B.C. Volunteer Lake Monitoring Program

SWAN LAKE

(Peace Region)

2003-2005

The Importance of Swan 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. 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?

The Ministry of Environment's (MOE) Volunteer Lake Monitoring Program (VLMP), in collaboration with the non-profit B.C. Lake Stewardship Society, is designed to help answer these questions. Through regular water sample collections, we can come to understand a lake's current water quality, identify the preferred uses for a given lake, and monitor water quality changes resulting from land development within the lake's watershed.

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 B.C. Lake Stewardship Society.

Swan Lake's VLMP program began in 2003 and has been conducted by the dedicated Swan Lake Enhancement Society. This Society has been involved with numerous other projects in addition to this program, including riparian planting, cleaning and maintaining the lake weir and fish ladder, environmental education and fund raising. This status report summarizes information derived from the VLMP program. Quality of the data has been found to be acceptable and 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. Swan Lake's watershed is 574 km^2 and is shown on the next page.

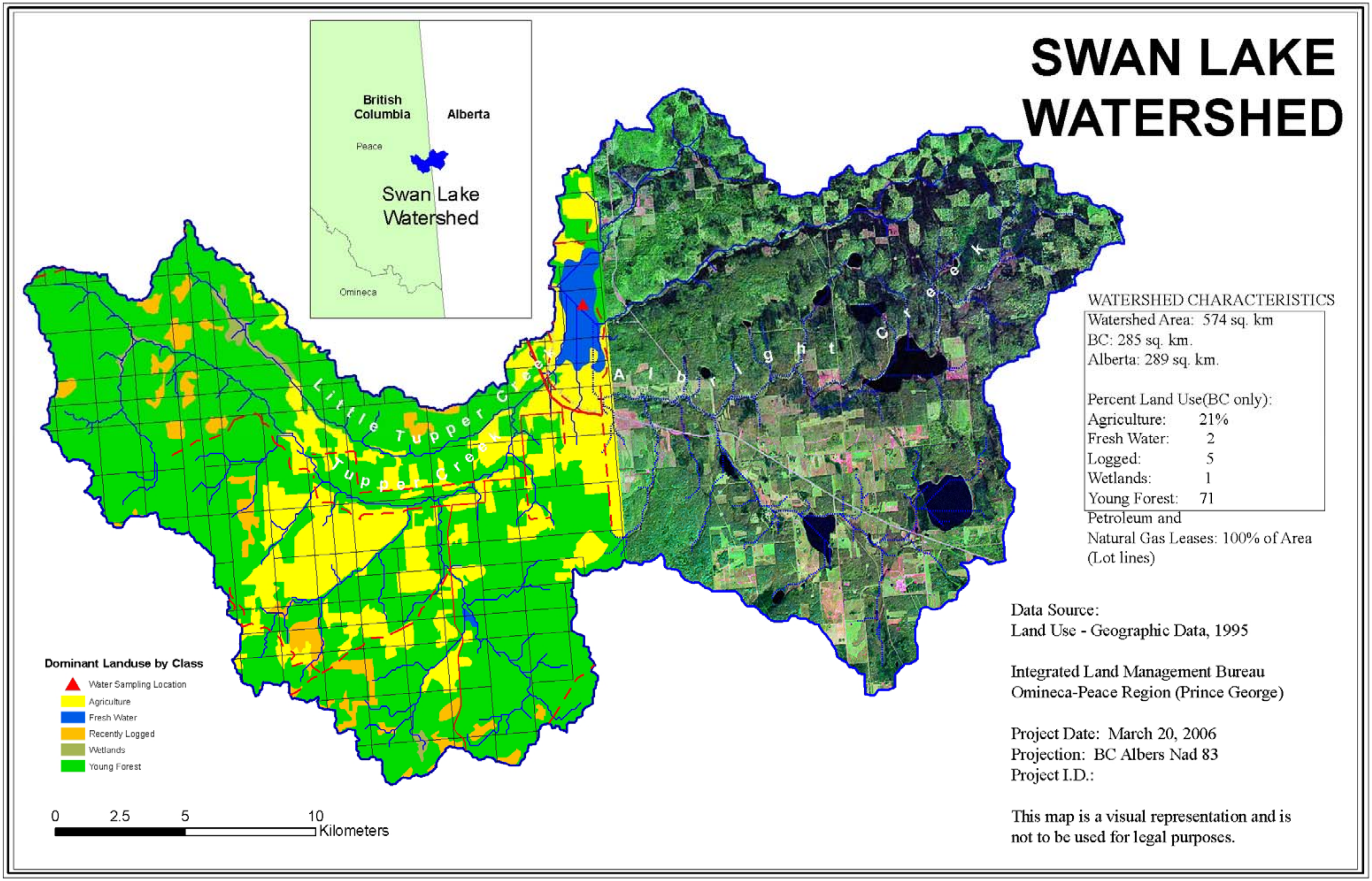
Watersheds are where much of the ongoing hydrological cycle takes place and play a crucial role in the purification of water. The quality of the water resource is largely determined by a watershed's capacity to buffer impacts and absorb pollution. This buffering capacity can be decreased by inappropriate land use activities.

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 down stream 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.

This study is one part of a broader water quality management program being carried out by the Environmental Quality Section in MOE's Omineca-Peace Region. The overall objectives of this program are to: monitor water quality, identify water quality problems, determine the causes, and work with local governments, landowners and other interested parties to improve or otherwise protect water quality and aquatic life.

The information gained through this study will be applied to the protection of water quality through various means, including education of property and land owners, development of watershed management plans, or the enforcement of provincial and local regulatory controls, where applicable.


SWAN LAKE WATERSHED
British Columbia
Alberta
Peace
Omineca
Swan Lake Watershed
Little Tupper Creek
Tupper Creek
Albright Creek
WATERSHED CHARACTERISTICS
Watershed Area: 574 sq. km
BC: 285 sq. km.
Alberta: 289 sq. km.
Percent Land Use(BC only):
Agriculture: 21%
Fresh Water: 2
Logged: 5
Wetlands: 1
Young Forest: 71
Petroleum and
Natural Gas Leases: 100% of Area
(Lot lines)
Data Source:
Land Use - Geographic Data, 1995
Integrated Land Management Bureau
Omineca-Peace Region (Prince George)
Project Date: March 20, 2006
Projection: BC Albers Nad 83
Project I.D.:
This map is a visual representation and is
not to be used for legal purposes.
Dominant Landuse by Class
Water Sampling Location
Agriculture
Fresh Water
Recently Logged
Wetlands
Young Forest
0
2.5
5
10
Kilometers

Swan Lake is located in the Peace region approximately 35km southeast of Dawson Creek, B.C. The lake is roughly 4.25km long with maximum and mean depths of 7.6m and 3.1m respectively. It has a surface area of 6.1km^2 and a shoreline perimeter of approximately 15km. Land use activities in the watershed include agriculture, range/grazing, oil and gas, forestry, recreation and residential development (page 2). Local residents indicated the main land use activity northeast of Swan Lake (Alberta) to be forestry, with agriculture to the southeast. The main inflowing tributaries to Swan Lake are Tupper Creek and Albright Creek (most of which is located in Alberta), which both enter at the lake's south end. Residents indicated this stream is very slow moving, due to an abundance of beaver dams and a constructed dyke. The Tupper Creek drainage has been described by residents as "flashy", having a low velocity during most of the year and a large discharge after heavy rain events and spring runoff. The outflowing tributary is the Tupper River, which drains from the northwest corner of the lake and is controlled by a weir.

Swan Lake contains the following sport fish: northern pike (*Esox lucius*), burbot (*Lota lota*), walleye (*Stizostedion vitreum*) and yellow perch (*Perca flavescens*). The only stocking that appears to have occurred was a 1984 walleye stocking/colonization program that consisted of transplanting 600 adult walleye from Charlie Lake near Fort St. John into Swan Lake.

Approximately 16% of Swan Lake's shoreline is currently developed. The lake has roughly 40 developed lots, with the south western shore having the highest density. While there are some permanent residences, most are summer cabins. There is also a Provincial Park on Swan Lake, which encompasses 0.67km^2 along the northwest shoreline. This park provides camping and picnicking sites, a swimming area, baseball diamonds, a playground and the only public parking and boat launch on the lake.

There is a long history of weed (*Myriophyllum)* and algal (*Aphanizomenon)* problems in Swan Lake, with Ministry files documenting complaints back to 1968. There were numerous studies undertaken to determine a viable option to deal with this problem, with a control weir at the Tupper River outlet being constructed in 1985. The effectiveness of the weir has been mixed and some residents have recommended a lake harvesting program be initiated.

The two main challenges for Swan Lake are likely the control of phosphorus (nutrient) and sediment loading. Phosphorus loading can promote summer algal blooms and the growth of dense macrophyte mats. There has been some sampling done on inflowing tributaries to Swan Lake, with Tupper Creek showing some external loading, especially during heavy rain events and spring runoff. However, as will be discussed on page 8, Swan Lake also appears to internally load phosphorus, which can be a major source of phosphorus during periods of bottom depth anoxia. The sediment loading is mainly probelematic after large rain events and spring runoff, which has lead to the infilling of the lake's southeast bay. This infilling also provides additional aquatic plant rooting habitat, possibly escalating the current weed problem.

Non-Point Source Pollution and Swan 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.

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 may 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

Lawn and garden fertilizer, 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 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.

Agriculture

Agriculture includes grain, livestock and mixed farming. These practices can alter water flow and increase sediment and chemical/bacterial/parasite inputs to water bodies.

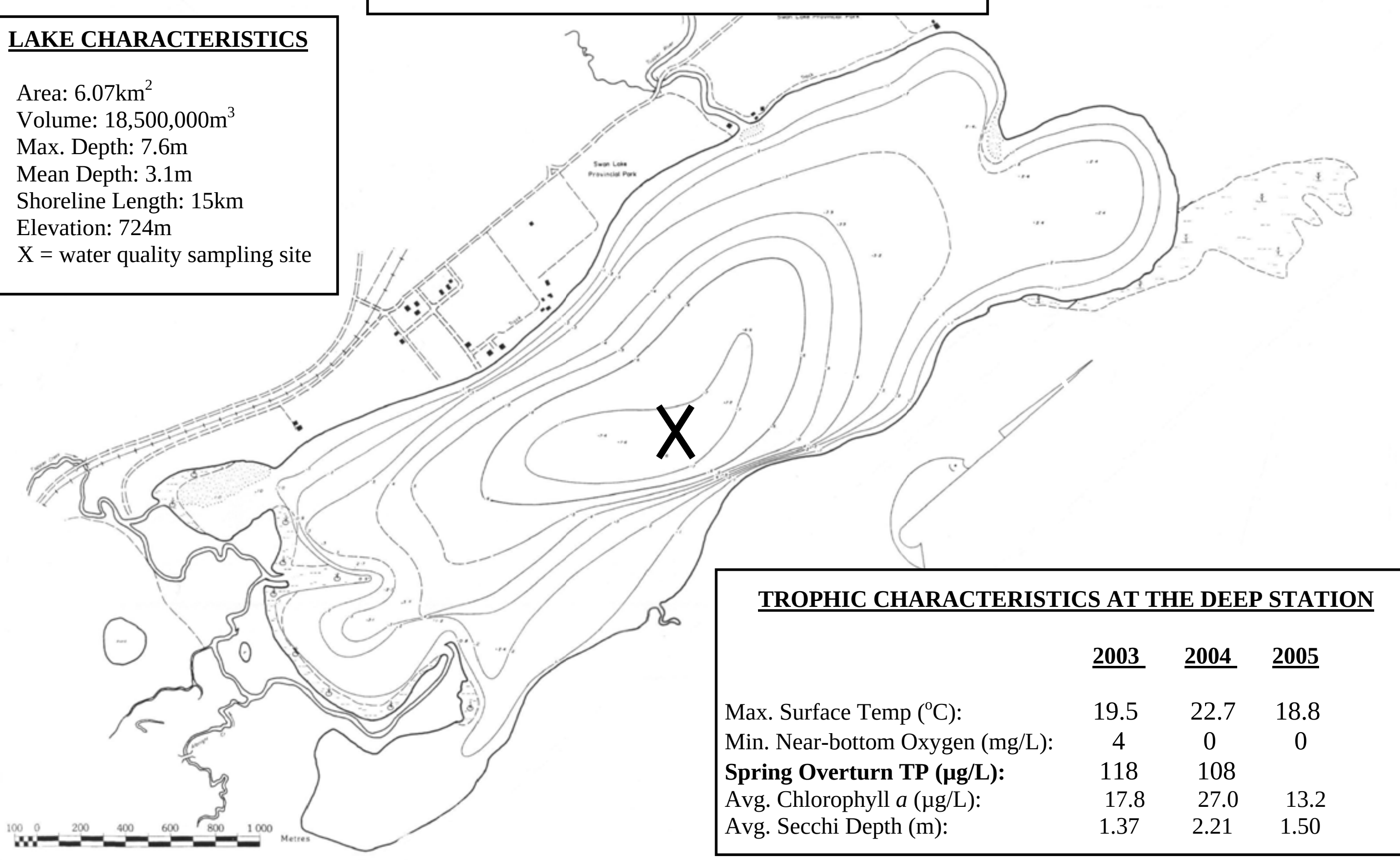
Boating

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

Swan Lake Bathymetric Map

LAKE CHARACTERISTICS

Area: 6.07km^2
Volume: 18,500,000m^3
Max. Depth: 7.6m
Mean Depth: 3.1m
Shoreline Length: 15km
Elevation: 724m
X = water quality sampling site



TROPHIC CHARACTERISTICS AT THE DEEP STATION

	2003	2004	2005
Max. Surface Temp (^oC):	19.5	22.7	18.8
Min. Near-bottom Oxygen (mg/L):	4	0	0
Spring Overturn TP (µg/L):	118	108	
Avg. Chlorophyll *a* (µg/L):	17.8	27.0	13.2
Avg. Secchi Depth (m):	1.37	2.21	1.50

What's Going on Inside Swan Lake?

Temperature

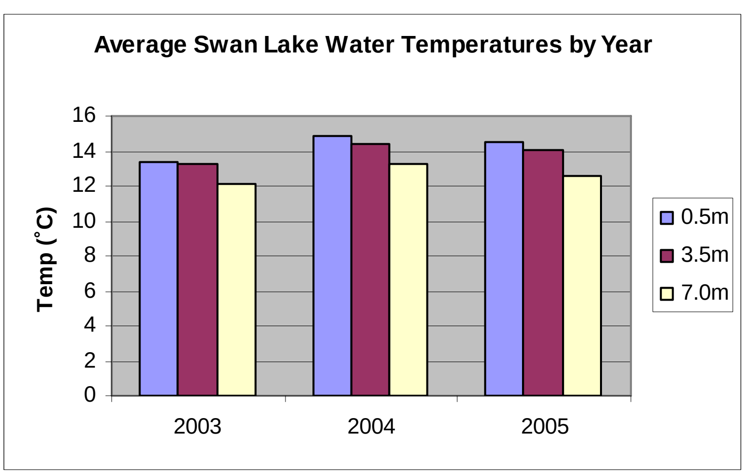
Lakes show a variety of annual temperature patterns based on each lake's location and depth. Most interior lakes form layers (stratify), with the coldest summer water near the bottom. Because cold water is more dense, it resists mixing into the warmer, upper layer for much of the summer. In spring and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

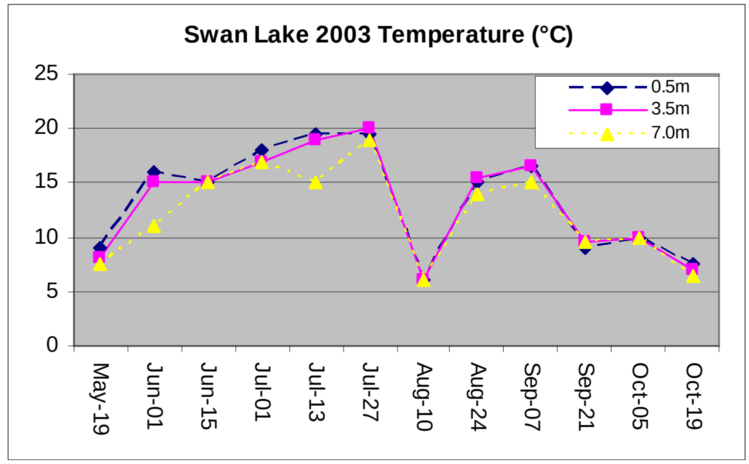
Lakes of only a few metres depth tend to mix throughout the summer or layer only temporarily, depending on wind conditions. In winter, the temperature pattern of these lakes is similar to that of deeper lakes.

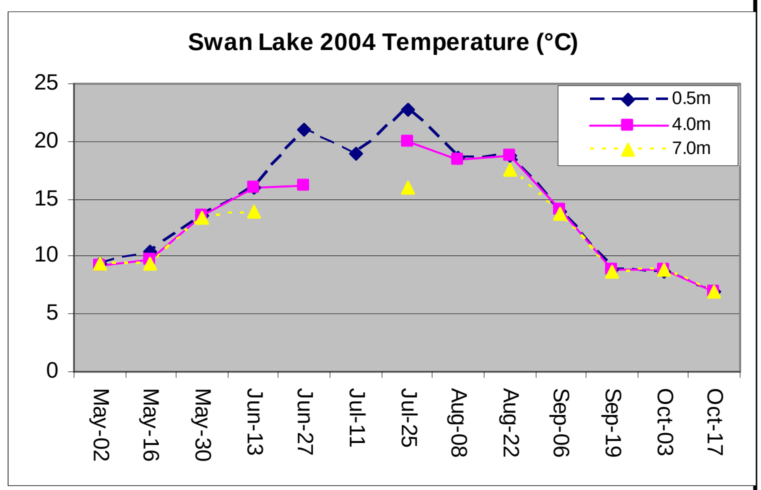
Temperature stratification patterns are very important to lake water quality. They determine much of the seasonal oxygen, phosphorus and algal conditions. When abundant, algae can create problems for most lake users.

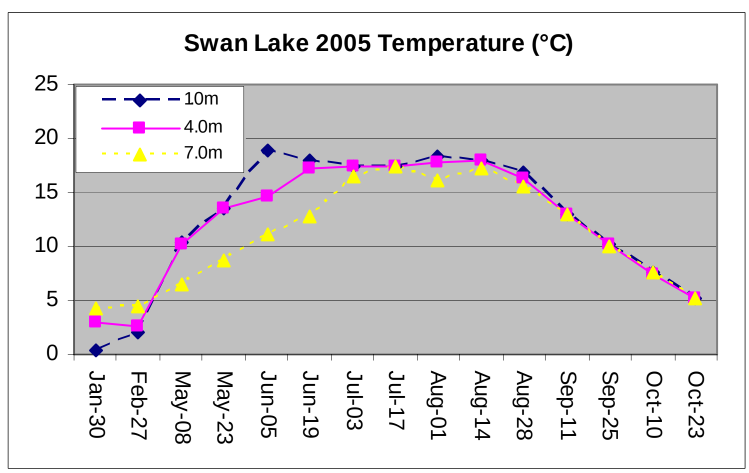
Temperature was measured at the Swan Lake deep station from 2003-2005. The figures on the next column illustrate profiles collected. All three years show the lake beginning to stratify in early/mid May. This stratification appears weak however and does not usually hold throughout the summer. Both 2003 and 2005 appear to lose the stratification in July, while the 2004 stratification appears to hold until late August. Swan Lake water temperature appears to be very sensitive to change in air temperature, evident by the August 10th, 2003 sample when both air (measured at the Provincial weather station in Dawson Creek) and water temperature dropped substantially. The multiple stratifications through the summer are likely due to the shallow depth and open surface of Swan Lake (thus being more susceptible to wind action and water turbulence), which can cause mixing of the stratified layers. Because of these multiple stratifications, the lake is termed polymictic.

Maximum surface water temperatures reached 20°C, 23°C and 19°C in 2003, 2004 and 2005 respectively. Summer average temperature showed 2004 to be the warmest at all three water depths, followed by 2005 and 2003.









What's Going on Inside Swan Lake?

Dissolved Oxygen

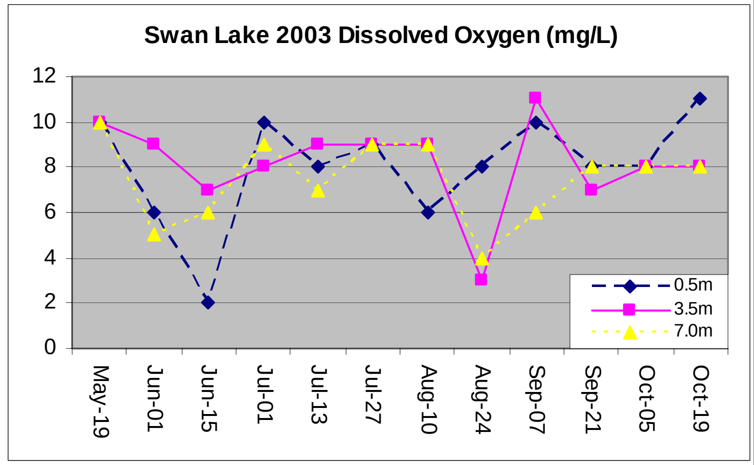
Oxygen is essential to life in lakes. It enters lake water from the air by wind action and plant photosynthesis. Oxygen is consumed by respiration of animals and plants, including the decomposition of dead organisms by bacteria. A great deal can be learned about the health of a lake by studying oxygen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

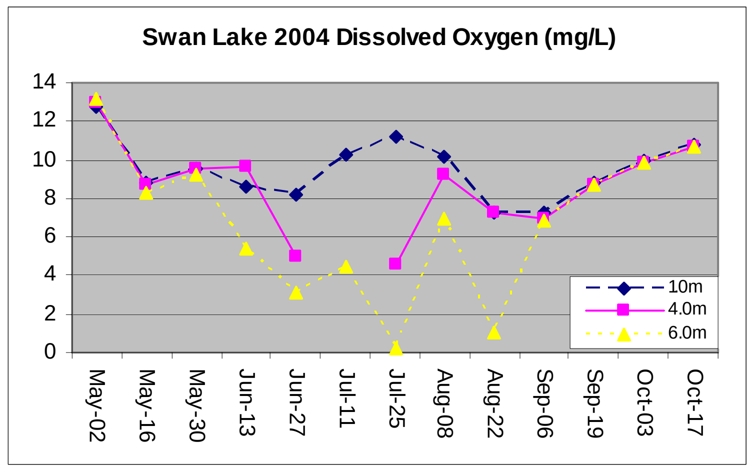
Lakes that are unproductive (oligotrophic) will have sufficient oxygen to support life at all depths through the year. But as lakes become more productive (mesotrophic-eutrophic), and increasing quantities of plants and animals respire and decay, more oxygen consumption occurs, especially near the bottom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

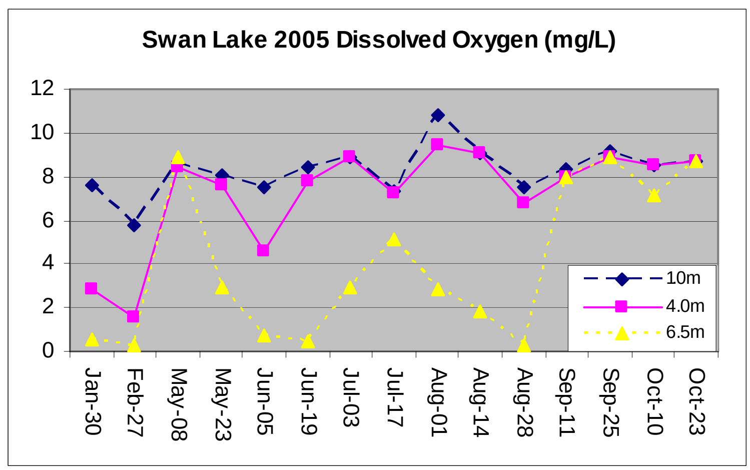
In productive lakes, oxygen in the isolated bottom layer may deplete rapidly (often to anoxia), forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 20% saturation). Fish kills can occur when decomposing or respiring algae use up the oxygen. In summer, this can happen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

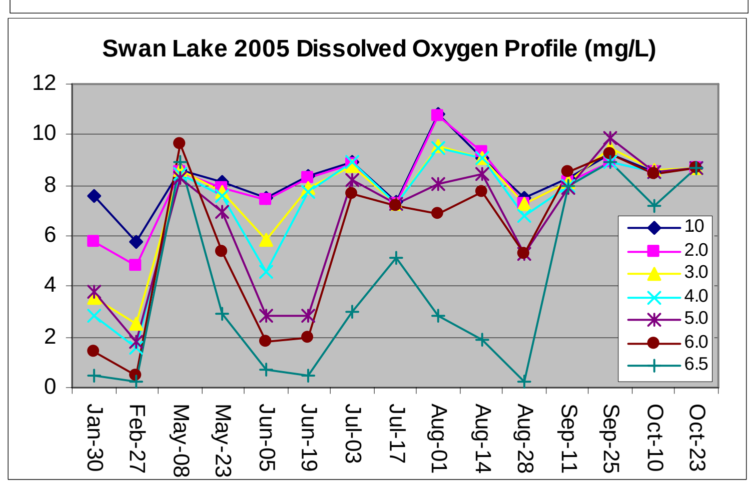
The figures on the next column display oxygen patterns for the Swan Lake deep station from 2003-2005 (dissolved oxygen was determined by the Winkler titration method in 2003 and by a meter in 2004 and 2005). Different patterns were observed in each year, probably attributable to the lakes high sensitivity to air temperature and ambient weather conditions. Generally, the surface level oxygen was near saturation in all three years, showing slight changes throughout the summer, possibly due to changes in temperature and algal densities. Bottom level oxygen in 2004 and 2005 fluctuated around anoxia, which occurred during periods of stratification. When the stratification was lost, oxygen levels increased. The bottom water oxygen depletion appears to occur rapidly in 2004 and 2005, probably due to bacterial decomposition of settled organic matter, which uses up oxygen. The water with less than 4mg/L oxygen (specifically the lake bottom during periods of stratification), would not have supported fish.

The last figure presented is the complete oxygen profile for 2005, with measurements taken at 1m intervals. A few interesting facts are of note, starting with the winter stratification observed on both the January and February dates. There are distinct layers present, with bottom level oxygen approaching anoxia. This stratification is broken in May with spring turnover, however is quickly re-established until September. Most of the lake does mix on July 17th, however the bottom layer doesn't appear to be fully oxygenated (the lake may have totally mixed between sample dates). Following this mixing event, the bottom layer is again depleted of oxygen, while the top 6m of the lake stay relatively close to saturation. The whole lake goes through a turnover event on September 11th, when all layers in the lake have a concentration of 8mg/L.









What's Going on Inside Swan Lake?

Trophic Status and Phosphorus

The term "trophic status" is used to describe a lake's level of productivity and depends on the amount of nutrient available for plant growth, including tiny floating algae called phytoplankton. Algae are important to the overall ecology of lakes 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 4), total phosphorus (TP) in a lake can be greatly influenced by human activities.

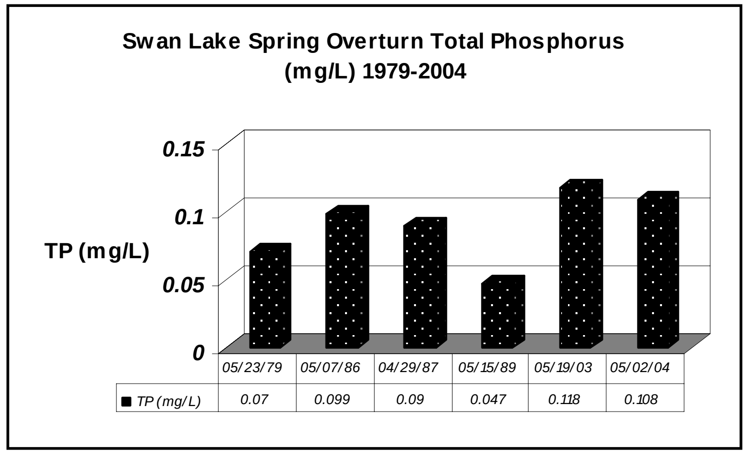
The trophic status of a lake can be determined by measuring productivity. The more productive a lake is the higher the algal growth and therefore the less clear the water becomes. Water clarity is measured using a ***Secchi disc***. Productivity is also determined by measuring nutrient levels and ***chlorophyll*** (the green photosynthetic pigment of algae). Phosphorus concentrations measured during spring overturn can be used to predict summer algae productivity.

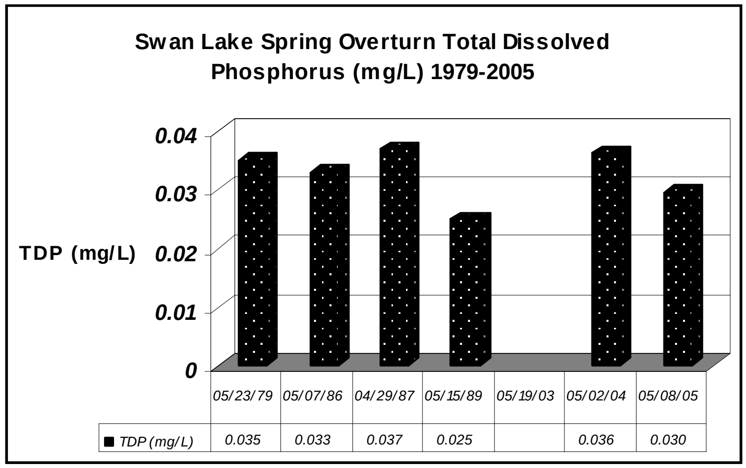
Lakes of low productivity are referred to as ***oligotrophic***, meaning they are typically clear water lakes with low nutrient levels (1-10 µg/L TP), sparse plant life (0-2 µg/L Chl. *a*), and low fish production. Lakes of high productivity are ***eutrophic***. They have abundant plant life (>7 µg/L 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 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.

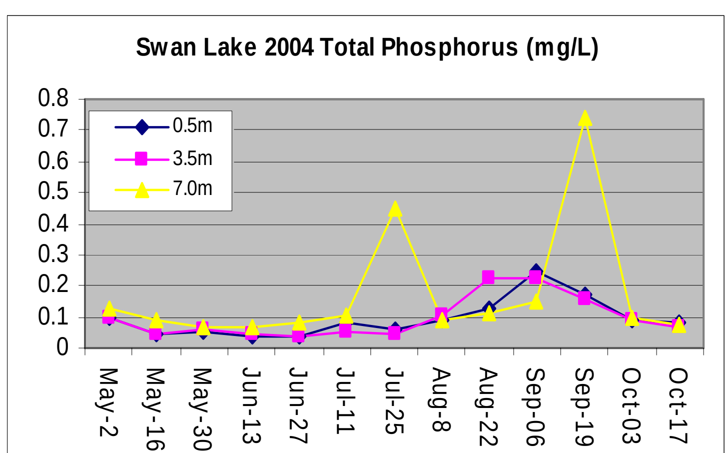
Swan Lake spring TP levels had some variability between 2003-2005, however all concentrations did indicate eutrophy. In fact, most samples collected between 1979 and 2004 showed eutrophy. As the first figure in the next column illustrates, spring TP concentrations have indicated a eutrophic condition on Swan Lake since first measured in 1979 (a clean spring sample was not collected in 2005). The variability that does exist may be due to several reasons such as extended periods of winter internal loading or changing phosphorus inputs from Tupper Creek during spring runoff. As seen in the TDP figure for the same time period, the dissolved phosphorus concentrations have been much less variable over the historical record. This suggests that most of the variability seen in the TP figure is due to particulate phosphorus.

Average total phosphorus values at the surface varied substantially between the three years in this program, with summer averages being 0.068mg/L, 0.093mg/L and 0.044mg/L in 2003-2005 respectively. Furthermore, bottom depth phosphorus values differed greatly, with normal steady conditions interrupted by large spikes in concentration. When comparing these lake TP spikes to the tributary data collected during the program (page 10), specifically from the Tupper Creek crossing at Highway #2 (which flows into the south end of the lake), there appears to be a correlation. Large

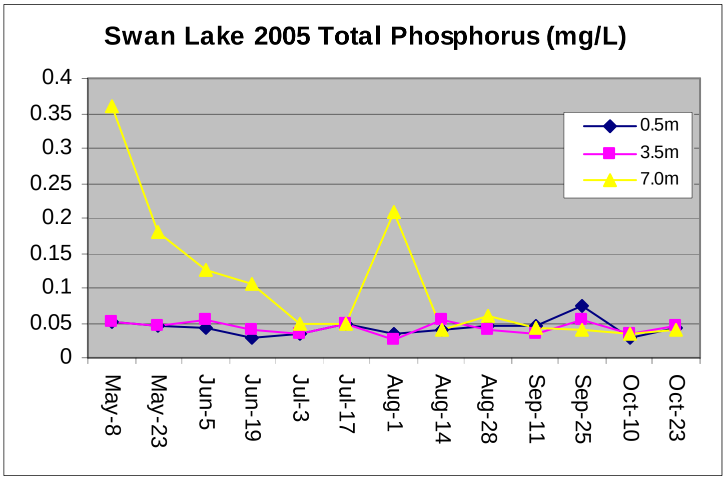




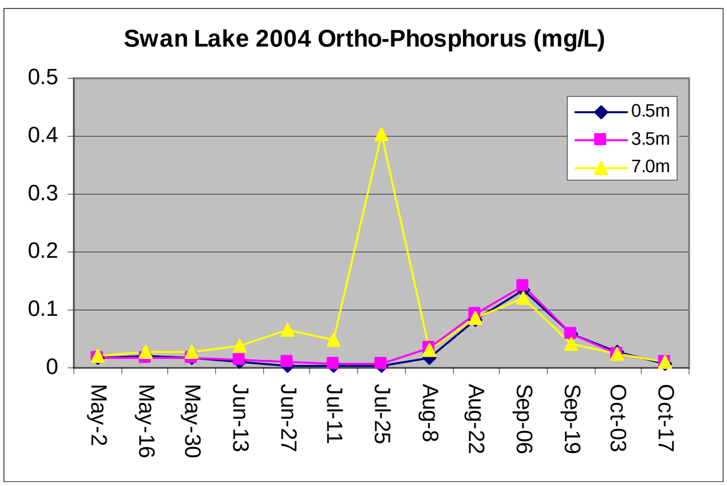
spikes in bottom depth TP observed in all three years are similar to spikes observed in the Tupper Creek TP levels. Furthermore, most of the spikes observed were preceded by either a large precipitation event or spring runoff. Because of this, these data tend to suggest external loading of TP, probably sediment bound (as seen in the turbidity data collected in 2005), from Tupper Creek. Ortho-phosphorus concentrations were found to be negligible, so the amount of immediately bio-available phosphorus was low. This is confirmed when looking at chlorophyll *a* data for the same time periods as the sediment/phosphorus spikes, which does not show any substantial increase in algae. Regardless, Swan Lake appears to be impacted, at least by sediment and TP, by Tupper Creek. More detailed sampling on Tupper Creek is recommended, as well as the collection of flow data, so that sediment/phosphorus loads, as well as sources can be identified. The use of automated turbidity samplers is one possibility.

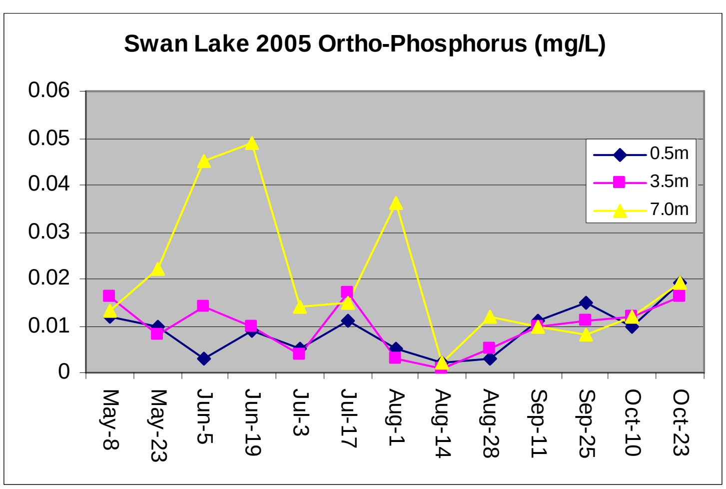


What's Going on Inside Swan Lake?



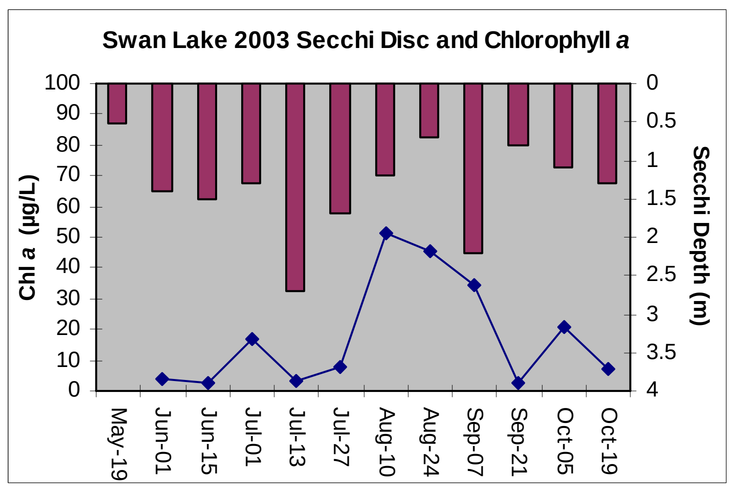
As displayed below in the lake ortho-phosphorus data, which is the phosphorus form available to biological organisms, there were large spikes in concentration during periods of low bottom depth oxygen, suggesting internal phosphorus loading. Although this does not occur frequently (due to the constant mixing of the water column), there are short periods during each of the three summers on record when dissolved oxygen concentrations were at anoxia (e.g. July 25th in 2004). This resulted in a bottom sediment chemical shift, releasing bio-available phosphorus to the lake. As seen in the chlorophyll *a* data, this released bio-available phosphorus resulted in algal blooms on numerous occasions. This suggests that Swan Lake is not only sensitive to external phosphorus loading from the watershed, but also to internal loading from the lake itself.

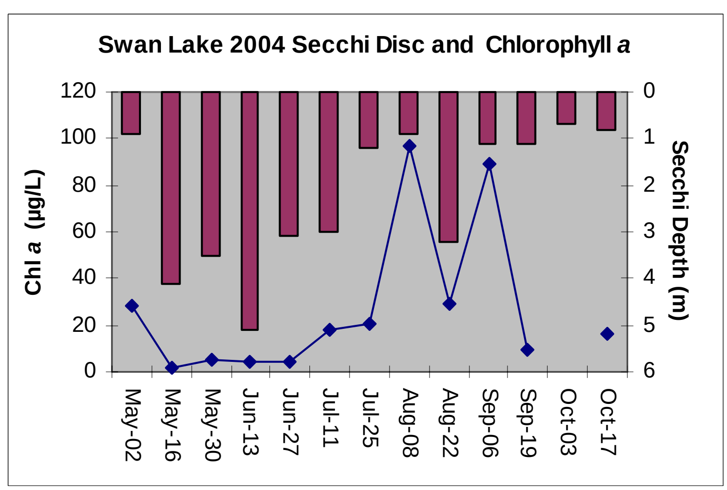




Chlorophyll *a* data, seen in the graphs below, show similar trends between 2003 and 2005, albeit different concentrations, with a three year summer average of 20.3µg/L. All three years show an initial algal bloom in the early spring (also refer to the Secchi data). This is probably due to the abundance of available nutrients and warmer temperatures after ice off and lake turnover. Productivity in the lake is low in winter because of the ice and snow cover, and these available nutrients are not used. When the lake opens up, warm water, high light levels and an abundance of ortho-phosphorus promotes algal growth. This initial bloom is then followed by a slow decline in algal levels, usually followed by another large, mid-summer bloom. Levels then decrease through the fall. The mid-summer bloom that usually occurs can be attributed to the release of bio-available phosphorus from bottom sediments during periods of hypolimnetic anoxia. The fall bloom, seen in each of the three years during October, can probably be attributable to the fall overturn event.

Water visibility, which is measured by Secchi disc (seen in the same figure), is used as an indicator for summer chlorophyll *a* concentrations. Secchi appeared to be a relatively good indicator of chlorophyll *a* during this program, with a three year average of 1.68m at the deep station, again suggesting eutrophy. However, there were some instances where a decrease in Secchi depth was observed when no increase in chlorophyll *a* was detected. This might be due to high inorganic sediment levels entering the lake from Tupper Creek. Overall, Secchi depth should be considered as a good alternative to chlorophyll *a* sampling if long term trends are to be established in Swan Lake.

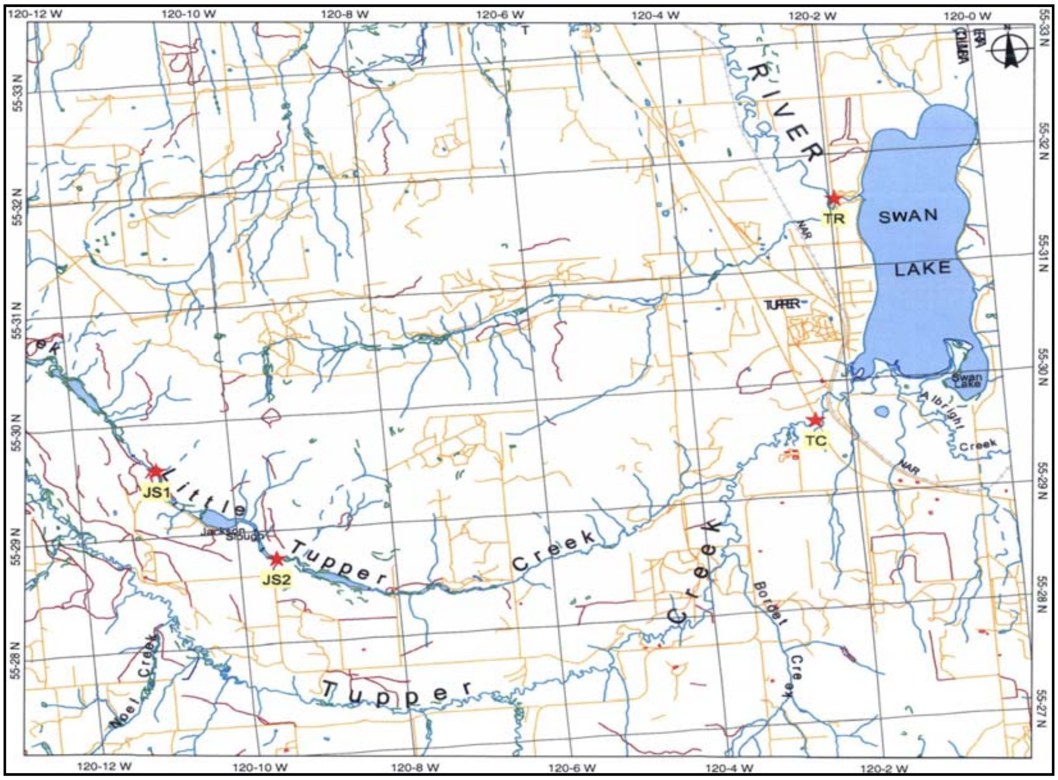




What's Entering Swan Lake?

Swan Lake tributary data was collected from 2003-2005, which included measurement of total phosphorus, total dissolved phosphorus, ortho-phosphorus and turbidity. This sampling was done at four locations: Tupper Creek upstream of Jackson Slough (JS1), Tupper Creek downstream of Jackson Slough (JS2), Tupper Creek at the Highway #2 crossing (TC) and Tupper River below the weir (TR). Refer to the map that shows the sampling locations.

Jackson Slough, a project of Ducks Unlimited Canada, was developed in 2002 to help create and preserve habitat for the many waterfowl, birds and wildlife in the area. The project consisted of installing a dam and weir to help manage water levels, 1500m of fencing to restrict livestock use of wetland edges, the creation of aerated dugouts as alternative water for livestock, the installation of duck boxes and floating nesting islands and working with local landowners.



Little Tupper Creek was sampled both upstream and downstream of Jackson Slough to try and evaluate the effectiveness of the slough as a sediment/phosphorus "sink". Ideally, if large amounts of sediment and phosphorus were to flow into the slough from Tupper Creek, they would settle out and be taken up by aquatic life before subsequently draining into Tupper Creek and Swan Lake. Results from the three year sampling program for TP, TDP and Ortho-P indicate a reduction in both particulate and dissolved phosphorus forms through Jackson Slough, suggesting two things are happening. The first being Jackson Slough is effectively settling out phosphorus bound particulates, and the second being biologically active orthophosphorus is being taken up by aquatic life before it leaves the slough. However, this is not being substantiated by the turbidity data collected in 2005, where the clarity of the water was actually better upstream than downstream. One possible explanation for this, given by the lake residents who collected the samples, is the abundance of beaver activity near JS2 that continuously stir up the water and sediment.

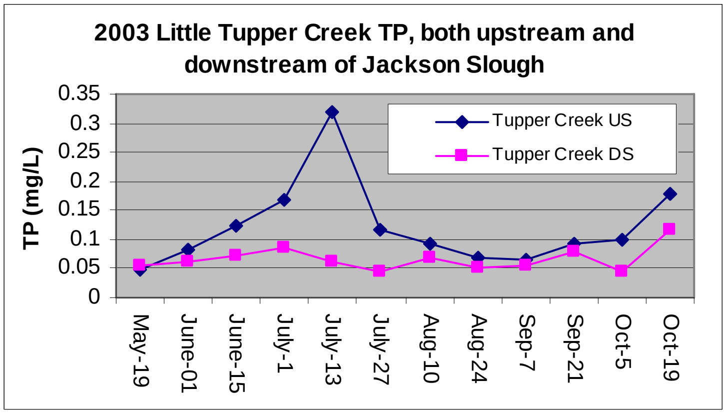
Tupper Creek was also sampled at the Highway #2 crossing (TC) to determine the impact of land use activity downstream of Jackson Slough (JS2), as well as the impact from the main Tupper Creek drainage. When the TP and turbidity data is compared between the two sites, it is apparent there is no impact during most of the year. However, there are instances in each of the three sample years, when there is a very large spike in TP and turbidity at the TC site that is not detected at JS2. Both 2003 and 2004 spikes can be related to heavy precipitation events that occurred prior to the sampling date, and the 2005 spike can be attributed to very warm temperatures in the spring, probably influencing spring runoff. Conversations with local residents did indicate that Tupper Creek is very flashy, and responds quickly to precipitation. As previously discussed, these large TP and turbidity spikes were also detected in the bottom waters at the deep station in Swan Lake. The exact source of the particulate and TP is unknown, however, the area between sites JS2 and TC, as well as the main Tupper Creek drainage, is dominated by agriculture, with some gas wells. The source of the turbidity and TP may be from a combination of sediment from natural and human induced stream erosion, bridge crossings and overland flow from agricultural fields.

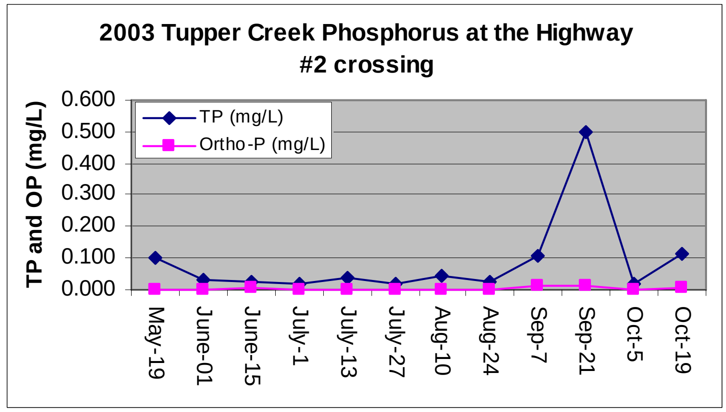
The data collected at the Tupper River site (TR), which is an outlet of Swan Lake, showed different concentrations during the sample years; however, did show a similar pattern. Although the data differed, TP concentrations found in the Tupper River appear to correlate to algal blooms (spikes in the chlorophyll *a* data) in Swan Lake. This is seen in both the 2003 and 2004 data, as only turbidity data were collected in 2005. The 2005 turbidity data does not correlate with the chlorophyll *a* or the Tupper Creek at Highway #2 turbidity data.

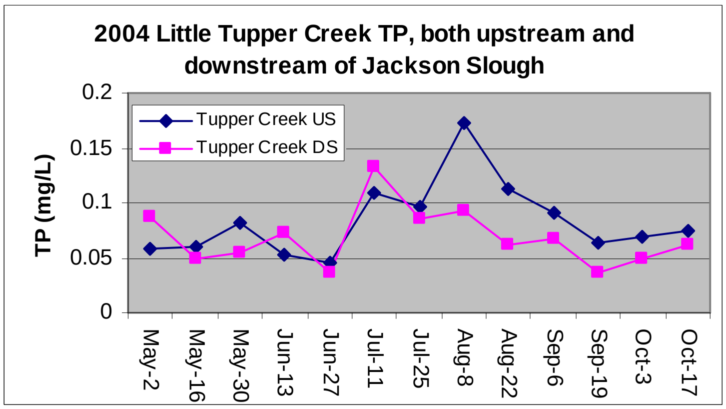
Overall, Jackson Slough appears to be very effective in reducing phosphorus levels from Little Tupper Creek. Total phosphorus is decreased substantially between the upstream and downstream sites.

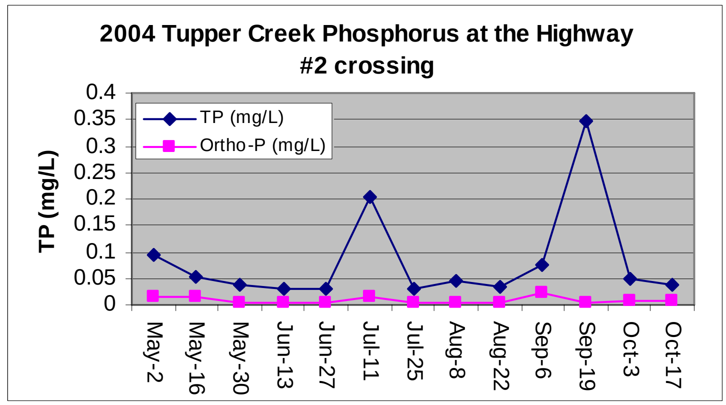
The three year dataset collected at site TC indicates that during spring runoff and large precipitation events there is a noticeable effect on Swan Lake. It is recommended that further sampling occurs throughout the main Tupper Creek drainage, as well as in Little Tupper Creek downstream of JS2, to try and identify where the inputs are originating. Once this is determined, proper management can occur.

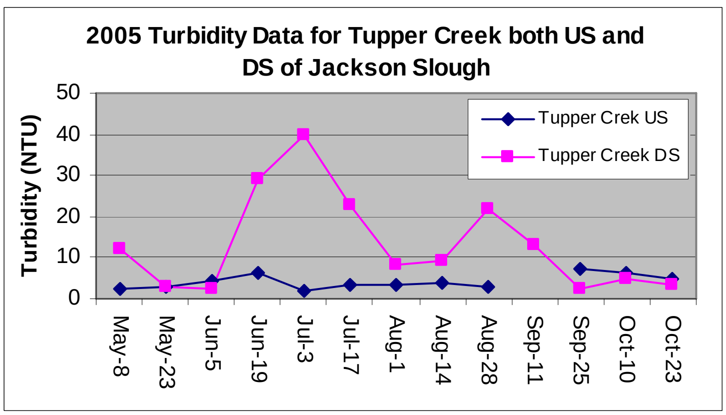
What's Entering Swan Lake?

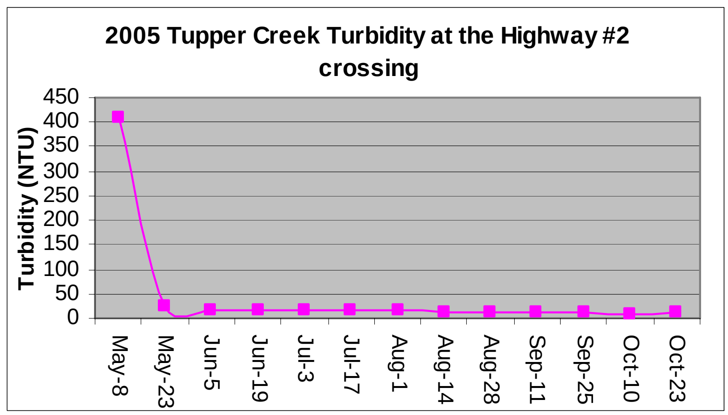


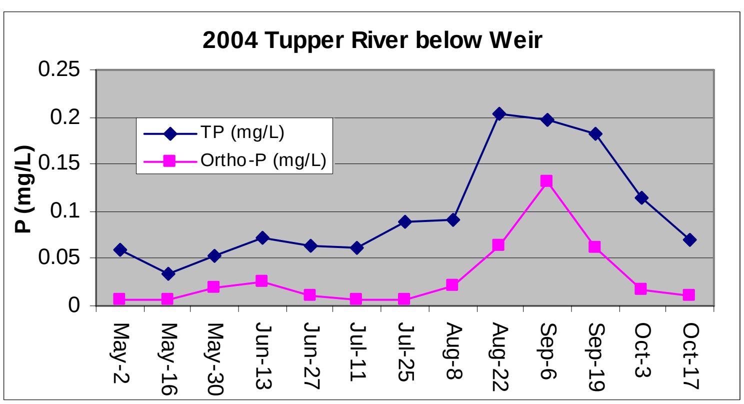












Swan Lake Lakeshore Survey Summary

Swan Lake's shoreline is approximately 16% developed, including a Provincial Park and 40 private lots. The private lots are concentrated on the south-western shore, and are both summer cabins and permanent residences. Future development on the lake appears imminent.

A lakeshore land-use survey was conducted on Swan Lake during the fall of 2005 by MOE. This survey was conducted using a motorized boat, with a photograph taken at each residence or developed area (a copy of the full lakeshore survey report is available on request). Notes were taken regarding riparian buffer classification, encroachment of buildings and livestock, visible erosion and questionable land-use practices.

Shoreline Survey Results	Number of Residences	% of Total
Total number of residences	40	100
Encroaching[1] outhouse	0	0
Encroaching house	1	2.5
Encroaching cattle pasture	1	2.5
Complete riparian[2] buffer	1	2.5
High riparian buffer	5	12.5
Moderate riparian buffer	7	17.5
Low riparian buffer	16	40
No riparian buffer	11	27.5
Private boat launches	5	12.5
Visible shoreline erosion	21	52.5
Retaining walls\breakwaters	4	10
Treated wood structures	0	0
Imported material on shore (grave/sand)	1	2.5
Large effluent-type pipes	0	0

[1]According to the Peace River Regional District, encroaching is defined as less than 15m (house), 30m (outhouse) and 15m (livestock).
[2]Refer to the Swan Lake Shoreline Survey (2005) for a definition of the buffer classification system.

As seen in the above table, there were very few encroaching properties on Swan Lake. Only 2.5% of houses were encroaching, compared to 9% - 22%, the range for the other lakes surveyed in the Omineca-Peace region. However, the encroaching livestock was evident on the northern tip of the lake, where a trampled shoreline and very little vegetation was observed. Furthermore, reports from local residents suggest that cattle wade in the lake during the hot summer months.

Approximately 67.5% of Swan Lake residents had low or no riparian buffers along the shoreline. The damage done by this extensive vegetation removal was evident in the high level of shoreline erosion. The amount of erosion varied, largely dependant on the condition of the riparian buffer, the slope of the property and the use of breakwaters.

Breakwaters were installed at approximately 10% of the residences, all having moderate or low riparian buffers. Although these breakwaters are useful in preventing erosion where they are installed, they can often deflect currents to adjacent lots increasing erosion there. Furthermore, these unnatural breakwaters can destroy or damage fish and wildlife habitat, compared to the more natural approach of vegetated riparian buffers.

Overall, the shoreline of Swan Lake is in relatively good condition given the lack of riparian areas; however, with future development expected the current state of residential riparian areas and livestock grazing need to be addressed in order to protect water quality and habitat values. For a detailed summary of the lakeshore survey, please phone or email the MOE or PRRD contacts provided on page 14.

Historical Look at Swan Lake

Lake Coring; What does it Mean?

The Swan Lake VLMP was initiated well after local land development and possible impacts to the lake began. So, although this monitoring program can accurately document current lake quality, it cannot reveal historical "baseline" conditions or long term water quality trends. Here lies the value in coring lake sediments. Past changes in water quality can be inferred by studying the annual deposition of algal cells (in this case diatoms) on the lake bottom.

Swan Lake's basin was cored and sectioned by the Ministry in 2004. The 32cm core, which represents sedimentation over the last 150 years, was analysed by Dr. Brian Cummings of Queen's University. His report is available on request.

Dating processes (a lead 210 profile) indicated the Swan Lake core was of good quality and would provide reliable records of environmental history over the past 150 years. However, after the core was sectioned and prepared for diatom analysis, it was found that no diatoms were preserved in the core. According to Dr. Cummings this has occurred on occasion in other British Columbia lakes. The lack of diatoms was explained on other lakes chemically, typically by high concentrations of sodium carbonate. Unfortunately, sodium carbonate was not a parameter included during this study.

There is still some useful information that can be taken from this analysis. Sedimentation rates determined by the core indicated high rates of deposition since 1940 (approximately 20cm at the deep station), with the highest accumulations occurring around 1997 to 1999. According to local residents, the opening and clearing of land for agricultural purposes was initiated in the Swan Lake basin during the 20s, 30s and 40s, which may be the reason for the initial sedimentation increase. The high sediment loads between 1997 and 1999 are probably the result of heavy precipitation, combined with poor land use activities in the area (the Tupper Creek drainage). According to data collected from Provincial rain gauges near Swan Lake, there were some very large precipitation events during this three year period.

Analysis of organic matter from the core indicated highly inorganic sediments, with organic matter only comprising 9-13%. There was a small and steady increase in percent organics from around 1920 until 1960, and then decreasing steadily until 1997. Small increases have occurred from 1997 until 2004. Increases in organic matter can be attributed to several factors including increased in-lake production of organic matter, increased inputs of organic matter from tributaries and decreased inputs of inorganic matter.

SUMMARY

Recent VLMP water quality results suggest that Swan Lake is eutrophic, which agrees with the historical MOE water quality record (page 7). From the 2003-2005 data, there appears to be phosphorus loading from both external and internal sources. More specifically, the Tupper Creek drainage appears to be a large source of TP during heavy rain events and spring runoff, which can be seen in the TP data collected at the lake's deep station. Further sampling throughout the watershed, specifically the Tupper Creek drainage, is recommended to try and identify where the phosphorus and sediment are originating so that proper management activities can occur. Furthermore, future developers in the area need to be aware of the sensitivity of Swan Lake to activities throughout the watershed, and how those activities can degrade the water quality if proper management is not undertaken. The results of the 2005 shoreline survey also indicated that many residents who either live or have summer cabins on the lake have little or no riparian buffers. It is recommended that these residents plant vegetation along their shorelines, which will help to control erosion, provide fish and waterfowl habitat and be more aesthetically pleasing. Regardless, all residents and land developers within the watershed are encouraged to practice good land management such that nutrient and/or sediment addition to the lake and its tributaries is minimized.

Household Tips to Keep Swan 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 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 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, 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.

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 4 stroke engines, which are less polluting than 2 stroke engines, whenever possible. Use an electric motor where practical.
- Keep motors well maintained and tuned to prevent fuel and lubricant leaks.
- 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.
- 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

Public Feedback Welcomed

Ministry of Environment
Contact: Bruce Carmichael or James Jacklin
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Prince George, BC, V2L 3H9
Ph: (250)-565-6455 or (250)-565-4403
Email: Bruce.Carmichael@gov.bc.ca
James.Jacklin@gov.bc.ca

Swan Lake Enhancement Society
Contact: Janet Stevens
Ph: (250)-786-0115

Peace River Regional District
Contact: Bruce Simard,
Manager of Developmental Services
P.O. Box 810
Dawson Creek, BC, V1G 4H8
Ph: 1-800-670-7773
Email: bsimard@pris.bc.ca

The B.C. Lake Stewardship Society
Contact:
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Kelowna, BC, V1Y 4Z4
Ph: 1-877-BC-LAKES
Email: BCLSS@hotmail.com
Website: www.bclss.org

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