BC Lake Stewardship and Monitoring Program

Ness Lake 1994 - 1996 & 2008

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

The Importance of Ness Lake & its Watershed

British Columbians want lakes to provide good water quality, aesthetics and recreational opportunities. When these features are not apparent in recreational lakes, questions arise. People begin to wonder if the water quality is getting worse, if the lake has been affected by land development, and what conditions will result from more development within the watershed.

The BC Lake Stewardship Society (BCLSS), in partnership with the Ministry of Environment (MoE), has designed a program, entitled *The BC Lake Stewardship and Monitoring Program* (BCLSMP), to help answer these questions. Through regular water sample collections, we can begin to understand a lake's current water quality, identify the preferred uses for a given lake, and monitor water quality changes resulting from land development within the lake's watershed. The level for a particular lake depends on study objectives as well as funding and human resources available. This report provides the 1994 - 1996 and 2008 preliminary results of a Level III program for Ness Lake.

Through regular status reports, the BCLSMP 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.

Ness Lake's monitoring program began in 1994 and since 1996, it has been coordinated by volunteers who live on the East Basin of Ness Lake in partnership with the MoE. This status report summarizes information derived from the program. Quality of the data has been found to be acceptable. Data quality information is available on request.

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. The watershed area of Ness Lake is 19.05 km^2.

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.

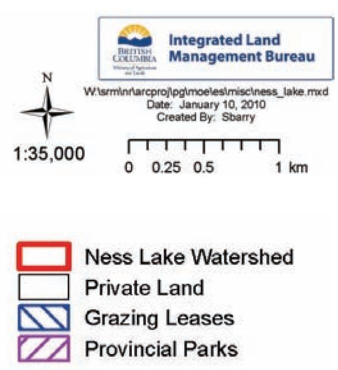
Human activities that impact water bodies range from small but widespread and numerous *non-point* sources throughout the watershed to large *point* sources of concentrated pollution (e.g. waste discharge outfalls, spills, etc). Undisturbed watersheds have the ability to purify water and repair small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

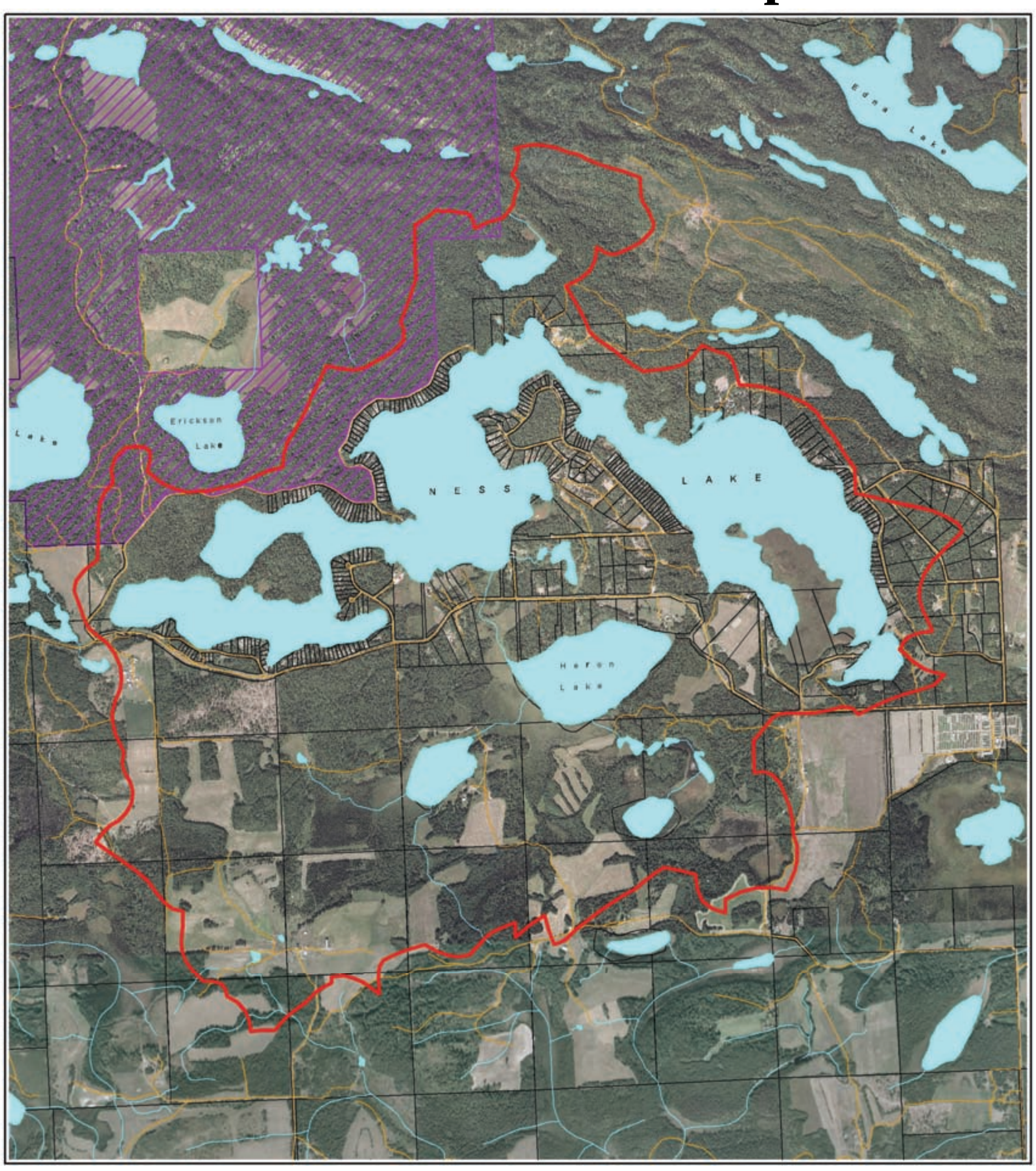
Ness Lake is located in the Omineca region of B.C., approximately 35 km northwest of Prince George, via Highway 97 and Chief Lake Road. The lake lies at an elevation of 778 m, and has maximum and mean depths of 18.3 m and 6.7 m, respectively. It has a surface area of 4 km^2 and a shoreline perimeter of 18.8 km. Ness lake is a popular lake for angling, and contains both sport and non-sport fish species. Sport fish include: kokanee, and brook and rainbow trout. Other species include largescale and longnose suckers, red-side shiners, and prickly sculpin. Within the past 5 years, Ness Lake has been stocked annually with rainbow and brook trout, and was stocked with kokanee in the spring of 2010 (FISS, 2010). Additionally, local residents report that kokanee were stocked in the lake in 2009 (Floria, 2010).

The lake has only one inflow, Heron Creek and no outflows. Although unconfirmed, it has been suggested that lake levels are maintained by a groundwater interface throughout the lake due to the lake's position in an eskers formation, which are often made up of porous sand or gravelly substrates (Heslop 2010, Pers. Comm.). The flushing rate, a 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 faster excess nutrients can be removed from the system. The flushing rate for Ness Lake is unknown, however it's likely quite low as the lake has no outflows.

The lake has three main basins: the central and east basins, which are quite developed, and the southwest basin, which has only a few residences, is sheltered by mostly forested shoreline, and has a wetland area on one end (Heslop 2010, Pers. Comm.). The map below shows the land use within the Ness Lake watershed. There is a considerable amount of residential development surrounding the lake, as well as a 14 ha Regional Park, an Elks Camp, and a large Bible Camp. Included in the 59% of privately owned land within the watershed is 1.39 km^2 of wetlands. In October 2005, a shoreline survey was conducted along Ness Lake. Of the 265 lakeshore residences, 42.3% had complete or high riparian buffers, and 57.7% had moderate, low or no riparian buffer (MoE, 2005). In 2005, a shoreline bacterial study was completed by the Ministry of Environment. The data indicated Ness Lake's water quality is unsuitable for human consumption without prior treatment (Jacklin, 2005). Copies of this report are available upon request from the BCLSS office. The lake is used for general recreational purposes and provides good public access.

Ness Lake Watershed and Land Use Map





WATERSHED CHARACTERISTICS

Watershed Area:	19.05 km^2
Percent Land Use	
Private Land:	59%
Lake:	22
Forested:	18

Non-Point Source Pollution and Ness 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. Potential sources of nutrients (nitrogen & phosphorus) include chemical fertilizers and improperly situated winter feeding areas.

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.

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 nutrient loading to 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

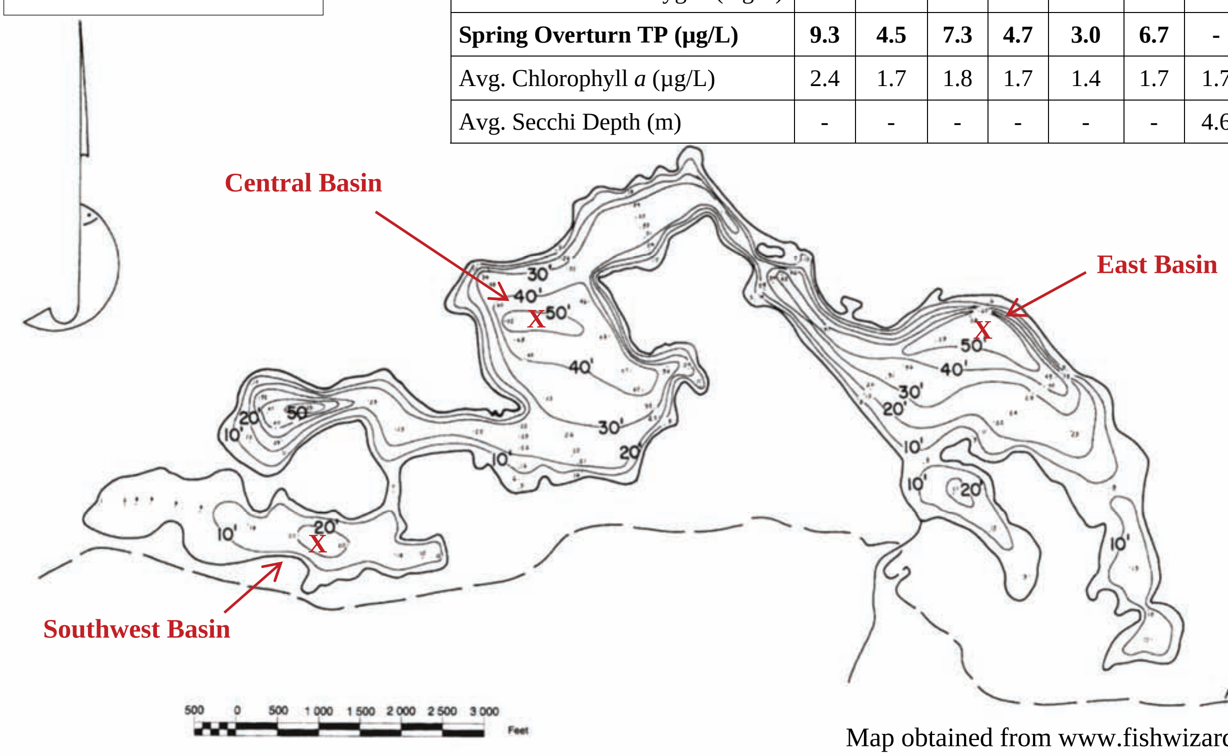
Oil and fuel leaks are the main concerns of boat operation on small lakes. With larger boats, sewage and grey water discharges are issues. Other problems include the spread of aquatic plants and the dumping of litter. In shallow water operations, the churning up of bottom sediments and nutrients is a concern.

Ness Lake Bathymetric Map

Lake characteristics

Area: 2 km^2
Max depth: 18.3 m
Mean depth: 6.7 m
Shoreline length: 18.8 km
Elevation: 778 m

Trophic Characteristics	1994			1995			1996			2008		
	SW Basin	Central Basin	East Basin	SW Basin	Central Basin	East Basin	SW Basin	Central Basin	East Basin	SW Basin	Central Basin	East Basin
Max. Surface Temp. (°C)	-	-	-	-	-	-	22.0	21.0	21.0	20.0	20.0	20.0
Min Near-bottom Oxygen (mg/L)	-	-	-	-	-	-	6.0	5.0	8.0	9.0	9.0	8.0
Spring Overturn TP (µg/L)	**9.3**	**4.5**	**7.3**	**4.7**	**3.0**	**6.7**	-	**4.7**	**13.7**	**14.0**	**9.3**	**10.7**
Avg. Chlorophyll *a* (µg/L)	2.4	1.7	1.8	1.7	1.4	1.7	1.7	1.5	1.2	1.8	1.2	1.2
Avg. Secchi Depth (m)	-	-	-	-	-	-	4.6	5.8	6.2	4.0	6.4	6.9



Map obtained from www.fishwizard.com (2008)

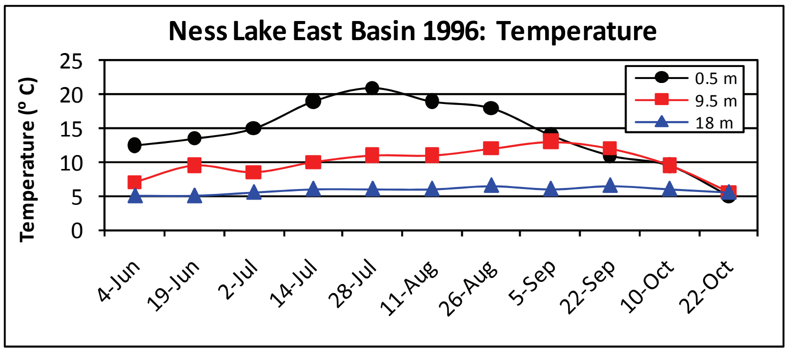
What's Going on Inside Ness Lake?

Temperature

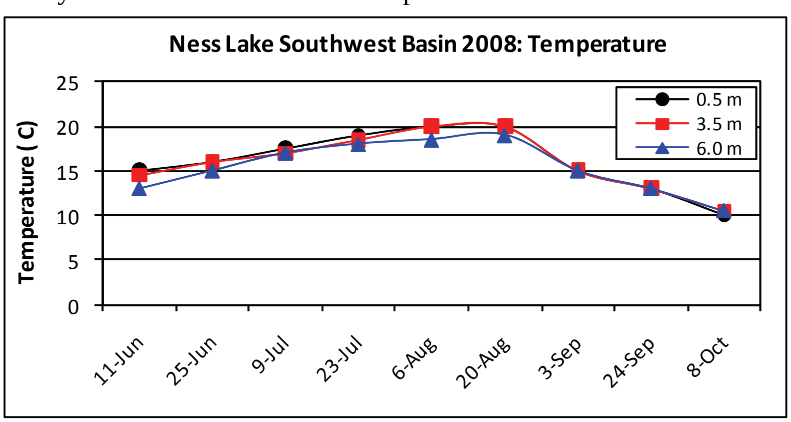
Lakes show a variety of annual temperature patterns based on their location and depth. Most interior lakes form layers (stratify), with the coldest summer water near the bottom. Because colder water is more dense, it resists mixing into the warmer, upper layer for much of the summer. In spring and fall, 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 most dense water (4°C) near the bottom.

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

The review of ice-on and ice-off dates is important to the growing issue of climate change, particularly with how it is affecting B.C. lakes.



Temperature was measured seasonally at three sites (Central Basin, East Basin & Southwest Basin) in 1996 and 2008, and in the Central Basin in 1994 at spring overturn. The graph above shows the 1996 temperature data in the East Basin, which is similar to 2008. Temperature patterns at the East Basin are comparable to the Central Basin readings. The October 22, 1996 sample date shows a similar temperature at all depths, indicating fall overturn. Sampling was not conducted as late into October in 2008, therefore fall overturn data was not captured. Additionally, spring overturn was missed as the June 4, 1996 reading shows thermal stratification. Sampling was initiated earlier in the season in 2008, however the data indicates stratification was already occurring. The graph below shows that the Southwest Basin experienced uniform temperature profiles more than once in 2008 (comparable to 1996). This is likely due to the basin's shallow depth.

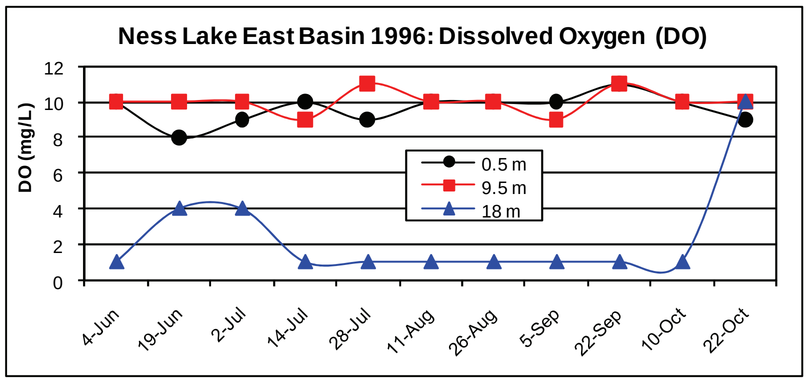


Dissolved Oxygen

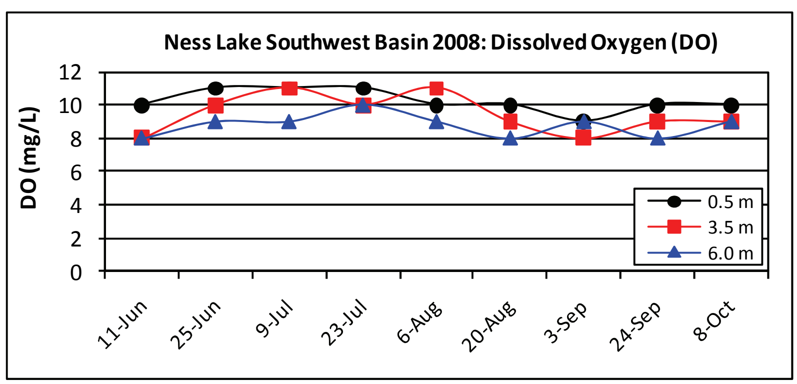
Oxygen is essential to life in lakes. It enters lake water from the air by wind action and plant photosynthesis. Oxygen is consumed by respiration of animals and plants in summer, including the decomposition of dead organisms by bacteria. A great deal can be learned about the health of a lake by studying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

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

In productive lakes, oxygen in the isolated bottom layer may deplete rapidly (often to anoxia), forcing fish to move into the upper layer (salmonids are stressed when oxygen levels fall below about 20% saturation) where temperatures may be too warm. Fish kills can occur when decomposing or respiring algae use up the oxygen. In the summer, this can happen on calm nights after an algal bloom, but most fish kills occur during late winter or at initial spring mixing because oxygen has been depleted under winter ice.



The figure above shows the 1996 oxygen pattern for Ness Lake at the East Basin, which is comparable to the oxygen patterns in the Central Basin. Surface (0.5 m) and mid-depth (9.5 m) oxygen remained near saturation, not dropping below 8 mg/L. Both basins exhibited low oxygen levels in the bottom waters, which would not have supported fish for most of the sampling period while levels were below 4 mg/L. Vertical mixing and the aeration of bottom waters occurred with the onset of cooler fall temperatures. The 2008 data is comparable to the 1996 data, however the last sample was collected on October 8th, and mixing had not yet occurred.



The graph above shows the oxygen pattern for the Southwest Basin. The basin remains quite mixed throughout the season, with high oxygen levels at all three depths, likely due to the shallow depth the basin water (maximum depth 7 m).

Trophic Status and Phosphorus

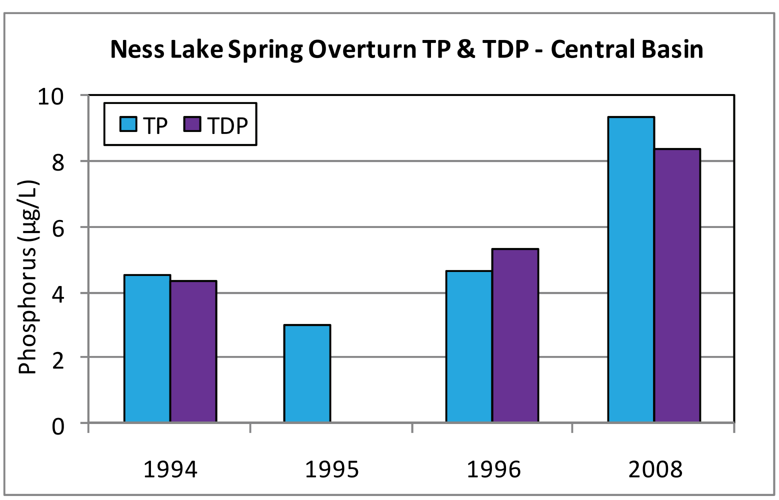
The term "trophic status" is used to describe a lake's level of productivity and depends on the amount of nutrients available for plant growth, including tiny floating algae called phytoplankton. Algae are important to the overall ecology of the lake because they are food for zooplankton, which in turn 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. As mentioned earlier (page 3), total phosphorus (TP) in a lake can be greatly influenced by human activities.

The trophic status of a lake can be determined by measuring productivity. The more productive a lake is the higher the algal growth and therefore the less clear the water becomes. Water clarity is measured using a ***Secchi disc***, a black and white disc used to indicate the depth of light penetration. Productivity is also determined by measuring nutrient levels and ***chlorophyll*** (the green photosynthetic pigment of algae). The concentration of chlorophyll *a* in lake water is an indicator of the density of algae present in that same water and is directly related to the Secchi depth. Phosphorus concentrations measured during spring overturn can be used to predict summer algal productivity.

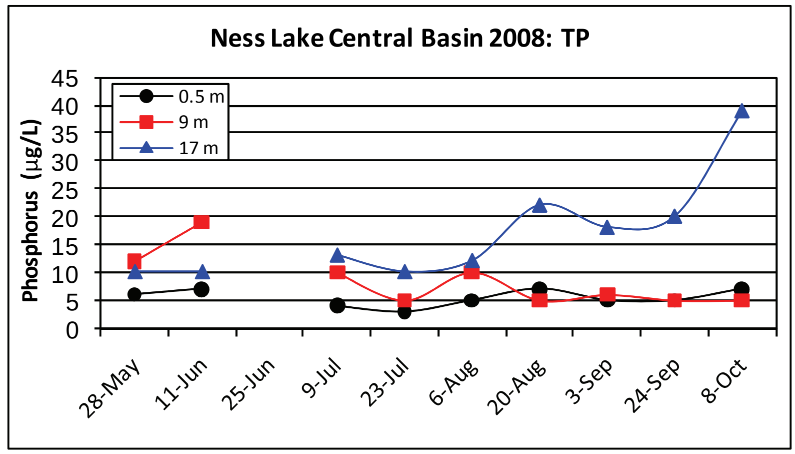
Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels (1-10 µg/L TP), sparse plant life (0-2 µg/L chl. *a*) and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 µg/L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

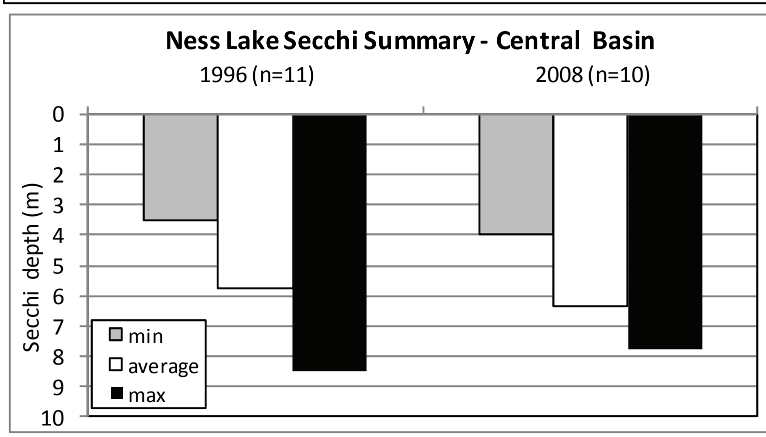
Lake sediments can themselves be a major source of phosphorus. If deep-water oxygen becomes depleted, a chemical shift occurs in bottom sediments. This shift causes sediment to release phosphorus to overlying waters. This *internal loading* of phosphorus can be natural but is often the result of external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

Ness Lake's average spring TP values for the Central, East & Southwest Basins are shown on page 3. In the Central Basin (graphed below), the average TP appears to have increased from the mid-1990s to 2008, however all values suggest oligotrophic conditions. In the East Basin, an increase in average spring TP values appears to have occurred from 1995 to 1996. Average spring TP values in 1994 and 1995 suggest oligotrophic conditions (7.3 µg/L and 6.7 µg/L respectively) while 1996 and 2008 values indicate slightly mesotrophic conditions (13.7 µg/L and 10.7 µg/L respectively). The average spring TP in the Southwest Basin appears to have increased substantially from the mid-1990s to 2008. Overturn TP readings in the Southwest Basin suggest oligotrophic conditions in 1994 and 1995, and slightly mesotrophic conditions in 2008. Data from further sampling in 2009 and 2010 will assist in this interpretation.



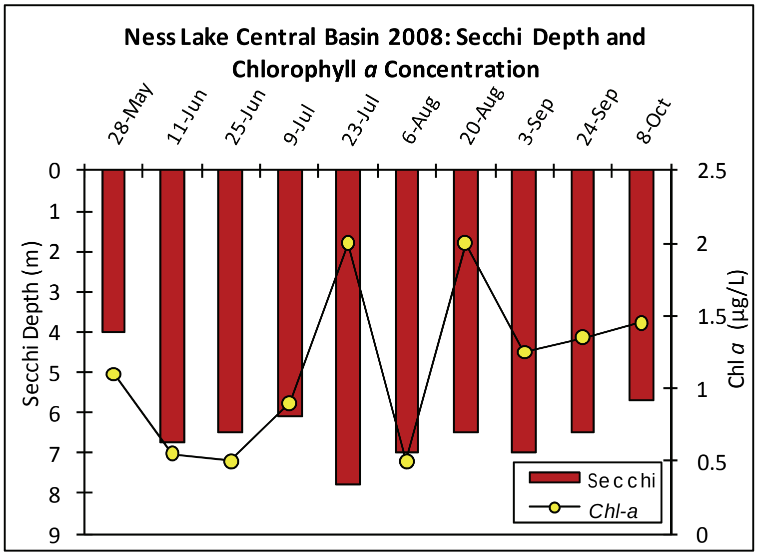
The following graph displays the phosphorus cycling in Ness Lake in the Central Basin in 2008. It appears that internal loading is taking place in the latter half of the summer, peaking on October 8th when TP near the bottom (17.4 m) reached 39 µg/L and orthophosphorus (OP), the form released from bottom sediments, spiked to 18 µg/L (46% of the TP). High OP levels at the bottom coincided with low DO levels, further supporting the claim of internal phosphorus loading from the sediments. In the East Basin, there appeared to be a small amount of internal loading taking place on the same date, which also occurred with low DO levels. Review of sampling data for 2009 and 2010 may provide further information on internal loading.

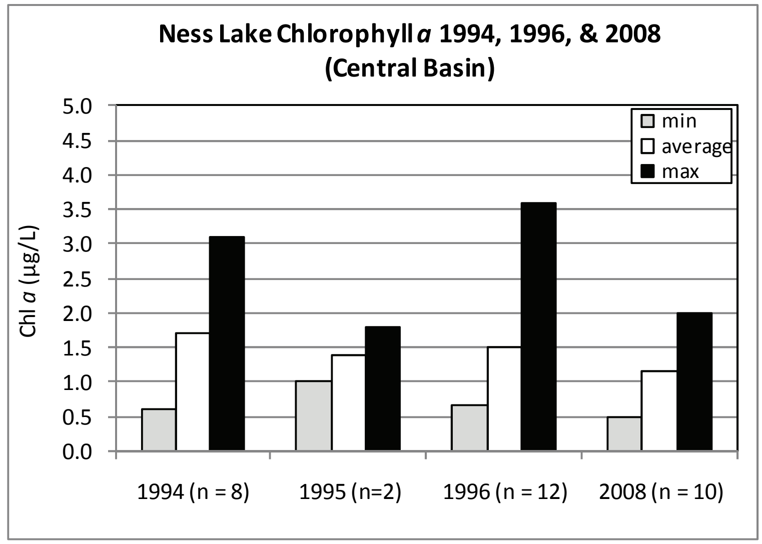




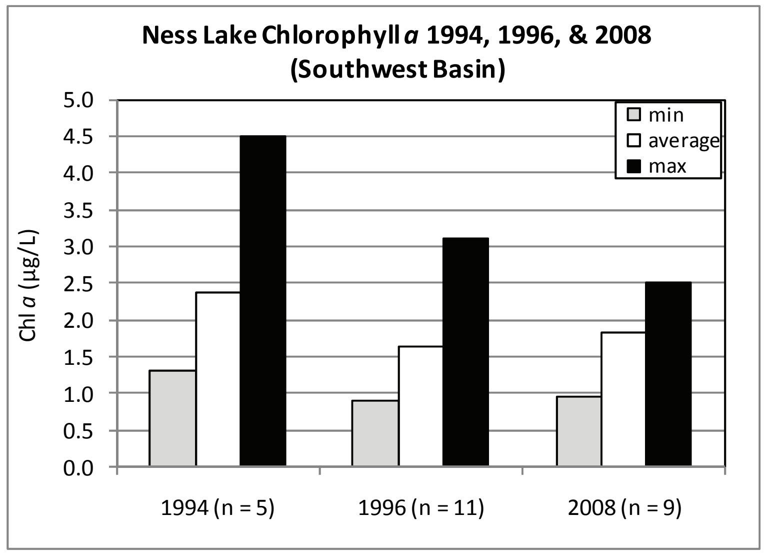
The Secchi Summary graph above shows the minimum, average and maximum Secchi readings for Ness Lake at the Central Basin from 1996 & 2008, as well as the number of readings in each year (n). The average Secchi depth measurement was 5.8 m in 1996 and 6.4 in 2008, suggesting oligotrophic conditions (>6 m). In the East Basin, average Secchi measurements were 6.2 m and 6.9 m in 1996 and 2008 respectively, also suggesting oligotrophic conditions. The Southwest Basin Secchi averages were lower at 4.0 m (1996) and 4.7 m (2008), suggesting mesotrophic conditions.

The 2008 Secchi graph for the East Basin, on the following page, shows the relationship between Secchi and chlorophyll *a* in Ness Lake. The 2008 Secchi depths for Ness Lake in the East Basin ranged from 4.9 m (May 28th) to 8.8 m (Aug. 6th).





The two graphs on the right show the average chlorophyll *a* readings from the Central Basin and the Southwest Basin in 1994, 1995 (Central Basin only) 1996 and 2008, and the number of readings (n). Average chlorophyll *a* values in the Central Basin were 1.7 µg/L, 1.4 µg/L, 1.5 µg/L and 1.2 µg/L in 1994, 1996, 1995 and 2008 respectively, suggesting oligotrophic conditions. Average chlorophyll *a* values in the East Basin were 1.8 µg/L, 1.7 µg/L, 1.2 µg/L and 1.2 µg/L in 1994, 1996, 1995 and 2008 respectively, also suggesting oligotrophic conditions. In the Southwest Basin, average chlorophyll *a* values were 2.4 µg/L, 1.7 µg/L, and 1.8 µg/L in 1994, 1996 and 2008 respectively, suggesting mesotrophic conditions in 1994 and oligotrophic conditions in 1996 and 2008.



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.

Ness Lake has not had a plant survey done, however *Isoetes l.* (lake quillwort) has been identified in the lake.

Aquatic plants play an important role in the lifecycles of aquatic insects, provide food and shelter from predators for young fish, and also provide 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 Ness Lake?

In the Central Basin, overturn TP appears to have increased substantially from the mid-1990s to 2008 however TP, Secchi and chl. *a* data indicates that the Central Basin is oligotrophic for all years. In the East Basin, overturn TP does not show an increase in 2008 relative to the mid-1990s, as the Central Basin does. Secchi and chl. *a* data suggest the East Basin was oligotrophic for all years, whereas TP indicates the East Basin was oligotrophic in 1994 and 1995 and slightly mesotrophic in 1996 and 2008. In the Southwest Basin, overturn TP appears to have increased substantially from the mid-1990s to 2008, and suggests oligotrophic conditions in 1994 and 1995, and slightly mesotrophic conditions in 2008. Secchi data indicates mesotrophic conditions and has decreased from a mean of 4.6 m in 1996 to 4.0 m in 2008. Chl. *a* suggests mesotrophic conditions in 1994 and oligotrophic conditions in 1995, 1996 and 2008. Three consecutive years of Secchi readings would allow for more meaningful interpretation of that data. If volunteers are willing, a minimum of 12 Secchi and surface temperature readings should be collected at regular intervals throughout the sampling season (from ice-off to ice-on). It may be useful to analyze a sediment core for long term cyanopigment and/or chironomid patterns in an attempt to better understand past trends in summer algal densities.

Following the completion of the 2009 and 2010 monitoring program, a recommendation can be made for future monitoring. Volunteers are also encouraged to record ice on/off dates as these are valuable for climate change studies.

Tips to Keep Ness 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. Eurasian milfoil is an aggressive invasive aquatic weed. Be sure to familiarize yourself with this plant and remove and discard any fragments.
- 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.

Photo by Kirsten Heslop

Photo by James Jacklin

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Land Use Map:
Sean Barry - Integrated Land Management Bureau (ILMB)

Bathymetric Map:
Fish Wizard

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