BC Lake Stewardship and Monitoring Program

Round Lake 2002-2005

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

The Importance of Round 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, 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 results of a Level II program for Round Lake for the years 2002 to 2005.

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 volunteers and the BC Lake Stewardship Society.

The watershed area of Round Lake is approximately 27 km². 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.

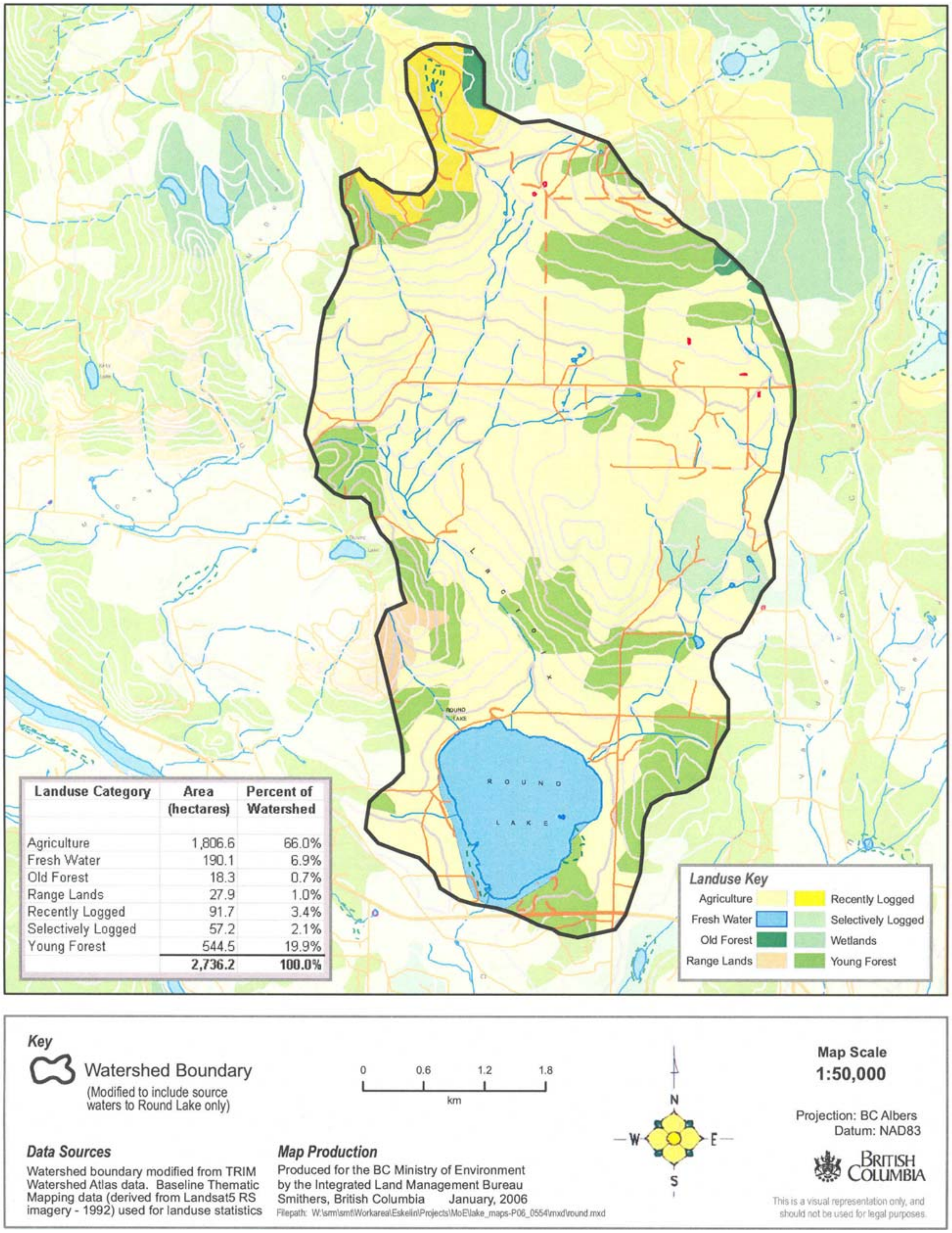
Human activities that impact water bodies range from small but widespread and numerous *non-point* sources throughout the watershed to large *point* sources of concentrated pollution (e.g. waste discharge outfalls, spills, etc). Undisturbed watersheds have the ability to purify water and repair small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

Round Lake is located approximately 24 km southeast of Smithers and lies at an elevation of 579 metres. The lake has a maximum depth of 20.4 m and a mean depth of 9.6 m. Its surface area is 182 hectares and the shoreline perimeter is 5.3 km. Round Lake contains burbot, prickly sculpin, longnose sucker, northern pikeminnow and peamouth chub and has been stocked with rainbow and cutthroat trout.

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. The flushing rate of Round Lake is estimated to be once every three years or longer. This moderate flushing rate indicates that Round Lake has an average ability to assimilate additional nutrients and may be less sensitive to eutrophication.

The map below shows the Round Lake watershed and its associated land use practices. The watershed largely includes private lands used for agriculture (grain and forage and cattle farming) and residential purposes, making agriculture an important concern for non-point source pollution. General information on non-point source pollution is provided on the following page.

Round Lake Watershed Land Use Map



Non-Point Source Pollution and Round 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.

Agriculture

Agriculture including grains, livestock, and mixed farming, can alter water flow and increase sediment and chemical/ bacterial/parasitic input into water bodies.

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 maintained pit privies, used for the disposal of human waste and grey water, can also be significant contributors.

Properly located and maintained septic tanks do not pose a threat to the environment, however, mismanaged or poorly located tanks can result in a health hazard and/or excessive nutrients getting into the lake. Excessive nutrients such as phosphorus can cause a variety of problems including increased plant growth and algal blooms.

Stormwater Runoff

Lawn and garden fertilizer, sediment eroded from modified shorelines or infill projects, oil and fuel leaks from vehicles, snowmobiles 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 a 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.

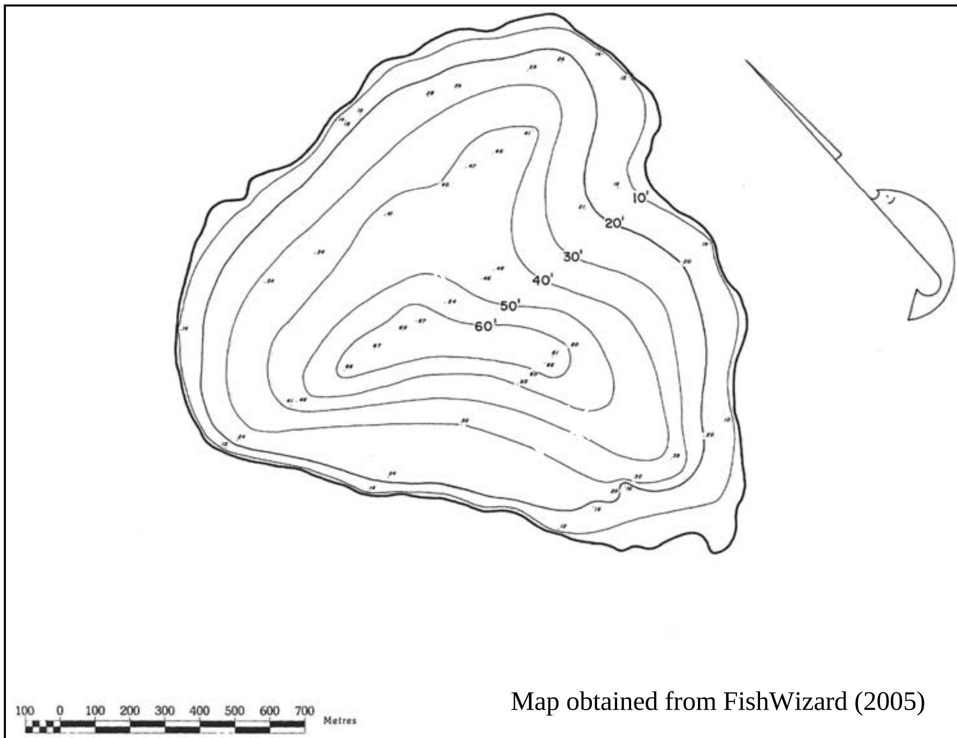
Boating

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.

Forestry

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

Round Lake Bathymetric Map



Map obtained from FishWizard (2005)

What's Going on Inside Round Lake?

Temperature

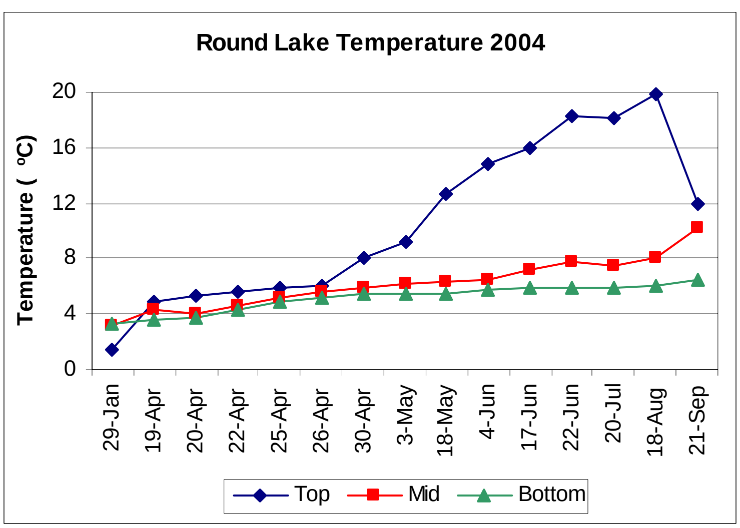
Lakes show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest water near the bottom. Because colder water is more dense, it resists mixing into the warmer, upper layer for much of the summer. When the warmer oxygen rich surface water distinctly separates from the cold 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 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.

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. These lakes generally do not freeze and circulate freely in the winter at or above 4°C and stratify in the summer.

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 lake users. Continuously monitored surface temperature can provide us with information not only on algal blooms, but also provide important data to climate change studies.

The following figure illustrates the Round Lake's temperature patterns for 2004. The lake was stratified by the end of April. The surface and mid-depth temperatures rose consistently from mid April until the end of August while the bottom temperature rose until June 22nd and remained at approximately 6°C.



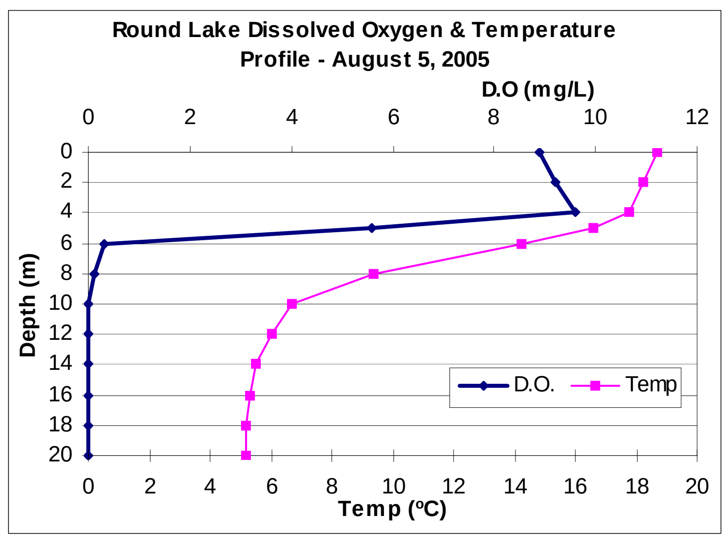
The maximum surface temperature measured in 2005 was 21°C on July 20th. The maximum surface temperatures recorded in 2002, 2003 and 2004 were 19.2°C (July 23rd), 22.5°C (July 23rd) and 23.3°C (July 22nd), suggesting there has been little change in surface temperature readings in Round Lake during these sampling years.

The timing of freeze up and break up of BC lakes is important information for climate change research. The BCLSS is interested in this information. Ice on and off dates were collected on Round Lake from 1998 to 2005. If additional data have been recorded in the past, please send the information to the BCLSS so that it can be incorporated into climate change studies.

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 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 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.



The above graph illustrates stratification in Round Lake. The bottom 10 metres of Round Lake are anoxic (oxygen depleted). The thermocline is clearly visible from 4 to 10 metres depth.

Trophic Status

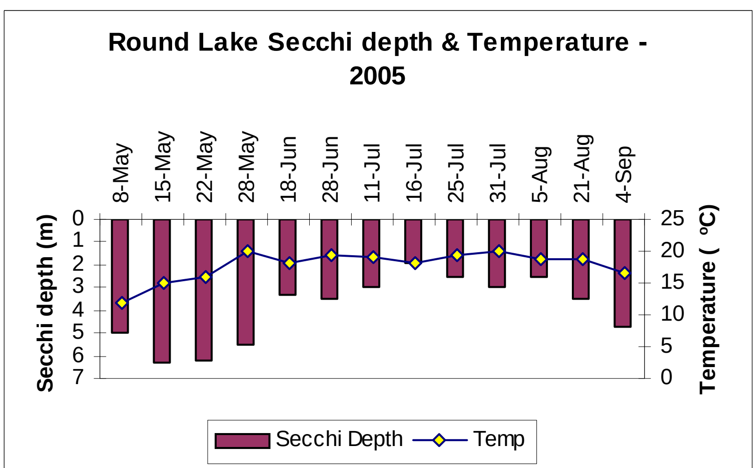
The term *trophic status* is used to describe a lake's level of productivity which is often determined by measuring levels of phosphorus (TP), algal chlorophyll *a* (the green photosynthetic pigment), and water clarity. Establishing the trophic condition of a lake allows inter-lake comparisons and general 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 *u*g/L TP), sparse plant life (0-2 *u*g/L chl. *a*) and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 *u*g/L chl. *a*) including algae, because of higher nutrient levels (>30 *u*g/L TP). Lakes with an intermediate productivity are called ***mesotrophic*** (10-30 *u*g/L TP and 2-7 *u*g/L chl. *a*) and generally combine the qualities of oligotrophic and eutrophic lakes.

Water Clarity

As mentioned in the previous section, one method of determining productivity is 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 lake water can be evaluated by using a Secchi disk, a black and white disk that measures the depth of light penetration.

The average Secchi depth for Round Lake ranged from 1.8 m to 3.9 m from 2002 to 2005, indicating that there was little change during these years of data collection. The average Secchi depth measurements were within the 2 - 5 meter range for mesotrophic lakes.



The Secchi depth and surface temperature for Round Lake in summer 2005 are shown in the graph above. The minimum (shallowest) and maximum (deepest) Secchi depths recorded in 2005 were 1.9 m and 6.3 m on July 16th and May 15th, respectively.

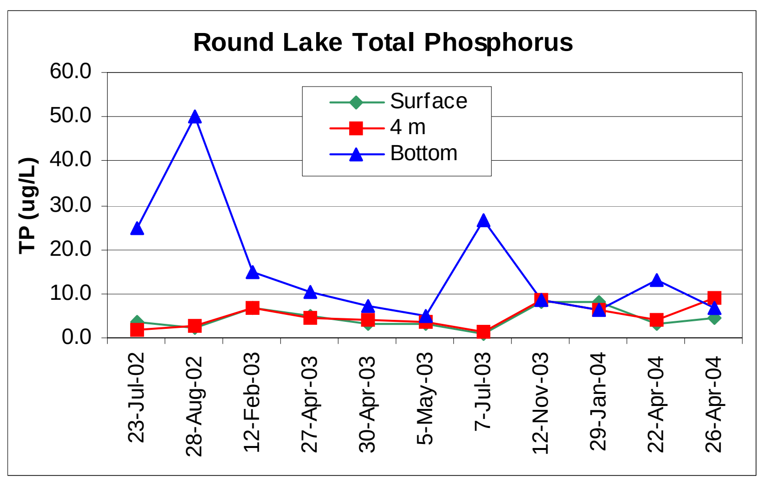
Natural variations and trends in Secchi depth and temperature not only occur between years, but also throughout one season. In general, as temperature increases during the summer months, the Secchi depth decreases. As temperature increases, so do some species of algae. Due to the increase in algae, the water clarity can decrease and the Secchi depth decreases.

Phosphorus

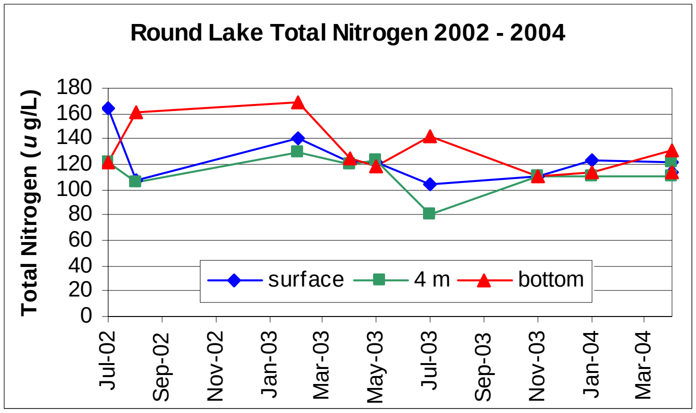
As mentioned previously, productivity can also be determined by measuring nutrient (i.e. phosphorus) levels. Phosphorus concentrations measured during spring overturn can be used to predict summer algal productivity. In most lakes, phosphorus accelerates algae growth and may artificially age a lake. 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.

The following diagram displays 2002 - 2004 phosphorus cycling in Round Lake. Low TP levels were observed in the two uppermost sample depths throughout sampling period. The noticeable increase of TP in the lake bottom in July 2002 (25 *u*g/L), August 2002 (50.3 *u*g/L) and July 2003 (26.7 *u*g/L) is likely due to a release of nutrients from the bottom sediments where anoxic conditions were present. Spring overturn appears to begin at the end of April in both 2003 and 2004 as shown by the uniformity of the TP concentrations. The uniformity in TP evident on the November 12, 2003 reading indicates fall overturn as occurring in Round Lake.



The 2003 Round Lake spring overturn TP surface concentrations was 3.3 *u*g/L, compared to 4.5 *u*g/L in 2004. Average spring overturn TP values for the lake for 2003 and 2004 are 4.0 and 6.8 *u*g/L, respectively. Although the 2004 and 2003 TP values indicate oligotrophic conditions for Round Lake this appears unlikely based on the depth of anoxic water and may be a result of missing sampling data.



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.

As shown in the above graph, total nitrogen concentrations were variable throughout the sampling years. Near bottom nitrogen was higher than in the surface or mid-depth water for most of the season, an expected trend considering the isolation of the deeper water as a result of thermal stratification and accumulation of sinking biomass. The average N:P ratio for 2002 - 2004 samples is 16:1 which means that the lake is a phosphorus-limited system for the growth of algae.

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.

Chlorophyll *a* data was collected on Round Lake in 1982, 1989, 1991, 1992, 2002 and 2003. Chlorophyll *a* averages in 1982, 1989, 1991 and 2002 (15.5, 26.5, 53.1 and 14.43 *u*g/L, respectively) indicate eutrophic conditions, while the 1992 (9.6 *u*g/L) & 2003 (4.25 *u*g/L) values indicate mesotrophic conditions (agreeing with the Secchi and phosphorus based classification) in Round Lake.

A Historical Look at Round Lake

The Round Lake volunteer monitoring program was initiated well after local land development and possible impacts to the lake began. Although this monitoring program can accurately document current lake quality, it cannot reveal historical baseline conditions or long term water quality trends. Here lies the value in coring lake sediments. Past changes in water quality can be inferred by studying the annual deposition of algal cells (in this case, diatoms) on the lake bottom.

A sediment core sample was obtained from the deep basin in Round Lake. The 42 cm sediment core was separated into 1 cm slices and analyzed by Dr. Brian Cumming of Queen's University. His report, *Assessment of Changes in Total Phosphorus in Round Lake, BC: A Paleolimnological Assessment*, is available upon request.

Diatoms are a type of algae commonly found in lake environments. Their glass-like shell (known as a frustule) is composed of silicon. This frustule leaves a permanent record of diatom history in lake bottoms. There are two main types of diatoms, the Centrales, which have radial symmetry (e.g. *Cyclotella stelligera* seen in the left photo) and the Pennales, which have bilateral symmetry (e.g. *Navicula miniscula*

Historical changes in relative diatom abundance were measured directly by microscopy. By knowing the age of various core sections and the phosphorus preferences of the specific diatom in each section, historical changes in lake phosphorus concentrations, chlorophyll, and water clarity can be estimated.

The sediment core indicates that Round Lake has undergone little change in species composition over the last several hundred years. The lake appears to have been meso-eutrohic since before 1900 (pre-development). This is determined from the dominance of a meso-eutrophic diatom species and other sub-dominant meso-eutrophic species throughout the core.

The diatom-inferred total phosphorus estimates indicate stable mid-summer mesotrophic-eutrophic conditions (TP between 19 to 20 *u*g/L) since before 1900. Results from water samples collected by the Ministry of Water, Land and Air Protection in 2002 show mean mid-summer concentration at the deep station epilimnion to be 26 *u*g/L.

A comparison of pre-settlement sediment loading rates with current rates can indicate the impact of human development in an area. The sediment core analysis suggests that sedimentation rates increased in 1900, around the same time human settlement occurred, and more significantly in the 1950's with larger increases in the 1980's. Land development in the Round Lake watershed includes extensive land clearing, road construction and residential and agricultural land use.

According to Cumming (2004), in approximately 1996, a change in the content ratio of the sediment is noted by a sharp decline in the percent of organic matter. Cumming states that the recent decrease may be attributed to several factors including decreased in-lake production of organic matter, decreased inwash or organic matter, or increases in the load of inorganic matter to the lake.

Should Further Monitoring Be Done on Round Lake?

The data collected on Round Lake indicates that the water quality has remained relatively stable in terms of Secchi depth and nitrogen and phosphorus concentrations over the last three years. All residents and land developers within the watershed are advised to continue to practice good land management so that nutrient migration to the lake and its tributaries is minimized.

It would be worthwhile to continue monitoring Secchi, temperature, phosphorus, nitrogen and spring overturn data. These measurements will continue to provide additional information on lake trophic status and determine habitat availability for fish.

In addition to continued water quality monitoring, ice-on and ice-off dates should be recorded for climate change studies.

Tips to Keep Round 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. Eurasian milfoil is an aggressive invasive aquatic weed. Be sure to familiarize yourself with this plant and remove and discard any fragments.
- 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

Ministry of Environment
Contact: AJ Downie
Bag 5000
Smithers, BC V0J 2N0

Phone: (250) 847-7277
Email: AJ.Downie@gov.bc.ca

Round Lake Watershed Enhancement Society
Contact: Iva Allen
12978 Degner Road
Telkwa, BC V0J 2X2

The BC Lake Stewardship Society
#4-552 West Ave
Kelowna, BC V1Y 4Z4

Phone: (250) 717-1212
Toll Free: 1-877-BC-LAKES
Email : bclss@hotmail.com
Website: www.bclss.org

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AJ Downie & Julia Kokelj (Ministry of Environment)
Dawn Roumieu & Carolyn Johns (BC Lake Stewardship Society)

Watershed Land Use Map Credit:
Ministry of Environment - Smithers, BC

Lake Specific Document Produced by:
BC Lake Stewardship Society

Photo Credit:
Ministry of Environment - Smithers, BC

Bathymetric Map
FishWizard (www.fishwizard.com)

References

Cumming, Brian. 2004. Assessment of Changes in Total Phosphorus in Round Lake, BC: A Paleolimnological Assessment. Prepared for the Ministry of Water, Land and Air Protection, Skeena Region, BC.

Kokelj, Julia. 2003. Summary of Paleolimnological Assessment by Dr. B. Cumming, Queen's University. Prepared for the Ministry of Water, Land and Air Protection, Skeena Region, BC.

Kokelj, Julia. 2004. Round Lake Draft Management Plan. Prepared for the Round Lake Watershed Enhancement Society and the Ministry of Water, Land and Air Protection, Skeena Region, BC.