BC Lake Stewardship and Monitoring Program

Kalamalka Lake 2008-14

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

The Importance of Kalamalka 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 2008-14 results of a Level I program for Kalamalka 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.

Kalamalka Lake is located approximately 4 km south of the City of Vernon in the Okanagan Valley in the Interior Plateau of southern central British Columbia. The lake has two provincial parks, Kalamalka Lake Provincial Park and Kekuli Bay Provincial Park. The lake has several beaches along its shores, including: Kal Beach, Cosens Bay Beach, Jade Bay Beach, Juniper Bay Beach, Kirkland Park Beach, and Kaloya Regional Park Beach. The lake is popular with recreational users, particularly for swimming, boating, and waterskiing (Wikipedia, 2015). In 2008 Kalamalka Lake Protected Area became part of Kalmalka Lake Park, encompassing an area of 42.1 km^2, and is now managed as part of the park (BC Parks, 2015).

Kalamalka Lake has been used as the primary source of drinking water for the City of Vernon urban area for many decades (Regional District of North Okanagan, 2015). The Kalamalka Lake water source supplies approximately 45% of the utility's water via the Mission Hill Water Treatment Plant (RDNO, 2015). The Kalamalka Lake system provides 69% of domestic customers while the Duteau Creek system provides 31% (RDNO, 2015). However, these numbers shift depending on how the water system is running .

A 2010 foreshore inventory report identified that the two main foreshore uses are natural area parks (28%) and transportation (highway, railway, roads) (23.3%) (Schleppe, 2010). The foreshore inventory report further noted that 57.3% of the shoreline has a high level of impact (approximately 25 km of shoreline), 10.7% (or 5 km of shoreline) of moderate impact, and 33.3% (or 15.5 km of shoreline) of low impact (Schleppe, 2010). The most common habitat modifications were docks, retaining walls, and groynes, and 11 boat launches and 9 marinas were observed (Schleppe, 2010).

Kalamalka Lake has a surface area of 25.7 km2, a perimeter of 42.5 km and lies at an elevation of 391 m. The average depth of the lake is 58.5 m and the maximum depth is 141.7 m (FIDQ 2015).

Kalamalka Lake has two overland inflows, Coldstream Creek and Oyama Creek and one outflow, Vernon Creek, which flows from Kalamalka Lake into Okanagan Lake (BC Government, 1976). Most of the inflow to the lake is from Coldstream Creek and Wood Lake (via Oyama canal), however, groundwater recharge is likely a large but unknown component (Sokal, Pers. Comm., 2015). The lake contains kokanee, rainbow trout, lake trout, yellow perch, northern pikeminnow, pumpkinseed, redshide shiner, mountain whitefish, peamouth chub, largescale sucker, and cutthroat trout. (FIDQ, 2015). Historically the lake was stocked with rainbow trout, cutthroat trout, steelhead and kokanee but lake stocking has not occurred since 1978 (FIDQ, 2015).

What's Going on Inside Kalamalka Lake?

Temperature

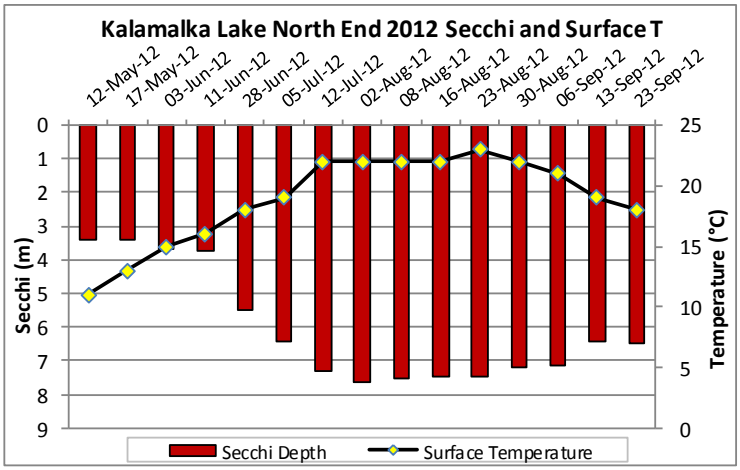
Lakes show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest water at the bottom. Because colder water is more dense, it resists mixing into the warmer upper layer for much of the summer. In spring and fall, these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

Coastal lakes in BC are more often termed warm monomictic lakes because they turn over once per year. These lakes have temperatures that do not fall below 4°C. Warm monomictic lakes generally do not freeze and circulate freely in the winter at or above 4°C, and stratify only in the summer. Kalamalka 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 global warming is affecting our lakes. Ice-on and -off dates for Kalamalka Lake have not been submitted to the BCLSS as the lake does not usually freeze completely. Volunteers note that the lake has only frozen completely twice in the past 50 years.

Surface temperature readings serve as an important ecological indicator, allowing us to 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.

Surface temperature (T) and Secchi depth (water clarity) were measured in North End from 2008-14 and in the South End in 2014 (sites marked on map on p. 3). Minimum data requirements were met in 2010, 2011, 2012, and 2014. The adjacent graph illustrates the 2012 Secchi and T data from the North End. The maximum T was 23°C (Aug 23) and the minimum T was 11°C (May 12). For the North End, the minimum T between 2008-14 ranged from 9°C (2014) to 17°C (2013) and the maximum T ranged from 18°C (2014) to 26°C (2013). For the South End in 2014, the minimum T was 11°C (May 15) and the maximum T was 25°C (Aug 3).



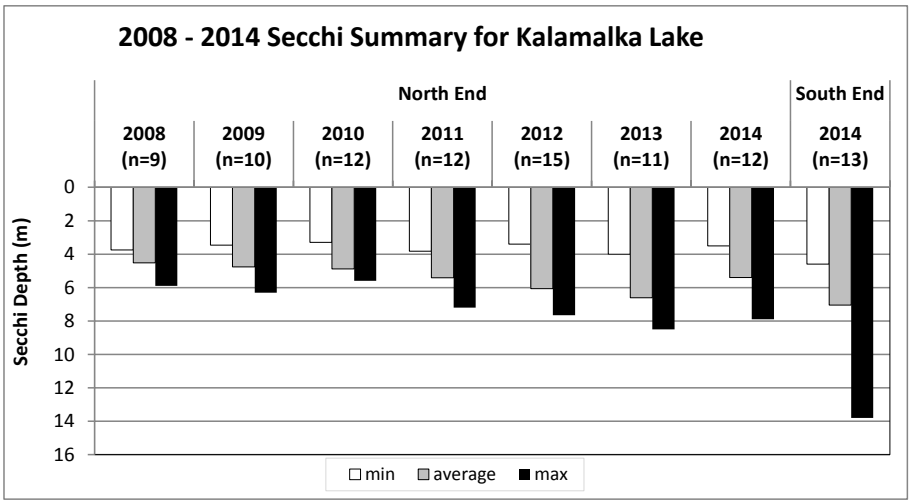
Trophic Status and Water Clarity

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.

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 the data for Kalamalka Lake. It is important to note that the graph does not include March and April sampling when Secchi depth is the greatest.

The adjacent graph shows the minimum, average and maximum Secchi readings for the North End from 2008-14 and the South End in 2014 (right side of graph), as well as the number of readings for each year (n). The maximum reading for the North End was 8.5 m (2013) and the minimum was 3.3 m (2010). The maximum reading for the South End in 2014 was 13.8 m and the minimum was 4.6 m. The average Secchi readings for the North End ranged from 4.5 m (2008) to 6.6 m (2013) and average for the South End was 7.1 m. However only considering the years that met minimum data requirements for the North End (2010, 2011, 2012, and 2014), average seasonal Secchi values ranged from 4.9 m to 6.6 m. Based on these summer average Secchi values, Kalamalka Lake was exhibiting mesotrophic (3-6 m) to oligotrophic (>6 m) conditions (Nordin, 1985). It should be noted that because Kalamalka Lake is marl (see p. 3), marl particles may be affecting water clarity readings (in addition to algal particles). Data show that Kalamalka Lake has remained stable throughout the sampling period.



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. The higher the flushing rate, the more quickly excess nutrients can be removed from the system. The flushing rate for Kalamalka Lake is 55-65 years (Lejbak, 2013). The slow flushing period and suggests Kalamalka Lake retains a large proportion of the nutrients that enter it, however, since Kalamalka Lake is a marl lake, calcium carbonate will bind with phosphorus and settle out of the water column thereby reducing the impacts of nutrient loading (see "Marl Lakes" section) (Sokal, Pers. Comm., 2015).

Land Use and Pollution Sources

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

Land uses surrounding Kalamalka Lake include: private residential, agricultural, a railway, a major highway, beaches and parklands. The lake is popular for camping, fishing, swimming and boating.

Larratt (2011) indicates that Coldstream Creek carries 80% of the overland flows into Kalamalka Lake and that there is significant agricultural activity and streamside development along this tributary. Larratt also notes that Coldstream Creek is capable of strongly impacting the entire North Arm during freshet and storms.

Local residents are encouraged to ensure their septic systems are up to standard and that their land use activities are following good environmental practices. Further information on keeping Kalamalka Lake healthy can be found on the following page.

Marl Lakes

The climate, hydrology, and basin geology within a watershed help to determine the chemistry of a lake. The chemical composition of the water helps to determine the types of species that can survive there and the water's recreational and drinking water value. Human activity within the watershed can also have an impact on the chemical composition of a lake. Some lakes, such as hardwater lakes, have a natural way of combating problems such as acidification.

Hardwater lakes have a high pH level, which causes calcium carbonate to precipitate and remove phosphorus from the water column by adsorption of phosphorus to the calcium carbonate. One type of hardwater lake is a marl lake. Marl lakes are generally saturated with calcium and carbonate ions. The sediment of these lakes consist of marl, a soft-textured mixture of clay, sand, and limestone. When the calcium carbonate in these lakes begins to precipitate, phosphorus is effectively removed as a co-precipitate. Therefore, these lakes can reduce the impact of phosphorus loading from sources such as septic systems, livestock, domestic gardening, car washing, and agriculture. In other words, marl lakes are more resistant to eutrophication.

But how do we decide if a lake is a marl lake or not? There are a few qualities that we can use to determine this. The first is a visible shift from dark blue/green to extreme turquoise colour during periods of warmer temperatures. Tiny particles remain suspended in the water, refracting light and causing the lake to turn a light aquamarine (lake whitening). Another quality of a marl lake is high calcium concentrations in the sediment, especially in the shallower areas. These sediments are often lighter in colour due to the increased amount of limestone (calcium carbonate).

Since phosphate precipitates with calcium, marl lakes generally have low phosphorus levels and good water clarity. Calcium carbonate precipitates can be observed on vegetation and along the lake's edge. The presence of *Chara* species also indicates the possibility of a marl lake. Charophytes are a type of large, structurally complex green algae that attach to substrates. The rhizoids that enable this attachment play an important role in the absorption of nutrients and extraction of calcium carbonate.

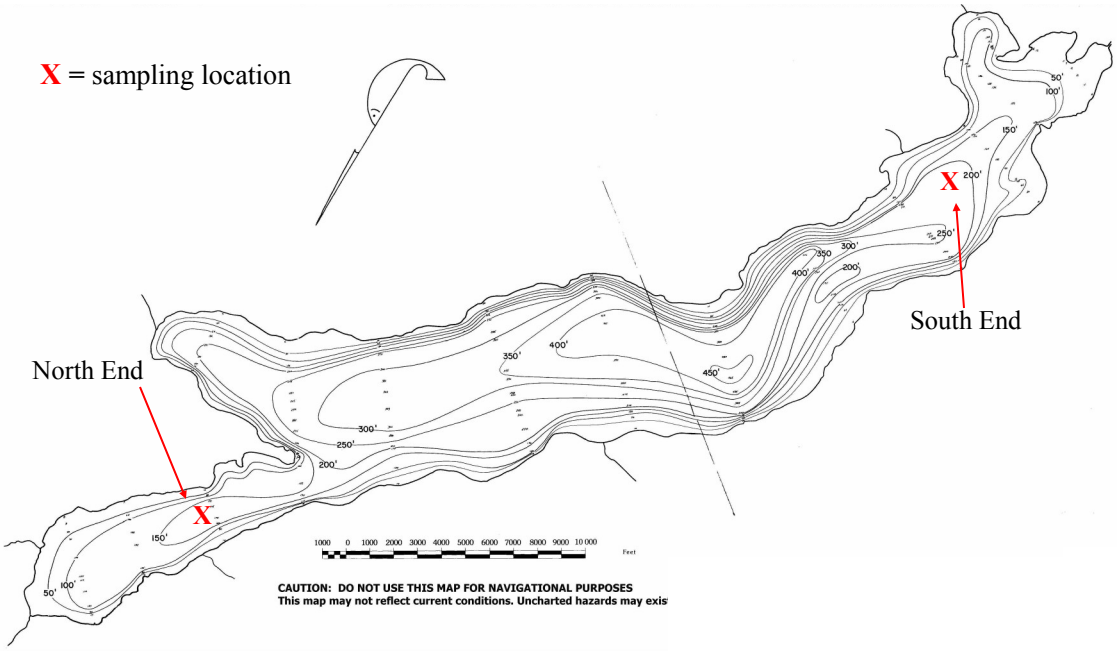
Many hardwater lakes in the interior dry belt of British Columbia can be classified as marl lakes, including Kalamalka Lake.

Should Further Monitoring be Done on Kalamalka Lake?

Generally, trophic status is based on a combination of parameters such as Secchi, nutrients and chlorophyll *a*. The data collected on Kalamalka Lake from 2008-14 indicate that the water quality has remained stable throughout the sampling years. Average annual Secchi readings place the lake in the mesotrophic to oligotrophic classification however since the lake is marl, this classification may not reflect the true trophic status of the lake as marl lakes generally have good water clarity.

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 are minimized.

Kalamalka Lake Bathymetric Map



Tips to Keep Kalamalka Lake Healthy

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.
- 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.

Yard Maintenance, Landscaping and 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 ladybugs, as well as pests.
- Compost yard and kitchen waste and use it to boost your garden's health as an alternative to chemical fertilizers.
- Pick up after your pets as pet waste can lead to bacterial contamination of lake water.

Boating

- Do not throw trash overboard or use lakes or other water bodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals.
- Conduct major maintenance chores on land.
- Keep motors well maintained and tuned to prevent fuel and lubricant leaks.
- Use absorbent bilge pads for minor 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 blue or pink closed-cell extruded polystyrene billets or washed plastic barrel floats. All floats should be labelled with the owner's name, phone number and confirmation that barrels have been properly maintained.
- Leading by example is often the best method of improving practices - help educate fellow boaters.

Who to Contact for More Information

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Photo Credit: Maria Besso

Bathymetric Map:
FIDQ (Fisheries Inventory Data Query)

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