BC Lake Stewardship and Monitoring Program

Wasa Lake 2004 - 2006

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

The Importance of Wasa 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 provides the results of a Level II program for Wasa 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 Wasa Lake is 12.15 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.

Wasa Lake is located approximately 35 km east of Kimberly and 40 km north of Cranbrook in the East Kootenay region. Wasa Lake is sometimes referred to as Hanson Lake and lies at an elevation of 772 m. The lake has a maximum depth of 13.1 m and a mean depth of 3.8 m. Its surface area is 1.1 km^2 and the shoreline perimeter is 6.98 km.

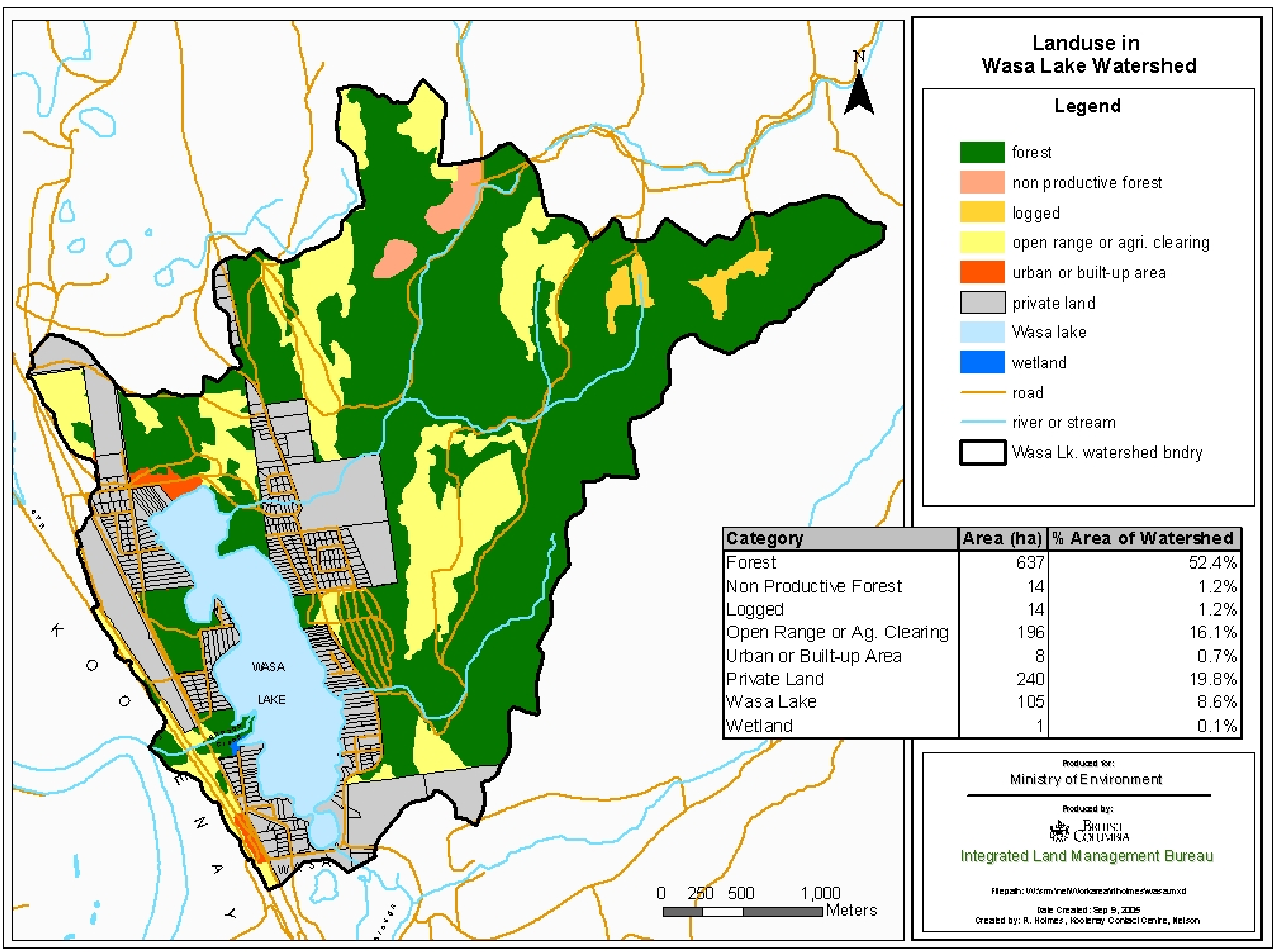
Wasa Lake contains Brook Trout, Burbot, Lake Chub, Largemouth Bass, Largescale Sucker, Northern Pikeminnow, Peamouth Chub, Rainbow Trout, Threespine Stickleback and Yellow Perch. Wasa Lake is a popular recreation lake with a small community containing both year round and seasonal residences totaling 346 properties. The lake is advertised as the warmest swimming lake in the Kootenays, which makes it a common vacation destination for families (BC Parks website, 2008). There is also a provincial park with 104 campsites and a large day use area on the lake.

Wasa Lake is a kettle lake, it was formed as a depression in glacial deposits and has no continuous inputs or outputs. It remains a lake because the depression it forms is lower than the surrounding water table; this means that fluctuations in the water table result in fluctuations in the lake level (McArthur, 2005). During freshet, it appears that the Kootenay River is the major contributing factor to the lake's level (Baker, 1987). Wasa Lake's depth changes throughout the summer following changes in the level of the Kootenay River. High water levels in the Kootenay River affect water table levels, which in turn affect the water level in Wasa Lake (McArthur, 2005).

The flushing rate is a measure of time that inflow replaces the lake water volume. It is important because the slower the flushing rate, the less the lake has ability to assimilate additional nutrients, and therefore avoid unnatural eutrophication. The flushing rate of Wasa Lake is unknown, however, considering that there are no inflows or outflows, it's likely that Wasa Lake has a low ability to assimilate nutrients.

The map below shows the Wasa Lake watershed and its associated land use practices. Land use in the watershed is approximately 52% forested, 20% private, 17% open range or agricultural use, 1% logged, 1% non productive, and less than 1% wetland. A 144 hectare provincial park occupies some portions of the north, east and west shores of the lake.

Wasa Lake Watershed Map



Category	Area (ha)	% Area of Watershed
Forest	637	52.4%
Non Productive Forest	14	1.2%
Logged	14	1.2%
Open Range or Ag. Clearing	196	16.1%
Urban or Built-up Area	8	0.7%
Private Land	240	19.8%
Wasa Lake	105	8.6%
Wetland	1	0.1%

Non-Point Source Pollution and Wasa Lake

Point source pollution originates from municipal or industrial effluent outfalls. Other pollution sources exist over broader areas and may be hard to isolate as distinct effluents. These are referred to as non-point sources of pollution (NPS). Shoreline modification, urban stormwater runoff, onsite septic systems, agriculture, and forestry are common contributors to NPS pollution. One of the most detrimental effects of NPS pollution is phosphorus loading to water bodies. The amount of total phosphorus (TP) in a lake can be greatly influenced by human activities. If local soils and vegetation do not retain this phosphorus, it will enter watercourses where it will become available for algal production.

Agriculture

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

Onsite Septic Systems and Grey Water

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

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

Stormwater Runoff

Lawn and garden fertilizer, sediment eroded from modified shorelines or infill projects, oil and fuel leaks from vehicles, snowmobiles and boats, road salt, and litter can all be washed by rain and snowmelt from properties and streets into watercourses. Phosphorus and sediment are of greatest concern, providing nutrients and/or a rooting medium for aquatic plants and algae. Pavement prevents water infiltration to soils, collects hydrocarbon contaminants during dry weather and increases direct runoff of these contaminants to lakes during storm events.

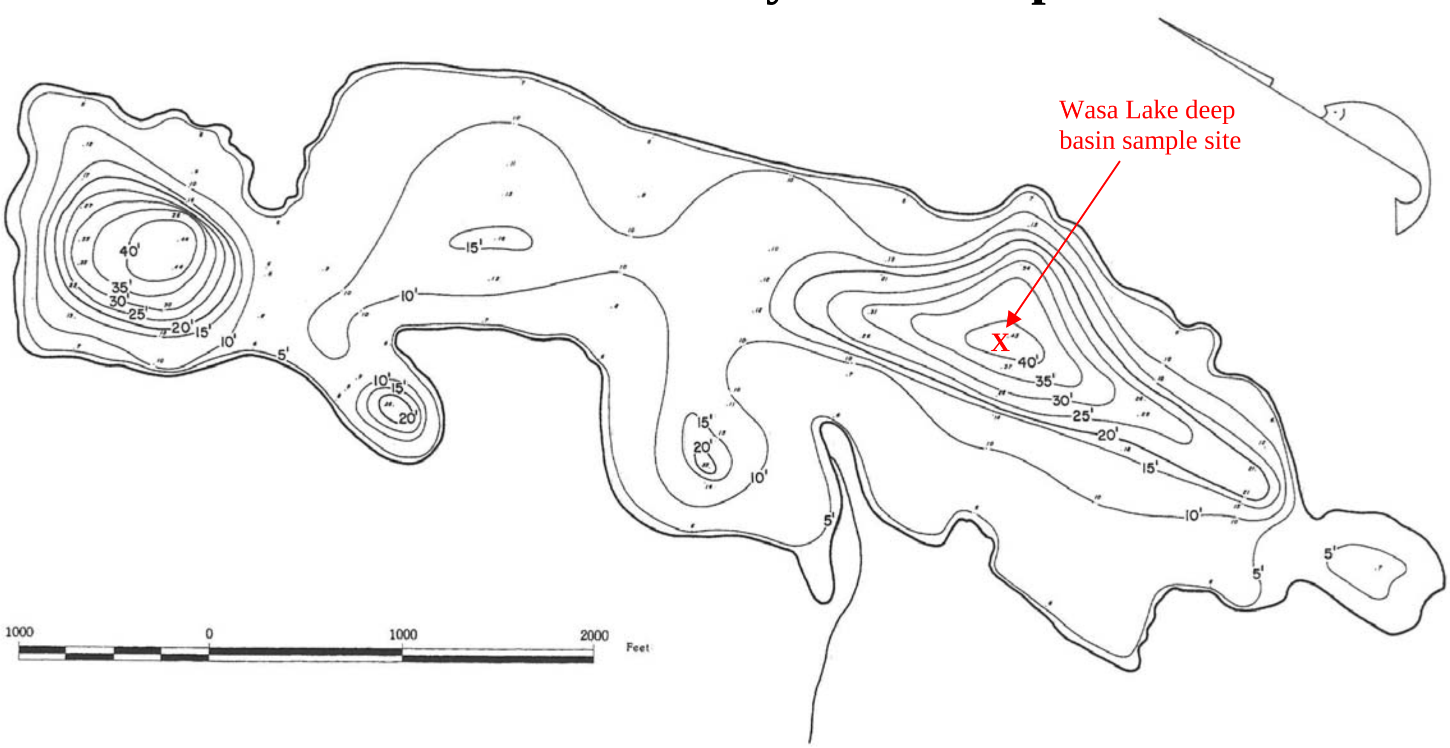
Forestry

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

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 Wasa 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.

Wasa Lake Bathymetric Map



Map obtained from www.fishwizard.com (2005)

What's Going on Inside Wasa Lake?

Temperature

Lakes show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest water near the bottom. Because colder water is more dense, it resists mixing into the warmer, upper layer for much of the summer. When the warmer oxygen rich surface water distinctly separates from the cold oxygen poor water in the deeper parts of the lake, it is said to create a thermocline, a region of rapid temperature change between the two layers.

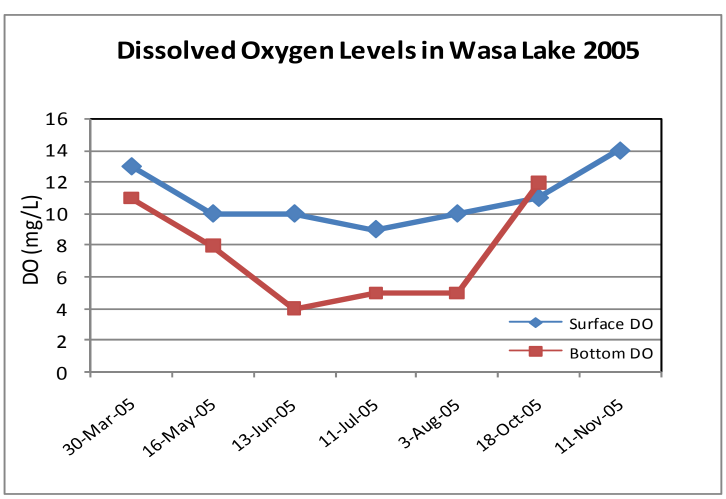
In spring and fall, these lakes usually mix from top to bottom (overturn) as wind energy overcomes the reduced temperature and density differences between surface and bottom waters. In the winter, lakes re-stratify under ice with the densest water (4°C) near the bottom. Because these types of lakes turn over twice per year, they are called dimictic lakes. These are the most common type of lake in British Columbia. Wasa Lake is a dimictic lake.

Coastal lakes in BC are more often termed warm monomictic lakes. These lakes turn over once per year. Warm monomictic lakes have temperatures that do not fall below 4°C. These lakes generally do not freeze and circulate freely in the winter at or above 4°C and stratify in the summer.

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 lake users.

The timing of freeze up and break up of BC lakes is important information for climate change research. The BCLSS is interested in this information. If these dates have been recorded in the past, please send the information to the BCLSS so that it can be incorporated into climate change studies.

Dissolved oxygen (DO) and temperature data were collected at a deep site on Wasa Lake from 2004 to 2006. Surface temperatures were taken, and surface and bottom DO readings were taken. The previous graph shows the surface and bottom DO data collected throughout 2005. The lake appears to have been relatively well mixed at spring overturn resulting in representative samples.



However, in 2004 and 2006, sampling began later in the season, June 7 and May 10 respectively, so overturn might have been missed in those years. As surface temperature readings, but not temperature gradient data was collected for Wasa Lake, it is not possible to determine whether the lake was in spring overturn in 2004 and 2006. The previous graph indicates that the lake is undergoing overturn in the fall, as the lake is well mixed on October 18. Readings taken in 2004 and 2006, November 17 and October 31, respectively, also indicate that the lake was sampled during fall overturn.

Surface temperature data from 2005 is graphed with Secchi readings for the same year on the following page, under the section titled *Trophic Status*. It is also important to note that the minimum requirement of 12 readings taken during a sampling season was not met in 2004 through 2006.

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 (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.

As mentioned, the previous graph indicates that fall overturn occurred on or around October 18. Since Wasa Lake was not sampled during spring overturn (as is ideal), fall overturn values could still be considered representative (Nordin 2008, *pers. comm.*). Nutrient concentrations at overturn can be compared each fall to determine trends.

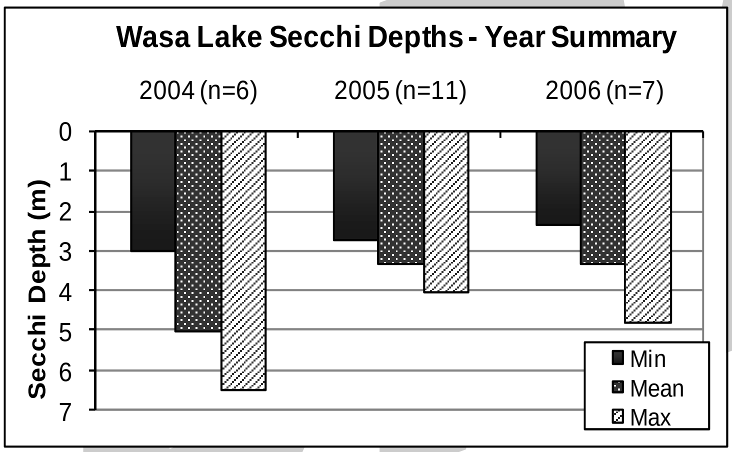
Trophic Status

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, 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.

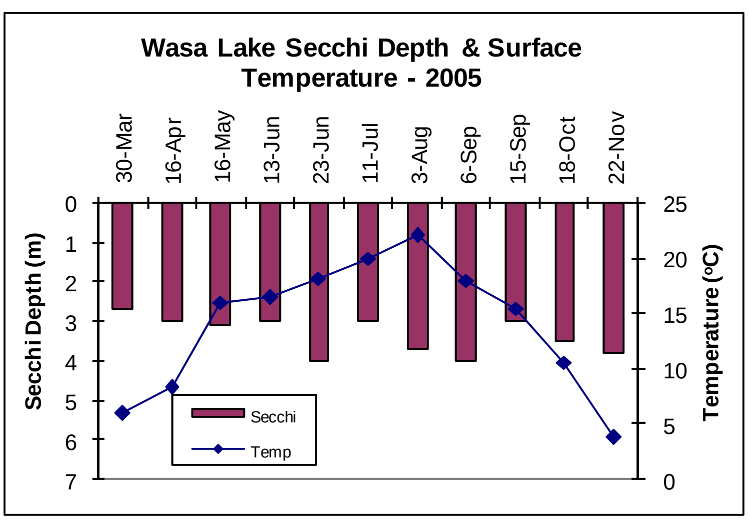
Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels (1-10 *u*g/L TP), sparse plant life (0-2 *u*g/L chl. *a*) and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 *u*g/L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

Water Clarity

As mentioned in the previous section, one method of determining productivity is water clarity. The more productive a lake is, the higher the algal growth and, therefore, the less clear the water becomes. The clarity of the lake water can be evaluated by using a Secchi disk, a black and white disk that measures the depth of light penetration.



The graph above shows the minimum, mean and maximum Secchi depths recorded at the deep site on Wasa Lake from 2004 to 2006, as well as the number of readings each year (n). During these years of sampling the mean Secchi depth measurements ranged from 3.3 m (2006) to 5.0 m (2004), indicating relatively little change has occurred during the sampling period. Based on these Secchi values Wasa Lake was exhibiting mesotrophic conditions.

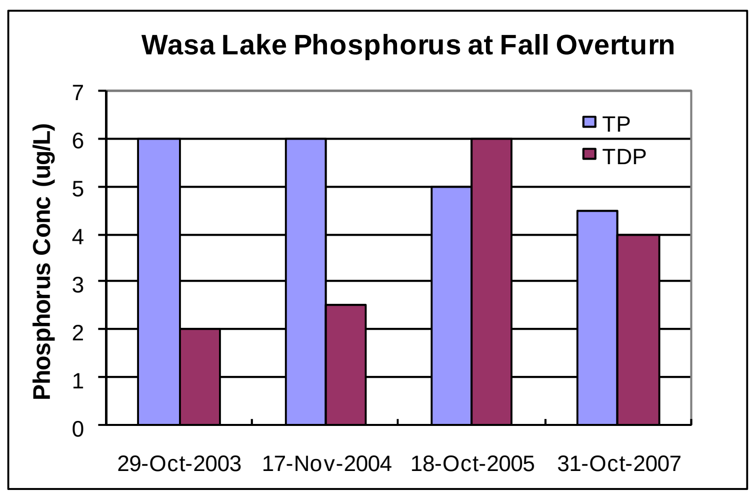


Natural variation and trends in Secchi depth and temperature not only occur between years, but also throughout one season. In general as temperature increases during the summer months, the Secchi depth decreases. As temperature increases, some species of algae increase in abundance. Due to the increase in algae, the water clarity decreases and the Secchi depth decreases. This trend is not apparent in the previous graph of the 2005 data. Graphs from 2004 and 2006 are not included as too few readings were taken in those years. Observations of local resident (Ashmore 2008, *pers. comm.*) indicate that water clarity readings may be affected by re-suspension of bottom sediments in this relatively shallow lake.

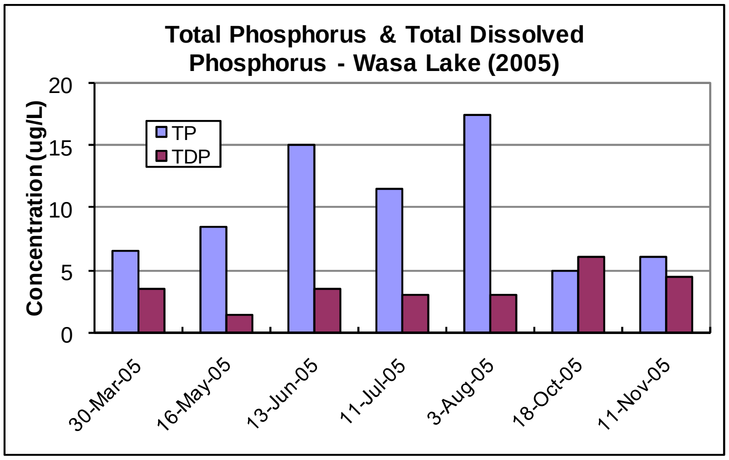
Phosphorus

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.



As previously mentioned, spring overturn was missed during several sampling years and consequentially fall overturn data is being used for analysis. Monitoring on Wasa Lake was initiated in the fall of 2003, resulting in four years of chemistry data. Based on the fall overturn phosphorus data collected from 2003 to 2006 (above graph), there appears to be a slightly declining trend in total phosphorus (TP) and some variability in total dissolved phosphorus (TDP). These values are likely within the range of natural variability for the lake. All of the TP and TDP data falls within the range for an oligotrophic lake.

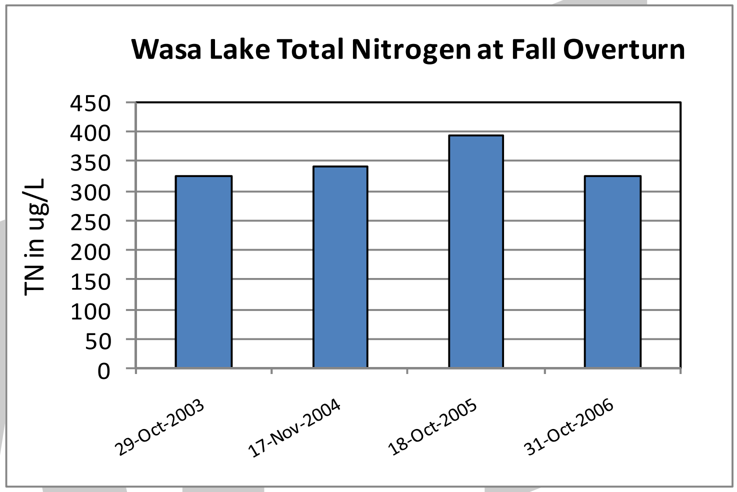


The above graph shows the TP and TDP data collected throughout the 2005 sampling season. Too few samples were collected in 2004 and 2006, making comparison of data from those years to the 2005 data difficult. The fluctuation of both TP and TDP levels illustrated in the above graph may be due to re-suspension of bottom sediments and/or nutrient rich bottom waters caused by considerable boat traffic on the lake and/or strong southern winds (Ashmore, 2008); however, this cannot be confirmed as no quality assurance/quality control (QA/QC) was conducted to verify the data .

Nitrogen

Nitrogen is the second most important nutrient involved in lake productivity. In BC lakes, nitrogen is rarely the limiting nutrient for algae growth (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 ratio is approximately 64:1, which means the lake is a phosphorus limited system. Although an increase in nitrogen should not increase algae biomass, it could result in a change to the species of algae present, possibly to a less desirable species.



Total nitrogen values collected at fall overturn are shown in the above graph. Values range from 325 *u*g/L (2003 and 2006) to 395 *u*g/L (2005). The slight fluctuations observed in the graphed data are likely due to natural variability. Based on these nitrogen levels, Wasa Lake falls into the mid-range of the mesotrophic classification (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.

Plant species found in Wasa Lake include: *Carex* (sedges), *Menyanthes trifoliate* (bog-bean or buckbean), *Nuphar polysepalum* (yellow pond lily), *Potemogeton* (pond weeds, 2 species), *Potentilla palustris* (marsh cinquefoil) and *Ranunculus* (buttercups, 3 species).

Aquatic plants play an important role in the lifecycle of aquatic insects, provides food and shelter from predators for young fish, and also provides food for waterfowl, beavers and muskrats.

Aquatic plant species can spread between lakes via boaters. 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 Wasa Lake?

Wasa Lake is an oligotrophic lake as indicated by it's phosphorus concentrations. Secchi depth and nitrogen indicate mesotrophic conditions, however, Secchi depth (clarity) may be affected by re-suspension of bottom sediments in this relatively shallow lake. The data collected on Wasa lake indicates that the water has remained relatively stable in terms of Secchi depth, phosphorus and nitrogen. Further monitoring of water chemistry is not necessary at this time. However, it is important that an adequate number of Secchi and surface temperature readings are collected during a sampling season.

If volunteers are willing to continue monitoring Wasa Lake, a minimum of twelve Secchi and surface temperature readings taken at evenly spaced intervals during the spring and summer will provide valuable data. Chlorophyll *a* measurements throughout the summer would be helpful in assessing lake productivity. Additionally, dissolved oxygen/temperature profiles (multiple depths) during spring overturn and throughout the summer would aid in understanding the effect of potential re-suspension of bottom sediments and nutrients. Long-term collection of Secchi and surface temperature data could help identify early warning signs should there be a deterioration in water quality. If a declining trend in water quality is observed, monitoring for spring overturn water chemistry should be resumed.

Temperature data is also valuable for climate change studies. As well, freeze-up and break-up of ice should be recorded for climate change studies.

Tips to Keep Wasa Lake Healthy

Yard Maintenance, Landscaping & Gardening

- Minimize the disturbance of shoreline areas by maintaining natural vegetation cover.
- Minimize high-maintenance grassed areas.
- Replant lakeside grassed areas with native vegetation.
- Do not import fine fill.
- Use paving stones instead of pavement.
- Stop or limit the use of fertilizers and pesticides.
- Do not use fertilizers in areas where the potential for water contamination is high, such as sandy soils, steep slopes, or compacted soils.
- Do not apply fertilizers or pesticides before or during rain due to the likelihood of runoff.
- Hand pull weeds rather than using herbicides.
- Use natural insecticides such as diatomaceous earth. Prune infested vegetation and use natural predators to keep pests in check. Pesticides can kill beneficial and desirable insects, such as lady bugs, as well as pests.
- Compost yard and kitchen waste and use it to boost your garden's health as an alternative to chemical fertilizers.

Agriculture

- Locate confined animal facilities away from waterbodies. Divert incoming water and treat outgoing effluent from these facilities.
- Limit the use of fertilizers and pesticides.
- Construct adequate manure storage facilities.
- Do not spread manure during wet weather, on frozen ground, in low-lying areas prone to flooding, within 3 m of ditches, 5 m of streams, 30 m of wells, or on land where runoff is likely to occur.
- Install barrier fencing to prevent livestock from grazing on streambanks and lakeshore.
- If livestock cross streams, provide graveled or hardened access points.
- Provide alternate watering systems, such as troughs, dugouts, or nose pumps for livestock.
- Maintain or create a buffer zone of vegetation along a streambank, river or lakeshore and avoid planting crops right up to the edge of a waterbody.

Onsite Sewage Systems

- Inspect your system yearly, and have the septic tank pumped every 2 to 5 years by a septic service company. Regular pumping is cheaper than having to rebuild a drain-field.
- Use phosphate-free soaps and detergents.
- Don't put toxic chemicals (paints, varnishes, thinners, waste oils, photographic solutions, or pesticides) down the drain because they can kill the bacteria at work in your onsite sewage system and can contaminate waterbodies.
- Conserve water: run the washing machine and dishwasher only when full and use only low-flow showerheads and toilets.

Auto Maintenance

- Use a drop cloth if you fix problems yourself.
- Recycle used motor oil, antifreeze, and batteries.
- Use phosphate-free biodegradable products to clean your car. Wash your car over gravel or grassy areas, but not over sewage systems.

Boating

- Do not throw trash overboard or use lakes or other waterbodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemicals.
- Conduct major maintenance chores on land.
- Use absorbent bilge pads to soak up minor leaks or spills.
- Check for and remove all aquatic plant fragments from boats and trailers before entering or leaving a lake.
- 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

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BC Lake Stewardship Society

Photo Credit:
Susanne Ashmore?

Bathymetric Map:
Fish Wizard

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