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Quality Assurance Project Plan
for
Loon Lake Citizen Monitoring Program PLAN I

Grant Number G0800014

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Prepared for
Loon Lk. Property Owners Association
and
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Table of Contents

Background

Loon Lake is a kettle lake located in southeastern Stevens County approximately 28 miles northeast of Spokane, Washington. It has a surface area of approximately 1100 acres, a volume of around 57,000 acre-feet, and a maximum depth of 103 feet (Figure 1). There are five intermittent inlet/wetland tributaries and a regulated man-made outlet which is a tributary to the Colville River via Sheep Creek. The lake level is controlled with a weir gate by Department of Ecology to maintain a maximum level established by Stevens County Superior Court at an elevation of 2,381.25 feet (NVG29). About 70 percent of the watershed is forested or uncultivated, but more than 80 percent of the shoreline has been developed for residences.

Water quality studies conducted on Loon Lake in the 1970's and 80's documented reduced water clarity and lack of hypolimnetic dissolved oxygen in the summer (Singleton *et al*, 1980). These studies helped initiate the installation of a sewer collection system around a majority of the lake to eliminate nutrient pollution from on-site septic systems. More recent fishery management studies for Washington Department of Fish and Wildlife continue to point to an anoxic hypolimnion limiting Loon Lake salmonid habitat (Scholz *et al*, 1988, McClellan *et al*, 2005). However, there has been a lack of systematic monitoring of the lake which could be used to better quantify the timing and extent of dissolved oxygen declines and changes in nutrient concentrations. The Loon Lake Property Owners Association (LLPOA) have taken the local initiative to begin a limited lake monitoring program in an attempt to acquire more updated and complete water quality information on a continuing basis.

Project Description

There has been little systematic monitoring of Loon Lake water quality in the last ten years or more even though much effort has been spent in the past to improve water quality. In recent years substantial amounts of money from Ecology grants with local match from the Loon Lake Management District has been spent to control milfoil in the lake. The citizen's lake monitoring project will provide long-term monthly monitoring of lake water quality during the summer stratification to better document changes in water quality.

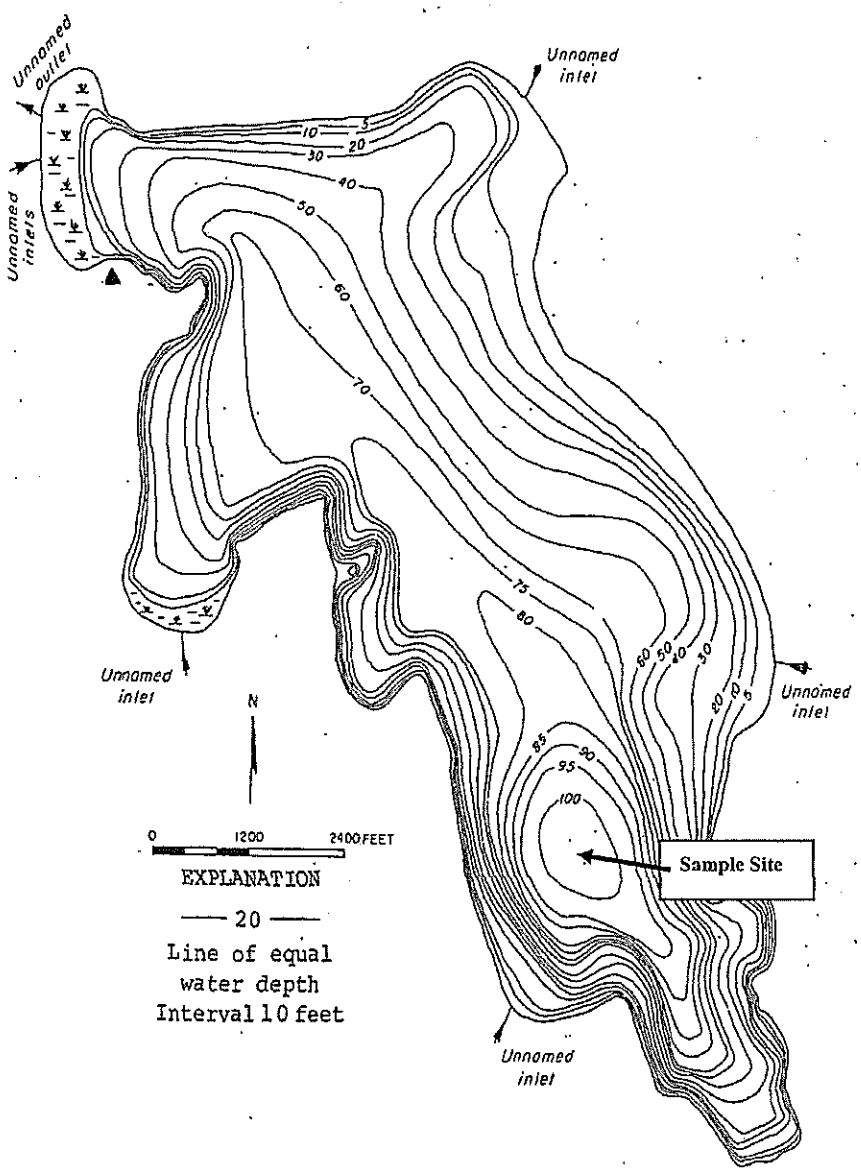
The monitoring project will be very limited in the scope of parameters due to available funds and manpower. However it is felt that with good quality control in place, the monitoring design will provide a credible basis for quantifying trends and better understanding potential changes in water clarity, primary productivity (algae), nutrients levels, and dissolved oxygen.

The proposed monitoring will use a Hydrolab® data sonde to measure water column dissolved oxygen, pH, temperature, and conductivity at the deepest location in the lake. Composite samples will be collected from each lake stratum for total phosphorus and total nitrogen. Secchi Disk measurements and chlorophyll a samples will be collected from the upper layer (epilimnion) to quantify changes in clarity and primary productivity.

2003

It is anticipated that information obtained from the long-term monitoring will be used to help guide future fishery and watershed management decisions for protection and restoration that will likely need to be made as recreational and residential development increase in the watershed.

Figure 1. Bathymetric map of Loon Lake, Washington with monitoring location.



Loon Lake, Stevens County. From Washington Department of Game, February 14, 1955.

The long-term monitoring results will help guide any future studies that may follow if collected data continues to confirm the declining trend of cold water fishery habitat reported in previous fishery studies.

Organization and Schedule

Loon Lake long term monitoring is designed to occur annually during summer stratification as long as there is local commitment to continue sampling and funding the lab analyses. Jim Davies has been the lead in obtaining the initial Husseman Grant money to purchase the Hydrolab data sonde and will serve as the Loon Lake Property Owners Association (LLPOA) primary contact for lake monitoring activities. A core team of volunteers have been trained by WA Fish and Wildlife and Ecology staff to calibrate and operate the Hydrolab and collect lake samples (see list below). Jim Davies also attended a training workshop conducted by Hach/Hydrolab technical staff in September of 2007. Sampling and Hydrolab operation will be performed by trained volunteers.

Laboratory analysis will be conducted by a laboratory accredited for the analyses methods required in this document. The contract for lab services will be finalized by the end April each year.

Schedule

- QA project plan – Final Approval April 2008
- Sampling – Ongoing annually May-September
- Annual Data Summary Report – Spring Summary Report to LLPOA

SAMPLING TEAM LIST - LOON LAKE WATER QUALITY MONITORING PROGRAM

			QUALIFICATIONS	
Name	telephone #	e-Mail	OJT	HYDR
Jim Davies*	233-2651	[illegible]	X	X
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Bob French**	233-8331	[illegible]	X	X
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Charlie ?,

X= qualified, 0= not qualified, x= partially qualified

*Team Leader, ** Asst. Team Leader,*** On standby for future training

Quality Objectives

The quality objectives were primarily based on those previously developed for the Lake Tapps monitoring program by Dave Hallock (2004). Data quality objectives (DQOs) for the critical measurements (Secchi depth, TP, TN, and chlorophyll *a*) are included in Table 1.

All analytical parameters must be analyzed by a laboratory accredited by the State of Washington for those specific parameters, as per Ecology Executive Policy 1-22.

Limit of Detection*

Secchi Depth

The limit of detection is not applicable to Secchi depth data.

Total Phosphorus

An adequate limit of detection is particularly important for TP measurements especially when you are trying to identify trends. The lowest concentration reported in 2007 was above 8 µg/L. It would be preferred to have the limit of detection well below 5 µg/L, but it is unrealistic with a colorimetric test. With diligent quality control, the lab should achieve a reporting limit below 8 µg/L.

Chlorophyll *a*

Low values for chlorophyll *a* are also frequently encountered. However, chlorophyll *a* detection limits are less critical than those for TP. A detection limit near the fifth percentile of monitored lakes should be adequate (0.5 µg/L).

Total Persulfate Nitrogen

Although TN is not in itself a critical measurement, results are used to determine nutrient limitation status (*i.e.*, phosphorus or nitrogen). Therefore, the detection limit should be comparable as low as possible. Standard Methods states TPN detection limit is 20 ug/L. Ecology's Manchester lab reports a MDL of 25 ug/L.

*Note: Because the different methods for calculating detection limit yield widely different results, any contract lab should establish method detection limits per 40CFR 136, Federal Register, October 26, 1984

Precision

The percent coefficient of variation (CV%) for a given set of duplicate **Secchi disk** readings should not exceed 10 percent. The relative percent difference for the entire set of duplicate readings should not exceed five percent.

The relative percent difference for lab split samples for phosphorus, nitrogen and chlorophyll *a* should not exceed 20 percent. Total precision from field duplicate samples should be ≤ 25 percent (Table 1).

Bias

There are no reference standards for Secchi depth; however, volunteer-collected Secchi readings should be with 10 percent of Ecology staff-collected readings.

The bias for analytical parameters based on lab control standards should be within ±20 percent recovery. Bias will also be evaluated by the use of matrix spikes. A ~25 µg/L spike is suggested. Recoveries should be between 80 and 120 percent.

Table 1. Measurement Quality Objectives of Lab Analyses

Parameter	Lab control Standard (LCS)	Field Duplicate Samples	Matrix Spikes	Matrix Spike-Duplicates	Surrogate Standards	Lowest Concentrations of Interest
	% Recovery Limits	Relative Percent Difference (RPD)	% Recovery Limits	Relative Percent Difference (RPD)	% Recovery Limits	Units of Concentration
Total Phosphorus	80–120	≤25	80-120	≤20	NA	5 ug/L
Total Persulfate Nitrogen	80–120	≤25	80-120	≤20	NA	20 ug/L
chlorophyll *a*	80–120	≤25	80-120	≤20	NA	2 ug/L

Comparability

For future trend analyses, comparability of the results is very important. Documented standard sampling procedures will be used. The analytical method will be selected to provide results with minimum bias and good precision and the data quality will be carefully documented. These methods should be used consistently throughout the project unless it clearly shown that a new method will be more accurate and precise.

Sampling Rationale and Design

The sampling design is based on the goal of determining long-term trends in dissolved oxygen and nutrients through the summer stratified lake water column (mid-May through September). A recently purchased Hydrolab® submersible data sonde will be used to collect temperature, pH, conductivity, and dissolved oxygen at one meter intervals from surface to sixteen meters and two meter intervals from sixteen meters to near the bottom.

To reduce laboratory analytical costs, depth-weighted composite samples will be collected for phosphorus and nitrogen from designated depths which have been determined to be generally representative of Loon Lake's epilimnion, metalimnion and hypolimnion over the deepest point in the lake. Average algae production will be monitored with one depth-weighted composite sample for Chlorophyll *a* collected from the top five meters of the euphotic zone. Water clarity will be measured using a standard Secchi disk (see Table 2). Very low analytical detection limits were chosen for the nutrients due to anticipated low concentrations and to reduce the magnitude of uncertainty introduced into the data set by analytical variability.

Table 2. Loon Lake Citizen Monitoring Plan

PARAMETER	FREQUENCY	RANGE		UNIT	METHOD
		Min	Max		
Secchi Disk Depth in meters	**3 sample excursions per year: mid-May, mid-July, and late Sept** **Lake profiles will be conducted at approximately 4-week intervals May-September**	1	40	meters	20 cm diameter limnological
Total Nitrogen* Epilimnion Composite 1,3,5 M Metalimnion Composite 9,12,15 M Hypolimnion Composite 21,24,27 M		<25	500	µg/L	Total Persulfate Nitrogen
Total Phosphorus* Epilimnion Composite 1,3,5 M Metalimnion Composite 9,12,15 M Hypolimnion Composite 21,24,27 M		<5	100	µg/L	Stannous Chloride
Chlorophyll *a** Epilimnion Composite 1,3,5 M		<1	25	µg/L	Spectro-photometric
Profile w/ Data Sonde 1 meter intervals from surface - 16M 2 meter intervals from 16 - 28M		Pre- and post-calibration checks will be conducted daily			
Oxygen		<1	15	mg/L	Hydrolab® Data Sonde
Temperature		0	25	°C	
Conductivity		10	200	µmhos/cm	
pH		5	10	Std. Units	
Depth		0	28	meters	

*Field QC Samples - One duplicate composite sample of a random lake stratum will be collected during each field excursion for analyses of TP and TN. A duplicate epilimnetic composite for chlorophyll *a* will also be collected on each field excursion.

Comparability

The goal of the monitoring plan is to evaluated long-term changes in Loon Lake water quality. Since so few samples will be collected each year, it is imperative that the variability in sampling and analytical procedures be minimized for as many years as sampling continues. It is also important that future sampling and analyses be performed following standardized procedures equivalent to those identified in this plan. Procedures may be modified in the future, but any modifications need to insure that the quality objectives in the monitoring program are met.

Sampling Procedures

The sampling location shall be identified as the approximate location of the greatest depth of the lake. The sampling site can be located by visual triangulation from on-shore land marks and/or by GPS. Confirmation of the correct sampling site must also be made by confirming a water depth of 100 feet or greater.

Where applicable, samples will be collected equivalent to methods from the most current Ecology's Manchester Environmental Laboratory Users Manual (Ecology, 2005). Samples will be collected beginning at the surface in either a van Dorn or a Kemmerer sampler, which will be rinsed in lake water several times prior to beginning collection of samples. Samples for each stratum will be composited in equal volumes from the depths specified for each stratum in the monitoring plan. Sample bottles will be labeled by location and appropriate stratum. Samples will be stored on ice and delivered on the same day by the sample team's designated courier to the contract lab.

The sampling team lead identified for each sampling trip is responsible for identifying that adequate personnel are scheduled, the data sonde is prepared the day before and pre- and post-calibration is completed by trained team members the day of sampling. The lead will also make sure that the lab is notified and arrangements have been confirmed for transporting and receiving the samples. All field notes will be kept on a standardized form adopted by the LLPOA monitoring staff and reviewed and approved by Ecology.

Measurement Procedures

The analytical procedures are summarized in Table 3 below. An accredited laboratory must be used with quality control procedures in place. Calibration of the Hydrolab® will occur for all parameters the morning before each sampling event using protocol for calibration as described below. Post calibration of the Hydrolab® will be completed and documented following each sampling event. In order for the Hydrolab sonde data to be accepted, the post-calibration check must be within ±0.5 mg/L of the true value for dissolved oxygen, ±0.1 s.u. of pH calibration standard, and ±10 µmhos of conductivity calibration standard.

Table 3. Analytical procedures. (NA = Not applicable.)

Parameter	Strata Sampled[1]	Volume Req'd	Preserv-ation[1]	Analytical Method	Limit of Detection
Secchi	NA	NA	NA	NA	NA
Total Phosphorus	epi., meta., hypo.	500 mL	H_2SO_4 to pH<2	EPA 365.4	5 µg/L
Total Persulfate Nitrogen	epi.,meta., hypo.	125 mL	H_2SO_4 to pH<2	SM 4500-NO_3 B	10 µg/L
Chlorophyll *a*	epi.	1000 mL	$CaCO_3$[2]	SM 10200H	1.0 µg/L
Profiled Parameters - Hydrolab® data sonde profiling instrument					
Oxygen	NA	NA	NA	LDO	0 mg/L
Temp.	NA	NA	NA	Thermistor	NA (°C)
Cond. (µmho)	NA	NA	NA	electrode	NA
pH	NA	NA	NA	Glass pH	NA (SU)
Depth	NA	NA	NA	Strain-gage	NA

[1] All samples will be composited and kept on ice or stored at 4°C until delivery to the lab.
[2] Chlorophyll samples must not be exposed to sunlight when transported and stored by using opaque or foil-wrapped containers.

Data Sonde Operation and Calibration

Protocol for field calibrating measurements using the Hydrolab® data sonde will follow standard procedures described below. Water column field measurements will be taken beginning at the surface and lowering the sonde at 1 meter intervals to 16 meters, then 2 meter intervals to 28 meters. The data sonde will be allowed to rest at each depth until fluctuations in the indicated value become relatively stable.

The proper use storage, cleaning, and calibration will follow the Hach Hydrolab manual supplied with the data sonde. The Hach manual supersedes others if discrepancies in the procedures are discovered between the Hach manuals and the QAPP.

Note: Ecology would prefer that Winkler Titrations for dissolved oxygen be used to provide a secondary QA check of the oxygen data. However, it is acknowledged that the required facilities and expertise to perform the titrations may be beyond the resources available to the LLPOA volunteer monitoring team.

Definitions

Calibration: To standardize or correct sensors after determining, by measurement or comparison with a standard, the correct value.

Conductivity: A measure of the ability of water to pass an electrical current. This parameter indicates the amount of dissolved substances (salts) present in the water.

D.O.: Dissolved oxygen in water, measured in mg per liter.

D.O.%: The percent saturation of dissolved oxygen in water.

Multiprobe: The combination of several sensors, electrodes, or probe assemblies into a complete, stand-alone piece of equipment which simultaneously measures several parameters for profiling, spot-checking, or logging readings and data. A multiprobe is a multiparameter instrument.

pH: pH is the negative logarithm of the hydronium ion concentration in solution. Solutions with a pH less than 7 are considered acidic, while those with a pH greater than 7 are considered basic.

Post-checking: Assessing the performance of a sensor after use by noting the variation from a standard, to ascertain necessary correction factors.

Profiling: Lowering a multiprobe through a water column to measure changes in values with depth.

Data sonde: Generic term for a water quality multiprobe.

Total dissolved gas: The amount of gaseous compounds dissolved in a liquid.

Personnel Qualifications/Responsibilities

The equipment user must be on the list of approved Hydrolab users and properly trained to use any Hydrolab equipment. A Hydrolab custodian or company representative can help fulfill the training requirement.

Equipment, Reagents, and Supplies

- pH buffer solution (non-toxic)
- Conductivity standard solution (non-toxic)
- Tap and deionized water

- Data Sonde
- Sonde calibration cup, other communication cables, charger, probe protection cage
- Laptop and HyperTerminal if applicable
- Hydrolab manuals

Summary of Calibration Procedures

Calibration

Rinse the probes a minimum of three times with distilled or deionized water, then at least once with a small amount of the standard you are using. Discard and shake out. Then slowly pour the calibration standard over the probes. Make sure the standard covers every probe on the data sonde because they make references to each other.

Always discard used conductivity standard after each use. It goes bad very quickly, especially the 100 µS standard. Opened conductivity standard bottles should not be kept longer than two weeks. pH 9.15 (low ionic strength solution) fouls quickly as well, so check it against a new bottle if you've used it several times, or if it's been opened and stored longer than one month. Other standards should be carefully checked for expiration dates and possible fouling before each use.

Recommended Calibration Order

1. Conductivity (0, then your standard; bracket expected field readings if possible)
2. pH (7, then 10 or 4; bracket expected field readings if possible)
3. D.O.
4. Depth (if necessary)
5. Temperature is factory-calibrated.

Calibration Procedures

- Conductivity: Start by completely drying off the conductivity probe with a cotton swab or paper towel, then calibrate to 0.0 µS. Then calibrate using your standard (100, 1000, 10,000 µS or other; bracket expected field readings if possible).

- pH: A two point calibration is most common. Cover all probes with the standard. Always start with pH 7 standard, then 4 or 10; bracket expected field readings if possible. If you're doing a three point calibration, start with pH 7 standard, then 10, then 4.

- D.O.: The water saturated air calibration method is preferred. Use this method when water saturated air is applied to the sensor.
    1. Connect the sensor to a PC.
    2. Start Hydras 3 LT. Wait for Hydras 3 LT to establish communications with the sensor. Click the OPERATE SONDE button.
    3. Click the Calibration tab and select the LDO [SAT] tab.

4. Place the calibration cup with one end sealed so that the calibration cup opening is facing upwards. The data sonde will be inserted downwards into this cup.
5. Fill the calibration cup with approximately ½ inches of deionized water or tap water (specific conductance less than 0.5 mS/cm). Water will not touch the top of the sensor cap.
6. Carefully remove any water droplets from the sensor cap and temperature probe with the corner of a tissue or clean cotton cloth. It is important that no evaporative cooling take place either on the sensor cap or the temperature probe during calibration. Note: It is important to maintain temperature stability during calibration. Care should be taken to keep the data sonde out of direct sunlight or away from any other energy/heat source which will cause the temperature in the calibration cup to change during calibration. A reflective sun-shield is recommended if no natural shade is available. If the temperature in the calibration cup changes more than 0.5 °C during the calibration, it is recommended to recalibrate the sensor.
7. Gently set the sonde with sensors down into the calibration cup blocking any air exchange with the outside environment. Do not screw the calibration cup fully onto the sonde body as the compression of the o-ring will increase the pressure inside the calibration cup to above the barometric pressure and give a false 100% saturated reading. The goal is to block air exchange between the sealed calibration cup and the outside.
8. Allow the dissolved oxygen and temperature readings to stabilize. As the temperature sensor has a smaller thermal mass than the luminescent dissolved oxygen sensor, it is best to allow the entire unit to stabilize for an additional 3–5 minutes after the temperature sensor stabilizes. At this point, the air inside the calibration cup should be fully saturated with water, hence the name "water saturated air."
9. Determine the barometric pressure for entry as the calibration standard. Enter the barometric pressure in the field provided.
10. Click CALIBRATE. A "Calibrate Successful!" screen will be displayed.

NOTE: An alternative calibration method using air saturated water may be used as described in the Hydrolab manual for the LDO probe

- Depth: Place the data sonde sensors just under the surface of the water (in bucket or out in the field) and calibrate to 0.

- Temperature is already factory-calibrated and cannot be recalibrated.

Cleaning

- Gently wipe the D.O. sensor with a cotton swab to remove any residue or oily build-up.
- Gently wipe the glass pH probe. If it's really dirty, a soft toothbrush may be used. No ethanol should be used.
- There is no need to clean the white reference probe unless it's visibly dirty. No ethanol should be used.

- Firmly wipe the conductivity electrodes with a cotton swab. Ethanol may be used if necessary.
- Wipe down everything else and make sure there are no problems for the next user.
- If you run into problems or something doesn't work properly, consult the troubleshooting section of a Hydrolab manual, call Hach's technicians directly.

Storage

Hydrolab and Electronic Data Solutions manuals must be followed. Manuals can be downloaded from the Hach at http://www.hydrolab.com/pdf/SS_Manual.pdf

Quality Control

Field QC

One blind field replicate composite sample will be collected and analyzed for nutrients from one of the lake stratum as part of each sampling event. A field replicate chlorophyll *a* composite sample will also be collected and analyzed with every sampling event.

One field blank will be prepared and analyzed for each field sampling event.

Analytical QC

The analytical laboratory shall be accredited by Ecology and have a QA plan that meets the minimum guidance for an acceptable QA plan. Initially the QA plan will be consistent with the QA plan adopted in 2007 by the Spokane Tribal Laboratory. The labs QA plan will be reviewed annually with the contract lab to assure an adequate evaluation to determine if the measurement quality objectives have been met.

The following QC will be applied to all analytical parameters being contracted by the lab (total phosphorus, total nitrogen, chlorophyll *a*)

Table 4. QC Samples, Types and Frequency

Parameter	Field		Laboratory			
	Blanks	Replicates	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes
Total Phosphorus	1/sample event	1/sampling event	1/sample batch	1/sample batch	1/sample batch	1/sample batch
Total Nitrogen						
Chlorophyll *a*						

Data Management Procedures

Field data will be recorded on a standard form developed by LLPOA. The data will be transferred to a spreadsheet software program compatible with most general PC applications. Pre- and post-calibration information of the data sonde will be included.

The data package from the laboratory shall include the data with a narrative discussing any problems with the analyses, corrective action taken, changes to the reference method, and an explanation of data qualifiers.

The lab data package will also include all of the QC results for the year with a brief summary discussion of results as they relate to the Loon Lake measurement quality objectives. The QC analysis should be received no latter than December of each year.

Data that has satisfied the quality objectives will be submitted to Ecology's EIM database at the end of each year by the team leader. Data will then be entered into EIM by the WQP data coordinator after review and quality assessment.

Audits and Reports

On going review of the data will be conducted as the data is transferred into the data spreadsheet by the team's designee.

The LLPOA monitoring team will work with Ecology staff or other lake professional to provide an end of the year data summary report will include QC review. An executive summary will be included annually in the Spring LLPOA newsletter. Following successive years of sampling, a more extensive discussion of findings and trends may be developed with recommendations for future lake management.

Data Verification and Quality Assessment

Data verification involves examining the data for errors or omissions as well as examining the results for compliance with QC acceptance criteria. Laboratory results are reviewed and verified by qualified and experienced lab staff. Their findings are documented in the case narrative. Field results should also be verified, preferably before leaving the site where the measurements were made.

Once the measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions
- Results for QC samples described and Quality Control evaluation, accompany the sample results
- Established criteria for QC results were met
- Data qualifiers are properly assigned where necessary
- Data specified in Sampling Process Design, were obtained
- Methods and protocols specified in the QA Project Plan were followed

The LLPOA monitoring team leader will be responsible for verifying that the monitoring data are consistent with the above and with the assistance of Ecology confirming that the components of the QAPP are being implemented. The data will be assessed for usability each year before the

data is entered into EIM. The QAPP will be modified where deficiencies in study design or analytical procedures are discovered.

Since the data is to be used to evaluate long-term general trends, it will be necessary to perform several years of consistent sampling, using the same analytical methods. An evaluation of the data after several years will allow of temporal and spatial analysis that has not been possible for Loon Lake due to inadequate sample frequency. Consistent monitoring will further help when consideration is being made for more intensive evaluations of Loon Lake. Year to year comparisons will likely be presented, but it will need to be continually pointed out that unquantified variability will limit the conclusions from the minimalist monitoring design.

Generally accepted graphical representations of limnological changes in parameters over depths, seasons, and years will be used to illustrate the physical-chemical interactions occurring in the lakes. Some analysis may also try to incorporate some of the historical representations to allow discussions of water quality as they were presented in past work. Ecology will work with LLPOA and others to provide presentations of the information appropriate for the audience. It is anticipated that a more comprehensive statistical and limnological evaluation will be able to be performed after 4-5 years of sampling.

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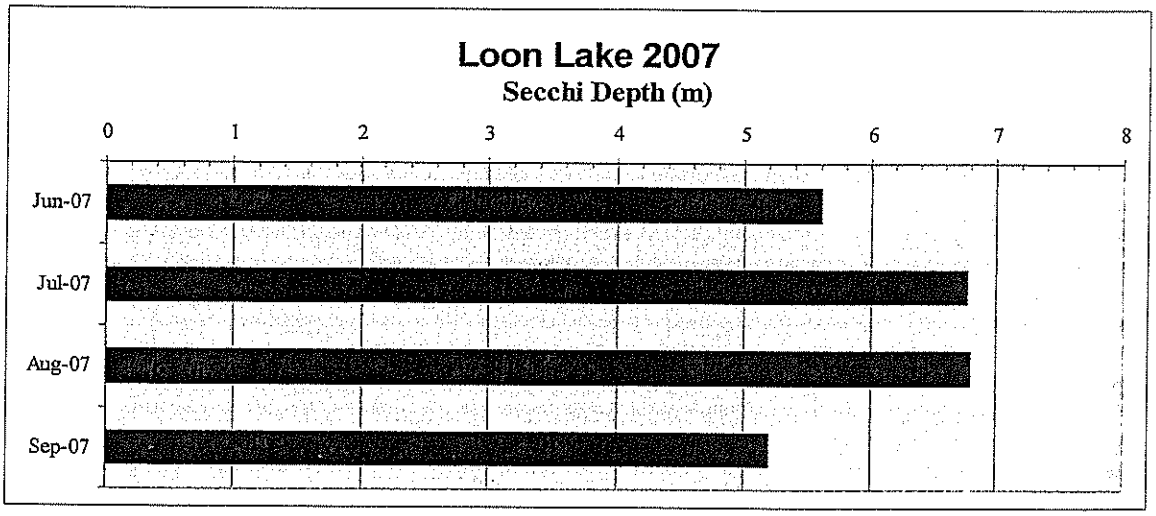
Loon Lake Citizen Water Quality Monitoring 2007

The citizen monitoring program was successful last year and the information gathered allows for general comparisons to previous years. It will take many years of careful monitoring with good quality control before definitive conclusions can be made about water quality trends. Below is a summary of what was found.

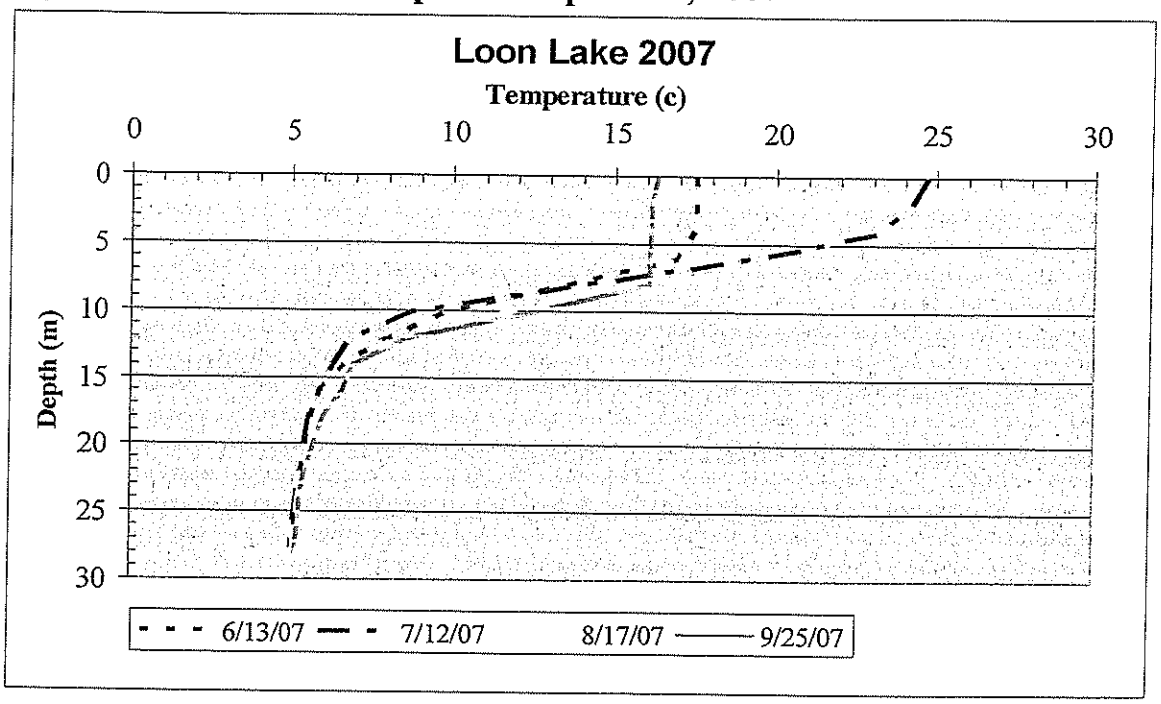
The clarity of the lake is measured by lowering a Secchi disk down until it disappears in the water. Last year's measurements were relatively good and very similar to years reported in the past. In 1985 the fisheries study conducted for the Department of Fish and Wildlife by EWU reported a summer average of 6.5 meters (21 feet). As you can see from Figure 1, the 2007 Secchi disk measurements averaged about the same (6.1 meters).

Figure 1. Loon Lake Secchi disk clarity, 2007



The water was also measured from top to bottom for temperature, dissolved oxygen, pH, and conductivity with the new Hydrolab Data Sonde purchased by a grant from the Department of Ecology. Now that LLPOA has the Hydrolab, it will allow yearly monitoring of the lake as long as it is well calibrated, cared for, and there are adequately trained citizen volunteers. The temperature measured over depth for each field trip is shown in Figure 2 and is consistent with past years of monitoring. It clearly shows the typical summer stratification of our deeper regional lakes. The measured profile shows a top warmer layer (epilimnion), the middle layer where temperature drops relatively quickly with depth (metalimnion), and the cold bottom layer (hypolimnion).

Figure 2. Loon Lake temperature profiles, 2007



When a lake is thermally stratified, the bottom layer cannot mix with the upper layer and re-oxygenate. If there is too much decaying organic matter in the water (dead algae and pollution), the oxygen is used up in the decaying process and depleted from the hypolimnion (bottom layer). Figure 3 shows that there is plenty of oxygen in the water column at the upper layers but later in the summer, the dissolved oxygen goes to less than one milligram per liter (mg/L) in the bottom half of the lake. When this happens, fish don't survive very well near the bottom and phosphorus starts to be released from the sediments. The dissolved oxygen levels in the lake are not good, but are similar to those found in previous studies. It is not possible at this time to say if they are getting better or worse. The elevated phosphorus of the hypolimnion caused by depleted oxygen can be seen in Figure 4. This phosphorus gets remixed into the lake during the fall and supplies phosphorus to the next year's algae growth.

The self-perpetuating cycle of internal phosphorus loading continues to get worse if pollution is not controlled. The Loon Lake Sewer District was formed to stop septic system phosphorus from getting into the lake and has done a lot to slow the process. However it very important that other sources of phosphorus are stopped such as storm water from driveways and roads, and fertilizer from landscaping. It is also important to provide shoreline vegetative buffers to absorb nutrients as they migrate toward the lake. Loon Lake really needs everyone to work toward its protection every day.

Figure 3. Loon Lake Dissolved Oxygen profiles, 2007

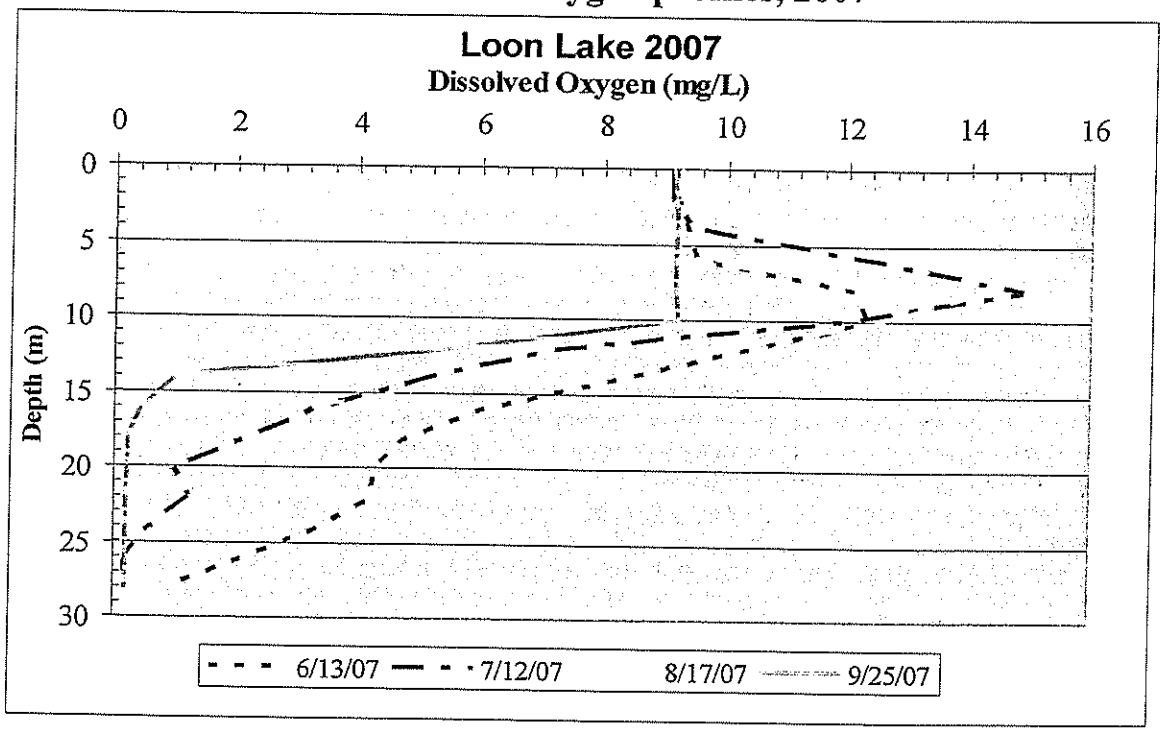
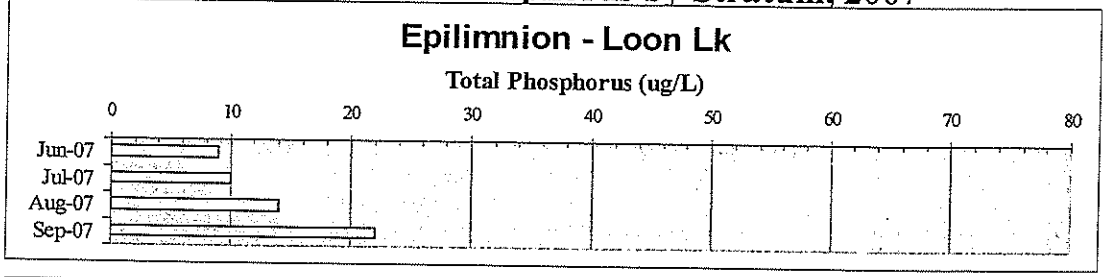
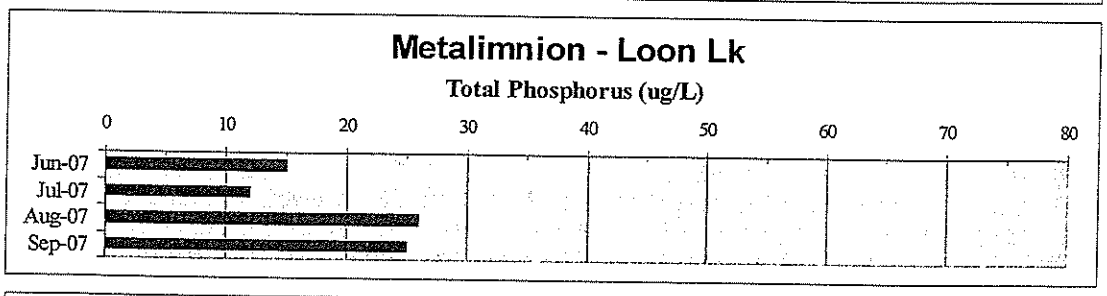
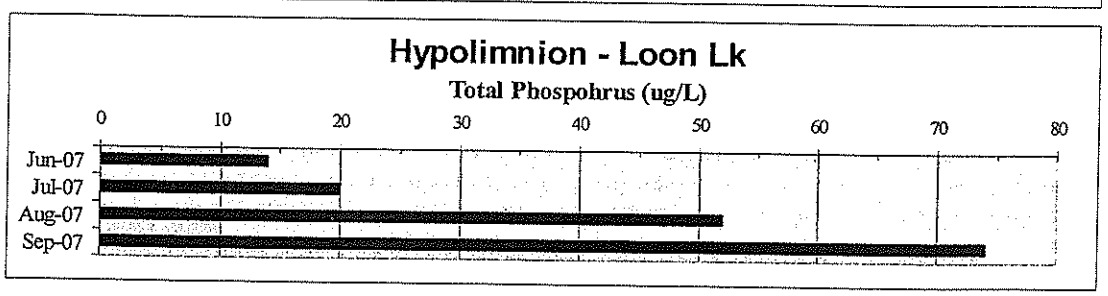


Figure 4. Loon Lake Total Phosphorus by Stratum, 2007







ATTACHMENT F, P.3