BC Lake Stewardship and Monitoring Program

Rose Lake 1992, 2003 - 2007

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

The Importance of Rose Lake & its Watershed

British Columbians want lakes to provide good water quality, aesthetics and recreational opportunities. When these features are not apparent in recreational lakes, questions arise. People begin to wonder if the water quality is getting worse, if the lake has been affected by land development, and what conditions will result from more development within the watershed.

The BC Lake Stewardship Society (BCLSS), in partnership with the Ministry of Environment, has designed a program, entitled *The BC Lake Stewardship and Monitoring Program*, to help answer these questions. Through regular water sample collections, we can begin 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 appropriate for a particular lake depends on funding and human resources available. In some cases, data collected as part of a Level I or II program can point to the need for a more in-depth Level III program. This report gives the 2003 - 2007 results of a Level II program for Rose Lake, and as well summarizes historical data available for the 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.

The watershed area of Rose Lake is over 87 km^2. 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.

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 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 downstream 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. waste discharge outfalls, spills, etc). Undisturbed watersheds have the ability to purify water and repair small amounts of damage from pollution and alterations. However, modifications to the landscape and increased levels of pollution impair this ability.

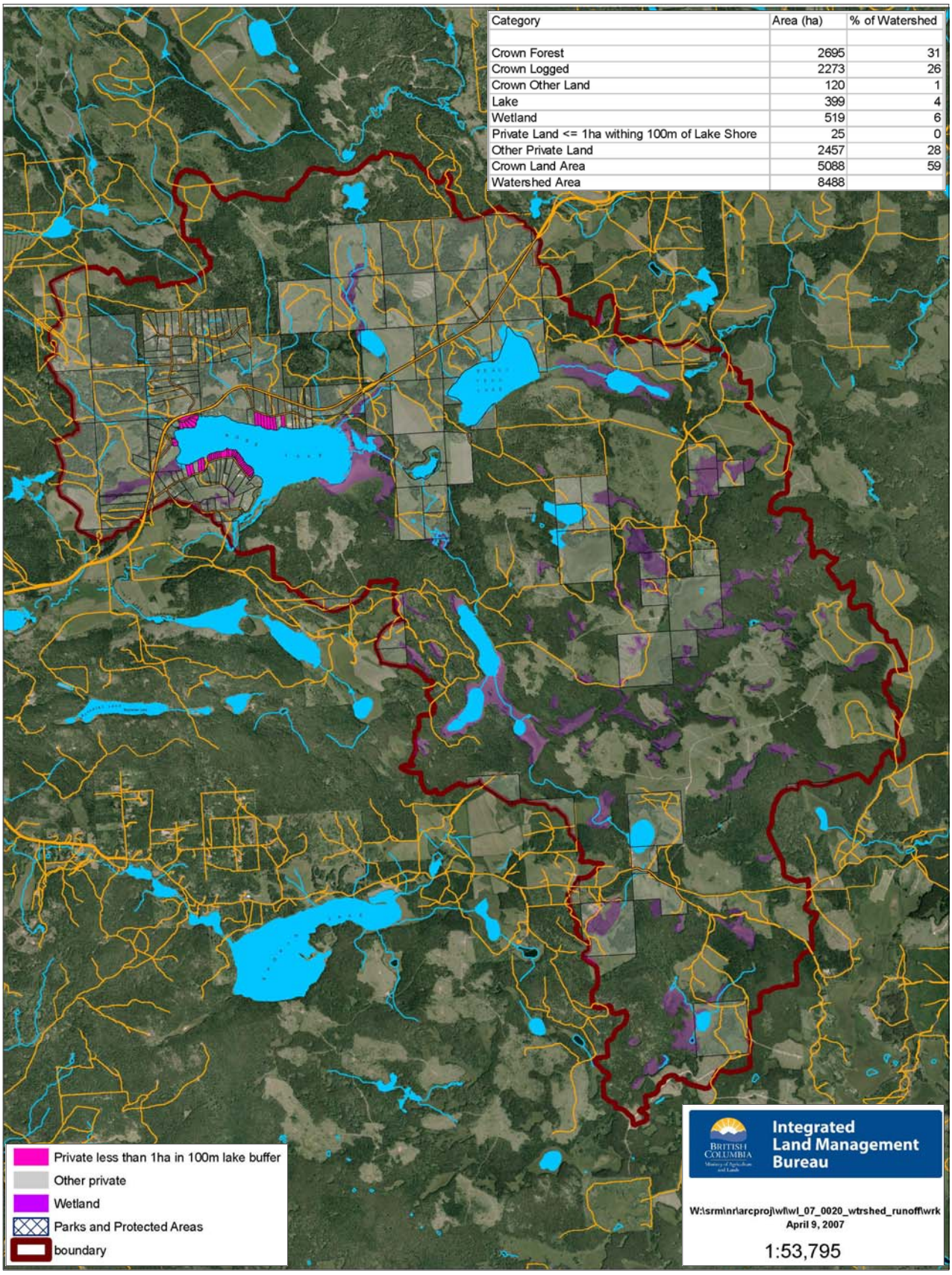
Rose Lake is located approximately 16 km east of 150 Mile House in the Cariboo region and lies at an elevation of 994 m. The lake has a maximum depth of 17.7 m and a mean depth of 6.1 m. Its surface area is 230 hectares and the shoreline perimeter is 11.3 km. Rose Lake contains Northern Pikeminnow (formerly Northern Squawfish), Peamouth Chub, Rainbow Trout, Redside Shiner and Sucker (General).

The flushing rate is a measure of time that inflow replaces the lake water volume. It is important because the longer the retention time, the less the lake has the ability to assimilate additional nutrients, and therefore avoid unnatural eutrophication. Based on limited data, the flushing rate of Rose Lake is estimated to be greater than 10 years. The long

flushing rate, shallow mean depth (6.1 m) and significant activity in this small watershed indicate that Rose Lake is highly sensitive (O'Keefe, et al, 2000).

Land use around the lake is made up of residential/developed areas with cabins located mostly on the Southwest and North shores, considerable agricultural and farming activity in the immediate vicinity of the lake, and intermittent spruce forests. There is a dam structure on the outlet creek with a juvenile fish passage built in. The purpose of this dam is for downstream irrigation so outlet flow has the potential to be variable. Some residents use lake water as a potable water supply.

Rose Lake Watershed Map



Non-Point Source Pollution and Rose 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 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.

The greatest challenge to Rose Lake is phosphorus (nutrient) loading. This loading may promote summer algal blooms and the spread of aquatic plants.

Agriculture

Agriculture is economically and culturally important. When practices are improperly managed, however, there can be significant NPS impacts, such as nutrients and pathogens from manure and damage to shorelines from livestock access.

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 become significant sources of nutrients and pathogens. Poorly located or maintained pit privies, used for the disposal of human waste and grey water, can also be significant contributors.

Stormwater Runoff

Over-fertilizing of lawns and gardens, oil and fuel leaks from vehicles , snowmobiles and boats, road salt, and litter are all washed by rain and snowmelt from our yards and streets. Pavement increases runoff of surface water and the amount of contaminants entering water bodies. Pavement collects contaminants during dry weather, and prevents water from soaking into the ground during storm events. Phosphorus and sediment are of greatest concern, providing nutrients and/or a rooting medium for aquatic plants and algae.

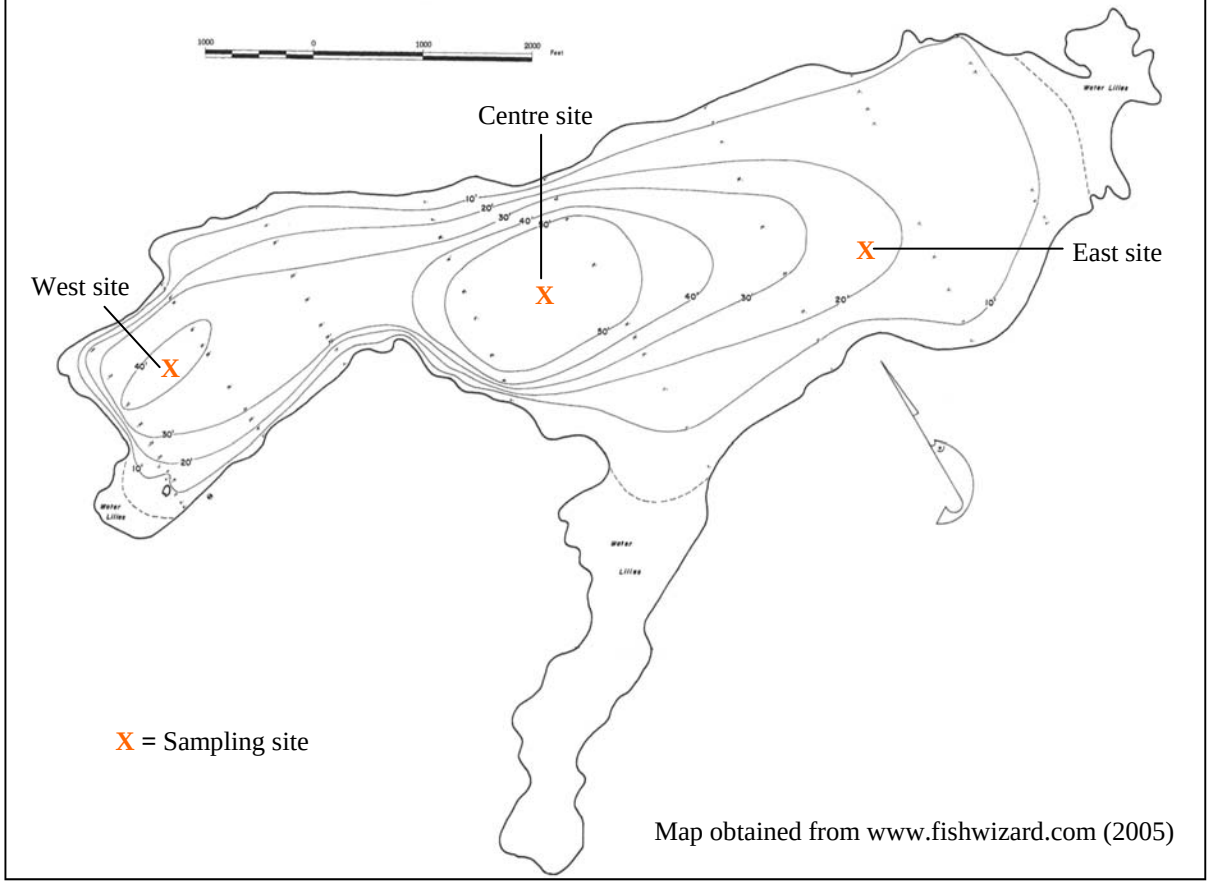
Forestry

Forestry, which includes clear cutting, road building and other land disturbances is essential to the economy, however it can increase sediment and phosphorus, and alter water flow.

Boating

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

Rose Lake Bathymetric Map



Map obtained from www.fishwizard.com (2005)

What's Going on Inside Rose Lake?

Temperature

BC lakes can show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest water near the bottom. Because colder water is more dense, it resists mixing into the warmer, upper layer for much of the summer. When the warmer oxygen rich surface water distinctly separates from the cold, often oxygen poor, water in the deeper parts of the lake, it is said to create a thermocline, a region of rapid temperature change between the two layers.

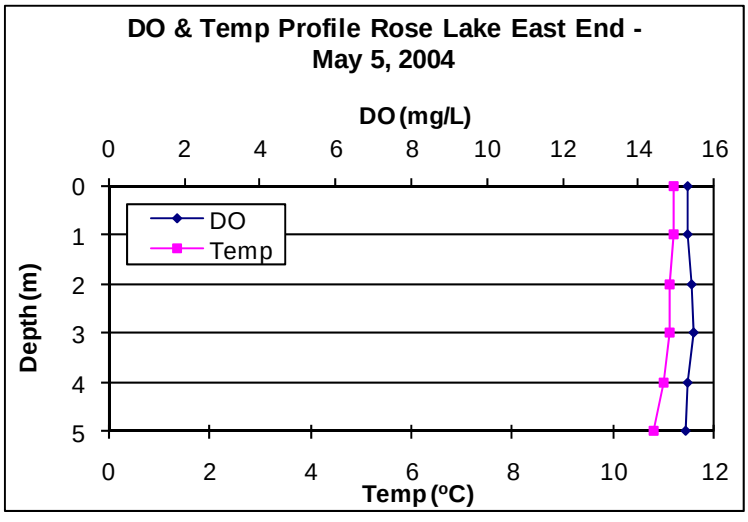
In spring and fall, these lakes usually mix from top to bottom (overturn) as wind energy overcomes the reduced temperature and density differences between surface and bottom waters. In the winter, lakes re-stratify under floating ice with the densest water (4°C) near the bottom. Because these types of lakes turn over twice per year, they are called dimictic lakes. These are the most common type of lake in British Columbia. Rose Lake is dimictic.

Coastal lakes in BC are more often termed warm monomictic lakes. These lakes turn over once per year. Warm monomictic lakes have temperatures that do not fall below 4°C in the winter and stratify in the summer.

Surface temperature readings serve as an important ecological indicator. By measuring surface temperature, we can record and compare readings from season to season and year to year. Temperature stratification patterns are also very important to lake water quality. They determine much of the seasonal oxygen, phosphorus, and algal conditions. When abundant, algae can create problems for lake users.

The timing of freeze up and break up of BC lakes is important information for climate change research. BCLSS is interested in this information. If these dates have been recorded in the past, please send the information to BCLSS so that it can be incorporated into climate change studies.

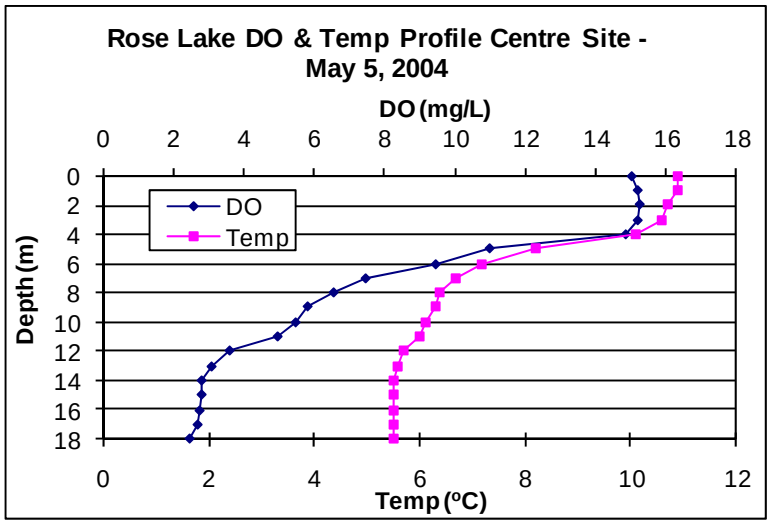
Dissolved oxygen and temperature data was collected at 3 sites (see map on page 3) on Rose Lake between 2003 and 2005.



Data collected in each of the three years show the lake was not well mixed at the centre and west sites. However, the profiles suggest that spring overturn had occurred relatively recently as the thermocline was not strongly developed.

The previous graph from the east site indicates that Rose Lake was relatively well mixed at that location. The isothermal conditions at this site may be attributed to the site's shallow depth.

The following graph shows the dissolved oxygen and temperature data collected on May 5, 2004 at the centre site. The profile suggests the onset of thermal stratification and the beginning of a thermocline at a depth of 4 m.



Dissolved Oxygen

Oxygen is essential to life in lakes. It enters lake water from the air by wind action and also through plant photosynthesis. Oxygen is consumed by respiration 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 less productive (oligotrophic) will have sufficient oxygen to support life at all depths throughout 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 levels fall below about 20% saturation) where temperatures may be too warm. Fish kills can occur when decomposing or respiring algae use up the oxygen. In the summer, this can happen on calm nights after an algal bloom, but most fish kills occur during late winter or at initial spring mixing because oxygen has been depleted under winter ice.

Spring overturn is a good time to get a representative sample because the water is well mixed. Nutrient concentrations can be compared each spring to determine trends.

Trophic Status

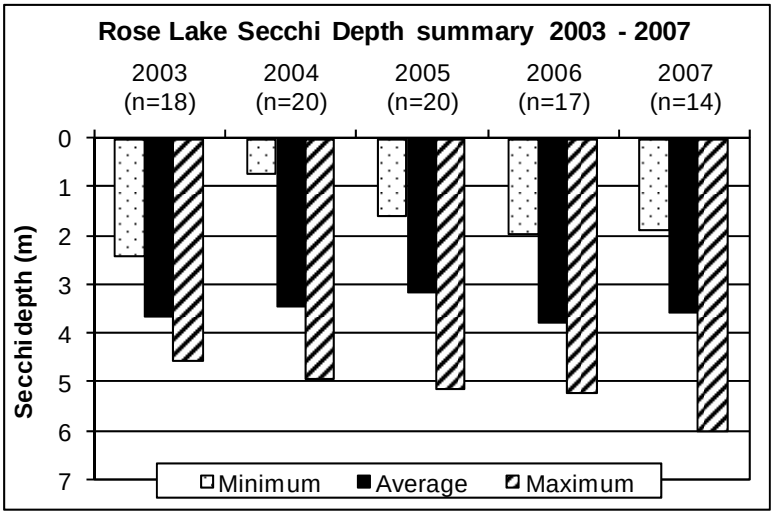
The term *trophic status* is used to describe a lake's level of productivity and depends on the amount of nutrients available for plant growth, including tiny floating algae called phytoplankton. Trophic status is often determined by measuring levels of phosphorus, algal chlorophyll *a* (the green photosynthetic pigment), and water clarity. Establishing the trophic condition of a lake allows inter-lake comparisons and general biological and chemical attributes of a lake to be estimated.

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.

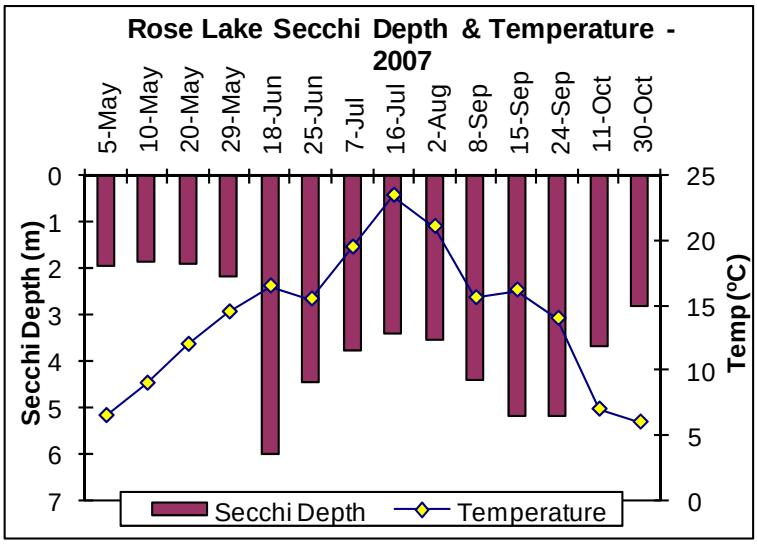
Water Clarity

One method of determining productivity is by measuring water clarity. The more productive a lake is, the higher the algal growth, and, therefore, the less clear the water becomes. The clarity of the water can be evaluated by using a Secchi disc, a black and white disk that measures the depth of light penetration. The greater the Secchi depth the greater the water clarity.

Secchi depth readings for all years were conducted at the centre site. The graph below shows the minimum, average and maximum Secchi depths recorded on Rose Lake from 2003 to 2007, as well as the number of readings each year (n). Average Secchi depth measurements ranged from 3.2 m (2005) to 3.8 m (2006), indicating that there has been little change during the years of data collection. The lowest Secchi readings occur in the early spring of each year shortly after ice out. It should be noted that there were no spring Secchi measurements in 2003 which would contribute to a higher average Secchi depth for that year. The average Secchi depths were in the range for mesotrophic, or medium productivity, lakes.



Natural variation and trends in Secchi depth and temperature not only occur between years, but also throughout one season. In general, as temperature increases during the summer months, the Secchi depth decreases. As temperature increases, so do some species of algae. Due to the increase in algae, the water clarity can decrease as evidenced by a decrease in the Secchi depth. This trend is evident in the following graph of the 2007 Secchi data.



Phosphorus

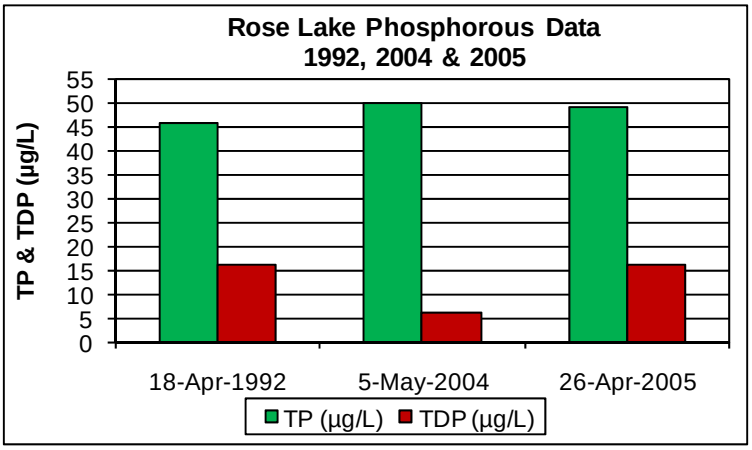
As mentioned previously, productivity can also be determined by measuring phosphorus levels. Phosphorus concentrations measured during spring overturn can be used to predict summer algal productivity. Productivity is dependant on the amount of nutrients (phosphorus and nitrogen) in a lake, which are essential for plant growth, including algae. Algae are important to the overall ecology of a lake because they are the food for zooplankton, which in turn are the 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, however, phosphorus accelerates growth and artificially ages a lake. Total phosphorus (TP) in a lake can be greatly influenced by human activities.

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.

Chemistry sampling in Rose Lake was conducted between mid April and early June in 1992, 1998, 2003, 2004, and 2005.

The lake profile for 1998 shows that the lake was strongly stratified, therefore the values do not reflect spring overturn conditions. For this reason the 1998 data is not included in this report. Data quality problems occurred in 2003 (very poor replication in total phosphorus values), therefore this data was also excluded from the analysis.

As shown in the graph below, TP values in 2004 and 2005 were 50 µg/L and 49 µg/L, respectively, only slightly higher than the 46 µg/L recorded in 1992. The TP values for Rose Lake are above the 30 µg/L threshold for eutrophic lakes. The total dissolved phosphorus values show some variability, however there is no evidence of an increasing trend.

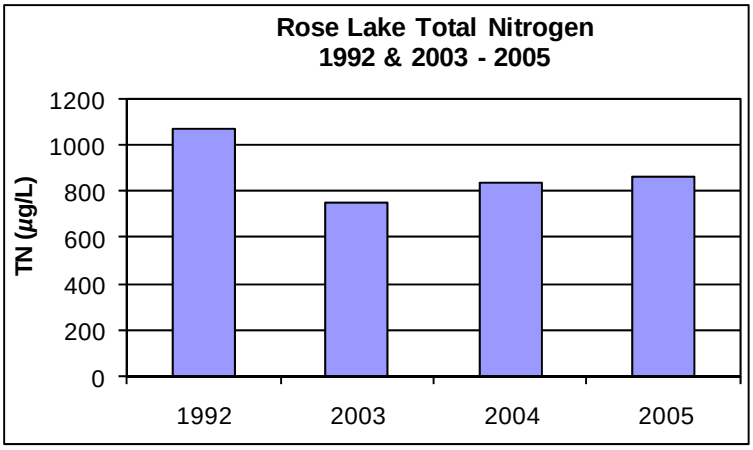


The majority of Rose Lake is shallow making it susceptible to re-suspension of phosphorus from bottom sediments. For this reason, internal phosphorus loading during the summer may be a large factor in determining Rose Lake's phosphorus load. Further monitoring may be required to better understand Rose Lake's stratification/mixing and phosphorus cycle.

Nitrogen

Nitrogen is the second most important nutrient involved in lake productivity. In BC lakes, nitrogen is rarely the limiting nutrient for algae growth. In most lakes, the ratio of nitrogen to phosphorus is well over 15:1, meaning excess nitrogen is present. In lakes where the ratio is less than 5:1, nitrogen becomes limiting to algae growth and can have major impacts on the amount and species of algae present.

The N:P ratio for Rose Lake is approximately 20:1, which means the lake is a phosphorus limited system. Although an increase in nitrogen should not increase algae biomass, it could result in a change to the species present, possibly to a less desirable species.



The average total nitrogen (TN) values in Rose Lake for 1992 and 2003 - 2005 are shown in the graph above. The values for nitrogen ranged from 750 µg/L in 2003 to 860 µg/L in 2005, somewhat lower than the 1070 µg/L recorded in 1992. TN values for all sampling years place Rose Lake in the eutrophic range (Nordin, 1985).

Chlorophyll a

Chlorophyll *a* is the common green pigment found in almost all plants. In lakes, it occurs in plants ranging from algae (phytoplankton) to rooted aquatic forms (macrophytes). Chlorophyll captures the light energy that drives the process of photosynthesis. While several chlorophyll pigments exist, chlorophyll *a* is the most common. The concentration of chlorophyll *a* in lake water is an indicator of the density of algae present in that same water.

Mean summer chlorophyll *a* values were calculated from spring overturn phosphorus values and were 10.4 µg/L in 1992, 11.3 µg/L in 2004 and 11.1 µg/L in 2005, indicating eutrophic conditions.

Aquatic Plants

Aquatic plants are an essential part of a healthy lake. Factors that affect the type and amount of plants found in a lake include the levels of nutrients (i.e. phosphorus), temperature, and introduction of invasive species.

Some of the plant species found in Rose Lake include: *Myriophyllum* (water milfoil family) species, *Rannunculus* (buttercup) species, and *Potamogeton* (pondweeds)

Myriophyllum is the genus name for water milfoil, consisting of both native and introduced species. In Rose Lake, it is the native species, northern watermilfoil, that is present. This species of milfoil does not pose the same problems as the exotic Eurasian milfoil as it does not normally out compete the other plant species in the lake.

Aquatic plants play an important role in the lifecycle of aquatic insects, providing food and shelter from predators for young fish, and also providing food for waterfowl, beavers and muskrats.

Aquatic plant species can spread between lakes via boaters. Be sure to check for and remove all aquatic plant fragments from boats and trailers before entering or when leaving a lake.

Should Further Monitoring Be Done on Rose Lake?

Rose Lake is a eutrophic lake as indicated by total phosphorus, nitrogen and chlorophyll *a* values. Water clarity (Secchi depth) is in the mesotrophic range. The data collected on Rose Lake indicates that the water quality has remained stable in terms of phosphorus and Secchi depth. Volunteers are continuing to monitor Secchi depth and surface temperature which will provide valuable long term records and help to identify early warning signs should there be a deterioration in water quality.

Rose Lake is considered sensitive to eutrophication due to its extensive shallow areas, low flushing rate and highly developed watershed. Further monitoring of dissolved oxygen and temperature profiles (multiple depths) would aid in understanding the effects of potential destratification. These measurements would provide additional information on habitat availability for rainbow trout. In addition to continued monitoring, ice-on and ice-off dates should be recorded for climate change studies.

Tips to Keep Rose 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.
- Do not 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 and lakeshore.
- If livestock cross streams, provide graveled or hardened access points.
- Provide alternate watering systems, such as troughs, dugouts, 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 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 absorbent bilge pads to soak up minor leaks or spills.
- 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 blue or pink closed-cell extruded polystyrene billets 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.
- Remember: when within 150 m of shore adjust your speed accordingly to prevent waves from eroding banks.
- Adhere to British Columbia's Universal Shoreline Speed Restriction which limits all power-driven vessels to 10 km/hr within 30 m of shore. Exceptions to this restriction include:
  - vessels traveling perpendicularly to shore when towing a skier, wakeboard, etc.
  - rivers less than 100 m wide
  - buoyed channels

Who to Contact for More Information

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Bathymetric Map:
FishWizard (www.fishwizard.com)

Photo Credit:
Chris Swan, Ministry of Environment

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