The Importance of Moberly Lake & its Watershed

British Columbians want lakes to provide good water quality, aesthetics and recreational opportunity. When we don't see these features in our local lakes, we want to know why. Is water quality getting worse? Has the lake been polluted by land development? What uses can be made of the lake today? And, what conditions will result from more development within the watershed?

The Ministry of Environment's Volunteer Lake Monitoring Program (VLMP), in collaboration with the non-profit B.C. Lake Stewardship Society, is designed to help answer these questions. Through regular water sample collections, we can come to understand a lake's current water quality, identify the preferred uses for a given lake, and monitor water quality changes resulting from land development within the lake's watershed.

A **watershed** is defined as the entire area of land that moves the water it receives to a common waterbody. The term watershed is misused when describing only the land immediately around a waterbody or the waterbody itself. The true definition represents a much larger area than most people normally consider. Moberly Lake's watershed, shown on the next page, is 1039 square kilometers.

Watersheds are where much of the ongoing hydrological cycle takes place and play a crucial role in the purification of water. Although no "new" water is ever made, it is continuously cleansed and recycled as it moves through watersheds and other hydrologic compartments. The quality of the water resource is largely determined by a watershed's capacity to buffer impacts and absorb pollution.

Through regular status reports, the VLMP can provide communities with monitoring results specific to their local lake and with educational material on lake protection issues in general. This useful information can help communities play a more active role in the protection of the lake resource. Finally, the VLMP allows government to use its limited resources efficiently thanks to the help of area volunteers and the B.C. Lake Stewardship Society.

Every component of a watershed (vegetation, soil, wildlife, etc.) has an important function in maintaining good water quality and a healthy aquatic environment. It is a common misconception that detrimental land use practices will not impact water quality if they are kept away from the area immediately surrounding a water body. Poor land-use practices anywhere in a watershed can eventually impact the water quality of the down stream environment.

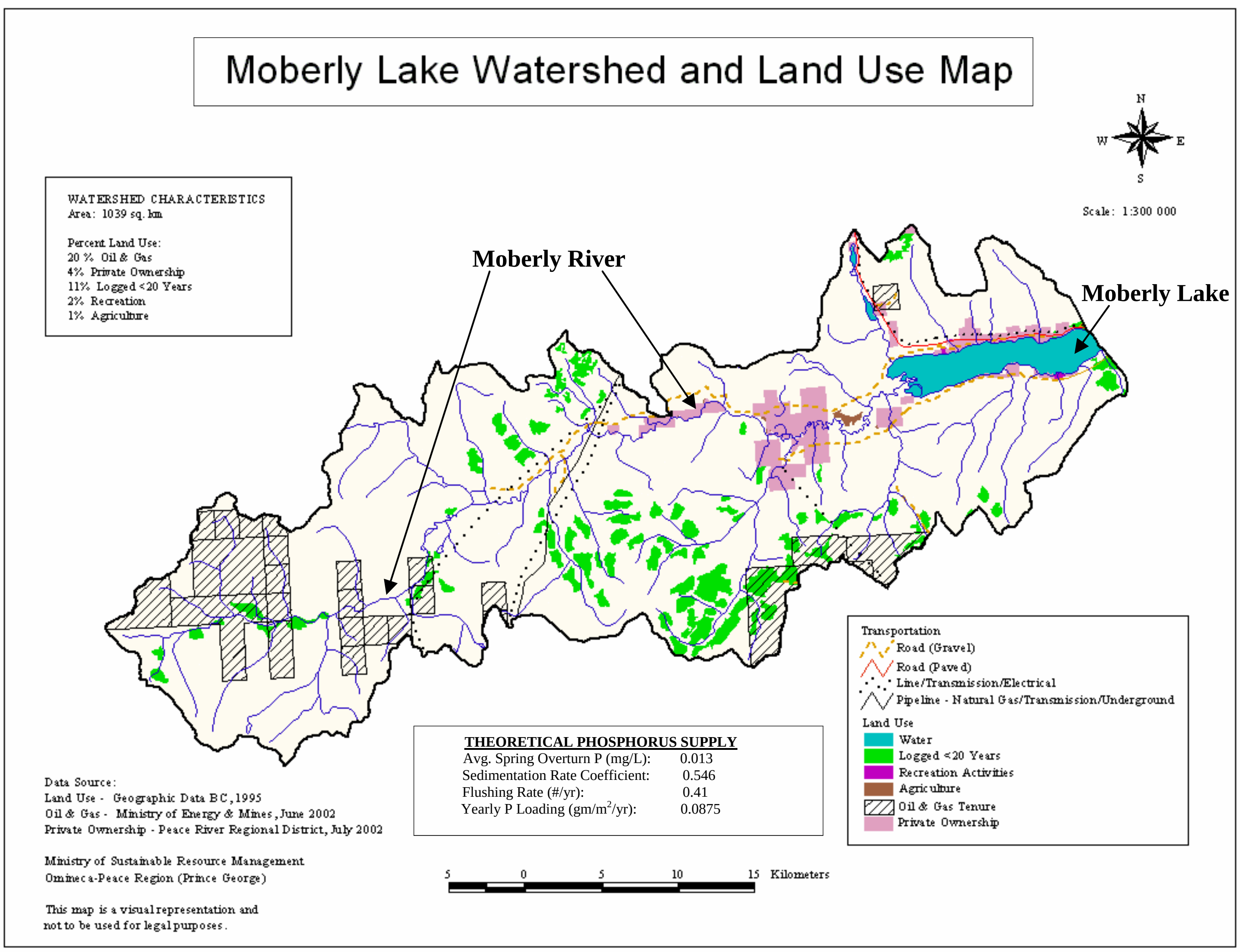
Moberly Lake's VLMP program began in 1999 and has been conducted by the Moberly Volunteer Lake Water Testing Group. This status report summarizes information derived from the program and compares it to 1990 government data. Quality of the laboratory data appears to be acceptable, however, concerns exist with field collection techniques that may have biased some of the results. Data quality information is available on request.

Human activities that impact water bodies range from small but widespread and numerous "non-point" sources throughout the watershed to large "point" sources of concentrated pollution (e.g. outfalls, spills, etc.). Undisturbed watersheds have the ability to purify water and repair small amounts of damage from pollution and alteration. However, modifications to the landscape and increased levels of pollution impair this ability.

Moberly Lake is located...in the Omineca Peace region approximately 25 km northwest of Chetwynd, B.C. on Highway 29. This sizeable lake is roughly 14 km long, with maximum and mean depths of 42.7 m and 18.3 m, respectively. Its surface area is 29.4 km^2 and it has a shoreline perimeter of 41.2 km. The map below shows the Moberly Lake watershed and its associated land use practices. It is believed that land use practices in the Moberly Lake watershed are integral to the health of the lake. Lake water quality does likely benefit from a fast flushing rate of 0.41 times/year (i.e. a short water retention time of 2.4 years); however, because of this, the water entering Moberly Lake is highly dependant on the Moberly River (which has inputs from the whole watershed), and thus could be impacted by any widespread detrimental land use activities in the basin.

Moberly Lake contains the following sport fish: arctic grayling (*Thymallus arcticus),* burbot (*Lota lota*), bull trout (*Salvelinus confluentus)*, lake trout (*S. namaycush*), mountain whitefish (*Prosopium williamsoni*), lake whitefish (*Coregpmis clupeaformis)* and northern pike (*Esox lucius)*. The lake draws thousands of tourists each year, who spend time at the Moberly Lake Provincial Park, the Spencer Tuck Park, and the two religious camps. Additionally, the Moberly Lake First Nation members continue to maintain a sustenance fishery on the lake as part of their traditional resource.

Land use within the watershed includes residential development (305 housing lots, including 151 First Nation properties), forestry, agriculture, oil & gas development and recreational activities. The greatest challenge to lake management is likely the control of phosphorus (nutrient) loading. This loading may promote summer algal blooms and the spread of aquatic plants. Although the lake is considered oligotrophic (which means it is not productive and generally does not generate much aquatic vegetation - as will be discussed in subsequent sections), inputs of phosphorus can increase the lake productivity, and hence increase the plant and algae biomass within the lake. Reports do exist in Ministry files of increased algae blooms and aquatic plant infestations around the north and south shores of the lake, suggested to be caused by increased nutrient loadings to the water by poorly designed septic systems.



Non-Point Source Pollution and Moberly Lake

“Point source” pollution originates from municipal or industrial effluent outfalls. Other pollution sources exist over broader areas and may be hard to isolate as distinct effluents. These are referred to as “non-point” sources of pollution (NPS). Shoreline modification, urban stormwater runoff, onsite septic systems, agriculture and forestry are common contributors to NPS pollution. One of the most detrimental effects of NPS pollution is phosphorus loading to water bodies. The amount of total phosphorus (TP) in a lake can be greatly influenced by human activities. If local soils and vegetation do not retain this phosphorus, it will enter watercourses where it will become available for algal production.

Onsite Septic Systems and Grey Water

Onsite septic systems effectively treat human waste water and wash water (grey water) as long as they are properly located, designed, installed, and **maintained**. When these systems fail they may become significant sources of nutrients and pathogens. Poorly maintained pit privies, used for the disposal of human waste and grey water, can also be significant contributors.

Stormwater Runoff

Lawn and garden fertilizer, sediment eroded from modified shorelines or infill projects, oil and fuel leaks from vehicles and boats, road salt, and litter can all be washed by rain and snowmelt from properties and streets into watercourses. Phosphorus and sediment are of greatest concern, providing nutrients and/or rooting medium for aquatic plants and algae. Pavement prevents water infiltration to soils, collects hydrocarbon contaminants during dry weather and increases direct runoff of these contaminants to lakes during storm events.

Tree Harvesting

Harvesting can include clear cutting, road building and land disturbances, which may alter water flow and increase sediment and phosphorus inputs to water bodies.

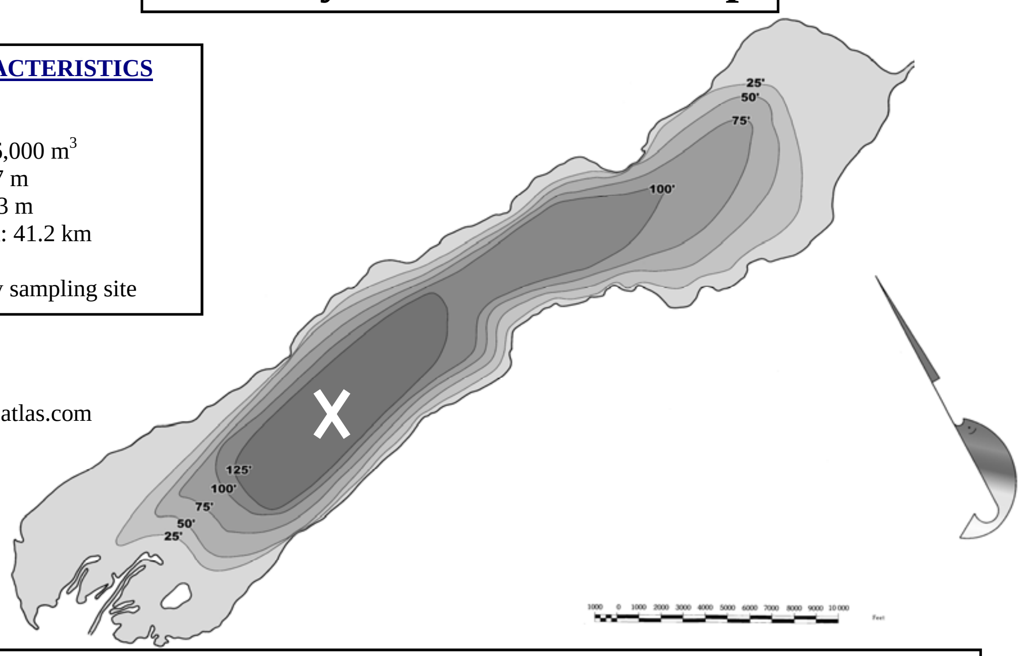
Boating

Oil and fuel leaks are the main concerns with boat operation on small lakes. With larger boats, sewage and grey water discharges are issues. Other problems include litter, the spread of aquatic plants, and the churning up of bottom sediments and nutrients in shallow water operations.

Moberly Lake Contour Map

LAKE CHARACTERISTICS

Area: 2943 ha
Volume: 533,956,000 m^3
Max. Depth: 42.7 m
Mean Depth: 18.3 m
Shoreline Length: 41.2 km
Elevation: 692 m
X = water quality sampling site



Map supplied by Anglersatlas.com

MOBERLY LAKE TROPHIC CHARACTERISTICS

	1989	1990	1999	2000	2002	2003
Max. Surface Temp (°C):	-	-	-	17	17	18
Min. Near-bottom Oxygen (mg/L):	-	-	-	3.0	-	6.0
Spring Overturn TP (mg/L):	**0.009**	**0.018**	-	**0.005**	**0.019**	**-**
Avg. Chlorophyll a (µg/L):	3.35	4.8	-	1.61	-	3.07
Avg. Secchi Depth (m):	-	-	-	4.5	-	4.2

What's Going on Inside Moberly Lake?

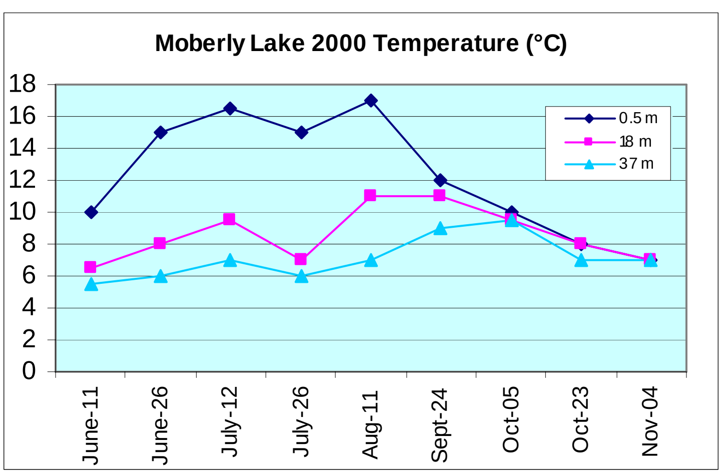
Temperature

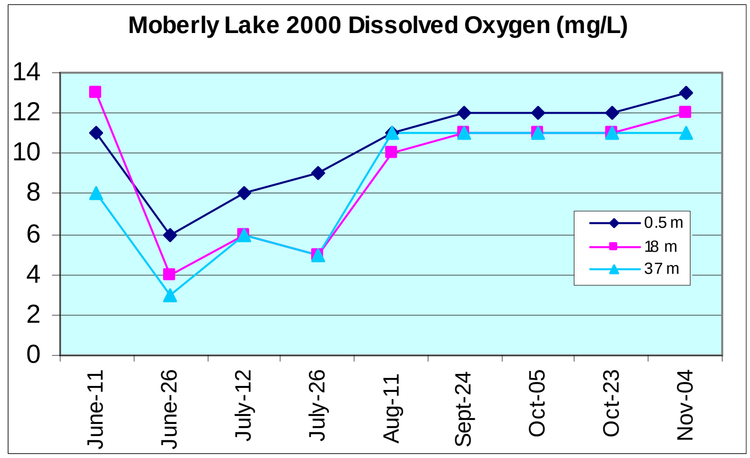
Lakes show a variety of annual temperature patterns based on each lake's location and depth. Most interior lakes form layers (stratify), with the coldest summer water near the bottom. Because colder water is denser, it resists mixing into the warmer, upper layer for much of the summer. In spring and fall, these lakes usually mix from top to bottom (overturn) as wind energy overcomes the reduced temperature and density differences between surface and bottom waters. In the winter, lakes re-stratify under ice with the most dense water (4°C) near the bottom.

Lakes of only a few metres depth tend to mix throughout the summer or layer only temporarily, depending on wind conditions. In winter, the temperature pattern of these lakes is similar to that of deeper lakes.

Temperature stratification patterns are very important to lake water quality. They determine much of the seasonal oxygen, phosphorus and algal conditions. When abundant, algae can create problems for most lake users.

Temperature was measured in the central basin of Moberly Lake during 2000 and 2003 with sporadic measurements through 89, 90, 91, 99 and 02. The figure below illustrates Moberly Lake water temperatures for 2000. These temperature patterns are similar to those for 1990 and 2003, years with a similar number of samples collected. The deep basin appears to stratify in late May/early June, as the basin had already stratified during the first sample collection on June 11th (this was also the case in 2003). This stratification appears to hold throughout the summer and early fall until the lake experiences fall overturn, evident on the October 5th sampling date. The continuation of this stratification throughout the summer is likely due to the deep basin and a strong temperature/density gradient (the thermocline) that resists mixing between the top and bottom water layers (the epilimnion and hypolimnion, respectively). The maximum surface temperature, reached by early August, was 17.0°C (18°C for 2003). Shorter days and cooling air temperatures through late September caused a loss of lake stratification, leaving the water temperature nearly uniform with depth at 9.5°C by early to mid-October. This differs slightly from the 1990 data set, which shows the lake becoming isothermal (i.e. a uniform temperature with depth) in early September.





Dissolved Oxygen

Oxygen is essential to life in lakes. It enters lake water from the air by wind action and plant photosynthesis. Oxygen is consumed by respiration of animals and plants, including the decomposition of dead organisms by bacteria. A great deal can be learned about the health of a lake by studying oxygen patterns and levels.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen to support life at all depths through the year. But as lakes become more productive (eutrophic), and increasing quantities of plants and animals respire and decay, more oxygen consumption occurs, especially near the bottom where dead organisms accumulate.

In productive lakes oxygen in the isolated bottom layer may deplete rapidly (often to anoxia), forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 20% saturation). Fish kills can occur when decomposing or respiring algae use up the oxygen. In summer, this can happen on calm nights after an algal bloom, but most fish kills occur during late winter or at initial spring mixing.

The figure above shows the oxygen pattern of the Moberly Lake basin for 2000. Surface water oxygen remained near saturation for most of the summer, but appeared to drop considerably at all depths on June 26th. After this decrease in dissolved oxygen, levels apparently rose throughout the remainder of the summer as the surface waters became equilibrated with the atmosphere. The strong temperature gradient that was present (as mentioned in the previous section), wind activity, plankton density and distribution, as well as settling of organic material to the bottom of the lake, likely influenced oxygen distribution throughout the water column. Lake overturn, which is evident on the temperature profile graph on October 5th, is also seen in the dissolved oxygen profile. Results from 1989 thru 1991 (summarized in a Ministry report) suggest that D.O. levels are generally the same at all water depths (ranging from 8-10 mg/L), with the exception of August, when near bottom levels range from 3-5 mg/L O_2. Sporadic VLMP results from 1999, 2002 and 2003 concur with the 1991 Ministry report for most dates. The one exception is the 2003 mid-depth D.O., which was typically lower than the surface and bottom concentrations by 2-3 mg/L throughout the summer (probably due to either field error or the combined effect of oxygen consumption by decomposition and zooplankton respiration). These differ from the 2000 dataset, however, indicating that either Moberly Lake had abnormal dissolved oxygen conditions in 2000 compared to most years, or more likely, that field sampling error occurred through the collection period.

What's Going on Inside Moberly Lake?

Trophic Status and Phosphorus

The term "trophic status" is used to describe a lake's level of productivity and depends on the amount of nutrient available for plant growth, including tiny floating algae called phytoplankton. Algae are important to the overall ecology of the lake because they are food for zooplankton, which in turn are food for other organisms, including fish. In most lakes, phosphorus is the nutrient in shortest supply and thus acts to limit the production of aquatic life. When in excess, phosphorus accelerates growth and may artificially age a lake. As mentioned earlier (page 3), total phosphorus (TP) in a lake can be greatly influenced by human activities.

The trophic status of a lake can be determined by measuring productivity. The more productive a lake is the higher the algal growth and therefore the less clear the water becomes. Water clarity is measured using a ***Secchi disc***. Productivity is also determined by measuring nutrient levels and ***chlorophyll*** (the green photosynthetic pigment of algae). Phosphorus concentrations measured during spring overturn can be used to predict summer algal productivity.

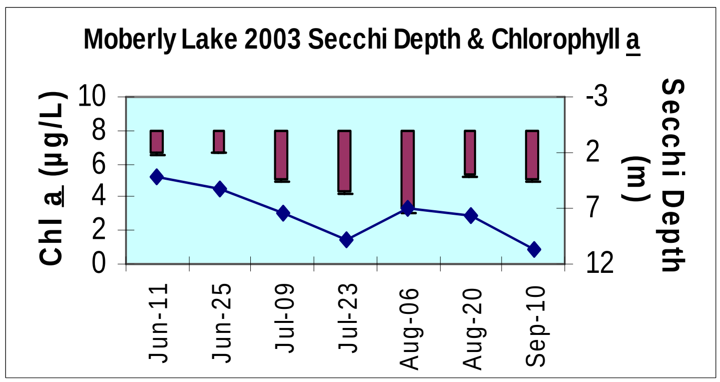
Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels (1-10 µg/L TP), sparse plant life (0-2 µg/L Chl. a), and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 µg/L Chl. a), including algae, because of higher nutrient levels (>30 µg/L TP). Lakes with an intermediate productivity are called ***mesotrophic*** (10-30 µg/L TP and 2-7 µg/L Chl. a) and generally combine the qualities of oligotrophic and eutrophic lakes.

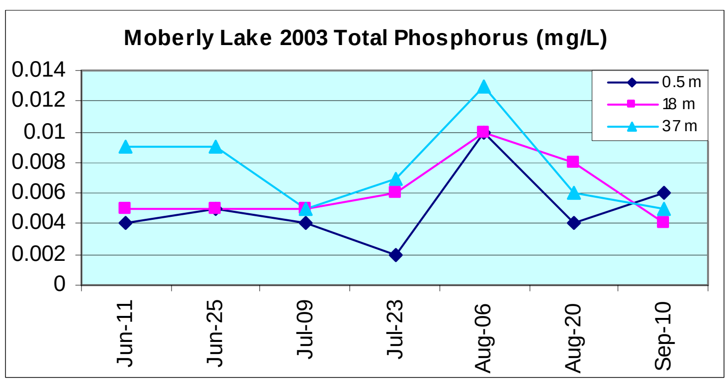
Lake sediments can themselves be a major source of phosphorus. If deep-water oxygen becomes depleted, a chemical shift occurs in bottom sediments. This shift causes sediment to release phosphorus to overlying waters. This "internal loading" of phosphorus can be natural but is often the result of phosphorus pollution. Lakes displaying internal loading have elevated algal levels and generally lack recreational appeal.

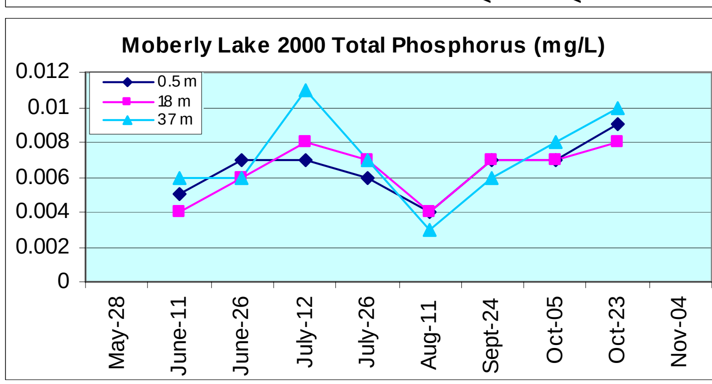
Moberly Lake spring TP levels (page 3) have averaged 0.013 mg/L, implying oligotrophic/mesotrophic conditions, but based on very sporadic data since 1989. The 2000 spring TP has a value of 0.005 mg/L, which is lower than the average and lies within the oligotrophic classification (sampling in 2003 began after spring turnover had already occurred; however, early season total phosphorus values were still low in the oligotrophic range). There are some differences between the 1990 and the 2000 levels, with many possibilities for why these years differ in TP concentrations, including: fluctuating inputs from the Moberly River, temperature changes, inconsistent sampling dates, differing spring overturn dates, lab error and field sampling error.

Chlorophyll a data, seen in the graph to the upper right for 2003, which was also collected sporadically between 1989 and 2002, shows differences in annual values. Although late summer/early fall values were consistent between most years, mid-summer values were slightly higher in 1989 and 1990 compared to 1999 and 2000. This may be a natural annual variation caused by differing productivity rates (which can be affected by changes in temperature, dissolved oxygen, light levels and total phosphorus concentrations), or may be due to sampling and/or laboratory error. Regardless, all of the chlorophyll a levels closely border normal oligotrophic and mesotrophic conditions. The 2000 summer average chlorophyll concentration was 1.61 µg/L, which falls into the oligotrophic category. The 2003 value was 3.07 µg/L, which is just in the mesotrophic category. Water visibility, which is measured by secchi disc (seen in the same figure), is used as an indicator for summer chlorophyll concentrations. Secchi was a good indicator of chlorophyll in 2003.

The latter diagrams below display 2003 and 2000 phosphorus cycling in Moberly Lake. Low TP levels were observed in all three sample depths throughout most of the summer. Average summer total phosphorus (TP) in the sample basin was 0.005 mg/L at the surface (0.006 mg/L in 2000). There was a rise at all three depths on the August 6th sample, which is also shown in the chlorophyll a data. This unusual summer peak may have been influenced by storm events that transported nutrients into the lake via the Moberly River. Furthermore, the Moberly River is generally highest during June and July, which may have influenced the TP rise that began in July. The 2000 data shows similar concentrations to the 2003 data, both characteristic of an oligotrophic lake. Although there were TP peaks during different parts of the summer, the concentrations and trends are somewhat normal. Typical oligotrophic lakes show similar TP concentrations at all depths within the water column. This is observed in both 2000 and 2003. There is some discrepancy with this data when compared to the results from the 1991 Ministry report, when TP values are approximately double those from the VLMP. This may be due to differing flow volumes and inputs from the Moberly River, different sampling locations, field sampling error or laboratory analysis error. Internal phosphorus loading that may cause a difference in TP levels is unlikely for Moberly Lake, as anoxic conditions are never present for a significant amount of time at the lake bottom.







SUMMARY

Data from previous Ministry reports, as well as the data from the VLMP, suggest that Moberly Lake generally shows oligotrophic conditions and is thus a low productivity lake in good condition. Due to significant differences between previous Ministry data and that data collected by the VLMP (especially regarding dissolved oxygen and total phosphorus), future sampling is recommended to help attain a more substantial data set that may help to better identify water quality trends. Furthermore, it may be beneficial to regularly sample the Moberly River where it enters the lake to help identify possible influences that may be causing the high variability in spring TP. A shoreline survey/sampling may also be beneficial, which may help identify where septic systems are leaking into the water, as well as residential properties that have degraded shoreline habitat/bank stability. Regardless, all residents and land developers within the watershed are advised to practice good land management such that nutrient or sediment addition to the lake and its tributaries are minimized.

Household Tips to Keep Moberly Lake Healthy

Yard Maintenance, Landscaping & Gardening

- Minimize the disturbance of shoreline areas by maintaining natural vegetation cover.
- Minimize high-maintenance grassed areas.
- Replant lakeside grassed areas with native vegetation. Do not import fine fill.
- Use paving stones instead of pavement.
- Stop or limit the use of fertilizers and pesticides.
- Don't use fertilizers in areas where the potential for water contamination is high, such as sandy soils, steep slopes, or compacted soils.
- Do not apply fertilizers or pesticides before or during rain due to the likelihood of runoff.
- Hand pull weeds rather than using herbicides.
- Use natural insecticides such as diatomaceous earth.
- Prune infested vegetation and use natural predators to keep pests in check. Pesticides can kill beneficial and desirable insects, such as lady bugs, as well as pests.
- Compost yard and kitchen waste and use it to boost your garden's health as an alternative to chemical fertilizers.

Agriculture

- Locate confined animal facilities away from waterbodies. Divert incoming water and treat outgoing effluent from these facilities.
- Limit the use of fertilizers and pesticides.
- Construct adequate manure storage facilities.
- Do not spread manure during wet weather, on frozen ground, in low-lying areas prone to flooding, within 3 m of ditches, 5 m of streams, 30 m of wells, or on land where runoff is likely to occur.
- Install barrier fencing to prevent livestock from grazing on streambanks.
- If livestock cross streams, provide graveled or hardened access points.
- Provide alternate watering systems, such as troughs, dug-outs, or nose pumps for livestock.
- Maintain or create a buffer zone of vegetation along a streambank, river or lakeshore and avoid planting crops right up to the edge of a waterbody.

Onsite Sewage Systems

- Inspect your system yearly, and have the septic tank pumped every 2 to 5 years by a septic service company. Regular pumping is cheaper than having to rebuild a drain-field.
- Use phosphate-free soaps and detergents.
- Don't put toxic chemicals (paints, varnishes, thinners, waste oils, photographic solutions, or pesticides) down the drain because they can kill the bacteria at work in your onsite sewage system and can contaminate water-bodies.
- Conserve water: run the washing machine and dish-washer only when full and use only low-flow shower-heads and toilets.

Auto Maintenance

- Use a drop cloth if you fix problems yourself.
- Recycle used motor oil, antifreeze, and batteries.
- Use phosphate-free biodegradable products to clean your car. Wash your car over gravel or grassy areas, but not over sewage systems.

Boating

- Do not throw trash overboard or use lakes or other water-bodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals.
- Conduct major maintenance chores on land.
- Use four stroke engines, which are less polluting than two stroke engines, whenever possible. Use an electric motor where practical.
- Keep motors well maintained and tuned to prevent fuel and lubricant leaks.
- Use absorbent bilge pads to soak up minor oil and fuel leaks or spills.
- Recycle used lubricating oil and left over paints.
- Check for and remove all aquatic plant fragments from boats and trailers before entering or leaving a lake.
- Do not use metal drums in dock construction. They rust, sink and become unwanted debris. Use Styrofoam or washed plastic barrel floats. All floats should be labeled with the owner's name, phone number and confirmation that barrels have been properly emptied and washed.

Who to Contact for More Information

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Greg Warren

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James Jacklin (cover) and Reg Whiten (Page 7)

Carmen Hazlehurst and Craig Lalonde planting trees on the Saulteau First Nations Moberly Lake shoreline.

Clive Calloway, of the Living by Water project, giving a lakeshore and water protection lesson to the students from Moberly Lake Elementary.

Volunteer Andy Teslyk taking a secchi depth measurement, with Carmen Hazlehurst looking on and recording the results.