BC Lake Stewardship and Monitoring Program

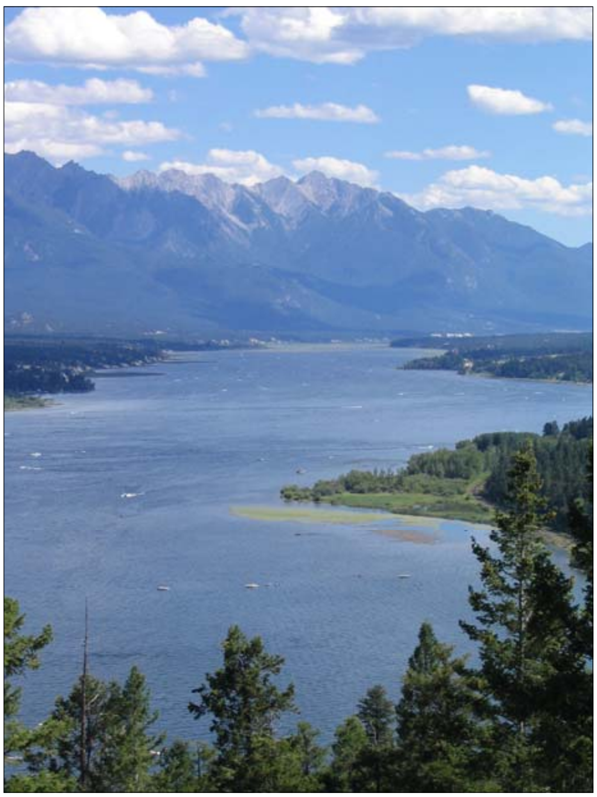
WINDERMERE LAKE 2005 - 2007

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

The Importance of Windermere 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* (BCLSMP), 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. The Lake Windermere Project (LWP) samples beyond a typical BCLSMP Level III. This report summarizes the 2006 & 2007 Level III results for Windermere 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 LWP began sampling in 2005. Following the production of the Masse & Miller report in fall 2005 and subsequent recommendations, the sampling program expanded in 2006. The quality of the laboratory data appears to be acceptable, however a full quality assurance analysis has not yet been completed. The quality assurance analysis is scheduled for the end of the project in 2010.

The watershed area of Windermere Lake is 890 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.

Windermere Lake is located between Invermere and Fairmont Hotsprings in the Rocky Mountain Trench. The lake lies at an elevation of 798 m, has a maximum depth of 6.4 m and a mean depth of 3.4 m. Its surface area is 1610 hectares and the shoreline perimeter is 36 km. Urban Systems (2001) found a high diversity of fish species in Windermere Lake which was credited to the lake's continuity with the Columbia River, as the lake is not a true lake but a widening of the river. Windermere Lake supports a number of both sport and coarse fish species. Sport fish include: bull trout, rainbow trout, kokanee, mountain whitefish, westslope cutthroat trout, burbot, and largemouth bass. Coarse species include: chislemouth chub, torrent sculpin, largescale sucker, northern squawfish, pumpkinseed, redside shiner, sunfish, and longnose sucker. Although there is a high diversity of fish in the lake the total numbers are low. The competition by many coarse fish and the lack of recruitment habitat cause low fisheries productivity (Urban Systems, 2001). Recent studies have found that the burbot population has declined drastically, causing the Ministry of Environment to close the fishery (Holmes, 2007).

Windermere Lake is both fed and drained by the Columbia River which has a strong influence on the lake's water chemistry (McKean and Nordin, 1985). Lake uses include drinking water, industrial, irrigation, fisheries, wildlife and recreation. Masse and Miller (2005) reported there were 36 water licenses on Windermere Lake as of 2005. This water is drawn from the lake for irrigation, land improvement, water intakes and domestic supply (Masse and Miller, 2005).

The flushing rate is a measure of time that inflow replaces the lake water volume. It is important because a longer retention time decreases the lake's ability to assimilate additional nutrients and therefore avoid unnatural eutrophication. The flushing rate of Windermere Lake is 47 days. This rapid flushing rate and shallow mean depth (3.4 m) indicates Windermere Lake has a high ability to assimilate nutrients.

The Regional District of the East Kootenay has provided the map on page 4 showing land uses in the Windermere Lake watershed. The majority of residential land use (town of Invermere) is concentrated at the north end of the lake. The north sampling site (see map page 3) is closest to Invermere and most likely to show impacts on water quality associated with residential land use activities.

Non-Point Source Pollution and Windermere 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. Septic systems must be located on suitable soil. 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. Much of the east side of Windermere Lake contains soil unsuitable for in ground sewage disposal, resulting in areas with noticeable or significant leachate seepage (Urban Systems, 1999).

Stormwater Runoff

Lawn and garden fertilizer, chemical pesticides, 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. Use gravel, interlocking stone or brick instead of concrete or asphalt. Dispose of hazardous wastes at collection or recycling depots; never dump them directly into storm drains. Sweep driveways and sidewalks instead of hosing them off.

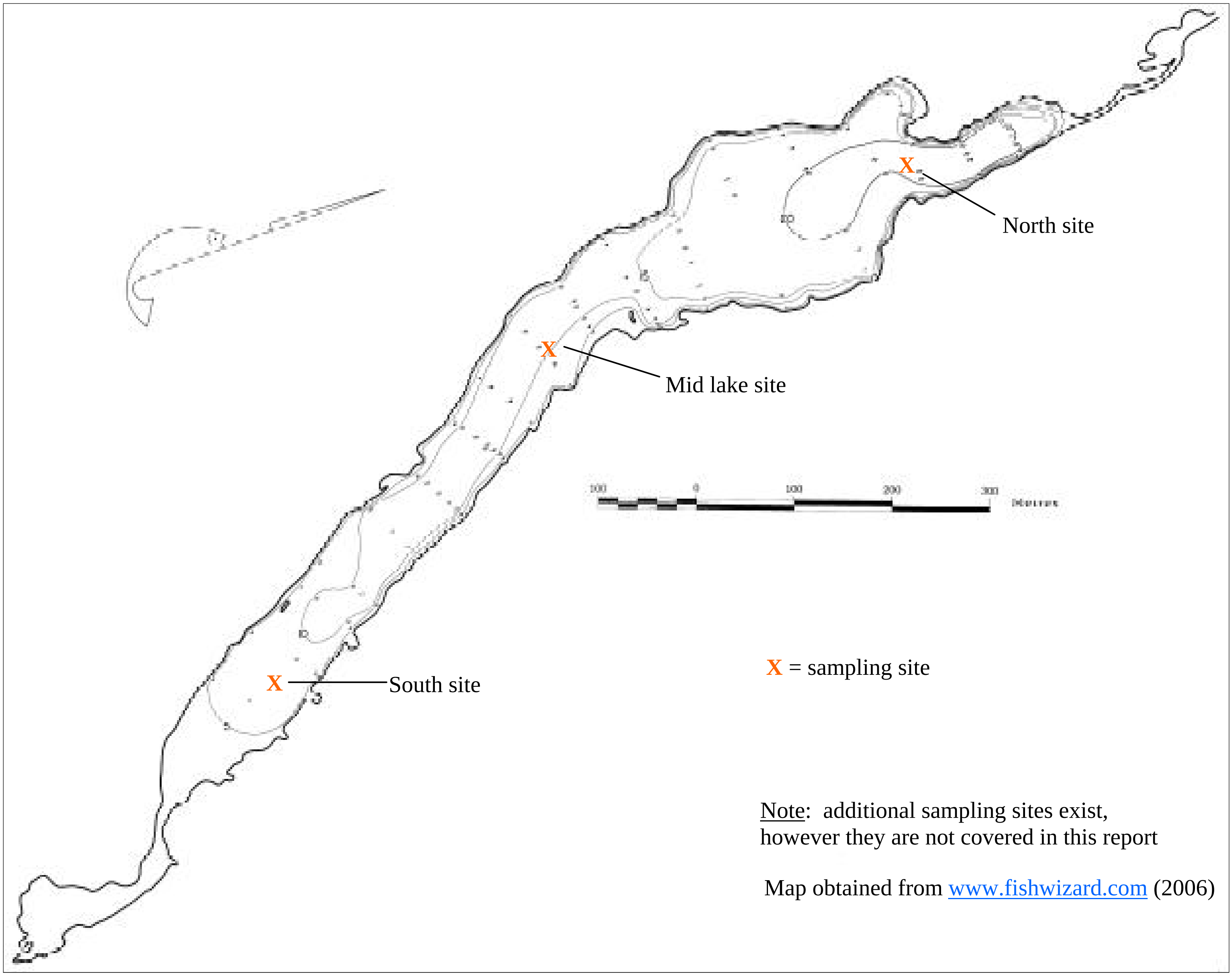
Tree Harvesting

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 concern 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 lakes, such as Windermere Lake, the churning up of bottom sediments and nutrients is a serious concern. Decrease speed or turn off your propeller in shallow waters to avoid stirring up bottom sediments. Within 150 m of shore, prevent erosive wave action by watching the boat wake and adjusting your speed accordingly.

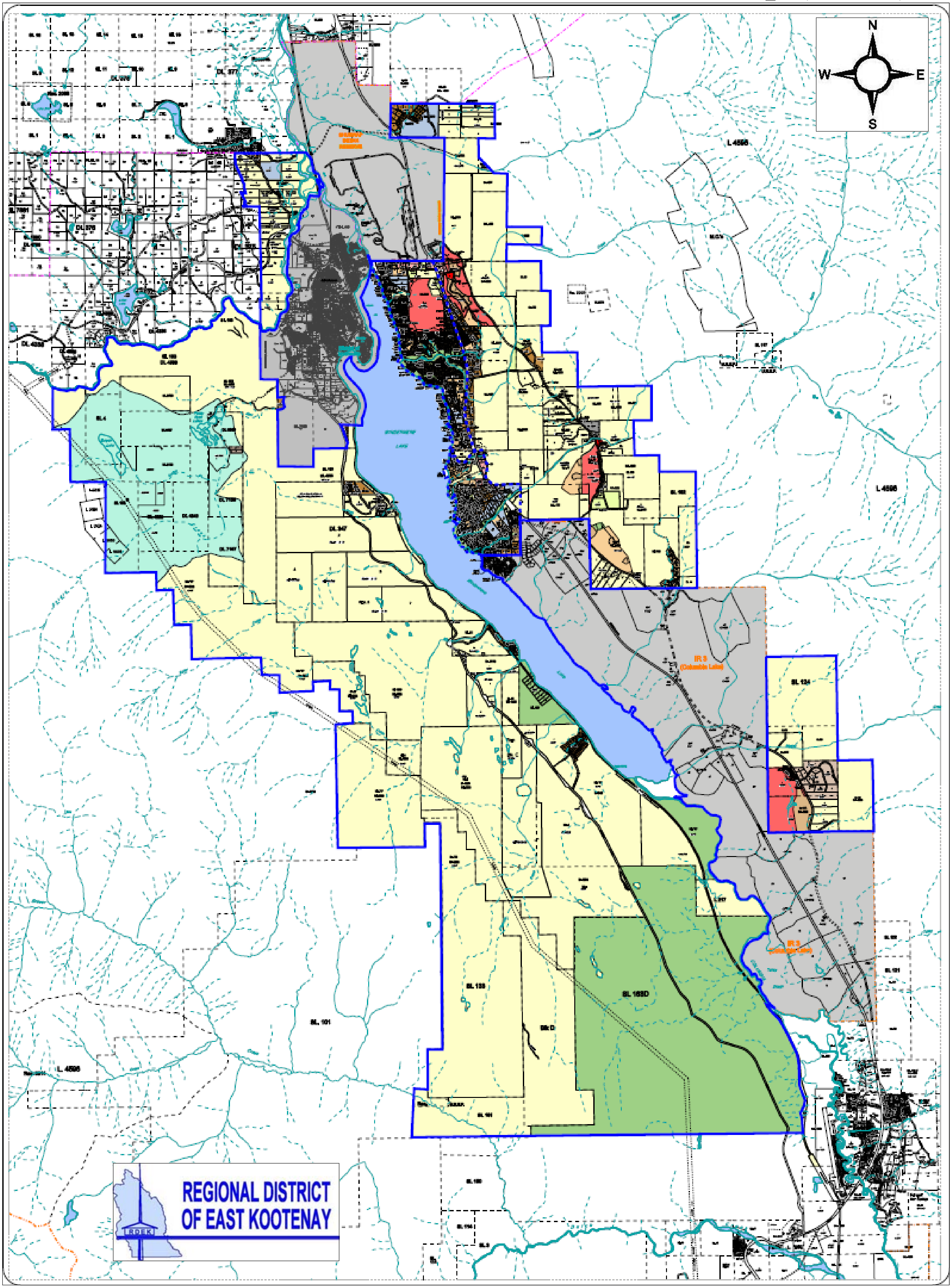
Windermere Lake Bathymetric Map

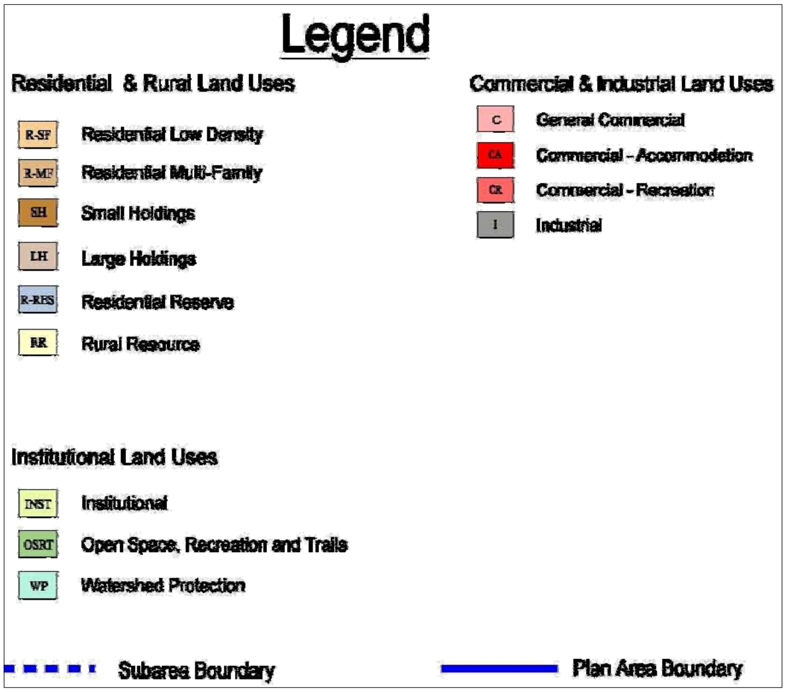


Note: additional sampling sites exist, however they are not covered in this report

Map obtained from www.fishwizard.com (2006)

Windermere Lake Watershed Land Use Map (Draft)





What's Going on Inside Windermere Lake?

Temperature

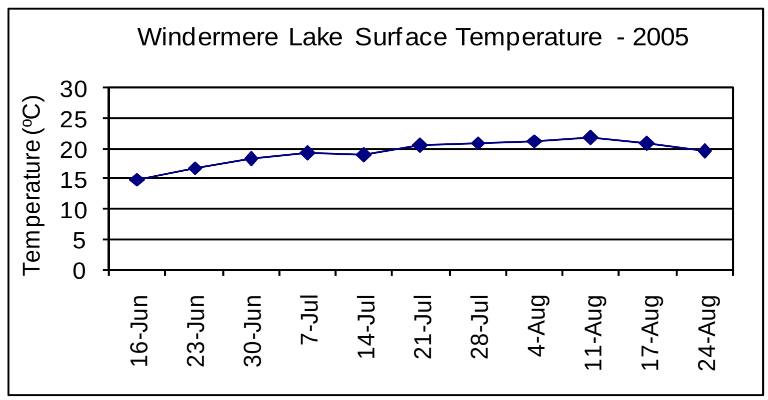
Lakes show a variety of annual temperature patterns based on each lake's location and depth. Most interior lakes form layers (stratify), with the coldest water near the bottom. Because colder water is denser, it resists mixing into the warmer, upper layer for much of the summer. In spring and fall, these 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.

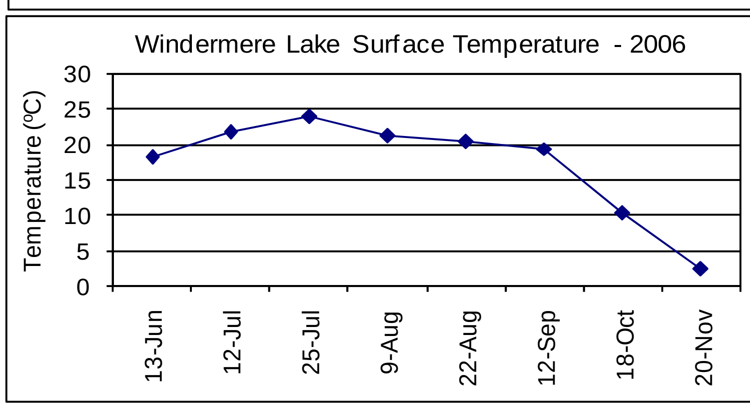
Lakes of only a few metres depth tend to mix throughout the summer or layer only temporarily, depending on wind conditions. In winter, the temperature pattern of these lakes is similar to that of deeper lakes.

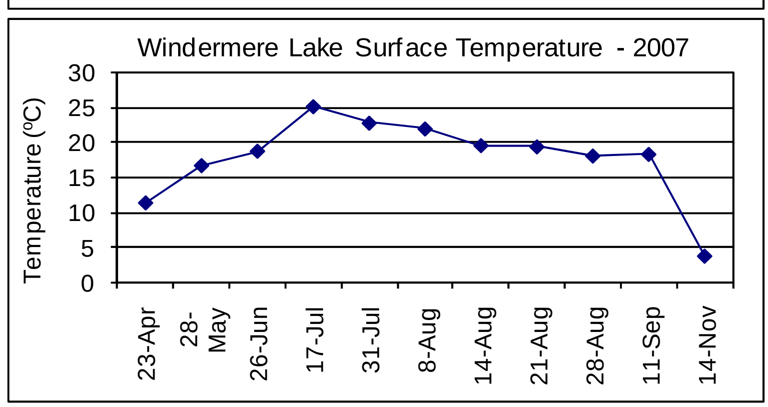
Surface temperature readings serve as an important ecological indicator. By measuring surface temperature, we can record and compare readings from season to season and year to year. Temperature stratification patterns are also very important to lake water quality. They determine much of the seasonal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

The timing of freeze-up and break-up of BC lakes is important information for climate change research. By comparing ice on & off dates to climate trends, we can examine how global warming is affecting our lakes. The LWP has been collecting ice data since 2005.

The figures to the right display the surface water temperatures measured at the north site in 2005, 2006 and 2007. In 2005,







sampling did not occur beyond August, whereas the 2006 and 2007 data captured the fall season. The maximum surface temperatures reached were 21.8°C, 23.5°C and 25.1°C in 2005, 2006 and 2007, respectively.

Historical temperature data shows that Windermere Lake does not stratify in the summer. This lack of thermal stratification is likely due to the shallow depth of the lake and strong wind action. Bottom temperatures (not shown) varied little from the surface, supporting previous findings that stratification does not occur. Mid-depth temperatures were sampled in 2005 only and were omitted from sampling following the Masse & Miller report in 2005.

Dissolved Oxygen

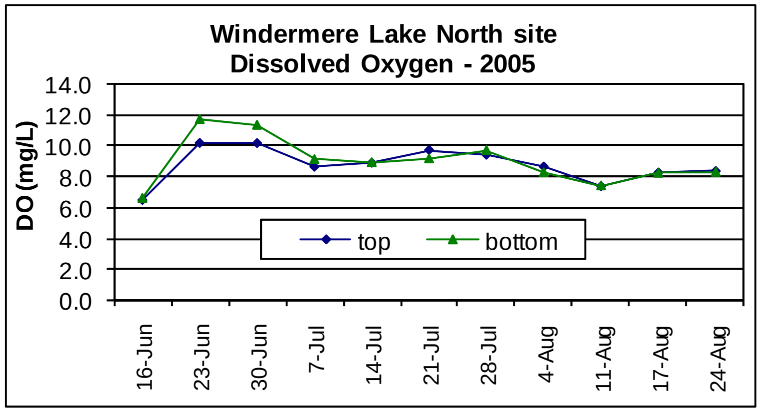
Oxygen is essential to life in lakes. It enters lake water from the air by wind action and plant photosynthesis. Oxygen is consumed by respiration of animals and plants, including the decomposition of dead organisms by bacteria. A great deal can be learned about the health of a lake by studying oxygen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

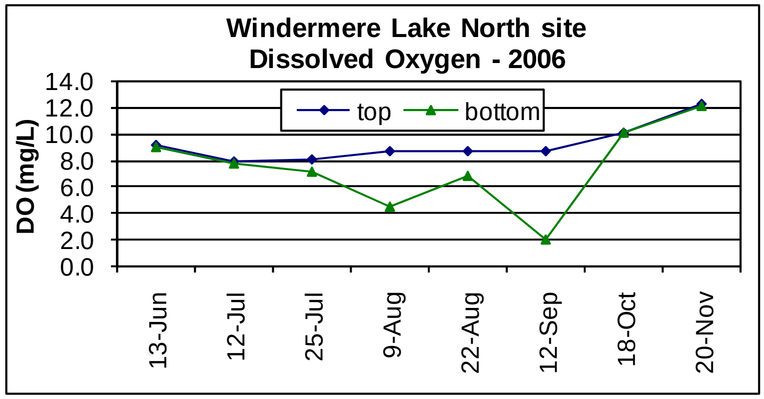
Lakes that are unproductive (oligotrophic) will have sufficient oxygen to support life at all depths through the year. But as lakes become more productive (eutrophic), and increasing quantities of plants and animals respire and decay, more oxygen consumption occurs, especially near the bottom where dead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

Results from nine of the eleven dissolved oxygen (DO) readings in 2007 lack confidence due to a faulty probe and are therefore not included in this report. This lack of data will not impair the 2010 analysis. Windermere Lake has generally high (close to 100% saturation) DO levels throughout the water column as the lake is well mixed (as discussed previously).

The following graphs show the oxygen pattern of the north site for 2005 and 2006. In September 2006 the DO in the bottom water (sampled at 0.5 m from the bottom) decreased to 2.0 mg/L. The decrease in DO may be due in part to the respiration of organisms and the process of decomposition which use up oxygen in the lake. When temperatures decrease in the fall, dissolved oxygen levels start to gradually increase.





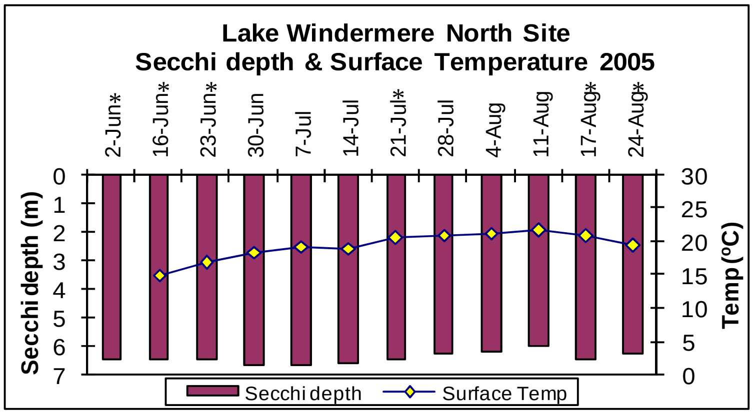
Courtney (1999) noted increases in DO saturation at the north station which were attributed to the close proximity to urban development. The increased saturation could be indicative of increased photosynthetic activity and potentially increased eutrophication (Courtney, 1999).

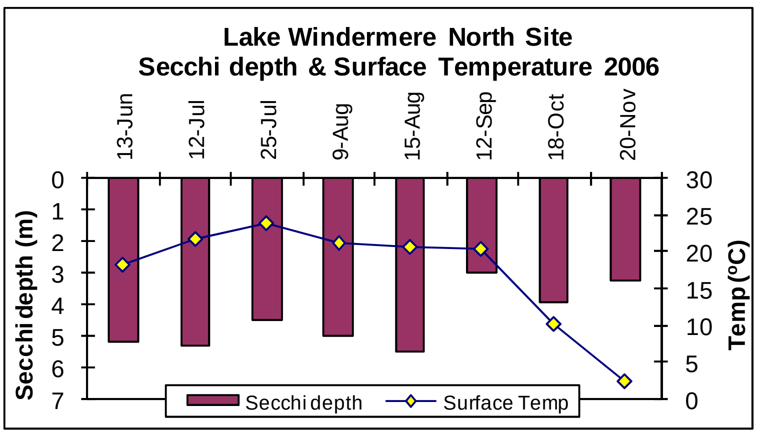
Water Clarity

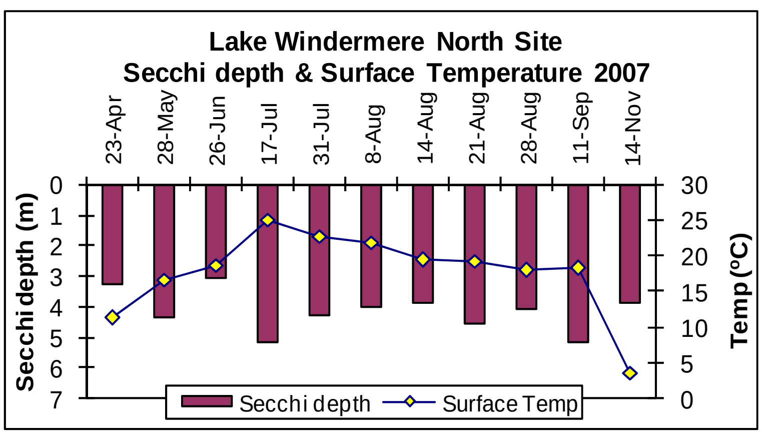
The term "trophic status" is used to describe a lake's level of productivity and depends on the amount of nutrient available for plant growth, including tiny floating algae called phytoplankton. Algae are important to the overall ecology of the lake because they are food for zooplankton, which in turn 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 a* (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.



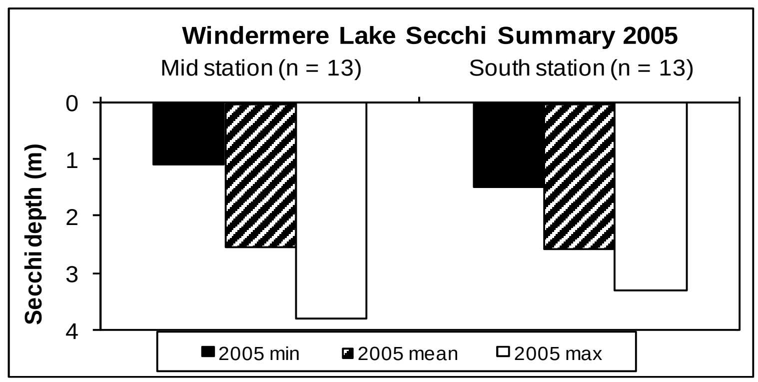


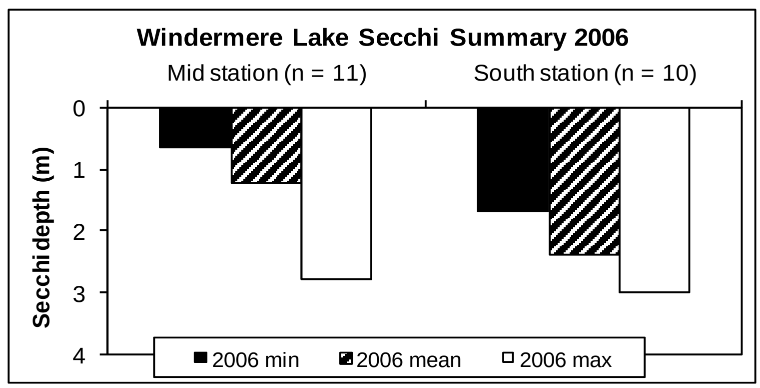


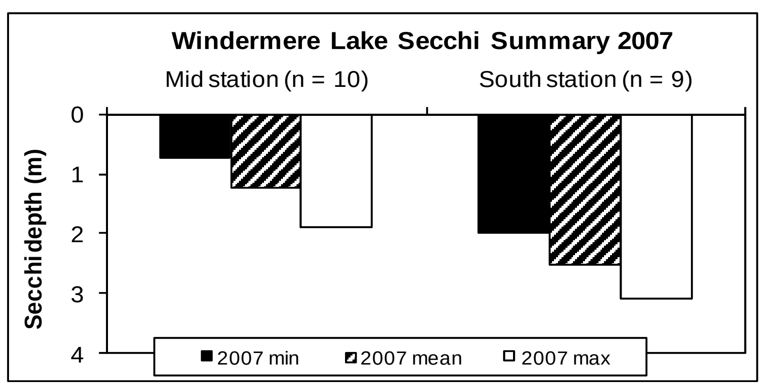
Generally, as the surface temperature increases the Secchi depth decreases due to increased algal growth in the water column. Plots of the Secchi depths and surface temperature data throughout the sampling season appear to show a moderate correlation between these parameters. The 2005, 2006 and 2007 graphs from the north site are shown above (* indicates reading on bottom).

The Columbia River is the main inflow to Windermere Lake. Turbidity values at the south end of the lake are affected by the suspended sediment of the river especially during freshet (McKean and Nordin, 1985). McKean and Nordin (1985) reported a decrease in turbidity values from the south end to the north end which they attributed to sedimentation, rather than dilution, as the most likely cause of the decrease. This trend is not apparent in the 2005 - 2007 data.

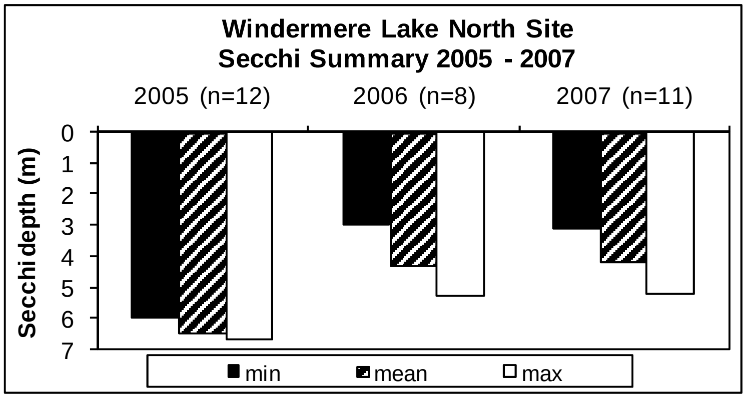
Secchi disc data from the mid and south sites for all three years is summarized in the following graphs (n = number of readings). The south site had similar values in all sampling years. The shallow depth of the lake resulted in a large majority of the Secchi readings reaching the lake bottom. The south site had 54% (7 of 13), 80% (8 of 10), and 89% (8 of 9) of Secchi readings on the bottom in 2005, 2006, and 2007, respectively. Similarly, the mid station had 100% of readings at the bottom in 2005 and 2007, and 82% (9 of 11) in 2006. At the north station, 50% (6 of 12) of the Secchi readings in 2005 were seen at the bottom, while none of the 2006 and 2007 readings reached the bottom of the lake.







Secchi data from the north site cannot be compared to the south and mid sites data due to the greater number of readings on the bottom at the latter sites. For this same reason, the average for the lake (mean of all three sampling sites combined) is not a valid comparison among years. This also applies to comparing sites within the lake. The north site may be the best site for year to year comparisons due to its depth and fewer number of readings on the lake bottom.



The north site Secchi data is shown in the graph above. The average Secchi depths at the north site for 2005, 2006 and 2007 were 6.4 m, 4.3 m, and 4.2 m, respectively. The 2006 data did not meet the minimum requirement of 12 samples, due to a high level of boat traffic in August and subsequent "boat chop" that builds at the north end of the lake, making a comparison to the 2005 and 2007 data difficult. The greater minimum, mean and maximum Secchi values in 2005 is likely due to the sampling time frame (early June to late August). Since the 2005 sampling did not capture the spring season (when increased turbidity from the Columbia River may decrease water clarity) Secchi values are likely higher than if the spring data had been collected. Although the 2006 data did not meet the minimum number of samples required, and the 2007 season fell just short of the minimum samples, the values appear to be consistent between these years and should be representative of the lake's conditions.

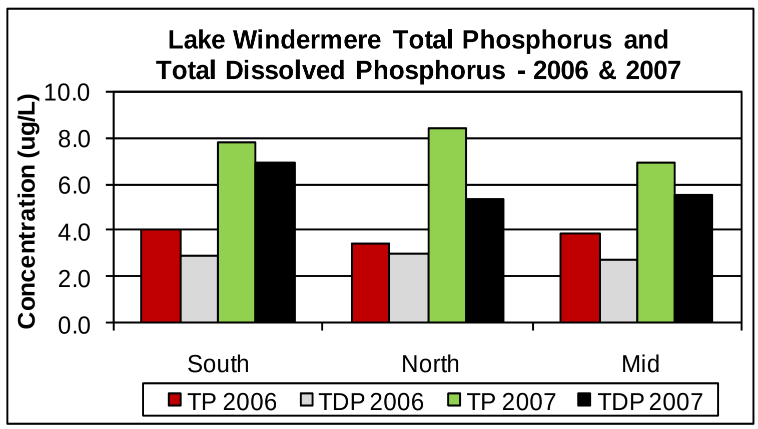
Phosphorus

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 dependent 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 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 themselves can be major sources 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.

Spring overturn sampling in April 1983 showed TP to be 9.8 µg/L and total dissolved phosphorus (TDP) to be 5 µg/L, which appeared to be higher than in previous years (McKean and Nordin, 1985). Similarly, Courtney (1999) reported that the 1999 sampling results were higher than those from the 1970's (generally below detection limits) and 1980's (just above detection limits). However, as McKean and Nordin (1985) noted, several more years of overturn data would be required to determine if the increase is part of a long term trend.

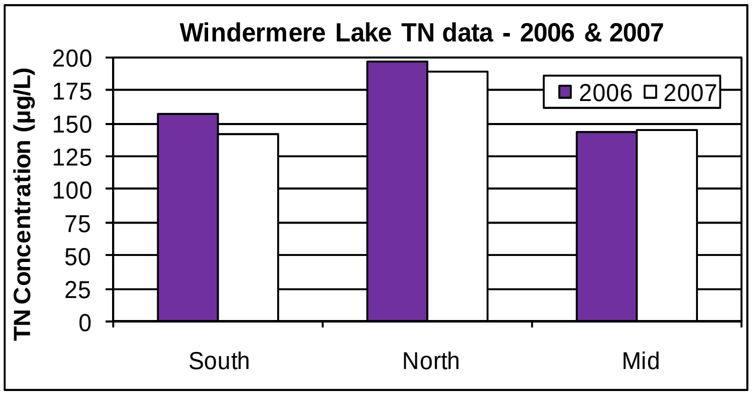
The diagram below presents the 2006 & 2007 TP & TDP data from Windermere Lake. Samples were collected from the surface (0.5 m) and the bottom (0.5 m from the bottom). The diagram presents the average summer values for the entire water column (average of top and bottom data) for TP and TDP from the three sampling sites. As the graph shows, all three sites had similar TP and TDP concentrations. Courtenay (1999) reported finding higher levels at the north and mid sites. However the 2006 and 2007 data are not consistent with his findings.



Based on the 2006 & 2007 TP data, Windermere Lake falls well within the oligotrophic rating. As previously mentioned, three years of data is preferred because with only one year of data there is a risk of only sampling during atypical weather or other environmental conditions that would not reflect the true nature of the water. Continued monitoring will provide a better baseline for future analysis and will allow for a valid comparison to historical data to determine long term trends within the lake.

Nitrogen

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



Nitrogen data was collected on Windermere Lake as described in the phosphorus section. As the previous graph shows, the north site had the highest average summer total nitrogen (TN) values (198 µg/L in 2006 & 189 µg/L in 2007). The 2006 and 2007 TN values from the south and mid sites were similar. In 2006 the south and mid sites reported values of 157 and 143 µg/L, respectively, while the 2007 data was 142 and 144 µg/L, respectively. Based on these nitrogen values Windermere Lake falls into the lower range of the mesotrophic classification (Nordin, 1985).

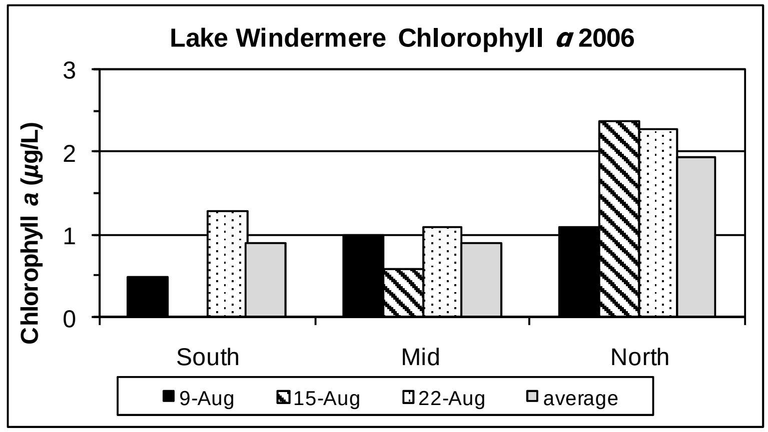
The N:P ratio is approximately 45:0, which means the lake is a phosphorus limited system.

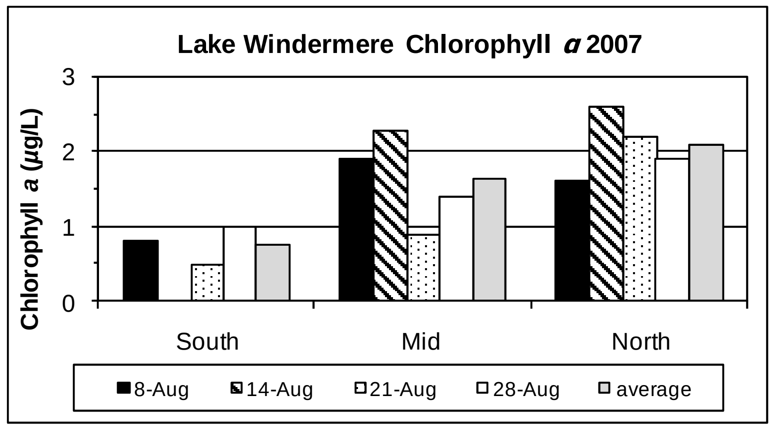
Chlorophyll a

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 light energy that drives the process of photosynthesis. While several chlorophyll pigments exists, chlorophyll *a* is the most common. The concentration of chlorophyll *a* in the lake water is an indicator of the density of algae present.

Chlorophyll *a* was sampled at three sites on Windermere Lake in 1976 and at the north and mid sites in 1982. Using this data McKean and Nordin (1984) developed a relationship between P and mean summer chlorophyll *a*. The model suggested P concentrations in Windermere Lake indicated oligotrohpic tending to mesotrophic conditions. However, McKean and Nordin also noted that the model predicted higher chlorophyll *a* values than were found in Windermere Lake which was attributed to the lake's high flushing rate.

The following graphs show the 2006 & 2007 chlorophyll *a* data. The north site had the highest readings on all sampling events with the exception of August 8, 2007. The 2006 averages at the north, mid and south sites were 1.9, 0.9 and 0.9 µg/L, respectively which fall in the oligotrophic range (0 - 2 µg/L) and are consistent with the above mentioned study. The 2007 average values were 2.1, 1.6 and 0.8 µg/L at the north, mid and south sites, respectively. The 2007 averages from the mid and south sites are within the oligotrophic range but the north site value just exceeds the threshold.





A Historical Look at Windermere Lake

The Windermere Lake monitoring program was initiated well after local land development and possible impacts to the lake began. While this program can accurately document current lake water 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.

The deepest point (north site) in Windermere Lake was cored on July 23, 1998 by Ministry of Environment, Lands and Parks staff. The 35 cm core was separated into 5 mm sections and analyzed by Dr. Brian Cumming of Queen's University. His report is available upon request.

Historical changes in relative diatom abundance were measured directly by microscopy. 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 Windermere Lake sediments were dominated by benthic (those living on the surface of the sediments) diatom species with some epiphytic forms (those living on aquatic plants). The benthic component in Windermere Lake is much larger compared to the phytoplankton component due to light penetration to the bottom throughout the entire lake.

Cumming infers historical water quality utilizing a database comprised of over 200 B.C. lakes that are generally deeper, with minor benthic components (Wilson, *et al*., 1996 as cited in McDonald, 2000). Therefore, reconstruction of the diatom community from sediment coring is a less useful tool for determining historic water quality in Windermere Lake than in deeper lakes.

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* seen in the right photo).

The sediment core indicates that Windermere Lake has undergone a change in species composition over the last several hundred years. Algae commonly associated with clean water and low nutrient levels were displaced by forms that may cause taste and odour problems in water supplies.

Cumming (1999) reported minor changes in the diatom community structure starting around 1950 as evidenced by the loss of a few diatom species and the appearance of others. However, the species identified are not well represented in the B.C. lakes database used to infer changes in phosphorus. Therefore, predictions of change in the total phosphorus in Windermere Lake are considered preliminary.

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 sedimentation rates increased around 1920, peaking in the late 1940's, then returned to historic levels from 1960 to present. Land development in the Windermere Lake watershed increased between 1920 to 1960 but has greatly accelerated since 1970. Since the increased sedimentation rate does not coincide with the population increase around Windermere Lake, Cumming (1999) suggested land disturbances associate with logging and cattle ranching may have caused the increased sedimentation rate.

In conclusion, although the evidence is not strong, the core suggests subtle changes in the water quality, benthic community composition and sedimentation of Windermere Lake beginning around 1950 which coincides with the time of accelerated settlement in the area.

Should Further Monitoring Be Done on Windermere Lake?

The initial data suggests that Windermere Lake generally shows oligotrophic conditions. Further sampling for chlorophyll *a* and Secchi (minimum 12 samples) is required in order to establish adequate baseline data which allows for meaningful conclusions to be made about the trophic status and health of Windermere Lake. The Lake Windermere Project has completed the third year of a five year monitoring program. At the end of the five year program a major expert review will be solicited to compile, analyze and quality assure all data collected. The monitoring currently underway is required for the Ministry of Environment to update their Water Quality Objectives. One reason for protecting the lake and its watershed is the direct connectivity of Windermere Lake to the Columbia River Wetlands and Wildlife Management Area. Due to the high level of development in the Windermere Lake watershed it is important that the program continue. 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.

Tips to Keep Windermere 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 water-bodies. 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, 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.
- Avoid septic additives. These products can potentially shorten the life of your septic field.
- 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 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 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.
- 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

Ministry of Environment
#401 - 333 Victoria St.
Nelson, BC V1L 4K3
Phone: (250) 354-6355
Fax: (250) 354-6332

Lake Windermere Project
Heather Leschied
Box 601
Invermere, BC V0A 1K0
Phone/Fax: (250) 341-6898

The BC Lake Stewardship Society
#203 - 1889 Springfield Rd.
Kelowna, BC V1Y 5V5

Phone: (250) 717-1212
Toll Free: 1-877-BC-LAKES
Fax: (250) 717-1226
Email: info@bclss.org
Website: www.bclss.org

Acknowledgements

Lake Windermere Project:
Heather Leschied & Amanda Fedrigo

Volunteer Monitoring by:
Joan Birkett, Rosemary Clark, Charlotte Dibbs, Kelly Dick, Nory Esteban, Hans & Lilo Fuhrer, Dave Gilbride, Melissa Hogg, Loreen Jacobs, Murray Kubain, Arnor Larson, Heather Leschied, Mick McCullagh, Lindsay McPherson, Nancy & Hillary Nester, Brian Nickurak, Billy Page, Andrew Scott, Dot Smith, Sara Stewart, and Gerry Wilkie

Data Compiling by:
Carolyn Johns (BCLSS)

Report Prepared by:
Carolyn Johns
BC Lake Stewardship Society

Report Review by:
Alison Stent (MoE - Nelson)
Heather Leschied

Bathymetric Map:
FishWizard (www.fishwizard.com)

Photo Credit:
Heather Leschied

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