BC Volunteer Lake Monitoring Program

CLUCULZ LAKE 1999

The Importance of Cluculz Lake & its Watershed

British Columbians want lakes to provide good water quality, aesthetics and recreational opportunity. When we don't see these features in our local lakes, we want to know why not. Is water quality getting worse? Has the lake been polluted by land development? What uses can be made of the lake today? And, what conditions will result from more development within the watershed?

BC Environment's Volunteer Lake Monitoring Program (VLMP), in collaboration with the non-profit BC Lake Stewardship Society, is designed to help answer these questions. Through regular water sample collection, 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.

Through regular status reports, the VLMP 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, the VLMP allows government to use its limited resources efficiently thanks to the help of area volunteers and the BC Lake Stewardship Society.

Cluculz Lake's VLMP program began in 1994 and has been conducted by various members of the Cluculz Lake Community Association. This status report summarizes information derived from the 1994 to 1999 sampling programs. Monitoring was not carried out in 1997. 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. Cluculz Lake's watershed is shown on the next page.

Watersheds are where much of the never ending hydrological cycle takes place and play a crucial role in the purification of water. No "new" water is ever made - water is only cleansed through its continuous natural recycling in watersheds. 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. This is not true. 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. 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.

Cluculz Lake is located... in the Omineca-Peace region, just south of Highway 16 and 51 km west of Prince George, BC. It lies within the Nechako portion of the Fraser River drainage. This sizeable, deep lake is roughly 20 km long, with an average depth of 30 metres and a maximum depth of 61 m. The lake generally has a steep drop-off from shoreline, and has one main basin and three islands. Its surface area is 2520 hectares and it has a shoreline perimeter, including the three islands, of 53.1 km. Cluculz Lake contains the following sport fish: rainbow trout *(Oncorhynchus mykiss)*, lake char *(Salvelinus namaycush)*, dolly varden (*Salvenlinus malma)*, burbot (*Lota lota)*, kokanee (*Onconrbynchus nerka)*, and mountain whitefish *(Prosopium williamsoni)*.

Land use within the watershed includes lakeshore development, forestry and agriculture. There are 659 lakeshore lots, of which roughly 460 are known to have summer or permanent residences. Several privately owned resorts also exist. Approximately 140 residences are thought to use surface water as a potable supply. Both Prince George and Vanderhoof residents use the lake for general recreational purposes. The greatest challenge to the lake is likely the control of phosphorus (nutrient) loading which may be causing increased aquatic plant growth and the occasional outbreak of blue-green algae. Reports of aquatic plant infestations and algal blooms are fairly common within BC Environment files and the aquatic plant *Elodea canadensis* (canadian pondweed) has been identified as a problem species in the lake. Phosphorus loading may have promoted the summer *Aphanizomenon flos-aquae* algal bloom of 1997; unfortunately water quality data were not collected that year.

Cluculz Lake Watershed and Land Use Map

WATERSHED CHARACTERISTICS

Area: 629.96 km^2

Percent Land Usage:

1 % Residential (Developed)

21 % Forestry

4 % Agriculture

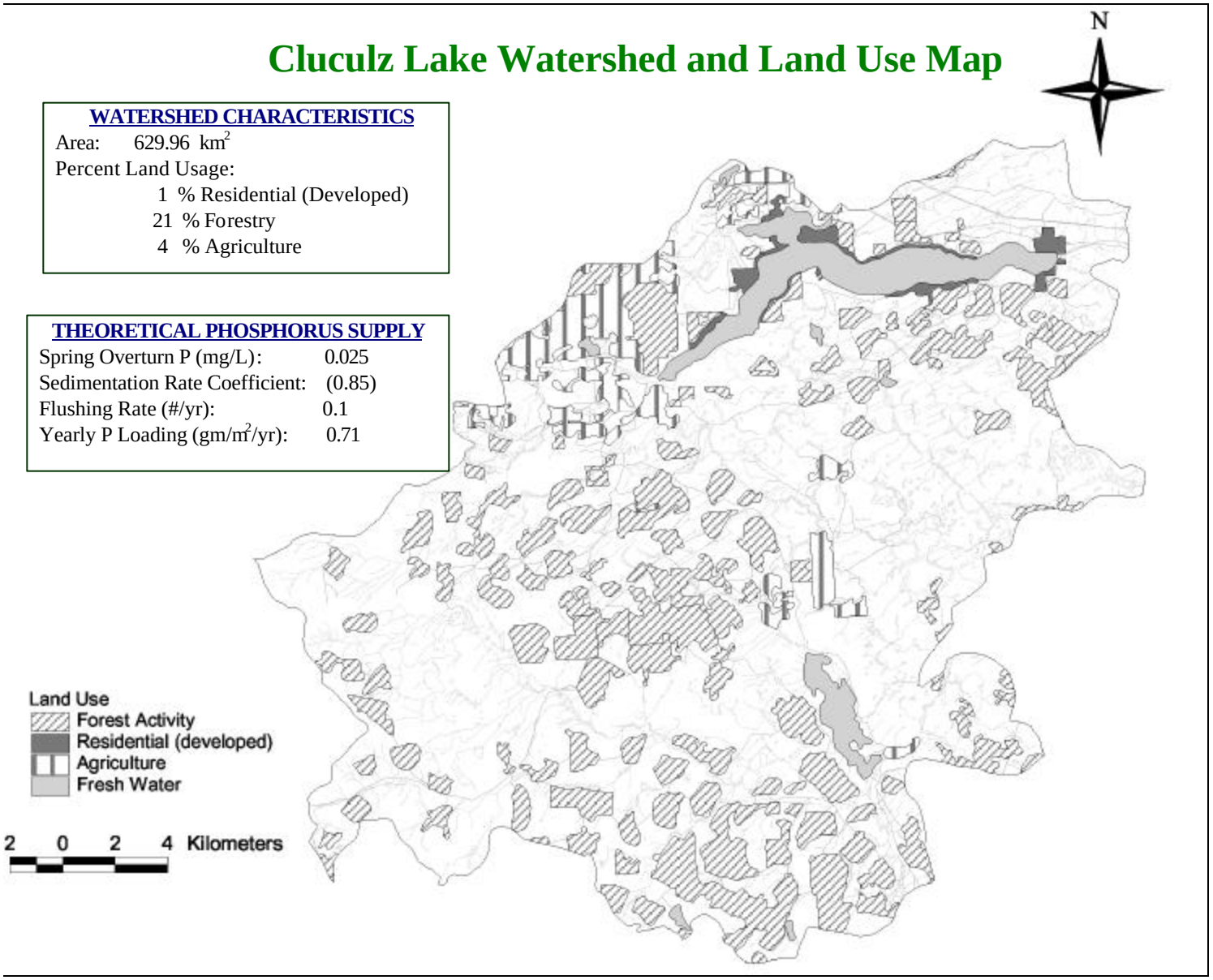
THEORETICAL PHOSPHORUS SUPPLY

Spring Overturn P (mg/L): 0.025

Sedimentation Rate Coefficient: (0.85)

Flushing Rate (#/yr): 0.1

Yearly P Loading ($gm/m^2/yr$): 0.71



Non Point Source Pollution and Cluculz Lake

Effluent outfalls are pollution sources that affect water quality from a known "point" location. However, other pollution sources exist over broader areas. These are called "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 is phosphorous loading to water bodies.

Stormwater Runoff

Fertilizers on lawns and gardens, sediment eroded from modified shorelines or infill projects, oil and fuel leaks from vehicles 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 rooting medium for aquatic weed and algae growth. Pavement prevents water infiltration to soils, collects hydrocarbon contaminants during dry weather and increases direct runoff of these contaminants to lakes during storm events.

Tree Harvesting

Harvesting can include clear cutting, road building and land disturbances that alter water flow and increase sediment and phosphorous inputs to 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 maintained pit privies, used for the disposal of human waste and grey water, can also be significant contributors.

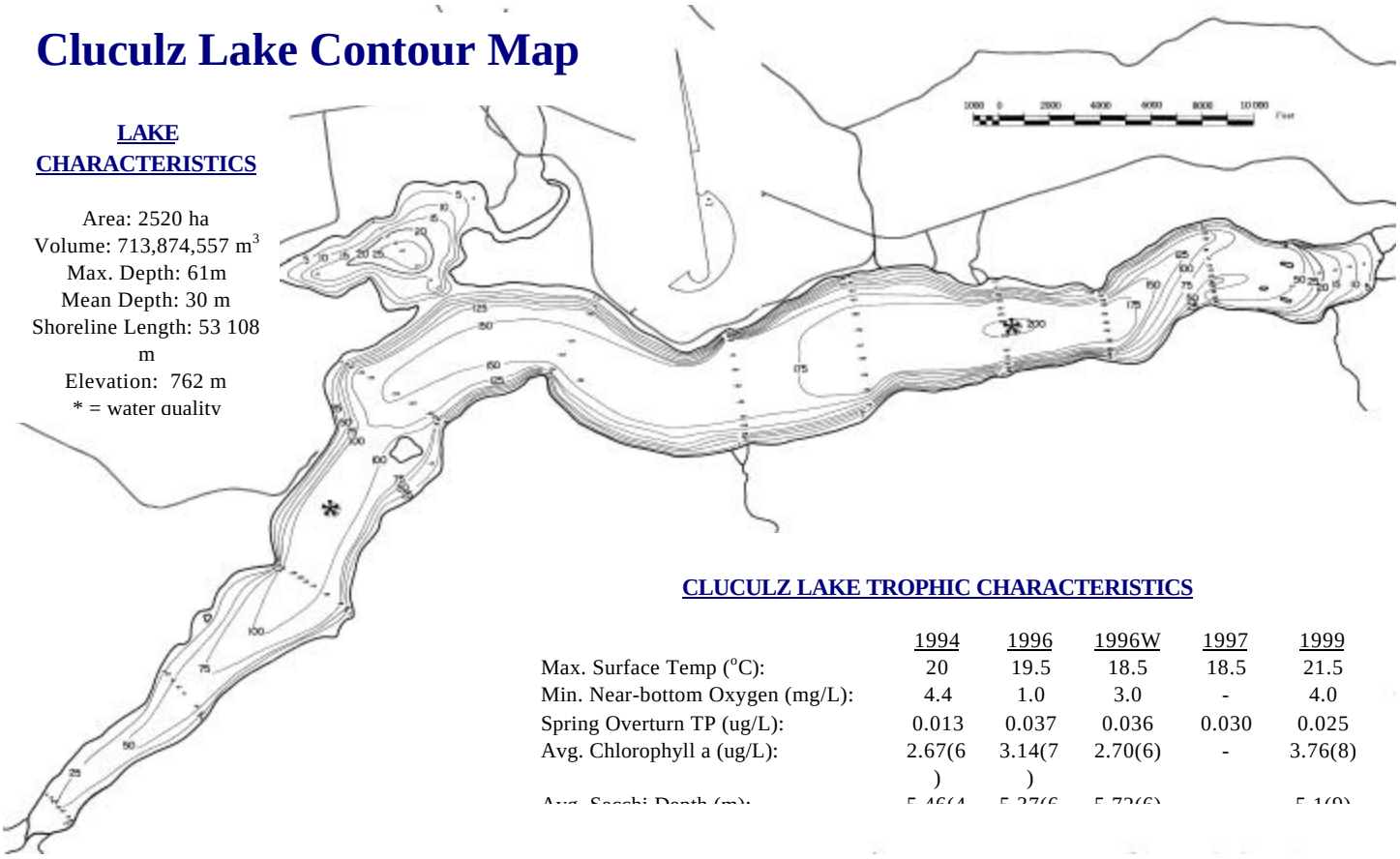
Agriculture

Agriculture is economically and culturally important. When these practices are poorly managed, however, significant NPS impacts to water can result, such as nutrient and pathogen introductions from manure and habitat damage from livestock access to shorelines.

Boating

Oil and fuel leaks are the main concerns from boat operation on small lakes. With larger boats, sewage and grey water discharges are an issue. Other problems include litter, the spread of aquatic plants and, in shallow water operation, the churning up of bottom sediment and nutrients.

Cluculz Lake Contour Map



LAKE CHARACTERISTICS

Area: 2520 ha
Volume: 713,874,557 m^3
Max. Depth: 61m
Mean Depth: 30 m
Shoreline Length: 53 108 m
Elevation: 762 m
* = water quality

CLUCULZ LAKE TROPHIC CHARACTERISTICS

	1994	1996	1996W	1997	1999
Max. Surface Temp (°C):	20	19.5	18.5	18.5	21.5
Min. Near-bottom Oxygen (mg/L):	4.4	1.0	3.0	-	4.0
Spring Overturn TP (ug/L):	0.013	0.037	0.036	0.030	0.025
Avg. Chlorophyll a (ug/L):	2.67(6)	3.14(7)	2.70(6)	-	3.76(8)
Avg. Secchi Depth (m):	5.46(4	5.27(6	5.72(6)		5.1(9)

What's Going on Inside Cluculz Lake?

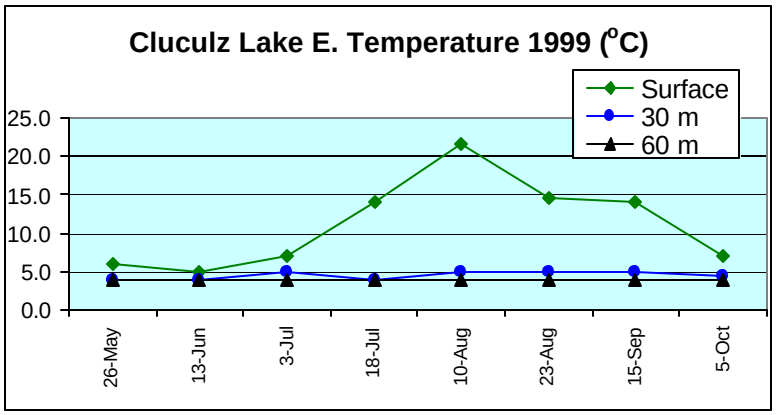
Temperature

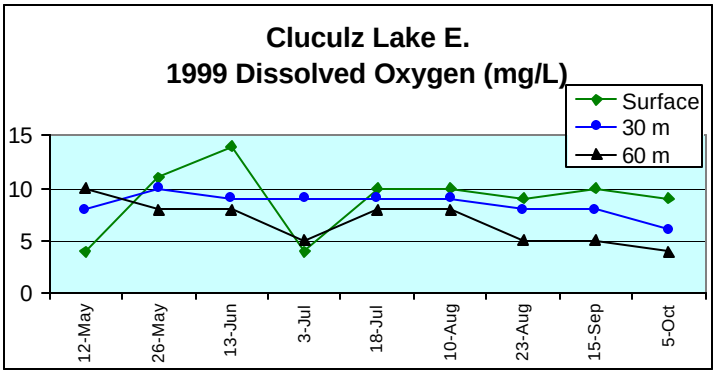
BC lakes can show a variety of annual temperature patterns based on each lake's location and depth. Most interior lakes form layers (stratify), with the coldest summer water near the bottom. Because this colder water is denser, it resists mixing into the warmer, upper layer for much of the summer. In spring and fall, these lakes usually mix from top to bottom 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 as they determine much of the seasonal oxygen, phosphorus and algal conditions. When abundant, algae can create problems for most lake users.

Cluculz Lake's west and east stations displayed similar temperature patterns from 1994 to1999. The diagram below indicates the patterns at various depths in the east station in 1999. Overturn occurred in early May and mixing continued throughout June. Surface waters warmed in July and a maximum surface temperature of 21.5 °C was measured in August. Due to lack of mixing below several meters depth, bottom and mid-depth temperatures were not significantly influenced by warm surface conditions and remained stable at roughly 4 °C. Cooling air temperatures and shortening daylight hours through September caused a loss of stratification, likely in mid October, leaving water temperature nearly uniform with depth.





Dissolved Oxygen

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

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more 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 the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 20% saturation). Fish kills occur when decomposing or respiring algae use up the oxygen. In summer, this can happen on clam nights after an algal bloom, but most fish kills occur during late winter or at initial spring mixing.

The above graph illustrates the oxygen pattern for 1999. Previous years have shown pattern variability and more sampling is required before conclusions are drawn. Surface oxygen was usually near saturation except for the occasional 4 mg/L levels, which are as yet unexplained. Cluculz Lake displayed slight declines in both bottom and mid-depth oxygen from August to October. Bottom oxygen levels between 4 and 8 mg/L would support fish life and would not facilitate phosphorus release from bottom sediments to overlying waters. Oxygen saturation should have been regained at all depths with overturn in October.

What's Going on Inside Cluculz Lake?

Trophic Status and Phosphorus

The term "trophic status" is used to describe a lake's level of productivity. Productivity is dependent on the amount of nutrients (phosphorus and nitrogen) that are essential 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, however, phosphorus accelerates growth and may artificially age a lake.

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. ***Secchi depth*** is water clarity measured using a ***Secchi disc***. Productivity is also determined by measuring nutrient levels and ***chlorophyll*** (the green photosynthetic pigment of algae). Spring overturn phosphorus concentrations in a lake drive and 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, sparse plant life, and low fish production. Lakes of high productivity are ***eutrophic***, that is, they have abundant plant life, including algae, because of higher nutrient levels. Lakes with an intermediate productivity are called ***mesotrophic*** and generally combine the qualities of oligotrophic and eutrophic lakes.

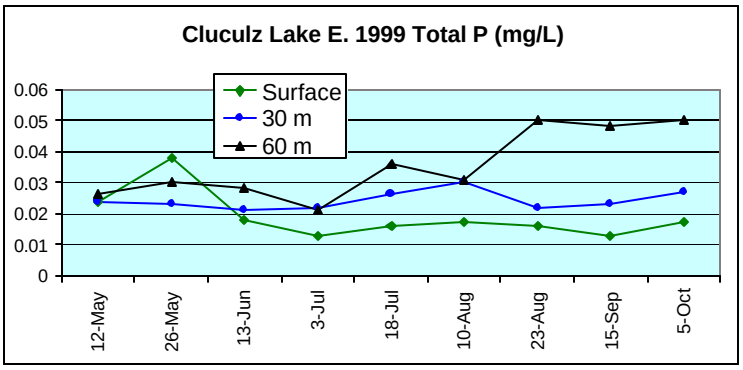
The amount of total phosphorus (TP) in a lake can be greatly influenced by human activities (see NPS section). If local soils and vegetation do not retain this phosphorus, it will enter watercourses where it will become available for algal production.

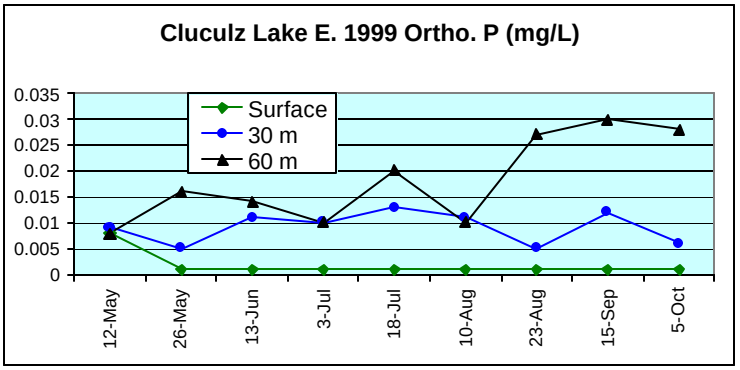
Lake sediments can themselves be a major source of phosphorus. If deep-water oxygen becomes depleted, a chemical shift occurs in bottom sediments. This shift causes sediment to both release phosphorus to overlying waters and to generate hydrogen sulphide (H_2S). This "internal loading" of phosphorus can be natural, but is often the result of phosphorus pollution. Lakes displaying internal loading have elevated algal levels and generally lack recreational appeal.

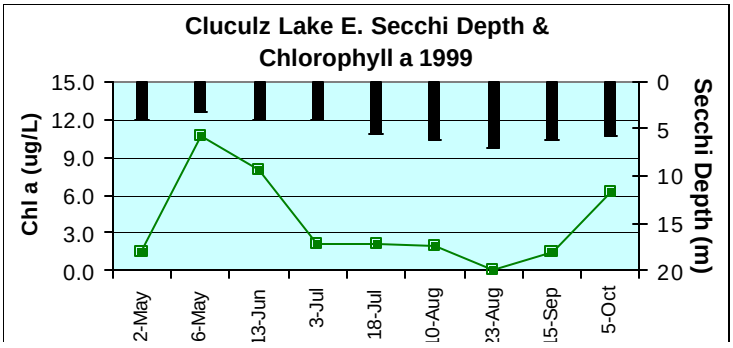
Cluculz Lake spring TP levels between 1983 and 1999 have varied considerably from 0.023 to 0.037 mg/L and in 1994 were as low as 0.013 mg/L. A clear yearly trend is not evident. This along with the oxygen data implies that Cluculz can have variable but generally reasonable water

The diagrams below display 1999 of total phosphorus cycling in Cluculz Lake. Summer total phosphorus ranged from 0.013 mg/L at surface to 0.050 mg/L near bottom. Through numerous years of sampling, the lake has shown no clear signs of internal phosphorus loading. Deep water orthophosphorus peaked at only 0.030 mg/L in September of 1999. Deep water oxygen levels of 4 mg/L and the lack of H_2S generation infer an absence of internal phosphorus loading. During the blue-green algae outbreak of 1997, phosphorus loading was not evaluated.

Chlorophyll and Secchi data generally mirror phosphorus results, showing no clear trend. Average summer algal chlorophyll ranged from 2.7 to 3.8 ug/L. Average Secchi depths showed low variability over the years. As per the diagram below, Cluculz Lake Secchi is a good indicator of chlorophyll concentration.







Problems and Solutions

Lake Coring; What does it Mean

The Cluculz Lake VLMP began well after local land development and its possible impacts started. So, although this program can document current water quality for future reference, it cannot reveal historical lake water quality. One might ask if Cluculz is polluted or just naturally green. This is the value of lake sediment coring. Cluculz Lake's deep station was cored by BC Environment in 1999. The 37 cm, 300 year core was analyzed by Dr. Brian Cummings of Queen's University.

By knowing the age of the various core sections and the phosphorus preference of specific diatoms, historical changes in phosphorus, chlorophyll, secchi and general lake quality can be estimated.

Analysis of the Cluculz Lake core determined that diatom algae species composition has only undergone minor changes over the last 300 years. The lake contains historically high concentrations of phosphorus, and recent changes are within the range observed over the core length.

Lakeshore Land Use Survey

In 1999, BC Environment commissioned a photo survey of lakeshore development practices that may impair Cluculz Lake water quality. The following table summarizes the findings, the related problems and their solutions. BC Environment will correspond directly with a number of property owners, requesting that alternatives designed to limit aquatic impairment be undertaken. **All residents should review their land use practices.**

LAND USE	IMPACT	ALTERNATIVE
Riparian Clearing (replacing natural vegetation within 15 m of the lake with grass) **48% Of Properties**	**Reduces terrestrial nutrient uptake leading to an increase in nutrient uptake by aquatic plants and algae. Fertilizers increase runoff of toxins and nutrients in turn, causing more aquatic plant and algal growth. Increases erosion and loss of bank stability. Disrupts fish habitat and production.**	**Practice strategic clearing for partial view and pathway to lakeshore, rather than "clean-sweep" approach. Leave patches or strips of native plants where possible and replant shoreline areas with native species such as alder, black cottonwood, willow and red-osier dogwood. Leave or add vegetation between septic fields or pit privies and the lakeshore to increase the uptake of nutrients before they reach the water. Disturbed areas within the riparian zone should be revegetated with the natural vegetation as soon as possible, and the use of fertilizers should be avoided or minimized.**
Cabin Encroachment (within 15 m of the lake) **6%**	**Increases the rate of erosion and nutrient loading. Reduces foreshore vegetation cover, which is detrimental to habitat conservation and water quality. The lakeshore view is often altered and undesirable for other lake users.**	**Wherever possible, lots should be clustered together in an area away from the shoreline to increase the amount of shoreline available for common use and for habitat conservation. Cabins should be placed as far from shore as possible allowing for maximum foreshore area and natural vegetation in turn, reducing the rate of erosion. During cabin construction, all debris should be kept away from the water and natural vegetation should be replanted as soon as possible.**
Breakwaters (Concrete, Cobble or Pressure treated wood) and Beach Creation **4%**	**Fill may erode and replace the natural lake substrate, creating a nutrient-rich environment for aquatic plants. It may act as a nutrient source to promote algal growth. Impacts fish habitat, migration and feeding.**	**Build a small dock for swimming and lake access. Use public beaches for swimming. Do not construct beaches or import fill with in 15 m of the shore. If adding fills outside the 15 m buffer, the fill should be low in phosphorus and should be placed in a manner which minimizes erosion. It is best to avoid fills and breakwaters whenever possible. Maintain natural soils and vegetation for soil stability and nutrient uptake.**
Metal Barrel Floats in Docks **3%**	**Metal drums may contain toxins and often rust and sink to the bottom causing unwanted debris.**	**Use plastic or styrofoam floats. All floats should be labeled with the owner's name, phone number and confirmation that they have been properly emptied and washed out.**

Recent VLMP and sediment coring results suggest that Cluculz Lake has a fair to good recreational water quality that may be in the very early stages of decline. Additional years of VLMP data are required to investigate any possible trend. Regardless, all residents and land developers within the watershed are advised to practice good land management such that nutrient or sediment addition to the lake and its tributaries are minimized. Refer to "Household Tips".

Household Tips to Keep Cluculz 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.
- Don't 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.

Agriculture

- Locate confined animal facilities away from waterbodies. Divert incoming and treat outgoing runoff 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, or 30 m of wells, or on land where runoff is likely to occur.
- Install barrier fencing to prevent livestock from grazing on streambanks.
- If livestock cross streams, provide gravelled 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.

Auto Maintenance

- Check your car's fuel, oil, brake, transmission, exhaust and cooling systems regularly. Fix leaks or other problems immediately.
- Use a dropcloth if you fix problems yourself.
- Recycle used motor oil, antifreeze, and batteries at collection centres.
- Use phosphate-free biodegradable products to clean your car. Wash your car over gravel or grassy areas, but not over sewage systems.

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 dishwasher only when full and use only low-flow showerheads and toilets.

Boating

- Do not throw trash overboard or use lakes or other waterbodies as toilets.
- Use biodegradable, phosphate-free cleaners instead of harmful chemical cleaners to clean the inside and outside of your boat.
- Conduct major maintenance chores on land.
- Keep motors well maintained and tuned to prevent fuel and lubricant leaks.
- Use 4 stroke engines, which are less polluting than 2 stroke engines, whenever possible. Use an electric motor where practical.
- Use absorbent bilge pads to soak up minor oil and fuel 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.
- Help educate fellow boaters.

Who to Contact for More Information

Ministry of Environment, Lands and Parks
Contact: Bruce Carmichael
Public Feedback Welcomed
3rd Floor, 1011-4th Ave
Prince George BC, V2L 3H9
Ph: 250-565-6455
e-mail: Bruce.Carmichael@gems9.gov.bc.ca

Cluculz Lake Water Quality Monitoring Volunteers
Contact: Tim Clark
Ph: 250-613-6803

Regional District of Bulkley Nechako
Contact: Mark Andison
492 W. Highway 16
Burns Lake BC
Ph: 250-692-3195
Fax: 250-692-3305

The BC Lake Stewardship Society
Contact: Michelle Boshard
Science Building, 3333 College Way
Kelowna BC, V1V 1V7
Ph: 1-877-BC-LAKES (or 250-868-1027)
Email: cwconsul@direct.ca

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