BC Lake Stewardship and Monitoring Program

Purden Lake 2004 - 2006

A partnership between the BC Lake Stewardship Society and the Ministry of Environment

The Importance of Purden 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 BC Lake Stewardship Society, in partnership with the Ministry of Environment (MoE), has designed a program, entitled *The BC Lake Stewardship and Monitoring Program*, 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. There are different levels of lake monitoring and assessment. The level for a particular lake depends on study objectives as well as funding and human resources available. This report provides the three year results of a Level III program for Purden Lake.

Through regular status reports, this program 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, this program allows government to use its limited resources efficiently thanks to the help of area volunteers and the BC Lake Stewardship Society.

Purden Lake's monitoring program began in 2004 and has been coordinated by the Purden Lake Volunteer Water Quality Testing Group. This status report summarizes information derived from the program. Quality of the data has been found to be acceptable, with some minor problems identified. Data quality information is available on request.

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. Purden Lake's watershed, shown on the next page, is 67 km^2.

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.

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.

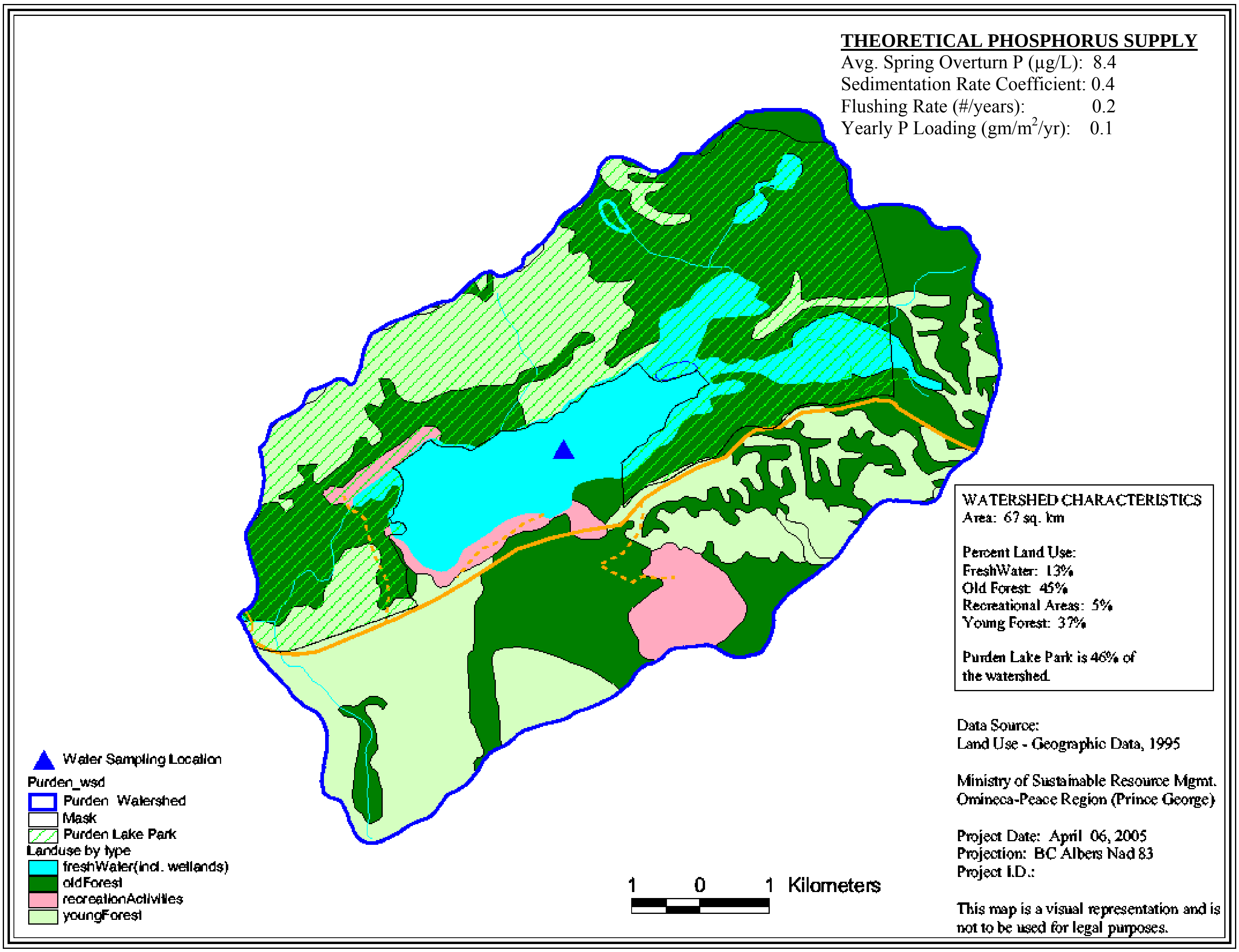
Human activities that impact water bodies range from small but widespread and numerous "non-point" sources throughout the watershed to large "point" sources of concentrated pollution (e.g. outfalls, spills, etc.). Undisturbed watersheds have the ability to purify water and repair small amounts of damage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

Purden Lake is located in the Omineca Peace region approximately 64 km east of Prince George, B.C. on the Yellowhead Highway (#16). This lake is roughly 7.5 km long, with maximum and mean depths of 52.4 m and 27.7 m, respectively. Its surface area is 8.4 km^2 and it has a shoreline perimeter of 24.7 km. The map below shows the Purden Lake watershed and its associated land use practices. The watershed is almost entirely forested. Just over 50 % of the watershed is identified as either park or private recreational land. Industrial activity is very limited.

Fishing is popular on Purden Lake, with the lake containing rainbow trout (*Oncorhynchus mykiss*) and burbot (*Lota lota*). The lake is stocked annually with rainbow trout. Purden Lake Provincial Park encompasses 384 ha of the north, east and south shores of the lake and offers 78 campsites, lakeside walking trails, a day use area, sandy beaches and a boat launch. Shoreline development also includes approximately 55 private recreational lots, almost all of which are used on a seasonal basis with outhouses for sewage disposal.

Although Purden Lake is not thought to be under any specific threat to its water quality, the greatest challenge to lake management would likely be the control of phosphorus (nutrient) loading. This loading could promote summer algal blooms and the spread of aquatic plants. MOE files do not contain reports of algal bloom or aquatic plant problems on Purden Lake. Concern should exist over the potential introduction of the endemic *Elodea canadensis* (Canadian pondweed) into the lake. This aggressive aquatic plant has the potential to colonize and overrun those shoreline areas where fine grained sediments are common. Its impact on recreation in those areas could be significant.

Purden Lake Watershed and Land Use Map



Non-Point Source Pollution and Purden 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.

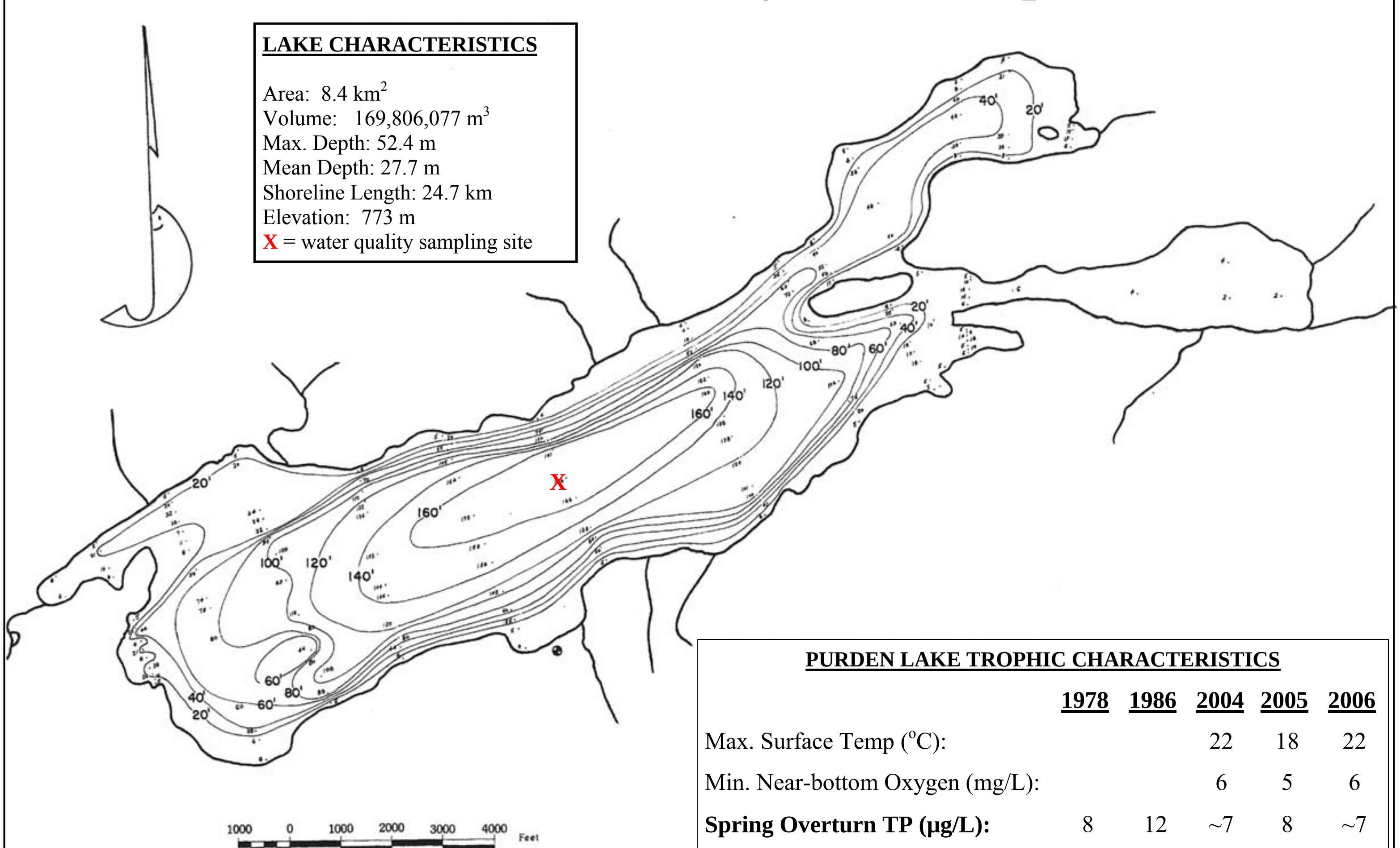
Boating

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.

Purden Lake Bathymetric Map

LAKE CHARACTERISTICS

Area: 8.4 km^2
Volume: 169,806,077 m^3
Max. Depth: 52.4 m
Mean Depth: 27.7 m
Shoreline Length: 24.7 km
Elevation: 773 m
X = water quality sampling site



PURDEN LAKE TROPHIC CHARACTERISTICS

	1978	1986	2004	2005	2006
Max. Surface Temp (^oC):			22	18	22
Min. Near-bottom Oxygen (mg/L):			6	5	6
Spring Overturn TP (µg/L):	8	12	~7	8	~7
Avg. Chlorophyll *a* (µg/L):			1.9	0.9	2.0
Avg. Secchi Depth (m):			8.0	7.4	9.1

What's Going on Inside Purden Lake?

Temperature

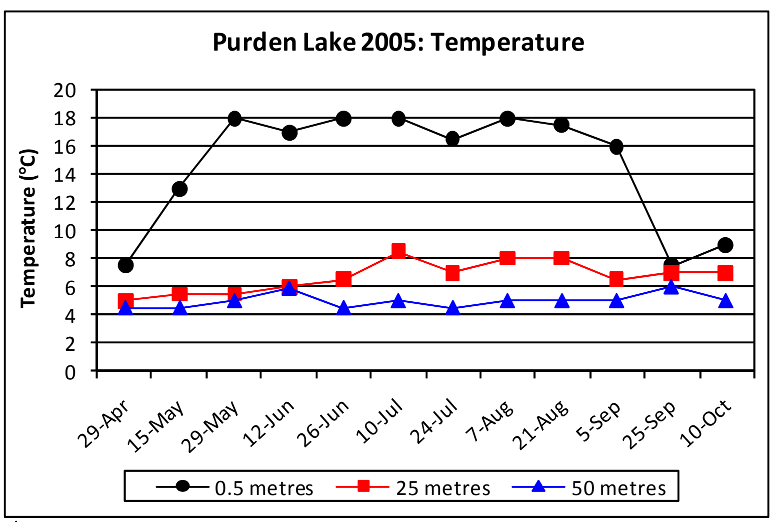
Lakes show a variety of annual temperature patterns based on each lake's location and depth. Most interior lakes form layers (stratify), with the coldest summer water near the bottom. Because colder water is denser, it resists mixing into the warmer, upper layer for much of the summer. In spring and 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 in 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 at three depths on Purden Lake during 2004 - 2006. The figure below illustrates Purden Lake water temperatures for 2005. These temperature patterns were similar for all three study years. When sampling began on April 29th, the lake was nearly isothermal (uniform temperature with depth) during spring overturn, but was stratified by May 15th. This stratification holds throughout the summer, 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).

Surface temperatures were between 16 °C and 18 °C from late May to early September. Mid-depth and bottom temperatures were substantially lower and consistent through the sampling season. Shorter days and cooling air temperatures through early September led to a loss of thermal stratification followed by fall overturn in late September.

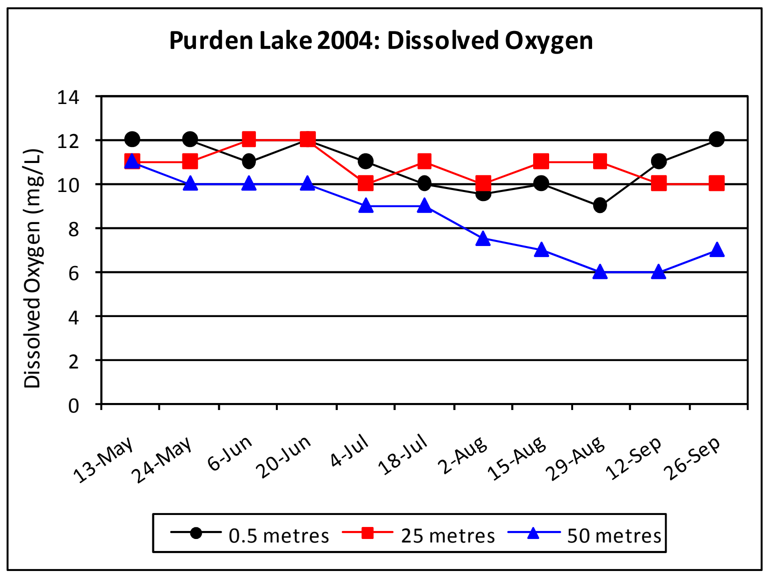


Dissolved Oxygen

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 in summer, 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 (salmonids 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 patterns for Purden Lake in 2004. They are comparable to the oxygen patterns for the other two study years. Surface and mid-depth water remained near saturation for most of the summer, not dropping below 9 mg/L and 10 mg/L, respectively. The lake displayed a gradual decline in dissolved oxygen (DO) at the near-bottom depth through the sampling period, with the waters reaching a minimum of 6 mg/L. Anoxic conditions were not reached and these bottom concentrations would support aquatic life. The strong temperature gradient that was present, 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. Vertical mixing and the aeration of bottom waters is not evident as fall overturn had not occurred by the end of the sampling season. This likely happened in early October.

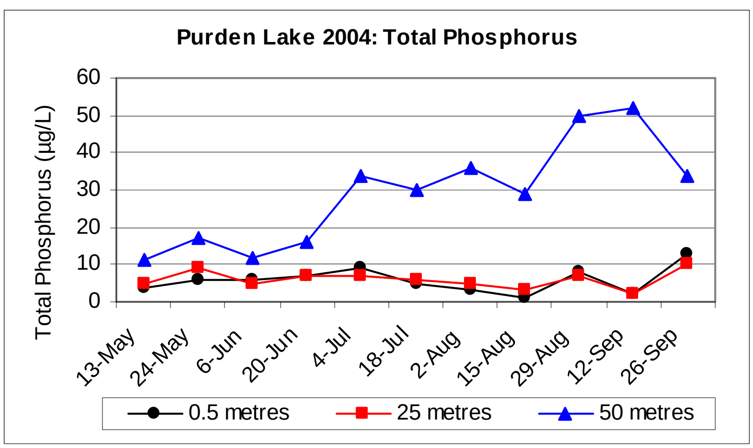
Trophic Status and Phosphorus

The term "trophic status" is used to describe a lake's level of productivity and depends on the amount of nutrients 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.

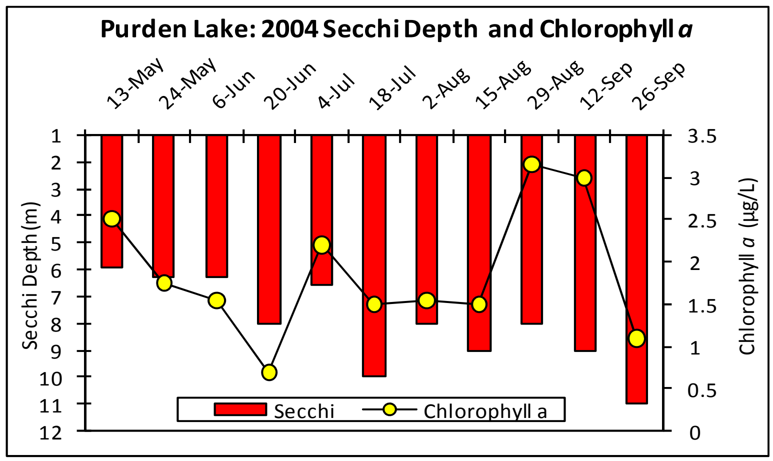
Lake sediments can themselves be a major source of phosphorus. If deep-water oxygen becomes depleted, a chemical shift occurs in bottom sediments. This shift causes sediment to release phosphorus to overlying waters. This "internal loading" of phosphorus can be natural but is often the result of phosphorus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



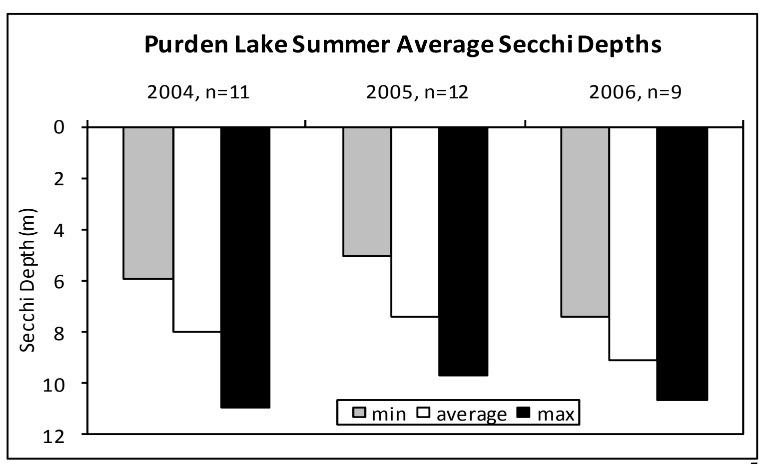
For five years, measured between 1978 and 2006, Purden Lake spring overturn TP (p. 3) averaged 8.4 µg/L, indicating that the lake is oligotrophic. The concentrations were also fairly stable over that period, implying no shift toward a mesotrophic status.

The above graph displays 2004 phosphorus cycling in Purden Lake. TP was nearly uniform throughout the water column on the first day of sampling (May 13th), as spring overturn was underway. Phosphorus levels at lake bottom rose gradually while surface and mid-levels remained relatively constant. Bottom TP levels peaked at only 52 µg/L and then began to decline, suggesting fall overturn occurred sometime in October. Given the presence of oxygen and the lack of hydrogen sulphide during the bottom peaks on August 29th and September 12th, it is likely these peaks are the result of organic settling of dead algae rather than internal phosphorus loading. Orthophosphorus comprised 50% of the peak total phosphorus and was of fairly low concentration. The general trend in surface TP is reflected by chlorophyll *a* readings (see chlorophyll *a* graph below), with higher concentrations in both TP and chlorophyll *a* occurring on July 4th and August 29th.

The graph below displays Purden Lake water clarity and chlorophyll *a* concentrations. Water clarity is measured using a Secchi disc, a black and white disc used to indicate the depth of light penetration. Secchi disc depth was a reasonable indicator of chlorophyll *a* in 2004. The summer average chlorophyll *a* concentration was 1.9 µg/L and the summer average Secchi depth was 8 m, further indicating the oligotrophic conditions of Purden Lake.



The following graph shows the minimum, average and maximum Secchi depths recorded for Purden Lake from 2004 to 2006, as well as the number of readings each year (n). During these years of sampling the average Secchi depth measurements ranged from 7.4 m (2005) to 9.1 m (2006), indicating relatively little change has occurred during the sampling period. Based on these Secchi values Purden Lake was exhibiting oligotrophic conditions.



Should Further Monitoring Be Done on Purden Lake?

Recent lake monitoring results suggest that Purden Lake has good recreational water quality that has remained stable during the three year sampling period and likely since 1978. Secchi, chlorophyll *a*, and phosphorus values all indicate Purden Lake is oligotrophic. Additional years of data during spring overturn are recommended to confirm the lake's current nutrient status, and evaluate annual fluctuations in spring TP levels. The full Level III program (sampling every two weeks) should be repeated beginning in 2014. 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. The transplanting of aquatic plants into Purden Lake is to be avoided.

Tips to Keep Purden 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.

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 waterbodies.
- Conserve water: run the washing machine and dishwasher only when full and use only low-flow showerheads 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 waterbodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals.
- Conduct major maintenance chores on land.
- Use 4 stroke engines, which are less polluting than 2 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 polystyrene (completely contained and sealed in UV treated material) 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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FishWizard (www.fishwizard.com)

Land Use Map:
Sean Barry - Integrated Land Management Bureau (ILMB)

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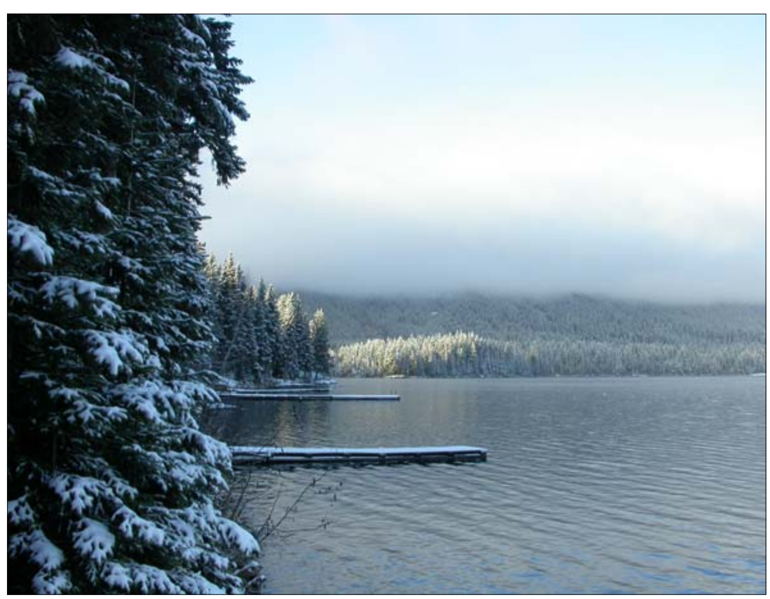
Back page: Bruce Carmichael

References

Nordin, R.N. 1985. Water Quality Criteria for Nutrients and Algae. Water Quality Unit, Resource Quality Section. Ministry of Environment, Lands and Parks. Victoria, B.C.

Purden Lake volunteers