BC Lake Stewardship and Monitoring Program

Caverhill Lake 2004 - 2012

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

The Importance of Caverhill Lake & its Watershed

British Columbians want lakes to provide good water quality, aesthetics, and recreational opportunities. When these features are not apparent in our local lakes, people begin to wonder why. Concerns often include whether the water quality is getting worse, if the lake has been impacted by land development or other human activities, and what conditions will result from more development within the watershed.

The BC Lake Stewardship Society (BCLSS), in collaboration with the Ministry of Environment (MoE), has designed a program, entitled *The BC Lake Stewardship and Monitoring Program*, to address these concerns. Through regular water sample collections, we can come to understand a lake's current water quality, identify the preferred uses for a given lake, and monitor water quality changes resulting from land development within the lake's watershed. There are different levels of lake monitoring and assessment. The level appropriate for a particular lake depends on the 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 2004-2012 results of a Level II program for Caverhill Lake.

The BCLSS can provide communities with both lake-specific monitoring results and educational materials on general lake protection issues. 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 with the help of local volunteers and the BCLSS.

A **watershed** is defined as the entire area of land that moves the water it receives into 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 hydrologic cycle occurs 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 waterbody. Poor land use practices 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.

Caverhill Lake is located approximately 103 km northwest of Kamloops in the North Thompson region. Caverhill Lake has a surface area of 5.4 km^2, a perimeter of 27.5 km and lies at an elevation of 1378 m. The average depth of the lake is 13.8 m, while the deepest spot is 40.2 m (Caverhill Lake bathymetric map accessed on HabitatWizard, 2015). The shores of the lake are largely undeveloped with an old trappers cabin at the north end and Caverhill Lake Lodge at the south end (Petrovcic and Kurtz, 1991). The only access to the lodge is across Caverhill Lake by boat, or by private float plane or helicopter (www.caverhilllodge.com, 2015).

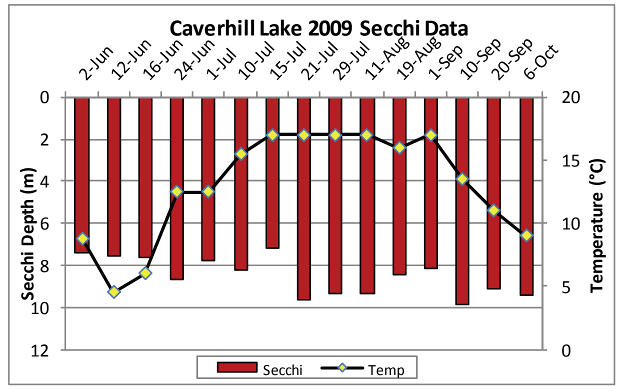
A survey of Caverhill Lake indicated that there are 7 inflows (one of which is Chester Creek, which flows into Caverhill Lake from Chester Lake) and 1 outflow (Caverhill Creek) (Petrovcic and Kurtz, 1991 and Loney 2015, Pers. Comm.) . The lake contains kokanee and rainbow trout. In the past 5 years the lake has not been stocked. Caverhill Lake is not stocked (Sidney 2015, Pers. Comm.).

What's Going on Inside Caverhill 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 at the bottom. Because colder water is more dense, 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 densest water (4 °C) near the bottom. These lakes are called dimictic lakes because they turn over twice per year. They are the most common type of lake in British Columbia. Caverhill Lake is classified as a dimictic lake.

Ice-on and ice-off dates for BC lakes are important data for climate change research. By comparing these dates to climate change trends, we can examine how climate change is affecting our lakes. Volunteers have been reporting ice-on and ice-off dates for Caverhill Lake since 2004. The earliest ice-off date reported was May 12/13 and the latest ice-on date was Dec 17/07.



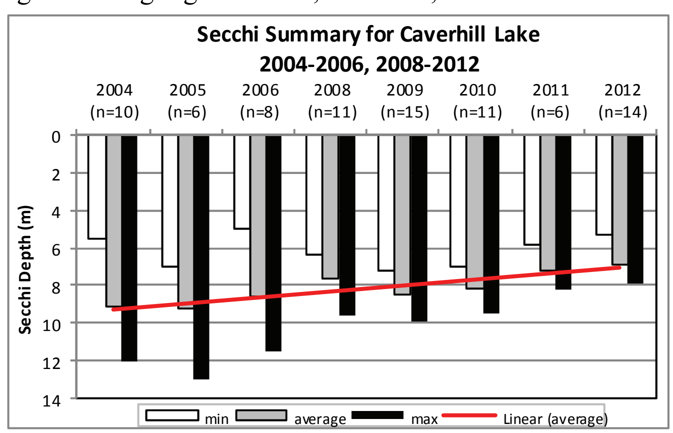
Surface temperature readings serve as an important ecological indicator. By measuring surface temperature, we can record and compare readings from season to season and year to year. Surface temperature helps to determine much of the seasonal oxygen, phosphorus, and algal conditions. Temperature and Secchi depth (water clarity) were measured at the deep site, (see bathymetric map on p. 3 for location) from 2004-06 & 2008-12. Minimum data requirements (12 evenly spaced samples between ice-off and ice-on) were not met in most years (they were met in 2009 and 2012). The adjacent graph illustrates the 2009 Secchi and temperature data. The maximum surface temperature was 17°C (Jul 15, 21, 29, Aug 11 & Sep 1) and the minimum surface temperature was 4.5°C (Jun 12). The maximum surface water temperatures measured in 2004, 2005, 2006, 2008, 2010, 2011 and 2012 were 20.0°C (Aug 1), 18.0°C (Aug 15), 20.0°C (Jul 28), 17.5°C (Aug 4), 20.0°C (Jul 28 & Aug 6), 16.0°C (Jul 28) and 19.0°C (Aug 11 & 17), respectively. Minimum surface temperatures were 8.5°C (Oct 17), 8.0°C (Oct 16), 8.0°C (Oct 17), 8.0°C (Oct 12), 4.9°C (May 25), 7.0°C (Oct 16) and 6.0°C (Jun 8) in 2004, 2005, 2006, 2008, 2010, 2011 and 2012, respectively.

Trophic Status and Water Clarity

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

Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels, sparse plant life and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life because of higher nutrient levels. Lakes with an intermediate productivity are called ***mesotrophic*** and generally combine the qualities of oligotrophic and eutrophic lakes.

One measure of productivity is water clarity. The more productive a lake, 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 20 cm diameter black and white disc that measures the depth of light penetration.



Natural variation and trends in Secchi depth and temperature not only occur between years, but also throughout one season. In general, as temperatures increase during the summer months, Secchi depth decreases. As the temperature of the lake increases, so do some species of algae. Due to the increase in algae, the water clarity can decrease. This general trend is not apparent in Caverhill Lake during any of the sampling years.

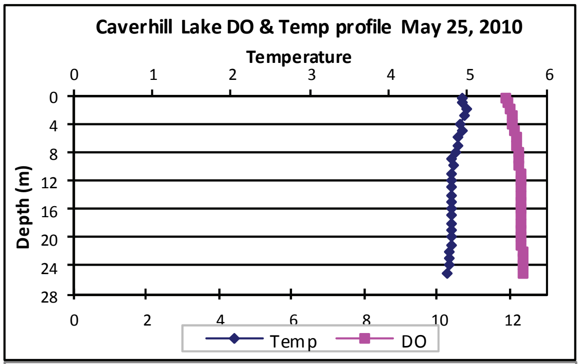
The graph above illustrates the minimum, average and maximum Secchi readings from 2004-06 & 2008-12, as well as the number of readings for each year (n). The maximum reading for all sampling years, 13.0 m, occurred on Oct. 16, 2005. The lowest Secchi depth measured was 5.0 m on May 30, 2006. The average Secchi readings for Caverhill Lake ranged from 6.8 m (2012) to 9.3 m (2005). Although each year of data collected did not meet the minimum data requirement of 12 evenly spaced readings from spring overturn through the fall, the average Secchi readings for Caverhill Lake fall into the oligotrophic (>6 m) throughout the entire sampling period (Nordin, 1985). The linear trendline for average seasonal Secchi depth (red line on graph) suggests a trend of decreased Secchi readings over time. Additional data is required to confirm this.

The flushing rate, another factor that affects water quality, is the rate of water replacement in a lake and depends on the amount of inflow and outflow of a lake. The higher the flushing rate, the more quickly excess nutrients can be removed from the system. The flushing rate for Caverhill Lake is unknown at this time.

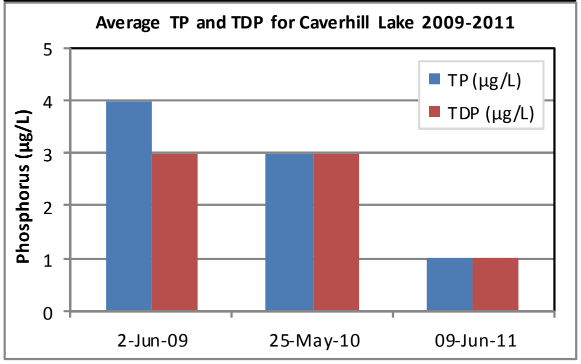
Dissolved Oxygen and Water Chemistry

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.

Surface dissolved oxygen (DO) readings were collected on Caverhill Lake from 2004-06 & 2008-11. Surface DO values ranged from 8-11 mg/L. Additionally multiple depth DO and temperature (T) profile readings were collected on Jul 28/06, Jun 2/09, May 25/10 & Jun 9/11. The graph on the right shows the DO/T data from May 25/10. T (blue line, refer to top axis for values) was 4.9ºC at the surface and 4.7ºC at 25 m and DO (pink line, refer to bottom axis for values) was 11.9 mg/L at the surface and 12.4 mg/L at 25 m, indicating the lake was mixed. The DO/T profile from Jun 2, 2009 showed DO values were homogenous throughout the water column (ranging from 10.9-10.1 mg/L) and T values were 8.7ºC at the surface and 4.6ºC at 25 m, indicating warming of the surface waters. The Jul 28/06 summer DO/T profile comprised readings to 24 m depth and showed DO values were homogenous throughout the water column (9.5-8.4 mg/L) and T values ranged from 20.2ºC (surface) to 6.4ºC (24 m).



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. Water chemistry samples were collected during the spring from 2009-11. In 2009 samples were collected from 0.5 m and 35 m, in 2010 samples were collected from 0.5 m and 23 m, and in 2011 composite (combined) samples were taken from 0.5-6 m and 14-26 m. For each year, these values were averaged. A graph depicting the average TP and total dissolved phosphorus (TDP) is shown on the right. Values from 2011 were below the detection limit of 2 µg/L and are shown as half the detection limit for graphing purposes. Average TP values from 2009-11 for Caverhill Lake were low, ranging from <2-4 µg/L, indicating that the lake was exhibiting oligotrophic conditions (1-10 µg/L).



Nitrogen is the second most important nutrient 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 N:P ratio is less than 5:1, nitrogen becomes limiting to algae growth and can major impacts on the amount and species present. From 2009-11, nitrogen concentrations in Caverhill Lake ranged from 125 µg/L to 165 µg/L and N:P ratios ranged from 31:1 to 258:1, which means the lake is a phosphorus limited system.

Chlorophyll *a* (chl. *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, chl *a* is the most common. The concentration of chl *a* in lake water is an indicator of the density of algae present in that same water. Chl. *a* values collected at spring overturn from 2009-11 ranged from 2.0-2.6 mg/L. Although it is difficult to draw conclusions about the trophic status of the lake using this parameter because single point samples do not account for seasonal variability, the values measured are indicative of an oligotrophic lake (Nordin, 1985)..

Land Use and Pollution Sources

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

Caverhill Lake has relatively little development, limited cattle grazing and some logging activity. Local residents are encouraged to ensure their septic systems are up to standard and that their land use activities are following good environmental practices. Recreational users of the lake are also encouraged to ensure their boats and equipment are properly maintained. Further information on keeping Caverhill Lake healthy can be found on the following page.

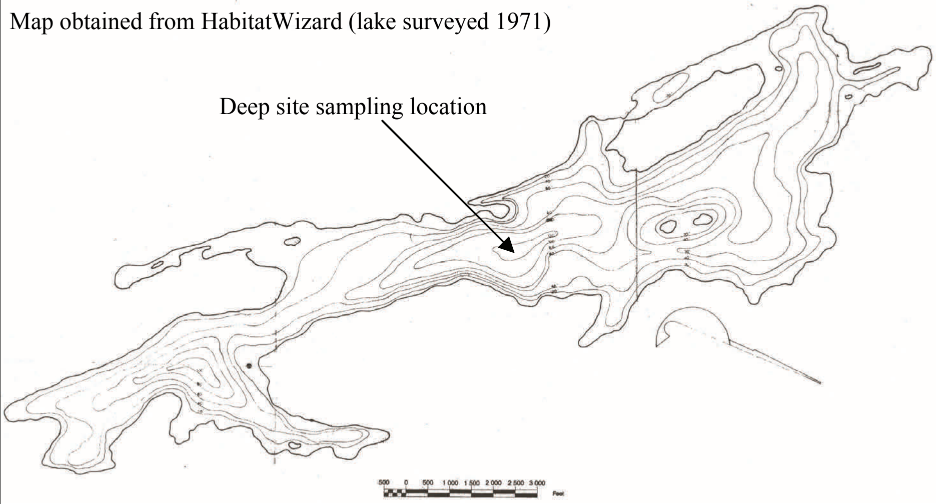
Should Further Monitoring Be Done on Caverhill Lake?

The data collected on Caverhill Lake from 2004-06 to 2008-12 indicate that the water quality has remained relatively stable over the sampling years. Based on Secchi and TP data, Caverhill Lake was exhibiting oligotrophic conditions.

Local volunteers are encouraged to continue to record Secchi and surface temperature readings, with an emphasis on collecting a minimum of 12 evenly spaced readings between ice-off and ice-on. These data are important for long term records and will help identify early warning signs should there be a deterioration in water quality from its current state. Local volunteers are also encouraged to continue recording ice-on and -off dates as this information is important for climate change research.

Caverhill Lake Bathymetric Map

Map obtained from HabitatWizard (lake surveyed 1971)



Tips to Keep Caverhill Lake Healthy

Camping and Recreation

- Ensure black and grey water are contained and disposed of at a sanitation station.
- When washing yourself or your dishes, dip water out of the lake using a clean container and move 30 m away.
- Dispose of used water by throwing it over a large area away from your site, the sites of others, and flowing or standing water.
- Use phosphate-free, biodegradable soaps.
- If you pack it in - pack it out. Remove all garbage including biodegradable soaps.
- Ensure all vehicles are well maintained and tuned to prevent fuel leaks.

Boating

- Do not throw trash overboard or use lakes or other water bodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals when cleaning your boat.
- Check for and remove all aquatic plant fragments from boats and trailers before entering or leaving a lake.
- Keep motors well maintained and tuned to prevent fuel and lubricant leaks.
- Conduct major maintenance chores on land.
- Use absorbent bilge pads to soak up minor oil and fuel leaks or spills.
- Recycle used lubricating oil and left over paints.
- Leading by example is often the best method of improving practices—help educate fellow boaters.

Onsite Sewage Systems

- Make sure that your system meets local requirements before installing, repairing, or upgrading an onsite sewage system.
- 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 drainfield.
- Use phosphate-free soaps and detergents.
- Do not 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.
- Use biodegradable household cleaners instead of bleach or other hazardous products (which will kill the good bacteria in your system).
- Don't overwater the drainfield or allow roof or perimeter drains to run onto the drainfield.
- Avoid using septic tank 'starters' or similar products. Allow bacteria to act on their own.

Who to Contact for More Information

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Photo Credit:

Marlene Loney

Bathymetric Map:

Habitat Wizard