ENVIRONMENTAL PROTECTION DIVISION

ENVIRONMENTAL SUSTAINABILITY AND

STRATEGIC POLICY DIVISION

MINISTRY OF ENVIRONMENT

WATER QUALITY ASSESSMENT AND OBJECTIVES FOR CUSHEON LAKE, MAXWELL LAKE, ST. MARY LAKE AND WESTON LAKE: SALT SPRING ISLAND, B.C.

TECHNICAL REPORT

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EXECUTIVE SUMMARY

This document presents a summary of the ambient water quality of Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake: Salt Spring Island, British Columbia, and proposes water quality objectives designed to protect existing and future water uses. The water quality assessment for the lake and an evaluation of the watershed form the basis for the objectives.

Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake are the four largest lakes on Salt Spring Island, BC. The majority of people on the island rely on surface waters as the source of their drinking water, and the four lakes covered in the report supply drinking water to the two largest towns on Salt Spring Island (Ganges and Fulford Village), as well as to local waterworks authorities and individual licensees. Excess nutrients in the lakes result in algal blooms and low dissolved oxygen levels that in turn affect drinking water quality and aquatic life survival. Households within the watersheds contribute some nutrients, while other activities that potentially impact water quality include recreation, agriculture, erosion and the presence of wildlife.

Water quality monitoring was conducted between the 1970s and 2007. The results of this monitoring indicated that the lakes are mesotrophic and the overall state of the water quality is moderate. All chemical, physical and biological parameters met provincial water quality guidelines with the exception of temperature, dissolved oxygen, total phosphorous, turbidity, pH, true colour, and TOC. In order to maintain and protect the water quality in the lakes, ambient water quality objectives were set for temperature, dissolved oxygen, secchi depth, total phosphorous, total ammonia, N:P ratio, turbidity, true colour, TOC, phytoplankton and chlorophyll *a*.

Future monitoring recommendations include attainment monitoring at all four lakes, every 3-5 years, depending on available resources and whether activities, such as development, are underway within the watershed. This monitoring should be conducted for one year on a quarterly basis at the deep station sites. Vancouver Island Health Authority's beach monitoring program should be expanded to include five weekly samples in a 30 day period during the summer low at bathing beaches.

Water Quality Objectives for Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake: Salt Spring Island

Variable	Objective Value	Lakes that Guideline Applies To:
Temperature	≤ 15°C summer maximum hypolimnetic temperature (<6m depth)	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Dissolved oxygen	≥ 8 mg/L for depth ≤ 19°C and 3 m deeper	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Dissolved oxygen	≥2 mg/L above bottom sediments	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Secchi depth	≥3m annual average	Cusheon Lake, St. Mary Lake, Weston Lake
Secchi depth	≥4m annual average	Maxwell Lake
Total phosphorus	13.5 µg/L max during spring and fall turnover	Cusheon Lake, St. Mary Lake, Weston Lake
Total phosphorus	10 µg/L max during spring and fall turnover	Maxwell Lake
Total ammonia	Average concentration ≤ 1.8 mg/L	St. Mary Lake and Weston Lake
N:P ratio	≥ 15:1	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Turbidity	2.0 NTU max, 95th percentile ≤1 NTU	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
True colour	15 TCU max	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
TOC	6.0 mg/L average	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Phytoplankton	≤ 50% cyanobacteria (measured by cells/mL) in phytoplankton sample	Cusheon Lake, St. Mary Lake, Weston Lake
Chlorophyll *a*	2 µg/L to 7 µg/L average	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake

Designated water uses: drinking water, aquatic life, irrigation, and wildlife

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1.0 INTRODUCTION

The British Columbia (BC) Ministry of Environment (MOE) is conducting a program to assess water quality in priority watersheds. The purpose of this program is to accumulate the baseline data necessary to assess both the current state of water quality and long-term trends, and to establish ambient water quality objectives on a watershed specific basis. Water quality objectives provide goals that need to be met to ensure protection of designated water uses. The inclusion of water quality objectives into planning initiatives can help protect watershed values, mitigate impacts of land-use activities, and protect water quality in the context of both acute and chronic impacts to human and aquatic ecosystem health. Water quality objectives provide direction for resource managers, serve as a guide for issuing permits, licenses, and orders by MOE, and establish benchmarks for assessing the Ministry's performance in protecting water quality. Water quality objectives and attainment monitoring results are reported out both to local stakeholders and on a province wide basis through forums such as State of the Environment reporting.

Vancouver Island's topography is such that the many watersheds of the MOE's Vancouver Island Region are generally small ($<500\ km^2$). As a result, the stream response times can be relatively short and opportunities for dilution or settling are often minimal. Rather than developing water quality objectives for these watersheds on an individual basis, an ecoregion approach has been implemented. The ecoregion areas are based on the eco*sections* developed by Demarchi (1996). However, for ease of communication with a wide range of stakeholders the term "eco*region*" has been adopted by Vancouver Island MOE regional staff. Thus, Vancouver Island has been split into six terrestrial ecoregions, based on similarities in characteristics such as climate, geology, soils, and hydrology (Figure 1).

Fundamental baseline water quality should be similar in all streams and all lakes throughout each ecoregion. However, the underlying physical, chemical and biological differences between streams and lakes must be recognized. Representative lake and stream watersheds within each ecoregion are selected (initially stream focused) and a three year monitoring program is implemented to collect water quality and quantity data, as well as biological data. Standard baseline monitoring programs have been established for use in streams and lakes to maximize data comparability between watersheds and ecoregions, regardless of location. Water quality objectives will be developed for each of the representative lake and stream watersheds, and these objectives will also be applied on an interim basis to the remaining lake and stream watersheds within that ecoregion. Over time, other priority watersheds within each ecoregion will be monitored for one year to verify the validity of the objectives developed for each ecoregion, and to determine whether the objectives are being met for individual watersheds.

Figure 1. Overview of Vancouver Island Ecoregions

Partnerships formed between the MOE, local municipalities, and stewardship groups are a key component of the water quality network. Water quality sampling conducted by the public works departments of local municipalities and stewardship groups has enabled the Ministry to significantly increase the number of watersheds studied and the sampling regime within these watersheds. These partnerships have allowed the Ministry to study watersheds over a greater geographic range and in more ecoregions across Vancouver Island, have resulted in strong relationships with local government and interest groups, provided valuable input and local support, and, ultimately, resulted in a more effective monitoring program.

This report examines the existing water quality of four lakes on Salt Spring Island: Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake (Figure 2). As well, it recommends water quality objectives for these lakes based on potential impacts and water quality parameters of concern. Salt Spring Island is the largest of the southern Gulf Islands, located between Victoria and Vancouver, and has the largest population of these islands. The majority of people on the island rely on surface waters as the source of their drinking water, and the four lakes covered in the report supply drinking water to the two largest towns on Salt Spring Island (Ganges and Fulford Village), as well as to local waterworks authorities and individual licensees.

All of the lakes have had historical water quality issues, and numerous water quality studies have previously been conducted on each of these lakes (e.g. Nordin, 1985, Nordin, *et al*., 1982, Holms, 1996, Nordin, *et al*., 1983, Goddard, 1976, McPherson, 2004, Sprague, 2007, St. Mary Lake Steering Committee, 2008). The primary concern in each of the lakes is excess nutrients, resulting in algal blooms and low dissolved oxygen levels that in turn affect drinking water quality and aquatic life survival. Some of these nutrients are contributed by households within the watersheds. Other anthropogenic activities that potentially impact water quality include recreation and agriculture. These activities, as well as erosion (both natural and resulting from deforestation) and the presence of wildlife, all potentially affect water quality in these lakes.

The majority of the Salt Spring Island lakes are on private land. Private land is bound by general laws such as the *Drinking Water Protection Act, the Fisheries Act, Water Act, Wildlife Act*, and the *Private Managed Forest Land Act*. The MOE relies on such legislation, and uses tools, such as water quality objectives, to ensure that all watersheds and /or water supplies are managed in a consistent manner and to protect water quality within these watersheds.

The project consisted of five phases: collecting water quality data, gathering information on water use, determining land use activities that may influence water quality, assessing water quality based on land use influences and establishing water quality objectives.

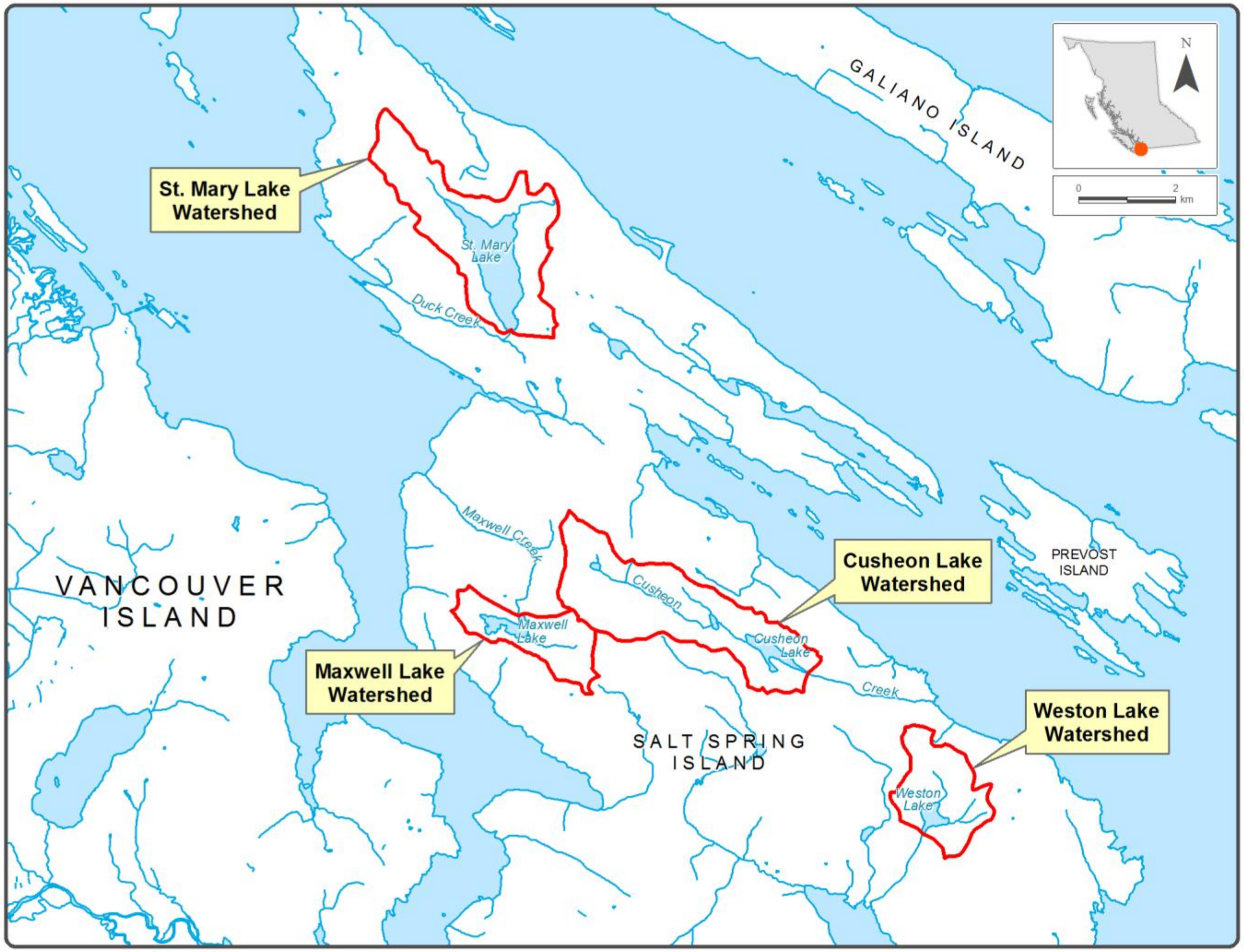


Figure 2. Overview Map of Salt Spring Island, showing location of Cusheon, Maxwell, St. Mary and Weston lakes.

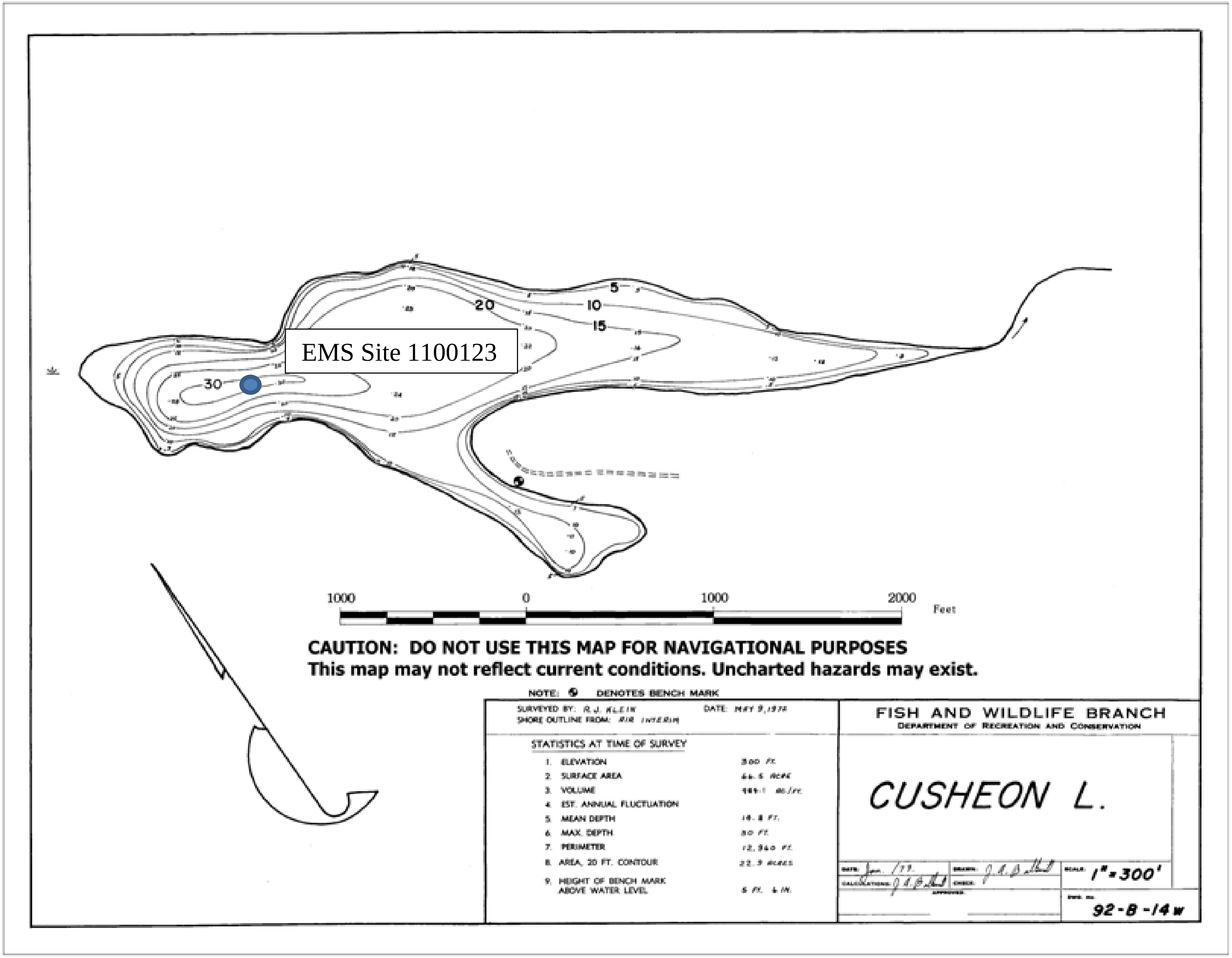
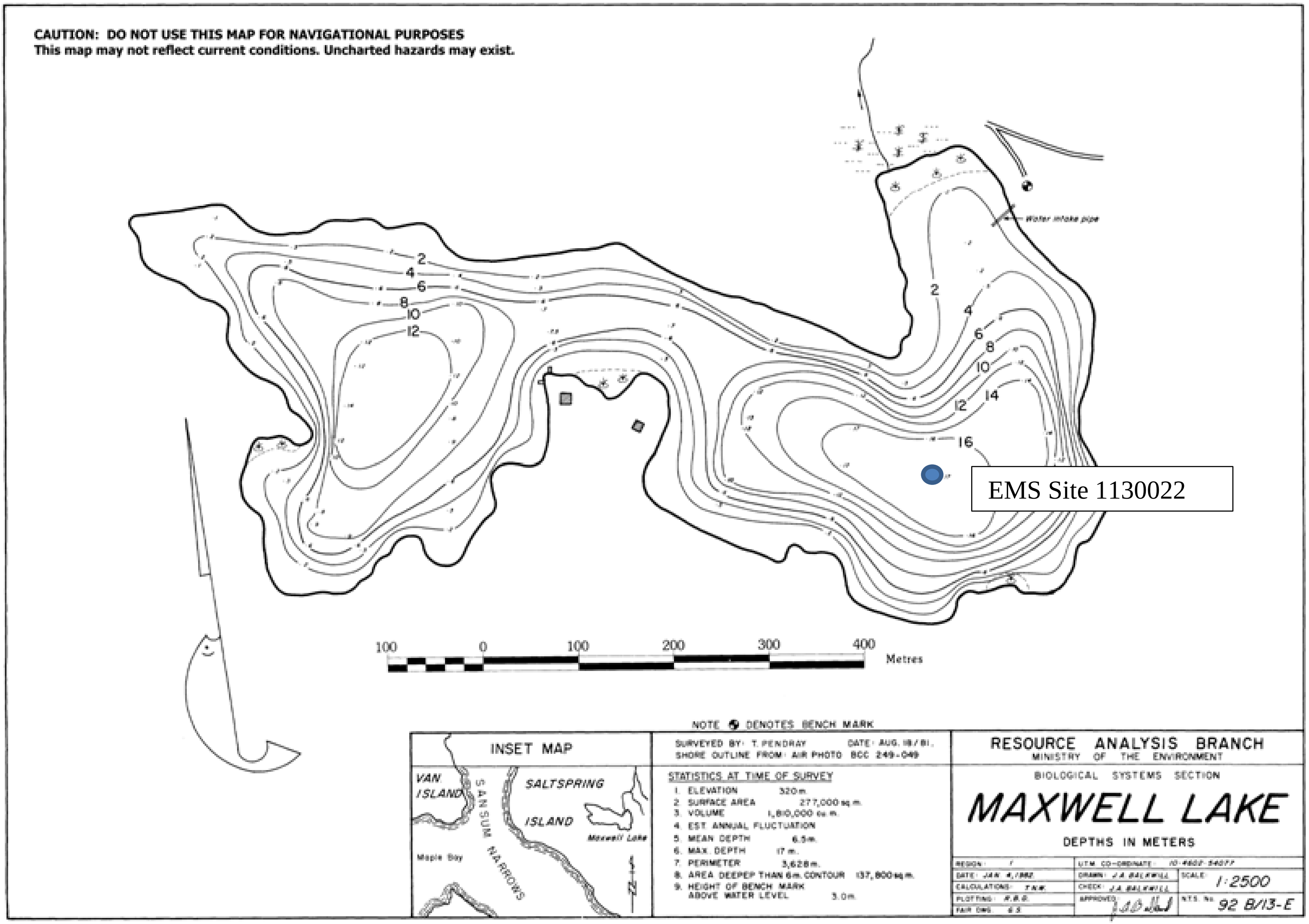


Figure 3. Cusheon Lake, showing monitoring location (EMS Site 1100123).



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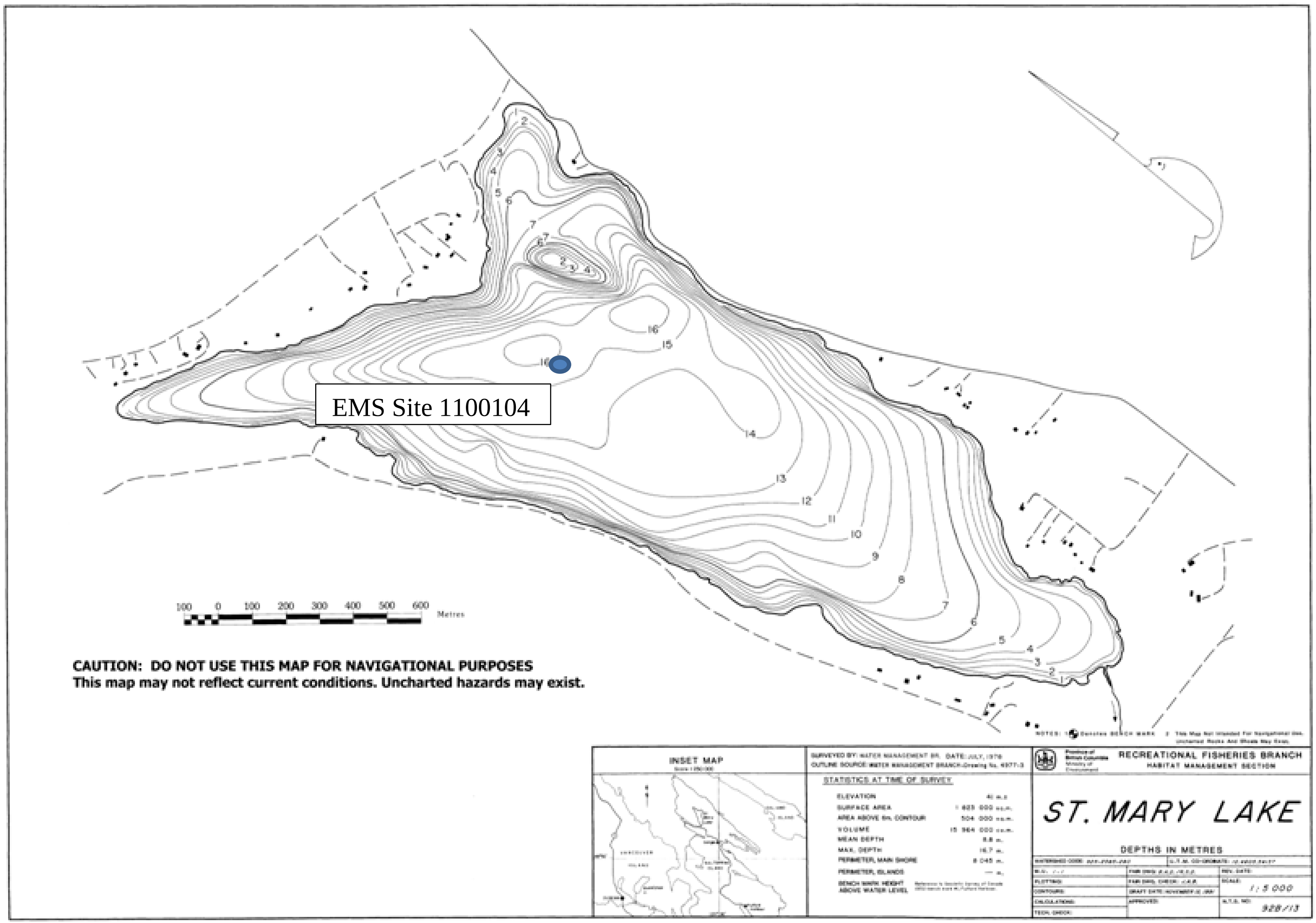

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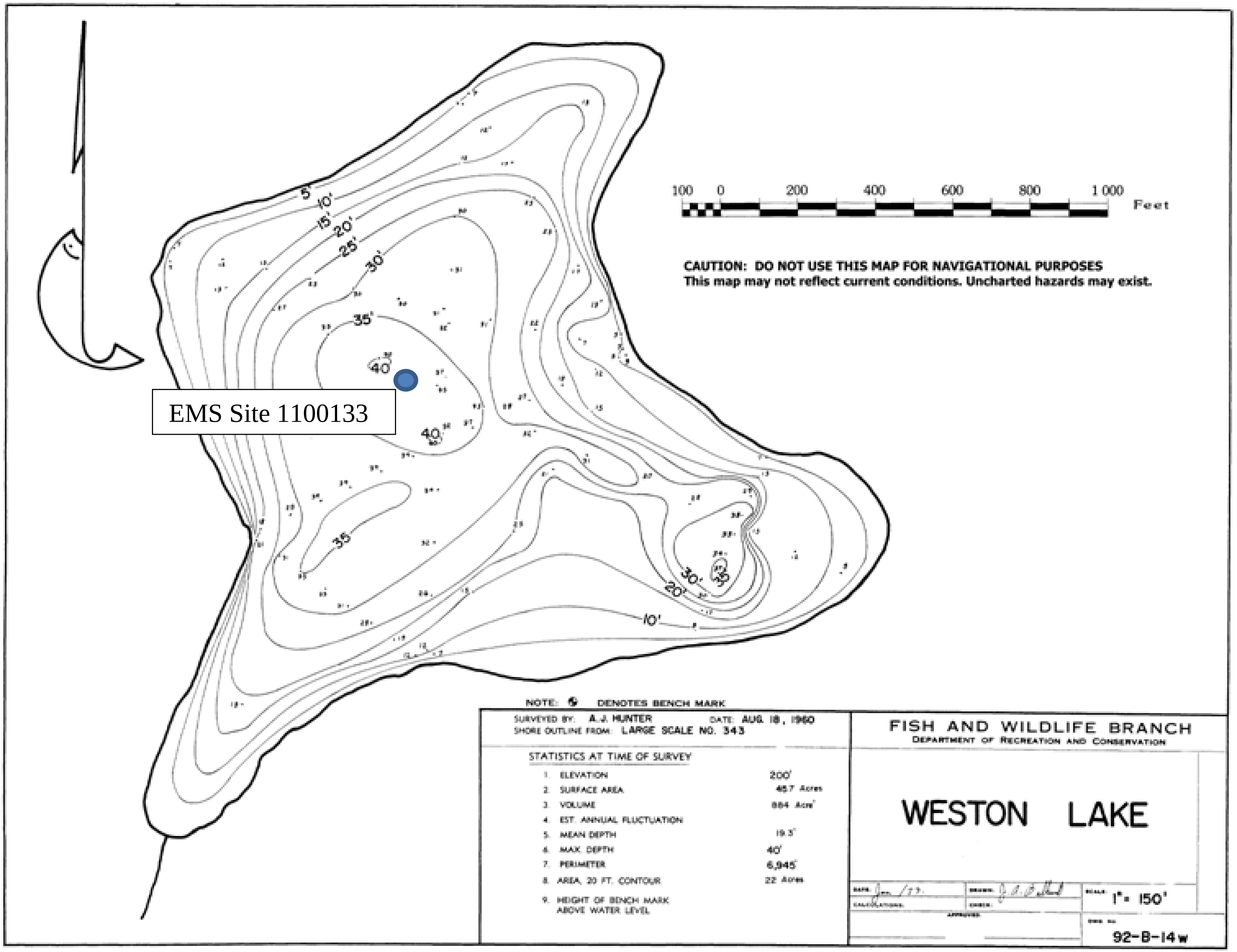


Figure 6. Weston Lake showing monitoring location (EMS Site 1100133).

2.0 WATERSHED PROFILES AND HYDROLOGY

Salt Spring Island is the largest and most populous of the Gulf Islands, with a total land area of 182 km^2 and a permanent population of approximately 9,640 (B.C. Stats, 2006). Of the seven lakes on Salt Spring Island, the four covered in this report are the largest and most utilized for drinking water and recreation. The lakes also have important sport fisheries.

2.1 LAKE CHARACTERISTICS

Characteristics of the four study lakes are summarized in Table 1. Of note is the fact that three of the lakes (Cusheon, Maxwell and Weston) have a small surface area and are relatively shallow. Watershed areas, especially for Maxwell Lake and Weston Lake, are small in absolute terms, but because the lakes themselves are so small, the supply areas for the lakes (*i.e*. the amount of land contributing nutrients and potential contaminants) are actually quite large.

Table 1. Lake Characteristics for Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake on Salt Spring Island.

	Elevation (m)	Surface Area (ha)	Perimeter (m)	Maximum Depth (m)	Mean Depth (m)	Littoral area (ha)*	Watershed area (km^2)	Residence time (yr)
Cusheon Lake	99	26.9	3,950	9.1	4.5	9.15	7.2	0.8
Maxwell Lake	317	28.1	3740	17.9	6.5	12.62	1.2	1.7
St. Mary Lake	42	189.6	7950	16.7	8.8	56.88	7.1	5.4*
Weston Lake	69	18.4	2117	12.2	5.9	9.57	1.7	2**

*estimated (from Nordin *et al.* 1983) **estimated (from Nordin, 1986)

Lower elevations of Salt Spring Island (including Cusheon Lake, St. Mary Lake and Weston Lake, fall within the Coastal Douglas-fir (moist maritime) biogeoclimatic zone, while higher elevations (above about 250 m, including Maxwell Lake) fall within the Coastal Western Hemlock (eastern very dry maritime) biogeoclimatic zone. The lakes fall within the Southern Gulf Islands (SGI) ecoregion established for Vancouver Island by MOE staff (see Figure 1).

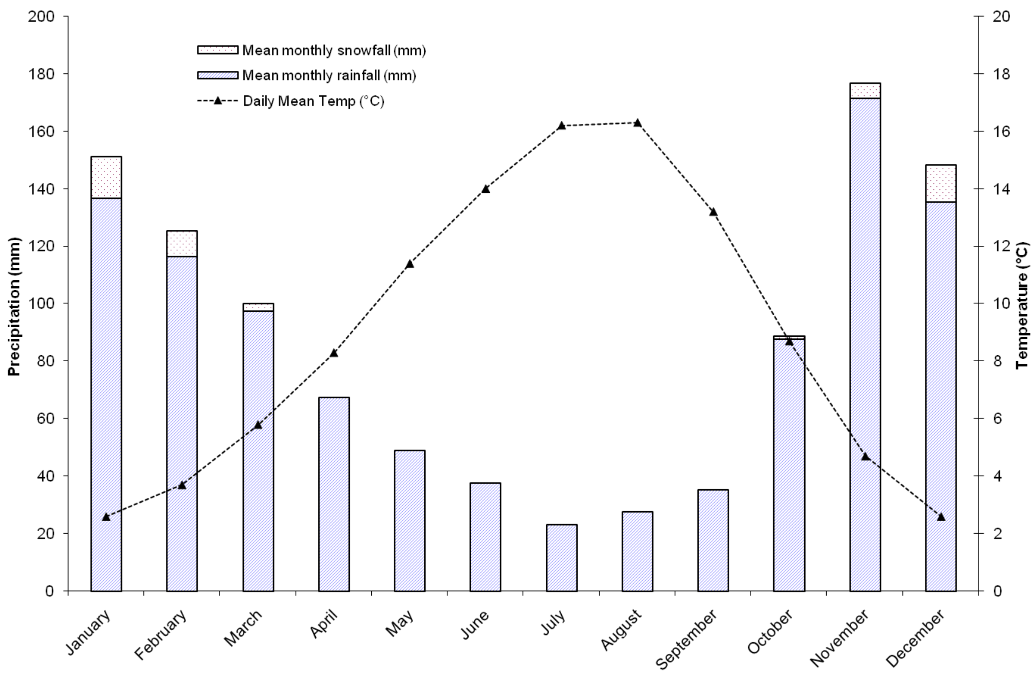
The underlying geology of Salt Spring Island is quite varied. Weston Lake is found within the Salt Spring Plutonic Suite, composed of granodioritic intrusive rocks from the Late Devonian era including granodiorite, feldspar porphyry, quartz-feldspar porphyry, and coeval with McLaughlin Ridge Formation. Maxwell Lake is found within the Sicker Group – Nitinat Formation, composed of volcanic rock from the Upper Devonian era, described as pyroxene-feldspar phyric agglomerate, breccia, lapilli tuff, massive and pillowed flows, massive tuffite, laminated tuff, jasper and chert. Finally, St. Mary Lake and Cusheon Lake are found within the Nanaimo Group of stratigraphy, composed of sedimentary rock from the Upper Cretaceous period including a boulder, cobble and pebble conglomerate, coarse to fine sandstone, siltstone, shale, and coal (Santonian to Maastrichtian) (iMapBC, 2008). Earlier reports contain detailed descriptions of soils and their distributions within the Cusheon Lake (CWMPSC, 2007), St. Mary Lake (Nordin, *et al.*, 1983) and Maxwell Lake (Nordin, *et al.*, 1982) watersheds.

2.2 HYDROLOGY AND PRECIPITATION

Environment Canada operates two weather stations on Salt Spring Island for which climate normal data are available: Site 1016992 near Cusheon Lake (elevation 108 m, Figure 7) and Site 1016995 near St. Mary Lake (elevation 46 m, Figure 8) (Environment Canada, 2008). Data from the two sites are very similar, as would be expected, but show to some extent the effects of elevation on precipitation and temperature. Average annual precipitation is 5% higher at the Cusheon Lake site (1028 mm versus 974 mm) and the daily mean temperature is about 1.4°C cooler (9.0°C vs 10.4°C) than the St. Mary Lake site. Precipitation at both sites is very low during the summer.

Water Survey Canada (WSC) measured water level in Cusheon Lake between 1976 and 1998 (Figure 9) and discharge in Cusheon Creek, downstream from the lake, for 25 years between 1970 and 1998 (Figure 10) (Water Survey Canada, 2008). Less data exists for the other lakes. There is ten years worth of discharge data (between 1980 and 1998, primarily between the months of April and September) for Duck Creek downstream from St. Mary Lake, and four years of level data for St. Mary Lake. Similarly, there are sporadic level measurements for Maxwell Lake and Weston Lake, made during the early 1980's. However, a similar trend is seen at all four lakes – water levels gradually decrease over the summer until September or October, when they reach their lowest levels. Fall and winter rains then raise water levels to peak levels in December and

January. Outflows from the lakes typically dry up during the mid-summer and do not resume until early to mid autumn.



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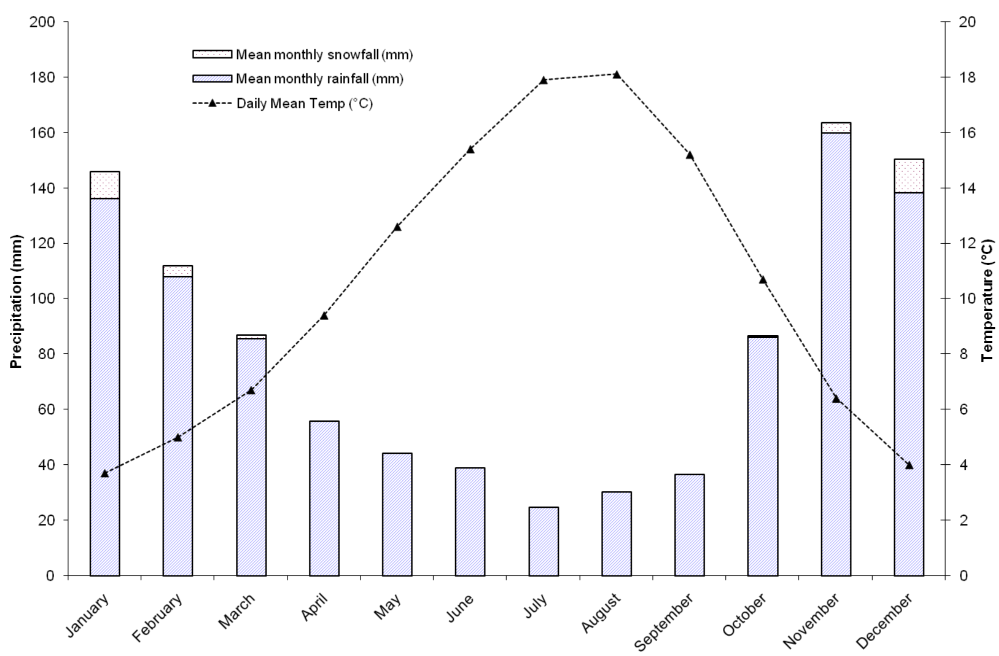

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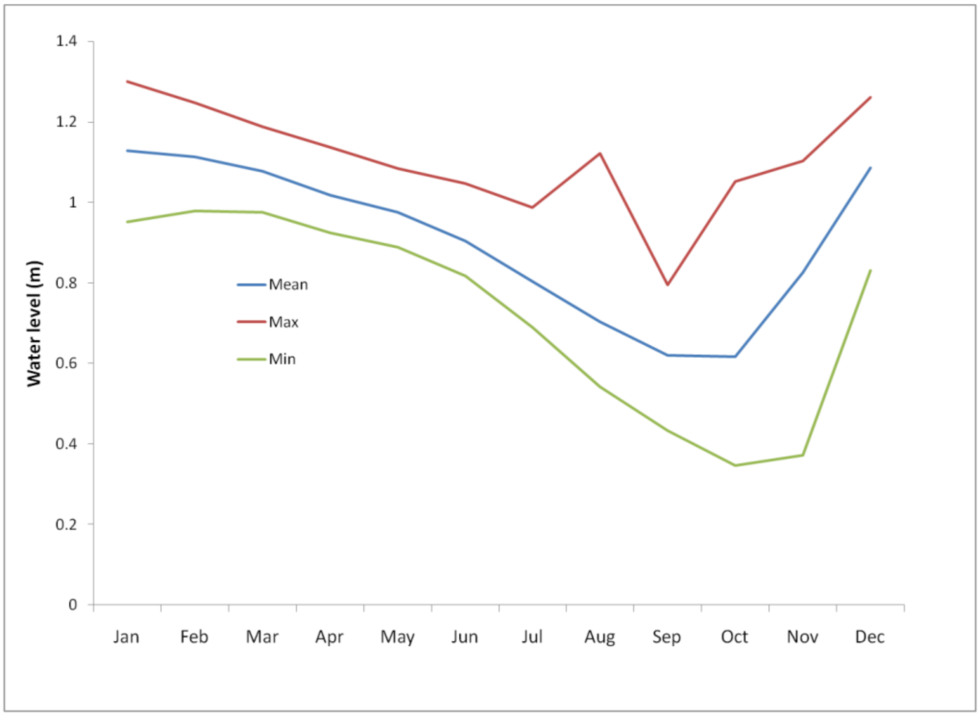

Figure 9. Minimum, maximum and average daily level data for Cusheon Lake near Ganges (Water Survey Canada Station 08HA038) between 1976 and 1998 (Water Survey Canada, 2008).

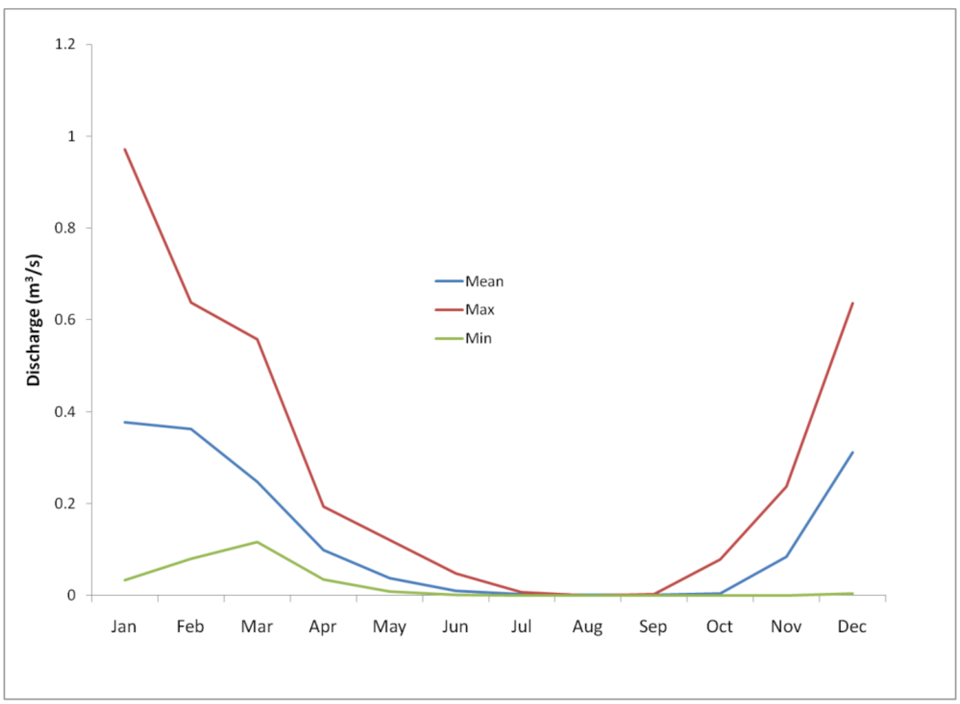

Figure 10. Minimum, maximum and average daily discharge data for Cusheon Creek at the outlet of Cusheon Lake (Water Survey Canada Station 08HA026) between 1970 and 1998 (Water Survey Canada, 2008).

3.0 WATER USES

3.1 WATER LICENSES

All four of the lakes discussed in this report are important sources of drinking water to the residents of Salt Spring Island. Cusheon Lake provides drinking water to approximately 1,200 residents, including households around the lake, as well as to the Beddis Water System (which has recently been incorporated into the CRD) (Table 2). Maxwell Lake supplies water to much of Ganges and the surrounding area. St. Mary Lake provides drinking water to residences around the lake, as well as both the North Salt Spring Waterworks District and the Capital Regional District Waterworks, supplying about 900 residences in total. In 2006, a weir was constructed on Duck Creek, the outflow from St. Mary Lake, in order to increase storage capacity and supply sufficient volumes of water to meet existing licences. It is projected that these licenses should meet demand through the year 2020. Weston Lake provides drinking water to the community of Fulford Harbour and the surrounding farms and houses (approximately 101 lots) and was incorporated into the CRD in 2004 (CRD, 2008). The outflow on Maxwell Lake is controlled by a 3.5 metre earth-filled dam owned and operated by the North Salt Spring Waterworks district, which allows them to increase the storage capacity of the lake during the fall and winter months and draw down the lake during the dry summer months.

Table 2. Summary of licensed water withdrawals from Cusheon Lake.

Use	No. of licensed withdrawals	Total volume (dam^3/a)	Principal Licensee
Domestic	38	41.48	Various
Enterprise	1	7.47	VIS2688 Strata
Irrigation	2	23.86	Various
Waterworks Local Auth	2	102.88	Capital Regional District
Total:	43	175.68	

Table 3. Summary of licensed water withdrawals from Maxwell Lake.

Use	No. of licensed withdrawals	Total volume (dam^3/a)	Principal Licensee
Domestic	2	1.66	Various
Waterworks Local Auth	4	663.73	North Salt Spring Waterworks District
Total:	6	665.39	

Table 4. Summary of licensed water withdrawals from St. Mary Lake.

Use	No. of licensed withdrawals	Total volume (dam^3/a)	Principal Licensee
Domestic	28	26.55	Various
Enterprise	6	29.87	Various
Fire Protection	1	252.72	Salt Spring Island Fire Protection District
Irrigation	10	102.20	Various
Stockwatering	3	2.85	Various
Waterworks Local Auth	9	1,432.29	North Salt Spring Waterworks District, CRD
Total:	57	1,846.48	

Table 5. Summary of licensed water withdrawals from Weston Lake.

Use	No. of licensed withdrawals	Total volume (dam^3/a)	Principal Licensee
Domestic	13	13.27	Various
Fire Protection	1	252.72	Salt Spring Island Fire Protection
Greenhouses	1	0.66	Various
Irrigation	3	20.72	Various
Waterworks Local Auth	2	116.15	Capital Regional District
Total:	20	403.53	

3.2 FISHERIES

Cusheon Lake, St. Mary Lake and Weston Lake all have important sport-fisheries, and are regularly stocked with fish. All of these lakes have boat motor restrictions which allow only electric motors.

Access to Maxwell Lake is restricted, but it was stocked with 3,000 cutthroat trout (*Oncorhynchus clarki*) between 1923 and 1939, as well as 32,000 rainbow trout (*O. mykiss*) fingerlings, primarily in the 1940's. Currently, Maxwell Lake is known to contain cutthroat trout, rainbow trout, and threespine stickleback (*Gasterostreus aculeatus*) (HabitatWizard, 2008).

Cusheon Lake has been stocked with 82,216 cutthroat trout between 1919 and 2006, as well as 20,000 rainbow trout between 1947 and 1951 (HabitatWizard, 2008). Other species known to exist in Cusheon Lake include smallmouth bass (*Micropterus dolomieu*), threespine stickleback and sculpin (*Cottus asper*) (HabitatWizard, 2008).

St. Mary Lake is stocked annually with cutthroat trout, rainbow trout and steelhead. Over 255,000 cutthroat have been stocked between 1954 and 2006, along with almost 48,000 rainbow trout and 130,000 steelhead (HabitatWizard, 2008). Smallmouth bass were introduced to the lake in about 1920 and remain plentiful. As well, in recent years, yellow perch (*Perca flavescens*) have been introduced and are now found in relatively high numbers.

Weston Lake was stocked with 12,500 cutthroat between 1927 and 1957, as well as 67,000 rainbow trout between 1960 and 2006, and 22,000 steelhead between 1980 and 1987 (HabitatWizard, 2008).

3.3 RECREATION

As mentioned in Section 3.2 above, access is restricted to Maxwell Lake. However, primary-contact recreation (*i.e*. swimming) is encouraged on the remaining three lakes during the summer months by local resorts and travel guides (*e.g*. Saltspringmarket.com, 2008). Cusheon Lake, St. Mary Lake and Weston Lake all have public access, and are very popular family swimming destinations during the summer months. The lakes are also utilized for a number of other secondary-contact recreational activities, including boating, canoeing, kayaking, etc.

3.4 FLORA AND FAUNA

Salt Spring Island provides habitat to a wide variety of both animal and plant species. Within the Maxwell Lake watershed, there is a six hectare property covered by a conservation covenant connected with the threatened Garry Oak Coastal Bluff ecosystem to the west (Salt Spring Island Conservancy, 2008a). Other COSEWIC (Committee on the Status of Endangered Wildlife in Canada)-listed species found on Salt Spring Island include sharp-tailed snake (*Contia tenuis*), the yellow Montane violet (*Viola praemorsa* ssp. *praemorsa*), Macoun's meadowfoam (*Limnanthes macounii*), phantom orchid (*Cephalanthera austiniae*), and the Dun skipper (*Euphyes vestries*) (Salt Spring Island Conservancy, 2008b). Other vertebrates within the watersheds include red-legged frogs

(*Rana aurora*), rough-skinned newts (*Taricha granulosa*), beaver (*Castor canadensis*), otter (*Lutra canadensis*), native muskrat (*Ondatra zibethicus*) and non-native muskrat (*Myocastor coypus*) (Reimer, 2003). Birds of note that utilize the watersheds include the great blue heron (*Ardea herodias*), belted kingfishers (*Ceryle alcya*) and bald eagles (*Haliaeetus leucocephalus*) (Reimer, 2003).

3.5 DESIGNATED WATER USES

Designated water uses are those water uses that are designated for protection in a watershed or waterbody. Water quality objectives are designed for the substances or conditions of concern in a watershed so that attainment of the objectives will protect the designated uses.

As discussed in Section 3.1 above, 126 consumptive water licenses (*i.e*. those not including storage or conservation licenses) have been issued for the four lakes, with domestic use the primary use. Irrigation licenses have also been issued for Cusheon Lake, St. Mary Lake and Weston Lake. As discussed in Section 3.3 above, these three lakes are also extensively used for primary and secondary contact recreation. In addition, the presence of salmonid species in all of the lakes, as well as the normal fauna of the area, suggests that water uses to be protected in Cusheon Lake, St. Mary Lake and Weston should include drinking water, irrigation, primary-contact recreation, and protection of wildlife and aquatic life; while in Maxwell Lake they should include drinking water and protection of wildlife and aquatic life. Ultimately, water quality objectives are developed to protect the most sensitive water use at the site.

4.0 INFLUENCES ON WATER QUALITY

Three of the four study lakes have relatively small tributaries compared to their volumes. St. Mary Lake has two small unnamed tributaries that contribute the majority of their flow in December and January, generally drying up between June and November. It is estimated that they contribute a combined total of 30% of the overall inflow to St. Mary Lake (Nordin, *et al*., 1983). The remainder of the contributions comes from overland flow and groundwater. Maxwell Lake has no significant tributaries, relying solely on groundwater and overland flow as a water supply (Nordin, *et al*., 1982). There are no hydrometric data available for the tributaries to Weston Lake, but groundwater and overland flow are likely significant contributors to freshwater inflow into this lake as well. Only Cusheon Lake, with 75% of the flow coming from upstream lakes (Roberts and Blackburn), receives relatively small amounts of total inflow from overland flow or groundwater input. For this reason, activities on or near the foreshores of the lakes are likely to have the greatest impact on water quality within the lakes, with relative impacts decreasing with distance from the lakes as suspended sediments, nutrients and contaminants can bind to soils as they pass through them, depending on soil porosity and composition.

4.1 LAND OWNERSHIP

In contrast to the majority of British Columbia, where Crown Lands account for much of land ownership, almost all of the land on Salt Spring is privately owned. In most of the watersheds, the majority of the land has been modified in some way. In the Cusheon Lake watershed, 62% of the watershed has been logged or otherwise cleared, 17% is used for residences and businesses (including a golf course), 8% is used for agricultural purposes, and only 13% is considered to be in its natural condition (CWMPSC, 2007) (Table 6). Land-use within the St. Mary Lake watershed is summarized in Table 7. A detailed break-down of land use within the Weston Lake watershed is not available, but the majority is used for residential and agricultural purposes. Only the Maxwell Lake watershed and Rippon Creek watershed, which is diverted into Maxwell Lake, are relatively pristine. In 2002, Texada Land Co. and other private landowners sold the watershed lands to North Salt Spring Waterworks District. District ratepayers supplied most of the funds with the remainder raised primarily by public donations through the Salt Spring Island Water Preservation Society and other non-profit community groups. The Salt Spring Island Conservancy holds a covenant on a large part of the watershed lands in order to protect it in perpetuity.

Table 6. Break-down of land use within Cusheon Lake watershed (from CWMPSC, 2007).

Type of landscape	Area, hectares	Percent of total basin
Modified landscape		
Young forest	569.5	61.60%
Rural	129.1	14.00%
Agriculture	72.6	7.90%
Sub-total, modified landscape	771.2	83.30%
Natural landscape		
Woodland	49.9	5.70%
Mature forest	23.5	2.50%
Riparian	22.8	2.50%
Wetland	17.9	1.90%
Herbaceous	3.5	0.4
Sub-total, natural landscape	117.6	12.70%
Lakes		
Cusheon Lake	29.6	
Blackburn Lake	3.6	
Roberts Lake	2.8	
Subtotal, lakes	36	3.90%
Total Watershed Area	924.8	100%

Table 7. Break-down of land use within St. Mary Lake watershed (from Reimer, 2003).

Use	Area (ha)	Percent of total basin
Agriculture	93	9.7%
Park reserve	116	12.1%
Rural watershed	338	35.1%
Commercial use (resorts)	11	1.1%
Lake shoreline protection	65	6.8%
Residential/Rural residential	339	35.2%
Total:	962	100.0

Land ownership and use can impact water quality in a number of ways. On Salt Spring Island the primary concern with all of the lakes is nutrification, which tends to result in increased algal production. Residences (especially those that utilize septic fields, as is the case for all of the houses within the three watersheds) can contribute significant amounts of both phosphorus and nitrogen through groundwater movement, primarily through aging or failing septic systems. Recent changes in building codes have set strict guidelines regarding distances that septic fields must be from surface waters including lakes and creeks. However, many of the homes in the Cusheon Lake, St. Mary Lake and Weston Lake watersheds predate these regulations and therefore their septic fields are much closer to the lake than would be permitted in newly constructed residences.

Agricultural uses involving grazing animals are also a significant potential source of nutrients, as waste from these animals can be transported in overland flow. When portions of a watershed are cleared and building or roads are constructed, these areas become impermeable to water, thus speeding overland flow. Any contaminants on those surfaces, including oil and gasoline from automobiles, will be washed into waterways with little or no absorption by the land. It is estimated that between eight and ten percent of the St. Mary Lake watershed consists of impervious surfaces (Reimer, 2003). Cusheon Lake and Weston Lake likely have similar ratios of impervious surfaces. As well, stormwater runoff in both the St. Mary Lake and Weston Lake watersheds has been identified as a significant source of nutrients and fecal coliforms. Coliform levels were high enough in the Weston Lake watershed to warrant further investigation (Cameron, *et al.*, 2006). Using bacterial source tracking (BST), researchers were able to determine that the source of the coliforms entering Weston Lake through the stormwater effluent were not human in origin, but rather from animal sources (Cameron, *et al*., 2006).

4.2 LICENSED WATER WITHDRAWALS

Water withdrawals can affect lake levels, as well as flows in streams leaving the lakes, if licensed withdrawals are large relative to the volume of water in the system. Low summertime precipitation on Salt Spring Island (see Section 2.2) coupled with an almost doubling of the population due to the influx of tourists can result in significant stresses on the drinking water supply. Outflows into Cusheon Creek from Cusheon Lake and Duck

Creek from St. Mary Lake typically cease in June or July and do not resume until October or November. Outflow measurements from Maxwell Lake and Weston Lake are not available, but they are also likely low to non-existent during the summer and early fall. In addition to impacting biota in streams draining the lakes, the lake draw-down can impact plants and aquatic life along the edges of the lake when previously covered areas are exposed.

Studies were conducted in St. Mary Lake in 1997 (Westland Resource Group, 1998) and again in 2004 (Hatfield and Parks, 2004) to examine the potential impacts resulting from increased draw-down of the lake to meet the needs of a rapidly increasing population on Salt Spring Island. These reports conclude that there would likely be impacts to spawning habitat for smallmouth bass, and to rearing habitat for juvenile bass and salmonids. It was not thought that water quality would be significantly impacted, although there would likely be an increase in maximum summer temperatures in surface waters, and the potential for changes in dissolved oxygen concentrations was unknown. In 2006, as part of the project, a low head dam was built with a low-level output that should ensure a minimum flow (approximately 10% mean annual discharge) in Duck Creek year-round. The benefits of this year-round flow to aquatic life in the creek are thought to offset any impacts on habitat in the lake (Hatfield and Parks, 2004; Hatfield and Parks, 2007). As well, passage was provided for both adult and juvenile fish movement over the dam.

Construction of a 3.5m high dam at the outlet of Maxwell Lake in 1994 increased its holding capacity, raising the water level one metre above existing levels during the winter months.

4.3 FOREST HARVESTING AND FOREST ROADS

Forestry activities can impact water both directly and indirectly in several ways. The removal of trees can decrease water retention times within the watershed and result in a more rapid response to precipitation events and earlier and higher spring freshets. The improper construction of roads can change drainage patterns, destabilize slopes, and introduce high concentrations of sediment to streams.

Land within the Maxwell Lake watershed was owned by Texada Land Co., who had plans to harvest the timber; however, this land was purchased from the logging company and is now protected. Selective logging occurred in 2003 and 2004 around Roberts Lake, the uppermost lake in the Cusheon Lake watershed (CWMPSC, 2007). There is no active logging in the remaining watersheds, although trees are occasionally removed to allow for construction or other development.

4.4 RECREATION

Recreational activities can affect water quality in a number of ways. Erosion associated with 4-wheel drive and ATV vehicles, direct contamination of water from vehicle fuel, and fecal contamination from human and domestic animal wastes (*e.g.*, dogs or horses) are typical examples of potential effects.

Cusheon Lake, St. Mary Lake and Weston Lake experience high levels of recreational activity, primarily during the summer months. Activities include swimming and sun-bathing, as well as fishing and various other water-based activities. There are concerns that these activities could significantly impact water quality and indirectly human health. Fecal coliforms and other contaminants associated with swimmers (especially infants and toddlers) and pets as well as debris left by picnickers could significantly impact water quality in these lakes.

Although the Maxwell Lake watershed is largely owned by North Salt Spring Waterworks District and access is restricted, unpermitted recreational activities such as ATV use, swimming, hiking, and camping occur regularly. The risk of forest fire from illegal campfires and smoking threatens both the watershed land and water quality.

4.5 WILDLIFE

Wildlife can influence water quality through the deposition of fecal material which may include pathogens such as *Giardia lamblia*, which causes giardiasis or "beaver fever", and *Cryptosporidium* oocysts which cause the gastrointestinal disease, cryptosporidiosis (Health Canada, 2004). Microbiological indicators, such as *Escherichia coli,* are used to assess the risk of fecal contamination to human health. Fecal contamination of water by animals is generally considered to be less of a concern to human health than contamination by humans because there is less risk of inter-species transfer of pathogens. However, without specific source tracking methods, it is impossible to determine the origins of coliforms.

The Salt Spring Island watersheds contain valuable wildlife habitat, and provide homes for a wide variety of warm-blooded species including blacktail deer, beaver, otter, and muskrat, as well as occasional sightings of black bears and cougars. The watersheds are also inhabited by various waterfowl, as well as eagles, hawks, owls, and numerous other species of small birds. Therefore, a risk of fecal contamination from natural wildlife populations within the watershed does exist.

4.6 PERMITTED DISCHARGES

There are no permitted discharges to any of the Salt Spring Island lakes considered in this report.

5.0 STUDY DETAILS

This report provides an assessment of water quality data collected from Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake from the 1970s until 2007. Water samples were collected at one site on each of the lakes, at the deepest point (Figure 3-6) (EMS Site 1100123 on Cusheon Lake, Site 1130022 on Maxwell Lake, Site 1100104 on St. Mary Lake, and Site 1100133 on Weston Lake). Samples after 2002 were collected specifically for the purpose of developing this objectives report and were collected in March and November, while the water column was mixed, and during May/June and August, when the water column was thermally stratified. All samples were collected according to Resource Inventory Standards Committee (RISC) standards (Cavanagh *et al.*, 1994).

Water chemistry samples were collected at surface (0.5m), at mid-depth (10m, for Maxwell and St. Mary lakes only) and at 1 metre from the bottom. Surface samples were collected by hand and water column samples were collected using a Van Dorn bottle. The deep station samples were analyzed for the following parameters:

- Physical: pH, silica, true color, specific conductivity, turbidity, non-filterable residue
- Carbon: total inorganic carbon, total organic carbon
- Nutrients: total phosphorus, total dissolved phosphorus, nitrate, nitrite, ammonia, total Kjeldahl N
- Total and dissolved metals concentrations (spring only)

Water chemistry analyses were conducted by Maxxam Analytics Inc. in Burnaby, British Columbia.

Depth profiles were conducted in the field for dissolved oxygen, water temperature, oxidation-reduction potential (ORP), pH and conductivity using a Hydrolab Surveyor 4. Measurements were made every metre between the surface and bottom depth. Water clarity was measured on each sampling day using a Secchi disc, which is a 20 cm diameter circular plastic disk whose surface is divided into four quadrants alternating in colour between black and white. The disk is lowered into the water with a rope, and the depth at which it disappears from sight is termed the extinction, or Secchi, depth.

Phytoplankton and chlorophyll *a* samples were collected by taking one litre grab samples at a depth of 0.5 m. Chlorophyll *a* samples were field filtered using 0.45 µm filter paper and then analyzed at the laboratory (Maxxam Analytics Inc.). Phytoplankton samples were preserved with Lugol's solution and shipped on ice to the laboratory for analyses. Zooplankton samples were collected to determine community composition and densities using a 10 m vertical tow in a Wisconsin-style net with a mouth area of 0.07 m^2, a net opening diameter of 0.3 m and a mesh size of 80 µm. Zooplankton samples were preserved with formalin and shipped on ice to the lab for identification and enumeration. Phytoplankton and zooplankton taxonomy was done by Fraser Environmental Services, in Surrey, British Columbia. All biological samples were collected following Ministry of Environment approved methods (Cavanagh *et al.*, 1997).

Data collected from previous years (from 1974 in Cusheon Lake and St. Mary Lake, from 1981 in Maxwell Lake and from 1985 in Weston Lake) are also analyzed to determine what trends, if any, are occurring with the major water quality parameters. Data are summarized in Appendix A (Table 22- Table 25).

6.0 WATER QUALITY ASSESSMENT AND OBJECTIVES

There are two sets of guidelines that are commonly used to determine the suitability of drinking water. The British Columbia MOE water quality guidelines are used to assess water at the point of diversion of the natural stream into a waterworks system. These BC guidelines are also used to protect other designated water uses such as recreation and habitat for aquatic life. The development of water quality objectives for a specific water body can be integrated into an overall fundamental water protection program designed to protect all uses of the resource, including drinking water sources.

The British Columbia *Drinking Water Protection Act* sets minimum disinfection requirements for all surface supplies as well as requiring drinking water to be potable. The Vancouver Island Health Authority (VIHA) determines the level of treatment and disinfection required based on both source and end of tap water quality. As such, VIHA requires all surface water supply systems to provide two types of treatment processes.

The Cusheon Lake and Weston Lake water systems are operated by North Salt Spring Waterworks District (NSSWD) under a contract from the Capital Regional District (CRD). Both water treatment plants utilize dissolved air flotation to remove organic colloids and algal cells, followed by mixed media (sand and anthracite) filtration, ultraviolet treatment to kill pathogens and chlorination to provide a residual disinfectant throughout the distribution systems. The Highland and Fernwood water systems, operated by the CRD, and NSSWD, all withdraw water from St. Mary Lake. The NSSWD sytem utilizes pre-chlorination, pressure sand filters, and post-chlorination (Hutton, pers comm. 2008). Maxwell Lake is managed by the North Salt Spring Waterworks District as well, and is treated using chlorination only. In addition, VIHA requires all new water systems to effectively treat the water for viruses and parasites, such as *Cryptosporidium* and *Giardia* (VIHA, 2006). The Cusheon Lake and Weston Lake treatment plants address this requirement with their installation of UV treatment, while the pressure sand filter utilized on St. Mary Lake also serves to remove Cryptosporidium oocysts.

6.1 LIMNOLOGICAL CHARACTERISTICS

Limnological characteristics are generally considered to be those related to the dynamics of the lake, including whether thermal or chemical stratification occurs. Thermal stratification is driven by the fact that water is at its most dense at about 4°C. In most lakes in BC, the water column will be easily mixed at 4°C. In the spring, the surface waters warm up and become less dense, and the temperature gradient is large enough that the wind-induced currents are unable to cause mixing, leading to summer stratification of the water column. In the fall, surface waters cool and the temperature gradient becomes small enough again for the wind-induced currents to cause the lake volume to mix, leading to a fall turnover of the lake. In the winter, the surface water cools below 4°C, becoming less dense, which leads to another stratification period. This stratification is broken down in the spring, and spring turnover occurs. For some lakes, particularly in coastal BC, the winter surface temperatures do not fall below 4°C for a long enough period to allow for winter stratification, and thus these lakes are monomictic. monomictic. Salt Spring Island lakes do not typically experience winter stratification.

Water column stratification results in a division of the water column into three sections – the epilimnion or top layer, the metalimnion or middle layer (which contains the thermocline, the plane of maximum rate of decrease of temperature with respect to depth (Wetzel 2001) and the hypolimnion, or bottom layer. This can have various consequences to water chemistry, because in a strongly stratified lake, water in the hypolimnion does not mix with surface waters. If the depth of the hypolimnion is greater than the euphotic depth (the maximum depth at which photosynthesis meets or exceeds respiration), dissolved oxygen levels are not replenished because there is no exchange with the atmosphere (as there is in the epilimnion), or production of oxygen through photosynthesis. In some lakes, oxygen concentrations decrease sufficiently to impact fish species.

Dissolved oxygen levels in the hypolimnion can become depleted due to the decomposition of algae that dies and sinks to the bottom. As well, if waters near the sediment become anoxic, chemical reactions can result that release nutrients and other chemical parameters from sediments back into the water column. This explanation of stratification is very simplified and there are a number of different factors that affect stratification and water chemistry; but it gives an overview of typical lake dynamics in the temperate zone, such as Salt Spring Island.

6.1.1 Temperature Stratification

Temperature is important to the quality of drinking water supplies for both health and aesthetic reasons. As water temperature increases, so does the potential for biological growth. Increased biological growth can increase chlorine demand and reduce the effects of the chlorination process. In addition, decaying organics in the water can cause taste and odor problems for the consumer. Water temperature is a critical factor for aquatic life. Fish and invertebrate’s body temperatures are, to a large extent, controlled by their environment. Water temperature directly affects the activity and physiological processes of fish and aquatic invertebrates at all life stages. The capacity for water to carry dissolved oxygen, which is critical to aquatic life, is inversely related to temperature. Temperature can also affect the toxicity of other parameters, such as ammonia, and increase the solubility of chemical compounds.

Water quality guidelines for temperature have been developed for several water uses (see Oliver and Fidler, 2001). For drinking water supplies, it is recommended that water temperature be less than 15°C to protect the aesthetic quality of the water. For the protection of aquatic life in lakes, the allowable change in temperature is +/-1°C from naturally occurring levels. In streams, the optimum temperature ranges for trout and salmonids are based on specific life history stages such as incubation, rearing, migration and spawning.

In each of the lakes, thermal stratification begins between late March and early April, and continues until late October. Depth of the hypolimnion varies between years and between lakes, generally it is between three and four metres depth in Cusheon Lake (Figure 11), three to six metres deep in Maxwell Lake (Figure 12), five to six metres deep in St. Mary Lake (Figure 13), and between one to four metres deep in Weston Lake (Figure 14). In each of the figures, water temperature measured at one metre intervals from the surface to the bottom of the lake are shown for a number of sampling dates. In those instances where the line appears to be straight from top to bottom (*e.g*. October 29, 1974 in Figure 11), the lake is the same temperature from the surface to the bottom and the entire water column mixes freely. During the summer months, the thermocline is evident as the portion of the water column where the temperature changes most rapidly with depth.

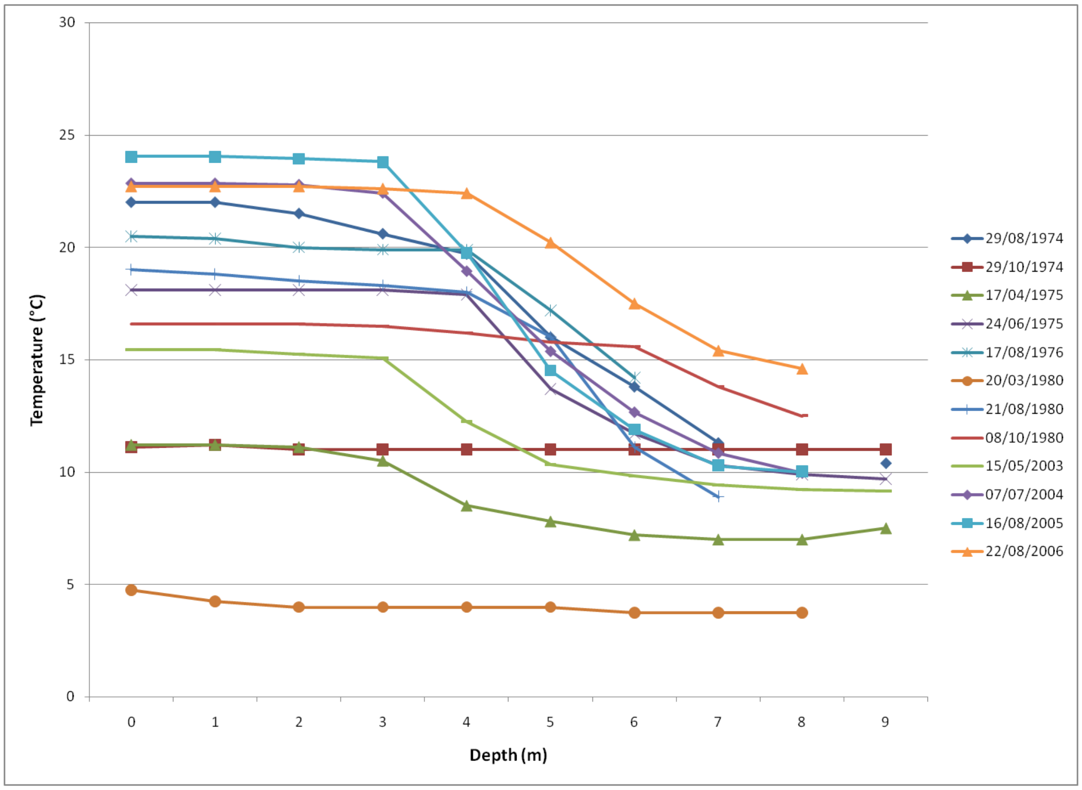

Figure 11. Water temperature measured at one metre intervals in Cusheon Lake at the deepest point.

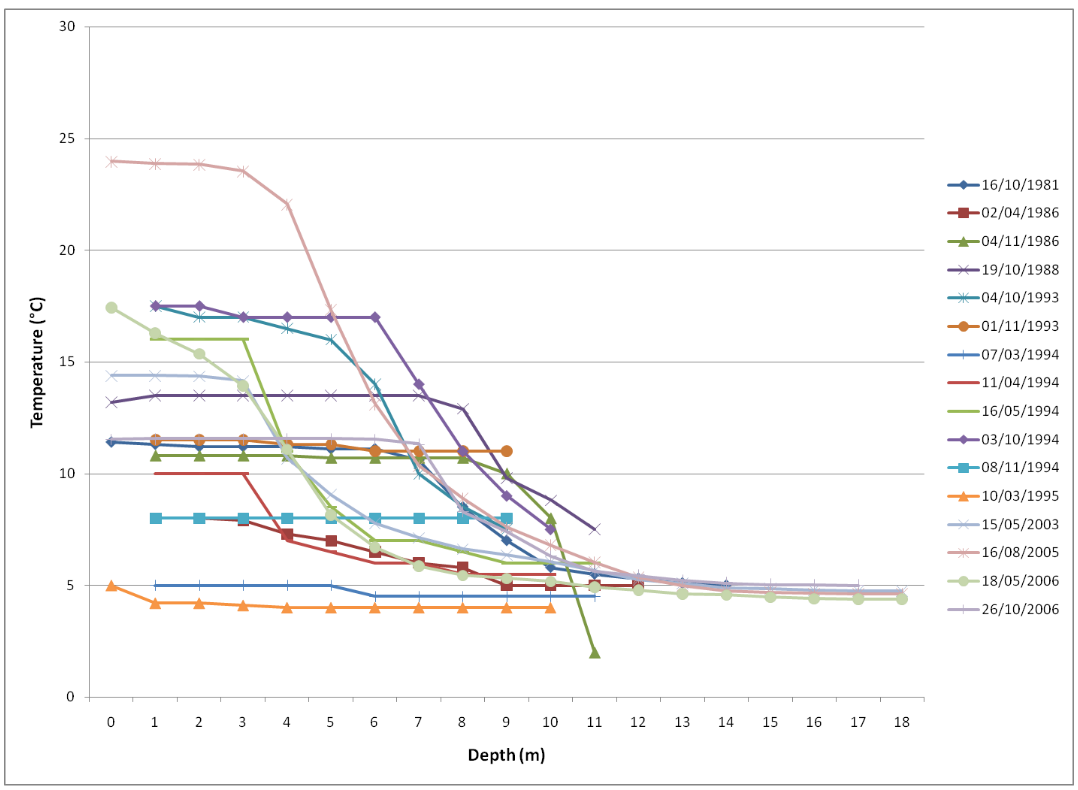

Figure 12. Water temperatures measured at one metre intervals in Maxwell Lake at the deepest point.

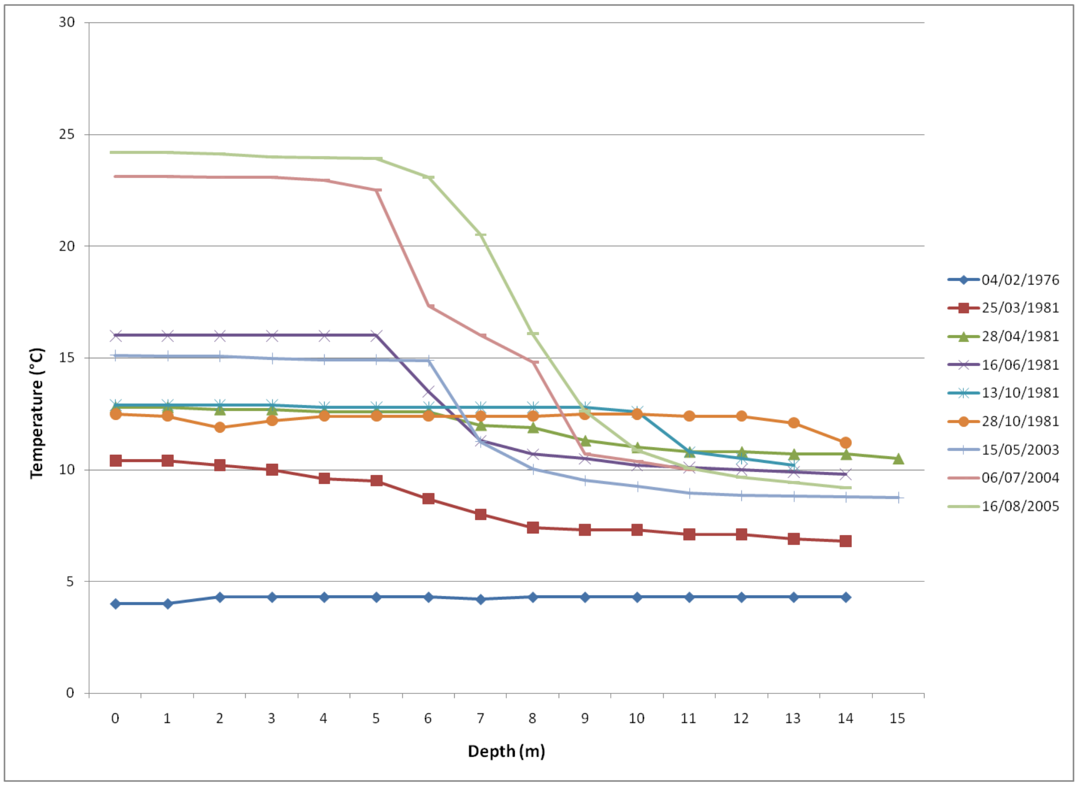

Figure 13. Water temperature measured at one metre intervals in St. Mary Lake at the deepest point.

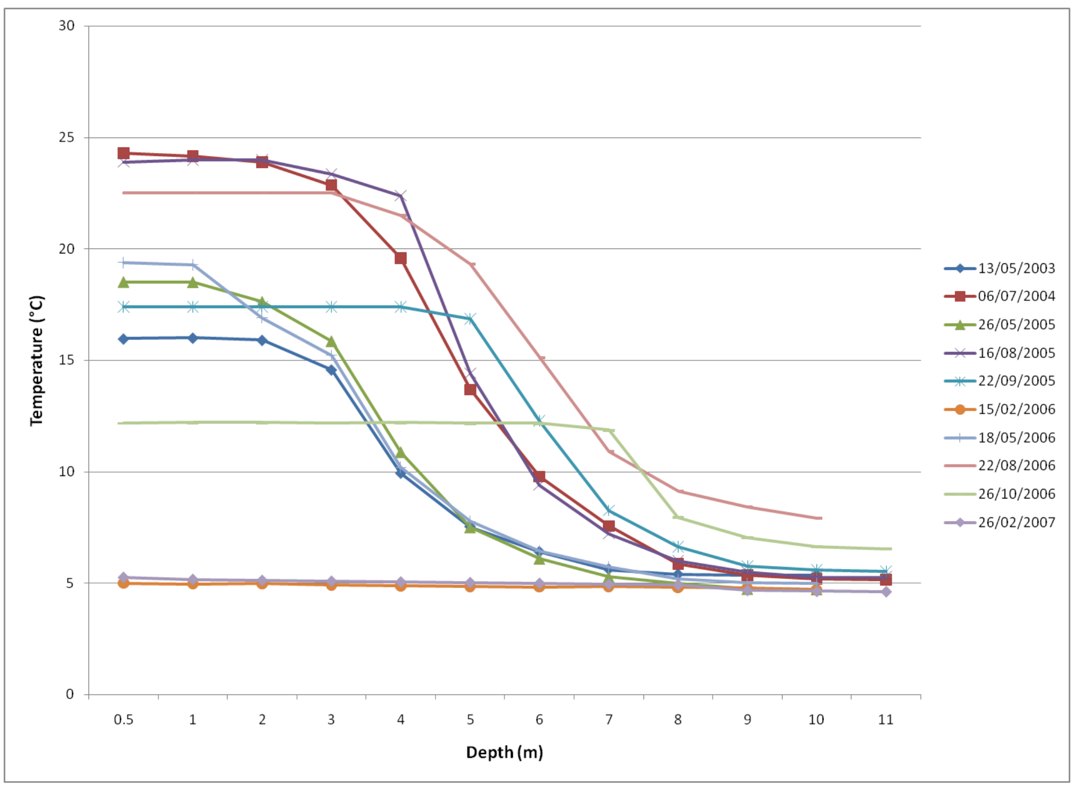

Figure 14. Water temperature measured at one metre intervals in Weston Lake at the deepest point.

Peak summer temperatures in the surface waters of each of the lakes consistently exceed the aesthetic drinking water guideline of 15°C, with maximum recorded values approaching 25°C in all of the lakes. It is not likely that management activities would be able to significantly decrease surface temperatures, but aesthetic problems arising from these warm temperatures can be mitigated to some extent by adjusting the depth of water intakes to take cooler water from within the thermocline. Deep-water intakes (below the thermocline) are not recommended, due to problems with depleted oxygen levels and the resulting deleterious effects on water quality (see Section 6.1.2 below).

Summer surface water temperatures typically exceed the aquatic life guideline of 19°C for rainbow trout, the most temperature sensitive species in each of the lakes (Oliver, *et al*., 2001). Fish would typically need to stay within or below the thermocline to avoid physiological stresses associated with elevated water temperatures. In an attempt to keep the deeper waters cooler for a refuge for fish, ***the proposed water quality objective for temperature is a summer maximum temperature of 15°C in the hypolimnion, from 6 m in depth to the bottom of Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.***

6.1.2 Dissolved Oxygen

Dissolved oxygen (DO) levels are important for the survival of aquatic organisms, especially species sensitive to low oxygen levels such as salmonids. Oxygen becomes dissolved in water on the surface of lakes as a result of diffusion from the atmosphere, as well as from photosynthetic activity from plants and algae. When deeper waters no longer mix with surface waters, due to stratification, concentrations of DO can decrease. This occurs as a result of decomposition of organic materials, especially in eutrophic lakes (*i.e.*, lakes with high levels of nutrients and therefore high biological productivity). If the euphotic zone (the zone where light penetration is sufficient to allow photosynthesis) lies above the thermocline, no photosynthesis occurs in deeper waters, and therefore oxygen depletion from decomposition occurs. The guideline for the minimum instantaneous DO concentration for aquatic life is 5 mg/L (BC Ministry of Environment, 1997).

During the summer months, when waters are stratified, DO depletion occurs in all four of the Salt Spring Island lakes, with DO concentrations approaching 0 mg/L near the sediments (Figure 15 - Figure 18). During the winter months, dissolved oxygen concentrations remain relatively high throughout the water column, although concentrations at the water-sediment interface may remain very low (e.g. December 18, 1974 in Figure 15). In Maxwell Lake (Figure 16) and Weston Lake (Figure 18), dissolved oxygen concentrations actually increase through the thermocline before decreasing in the hypolimnion when the waters are stratified (termed a positive heterograde curve (B.C. Ministry of Environment, 1997)). This is due to the solubility of oxygen, which increases in cooler water. This suggests that the euphotic zone in these two lakes lies somewhere within the metalimnion (or thermocline), and that photosynthesis is keeping dissolved oxygen levels relatively high in this area. This has important repercussions for aquatic life, especially salmonids, in those lakes.

Surface concentrations of DO during the summer in each of the lakes is near 8 mg/L, but temperatures in the surface waters are considerably above the aquatic life guideline (see Section 6.1.1). Therefore, fish must swim in deeper waters, with cooler temperatures, to avoid physiological stress associated with warmer temperatures. In Cusheon Lake and St. Mary Lake, fish utilizing the cooler water of the metalimnion are subjected to lower dissolved oxygen levels, and are therefore forced to move up and down in the water column between optimal temperatures and optimal DO concentrations. In Maxwell Lake and Weston Lake, the elevated DO and cooler temperatures in the metalimnion allow the fish to remain in that area, relatively unstressed.

In order to protect aquatic life, an objective for dissolved oxygen is proposed for Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake. ***The objective is that DO concentrations should remain above 8 mg/L in that portion of the water column that is 19°C or cooler, for a depth of at least three metres.*** So, for example, if surface temperatures in St. Mary Lake were 24°C and water temperatures cooled to 19°C at five metres depth, then the dissolved oxygen concentration between five metres and eight metres should be at least 8 mg/L. This will give salmonids a relatively stress-free zone to retreat to during the summer months. If productivity in the lakes decreases due to decreased nutrient inputs, then the depth of the euphotic zone should increase such that the metalimnion remains well oxygenated.

Another concern associated with decreased oxygen levels near the bottom of the lake is chemical changes that occur in the sediment. At low or anoxic levels, the affinity of iron to bind phosphorus (the key nutrient in aquatic systems, see Section 6.2.1) decreases, and phosphorus begins to be released from the sediments. This results in a positive-feedback loop, with increased phosphorus contributing to increased algal growth, and increased algal growth resulting in decreased light penetration (and therefore no oxygen being produced in the hypolimnion) as well as lower oxygen levels in the hypolimnion resulting from the decomposition of algae. The minimum DO concentration necessary to prevent phosphorus release at the sediment-water interface is 2 mg/L (Marsden, 1989). For this reason, an additional objective for dissolved oxygen is proposed. ***The objective is that dissolved oxygen in the bottom metre of the lake, measured at the deepest point, should remain above 2 mg/L during the summer months.***

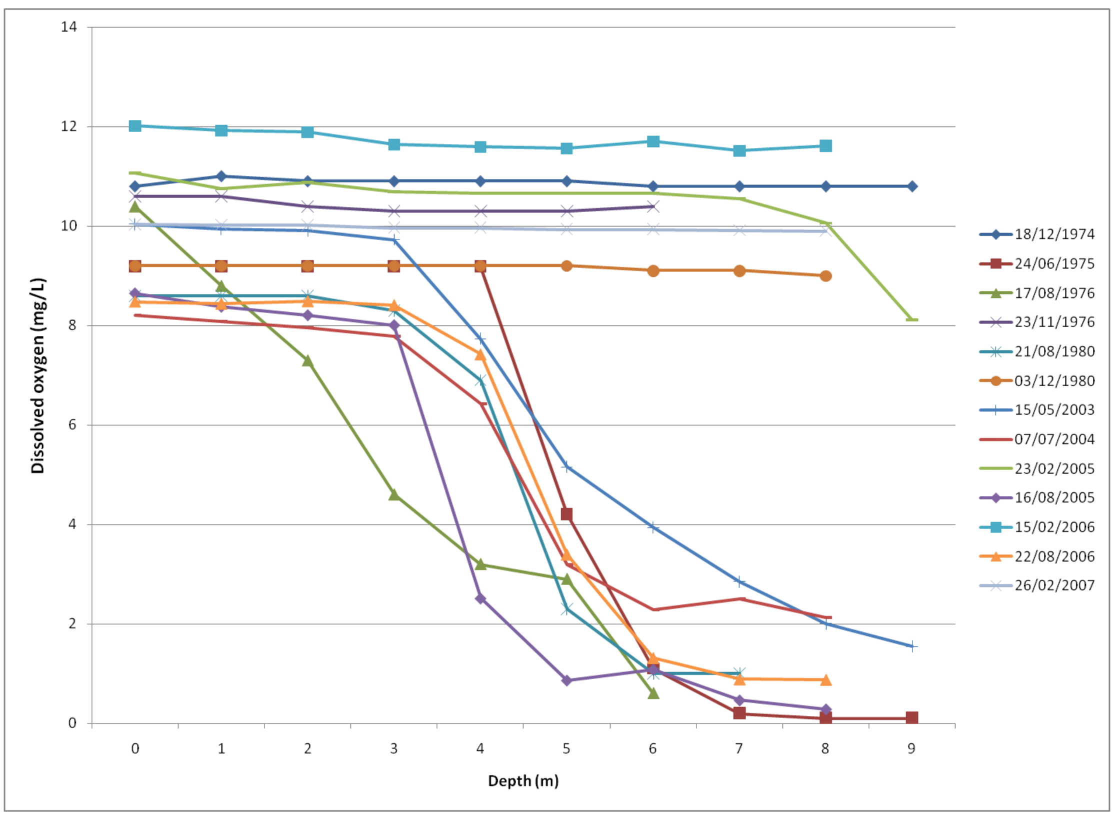

Figure 15. Dissolved oxygen concentrations in Cusheon Lake at the deepest point.

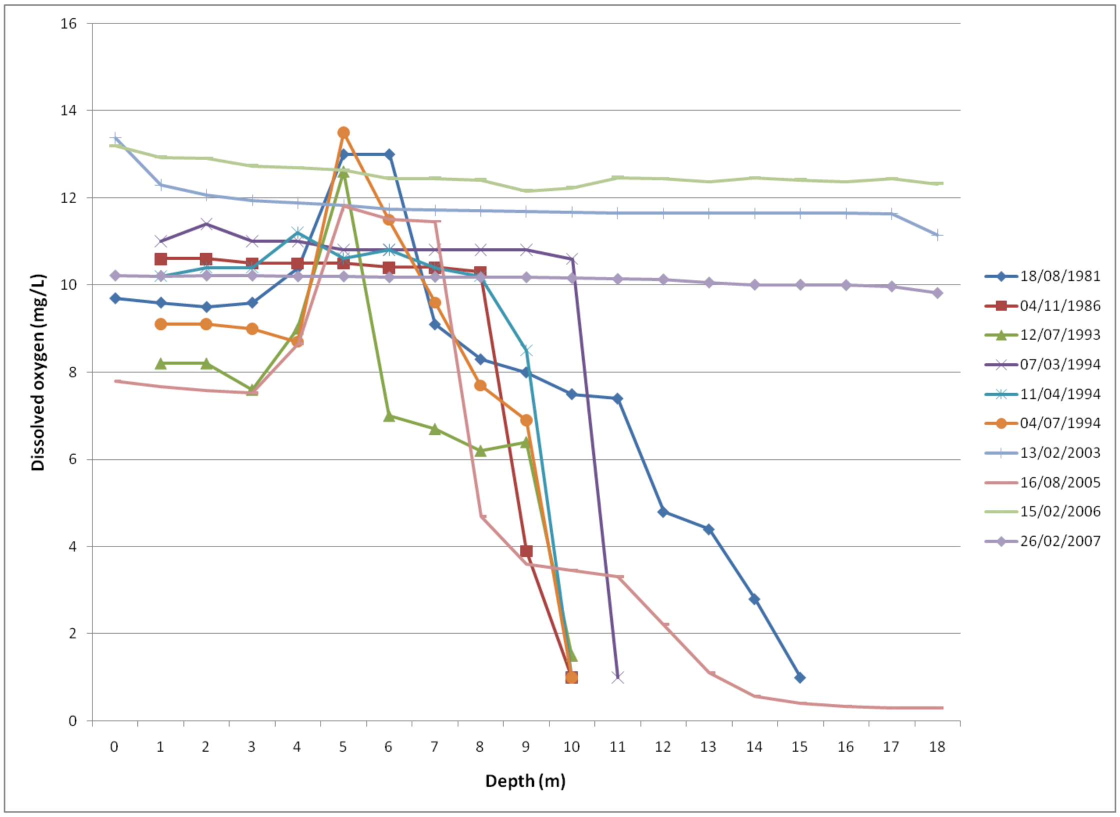

Figure 16. Dissolved oxygen concentrations in Maxwell Lake at the deepest point.

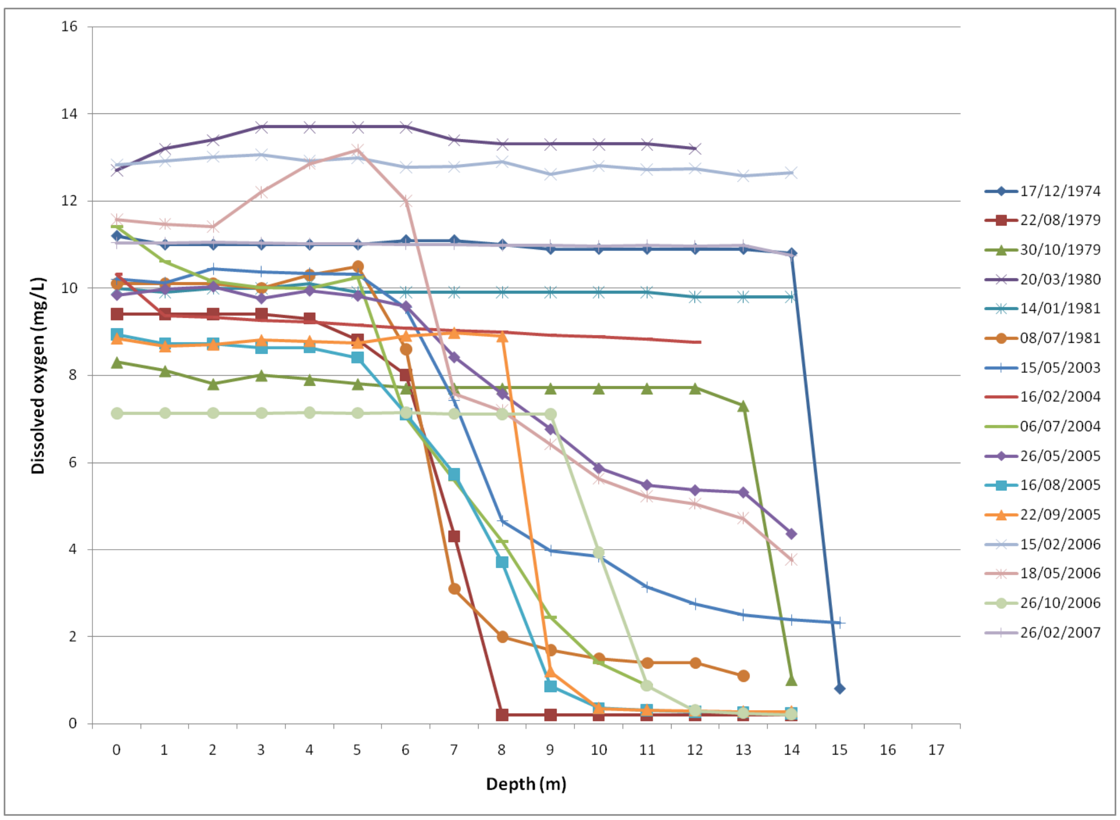

Figure 17. Dissolved oxygen concentrations in St. Mary Lake at the deepest point.

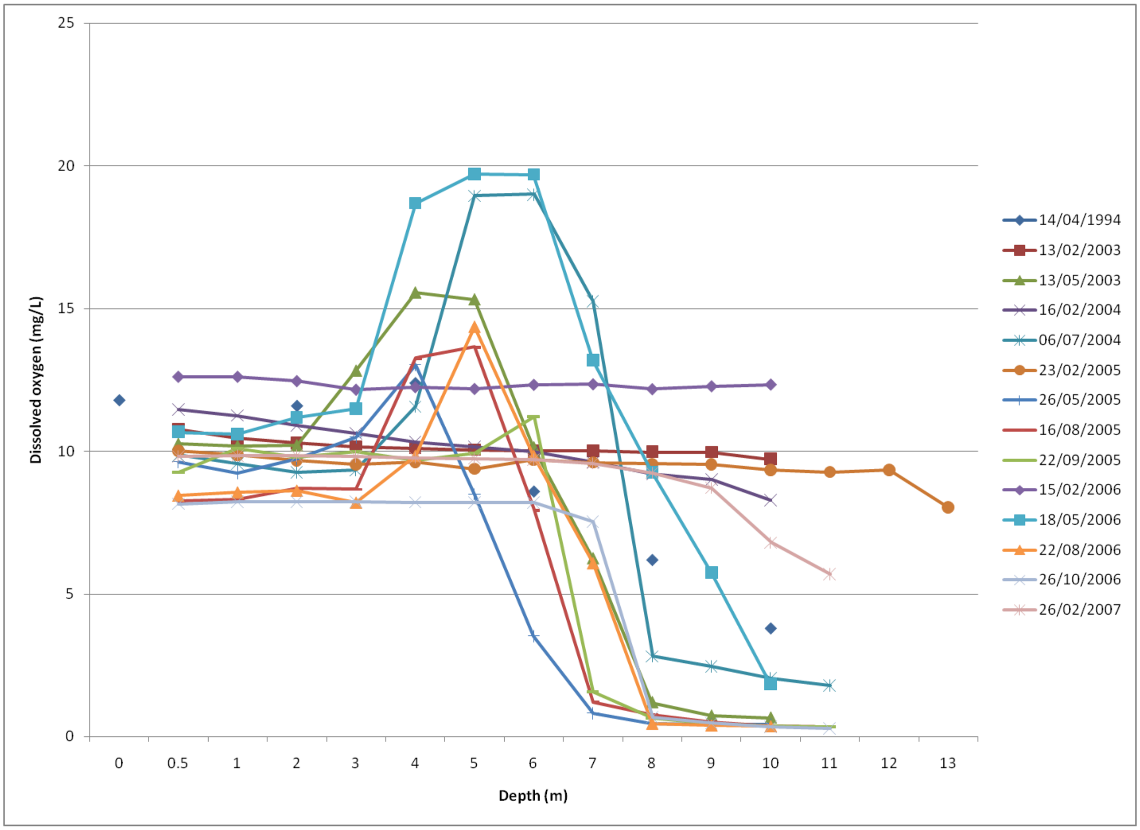

Figure 18. Dissolved oxygen concentrations in Weston Lake at the deepest point.

6.1.3 Water Clarity

As water clarity is primarily affected by colour, suspended solids and algal growth, Secchi disks provide a simple, inexpensive means of measuring changes in a number of important parameters. As well, because the disks are inexpensive and simple to use, laypeople can be easily trained in their use. For this reason, Secchi depths are a popular and useful measurement for volunteer water stewards, as well as water quality professionals. Lakes with high Secchi depths tend to be oligotrophic (low biological productivity), while eutrophic lakes (those with high biological productivity) tend to have low Secchi depths. The Health Canada recreational guideline for Secchi depths is a minimum of 1.2 m (Health Canada, 2012).

Mean annual extinction depths for each of the four lakes are shown in Figure 19 - Figure 22. Mean values are used because individual values can show high variability over the course of a year, or even a given month. Transient events such as rainfall or snowmelt runoff, as well as algal blooms, contribute to this variability. In some instances (e.g., the

7.0 m value measured in St. Mary Lake in 2006), only one measurement was taken in the year, and these values tend to comprise the extremes seen in the figures. In Cusheon Lake and Weston Lake, the fitted lines indicate that secchi depths have remained relatively unchanged over the period of record, while there appears to be a slight increasing trend in St. Mary Lake and a slight decreasing trend in Maxwell Lake. The overall average for all measured values was highest in Maxwell Lake (3.8m), and lowest in St. Mary Lake (2.8m).

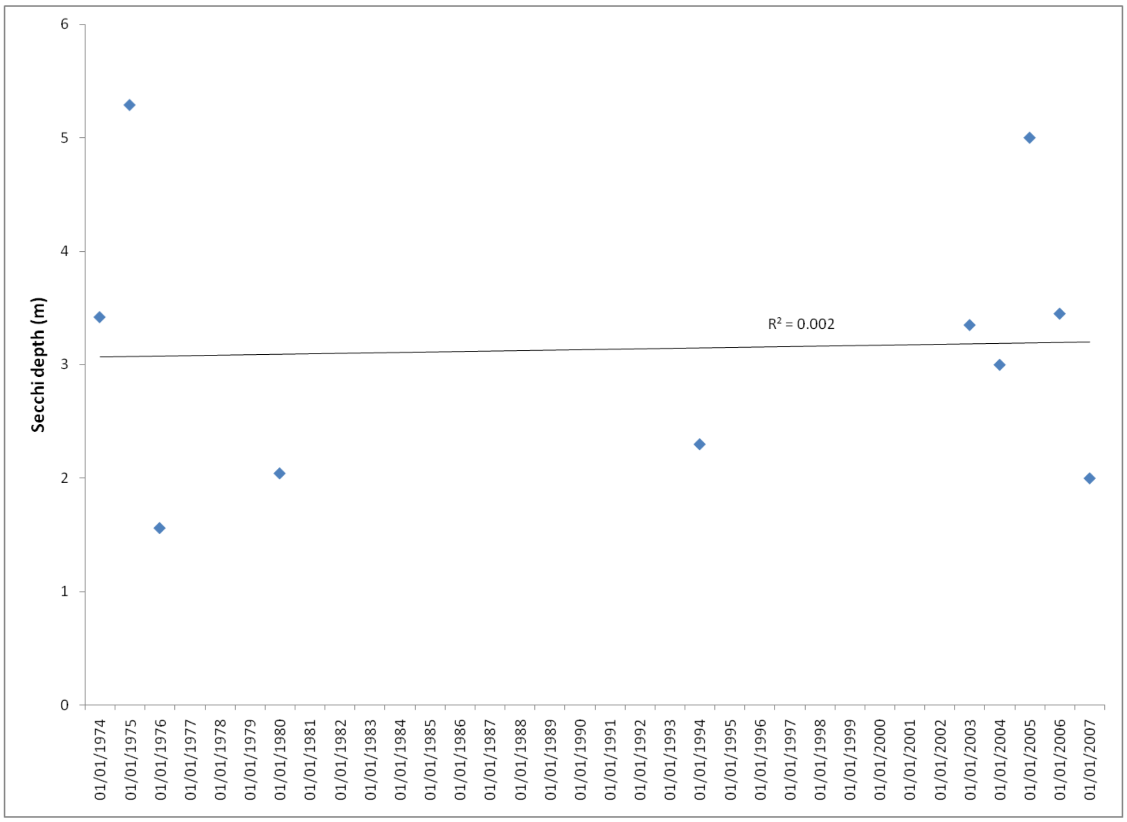

Figure 19. Mean annual Secchi depth measured in Cusheon Lake.

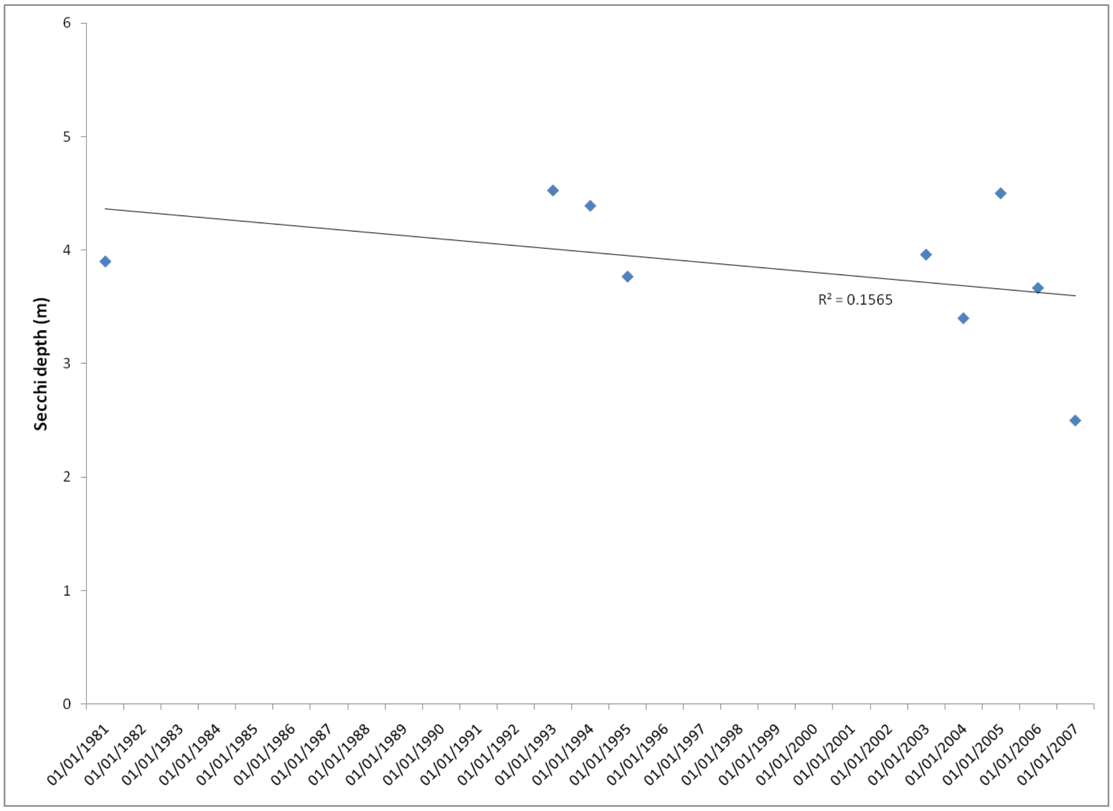

Figure 20. Mean annual Secchi depth measured in Maxwell Lake.

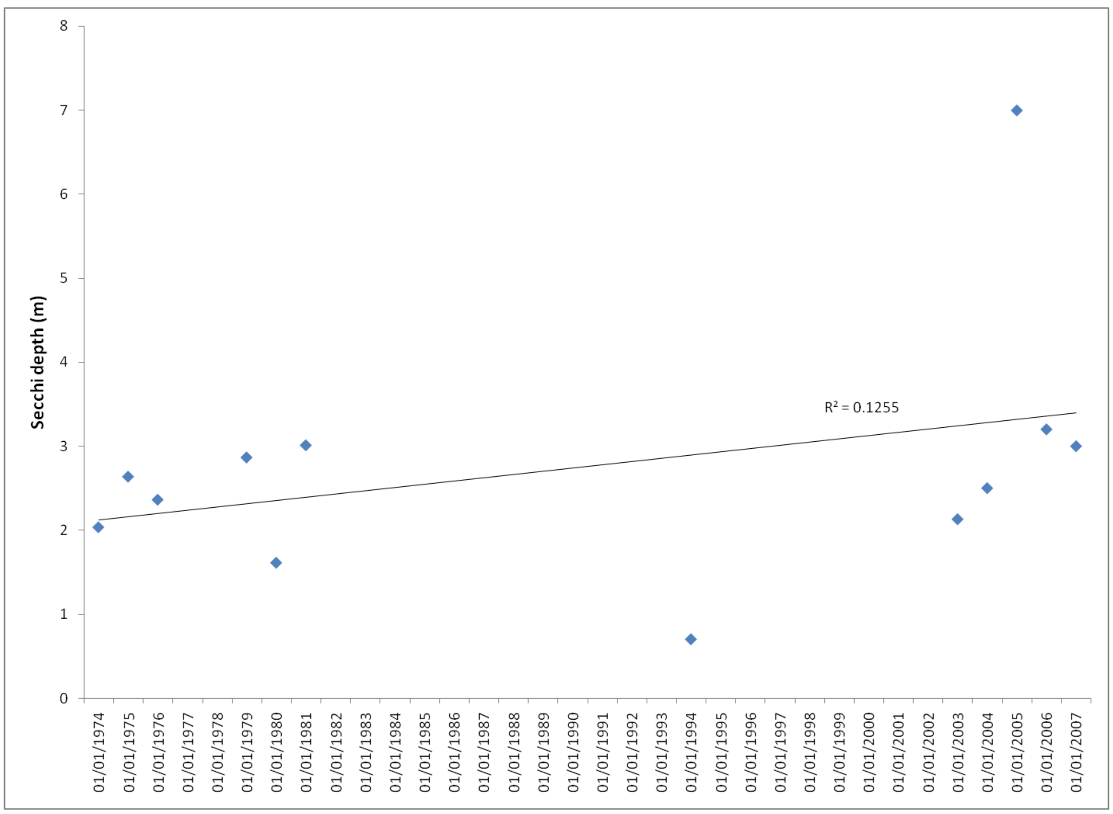

Figure 21. Mean annual Secchi depth measured in St. Mary Lake.

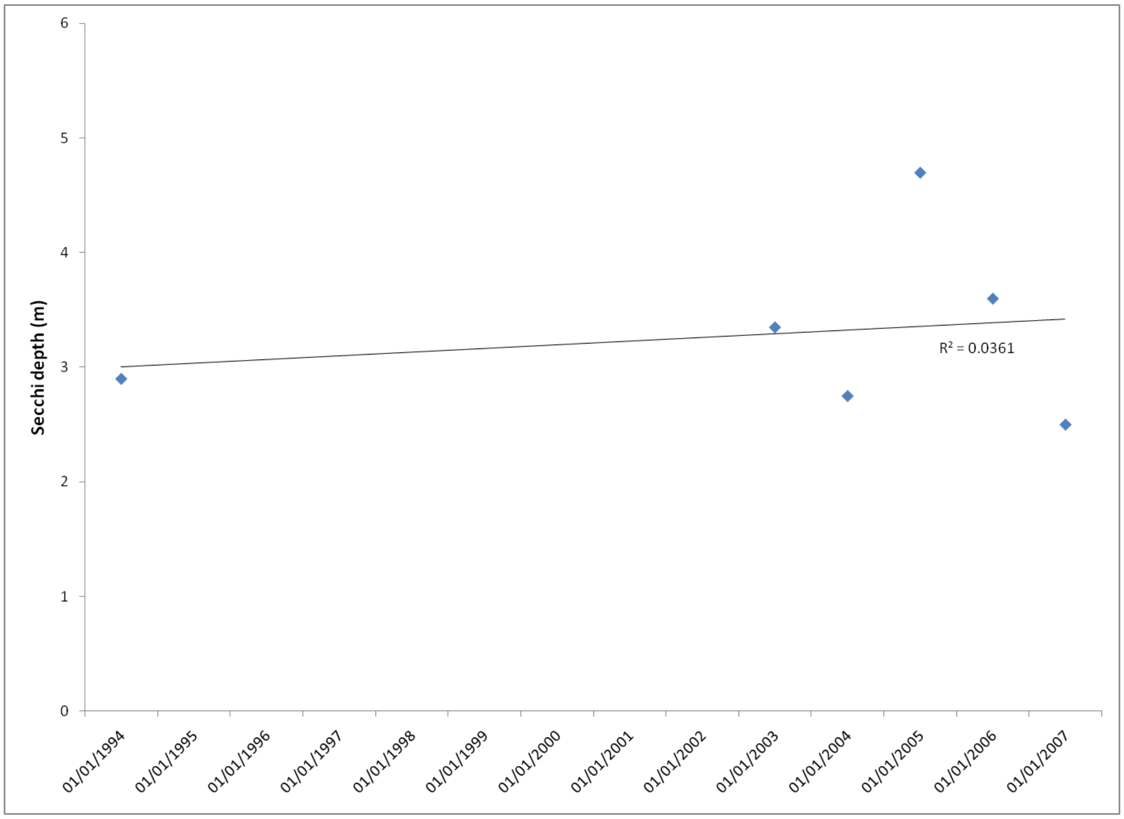

Figure 22. Mean annual Secchi depth measured in Weston Lake.

In order to maintain the existing recreational water quality of the four lakes, we recommend a water quality objective for Secchi depth. ***In Cusheon Lake, St. Mary Lake and Weston Lake, the water quality objective is that the mean annual Secchi depth (based on a minimum of four measurements each year) be at least 3m, while in Maxwell Lake, the objective for the mean annual Secchi depth is a minimum of 4m.*** Meeting these objectives would ensure that some aspects of water quality does not degrade below existing levels, and in Cusheon and St. Mary Lake may require an improvement in existing water quality to allow these lakes to meet the guideline.

6.2 WATER CHEMISTRY

6.2.1 Nutrients (Phosphorus, Ammonia, Nitrate, and Nitrite)

The concentrations of nitrogen (including nitrate and nitrite) and phosphorus are important parameters, since they tend to be the limiting nutrients in biological systems. Productivity is therefore directly proportional to the availability of these nutrients. Nitrogen is usually the limiting nutrient in terrestrial systems, while phosphorus tends to be the limiting factor in freshwater aquatic systems. In watersheds where drinking water is a priority, it is desirable that nutrient levels remain low to avoid algal blooms and foul tasting water. Similarly, to protect aquatic life, nutrient levels should not be too high or the resulting proliferation of algae and other plants can deplete oxygen levels when they die and begin to decompose, as well as during periods of low productivity when plants consume more oxygen than they produce (*i.e.*, at night and during the winter under ice cover).

6.2.1.1 Phosphorus

In lakes, a well defined relationship exists between total phosphorus concentrations (measured at spring turnover), and the amount of algal biomass (measured as chlorophyll *a*) produced in a lake during the growing season. Since phosphorus is much less difficult to measure than algal biomass, and can be easily correlated to other important lake characteristics such as water clarity and hypolimnetic dissolved oxygen, the guideline for nutrients and algae in lakes is presented in terms of total phosphorus concentrations (Nordin, 2001). The guideline for maximum total phosphorus concentrations in B.C. lakes is 10 µg/L to protect drinking water and recreation, and a range of 5 to 15 µg/L to protect aquatic life when salmonids are the dominant species (Nordin, 2001).

Most lakes in BC freeze over and stratify in winter, and for those lakes, the guidelines for total phosphorus apply to spring turnover concentrations. Lakes are typically sampled during the spring and fall because this is when turnover, or vertical mixing of the water column, occurs. Ideally, in a well-mixed lake, concentrations of phosphorus would be identical throughout the water column, but this is seldom the case. For that reason, concentrations are generally measured at a series of depths, and the average total phosphorus concentration is compared with the guidelines. Generally, spring turnover is when the highest concentrations of phosphorus are found. Later in the season, phosphorus is bound in micro-organisms such as phytoplankton, and is therefore found in lower quantities in solution. However, if lakes are undergoing internal nutrient loading, as typically occurs in eutrophic lakes, then the highest concentrations of phosphorus may be found in the fall.

For Salt Spring Island lakes, the guidelines may be more appropriately applied for concentrations measured just after the autumn turnover and again at spring turnover. There have been well documented cases of winter algal blooms and die-offs in the lakes, which can change the phosphorus concentrations during the winter. Furthermore, there is usually no stratification during the winter and hence no distinct spring turnover. The lakes generally remain mixed from late autumn until early spring, so the historic sampling in February would be expected to adequately assess the nutrient concentrations and subsequent predictions for summer algal growth.

Measurements from late spring to early fall are used to document seasonal changes, but are less representative of the lakes' nutrient status because of variable occurrence of plant and algal growth and any subsequent die-off. The plants can take up some of the available phosphorus, removing it from the water, or an algal die-off can remove nutrients when the cells sink to the bottom sediments. As well, when the lake is stratified during the summer, low oxygen levels in the hypolimnion can result in the release of phosphorus from sediments, as discussed in Section 6.1. In each of the lakes, thermal stratification can begin as early as early April and persist until late October.

Spring overturn total phosphorus concentrations for Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake are shown in Figure 23 - Figure 26, respectively. Phosphorus concentrations were lowest in Maxwell Lake, and highest in St. Mary Lake. The average spring overturn concentration of total phosphorus for the entire period of record was 15.6 µg/L in Cusheon Lake, 9.2 µg/L in Maxwell Lake, 25.2 µg/L in St. Mary Lake and 17.6 µg/L in Weston Lake. The average spring overturn total phosphorus concentration in Maxwell Lake was below the drinking water guideline and well within the aquatic life guideline each year for the period of record, while annual springtime averages for Cusheon Lake and Weston Lake usually exceeded the drinking water guideline but were within the aquatic life guideline. Concentrations of spring overturn phosphorus in St. Mary Lake were consistently considerably higher than the drinking water guideline and usually exceeded the aquatic life guideline as well. There does not appear to be a trend in total phosphorus concentrations at spring overturn in any of the lakes over the period of record with the exception of Weston Lake. In Weston Lake, it appears that average spring overturn phosphorus concentrations are decreasing over time

(Figure 26). Studies conducted in 1998 used statistical analyses to determine that there was a decreasing trend in Maxwell Lake between 1985 and 1994 (Regnier, 1998a), and no discernable trend in either Cusheon Lake (1976 – 1998) or St. Mary Lake (1974 – 1998) (Regnier, 1998b).

As all of the lakes discussed in this report are used as drinking water supplies, ideally the spring overturn phosphorus concentration of each of the lakes should consistently meet the source drinking water guideline (10 µg/L). As well, 10 µg/L is considered the threshold beyond which symptoms of hypolimnetic oxygen depletion occur (Nordin, 2001). However, paleolimnological assessments (which analyzes the diatom community composition in sediment cores, thereby estimating historical phosphorus concentrations) have been made for both Cusheon Lake and St. Mary Lake (Cumming *et al.* 2005; Cumming *et al.* 2006), and these assessments suggest that total phosphorus concentrations in both lakes have been in the mesotrophic range (varying between 13 µg/L and 16 µg/L for St. Mary Lake, and between 10 µg/L and 17 µg/L for Cusheon Lake) even prior to human habitation. As it is unreasonable to propose a water quality objective at levels below those which would occur naturally (without antropogenic impact), ***we recommend a water quality objective for Cusheon Lake, St. Mary Lake and Weston Lake allowing a maximum phosphorus concentration of 13.5 µg/L when the lake is mixed (spring or autumn). In Maxwell Lake, to protect existing ambient conditions, the recommended water quality objective is a maximum of 10 µg/L total phosphorus at the time of lake mixing (spring or autumn).*** It is also recommended that in the future, an assessment of the mixed conditions in these lakes should be made just after the autumn turnover, which usually occurs in late October or early November. Spring turnover conditions should continue to be assessed to correlate with historic data. Because of the uncertainty of the exact time of fall turnover, it would be beneficial to make some additional adjustments to the sampling schedule, to focus more effort on the autumn period, including a survey aimed at the period just before turnover, which would obtain the final stages of the seasonal pattern resulting from summer stratification. That would be followed by the above mentioned sampling aimed at the post-turnover situation.

Sampling should occur in February or March for spring turnover (prior to thermal stratification) and likely in November just after the autumn turnover or mixing of the lake. Spring and autumn phosphorus concentrations for all of the lakes should be based on the mean of at least three samples collected at the deepest point in the lake (one at the surface, one mid-column and one near the bottom of the lake).

In 1986, an aerator was installed in St. Mary Lake which operated between April and October each year (the typical period of stratification) until 1993 (Holms, 1996). During this period, total spring phosphorus concentrations decreased considerably (Figure 25). Two new, larger capacity aerators were installed in July 2008, with the objective of eliminating or greatly reducing regeneration of phosphorus from bottom sediments. When that large phosphorus load is reduced, remedial measures for inputs from domestic sewage will be required to meet the objectives described here (see St Mary Lake Wateshed management plan recommendations (SMLSC, 2008)). For Cusheon Lake, just over half of the phosphorus load is from land runoff. The phosphorus objective recommended here conforms with the objective stated in the management plan (CWMPSC, 2007), and meeting it will require an input reduction of 18kg of phspohorus annually (Sprague 2007, CWMPSC, 2007). A similar strategy may be required for Weston Lake for which no management plan yet exists, while Maxwell Lake currently meets the recommended objective.

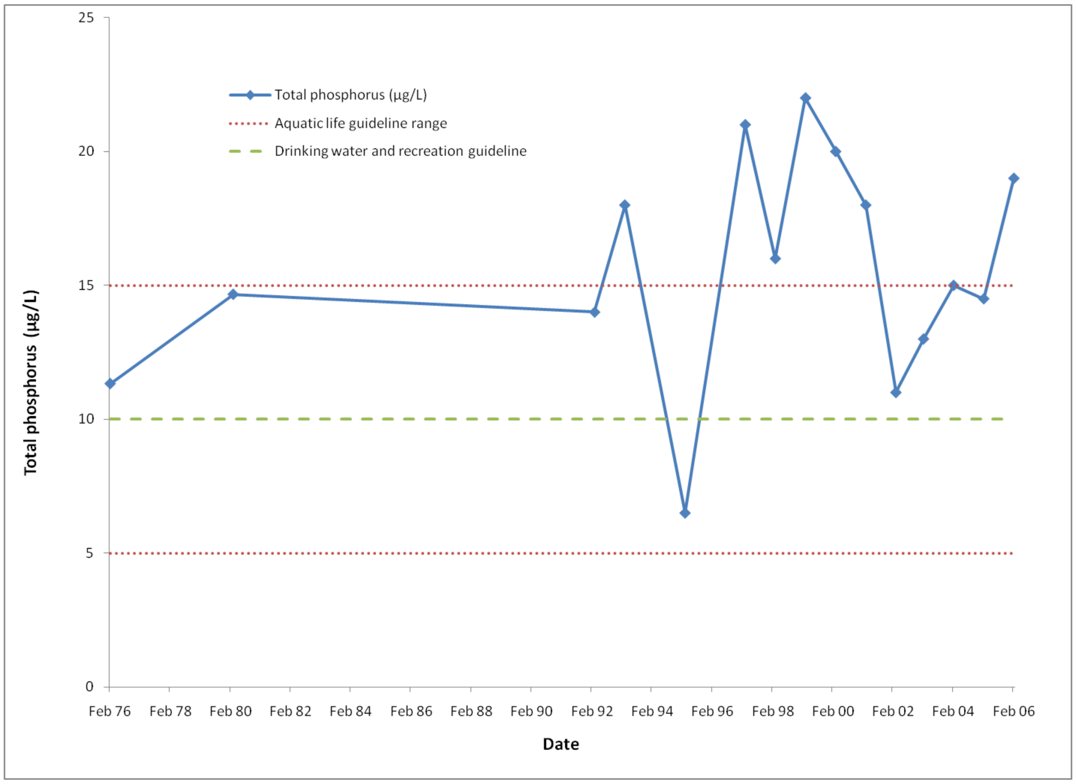

Figure 23. Spring overturn (February-March) total phosphorus concentrations in Cusheon Lake between 1976 and 2006.

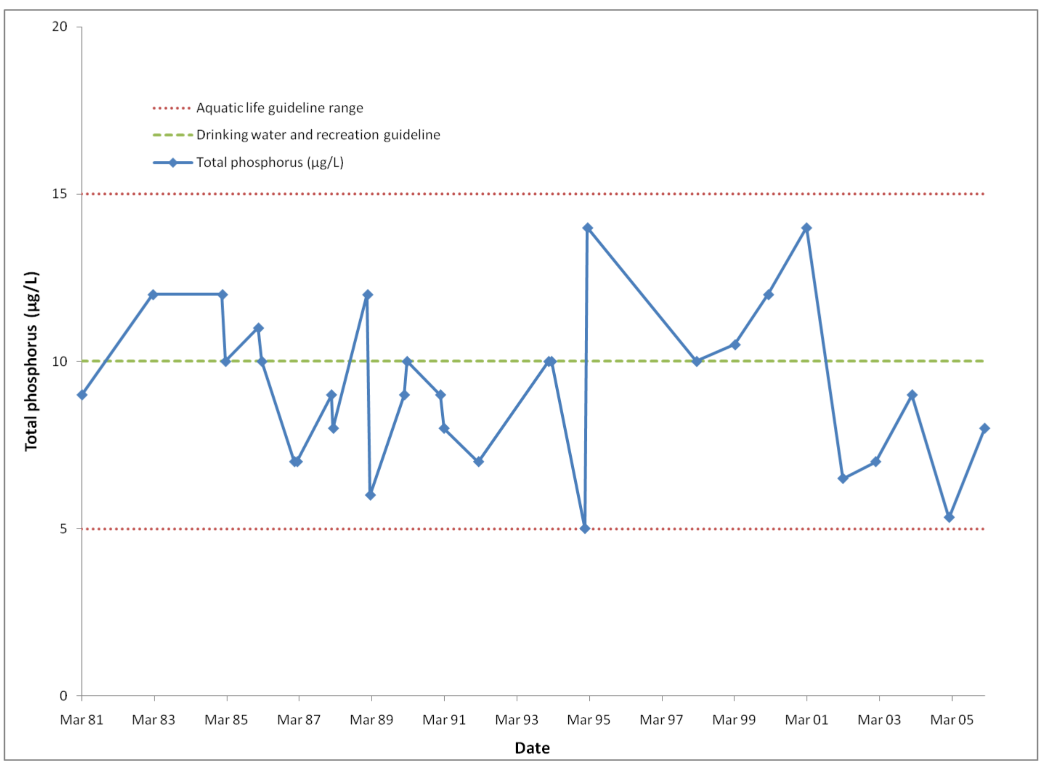

Figure 24. Spring overturn (February-March) total phosphorus concentrations in Maxwell Lake between 1981 and 2006.

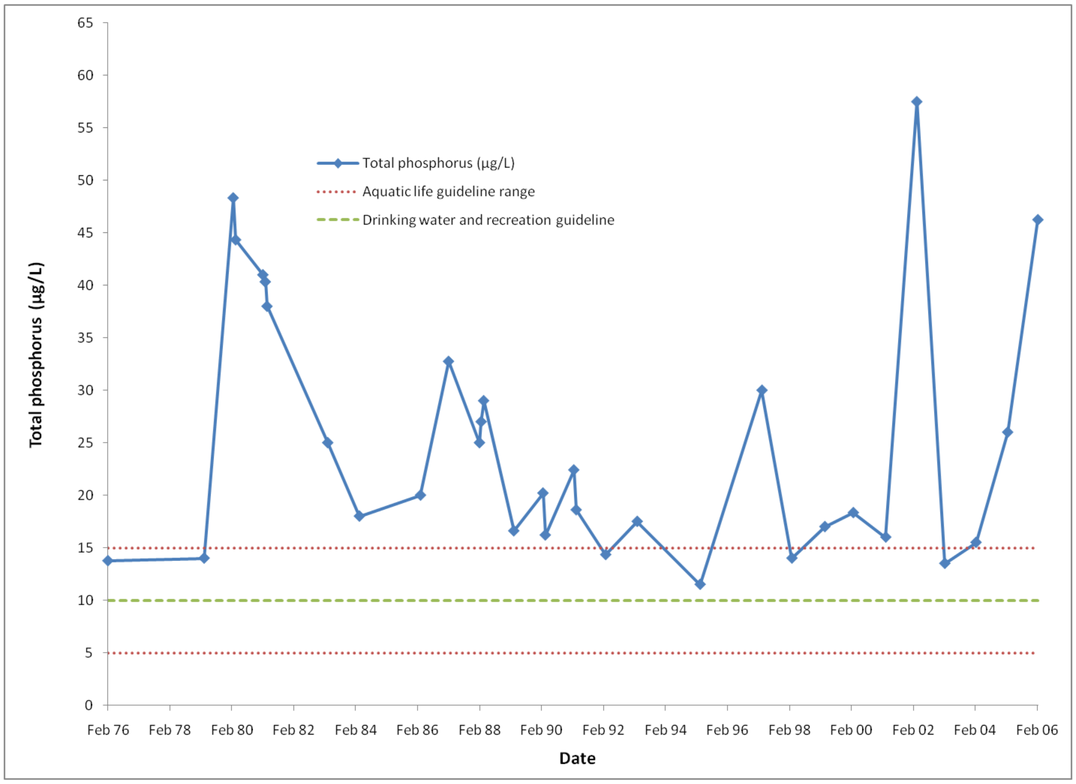

Figure 25. Spring overturn (February-March) total phosphorus concentrations in St. Mary Lake between 1976 and 2006.

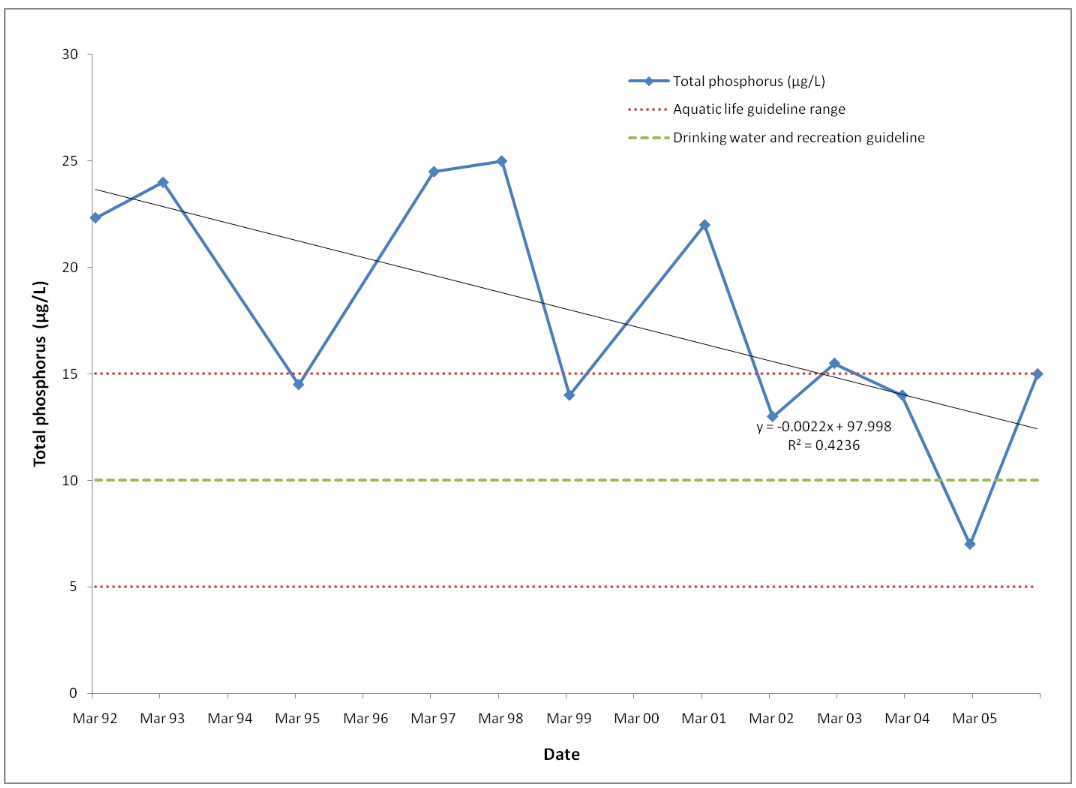

Figure 26. Spring overturn (February-March) total phosphorus concentrations in Weston Lake between 1992 and 2006.

An examination of total phosphorus concentrations measured at other times of the year show values considerably higher than those seen during spring overturn for each of the four lakes (Table 8). Almost all of the elevated total phosphorus concentrations occur in the bottom or near the bottom of the lakes, and generally while the lake is stratified. An exception to this was on November 18, 2004 in Weston Lake, when a concentration of 205 µg/L was measured at 10 metres depth while the surface concentration was 12 µg/L. In this instance, it is possible that the sampling device may have disturbed the sediment, as turbidity in the sample was also elevated (6.1 NTU).

Comparing total phosphorus concentrations in the surface waters with deeper waters while the lake was stratified (i.e. between mid-May and mid-October), concentrations were generally considerably higher in the deeper waters (Table 8). This supports the observations that severe phosphorus loading from the sediments is occurring in Cusheon and St. Mary Lakes (Sprague 2007, Nordin and McKean 1983). While ortho-phosphorus concentrations were not measured often enough to determine a strong correlation between elevated hypolimnion total phosphorus and elevated ortho-phosphorus, one set of samples collected on August 17, 1981 near the bottom of St. Mary Lake had total phosphorus concentrations of 640 to 920 µg/L, and ortho-phosphorus concentrations ranging from 352 to 363 µg/L. Phosphorus released from sediments is generally in the form of ortho-phosphorus, further supporting the observations of internal loading.

Table 8. Summary of maximum total phosphorus concentrations and the dates on which they occurred, as well as a comparison between epilimnion and hypolimnion concentrations of total phosphorus.

	Maximum total phosphorus (µg/L)	Date of maximum total phosphorus	Average difference, epilimnion to hypolimnion (µg/L)
Cusheon Lake	930	Sept 17, 2001	192
Maxwell Lake	145	August 22, 2006	32
St. Mary Lake	920	August 17, 1981	65
Weston Lake	205	November 18, 2004	48

Studies have been conducted within the Cusheon Lake (CWMPSC, 2007; Sprague, 2007) and St. Mary Lake (Nordin and McKean, 1983) watershed to determine sources of phosphorus, as well as their estimated relative contribution to total phosphorus loadings

(Table 9, Table 10). Total estimated loadings to St. Mary Lake are much higher than loadings to Cusheon Lake, but the higher concentrations of phosphorus found in St Mary Lake is tempered by its much larger volume of water. Almost 65% of the annual loading to the water has been from internal loading from the sediment, a factor which will be reduced considerably (or eliminated) if the recently installed aerators are successful in preventing hypolimnetic anoxia.

The sources of phosphorus in Cusheon Lake are quite different (Table 9). Sprague (2007) calculated the magnitudes of potential sources and found that slightly more than half of the total yearly input to the Cusheon waters came from land runoff, partly via the upstream lakes. That source is potentially much smaller for St. Mary Lake, being only about 4% of the total. Regeneration from the Cusheon sediments accounts for only 21% of the total, rather than almost two-thirds in St. Mary Lake. The proportions from septic field leakage are similar in the two lakes, but the absolute amount going to Cusheon is only about one-tenth of that for St. Mary Lake, and it must be rememebered that the two lakes have approximately the same yearly flow-through of water to assimilate these loads. Sources of phosphorus loadings have not been determined for Maxwell and Weston Lakes, but some differences can be postulated. Septic loadings in Maxwell Lake would be non-existent, while relative loadings from grazing animals (transported as runoff) are thought to have been higher some years ago in the Weston Lake watershed (Nordin, 1985).

Table 9. Summary of estimated annual phosphorus loadings to Cusheon Lake (from Sprague, 2007 and CWMPSC, 2007).

	kg P	Percent
Land runoff and upstream lakes input	62.7	53.5
Rainfall to surface of lake	2.6	2.3
65 residences near lake	17.7	15.1
26 units in trailer court	7.8	6.6
Shoreline clearing at 40 residences	1.4	1.1
Regeneration from deep sediments of lake	25.0	21.3
Total loading to lake (kg P/yr)	117.3	99.9

Table 10. Summary of estimated annual phosphorus loadings to St. Mary Lake (from Nordin and McKean, 1983).

	1979 – 80		1980 – 1981		1981-1982	
	kg P	%	kg P	%	kg P	%
Internal loadings	465	57.8	560	62.2	850	71.4
Septic system input	290	36.0	290	32.2	290	24.4
Streams	40	5.0	40	4.4	40	3.4
Groundwater	10	1.2	10	1.1	10	0.8
Total:	805	100.0	900	100.0	1,190	100.0

For Cusheon Lake, it has been estimated that if the total yearly loading of phosphorus (external and internal) were reduced by 17.7 kg to about 100 kg, a mixed lake concentration of 13.5 µg/L would be achieved and that was recommended as an objective (Sprague, 2007; CWMPSC, 2007). The management plan for St. Mary Lake sets an objective for a mixed lake concentration between 10 and 15 µg/L, preferably in the lower rart of that range (SMSC, 2008). It is estimated that a reduction of 292 kg of phosphorus lading would result in a concentration of about 12 µg/L. That could be achieved by reducing any of the inputs, such as 80% of the sediment regeneration plus 67% of the human sewage input. If and when those objectives are achieved, primary production in the form of algae will decrease in those two lakes and blooms will be modest. This in turn will result in an increase in the euphotic depth (because decreased algal levels will result in increased water clarity and therefore increased light penetration). Photosynthetic production of oxygen in the lower water levels, coupled with a decrease in oxygen consumption (because of decreased algal production in the epilimnion), would likely maintain dissolved oxygen levels at the sediment-water interface above 2 mg/L, therefore preventing internal loading of phosphorus. That oxygen in the hypolimnion is virtually certain in St. Mary Lake if the aerators continue to operate effectively. In this way, the positive-feedback loop discussed in Section can be avoided and overall water quality will improve.

6.2.1.2 Nitrogen (Ammonia, Nitrate and Nitrite)

The BC MOE guideline for the maximum concentration for nitrate in drinking water is 10 mg/L as nitrogen and the guideline for nitrite is a maximum of 1 mg/L as nitrogen. When both nitrate and nitrite are present, their combined concentration must not exceed 10 mg/L as N. There is no BC guideline for ammonia in drinking water. For the protection of aquatic life the maximum concentration of nitrate is 200 mg/L and the maximum concentration of nitrite is 0.06 mg/L (Nordin, *et al.*, 2001). The guidelines for maximum ammonia concentrations for the protection of aquatic life are dependent on temperature and pH; as both of these factors increase in the water, so does the toxicity of ammonia. The same is true for average ammonia concentrations. The guidelines for forms of nitrogen are currently being reviewed and will likely become more stringent.

A summary of the nitrogen sampling conducted in the four lakes is given in Table 11 - Table 14. Concentrations of dissolved nitrite were consistently below the guideline levels in all of the lakes on those occasions when it was measured independently of nitrate, with the exception of one sample in St. Mary Lake, collected from 14m depth on October 17, 1994. This value (0.072 mg/L) exceeded the guideline for the protection of aquatic life of 0.06 mg/L, but was well below the drinking water guideline of 1 mg/L. The next-highest nitrite value measured in St. Mary Lake was 0.021 mg/L. There were a number of other occasions when nitrate and nitrite were measured together, and in those instances it is not possible to determine whether compliance had been achieved with the nitrite guidelines for aquatic life guideline.

Concentrations of nitrate, as well as concentrations of nitrate + nitrite, were consistently well below 1 mg/L and therefore well below the drinking water guideline of 10 mg/L in all four of the study lakes.

Ammonia concentrations were occasionally high in each of the lakes, exceeding 1 mg/L in all of the lakes except Maxwell Lake. Unfortunately, as ammonia toxicity is directly correlated with pH and temperature, both pH and temperature must be measured at the same time as the ammonia concentration, and this did not occur for any of the samples in any of the lakes. However, the maximum ammonia concentrations were consistently measured near the sediment/water interface. This is due to the action of nitrifying bacteria acting on decaying matter in the sediments, which degrade nitrogen into ammonia and nitrites (Wetzel, 1983). Almost all of the instances where dissolved ammonia concentrations exceeded 1.0 mg/L occurred in the late summer/early fall (between August and November), when senescence is highest. Water temperatures near the bottom of the lakes were consistently at or below 11°C (in Weston Lake, lake bottom temperatures were below 8°C), and pH measured on those occasions when dissolved ammonia exceeded 1.0 mg/L was consistently below 7.3 pH units at all of the sites. At a temperature of 11°C and a pH of 7.3, the guideline for the maximum total ammonia concentration for the protection of aquatic life is approximately 16 mg/L, and the average guideline is 1.83 mg/L. Therefore, it appears that ammonia concentrations in St. Mary Lake and Weston Lake may occasionally approach the average aquatic life guideline. ***For that reason, an objective is proposed for ammonia concentrations in both St. Mary Lake and Weston Lake, such that the average concentration of total ammonia measured in a minimum of five samples collected within a 30-day period should not exceed 1.8 mg/L***. Water samples should be collected during the late fall and as near to the sediment/water interface as possible, and water temperature and pH should be measured at the same time to enable a determination of the guideline level. If phosphorus loadings to St. Mary Lake and Weston Lake are reduced, then biological productivity should also be reduced and ammonia levels resulting from the decomposition of the biological matter should also decrease. As well, ammonia release from the sediments will be considerably lower if the bottom waters remain oxygenated (Wetzel, 1983).

Table 11. Summary of various forms of nitrogen in Cusheon Lake, 1974 – 2007

Parameter	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Std Dev	No. of Samples
Ammonia - D	0.005	1.04	0.067	0.165	112
Nitrate - D	< 0.002	0.561	0.211	0.210	45
Nitrate + Nitrite - D	< 0.002	0.65	0.204	0.210	155
Nitrite - D	< 0.002	0.018	0.005	0.002	53
Kjeldahl Nitrogen - D	0.16	1.3	0.390	0.267	16
Organic Nitrogen - T	0.16	0.86	0.402	0.152	64
Nitrogen - T	0.24	1.7	0.630	0.249	119

Table 12. Summary of various forms of nitrogen in Maxwell Lake, 1981 – 2007.

Parameter	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Std Dev	No. of Samples
Ammonia - D	0.005	0.414	0.025	0.069	72
Nitrate - D	< 0.002	0.058	0.013	0.012	44
Nitrate + Nitrite - D	< 0.002	0.1	0.017	0.014	84
Nitrite - D	< 0.002	0.006	0.004	0.001	49
Kjeldahl Nitrogen - D	0.21	0.91	0.311	0.163	21
Organic Nitrogen - T	0.07	0.5	0.253	0.080	36
Nitrogen - T	0.16	0.91	0.299	0.130	59
Nitrogen - D	0.222	0.912	0.321	0.161	21

Table 13. Summary of various forms of nitrogen in St. Mary Lake, 1974 – 2007.

Parameter	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Std Dev	No. of Samples
Ammonia - D	< 0.005	1.65	0.099	0.219	578
Nitrate - D	< 0.002	0.233	0.038	0.066	40
Nitrate + Nitrite - D	< 0.002	0.87	0.059	0.118	630
Nitrite - D	< 0.002	0.072	0.005	0.009	71
Kjeldahl Nitrogen - D	0.24	1.6	0.585	0.332	34
Organic Nitrogen - T	0.03	1.23	0.395	0.167	248
Nitrogen - T	0.17	1.61	0.569	0.256	297
Nitrogen - D	0.252	1.602	0.618	0.311	34

Table 14. Summary of various forms of nitrogen in Weston Lake, 1986 – 2007.

Parameter	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Std Dev	No. of Samples
Ammonia - D	< 0.002	2.9	0.279	0.612	56
Nitrate - D	0.001	0.351	0.130	0.140	30
Nitrate + Nitrite - D	< 0.002	0.358	0.138	0.126	58
Nitrite - D	< 0.002	0.008	0.004	0.002	30
Kjeldahl Nitrogen - D	0.33	2.7	0.893	0.798	16
Organic Nitrogen - T	< 0.02	0.93	0.385	0.189	16
Nitrogen - T	0.34	3.59	0.976	0.751	36
Nitrogen - D	0.334	2.704	1.021	0.744	16

On sampling days when both total nitrogen and total phosphorus were measured, the ratio of nitrogen to phosphorus was calculated. The N:P ratio is significant because when the ratio is less than 5:1 (based on actual weight, rather than atomic weight), a freshwater aquatic system can be considered nitrogen limited; ratios between 5:1 and 15:1 indicate no limitation or co-limitation, and ratios greater than 15:1 indicate phosphorus limitation (Nordin, 2001). In most bodies of water, phosphorus is the limiting nutrient, and this condition tends to be associated with oligotrophic conditions, while those limited by nitrogen availability are associated with eutrophic conditions. As well, phytoplankton populations limited by nitrogen tend to be dominated by cyanobacteria, because they are able to fix atmospheric nitrogen.

The N:P ratio was determined in both the epilimnion and the hypolimnion of the four lakes, since it has been found that phosphorus concentrations are much higher in the hypolimnion than in the epilimnion during stratification (see Section 6.2.1.1). As well, nutrient limitation is not as significant in the hypolimnion, since it is generally below the euphotic zone (and therefore deeper than the level that algae are able to grow).In Cusheon Lake and St. Mary Lake, the N:P ratio in the hypolimnion was occasionally less than 5:1, with seven of 33 values below 5:1 in Cusheon Lake and 12 of 68 values less than 5:1 in St. Mary Lake. The minimum ratio in Cusheon Lake was 1.3:1, while the minimum ratio in St. Mary Lake was 1.8:1. In the epilimnion of these two lakes and in both the epilimnion and hypolimnion of Maxwell and Weston lakes, the N:P ratio was consistently above 5:1, and usually above 15:1, suggesting that productivity in the four lakes is phosphorus limited. To ensure that the lakes continue to be phosphorus limited, we recommend a water quality objective for the N:P ratio in all of the four study lakes. ***The objective is that the ratio of nitrogen to phosphorus in the epilimnion should remain above 15:1 at all times during the year.***

6.2.1.3 Silica

The concentration of silica in freshwater is significant, because silica can be a limiting factor in the growth of diatomaceous algae. Diatoms require large amounts of silica to synthesize their frustules, or cell walls. For this reason, silica availability can strongly influence patterns of algal succession and productivity in lakes (Wetzel, 1983). Diatoms are generally considered “good” phytoplankton, unlike cyanobacteria which can cause taste and odor problems, and in some cases produce neurotoxins.

Concentrations of silica measured in the four lakes varied with depth, as is typical. Photosynthesis in the epilimnion results in uptake of silica from the water column. In deeper water, below the euphotic zone, silica uptake is much lower. It appears that silica concentrations vary according to the phytoplankton species composition. In Cusheon Lake, St. Mary Lake and Weston Lake, summer concentrations of dissolved silica in the surface water are often high (as high as 7.6 mg/L in August 2006 in Cusheon Lake, as high as 6.7 mg/L in July 1980 in St. Mary Lake, and as high as 6.5 mg/L in August 2005 in Weston Lake). In other years, summer concentrations are considerably lower in those lakes, suggesting that diatoms make up a larger proportion of the phytoplankton community. In contrast, concentrations of dissolved silica are consistently low in the more oligotrophic Maxwell Lake, with surface concentrations ranging from 0.7 mg/L to

2.3 mg/L, suggesting that diatoms make up a significant proportion of phytoplankton in that lake most years. In general, it would be preferably to see low concentrations of silica in all of the lakes during the growing season, as this would indicate that “good” diatomaceous phytoplankton are abundant.

6.2.2 pH

pH measures the concentration of hydrogen ions (H^+) in water. That concentration can range over 14 orders of magnitude, so pH is defined on a logarithmic scale between 0 and 14. A pH between 0 and 7 is acidic (the lower the number, the more acidic the water) and a pH between 7 and 14 is alkaline (the higher the number, the more basic the water). The aesthetic objective for drinking water is a pH between 6.5 and 8.5 (Nagpal *et al.*, 2006). Corrosion of metal plumbing may occur at both low and high pH outside of this range, while scaling or encrustation of metal pipes may occur at high pH. The effectiveness of chlorine as a disinfectant is also reduced outside of this range. The aquatic life guideline allows a pH range between 6.5 and 9.0 pH units. Outside of this range, toxicity to fish begins to occur.

The mechanisms of pH profiles in lakes are affected to a large degree by photosynthesis. As photosynthetic activity increases (generally in the afternoon), carbon dioxide concentrations in the water decrease. This decrease in carbon dioxide results in an increase in pH. In soft waters with low buffering capacities (low carbonate levels) such as those seen in the Salt Spring lakes, pH fluctuates much more readily than in waters with high buffering capacities. Increases in pH that result in carbon dioxide concentrations below 10 µmol/L can result in a shift in the phytoplankton community structure to cyanobacteria (see Section 6.3.1 , below) (McKean, *et al.*, 1991). Decreases in photosynthetic activity (e.g. during the night, or below the euphotic zone) result in increased carbon dioxide levels, and therefore a decrease in pH.

pH profiles measured in the field are shown in Figure 27 to Figure 30. All of the lakes showed a wide degree of variability in pH, with values ranging from approximately 6 pH units to as high as 8.5 pH units. As such, pH in each of the lakes was occasionally below both the drinking water and aquatic life threshold of 6.5 pH units. Typically we would expect to see the lowest pH values during the winter months, when inputs from low-pH rainwater are at their highest, but no such seasonal trends were seen in any of the lakes. However, pH did typically change with depth in each of the lakes, increasing in the first few metres becausee of reductions in carbon dioxide produced by photosynthesis, and then decreasing in deeper waters as light penetration decreased. Values were likely slightly lower in general at the surface due to carbon dioxide in the atmosphere diffusing into the surface waters.

A ten-year study conducted between 1984 and 1994 in Maxwell Lake to look for potential effects of acid rain showed no trends in pH over the period (Phippen, *et al*., 1996). It would appear that occasional low pH is a natural phenomenon in the four Salt Spring Island lakes, and it is not likely that anthropogenic activities will affect pH in these lakes. Therefore ***no objective is proposed*** for pH in Cusheon, Maxwell, St. Mary or Weston Lake.

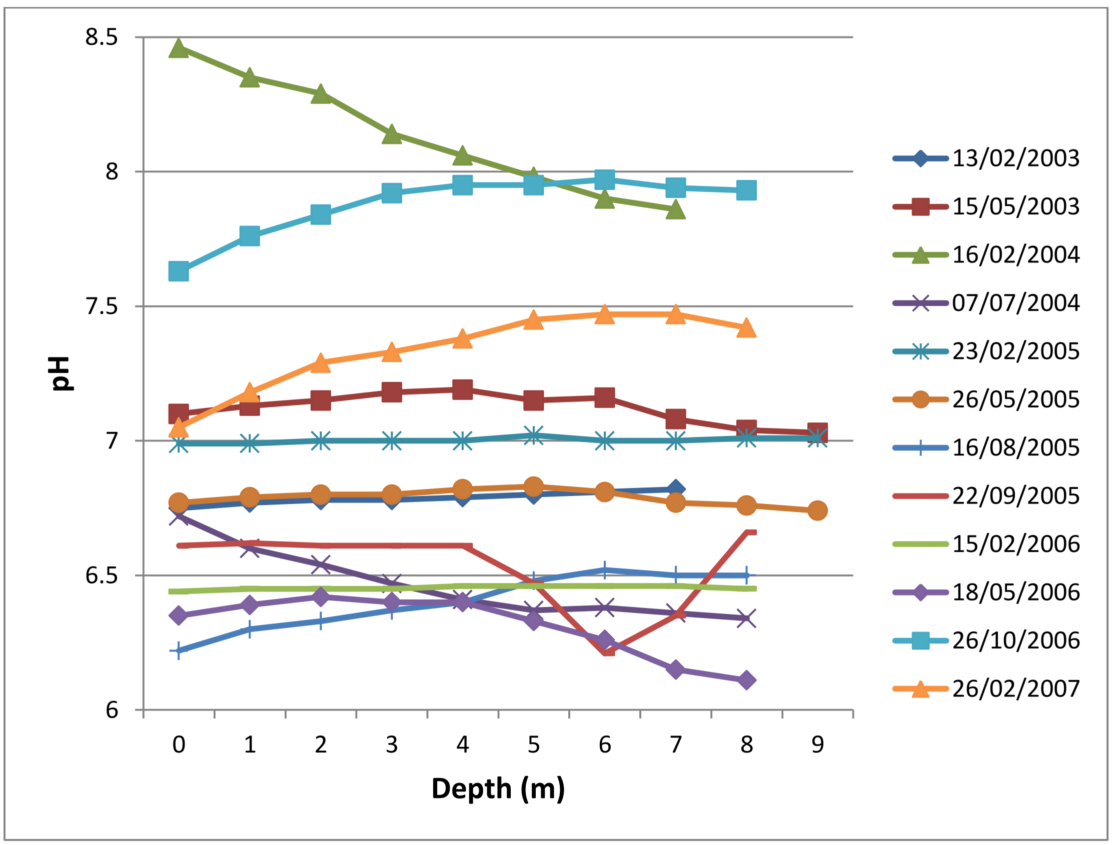

Figure 27. Field pH profiles in Cusheon Lake between 2003 and 2007.

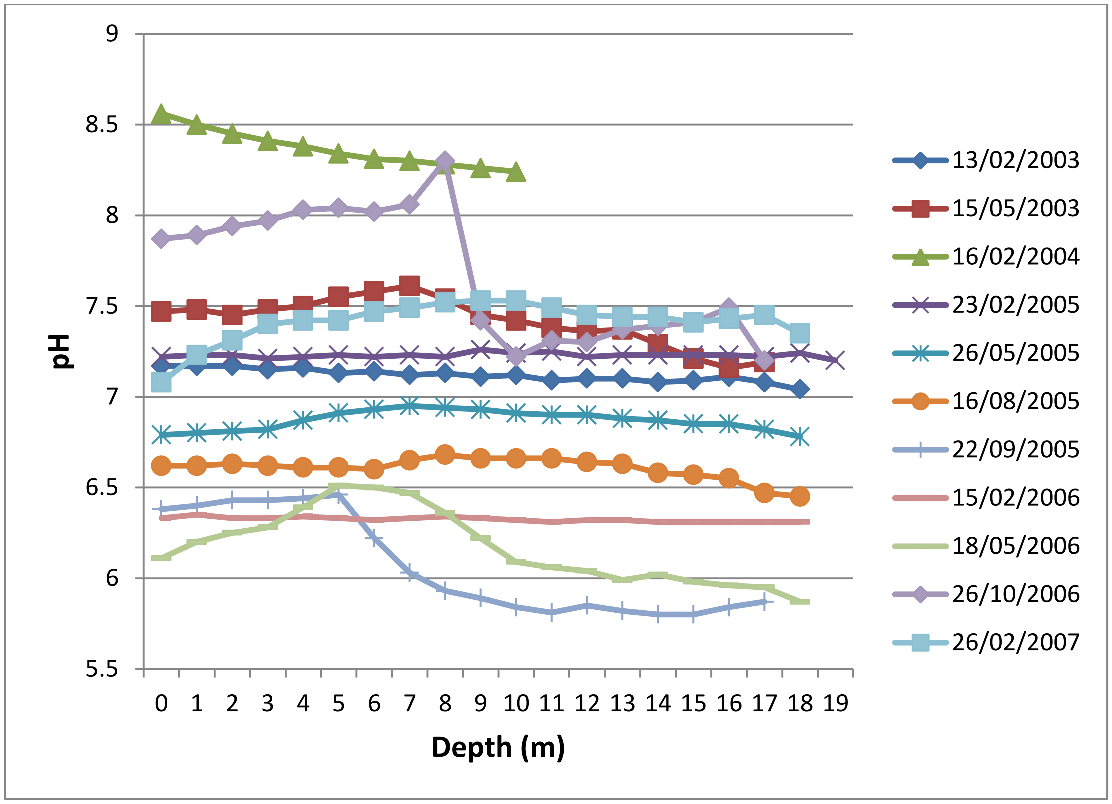

Figure 28. Field pH profiles in Maxwell Lake between 2003 and 2007.

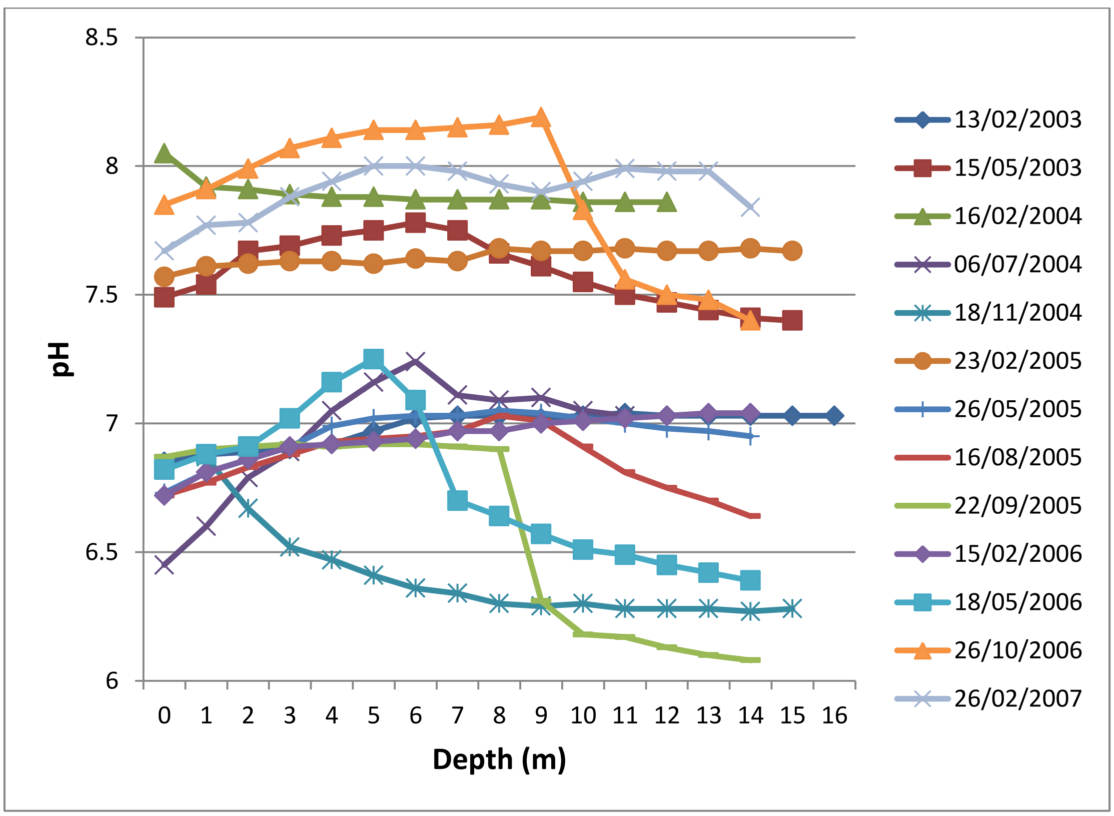

Figure 29. Field pH profiles in St. Mary Lake between 2003 and 2007.

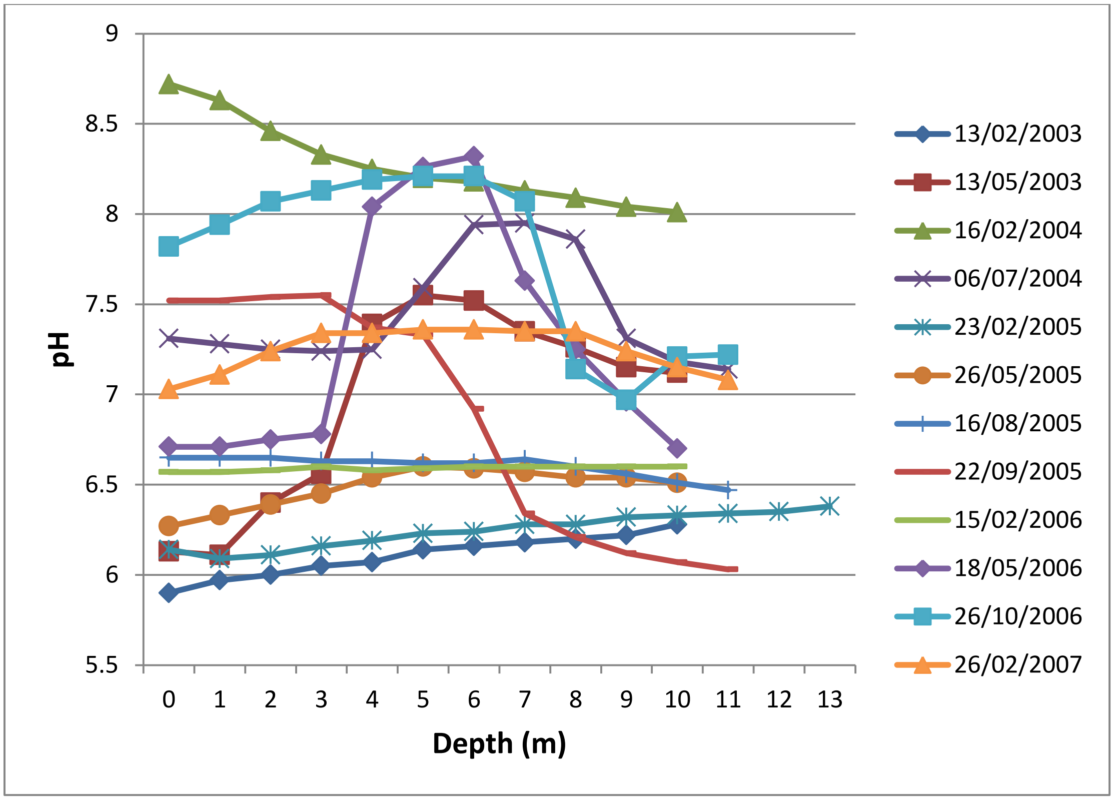

Figure 30. Field pH profiles in Weston Lake between 2003 and 2007.

6.2.3 Conductivity

Conductivity refers to the ability of a substance to conduct an electric current. The conductivity of a water sample gives an indication of the concentration of dissolved ions in the water. The more ions dissolved in a solution, the greater the electrical conductivity. Temperature affects the conductivity of water (a 1ºC increase in temperature results in approximately a 2% increase in conductivity), so specific conductivity is normalized to 25ºC (*i.e.* specific conductivity) to allow comparisons to be made. Coastal systems, with high annual rainfall values and typically short water retention times, generally have low specific conductivity (<80 µS/cm), while interior watersheds generally have higher values. Increased flows resulting from precipitation events or snowmelt tends to dilute the ions, resulting in decreased specific conductivity levels with increased flow levels. Therefore, water level and specific conductivity tend to be inversely related. However, in situations such as landslides where high levels of dissolved and suspended solids are introduced to the stream, specific conductivity levels tend to increase. Effluent discharges, including septic leakage, can also raise conductivity. As such, significant changes in specific conductivity can be used as an indicator of potential deleterious effects.

Specific conductivity measured in the four lakes varied seasonally, with minimum values occurring in the spring and maximum values occurring in the early fall. This is due to the diluting effect of rainwater and snowmelt. All of the lakes receive the majority of their inputs through the winter and early spring, from rainfall within their watersheds. Cusheon Lake showed the widest degree of variability, with specific conductivity values ranging from 58 µS/cm to 197 µS/cm (Figure 31). Maxwell Lake showed the least variability, with specific conductivity values ranging from 26 µS/cm to 86 µS/cm (Figure 32). St. Mary Lake and Weston Lake showed moderate variability, with values ranging from 97 µS/cm to 208 µS/cm for St. Mary Lake (Figure 33) and from 82 µS/cm to 168 µS/cm for Weston Lake (Figure 34). Conductivity was fairly consistent with depth regardless of whether or not the lake was stratified. Increases in specific conductivity in the bottom few metres of water are common in all of the lakes when they are stratified, reflecting the release of ions from sediments in hypoxic conditions. In St. Mary Lake and Weston Lake, specific conductivity in the metalimnion occasionally decreases from surface values, likely reflecting higher concentrations of ions in the surface waters associated with phytoplankton. All values were well below the drinking water guideline of 700 µS/cm, and no objective is proposed for specific conductivity in the Salt Spring Island lakes.

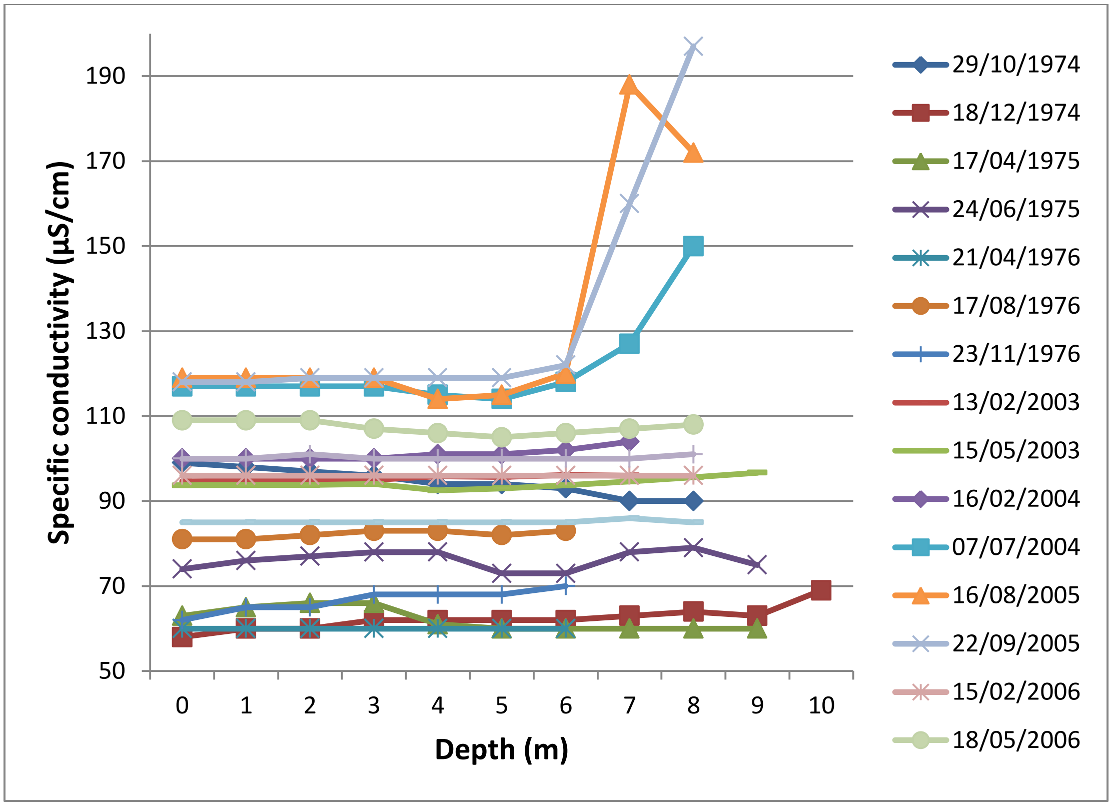

Figure 31. Specific conductivity measured in Cusheon Lake between 1974 and 2007.

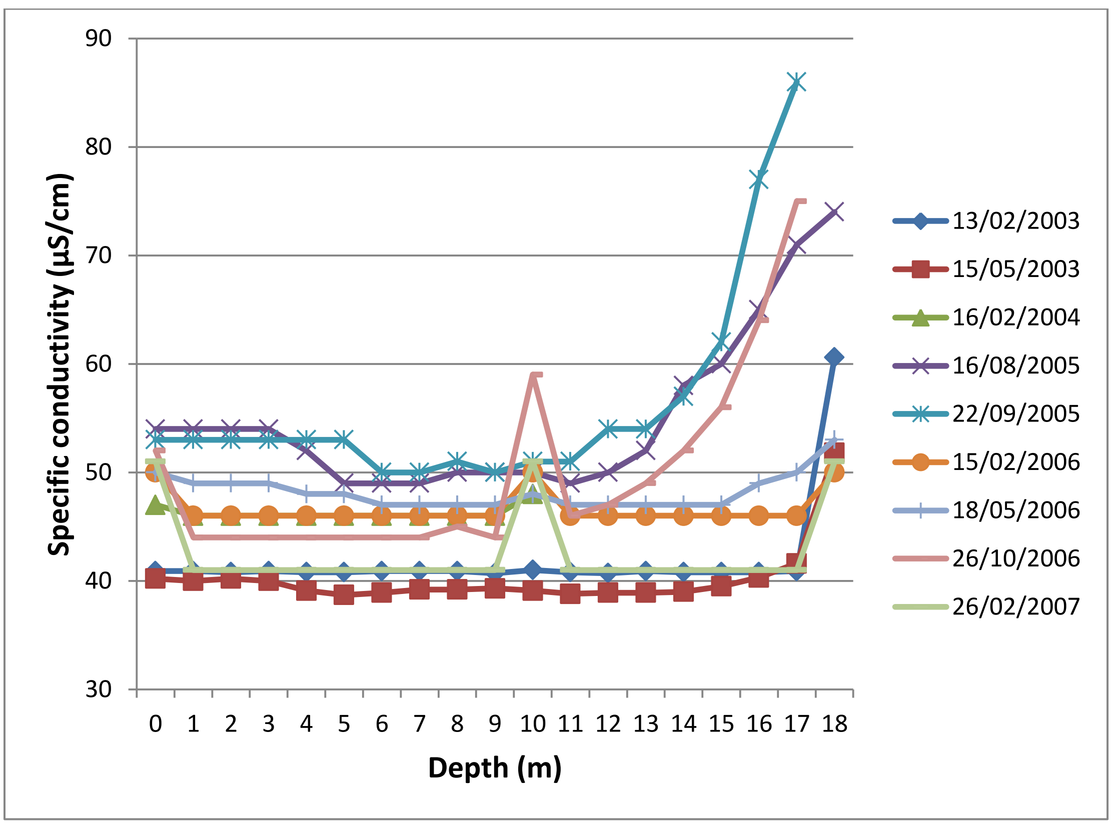

Figure 32. Specific conductivity measured in Maxwell Lake between 2003 and 2007.

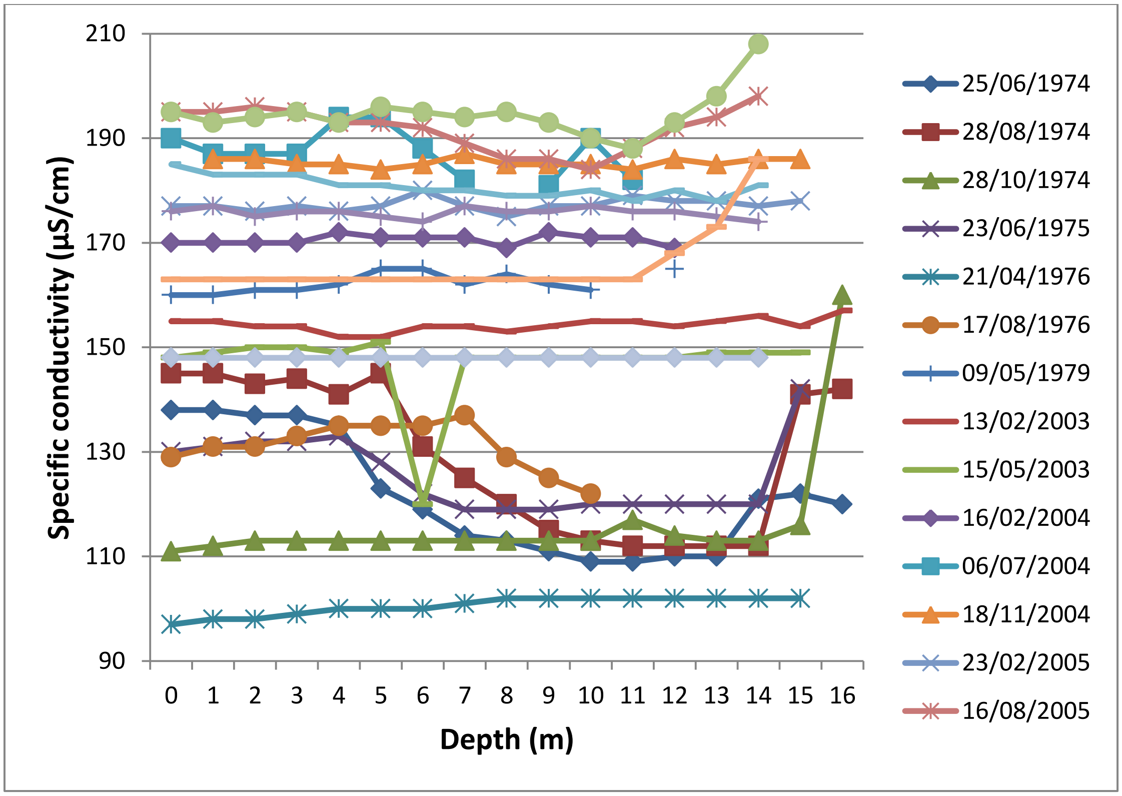

Figure 33. Specific conductivity measured in St. Mary Lake between 1974 and 2006.

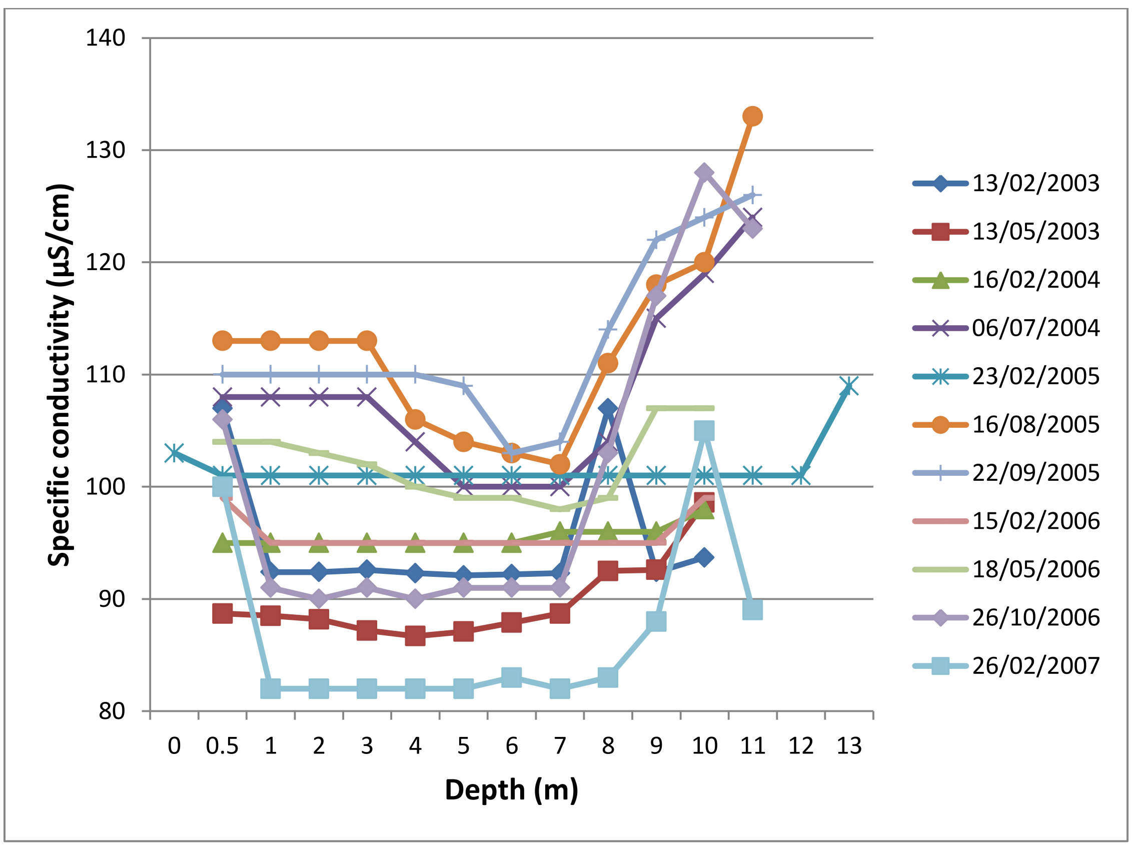

Figure 34. Specific conductivity measured in Weston Lake between 2003 and 2007.

6.2.4 Turbidity

Turbidity is a measure of the clarity or cloudiness of water, and is measured by the amount of light scattered by the particles in the water as nephelometric turbidity units (NTU). Elevated turbidity levels can decrease the efficiency of disinfection, potentially allowing pathogens to survive in the water system. As well, there are aesthetic concerns with cloudy water, and particulate matter can clog water filters and leave a film on plumbing fixtures. Vancouver Island Health Authority (VIHA) follows the Canadian Drinking Water Quality Guidelines which states that drinking water at the point of treatment should be below 1 NTU (95% of days) and not above 5 NTU on more than 2 days in a 12 month period (Dr. Paul Hasselback, VIHA, pers. comm, 2012).

The water districts associated with Cusheon Lake, St. Mary Lake and Weston Lake all use treatment to remove turbidity, while water from Maxwell Lake receives no treatment for turbidity. In addition, individual domestic water license holders likely do not have filtration systems in place therefore raw untreated drinking water is the most sensitive use in these watersheds.

A summary of turbidity values measured in the four lakes is summarized in Table 15. Mean turbidity values were lower in the surface water than in the bottom waters in all of the lakes. However, maximum turbidity values were similar in surface waters and bottom waters for both Cusheon Lake (15.3 NTU and 9.8 NTU, respectively) and St. Mary Lake (9.8 NTU and 10.9 NTU, respectively), and mean concentrations at the surface were only slightly lower than the mean turbidity of the bottom waters (2.5 NTU versus 3.1 NTU in Cusheon Lake, and 2.1 NTU versus 2.4 NTU for surface waters versus bottom waters in St. Mary Lake). In Weston Lake, the maximum turbidity in the bottom water was more than twice as high as the surface maximum (13 NTU versus 6.2 NTU), while in Maxwell Lake, the maximum bottom turbidity values was almost three times the surface water maximum (5.2 NTU versus 1.8 NTU). Turbidity in all of the lakes is likely a result of algal productivity rather than suspended inorganics, with elevated values occurring both mid-winter and mid-summer in all of the lakes. This is likely due to the fact that some of the SSI lakes, such as St. Mary and Cusheon, can have both summer and winter algal blooms. Due to the occasional high turbidity values in all of the lakes there is the need for a water quality objective for turbidity. ***If we consider Maxwell Lake to be the ambient, non-impacted condition, a reasonable objective for turbidity in all of the lakes would be that total turbidity measured should not exceed a maximum of 2.0 NTU at any time (1 NTU above ambient levels) and that turbidity at the intake be < 1 NTU 95% of the time.*** It should be noted elevated turbidity values are considered likely to affect disinfection in a chlorine-only system (Dr. Paul Hasselback, VIHA, pers. comm, 2012). The requirement for turbidity at the intake to be <1 NTU 95% of the time is included to align with VIHA criteria. It is recognized that the BC MOE sampling frequency is not sufficient to compare to this objective, and it is up to the water purveyor to meet the sampling requirements for comparison to the VIHA criteria. As noted in Section 5.0 BC MOE has not sampled at the drinking water intake. In future monitoring, samples should be taken at the intake to compare to any objectives that are set to protect drinking water use. An alternative to help meet drinking water criteria would be to treat the raw water prior to chlorination to remove some of the turbidity and increase chlorine efficiency. As mentioned above, some of the water purveyors do in fact filter the water prior to chlorination (see Section 6.0).

Table 15. Summary of minimum, maximum and average turbidity measured in the surface water (upper 1m) and bottom water (lower 1m) in Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.

	Minimum (NTU)	Maximum (NTU)	Average (NTU)
Cusheon Lake			
Surface	0.4	15.3	2.5
Bottom	0.77	9.8	3.1
Maxwell Lake			
Surface	0.2	1.8	0.6
Bottom	0.8	5.2	2.4
St. Mary Lake			
Surface	0.3	9.8	2.1
Bottom	0.5	10.9	2.4
Weston Lake			
Surface	0.4	6.2	1.8
Bottom	0.8	13	6.7

6.2.5 Colour and Total Organic Carbon

Colour in water is caused by dissolved and particulate organic and inorganic matter. True colour is a measure of the dissolved colour in water after the particulate matter has been removed, while apparent colour is a measure of the dissolved and particulate matter in water. Colour can affect the aesthetic acceptability of drinking water, and the aesthetic objective is a maximum of 15 true colour units (TCU) (Moore, *et al*., 1997). Colour is also an indicator of the amount of organic matter in water. When organic matter is chlorinated it produces disinfection by-products such as trihalomethanes (THMs) and haloacetic acids (HAAs) (Health Canada, 2008).

Colour was typically measured in both the surface water and bottom water of each lake, with bottom waters generally having considerably more colour than surface waters (Table 16). Cusheon Lake and Weston Lake usually had higher colour than either Maxwell Lake or St. Mary Lake. In Cusheon Lake, true colour in the surface water ranged from below detectable limits (<5 TCU) to 30 TCU, and 16 of 35 samples exceeded the 15 TCU drinking water guideline. Water from the bottom of the lake ranged from 15 TCU to 140 TCU, and 10 of 13 samples had colour exceeding the guideline. In Weston Lake, values ranged from < 5 TCU to 40 TCU and six of 23 samples exceeded the drinking water guideline in the surface water samples, while 10 of 13 samples in the bottom water exceeded the guideline and values ranged from 10 TCU to 50 TCU.

True colour levels in Maxwell Lake and St. Mary Lake were considerably lower, with values ranging from below detectable limits (< 5 TCU) to 20 TCU in Maxwell Lake surface waters, and only one of 51 values exceeded the drinking water guideline. In the deeper waters, colour ranged from below detectable limits to 60 TCU, and four of fourteen samples exceeded the guideline. In St. Mary Lake, colour was even lower, with values ranging from < 5 TCU to 18 TCU and only one of 74 samples slightly exceeded the guideline in the surface water. In the deeper waters values ranged from below detectable limits to 20 TCU and only one of the 61 samples exceeding the drinking water guideline.

Table 16. Summary of true colour and drinking water guideline compliance in Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.

	Minimum (TCU)	Maximum (TCU)	Average (TCU)	No. of Samples	90th %ile	% of samples >15 TCU
Cusheon Lake						
Surface	< 5	30	16	31	25	51.6%
Bottom	14	140	45	13	118	76.9%
Maxwell Lake						
Surface	< 5	20	7	51	10	2.0%
Bottom	5	60	18	14	44	28.6%
St. Mary Lake						
Surface	< 5	18	6	74	10	1.4%
Bottom	< 5	20	6	61	10	1.6%
Weston Lake						
Surface	< 5	40	14	23	25	26.1%
Bottom	10	50	27	13	40	76.9%

Colour is often closely correlated with organic carbon concentrations, as humic acids (high in organic carbon) are often major contributors to colour in water. Elevated total organic carbon (TOC) levels (above 4.0 mg/L) can result in higher levels of THMs in finished drinking water if chlorination is used to disinfect the water (B.C. Ministry of Environment, 2006). Total organic carbon (TOC) concentrations were relatively high in all of the lakes, but were highest in Weston Lake and Cusheon Lake (Table 17). In those lakes, almost all of the water samples collected had TOC concentrations exceeding the drinking water guideline of 4 mg/L, established to protect against disinfection by-products. Concentrations were lower in Maxwell Lake and St. Mary Lake, but a large percentage of these samples also exceeded the guideline. As Maxwell Lake is relatively free from inputs from human activities, it is reasonable to consider true colour and TOC concentrations in this lake as typical for the ecoregion. ***For this reason, a water quality objective is proposed for both true colour and TOC. The true color objective is that the maximum in all lakes should not exceed 15 TCU at any time of the year. Similarly, the average TOC concentration should not exceed 6 mg/L in any of the lakes, based on the 90th percentiles of the data collected for Maxwell Lake.*** It is recognized that the objective for TOC exceeds the MOE source drinking water guideline; however it reflects natural background levels (*i.e.* those seen in Maxwell Lake). It is hoped that through watershed management planning, true colour levels and TOC concentrations can be decreased to the point where they consistently meet water quality guideline levels. If there are concerns over the naturally high TOC values (and corresponding high true color values), and the subsequent higher potential for the formation of disinfection by-products, the raw water should be treated to remove organics prior to chlorination. This type of pre-treatment is currently in operation for the water districts which supply water from St. Mary, Cusheon and Weston Lakes. For both colour and TOC, monitoring should also be conducted at the drinking water intake. As the intakes in these lakes are located above the hypolimnion to avoid anoxic, high-nutrient water, and because true colour levels in surface waters are considerably lower than the deep water samples (with the exception of St. Mary Lake, where true colour levels are low throughout the water column), guidelines for true colour may be consistently met at the intakes. Average true colour measured in the surface waters of both Cusheon and Weston Lake were very close to the guideline level (with Cusheon Lake just exceeding the guideline and Weston Lake just meeting the guideline).

Table 17. Summary of total organic carbon concentrations in Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.

	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	No. of Samples	% Samples exceeding guideline
Cusheon Lake	3	12	6.1	120	89.2%
Maxwell Lake	3	7.5	4.6	54	70.4%
St. Mary Lake	1	10	4.4	227	42.3%
Weston Lake	3.9	10.3	6.6	35	97.1%

6.2.6 Metals

A number of samples from each lake have been analyzed for total, dissolved and extractable concentrations of various metals. Analytical methods changed a number of times between when the earliest samples were collected (1974 for Cusheon Lake and St. Mary Lake, 1981 for Maxwell Lake and 1985 for Weston Lake) and 2007, with detection limits becoming more sensitive over time. Earlier samples had detection limits exceeding the drinking water or aquatic life guideline for a number of metals (including arsenic, mercury, lead and silver). However, more recent samples had concentrations of these metals generally at or below detection limit, and well below drinking water and/or aquatic life guidelines (whichever is the more sensitive use for a given metal). Exceptions to this were concentrations of total cadmium measured in Maxwell Lake on November 11, 1991 and November 14, 1991, with concentrations of 0.0035 mg/L and 0.0013 mg/L, respectively. These values are considerably above the aquatic life guideline of 0.00003 mg/L (0.03 µg/L). However, the detection limit for these analyses was < 0.0005 mg/L, higher than the guideline level. When more sensitive analyses were employed later in the sampling record (after May 15, 2003, the detection limit was < 0.00001 mg/L), all values were at or below the detection limit. If possible, more sensitive analytical methods should be employed to measure total cadmium, with a detection limit of not more than 0.003 µg/L, as the detection limit should be not more than one tenth the guideline limit (Cavanagh, *et al*., 1998).

A second instance of guideline exceedance occurred on September 23, 1985 in St. Mary Lake. Here, samples collected near the bottom of the lake (from 8 m to 14 m depth) had elevated levels of both manganese and zinc. The maximum concentration of manganese, 1.24 mg/L, exceeded the aquatic life guideline of 1.1 mg/L, and concentrations of total zinc ranged from 127 to 155 mg/L, much higher than the aquatic life guideline of 0.033 mg/L. Again, almost all other values were well below the guideline levels, and the cause of these elevated values is unknown. It does not appear that the sediment was disturbed while sampling (which would stir up the bottom and cause increased concentrations of various metals) because the turbidity for those samples was not elevated. Neither the dissolved oxygen concentration nor the oxidation-reduction potential was measured on that date, so while it is likely that anaerobic conditions resulted in the release of metals from the sediment, this cannot be confirmed.

Regardless, as there are no significant anthropogenic sources of any of the metals sampled within the watershed, and as the drinking water guideline is not being exceeded (aquatic life will likely have evolved to the exisiting conditions, if they are natural in origin), ***no guideline is recommended for any metal in any of the watersheds.***

Metal speciation determines the biologically available portion of the total metal concentration. Only a portion of the total metals level is in a form that can be toxic to aquatic life. Naturally occurring organics in the watershed can bind substantial proportions of the metals which are present, forming metal complexes which are not biologically available. The relationship will vary both seasonally and depending upon the metal (e.g. copper has the highest affinity for binding sites in humic materials). Levels of organics as measured by dissolved organic carbon (DOC) vary from ecoregion to ecoregion. To aid in future development of metals objectives, DOC has been included in the Salt Spring lakes monitoring program.

6.2.7 Coliform Bacteria

Coliform bacteria are present in large numbers in the feces of warm-blooded animals, and although rarely pathogenic themselves, they are used as indicators of fecal contamination in water. Fecal coliforms are quite specific to the feces of warm-blooded animals and *E. coli* are even more specific, whereas total coliforms have many non-fecal sources (e.g. soils, plants), and thus are less indicative of fecal contamination. Coliforms generally do not survive long in cold, fresh water (Brettar, *et al*., 1992), but can survive for prolonged periods in stream sediment, soils or fecal material, when associated with particulate matter, or in warmer water (Howell, *et al*., 1996, Tiedemann, *et al*., 1987). Disturbance of these sediments can therefore result in coliforms appearing in overlying water for extended periods (Jawson, *et al.*, 1982, Stephenson, *et al.*, 1982). The inclusion of a small piece of fecal matter in a sample can result in extremely high concentrations (>1000 CFU/100 mL), which can skew the overall results for a particular site. It is therefore important to consider the range of values, as well as the standard deviation, to determine if numbers are consistently high or if one value "artificially" inflated the mean. For this reason, the 90th percentile is generally used to determine if the water quality guideline is exceeded, as extreme values would have less effect on the data.

The drinking water guideline for raw waters receiving disinfection only (which would apply to Maxwell Lake) is that the 90th percentile of at least five samples collected in a 30-day period should not exceed 10 CFU/100 mL. The guideline for raw water receiving partial treatment (consisting of filtration or sedimentation, and disinfection, as occurs for St. Mary Lake) is a 90th percentile of 100 CFU/100 mL (B.C. Ministry of Environment, 2006). Water which receives complete treatment (which applies to Cusheon Lake and Weston Lake) has no applicable drinking water guideline.

Fecal coliforms and *E. coli* were not analyzed as part of the ambient water monitoring program on any of the lakes, but the VIHA collects water samples at bathing beaches on Cusheon Lake, St. Mary Lake and Weston Lake and analyzes them for fecal coliform concentrations. The applicable MOE recreation guideline for fecal coliforms is ≤ 200 CFU/100 mL (geometric mean), because primary contact recreation is the most sensitive water use at the bathing beaches (Cusheon and St. Mary Lakes).

The VIHA collects water samples once a week in early April through early May each year at each of the three lakes, and then biweekly through August. In Cusheon Lake, 51 of 61 samples collected between April 9, 2001 and August 14, 2007 at the public access off Cusheon Lake Road had measureable concentrations of fecal coliforms, with values ranging from 1 CFU/100 mL to 650 CFU/100 mL. Geometric means calculated for the data ranged from 1.3 CFU/100 mL to 3.8 CFU/100 mL, all well within guideline levels. In St. Mary Lake, fecal coliform concentrations ranged from 1 CFU/100 mL to 260 CFU/100 mL in the 45 of 62 samples where fecal coliforms were detected. Samples were collected at the public access south of the resort at 1450 North End Road. Geometric means of five sets of samples ranged from 1 CFU/100 mL to 3.7 CFU/100 mL, again well within guideline levels. At Weston Lake, samples were collected at the public access off of Beaver Point Road, at the north end of the lake. Fecal coliforms were found in 44 of 51 samples, with concentrations ranging from 1 CFU/100 mL to 100 CFU/100 mL and geometric means ranging from 1 CFU/100 mL to 5.2 CFU/100 mL. It does not appear that fecal coliforms are a significant concern for swimming in any of the lakes, and ***therefore no objective is proposed***. However, it does appear that occasional higher concentrations of fecal coliforms are found in each of the lakes, generally late in the summer. For this reason, we recommend that VIHA conduct five samples in 30 days sampling towards the end of the summer, when water temperatures and bathing use are at their highest, as this is the period when we would expect to see the highest concentrations of fecal coliforms.

6.3 BIOLOGICAL ANALYSIS

Biological sampling is an important tool for monitoring water quality. While traditional water quality monitoring typically measures individual physic-chemical characteristics and determines if they are a potential concern, aquatic biota (including plankton, macrophytes, invertebrates and vertebrates) reflect all aspects of the quality of their environment. The cumulative effects of many minor contaminants which, on their own, might not be of concern can nonetheless result in changes in the biota of a system. Both phytoplankton (algae) and zooplankton (microscopic or verysmall suspended or free-swimming animals) were sampled a number of times from each of the lakes between 2003 and 2007 to determine species compositions and to examine changes in populations that might help pinpoint environmental stressors.

6.3.1 Phytoplankton and Chlorophyll *a*

Phytoplankton populations can have huge impacts on water quality, and may give an indication of contaminant and nutrient levels in a lake. Algal blooms resulting from elevated nutrient levels can impair water quality in a number of ways. Algae can impart taste and odour to drinking water, requiring expensive treatments to remove algal particles. If algae are not removed prior to chlorination, by-products can be formed that are potentially carcinogenic (Nordin, 2001). Some species of phytoplankton (specifically “blue-green algae”, or cyanobacteria) also contain toxins. Allergic reactions to algae in drinking water, or from exposure to algae while swimming, are also common. Aesthetically, algal blooms reduce water clarity and can result in an unpleasant “scum” on the surface of the water, as well as give the water a strong odour.

Changes in algal populations can also affect other biota in the lake, including the zooplankton populations that feed on the algae and fish that feed either on algae, zooplankton or aquatic invertebrates. Increased algal concentrations can decrease available oxygen during the night or under ice cover, or at depth as it decomposes. Decreased water clarity resulting from high algal concentrations can reduce feeding visibility, and elevated algal concentrations often result in a shift from sports fish such as salmonids to less desirable species such as suckers and carp. Some species of algae can also impart a “muddy” flavour to fish flesh (Nordin, 2001), decreasing the popularity of sports fishing on a given lake.

Phytoplankton samples were collected at each site with one-litre grab samples at the surface, according to RISC standards (Cavanagh, *et al*., 1997a). Samples were preserved with Lugol’s solution, stored on ice and shipped overnight to Fraser Environmental Laboratory for identification and enumeration.

Results from the phytoplankton samples are summarized in Table 30 - Table 33. The complete results are tabulated in Appendix I. Phytoplankton concentrations and species richness are summarized in Table 18.

St. Mary Lake consistently had the highest concentrations of phytoplankton (an average 32,864 cells/mL), while Maxwell lake had the lowest concentrations (average concentration of 831 cells/mL). Species richness was highest in Weston Lake and Cusheon Lake, with an average of 58 species per sample and 51 species per sample, respectively, while species richness was lowest in Maxwell Lake (average of 20 species per sample).

Table 18. Summary of phytoplankton concentration and species richness in Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake, 2003-2007.

	Minimum	Maximum	Average	No. of Samples
Cusheon Lake				
Concentration (cells/mL)	295	9,683	1,600	12
Number of species	35	73	51	12
Maxwell Lake				
Concentration (cells/mL)	196	2075	831	10
Number of species	15	30	20	10
St. Mary Lake				
Concentration (cells/mL)	1,277	166,626	32,864	13
Number of species	17	64	39	13
Weston Lake				
Concentration (cells/mL)	568	26,344	4,955	13
Number of species	37	75	58	13

The phytoplankton community in Cusheon Lake was dominated most years by cryptomonads, with *Chroomonas actua* composing the majority of the plankton community in most years (6% to 79% of the cells collected, with an average of 42% in each sample). Another crytomonad, *Cryptomonas ovata*, was prevalent in the February 2005 sample (10%). In August and September 2005 and August 2006, the cyanobacteria *Anabaena affinis*, *A. cf circinalis*, and another unidentified *Anabaena* species were present. In May 2003 and February 2005, the pennate diatom *Asterionella formosa* was numerous (32% and 15% of the total cells/mL, respectively). Other species that were prevalent in at least one sample were *Melosira granulate* (Order Centrales), and *Gloeocystis ampla* and *Sphaerocystis schroeteri* (Order Rhizochrysidales).

While Maxwell Lake had the lowest average concentration of phytoplankton and the lowest species richness, it had a higher number of species that comprised at least 10% of a given sample (17 species, compared with 11 species in Cusheon Lake, 13 species in St. Mary Lake, and 14 species in Weston Lake). Unlike the other lakes, no one species could be said to predominate from year to year or even from sample to sample. Species that comprised the majority (*i.e.* >50%) of one of the samples include *Urogleopsis cf americana* (Order Ochromonadales) (53% of the cells on Feb 16, 2004); *Tetraedron minimum* (Order Chlorococcales) (54% on Feb 23, 2005); *Asterionella formosa* (Order Pennales) (60% on June 16, 2005), *Rhizosolenia eriensis* (Order Centrales) (53% of sample on May 18, 2006) and *Dinobryon divergens* (Order Ochromonadales) (68% on February 26, 2007). The dominance by a particular species occurred almost exclusively during the winter months (with the exception of one sample collected in June), while samples collected during the summer months had more diverse phytoplankton communities.

In St. Mary Lake, samples collected between November 18, 2004 and May 26, 2005, as well as from September 22, 2005 to May 18, 2006, had the cyanobacteria *Oscillatoria tenuis* (Order Oscillatoriales) comprise the vast majority of the sample, with between 89% and 99.9% of all cells collected in five of the six samples where it predominated. Other cyanobacteria, including *Lyngbya limnetica* (Order Oscillatoriales) and *A. spirpoides*, *A. cf circinalis*, *A. affinis*, and *Aphanixomenon flos-aquae* (Order Nostocales) were also present in a number of samples. The pennate diatom *Asterionella formosa* was dominant in one sample, collected on February 26, 2007. Other species which comprised at least 10% of one or more samples were *Cyclotella* sp., *Melosira granulate*, and

Cyclotella glomerata (Order Centrales), *Synechocystis diplococcus* (Order Chroococcales), *Chroomonas actua* (Order Cryptomonadales), and *Mallomonas akrokomos* (Order Ochromonadales).

In Weston Lake, the cyanobacteria *Oscillatoria tenuis* (Order Oscillatoriales) was prevalent in six of thirteen samples collected between 2003 and 2007, comprising up to 85% of a total sample. Other cyanobacteria (*A. affinis* and *A. cf circinalis* (Order Nostocales)), were also prevalent in at least two samples each. Other prevalent species in Weston Lake were *Cyclotella glomerata* (Order Centrales), *Botryococcus braunii* and *Anacystis elachista* (Order Chlorococcales), *Chroomonas actua* (Order Cryptomonadales), *Dinobryon divergens*, *Synura* sp., and *Mallomonas akrokomos* (Order Ochromonadales), *Fragilaria crotonensis*, *Tabellaria flocculosa*, and *Asterionella formosa* (Order Pennales), and *Sphaerocystis schroeteri* (Order Tetrasporales).

From the phytoplankton sampling conducted in the four lakes, it is apparent that cyanobacteria are the predominant species in Cusheon Lake, St. Mary Lake and Weston Lake on occasion. Because of concerns associated with cyanobacteria (including toxicity in drinking water and to wildlife, as well as the aesthetically unpleasing surface scum that they typically leave), an objective is proposed for the phytoplankton composition in Cusheon Lake, St. Mary Lake, and Weston Lake. ***The objective is that cyanobacteria should not comprise more than 50% of the phytoplankton cells in a given sample from any of these lakes at any time during the year***.

6.3.2 Chlorophyll *a*

Ideally, were cyanobacteria concentrations to decrease, overall phytoplankton concentrations (measured in terms of chlorophyll *a*), would also decrease in Cusheon Lake, St. Mary Lake and Weston Lake. As discussed in 6.2.1.1, above, chlorophyll *a* is closely correlated with spring overturn total phosphorus concentrations. Chlorophyll *a* acts as a surrogate for more detailed phytoplankton sampling, as it measures the photosynthetic pigment typically found in phytoplankton. Values below 3 µg/L are considered an indication of low productivity and values above 15 µg/L are generally considered to indicate high productivity. Agriculture, sewage effluent, forest harvesting, urban development and recreational activities can add nutrients to a lake, increasing chlorophyll *a* concentrations (Cavanagh et al., 1997). As discussed in Section 6.2.1.1, paleolimnological studies conducted on Cusheon Lake and St. Mary Lake suggest that historically (prior to anthropogenic activities occurring within their watersheds), both lakes were mesotrophic (Cumming et al. 2005; 2006). This would translate to average chlorophyll *a* concentrations in the range of 2 µg/L to 7 µg/L (Nordin, 2001). Due to the variability in concentrations of chlorophyll *a* in lakes (algal blooms can cause orders of magnitude changes in chlorophyll *a* concentrations over short periods of time), no Water Quality Guidelines have been proposed for chlorophyll *a* concentrations in lakes. A limited number of samples have been analyzed for chlorophyll *a* in each of the four lakes since 2003 (in most cases, once or twice a year), making a long-term assessment of trends difficult (especially considering the seasonal variability of this parameter). Figure 35 shows annual average concentrations of chlorophyll *a* in each of the four lakes between 1979 and 2007. In general, average concentrations fell within the mesotrophic range (2 µg/L to 7 µg/L). In order to ensure that chlorophyll *a* concentrations remain within the appropriate range, ***we recommend that average chlorophyll a concentrations (based on a minium of four samples collected on a quarterly basis) remain within the range of 2 µg/L to 7 µg/L for Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.***

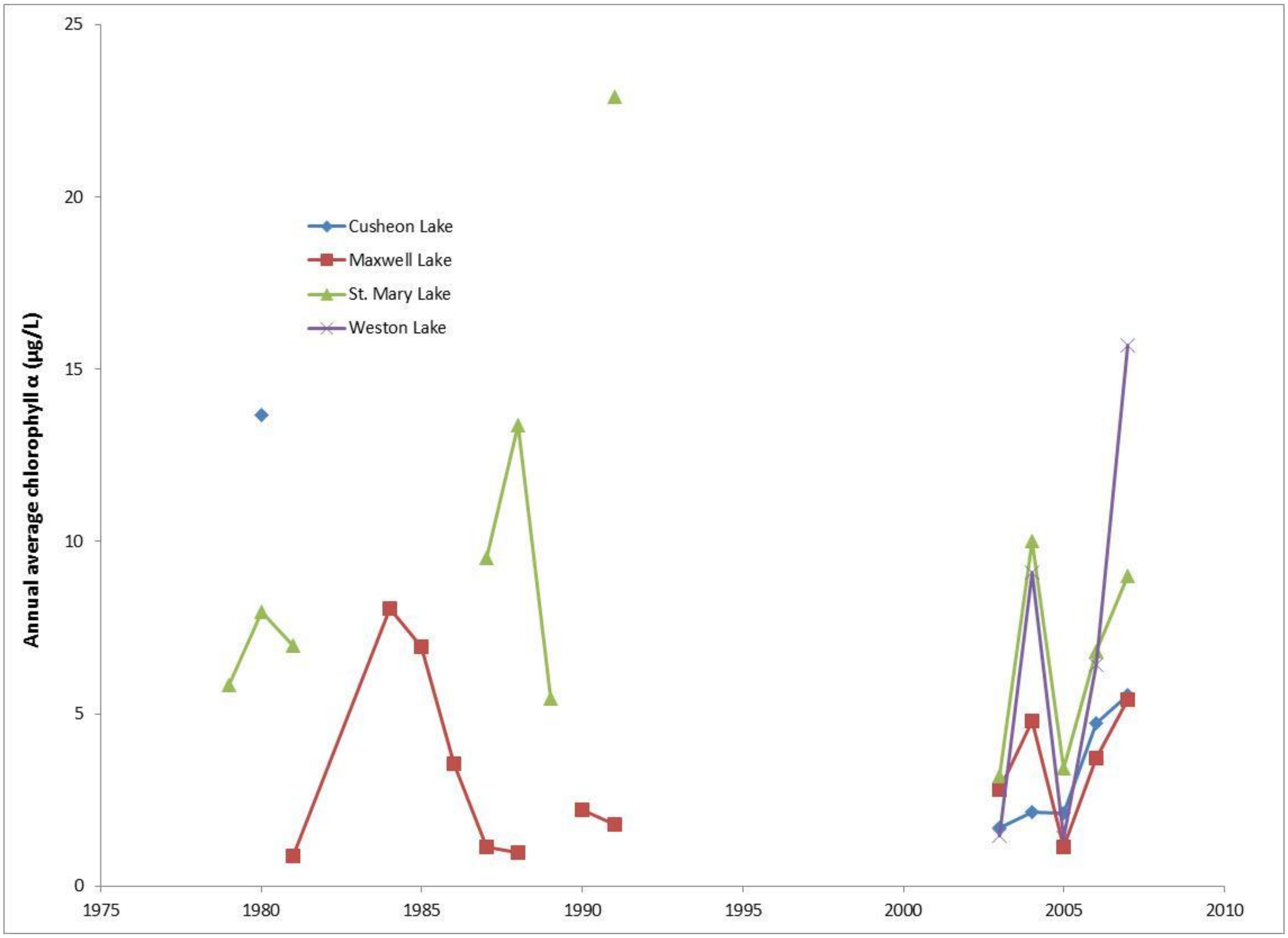

Figure 35. Comparison of average annual chlorophyll *a* concentrations measured in the four Salt Spring Island lakes between 1979 and 2007.

6.3.3 Zooplankton

Phytoplankton are called primary producers, because they are capable of producing their own energy through photosynthesis. Zooplankton represent the second trophic level in a lake, generally preying upon phytoplankton, as well as other zooplankton species. For this reason, zooplankton communities are sensitive to changes in phytoplankton community, and they are also sensitive to water quality changes. They do not have negative impacts on water quality or impair water uses in the way that phytoplankton tend to, but their species composition and densities can give insights into water quality.

Zooplankton were collected using a 10 m vertical tow in a Wisconsin-style net with a mouth area of 0.07 m^2, a net opening diameter of 0.5 m and a mesh size of 80 µm. Samples were preserved with formalin and shipped to the lab on ice for species identification and enumeration. All samples were collected following Ministry of Environment approved methods (Cavanagh, *et al*., 1997b).

A summary of dominant zooplankton species collected in each of the four lakes is given in Table 34 -

Table 37. A complete list of all species present in each sample and their abundance is given in Appendix II. Zooplankton concentration and species richness is summarized in Table 19.

Table 19. Summary of average zooplankton density and species richness in samples collected from Cusheon Lake, Maxwell Lake, St. Mary Lake and Weston Lake.

	Minimum	Maximum	Average	No. of Samples
Cusheon Lake				
Number of organisms/sample	4,813	173,611	51,736	12
Number of species	17	36	27	12
Maxwell Lake				
Number of organisms/sample	21,297	498,190	95,818	11
Number of species	15	30	21	11
St. Mary Lake				
Number of organisms/sample	1,610	44,177	19,207	13
Number of species	6	27	16	13
Weston Lake				
Number of organisms/sample	11,372	436,286	77,106	11
Number of species	19	34	25	11

Maxwell Lake had the highest average concentration of zooplankton per sample (95,818), followed by Weston Lake (77,106), Cusheon Lake (51,736) and St. Mary Lake (19,207).

Cusheon Lake had the highest species diversity, with an average of 27 species per sample, while St. Mary Lake had the lowest species diversity (average 16 species/sample).

In all of the lakes, two rotifer species were the dominant zooplankton species: *Kellicottia longispina*, and *Keratella cochlearis*. A number of other rotifer species were present in each of the lakes, and Cusheon Lake, St. Mary Lake and Weston Lake all had significant numbers of copepods in at least four samples. There were four species of cyclopoids in St. Mary Lake (*Diaptomus cf oregonensis*, *Skistodiaptomus oregonensis*, *Diaphanosoma birgei* and *Diaphanosoma* sp.) that were prevalent in one or more samples as well.

Due to the natural variability associated with zooplankton communities, it is difficult to recommend specific objectives. Based on our observations, it would appear that higher concentrations of zooplankton are preferable (as was seen in Maxwell Lake), partially because the zooplankton are efficient grazers of the phytoplankton community. Species richness is also preferable to only one or two species dominating, as this gives the community greater robustness should environmental conditions shift. Finally, it appears that copepod dominance may be associated with degraded water quality (as they were present in significant numbers in Cusheon Lake, St. Mary Lake and Weston Lake, but not Maxwell Lake), and for this reason it would be preferable that copepods not dominate the species composition. There is no zooplankton objective recommended at this time.

7.0 SUMMARY OF PROPOSED WATER QUALITY OBJECTIVES AND MONITORING SCHEDULE

Table 20. Summary of proposed water quality objectives for Salt Spring Island lakes.

Variable	Objective Value	Lakes that Guideline Applies To:
Temperature	≤ 15°C summer maximum hypolimnetic temperature (<6m depth)	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Dissolved oxygen	≥ 8 mg/L for depth ≤ 19°C and 3 m deeper	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Dissolved oxygen	≥2 mg/L above bottom sediments	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Secchi depth	≥3m annual average	Cusheon Lake, St. Mary Lake, Weston Lake
Secchi depth	≥4m annual average	Maxwell Lake
Total phosphorus	13.5 µg/L max during spring and fall turnover	Cusheon Lake, St. Mary Lake, Weston Lake
Total phosphorus	10 µg/L max during spring and fall turnover	Maxwell Lake
Total ammonia	Average concentration ≤ 1.8 mg/L	St. Mary Lake and Weston Lake
N:P ratio	≥ 15:1	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Turbidity	2.0 NTU max, 95th percentile ≤1 NTU	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
True colour	15 TCU max	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
TOC	6.0 mg/L average	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake
Phytoplankton	≤ 50% cyanobacteria (measured by cells/mL) in phytoplankton sample	Cusheon Lake, St. Mary Lake, Weston Lake
Chlorophyll *a*	2 µg/L to 7 µg/L average	Cusheon Lake, Maxwell Lake, St. Mary Lake, Weston Lake

Designated water uses: drinking water, aquatic life, irrigation, and wildlife

A summary of the recommended monitoring schedule is given in Table 21. Monitoring should be conducted in each of the lakes quarterly (including during spring overturn, ideally by the end of February), to determine if the water quality objectives proposed in this document for nutrients are being attained. Samples should be collected at a minimum of three depths (surface, mid-water and near-bottom), and analyzed for nutrients (total phosphorus, ortho-phosphorus, total nitrogen, ammonia, nitrate and nitrite), TOC and DOC, pH, conductivity, true colour, phytoplankton and zooplankton, and chlorophyll *a*. Temperature and dissolved oxygen profiles should also be conducted, and Secchi depth should be measured.

It is also recommended that the VIHA beach monitoring program continue at Cusheon Lake, St. Mary Lake and Weston Lake. If possible, five samples within a 30-day period should be collected between late July and early September (likely the period of highest bacteriological concentrations) to determine if guidelines for fecal coliforms are being met.

Table 21. Proposed schedule for future water quality and plankton monitoring in Salt Spring Island lakes.

Frequency and timing	Characteristic to be measured
Spring and Fall turn-over (late February – early April and late September-early October) – at least three depths (surface, mid-water, near-bottom)	Nutrients (nitrogen species, total phosphorus), pH, specific conductivity, TSS, turbidity, colour, TOC, DOC, chl *a*, dissolved oxygen, temperature
Spring turn-over (late February – early April)	Zooplankton and phytoplankton tow
(May and August,– at least three depths (surface, mid-water, near-bottom)	Nutrients (nitrogen species, total phosphorus), pH, specific conductivity, TSS, turbidity, colour, TOC, DOC, chl *a*, dissolved oxygen, temperature, zooplankton and phytoplankton
Mid-summer (August)	Zooplankton and phytoplankton tow

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Table 22. Summary of general water chemistry measured at Site 1100123, Cusheon Lake at deepest point, mid-lake west arm, 1974 – 2007.

	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity Total (ueq/L)	455	455	455	0	1
Alkalinity pH 4.5/4.2 (mg/L)	18.8	28.2	22.1	5.3	3
Alkalinity pH 8.3 (mg/L)	< 0.5	< 1	< 0.7		5
Alkalinity Total 4.5 (mg/L)	18.9	48.4	25.0	4.6	71
Ammonium (mg/L)	0.02	0.02	0.02	0	1
Ammonia Dissolved (mg/L)	< 0.005	1.04	0.065	0.158	122
Bromide Dissolved (mg/L)	< 0.05	< 0.1	< 0.06	0.02	48
C.O.D. (mg/L)	< 10	34.2	17.5	6.5	27
Carbon Diss. Inorganic (mg/L)	6	8.7	7.0	0.6	29
Carbon Dissolved Organic (mg/L)	1.7	7.5	5.1	1.0	43
Carbon Total Dissolved (mg/L)	10.9	13.8	12.2	0.6	29
Carbon Total Inorganic (mg/L)	1	17	6.7	2.5	123
Carbon Total Organic (mg/L)	3	12	6.0	1.6	138
Chlorophyll *a* (mg/L)	0.0007	0.034	0.011	0.010	45
Chloride - D (mg/L)	5.7	16	9.3	1.7	75
Chloride - S (mg/L)	9.75	9.75	9.75	0	1
Coliforms fecal (CFU/100mL)	< 1	3	1.5	0.8	6
Coliforms fecal (MPN)	< 2	5	3	1.7	3
Coliforms total (MPN)	2	13	5.5	5.2	4
Color True (TCU)	< 5	400	26.3	45.5	103
ColorTAC (TAC)	9	24	18.1	4.7	11
Diss Oxy (mg/L)	< 0.1	12.6	7.7	3.4	318
Extinction Depth (m)	0.762	5.5	3.2	1.4	45
Fluoride D (mg/L)	0.02	0.08	0.04	0.02	40
Fluoride T (mg/L)	0.03	0.05	0.03	0.01	6
Hardness Total (D) (mg/L)	34	46.7	37.2	3.1	15
Hardness Total (Extr) (mg/L)	30.4	41.7	37.1	2.7	33
Hardness Total (T) (mg/L)	28.2	39.0	34.0	3.1	27
Nitrogen Kjeldahl T (mg/L)	0.12	1.18	0.43	0.19	101
Nitrate - S (mg/L)	3.01	3.01	3.01		1
Nitrate – T (mg/L)	< 0.02	< 0.02	< 0.02		1
Nitrate (NO3) Dissolved (mg/L)	< 0.002	0.561	0.170	0.202	67
Nitrate + Nitrite Diss. (mg/L)	< 0.002	0.65	0.190	0.207	177
Nitrite - T (mg/L)	< 0.005	< 0.005	< 0.005	0	2
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.018	0.005	0.002	75
Nitrogen (Kjel.) Tot Diss (mg/L)	0.16	1.3	0.39	0.27	16

Table 22 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
Nitrogen Organic-Total (mg/L)	0.16	0.86	0.40	0.15	64
Nitrogen Total (mg/L)	0.24	1.7	0.62	0.25	129
Nitrogen Total Dissolved (mg/L)	0.292	1.306	0.593	0.271	16
ORP (mV)	77	386	279.7	98.4	116
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.254	0.023	0.036	147
P--E (mg/L)	< 0.1	< 0.1	< 0.1	0	15
pH (pH units)	6.11	8.6	7.1	0.5	243
Phaeophytin A (mg/L)	< 0.0005	< 0.0005	< 0.0005	0	40
Phosphorus Tot. Dissolved (mg/L)	< 0.002	0.61	0.024	0.067	142
P--T (mg/L)	< 0.003	0.93	0.047	0.108	157
Total solids (mg/L)	70	106	82.2	7.6	67
Total dissolved solids 1.0u (mg/L)	54	116	80.1	14.5	18
Total susp. solids - fixed. (mg/L)	< 1	4	1.3	0.7	38
Total suspended solids (mg/L)	< 10	18	3.9	3.8	47
ResT:Fx (mg/L)	34	68	48.5	6.7	39
ResT:Vol (%(W/W))	34.8	34.8	34.8		1
ResVolNF (mg/L)	1	2	1.3	0.6	3
Silica - D (mg/L)	5	13.5	9.1	1.9	90
SO4-:S (mg/L)	11.6	11.6	11.6	0	1
Specific Conductance (µS/cm)	58	375	112.8	65.7	329
Sulfate - D (mg/L)	5.2	12.8	9.5	1.4	69
Sulfate Total (mg/L)	9	9	9	0	2
Tanins and Lignins:T (mg/L)	0.2	1.3	0.7	0.3	25
Temp (°C)	1.5	24.04	11.6	5.6	330
Turbidity(NTU)	0.11	15.3	2.8	2.9	109

Table 23. Summary of general water chemistry measured at Site 1130022, Maxwell Lake at deepest point, 1981 - 2007.

	Minimum	Maximum	Average	Std Dev	No. of samples
Acidity - free (ueq/L)	< 0.1	0.8	0.1	0.1	144
Acidity - total (ueq/L)	< 15	166	85.4	47.0	12
Acid<8.3 (ueq/L)	17.1	226	52.9	28.8	132
Alkalinity – total (ueq/L)	99.4	335	273.4	35.9	141
Alkalinity pH 4.5/4.2 (mg/L)	12.1	13	12.5	0.3	6
Alkalinity pH 8.3 (mg/L)	< 1	< 1	< 1	0	2
Alkalinity Total 4.5 (mg/L)	12.3	16.7	13.8	0.9	35
Ammonium (mg/L)	< 0.01	0.15	0.02	0.03	143
Ammonia Dissolved (mg/L)	< 0.005	0.414	0.025	0.069	72
Bromide Dissolved (mg/L)	< 0.05	< 0.1	< 0.05	0.01	23
C.O.D. (mg/L)	12.6	12.8	12.65	0.1	4
Carbon Dissolved Organic (mg/L)	3	5.4	4.4	0.7	18
Carbon Total Dissolved (mg/L)	8	11	9.5	1.3	4
Carbon Total Inorganic (mg/L)	2	9.1	4.1	1.4	47
Carbon Total Inorganic (ug/g)	2960	2960	2960		1
Carbon Total Organic (mg/L)	3	7.5	4.6	0.8	54
Chlorophyll *a* (mg/L)	0.0005	0.0192	0.003	0.003	60
Chloride - D (mg/L)	3.6	4.51	4.04	0.20	50
Chloride - S (mg/L)	3.14	5.19	4.43	0.39	144
Coliforms fecal (CFU/100mL)	< 1	10	1.4	2.0	37
Color True (TCU)	< 5	60	9.0	9.0	82
ColorTAC (TAC)	1	12	5.5	2.2	121
Diss Oxy (mg/L)	0.17	17.5	8.65	3.16	705
E Coli (CFU/100mL)	< 2	< 2	< 2	0	1
Extinction depth (m)	2.5	5.2	4.1	0.6	23
Fluoride - D (mg/L)	< 0.01	0.1	0.06	0.04	40
Fluoride - T (mg/L)	0.02	0.02	0.02	0	3
Hardness Total (D) (mg/L)	0.6	19.5	15.2	6.2	8
Hardness Total (Extr) (mg/L)	14.7	18.2	16.3	1.0	17
Hardness Total (T) (mg/L)	13.3	17.5	16.0	1.0	21
Moisture (%(W/W))	95.3	95.3	95.3	0	1
Nitrogen Kjeldahl - T (mg/L)	0.14	0.42	0.26	0.04	101
Nitrogen Kjel. Tot Diss (mg/L)	0.21	0.91	0.31	0.16	21
Nitrate - S (mg/L)	< 0.01	11.7	0.24	1.37	144
Nitrate (NO3) Dissolved (mg/L)	< 0.002	0.058	0.013	0.012	44
Nitrate + Nitrite Diss. (mg/L)	< 0.002	0.1	0.017	0.014	84
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.006	0.004	0.001	49
Nitrogen Organic-Total (mg/L)	0.07	0.5	0.25	0.08	36

Table 23 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
Nitrogen Total (mg/L)	0.16	0.91	0.30	0.13	59
Nitrogen Total Dissolved (mg/L)	0.222	0.912	0.321	0.161	21
ORP (mV)	46	439	266.1	125.6	215
Ortho-Phosphate Dissolved (mg/L)	< 0.001	< 0.05	0.021	0.023	55
PartSize (%(W/W))	< 0.1	< 0.1	< 0.1		1
pH (pH units)	5.8	8.56	7.01	0.55	353
pH(Rain) (pH units)	6.13	7.72	7.18	0.27	144
Phaeophytin A (mg/L)	< 0.0005	< 0.0005	< 0.0005		1
Phosphorus Tot. Dissolved (mg/L)	< 0.002	0.044	0.005	0.004	186
PS>400 (%(W/W))	20.4	20.4	20.4	0	1
PS100 (%(W/W))	20.4	20.4	20.4	0	1
PS140 (%(W/W))	6.1	6.1	6.1	0	1
PS200 (%(W/W))	10.2	10.2	10.2	0	1
PS270 (%(W/W))	6.1	6.1	6.1	0	1
PS30 (%(W/W))	4.1	4.1	4.1	0	1
PS400 (%(W/W))	16.3	16.3	16.3	0	1
PS50 (%(W/W))	16.3	16.3	16.3	0	1
P--T (mg/L)	< 0.002	0.145	0.010	0.012	168
Total solids (mg/L)	30	52	39.3	5.7	45
Total dissolved solids 1.0u (mg/L)	16	56	40.3	6.4	104
Total susp. solids fixed. (mg/L)	< 1	2	1.1	0.3	12
Total suspended solids (mg/L)	0	10	2.8	2.8	23
ResT:Fx (mg/L)	14	16	15.5	0	4
ResT:Vol (%(W/W))	51.1	51.1	51.1		1
Silica - D (mg/L)	0.2	4	1.9	0.8	53
SO4-:S (mg/L)	2.79	4.8	4.0	0.4	144
Specific Conductance (µS/cm)	3.53	365	77.9	83.5	387
Sulfate:D (mg/L)	2.58	4.4	3.1	0.4	39
Temp (°C)	1.3	25	9.7	5.7	777
Temp(Air) (°C)	14	14	14		1
Turbidity (NTU)	< 0.1	12.9	1.0	1.5	88

Table 24. Summary of general water chemistry measured at Site 1100104, St. Mary Lake at deepest point, N. end - 1974 - 2007.

	Minimum	Maximum	Average	Std Dev	No. of Samples
Alkalinity pH 4.5/4.2 (mg/L)	30	35.9	33.5	3.1	5
Alkalinity pH 8.3 (mg/L)	0.5	7.7	2.1	1.9	16
Alkalinity Total 4.5 (mg/L)	23.8	49.1	31.2	3.3	323
Ammonia Dissolved (mg/L)	0.005	1.65	0.099	0.219	578
B.O.D. (mg/L)	10	10	10.0	0.0	11
Biomass (mg)	10.9	200	105.6	94.6	3
Biomass - Fixed (mg)	3.1	10	5.7	3.7	3
Bromide Dissolved (mg/L)	0.05	0.128	0.073	0.029	14
C.O.D. (mg/L)	10	68	16.0	9.3	257
Carbon Dissolved Organic (mg/L)	1.8	5	3.3	1.0	30
Carbon Total Inorganic (mg/L)	1	17.1	8.3	2.6	273
Carbon Total Organic (mg/L)	1	10	4.4	1.7	227
Chlorophyll *a* (mg/L)	0.0005	0.0311	0.0080	0.0052	235
Chloride - D (mg/L)	1	30.7	23.9	3.0	223
Coliforms - fecal (CFU/100mL)	< 1	1	1		1
Coliforms - fecal (MPN)	< 2	5	2.2	0.8	15
Coliforms - total (MPN)	< 2	11	4.3	2.9	16
Color True (TCU)	< 5	20	6.0	2.4	402
ColorTAC (TAC)	1	17	5.6	3.2	63
Diss Oxy (mg/L)	0	13.7	7.4	3.8	830
E. coli (CFU/100mL)	1	1	1		1
ExtDepth (m)	0.3962	8.5	2.4	1.6	78
Fluoride - D (mg/L)	< 0.05	0.1	0.06	0.02	7
Fluoride - T (mg/L)	0.04	0.06	0.05	0.01	7
Hardness Total (D) (mg/L)	27.1	37.6	34.4	1.8	53
Hardness Total (Extr) (mg/L)	31.3	31.4	31.4	0.1	3
Hardness Total (T) (mg/L)	22.7	38.2	34.2	3.4	25
Nitrogen Kjeldahl - T (mg/L)	0.1	2.3	0.5	0.3	347
Nitrogen (Kjel.) Tot Diss (mg/L)	0.24	1.6	0.6	0.3	34
Nitrate - T (mg/L)	0.02	0.02	0.02	0	4
Nitrate (NO3) Dissolved (mg/L)	< 0.002	0.233	0.038	0.066	40
Nitrate + Nitrite Diss. (mg/L)	0.002	0.87	0.059	0.118	630
Nitrite - T (mg/L)	0.005	0.005	0.005	0	4
Nitrogen - Nitrite Diss. (mg/L)	0.002	0.072	0.005	0.009	71
Nitrogen Organic-Total (mg/L)	0.03	1.23	0.42	0.21	260
Nitrogen Total (mg/L)	0.17	2	0.6	0.3	309
Nitrogen Total Dissolved (mg/L)	0.252	1.602	0.6	0.3	34

Table 24 (continued)

	Minimum	Maximum	Average	Std Dev	No. of Samples
ORP (mV)	8	444	295.3	122.8	208
Ortho-Phosphate Dissolved (mg/L)	0.001	0.363	0.025	0.057	562
pH (pH units)	6.08	9.5	7.4	0.5	753
Phaeophytin A (mg/L)	0.0005	0.0005	0.0005	0	92
Phosphorus Tot. Dissolved (mg/L)	0.002	0.407	0.031	0.064	586
P--T (mg/L)	0.002	0.92	0.058	0.110	620
Total solids (mg/L)	92	140	106.3	7.8	205
Total dissolved solids 1.0u (mg/L)	42	114	97.4	12.6	58
Total susp. solids fixed. (mg/L)	1	7	1.6	1.1	174
Total suspended solids (mg/L)	< 5	20	3.4	2.9	189
ResT:Fx (mg/L)	42	98	74.7	8.3	172
ResT:Vol (%)	33.8	35.2	34.5	1.0	2
ResVolNF (mg/L)	1	6	2.5	2.2	12
Silica - D (mg/L)	0.3	14.1	5.7	3.1	352
Specific Conductance (µS/cm)	90	1986	172.7	70.0	861
Sulfate - D (mg/L)	13	24.8	20.3	3.0	235
Sulfate Total (mg/L)	15	15	15.0	0.0	4
Sulfide Total (mg/L)	0.5	0.5	0.5	0	9
Tanins and Lignins:T (mg/L)	0.1	0.4	0.3	0.1	28
Temp (C)	1	25	11.6	5.0	898
Turbidity (NTU)	0.3	14.8	2.3	2.3	279

Table 25. Summary of general water chemistry measured at Site 1100133, Weston Lake at deepest point, 1985 - 2007.

	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity pH 4.5/4.2 (mg/L)	22.3	33.1	28.9	5.2	5
Alkalinity pH 8.3 (mg/L)	< 1	< 1	< 1	0	2
Alkalinity Total 4.5 (mg/L)	25.8	51.5	32.0	5.9	22
Ammonia Dissolved (mg/L)	< 0.002	2.9	0.279	0.612	56
Bromide Dissolved (mg/L)	< 0.05	0.1	0.1	0.0	10
Carbon Dissolved Organic (mg/L)	2.4	8.1	6.2	1.3	14
Carbon Total Inorganic (mg/L)	5.2	17.3	8.6	3.2	24
Carbon Total Inorganic (ug/g)	1970	1970	1970.0		1
Carbon Total Organic (mg/L)	3.9	10.3	6.6	1.2	35
Chlorophyll *a* (mg/L)	0.0005	0.0226	0.0040	0.0062	22
Chloride - D (mg/L)	6.6	24.7	10.0	3.9	35
Coliforms - fecal (CFU/100mL)	4	4	4		1
Color True (TCU)	< 5	50	18.5	11.8	43
ColorTAC (TAC)	8	23	15.5	6.9	6
Diss Oxy (mg/L)	0.28	19.72	8.56	4.40	157
E. coli (CFU/100mL)	< 1	< 1	< 1		1
ExtDepth (m)	1.9	5	3.3	1.0	10
Fluoride - D (mg/L)	0.03	0.03	0.03	0	2
Fluoride - T (mg/L)	< 0.01	0.03	0.02	0.01	7
Hardness Total (T) (mg/L)	28.2	38.83	34.02	3.28	11
Nitrogen Kjeldahl T (mg/L)	0.33	4.17	0.68	0.75	26
Nitrate (NO3) Dissolved (mg/L)	< 0.002	0.351	0.130	0.140	30
Nitrate + Nitrite Diss. (mg/L)	< 0.002	0.358	0.138	0.126	58
Nitrite - T (mg/L)	< 0.005	< 0.005	< 0.005	0	4
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.008	0.004	0.002	30
Nitrogen (Kjel.) Tot Diss (mg/L)	0.33	2.7	0.89	0.80	16
Nitrogen Organic-Total (mg/L)	< 0.02	0.93	0.39	0.19	16
Nitrogen Total (mg/L)	0.34	3.59	0.98	0.75	36
Nitrogen Total Dissolved (mg/L)	0.334	2.704	1.021	0.744	16
ORP (mV)	59	420	305.2	108.5	140
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.083	0.024	0.026	22
pH (pH units)	5.9	8.72	7.1	0.7	189
Phosphorus Tot. Dissolved (mg/L)	< 0.002	0.096	0.010	0.015	56
P--T (mg/L)	0.004	0.205	0.026	0.036	58
Total solids (mg/L)	50	98	77.3	12.1	26
Total dissolved solids 1.0u (mg/L)	50	140	75.7	21.0	18
Total susp. solids (mg/L)	< 1	20	7.8	6.3	12

Table 25 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
ResT:Vol (%(W/W))	56.4	56.4	56.4	0	1
Silica - D (mg/L)	< 0.5	8	4.5	2.2	48
Specific Conductance (µS/cm)	5	371	115.3	59.0	190
Sulfate - D (mg/L)	4	6.8	5.4	1.0	14
Sulfate Total (mg/L)	4	5	4.7	0.5	4
Temp (°C)	3.86	24.28	9.24	6.21	157
Turbidity(NTU)	0.4	13	3.2	3.5	41

Table 26. Summary of metals concentrations measured at Site 1100123, Cusheon Lake at deepest point, mid-lake west arm, 1974 – 2007.

	Minimum	Maximum	Average	Std Dev	No. of samples
Ag-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	4
Ag-E (mg/L)	< 0.01	< 0.01	< 0.01	0	15
Ag-T (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	12
Al-D (mg/L)	0.0021	0.04	0.018	0.016	5
Al-E (mg/L)	< 0.05	0.06	0.05	0	15
Al-T (mg/L)	0.0031	0.42	0.0852	0.0723	51
As-D (mg/L)	0.0002	0.0007	0.0004	0.0002	4
As-E (mg/L)	< 0.05	< 0.05	< 0.05	0	15
As-T (mg/L)	0.0001	0.0013	0.0003	0.0003	49
Ba-D (mg/L)	0.0063	0.0078	0.0070	0.0006	4
Ba-E (mg/L)	0.005	0.008	0.007	0.001	15
Ba-T (mg/L)	0.003	0.0119	0.007	0.002	48
B--D (mg/L)	< 0.1	< 0.1	< 0.1	0	4
B--E (mg/L)	0.02	0.03	0.023	0.005	15
Be-D (mg/L)	< 0.00002	0.00002	0.00002	0	4
Be-E (mg/L)	< 0.001	< 0.001	< 0.001	0	15
Be-T (mg/L)	< 0.00002	0.0011	0.0007	0.0005	12
Bi-D (mg/L)	< 0.00002	0.00002	0.00002	0	4
Bi-T (mg/L)	< 0.00002	< 0.05	< 0.014	0.017	24
B--T (mg/L)	0.01	0.1	0.0	0.0	36
Ca-D (mg/L)	7.5	13.6	9.2	1.3	39
Ca-E (mg/L)	8.4	11.1	9.9	0.8	18
Ca-S (mg/L)	10.6	10.6	10.6		1
Ca-T (mg/L)	7.6	14.1	9.9	1.2	72
Cd-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	4
Cd-E (mg/L)	< 0.005	< 0.005	< 0.005	0	15
Cd-T (mg/L)	< 0.00001	0.00001	0.00001	0	61
Co-D (mg/L)	0	0.001	0.00025	0.0005	4
Co-E (mg/L)	< 0.005	0.007	0.005	0.001	15
Co-T (mg/L)	< 0.000005	0.011	0.004	0.003	48
Cr-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	4
Cr-E (mg/L)	< 0.005	0.007	0.005	0.001	15
Cr-T (mg/L)	< 0.0002	0.0011	0.0004	0.0003	12
C--T (mg/L)	9.5	23.8	13.1	2.3	54
Cu-D (mg/L)	0.0003	0.0011	0.0007	0.0004	4
Cu-E (mg/L)	< 0.005	< 0.005	< 0.005	0	15
Cu-T (mg/L)	< 0.0005	< 0.006	0.003	0.002	64
Fe-D (mg/L)	0.31	0.31	0.31	0	1

Table 26 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
Fe-E (mg/L)	0.074	0.244	0.154	0.000	15
Fe-T (mg/L)	< 0.09	1.6	0.22	0.25	52
Hg-T (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	12
K--D (mg/L)	0.4	0.6	0.5	0.1	7
K--E (mg/L)	0.4	0.7	0.5	0.1	18
K--S (mg/L)	0.19	0.19	0.19	0	1
K--T (mg/L)	< 0.3	1	0.6	0.2	33
Li-D (mg/L)	0.0004	0.0007	0.0006	0.0001	4
Li-T (mg/L)	0.0004	0.0008	0.0006	0.0001	12
Mg-D (mg/L)	1.9	3.1	2.4	0.3	39
Mg-E (mg/L)	2.3	3.1	2.8	0.3	18
Mg-S (mg/L)	2.77	2.77	2.77	0	1
Mg-T (mg/L)	2	3.4	2.6	0.3	70
Mn-D (mg/L)	0.0323	0.952	0.2521	0.3977	5
Mn-E (mg/L)	0.002	0.466	0.115	0.130	15
Mn-T (mg/L)	0.015	1.05	0.065	0.145	51
Mo-D (mg/L)	< 0.0001	0.0001	0.0001	0	4
Mo-E (mg/L)	< 0.01	< 0.01	< 0.01	0	15
Mo-T (mg/L)	< 0.0001	0.0114	0.0061	0.0043	48
Na-D (mg/L)	4.7	9.3	6.1	1.3	15
Na-E (mg/L)	5.3	6.4	6.0	0.4	18
Na-S (mg/L)	5.58	5.58	5.58	0	1
Na-T (mg/L)	5	6.99	5.87	0.46	33
Ni-D (mg/L)	0.0002	0.0006	0.0004	0.0002	4
Ni-E (mg/L)	< 0.02	< 0.02	< 0.02	0	15
Ni-T (mg/L)	< 0.0002	< 0.02	0.0115	0.007	64
Pb-D (mg/L)	0.0001	0.0001	0.00005	0	4
Pb-E (mg/L)	< 0.05	0.06	0.05	0.00	15
Pb-T (mg/L)	< 0.0001	0.003	0.0009	0.0009	28
Sb-D (mg/L)	0.0001	0.0001	0.0001	0.00005	4
Sb-E (mg/L)	< 0.05	< 0.05	< 0.05	0	15
Sb-T (mg/L)	< 0.000005	< 0.06	< 0.036	0.03	48
S--E (mg/L)	2.78	3.12	3.00	0.11	15
Se-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	4
Se-E (mg/L)	< 0.05	< 0.05	< 0.05	0	15
Se-T (mg/L)	< 0.0002	0.07	0.0376	0.0252	48
Si-E (mg/L)	3.63	5.23	4.25	0.45	18
Si-T (mg/L)	2.7	5.08	4.10	0.54	36

Table 26 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
Sn-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	4
Sn-E (mg/L)	< 0.05	< 0.05	< 0.05	0	15
Sn-T (mg/L)	< 0.00001	< 0.06	< 0.035	0.026	48
Sr-D (mg/L)	0.0625	0.0911	0.073	0.013	4
Sr-E (mg/L)	0.072	0.085	0.078	0.004	15
Sr-T (mg/L)	0.0505	0.0982	0.069	0.008	48
S--T (mg/L)	2.6	3.5	3.1	0.2	30
Te-T (mg/L)	< 0.02	< 0.02	< 0.02	0	12
Ti-E (mg/L)	< 0.002	0.005	0.003	0.001	15
Ti-T (mg/L)	< 0.002	0.017	0.004	0.004	36
Tl-D (mg/L)	< 0.000002	0.000002	0.000002	0	4
Tl-T (mg/L)	< 0.000002	< 0.03	< 0.012	0.0145	24
U--D (mg/L)	0.000002	0.000002	0.000002	0	4
U--T (mg/L)	0.000002	0.000002	0.000002	0	12
V--D (mg/L)	0.0001	0.0004	0.0002	0.0001	4
V--E (mg/L)	< 0.01	< 0.01	< 0.01	0	15
V--T (mg/L)	< 0.0001	0.0114	0.006	0.004	48
Zn-D (mg/L)	0.0003	0.0358	0.010	0.017	4
Zn-E (mg/L)	< 0.002	0.003	0.002	0.000	15
Zn-T (mg/L)	0.0004	0.0479	0.005	0.006	64
Zr-T (mg/L)	< 0.003	< 0.005	0.004	0.001	12

Table 27. Summary of metals concentrations measured at Site 1130022, Maxwell Lake at deepest point, 1981 - 2007.

	Minimum	Maximum	Average	Std. Dev.	No. of samples
Ag-D (mg/L)	< 0.01	< 0.01	< 0.01	0.005	4
Ag-E (mg/L)	< 0.01	< 0.01	< 0.01		7
Ag-T (mg/L)	< 0.03	< 0.03	< 0.03	0.01	32
Al-D (mg/L)	0.0068	0.05	0.03	0.04	110
Al-E (mg/L)	< 0.05	< 0.05	< 0.05		7
Al-T (mg/L)	0.0047	0.2	0.0376	0.0328	175
As-D (mg/L)	< 0.0001	0.0002	0.0001	0.0001	3
As-E (mg/L)	< 0.05	< 0.05	< 0.05		7
As-T (mg/L)	< 0.0001	0.0003	0.15	0.11	66
Ba-D (mg/L)	0.003	0.01	0.010	0.002	64
Ba-E (mg/L)	0.002	0.007	0.004	0.002	7
Ba-T (mg/L)	< 0.001	0.02	0.007	0.004	66
B--D (mg/L)	0.008	< 0.02	0.010	0.001	61
B--E (mg/L)	< 0.01	0.01	0.01		7
Be-D (mg/L)	< 0.00002	< 0.001	0.00025	0.0005	4
Be-E (mg/L)	< 0.001	< 0.001	< 0.001		7
Be-T (mg/L)	< 0.00002	< 0.003	0.001	0.001	32
Bi-D (mg/L)	< 0.00002	< 0.02	< 0.005	0.01	4
Bi-T (mg/L)	< 0.00002	< 0.05	< 0.01	0.019	19
B--T (mg/L)	0.008	< 0.05	0.014	0.011	19
Ca-D (mg/L)	< 0.02	6.2	5.01	1.42	65
Ca-E (mg/L)	4.2	5.1	4.53	0.29	10
Ca-S (mg/L)	3.39	6.53	5.34	0.57	132
Ca-T (mg/L)	< 0.02	8.84	5.14	1.05	121
Cd-D (mg/L)	< 0.00001	< 0.01	0.003	0.004	63
Cd-E (mg/L)	< 0.005	< 0.005	< 0.005	0	7
Cd-T (mg/L)	< 0.00001	0.0035	0.00046	0.0004	63
Co-D (mg/L)	< 0.000005	< 0.1	< 0.09	0.024	64
Co-E (mg/L)	< 0.005	0.012	0.006	0.003	7
Co-T (mg/L)	< 0.000005	0.1	0.076	0.042	128
Cr-D (mg/L)	0.0002	< 0.02	0.009	0.003	64
Cr-E (mg/L)	< 0.005	< 0.005	< 0.005	0	7
Cr-T (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	13
C--T (mg/L)	5.9	16.6	8.9	1.8	43
Cu-D (mg/L)	0.0002	< 0.01	0.003	0.004	64
Cu-E (mg/L)	< 0.005	< 0.005	< 0.005	0	7
Cu-T (mg/L)	0.0003	0.0009	0.0005	0.0002	134
Fe-D (mg/L)	< 0.01	0.09	0.02	0.02	62

Table 27 (continued)

	Minimum	Maximum	Average	Std. Dev.	No. of samples
Fe-E (mg/L)	0.006	0.051	0.027	0.017	7
Fe-T (mg/L)	< 0.01	0.35	0.06	0.05	116
K--D (mg/L)	0.2	0.6	0.3	0.1	14
K--E (mg/L)	0.3	0.5	0.3	0.1	10
K--S (mg/L)	0.11	0.51	0.32	0.08	144
K--T (mg/L)	< 0.3	1	0.5	0.2	19
Li-D (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	3
Li-T (mg/L)	< 0.0001	0.0003	0.0001	0.0001	13
Mg-D (mg/L)	< 0.02	1.37	1.14	0.31	65
Mg-E (mg/L)	1	1.2	1.1	0.1	10
Mg-S (mg/L)	0.79	1.64	1.19	0.13	132
Mg-T (mg/L)	< 0.02	3.07	1.19	0.27	121
Mn-D (mg/L)	< 0.0004	0.54	0.018	0.066	65
Mn-E (mg/L)	0.002	0.188	0.037	0.067	7
Mn-T (mg/L)	0.0077	0.08	0.021	0.015	129
Mo-D (mg/L)	0.0001	< 0.01	0.009	0.002	64
Mo-E (mg/L)	< 0.01	< 0.01	< 0.01	0	7
Mo-T (mg/L)	< 0.0001	< 0.01	0.009	0.003	129
Na-D (mg/L)	2.8	4	3.0	0.3	16
Na-E (mg/L)	2.4	2.7	2.5	0.1	10
Na-S (mg/L)	2.03	3.7	2.9	0.3	144
Na-T (mg/L)	2.4	3.31	2.7	0.3	19
Ni-D (mg/L)	0.0001	< 0.05	0.017	0.022	64
Ni-E (mg/L)	< 0.02	< 0.02	< 0.02	0	7
Ni-T (mg/L)	< 0.0001	0.0001	0.0001	0	13
Pb-D (mg/L)	< 0.00001	< 0.1	< 0.04	0.05	63
Pb-E (mg/L)	< 0.05	< 0.05	< 0.05		7
Pb-T (mg/L)	< 0.00001	0.0005	0.0001	0.0001	13
P--E (mg/L)	< 0.1	< 0.1	< 0.1		7
Sb-D (mg/L)	0.000005	< 0.015	0.004	0.008	4
Sb-E (mg/L)	< 0.05	< 0.05	< 0.05	0	7
Sb-T (mg/L)	0.000005	< 0.06	< 0.03	0.028	32
S--E (mg/L)	0.9	1.02	0.98	0.04	7
Se-D (mg/L)	< 0.0002	< 0.03	< 0.008	0.0149	4
Se-E (mg/L)	< 0.05	< 0.05	< 0.05		7
Se-T (mg/L)	< 0.0002	0.0004	0.0002	0.0001	13
Si-D (mg/L)	0.55	0.55	0.55		1
Si-E (mg/L)	0.26	1.36	0.686	0.385	10

Table 27 (continued)

	Minimum	Maximum	Average	Std. Dev.	No. of samples
Si-T (mg/L)	0.28	1.22	0.77	0.30	17
Sn-D (mg/L)	0.00001	< 0.02	0.005	0.01	4
Sn-E (mg/L)	< 0.05	< 0.05	< 0.05	0	7
Sn-T (mg/L)	0.00001	< 0.06	0.028	0.028	32
Sr-D (mg/L)	0.014	0.0167	0.016	0.001	4
Sr-E (mg/L)	0.015	0.019	0.017	0.002	7
Sr-T (mg/L)	0.014	0.02	0.016	0.001	32
S--T (mg/L)	0.93	1.49	1.11	0.15	18
Te-D (mg/L)	< 0.02	< 0.02	< 0.02		1
Te-T (mg/L)	< 0.02	< 0.05	< 0.035		6
Ti-D (mg/L)	< 0.003	< 0.003	< 0.003		1
Ti-E (mg/L)	< 0.002	0.005	0.003	0.001	7
Ti-T (mg/L)	< 0.002	0.006	0.003	0.001	19
Tl-D (mg/L)	< 0.000002	< 0.02	< 0.005	0.01	4
Tl-T (mg/L)	< 0.000002	< 0.03	0.0066	0.0124	19
U--D (mg/L)	< 0.000002	< 0.000002	< 0.000002	0	3
U--T (mg/L)	< 0.000002	< 0.000002	< 0.000002	0	13
V--D (mg/L)	< 0.0001	< 0.02	< 0.01	0.0026	64
V--E (mg/L)	< 0.01	< 0.01	< 0.01	0	7
V--T (mg/L)	< 0.0001	0.04	0.0091	0.0046	129
Zn-D (mg/L)	0.0001	0.06	0.0075	0.0077	61
Zn-E (mg/L)	< 0.002	0.003	0.0021	0.0004	7
Zn-T (mg/L)	0.0005	0.0017	0.0024	0.0032	13
Zr-D (mg/L)	< 0.003	< 0.003	< 0.003	0	1
Zr-T (mg/L)	< 0.003	< 0.005	< 0.004	0	6

Table 28. Summary of metals concentrations measured at Site 1100104, St. Mary Lake at deepest point, N. end - 1974 - 2007.

	Minimum	Maximum	Average	Std Dev	No. of Samples
Ag-D (mg/L)	<0.00001	0.00001	0.00001	0	7
Ag-T (mg/L)	<0.00001	<0.00001	<0.00001	0	18
Al-D (mg/L)	0.0006	0.1	0.0259	0.0235	38
Al-T (mg/L)	0.0012	0.34	0.063	0.048	247
As-D (mg/L)	0.0004	0.001	0.0006	0.0002	7
As-T (mg/L)	0.0003	0.0013	0.0005	0.0002	18
Ba-D (mg/L)	0.0108	0.0195	0.0137	0.0038	7
Ba-T (mg/L)	0.006	0.05	0.017	0.007	152
B--D (mg/L)	0.1	0.1	0.1	0	4
Be-D (mg/L)	< 0.00002	0.00002	0.00002	0	7
Be-T (mg/L)	< 0.00002	< 0.001	0.0007	0.0005	67
Bi-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	7
Bi-T (mg/L)	0	0.05	0.02	0.01	56
B--T (mg/L)	0.03	0.09	0.05	0.01	49
Ca-D (mg/L)	5.9	10.1	8.7	0.7	77
Ca-E (mg/L)	7.9	7.9	7.9	0.0	3
Ca-T (mg/L)	5.53	12.3	9.6	0.9	398
Cd-D (mg/L)	< 0.00001	0.0001	0.00001	0	7
Cd-T (mg/L)	< 0.00001	0.00001	0.00001	0	10
Co-D (mg/L)	< 0.000005	0.0003	0.00006	0.0001	7
Co-T (mg/L)	< 0.000005	0.013	0.003	0.002	67
Cr-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	7
Cr-T (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	18
C--T (mg/L)	8.5	23.8	12.6	2.5	119
Cu-D (mg/L)	0.0001	0.0006	0.0002	0.0002	7
Cu-T (mg/L)	< 0.0002	0.0031	0.0007	0.0006	18
Fe-D (mg/L)	< 0.01	0.92	0.24	0.26	31
Fe-T (mg/L)	< 0.01	1.5	0.12	0.19	338
Hg-T (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	15
K--D (mg/L)	0.7	0.7	0.7	0	5
K--E (mg/L)	0.7	0.8	0.8	0.1	3
K--T (mg/L)	0.7	1.1	0.9	0.1	22
Li-D (mg/L)	0.007	0.0082	0.0075	0.0005	7
Li-T (mg/L)	0.0063	0.0085	0.0075	0.0006	18
Mg-D (mg/L)	2.2	3.3	2.8	0.2	77
Mg-E (mg/L)	2.8	2.8	2.8	0.0	3
Mg-T (mg/L)	1.611	3.95	3.16	0.28	398
Mn-D (mg/L)	< 0.0002	0.49	0.17	0.19	38

Table 28 (continued)

	Minimum	Maximum	Average	Std Dev	No. of Samples
Mn-T (mg/L)	< 0.0018	1.24	0.078	0.169	339
Mo-D (mg/L)	< 0.0001	0.0001	0.0001	0	7
Mo-T (mg/L)	< 0.0001	0.04	0.0067	0.0052	336
Na-D (mg/L)	15.2	27.1	21.6	1.6	188
Na-E (mg/L)	16.2	16.2	16.2	0.0	3
Na-T (mg/L)	16.3	21.2	19.0	1.6	22
Ni-D (mg/L)	< 0.0001	0.0006	0.0002	0.0002	7
Ni-T (mg/L)	< 0.0001	0.0008	0.0002	0.0002	14
Pb-D (mg/L)	< 0.00001	0.0001	0.00001	0	7
Pb-T (mg/L)	< 0.00001	0.0004	0.0001	0.0001	18
Sb-D (mg/L)	0.000005	0.0002	0.00006	0	7
Sb-T (mg/L)	0	0.06	0.02	0.02	67
Se-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	7
Se-T (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	18
Si-E (mg/L)	1.79	1.8	1.80	0.01	3
Si-T (mg/L)	0.62	6.3	3.38	1.21	51
Sn-D (mg/L)	< 0.00001	0.0001	0.00001	0	7
Sn-T (mg/L)	0	0.06	0.02	0.02	67
Sr-D (mg/L)	0.0889	0.0998	0.095	0.004	7
Sr-T (mg/L)	0.029	0.117	0.091	0.014	67
S--T (mg/L)	4.58	5.68	5.01	0.30	17
Te-T (mg/L)	0.02	0.05	0.02	0.01	38
Ti-T (mg/L)	0.002	0.009	0.0032	0.0012	49
Tl-D (mg/L)	< 0.000002	0.000002	0.000002	0	7
Tl-T (mg/L)	< 0.000002	0.03	0.02	0.01	56
U--D (mg/L)	< 0.000002	0.000002	0.000002	0	7
U--T (mg/L)	< 0.000002	0.000002	0.000002	0	18
V--D (mg/L)	0.0001	0.0003	0.0002	0	7
V--T (mg/L)	0.0001	0.07	0.0082	0.0087	308
Zn-D (mg/L)	< 0.0001	0.0499	0.0127	0.0215	7
Zn-T (mg/L)	< 0.0002	0.24	0.014	0.020	352
Zr-T (mg/L)	< 0.003	< 0.005	< 0.003	0.0005	38

Table 29. Summary of metals concentrations measured at Site 1100133, Weston Lake at deepest point, 1985 - 2007.

	Minimum	Maximum	Average	Std Dev	No. of samples
Ag-D (mg/L)	< 0.000002	< 0.000002	< 0.000002	0	2
Ag-T (mg/L)	< 0.000002	< 0.000002	< 0.000002	0	10
Al-D (mg/L)	0.0224	0.0231	0.0228	0.0005	2
Al-T (mg/L)	0.0096	0.24	0.0664	0.0455	33
As-D (mg/L)	0.0002	0.0002	0.0002	0	2
As-T (mg/L)	0.0001	0.0003	0.0002	0.0001	10
Ba-D (mg/L)	0.0064	0.0065	0.0065	0.0001	2
Ba-T (mg/L)	0.004	0.0139	0.0073	0.0023	30
Be-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	2
Be-T (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	10
Bi-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	2
Bi-T (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	10
B--T (mg/L)	< 0.01	0.11	0.04	0.03	20
Ca-T (mg/L)	8.5	13.2	11.0	1.4	31
Cd-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	2
Cd-T (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	10
Co-D (mg/L)	0.000005	0.000005	0.000005	0	2
Co-T (mg/L)	< 0.000005	0.0001	0.00001	0.00003	10
Cr-D (mg/L)	0.0002	0.0002	0.0002	0	2
Cr-T (mg/L)	< 0.0002	0.027	0.005	0.006	36
C--T (mg/L)	10.8	25.2	15.4	3.5	24
Cu-D (mg/L)	0.0006	0.001	0.0008	0.0003	2
Cu-T (mg/L)	0.0005	0.0013	0.0008	0.0003	10
Fe-T (mg/L)	0.029	1.25	0.131	0.238	26
K--T (mg/L)	< 0.5	1	0.7	0.2	19
Li-D (mg/L)	< 0.0001	0.0002	0.00015	0.0001	2
Li-T (mg/L)	0.0001	0.0003	0.00022	0.0001	10
Mg-T (mg/L)	1.35	3.64	1.85	0.49	31
Mn-D (mg/L)	0.0003	0.0016	0.0010	0.0009	2
Mn-T (mg/L)	< 0.005	0.32	0.028	0.057	36
Mo-D (mg/L)	0.0002	0.0002	0.0002	0	2
Mo-T (mg/L)	0.0002	0.0002	0.0002	0	36
Na-D (mg/L)	5.6	8.1	6.5	0.7	11
Na-T (mg/L)	4.9	6.23	5.5	0.4	19
Ni-D (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	2
Ni-T (mg/L)	< 0.0001	0.05	0.016	0.017	36
Pb-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	2
Pb-T (mg/L)	< 0.00001	0.0003	0.0001	0.0001	10

Table 29 (continued)

	Minimum	Maximum	Average	Std Dev	No. of samples
Sb-D (mg/L)	0	0	0	0	2
Sb-T (mg/L)	< 0.000005	0.000005	0.000005	0	30
Se-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	2
Se-T (mg/L)	< 0.0002	< 0.0002	< 0.0002	0	30
Si-T (mg/L)	0.71	3.55	2.18	1.00	22
Sn-D (mg/L)	< 0.00001	0.0001	0.00005	0.0001	2
Sn-T (mg/L)	< 0.00001	0.00001	0.00001	0	30
Sr-D (mg/L)	0.0289	0.0303	0.0296	0.0010	2
Sr-T (mg/L)	0.024	0.104	0.035	0.018	30
S--T (mg/L)	1.47	1.8	1.7	0.1	14
Te-T (mg/L)	< 0.02	0.05	0.03	0.01	12
Ti-T (mg/L)	< 0.002	0.008	0.003	0.001	20
Tl-D (mg/L)	< 0.000002	0.000002	0.000002	0	2
Tl-T (mg/L)	< 0.000002	0.000002	0.000002	0	10
U--D (mg/L)	0	0	0	0	2
U--T (mg/L)	0	0	0	0	10
V--D (mg/L)	0.0002	0.0002	0.0002	0	2
V--T (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	10
Zn-D (mg/L)	0.0008	0.001	0.0009	0.0001	2
Zn-T (mg/L)	< 0.0003	0.0282	0.0069	0.0059	36
Zr-T (mg/L)	< 0.003	0.005	0.0035	0.0009	12

Table 30. Dominant (*i.e.* >10% of sample) phytoplankton species for Cusheon Lake.

	2003/02/13		2003/05/15		2004/02/16		2004/07/06		2005/02/23		2005/05/26		2005/08/16		2005/09/22		2006/02/15		2006/05/18		2006/08/22		2007/02/26	
cells/mL	976		857		354		860		1128		935		1431		1915		295		305		9683		458	
Order : Centrales																								
Melosira granulata															689	36%								
Order : Cryptomonadales																								
Chroomonas acuta	345	35%	375	44%	195	55%	109	13%	574	51%	384	41%	143	10%	403	21%	221	75%	241	79%			331	72%
Cryptomonas ovata / erosa									118	10%														
Order : Nostocales																								
Anabaena affinis													608	43%							2759	29%		
Anabaena cf circinalis																					1424	15%		
Anabaena spp.													216	15%	196	10%								
Order : Ochromonadales																								
Uroglena volvox	195	20%																						
Uroglenopsis cf americana											140	15%												
Order : Pennales																								
Asterionella formosa			274	32%					174	15%														
Order : Rhizochrysidales																								
Gloeocystis ampla							325	38%			134	14%												
Sphaerocystis schroeteri							157	18%			112	12%									854	10%		

Table 31. Dominant (*i.e*. >10% of sample) phytoplankton species for Maxwell Lake.

	2003/02/13		2003/05/15		2004/02/16		2005/02/23		2005/05/26		2005/06/16		2005/09/22		2006/05/18		2006/08/22		2007/02/26	
cells/mL	2075		753		1499		787		196		237		473		570		606		1114	
Order : Centrales																				
Cyclotella sp.	622	30%																		
Rhizosolenia eriensis / longiseta															302	53%				
Rhizosolenia cf longiseta			101	13%																
Order : Chlorococcales																				
Crucigenia tetrapedia											34	14%					68	11%		
Scenedesmus sp.																	110	18%		
Selenastrum minutum													122	26%						
Tetraedron minimum							423	54%												
Anacystis sp. aka Microcystis sp.	496	24%											70	15%						
Order : Dinokontae																				
Peridinium cf inconspicuum			78	10%					43	22%					134	24%				
Order : Ochromonadales																				
Dinobryon bavaricum									73	37%									171	15%
Dinobryon divergens																			756	68%
Dinobryon cf sertularia			140	19%																
Uroglenopsis cf americana					946	63%														
Order : Pennales																				
Achnanthes minutissima			104	14%																
Asterionella formosa											143	60%					192	32%		
Fragilaria crotonensis			98	13%																
Order : Volvocales																				
Pandorina morum									22	11%										
Unidentified flagellate algae			392	52%																

Table 32. Dominant (*i.e.* >10% of sample) phytoplankton species for St. Mary Lake.

	2003/02/13		2003/05/15		2004/02/16		2004/07/06		2004/11/18		2005/05/26		2005/05/26		2005/08/16		2005/09/22		2006/02/15		2006/05/18		2006/08/22		2007/02/26	
cells/mL	10453		1313		5055		52759		48238		18174		59114		1277		7865		166626		49804		3811		2741	
Order : Centrales																										
Cyclotella sp.																									473	17%
Melosira granulata																							507	13%		
Cyclotella glomerata					2314	46%																				
Order : Chroococcales																										
Synechocystis diplococcus ?	3174	30%																								
Order : Cryptomonadales																										
Chroomonas acuta			510	39%	1015	20%									305	24%										
Order : Nostocales																										
Anabaena spiroides															308	24%										
Anabaena cf circinalis	3204	31%													232	18%										
Anabaena affinis															174	14%	840	11%					2582	68%		
Aphanizomenon flos-aquae?							31577	60%			1976	11%									5465	11%				
Order : Ochromonadales																										
Mallomonas akrokomos																									350	13%
Order : Oscillatoriales																										
Lyngbya limnetica							17052	32%																		
Oscillatoria tenuis									47882	99%	16145	89%	59096	100%			5298	67%	166430	100%	44322	89%				
Order : Pennales																										
Asterionella formosa																									1562	57%
Unidentified flagellate algae			440	33%																						
Unidentified colonial algae	1156	11%																								

Table 33. Dominant (i.e. >10% of sample) phytoplankton species for Weston Lake.

	2003/02/13		2003/05/15		2004/02/16		2004/07/06		2004/11/18		2005/02/23		2005/05/26		2005/08/16		2005/09/22		2006/02/15		2006/05/18		2006/08/22		2007/02/26	
Cells/mL	14498		1599		26344		1137		1851		1047		837		874		1422		9024		568		3587		1621	
Order : Centrales																										
Cyclotella glomerata			409	26%																			2055	57%		
Order : Chlorococcales																										
Botryococcus braunii													90	11%												
Anacystis elachista									644	35%					105	12%	672	47%								
Order : Cryptomonadales																										
Chroomonas acuta											210	20%			182	21%	244	17%			188	33%				
Order : Nostocales																										
Anabaena affinis															116	13%							1120	31%		
Anabaena cf circinalis													336	40%							186	33%				
Order : Ochromonadales																										
Dinobryon divergens																			1641	18%						
Synura ?																									291	18%
Mallomonas akrokomos											218	21%													720	44%
Order : Oscillatoriales																										
Oscillatoria tenuis	9617	66%	448	28%	22339	85%	823	72%	308	17%									6860	76%						
Order : Pennales																										
Fragilaria crotonensis									596	32%																
Tabellaria flocculosa											134	13%														
Asterionella formosa											339	32%													165	10%
Order : Tetrasporales																										
Sphaerocystis schroeteri													157	19%							112	20%				
Unidentified flagellate algae			266	17%																						

Table 34. Dominant (*i.e.* >10% of sample) zooplankton species in Cusheon Lake.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/26	2005/05/26	2005/08/06	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Total organisms/sample	30743	173611	22696	47525	7534	86952	85091	34382	4813	95852	24033	7601
Subclass : Copepoda												
Copepod nauplii					1083 14%				1140 24%			1767 23%
Ceriodaphnia sp.											3867 16%	
Phylum : Rotifera												
Conochilus sp.				18915 40%						21867 23%	2400 10%	
Gastropus sp.			3958 17%				11288 13%					
Hexarthra sp.							11375 13%	5733 17%				
Kellicottia longispina	24125 78%	132000 76%				8800 10%	15750 19%	3667 11%	1340 28%	52300 55%	6033 25%	1833 24%
Keratella cochlearis			10292 45%			46000 53%						1033 14%
Keratella quadrata					1117 15%				1280 27%			900 12%
Polyarthra sp.				15860 33%		13867 16%	17588 21%	8800 26%			4200 17%	
Synchaeta					3383 45%							

Table 35. Dominant (*i.e.* >10% of sample) zooplankton species in Maxwell Lake.

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Total organisms/sample	80824	47626	58739	40741	43492	68360	52701	117956	498190	24071	21297
Phylum : Rotifera											
Gastropus sp.					15667 36%						
Hexarthra sp.							7050 13%				
Kellicottia longispina	25334 31%	24867 52%		5920 15%	4583 11%	22680 33%	18850 36%	73800 63%	413500 83%	8150 34%	3038 14%
Keratella cochlearis	27834 34%		16400 28%	8840 22%	10417 24%	11460 17%		13300 11%		6450 27%	5475 26%
Keratella quadrata			17267 29%								5063 24%
Polyarthra sp.	14167 18%		14667 25%								
Synchaeta					4500 10%						
Unidentified Rotifera		6467 14%									
Phylum : Protozoa											
Unidentified ciliate				12320 30%				14700 12%		3450 14%	

Table 36. Dominant (*i.e.* >10% of sample) zooplankton species in St. Mary Lake.

	2003/02/13		2003/05/15		2004/02/16		2004/07/06		2004/11/18		2005/02/23		2005/05/26		2005/08/16		2005/09/22		2006/02/15		2006/05/18		2006/08/22		2007/02/26	
Total organisms/sample	3978		40552		29982		12341		14280		2954		19388		43003		44177		1610		11765		16328		9338	
Subclass : Copepoda																										
Copepod nauplii	2100	53%	8167	20%	4400	15%															1767	15%			1,275	14%
Order : Cyclopoida																										
Diaptomus cf oregonensis Adult							2000	16%																		
Diaptomus cf oregonensis Copepodid									3000	21%																
Skistodiaptomus oregonensis Adult	1830	46%																								
Diaphanosoma birgei							2458	20%																		
Diaphanosoma sp.															5775	13%										
Phylum : Rotifera																										
Conochilus sp.																	18733	42%								
Filinia sp.															14588	34%										
Kellicottia longispina			23000	57%																						
Keratella cochlearis					14133	47%	1750	14%	10467	73%	2020	68%	5880	30%			11667	26%	880	55%	1233	10%	15500	95%		
Keratella quadrata					3800	13%													200	12%	7233	61%			4,613	49%
Polyarthra sp.							3667	30%					12320	64%												
Synchaeta																			200	12%					2,525	27%
Phylum : Protozoa																										
Unidentified ciliate															5288	12%										

Table 37. Dominant (*i.e.* >10% of sample) zooplankton species in Weston Lake.

	2004/02/16		2004/07/06		2004/11/18		2005/02/26		2005/05/26		2005/08/16		2005/09/22		2006/02/15		2006/05/18		2006/08/22		2007/02/26	
	21280		52041		19397		12485		436286		51903		45397		45366		135687		16956		11372	
Subclass : Copepoda																						
Copepod nauplii							4080	33%							5920	13%					1833	16%
Order : Cladocera																						
Ceriodaphnia acanthina					2267	12%																
Phylum : Rotifera																						
Kellicottia longispina											13850	27%	8333	18%			61500	45%				
Keratella cochlearis	10958	51%	24292	47%	6533	34%	4427	35%	327500	75%			11050	24%	9060	20%	33900	25%	4967	29%	6050	53%
Keratella quadrata	3250	15%					1440	12%			10650	21%										
Polyarthra sp.					2800	14%																
Ptygura / Callotheca sp.			17667	34%							6450	12%	7000	15%								
Synchaeta															7020	15%						
Phylum : Protozoa																						
Unidentified ciliate					2467	13%									17520	39%						

APPENDIX I. PHYTOPLANKTON RESULTS

Table 38. Phytoplankton results for Cusheon Lake, 2003-2007.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Order : Centrales												
Cyclotella bodanica			1.4									
Cyclotella glomerata	Present		2.8		Present							17.1
Cyclotella sp.												3.8
Melosira granulata			Present		5.6		Present	688.8	Present	Present		
Melosira italica	18				Present		Present					7.6
Melosira sp.			2.8	Present	Present	Present	Present	Present	5.6		Present	5.7
Rhizosolenia eriensis / longiseta		2.8										
Order : Chlorococcales												
Actinastrum					Present							
Ankistrodesmus falcatus							11.2	5.6	Present	Present	53.4	
Ankistrodesmus sp.				2.8	Present							Present
Botryococcus braunii				Present			67.2			Present	Present	
Closteriopsis longissima												
Closteriopsis sp.		Present			Present			Present	Present			Present
Crucigenia crucifera											Present	
Crucigenia quadrata			Present				Present	11.2			Present	Present
Crucigenia tetrapedia					Present		Present	11.2			142.4	
Crucigenia sp.							Present				71.2	
Elakatothrix gelatinosa		Present		Present	5.6	Present	8.4	5.6	Present	Present	Present	Present
Kirchneriella sp. ?							Present	2.8			Present	
Nephrocytium ecdysiscepanum								Present				
Nephrocytium					Present		Present				Present	
Oocystis parva							Present	Present				
Oocystis spp.	Present			Present			Present	Present		Present	427.2	Present
Pediastrum tetras							22.4				Present	
Pediastrum							Present	22.4			Present	
Quadrigula closterioides							Present	Present			Present	
Quadrigula lacustris		Present		Present		Present	Present		Present	Present	Present	
Quadrigula sp.					Present	Present						
Scenedesmus cf arcuatus											Present	
Scenedesmus bijuga												Present
Scenedesmus cf denticulatus				Present			33.6	Present			142.4	
Scenedesmus sp.			Present				5.6		Present		35.6	
Selenastrum minutum				Present			Present	Present			53.4	
Schroederia Judayi				2.8	Present	2.8	Present	8.4				
Schroederia setigera	Present	Present							Present	Present	Present	
Schroederia sp.									Present			
Tetraedron minimum							Present	Present			Present	
Tetraedron sp.								Present				

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Order : Cladophorales												
Unidentified Cladophorales											1495.2	
Order : Chroococcales												
Agmenellum tenuissima								Present				
Anacystis elachista												
Anacystis limneticus										Present		
Anacystis sp. aka Microcystis sp.		Present	Present	Present				Present		Present	178.0	Present
Gomphosphaeria sp. aka Coelosphaerium sp.				84.0				Present				
Order : Cryptomonadales												
Chroomonas acuta	345	375.2	194.6	109.2	574.0	383.6	142.8	403.2	221.2	240.8	569.6	330.6
Cryptomonas cf marssonii	18											
Cryptomonas ovata / erosa	9	2.8	28.0	19.6	117.6	11.2	14.0	78.4	4.2	2.8	17.8	5.7
Cryptomonas sp.	6	Present	22.4	8.4	11.2	8.4	Present	8.4	4.2	2.8	Present	Present
Unidentified Cryptomonadales	0.8											
Order : Dinokontae												
Ceratium hirundinella		Present		Present			Present	2.8			Present	
Gymnodinium sp. ?							Present					Present
Peridinium cf inconspicuum		Present	Present									
Peridinium / Glenodinium			Present	Present	25.2				Present		Present	
Unidentified Dinokontae			Present									Present
Order : Euglenales												
Euglena					Present			2.8	Present		Present	Present
Phacus												Present
Trachelomonas sp.		Present	2.8	Present		2.8	2.8	8.4	2.8	Present	Present	3.8
Order : Nostocales												
Anabaena affinis						Present	607.6	84.0		Present	2,759.0	
Anabaena cf circinalis				28.0			Present				1,424.0	
Anabaena flos-aquae		Present		Present				Present				
Anabaena spiroides							Present	84.0			Present	
Anabaena spp.		Present				75.6	215.6	196.0		5.6	Present	
Aphanizomenon flos-aquae?	4		Present	11.2			Present	154.0			534.0	
Nostoc							Present					
Order : Ochromonadales												
Chrysosphaerella longispina								Present				
Chrysosphaerella sp.			Present									
Dinobryon bavaricum	Present	8.4	Present	11.2			117.6	8.4		Present	338.2	Present
Dinobryon divergens		8.4	Present	16.8			28.0	Present			Present	Present
Dinobryon cf sertularia		8.4	Present	Present	8.4	Present	Present				Present	Present
Dinobryon spp.		5.6	Present	11.2	Present		5.6	Present			Present	Present
Uroglena volvox	195											
Mallomonas akrokomos	33	19.6	32.2	5.6	25.2	19.6		14.0	2.8	8.4		7.6
Mallomonas producta		2.8										
Mallomonas sp.		Present	12.6	Present	Present				Present		Present	Present
Synura cf ulvella			Present									Present
Synura ?		Present			78.4			Present	Present			
Uroglenopsis cf americana					Present	140.0				Present	Present	

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Unidentified Ochromonadales			Present									
Order : Oscillatoriales												
Lyngbya Birgei		Present										
Lyngbya limnetica		Present	Present				16.8	Present			320.4	Present
Lyngbya sp.		Present							Present		Present	Present
Oscillatoria tenuis	Present		Present	Present	Present			Present	Present	Present		Present
Oscillatoria sp.							Present		Present	Present		Present
Phormidium mucicola											Present	
Order : Pennales												
Achnanthes minutissima		11.2	2.8	Present		11.2	2.8		5.6	1.4	Present	1.9
Achnanthes sp.	0.8											
Amphora ovalis			Present						Present			
Asterionella formosa	12	274.4	35.0	Present	173.6	19.6	Present	Present	Present	29.4	Present	30.4
Ceratoneis arcus					Present	Present			1.4			
Ceratoneis sp.		Present	Present	Present	Present	Present		Present		Present		Present
Cocconeis placentula			1.4				Present				Present	
Cocconeis						Present	Present		Present			
Cymatopleura solea		Present										
Cymbella cf minuta	0.8		Present		Present				Present	Present		Present
Cymbella spp.		Present	Present				Present		Present	Present	Present	3.8
Diatoma cf elongatum		Present	Present		Present	Present	Present		Present	Present		Present
Diatoma heimale			1.4									
Diatoma sp.										Present		
Diploneis sp.					Present				1.4	Present		
Epithemia cf sorex							Present					
Epithemia turgida							Present					
Eunotia cf pectinalis		Present	Present	Present	Present	Present	Present	Present	2.8			Present
Eunotia sp.	Present	Present					Present				Present	
Fragilaria crotonensis	17.6	Present	8.4	Present	8.4	Present	2.8	2.8	8.4	1.4	35.6	13.3
Fragilaria sp.	2.4		Present	Present	22.4	Present	2.8	Present	8.4	1.4		20.9
Gomphonema acuminatum							Present					
Gomphonema constrictum		Present										
Gomphonema olivaceum		2.8	Present		Present		Present					
Gomphonema spp.	Present	Present	5.6	Present	Present	Present	Present		Present	Present	Present	1.9
Meridion circulare												Present
Navicula spp.	0.8	2.8	Present	Present	5.6	Present	Present	Present	1.4	Present		Present
Nitzschia spp.							Present			Present	Present	Present
Pinnularia sp.							Present		Present			
Pleurosigma/Gyrosigma					Present			Present	Present	Present	Present	Present
Stauroneis sp.	Present	Present										
Surirella sp.		Present										
Synedra actinastroides							Present					
Synedra cf ulna		Present	Present		Present	Present	Present		Present	Present	Present	3.8
Synedra sp.	0.8	Present			Present	Present	Present	Present	Present	Present		Present
Tabellaria fenestrata	7.2	Present	Present			Present					Present	Present
Tabellaria flocculosa		Present	Present									

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Unidentified Pennales	Present		Present	Present	Present	Present	2.8	Present	2.8	Present	17.8	Present
Order : Rhizochrysidales												
Stipitococcus sp.	8											
Gloeocystis ampla		Present	Present	324.8		134.4	Present			11.2		
Sphaerocystis schroeteri		39.2		156.8		112.0	Present	Present	22.4	Present	854.4	Present
Order : Ulothricales												
Dactylococcopsis Smithii							Present				Present	
Geminella sp.							100.8					
Ulothrix		Present										
Ulothrix cf variabilis								Present				
Order : Volvocales												
Chlamydomonas sp.	15.2	Present	Present									
Eudorina elegans	Present	Present	Present	Present	67.2			106.4		Present	142.4	
Gonium sp. ?										Present	Present	
Pandorina morum											Present	
Volvox		Present		Present		Present	Present	Present	Present	Present		
Unidentified Volvocales		11.2		67.2	Present	14.0	11.2	Present		Present	71.2	Present
Order : Zygnematales												
Arthrodesmus sp.				Present								
Closterium sp.											Present	
Cosmarium sp							Present	Present			Present	Present
Hyalotheca												Present
Mougeotia sp.								Present				
Spirogyra sp. ?		Present	Present									
Staurastrum paradoxum		Present		Present		Present		Present	Present			
Staurastrum sp.				Present			Present	Present				
Xanthidium sp.								Present			Present	
Zygnema sp.							Present					
Phylum : Chrysophyta (Golden-Brown Algae)												
Chrysophyte flagellate	27											
Chrysophyte cyst	0.8											
Chrysophyte unicellular											Present	
Chrysophyte colonial											Present	
Phylum : Chlorophyta (Green Algae)												
Chlorophyte flagellate	12											
Chlorophyte colonial	Present											
Unidentified Algal												
Unidentified flagellate	237	70	Present	Present	Present	Present	Present	Present				Present
Unidentified filamentous algae		11.2	Present	Present	Present		8.4	5.6	Present	Present	Present	Present
Unidentified branched filamentous algae										Present		
Unidentified colonial	4.8											
Unidentified unicellular cells		Present										Present
Cells/mL	**38399.2**	**38531.6**	**38387.2**	**39033.6**	**39534.4**	**39433.2**	**40002.4**	**40526.6**	**39058.4**	**39160.2**	**47139**	**39596.9**

Table 39. Phytoplankton results for Maxwell Lake, 2003-2007.

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/06/16	2005/09/22	2006/05/18	2006/08/22	2007/02/26
Order : Centrales										
Cyclotella bodanica			Present				Present			
Cyclotella glomerata				Present	Present		Present			
Cyclotella sp.	621.9	Present	5.7	Present	Present		Present	1.4	11.4	
Melosira italica	200.6		79.8	19.6	Present		Present			
Melosira sp.			Present	28.0	Present	Present	Present	4.2	1.9	33.6
Rhizosolenia eriensis / longiseta				5.6	2.8	Present		302.4	15.2	
Rhizosolenia cf longiseta	206.5	100.8								
Order : Chlorococcales										
Ankistrodesmus falcatus	Present	Present					Present			
Ankistrodesmus sp.		16.8	Present	2.8	11.2	Present	2.8	19.6	22.8	Present
Botryococcus braunii		44.8			Present	Present	Present	Present	Present	Present
Closteriopsis longissima										
Closteriopsis sp.			Present	Present	Present	Present	Present	Present	Present	
Coelastrum cambricum							Present			
Coelastrum microporum		Present								
Crucigenia quadrata		Present			Present		Present			
Crucigenia tetrapedia	Present	Present	22.8	Present	5.6	33.6	44.8	16.8	68.4	
Crucigenia sp.						Present				
Dictyosphaerium pulchellum		Present							Present	
Dictyosphaerium	24.0									
Elakatothrix gelatinosa		11.2				Present	Present			
Monoraphidium sp.	47.2									
Nephrocytium			Present	Present			Present		Present	
Oocystis spp.		Present							7.6	
Pediastrum privum	Present									
Pediastrum tetras								Present		
Pediastrum							Present	Present		
Quadrigula closterioides									Present	
Quadrigula lacustris			Present					Present		
Scenedesmus bijuga									Present	
Scenedesmus cf denticulatus							Present		Present	
Scenedesmus cf dimorphus							Present			
Scenedesmus quadricauda		Present	45.6				Present	Present		
Scenedesmus sp.		Present	Present		Present	Present	5.6	Present	110.2	
Selenastrum minutum	17.7	5.6			Present	5.6	121.8	2.8	9.5	
Schroederia setigera	Present									
Schroederia sp.										
Tetraedron minimum	106.2	Present	34.2	422.8	1.4	2.8	4.2	1.4	9.5	33.6
Order : Chlorococcales										
Tetraedron sp.					Present		Present	1.4		Present
Unidentified Cladophorales										
Agmenellum tenuissima										
Anacystis aeruginosa										Present

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/06/16	2005/09/22	2006/05/18	2006/08/22	2007/02/26
Anacystis elachista					Present					
Anacystis limneticus			Present							
Anacystis cf turgidus							Present			
Anacystis sp. aka Microcystis sp.	495.6	Present	Present			Present	70	Present	Present	Present
Order : Cryptomonadales										
Chroomonas acuta			11.4	58.8		1.4	11.2			5.6
Cryptomonas ovata / erosa	11.8	5.6	39.9	11.2	2.8	8.4	14.0	Present	17.1	30.8
Cryptomonas sp.	35.4	8.4	34.2	30.8	5.6	Present	11.2	5.6	3.8	5.6
Unidentified Cryptomonadales	17.7									
Order : Dinokontae										
Ceratium hirundinella					Present	Present		Present	Present	
Gymnodinium sp. ?					Present	2.8	Present	Present	3.8	
Peridinium bipes	3.2									
Peridinium cf inconspicuum		78.4			43.4	18.2	44.8	134.4	15.2	Present
Peridinium / Glenodinium	Present	8.4	28.5	8.4	Present	4.2	1.4	Present	5.7	Present
Peridinium	0.8									
Unidentified Dinokontae		Present	Present		Present		Present		Present	
Order : Euglenales										
Euglena	Present	Present	Present	8.4		Present	Present	Present	Present	2.8
Phacus	1.6		Present	Present	Present		Present			
Trachelomonas sp.	1.6	Present	Present	Present	Present	Present	1.4	Present	Present	Present
Unidentified Euglenales	Present									
Order : Nostocales										
Anabaena affinis			45.6	Present			25.2			
Anabaena spp.	Present	16.8	Present	Present	Present	Present	2.8	Present	Present	Present
Aphanizomenon ?				Present						
Pseudanabaena cf catenata	Present									
Pseudanabaena sp.			Present							
Order : Ochromonadales										
Chrysosphaerella longispina							9.8			
Dinobryon bavaricum		33.6	Present	Present	72.8	5.6	25.2	1.4	28.5	170.8
Dinobryon cylindricum	0.8									
Dinobryon divergens		Present	Present	Present		Present	1.4	1.4	Present	756.0
Dinobryon cf elegantissimum		11.2								
Dinobryon cf sertularia	0.8	140.0	5.7	19.6	1.4		Present	22.4	Present	Present
Dinobryon spp.			5.7	Present	2.8	Present	1.4	Present	Present	11.2
Uroglena volvox										
Mallomonas sp.	4.0	Present	Present							
Synura cf ulvella	Present		Present	22.4						Present
Synura ?		Present					Present			
Uroglenopsis cf americana			946.2	Present					Present	
Uroglena sp.	15.2									
Unidentified Ochromonadales						Present	Present			
Order : Oedogoniales										
Bulbochaete sp.		Present							Present	
Oedogonium sp. ?		Present				Present	Present	Present	Present	

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/06/16	2005/09/22	2006/05/18	2006/08/22	2007/02/26
Order : Oscillatoriales										
Lyngbya limnetica		Present	34.2	Present	Present	Present	Present		Present	
Lyngbya sp.		Present				Present		Present		
Oscillatoria tenuis		Present	Present	Present			Present		Present	Present
Oscillatoria sp.		Present		Present	Present	Present	Present		Present	
Unidentified Oscillatoriales							Present			
Order : Pennales										
Achnanthes minutissima		103.6	5.7	Present	4.2	1.4	Present	12.6	3.8	11.2
Achnanthes sp.	Present									
Amphora ovalis							Present	Present	Present	
Asterionella formosa	3.2	56.0	131.1	53.2	2.8	142.8	18.2	5.6	191.9	33.6
Ceratoneis arcus		Present					Present			
Ceratoneis sp.				Present	Present		Present	Present	Present	
Cocconeis placentula				Present	1.4					
Cymbella cf minuta		Present	Present	Present	Present		Present	Present		
Cymbella spp.		Present	Present	Present	Present		Present	1.4	Present	2.8
Denticula sp.					Present					
Diatoma cf elongatum								Present	Present	
Diatoma sp.					Present					
Didymosphenia geminata			Present							
Eunotia cf pectinalis		Present	Present	Present	Present	Present	1.4	Present	Present	Present
Eunotia sp.	Present	Present								
Fragilaria crotonensis		98.0		64.4	5.6	1.4	4.2	14.0	28.5	2.8
Fragilaria sp.	Present		22.8	30.8	1.4	4.2	11.2	5.6	3.8	2.8
Frustulia rhomboides					Present		Present			
Gomphonema acuminatum							Present			
Gomphonema constrictum					Present					
Gomphonema spp.	0.8				Present			Present	Present	Present
Navicula radiosa					Present					
Navicula spp.	Present	Present		Present	1.4	Present	Present	4.2	1.9	Present
Nitzschia spp.							Present	1.4	Present	Present
Pinnularia sp.								Present	Present	
Pleurosigma/Gyrosigma		Present		Present			Present		Present	
Stauroneis sp.	Present									Present
Surirella sp.		Present	Present				Present			
Synedra acus							Present			
Synedra actinastroides		Present								
Synedra cf ulna		Present	Present	Present	Present	Present	Present		Present	Present
Synedra sp.	4.0		Present	Present	Present	Present	Present	Present	Present	
Tabellaria fenestrata	5.9	Present	Present	Present	2.8	Present	29.4	Present	38.0	Present
Tabellaria flocculosa		Present	Present							
Unidentified Pennales		Present	Present	Present	4.2	Present	Present	8.4	1.9	5.6
Order : Rhizochrysidales										
Diceras phaseolus		5.6	Present	Present	Present	2.8	1.4	1.4	Present	
Order : Tetrasporales										
Gloeocystis ampla		Present					4.2	Present	Present	

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/06/16	2005/09/22	2006/05/18	2006/08/22	2007/02/26
Sphaerocystis schroeteri						Present				
Order : Ulothricales										
Ulothrix						Present	Present		Present	Present
Ulothrix cf variabilis						Present	Present			
Order : Volvocales										
Carteria									Present	
Chlamydomonas sp.	0.8	Present	Present	Present		Present	2.8			Present
Eudorina elegans		Present		Present						Present
Gonium sociale				Present						
Pandorina morum	Present	Present			22.4					Present
Unidentified Volvocales			Present	Present		Present	Present	Present	Present	Present
Order : Zygnematales										
Arthrodesmus sp.	Present		Present			Present	Present		Present	
Bambusina sp.						Present	1.4	Present	3.8	
Closterium sp.								Present	Present	
Cosmarium sp		Present	Present	Present		1.4	Present	Present	1.9	
Euastrum sp.		Present	Present			Present		Present	Present	
Gonatozygon sp.								Present	Present	
Hyalotheca					Present					
Mougeotia sp.		Present						Present	Present	5.6
Spondylosium planum		Present	Present			Present	Present	Present	Present	Present
Staurastrum paradoxum		Present				Present	Present	Present	Present	Present
Staurastrum sp.						Present			Present	
Xanthidium sp.					Present					
Zygnema sp.								Present		
Unidentified Zygnematales		8.4			Present	Present	Present	Present	Present	Present
Phylum : Chrysophyta (Golden-Brown Algae)										
Chrysophyte flagellate	135.7									
Chrysophyte cyst	5.9									
Chrysophyte unicellular	17.7									
Phylum : Chlorophyta (Green Algae)										
Chlorophyte flagellate	17.7									
Chlorophyte unicellular	23.6								Present	
Unidentified Algal										
Unidentified flagellate	47.2	392	Present	Present	Present		Present			
Unidentified filamentous algae		Present	Present	Present	Present	Present		Present	Present	
Unidentified branched filamentous algae							Present			
Unidentified colonial			Present	Present						
Unidentified unicellular cells		Present								Present
Cells/mL	**2075.1**	**753.2**	**1499.1**	**786.8**	**196**	**236.6**	**473.2**	**569.8**	**606.1**	**1114.4**

Table 40. Phytoplankton results for St. Mary Lake, 2003-2007.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/05/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Order : Centrales													
Cyclotella bodanica		5.6	17.8										Present
Cyclotella glomerata	218.3	16.8	2,314.0		Present		Present	11.2					
Cyclotella sp.	5.9		17.8		Present		Present	Present	5.6	Present	Present	Present	473.2
Melosira granulata												506.8	Present
Melosira italica	88.5	Present	71.2		71.2		Present		5.6	Present			Present
Melosira sp.							Present			Present		Present	Present
Rhizosolenia eriensis / longiseta	2.4		409.4	71.2	Present	Present	17.8	11.2	5.6		Present	Present	
Rhizosolenia cf longiseta		Present											
Stephanodiscus cf Hantzschii	23.6		Present										
Stephanodiscus Niagarae	17.7	2.8	462.8		17.8	Present	Present		Present	Present		Present	2.8
Order : Chlorococcales													
Ankistrodesmus falcatus	35.4	16.8	71.2						Present			Present	
Ankistrodesmus sp.		Present			17.8		Present	2.8	Present			14.0	44.8
Botryococcus braunii		Present		Present		Present	Present	Present	Present		Present	Present	
Closteriopsis sp.		Present	Present	Present	Present	Present	Present		Present				
Crucigenia quadrata	23.6	22.4	71.2		Present		Present						
Crucigenia rectangularis		Present		Present									
Crucigenia sp.	47.2							Present					
Dictyosphaerium pulchellum			Present										
Dictyosphaerium	64.0											Present	
Elakatothrix gelatinosa	0.8	Present		17.8	Present	Present		5.6	5.6			14.0	11.2
Kirchneriella sp. ?	283.2		391.6					Present	22.4				
Monoraphidium sp.	0.8												
Nephrocytium									Present			Present	
Oocystis parva		22.4						Present					
Oocystis spp.	76.7	Present	Present	106.8				Present	16.8			Present	
Pediastrum													Present
Quadrigula closterioides									Present				
Quadrigula lacustris				Present									
Scenedesmus cf denticulatus			Present										
Scenedesmus cf dimorphus			Present	Present									
Scenedesmus quadricauda	1.6	Present	Present		Present								
Scenedesmus sp.			Present										
Selenastrum minutum	11.8			Present	Present			2.8	8.4			78.4	
Schroederia Judayi				Present				2.8					5.6
Schroederia setigera													11.2
Tetraedron minimum	23.6	2.8	Present										Present
Agmenellum tenuissima					Present								
Anacystis elachista			Present	2136					Present			Present	
Anacystis limneticus		Present							Present				Present
Anacystis sp. aka Microcystis sp.	163.2	Present	Present	Present					Present			Present	Present
Gomphosphaeria Nagelianum aka Coelosphaerium	Present												

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/05/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
naegelianum/naegeliana													
Gomphosphaeria sp. aka Coelosphaerium sp.			Present										
Synechocystis diplococcus ?	3,174.2												
Order : Cryptomonadales													
Chroomonas acuta	106.2	509.6	1,014.6	338.2	249.2	Present	Present	305.2	254.8	160.2	17.8	246.4	173.6
Cryptomonas ovata / erosa		50.4	35.6	Present	Present	Present		5.6	2.8	Present	Present		70.0
Cryptomonas sp.		5.6	53.4	Present	Present	Present	Present	Present	5.6				8.4
Unidentified Cryptomonadales	0.8												
Order : Dinokontae													
Ceratium hirundinella				Present		Present		Present	2.8		Present	Present	
Ceratium sp.				Present									
Gymnodinium sp. ?											Present		
Peridinium cf inconspicuum		Present											
Peridinium / Glenodinium	Present	Present	Present							Present			
Unidentified Dinokontae									Present		Present		
Order : Euglenales													
Euglena								Present					
Trachelomonas sp.		Present	Present	Present	Present	Present		Present	2.8	Present	Present	Present	Present
Order : Nostocales													
Anabaena affinis				1,424.0	Present	Present		173.6	840.0		Present	2,581.6	
Anabaena cf circinalis	3,203.7		Present	Present		Present		232.4	22.4		Present		
Anabaena flos-aquae				Present	Present							Present	
Anabaena spiroides			Present	Present				308.0	Present				
Anabaena spp.	Present	Present	Present	Present		53.4	Present	39.2	725.2	Present	Present	11.2	Present
Aphanizomenon flos-aquae?			Present	31,577.2		1,975.8		Present	428.4		5,464.6	84.0	
Nostoc				Present								84.0	
Pseudanabaena cf catenata			Present	Present									
Unidentified Nostocales													Present
Order : Ochromonadales													
Dinobryon bavaricum		16.8		Present	Present	Present		25.2	8.4		Present		
Dinobryon cf elegantissimum		Present											
Dinobryon spp.		42.0				Present					Present		
Mallomonas akrokomos			Present										350.0
Mallomonas producta				Present									
Mallomonas sp.			Present	Present									
Unidentified Ochromonadales			Present										
Order : Oedogoniales													
Oedogonium sp. ?		Present							Present				
Order : Oscillatoriales													
Lyngbya limnetica		Present	Present	17,052.4	Present	Present		Present	98.0	Present		56.0	
Lyngbya sp.										Present			
Oscillatoria tenuis			Present		47,882.0	16,144.6	59,096.0	Present	5,297.6	166,430.0	44,322.0		
Oscillatoria sp.	Present							16.8					
Order : Pennales													
Achnanthes minutissima	Present	19.6	Present		Present	Present		Present	Present				8.4
Amphora	Present												

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/05/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Asterionella formosa	0.8		Present						Present	Present			1,562.4
Ceratoneis sp.			Present										
Cocconeis placentula	0.8	Present	Present	Present	Present	Present			Present				Present
Cocconeis										Present			
Cymatopleura solea		Present											
Cymbella cf minuta		2.8	Present			Present							
Cymbella spp.		Present	Present		Present			Present	Present				Present
Diatoma cf elongatum		Present								Present			Present
Diploneis sp.			Present									Present	
Epithemia cf sorex												Present	
Epithemia turgida			Present									Present	Present
Epithemia ?			Present										Present
Eunotia cf pectinalis		Present											
Eunotia sp.		Present								17.8			
Fragilaria crotonensis	11.8	106.4	124.6	17.8	Present	Present	Present	19.6	14.0			19.6	11.2
Fragilaria vaucheriae	1.6												
Fragilaria sp.	11.8		Present	Present	Present	Present	Present	2.8	2.8	17.8		Present	Present
Frustulia rhomboides		2.8											
Gomphonema constrictum			Present										
Gomphonema olivaceum		Present	Present										Present
Gomphonema spp.		Present	Present		Present	Present			Present			2.8	
Meridion circulare			Present										
Navicula spp.	Present	Present	Present	Present	Present	Present		2.8	Present	Present		Present	Present
Nitzschia spp.	Present		Present					Present	Present			Present	Present
Pinnularia sp.												Present	
Pleurosigma/Gyrosigma		Present	Present										
Rhopalodia gibba						Present							
Stauroneis sp.						Present							
Surirella sp.		Present											
Synedra acus			Present					Present					
Synedra incisa	0.8												
Synedra cf radians	147.5												
Synedra rumpens	41.3												
Synedra cf ulna			Present		Present	Present		2.8				Present	Present
Synedra sp.	17.7		Present					Present	Present				Present
Tabellaria fenestrata		Present											
Tabellaria flocculosa		28.0											
Unidentified Pennales	1.6	Present	Present	17.8	Present	Present	Present	Present	Present	Present	Present	Present	8.4
Order : Tetrasporales													
Sphaerocystis schroeteri	12.8	Present	Present	Present	Present			100.8	89.6			67.2	Present
Order : Ulothricales													
Ulothrix		Present				Present			Present				
Order : Volvocales													
Chlamydomonas sp.	2	Present					Present						
Eudorina elegans				Present								44.8	
Scourfieldia sp.	11.8												

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/05/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Volvox				Present									
Unidentified Volvocales			Present	Present	Present		Present	Present	Present			Present	
Order : Zygnematales													
Closterium sp.	3.2												
Cosmarium sp			Present					5.6				Present	
Hyalotheca		Present					Present						
Mougeotia sp.		Present							Present				
Spondylosium planum		Present		Present									
Staurastrum paradoxum			Present					Present				Present	
Staurastrum sp.		Present							Present			Present	
Zygnema sp.			Present						Present				
Unidentified Zygnematales				Present									
Phylum : Chrysophyta (Golden-Brown Algae)													
Chrysophyte flagellate	88.5												
Chrysophyte cyst	Present												
Phylum : Chlorophyta (Green Algae)													
Chlorophyte flagellate	29.6												
Chlorophyte colonial	283.2												
Chlorophyte unicellular	873.2												
Unidentified Algal													
Unidentified flagellate	182.9	439.6	Present										
Unidentified filamentous algae						Present		Present					
Unidentified colonial	1156.4												
Unidentified unicellular cells		Present											
Cells/mL	**10452.5**	**1313.2**	**5055.2**	**52759.2**	**48238**	**18173.8**	**59113.8**	**1276.8**	**7865.2**	**166625.8**	**49804.4**	**3810.8**	**2741.2**

Table 41. Phytoplankton results for Weston Lake, 2003 - 2007.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Order : Centrales													
Cyclotella bodanica	27.0	2.8					25.2						
Cyclotella glomerata		408.8					Present		5.6		5.6	2,055.2	
Cyclotella sp.				Present		Present	Present	Present	Present		Present	Present	
Melosira italica	222.0	Present	142.4	Present	11.2	Present				33.6			Present
Melosira sp.		Present	Present			Present		Present		Present			
Rhizosolenia eriensis / longiseta											Present		
Order : Chlorococcales													
Actinastrum						Present							
Ankistrodesmus falcatus	Present	Present							Present			Present	
Ankistrodesmus sp.		2.8				Present		7.0				Present	
Botryococcus braunii	12.8	Present	Present	Present	Present	Present	89.6	67.2	22.4	44.8	44.8	Present	Present
Closteriopsis longissima													
Closteriopsis sp.				Present									
Coelastrum microporum		22.4		Present			Present	16.8	Present			Present	
Coelastrum sp. ?									33.6			Present	
Crucigenia crucifera	3.2	11.2						22.4					
Crucigenia quadrata	24.0	11.2		Present			Present	53.2	11.2		Present	Present	
Crucigenia rectangularis				33.6				Present	Present				
Crucigenia tetrapedia		Present		11.2				61.6	11.2		Present	22.4	
Dictyosphaerium pulchellum												Present	
Dictyosphaerium	3.2												
Elakatothrix gelatinosa	12.0	44.8		Present	Present	Present	Present	15.4	Present	Present	Present	2.8	Present
Kirchneriella sp. ?					Present		Present	Present					
Nephrocytium							Present		Present		Present		
Oocystis parva							Present	Present	Present				
Oocystis spp.	12.0	Present	Present	5.6			Present	Present	16.8			5.6	
Pediastrum		Present			Present			Present				Present	
Quadrigula closterioides		Present		Present	33.6		Present	Present	11.2		Present	Present	
Quadrigula lacustris							22.4	11.2	Present				
Scenedesmus cf arcuatus		Present							Present			Present	
Scenedesmus cf aculeolatus	117.0						Present						
Scenedesmus bijuga												Present	
Scenedesmus cf denticulatus		Present							11.2		Present	Present	
Scenedesmus quadricauda						Present						Present	Present
Scenedesmus sp.				28.0		Present	Present	11.2	Present		Present	Present	Present
Selenastrum minutum	15.0	Present		5.6			Present	11.2	28.0		12.6	84.0	Present
Schroederia Judayi				5.6					Present				
Schroederia sp.													
Tetraedron caudatum												Present	
Tetraedron minimum	Present	Present		2.8			Present	11.2	5.6		Present	11.2	
Tetraedron sp.				2.8			Present	2.8					
Treubaria sp.								Present					
Unidentified Chlorococcales							Present						

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Agmenellum tenuissima								Present	Present			Present	
Agmenellum sp.								Present					
Anacystis aeruginosa							Present	Present					Present
Anacystis elachista		56	Present	98	644	Present	Present	105	672		Present	84	
Anacystis cf incerta aka Microcystis incerta	1,011.0												
Anacystis limneticus		Present							67.2			Present	
Anacystis sp. aka Microcystis sp.	504	Present	Present	Present	Present	Present	Present	Present		Present	Present	Present	Present
Gomphosphaeria Nagelianum aka Coelosphaerium naegelianum/naegeliana	615.0												
Gomphosphaeria pallidum		Present											
Gomphosphaeria sp. aka Coelosphaerium sp.	372.0	Present			Present	Present							
Order : Cryptomonadales													
Chroomonas acuta	138.0	58.8	373.8	22.4	92.4	210.0	61.6	182.0	243.6	193.2	187.6	81.2	106.4
Cryptomonas cf marssonii	6.0												
Cryptomonas ovata / erosa	36.0	14.0	Present	8.4	109.2	22.4	Present	14.0	25.2	70.0	1.4	14.0	19.6
Cryptomonas sp.	51.0	2.8	160.2	Present	2.8	30.8	Present	Present	5.6	14.0	Present	2.8	89.6
Unidentified Cryptomonadales	6.0												
Order : Dinokontae													
Ceratium hirundinella		Present		Present			Present	5.6	2.8		1.4	Present	
Gymnodinium sp. ?								Present				2.8	Present
Peridinium cf inconspicuum		2.8	Present			Present		2.8				Present	
Peridinium / Glenodinium		2.8	Present	Present	Present	Present	Present	Present	Present	Present	1.4	Present	Present
Peridinium	0.8												
Unidentified Dinokontae			Present			Present	Present		Present	Present			
Order : Euglenales													
Euglena	Present					Present				Present	Present	Present	Present
Trachelomonas sp.	0.8	2.8	Present	Present	8.4	16.8	5.6	Present	Present	Present	Present	Present	Present
Order : Nostocales													
Anabaena affinis		Present	Present		Present		Present	116.2	56.0		Present	1,120.0	
Anabaena cf circinalis	16.8	Present	Present	Present			336.0		Present		186.2	Present	
Anabaena flos-aquae		Present					Present	Present					
Anabaena spp.	345.0	64.4		Present	Present	Present	47.6	11.2	106.4	Present	Present	Present	Present
Aphanizomenon flos-aquae?	261.0				Present	Present	28.0		42.0				
Nostoc				Present									
Pseudanabaena cf catenata				Present									
Pseudanabaena sp.													
Family : Rivulariacea ?													
Unidentified Rivulacea								Present					
Order : Ochromonadales													
Dinobryon bavaricum		2.8	2,207.2	81.2				32.2	19.6	Present		Present	
Dinobryon cylindricum	8.0												
Dinobryon divergens			Present			2.8			Present	1,640.8			Present
Dinobryon cf sertularia			284.8				Present						Present
Dinobryon spp.			231.4	Present			Present	Present	Present	Present	Present		5.6

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Uroglena volvox													
Mallomonas akrokomos	51.0		Present	Present	14.0	218.4				Present			719.6
Mallomonas producta			Present							Present		2.8	Present
Mallomonas pseudocoronata								Present	Present				
Mallomonas cf tonsurata	18.0												
Mallomonas sp.	27.0							Present					
Ochromonas spp.		Present											
Synura cf ulvella						2.8				44.8			
Synura ?									Present				291.2
Uroglenopsis cf americana						Present							
Order : Oedogoniales													
Bulbochaete sp.												Present	
Oedogonium sp. ?								Present	Present				
Order : Oscillatoriales													
Lyngbya Birgei								Present	Present				
Lyngbya limnetica		Present		Present	Present			25.2	Present	56.0	Present	70.0	56.0
Lyngbya sp.						Present		Present	Present	Present	Present	Present	Present
Oscillatoria tenuis	9,617.0	448.0	22,339.0	823.2	308.0	Present	Present	Present	Present	6,860.0	Present	Present	112.0
Oscillatoria sp.	5.6		Present				Present	Present			Present	Present	50.4
Order : Pennales													
Achnanthes minutissima	0.8	14.0		2.8		Present	2.8	Present	Present	Present	5.6	Present	5.6
Amphora	Present	Present											
Amphora ovalis									Present		Present	Present	
Asterionella formosa	48.0	25.2	462.8		22.4	338.8	Present	4.2	22.4	53.2	1.4		165.2
Ceratoneis sp.		Present			Present				Present			Present	
Cocconeis pediculus		Present											
Cocconeis placentula	Present	Present	Present	Present	Present				Present				
Cocconeis							Present						
Cymatopleura solea		2.8											
Cymbella cf minuta									Present		1.4		
Cymbella spp.		Present		Present	Present	Present	Present	Present	Present	Present	Present	Present	
Denticula sp.					Present								
Diatoma cf elongatum		Present						Present			Present		
Diatoma vulgare									Present				
Diatoma sp.								1.4					
Diploneis sp.	Present												
Epithemia turgida				Present	Present	Present			Present				
Eunotia cf pectinalis		Present	Present	Present		Present	Present	Present	Present	Present	Present	Present	Present
Eunotia sp.	1.6	Present		Present	2.8	Present	Present						
Fragilaria crotonensis	318.0	81.2	142.4	Present	596.4	53.2	Present	29.4	2.8	5.6	Present	Present	Present
Fragilaria vaucheriae											Present		
Fragilaria sp.	Present		Present	Present	Present	16.8	Present	Present		5.6	Present	Present	Present
Frustulia rhomboides		Present											
Gomphonema acuminatum		Present									Present		
Gomphonema constrictum					Present	Present	Present						Present
Gomphonema olivaceum		Present		Present					Present				

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Gomphonema spp.	Present	Present		Present		Present	Present	1.4		2.8	1.4	Present	
Meridion circulare										Present			Present
Navicula spp.	Present	5.6	Present	Present	5.6	Present	Present	Present	Present		1.4	Present	Present
Nitzschia spp.	0.8	Present		Present		Present		Present			Present	Present	Present
Pinnularia sp.									Present				
Pleurosigma/Gyrosigma		Present		Present		Present		Present		Present	Present		
Rhopalodia gibba													Present
Stauroneis sp.		Present							Present			Present	
Surirella sp.		Present											
Synedra cf ulna		Present	Present	Present	Present				Present		Present		Present
Synedra sp.	0.8	Present				Present		Present			Present		Present
Tabellaria fenestrata	8.8	Present	Present	Present	Present	Present	61.6	Present	Present	Present	Present	Present	Present
Tabellaria flocculosa	1.6	Present	Present			134.4							
Unidentified Pennales		Present	Present	Present	Present	Present	Present	12.6	Present	Present	Present	Present	Present
Order : Tetrasporales						Present							
Gloeocystis ampla				5.6									
Pseudosphaerocystis lacustris	51.0												
Sphaerocystis schroeteri	12.8	22.4		Present	Present		156.8	33.6	Present	Present	112.0	22.4	Present
Order : Ulothricales											Present		
Dactylococcopsis Smithii							Present					5.6	
Ulothrix				Present							Present		
Ulothrix cf variabilis				Present									
Order : Vaucheriales													
Vaucheria sp.							Present						
Order : Volvocales													
Chlamydomonas sp.	0.8				Present				Present	Present			Present
Eudorina elegans	Present	Present	Present			Present	Present			Present	Present	Present	Present
Gonium sp. ?												Present	
Pandorina morum													
Volvox	Present		Present		Present								
Unidentified Volvocales		Present	Present	Present	Present	Present	Present	5.6	Present	Present	Present	Present	Present
Order : Zygnematales													
Arthrodesmus sp.				Present	Present		Present		Present			Present	
Closterium sp.												Present	
Cosmarium sp				Present	Present		Present	Present			1.4	Present	Present
Gonatozygon sp.				Present					Present				
Mougeotia sp.		Present									2.8	Present	
Spondylosium planum		Present						Present			Present	Present	
Staurastrum paradoxum				Present	Present			Present				Present	
Staurastrum sp.				Present	Present		Present	Present	Present			Present	
Xanthidium sp.				Present								Present	
Zygnema sp.									Present				
Unidentified Zygnematales				Present	Present		Present	Present		Present	Present	Present	
Fungal hyphae							Present			Present			

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Phylum : Chrysophyta (Golden-Brown Algae)													
Chrysophyte flagellate	30.0												
Chrysophyte cyst	1.6												
Chlorophyte flagellate	9.0												
Chlorophyte colonial	6.4												
Chlorophyte unicellular	377.6								Present				
Unidentified Algae													
Unidentified flagellate	81	266	Present	Present	Present	Present	Present		Present	Present		Present	Present
Unidentified filamentous algae		22.4		Present			Present	Present					
Unidentified branched filamentous algae										Present	Present	Present	
Unidentified colonial	9.0												
Unidentified unicellular cells		Present											
Cells/mL	**14497.8**	**1598.8**	**26344**	**1136.8**	**1850.8**	**1047.2**	**837.2**	**873.6**	**1422.4**	**9024.4**	**568.4**	**3586.8**	**1621.2**

APPENDIX II. ZOOPLANKTON RESULTS

Table 42. Zooplankton results for Cusheon Lake, 2003 - 2007.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/26	2005/05/26	2005/08/06	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Subclass : Copepoda												
Copepod nauplii	1,083.3	3,600.0	1,333.3	1,993.3	1,083.3	8,133.3	3,237.5	1,866.7	1,140.0	7,533.3	866.7	1,766.7
Order : Cyclopoida												
Eucyclops speratus Adult		1.0										
Mesocyclops leuckarti / edax Adult				6.5			13.7				2.0	
Mesocyclops leuckarti / edax Copepodite							82.2				50.0	
Mesocyclops cf. americanus Adult										10.0		
Mesocyclops cf. americanus Copepodite										27.0		
Orthocyclops cf modestus Adult						35.0	6.0	4.0			4.0	
Orthocyclops cf modestus Copepodite						50.0		20.0	2.0		15.0	
Orthocyclops cf modestus		1.0		13.0								
Tropocyclops parsinus Adult				13.0		2.0	25.0	2.0				
Tropocyclops parsinus Copepodite						6.0		10.0				
Unidentified Cyclopoida Copepodite	3.0	80.0	29.1	156.0	1.0	133.3	385.0	273.4	3.0	8.0	86.7	2.0
Order : Calanoida												
Diaptomus hesperus Adult	37.5	200.0	87.5	182.0	76.7	264.3	160.0	50.0		306.7	116.7	160.0
Diaptomus hesperus Copepodite		80.0					45.0	10.0	80.0	133.3		
Diaptomus cf oregonensis Adult			59.4	312.0	56.7	40.0	140.0	91.7	94.0	166.7	93.3	220.0
Diaptomus cf oregonensis Copepodid								35.0		80.0	40.0	
Diaptomus sp. Copepodite	225.0			910.0			490.0	286.7				
Skistodiaptomus oregonensis Adult	31.3	100.0										
Unidentified Calanoida Copepodite		1,866.7	46.9		100.0	2,133.3			60.0	5,066.7	203.3	120.0
Order : Cladocera												
Bosmina longirostris						1.0	2.0	1.0	1.0	4.0	2.0	
Ceriodaphnia sp.		200.0		58.5		26.0	1,516.7	786.7		2.0	3,866.7	
Chydorus sp.						4						2
Daphnia Juvenile			34.4		90.0				180.0	120.0		220.0
Daphnia pulex	750.0	60.0		208.0	75.0							
Daphnia pulex / pulicaria		240.0		156.0		920.0	25.0	893.4	260.0	1,280.0		100.0
Daphnia pulicaria			6.3	104.0							15.0	
Daphnia rosea			57.3		13.3		20.0	80.0				10.0
Daphnia rosea / ambigua		120.0										
Daphnia sp.	25.0	40.0						166.7				
Diaphanosoma brachyurum				736.7								
Diaphanosoma sp.							933.3	2.0			266.7	
Holopedium gibberum		4.0		58.5			315.0	253.4	43.3	560.0	93.3	
Unidentified Cladocera immature				43.3	10.0						200.0	
Family : Chydoridae												
Alona ?		1.0										

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/26	2005/05/26	2005/08/06	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Phylum : Rotifera												
Anuraeopsis fissa				86.7			1,283.3				1,233.3	
Anuraeopsis sp. ?								66.7				
Ascomorpha cf ecaudis												
Ascomorpha spp.	250.0		625.0	606.7	16.7	133.3	1,866.7	200.0			266.7	
Asplanchna cf priodonta												
Asplanchna sp.		133.3		736.7		266.7	291.7	1,533.3	9.0	333.3		
Brachionus sp.			125.0									
Callotheca sp.		266.7			133.3							100.0
Conochilus sp.	125.0	3,600.0	125.0	18,915.0	16.7	1,333.3	1,341.7			21,866.7	2,400.0	
Epiphanes sp. ?						333.3						
Euchlanis sp.											2.0	
Filinia cf longiseta						200.0						
Filinia sp.		333.3					116.7					66.7
Gastropus sp.		9,066.7	3,958.3	1,863.3		2,466.7	11,287.5	2,266.7	60.0	133.3	300.0	
Hexarthra sp.				3,423.3			11,375.0	5,733.3		10.0	300.0	
Kellicottia bostoniensis						133.3	1,633.3	2,400.0			133.3	
Kellicottia longispina	24,125.0	132,000.0	1,958.3	86.7	33.3	8,800.0	15,750.0	3,666.7	1,340.0	52,300.0	6,033.3	1,833.3
Keratella cochlearis	1,916.7	16,400.0	10,291.7	130.0	683.3	46,000.0	3,325.0	2,266.7	140.0	3,733.3	866.6	1,033.3
Keratella quadrata	750.0	3,733.3	1,583.3	26.0	1,116.7	266.7	583.3	666.7	1,280.0	200.0		900.0
Keratella serrulata					10.0					40.0		
Lecane sp.							35.0	10.0				
Macrochaetus longipes											20.0	
Ploesoma hudsoni											20.0	
Ploesoma sp.				4.0		20.0	233.3				20.0	
Polyarthra sp.	958.3	600.0	958.3	15,860.0	500.0	13,866.7	17,587.5	8,800.0			4,200.0	433.3
Pompholyx sp.						866.7	5,775.0	466.7			166.7	
Ptygura libera				130.0								
Ptygura / Callotheca sp.							291.7	266.7			233.3	
Synchaeta	166.7		208.3		3,383.3	333.3	116.7		60.0	1,600.0	333.3	533.3
Trichocerca sp.		133.3		130.0		133.3	4,112.5	600.0			1,400.0	
Trichotria sp.					16.7	2.0			20.0	40.0		
Unidentified Rotifera	291.7	733.3	958.3	303.3	100.0		583.3	200.0	12.0	266.7	166.7	100.0
Class : Bdelloidea												
Unidentified Bdelloidea					16.7							
Family : Mysidacea												
Order : Ostracoda	3.0											
Unidentified Ostracoda				1.0					19.3			
Order : Diptera												
Family : Chironomidae												
Chironomid				1.0								
Chironomid Larvae						1.0			1.0			
Unidentified Chironomid											2.0	
Family : Chaoboridae		2.0										
Chaoborus sp.		9.0		260.0		46.0	105.0	70.0	6.0	26.0	14.0	

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2005/02/26	2005/05/26	2005/08/06	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Family : Ceratopogonidae												
Unidentified Ceratopognidae		3.0										
Group : Hydracarina												
Unidentified Hydracarina	1.0	3.0		10.0		1.0		2.0	2.0	5.0		
Order : Harpacticoida												
Unidentified Harpacticoida					1.0							
Phylum : Protozoa												
Unidentified ciliate			250.0					333.3				
Total number organisms/sample	**30742.5**	**173610.6**	**22695.7**	**47524.5**	**7533.7**	**86951.5**	**85090.6**	**34381.5**	**4812.6**	**95852**	**24032.6**	**7600.6**

Table 43. Zooplankton results for Maxwell Lake, 2003 – 2007.

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Subclass : Copepoda											
Copepod nauplii	1,500.0	3,200.0	1,200.0	906.7	1,240.0	1,280.0	2,433.3	1,600.0	7,333.3	333.3	475.0
Order : Cyclopoida											
Cyclops cf vernalis Adult		14.0			1.0				12.0		
Cyclops cf vernalis Copepodite		1,533.3									
Diacyclops thomasi copepodid	300.0										
Eucyclops cf agilis Adult									1.0		
Macrocyclops cf fucus Adult										1.0	
Unidentified Cyclopoida Copepodite			368.9	192.0	560.0	220.0	400.0	114.4	1,900.0	67.5	87.5
Order : Calanoida											
Diaptomus cf oregonensis Adult		40.0					1.0				
Diaptomus cf oregonensis Copepodid		25.0									
Diaptomus sp.									2.0		
Unidentified Calanoida Copepodite				3.0	1.0				2.0		
Order : Cladocera											
Bosmina longirostris	2,205.0	4,400.0	24.0	73.7	45.0	6,200.0	4,633.3	6,600.0	3,800.0	500.0	185.0
Ceriodaphnia acanthina							1.0				
Ceriodaphnia sp.	1.0	2.0				680.0	220.0			35.0	
Chydorus sp.		10				1			2		
Daphnia pulex / pulicaria							2.0				
Daphnia rosea		2.0					4.0				
Daphnia sp.									2.0		
Diaphanosoma sp.						172.0	46.4			15.0	
Unidentified Cladocera immature							100.0			33.3	
Phylum : Rotifera											
Ascomorpha spp.	3,166.5	200.0	66.7		3,000.0	40.0	766.7		66.7		
Asplanchna sp.	17.5	666.7		8.0	240.0	2,160.0	433.3	333.3	40,000.0	166.7	2.0
Asplanchnopus ?								466.7			
Callotheca sp.	500.0	66.7	40	1,160.0	360.0	1,680.0		1,066.7	366.7	200.0	1,462.5
Conochilus sp.	666.5									600.0	
Epiphanes sp. ?					48.0						
Euchlanis sp.									20.0		
Filinia sp.			533.3	26.7	120.0	1,520.0	1,750.0	266.7		833.3	1,775.0
Gastropus sp.			3200	2,240.0	15,666.7	1,120.0	1,200.0	2,533.3	2,100.0	466.7	825.0
Hexarthra sp.						6,000.0	7,050.0			266.7	
Kellicottia bostoniensis					24.0	120.0	633.3			66.7	25.0
Kellicottia longispina	25,333.5	24,866.7	2,733.0	5,920.0	4,583.3	22,680.0	18,850.0	73,800.0	413,500.0	8,150.0	3,037.5
Keratella cochlearis	27,833.5	3,266.7	16,400.0	8,840.0	10,416.7	11,460.0	2,350.0	13,300.0	7,100.0	6,450.0	5,475.0
Keratella quadrata	3,500.0	2,133.3	17266.7	3,093.3	833.3	4,140.0	333.3	200.0	533.3	400.0	5,062.5
Keratella serrulata									33.3		20.0
Lecane sp.							5.0	40.0			
Notholca squamula				26.7							
Ploesoma hudsoni					6.0						

	2003/02/13	2003/05/15	2004/02/16	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Ploesoma sp.					560.0	1,240.0	2,850.0		100.0	833.3	
Polyarthra sp.	14,166.5	733.3	14666.7	3,386.7	280.0	3,420.0	2,700.0	400.0	66.7	633.3	1,312.5
Pompholyx sp.							66.7			33.3	
Ptygura / Callotheca sp.							1,700.0				
Synchaeta	300.0		133.3	1,880.0	4,500.0	2,720.0	2,450.0	2,266.7	16,333.3	300.0	937.5
Trichocerca sp.					120.0	1,240.0	1,000.0		466.7	166.7	
Trichotria sp.			40	8.0	6.0				33.3		
Unidentified Rotifera	1,333.0	6,466.7	800	640.0	400.0	240.0	100.0	200.0	66.7	66.7	75.0
Class : Bdelloidea											
Unidentified Bdelloidea			133.3	16.0	1.0	24.0	20.0	66.7	10.0	2.0	15.0
Order : Diptera											
Family : Chironomidae											
Chironomid Larvae						1.0		1.0	1.0		
Unidentified Chironomid	1.0										
Family : Chaoboridae											
Chaoborus sp.						2.0	2.0				
Family : Ceratopogonidae											
Unidentified Ceratopognidae									1.0		
Group : Hydracarina											
Unidentified Hydracarina									4.0		
Phylum : Protozoa											
Unidentified ciliate			1133.3	12,320.0	480.0		600.0	14,700.0	4,333.3	3,450.0	525.0
Total number organisms/sample	**80824**	**47626.4**	**58739.2**	**40740.8**	**43492**	**68360**	**52701.3**	**117955.5**	**498190.3**	**24070.5**	**21297**

Table 44. Zooplankton results for St. Mary Lake, 2003 - 2007.

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Subclass : Copepoda													
Copepod nauplii	2,100.0	8,166.7	4400	1,125.0	66.7	80.0	212.0	2,150.0	4,266.7	40.0	1,766.7		1,275.0
Order : Cyclopoida													
Diacyclops thomasi adult													1.0
Diacyclops thomasi copepodid									20.0				
Eucyclops cf agilis Adult						3.0							
Eucyclops cf agilis Copepodite						1.0							
Eucyclops sp. Adult								1.0			1.0		
Eucyclops sp. Copepodite											6.0		
Mesocyclops leuckarti / edax Adult								6.0					
Mesocyclops cf. americanus Adult											30.0		
Mesocyclops cf. americanus Copepodite											20.0		
Orthocyclops cf modestus Adult					6.0			7.0	4.0				
Orthocyclops cf modestus Copepodite									20.0				
Unidentified Cyclopoida Copepodite			4	1.0	1.0		1.0	18.0					1.0
Unidentified Cyclopoida Adult	2.0												
Order : Calanoida													
Diaptomus cf oregonensis Adult		1,675.0		2,000.0	600.0	225.0	224.0	1,075.0	1,866.7	83.7	65.0		192.5
Diaptomus cf oregonensis Copepodid		875.0		1,041.7	3,000.0		160.0	2,450.0	733.3		600.0		40.0
Diaptomus cf oregonensis			2133.3										
Skistodiaptomus oregonensis Adult	1,830.0												
Skistodiaptomus oregonensis Copepodid	2.0												
Unidentified Calanoida Copepodite									10.0				
Order : Cladocera													
Bosmina longirostris								2.0	90.0		1.0	6.0	
Ceriodaphnia sp.		3.0											
Chydorus sp.		1	4	2					4		2		
Daphnia cf ambigua		3.0											
Daphnia pulex		1.0											1.0
Daphnia pulex / pulicaria		10.0							10.0		1.0		165.0
Diaphanosoma birgei				2,458.3	6.0		4.0						
Diaphanosoma sp.								5,775.0	400.0		2.0		
Holopedium gibberum		1.0											
Neomysis mercedis		11		16		1	2		1				
Family : Chydoridae													
Alona spp.			1										
Unidentified Chydoridae							1.0						
Phylum : Rotifera													
Ascomorpha spp.			66.7					650.0					
Asplanchna cf priodonta								1,475.0					
Asplanchna sp.		4.0											
Asplanchnopus ?								3,200.0					
Brachionus patulus				6.3					10.0				
Callotheca sp.			200				80.0		533.3		100.0		

	2003/02/13	2003/05/15	2004/02/16	2004/07/06	2004/11/18	2005/02/23	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Conochilus sp.		83.3	133.3					50.0	18,733.3				25.0
Euchlanis sp.									20.0				
Filinia sp.		166.7				20.0		14,587.5	333.3		33.3		
Gastropus sp.		2,916.7	1133.3	208.3			80.0	250.0					
Hexarthra sp.									666.7				
Kellicottia longispina	14.0	23,000.0	266.7	15.7		160.0	160.0	475.0	2,533.3		566.7	66.7	
Keratella cochlearis	30.0	1,833.3	14133.3	1,750.0	10,466.7	2,020.0	5,880.0	2,587.5	11,666.7	880.0	1,233.3	15,500.0	175.0
Keratella quadrata		1,083.3	3800		33.3	260.0		100.0	10.0	200.0	7,233.3		4,612.5
Lecane sp.			10	6.3		12.0		50.0	10.0				
Lepadella sp.						12.0							
Notholca sp.			10										
Ploesoma sp.							24.0		20.0				
Polyarthra sp.		166.7	2800	3,666.7	66.7	60.0	12,320.0	1,600.0	1,333.3	160.0	66.7		250.0
Pompholyx sp.												266.7	50.0
Synchaeta			10				120.0			200.0			2,525.0
Testudinella sp.			10			20.0		25.0		3.0			
Trichocerca sp.		50.0		41.7				950.0	733.3			333.3	
Unidentified Rotifera		500.0	600		33.3	60.0	120.0	225.0	133.3	40.0			
Order : Ostracoda													
Unidentified Ostracoda				1.0									
Order : Diptera													
Unidentified Diptera													
Family : Chironomidae													
Chironomid Larvae										1.0			
Family : Chaoboridae													
Chaoborus sp.								6.0	15.0		3.0	155.5	
Group : Hydracarina													
Unidentified Hydracarina		1.0											
Order : Harpacticoida													
Unidentified Harpacticoida				1.0									
Phylum : Protozoa													
Unidentified ciliate			266.7			20.0		5,287.5		2.0	33.3		25.0
Phylum : Chordata													
Unidentified fish elvin											1.0		
Total number organisms/sample	**3978**	**40551.7**	**29982.3**	**12341**	**14279.7**	**2954**	**19388**	**43002.5**	**44177.2**	**1609.7**	**11765.3**	**16328.2**	**9338**

Table 45. Zooplankton results for Weston Lake, 2003 - 2007.

	2004/02/16	2004/07/06	2004/11/18	2005/02/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Subclass : Copepoda											
Copepod nauplii	1125	291.7	1,000.0	4,080.0	6,125.0	2,800.0	1,700.0	5,920.0	7,400.0	1,266.0	1,833.3
Order : Cyclopoida											
Cyclops cf vernalis Adult										2.0	
Cyclops cf vernalis					2.0	2.0					
Macrocyclops sp.					4.0						
Orthocyclops cf modestus Adult					5.0	99.4	3.0			14.0	
Orthocyclops cf modestus Copepodite						45.0	65.0			15.0	
Unidentified Cyclopoida Copepodite		8.0	200.0	96.0	425.0	333.3	400.0	480.0	195.0	200.0	35.0
Unidentified Cyclopoida Nauplius	40.6										
Unidentified Cyclopoida Adult				1.0							
Order : Calanoida											
Diaptomus cf oregonensis Adult	106.3	3.0	526.5	568.0	400.0	105.0	243.3	243.0	646.7	65.0	115.0
Diaptomus cf oregonensis Copepodid	34.1	58.5	733.3	24.0	2,000.0	333.3	600.0	123.0	3,066.7	45.0	
Order : Cladocera											
Bosmina longirostris	4	10.0	110.0	8.0	1.0	1,100.0	47.2	24.0	866.7	533.3	163.3
Ceriodaphnia acanthina			2,266.7								
Ceriodaphnia sp.	8	4.5		40.0	662.5	600.0	3,500.0	120.0	1,200.0	500.0	4.0
Chydorus sp.					1	1	47.5		2		
Daphnia Juvenile				48.0	12.0	51.7	52.2	60.0	66.7		
Daphnia rosea	4	18.0	480.0	56.0	163.8	4.0	20.0	33.0	720.0		25.0
Daphnia sp.			80.0								41.1
Diaphanosoma brachyurum					2.0						
Diaphanosoma sp.		416.7				120.0	170.0			40.0	
Holopedium gibberum		Present	30.0		350.0	27.5	2.0		90.0		
Sub-class : Malacostraca											
Family : Chydoridae											
Cladoceran juvenile										100.0	
Unidentified Chydoridae			1.0								
Phylum : Rotifera											
Ascomorpha spp.	1166.7	41.7	66.7		166.7		600.0		66.7	100.0	
Asplanchna sp.			5.0		1,666.7	233.3	27.8	1.0	200.0		2.0
Brachionus sp.	500										
Callotheca sp.	83.3			26.6				80.0	66.7	1,100.0	66.7
Conochilus sp.				26.6	250.0	333.3	1,166.7		1,933.3		33.3
Filinia sp.				133.3	15,250.0	266.7	166.7	360.0	7,400.0	1,266.7	5.0
Gastropus sp.	708.3		1,666.7		5,000.0	266.7	66.7	800.0	866.7	20.0	1,133.3
Kellicottia bostoniensis				26.6	1,500.0	2,400.0	1,733.3	160.0	333.3	900.0	5.0
Kellicottia longispina	416.7	4,625.0		80.0	14,500.0	13,850.0	8,333.3	360.0	61,500.0	1,166.7	366.7
Keratella cochlearis	10958.3	24,291.7	6,533.3	4,426.7	327,500.0	3,500.0	11,050.0	9,060.0	33,900.0	4,966.7	6,050.0
Keratella quadrata	3250	2,875.0		1,440.0	3,916.7	10,650.0	2,366.7	2,640.0	7,200.0	966.7	233.3
Lepadella sp.				26.6							

	2004/02/16	2004/07/06	2004/11/18	2005/02/26	2005/05/26	2005/08/16	2005/09/22	2006/02/15	2006/05/18	2006/08/22	2007/02/26
Notholca sp.		41.7									
Ploesoma sp.			50.0		83.3	300.0	266.7			66.7	
Polyarthra sp.	208.3	500.0	2,800.0	746.7	38,250.0	1,800.0	2,633.3	280.0	133.3	1,233.3	
Pompholyx sp.					3,083.3	2,650.0	1,500.0		66.7		100.0
Ptygura / Callotheca sp.		17,666.7	66.7		83.3	6,450.0	7,000.0				
Synchaeta	250	375.0	193.4	506.7	11,250.0	166.7	33.3	7,020.0	1,200.0	233.3	1,100.0
Trichocerca sp.	41.6	166.7	80.0		166.7	1,000.0	1,300.0		133.3	633.3	
Trichotria sp.			40.0								
Unidentified Rotifera	1875	583.3		106.7	416.7	133.3	66.7	80.0	66.7	33.1	
Class : Bdelloidea											
Unidentified Bdelloidea				16.0	2.0	2.0		1.0			60.0
Phylum : Arthropoda											
Family : Chironomidae											
Chironomid Larvae						1.0	1.0	1.0			
Family : Chaoboridae											
Chaoborus sp.		22.0	1.0		44.0	120.7			64.0	38.0	
Unidentified Chaoboridae					3.0						
Group : Hydracarina											
Unidentified Hydracarina						7.0	1.0		2.0	1.0	
Order : Harpacticoida											
Unidentified Harpacticoida				1.0							
Phylum : Nematoda											
Unidentified Nematoda		41.7									
Phylum : Protozoa											
Unidentified ciliate	500		2,466.7		3,000.0	2,150.0	233.3	17,520.0	6,300.0	1,450.0	