BC Lake Stewardship and Monitoring Program

Prospect Lake 1986-1990, 1992-1995, 1998-2002, 2005-2011

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

The Importance of Prospect 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 1986 - 1990, 1992 - 1995, 1998 - 2002, and 2005 - 2011 results of a Level II program for Prospect Lake.

Through regular status reports, this program can provide communities with monitoring results specific to their local lake and with educational material on lake protection issues in general. This useful information can help communities play a more active role in the protection of the lake resource. Finally, this program allows government to use its limited resources efficiently thanks to the help of area volunteers and the BC Lake Stewardship Society.

The watershed area of Prospect Lake is approximately 10.2 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.

Prospect Lake is located 18 km northeast of Victoria and lies at an elevation of 47 m. The lake has a number of natural bays as well as an island (District of Saanich, 2012). The lake has a maximum depth of 14 m and a mean depth of 6.7 m. Its surface area is 0.6 km^2 and the shoreline perimeter is 4.7 km (with an additional 0.09 km of shoreline from the island). Prospect Lake contains cutthroat trout, rainbow trout, smallmouth bass, prickly sculpin, brown catfish, and pumpkinseed (FISS, 2012). In the past 5 years the lake has been stocked annually each spring and fall. In 2007 and 2008, it was stocked with both cutthroat trout and rainbow trout, and since then it has been stocked with rainbow trout only (FISS, 2012).

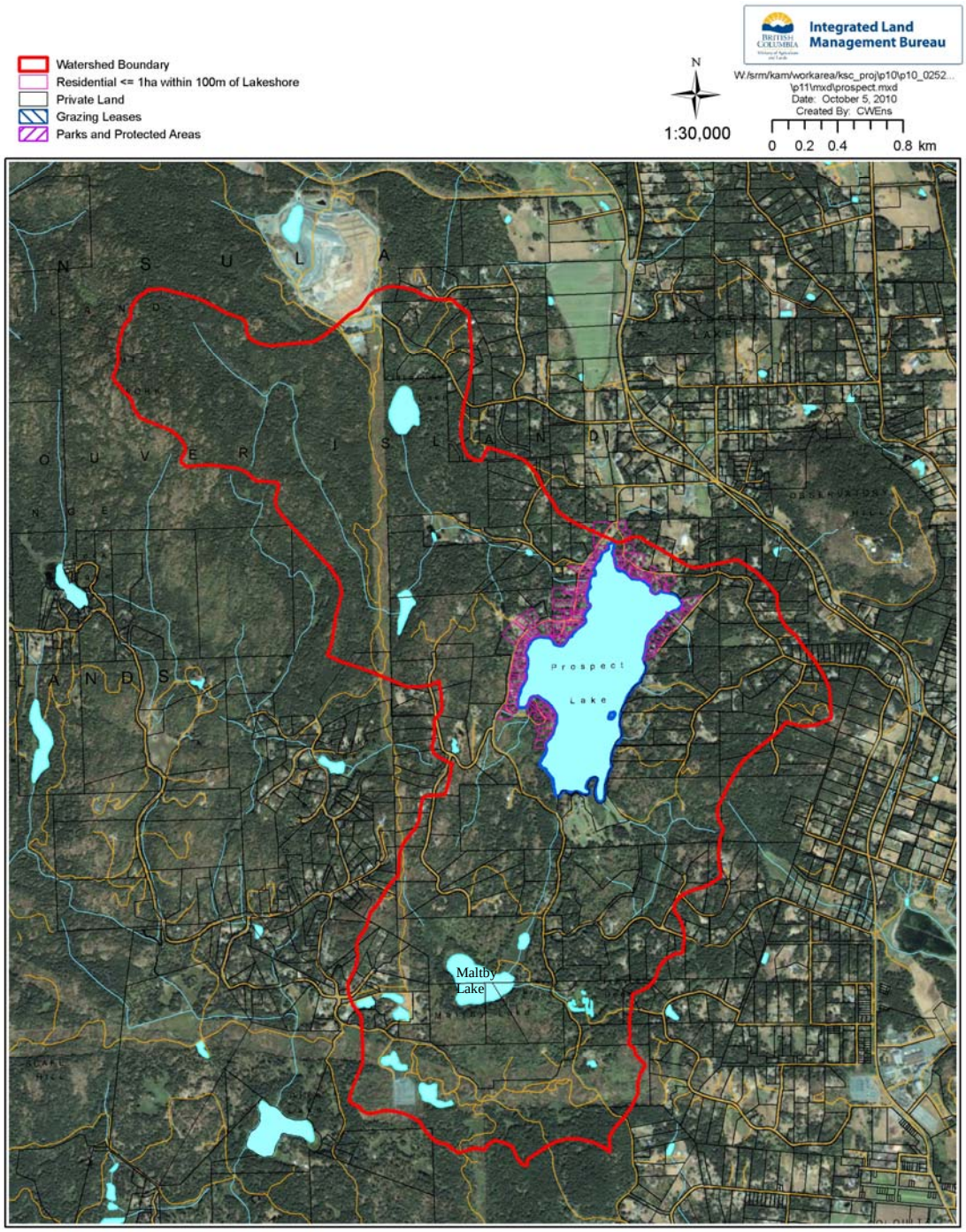
Prospect Lake has two carry-in boat launches (one in Whitehead Park on the north end of the lake, and one in Estelline Park on the west side of the lake). A trailer boat launch is located off Echo Drive (on the east side of the lake). Jet skis and Sea-Doos are prohibited (due to a Noise Bylaw), and power craft are restricted to a maximum speed of 8 km/hr, except within buoys located in the middle of the lake where the speed limit is 60 km/hr between 10:00 am and 1/2 hr before sunset. (District of Saanich, 2012).

In the past, e-coli levels attributed to a high populations of Canada Geese have resulted in beach closures (Grew, 2012, Pers. Comm.).

The water level of the lake varies very little and is controlled by a weir at the north end of the lake, on Tod Creek (Grew, 2012, Pers. Comm.). 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 (or shorter the retention time), the more quickly excess nutrients can be removed from the system. The retention time of Prospect Lake is estimated to be 0.8 years (Rieberger, 2012), suggesting the lake has a high ability to assimilate nutrients.

The map below shows the Prospect Lake watershed (within the Tod Creek Watershed) and its associated land use practices. It's important to note that the watershed area is relatively small, at 10.2 km^2. Land use around the lake is approximately 72% forested (43% privately owned), 11% open range/grasslands (8% privately owned), 3% barren or sparsely vegetated (1.6% privately owned), and 3% developed (1.6% privately owned). The lake itself comprises approximately 9% of the watershed area. The lake is fed by numerous small streams and is drained by Tod Creek on the north end (Grew, 2012, Pers. Comm.).

Prospect Lake Watershed Map



Category	Area (ha)	% of Watershed
Agricultural Land	1.6	0.2%
Barren or Sparsely Vegetated	32.8	3.2%
Developed	32.8	3.2%
Forested	733.3	72.1%
Open Range/ Grasslands	116.1	11.4%
Shrub Land	4.1	0.4%
Water	91.5	9.0%
Wetlands	4.8	0.5%
Watershed Area	1017.2	

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

Onsite Septic Systems and Grey Water

Onsite septic systems effectively treat human waste water and wash water (grey water) as long as they are properly located, designed, installed, and maintained. When these systems fail, they become significant sources of nutrients and pathogens. Poorly maintained pit privies, used for the disposal of human waste and grey water, can also be significant contributors.

Stormwater Runoff

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

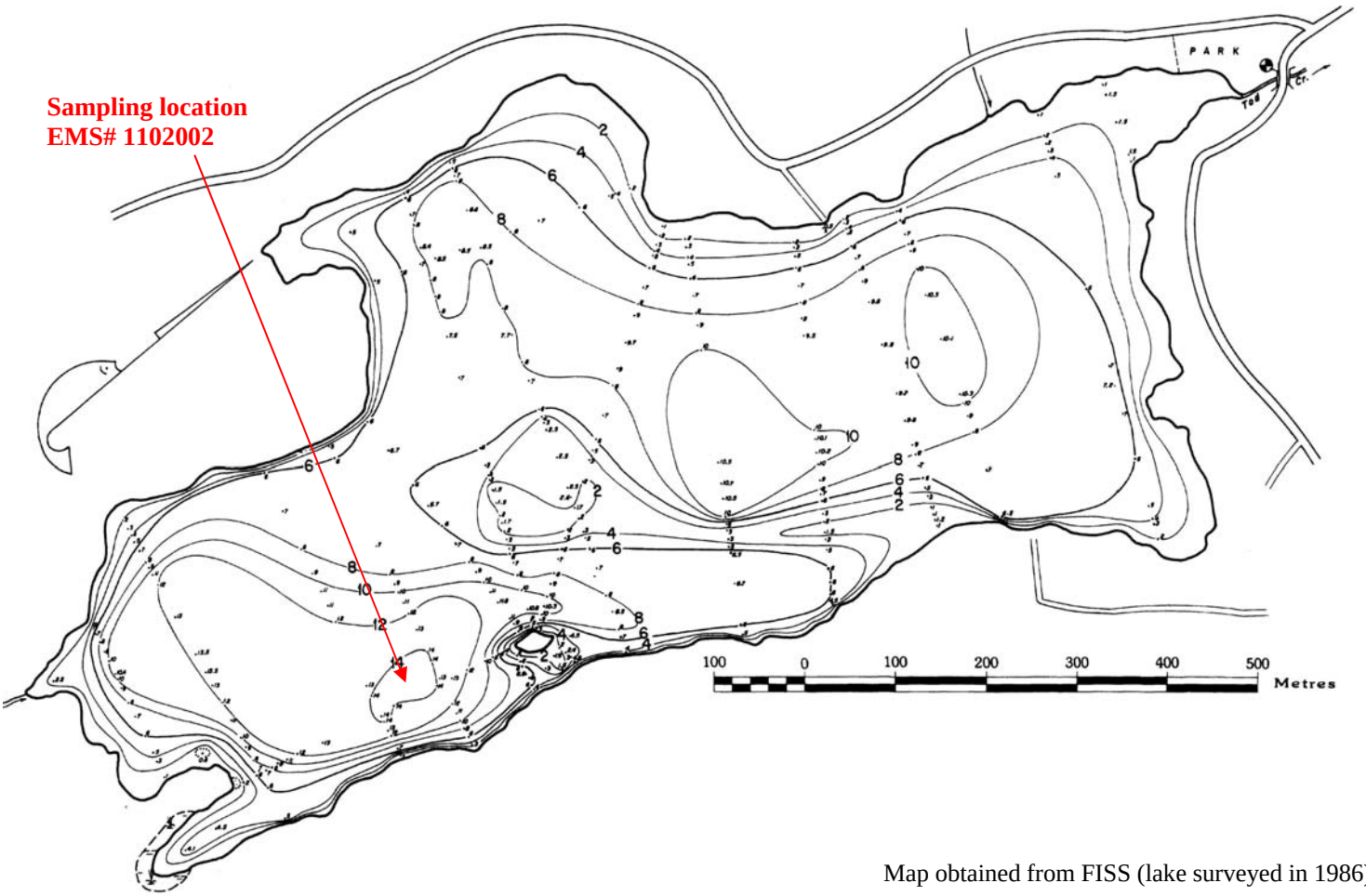
Forestry

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

Boating

Oil and fuel leaks are the main concerns of boat operation on small lakes. With larger boats, sewage and grey water discharges are issues. Other problems include the spread of aquatic plants and the dumping of litter. In shallow water operations, the churning up of bottom sediments and nutrients is a serious concern. As mentioned, jet skis and Sea-Doos are not permitted on Prospect Lake, and speed restrictions are in place for motorized boat traffic.

Prospect Lake Bathymetric Map



Map obtained from FISS (lake surveyed in 1986)

What's Going on Inside Prospect Lake?

Temperature

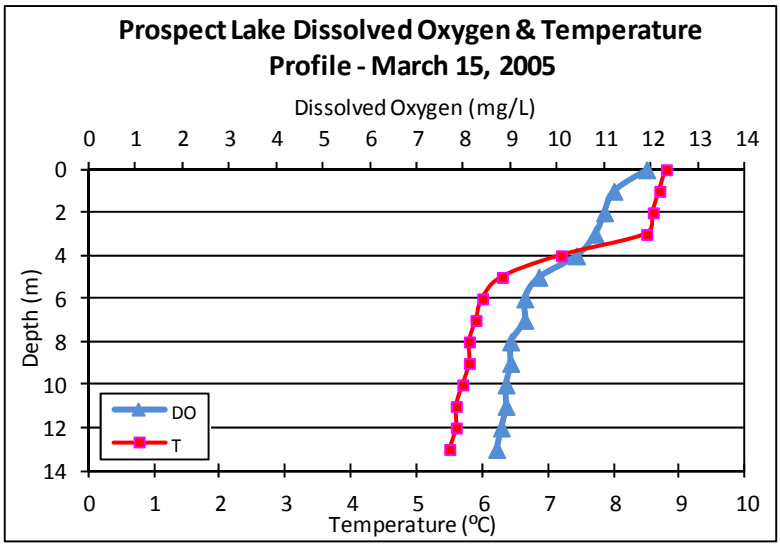
Lakes show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest water near the bottom. Because colder water is more dense, it resists mixing into the warmer, upper layer for much of the summer. When the warmer oxygen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

Prospect Lake is typical of coastal lakes in BC, which are often referred to as warm monomictic lakes. 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.

Dissolved oxygen (DO) and temperature (T) data were collected on Prospect Lake on April 13, 1994, January 21, 2004, November 23, 2004, and March 15, 2005. The graph below shows the DO and T data collected on March 15, 2005. DO/T readings show the lake was slightly stratified at this time with DO values ranging from 8.7 - 11.9 mg/L and T values ranging from 5.5 - 8.8 ºC. DO/T profiles collected on April 13, 1994, and January 21, 2004 show the lake was mixed at the time of sampling. T data collected on November 23, 2004 show that the temperature was mixed throughout the water column and the DO data show the lake was mixed (5.7 - 8.5 mg/L) until the 13 m mark, when it declined suddenly (<0.3 mg/L).



Dissolved Oxygen

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

Lakes that are less productive (oligotrophic) will have sufficient oxygen to support life at all depths throughout the year. But as lakes become more productive (eutrophic) and increasing quantities of plants and animals respire and decay, more oxygen consumption occurs, especially near the bottom where dead organisms accumulate. In productive lakes, oxygen in the isolated bottom layer may deplete rapidly (often to anoxia), forcing fish to move into the upper layer (fish 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.

As mentioned, the previous graph indicates that the lake was already stratified at the time of sampling. When a lake is thoroughly mixed at spring overturn, it is a good time to get a representative sample as chemicals in the water column are uniform. Nutrient concentrations can be compared each spring to determine trends.

Trophic Status

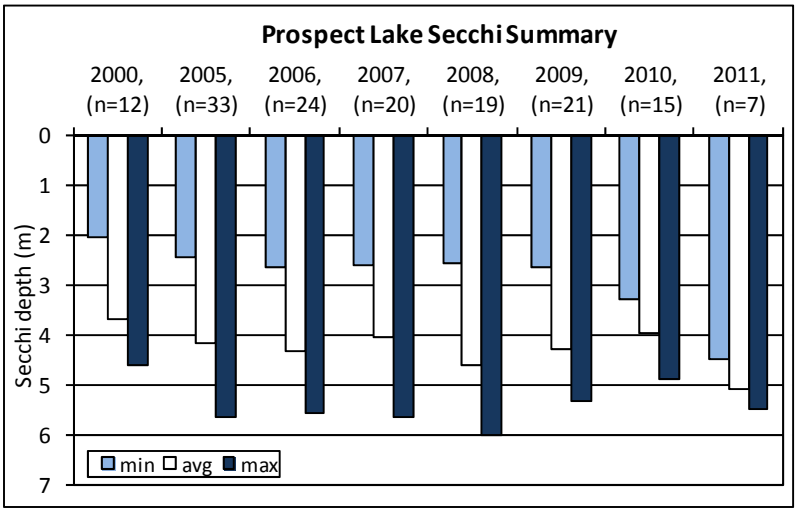
The term *trophic status* is used to describe a lake's level of productivity and depends on the amount of nutrients available for plant growth, including tiny floating algae called phytoplankton. Trophic status is often determined by measuring levels of phosphorus (TP), algal chlorophyll *a* (chl. *a*)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

Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels (1 -10 µg/L TP), sparse plant life (0-2 µg/L chl. *a*) and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 µg/L chl. *a*) including algae, because of higher nutrient levels (>30 ug/L TP). Lakes with an intermediate productivity are called ***mesotrophic*** (10-30 µg/L TP and 2-7 µg/L chl. *a*) and generally combine the qualities of oligotrophic and eutrophic lakes.

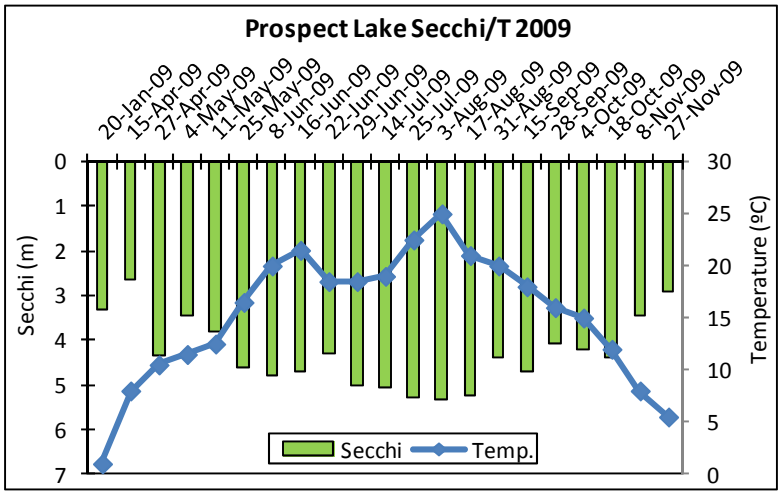
Water Clarity

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 disc, a black and white disc that measures the depth of light penetration.

Secchi readings were taken on Prospect Lake in 2000 and from 2005 - 2011 at EMS site 1102002 (see pg. 3). Minimum, average and maximum depths are shown in the following graph. It's important to note that too few samples were collected (data requirements are a minimum of 12 samples collected regularly through-



out the season) in 2011, with the first Secchi readings collected on June 21st, therefore, the minimum, maximum and average values graphed above do not accurately reflect the seasonal conditions for the lake. Usually Secchi readings are lower in the spring when the lake is undergoing mixing, this is largely due to an increase in algae (associated with increased nutrients available from mixing, and increased daylight and temperature). Average summer Secchi depth measurements ranged from 3.7 m (2000) to 5.1 m (2011), placing the lake in the mesotrophic (3-6 m) classification (Nordin, 1985). The small range in average Secchi depths indicate that there has been little change in water clarity for Prospect Lake over the sample years.



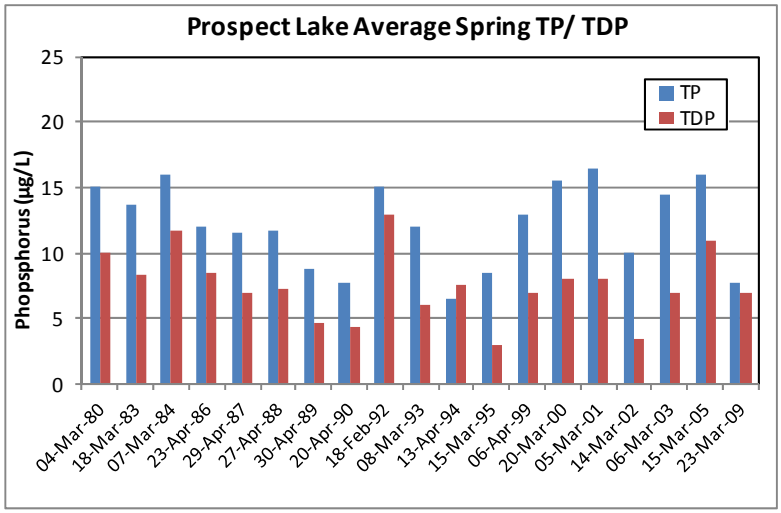
Natural variation and trends in Secchi depth and temperature not only occur between years, but also throughout one season. For example, the above graph for 2009 indicates that the temperature increases to a maximum on August 3rd and then declines. Secchi depth is most shallow in the late winter/early spring, increases over the summer and early fall, then decreases again in late fall/ early winter. Generally, 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 as well. This trend is observed in the Secchi and temperature data collected for Prospect Lake.

Phosphorus

As mentioned previously, productivity can also be determined by measuring phosphorus levels. Phosphorus concentrations measured during spring overturn can be used to predict summer algal productivity. Productivity is dependant on the amount of nutrients (phosphorus and nitrogen) in a lake, which are essential for plant growth, including algae. Algae are important to the overall ecology of a lake because they are the food for zooplankton, which in turn are the food for other organisms, including fish. In most lakes phosphorus is the nutrient in shortest supply and thus acts to limit the production of aquatic life. When in excess, however, phosphorus accelerates growth and artificially ages a lake. Total phosphorus (TP) in a lake can be greatly influenced by human activities.

Lake sediments can themselves be a major source of phosphorus. If deep-water oxygen becomes depleted, a chemical shift occurs in bottom sediments. This shift causes sediment to release phosphorus to overlying waters. This *internal loading* of phosphorus can be natural but is often the result of phosphorus pollution. Lakes displaying internal loading have elevated algal levels and generally lack recreational appeal.

DO and T profiles were not collected on the same dates that nutrients were sampled. Total phosphorus (TP), total dissolved phosphorus (TDP), and total nitrogen (TN) values were collected in the spring in 1980, 1983, 1984, 1986, 1987, 1988, 1989, 1990, 1992, 1993, 1994, 1995, 1999, 2000, 2001, 2002, 2003, 2005, 2007 & 2009. For the sample years between 1986 - 1990 and 1993-1995, TP and TDP were sampled and TN was not. In 1980, 1983, 1984, 1988, 1989, 1990, 2007 and 2009, nutrients were sampled at top, mid- and bottom depths. In all other years, samples were collected at top and mid-depths or top and bottom depths only. Since DO/T data were not collected on these sample dates, and the nutrient was not sampled at multiple depths (to determine if the lake was mixed) it is not possible to determine if nutrient samples were collected while the lake was in overturn.



The above graph shows the averaged TP and TDP values from the data collected in 1980, 1983-84, 1986-90, 1992-95, 1999-03, 2005 and 2009. Average TP values from 1980, 1983, 1984, 1986 -88, 1992-93, 1999-2003, and 2005 fall within the mesotrophic range (10 – 30 µg/L). Average TP values from 1989-90, 1994-95, and 2009 fall within the oligotrophic range (<10 µg/L). The mesotrophic status classification (the lake fell into this category for 14 of the 19 years sampled) agrees with the mesotrophic classification of the lake based on average Secchi readings from 2000 and 2005-2011, however the nutrient data are not conclusive as they may not have been collected while the lake was in overturn..

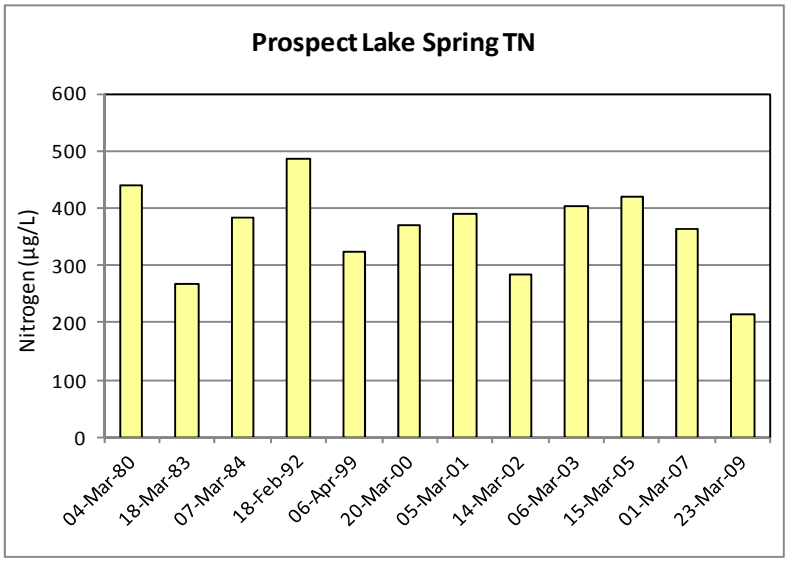
Nitrogen

Nitrogen is the second most important nutrient involved in lake productivity. In BC lakes, nitrogen is rarely the limiting nutrient

for algae growth (see phosphorus). 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 is less than 5:1, nitrogen becomes limiting to algae growth and can have major impacts on the amount and species of algae present.

The N:P ratios for Prospect Lake ranged from 19.5:1 to 28.5:1 for all years sampled, which means the lake was a P-limited (>15:1) system. A change in this ratio (for example with P increases from internal loading) could negatively affect the algae communities in the lake e.g. could result in an increase in N-fixing algae such as blue-greens.

As seen in the graph on the right, average spring overturn TN concentrations were 440 µg/L, 267 µg/L, 383 µg/L, 485 µg/L, 325 µg/L, 370 µg/L, 390 µg/L, 285 µg/L, 405 µg/L, 420 µg/L, 363 µg/L, and 213 µg/L in 1980, 1983, 1984, 1992, 1999, 2000, 2001, 2002, 2003, 2005, 2007, and 2009 respectively, likely reflecting natural variability. As the following graph shows, the total nitrogen concentrations have remained relatively stable over the sampling years. Although the lake was P-limited in all of the sampling years, average TN values fall into the mesotrophic range (Nordin, 1985).



Aquatic Plants

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

The aquatic plant communities on Prospect Lake were surveyed in 1980. The species documented as occurring in Prospect Lake include: *Potemogeton pectinatus* (sago pondweed), *P. pusillus* (small pondweed), *P. natans* (floating pondweed), *P. robbinsii* (fern pondweed), *P. amplifolius* (large-leaf pondweed), *Isoetes spp.* (quillwort), *Elodea canadensis* (Canada waterweed), *Polygonum amphibium* (water smartweed), *P. hydropiperoides* (swamp smartweed), *Eleocharis palustris* (creeping spikerush), *Ranunculus aquatilis* (water-crowfoot), *R. flammula* (creeping spearwort), *Ceratophyllum demersum* (coontail), *Sium sauve* (water parsnip), *Typha latifolia* (broad-leaved cattail), *Potentilla palustris* (marsh cinquefoil), *Fontinalis antipyretica* (water moss), *Utricularia vulgaris* (bladderwort), *Nuphar polysepalum* (yellow pond-lily), *Sagittaria spp.* (arrowhead), *Myosotis spp.* (forget-me-not), *Chara spp.* (muskgrass/stonewort), *Oenanthe sarmentosa* (water parsley), *Montia Fontana* (water chickweed), *Nymphaea spp.* (white water lily), *Scirpus lacustris* (bulrush), *Iris pseudocorus* (yellow flag iris), and *Lysimachia thyrsiflora* (tufted loosestrife). Given the diversity of plants documented in 1980, and the time that has passed since that survey, it's possible that the plant community has changed significantly. Locals report that there have been problems with the overgrowth of Eurasian water milfoil (*Myriophyullum spicatum* - an invasive species) and pond lilies (Grew, 2012, Pers. Comm.). It would be beneficial to conduct another plant survey of the lake.

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

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

Should Further Monitoring Be Done on Prospect Lake?

Average Secchi readings indicate a mesotrophic lake, and readings suggest the clarity has remained relatively stable between 2000 and 2011. Due to the limitations of the nutrient data, it is not possible to determine if they were collected during overturn and conclusions can not be drawn. Based on average spring TP values for 14 of the 19 years sampled, the lake fell in the mesotrophic classification, while data from the 5 other years place the lake in the oligotrophic category. N:P ratios indicate the lake was P-limited in all years sampled.

If possible, it would be beneficial to collect 3 consecutive years of overturn DO/T profiles and nutrient data at multiple depths. In the interim, if volunteers are willing, it would be worthwhile to continue to collect a minimum of 12 evenly-spaced Secchi and surface temperature readings between spring and fall to compare against the baseline data presented here. It would also be worthwhile to conduct another plant survey of the lake.

Tips to Keep Prospect 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 run-off 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, dug-outs, 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 on-site 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 water-bodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals.
- Conduct major maintenance chores on land.
- Use absorbent bilge pads to soak up minor leaks or spills.
- Check for and remove all aquatic plant fragments from boats and trailers before entering or leaving a lake.
- Do not use metal drums in dock construction. They rust, sink and become unwanted debris. Use 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

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Kevin Rieberger (Ministry of Environment - Victoria)

Bathymetric Map:
FISS (Fisheries Inventory Summary System)
http://a100.gov.bc.ca/pub/fidq/main.do

Land Use Map:
Chris Ens (Ministry of Forests, Lands and Natural Resource Operations - Kamloops)

Photo Credit:
Prospect Lake and District Community Association (front cover)
Mike Grew (p. 6 and 7)

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