6 |
| **inundated live trees** | 0.1 |
| **overhanging vegetation** | 0.2 |
| **rock ledges or sharp dropoffs** | 0.2 |
| **boulders** | 0.3 |
| **human structures** | 0.0 |

---

# Questionnaire

MEDICAL, WEST

**Results compiled from** 1 **Surveys.** **Average time (years) respondents spent on lake:** 12.00

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | 0.0 | View: | 0.0 | Distance to Lake: | 0.0 |
| Public Access: | 0.0 | Swim Beach: | 0.0 | Canada Geese: | |
| Water Clarity: | -1.0 | Water Qual. for Swim: | 0.0 | | |
| Fishing Quality: | 0.0 | Aquatic Plants: | -1.0 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **2.0**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 2.0 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 2.0 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.0 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 3.0 | Good Warmwtr Fishing: | 3.0 | Natural Scenery: | 3.0 |
| Plant Growth: | 1.0 | Good Swimming: | 3.0 | Public Beach: | 3.0 |
| Natural Shoreline: | 3.0 | Less Algae: | 5.0 | Canada Geese: | 3.0 |
| No Odors: | 3.0 | Public Access: | 3.0 | | |
| Good Coldwtr Fishing: | 3.0 | Clear Water: | 5.0 | | |

**Tabulated Results**

| Survey ID | Date | ----------Residency---------- | Rent or Own | Primary Activity* | Purchase Factor? | ----------Water Clarity---------- Has it Changed? | When? |
|---|---|---|---|---|---|---|---|
| 62 | 8/11/1998 | Visitor | | 2 | ☐ | Worse | 1987 |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

MEDSP2

Date 8/11/1998 Station: 1
Sample ID 11

Cladoceran appear daphnia-like but lack the long spine, distinct eye-spot and head. Looks like giant Ostracod but has obvious Cladoceran features. More round than oval. Most likely D. schodleri

Number of organisms measured: 72

| Group | Percent |
|---|---|
| Cladoceran | 100.0% |
| Copepod | |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 81.9% |
| Large >= 1mm | 18.1% |
| Ratio of large to Small | 0.22 |
| Average size (mm): | 0.76 |

## Aquatic Plant Data

MEDICAL, WEST

Sampler: Parsons, O'Neal

Survey Date: 7/14/1998

Max depth of growth (M): 4.5

Comments Sunny, breeze. Much long thin blue-green algae in water. Ceratophyllum is dominant submersed plant. Animals observed include: many duck families (dabblers and greebes). Raccoons on shore. Ruddy ducks, osprey, heron, geese, many blackbirds, some dead fish floating, gold fish, turtle. Conducted habitat survey for Kirk Smith. Heavy algae growth on some plants (deeper ones), forming surface scum unprotected areas. Water level seems up, all Ponderosa pines along shore are dead.

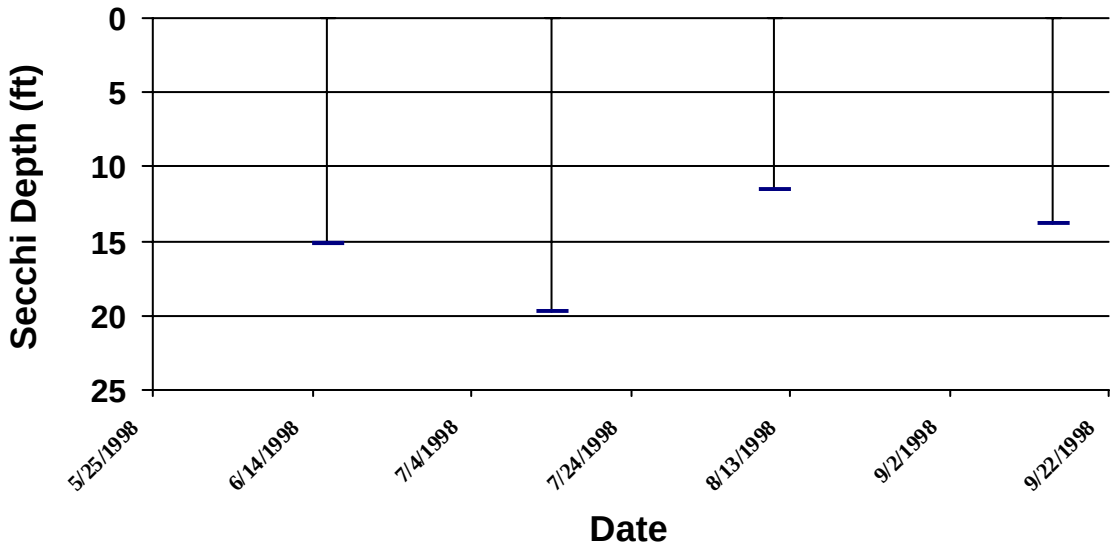
SPECIES LIST

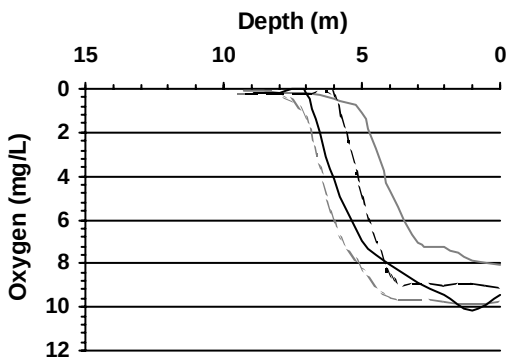
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Ceratophyllum demersum* | Coontail; hornwort | 4 | dominant in much of lake, forming surface mats |
| *Lemna sp.* | duckweed | 2 | more common at south end |
| *Myriophyllum sibiricum* | northern watermilfoil | 2 | blooming |
| *Phalaris arundinacia* | reed canarygrass | 3 | along shore |
| *Potamogeton crispus* | curly leaf pondweed | 2 | patches along west and east shores |
| *Potamogeton pectinatus* | sago pondweed | 3 | some dense stands |
| *Potamogeton pusillus* | slender pondweed | 1 | not much, fruiting |
| *Scirpus sp.* | bulrush | 2 | |
| *Typha sp.* | cat-tail | 2 | |

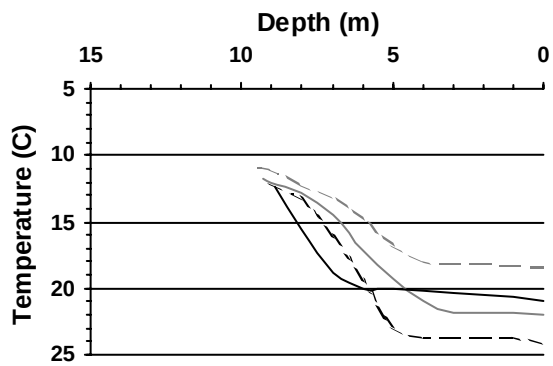
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

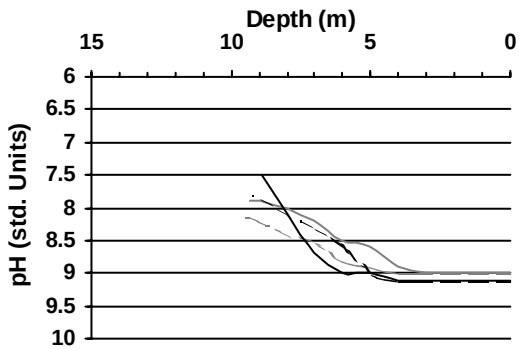
# Secchi Depth and Profile Graphics

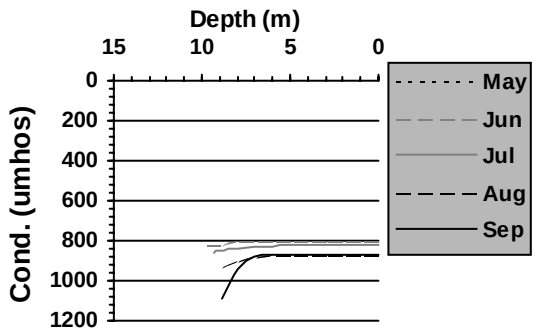
**Station:** 1 MEDSP2



# Secchi Data and Field Observations

MEDICAL, WEST

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/16/1998 | | | 15.18 | 3 | 0 | 1 | | | | 6 | 7 | 9 | 0 |
| | Sampler: | HALLOCK | | Remarks: | APHANIZOMENON BLOOM IN PROGRESS. NO BLUE-GREEN AT 6M BUT LARGE DAPHNIA. NO BIOTA AT 8M | | | | | | | | |
| 7/14/1998 | | | 19.8 | 6 | 5 | 1 | | 3 | 3 | 30 | 31 | 4 | 0 |
| | Sampler: | HALLOCK | | Remarks: | COWS ALONG SHORE. LOTS OF ALGAL CLUMPS W/OCCASIONAL APHANIZOMENON FLAKES. GOLDFISH OBSERVED | | | | | | | | |
| 8/11/1998 | | | 11.55 | 3 | 0 | 1 | | 3 | 1 | 0 | 17 | 2 | 0 |
| | Sampler: | HALLOCK | | Remarks: | MODERATE APHANIZOMENON BLOOM | | | | | | | | |
| 9/15/1998 | | | 13.86 | 6 | 0 | 1 | | 3 | 1 | 0 | 23 | 2 | 0 |
| | Sampler: | HALLOCK | | Remarks: | COLONIAL ALGAL BLOOM EVIDENT--SAMPLE TAKEN. H2S SMELL EVIDENT AT 8M AND ON ANCHOR. | | | | | | | | |
| **Station 2** | | | | | | | | | | | | | |
| 7/14/1998 | | | 19.8 | 6 | 0 | 1 | | | | 0 | 0 | 0 | 0 |
| | Sampler: | HALLOCK | | Remarks: | | | | | | | | | |
| **Station 3** | | | | | | | | | | | | | |
| 8/11/1998 | | | 12.21 | 3 | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | HALLOCK | | Remarks: | | | | | | | | | |
| 9/15/1998 | | | 13.2 | 6 | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | HALLOCK | | Remarks: | | | | | | | | | |

# MOSES

GRANT County

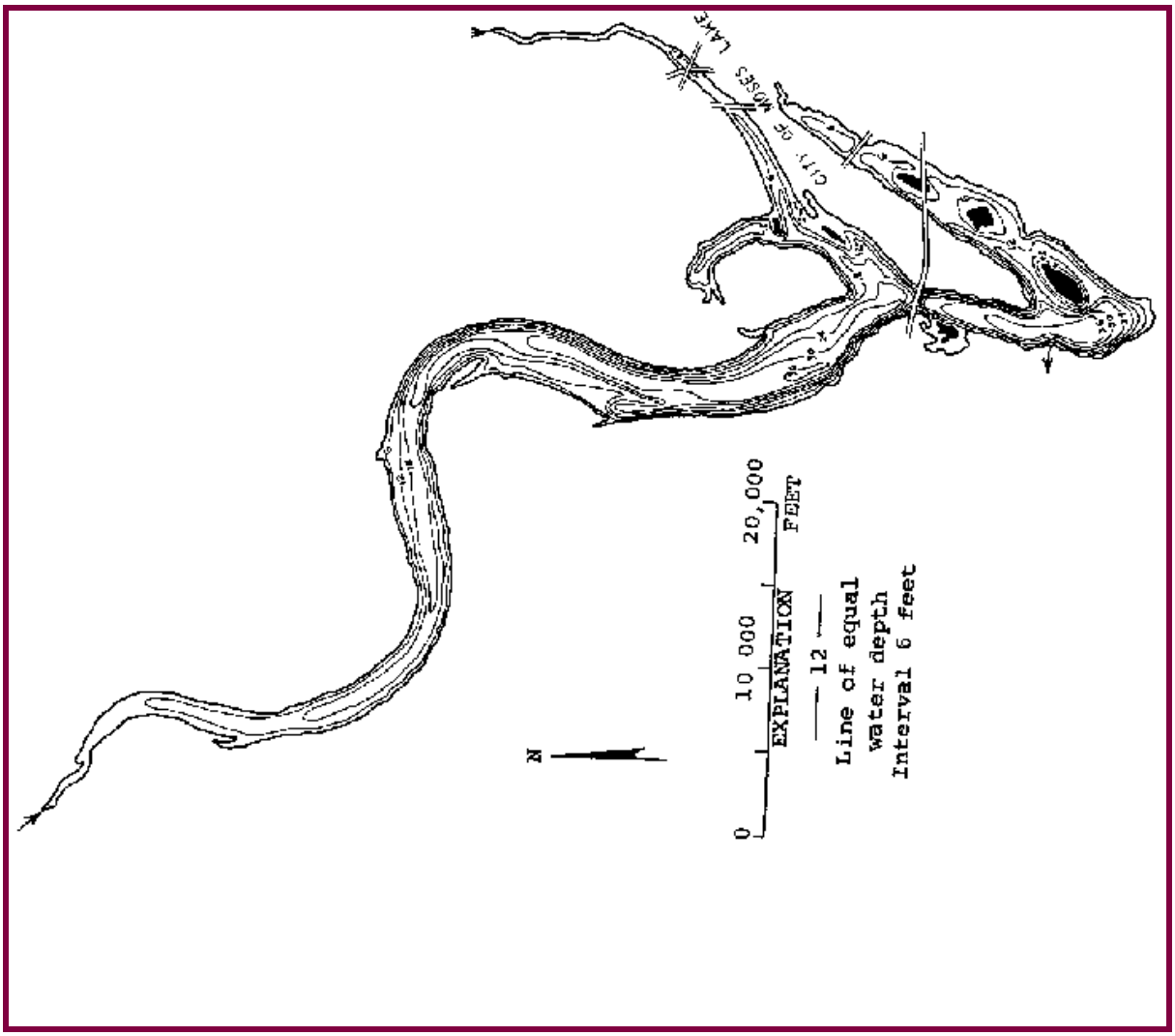
***Lake ID:*** *MOSGR1*

***Ecoregion:*** 7

Moses Lake provides a large aquatic recreational opportunity for the arid central part of Washington State. This large lake is located along I-90 just to the west of the City of Moses Lake.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 6800 | 38 | 19 | 3080 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 131000 | 62.31 | 1046 | 47 03 47. | 119 19 08. |



## Station Information

MOSGR1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 06 40.5 | longitude: 119 18 47.9 |
| | Description: | Near the south end of Parker Horn; northeast of the state park and across from a boat launch on the east shore. | |
| Secondary Station | Station # 2 | latitude: 47 05 15.8 | longitude: 119 18 25.1 |
| | Description: | Approximately mid-lake out from the WDFW launch on Pelican Horn. | |
| Secondary Station | Station # 3 | latitude: 47 10 10.0 | longitude: 119 19 58.9 |
| | Description: | In main lake approximately 7500 feet southeast of Connelly Park (around the bend where the lake turns south, opposite inlet on west bank). | |
| Secondary Station | Station # 4 | latitude: 47 07 22.1 | longitude: 119 20 33.2 |
| | Description: | Deep spot about 1.5 miles NW of state park launch. Out from white house with wood railed stairway on west shore. | |
| Secondary Station | Station # 5 | latitude: 47 05 03.5 | longitude: 119 19 36.3 |
| | Description: | Just north of northern-most outlet. Slightly west of center channel. | |

## Trophic State Assessment for 1998

MOSES

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 58 | N |
| TSI_Phos: | 63 | |
| TSI_Chl: | 64 | |
| Narrative TSI:[a] | E | |

Moses Lake has a long history of water quality problems and has been the subject of restoration efforts in the past. It remains in a eutrophic condition, though the water quality of the lake is improved as a result of earlier restoration efforts. There were no user perception surveys distributed for this lake so we cannot ascertain the public's desired uses or perception of the water quality in Moses Lake. This information is particularly important for this lake because Moses Lake is a large water body near a relatively densely populated city in central Washington. It is a valuable recreational and wildlife asset for the community; still, further management to improve water quality will likely be very expensive. The zooplankton community appears to be healthy and could support a good fishery. There were many blue-green algae colonies in the water column during all sampling events. Aphanizomenon and Microcystis were particularly abundant. Late summer anoxia in the hypolimnion is to be expected for this lake considering the high nutrient and chlorophyll concentrations. The lake may be nitrogen limited through most of the growing season. Although nutrient rich, the habitat survey did not reveal an overabundance of aquatic vegetation. This may be because of the reduced water clarity in the lake. Human influences (see habitat survey) may have an impact on waterfowl abundance. In particular, geese were observed congregating at parks and other grassy areas.

Our objectives for monitoring Moses Lake were to fulfill post-management monitoring requirements and to support work being conducted by others in 1998. Establishing a nutrient criterion for Moses Lake was not one of our objectives for this lake.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

MOSES

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/17/1998 | | L | | | | | 2 | | | |
| | | L | | | | | 88 | | | |
| | | L | | | | | 13 | | | |
| 7/15/1998 | | L | | | | | 6 | | | |
| | | L | | | | | 1 U | | | |
| | | L | | | | | 1 U | | | |
| 8/12/1998 | | L | | | | | 33 J | | | |
| | | L | | | | | 1000 G | | | |
| | | L | | | | | 1 U | | | |
| 9/16/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 1 U | | | |
| | | L | | | | | 1 U | | | |
| **Station 1** | | | | | | | | | | |
| 6/17/1998 | | E | 98.4 J | .655 | 7 | 50 | | 150 | | 13 J |
| 7/15/1998 | | E | 111 | 1.15 | 10 | 45.9 | | | | 7 J |
| | | H | 78.8 | .759 | 10 | | | | | |
| 8/12/1998 | | E | 38.5 | .521 | 14 | 19.2 | | | | 7.9 |
| 9/16/1998 | | E | 69 | .507 | 7 | 42.5 | | | | 3.9 |
| **Station 2** | | | | | | | | | | |
| 6/17/1998 | | E | 45.1 J | .573 | 13 | 19.8 | | | | 8.3 J |
| 7/15/1998 | | E | 48.1 | .868 | 18 | 47.7 | | | | 10 J |
| 8/12/1998 | | E | 48.5 | .665 | 14 | 15 | | | | 8 |
| | | H | 42.7 | .614 | 14 | | | | | |
| 9/16/1998 | | E | 53 | .491 | 9 | 27.8 | | | | 3.8 |
| **Station 3** | | | | | | | | | | |
| 6/17/1998 | | E | 57.5 J | .644 | 11 | 31.6 | | | | 10 J |
| 7/15/1998 | | E | 67.2 | .858 | 13 | 42.5 | | | | 10 J |
| | | H | 102 | 1.11 | 11 | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8/12/1998 | E | 44.3 | .65 | 15 | 13.3 | 10 |
| | H | 175 | 1.58 | 9 | | |
| 9/16/1998 | E | 46 | .598 | 13 | 13 | 3 |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

MOSES

**Survey Date:** 9/16/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [1] **Agriculture(commercial, not hobby)**
- [2] **Residential**
- [4] **Commercial, Industrial**
- [ ] **Park, forest or natural**
- [3] **Major transportation**

**Impervious surfaces (Roads and parking area):** Mostly Curbed

### Observations (check mark denotes presence)

**BMP's** ☐

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Agriculture areas.

**Buffer zones around streams and wetlands** ☐

**Irrigation** ☐

**Survey Id:** 10

## Habitat Survey Summary Report

MOSES

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/19/1998

### Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.8 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.9 | **Number of stations with understory:** | 10 |

### Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.4 |

| | | |
|---|---|---|
| | **trees< 0.3 m DBH** | 0.7 |
| **Understory:** | **woody shrubs saplings** | 2.1 |
| | **tall herbs, forbs grasses** | 2.1 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.6 |
| | **herbs, forbs, grasses** | 3.0 |
| | **standing water or inundated veg** | 1.6 |
| | **barren or buildings** | 1.0 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 1.0 |
| | **loose sand** | 0.2 |
| | **other fine soil/sediment** | 0.2 |
| | **vegetated** | 3.6 |
| | **other** | 0.3 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 1.2 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.0 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.5 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 0.5 |
| **walls, dikes, or revetments** | 0.2 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.1 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.5 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.6 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.4 |
| **cobble** | 1.3 |
| **gravel** | 1.3 |
| **sand** | 1.9 |
| **silt** | 0.9 |
| **woody debris** | 0.2 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.8 |
| **emergent** | 1.3 |
| **floating** | 0.0 |
| **total weed cover** | 2.2 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.5 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.8 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.4 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 1.0 |
| **rock ledges or sharp dropoffs** | 0.2 |
| **boulders** | 0.1 |
| **human structures** | 0.1 |

---

## Zooplankton Report

MOSGR1

Date 8/12/1998 Station: 2 Lots of algal growth
Sample ID 13

Number of organisms measured: 54

| Group | Percent |
|---|---|
| Cladoceran | 63.0% |
| Copepod | 37.0% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 53.7% |
| Large >= 1mm | 46.3% |
| Ratio of large to Small: | 0.86 |
| Average size (mm): | 0.90 |

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## Aquatic Plant Data

MOSES

Sampler: Parsons, O'Neal Survey Date: 7/15/1998

Max depth of growth (M): 2.5

Comments sunny, calm. Blue-green algae bloom forming surface scum near shore in many areas. Lots of big carp, cormorants, greebes, geese, fish jumping. Bottom mostly rocky/sandy, not many submersed plants. Large sections of shoreline undeveloped. Conducted habitat survey for Kirk Smith.

SPECIES LIST

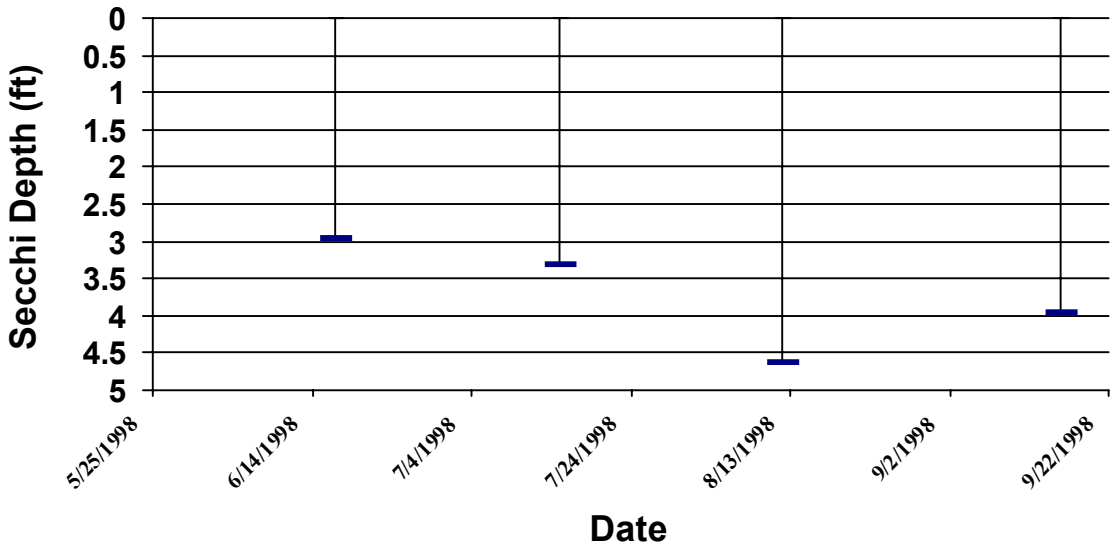
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Carex sp.* | sedge | 1 | in undeveloped areas of shore |
| *Ceratophyllum demersum* | Coontail; hornwort | 1 | only saw 1 sprig in deeper water |
| *Iris pseudacorus* | yellow flag | 2 | in south end |
| *Juncus sp.* | rush | 1 | in undeveloped areas of shore |

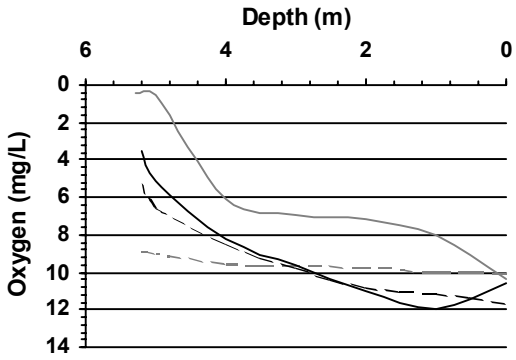
| | | | |
|---|---|---|---|
| *Lythrum salicaria* | purple loosestrife | 2 | northern end |
| *Myriophyllum sp.* | water-milfoil | 1 | one fragment found at MontLake Park dock |
| *Phalaris arundinacia* | reed canarygrass | 3 | |
| *Phragmites communis* | common reed | 2 | more at north-most site |
| *Potamogeton crispus* | curly leaf pondweed | 2 | |
| *Potamogeton illinoensis* | Illinois pondweed | 2 | |
| *Potamogeton pectinatus* | sago pondweed | 3 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 2 | in deeper water |
| *Scirpus sp.* | bulrush | 3 | bulrush, some dense patches in undeveloped areas |
| *Typha latifolia* | common cat-tail | 2 | seen at north end |

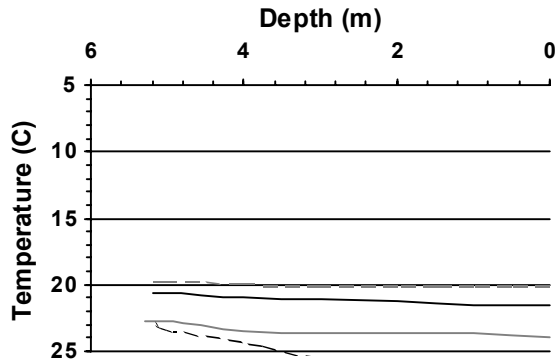
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

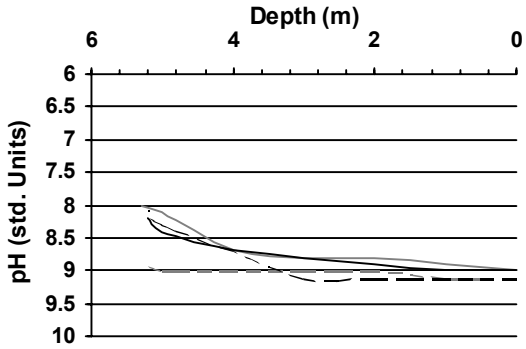
# Secchi Depth and Profile Graphics

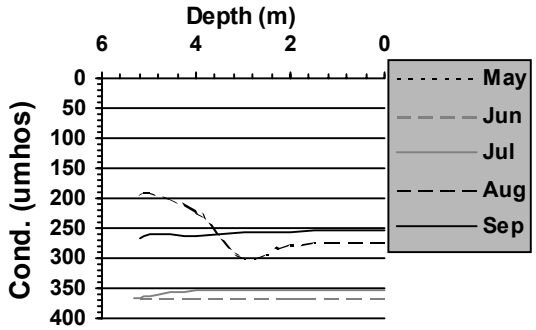
**Station:** 1 MOSGR1



# Secchi Data and Field Observations

MOSES

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/17/1998 | | | 2.97 | 2 | 0 | 1 | | 2 | 1 | 0 | 2 | 1 | 0 |
| | Sampler: HALLOCK | | | Remarks: | APHANIZOMENON BLOOM IN PROGRESS. TOOK SAMPLES. A FEW LARGE DAPHNIA IN ALL CASTS BUT NOT MANY. ST PARK IS ONLY UNDEVELOPED SHORELINE IN VIEW. RESORT HOTEL, CONDOS, LARGE HOMES. THERE ARE A DOZEN PARKS/WATER REC. AREAS AROUND LAKE. | | | | | | | | |
| 7/15/1998 | | | 3.3 | 3 | 70 | | | 1 | 1 | 37 | 7 | 4 | 0 |
| | Sampler: HALLOCK | | | Remarks: | LOTS OF NON-GAME FISH JUMPING. THICK APHANIZOMENON BLOOM, W/CLUMPS OF OTHER ALGAE. LARGE DAPHNIA IN ALL CASTS BUT NOT ABUNDANT. LESS APHANIZOMENON. AT 4.5M BUT STILL PRESENT. FINE GREASY CONSOLIDATED SEDIMENT ON ANCHOR. | | | | | | | | |
| 8/12/1998 | | | 4.62 | 6 | 0 | | | 1 | 1 | 0 | 15 | 1 | 1 |
| | Sampler: HALLOCK | | | Remarks: | NO APHANIZOMENON NOW. BLOOM IS MOSTLY SMALL SPECS W/SOME CLUMPS AND SHORT THIN TRICHOMES. TOOK SAMPLE | | | | | | | | |
| 9/16/1998 | | | 3.96 | 6 | 10 | | | 1 | 1 | 0 | 25 | 4 | 0 |
| | Sampler: HALLOCK | | | Remarks: | ALGAE BLOOM THICK THROUGHOUT BUT ESPECIALLY CLUMPING AND SCUMMY DOWNWIND. TOOK SAMPLE. ALSO TOOK ZOOPLANTON SAMPLE AT STATE PARK ACCESS | | | | | | | | |
| **Station 2** | | | | | | | | | | | | | |
| 6/17/1998 | | | 3.96 | 2 | 0 | 2 | | 2 | 1 | 0 | 1 | 2 | 0 |
| | Sampler: HALLOCK | | | Remarks: | APHANIZONMENON BLOOM NOT AS SEVERE AS SITE 1. NO CLUMPS. SOME LARGE DAPHNIA IN ALL CASTS. HEAVY MUD ON ANCHOR WHICH WAS SO FILLED WITH SMALL SNAIL SHELLS AS TO FEEL LIKE SAND. | | | | | | | | |
| 7/15/1998 | | | 3.63 | 2 | 30 | | | 1 | 1 | 0 | 2 | 2 | 0 |
| | Sampler: HALLOCK | | | Remarks: | LITTLE APHANIZOMENON BUT LOTS OF SMALL BLUE-GREEN CLUMPS. NOT AS MANY LARGE DAPHNIA AS SITE ONE BUT SOME SMALLER COPEPODS. | | | | | | | | |
| 8/12/1998 | | | 3.3 | 6 | 0 | | | 1 | 1 | 0 | 6 | 1 | 0 |
| | Sampler: HALLOCK | | | Remarks: | SIMILAR ALGAE ASSEMBLEDGE AS SITE #1 PERHAPS FEWER LARGER CLUMPS | | | | | | | | |
| 9/16/1998 | | | 4.95 | 6 | 20 | | | 1 | 1 | 30 | 0 | 4 | 0 |
| | Sampler: HALLOCK | | | Remarks: | ALGAE BLOOM EVIDENT HERE TOO BUT NOT AS BAD AS AT STATION 1 | | | | | | | | |
| **Station 3** | | | | | | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/17/1998 | | | 2.64 | 2 | 10 | 2 | | 2 | 1 | 0 | 0 | 2 | 0 |
| | Sampler: HALLOCK | | | Remarks: APHANIZOMENON BLOOM SIMILAR TO SITE#2. FISHERMEN REPORT WALLEYE AND PERCH. LOTS OF DEAD CARP. THIS BASIN SPARSELY DEVELOPED. | | | | | | | | | |
| 7/15/1998 | | | 4.29 | 2 | 50 | | | 1 | 1 | 0 | 3 | 1 | 0 |
| | Sampler: HALLOCK | | | Remarks: SURFACE ALGAE SMALLER COLONIES; APHANIZOMENON SPARSE BUT LOTS OF APHAN AT 2 AND 3M (MOVE DOWN DURING DAY?) 6M NO NOTICEABLE ALGAE. LOTS OF DAPHNIA AND COPEPODS. CONNOLLY PARK LAUNCH BAY IS FULL W/THICK BLUE-GREEN FORMING MATS. | | | | | | | | | |
| 8/12/1998 | | | 3.63 | 2 | 0 | 1 | | 2 | 2 | 0 | 0 | 2 | 0 |
| | Sampler: HALLOCK | | | Remarks: 5 & 6 M SAMPLES HAVE STRONG H2S SMELL. MUCH LESS CLUMPING THAT STATION #1. | | | | | | | | | |
| 9/16/1998 | | | 7.26 | 6 | 35 | 1 | | 1 | 1 | 0 | 33 | 0 | 0 |
| | Sampler: HALLOCK | | | Remarks: ALGAE BLOOM HERE TOO BUT LESS SEVERE THAN AT SITE #1. SAMPLED FOR VELIGERS OFF CONNELLY PARK | | | | | | | | | |

# OFFUTT

THURSTON County

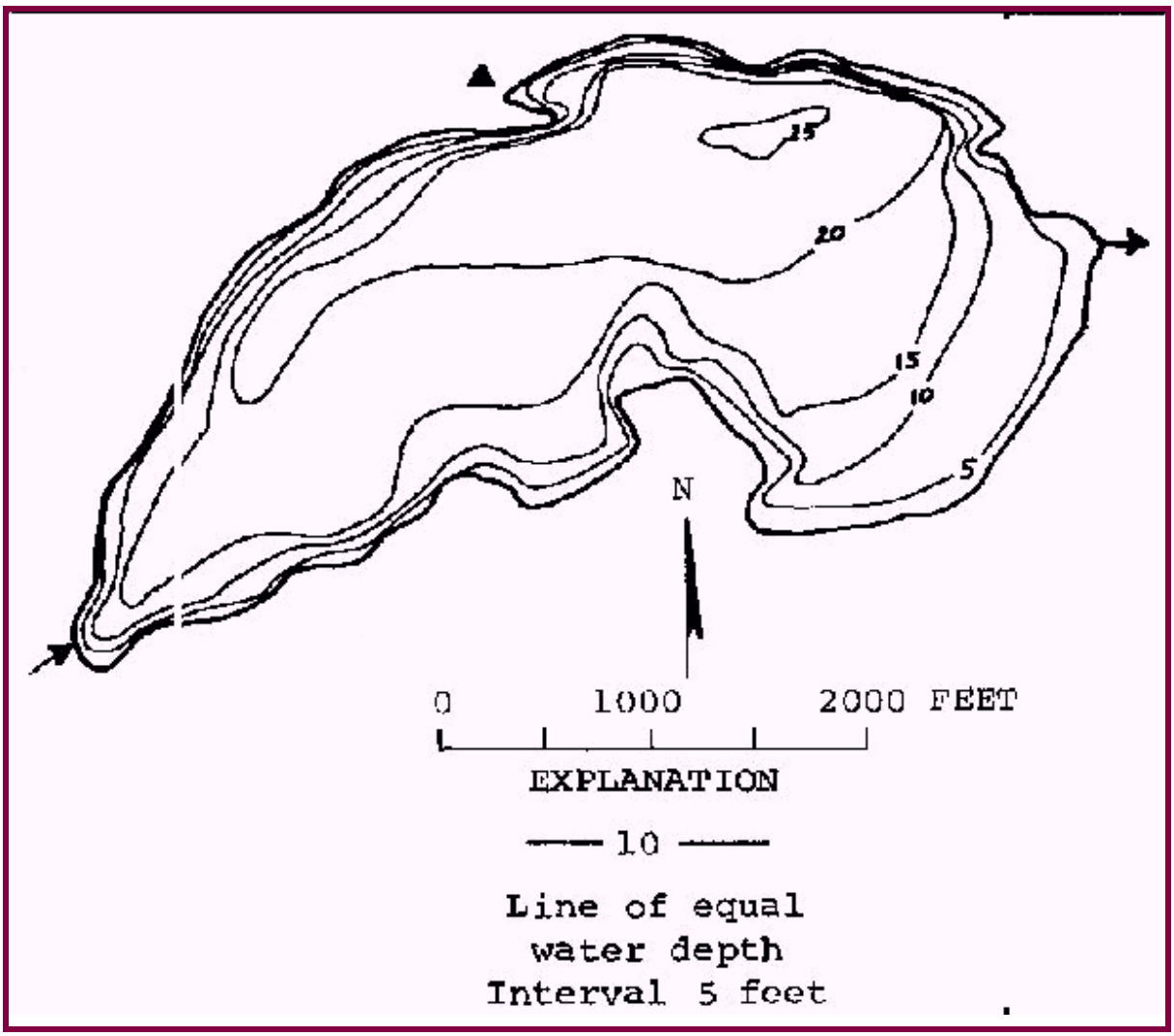
*Lake ID:* OFFTH1

*Ecoregion:* 2

Offutt Lake is in rural Thurston County, about 10 miles south of Olympia. It is fed by an unnamed surface inlet and drains to the Deschutes River. There is a small resort on the lake; however the lake receives little recreational use. Livestock has access to the western shores of the lake.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 200 | 25 | 15 | 3 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 2900 | 2.86 | 230 | 46 55 06. | 122 49 04. |



## Station Information

OFFTH1

| Primary Station | Station # 1 | latitude: 46 55 05.9 | longitude: 122 49 37.4 |
|---|---|---|---|
| | Description: | Deep part of lake approximately 250 feet north of the middle of a line extending from boat launch to outlet | |

## Trophic State Assessment for 1998

OFFUTT

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 44 |
| TSI_Phos: | 47 |
| TSI_Chl: | 49 |
| Narrative TSI:[a] | M |

Offut Lake is a relatively shallow lake that shows signs of natural eutrophication. The lake has retained most of its natural aesthetic appeal despite the established residential community surrounding the lake. There are large areas where natural vegetation has been allowed to flourish. Aquatic plants were generally sparse. Nutrients in the epilimnion were quite low except in September when concentrations may have been raised after mixing (mean total phosphorus 19.2). Water clarity somewhat indicates a mesotrophic lake despite the tannin colored water which may bias Secchi readings low. Hypolimnetic phosphorus concentrations were very high indicating internal loading. Our 1998 data indicate that Offut Lake may be phosphorus limited in mid-summer and nitrogen limited in early and late summer. With only four samples in one season, however, this is a very tenuous conclusion; a more thorough examination into biologically active forms of both phosphorus and nitrogen may reveal the true dynamic of nutrient limitation. The habitat survey revealed a shoreline influenced by human structures and modifications. These modifications may not affect water quality much, but they may attract an undesirable population of Canada geese. There were no user surveys returned for Offut Lake. There is a resort on the lake with a fishing dock so fishing is most likely a valued recreational use. Water quality measurements suggest a "put and take" fishery could be supported; zooplankton tended to be on the small side and dominated by copepods. There is an area where livestock water on the lake. Although there were colonies of blue-green algae observed in the water samples, dense algal blooms were not observed; lake water should be safe for drinking by livestock. There is the potential for livestock to contaminate water supplies with fecal material and nutrients; however, the water samples analyzed in 1998 for fecal coliform bacteria did not indicate a fecal contamination problem.

We recommend that the remaining natural shoreline be protected so that available habitat for Canada geese will not be artificially increased. We recommend the total phosphorus nutrient criterion for Offut Lake be set at 20 ug/L, the action value in the water quality regulations for Puget Lowlands lower mesotrophic lakes. Due to the limitations of the sampling conducted during this study, it is difficult to determine whether nitrogen is also limiting to the system. Future studies may propose a nitrogen criterion. Some septic infiltration into the lake from some of the older homes

along the lake may be occurring. In particular, these septic fields may be a source of nitrogen. Therefore, future investigation of Offut Lake should include evaluating the effects of nitrogen in the system and consultation with Thurston County officials to determine whether or not there is a septic seepage problem.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

OFFUTT

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/1/1998 | | L | | | | | 10 | | | |
| | | L | | | | | 4 | | | |
| 7/23/1998 | | L | | | | | 25 | | | |
| | | L | | | | | 9 J | | | |
| 8/10/1998 | | L | | | | | 4 | | | |
| | | L | | | | | 6 | | | |
| 9/24/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 1 | | | |
| **Station 1** | | | | | | | | | | |
| 6/1/1998 | | E | 19.1 | .229 | 12 | 3 | | 17.9 | | .8 |
| | | H | 60.6 | .337 | 6 | | | | | |
| 7/23/1998 | | E | 7.3 | .25 | 34 | 2.1 | | | | .7 |
| | | H | 114 | .377 | 3 | | | | | |
| 8/10/1998 | | E | 12.5 | .517 | 41 | 7.7 | | | | .9 |
| | | H | 246 | .254 | 1 | | | | | |
| 9/24/1998 | | E | 38.1 | .457 | 12 | 21.2 | | | | 1.8 |
| | | H | 60.1 | .53 | 9 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

OFFUTT

**Survey Date:** 9/24/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| 1 | **Agriculture(commercial, not hobby)** | 2 | **Residential** |
| | **Commercial, Industrial** | 3 | **Park, forest or natural** |
| | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** No Curbs

## Observations (check mark denotes presence)

**BMP's** ☐

**Odors** ☐

**Cattle** ☑ **Ducks** ☐ **Geese** ☐

Cattle have been observed entering the lake along the north-west shore of the lake. There is no fencing to keep the cattle out.

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☑

Most of the shoreline has natural vegetation along the shore. The wooded area along the northwest shore is where the cattle enter the lake.

**Irrigation** ☐

**Survey Id:** 30

# Habitat Survey Summary Report

OFFUTT

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/7/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 2.2 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.9 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.9 |
| | **trees< 0.3 m DBH** | 1.5 |
| **Understory:** | **woody shrubs saplings** | 2.1 |
| | **tall herbs, forbs grasses** | 1.2 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.0 |
| | **herbs, forbs, grasses** | 1.1 |
| | **standing water or inundated veg** | 0.6 |
| | **barren or buildings** | 1.3 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.2 |
| | **cobble/gravel** | 1.2 |
| | **loose sand** | 0.3 |
| | **other fine soil/sediment** | 0.7 |
| | **vegetated** | 3.2 |
| | **other** | 0.2 |

| | | |
|---|---|---|
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.2 |
| | **vertical dist (M from wtrln to high wt):** | 0.1 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.0 |
| **commercial** | 0.2 |
| **park facilities** | 0.4 |
| **docks/boats** | 0.9 |
| **walls, dikes, or revetments** | 0.6 |
| **litter, trash dump, or landfill** | 0.2 |
| **roads or railroad** | 0.2 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.8 |
| **other** | 0.2 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.6 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 1.0 |
| **gravel** | 1.4 |
| **sand** | 0.5 |
| **silt** | 1.3 |
| **woody debris** | 0.8 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 0.9 |
| **emergent** | 1.1 |
| **floating** | 0.9 |
| **total weed cover** | 1.8 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.3 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 0.9 |
| **snags** | 0.3 |
| **brush or woody debris** | 1.3 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 1.4 |
| **rock ledges or sharp dropoffs** | 0.0 |

| | |
|---|---|
| **boulders** | 0.0 |
| **human structures** | 0.8 |

## Zooplankton Report

OFFTH1

Date 6/1/1998 Station: 1
Sample ID 17

Number of organisms measured: 193

| Group | Percent |
|---|---|
| Cladoceran | 9.3% |
| Copepod | 90.7% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 91.2% |
| Large >= 1mm | 8.8% |
| Ratio of large to Small: | 0.10 |
| Average size (mm): | 0.40 |

## Aquatic Plant Data

OFFUTT

Sampler: Parsons, O'Neal Survey Date: 7/7/1998

Max depth of growth (M): 3 +

Comments cloudy, calm. Did habitat survey for Kirk Smith - LWQA program. Macrophytes sparse except at inflow and outflow wetland areas. Many patches of Nymphaea.

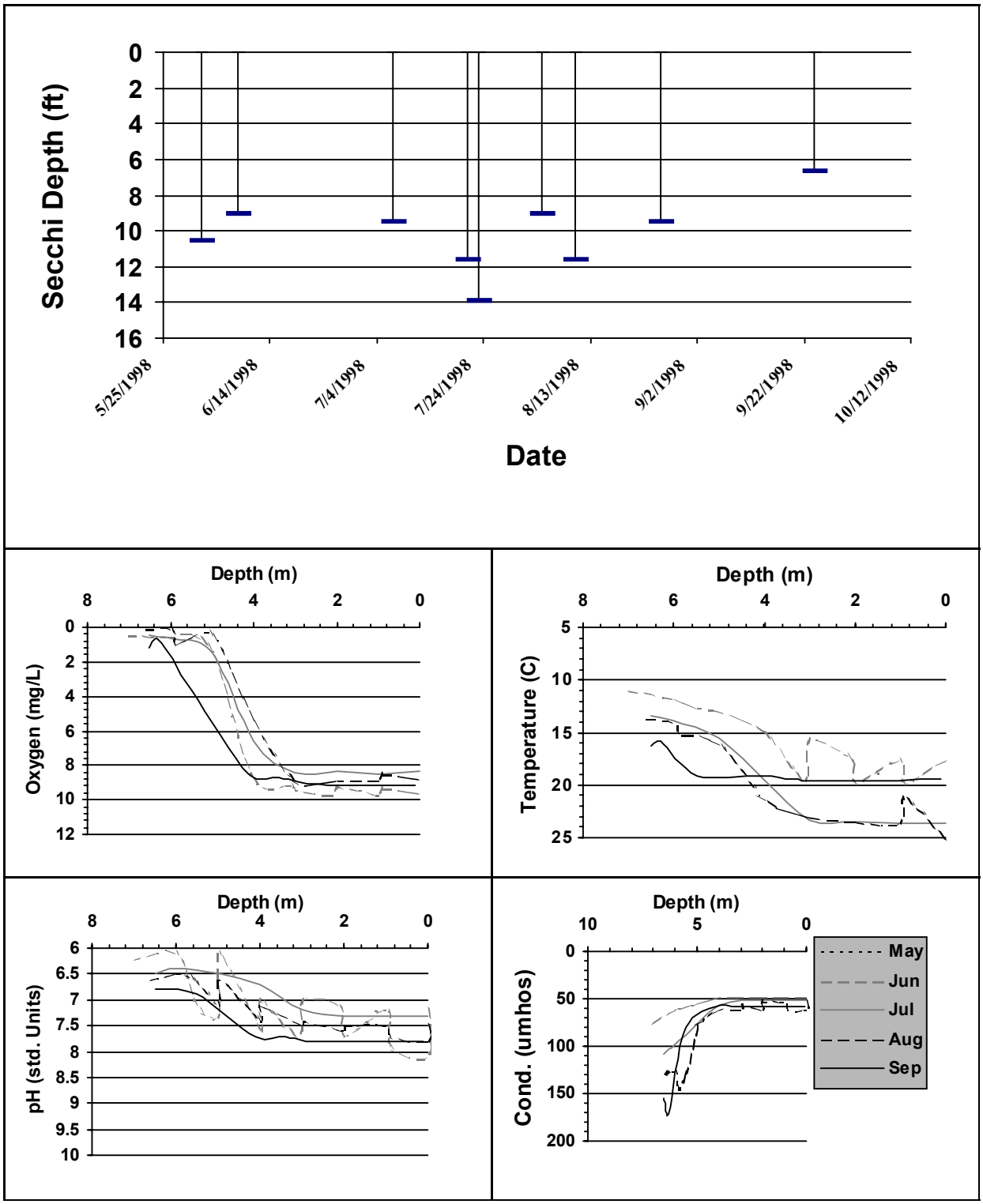
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 2 | |
| *Carex sp.* | sedge | 1 | |
| *Chara sp.* | muskwort | 2 | |
| *Eleocharis sp.* | spike-rush | 2 | |
| *Elodea canadensis* | common elodea | 2 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Juncus sp.* | rush | 2 | |
| *Ludwigia palustris* | water-purslane | 1 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | |
| *Nymphaea odorata* | fragrant waterlily | 3 | |
| *Polygonum sp.* | smartweed | 2 | |
| *Potamogeton amplifolius* | large-leaf pondweed | 3 | |
| *Potentilla palustris* | purple (marsh) cinquefoil | 1 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 2 | |
| *Salix sp.* | willow | | on shore |
| *Scirpus sp.* | bulrush | 2 | bulrush |
| *Tolypella intricata* | macro algae | 1 | |
| *Typha sp.* | cat-tail | 2 | |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 OFFTH1



# Secchi Data and Field Observations

OFFUTT

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/1/1998 | | | 10.5 | 7 | 100 | 2 | 1 | 4 | 4 | 0 | 7 | 6 | 0 |
| | Sampler: | SMITH | | Remarks: | ZOO NET PULLED THROUGH 6 METERS. FEC#1 AT RESORT, #2 AT BOAT LAUNCH | | | | | | | | |
| 6/8/1998 | | 20 | 9 | 6 | 75 | 2 | 1 | 5 | 4 | 0 | | 6 | 0 |
| | Sampler: | KELLY | | Remarks: | | | | | | | | | |
| 6/8/1998 | | | 9 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |
| 7/7/1998 | | 20 | 9.5 | 6 | 25 | 2 | 2 | 4 | 4 | 0 | 6 | 4 | 0 |
| | Sampler: | KELLY | | Remarks: | | | | | | | | | |
| 7/21/1998 | | 23 | 11.58 | 6 | 0 | 2 | 1 | 4 | 4 | 0 | 10 | 1 | 0 |
| | Sampler: | KELLY | | Remarks: | | | | | | | | | |
| 7/23/1998 | | | 13.86 | 2 | 20 | | | 5 | 5 | 0 | 6 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | SLIGHT BLUE-GREEN BLOOM. LOTS OF FRAGRENT LILLIES | | | | | | | | |
| 8/4/1998 | | 23 | 9 | 6 | 100 | 1 | 1 | 4 | 4 | 0 | 0 | 2 | 0 |
| | Sampler: | KELLY | | Remarks: | | | | | | | | | |
| 8/10/1998 | | | 11.55 | 3 | 0 | | | 4 | 3 | 0 | 0 | 3 | 0 |
| | Sampler: | SMITH | | Remarks: | NOTICEABLE BLUE-GREEN BLOOM. LARGE MASSES OF BRYOZOANS NEAR BOAT LAUNCH. STRONG MANUE IN THE BREEZE. FEC SAMPLES TAKEN SAME PLACE AS JULY | | | | | | | | |
| 8/26/1998 | | 23 | 9.5 | 6 | 100 | 1 | 1 | 4 | 4 | 0 | 0 | 1 | 0 |
| | Sampler: | KELLY | | Remarks: | LAKE HEIGHT STICK BROKEN. | | | | | | | | |
| 8/26/1998 | | | 9.5 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |
| 9/24/1998 | | | 6.6 | | 100 | 3 | | 4 | 2 | 0 | 134 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |

# PHILLIPS

MASON County

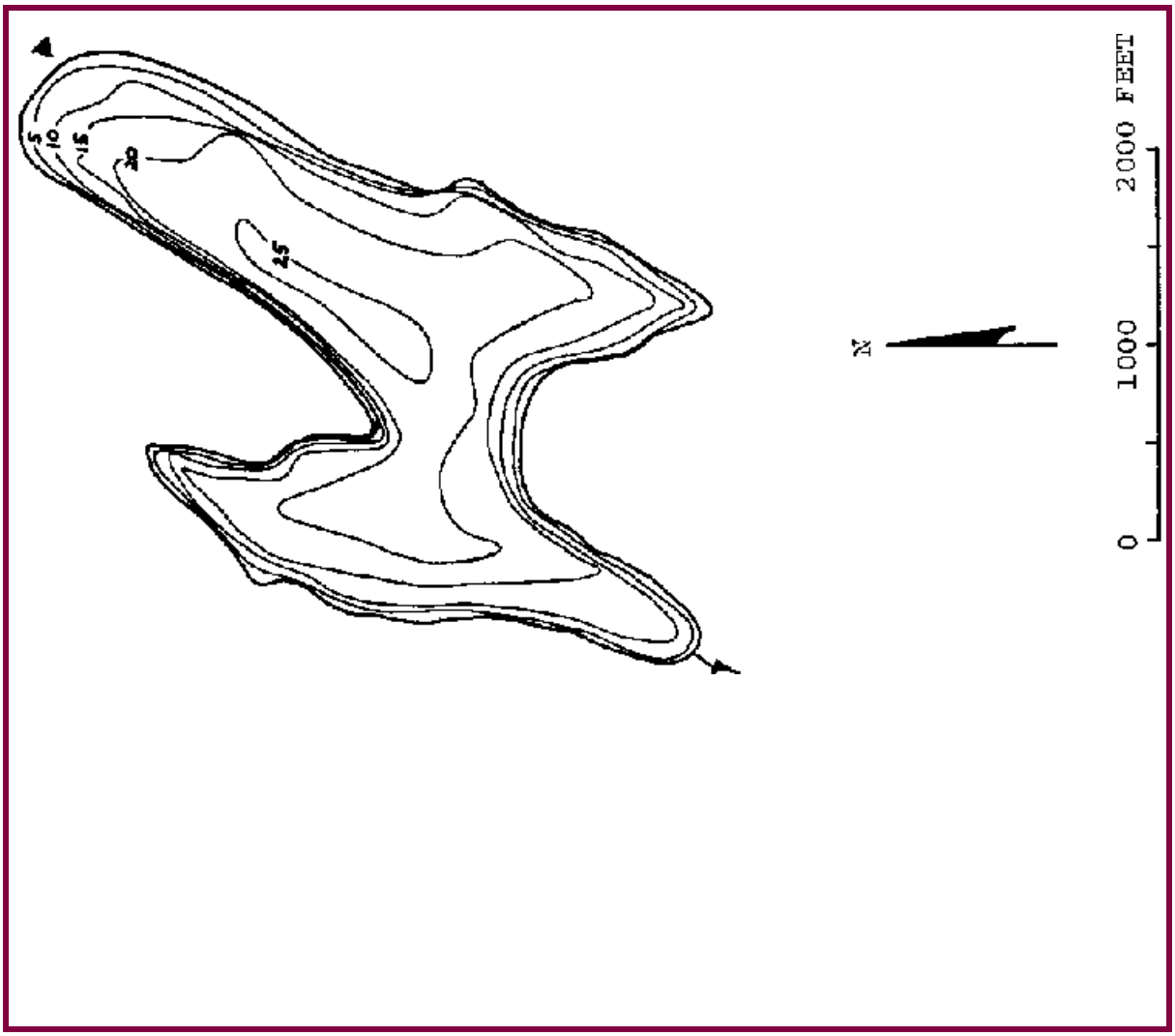
***Lake ID:*** *PHIMA1*

***Ecoregion:*** 2

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.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 110 | 25 | 16 | 1 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 1800 | 2.63 | 188 | 47 14 52. | 122 57 52. |



## Station Information

PHIMA1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 15 32.6 | longitude: 122 58 09.7 |
| | Description: | Deep site, approximately 500 feet east of a major point on the northern shore which bisects the lake into two distinct sides. | |
| Secondary Station | Station # 2 | latitude: | longitude: |
| | Description: | Due south (about 1500 feet) from the northwesternmost tip of the lake. | |

## Trophic State Assessment for 1998

PHILLIPS

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 39 |
| TSI_Phos: | 34 |
| TSI_Chl: | 38 |
| Narrative TSI:[a] | O |

Phillips Lake is an oligotrophic lake that is heavily used in the summer and is nearly built-out along the shoreline. Despite the heavy use, the water quality remains generally good, though there are periodic blue-green algal blooms. The mean phosphorus concentration was relatively low (7.6 ug/L). Non-toxic blooms of Anabaena flos-aquae have been identified in the past. Conductivity was extremely low. If more people become permanent residents there may be a higher likelihood of deteriorating water quality. The habitat survey shows substantial human influence along the shoreline. How human influence has impacted the lake is unclear, except that it may be attracting more Canada geese than desired. There have been reports of fish kills on Phillips Lake but there are no obvious water quality problems that may have contributed to those kills. There were no user surveys returned for the lake so we cannot determine whether there is a general perception of deteriorating water quality; however, some lake residents have formally expressed concern in the past by petitioning county commissioners to apply for a grant to study the lake and stop "the deteriorating condition." All beneficial uses appear to be supported. The lake is most likely phosphorus limited.

We recommend the phosphorus criterion for Phillips Lake be set at 10 ug/L, the action value in the water quality regulations for Puget Lowlands oligotrophic lakes.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

PHILLIPS

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/2/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 3 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/17/1998 | L | | | | | 1 | | | | |
| | L | | | | | 4 | | | | |
| 9/17/1998 | L | | | | | 3 | | | | |
| **Station 1** | | | | | | | | | | |
| 6/2/1998 | E | 6.6 | .237 | 36 | .86 | | | 9.6 | 2260 | .9 |
| 7/25/1998 | E | 6.2 | .235 | 38 | 1.5 | | | | | 1.4 J |
| 8/17/1998 | E | 9.3 J | .277 | 30 | 4.1 | | | | | 1 |
| 9/17/1998 | E | 8.1 | .247 | 30 | 4.2 | | | | | .9 |
| **Station 2** | | | | | | | | | | |
| 6/2/1998 | E | 11.2 J | .234 | 21 | .91 | | | | | |
| 7/25/1998 | E | 7 | | | | | | | | |
| 8/17/1998 | E | 7.9 | .263 | 33 | | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

PHILLIPS

**Survey Date:** 9/17/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [1] **Residential**
- [2] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

No silt screens at construction sites.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☐

Buffer zones were rare around the lake. Clear cuts were well away from the water.

**Irrigation** ☐

**Survey Id:** 50

# Habitat Survey Summary Report

PHILLIPS

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/21/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.4 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.7 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 2.7 |
| | **trees< 0.3 m DBH** | 0.7 |
| **Understory:** | **woody shrubs saplings** | 2.7 |
| | **tall herbs, forbs grasses** | 1.3 |
| **Ground Cover:** | **woody shrubs seedlings** | 2.1 |
| | **herbs, forbs, grasses** | 2.4 |
| | **standing water or inundated veg** | 0.1 |
| | **barren or buildings** | 1.1 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 0.9 |
| | **loose sand** | 0.0 |
| | **other fine soil/sediment** | 0.0 |
| | **vegetated** | 2.1 |
| | **other** | 2.6 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 1.0 |
| | **vertical dist (M from wtrln to high wt):** | 0.1 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.3 |
| **commercial** | 0.0 |
| **park facilities** | 0.0 |
| **docks/boats** | 2.0 |
| **walls, dikes, or revetments** | 1.6 |
| **litter, trash dump, or landfill** | 0.4 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.2 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.1 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.8 |
| **gravel** | 2.3 |
| **sand** | 2.3 |
| **silt** | 2.0 |
| **woody debris** | 1.6 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.5 |
| **emergent** | 0.1 |
| **floating** | 0.0 |
| **total weed cover** | 1.5 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.9 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.5 |
| **snags** | 0.1 |
| **brush or woody debris** | 1.4 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.9 |
| **rock ledges or sharp dropoffs** | 0.1 |
| **boulders** | 0.0 |
| **human structures** | 1.7 |

---

# Zooplankton Report

PHIMA1

Date 6/2/1998 Station: 1 Sample ID 16

Unknowns in Daphnia may not be Daphnia

Number of organisms measured: 154

| Group | Percent |
|---|---|
| Cladoceran | 55.2% |
| Copepod | 44.8% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 81.8% |
| Large >= 1mm | 18.2% |
| Ratio of large to Small: | 0.22 |
| Average size (mm): | 0.54 |

Date 8/17/1998 Station: 1 Sample ID 42

Site number one. Full of algae (? Or maybe some kind of tiny seed), made ID difficult. Also, many Cladoceran sheaths without bodes (weren't counted unless they were recognizable).

Number of organisms measured: 115

| Group | Percent |
|---|---|
| Cladoceran | 18.3% |
| Copepod | 81.7% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 96.5% |
| Large >= 1mm | 3.5% |
| Ratio of large to Small: | 0.04 |
| Average size (mm): | 0.32 |

## Aquatic Plant Data

PHILLIPS

Sampler: Parsons, O'Neal

Survey Date: 7/20/1998

Max depth of growth (M): >6

Comments Sunny, light breeze. Shoreline is developed, many bulkheads but also many trees left standing, and many down and submersed. Aquatic plant community sparse and low growing. Much epiphytic algae on substrate and plants in NE end. Observed rough-skinned newts, bullfrog, many small fish. Conducted habitat survey for Kirk Smith.

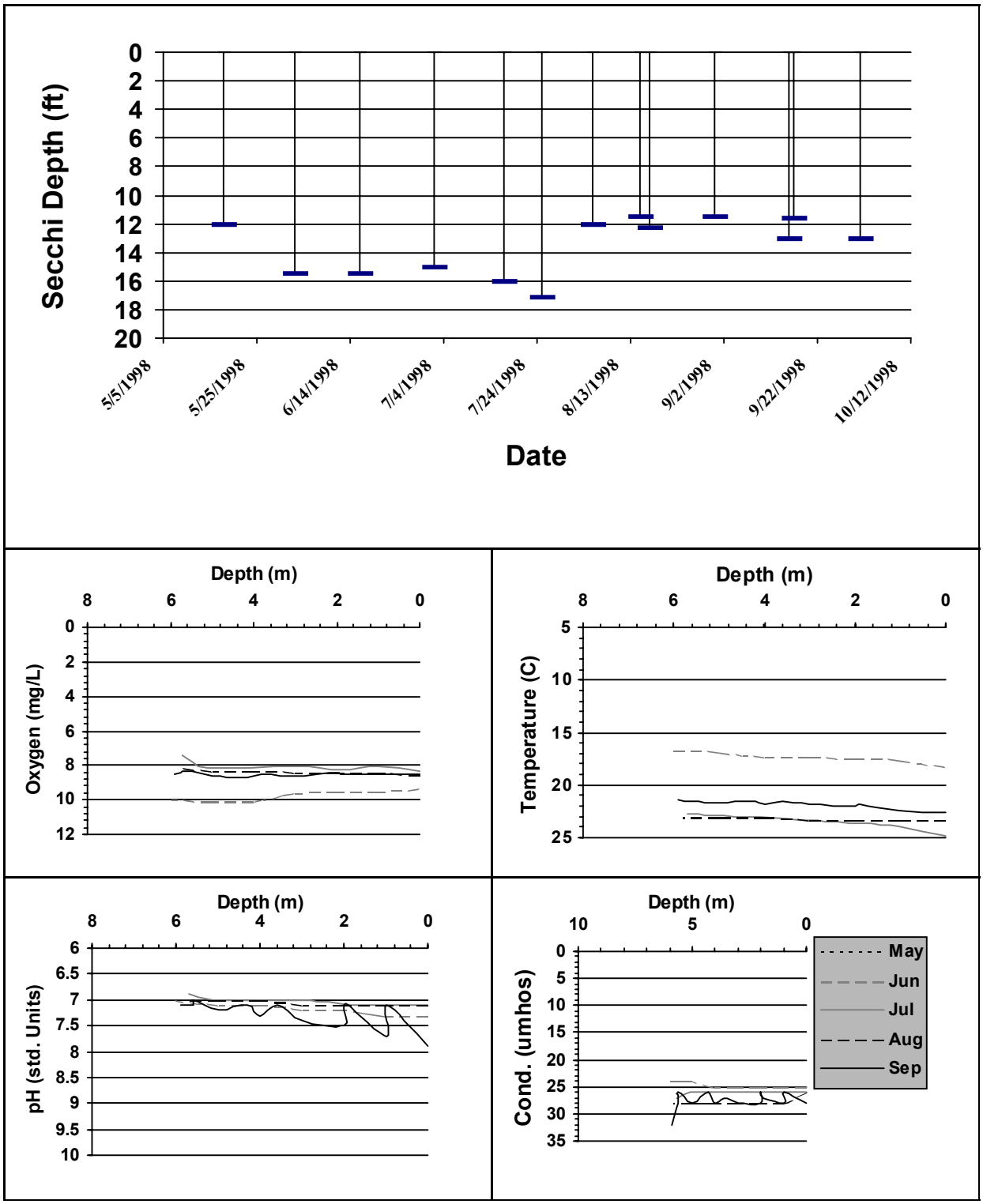
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Dulichium arundinaceum* | Dulichium | 1 | |
| *Elodea canadensis* | common elodea | 2 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Isoetes sp.* | quillwort | 3 | in shallow to deeper water |
| *Juncus sp. or Eleocharis sp.* | small grass-like plants | | |
| *Juncus sp.* | rush | 2 | emergent, few patches |
| *Najas flexilis* | common naiad | 1 | |
| *Nitella sp.* | stonewort | 2 | |
| *Potamogeton pusillus* | slender pondweed | 2 | |
| *Utricularia sp.* | bladderwort | 2 | in deep water, no flowers |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 PHIMA1



# Secchi Data and Field Observations

PHILLIPS

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 5/18/1998 | | 15 | 12 | 2 | 50 | 2 | 2 | 3 | 3 | 2 | 6 | 2 | 0 |
| | Sampler: | KEELEY | | Remarks: | STARTED TO RAIN. | | | | | | | | |
| 6/2/1998 | | 17.7778 | 14.5 | 2 | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |
| 6/2/1998 | | 17.8 | 15.5 | 2 | 0 | 2 | 1 | 4 | 3 | | | 1 | 0 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |
| 6/16/1998 | | 17.8 | 15.5 | 2 | 50 | 2 | 1 | 3 | 3 | 0 | 5 | 2 | 0 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |
| 7/2/1998 | | 19.4 | 15 | 2 | 50 | | 2 | 4 | 4 | 7 | 6 | 1 | 1 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |
| 7/17/1998 | | 22.2 | 16 | 2 | 0 | 2 | 3 | 4 | 4 | 0 | 2 | 0 | 0 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |
| 7/25/1998 | | | 17.16 | 2 | 0 | | | 4 | 4 | 0 | 0 | 0 | 8 |
| | Sampler: | SMITH | | Remarks: | LOTS OF BOATS. MANY SWIMMERS AT LAUNCH. | | | | | | | | |
| 8/5/1998 | | 23.9 | 12 | 2 | 0 | 3 | 1 | | 3 | 3 | 2 | 0 | 0 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |
| 8/15/1998 | | 23.3 | 11.5 | 6 | 50 | 2 | 3 | 2 | 2 | 4 | 0 | 2 | 1 |
| | Sampler: | KEELEY | | Remarks: | ALGAE BLOOM CONTINUES TO GET WORSE - WATER LOW. | | | | | | | | |
| 8/17/1998 | | | 12.21 | 2 | 90 | | | 4 | 4 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | CONSIDERABLE ALGAL BLOOM | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/31/1998 | | 23.3 | 11.5 | 6 | 0 | 2 | 1 | 2 | 3 | 8 | 2 | 0 | 1 |
| | Sampler: | KEELEY | | Remarks: | ALGAE BLOOM. | | | | | | | | |
| 9/16/1998 | | 22.2 | 13 | 6 | 0 | 1 | 1 | 4 | 3 | | 5 | 0 | 1 |
| | Sampler: | KEELEY | | Remarks: | NO ALGAE BLOOM. | | | | | | | | |
| 9/17/1998 | | | 11.55 | | 50 | 1 | | 5 | 5 | 0 | 2 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FEC#1 TAKEN AT INLET ON 2ND BASIN. FEC #2 AT BOAT LAUNCH. The Conductivity result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 10/1/1998 | | 17.8 | 13 | 2 | 75 | 2 | 1 | 3 | 4 | 0 | 5 | 0 | 0 |
| | Sampler: | KEELEY | | Remarks: | | | | | | | | | |

# POTHOLES

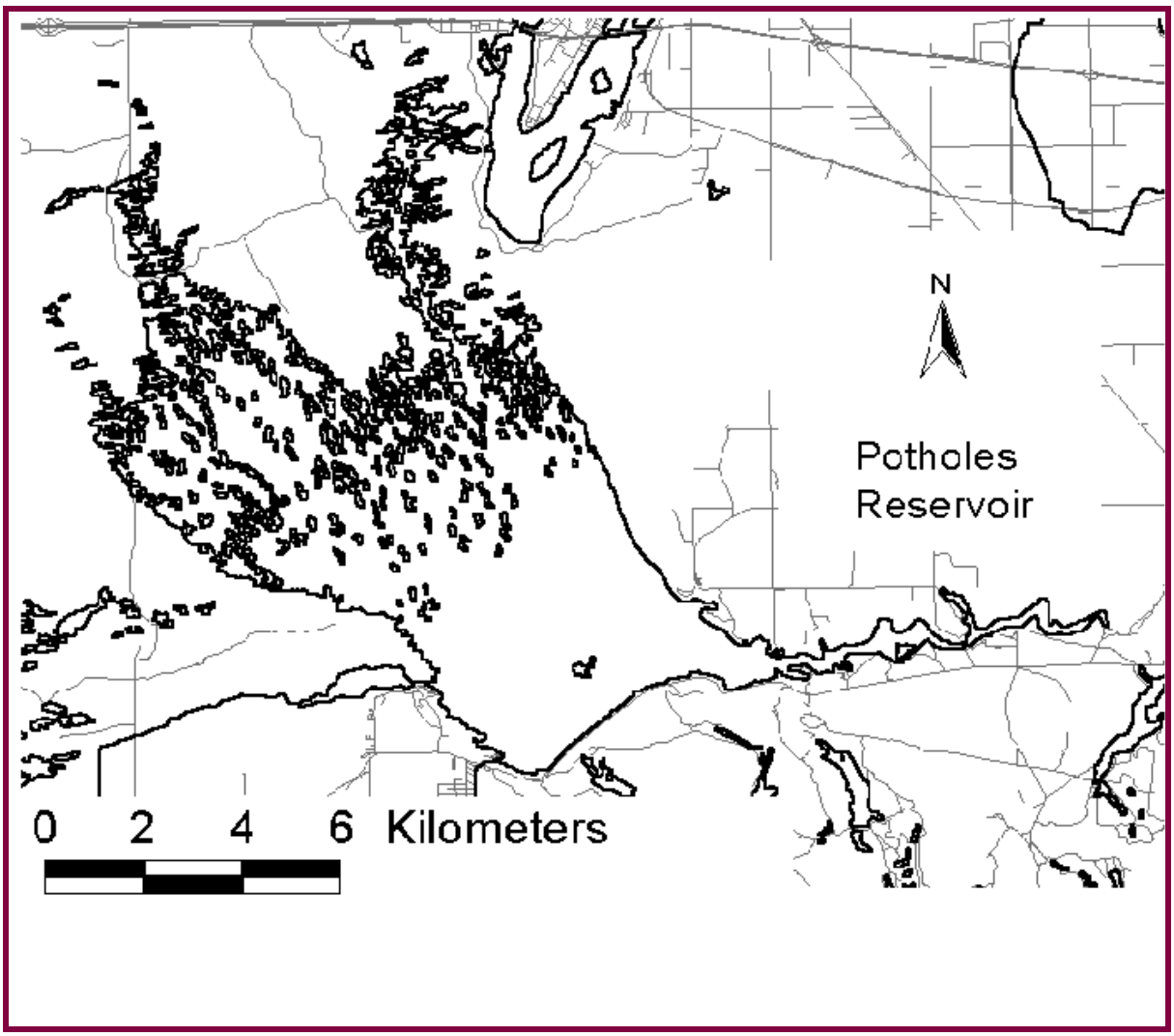
GRANT County

*Lake ID:* POTGR1

*Ecoregion:* 7

Potholes Reservoir is approximately 5 miles south of the City of Moses Lake and provides a large recreational opportunity for water enthusiasts. It receives water from Moses Lake and irrigation canals and provides water to the Columbia National Wildlife Refuge and the Seep Lakes Wildlife Area as well as many irrigation canals.

| Area (acres) | Maximum Depth (ft) | Mean Depth (ft) | Drainage (sq mi) | |
|---|---|---|---|---|
| 28000 | 142 | 18 | | |
| **Volume (ac-ft)** | **Shoreline (miles)** | **Altitude (ft abv msl)** | **Latitude** | **Longitude** |
| 500000 | | 1046 | 46 58 58. | 119 15 49. |



## Station Information

POTGR1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 46 59 40.0 | longitude: 119 19 53.0 |
| | Description: | Approx due east out from State Park launch, half-way to island. | |
| Secondary Station | Station # 2 | latitude: 46 59 30.0 | longitude: 119 20 30.0 |
| | Description: | From primary station, go parallel to shore about half-way to north-end islands. | |

## Trophic State Assessment for 1998

POTHOLES

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 56 | N |
| TSI_Phos: | 55 | |
| TSI_Chl: | 60 | |
| Narrative TSI:[a] | E | |

Potholes Reservoir is an interesting reservoir in that it receives nutrient rich water from Moses Lake and agricultural irrigation runoff and/or surplus. Consequently, Potholes Reservoir is a collecting point for water, nutrients and contaminants before entering the Potholes Canal system. The lake is a major wintering area for waterfowl. Water samples revealed an algae community rich in blue-greens. Oscillatoria, Aphanizomenon, Anabaena and Microcystis were all abundant. Oscillatoria appeared to be the dominant blue-green. Anoxia in the summertime hypolimnion resulted in phosphorus release from the sediments. The zooplankton appear to be sufficient to support a warmwater fishery, however, the anoxic hypolimnion and warm epilimnion may stress coldwater and coolwater fish species such as trout and walleye. This was especially evident in August and less so in July and September.

Few user surveys were returned for Potholes even though scores of them were distributed. Based on communications with a park ranger, a consultant from Dames and Moore, and personal observations, we believe the lake is a significant recreational resource for boaters, jet skiers, water skiers, some swimmers, especially at the State Park beach, and fishermen. Many fishermen still visit the lake even though the fishery has declined substantially in the last few years. Anecdotal information from a state fishery biologist suggest the fishery in the lake has collapsed. The water quality information collected in 1998 does not suggest water quality as the reason for the decline in that beneficial use. Although coldwater fish species may be stressed by the low dissolved oxygen and high water temperature condition of mid-summer, this condition has most likely remained unchanged historically and probably is similar to conditions when the fishery was thriving. Zooplankton populations appeared healthy with quitelarge average length, especially in August. The habitat survey does suggest there is very little structure, cover or vegetation for fish which inhabit the littoral zone. Aquatic plants were quite patchy and sparse, presumably due in part to the large water level fluctuations in the reservoir. The lack of structure combined with human and non-human fishing

pressure could be contributing to the declining fishery--though this is conjecture.

Water level fluctuation are likely also responsible for the high turbidity as waves from wind and boaters erode freshly exposed sediments along the shoreline. Even though the water clarity is not ideal for primary contact recreation (high chlorophyll and turbidity), it is better than conditions in nearby Moses Lake and most likely as good as could reasonably be expected.

Our primary purpose for monitoring Potholes was to support WDFW fisheries work. The system is large and complicated and our simple sampling design is inadequate to precisely identify a protective nutrient criterion for the lake. However, pending a more detailed analysis, we recommend a phosphorus criterion for Potholes Reservoir be set at current levels with an adjustment to for inter-annual variability (36 + 8.0 = 44 ug/L total phosphorus).

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

POTHOLES

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | |
| 6/18/1998 | | E | 41.7 | 1.19 | 29 | 13 | | 156 | | 2.3 J |
| | | H | 115 J | 1.58 | 14 | | | | | |
| 7/16/1998 | | E | 30.2 | .841 | 28 | 20.3 | | | | 5.5 J |
| | | H | 126 | 1.48 | 12 | | | | | |
| 8/13/1998 | | E | 27.8 | .879 | 32 | 17.1 | | | | 6.5 |
| | | H | 120 | 1.96 | 16 | | | | | |
| 9/16/1998 | | E | 42.2 | 1.06 | 25 | 45.9 | | | | |
| | | H | 188 | 2.16 | 11 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

POTHOLES

**Survey Date:** 9/16/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [1] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [2] **Residential**
- [ ] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

**Odors** ☐

**Cattle** ☐ **Ducks** ☑ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☐

Shoreline is natural but largely soft sediments which, w/large water level fluctuations and high winds, is susceptible to erosion.

**Irrigation** ☐

**Survey Id:** 50

---

# Habitat Survey Summary Report

POTHOLES

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/16/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 0.3 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 1.5 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 0.1 |
| | **trees< 0.3 m DBH** | 0.0 |
| **Understory:** | **woody shrubs saplings** | 1.5 |
| | **tall herbs, forbs grasses** | 0.2 |
| **Ground Cover:** | **woody shrubs seedlings** | 0.7 |
| | **herbs, forbs, grasses** | 0.6 |
| | **standing water or inundated veg** | 0.5 |
| | **barren or buildings** | 2.1 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.4 |
| | **cobble/gravel** | 1.5 |
| | **loose sand** | 2.6 |
| | **other fine soil/sediment** | 0.9 |
| | **vegetated** | 0.7 |
| | **other** | 0.0 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.2 |
| | **vertical dist (M from wtrln to high wt):** | 2.1 |

| | |
|---|---|
| **horiz. dist. (M from wtrln to high wt):** | 22.1 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 0.2 |
| **commercial** | 0.0 |
| **park facilities** | 0.3 |
| **docks/boats** | 0.2 |
| **walls, dikes, or revetments** | 0.3 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.5 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.1 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.8 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.5 |
| **cobble** | 1.2 |
| **gravel** | 1.5 |
| **sand** | 2.8 |
| **silt** | 0.2 |
| **woody debris** | 0.3 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 0.8 |
| **emergent** | 0.0 |
| **floating** | 0.0 |
| **total weed cover** | 0.8 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | 0.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 0.6 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.5 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.1 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.4 |
| **human structures** | 0.0 |

## Questionnaire

POTHOLES

**Results compiled from** 3 **Surveys.** **Average time (years) respondents spent on lake:** 9.00

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.3 | View: | 0.3 | Distance to Lake: | 0.0 |
| Public Access: | 0.0 | Swim Beach: | 0.3 | Canada Geese: | 0.7 |
| Water Clarity: | -0.3 | Water Qual. for Swim: | 0.0 | | |
| Fishing Quality: | 0.3 | Aquatic Plants: | 0.0 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **1.3**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.7 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.0 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.3 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 1.5 | Good Warmwtr Fishing: | 4.0 | Natural Scenery: | 4.0 |
| Plant Growth: | 3.0 | Good Swimming: | 4.0 | Public Beach: | 3.0 |
| Natural Shoreline: | 3.0 | Less Algae: | 4.0 | Canada Geese: | 4.0 |
| No Odors: | 3.0 | Public Access: | 3.5 | | |
| Good Coldwtr Fishing: | 4.5 | Clear Water: | 4.0 | | |

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Water Clarity: Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 32 | 9/15/1998 | Resident | Permanent | Own | 4 | ☐ | No | |
| | We like the lake/sand dunes and usually boat and sun but mostly on weekdays. We also do some fishing. The desert lake and surroundings are beautiful. The water is cloudy when it gets warmer. | | | | | | | |
| 50 | 8/20/1998 | Visitor | | | 2 | ☐ | Unknown | |
| 64 | 8/12/1998 | Visitor | | | 2 | ☐ | Unknown | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

POTGR1

Date 6/18/1998 Station: 1 Sample ID 3

Lots of blue-greens (Microcystis, Anabaena, Aphanizomenon)

Number of organisms measured: 139

| Group | Percent |
|---|---|
| Cladoceran | 20.1% |
| Copepod | 79.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 73.4% |
| Large >= 1mm | 26.6% |
| Ratio of large to Small: | 0.36 |
| Average size (mm): | 0.61 |

Date 8/13/1998 Station: 1 Sample ID 1

Number of organisms measured: 90

| Group | Percent |
|---|---|
| Cladoceran | 51.1% |
| Copepod | 48.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 46.7% |
| Large >= 1mm | 53.3% |
| Ratio of large to Small: | 1.14 |
| Average size (mm): | 1.09 |

## Aquatic Plant Data

POTHOLES

Sampler: Parsons, O'Neal

Survey Date: 7/16/1998

Max depth of growth (M): 1.2

Comments Sunny, light breeze. Did habitat survey for Kirk Smith. Did not spend time in islands area. Most of shoreline with willows except along dam and east shore - which have barren rock and sand. Submersed plants patchy in protected areas mostly. No milfoil seen.

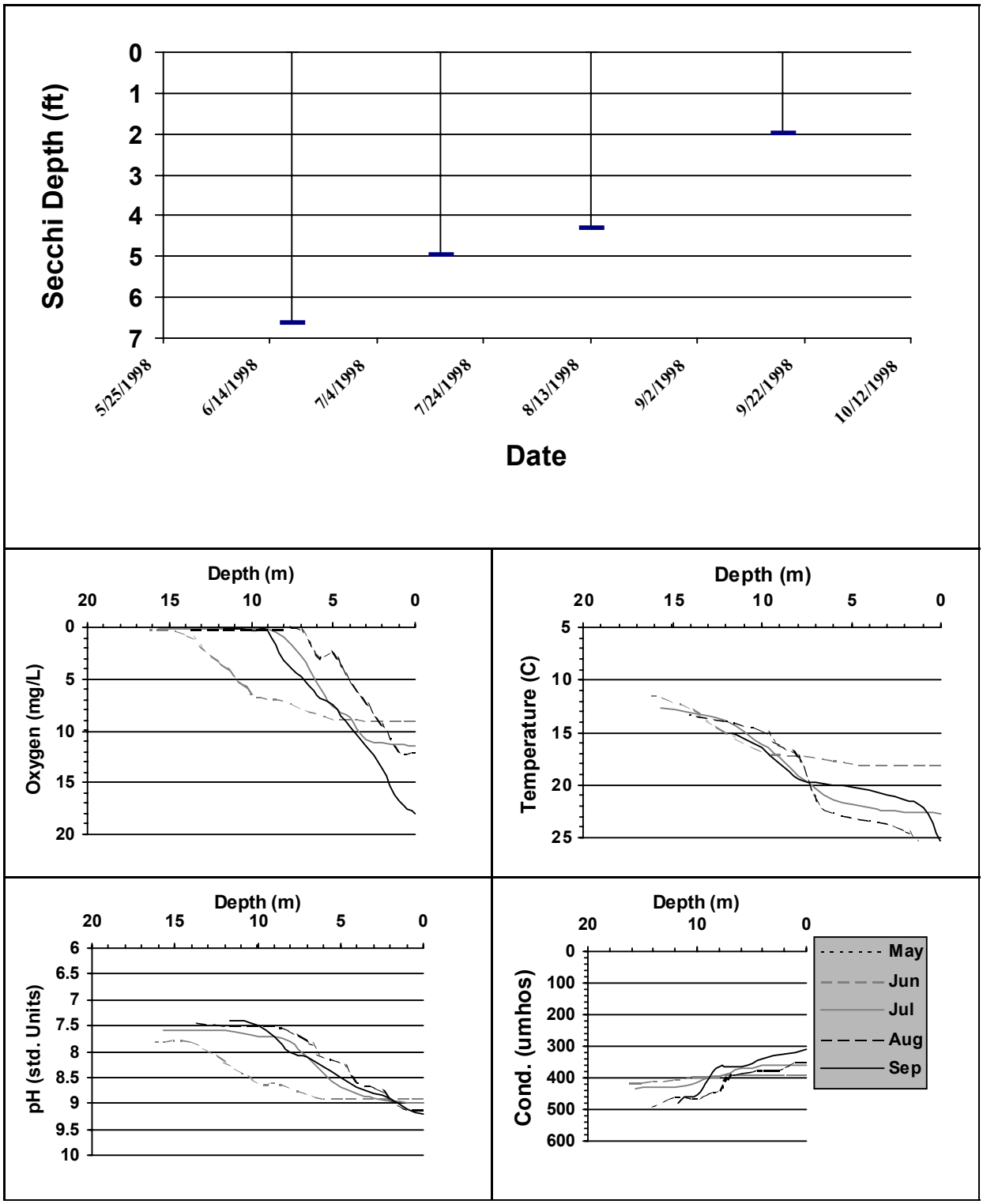
SPECIES LIST

| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Juncus sp.* | rush | 1 | |
| *Lemna sp.* | duckweed | 1 | few, near shore |
| *Polygonum sp.* | smartweed | 2 | pink flowers, on shore |
| *Potamogeton crispus* | curly leaf pondweed | 2 | the most common submersed plant |
| *Potamogeton pectinatus* | sago pondweed | 1 | in northern islands area |
| *Salix sp.* | willow | 3 | along shore or in shallow water |
| *Zannichellia palustris* | horned pondweed | 2 | most seen as uprooted floating mats |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 1 POTGR1



# Secchi Data and Field Observations

POTHOLES

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/18/1998 | | | 6.6 | 2 | 0 | 2 | | 3 | 2 | 0 | 0 | 12 | 0 |
| | Sampler: HALLOCK | | | Remarks: | ALGAE FILAGMENTS CLEARLY VISIBLE IN WATER COLUMN. OSCILLATORIA-LIKE PERHAPS SOME APHANIZOMENON. A VERY FEW LARGE DAPHNIA IN ALL CASTS EXCEPT 14M WHICH HAS LOTS. DFW DOING WALLEYE STUDY | | | | | | | | |
| 7/16/1998 | | | 4.95 | 6 | 0 | | | 3 | 2 | 0 | 36 | 7 | 0 |
| | Sampler: SMITH | | | Remarks: | LOTS OF SHORT, FINE FILAMENTOUS ALGAE IN SURFACE CASTS. FAINT H2S AT 11M, STRONG AT 14M. | | | | | | | | |
| 8/13/1998 | | | 4.29 | 6 | 0 | | | 1 | 1 | 0 | 50 | 12 | 0 |
| | Sampler: HALLOCK | | | Remarks: | ALGAE BLOOM LIKE MOSES STATION #2. SOME CLUMPS BUT NOT MANY. H2S @ 8 AND ESP. 13M. WATER LEVEL DOWN APPROX. 4 FEET FROM LAST MONTH. LARGE DEAD WHITEFISH | | | | | | | | |
| 9/18/1998 | | | 1.98 | 6 | 15 | | | 1 | 1 | 0 | 300 | 6 | 2 |
| | Sampler: HALLOCK | | | Remarks: | ALGAE BLOOM SIMILAR TO MOSES LAKE SITE #1 BUT LESS AGGREGATE. NOTE: ALL PREVIOUS SAMPLINGS HAVE BEEN IN AM. SURFACE DO IS OFF SCALE (>16.9 MG/L) . STRONG H2S SMELL AT 10M. TOOK ZEBRA MUSSEL SAMPLE AT PARK ACCESS. | | | | | | | | |

# SPANAWAY

PIERCE County

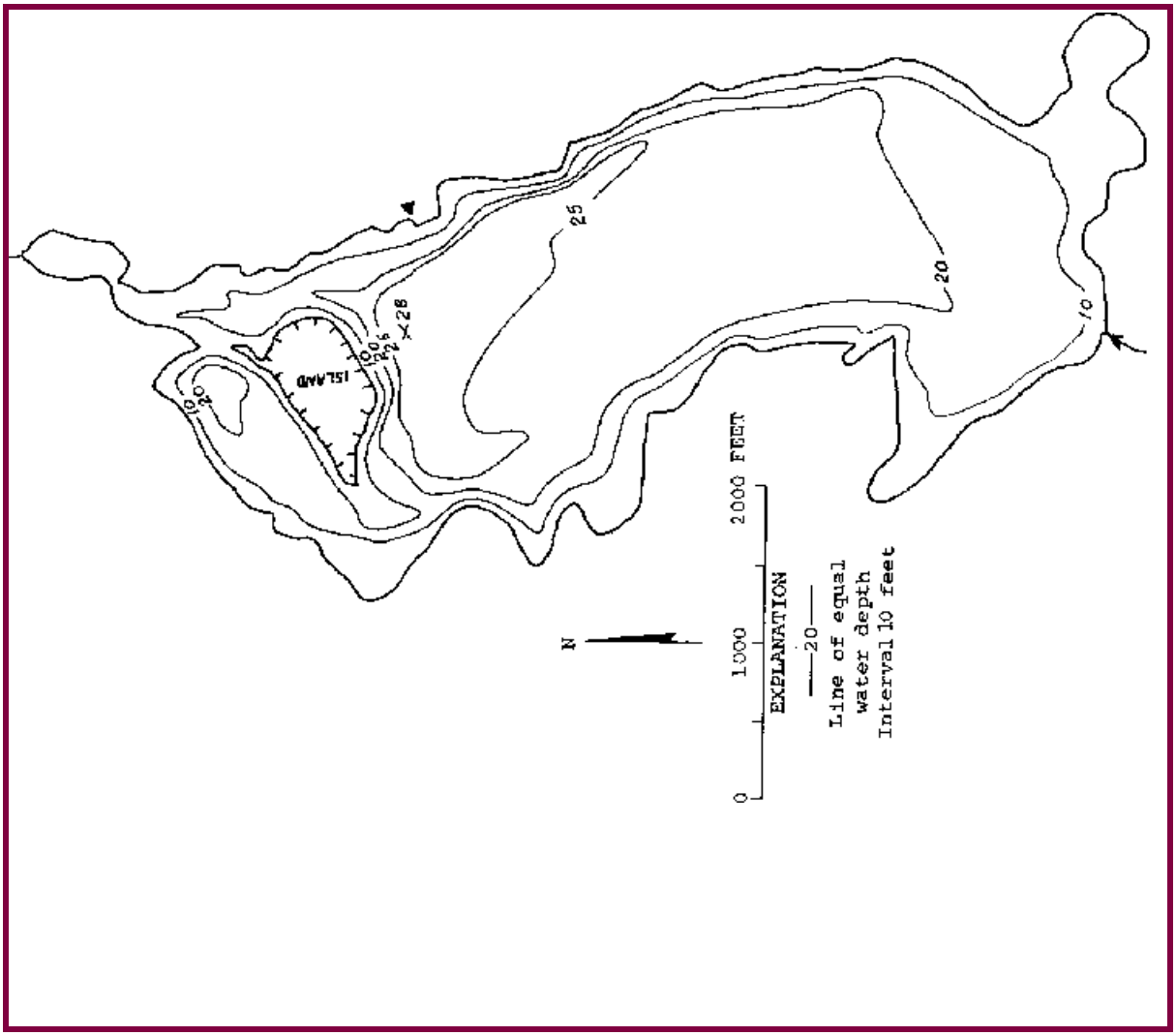
***Lake ID:*** *SPAPI1*

***Ecoregion:*** 2

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

| ***Area (acres)*** | ***Maximum Depth (ft)*** | ***Mean Depth (ft)*** | ***Drainage (sq mi)*** |
|---|---|---|---|
| 280 | 28 | 16 | 17 |

| ***Volume (ac-ft)*** | ***Shoreline (miles)*** | ***Altitude (ft abv msl)*** | ***Latitude*** | ***Longitude*** |
|---|---|---|---|---|
| 4600 | 4.36 | 320 | 47 07 11. | 122 26 45. |



## Station Information

SPAPI1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 47 06 47.0 | longitude: 122 27 01.7 |
| | Description: | In deep part of lake, due west of public boat launch and south of eastern shore of island | |
| Secondary Station | Station # 2 | latitude: 47 06 24.4 | longitude: 122 26 58.7 |
| | Description: | Across from boat launch, approximately 500 feet east of west shore at point directly across from boat launch | |
| Secondary Station | Station # 3 | latitude: | longitude: |
| | Description: | In horizontal middle of lake near south end, directly south of boat launch and directly east of a small cove just north of southern portion of lake; no coordinates recorded | |

## Trophic State Assessment for 1998

SPANAWAY

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 44 |
| TSI_Phos: | 48 |
| TSI_Chl: | 54 |
| Narrative TSI:[a] | ME |

Spanaway Lake is an urban lake bordered by a large city park along its northeast shore. The lake has suffered numerous blue-green algal blooms in recent history and shows a tendency to go anoxic in the hypolimnion during the summer, resulting in periodic internal nutrient release and very high hypolimnetic phosphorus concentrations. Records show that the lake was once dredged, which may have provided for many years of artificially clear water. Spanaway Lake is fed by a stream originating from a wetland. The wetland, park, and golf course are potential sources of nutrients to the lake. Natural shoreline is altered in the park and fertilizer runoff from the golf course may contribute to the eutrophication--although most of the runoff likely enters near the outlet of the lake. The user survey suggests the water clarity is deteriorating through the years with only one respondent out of 11 believing the clarity has improved. Detractors to the use of the lake, according to survey respondents, include the poor water clarity and the abundant Canada geese. All respondents said they'd rather have clearer water than fewer aquatic plants. A significant Aphanizomenon bloom was observed in August.

Although the lake has been productive for largemouth bass fishing in recent history, it's questionable whether the extensive anoxia in the summertime hypolimnion is conducive to a good trout fishery. Having both a good trout and bass fishery is important to the residents who responded to the survey. Water clarity may impair primary contact recreation at times but the overall Secchi TSI suggests more mesotrophic conditions. We assigned an overall assessment of meso-eutrophic. The habitat survey revealed significant human influence (lawns, buildings and docks) on the habitat of the lake. There was also a high population of geese on the lake to take advantage of all the human influences conveniently provided.

We recommend that a nutrient criterion be set at the ecoregion action value for lower mesotrophic Puget Lowland lakes, 20 ug/L.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

SPANAWAY

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 8/19/1998 | | L | | | | | 8 | | | |
| | | L | | | | | 13 | | | |
| 9/23/1998 | | L | | | | | 8 | | | |
| | | L | | | | | 12 | | | |
| **Station 1** | | | | | | | | | | |
| 6/12/1998 | | E | 12.8 | .818 | 64 | 11 | | 41.7 | 10800 | 1.6 J |
| | | H | 29.3 | 1.11 | 38 | | | | | |
| 7/30/1998 | | E | 15.8 | .476 | 30 | 6.8 | | | | 1.5 J |
| | | H | 340 | 2.31 | 7 | | | | | |
| 8/19/1998 | | E | 16.6 | .4 | 24 | 15.5 | | | | 1.5 |
| | | H | 15.3 | 1.63 | 107 | | | | | |
| 9/23/1998 | | E | 21.3 | .356 | 17 | 11.2 | | | | 1.5 |
| | | H | 318 | 2.39 | 8 | | | | | |
| **Station 3** | | | | | | | | | | |
| 6/12/1998 | | E | 12.7 | | | 8.8 | | | | |
| 9/23/1998 | | E | 29.2 | .339 | 12 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

SPANAWAY

**Survey Date:** 9/23/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | 1 | **Residential** |
| 4 | **Commercial, Industrial** | 2 | **Park, forest or natural** |
| 3 | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** Partially Curbed

### Observations (check mark denotes presence)

**BMP's** ☐

Natural vegetation lacking along shoreline.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Yes, manicured lawns and a public golf course.

**Buffer zones around streams and wetlands** ☑

**Irrigation** ☐

**Survey Id:** 30

---

# Habitat Survey Summary Report

SPANAWAY

**Data are averages of** ***10*** **Stations Surveyed** **Date of Visit:** 8/19/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.6 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.7 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.5 |
| | **trees< 0.3 m DBH** | 0.6 |
| **Understory:** | **woody shrubs saplings** | 2.2 |
| | **tall herbs, forbs grasses** | 1.5 |
| **Ground Cover:** | **woody shrubs seedlings** | 2.1 |
| | **herbs, forbs, grasses** | 2.7 |
| | **standing water or inundated veg** | 0.9 |
| | **barren or buildings** | 1.3 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.1 |
| | **cobble/gravel** | 1.8 |
| | **loose sand** | 0.7 |
| | **other fine soil/sediment** | 0.6 |
| | **vegetated** | 2.5 |
| | **other** | 0.8 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.5 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |

| | |
|---|---|
| **horiz. dist. (M from wtrln to high wt):** | 0.5 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.0 |
| **commercial** | 0.0 |
| **park facilities** | 0.4 |
| **docks/boats** | 1.2 |
| **walls, dikes, or revetments** | 0.9 |
| **litter, trash dump, or landfill** | 0.2 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.4 |
| **other** | 0.2 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.8 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.1 |
| **cobble** | 1.6 |
| **gravel** | 1.9 |
| **sand** | 1.2 |
| **silt** | 1.2 |
| **woody debris** | 0.3 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 0.5 |
| **emergent** | 1.2 |
| **floating** | 0.3 |
| **total weed cover** | 1.1 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.3 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 0.8 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.9 |
| **inundated live trees** | 0.1 |
| **overhanging vegetation** | 2.0 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 1.2 |

## Questionnaire

SPANAWAY

**Results compiled from** 11 **Surveys.** **Average time (years) respondents spent on lake:** 10.20

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.5 | View: | 0.7 | Distance to Lake: | 0.5 |
| Public Access: | -0.3 | Swim Beach: | -0.5 | Canada Geese: | -0.9 |
| Water Clarity: | -0.7 | Water Qual. for Swim: | -0.6 | | |
| Fishing Quality: | 0.0 | Aquatic Plants: | -0.3 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **2.0**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.6 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.5 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.0 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 3.6 | Good Warmwtr Fishing: | 4.4 | Natural Scenery: | 4.4 |
| Plant Growth: | 2.3 | Good Swimming: | 4.1 | Public Beach: | 2.2 |
| Natural Shoreline: | 3.5 | Less Algae: | 4.2 | Canada Geese: | 1.6 |
| No Odors: | 4.3 | Public Access: | 2.5 | | |
| Good Coldwtr Fishing: | 4.4 | Clear Water: | 4.1 | | |

**Tabulated Results**

| Survey ID | Date | ----------Residency---------- | | Rent or Own | Primary Activity* | ----------Water Clarity---------- Purchase Factor? | Has it Changed? | When? |
|---|---|---|---|---|---|---|---|---|
| 53 | 7/22/1998 | Resident | Permanent | Rent | 10 | ☑ | Worse | 1991 |
| 54 | 7/25/1998 | Resident | Permanent | Rent | 8 | ☑ | Worse | 1989-1990 |
| 55 | 8/10/1998 | Resident | Permanent | Rent | 10 | ☐ | Worse | 1994 |
| 56 | 8/16/1998 | Resident | Permanent | Rent | 8 | ☑ | Worse | 1996 |
| 57 | 8/25/1998 | Resident | Permanent | Rent | 3 | ☑ | Worse | 1997 |
| 58 | 7/29/1998 | Resident | Permanent | Rent | 1 | ☑ | Worse | |
| 69 | 8/24/1998 | Resident | Permanent | Rent | 7 | ☐ | No | |
| 73 | 8/31/1998 | Resident | Permanent | Rent | several of the above | ☐ | No | |
| 75 | 12/31/1998 | Resident | | Rent | | ☐ | Unknown | |
| 76 | 8/29/1998 | Visitor | | | 2 | ☐ | Better | 1993 |
| 83 | 8/19/1998 | Visitor | | | 10 | ☐ | Unknown | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

SPAPI1

Date 6/12/1998 Station: 1 Too few to count

Sample ID 14

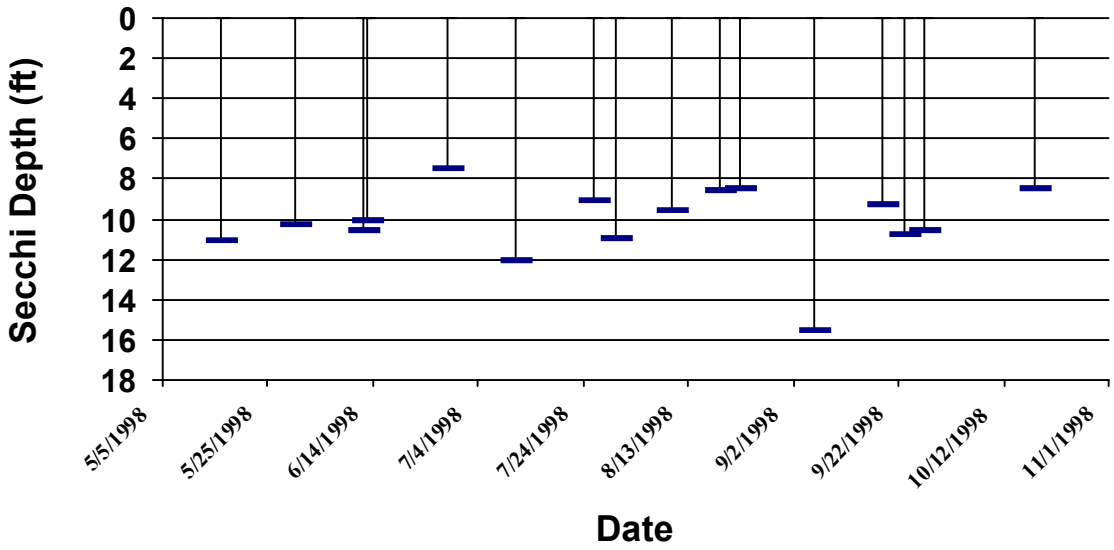
Number of organisms measured: 14

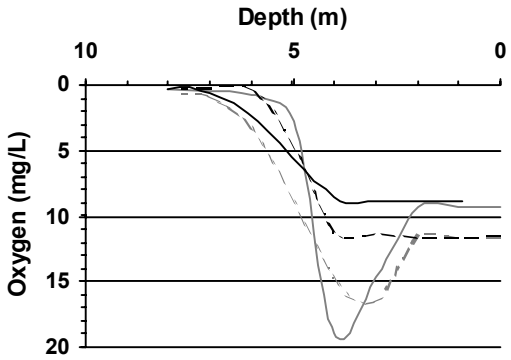
| Group | Percent |
|---|---|
| Cladoceran | 21.4% |
| Copepod | 78.6% |
| Other | |

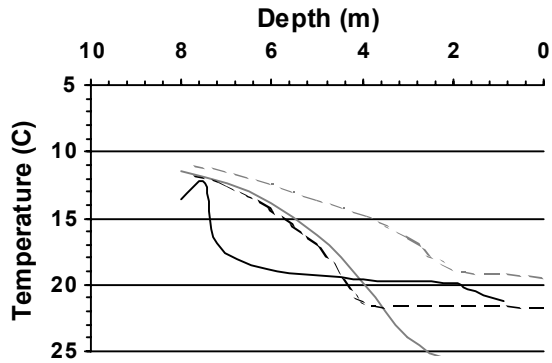
| Group | Percent |
|---|---|
| Small < 1mm | 85.7% |
| Large >= 1mm | 14.3% |
| Ratio of large to Small: | 0.17 |
| Average size (mm): | 0.51 |

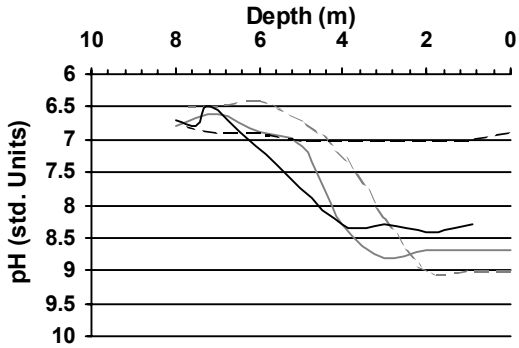
# Secchi Depth and Profile Graphics

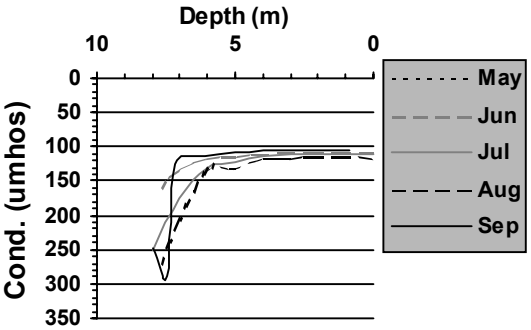
**Station:** 1 SPAPI1



# Secchi Data and Field Observations

SPANAWAY

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 5/16/1998 | | 13.3 | 11 | 6 | 100 | 4 | 4 | 4 | 4 | 5 | 6 | 1 | 0 |
| | Sampler: | THOMPSON | | Remarks: | | | | | | | | | |
| 5/30/1998 | | 15.6 | 10.25 | 6 | 100 | 2 | 2 | 3 | 3 | 8 | 6 | 6 | 1 |
| | Sampler: | THOMPSON | | Remarks: | | | | | | | | | |
| 6/12/1998 | | 18.8889 | 10.5 | 6 | 30 | | | 3 | 3 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | H2S ODOR AT 7 METERS. TWO ZOO TOWS AT SITE #3. The Oxygen result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 6/13/1998 | | 18.9 | 10 | 6 | 100 | 2 | 1 | 3 | 3 | 20 | 6 | 5 | 2 |
| | Sampler: | THOMPSON | | Remarks: | | | | | | | | | |
| 6/28/1998 | | 19.4 | 7.5 | 6 | 0 | 3 | 1 | 3 | 3 | 12 | 6 | 0 | 4 |
| | Sampler: | THOMPSON | | Remarks: | ALOT OF ALGAE. | | | | | | | | |
| 7/11/1998 | | 20.6 | 12 | 6 | 75 | 2 | 3 | 3 | 3 | 26 | 2 | 12 | 1 |
| | Sampler: | THOMPSON | | Remarks: | JULY 17TH - WARNING POSTED AT COUNTY PARK ON LAKE - "HIGH LEVELS OF FECAL COLIFORM; SWIM AT OWN RISK". | | | | | | | | |
| 7/26/1998 | | 25.6 | 9 | 6 | 0 | 2 | 1 | 1 | 1 | 28 | 0 | 2 | 23 |
| | Sampler: | THOMPSON | | Remarks: | LAKE STILL CLOSED TO SWIMMERS DUE TO HIGH LEVELS OF FECAL COLIFORM. LAKE HAS BEEN CLOSED SINCE JULY 17, 1998. | | | | | | | | |
| 7/30/1998 | | | 10.89 | 6 | 100 | 2 | | 1 | 1 | 74 | 110 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FECS IN THE WATER, CLOSED FOR SWIMMING. PARK ATTENDENT SAID THERE MAY HAVE BEEN ILLEGAL HERB APPLICATIONS ON ISLAND | | | | | | | | |
| 8/10/1998 | | 24.4 | 9.5 | 6 | 0 | 2 | 1 | 1 | 1 | 25 | 8 | 5 | 5 |
| | Sampler: | THOMPSON | | Remarks: | LAKE STILL OFFICIALLY CLOSED BY TACOMA HEALTH DEPT. DUE TO HIGH LEVELS OF FECAL COLIFORM. LAKE HAS BEEN CLOSED SINCE JULY 17, 1998. | | | | | | | | |
| 8/19/1998 | | | 8.58 | 3 | 0 | | | 3 | 3 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | 2 OSPREY FLYING TOGETHER. EXTREMELY STRONG H2S ODOR FROM 7.5M SAMPLE. ABUNDANT APHANIZOMENON BLOOM, SAMPLE TAKEN. NO BOATS OR WATERFOWL COUNTED. | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/23/1998 | | 21.1 | 8.5 | 6 | 25 | 2 | 1 | 1 | 1 | 44 | 8 | 5 | 1 |
| | Sampler: | THOMPSON | | Remarks: | LAKE STILL CLOSED PER HEALTH DEPT. DUE TO FECAL COLIFORM. | | | | | | | | |
| 9/6/1998 | | 22.2 | 15.5 | 6 | 0 | 1 | 1 | 3 | 3 | 24 | 6 | 3 | 7 |
| | Sampler: | THOMPSON | | Remarks: | HEALTH DEPT. REOPENED SPANAWAY LAKE ON 9/14/98. GREAT CLARITY TODAY BUT MORE WEEDS THAN I'VE SEEN IN TEN YEARS. | | | | | | | | |
| 9/19/1998 | | 20 | 9.25 | 6 | 25 | 1 | 4 | 3 | 3 | 16 | 6 | 3 | 3 |
| | Sampler: | THOMPSON | | Remarks: | LAKE REOPENED 9/4/98. | | | | | | | | |
| 9/23/1998 | | | 10.73 | 3 | 0 | | | 4 | 3 | 30 | 260 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | BALD EAGLE SPOTTED. FEC#1 AT PLATFORM ON SOUTH END; FEC#2 AT PLATFORM AT SWIM BEACH. STRONG H2S IN HYPO. | | | | | | | | |
| 9/27/1998 | | 16.7 | 10.5 | 6 | 100 | 2 | 5 | 3 | 3 | 8 | 8 | 5 | 0 |
| | Sampler: | THOMPSON | | Remarks: | | | | | | | | | |
| 10/18/1998 | | 14.4 | 8.5 | 8 | 50 | 1 | 3 | 1 | 1 | 6 | 400 | 7 | 1 |
| | Sampler: | THOMPSON | | Remarks: | BLUE-GREEN ALGAE MODERATE ALONG SHORE. LAKE WATER HAS TURNED BROWN! HUNDREDS(400+) OF ROOTS ON THE LAKE. | | | | | | | | |

# SUTHERLAND

CLALLAM County

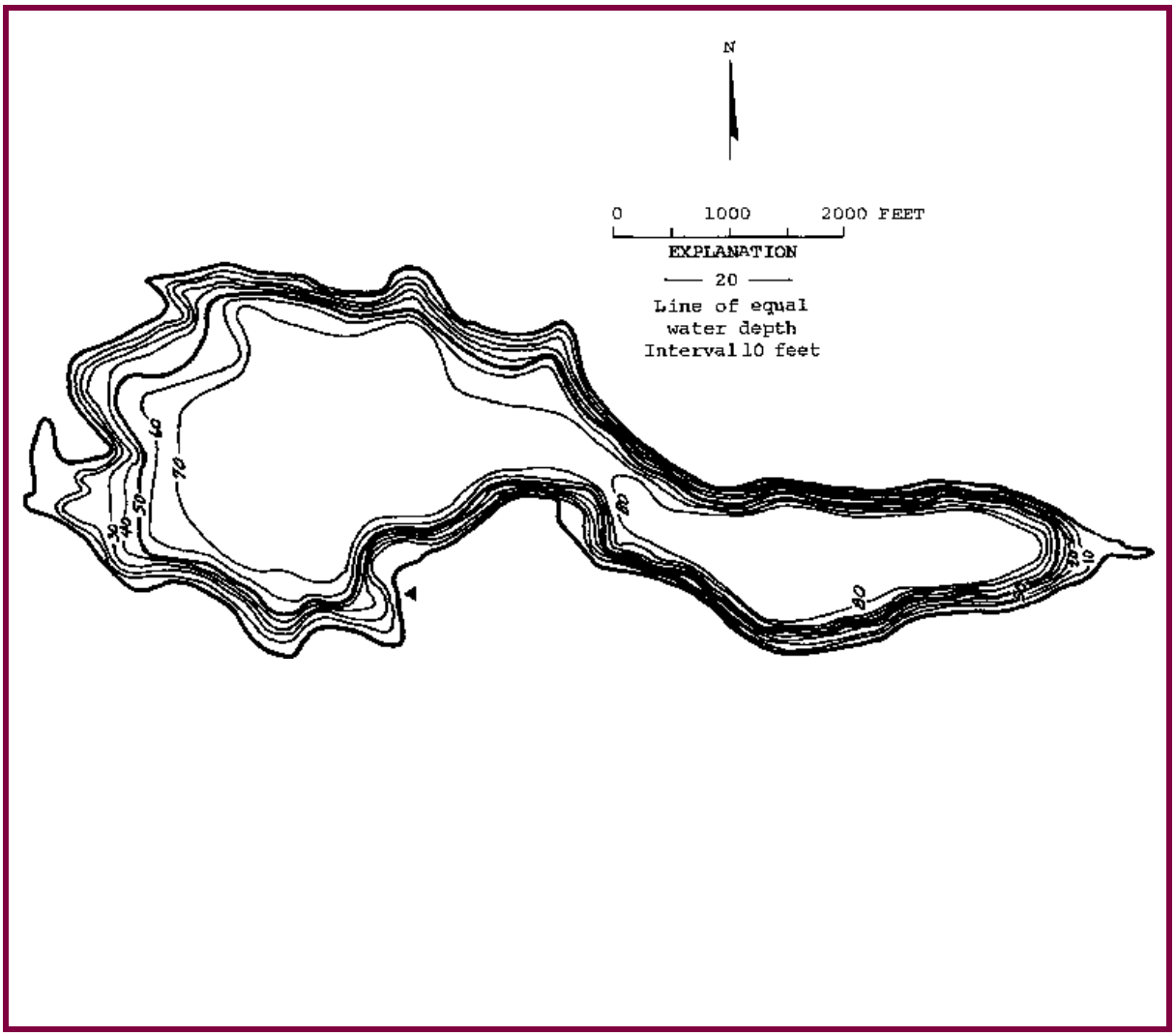
***Lake ID:*** *SUTCL1*

***Ecoregion:*** 1

Lake Sutherland is located just south of and adjacent to highway 101, approximately 3 miles east of Crescent Lake and 10 miles west of Port Angeles. Its outfall empties into Indian Creek which enters the Elwha River.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 369 | 86 | 57 | 8 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 20800 | 4.92 | 501 | 48 04 31. | 123 41 09. |



## Station Information

SUTCL1

| | | | |
|---|---|---|---|
| Primary Station | Station # 1 | latitude: 48 04 32.8 | longitude: 123 42 03.5 |
| | Description: | Deep part of lake approximately midway on a line extending from boat launch to east end of lake | |
| Secondary Station | Station # 2 | latitude: 48 04 37.7 | longitude: 123 42 29.2 |
| | Description: | In approximate middle of western portion of lake, about 1500 feet east of westernmost point of west shore | |

## Trophic State Assessment for 1998

SUTHERLAND

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 27 | N |
| TSI_Phos: | 26 | |
| TSI_Chl: | 26 | |
| Narrative TSI:[a] | O | |

Lake Sutherland is a very clear lake nestled in a valley just east of Crescent Lake. The lake is heavily used by boaters and jet skiers. Most of the homes around the lake are used seasonally only, but there are two recently constructed housing developments along the north shore. The water was particularly clear with Secchi depths so deep in June we could not measure the exact depth of the disk. Clarity, phosphorus, and chlorophyll concentrations were all near ultra-oligotrophic; however, the hypolimnion was anoxic during most of the summer and there was internal phosphorus loading to the hypolimnion. These are ominous signs; anthropogenic nutrient sources should be controlled before there is a response in surface water quality, not after. We do not know the status of the fishery, but zooplankton were fairly large, which generally indicates a good predator-prey ratio. Types of watercraft use appear to be the biggest detractor for survey respondents. There were also several complaints of the smell of gasoline on the water (which we noted also) and swimmers getting coated with a thin oily film after swimming in the lake. This most likely originated from the outboard motors and jet skis on the lake. To survey respondents, no odors in the water, good swimming, and natural scenery were the most desirable characteristics. The watershed survey showed a lack of a buffer zone at the inflow near the boat launch. There was recent clear-cutting in the watershed but no erosion observed. The habitat survey revealed a shoreline lined with cottages and homes. There were many docks on the shoreline as well. The substrate was mostly silt with considerable woody debris.

We recommend that local officials evaluate the use of the lake by various watercraft in order to determine whether or not restrictions are needed in order to protect beneficial uses. Local government should also consider applying for funding to further study the lake and watershed to identify and manage nutrient sources. For now, we recommend a nutrient criterion for total phosphorus of 7.7 ug/L (the average of our measured concentrations, 4.7 ug/L, plus an adjustment for inter-annual variability, 3.0 ug/L).

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

SUTHERLAND

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 8/13/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 2 | | | |
| 9/16/1998 | | L | | | | | 1 U | | | |
| | | L | | | | | 1 | | | |
| **Station 1** | | | | | | | | | | |
| 6/8/1998 | | E | 5.1 | .062 | 12 | .5 U | | 65.9 | 19600 | .5 U |
| | | H | 16 | .137 | 9 | | | | | |
| 7/30/1998 | | E | 3 U | .063 | 21 | .64 | | | | |
| | | H | 70.2 | .165 | 2 | | | | | |
| 8/13/1998 | | E | 4.4 | .049 | 11 | .5 U | | | | .5 U |
| | | H | 66.9 | .163 | 2 | | | | | |
| 9/16/1998 | | E | 6.2 | .052 | 8 | 1.1 | | | | .8 |
| | | H | 5.3 | .157 | 30 | | | | | |
| **Station 2** | | | | | | | | | | |
| 7/30/1998 | | E | 4 | | | | | | | |
| 8/13/1998 | | E | 4.1 | .064 | 16 | | | | | |
| 9/16/1998 | | E | | .042 | | .83 | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

SUTHERLAND

**Survey Date:** 9/16/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [ ] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [3] **Major transportation**
- [1] **Residential**
- [2] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

Shoreline very much developed around the lake. Lots of recent clear-cutting in watershed but no erosion observed.

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☐

Buffer zone absent around inflow near boat launch. Most of shoreline around the lake is developed but watershed is largely undevelped forest land with some clear-cutting in the recent past.

**Irrigation** ☐

**Survey Id:** 90

---

# Habitat Survey Summary Report

SUTHERLAND

**Data are averages of** ***10*** **Stations Surveyed** **Date of Visit:** 9/16/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.9 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 1.9 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.1 |
| | **trees< 0.3 m DBH** | 2.1 |
| **Understory:** | **woody shrubs saplings** | 2.6 |
| | **tall herbs, forbs grasses** | 0.5 |
| **Ground Cover:** | **woody shrubs seedlings** | 2.3 |
| | **herbs, forbs, grasses** | 1.1 |
| | **standing water or inundated veg** | 0.8 |
| | **barren or buildings** | 0.8 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.5 |
| | **cobble/gravel** | 1.0 |
| | **loose sand** | 0.4 |
| | **other fine soil/sediment** | 0.1 |
| | **vegetated** | 2.4 |
| | **other** | 1.2 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 1.2 |
| | **vertical dist (M from wtrln to high wt):** | 0.2 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.6 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.4 |

| | |
|---|---|
| **commercial** | 0.0 |
| **park facilities** | 0.2 |
| **docks/boats** | 1.8 |
| **walls, dikes, or revetments** | 0.8 |
| **litter, trash dump, or landfill** | 0.4 |
| **roads or railroad** | 0.4 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 0.7 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 6.8 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.4 |
| **cobble** | 0.9 |
| **gravel** | 0.9 |
| **sand** | 0.2 |
| **silt** | 2.7 |
| **woody debris** | 2.1 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.3 |
| **emergent** | 0.0 |
| **floating** | 0.1 |
| **total weed cover** | 0.1 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | 0.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 0.8 |
| **snags** | 0.2 |
| **brush or woody debris** | 1.2 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.7 |
| **rock ledges or sharp dropoffs** | 0.3 |
| **boulders** | 0.1 |
| **human structures** | 1.0 |

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# Questionnaire

SUTHERLAND

**Results compiled from** 13 **Surveys.** **Average time (years) respondents spent on lake:** 20.77

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | -0.4 | View: | 0.8 | Distance to Lake: | 0.0 |
| Public Access: | 0.0 | Swim Beach: | 0.3 | Canada Geese: | 0.0 |
| Water Clarity: | 0.0 | Water Qual. for Swim: | -0.1 | | |
| Fishing Quality: | 0.3 | Aquatic Plants: | -0.2 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **3.2**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.8 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.3 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.0 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.3 | Good Warmwtr Fishing: | 2.4 | Natural Scenery: | 4.7 |
| Plant Growth: | 2.4 | Good Swimming: | 4.7 | Public Beach: | 3.2 |
| Natural Shoreline: | 3.2 | Less Algae: | 4.1 | Canada Geese: | 3.1 |
| No Odors: | 4.7 | Public Access: | 2.9 | | |
| Good Coldwtr Fishing: | 4.2 | Clear Water: | 4.8 | | |

**Tabulated Results**

| Survey ID | Date | ----------Residency---------- | | Rent or Own | Primary Activity* | Purchase Factor? | ----------Water Clarity---------- Has it Changed? | When? |
|---|---|---|---|---|---|---|---|---|
| 34 | 9/12/1998 | Resident | Permanent | Rent | 10 | ☑ | No | |
| 36 | 9/9/1998 | Resident | Seasonal | Rent | 6 | ☑ | Worse | 1988 |
| | Water that does not smell like gas and oil and does not leave a film on glasses. | | | | | | | |
| 37 | 9/3/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 1995 |
| | Jet skis are very undesirable | | | | | | | |
| 38 | 9/8/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 95-96 |
| | Jet skis are very undesirable | | | | | | | |
| 39 | 9/8/1998 | Resident | Seasonal | Rent | 3 | ☐ | Unknown | |
| 40 | 9/4/1998 | Resident | Permanent | Rent | 2 | ☑ | No | |
| | Very desirable to have quiet boats and quiet people | | | | | | | |
| 41 | 9/5/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 1993 |
| | We must limit jet skis. They are a danger to swimmers and small boaters. I notice burning eyes after swimming. They are also operated in a very aggressive manner, bothering ducks and noise. | | | | | | | |
| 44 | 9/8/1998 | Resident | Permanent | Rent | several of the above | ☐ | Better | 1998 |
| | Do not want personal watercraft banned but do want usage regulated as to not create an unsafe condition in regards to all other uses. | | | | | | | |
| 45 | 9/8/1998 | Resident | Seasonal | Rent | working on property | ☑ | Unknown | |
| | too many jetskis | | | | | | | |
| 46 | 8/26/1998 | Resident | Permanent | Rent | 10 | ☑ | Worse | 1988 |
| 48 | 9/9/1998 | Resident | Seasonal | Rent | 6 | ☑ | Worse | 1988 |
| | The lake smells of gas and oil from all the jet ski type personal watercraft on the lake. The noise is also not conducive to the natural scenery. | | | | | | | |
| 49 | 9/3/1998 | Resident | Permanent | Rent | 6 | ☐ | No | |
| 52 | 9/16/1998 | Visitor | | | 4 | ☐ | Unknown | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

SUTCL1

Date 6/8/1998 Station: 1
Sample ID 24

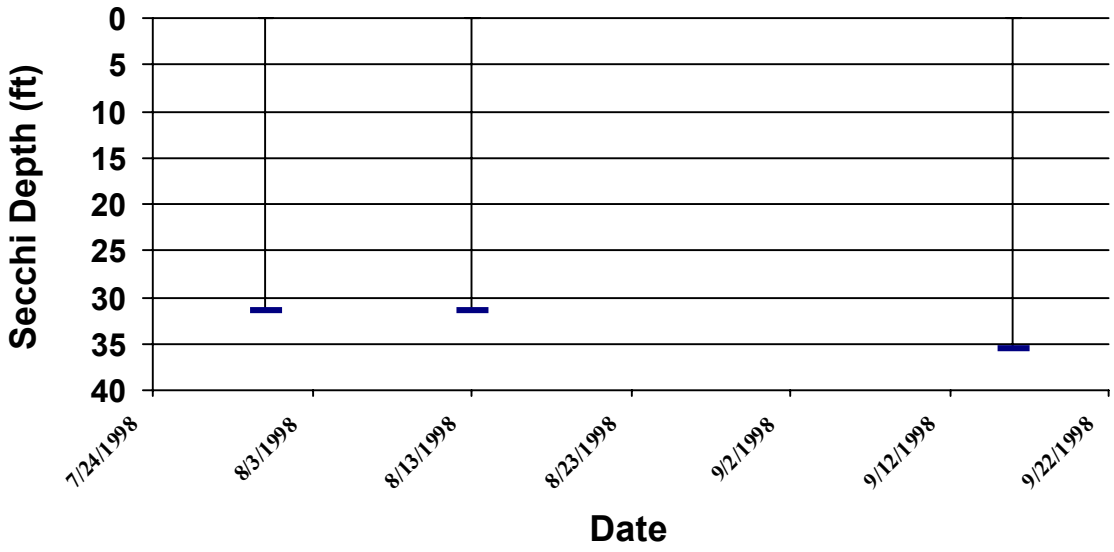
Number of organisms measured: 38

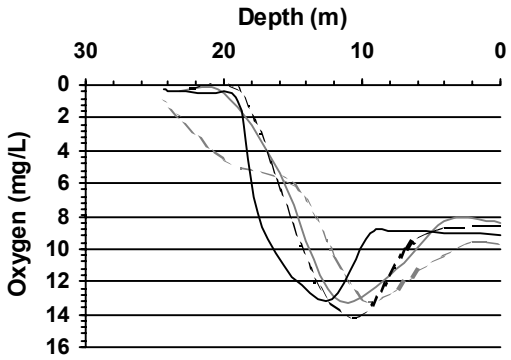
| Group | Percent |
|---|---|
| Cladoceran | 55.3% |
| Copepod | 44.7% |
| Other | |

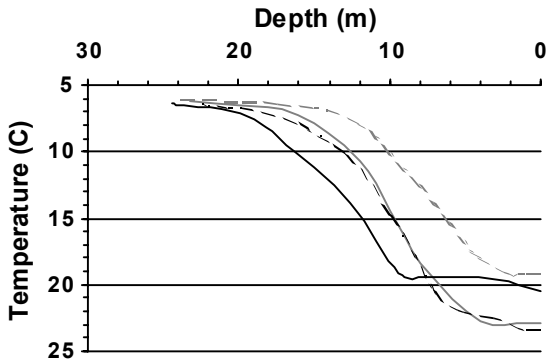
| Group | Percent |
|---|---|
| Small < 1mm | 65.8% |
| Large >= 1mm | 34.2% |
| Ratio of large to Small: | 0.52 |
| Average size (mm): | 0.85 |

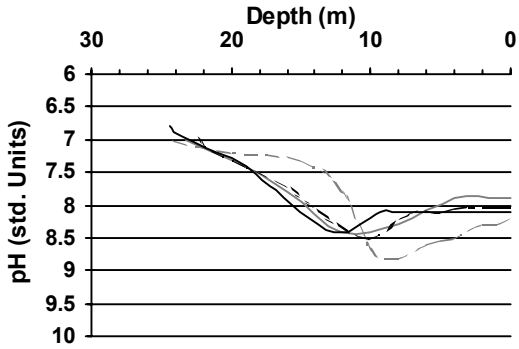
# Secchi Depth and Profile Graphics

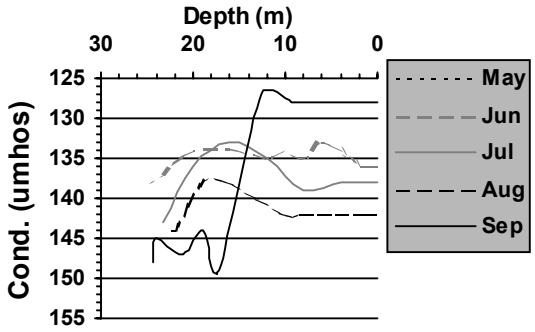
**Station:** 1 SUTCL1



# Secchi Data and Field Observations

SUTHERLAND

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/8/1998 | | | | 1 | 0 | 2 | | 5 | 5 | 0 | 0 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | SEVERAL HOME OWNERS ASSOCIATIONS ON THE LAKE. | | | | | | | | |
| 7/31/1998 | | | 31.35 | | 100 | 1 | | 5 | 5 | 0 | 1 | 0 | 3 |
| | Sampler: | SMITH | | Remarks: | STRONG H2S ODOR FROM 22 METER SAMPLE | | | | | | | | |
| 8/13/1998 | | | 31.35 | 1 | 0 | 1 | | 5 | 5 | 0 | 2 | 1 | 2 |
| | Sampler: | SMITH | | Remarks: | SPOKE WITH DEPUTY. STRONG H2S ODOR IN HYPO | | | | | | | | |
| 9/16/1998 | | | 35.5 | 1 | 0 | | | 4 | 5 | 0 | 183 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | H2S ODOR AT 22 METERS. The Conductivity and Oxygen results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |

# WILLIAM SYMINGTON

KITSAP County

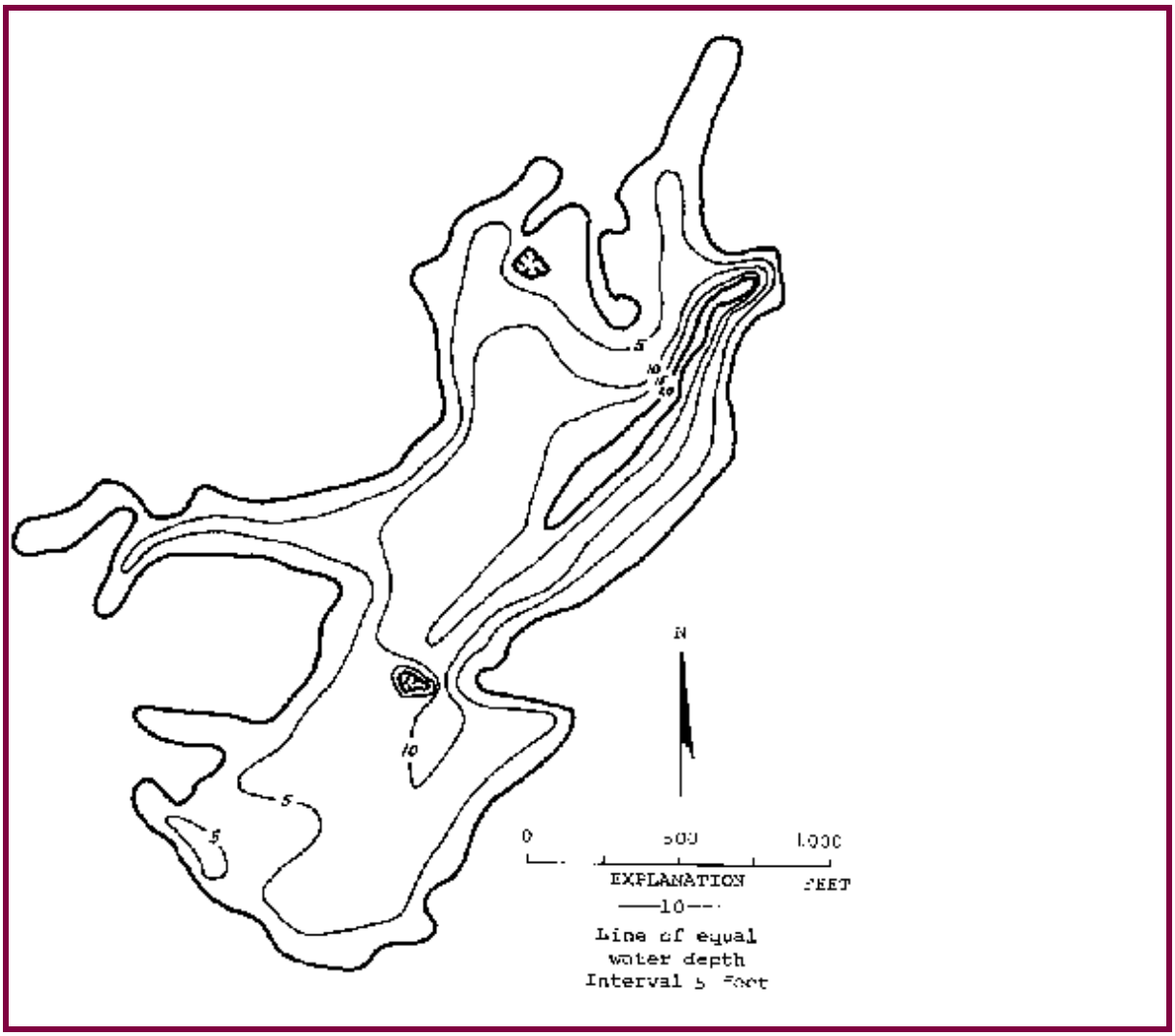
***Lake ID:*** *SYMKI1*

***Ecoregion:*** 2

William Symington Reservoir is a shallow lake located along the Big Beef Creek. Two private parks line its shores. The lake has abundant aquatic life including geese and lush aquatic macrophytes.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 60 | 23 | 7 | 7 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 422 | 2.74 | 390 | 47 35 56. | 122 49 27. |



## Station Information

SYMKI1

| | | | |
|---|---|---|---|
| Secondary Station | Station # 1 | latitude: 42 35 44.6 | longitude: 122 49 46.0 |
| | Description: | In deep part of lake approxiamtely midway on a line extending from southern island to northeast corner of deepest cove of lake | |
| Primary Station | Station # 2 | latitude: 47 35 48.2 | longitude: 122 49 41.2 |
| | Description: | Directly south of eastern shore of southern island on a line extending from two coves located directly east-west from one another | |

## Trophic State Assessment for 1998

WILLIAM SYMINGTON

Analyst: KIRK SMITH

| | | |
|---|---|---|
| TSI_Secchi: | 43 | N |
| TSI_Phos: | 39 | |
| TSI_Chl: | 45 | |
| Narrative TSI:[a] | M | |

William Symington Lake (Symington Lake) is a man-made reservoir in Kitsap County. The shoreline is approximately 50% developed (mostly residential) with timberland outside of the residential area. There is no public access. The lake is relatively shallow with numerous aquatic plants throughout. Waters are tannin-colored. There is a restriction on the use of outboard motors and the most prominent primary use of the lake is swimming at the two private beaches along the shoreline. It did not appear that boating of any kind was a significant form of recreation and, to survey respondents, watercraft restriction was the most desired characteristic of the lake. Having a public access and public beach were the least desired characteristics. The natural scenery is also a highly desired characteristic and the habitat survey did show very little human disturbance along the shoreline, lawns being an exception. The habitat survey confirmed the abundance of aquatic weed cover. The user survey also indicated that aquatic plants detracted from the enjoyment of the lake. Phosphorus concentrations were moderate (mean 11.3 ug/L total phosphorus).

It appears beneficial uses are supported on Symington Lake with the exception that swimming may be impaired by the abundant aquatic plant life and localized high fecal bacteria counts. Because swimming is an important characteristic, we suggest that homeowners groups (rather than local public entities because there is no public access) develop strategies to control the growth of aquatic vegetation and manage fecal bacteria sources (probably swimmers). We recommend a nutrient criterion for William Symington Lake be set at the ecoregion action value for lower mesotrophic Puget Lowland lakes, 20 ug/L.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

WILLIAM SYMINGTON

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | |
| 6/9/1998 | L | | | | | 5 | | | |
| | L | | | | | 14 | | | |
| 7/28/1998 | L | | | | | 19 J | | | |
| | L | | | | | 200 J | | | |
| 8/17/1998 | L | | | | | 180 | | | |
| | L | | | | | 29 | | | |
| 9/21/1998 | L | | | | | 7 | | | |
| | L | | | | | 9 | | | |
| **Station 1** | | | | | | | | | |
| 6/9/1998 | E | 12.8 | .244 | 19 | | | | | |
| **Station 2** | | | | | | | | | |
| 6/9/1998 | E | 11.7 | .254 | 22 | 1.4 | | 28.4 | 7100 | 1.2 |
| 7/28/1998 | E | 11.4 | .244 | 21 | 2.3 | | | | 1.2 |
| | H | 20.5 | .291 | 14 | | | | | |
| 8/17/1998 | E | 12.2 | .29 | 24 | 10.8 | | | | 2 |
| 9/21/1998 | E | 9.9 | .348 | 35 | 9 | | | | 1.8 |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

WILLIAM SYMINGTON

**Survey Date:** 9/21/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [4] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [3] **Major transportation**
- [1] **Residential**
- [2] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☑

Natural vegetation left around the shoreline

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

**Buffer zones around streams and wetlands** ☐

**Irrigation** ☐

# Habitat Survey Summary Report

WILLIAM SYMINGTON

**Data are averages of** ***10*** **Stations Surveyed** **Date of Visit:** 9/16/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 2.5 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.9 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 2.1 |
| | **trees< 0.3 m DBH** | 2.4 |
| **Understory:** | **woody shrubs saplings** | 2.6 |
| | **tall herbs, forbs grasses** | 1.7 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.6 |
| | **herbs, forbs, grasses** | 3.2 |
| | **standing water or inundated veg** | 0.9 |
| | **barren or buildings** | 0.7 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 0.6 |
| | **loose sand** | 0.0 |
| | **other fine soil/sediment** | 1.2 |
| | **vegetated** | 3.6 |
| | **other** | 0.2 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.5 |
| | **vertical dist (M from wtrln to high wt):** | 0.3 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.5 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.2 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 0.0 |
| **walls, dikes, or revetments** | 0.6 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |

| | |
|---|---|
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.4 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 1.2 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.0 |
| **gravel** | 0.3 |
| **sand** | 1.2 |
| **silt** | 3.2 |
| **woody debris** | 0.3 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 2.7 |
| **emergent** | 1.0 |
| **floating** | 1.4 |
| **total weed cover** | 3.0 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -1.0 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 2.0 |
| **snags** | 0.0 |
| **brush or woody debris** | 0.1 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 0.9 |
| **rock ledges or sharp dropoffs** | 0.1 |
| **boulders** | 0.0 |
| **human structures** | 0.1 |

---

# Questionnaire

WILLIAM SYMINGTON

**Results compiled from** 5 **Surveys.** **Average time (years) respondents spent on lake:** 9.00

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | 0.2 | View: | 0.8 | Distance to Lake: | 0.2 |
| Public Access: | 0.3 | Swim Beach: | 0.6 | Canada Geese: | -0.2 |
| Water Clarity: | 0.2 | Water Qual. for Swim: | 0.2 | | |
| Fishing Quality: | 0.4 | Aquatic Plants: | -0.4 | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?** **2.8**

**Which would you rather have, 1 or 2?**

| | |
|---|---|
| 1) Better fishing and more natural habitat, or 2) clearer water? | 1.6 |
| 1) Better fishing and more natural habitat, or 2) fewer aquatic plants? | 1.6 |
| 1) Clearer water, or 2) fewer aquatic plants? | 1.4 |

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 4.4 | Good Warmwtr Fishing: | 3.0 | Natural Scenery: | 4.2 |
| Plant Growth: | 2.0 | Good Swimming: | 4.2 | Public Beach: | 1.4 |
| Natural Shoreline: | 3.0 | Less Algae: | 3.2 | Canada Geese: | 3.2 |
| No Odors: | 4.0 | Public Access: | 1.6 | | |
| Good Coldwtr Fishing: | 3.6 | Clear Water: | 4.2 | | |

**Tabulated Results**

| Survey ID | Date | Residency | | Rent or Own | Primary Activity* | Water Clarity: Purchase Factor? | Water Clarity: Has it Changed? | Water Clarity: When? |
|---|---|---|---|---|---|---|---|---|
| 43 | 8/20/1998 | Resident | Permanent | Rent | 10 | ☑ | No | |
| 61 | 8/16/1998 | Resident | Permanent | Rent | 1 | ☐ | No | |
| 63 | 8/25/1998 | Resident | Permanent | Rent | 6 | ☑ | Worse | 1996 |
| 72 | 8/15/1998 | Resident | Permanent | Rent | 7 | ☐ | Unknown | |
| 86 | 8/20/1998 | Resident | Permanent | Rent | 10 | ☑ | Worse | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

SYMKI1

Date 6/9/1998 Station: 2 11 mLs observed
Sample ID 20

Number of organisms measured: 69

| Group | Percent |
|---|---|
| Cladoceran | 39.1% |
| Copepod | 60.9% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 87.0% |
| Large >= 1mm | 13.0% |
| Ratio of large to Small: | 0.15 |
| Average size (mm): | 0.52 |

## Aquatic Plant Data

WILLIAM SYMINGTON

Sampler: Parsons, O'Neal Survey Date: 9/16/1998

Max depth of growth (M): 3

Comments Sunny, light breeze. Did habitat survey form for Kirk Smith. Dammed creek to create the lake. Most of the lake is shallow and filled with vegetation. Water tea colored, especially in channels. Plant growth dense in shallows, the shoreline is modified from what the map indicates.

SPECIES LIST

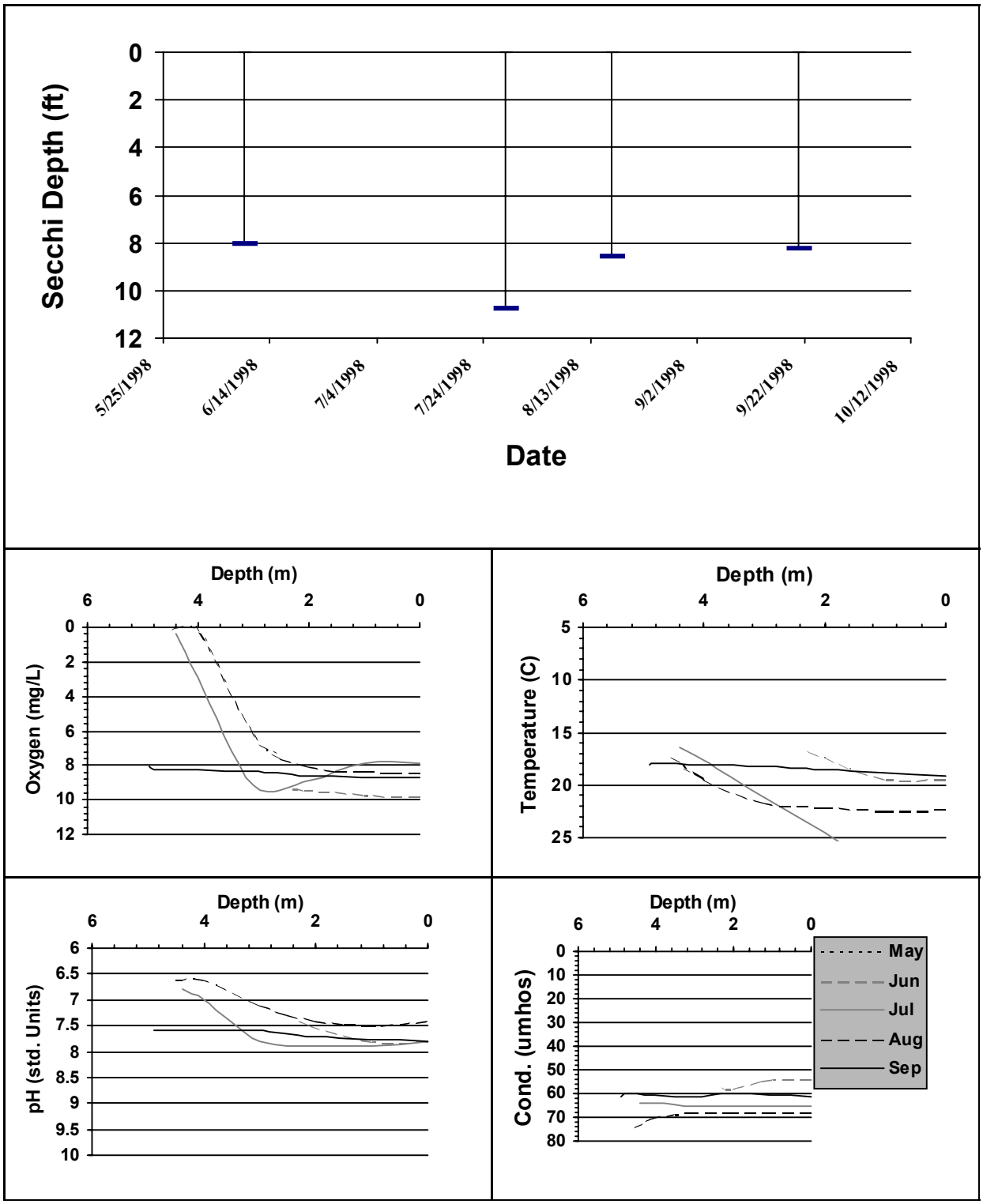
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 3 | |
| *Elodea canadensis* | common elodea | 3 | some dense patches |
| *Najas flexilis* | common naiad | 2 | |

| | | | |
|---|---|---|---|
| *Nitella sp.* | stonewort | 3 | a few species |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | |
| *Potamogeton amplifolius* | large-leaf pondweed | 3 | some dense patches |
| *Potamogeton epihydrus* | ribbonleaf pondweed | 2 | |
| *Potamogeton natans* | floating leaf pondweed | 2 | |
| *Potentilla palustris* | purple (marsh) cinquefoil | 2 | |
| *Potamogeton pusillus* | slender pondweed | 2 | |
| *Potamogeton zosteriformis* | eel-grass pondweed | 3 | |
| *Typha latifolia* | common cat-tail | 2 | |
| *unknown plant* | unknown | 2 | at north end |
| *Utricularia sp.* | bladderwort | 2 | U. minor? |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 2 SYMKI1



# Secchi Data and Field Observations

WILLIAM SYMINGTON

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 2** | | | | | | | | | | | | | |
| 6/9/1998 | | | 8 B | 7 | 100 | 2 | | 4 | 1 | 40 | 6 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |
| 7/28/1998 | | | 10.73 | 8 | 0 | | | 4 | 3 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | SAMPLES TAKEN AT SITE#2 (DEEP SITE). MANY SWIMMERS. Fecal bacteria were samples collected at the two parks. | | | | | | | | |
| 8/17/1998 | | | 8.58 | 7 | 100 | 1 | | 4 | 3 | 0 | 26 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FECS TAKEN AT PARKS FEC#1 AT DIV 5 PARK, FEC #2 AT DIV 1-4 PARK. | | | | | | | | |
| 9/21/1998 | | | 8.25 | 6 | 0 | 1 | | 5 | 4 | 12 | 56 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FEC#1 TAKEN NEAR BEACH AREA IN COVE NORTH OR DAM. FEC#2 AT COMMUNITY PARK FOR DIV 1-4. The Conductivity and Oxygen result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |

# WARD

THURSTON County

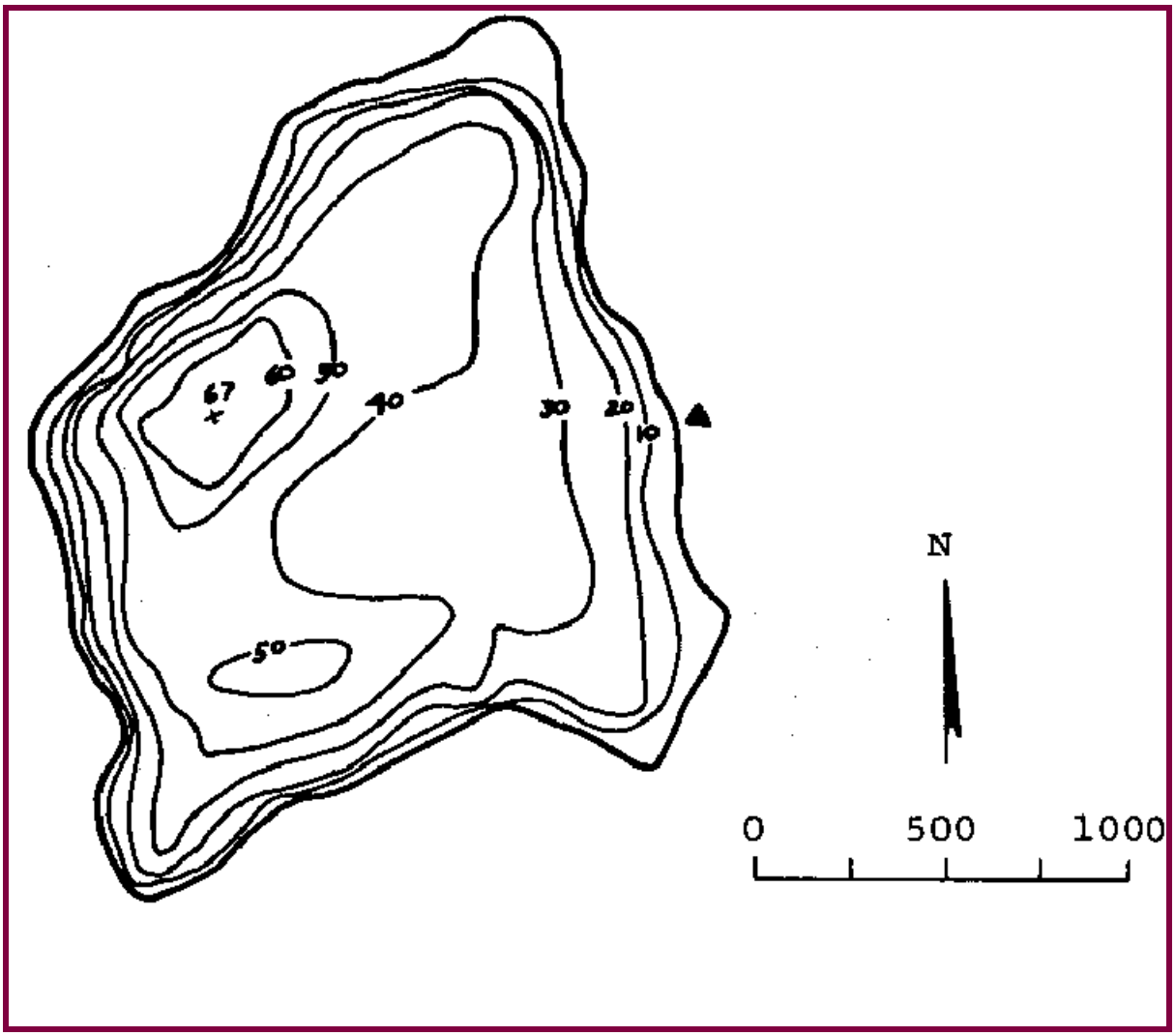
*Lake ID:* WARTH1

*Ecoregion:* 2

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.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 65 | 67 | 33 | 1 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 2100 | 1.36 | 123 | 47 00 21. | 122 52 36. |



## Station Information

WARTH1

Primary Station | Station # 1 | latitude: 47 00 26.3 | longitude: 122 52 44.2

Description: Deep part of lake directly west of boat launch about 500 feet east of west shore

## Trophic State Assessment for 1998

WARD

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 40 |
| TSI_Phos: | 34 |
| TSI_Chl: | 37 |
| Narrative TSI:[a] | OM |

About 60% of Ward Lake's shoreline is densely residential, the rest is undeveloped. The watershed is very small. The lake shows many characteristics of an oligotrophic lake (mean total phosphorus was 8.8 ug/L) but its late summer anoxic hypolimnion, significant internal loading, and noticeable algal blooms are more indicative of a mesotrophic lake. We have assigned an oligo-mesotrophic assessment. There were only two user surveys returned for Ward Lake and we cannot draw conclusions based on so few questionnaires. However, Ward Lake has been included in the LWQA program for many years and its uses have remained fairly constant during that time. The lake is primarily used by residents for swimming. The boat launch is frequented by fishermen who fish the lake primarily for kokanee and trout. The lake supports a very popular and healthy kokanee fishery. The habitat survey suggests there is abundant aquatic vegetation growth in the shallow portions of the lake near the shore. The survey also indicates that human influences on the shoreline include lawns and buildings. The substrate is mostly silt. The lake may be subjected to watershed impacts from runoff of lawn fertilizers and a nearby plant nursery. Algal blooms in 1998 produced a very green lake at times which is unusual for Ward Lake, though chlorophyll concentrations were still low to moderate. However, with the exception of a high fecal bacteria count in June, it appears that all the beneficial uses of the lake are still supported by the present water quality conditions.

Therefore, we recommend the nutrient criterion for Ward Lake be set at the ecoregional action value for oligotrophic Puget Lowland lakes, 10 ug/L total phosphorus.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

WARD

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/1/1998 | | L | | | | | 7 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | L | | | | | 240 J | | | | |
| 7/23/1998 | L | | | | | 6 | | | | |
| | L | | | | | 3 | | | | |
| 8/10/1998 | L | | | | | 11 | | | | |
| 9/24/1998 | L | | | | | 4 | | | | |
| **Station 1** | | | | | | | | | | |
| 6/1/1998 | E | 10.9 | .156 | 14 | 2 | | | 5 | 1290 | .6 |
| | H | 56.2 | .366 | 7 | | | | | | |
| 7/23/1998 | E | 9.1 | .246 | 27 | 1.9 | | | | | 1.3 |
| | H | 116 | .393 | 3 | | | | | | |
| 8/10/1998 | E | 7.8 | .222 | 28 | 1.5 | | | | | .6 |
| | H | 294 | .726 | 2 | | | | | | |
| 9/24/1998 | E | 7.4 | .237 | 32 | 2.6 | | | | | .6 |
| | H | 377 | .972 | 3 | | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

WARD

**Survey Date:** 9/24/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

| | | | |
|---|---|---|---|
| | **Agriculture(commercial, not hobby)** | 1 | **Residential** |
| 2 | **Commercial, Industrial** | | **Park, forest or natural** |
| 3 | **Major transportation** | | |

**Impervious surfaces (Roads and parking area):** Partially Curbed

### Observations (check mark denotes presence)

**BMP's** ☐

**Odors** ☐

**Cattle** ☐ **Ducks** ☐ **Geese** ☐

None

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☐

Yes. Green lawns evident along lakeshore and watershed.

**Buffer zones around streams and wetlands** ☑

Lots of riparian habitat along lakeshore.

**Irrigation** ☑

Southwest end of lake

# Habitat Survey Summary Report

WARD

**Data are averages of** *10* **Stations Surveyed** **Date of Visit:** 7/6/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.9 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.7 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.5 |
| | **trees< 0.3 m DBH** | 1.0 |
| **Understory:** | **woody shrubs saplings** | 1.9 |
| | **tall herbs, forbs grasses** | 1.1 |
| **Ground Cover:** | **woody shrubs seedlings** | 1.1 |
| | **herbs, forbs, grasses** | 1.1 |
| | **standing water or inundated veg** | 1.4 |
| | **barren or buildings** | 0.8 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.0 |
| | **cobble/gravel** | 0.4 |
| | **loose sand** | 0.4 |
| | **other fine soil/sediment** | 1.4 |
| | **vegetated** | 3.1 |
| | **other** | 0.9 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.6 |
| | **vertical dist (M from wtrln to high wt):** | 0.1 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.3 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.2 |
| **commercial** | 0.0 |
| **park facilities** | 0.1 |
| **docks/boats** | 1.4 |
| **walls, dikes, or revetments** | 0.7 |
| **litter, trash dump, or landfill** | 0.0 |
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.0 |
| **orchard** | 0.0 |
| **lawn** | 1.2 |

| | |
|---|---|
| **other** | 0.3 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 4.8 |

## Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.0 |
| **cobble** | 0.0 |
| **gravel** | 0.0 |
| **sand** | 0.2 |
| **silt** | 1.7 |
| **woody debris** | 0.5 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.3 |
| **emergent** | 0.7 |
| **floating** | 1.9 |
| **total weed cover** | 2.3 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.2 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.7 |
| **snags** | 0.1 |
| **brush or woody debris** | 1.0 |
| **inundated live trees** | 0.4 |
| **overhanging vegetation** | 0.9 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.0 |
| **human structures** | 0.8 |

---

# Questionnaire

WARD

**Results compiled from** 1 **Surveys.** **Average time (years) respondents spent on lake:**

**Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?**

| | | | | | |
|---|---|---|---|---|---|
| Types of WaterCraft: | | View: | | Distance to Lake: | |
| Public Access: | 1.0 | Swim Beach: | | Canada Geese: | |
| Water Clarity: | | Water Qual. for Swim: | | | |
| Fishing Quality: | 1.0 | Aquatic Plants: | | | |

**On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today?**

**Which would you rather have, 1 or 2?**

1) Better fishing and more natural habitat, or 2) clearer water?

1) Better fishing and more natural habitat, or 2) fewer aquatic plants? 1.0

1) Clearer water, or 2) fewer aquatic plants?

1) Clearer water, or 2) fewer aquatic plants?

**How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):**

| | | | | | |
|---|---|---|---|---|---|
| Restricted Watercraft: | 3.0 | Good Warmwtr Fishing: | 1.0 | Natural Scenery: | 4.0 |
| Plant Growth: | 3.0 | Good Swimming: | 1.0 | Public Beach: | 3.0 |
| Natural Shoreline: | 3.0 | Less Algae: | 5.0 | Canada Geese: | 1.0 |
| No Odors: | 5.0 | Public Access: | 3.0 | | |
| Good Coldwtr Fishing: | 5.0 | Clear Water: | 5.0 | | |

**Tabulated Results**

| Survey ID | Date | ----------Residency---------- | Rent or Own | Primary Activity* | Purchase Factor? | ----------Water Clarity---------- Has it Changed? | When? |
|---|---|---|---|---|---|---|---|
| 3 | 6/6/1998 | Visitor | | 2 | ☐ | Unknown | |

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

## Zooplankton Report

WARTH1

Date 6/1/1998 Station: 1 4 mLs observed
Sample ID 10

Number of organisms measured: 93

| Group | Percent |
|---|---|
| Cladoceran | 14.0% |
| Copepod | 86.0% |
| Other | |

| Group | Percent |
|---|---|
| Small < 1mm | 55.9% |
| Large >= 1mm | 44.1% |
| Ratio of large to Small: | 0.79 |
| Average size (mm): | 0.82 |

## Aquatic Plant Data

WARD

Sampler: Parsons, O'Neal Survey Date: 7/6/1998

Max depth of growth (M): 6

Comments partly cloudy, light breeze, bullfrogs, sparse plant cover - mostly Nymphaea. Shoreline drops steeply in most areas, plant community pretty homogeneous. Conducted habitat survey for Kirk Smith.

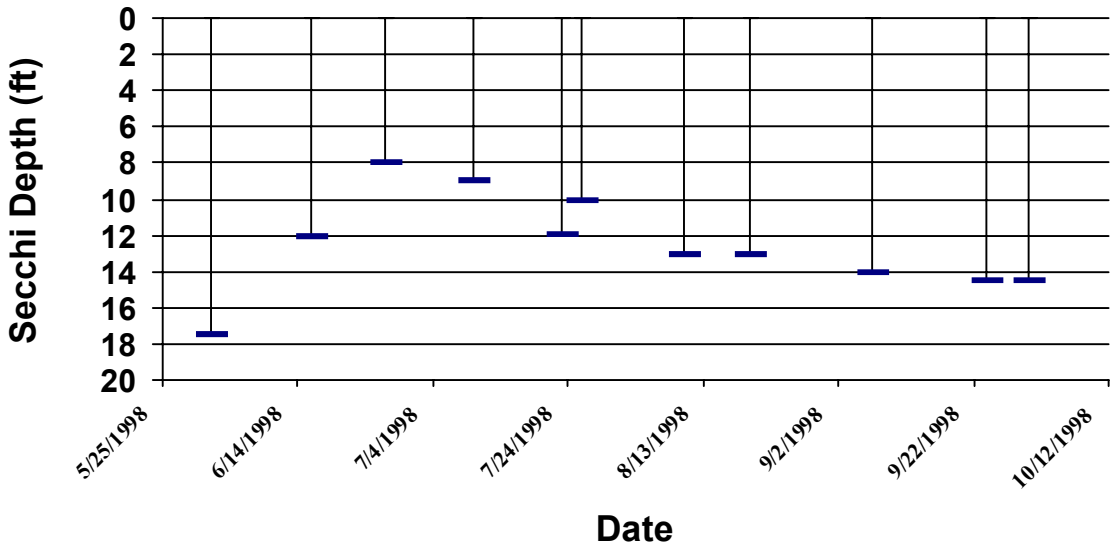
SPECIES LIST

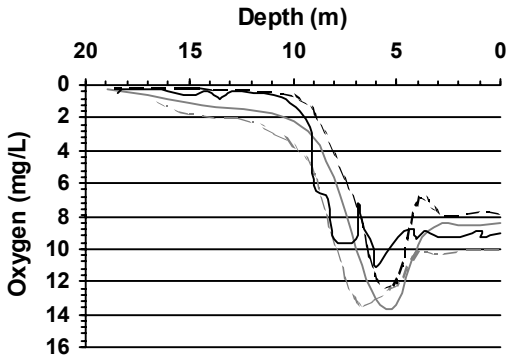
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Callitriche stagnalis* | pond water-starwort | 1 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Juncus sp. or Eleocharis sp.* | small grass-like plants | 1 | |
| *Nitella sp.* | stonewort | 3 | common in deep water, though not dense |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 1 | only saw 1 in flower |
| *Nymphaea odorata* | fragrant waterlily | 3 | present along most of shore to approx. 3 m deep |
| *Scirpus sp.* | bulrush | 2 | |
| *Typha sp.* | cat-tail | 2 | |
| *Utricularia sp.* | bladderwort | 1 | |

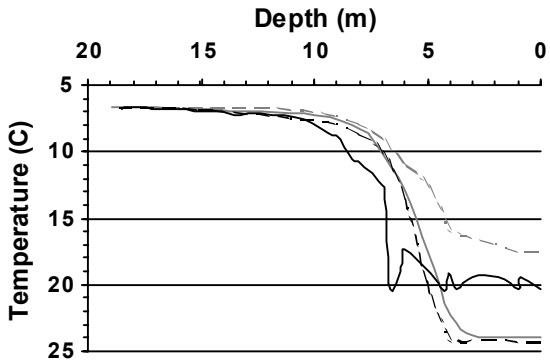
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

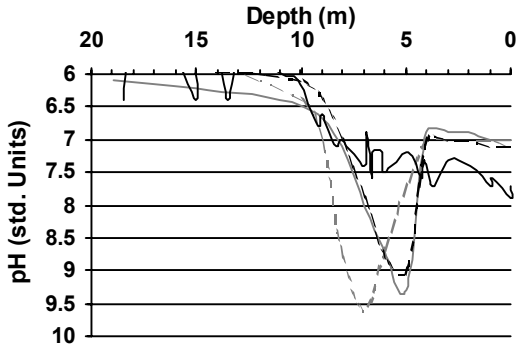
# Secchi Depth and Profile Graphics

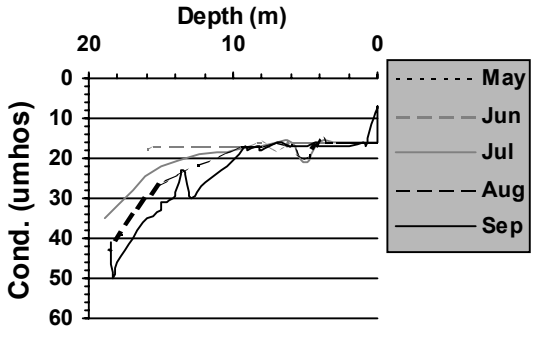
**Station:** 1 WARTH1



# Secchi Data and Field Observations

WARD

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 1** | | | | | | | | | | | | | |
| 6/1/1998 | | | 17 | 6 | 100 | 2 | | 5 | 5 | 0 | 2 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | ZOO TOW DOWN TO 10 METERS AT DEEP SITE. HIGHLY RESIDENTIAL APPROX 40% SHORELINE NATURAL. SMALL WATERSHED | | | | | | | | |
| 6/1/1998 | | 17.5 | 17.5 | 3 | 75 | 2 | 1 | 5 | 5 | 10 | 6 | 4 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 6/1/1998 | | | 17.5 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |
| 6/16/1998 | | 21 | 12 | 3 | 0 | 2 | 2 | 5 | 4 | 0 | 0 | 1 | 0 |
| | Sampler: | CLOUD | | Remarks: | BLOOM STARTING - MUCH CLEARER 4 DAYS AGO. | | | | | | | | |
| 6/27/1998 | | 19 | 8 | 4 | 75 | 1 | 2 | 5 | 4 | 30 | 1 | 1 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 7/10/1998 | | 22 | 9 | 3 | 50 | 1 | 1 | | | | | | |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 7/23/1998 | | | 11.88 | 2 | 100 | | | 4 | 4 | 0 | 7 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | H2S IN THE HYPOLIMNION | | | | | | | | |
| 7/26/1998 | | 25 | 10 | 7 | 0 | 1 | 1 | 5 | 4 | 0 | 0 | 2 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 8/10/1998 | | | 16.83 | 2 | 80 | | | 5 | 5 | 9 | 9 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | OXYGEN WAS INCREDIBLY LOW IN HYPOLIMNION | | | | | | | | |
| 8/10/1998 | | 26 | 13 | 8 | 0 | 1 | 1 | 5 | 5 | 0 | 4 | 0 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/20/1998 | | 26 | 13 | 8 | 0 | 2 | 1 | 5 | 5 | 3 | 4 | 2 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 9/7/1998 | | 26 | 14 | 9 | 0 | 1 | 1 | 5 | 5 | 0 | 2 | 2 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 9/24/1998 | | | 14.52 | 2 | 100 | 3 | | 4 | 5 | 0 | 26 | 1 | 0 |
| | Sampler: | SMITH | | Remarks: | SOME COOTS MIGRATING THROUGH. SOME GREBES TOO. The Conductivity result is qualified as an estimate due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 9/30/1998 | | 19 | 14.5 | 3 | 0 | 2 | 1 | | 5 | 10 | 0 | 0 | 0 |
| | Sampler: | CLOUD | | Remarks: | | | | | | | | | |
| 9/30/1998 | | | 14.5 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |

# WILDCAT

KITSAP County

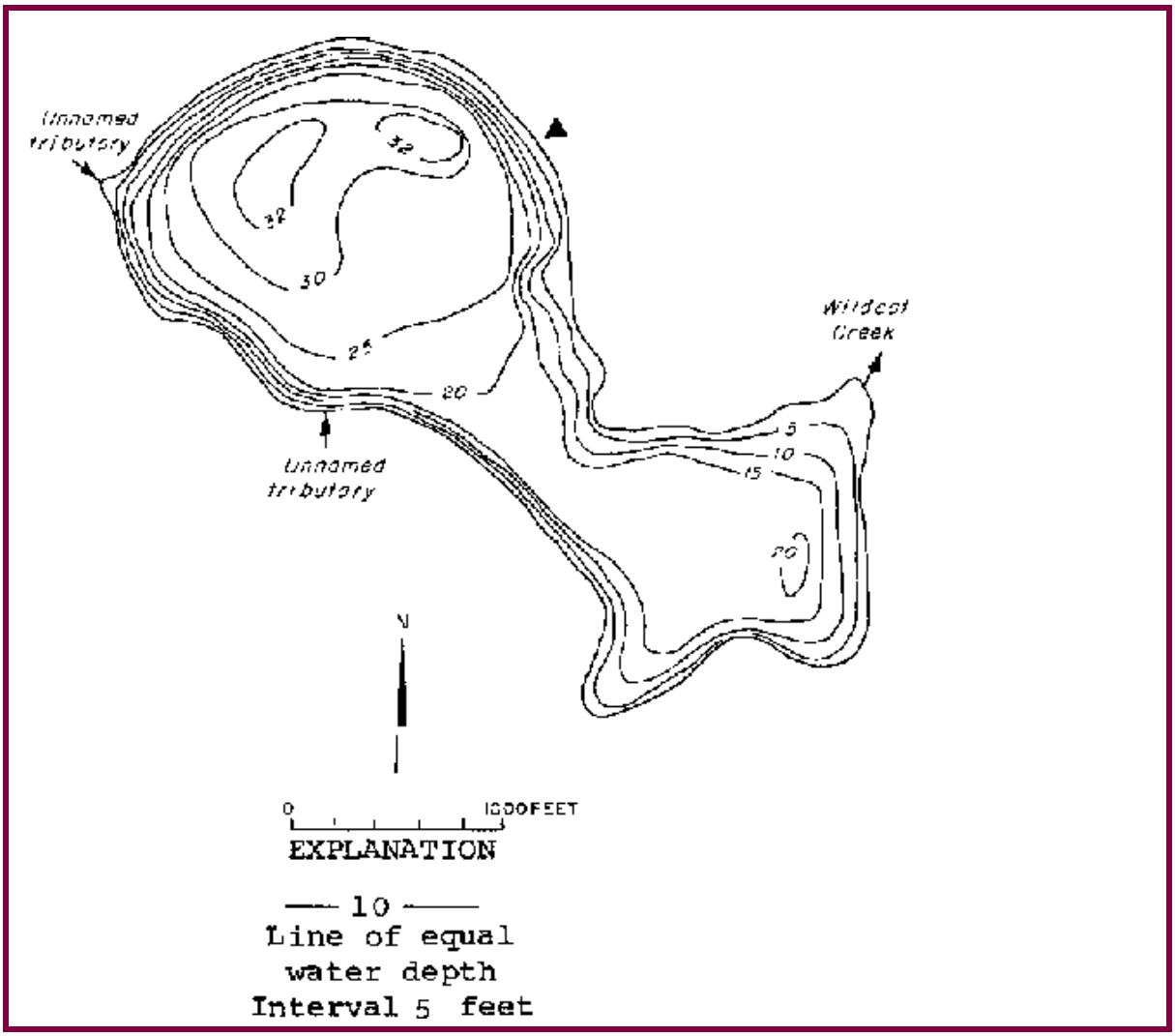
***Lake ID:*** *WILKI1*

***Ecoregion:*** 2

Wildcat Lake is located six miles northwest of Bremerton. It is fed by two inlets, and drains via Wildcat Creek to Dyes Inlet.

| *Area (acres)* | *Maximum Depth (ft)* | *Mean Depth (ft)* | *Drainage (sq mi)* |
|---|---|---|---|
| 120 | 33 | 18 | 3 |

| *Volume (ac-ft)* | *Shoreline (miles)* | *Altitude (ft abv msl)* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 2200 | 2.24 | 377 | 47 35 59. | 122 45 35. |



## Station Information

WILKI1

| | | | |
|---|---|---|---|
| Secondary Station | Station # 1 | latitude: 47 35 56.9 | longitude: 122 46 23.8 |
| | Description: | Approximately 200 feet from boat launch on a line extending from launch to southern tributary; pre-1996 data | |
| Primary Station | Station # 2 | latitude: 47 35 48.1 | longitude: 122 45 40.2 |
| | Description: | Deep part of lake, in the approximate center of a line extending from northwest tributary to boat launch; post-1996 data | |
| Secondary Station | Station # 3 | latitude: | longitude: |
| | Description: | In southeast portion of lake in the approximate middle of a line extending from the narrowest point in the lake to the southeasternmost end of shore | |

## Trophic State Assessment for 1998

WILDCAT

Analyst: KIRK SMITH

| | |
|---|---|
| TSI_Secchi: | 36 |
| TSI_Phos: | 33 |
| TSI_Chl: | 35 |
| Narrative TSI:[a] | O |

Wildcat Lake is an oligotrophic lake on the Kitsap peninsula. The watershed is about 75% forested, 15% residential, and 10% agriculture. The water is very clear and supports a put-and-take trout fishery and a bass fishery. There were no user surveys distributed on Wildcat Lake so we cannot determine the full extent of the uses and the public perception of their quality. However, besides the fishery, there is a public swimming beach on the lake. There is a speed limit for boats; no wakes are allowed. The habitat survey revealed buildings and lawns to be the most prominent human disturbances along the shoreline as is the case on most urban lakes. Aquatic vegetation was sparse which is not supportive of the bass fishery. The watershed survey revealed an area where a tributary was impacted by grazing livestock. Most of the lawns near the lake appeared to be well manicured and could be a source of nutrients from fertilizers. The lake is quite clear and low in phosphorus (mean total phosphorus was 7.7 ug/L). With little vegetation and low productivity, a bass fishery is most likely not supported in this lake. Zooplankton tended to be small with copepods dominant. The water quality is much better suited for the trout fishery and as a nursery for Coho smolts.

We recommend the nutrient criterion for Wildcat Lake be set at the ecoregional action value for oligotrophic Puget Lowland lakes, 10 ug/L total phosphorus.

[a] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

## Chemistry Data

WILDCAT

| Date | Time | Strata | Tot P (ug/L) | Tot N (mg/L) | TN:TP | Chloro-phyll (ug/L) | Fecal Col. Bacteria (#/100mL) | Hardness (mg/L) | Calcium (ug/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station 0** | | | | | | | | | | |
| 6/16/1998 | L | | | | | 1 | | | | |
| | L | | | | | 10 | | | | |
| 8/18/1998 | L | | | | | 7 | | | | |
| | L | | | | | 7 | | | | |
| 9/21/1998 | L | | | | | 2 | | | | |
| | L | | | | | 1 | | | | |
| **Station 2** | | | | | | | | | | |
| 6/16/1998 | E | 6.2 | .231 | 37 | | | 20.7 | 5100 | .5 | |
| | H | 19.9 | .374 | 19 | | | | | | |
| 7/24/1998 | E | 9.2 | .181 | 20 | .71 | | | | .7 J | |
| | H | 11.9 | .274 | 23 | | | | | | |
| 8/18/1998 | E | 6.8 | .161 | 24 | .5 U | | | | .6 | |
| | H | 24.7 | .28 | 11 | | | | | | |
| 9/21/1998 | E | 8.5 | .189 | 22 | 3 | | | | .6 | |
| **Station 3** | | | | | | | | | | |
| 6/16/1998 | E | 8 J | | | | | | | | |
| 7/24/1998 | E | 5.3 | .176 | 33 | 1.4 | | | | | |
| 8/18/1998 | E | 6.6 | .16 | 24 | 2.3 | | | | | |

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than

## Watershed Survey

WILDCAT

**Survey Date:** 9/21/1998

### Land Uses (1 = Primary, 2 = Secondary, etc.)

- [2] **Agriculture(commercial, not hobby)**
- [ ] **Commercial, Industrial**
- [ ] **Major transportation**
- [1] **Residential**
- [3] **Park, forest or natural**

**Impervious surfaces (Roads and parking area):** No Curbs

### Observations (check mark denotes presence)

**BMP's** ☐

No BMPs observed--possibly need to keep horses from accessing water.

**Odors** ☐

**Cattle** ☑ **Ducks** ☐ **Geese** ☐

Horses, not cattle, could possibly be entering inlet streams and freely accessing lake.

**Fertilizers and weed killers appear to be used in residential or agriculture area** ☑

Yes, it appears the majority of lakefront homes use lawn fertilizers.

**Buffer zones around streams and wetlands** ☐

**Irrigation** ☐

**Survey Id:** 50

# Habitat Survey Summary Report

WILDCAT

**Data are averages of** ***10*** **Stations Surveyed** **Date of Visit:** 8/20/1998

## Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

| | | | |
|---|---|---|---|
| **Canopy Layer Avg:** | 1.7 | **Number of stations with canopy:** | 10 |
| **Understory Avg:** | 2.7 | **Number of stations with understory:** | 10 |

## Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | | |
|---|---|---|
| **Canopy Layer:** | **trees > 0.3 m DBH** | 1.6 |
| | **trees< 0.3 m DBH** | 1.3 |
| **Understory:** | **woody shrubs saplings** | 1.5 |
| | **tall herbs, forbs grasses** | 1.2 |
| **Ground Cover:** | **woody shrubs seedlings** | 0.9 |
| | **herbs, forbs, grasses** | 2.1 |
| | **standing water or inundated veg** | 0.6 |
| | **barren or buildings** | 0.8 |
| **Substrate Type (within shoreline plot):** | **bedrock** | 0.0 |
| | **boulders** | 0.4 |
| | **cobble/gravel** | 0.9 |
| | **loose sand** | 0.8 |
| | **other fine soil/sediment** | 0.6 |
| | **vegetated** | 3.0 |
| | **other** | 0.8 |
| **Bank Features:** | **angle (O:<30; 1: 30-75; 2:nr vertical)** | 0.6 |
| | **vertical dist (M from wtrln to high wt):** | 0.5 |
| | **horiz. dist. (M from wtrln to high wt):** | 0.3 |

## Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)

| | |
|---|---|
| **buildings** | 1.0 |
| **commercial** | 0.0 |
| **park facilities** | 0.2 |
| **docks/boats** | 1.3 |
| **walls, dikes, or revetments** | 0.8 |
| **litter, trash dump, or landfill** | 0.0 |

| | |
|---|---|
| **roads or railroad** | 0.0 |
| **row crops** | 0.0 |
| **pasture or hayfield** | 0.2 |
| **orchard** | 0.0 |
| **lawn** | 1.3 |
| **other** | 0.0 |

## Physical Habitat Characteristics

| | |
|---|---|
| **station depth (at 10 m from shore)** | 2.1 |

### Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **bedrock** | 0.0 |
| **boulders** | 0.1 |
| **cobble** | 0.4 |
| **gravel** | 0.9 |
| **sand** | 0.0 |
| **silt** | 3.8 |
| **woody debris** | 1.1 |

## Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

| | |
|---|---|
| **submergent** | 1.6 |
| **emergent** | 1.2 |
| **floating** | 1.7 |
| **total weed cover** | 2.7 |
| **Do macrophytes extend lakeward (-1 = yes, 0 = no)** | -0.5 |

## Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)

| | |
|---|---|
| **aquatic weeds** | 1.5 |
| **snags** | 0.2 |
| **brush or woody debris** | 0.7 |
| **inundated live trees** | 0.0 |
| **overhanging vegetation** | 1.1 |
| **rock ledges or sharp dropoffs** | 0.0 |
| **boulders** | 0.2 |
| **human structures** | 1.1 |

---

# Zooplankton Report

WILKI1

Date 6/16/1998 Station: 1
Sample ID 21

Number of organisms measured: 19

| Group | Percent | Group | Percent |
|---|---|---|---|
| Cladoceran | 15.8% | Small < 1mm | 42.1% |
| Copepod | 84.2% | Large >= 1mm | 57.9% |
| Other | | Ratio of large to Small: | 1.38 |
| | | Average size (mm): | 0.86 |

Date 6/16/1998 Station: 3 Sample ID 8 — 2 mLs observed, not enough bio to sample

Number of organisms measured: 62

| Group | Percent | Group | Percent |
|---|---|---|---|
| Cladoceran | | Small < 1mm | 93.5% |
| Copepod | 100.0% | Large >= 1mm | 6.5% |
| Other | | Ratio of large to Small: | 0.07 |
| | | Average size (mm): | 0.31 |

Date 6/16/1998 Station: 3 Sample ID 23 — 12 mLs measured

Number of organisms measured: 26

| Group | Percent | Group | Percent |
|---|---|---|---|
| Cladoceran | 7.7% | Small < 1mm | 92.3% |
| Copepod | 92.3% | Large >= 1mm | 7.7% |
| Other | | Ratio of large to Small: | 0.08 |
| | | Average size (mm): | 0.44 |

## Aquatic Plant Data

WILDCAT

Sampler: Parsons, O'Neal — Survey Date: 8/20/1998

Max depth of growth (M):

Comments Sunny, calm. Popular fishing area, many people swimming at parks, and camps. Clear water. Sediments bare gravel/muck in some areas, but most areas with macrophyte growth. Did habitat survey for Kirk Smith. Observed many bass in the shallows, kingfisher, bullfrog.

SPECIES LIST

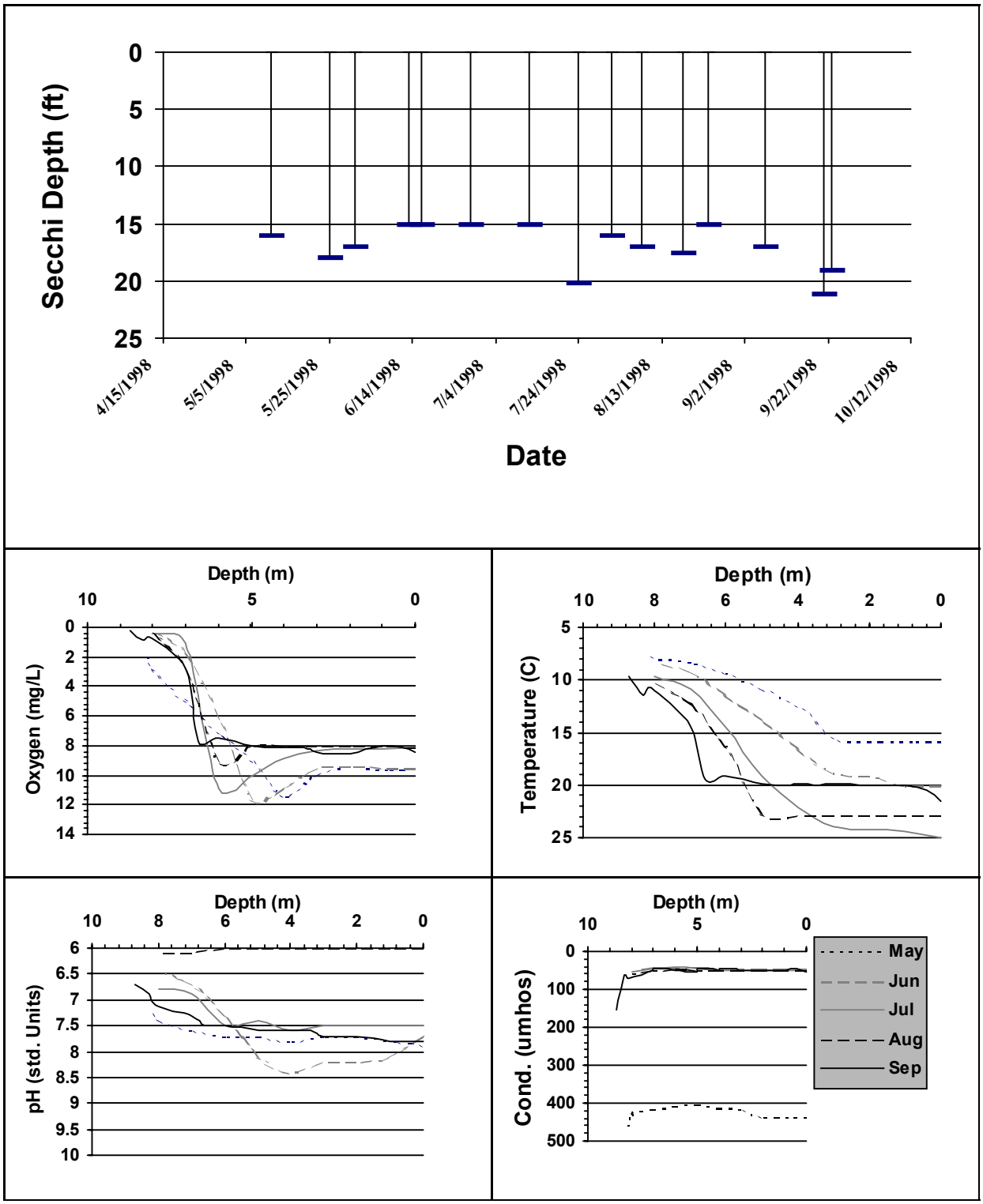
| Scientific Name | Common Name | Dist [a] | Comments |
|---|---|---|---|
| *Brasenia schreberi* | watershield | 2 | |
| *Carex sp.* | sedge | 2 | several species on shore |
| *Chara sp.* | muskwort | 1 | in shallow water |
| *Dulichium arundinaceum* | Dulichium | 2 | |
| *Elodea canadensis* | common elodea | 2 | |
| *Iris pseudacorus* | yellow flag | 2 | |
| *Isoetes sp.* | quillwort | 3 | most common submersed plant |
| *Juncus sp. or Eleocharis sp.* | small grass-like plants | 1 | |
| *Juncus sp.* | rush | 2 | several species, on shore |
| *Mentha piperita* | peppermint | 1 | |
| *Nuphar polysepala* | spatter-dock, yellow water-lily | 2 | |
| *Nymphaea odorata* | fragrant waterlily | 3 | dense in patches |

| | | | |
|---|---|---|---|
| *Potamogeton amplifolius* | large-leaf pondweed | 1 | |
| *Potamogeton gramineus* | grass-leaved pondweed | 2 | |
| *Potentilla palustris* | purple (marsh) cinquefoil | 1 | |
| *Potamogeton robbinsii* | fern leaf pondweed | 2 | |
| *Potamogeton sp (thin leaved)* | thin leaved pondweed | 2 | |
| *Potamogeton zosteriformis* | eel-grass pondweed | 1 | few seen |
| *Ranunculus flammula* | creeping buttercup | 1 | |
| *Typha latifolia* | common cat-tail | 2 | blooming |
| *Utricularia vulgaris* | common bladderwort | 1 | in shallows near outlet |
| *Vallisneria americana* | water celery | 2 | patch on south shore |

[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

# Secchi Depth and Profile Graphics

**Station:** 2 WILKI1



# Secchi Data and Field Observations

WILDCAT

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station 2** | | | | | | | | | | | | | |
| 5/11/1998 | | 16.7 | 16 | 7 | 75 | 2 | 3 | 5 | 5 | 0 | 2 | 3 | 0 |
| | Sampler: | SNOW | | Remarks: | FIRST READING OF 1998. | | | | | | | | |
| 5/11/1998 | | | 16 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |
| 5/25/1998 | | 16.7 | 18 | 7 | 75 | 2 | 3 | 5 | 5 | 2 | | 1 | 0 |
| | Sampler: | SNOW | | Remarks: | SPEED LIMIT 7 MPH ON LAKE. | | | | | | | | |
| 5/31/1998 | | 20 | 17 | 6 | 0 | 1 | 2 | 5 | 5 | 30 | 4 | 7 | 0 |
| | Sampler: | SNOW | | Remarks: | 70 DEGREES IN THE SHADE. | | | | | | | | |
| 6/13/1998 | | 21.1 | 15 | 7 | 25 | 1 | 2 | 5 | 5 | 0 | 4 | 2 | 0 |
| | Sampler: | SNOW | | Remarks: | TEMPERATURE IS 70 DEGREES OUTSIDE SHADE. | | | | | | | | |
| 6/16/1998 | | | 15 | 2 | 50 | | | | | 10 | 11 | 2 | 0 |
| | Sampler: | SMITH | | Remarks: | ZOOPLANKTON DUPS AT 4 METERS AT SITE #3 | | | | | | | | |
| 6/28/1998 | | 21.1 | 15 | 7 | 0 | 1 | 2 | 5 | 5 | 0 | | | |
| | Sampler: | SNOW | | Remarks: | 70 DEGREES IN THE SHADE. | | | | | | | | |
| 7/12/1998 | | 22.2 | 15 | 7 | 75 | 1 | 2 | 5 | 5 | 30 | 2 | 4 | 0 |
| | Sampler: | SNOW | | Remarks: | | | | | | | | | |
| 7/24/1998 | | | 20.13 | 2 | 10 | | | | | 13 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | | | | | | | | | |

| Date | Time | Temp-erature (F) | Secchi (ft) | Color (1-greens, 11-browns | Bright-ness (pct) | Wind (1-none, 5-gusty) | Rainfall (0-none, 5-heavy) | Aesthetics (1-bad, 5-good) | Swimming (1-poor, 5-good) | Geese (#) | Waterfowl (besides geese #) | Boats-Fishing (#) | Boats-Skiing (#) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/1/1998 | | 25.6 | 16 | 6 | 0 | 1 | 2 | 5 | 5 | 8 | 4 | 4 | 0 |
| | Sampler: | SNOW | | Remarks: | 68 DEGREES IN THE SHADE. | | | | | | | | |
| 8/8/1998 | | 25.6 | 17 | 7 | 0 | 1 | 1 | 5 | 5 | 8 | 3 | 5 | 0 |
| | Sampler: | SNOW | | Remarks: | 72 DEGREES IN THE SHADE. | | | | | | | | |
| 8/18/1998 | | | 17.49 | 2 | 100 | | | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | SMITH | | Remarks: | FEC#1 TAKEN AT POINT BETWEEN TWO BASINS; FEC#2 TAKEN AT BOAT RAMP. FECS TAKEN APPROX. 1230. NO BLUE-GREEN OBSERVED; UNUSUALLY CLEAR FOR THIS TIME OF YEAR. The pH results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 8/24/1998 | | 23.3 | 15 | 7 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 0 | 0 |
| | Sampler: | SNOW | | Remarks: | 65 DEGREES. LAKE IS LOW. | | | | | | | | |
| 9/7/1998 | | 23.3 | 17 | 8 | 75 | 1 | 1 | 5 | 5 | 6 | 4 | 3 | 0 |
| | Sampler: | SNOW | | Remarks: | | | | | | | | | |
| 9/21/1998 | | | 21.12 | 2 | 0 | 1 | | 5 | 5 | 1 | 23 | 1 | 0 |
| | Sampler: | SMITH | | Remarks: | FEC #1 AT NEW SWIMMING AREA. The Conductivity and Oxygen results are qualified as estimates due to postcalibration failing QA/QC requirements. | | | | | | | | |
| 9/23/1998 | | 21.7 | 19 | 7 | 0 | 2 | 1 | 5 | 5 | 2 | 8 | 0 | 0 |
| | Sampler: | SNOW | | Remarks: | 70 DEGREES IN THE SHADE. | | | | | | | | |
| 9/23/1998 | | | 19 | | 0 | | | | | 0 | 0 | 0 | 0 |
| | Sampler: | BELL-MCKINNON | | Remarks: | | | | | | | | | |

# Appendix C

## Quality Assurance/Quality Control Results for 1998

For details on procedures for evaluating QC data see Ecology's *Lake Water Quality Assessment Project Quality Assurance Project Plan* (in draft) (Hallock, 1995). This appendix is an evaluation of laboratory data in accordance with the quality assurance project plan.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**1998 TOTAL PHOSPHOROUS DATA**

**TOTAL PHOSPHOROUS LAB SPLITS**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Island | 06/03/98 | 9.6 | 9.9 | 9.8 | 0.21 | 2.18 | Liberty | 07/13/98 | 12.9 | 13.0 | 13.0 | 0.07 | 0.55 |
| Phillips | 06/03/98 | 11.2 | 12.7 | 12.0 | 1.06 | 8.88 | Wildcat | 07/24/98 | 5.3 | 5.3 | 5.3 | 0.00 | 0.00 |
| Spanaway H | 06/15/98 | 29.3 | 28.5 | 28.9 | 0.57 | 1.96 | Island | 07/25/98 | 10.1 | 9.2 | 9.7 | 0.64 | 6.59 |
| Spanaway E | 06/15/98 | 12.7 | 11.1 | 11.9 | 1.13 | 9.51 | Phillips | 07/25/98 | 7.0 | 7.9 | 7.5 | 0.64 | 8.54 |
| Wildcat | 06/17/98 | 8.0 | 8.4 | 8.2 | 0.28 | 3.45 | Mason | 07/26/98 | 3.8 | 3.6 | 3.7 | 0.14 | 3.82 |
| | | | | **Median CV %** | | **3.45** | Leland | 07/30/98 | 22.0 | 22.2 | 22.1 | 0.14 | 0.64 |
| | | | | | | | Sutherland | 07/30/98 | 4.0 | 1.5 | 2.8 | 1.77 | 64.28 |
| | | | | | | | | | | | **Median CV %** | | **3.82** |
| West Medical | 08/11/98 | 2840.0 | 2580.0 | 2710.0 | 183.85 | 6.78 | Leland | 09/14/98 | 28.8 | 30.7 | 29.8 | 1.34 | 4.52 |
| Moses | 08/12/98 | 38.5 | 40.9 | 39.7 | 1.70 | 4.27 | Crescent | 09/15/98 | 1.5 | 1.5 | 1.5 | 0.00 | 0.00 |
| Sutherland | 08/13/98 | 4.1 | 4.4 | 4.3 | 0.21 | 4.99 | West Medical | 09/15/98 | 2680.0 | 2710.0 | 2695.0 | 21.21 | 0.79 |
| Island | 08/17/98 | 9.2 | 9.5 | 9.4 | 0.21 | 2.27 | Sutherland | 09/16/98 | 76.0 | 76.0 | 76.0 | 0.00 | 0.00 |
| Phillips | 08/17/98 | 7.9 | 7.2 | 7.6 | 0.49 | 6.56 | Phillips | 09/17/98 | 8.1 | 8.1 | 8.1 | 0.00 | 0.00 |
| Wildcat | 08/18/98 | 24.7 | 25.1 | 24.9 | 0.28 | 1.14 | Mason | 09/18/98 | 4.3 | 4.5 | 4.4 | 0.14 | 3.21 |
| Long | 08/19/98 | 35.0 | 34.0 | 34.5 | 0.71 | 2.05 | Long | 09/23/98 | 28.1 | 26.9 | 27.5 | 0.85 | 3.09 |
| | | | | **Median CV %** | | **2.27** | | | | | **Median CV %** | | **0.79** |

All total phosphorous lab splits fall within the acceptable limit of median CV less than 7.5%.

**TOTAL PHOSPHOROUS NONSEQUENTIAL DUPLICATES**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Island | 06/02/98 | 8.7 | 9.6 | 9.15 | 0.64 | 7.0 | West Medical | 07/14/98 | 3000 | 2900 | 2950 | 70.71 | 2.4 |
| Phillips | 06/02/98 | 6.6 | 11.2 | 8.9 | 3.25 | 36.5 | Wildcat | 07/24/98 | 9.2 | 5.3 | 7.25 | 2.76 | 38.0 |
| Mason | 06/04/98 | 5.3 | 5.8 | 5.55 | 0.35 | 6.4 | Island | 07/25/98 | 5.2 | 10.1 | 7.65 | 3.46 | 45.3 |
| Leland | 06/05/98 | 17.2 | 14.8 | 16 | 1.70 | 10.6 | Phillips | 07/25/98 | 6.2 | 7 | 6.6 | 0.57 | 8.6 |
| Crescent | 06/08/98 | 1.5 | 8.2 | 4.85 | 4.74 | 97.7 | Mason | 07/26/98 | 3.1 | 3.8 | 3.45 | 0.49 | 14.3 |
| Symington | 06/09/98 | 11.7 | 12.8 | 12.25 | 0.78 | 6.3 | Leland | 07/30/98 | 15.7 | 22 | 18.85 | 4.45 | 23.6 |
| Spanaway | 06/12/98 | 12.8 | 12.7 | 12.75 | 0.07 | 0.6 | Sutherland | 07/30/98 | 1.5 | 4 | 2.75 | 1.77 | 64.3 |
| Wildcat | 06/16/98 | 6.2 | 8 | 7.1 | 1.27 | 17.9 | Crescent | 07/30/98 | 1.5 | 1.5 | 1.5 | 0.00 | 0.0 |
| | | | | **Median CV %** | | **8.8** | | | | | **Median CV %** | | **19.0** |

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**TOTAL PHOSPHOROUS NONSEQUENTIAL DUPLICATES (continued)**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Island | 08/17/98 | 9.6 | 9.2 | 9.4 | 0.28 | 3.0 | Crescent | 09/15/98 | 1.5 | 1.5 | 1.5 | 0.00 | 0.0 |
| Leland | 08/12/98 | 18.2 | 20.1 | 19.15 | 1.34 | 7.0 | Leland | 09/14/98 | 22.1 | 28.8 | 25.45 | 4.74 | 18.6 |
| Long | 08/19/98 | 39.3 | 35 | 37.15 | 3.04 | 8.2 | Long | 09/23/98 | 28.1 | 26.3 | 27.2 | 1.27 | 4.7 |
| West Medical | 08/11/98 | 2750 | 2840 | 2795 | 63.64 | 2.3 | Mason | 09/18/98 | 5.2 | 4.3 | 4.75 | 0.64 | 13.4 |
| Phillips | 08/17/98 | 9.3 | 7.9 | 8.6 | 0.99 | 11.5 | West Medical | 09/15/98 | 3050 | 2680 | 2865 | 261.63 | 9.1 |
| Sutherland | 08/13/98 | 4.4 | 4.1 | 4.25 | 0.21 | 5.0 | Spanaway | 09/23/98 | 21.3 | 29.2 | 25.25 | 5.59 | 22.1 |
| Wildcat | 08/18/98 | 6.8 | 6.6 | 6.7 | 0.14 | 2.1 | | | | | **Median CV %** | | **11.3** |
| | | | | **Median CV %** | | **5.0** | | | | | | | |

All total phosphorous nonsequential duplicates fall within the acceptable limit of median CV less than 21%.

**TOTAL PHOSPHOROUS SEQUENTIAL DUPLICATES**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| West Medical | 07/14/98 | 3000 | 2900 | 2950 | 70.711 | 2.4 |
| West Medical | 08/11/98 | 2630 | 2840 | 2735 | 148.49 | 5.43 |
| West Medical | 09/15/98 | 2680 | 3880 | 3280 | 848.53 | 25.9 |
| | | | | **Median CV%** | | **5.43** |

There is no QAPP standard for total phosphorous sequential duplicates.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**1998 TOTAL NITROGEN DATA**

| TOTAL NITROGEN LAB SPLITS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% | Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
| Ward | 06/02/98 | 0.156 | 0.164 | 0.160 | 0.006 | 3.5 | Liberty | 07/13/98 | 0.236 | 0.245 | 0.241 | 0.006 | 2.6 |
| Limerick | 06/03/98 | 0.186 | 0.187 | 0.187 | 0.001 | 0.4 | Medical | 07/14/98 | 1.020 | 1.020 | 1.020 | 0.000 | 0.0 |
| Crescent | 06/09/98 | 0.005 | 0.005 | 0.005 | 0.000 | 0.0 | Wildcat | 07/24/98 | 0.176 | 0.166 | 0.171 | 0.007 | 4.1 |
| Spanaway | 06/17/98 | 0.818 | 0.817 | 0.818 | 0.001 | 0.1 | Mason | 07/26/98 | 0.081 | 0.078 | 0.080 | 0.002 | 2.7 |
| Medical | 06/17/98 | 0.822 | 0.826 | 0.824 | 0.003 | 0.3 | Leland | 07/30/98 | 0.437 | 0.422 | 0.430 | 0.011 | 2.5 |
| | | | | **Median CV %** | | **0.3** | Sutherland | 07/30/98 | 0.063 | 0.054 | 0.059 | 0.006 | 10.9 |
| | | | | | | | | | | | **Median CV %** | | **2.7** |
| Ward | 08/10/98 | 0.222 | 0.221 | 0.222 | 0.001 | 0.3 | Leland | 09/14/98 | 0.570 | 0.550 | 0.560 | 0.014 | 2.5 |
| Leland | 08/10/98 | 0.386 | 0.386 | 0.386 | 0.000 | 0.0 | Crescent | 09/15/98 | 0.005 | 0.005 | 0.005 | 0.000 | 0.0 |
| West Medical | 08/11/98 | 1.280 | 1.330 | 1.305 | 0.035 | 2.7 | West Medical | 09/15/98 | 1.120 | 1.150 | 1.135 | 0.021 | 1.9 |
| Sutherland | 08/13/98 | 0.064 | 0.068 | 0.066 | 0.003 | 4.3 | Sutherland | 09/16/98 | 0.042 | 0.050 | 0.046 | 0.006 | 12.3 |
| Island | 08/17/98 | 0.180 | 0.177 | 0.179 | 0.002 | 1.2 | Wildcat | 09/21/98 | 0.189 | 0.176 | 0.183 | 0.009 | 5.0 |
| Phillips | 08/17/98 | 0.263 | 0.261 | 0.262 | 0.001 | 0.5 | Offut | 09/24/98 | 0.530 | 0.534 | 0.532 | 0.003 | 0.5 |
| Wildcat | 08/18/98 | 0.280 | 0.289 | 0.285 | 0.006 | 2.2 | | | | | **Median CV %** | | **2.2** |
| | | | | **Median CV %** | | **1.2** | | | | | | | |

All total nitrogen lab splits fall within the acceptable limit of CV less than 5%.

| TOTAL NITROGEN NONSEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% | Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
| Crescent | 06/08/98 | 0.005 | 0.005 | 0.005 | 0.000 | 0.0 | Crescent | 07/30/98 | 0.005 | 0.018 | 0.0115 | 0.009 | 79.9 |
| Island | 06/02/98 | 0.216 | 0.191 | 0.2035 | 0.018 | 8.7 | Island | 07/25/98 | 0.199 | 0.178 | 0.1885 | 0.015 | 7.9 |
| Leland | 06/05/98 | 0.416 | 0.415 | 0.4155 | 0.001 | 0.2 | Leland | 07/30/98 | 0.371 | 0.437 | 0.404 | 0.047 | 11.6 |
| Mason | 06/04/98 | 0.121 | 0.104 | 0.1125 | 0.012 | 10.7 | Mason | 07/26/98 | 0.09 | 0.081 | 0.0855 | 0.006 | 7.4 |
| Phillips | 06/02/98 | 0.237 | 0.234 | 0.2355 | 0.002 | 0.9 | West Medical | 07/14/98 | 1.36 | 1.33 | 1.345 | 0.021 | 1.6 |
| Symington | 06/09/98 | 0.254 | 0.244 | 0.249 | 0.007 | 2.8 | Wildcat | 07/24/98 | 0.181 | 0.176 | 0.1785 | 0.004 | 2.0 |
| | | | | **Median CV %** | | **1.9** | | | | | **Median CV %** | | **7.7** |

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**TOTAL NITROGEN NONSEQUENTIAL DUPLICATES (continued)**

| Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% | Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Island | 08/17/98 | 0.199 | 0.18 | 0.1895 | 0.013 | 7.1 | Crescent | 09/15/98 | 0.022 | 0.005 | 0.0135 | 0.012 | 89.0 |
| Leland | 08/12/98 | 0.384 | 0.386 | 0.385 | 0.001 | 0.4 | Leland | 09/14/98 | 0.56 | 0.57 | 0.565 | 0.007 | 1.3 |
| West Medical | 08/11/98 | 1.42 | 1.28 | 1.35 | 0.099 | 7.3 | Long | 09/23/98 | 0.44 | 0.45 | 0.445 | 0.007 | 1.6 |
| Phillips | 08/17/98 | 0.277 | 0.263 | 0.27 | 0.010 | 3.7 | West Medical | 09/15/98 | 1.13 | 1.12 | 1.125 | 0.007 | 0.6 |
| Sutherland | 08/13/98 | 0.049 | 0.064 | 0.0565 | 0.011 | 18.8 | Spanaway | 09/23/98 | 0.356 | 0.339 | 0.3475 | 0.012 | 3.5 |
| Wildcat | 08/18/98 | 0.161 | 0.16 | 0.1605 | 0.001 | 0.4 | Sutherland | 09/16/98 | 0.052 | 0.042 | 0.047 | 0.007 | 15.0 |
| | | | | **Median CV %** | | **5.4** | | | | | **Median CV %** | | **2.5** |

All total nitrogen nonsequential duplicates fall within the acceptable limit of CV less than 30%.

**TOTAL NITROGEN SEQUENTIAL DUPLICATES**

| Lake | Date | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| West Medical | 07/14/98 | 1.33 | 1.41 | 1.37 | 0.06 | 4.1 |
| West Medical | 08/11/98 | 1.28 | 1.31 | 1.295 | 0.02 | 1.6 |
| West Medical | 09/15/98 | 1.12 | 1.12 | 1.12 | 0.00 | 0.0 |
| | | | | **Median CV%** | | **1.6** |

There is no QAPP standard for total nitrogen sequential duplicates.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**1998 CHLOROPHYLL A DATA**

**CHLOROPHYLL A LAB SPLITS**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crocker | 06/08/98 | 10.3 | 10.7 | 10.5 | 0.28 | 2.7 | Moses | 07/15/98 | 42.5 | 44.6 | 43.6 | 1.48 | 3.4 |
| Spanaway | 06/15/98 | 11.0 | 10.0 | 10.5 | 0.71 | 6.7 | Long | 07/24/98 | 8.2 | 6.8 | 7.5 | 0.99 | 13.2 |
| Horseshoe | 06/17/98 | 33.5 | 31.4 | 32.5 | 1.48 | 4.6 | Spanaway | 07/30/98 | 6.8 | 7.2 | 7.0 | 0.28 | 4.0 |
| Moses | 06/18/98 | 50.0 | 54.0 | 52.0 | 2.83 | 5.4 | Crocker | 07/30/98 | 42.8 | 41.8 | 42.3 | 0.71 | 1.7 |
| | | | | **Median CV %** | | **5.0** | | | | | **Median CV %** | | **3.7** |
| Horseshoe | 08/10/98 | 24.2 | 23.3 | 23.8 | 0.64 | 2.7 | West Medical | 09/15/98 | 12.4 | 12.0 | 12.2 | 0.28 | 2.3 |
| Moses | 08/12/98 | 19.2 | 19.0 | 19.1 | 0.14 | 0.7 | West Medical | 09/15/98 | 11.3 | 11.8 | 11.6 | 0.35 | 3.1 |
| Potholes | 08/13/98 | 17.1 | 20.3 | 18.7 | 2.26 | 12.1 | | | | | **Median CV %** | | **2.7** |
| | | | | **Median CV %** | | **2.7** | | | | | | | |

All chlorophyll a lab splits fall within the acceptable limit of CV less than 10%.

**CHLOROPHYLL A NONSEQUENTIAL DUPLICATES**

| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crescent | 06/08/98 | 0.25 | 0.25 | 0.25 | 0 | 0.0 | Island | 07/25/98 | 3.4 | 3 | 3.2 | 0.283 | 8.8 |
| Island | 06/02/98 | 3.7 | 2.6 | 3.15 | 0.7778 | 24.7 | Leland | 07/30/98 | 4.6 | 4.4 | 4.5 | 0.141 | 3.1 |
| Phillips | 06/02/98 | 0.86 | 0.91 | 0.89 | 0.0354 | 4.0 | Mason | 07/26/98 | 0.25 | 0.73 | 0.49 | 0.339 | 69.3 |
| Spanaway | 06/12/98 | 11 | 8.8 | 9.9 | 1.5556 | 15.7 | West Medical | 07/14/98 | 12.3 | 10.6 | 11.45 | 1.202 | 10.5 |
| | | | | **Median CV %** | | **9.9** | Wildcat | 07/24/98 | 0.71 | 1.4 | 1.055 | 0.488 | 46.2 |
| | | | | | | | | | | | **Median CV %** | | **10.5** |
| Island | 08/17/98 | 4.2 | 4.4 | 4.3 | 0.1414 | 3.3 | Crescent | 09/15/98 | 0.25 | 0.52 | 0.385 | 0.191 | 49.6 |
| Leland | 08/12/98 | 4.8 | 6.8 | 5.8 | 1.4142 | 24.4 | Leland | 09/14/98 | 17.5 | 19.4 | 18.45 | 1.344 | 7.3 |
| West Medical | 08/11/98 | 16.4 | 13.2 | 14.8 | 2.2627 | 15.3 | Long | 09/23/98 | 9.5 | 11.2 | 10.35 | 1.202 | 11.6 |
| Wildcat | 08/18/98 | 0.25 | 2.3 | 1.28 | 1.4496 | 113.7 | West Medical | 09/15/98 | 12.4 | 11.3 | 11.85 | 0.778 | 6.6 |
| | | | | **Median CV %** | | **19.8** | Sutherland | 09/16/98 | 1.1 | 0.83 | 0.965 | 0.191 | 19.8 |
| | | | | | | | | | | | **Median CV %** | | **11.6** |

There is no QAPP standard for chlorophyll a nonsequential duplicates.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

| CHLOROPHYLL A SEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% | Lake | Date | #1 (ug/L) | #2 (ug/L) | Mean | S | CV% |
| Island | 06/02/98 | 2.6 | 3.7 | 3.15 | 0.778 | 24.7 | Island | 07/25/98 | 3 | 2.9 | 2.95 | 0.071 | 2.4 |
| Phillips | 06/02/98 | 0.91 | 1.3 | 1.11 | 0.276 | 25.0 | Leland | 07/30/98 | 4.4 | 5.3 | 4.85 | 0.636 | 13.1 |
| Spanaway | 06/12/98 | 8.8 | 10.2 | 9.5 | 0.990 | 10.4 | Mason | 07/26/98 | 0.73 | 0.25 | 0.49 | 0.339 | 69.3 |
| | | | | **Median CV %** | | **24.7** | West Medical | 07/14/98 | 10.6 | 10.4 | 10.5 | 0.141 | 1.3 |
| | | | | | | | Wildcat | 07/24/98 | 1.4 | 1.2 | 1.3 | 0.141 | 10.9 |
| | | | | | | | | | | | **Median CV %** | | **10.9** |
| | | | | | | | | | | | | | |
| Island | 08/17/98 | 4.4 | 4.8 | 4.6 | 0.283 | 6.1 | Crescent | 09/15/98 | 0.52 | 0.25 | 0.385 | 0.191 | 49.6 |
| Leland | 08/12/98 | 6.8 | 5.6 | 6.2 | 0.849 | 13.7 | Leland | 09/14/98 | 19.4 | 33.5 | 26.45 | 9.970 | 37.7 |
| West Medical | 08/11/98 | 13.2 | 13.8 | 13.5 | 0.424 | 3.1 | Long | 09/23/98 | 11.2 | 12 | 11.6 | 0.566 | 4.9 |
| | | | | **Median CV %** | | **6.1** | West Medical | 09/15/98 | 11.3 | 12.7 | 12 | 0.990 | 8.2 |
| | | | | | | | Sutherland | 09/16/98 | 0.83 | 0.72 | 0.775 | 0.078 | 10.0 |
| | | | | | | | | | | | **Median CV %** | | **10.0** |

August and September data are within the acceptable limit of 10% median CV. June, and July data exceed 10%, failing QAPP requirements.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

**1998 TURBIDITY DATA**

| TURBIDITY LAB SPLITS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lake | Date | #1 (NTU) | #2 (NTU) | Difference | Lake | Date | #1 (NTU) | #2 (NTU) | Difference |
| Ward | 06/02/98 | 0.6 | 0.5 | 0.1 | Liberty | 07/13/98 | 0.8 | 0.9 | 0.1 |
| Island | 06/03/98 | 0.8 | 0.8 | 0.0 | Medical | 07/14/98 | 4.8 | 4.8 | 0.0 |
| Limerick | 06/05/98 | 0.9 | 1.0 | 0.1 | Moses | 07/15/98 | 10.0 | 10.0 | 0.0 |
| Leland | 06/08/98 | 1.0 | 1.0 | 0.0 | Potholes | 07/16/98 | 5.5 | 5.4 | 0.1 |
| Sutherland | 06/09/98 | 0.25 | 0.25 | 0.0 | Ward | 07/24/98 | 1.3 | 1.2 | 0.1 |
| Wildcat | 06/10/98 | 1.2 | 1.2 | 0.0 | Mason | 07/26/98 | 0.25 | 0.25 | 0.0 |
| Long | 06/11/98 | 1.7 | 1.6 | 0.1 | Limerick | 07/27/98 | 1.3 | 1.3 | 0.0 |
| Spanaway | 06/15/98 | 1.6 | 1.6 | 0.0 | Symington | 07/28/98 | 1.2 | 1.2 | 0.0 |
| Wildcat | 06/17/98 | 0.5 | 0.5 | 0.0 | Spanaway | 07/30/98 | 1.5 | 1.4 | 0.1 |
| Moses | 06/18/98 | 13.0 | 13.0 | 0.0 | | | **Maximum difference** | | **0.1** |
| Potholes | 06/19/98 | 2.3 | 2.5 | 0.2 | | | | | |
| | | **Maximum difference =** | | **0.2** | | | | | |
| | | | | | | | | | |
| Ward | 08/10/98 | 0.6 | 0.6 | 0.0 | Horseshoe | 09/14/98 | 0.7 | 0.7 | 0.0 |
| Moses | 08/12/98 | 7.9 | 7.7 | 0.2 | West Medical | 09/15/98 | 0.8 | 0.9 | 0.1 |
| Sutherland | 08/13/98 | 0.25 | 0.25 | 0.0 | Moses | 09/16/98 | 3.0 | 2.6 | 0.4 |
| Symington | 08/17/98 | 2.0 | 2.0 | 0.0 | Phillips | 09/17/98 | 0.9 | 0.9 | 0.0 |
| Wildcat | 08/18/98 | 0.6 | 0.6 | 0.0 | Limerick | 09/18/98 | 0.8 | 0.8 | 0.0 |
| Spanaway | 08/19/98 | 1.5 | 1.6 | 0.1 | Symington | 09/21/98 | 1.8 | 1.8 | 0.0 |
| | | **Maximum difference =** | | **0.2** | Spanaway | 09/23/98 | 1.5 | 1.3 | 0.2 |
| | | | | | Ward | 09/24/98 | 0.6 | 0.6 | 0.0 |
| | | | | | | | **Maximum difference** | | **0.4** |

All turbidity splits are within 0.5 NTU and are considered acceptable.

**Appendix C - Quality Assurance/Quality Control Results for 1998**

| TURBIDITY NONSEQUENTIAL DUPLICATES | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lake | Date | #1 (NTU) | #2 (NTU) | Difference | Mean | S | CV% |
| Leland | 06/05/98 | 1 | 1.1 | 0.1 | 1.05 | 0.1 | 01/06/00 |
| | | | | | | **Median CV %** | **01/06/00** |
| Leland | 08/12/98 | 1.3 | 1.3 | 0 | 1.3 | 0.0 | 01/00/00 |
| | | | | | | **Median CV %** | **01/00/00** |
| Leland | 09/14/98 | 2.1 | 2.1 | 0 | 2.1 | 0.0 | 01/00/00 |
| | | | | | | **Median CV %** | **01/00/00** |

There are no QAPP requirements for turbidity nonsequential duplicates.

# Appendix D

## Hydrolab® Quality Assurance/Quality Control Results for 1998

For details on procedures for evaluating hydrolab® QC data see Ecology's *Lake Water Quality Assessment Project Quality Assurance Project Plan* (in draft) (Hallock, 1995) or see the hydrolab® post-calibration results of any prior Ecology lake water quality assessment program annual report.

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

## HYDROLAB POSTCALIBRATION DATA FOR 1998

| Date | Postcalibration for | DO field check | pH 7 | pH 10 | K | T | DO calibration |
|---|---|---|---|---|---|---|---|
| 6/2/1998 | Ward, Offut | P | P | P | -- | -- | -- |
| 6/4/1998 | Wildcat, Phillips | P | P | P | -- | -- | -- |
| 6/5/1998 | Limerick, Mason | F | P | P | -- | -- | P |
| 6/8/1998 | Crocker, Leland | P | P | -- | -- | -- | P |
| 6/10/1998 | Symington | P | P | P | -- | -- | P |
| 6/12/1998 | Long, Wildcat | P | P | P | -- | -- | -- |
| 6/16/1998 | Spanaway | F | P | P | P | P | P |
| 6/16/1998 | Liberty, Horseshoe | -- | P | P | -- | -- | P |
| 6/17/1998 | Medical, West Medical | -- | P | P | -- | -- | P |
| 6/18/1998 | Moses | -- | P | P | -- | -- | P |
| 6/18/1998 | Potholes | -- | P | P | -- | -- | P |
| 7/14/1998 | Liberty | P | P | P | -- | -- | P |
| 7/14/1998 | Medical, West Medical | -- | P | P | -- | -- | P |
| 7/16/1998 | Moses | P | P | P | -- | -- | P |
| 7/16/1998 | Potholes | P | P | P | -- | -- | P |
| 7/25/1998 | Long, Wildcat | F | P | P | -- | -- | P |
| 7/26/1998 | Island, Phillips | -- | P | P | -- | -- | P |
| 7/27/1998 | Mason | -- | P | P | -- | -- | P |
| 7/28/1998 | Limerick | -- | P | P | -- | -- | P |
| 7/30/1998 | Symington | -- | P | P | -- | -- | P |
| 7/31/1998 | Spanaway, Leland, Crocker | -- | P | P | -- | -- | P |
| 8/4/1998 | Sutherland, Crescent | -- | P | P | P | P | P |
| 8/11/1998 | Liberty, Horseshoe | -- | P | P | -- | -- | P |
| 8/12/1998 | Medical, West Medical | -- | P | P | -- | -- | P |
| 8/12/1998 | Ward, Offut | -- | P | P | P | P | P |
| 8/13/1998 | Leland, Crocker | P | P | P | -- | -- | P |
| 8/13/1998 | Moses | -- | P | P | -- | -- | P |
| 8/17/1998 | Crescent, Sutherland | -- | P | P | -- | -- | P |
| 8/18/1998 | Island, Phillips, Symington | -- | P | P | -- | -- | -- |
| 8/19/1998 | Wildcat, Mason, Limerick | -- | F | F | -- | -- | P |
| 9/14/1998 | Steilacoom | -- | P | P | -- | -- | P |
| 9/15/1998 | Leland, Crocker | -- | P | P | -- | -- | F |
| 9/15/1998 | Liberty, Horseshoe | -- | P | P | -- | -- | P |
| 9/16/1998 | Medical, West Medical | -- | P | P | -- | -- | P |
| 9/16/1998 | Crescent | -- | P | P | -- | -- | F |
| 9/17/1998 | Sutherland | -- | P | P | -- | -- | F |
| 9/17/1998 | Moses, Potholes | -- | P | P | -- | -- | P |
| 9/18/1998 | Island, Phillips | -- | P | P | -- | -- | P |
| 9/21/1998 | Mason, Limerick | -- | P | P | -- | -- | P |
| 9/23/1998 | Wildcat, Symington | P | P | P | -- | -- | F |
| 9/24/1998 | Long, Spanaway | -- | P | P | -- | -- | F |
| ######## | Offut, Ward | -- | P | P | F | P | P |

P = Passes QA/QC requirements
F = Fails QA/QC requirements
-- = No postcalibration done

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

**1998 DISSOLVED OXYGEN HYDROLAB DATA**

| DO NONSEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% | Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
| Island | 0 | 9.75 | 10.11 | 9.93 | 0.254558 | 2.56 | W. Medical | 0 | 8.07 | 7.72 | 7.895 | 0.247487 | 3.13 |
| 6/2/1998 | 1 | 9.73 | 9.88 | 9.805 | 0.106066 | 1.08 | 7/14/1998 | 1 | 7.9 | 7.96 | 7.93 | 0.042426 | 0.54 |
| | 2 | 9.79 | 9.96 | 9.875 | 0.120208 | 1.22 | | 2 | 7.27 | 7.97 | 7.62 | 0.494975 | 6.50 |
| | 3 | 9.87 | 10.02 | 9.945 | 0.106066 | 1.07 | | 4 | 4.63 | 7.43 | 6.03 | 1.979899 | 32.83 |
| | 4 | 10.02 | 10.14 | 10.08 | 0.084853 | 0.84 | | 5 | 1.12 | 3.08 | 2.1 | 1.385929 | 66.00 |
| | 5 | 9.98 | 10.22 | 10.1 | 0.169706 | 1.68 | | 6 | 0.48 | 0.58 | 0.53 | 0.070711 | 13.34 |
| Spanaway | 0 | 11.61 | 11.09 | 11.35 | 0.367696 | 3.24 | | 7 | 0.16 | 0.24 | 0.2 | 0.056569 | 28.28 |
| 6/12/1998 | 1 | 11.6 | 10.94 | 11.27 | 0.46669 | 4.14 | | 8 | 0.15 | 0.18 | 0.165 | 0.021213 | 12.86 |
| | 2 | 11.61 | 11.16 | 11.39 | 0.318198 | 2.79 | Island | 0 | 8.39 | 8.81 | 8.6 | 0.296985 | 3.45 |
| | 3 | 16.45 | 15.19 | 15.82 | 0.890955 | 5.63 | 7/25/1998 | 1 | 8.47 | 8.41 | 8.44 | 0.042426 | 0.50 |
| | 4 | 15.29 | 15.35 | 15.32 | 0.042426 | 0.28 | | 2 | 8.63 | 8.37 | 8.5 | 0.183848 | 2.16 |
| | 5 | 8.94 | 11.15 | 10.05 | 1.562706 | 15.56 | | 3 | 8.48 | 8.4 | 8.44 | 0.056569 | 0.67 |
| | 6 | 3.41 | 2.11 | 2.76 | 0.919239 | 33.31 | | 4 | 8.5 | 8.52 | 8.51 | 0.014142 | 0.17 |
| | | | | **Median CV%** | | **2.56** | | 5 | 8.88 | 8.98 | 8.93 | 0.070711 | 0.79 |
| | | | | | | | Leland | 1 | 7.64 | 7.9 | 7.77 | 0.183848 | 2.37 |
| | | | | | | | 7/30/1998 | 3 | 0.57 | 3.24 | 1.905 | 1.887975 | 99.11 |
| | | | | | | | | | | | **Median CV%** | | **3.29** |
| W. Medical | 0 | 9.05 | 9.31 | 9.18 | 0.183848 | 2.00 | W. Medical | 0 | 9.39 | 10.3 | 9.845 | 0.643467 | 6.54 |
| 8/11/1998 | 1 | 8.9 | 9.29 | 9.095 | 0.275772 | 3.03 | 9/15/1998 | 1 | 10.15 | 9.92 | 10.04 | 0.162635 | 1.62 |
| | 2 | 8.98 | 9.04 | 9.01 | 0.042426 | 0.47 | | 2 | 9.47 | 9.35 | 9.41 | 0.084853 | 0.90 |
| | 3 | 8.85 | 8.65 | 8.75 | 0.141421 | 1.62 | | 3 | 8.89 | 9.22 | 9.055 | 0.233345 | 2.58 |
| | 4 | 8.6 | 8.53 | 8.565 | 0.049497 | 0.58 | | 4 | 8.02 | 8.46 | 8.24 | 0.311127 | 3.78 |
| | 5 | 5.08 | 2.83 | 3.955 | 1.59099 | 40.23 | | 5 | 6.92 | 8.91 | 7.915 | 1.407142 | 17.78 |
| | 6 | 0.36 | 0.41 | 0.385 | 0.035355 | 9.18 | | 6 | 4.09 | 6.72 | 5.405 | 1.859691 | 34.41 |
| | 7 | 0.21 | 0.2 | 0.205 | 0.007071 | 3.45 | | 7 | 0.19 | 0.21 | 0.2 | 0.014142 | 7.07 |
| | 8 | 0.19 | 0.17 | 0.18 | 0.014142 | 7.86 | | 8 | 0.18 | 0.16 | 0.17 | 0.014142 | 8.32 |
| Island | 0 | 7.79 | 8.06 | 7.925 | 0.190919 | 2.41 | Phillips | 1 | 8.61 | 8.92 | 8.765 | 0.219203 | 2.50 |
| 8/17/1998 | 1 | 7.75 | 7.96 | 7.855 | 0.148492 | 1.89 | 9/17/1998 | 4 | 8.51 | 8.82 | 8.665 | 0.219203 | 2.53 |
| | 2 | 7.74 | 7.94 | 7.84 | 0.141421 | 1.80 | | | | | **Median CV%** | | **3.78** |
| | 3 | 7.73 | 7.85 | 7.79 | 0.084853 | 1.09 | | | | | | | |
| | 4 | 7.71 | 7.83 | 7.77 | 0.084853 | 1.09 | | | | | | | |
| | 5 | 7.78 | 7.75 | 7.765 | 0.021213 | 0.27 | | | | | | | |
| | | | | **Median CV%** | | **1.89** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

**DO SEQUENTIAL DUPLICATES**

| Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| Island | 0 | 10.11 | 9.39 | 9.75 | 0.509117 | 5.22 |
| 6/2/1998 | 1 | 9.88 | 9.56 | 9.72 | 0.226274 | 2.33 |
| | 2 | 9.96 | 9.73 | 9.845 | 0.162635 | 1.65 |
| | 3 | 10.02 | 9.89 | 9.955 | 0.091924 | 0.92 |
| | 4 | 10.14 | 10.04 | 10.09 | 0.070711 | 0.70 |
| | 5 | 10.22 | 10.09 | 10.16 | 0.091924 | 0.91 |
| Spanaway | 0 | 11.09 | 10.27 | 10.68 | 0.579828 | 5.43 |
| 6/12/1998 | 1 | 10.94 | 10.67 | 10.81 | 0.190919 | 1.77 |
| | 2 | 11.16 | 11.65 | 11.41 | 0.346482 | 3.04 |
| | 3 | 15.19 | 14.21 | 14.7 | 0.692965 | 4.71 |
| | 4 | 15.35 | 14.18 | 14.77 | 0.827315 | 5.60 |
| | 5 | 11.15 | 8.24 | 9.695 | 2.057681 | 21.22 |
| | 6 | 2.11 | 1.94 | 2.025 | 0.120208 | 5.94 |
| | | | | **Median CV%** | | **3.04** |

| Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| W. Medical | 0 | 7.72 | 7.67 | 7.695 | 0.035355 | 0.46 |
| 7/14/1998 | 1 | 7.96 | 7.8 | 7.88 | 0.113137 | 1.44 |
| | 2 | 7.97 | 7.93 | 7.95 | 0.028284 | 0.36 |
| | 4 | 7.43 | 7.52 | 7.475 | 0.06364 | 0.85 |
| | 5 | 3.08 | 2.96 | 3.02 | 0.084853 | 2.81 |
| | 6 | 0.58 | 0.32 | 0.45 | 0.183848 | 40.86 |
| | 7 | 0.24 | 0.22 | 0.23 | 0.014142 | 6.15 |
| | 8 | 0.18 | 0.17 | 0.175 | 0.007071 | 4.04 |
| Island | 0 | 8.81 | 8.22 | 8.515 | 0.417193 | 4.90 |
| 7/25/1998 | 1 | 8.41 | 8.29 | 8.35 | 0.084853 | 1.02 |
| | 2 | 8.37 | 8.29 | 8.33 | 0.056569 | 0.68 |
| | 3 | 8.4 | 8.28 | 8.34 | 0.084853 | 1.02 |
| | 4 | 8.52 | 8.37 | 8.445 | 0.106066 | 1.26 |
| | 5 | 8.98 | 8.67 | 8.825 | 0.219203 | 2.48 |
| Leland | 1 | 7.9 | 7.68 | 7.79 | 0.155563 | 2.00 |
| 7/30/1998 | 3 | 3.24 | 3.73 | 3.485 | 0.346482 | 9.94 |
| | | | | **Median CV%** | | **1.72** |

| Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| Island | 0 | 8.06 | 7.91 | 7.985 | 0.106066 | 1.32832 |
| 8/17/1998 | 1 | 7.96 | 7.85 | 7.905 | 0.077782 | 0.98396 |
| | 2 | 7.94 | 7.84 | 7.89 | 0.070711 | 0.89621 |
| | 3 | 7.85 | 7.89 | 7.87 | 0.028284 | 0.35939 |
| | 4 | 7.83 | 7.71 | 7.77 | 0.084853 | 1.09206 |
| | 5 | 7.75 | 7.68 | 7.715 | 0.049497 | 0.64157 |
| | | | | **Median CV%** | | **0.94** |

| Lake | Depth | #1 (mg/L) | #2 (mg/L) | Mean | S | CV% |
|---|---|---|---|---|---|---|
| Long | 0 | 7.78 | 7.64 | 7.71 | 0.098995 | 1.284 |
| 9/23/1998 | | | | **Median CV%** | | **1.28** |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

**1998 PH HYDROLAB DATA**

**PH NONSEQUENTIAL DUPLICATES**

| Lake | Depth | #1 | #2 | Mean | S | CV% | Lake | Depth | #1 | #2 | Mean | S | CV% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Island | 0 | 7.77 | 7.26 | 7.515 | 0.360624 | 4.80 | W. Medical | 0 | 9 | 9 | 9 | 0 | 0.00 |
| 6/2/1998 | 1 | 7.77 | 7.38 | 7.575 | 0.275772 | 3.64 | 7/14/1998 | 1 | 9 | 9 | 9 | 0 | 0.00 |
| | 2 | 7.75 | 7.45 | 7.6 | 0.212132 | 2.79 | | 2 | 9 | 9 | 9 | 0 | 0.00 |
| | 3 | 7.75 | 7.5 | 7.625 | 0.176777 | 2.32 | | 4 | 8.9 | 9 | 8.95 | 0.070711 | 0.79 |
| | 4 | 7.76 | 7.54 | 7.65 | 0.155563 | 2.03 | | 5 | 8.6 | 8.8 | 8.7 | 0.141421 | 1.63 |
| | 5 | 7.72 | 7.46 | 7.59 | 0.183848 | 2.42 | | 6 | 8.5 | 8.5 | 8.5 | 0 | 0.00 |
| Spanaway | 0 | 8.95 | 8.93 | 8.94 | 0.014142 | 0.16 | | 7 | 8.2 | 8.2 | 8.2 | 0 | 0.00 |
| 6/12/1998 | 1 | 8.98 | 8.96 | 8.97 | 0.014142 | 0.16 | | 8 | 8 | 8 | 8 | 0 | 0.00 |
| | 2 | 8.97 | 8.97 | 8.97 | 0 | 0.00 | Island | 0 | 7.5 | 7.4 | 7.45 | 0.070711 | 0.95 |
| | 3 | 8.19 | 8.47 | 8.33 | 0.19799 | 2.38 | 7/25/1998 | 1 | 7.5 | 7.5 | 7.5 | 0 | 0.00 |
| | 4 | 7.32 | 7.99 | 7.655 | 0.473762 | 6.19 | | 2 | 7.5 | 7.5 | 7.5 | 0 | 0.00 |
| | 5 | 6.69 | 7.29 | 6.99 | 0.424264 | 6.07 | | 3 | 7.5 | 7.5 | 7.5 | 0 | 0.00 |
| | 6 | 6.44 | 6.43 | 6.435 | 0.007071 | 0.11 | | 4 | 7.5 | 7.5 | 7.5 | 0 | 0.00 |
| | | | | **Median CV%** | | **2.38** | | 5 | 7.5 | 7.7 | 7.6 | 0.141421 | 1.86 |
| | | | | | | | Leland | 1 | 7.3 | 7.5 | 7.4 | 0.141421 | 1.91 |
| | | | | | | | 7/30/1998 | 3 | 6.5 | 6.7 | 6.6 | 0.141421 | 2.14 |
| | | | | | | | | | | | **Median CV%** | | **0.00** |
| W. Medical | 0 | 9.1 | 9.1 | 9.1 | 0 | 0.00 | W. Medical | 0 | 9.1 | 9.1 | 9.1 | 0 | 0.00 |
| 8/11/1998 | 1 | 9.1 | 9.1 | 9.1 | 0 | 0.00 | 9/15/1998 | 1 | 9.1 | 9.1 | 9.1 | 0 | 0.00 |
| | 2 | 9.1 | 9.1 | 9.1 | 0 | 0.00 | | 2 | 9.1 | 9.1 | 9.1 | 0 | 0.00 |
| | 3 | 9.1 | 9.1 | 9.1 | 0 | 0.00 | | 3 | 9.1 | 9.1 | 9.1 | 0 | 0.00 |
| | 4 | 9.1 | 9.1 | 9.1 | 0 | 0.00 | | 4 | 9.1 | 9.1 | 9.1 | 0 | 0.00 |
| | 5 | 9 | 8.9 | 8.95 | 0.070711 | 0.79 | | 5 | 9 | 9.1 | 9.05 | 0.070711 | 0.78 |
| | 6 | 8.6 | 8.7 | 8.65 | 0.070711 | 0.82 | | 6 | 9 | 9 | 9 | 0 | 0.00 |
| | 7 | 8.3 | 8.3 | 8.3 | 0 | 0.00 | | 7 | 8.7 | 8.8 | 8.75 | 0.070711 | 0.81 |
| | 8 | 8.1 | 8 | 8.05 | 0.070711 | 0.88 | | 8 | 8.1 | 7.9 | 8 | 0.141421 | 1.77 |
| Island | 0 | 7.4 | 7.1 | 7.25 | 0.212132 | 2.93 | Phillips | 1 | 7.1 | 7.5 | 7.3 | 0.282843 | 3.87 |
| 8/17/1998 | 1 | 7.4 | 7.1 | 7.25 | 0.212132 | 2.93 | 9/17/1998 | 4 | 7.1 | 7.4 | 7.25 | 0.212132 | 2.93 |
| | 2 | 7.4 | 7.1 | 7.25 | 0.212132 | 2.93 | | | | | **Median CV%** | | **0.00** |
| | 3 | 7.4 | 7.1 | 7.25 | 0.212132 | 2.93 | | | | | | | |
| | 4 | 7.3 | 7.1 | 7.2 | 0.141421 | 1.96 | | | | | | | |
| | 5 | 7.3 | 7.1 | 7.2 | 0.141421 | 1.96 | | | | | | | |
| | | | | **Median CV%** | | **0.82** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

| PH SEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 | #2 | Mean | S | CV% | Lake | Depth | #1 | #2 | Mean | S | CV% |
| Island | 0 | 7.26 | 7.79 | 7.525 | 0.374767 | 4.98 | W. Medical | 0 | 9 | 9 | 9 | 0 | 0.00 |
| 6/2/1998 | 1 | 7.38 | 7.78 | 7.58 | 0.282843 | 3.73 | 7/14/1998 | 1 | 9 | 9 | 9 | 0 | 0.00 |
| | 2 | 7.45 | 7.78 | 7.615 | 0.233345 | 3.06 | | 2 | 9 | 9.1 | 9.05 | 0.070711 | 0.78 |
| | 3 | 7.5 | 7.77 | 7.635 | 0.190919 | 2.50 | | 4 | 9 | 9 | 9 | 0 | 0.00 |
| | 4 | 7.54 | 7.72 | 7.63 | 0.127279 | 1.67 | | 5 | 8.8 | 8.8 | 8.8 | 0 | 0.00 |
| | 5 | 7.46 | 7.64 | 7.55 | 0.127279 | 1.69 | | 6 | 8.5 | 8.5 | 8.5 | 0 | 0.00 |
| Spanaway | 0 | 8.93 | 8.92 | 8.925 | 0.007071 | 0.08 | | 7 | 8.2 | 8.2 | 8.2 | 0 | 0.00 |
| 6/12/1998 | 1 | 8.96 | 8.97 | 8.965 | 0.007071 | 0.08 | | 8 | 8 | 8 | 8 | 0 | 0.00 |
| | 2 | 8.97 | 8.91 | 8.94 | 0.042426 | 0.47 | Island | 0 | 7.4 | 7.3 | 7.35 | 0.070711 | 0.96 |
| | 3 | 8.47 | 8.53 | 8.5 | 0.042426 | 0.50 | 7/25/1998 | 1 | 7.5 | 7.4 | 7.45 | 0.070711 | 0.95 |
| | 4 | 7.99 | 8.02 | 8.005 | 0.021213 | 0.26 | | 2 | 7.5 | 7.4 | 7.45 | 0.070711 | 0.95 |
| | 5 | 7.29 | 7.24 | 7.265 | 0.035355 | 0.49 | | 3 | 7.5 | 7.4 | 7.45 | 0.070711 | 0.95 |
| | 6 | 6.43 | 6.42 | 6.425 | 0.007071 | 0.11 | | 4 | 7.5 | 7.4 | 7.45 | 0.070711 | 0.95 |
| | | | | **Median CV%** | | **0.50** | | 5 | 7.7 | 7.6 | 7.65 | 0.070711 | 0.92 |
| | | | | | | | Leland | 1 | 7.5 | 7.2 | 7.35 | 0.212132 | 2.89 |
| | | | | | | | 7/30/1998 | 3 | 6.7 | 6.8 | 6.75 | 0.070711 | 1.05 |
| | | | | | | | | | | | **Median CV%** | | **0.85** |
| Island | 0 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | Long | 0 | 7.9 | 7.9 | 7.9 | 0 | 0.00 |
| 8/17/1998 | 1 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | 9/23/1998 | | | | **Median CV%** | | **0.00** |
| | 2 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | | | | | | | |
| | 3 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | | | | | | | |
| | 4 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | | | | | | | |
| | 5 | 7.1 | 7.1 | 7.1 | 0 | 0.00 | | | | | | | |
| | | | | **Median CV%** | | **0.00** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

**1998 TEMPERATURE HYDROLAB DATA**

| TEMPERATURE NONSEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 (C) | #2 (C) | Mean | S | CV% | Lake | Depth | #1 (C) | #2 (C) | Mean | S | CV% |
| Island | 0 | 17.24 | 17.34 | 17.29 | 0.070711 | 0.41 | W. Medical | 0 | 22 | 22.2 | 22.1 | 0.141421 | 0.64 |
| 6/2/1998 | 1 | 17.12 | 17.03 | 17.075 | 0.06364 | 0.37 | 7/14/1998 | 1 | 21.9 | 22.1 | 22 | 0.141421 | 0.64 |
| | 2 | 17.03 | 16.98 | 17.005 | 0.035355 | 0.21 | | 2 | 21.8 | 21.8 | 21.8 | 0 | 0.00 |
| | 3 | 16.98 | 16.93 | 16.955 | 0.035355 | 0.21 | | 4 | 20.9 | 21.7 | 21.3 | 0.565685 | 2.66 |
| | 4 | 16.85 | 16.76 | 16.805 | 0.06364 | 0.38 | | 5 | 19.3 | 20 | 19.65 | 0.494975 | 2.52 |
| | 5 | 16.19 | 15.99 | 16.09 | 0.141421 | 0.88 | | 6 | 17.2 | 16.6 | 16.9 | 0.424264 | 2.51 |
| Spanaway | 0 | 19.37 | 19.46 | 19.415 | 0.06364 | 0.33 | | 7 | 14.4 | 14.2 | 14.3 | 0.141421 | 0.99 |
| 6/12/1998 | 1 | 19.06 | 19.34 | 19.2 | 0.19799 | 1.03 | | 8 | 12.8 | 12.3 | 12.55 | 0.353553 | 2.82 |
| | 2 | 18.77 | 18.96 | 18.865 | 0.13435 | 0.71 | Island | 0 | 23 | 23.5 | 23.25 | 0.353553 | 1.52 |
| | 3 | 16.51 | 17 | 16.755 | 0.346482 | 2.07 | 7/25/1998 | 1 | 22.8 | 22.9 | 22.85 | 0.070711 | 0.31 |
| | 4 | 14.82 | 15.14 | 14.98 | 0.226274 | 1.51 | | 2 | 22.6 | 22.8 | 22.7 | 0.141421 | 0.62 |
| | 5 | 13.51 | 13.01 | 13.26 | 0.353553 | 2.67 | | 3 | 22.6 | 22.6 | 22.6 | 0 | 0.00 |
| | 6 | 12.4 | 12.24 | 12.32 | 0.113137 | 0.92 | | 4 | 22.5 | 22.5 | 22.5 | 0 | 0.00 |
| | | | | **Median CV%** | | **0.71** | | 5 | 21.5 | 21.9 | 21.7 | 0.282843 | 1.30 |
| | | | | | | | Leland | 1 | 25.4 | 26 | 25.7 | 0.424264 | 1.65 |
| | | | | | | | 7/30/1998 | 3 | 20.7 | 21.2 | 20.95 | 0.353553 | 1.69 |
| | | | | | | | | | | | **Median CV%** | | **1.15** |
| W. Medical | 0 | 24.1 | 24.3 | 24.2 | 0.141421 | 0.58 | W. Medical | 0 | 21 | 21.1 | 21.05 | 0.070711 | 0.34 |
| 8/11/1998 | 1 | 23.7 | 24.1 | 23.9 | 0.282843 | 1.18 | 9/15/1998 | 1 | 20.6 | 20.7 | 20.65 | 0.070711 | 0.34 |
| | 2 | 23.7 | 23.9 | 23.8 | 0.141421 | 0.59 | | 2 | 20.5 | 20.6 | 20.55 | 0.070711 | 0.34 |
| | 3 | 23.6 | 23.7 | 23.65 | 0.070711 | 0.30 | | 3 | 20.3 | 20.5 | 20.4 | 0.141421 | 0.69 |
| | 4 | 23.6 | 23.6 | 23.6 | 0 | 0.00 | | 4 | 20.2 | 20.3 | 20.25 | 0.070711 | 0.35 |
| | 5 | 22.9 | 22.3 | 22.6 | 0.424264 | 1.88 | | 5 | 20.1 | 20.1 | 20.1 | 0 | 0.00 |
| | 6 | 19.4 | 20.6 | 20 | 0.848528 | 4.24 | | 6 | 20 | 20 | 20 | 0 | 0.00 |
| | 7 | 16.1 | 16.6 | 16.35 | 0.353553 | 2.16 | | 7 | 18.9 | 19.2 | 19.05 | 0.212132 | 1.11 |
| | 8 | 13.3 | 12.9 | 13.1 | 0.282843 | 2.16 | | 8 | 15.6 | 15 | 15.3 | 0.424264 | 2.77 |
| Island | 0 | 22.6 | 22.6 | 22.6 | 0 | 0.00 | Phillips | 1 | 22 | 21.8 | 21.9 | 0.141421 | 0.65 |
| 8/17/1998 | 1 | 22.7 | 22.6 | 22.65 | 0.070711 | 0.31 | 9/17/1998 | 4 | 21.6 | 21.6 | 21.6 | 0 | 0.00 |
| | 2 | 22.6 | 22.6 | 22.6 | 0 | 0.00 | | | | | **Median CV%** | | **0.34** |
| | 3 | 22.6 | 22.5 | 22.55 | 0.070711 | 0.31 | | | | | | | |
| | 4 | 22.6 | 22.5 | 22.55 | 0.070711 | 0.31 | | | | | | | |
| | 5 | 22.6 | 22.5 | 22.55 | 0.070711 | 0.31 | | | | | | | |
| | | | | **Median CV%** | | **0.31** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

| TEMPERATURE SEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 (C) | #2 (C) | Mean | S | CV% | Lake | Depth | #1 (C) | #2 (C) | Mean | S | CV% |
| Island | 0 | 17.34 | 17.29 | 17.315 | 0.035355 | 0.20 | W. Medical | 0 | 22.2 | 22.2 | 22.2 | 0 | 0.00 |
| 6/2/1998 | 1 | 17.03 | 17.08 | 17.055 | 0.035355 | 0.21 | 7/14/1998 | 1 | 22.1 | 22.1 | 22.1 | 0 | 0.00 |
| | 2 | 16.98 | 16.97 | 16.975 | 0.007071 | 0.04 | | 2 | 21.8 | 21.8 | 21.8 | 0 | 0.00 |
| | 3 | 16.93 | 16.93 | 16.93 | 0 | 0.00 | | 4 | 21.7 | 21.6 | 21.65 | 0.070711 | 0.33 |
| | 4 | 16.76 | 16.59 | 16.675 | 0.120208 | 0.72 | | 5 | 20 | 19.8 | 19.9 | 0.141421 | 0.71 |
| | 5 | 15.99 | 16.04 | 16.015 | 0.035355 | 0.22 | | 6 | 16.6 | 16.3 | 16.45 | 0.212132 | 1.29 |
| Spanaway | 0 | 19.46 | 19.56 | 19.51 | 0.070711 | 0.36 | | 7 | 14.2 | 14.1 | 14.15 | 0.070711 | 0.50 |
| 6/12/1998 | 1 | 19.34 | 19.46 | 19.4 | 0.084853 | 0.44 | | 8 | 12.3 | 12.4 | 12.35 | 0.070711 | 0.57 |
| | 2 | 18.96 | 18.87 | 18.915 | 0.06364 | 0.34 | Island | 0 | 23.5 | 23.6 | 23.55 | 0.070711 | 0.30 |
| | 3 | 17 | 17.13 | 17.065 | 0.091924 | 0.54 | 7/25/1998 | 1 | 22.9 | 23 | 22.95 | 0.070711 | 0.31 |
| | 4 | 15.14 | 15.17 | 15.155 | 0.021213 | 0.14 | | 2 | 22.8 | 22.9 | 22.85 | 0.070711 | 0.31 |
| | 5 | 13.01 | 13.11 | 13.06 | 0.070711 | 0.54 | | 3 | 22.6 | 22.7 | 22.65 | 0.070711 | 0.31 |
| | 6 | 12.24 | 12.24 | 12.24 | 0 | 0.00 | | 4 | 22.5 | 22.5 | 22.5 | 0 | 0.00 |
| | | | | **Median CV%** | | **0.22** | | 5 | 21.9 | 22 | 21.95 | 0.070711 | 0.32 |
| | | | | | | | Leland | 1 | 26 | 26 | 26 | 0 | 0.00 |
| | | | | | | | 7/30/1998 | 3 | 21.2 | 21.4 | 21.3 | 0.141421 | 0.66 |
| | | | | | | | | | | | **Median CV%** | | **0.31** |
| | | | | | | | | | | | | | |
| Island | 0 | 22.6 | 22.6 | 22.6 | 0 | 0.00 | Long | 0 | 20.3 | 21 | 20.65 | 0.494975 | 2.40 |
| 8/17/1998 | 1 | 22.6 | 22.6 | 22.6 | 0 | 0.00 | 9/23/1998 | | | | **Median CV%** | | **2.40** |
| | 2 | 22.6 | 22.6 | 22.6 | 0 | 0.00 | | | | | | | |
| | 3 | 22.5 | 22.5 | 22.5 | 0 | 0.00 | | | | | | | |
| | 4 | 22.5 | 22.5 | 22.5 | 0 | 0.00 | | | | | | | |
| | 5 | 22.5 | 22.5 | 22.5 | 0 | 0.00 | | | | | | | |
| | | | | **Median CV%** | | **0.00** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

**1998 CONDUCTIVITY HYDROLAB DATA**

| CONDUCTIVITY NONSEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 (uS/cm | #2 (uS/cm | Mean | S | CV% | Lake | Depth | #1 (uS/cm | #2 (uS/cm | Mean | S | CV% |
| Island | 0 | 40.8 | 40.8 | 40.8 | 0 | 0.00 | W. Medical | 0 | 817 | 820 | 818.5 | 2.12132 | 0.26 |
| 6/2/1998 | 1 | 40.8 | 40.7 | 40.75 | 0.070711 | 0.17 | 7/14/1998 | 1 | 818 | 820 | 819 | 1.414214 | 0.17 |
| | 2 | 40.8 | 40.7 | 40.75 | 0.070711 | 0.17 | | 2 | 818 | 820 | 819 | 1.414214 | 0.17 |
| | 3 | 40.8 | 40.7 | 40.75 | 0.070711 | 0.17 | | 4 | 818 | 822 | 820 | 2.828427 | 0.34 |
| | 4 | 40.6 | 40.6 | 40.6 | 0 | 0.00 | | 5 | 823 | 818 | 820.5 | 3.535534 | 0.43 |
| | 5 | 40.2 | 40.5 | 40.35 | 0.212132 | 0.53 | | 6 | 827 | 824 | 825.5 | 2.12132 | 0.26 |
| Spanaway | 0 | 107.1 | 105.9 | 106.5 | 0.848528 | 0.80 | | 7 | 833 | 842 | 837.5 | 6.363961 | 0.76 |
| 6/12/1998 | 1 | 107.2 | 107.2 | 107.2 | 0 | 0.00 | | 8 | 836 | 844 | 840 | 5.656854 | 0.67 |
| | 2 | 106.9 | 106.8 | 106.85 | 0.070711 | 0.07 | Island | 1 | 42 | 42 | 42 | 0 | 0.00 |
| | 3 | 106.6 | 106.2 | 106.4 | 0.282843 | 0.27 | 7/25/1998 | 2 | 42 | 42 | 42 | 0 | 0.00 |
| | 4 | 110.7 | 109.3 | 110 | 0.989949 | 0.90 | | 3 | 42 | 42 | 42 | 0 | 0.00 |
| | 5 | 113 | 117.2 | 115.1 | 2.969848 | 2.58 | | 4 | 42 | 42 | 42 | 0 | 0.00 |
| | 6 | 118.3 | 125.7 | 122 | 5.23259 | 4.29 | | 5 | 42 | 42 | 42 | 0 | 0.00 |
| | | | | **Median CV%** | | **0.17** | Leland | 1 | 64 | 64 | 64 | 0 | 0.00 |
| | | | | | | | 7/30/1998 | 3 | 66 | 71 | 68.5 | 3.535534 | 5.16 |
| | | | | | | | | | | | **Median CV%** | | **0.17** |
| 8/11/1998 | 1 | 865 | 866 | 865.5 | 0.707107 | 0.08 | 9/15/1998 | 1 | 872 | 870 | 871 | 1.414214 | 0.16 |
| | 2 | 866 | 866 | 866 | 0 | 0.00 | | 2 | 869 | 871 | 870 | 1.414214 | 0.16 |
| | 3 | 867 | 866 | 866.5 | 0.707107 | 0.08 | | 3 | 869 | 870 | 869.5 | 0.707107 | 0.08 |
| | 4 | 867 | 867 | 867 | 0 | 0.00 | | 4 | 869 | 871 | 870 | 1.414214 | 0.16 |
| | 5 | 869 | 868 | 868.5 | 0.707107 | 0.08 | | 5 | 872 | 871 | 871.5 | 0.707107 | 0.08 |
| | 6 | 873 | 864 | 868.5 | 6.363961 | 0.73 | | 6 | 874 | 872 | 873 | 1.414214 | 0.16 |
| | 7 | 879 | 870 | 874.5 | 6.363961 | 0.73 | | 7 | 883 | 879 | 881 | 2.828427 | 0.32 |
| | 8 | 896 | 915 | 905.5 | 13.43503 | 1.48 | | 8 | 935 | 946 | 940.5 | 7.778175 | 0.83 |
| Island | 0 | 45 | 45 | 45 | 0 | 0.00 | Phillips | 1 | 26 | 27 | 26.5 | 0.707107 | 2.67 |
| 8/17/1998 | 1 | 45 | 45 | 45 | 0 | 0.00 | 9/17/1998 | 4 | 27 | 27 | 27 | 0 | 0.00 |
| | 2 | 45 | 45 | 45 | 0 | 0.00 | | | | | **Median CV%** | | **0.16** |
| | 3 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | 4 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | 5 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | | | | **Median CV%** | | **0.00** | | | | | | | |

**Appendix D - Hydrolab Quality Assurance/Quality Control Results for 1998**

| CONDUCTIVITY SEQUENTIAL DUPLICATES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | Depth | #1 (uS/cm | #2 (uS/cm | Mean | S | CV% | Lake | Depth | #1 (uS/cm | #2 (uS/cm | Mean | S | CV% |
| Island | 0 | 40.8 | 40.8 | 40.8 | 0 | 0.00 | W. Medical | 0 | 820 | 819 | 819.5 | 0.707107 | 0.09 |
| 6/2/1998 | 1 | 40.7 | 40.6 | 40.65 | 0.070711 | 0.17 | 7/14/1998 | 1 | 820 | 817 | 818.5 | 2.12132 | 0.26 |
| | 2 | 40.7 | 40.7 | 40.7 | 0 | 0.00 | | 2 | 820 | 814 | 817 | 4.242641 | 0.52 |
| | 3 | 40.7 | 40.6 | 40.65 | 0.070711 | 0.17 | | 4 | 822 | 824 | 823 | 1.414214 | 0.17 |
| | 4 | 40.6 | 40.6 | 40.6 | 0 | 0.00 | | 5 | 818 | 826 | 822 | 5.656854 | 0.69 |
| | 5 | 40.5 | 40.4 | 40.45 | 0.070711 | 0.17 | | 6 | 824 | 820 | 822 | 2.828427 | 0.34 |
| Spanaway | 0 | 105.9 | 107.2 | 106.55 | 0.919239 | 0.86 | | 7 | 842 | 841 | 841.5 | 0.707107 | 0.08 |
| 6/12/1998 | 1 | 107.2 | 107.2 | 107.2 | 0 | 0.00 | | 8 | 844 | 858 | 851 | 9.899495 | 1.16 |
| | 2 | 106.8 | 107 | 106.9 | 0.141421 | 0.13 | Island | 1 | 42 | 42 | 42 | 0 | 0.00 |
| | 3 | 106.2 | 106.2 | 106.2 | 0 | 0.00 | 7/25/1998 | 2 | 42 | 42 | 42 | 0 | 0.00 |
| | 4 | 109.3 | 110.2 | 109.75 | 0.636396 | 0.58 | | 3 | 42 | 42 | 42 | 0 | 0.00 |
| | 5 | 117.2 | 116.1 | 116.65 | 0.777817 | 0.67 | | 4 | 42 | 42 | 42 | 0 | 0.00 |
| | 6 | 125.7 | 125.2 | 125.45 | 0.353553 | 0.28 | | 5 | 42 | 42 | 42 | 0 | 0.00 |
| | | | | **Median CV%** | | **0.17** | | 1 | 64 | 64 | 64 | 0 | 0.00 |
| | | | | | | | Leland | 3 | 71 | 70 | 70.5 | 0.707107 | 1.00 |
| | | | | | | | 7/30/1998 | | | | **Median CV%** | | **0.09** |
| Island | 0 | 45 | 45 | 45 | 0 | 0.00 | Long | 0 | 98 | 98 | 98 | 0 | 0.00 |
| 8/17/1998 | 1 | 45 | 45 | 45 | 0 | 0.00 | 9/23/1998 | | | | **Median CV%** | | **0.00** |
| | 2 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | 3 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | 4 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | 5 | 45 | 45 | 45 | 0 | 0.00 | | | | | | | |
| | | | | **Median CV%** | | **0.00** | | | | | | | |