Results of the 2011 Water Quality Survey of Ten Lakes Located in the Carleton River Watershed Area of Digby and Yarmouth Counties, Nova Scotia

Prepared for

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By

M. Brylinsky
Acadia Center for Estuarine Research
Acadia University
Wolfville Nova Scotia

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SUMMARY

As a result of concerns that water quality was becoming seriously degraded within a number of lakes located within the Carleton, Meteghan, and Sissaboo River watersheds, in 2008 Nova Scotia Environment initiated a program designed to evaluate the water quality status of nine lakes located within these watersheds. The results of this initial evaluation indicated that water quality was impaired in a number of the lakes surveyed, particularly with respect to high nutrient concentrations resulting in the development of high algal concentrations. The water quality surveys were continued, with the addition of a tenth lake, in 2009, 2010 and 2011 to better document the extent of the degradation in water quality. This report presents the results of the 2011 water quality survey and makes some comparisons with the results obtained in the prior surveys.

It was difficult to detect consistent trends in water quality since 2008 as a result of the considerable variation among survey years in the time at which the surveys were carried out as well as climatic factors, such as precipitation and temperature, which have a strong influence on water quality. However, it is clear that water quality within several of the lakes surveyed is still severely degraded as a result of high nutrient inputs. The most severely impacted lakes are located within the upper region of the Meteghan and Carleton watersheds and are located in close proximity to areas having a high concentration mink farms. Nutrients within the impacted lakes consist of extremely high levels of inorganic phosphorus which is most likely a result of the use of superphosphate in the mink farming industry.

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Results of the 2011 Water Quality Survey of Ten Lakes Located in the Carleton River Watershed Area of Digby and Yarmouth Counties, Nova Scotia

1. Background

In 2008, as a result of concerns that water quality was becoming seriously degraded within a number of lakes located within the Carleton, Meteghan, and Sissaboo River watersheds, Nova Scotia Environment initiated a program designed to evaluate the water quality status of nine lakes located within these watersheds. The results of this initial evaluation (NSE 2009) indicated that water quality was impaired in a number of the lakes surveyed, particularly with respect to high nutrient concentrations resulting in the development of high algal concentrations. In some instances the high algal concentrations contained species of blue-green alga known to produce microcystins, a toxin that, under certain conditions, may be harmful to humans, livestock and wildlife. As a result, further studies, which included the addition of a tenth lake, were carried out in 2009 and 2010 to better document the extent of the degradation in water quality and to determine its potential causes.

An analysis of the results of the surveys carried out in the three year period between 2008 and 2010 (summarized by Brylinsky 2011) suggested that the source of the nutrients leading to the degradation of water quality was most likely a result of mink farming activities in the area, and that the degree of degradation was strongly influenced by water color which varied considerably depending on the amount of precipitation. In order to develop a more comprehensive database to better document the extent to which water quality varies annually, as well as to serve as a basis for evaluating any changes resulting from remediation activities, the lakes were again surveyed in 2011. This report briefly summarizes the results of all four surveys carried out to date.

2. Approach and Methods

The approach and water sampling methodologies were the same as those used in the prior surveys carried out in 2008, 2009 and 2010 the details of which are described in NSE (2009; 2010) and Brylinsky (2011). The surveys included, for each of the 10 lakes; (a) collection and analysis of water samples for nutrients (total and inorganic phosphorus and nitrogen), chlorophyll *a*, pH, alkalinity, turbidity, and color for surface and bottom waters at one mid-lake station and all major inlet and outlet streams; (b) measurement of Secchi Disk depth and depth profiles for conductivity, temperature and dissolved oxygen at the mid-lake stations; (c) estimates of phosphorus loading, when possible, at lake inlets and outlets and; (d) collection of shoreline water samples for analyses of blue-green algae composition and abundance, microcystin concentration and fecal coliform numbers.

A shortcoming of the 2011 survey was the incomplete survey carried out for Nowlans Lake due to its only access suitable for launching a boat having been barricaded by large boulders. As a result it was only possible to collect a shoreline water sample for this lake.

3. Results

The database used for analysis of the survey results is contained in Appendix I which includes the results of all surveys carried out between 2008 and 2011 as well as the results of historical surveys carried out by the Nova Scotia Department of Lands and Forests, Nova Scotia Department of Natural Resources and Nova Scotia Power Inc. The locations of the lake sampling stations used each year are shown on map figures contained in Appendix II.

3.1 Lake Phosphorus and Chlorophyll *a* Concentrations and Water Color

The annual variations in surface water total phosphorous and chlorophyll *a* concentration is illustrated in Fig. 3.1.1.

Other than a further increase in the already exceptionally high phosphorus levels of Placides Lake, there was relatively little change in 2011 relative to levels measured in 2010. Despite the higher phosphorus levels, there was a decrease in chlorophyll *a* levels for Placides Lake which may be related to the higher water color in 2011 imparting a greater degree of light limitation for algal growth This may also be true for Hourglass Lake. The higher total phosphorus and lower chlorophyll *a* levels observed in 2011 for Nowlans Lake may be related to the water sample having been collected near the shoreline as opposed to the deep lake station used in prior survey years.

The high total phosphorus concentration measured in 2009 at Parr Lake is difficult to explain as levels in other years were much lower.

The mostly greater water colors observed in 2011 compared to 2010 is a result of the higher precipitation occurring just prior to and during the survey periods (Fig. 3.1.2). Daily precipitation data collected at Yarmouth by Environment Canada for the five day period prior to each survey period and for the period over which the survey was carried out, amounted to 50, 99, 7 and 31 mm for 2008, 2009, 2010 and 2011 respectively.

Fig. 3.1.3 illustrates the strong inverse relationship between water color and Secchi depth.

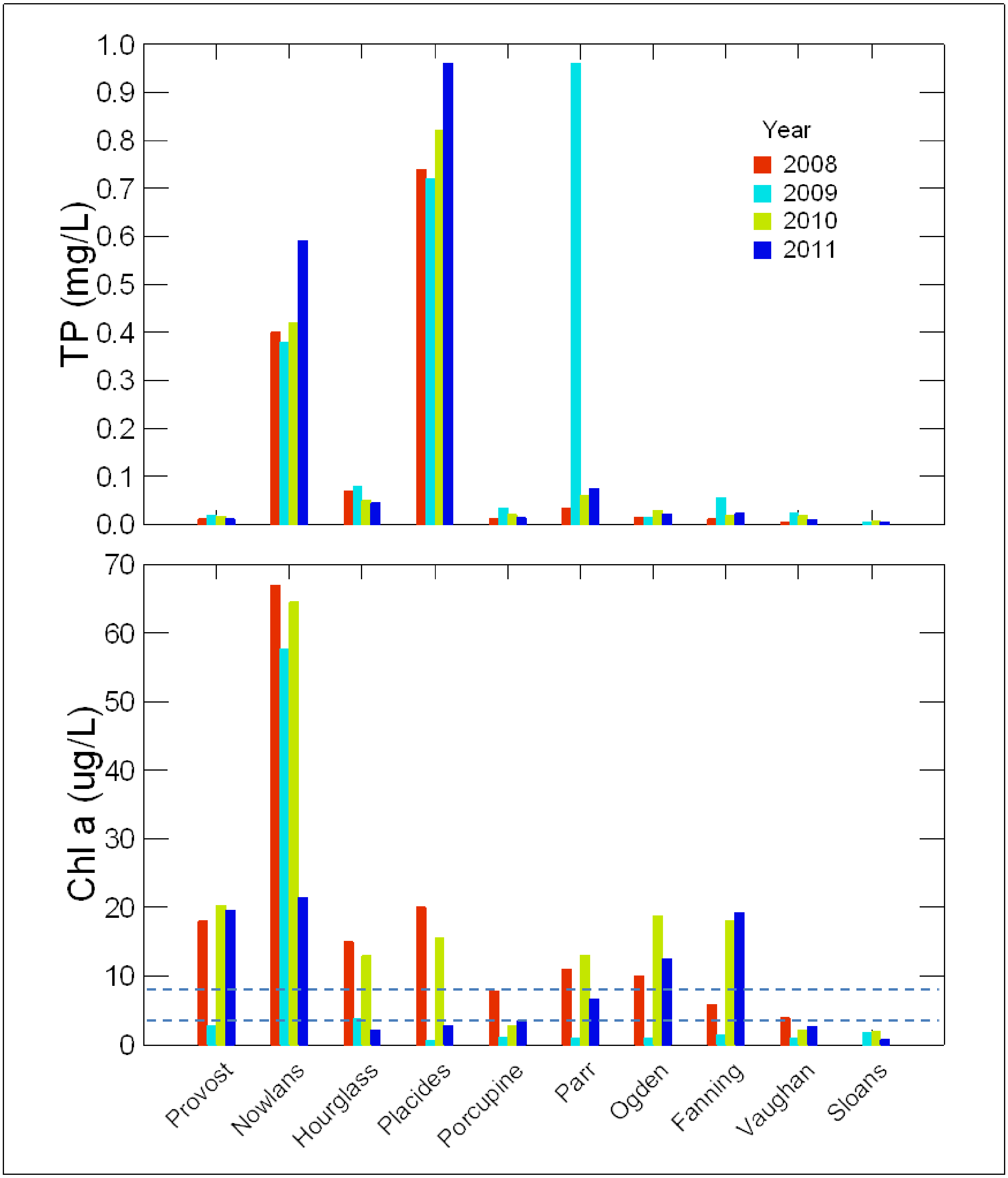

Fig.3.1.1 Annual variation in total phosphorus and chlorophyll *a* concentration (lower dashed line indicates division between oligotrophic and mesotrophic chlorophyll *a* levels and upper dashed line indicates division between mesotrophic and eutrophic chlorophyll *a* levels).

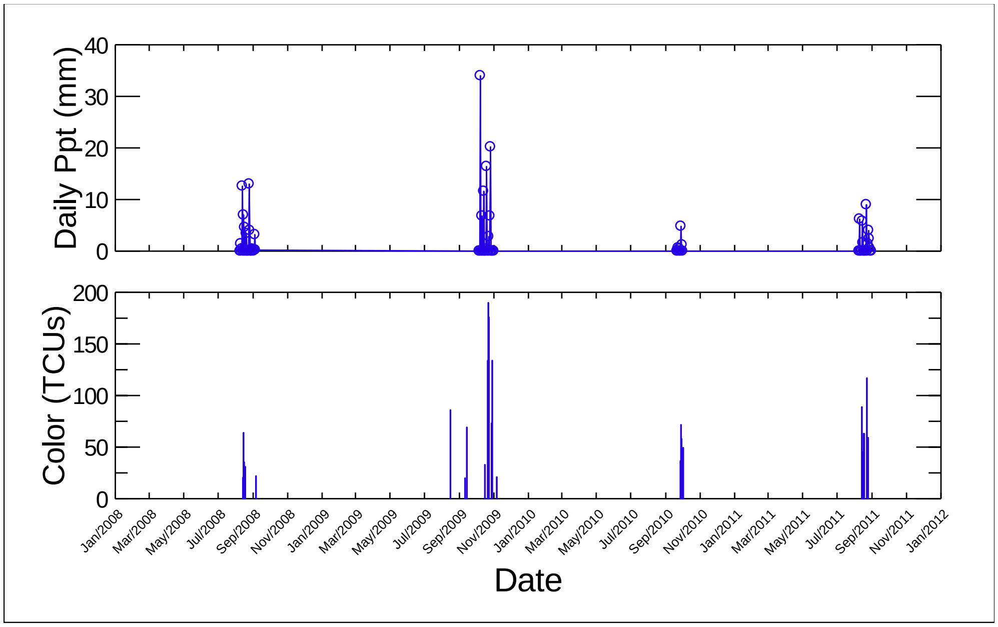

Fig 3.1.2 Relationship between precipitation and lake water color.

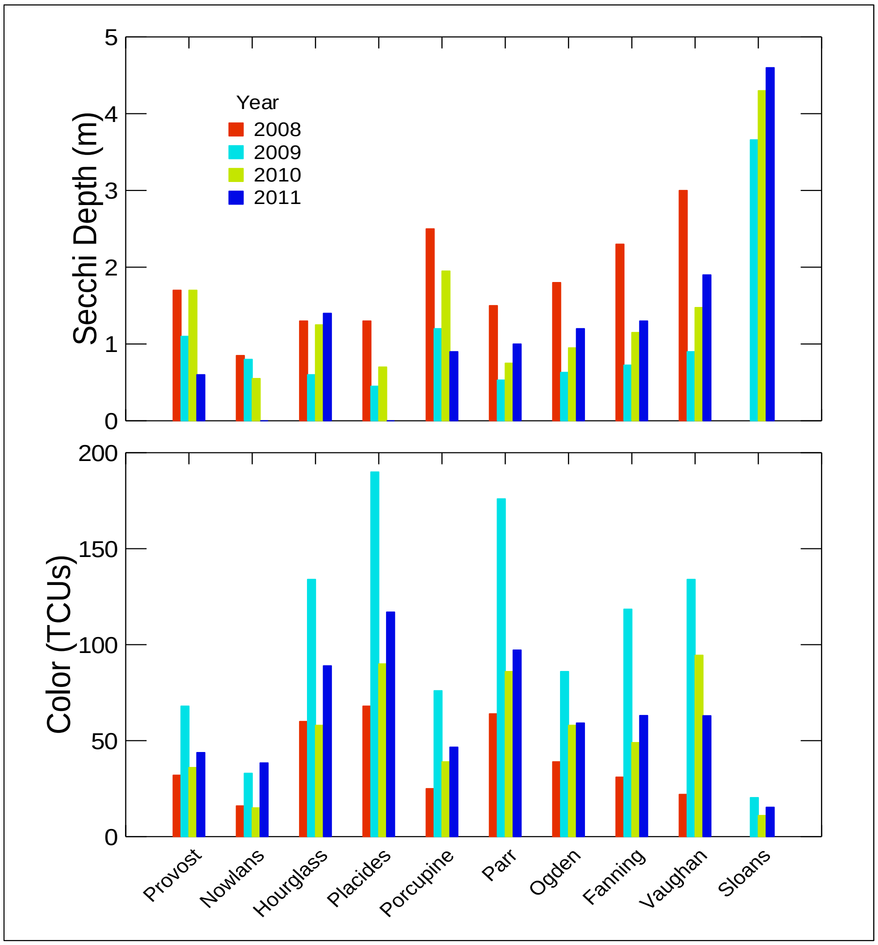

Fig 3.1.3 Relationship between Secchi depth and lake water color.

3.2. Total Phosphorus Concentrations at Lake Inputs

Table 3.2.1 is a summary of total phosphorus levels at the inlets to each of the surveyed lakes and Fig. 3.2.1 illustrates their variation over the four years in which they were surveyed. The highest inputs are at Nowlans and Placides Lakes. During 2011 the input levels at Placides Lake almost doubled over the levels measured in 2010. Porcupine Lake also had much higher levels in 2011 than in 2010.

Table 3.2.1 Annual variations in total phosphorus concentration at lake inputs.

Lake	Station	Year	Total P (mg/L)	Description of Input
Hourglass	HL-IN1	2009	0.170	Headwater lake with small spring input
		2010	0.037	
		2011	0.023	
Placides	PLAL-IN1	2009	0.610	Stream entering from Hourglass and Simonds Lakes
		2010	0.940	
		2011	1.600	
Porcupine	PORL-IN1	2009	0.079	Stream entering from Paul, Oliver and an unnamed lake
		2010	0.110	
		2011	0.300	
Parr	PARL-INA	2009	0.018	Input from Carleton River
		2010	0.099	
		2011	0.097	
	PARL-INB	2009	0.011	Stream input from Salmon and Grass Lakes
		2010	0.012	
		2011	0.076	
	PARL-INC	2009	0.016	Small unnamed stream
		2010	0.057	
		2011	0.012	
Ogden	OL-IN1	2009	0.076	Channel input from Parr Lake
		2010	0.054	
		2011	0.062	
Fanning	FL-IN1	2009	0.064	Input from Carleton River
		2010	0.024	
		2011	0.018	
	FL-IN2	2009	0.020	Small stream input from Cranberry Lake
		2010	0.008	
		2011	0.007	
	FL-IN3	2009	0.007	Small stream input from Mink Lake
		2010	0.005	
		2011	0.005	
Sloans	-	-	-	Headwater lake with no distinct water inputs
Vaughan	VL-IN1	2009	0.034	Stream input from Raynards Lake
		2010	0.014	
		2011	0.009	
	VL-IN2	2010	0.014	Channel input from Gavels Lake
		2011	0.008	
Nowlans	NL-IN1	2009	5.400	Headwater lake with distinct input from a drainage ditch
		2010	8.700	
		2011	7.900	
Provost	-	-	-	Headwater lake with no distinct water inputs

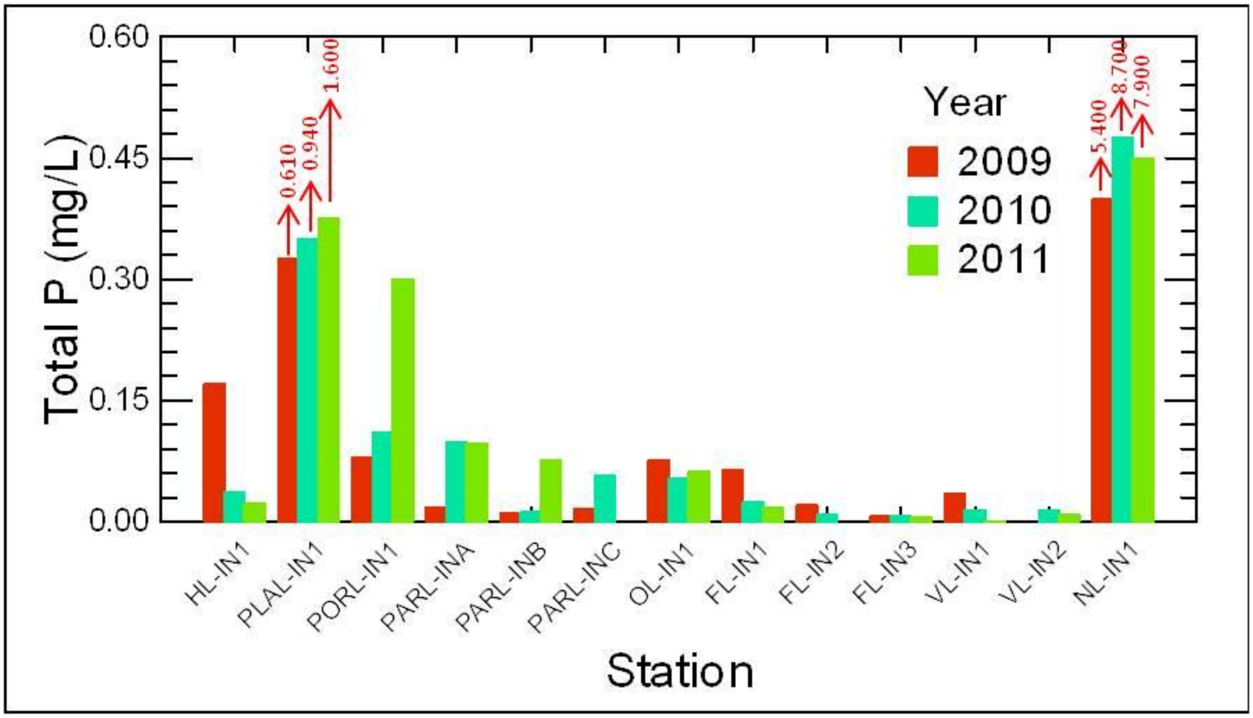

Fig 3.2.1 Total phosphorus levels at inputs to each lake.

3.3 Phosphorus Loading Comparisons

The number of phosphorus loading rates that could be measured during each survey year varied with the level of precipitation prior to and during the survey period. In 2009 these estimates were made at 25 sites. In 2010, however, due to low water levels and flows as a result of the extremely dry conditions, it was only possible to make these estimates at four sites. In 2011 loading estimates were made at 14 sites. These are summarized in Table 3.3.1.

Of particular note for 2011 are the high loadings at the inlet and outlet of Placides Lake and the increases in loadings at the input of Porcupine Lake and the output of Fanning Lake.

Table 3.3.1 Summary of daily nutrient loading estimates.

Lake	Station	Year	Width (m)	Depth (m)	Velocity (m/sec)	Total P (mg/L)	TP Loading (kg/day)
Hourglass	HL-IN1	2009	Springfed			0.170	0.002
	HL-OL1	2009	1.5	0.2	0.24	0.050	0.32
		2010	1.0	0.2	0.07	0.043	0.05
		2011	4.5	0.6	0.013	0.097	0.64
Placides	PLAL-IN1	2009	7.6	1.2	0.46	0.610	223.86
		2011	10.0	1.0	0.69	1.600	953.86
	PLAL-OL1	2009	4.5	1.2	0.37	0.660	116.26
		2011	15.0	0.8	0.54	1.100	577.37
Porcupine	PORL-IN1	2009	3.0	0.9	0.24	0.080	4.64
		2010	1.8	0.5	1.02	0.030	2.28
		2011	4.0	0.5	1.12	0.300	58.06
Parr	PARL-INA	2009	15.0	0.3	0.46	0.020	0.20
		2011	15.0	1.6	0.01	0.097	2.01
	PARL-INB	2009	3.0	0.9	0.28	0.010	0.73
		2010	2.0	0.5	0.20	0.012	0.21
	PARL-INC	2009	1.2	0.2	0.30	0.020	0.10
		2011	5.0	0.2	0.13	0.012	0.14
	PARL-OL1	2009	7.6	2.4	0.76	0.080	92.97
		2011	8.5	2.5	0.42	0.062	47.81
Ogden	OL-IN1	2009	6.1	2.2	0.91	0.080	80.53
		2010	5.0	0.5	2.00	0.054	23.33
		2011	8.5	2.5	0.42	0.062	47.81
	OL-OL1	2009	7.6	1.2	1.52	0.070	80.74
Fanning	FL-IN1	2009	5.5	1.2	1.00	0.060	36.99
		2011	20.0	0.8	0.23	0.018	5.938
	FL-IN2	2009	1.2	0.3	0.30	0.020	0.20
		2011	3.5	0.2	0.47	0.007	0.25
	FL-IN3	2009	1.2	0.6	0.30	0.010	0.14
	FL-OL1	2009	7.6	2.4	1.83	0.060	173.22
Sloans	SL-IN1	2009	0.6	1.5	0.05	0.038	0.15
	SL-OL6	2009	1.8	0.1	0.05	0.005	0.01
		2011	2.5	0.06	0.47	0.005	0.03
Vaughan	VL-IN1	2009	14.6	2.4	0.46	0.030	47.91
		2011	17.0	3.1	1.35	0.008	49.18
	VL-IN2	2009	24.3	2.2	0.30	0.010	19.78
		2011	27.0	2.6	0.31	0.009	16.92
	VL-OL1	2009	20.0	3.1	0.61	0.020	71.36
Provost	PROL-IN1	2009	1.2	0.3	0.17	0.010	0.08
	PROL-OL1	2009	1.5	0.6	0.24	0.020	0.35
		2011	2.0	0.2	0.52	0.015	0.34
Nowlans	NL-IN1	2009	1.5	0.3	0.02	5.400	4.40
		2010	0.5	0.1	0.50	8.700	18.79
	NL-OL1	2009	2.4	1.2	0.08	0.400	8.35

3.4 Lake Trophic Status

Table 3.4.1 lists the annual variation in trophic status for each lake based on chlorophyll *a* and water color levels using the rational proposed for dystrophic (colored) lakes by Brylinsky (2011). For many of the lakes there has been considerable variation in trophic status over the four years of study. Two of the lakes, Placides and Parr, have varied over four trophic levels ranging between ultra-oligotrophic and eutrophic, and two, Hourglass and Fanning, have varied over three trophic levels ranging from oligotrophic to eutrophic. Some of this variation is a result of differences in the time of year in which the surveys were carried out, particularly in relation to the degree of water column thermal stratification and to variations in water color between years which influences the degree of light, as opposed to nutrient, limitation of algal growth. The 2009 survey was carried out over a three month period beginning in September and ending in early November which corresponded to destratification of the water column and dilution of surface water algal biomass (i.e., chlorophyll *a*) by bottom waters. Trophic levels during this time were mostly within the oligotrophic category. This year was also characterized by high levels of water color which would impose an addition light limitation on algal growth. In 2010 the survey was carried out during late September at which time all but the deepest lakes (Ogden, Sloans and Vaughan) had become destratifed. The only two years in which the surveys were carried out at compatible times and water color levels were in 2008 and 2011. In comparing these two years, although there were changes in trophic levels within lakes, with two exceptions, the changes did not exceed more than one trophic category. The two exceptions were Placides Lake which changed from eutrophic in 2008 to oligotrophic in 2011, and Hourglass Lake which changed from eutrophic in 2008 to oligotrophic in 2011. The change in Placides Lake may be related to the much higher water color measured in 2011. The change in Hourglass Lake could be due to a change in the level of activities of the existing aquaculture facility located along its shoreline.

3.5 Water temperature and Dissolved Oxygen Profiles

Water depth profiles of temperature and dissolved oxygen are contained in Appendix IV. As is the case with changes in trophic status, differences in the time of the water quality surveys over the four survey years make it difficult to determine if significant annual differences in these parameters occur. The only two comparable years are 2008 and 2011 in which the surveys were carried out during August. In comparing these two years most of the lakes exhibited greater water temperatures, stronger temperature stratification, and a greater decrease in dissolved oxygen levels with depth in 2011. In 2011, the only lakes not exhibiting anoxic bottom waters were Sloans, Parr, and Provost Lake. Sloans Lake remains a relatively pristine lake having low phosphorus and chlorophyll *a* levels. Parr and Provost Lakes are relatively shallow and did not exhibit a well developed thermocline in either year.

Table 3.4.1 Yearly variation in trophic status based on chlorophyll *a* concentration and color.

Lake	Year	**Chl *a*** (μg/L)	Trophic Status	**Color** (TCUs)
Hourglass	2008	15.0	Eutrophic/*	60
	2009	3.8	Mesotrophic/***	134
	2010	13.0	Eutrophic/**	58
	2011	2.1	Oligotrophic/**	89
Placides	2008	20.0	Eutrophic/**	68
	2009	0.6	Ultra-oligotrophic/***	190
	2010	15.5	Eutrophic/**	90
	2011	2.8	Oligotrophic/***	117
Porcupine	2008	7.8	Mesotrophic/*	25
	2009	1.1	Oligotrophic/**	76
	2010	2.8	Mesotrophic/*	39
	2011	3.4	Mesotrophic/*	47
Parr	2008	11.0	Eutrophic/**	64
	2009	0.9	Ultra-oligotrophic/***	176
	2010	13.0	Eutrophic/**	86
	2011	6.7	Mesotrophic/**	97
Ogden	2008	10.0	Eutrophic/*	39
	2009	5.5	Mesotrophic/**	86
	2010	18.8	Eutrophic/**	58
	2011	12.5	Eutrophic/**	59
Fanning	2008	5.8	Mesotrophic/*	31
	2009	1.5	Oligotrophic/***	118
	2010	18.1	Eutrophic/*	49
	2011	19.2	Eutrophic/**	63
Sloans	2009	1.7	Oligotrophic/*	20
	2010	1.9	Oligotrophic/*	11
	2011	0.7	Oligotrophic/*	15.3
Vaughan	2008	3.9	Mesotrophic/*	22
	2009	0.9	Ultra-oligotrophic/***	134
	2010	2.2	Oligotrophic/**	95
	2011	2.6	Oligotrophic/**	63
Nowlans	2008	67.0	Hyper-eutrophic/*	16
	2009	58.0	Hyper-eutrophic/*	33
	2010	64.5	Hyper-eutrophic/*	15
	2011	21.4	Eutrophic/*	38
Provost	2008	18.0	Eutrophic/*	32
	2009	2.8	Mesotrophic/**	68
	2010	20.3	Eutrophic/*	36
	2011	19.6	Eutrophic/*	44

* <50 – Oligo-dystrophic ** ≥50 - <100 – Meso-dystrophic *** ≥100 – Eu-dystrophic

3.6 Water Quality Guidelines

Table 3.6.1 summarizes the values of each lake for Health Canada (2010) water quality guidelines relevant to recreational use. Two of these parameters, Secchi Disk depth and turbidity, are related to water clarity and are important mainly from an aesthetic viewpoint and are not actually harmful from a health perspective. Other than Secchi Disk depth, which often fell below the guideline of >1.2 m due largely to the naturally high colour of most the lakes, all of the lakes, with one exception, met the guidelines. The one exception was Nowlans Lake which exceeded the guideline for blue-green algal numbers in 2009 and for *E. coli* numbers in 2011. Although not above the guideline, Nowlans Lake was also the only lake to have ever exhibited microcystin levels above the limit of analytical detection.

Details of the blue-green algal species present and their individual numbers in each lake for each survey year are contained in Appendix III. In the 2011 survey, all of the lakes except Placides contained at least one species of blue-green algae and *Microcystis sp.* was present in only three (Nowlans, Hourglass and Sloans) of the ten lakes surveyed.

Table 3.6.1 Summary of annual results for parameters used to assess the suitability of lakes for recreational use (numbers in red indicate guideline was exceeded).

Lake	Year	Parameter (Numbers in parenthesis represent guideline values)						
		E. coli (<200/100ml)	**Secchi Depth** (>1.2 m)	**pH** (5.0-9.0)	**Turbidity** (<50 NTUs)	**Blue Green Algae** (<100,000 cells/ml)	**Microcystins**	
							Free	**Total** (<20 µg/L)
Hourglass	2008	-	1.3	6.2	1.09	48	< 0.20	-
	2009	< 2	0.6	6.2	1.18	33	< 0.20	-
	2010	7	1.3	6.8	1.22	6	< 0.20	-
	2011	5	1.4	6.1	1.09	145	< 0.20	< 0.20
Placides	2008	-	1.3	6.5	2.00	64	< 0.20	-
	2009	56	0.5	6.4	5.40	424	< 0.20	-
	2010	101	0.7	6.9	10.00	0	< 0.20	-
	2011	3	0.9	6.8	2.29	0	< 0.20	< 0.20
Porcupine	2008	-	2.5	6.6	0.95	56	< 0.20	-
	2009	1	1.3	6.6	1.15	2	< 0.20	-
	2010	12	2.0	6.9	0.65	20	< 0.20	-
	2011	75	0.8	6.9	1.25	870	< 0.20	< 0.20
Parr	2008	-	1.5	6.2	1.38	2,220	< 0.20	-
	2009	1	0.5	5.4	1.19	267	< 0.20	-
	2010	< 2	0.8	6.2	1.88	102	< 0.20	-
	2011	8	1.0	6.1	1.41	2,670	< 0.20	< 0.20
Ogden	2008	-	1.8	6.1	1.28	1,210	< 0.20	-
	2009	3	0.6	5.8	1.11	195	< 0.20	-
	2010	2	1.0	6.3	4.20	2,480	< 0.20	-
	2011	2	1.0	6.2	2.51	4,030	< 0.20	< 0.20

Table 3.6.1 (Con't.) Summary of annual results for parameters used to assess the suitability of lakes for recreational use (numbers in red indicate guideline was exceeded).

Fanning	2008	-	2.3	6.4	0.85	2,644*	< 0.20	-
	2009	-	0.7	5.9	1.23	5	< 0.20	-
	2010	3	1.2	6.4	2.82	4370*	< 0.20	-
	2011	8	1.3	6.2	4.06	70,100*	< 0.20	< 0.20
Sloans	2009	4-6	3.8	6.9	0.42	1,901*	< 0.20	-
	2010	2	4.3	7.0	0.32	3,075	< 0.20	-
	2011	1	4.6	6.9	0.36	856	< 0.20	< 0.20
Vaughan	2008	-	3.0	6.3	0.71	408	< 0.20	-
	2009	3	0.9	6.2	0.93	0	< 0.20	-
	2010	3-12	1.2	6.2	1.13	13*	< 0.20	-
	2011	0	1.8	6.2	1.02	160	< 0.20	< 0.20
Provost	2008	-	1.7	6.1	2.60	492	< 0.20	-
	2009	4	1.1	5.9	1.19	10	< 0.20	-
	2010	< 2	1.7	6.0	1.57	38	< 0.20	-
	2011	3	0.6	6.0	1.45	450	< 0.20	< 0.20
Nowlans	2008	-	0.9	6.5	19.6	94,125*	0.30	-
	2009	38	0.8	7.3	10.6	138,333*	< 0.20	-
	2010	57	0.6	8.0	34.3	27,725*	< 0.20	-
	2011	1203	-	7.4	30.10	78,900	< 0.20	11.82

*Number based on mean value of two or more samples collected at different locations.

4. Discussion

Although a total of four annual surveys have been carried out to date, a number of factors make it difficult to determine the degree of yearly variation in the surveyed lakes. The times of the water quality surveys varied considerably and included periods in which many of the lakes were either stratified, partially stratified, or unstratified, a condition that has a strong influence on the magnitudes of water quality parameters. The amount of precipitation between years, which is strongly correlated to water color, an important parameter influencing the response of algae to nutrient levels, also varied significantly between years. Variations in the nature and degree of activities within the watershed of each lake that affect the level of nutrient inputs to the lakes are also likely to occur. As a result, on the basis of the existing database, it is difficult to relate the changes observed in the trophic status of the surveyed lakes to land based human activities occurring within their respective watersheds. It is, however, clear that the lakes being surveyed are being subjected to exceptionally high levels of nutrient inputs and that under favourable conditions for algal growth exhibit the most severe consequences of nutrient-overenrichment, particularly the development of blue-green algal blooms, some of which contain toxic species, as well as the development of anoxic conditions in bottom waters which reduces the habitat available for most aquatic organisms.

5. Recommendations for Further Water Quality Surveys

It is unlikely that continued yearly routine water quality surveys will increase our current knowledge or understanding of the water quality status of the lakes surveyed. Future surveys should focus on identifying the point sources of nutrients entering each lake as suggested by

Brylinsky (2012). Once these have been identified, and remediation measures have been implemented, consideration should be given to the development of a more comprehensive monitoring program, perhaps volunteer based, that would provide an indication of the efficacy of the implemented remediation activities, with particular emphasis on the occurrence of *Microcystis* and microcystin levels.

6. References

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Appendix I

Database Used in Analyses

Appendix I Database Used in Analyses

LAKE	Date	Station	Depth (m)	Secchi Depth (m)	Chlorophyll (µg/L)	Color (TCUs)	Turbidity (NTUs)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Alkalinity (mg/L)	pH	Data Source
Hourglass	Sep/01/83		0	3		30		0.002	0.012	0.01	2.5	5.8	NSDL&F
Hourglass	Sep/01/83		5			55		0.001	0.011	0.01	7.2	6.1	NSDL&F
Hourglass	Sep/01/83		7			55		0.001	0.045	0.03	8.7	6.1	NSDL&F
Hourglass	Aug/14/08	HL-DS1	0	1.3	15	60		0.034	0.069	0.03	3.4	6.2	NSE
Hourglass	Oct/20/09	HL-AQIN1			6.5	139		0.056	0.080	0.22	2.0	6.1	NSE
Hourglass	Oct/20/09	HL-AQOL1			2.8	136		0.062	0.090	0.22	2.4	6.2	NSE
Hourglass	Oct/20/09	HL-DS1	0	0.6	3.8	134		0.057	0.078	0.21	2.1	6.2	NSE
Hourglass	Oct/20/09	HL-DS1	6			147		0.050	0.079	0.22	2.1	6.2	NSE
Hourglass	Oct/20/09	HL-IN1			11.1	224		0.115	0.170	0.01	2.8	5.7	NSE
Hourglass	Oct/20/09	HL-OL1	0		0.4	123		0.027	0.049	0.01	2.9	6.4	NSE
Hourglass	Sep/26/10	HL-AQIN1							0.050	0.21			NSE
Hourglass	Sep/26/10	HL-AQOL1			8	58	1.56	0.030	0.063	0.01	3.0	6.8	NSE
Hourglass	Sep/26/10	HL-DS1	0	1.3	13	58	1.22	0.022	0.050	0.01	2.9	6.8	NSE
Hourglass	Sep/26/10	HL-IN1			0.2	9.8	1.80	0.006	0.370	1.90	21.3	7.6	NSE
Hourglass	Sep/26/10	HL-OL1			2.5	45	1.06	0.006	0.043	0.03	3.9	6.9	NSE
Hourglass	Aug/14/11	HL-DS1	0	1.4	2.1	89		0.018	0.045	0.04			NSE
Hourglass	Aug/14/11	HL-DS1	6		2.1	167		0.330	0.390	0.01			NSE
Hourglass	Aug/14/11	HL-IN1				65		0.005	0.023	0.85			NSE
Hourglass	Aug/14/11	HL-OL1				73		0.006	0.022	0.01			NSE
Hourglass	Aug/14/11	HL-AQOL1				95	1.36	0.053	0.087	0.05	3.3	6.7	NSE
Placides	Aug/14/08	PLAL-DS1	0	1.3	20	68		0.580	0.740	0.35	3.4	6.5	NSE
Placides	Aug/14/08	PLAL-DS1	7			202		3.440	5.200	0.02	24.0	6.3	NSE
Placides	Oct/21/09	PLAL-1N1-A			0.2	187		0.580	0.630	1.25	2.2	6.0	NSE
Placides	Oct/21/09	PLAL-1N1-B			0.2	184		0.580	0.610	1.26	2.6	6.1	NSE
Placides	Oct/21/09	PLAL-DS1	0	0.4	0.6	190		0.661	0.720	1.10	2.8	6.5	NSE
Placides	Oct/21/09	PLAL-DS1	6			207		0.680	0.700	1.10	2.9	6.4	NSE
Placides	Oct/21/09	PLAL-IN1			0.2	187		0.580	0.610	1.28	3.0	6.2	NSE
Placides	Oct/21/09	PLAL-OL1			1	187		0.620	0.660	0.95	2.9	6.3	NSE
Placides	Sep/27/10	PLAL-DS1	0	0.7	15.5	90	7.98	0.705	0.820	0.47	4.7	6.9	NSE
Placides	Sep/27/10	PLAL-DS1	6			97	10.00	0.652	0.830	0.54	5.2	6.9	NSE
Placides	Sep/27/10	PLAL-IN1			0.5	105	3.02	0.078	0.940	1.31	5.0	6.8	NSE
Placides	Sep/27/10	PLAL-OL1			7.8	84	5.75	0.348	0.710	0.29	4.6	6.9	NSE
Placides	Aug/23/11	PLAL-DS1	0		2.8	117		0.786	0.960	0.58			NSE
Placides	Aug/23/11	PLAL-DS1	5			132		1.780	2.100	0.16			NSE
Placides	Aug/23/11	PLAL-IN1		0.9			2.27				5.1	6.8	NSE
Placides	Aug/23/11	PLAL-OL1					3.80				15.9	7.2	NSE
Porcupine	Aug/13/08	PORL-DS1	0	2.5	7.8	25		0.005	0.012	0.01	3.0	6.6	NSE
Porcupine	Aug/13/08	PORL-DS1	6			87		0.005	0.021	0.01	9.5	6.3	NSE
Porcupine	Oct/27/09	PORL-DS1	0		1.3	75		0.011	0.034	0.06	3.0	6.6	NSE
Porcupine	Oct/27/09	PORL-DS1	13			79		0.017	0.033	0.07	3.0	6.7	NSE
Porcupine	Oct/27/09	PORL-DS2	0	1.2	0.9	77		0.017	0.035	0.07	2.6	6.6	NSE
Porcupine	Oct/27/09	PORL-IN1			0.3	180		0.055	0.079	0.10	2.2	6	NSE
Porcupine	Oct/27/09	PORL-OL1			1.4	78		0.015	0.031	0.06	2.6	6.6	NSE
Porcupine	Sep/27/10	PORL-DS2	0	2.0	2.8	39	1.31	0.005	0.021	0.01	3.1	6.8	NSE
Porcupine	Sep/27/10	PORL-DS2	10		0.5		8.30	0.013		0.01	3.4	6.8	NSE
Porcupine	Sep/27/10	PORL-IN1			0.9	176	5.91	0.110	0.110	0.10	5.4	6.9	NSE
Porcupine	Sep/27/10	PORL-OL1			1	33	0.65	0.005	0.019	0.01	3.3	6.9	NSE
Porcupine	Aug/15/11	PORL-DS2	0	0.9	3.4	47		0.005	0.014	0.01			NSE

Appendix I Database Used in Analyses

LAKE	Date	Station	Depth (m)	Secchi Depth (m)	Chlorophyll (µg/L)	Color (TCUs)	Turbidity (NTUs)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Alkalinity (mg/L)	pH	Data Source
Porcupine	Aug/15/11	PORL-DS2	10			72				0.08			NSE
Porcupine	Aug/15/11	PORL-IN1				326		0.202	0.300	0.08			NSE
Porcupine	Aug/15/11	PORL-OL1				41		0.005	0.014	0.01			
Parr	Jul/03/86		0	2.8	11.0	55		0.001	0.006	0.01	1.0	5.7	NSDL&F
Parr	Aug/15/08	PARL-DS1	0	1.5	11.0	64		0.012	0.033	0.01	3.0		NSE
Parr	Oct/22/09	PARL-DS1	0	0.5	0.9	176		0.075	0.960	0.07	1.0	5.4	NSE
Parr	Oct/22/09	PARL-DS1	6			178		0.075	0.950	0.07	1.0	5.4	NSE
Parr	Oct/22/09	PARL-INA			0.1	142		0.006	0.018	0.01	2.2	6.2	NSE
Parr	Oct/22/09	PARL-INB			0.1	130		0.005	0.011	0.01	1.0	5.1	NSE
Parr	Oct/22/09	PARL-INC			0.1	183		0.005	0.016	0.01	1.0	5.0	NSE
Parr	Oct/22/09	PARL-OL1			1.1	168		0.059	0.076	0.06	1.0	5.5	NSE
Parr	Sep/27/10	PARL-DS1	0	0.9	13.0	86	1.88	0.031	0.061	0.01	1.1	6.2	NSE
Parr	Sep/27/10	PARL-INA			3.4	111	1.66	0.069	0.099	0.01	1.7	6.1	NSE
Parr	Sep/27/10	PARL-INB			0.1	115	0.23	0.005	0.012	0.01	1.5	5.9	NSE
Parr	Sep/27/10	PARL-INC			6.8	72	2.65	0.028	0.057	0.04	3.9	6.6	NSE
Parr	Sep/28/10	PARL-OL1	0		3.8	80	1.58	0.029	0.054	0.01	1.6	6.2	NSE
Parr	Aug 25/11	PARL-DS1	0	1	6.7	97		0.075	0.075	0.01			NSE
Parr	Aug 25/11	PARL-DS1	6			99		0.046	0.076	0.01			NSE
Parr	Aug 25/11	PARL-INA				117		0.068	0.097	0.03			NSE
Parr	Aug 25/11	PARL-INB				103		0.036	0.076	0.01			NSE
Parr	Aug 25/11	PARL-INC				107		0.005	0.012	0.01			NSE
Parr	Aug 25/11	PARL-OL1				92		0.033	0.062	0.01			
Ogden	Jul/09/86		0	1.3		40		0.001	0.004	0.01	1.2	6.2	NSDL&F
Ogden	Jul/03/02		0	1.5	0.7	67		0.007	0.012	0.01	2.5	5.9	Eaton
Ogden	Jul/03/02		12			64					2.3	5.6	Eaton
Ogden	Aug/28/02		13			97					2.0	5.6	Eaton
Ogden	Aug/15/08	OL-DS1	0	1.8	10.0	39		0.005	0.014	0.01	3.0	6.1	NSE
Ogden	Aug/15/08	OL-DS1	9			45		0.008	0.018	0.03	3.0	5.8	NSE
Ogden	Aug/15/08	OL-DS1	18			152		0.051	0.097	0.01	5.0	5.9	NSE
Ogden	Oct/22/09	OL-DS1	0	0.6	1.0	86		0.005	0.014	0.01	3.0	6.1	NSE
Ogden	Oct/22/09	OL-DS1	9			45		0.008	0.018	0.03	3.0	5.8	NSE
Ogden	Oct/22/09	OL-DS1	18			152		0.051	0.097	0.01	5.0	5.9	NSE
Ogden	Oct/22/09	OL-IN1			1.2	164		0.043	0.076	0.06	1.1	5.5	NSE
Ogden	Oct/22/09	OL-OL1			0.8	140	1.14	0.047	0.066	0.06	1.6	5.8	NSE
Ogden	Sep/28/10	OL-DS1	0	1.0	18.8	58	4.20	0.008	0.029	0.05	1.5	6.3	NSE
Ogden	Sep/28/10	OL-DS1	16		1.8	206	5.35	0.194	0.260	0.01	11.8	7.0	NSE
Ogden	Sep/28/10	OL-IN1	0		3.8	80	1.58	0.029	0.054	0.01	1.6	6.2	NSE
Ogden	Sep/28/10	OL-OL1			15.6	61	4.0	0.006	0.029	0.06	1.5	6.2	NSE
Ogden	Aug/25/11	OL-DS1	0	1.2	12.5	59		0.005	0.022	0.01			NSE
Ogden	Aug/25/11	OL-DS1	15			107		0.038	0.094	0.02			NSE
Ogden	Aug/25/11	OL-OL1				71		0.005	0.025	0.01	1.4	6.2	NSE
Fanning	Jul/11/86		0	1.6		25		0.001	0.004	0.01	1.3	5.5	NSDL&F
Fanning	Jul/03/02		0	1.7	1.9	63		0.007	0.011	0.02	1.0	5.9	Eaton
Fanning	Jul/03/02		9			62					1.8	5.7	Eaton
Fanning	Aug/28/02		0	3.0	3.6	34		0.001	0.008	0.01	2.1	6.2	Eaton
Fanning	Aug/28/02		9			97					4.8	6.0	Eaton
Fanning	Oct/23/02		5	2.6	2.1	33		0.001	0.012	0.01	2.0	6.1	Eaton
Fanning	Aug/17/08	FL-DS1	0	2.3	5.8	31		0.005	0.011	0.01	3.0	6.4	NSE
Fanning	Aug/17/08	FL-DS1	7			57		0.005	0.023	0.01	4.2	6.3	NSE
Fanning	Aug/17/08	FL-DS1	9			137		0.055	0.097	0.01	10.0	6.5	NSE

Appendix I Database Used in Analyses

LAKE	Date	Station	Depth (m)	Secchi Depth (m)	Chlorophyll (µg/L)	Color (TCUs)	Turbidity (NTUs)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Alkalinity (mg/L)	pH	Data Source
Fanning	Sep/13/09	FL-DS1	0	0.8	1.3	120		0.037	0.056	0.06	1.6	5.9	NSE
Fanning	Sep/13/09	FL-DS1	8			122		0.037	0.060	0.06	1.5	5.9	NSE
Fanning	Sep/13/09	FL-DS2	0	0.7	1.6	117		0.035	0.056	0.06	1.7	5.6	NSE
Fanning	Oct/13/09	FL-DS1	0	0.8	1.3	120		0.037	0.056	0.06	1.6	5.9	NSE
Fanning	Oct/13/09	FL-DS1	8			122		0.037	0.060	0.06	1.5	5.9	NSE
Fanning	Oct/13/09	FL-DS2	0	0.7	1.6	117		0.035	0.056	0.06	1.7	6.0	NSE
Fanning	Oct/14/09	FL-IN1			1.0	130		0.043	0.064	0.06	1.6	5.9	NSE
Fanning	Oct/14/09	FL-IN2			1.2	113		0.005	0.020	0.01	2.5	6.3	NSE
Fanning	Oct/14/09	FL-IN3			0.7	37		0.005	0.007	0.01	1.6	6.4	NSE
Fanning	Oct/14/09	FL-OL1			1.1	120		0.030	0.059	0.05	1.8	6.0	NSE
Fanning	Sep/30/10	FL-DS2	0		14.2	43	2.93	0.005	0.019	0.05	1.7	6.4	NSE
Fanning	Sep/30/10	FL-DS3	0	1.2	21.9	55	2.82	0.005	0.021	0.06	1.8	6.4	NSE
Fanning	Oct/01/10	FL-IN1			1.9	50	1.15	0.005	0.240	0.14	1.4	6.6	NSE
Fanning	Oct/01/10	FL-IN2			1.9	43	0.54	0.005	0.008	0.01	2.8	6.7	NSE
Fanning	Oct/01/10	FL-IN3			1.1	21	0.35	0.005	0.005	0.01	1.8	6.6	NSE
Fanning	Oct/01/10	FL-OL1			6.5	42	2.17	0.005	0.019	0.07	1.7	6.5	NSE
Fanning	Aug/18/11	FL-DS3	0	1.3	19.2	63	4.06	0.005	0.023	0.01	1.3	6.2	NSE
Fanning	Aug/18/11	FL-DS3	9			202		0.054	0.082	0.01	5.4		NSE
Fanning	Aug/18/11	FL-IN1				70	4.64	0.005	0.018	0.01	1.2	6.1	NSE
Fanning	Aug/18/11	FL-IN2				45	0.61	0.005	0.007	0.01	2.9	6.8	NSE
Fanning	Aug/18/11	FL-IN3				23	0.32	0.005	0.005	0.01	2.0	6.6	NSE
Fanning	Aug/18/11	FL-OL1				61	4.35	0.005	0.015	0.01	1.2	6.2	NSE
Sloans	Jul/03/86		0	5.8				0.001	0.003	0.01	2.9	5.8	NSDL&F
Sloans	Jul/04/02		0	4.4	1.3	14		0.001	0.003	0.01	3.8	6.9	Eaton
Sloans	Jul/04/02		3	4.0	1.5	18		0.001	0.003	0.01	3.6	6.8	Eaton
Sloans	Jul/04/02		10			14					3.6	6.2	Eaton
Sloans	Jul/04/02		10			14					3.8	6.2	Eaton
Sloans	Aug/28/02		0	4.8	0.9	11		0.001	0.010	0.01	4.0	6.8	Eaton
Sloans	Aug/28/02		3	6	1	10		0.001	0.010	0.01	4.0	6.8	Eaton
Sloans	Aug/28/02		15			14					4.3	6.0	Eaton
Sloans	Aug/28/02		15			18					4.0	5.9	Eaton
Sloans	Oct/23/02		0	4.2	1.6	12		0.001	0.005	0.01	3.8	6.6	Eaton
Sloans	Oct/23/02		6	4.5	1.6	10		0.001	0.005	0.01	3.8	6.6	Eaton
Sloans	Oct/23/02		15			18					6.0	6.2	Eaton
Sloans	Oct/23/02		15			60					8.0	6.2	Eaton
Sloans	Sep/10/09	SL-DS1	0	3.8	1.9	20		0.005	0.005	0.01	3.2	6.9	NSE
Sloans	Sep/10/09	SL-DS1	8		0.7			0.005	0.006				NSE
Sloans	Sep/10/09	SL-DS1	19			15		0.005	0.007	0.06	3.7	6.8	NSE
Sloans	Sep/10/09	SL-DS2	0		1.8	20		0.005	0.005	0.01	3.1	6.8	NSE
Sloans	Sep/10/09	SL-DS2	8	3.8	0.7			0.005	0.006				NSE
Sloans	Sep/10/09	SL-DS2	16			14		0.005	0.005	0.03	3.4	6.7	NSE
Sloans	Sep/10/09	SL-IN1-200m				132			0.044	0.01	14.1	7.2	NSE
Sloans	Sep/10/09	SL-IN1-50m			0.1	114		0.005	0.036	0.01	12.5	7.1	NSE
Sloans	Sep/10/09	SL-IN6			1.2	20		0.005	0.005	0.01	3.1	6.8	NSE
Sloans	Sep/10/09	SL-OL6			1.2	20		0.005	0.005	0.01	3.1	6.8	NSE
Sloans	Sep/13/09	SL-DS1	0	3.8	1.9	20			0.005	0.01	3.2	6.9	NSE
Sloans	Sep/13/09	SL-DS1	8		0.7				0.006				NSE
Sloans	Sep/13/09	SL-DS1	19			15			0.007	0.06	3.7	6.8	NSE
Sloans	Sep/13/09	SL-DS2	0	3.8	1.8	20			0.005	0.01	3.1	6.8	NSE

Appendix I Database Used in Analyses

LAKE	Date	Station	Depth (m)	Secchi Depth (m)	Chlorophyll (µg/L)	Color (TCUs)	Turbidity (NTUs)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Alkalinity (mg/L)	pH	Data Source
Sloans	Sep/13/09	SL-DS2	8		0.7				0.006				NSE
Sloans	Sep/13/09	SL-DS2	16			14			0.005	0.03	3.4	6.7	NSE
Sloans	Nov/05/09	SL-DS1	0	3.2	1.2	21			0.006	0.01	4.1	6.9	NSE
Sloans	Nov/05/09	SL-DS1	22			44			0.012	0.01	6.7	7.0	NSE
Sloans	Nov/05/09	SL-DS2	0	3.7	1.5	21			0.005	0.01	3.5	6.8	NSE
Sloans	Nov/05/09	SL-DS2	18			21			0.005	0.01	3.0	6.8	NSE
Sloans	Nov/05/09	SL-IN1-200m			0.1	69		0.005	0.014	0.01	4.1	6.7	NSE
Sloans	Nov/05/09	SL-IN1-50m			0.1	67		0.005	0.014	0.01	3.4	6.7	NSE
Sloans	Nov/05/09	SL-IN6			1.6	22		0.005	0.005	0.01	3.5	6.8	NSE
Sloans	Oct/01/10	SL-DS1	0	4.3	1.8	12	0.32	0.005	0.009	0.01	3.7	7.0	NSE
Sloans	Oct/01/10	SL-DS1	14		0.7	18	0.35	0.005	0.007	0.01	4.7	6.9	NSE
Sloans	Oct/01/10	SL-DS2	0	4.3	1.9	10	0.27	0.005	0.005	0.01	3.6	7.0	NSE
Sloans	Oct/01/10	SL-DS2	9		1.4	15	0.32	0.005	0.005	0.01	4.0	6.8	NSE
Sloans	Oct/01/10	SL-DS2	15		1.1	23	0.89	0.005	0.007	0.01	4.2	6.8	NSE
Sloans	Oct/01/10	SL-OL6			3.0	12	1.20	0.005	0.005	0.01	3.9	7.0	NSE
Sloans	Aug/16/11	SL-DS1	0	4.6	0.7	15	0.30	0.005	0.005	0.01	3.5	7.0	NSE
Sloans	Aug/16/11	SL-DS1	14			16	0.29	0.005	0.010	0.02	3.5	6.9	NSE
Sloans	Aug/16/11	SL-SL6				14	0.36	0.005	0.005	0.01	3.3	6.9	NSE
Vaughan	Aug/01/79		0	2.8		25				0.05	2.0	6.0	NSDL&F
Vaughan	Sep/05/08	VL-DS1	0	3	3.9	22		0.005	0.005	0.01	3.0	7.2	NSE
Vaughan	Sep/05/08	VL-DS1	10			94		0.005	0.012	0.01	8.1	6.3	NSE
Vaughan	Sep/05/08	VL-DS1	14			148		0.005	0.045	0.01	9.1	6.3	NSE
Vaughan	Oct/28/09	VL-DS1	0	0.9	1.3	88		0.014	0.033	0.06	1.8	6.2	NSE
Vaughan	Oct/28/09	VL-DS1	18			88		0.016	0.034	0.06	1.9	6.2	NSE
Vaughan	Oct/28/09	VL-DS2	0		0.5	180		0.005	0.015	0.02	1.0	4.7	NSE
Vaughan	Oct/28/09	VL-IN1			0.9	94		0.014	0.034	0.06	1.8	6.2	NSE
Vaughan	Oct/28/09	VL-IN2			0.4	104		0.005	0.014	0.08	1.0	4.6	NSE
Vaughan	Oct/28/09	VL-OL1			0.5	175		0.006	0.022	0.03	1.0	4.8	NSE
Vaughan	Oct/01/10	VL-DS1	0	1.2	2.8	69	1.13	0.018	0.018	0.04	1.6	6.2	NSE
Vaughan	Oct/01/10	VL-DS1	12		0.1	181	14.90	0.043	0.078	0.01	8.9	7.1	NSE
Vaughan	Oct/01/10	VL-DS2	0	1.8	1.5	120		0.005	0.019	0.04	1.0	5.5	NSE
Vaughan	Oct/01/10	VL-IN1			2.5	33	0.86	0.005	0.014	0.01	1.9	6.5	NSE
Vaughan	Oct/01/10	VL-OL1			0.5	121	0.75	0.005	0.017	0.04	1.0	5.2	NSE
Vaughan	Aug/17/11	VL-DS1	0	1.9	2.6	63	1.02	0.005	0.010	0.01	1.3	6.2	NSE
Vaughan	Aug/17/11	VL-DS1	15			112	4.89	0.061	0.087	0.01	7.9	7.2	NSE
Vaughan	Aug/17/11	VL-IN1				32	1.65	0.005	0.009	0.01	1.9	6.6	NSE
Vaughan	Aug/17/11	VL-IN2				102	1.12	0.005	0.008	0.01	1.0	5.2	NSE
Vaughan	Aug/17/11	VL-OL1				97	0.87	0.005	0.011	0.01	1.0	5.3	NSE
Provost	Sep/26/83		0	4				0.001	0.003	0.01	1.8	5.9	NSDL&F
Provost	Sep/26/83		8			15		0.001	0.003	0.01		5.5	NSDL&F
Provost	Sep/26/83		0	4				0.001	0.003	0.01	1.8	5.9	NSDL&F
Provost	Sep/26/83		8			15		0.001	0.003	0.01		5.6	NSDL&F
Provost	Aug/15/08	PROL-DS1	0	1.7	18.0	32		0.005	0.011	0.01	3.0	6.1	NSE
Provost	Aug/15/08	PROL-DS1	0	1.7	18.0	32		0.005	0.011	0.01	3.0	6.1	NSE
Provost	Oct/27/09	PROL-DS1	0	1.1	2.8	68		0.006	0.020	0.01	1.1	5.9	NSE
Provost	Oct/27/09	PROL-DS1	4			70		0.006	0.020	0.01	1.0	5.6	NSE
Provost	Oct/27/09	PROL-DS1	0	1.1	2.8	68		0.006	0.020	0.01	1.1	5.9	NSE
Provost	Oct/27/09	PROL-DS1	4			70		0.006	0.020	0.01	1.0	5.6	NSE
Provost	Oct/27/09	PROL-IN			0.1	269		0.005	0.014	0.01	1.0	4.3	NSE

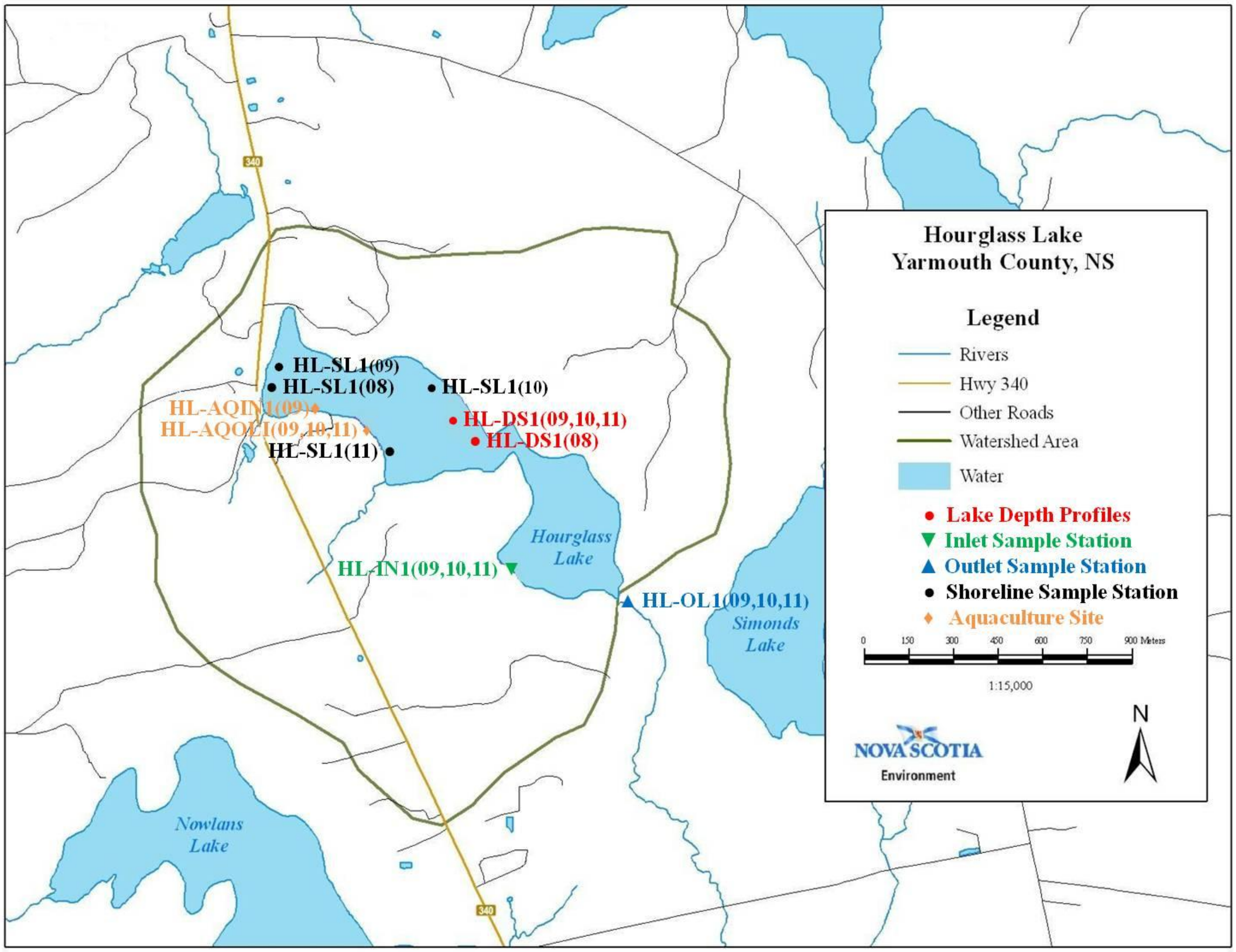
Appendix I Database Used in Analyses

LAKE	Date	Station	Depth (m)	Secchi Depth (m)	Chlorophyll (µg/L)	Color (TCUs)	Turbidity (NTUs)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Alkalinity (mg/L)	pH	Data Source
Provost	Oct/27/09	PROL-IN			0.1	269		0.005	0.014	0.01	1.0	4.3	NSE
Provost	Oct/27/09	PROL-OL1			2.1	75		0.005	0.016	0.01	1.0	5.4	NSE
Provost	Oct/27/09	PROL-OL1			2.1	75		0.005	0.016	0.01	1.0	5.4	NSE
Provost	Oct/01/10	PROL-DS1	0	1.7	20.3	36	1.57	0.005	0.016	0.04	1.0	6.0	NSE
Provost	Oct/01/10	PROL-DS1	0	1.7	20.3	36	1.57	0.005	0.016	0.04	1.0	6.0	NSE
Provost	Oct/01/10	PROL-OL1			9.9		1.37	0.005	0.015		3.2	6.6	NSE
Provost	Oct/01/10	PROL-OL1			9.9		1.37	0.005	0.015		3.2	6.6	NSE
Provost	Aug/15/11	PROL-DS1	0	0.6	19.6	44		0.005	0.011	0.01			NSE
Provost	Aug/15/11	PROL-DS1	6			55		0.005	0.016	0.01			NSE
Provost	Aug/15/11	PROL-DS1	0	0.6	19.6	43		0.005	0.011	0.01			NSE
Provost	Aug/15/11	PROL-DS1	6			55		0.005	0.016	0.01			NSE
Nowlans	Sep/27/83		0	1		5		0.002	0.006	0.01	7.7	6.2	NSDL&F
Nowlans	Sep/27/83		8			10		0.020	0.025	0.01		6.0	NSDL&F
Nowlans	Aug/14/08	NL-DS1	0	0.9	67	16		0.300	0.400	0.01	12.0	6.5	NSE
Nowlans	Oct/15/09	NL-DS1	0	0.8	57.7	33		0.029	0.380	0.01	9.5	7.3	NSE
Nowlans	Oct/15/09	NL-DS1	6			31		0.026	0.380	0.01	9.8	7.3	NSE
Nowlans	Oct/15/09	NL-IN1			0.1	86		5.100	5.400	3.40	67.4	7.5	NSE
Nowlans	Oct/15/09	NL-OL1			38.4	45		0.360	0.400	0.06	9.5	7.2	NSE
Nowlans	Sep/26/10	NL-DS1	0	0.6	64.5	15	28.00	0.287	0.420	0.01	12.9	8.5	NSE
Nowlans	Sep/26/10	NL-IN1			0.5	50	3.10	8.44	8.700	0.54	82.8	7.5	NSE
Nowlans	Sep/26/10	NL-OL1			88.0	35	34.34	0.247	0.420	0.01	10.7	7.6	NSE
Nowlans	Aug/22/11	-	0		21.4	38.4	30.10	0.423	0.590	0.01	10.4	7.4	NSE
Nowlans	Aug/22/11	NL-IN1				88	5.25	6.600	7.900	0.51	62.1	7.5	NSE

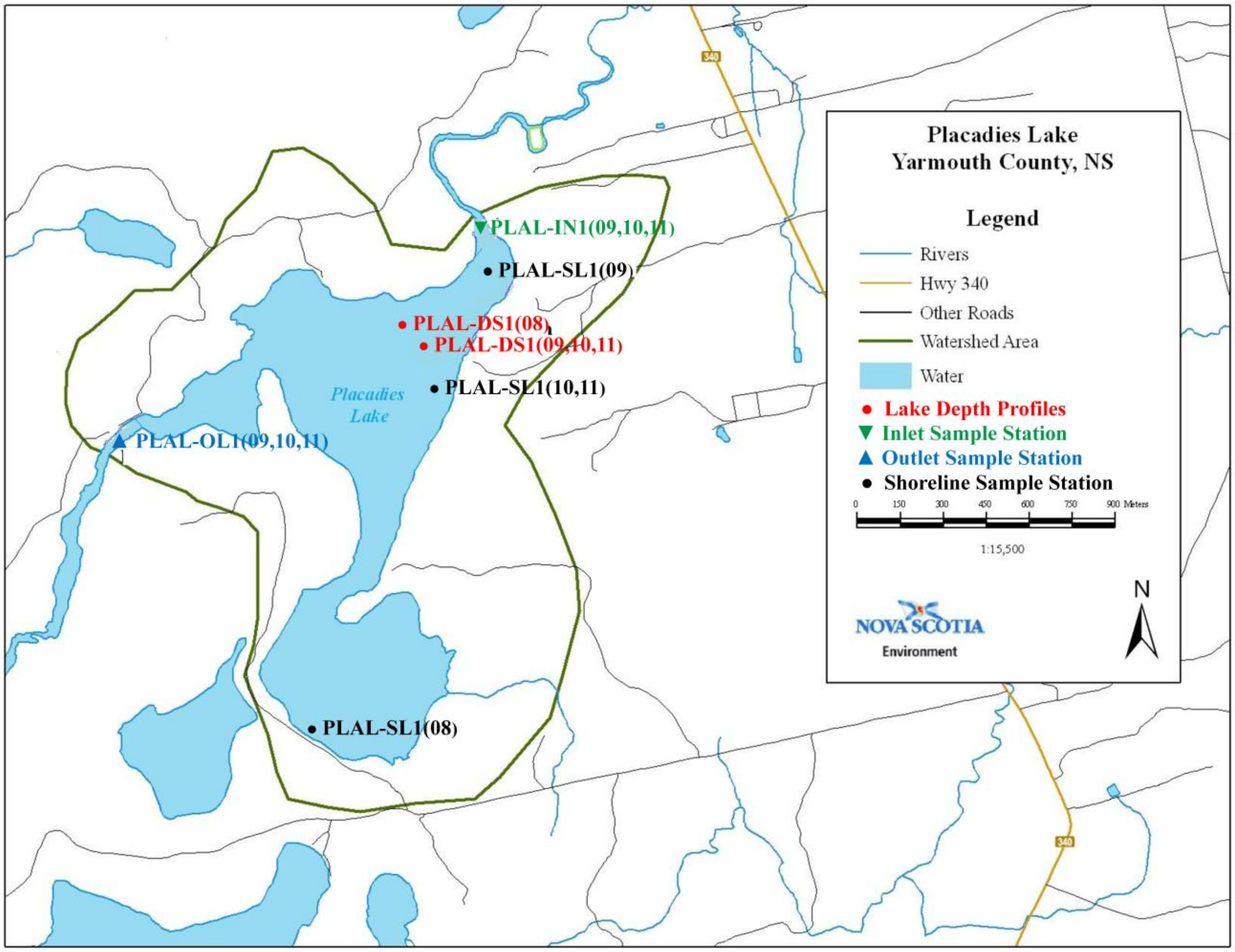
Appendix II

Maps Illustrating Sample Locations

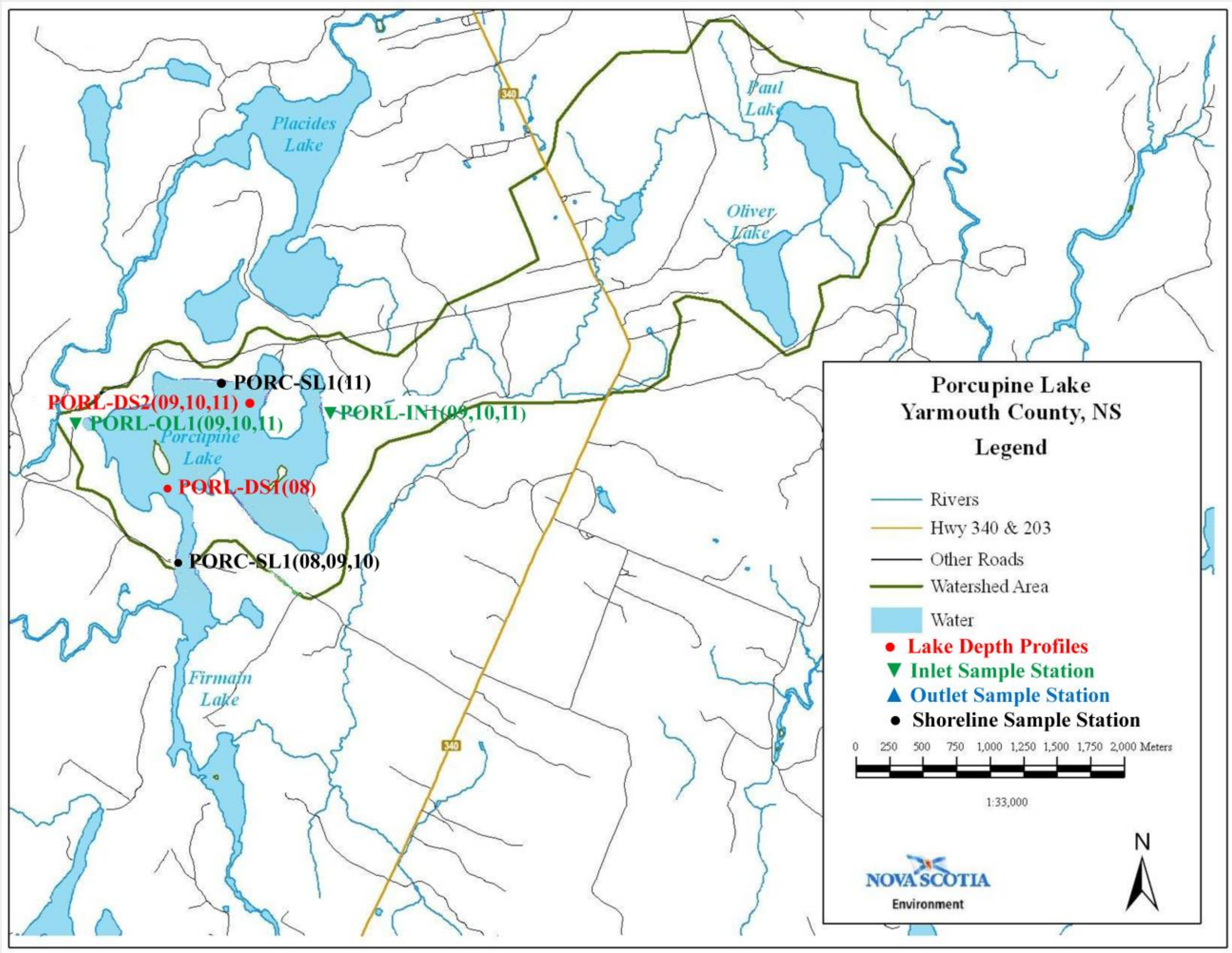
Hourglass Lake



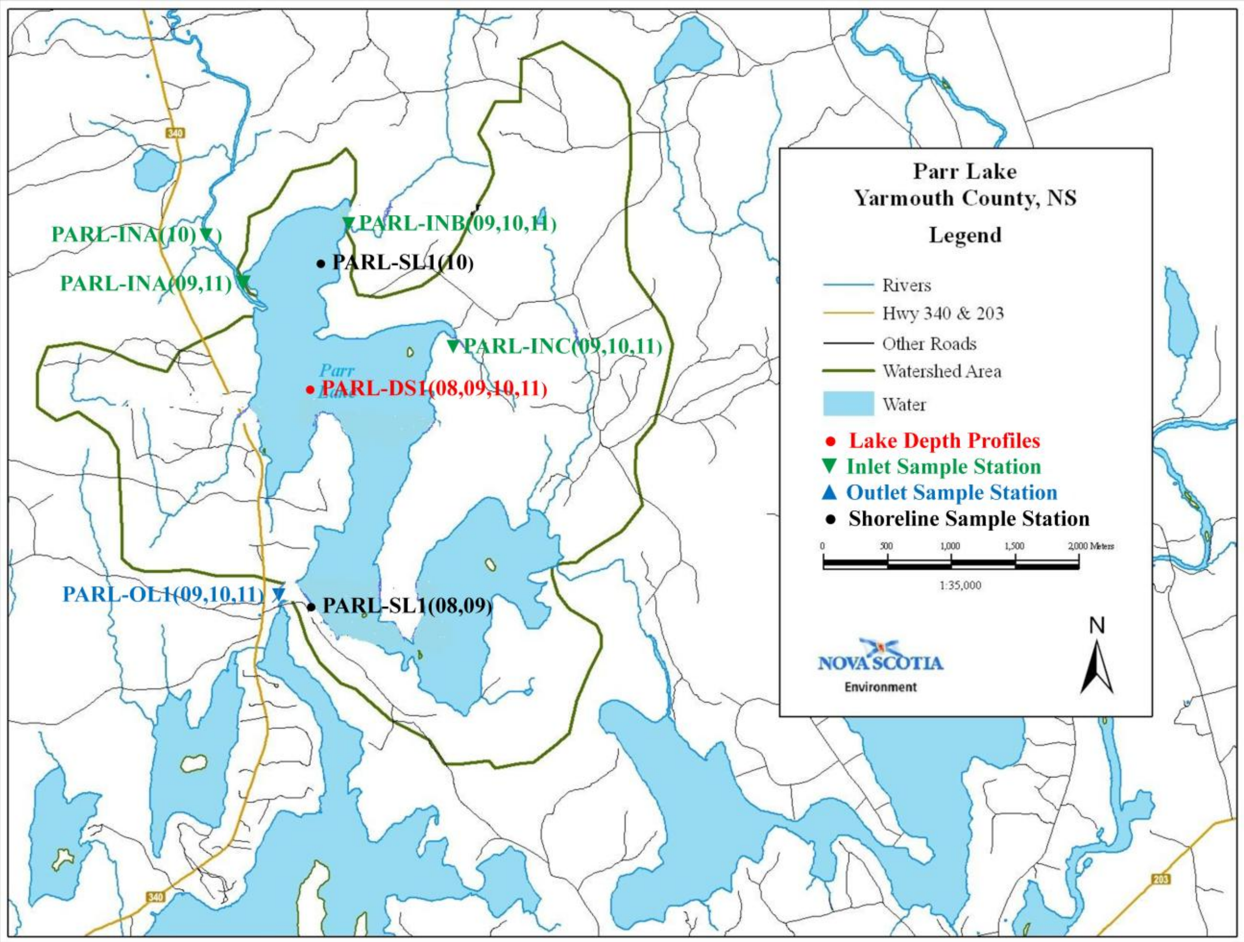
Placides Lake



Porcupine Lake

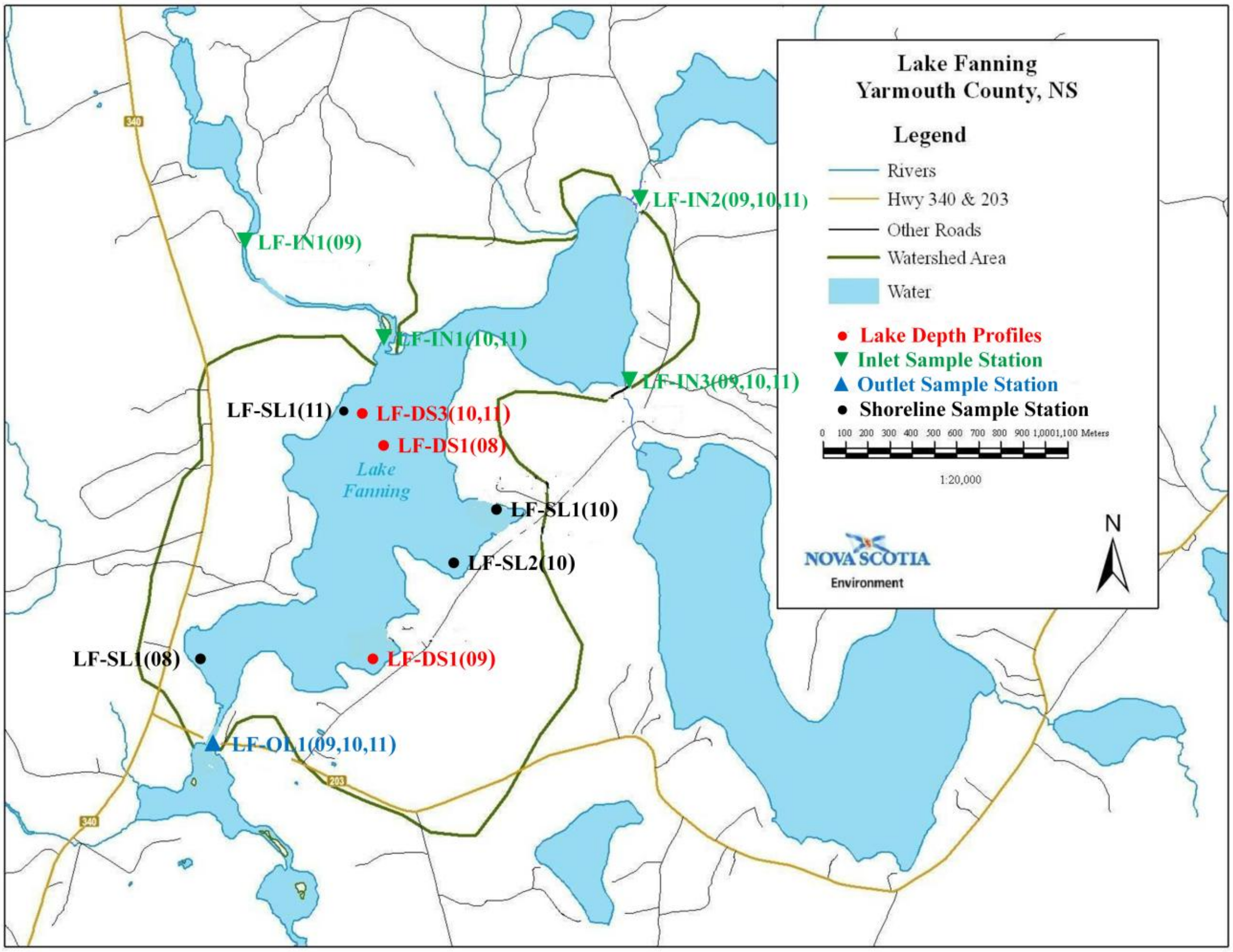


Parr Lake

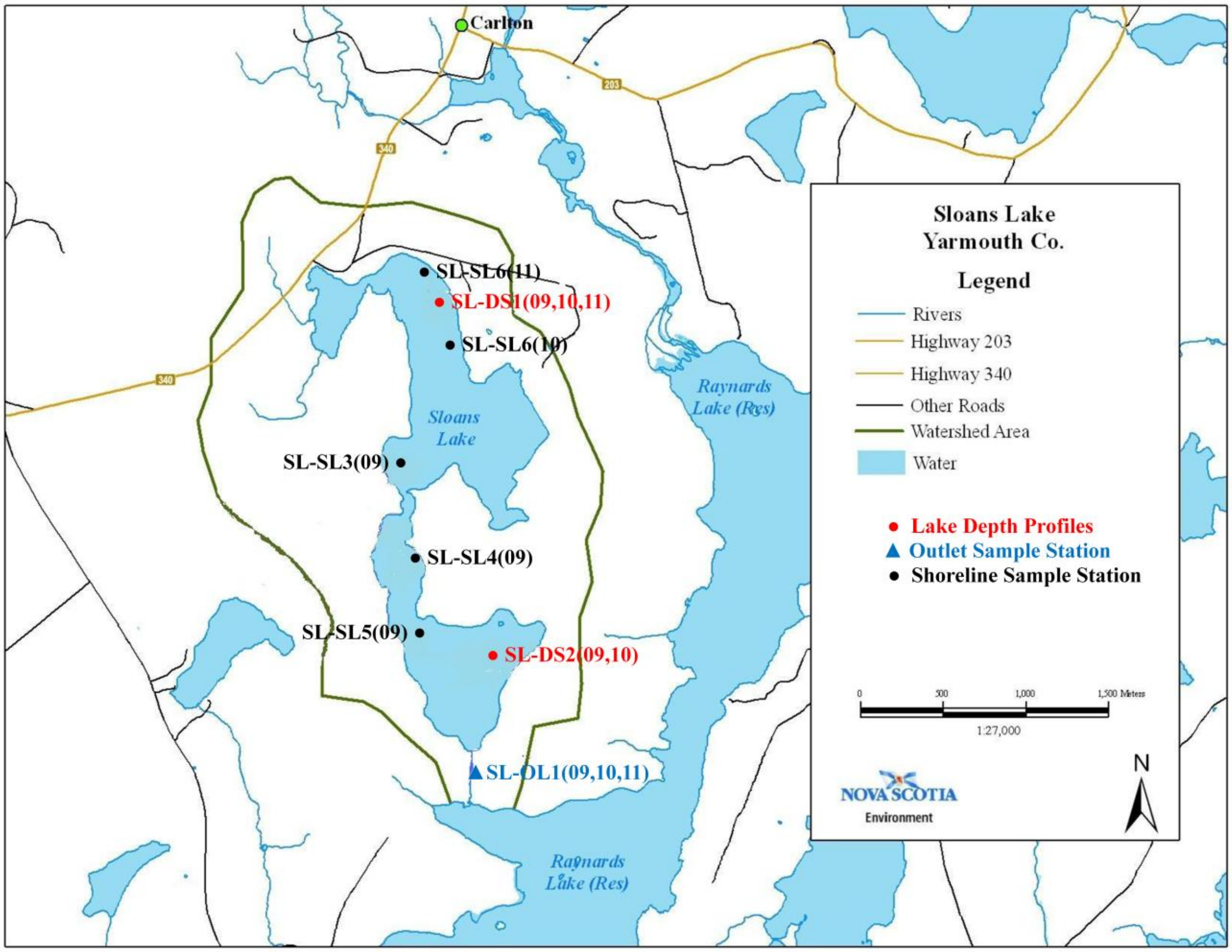

Parr Lake
Yarmouth County, NS
Legend
Rivers
Hwy 340 & 203
Other Roads
Watershed Area
Water
Lake Depth Profiles
Inlet Sample Station
Outlet Sample Station
Shoreline Sample Station
1:35,000
N
NOVA SCOTIA
Environment
PARL-INA(10)
PARL-INA(09,11)
PARL-INB(09,10,11)
PARL-SL1(10)
PARL-INC(09,10,11)
PARL-DS1(08,09,10,11)
PARL-OL1(09,10,11)
PARL-SL1(08,09)
340
203

Ogden Lake

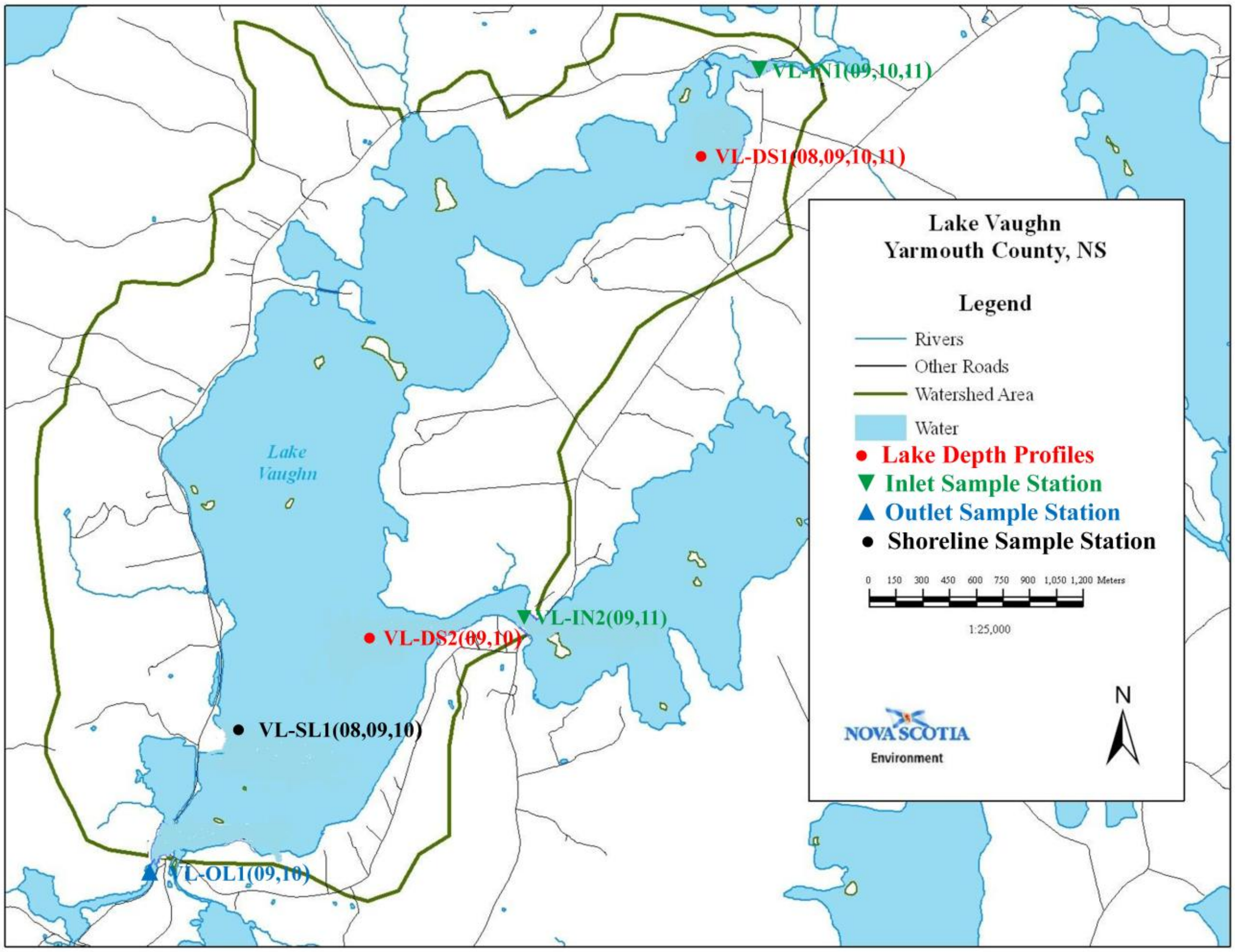
Fanning Lake



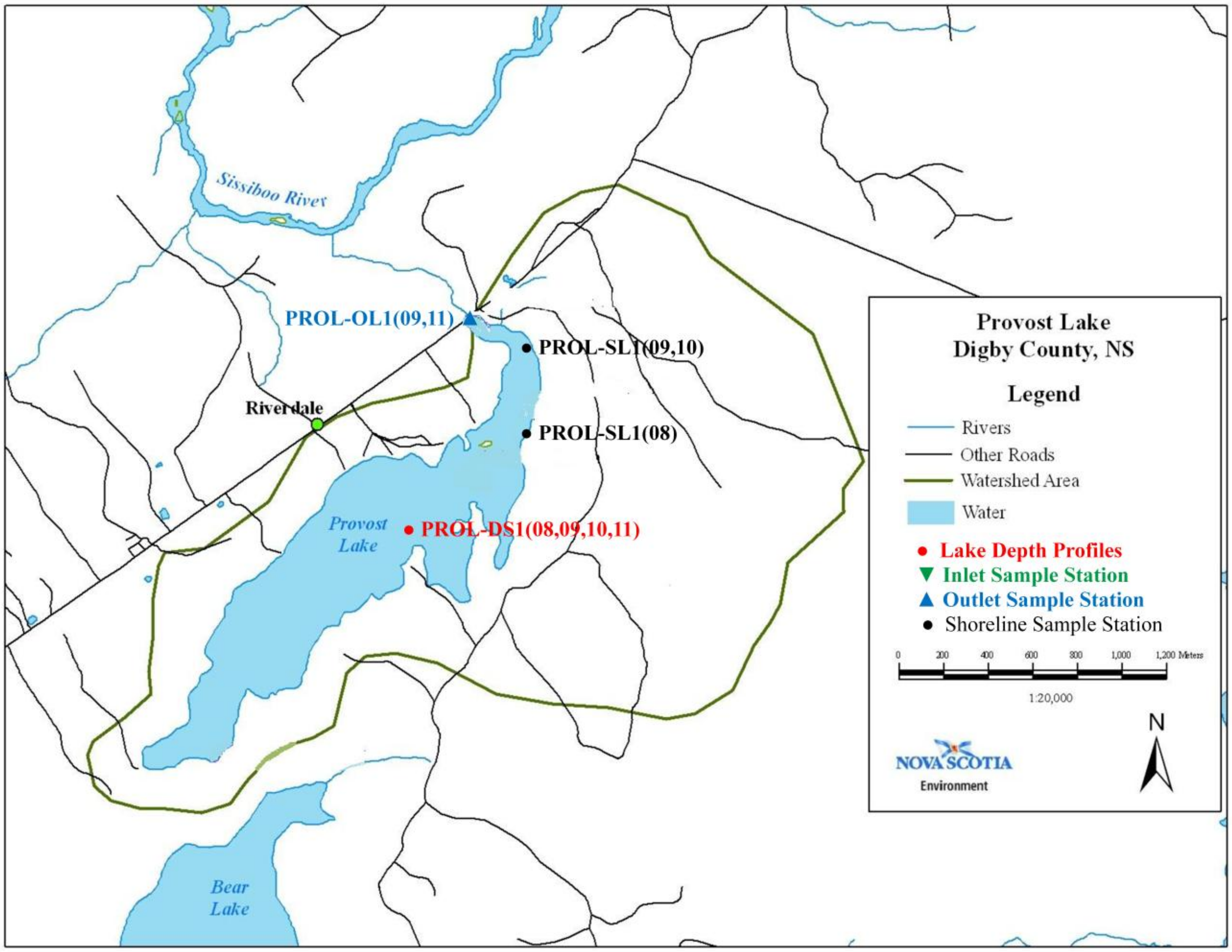
Sloans Lake


Carlton
203
340
340
SL-SL6(11)
SL-DS1(09,10,11)
SL-SL6(10)
Sloans Lake
SL-SL3(09)
SL-SL4(09)
SL-SL5(09)
SL-DS2(09,10)
SL-OL1(09,10,11)
Raynards Lake (Res)
Raynards Lake (Res)
Sloans Lake
Yarmouth Co.
Legend
Rivers
Highway 203
Highway 340
Other Roads
Watershed Area
Water
Lake Depth Profiles
Outlet Sample Station
Shoreline Sample Station
0
500
1,000
1,500 Meters
1:27,000
NOVA SCOTIA
Environment
N

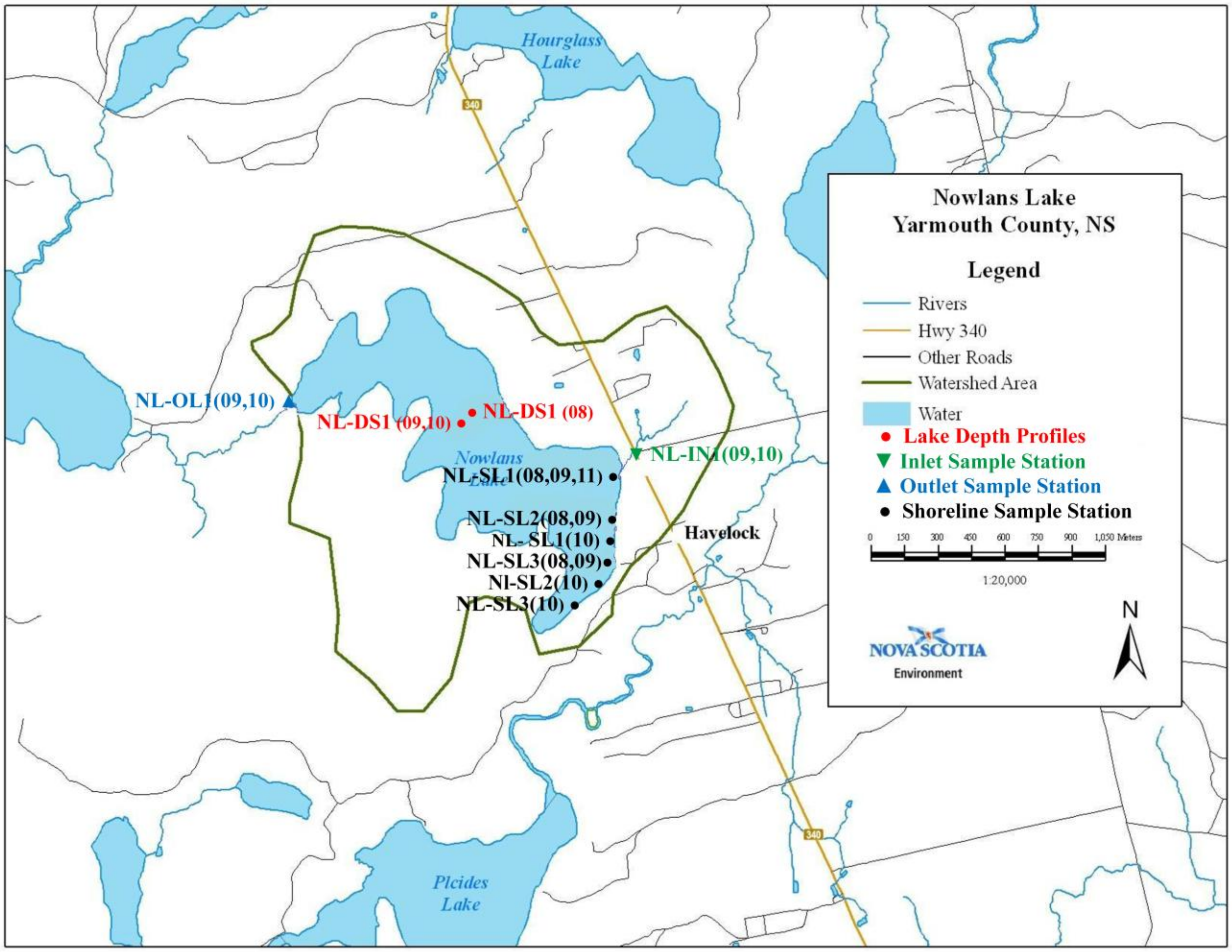
Lake Vaughan



Provost Lake



Nowlans Lake



Appendix III. Summary of Blue-green Algal Species Composition and Numbers

Lake	Date	Station	BGA (cells/ml)	Microcystis*	Anabaena*	Aphanocapsa	Oscillatoria*	Pseudoanabaena	Aphanothece	Gomphosphaeria	Spirulina	Aphanizomeneon*	Planktolyngbya	Aphanocapsa	Gomphosphaeris
Hourglass	08/27/08	HL-SL1	48									48			
Hourglass	10/20/09	HL-SL1	33										33		
Hourglass	09/26/10	HL-SL1	6				6								
Hourglass	08/14/11	HL-SL1	145	50				25					70		
Placides	08/27/08	PLAL-SL1	64									64			
Placides	10/21/09	PLAL-SL1	424					65					359		
Placides	09/27/10	PLAL-SL1	0												
Placides	08/23/11	PLAL-SL1	0												
Porcupine	08/28/08	PORL-SL1	56				56								
Porcupine	10/27/09	PORL-SL1	2										2		
Porcupine	09/27/10	PORL-SL1	20					20							
Porcupine	08/15/11	PORL-SL1	870		530		100	190		50					
Parr	09/04/08	PARL-SL1	2220			824						1390			
Parr	10/22/09	PARL-SL1	267					98				6	163		
Parr	09/27/10	PARL-SL1	102		22						80				
Parr	08/24/11	PARL-SL1	2670		2360			310							
Ogden	08/15/08	OL-SL1	1210		940		16					256			
Ogden	10/22/09	OL-SL1	195					130					65		
Ogden	09/28/10	OL-SL1	2480		2480										
Ogden	08/24/11	OL-SL1	4030		2110			1610		310					
Fanning	08/28.08	FL-SL1	128		24		32					72			
Fanning	10/15/08	FL-SL	5160		5140								17		
Fanning	10/13/09	FL-SL1	5									1	4		
Fanning	09/30/10	FL-SL1	7340		6940	20	372								
Fanning	10/12/10	FL-SL2	14000		14000										
Fanning	08/16/11	FL-SL1	70100		38400			31700							
Sloans	09/09/09	SL-NB	3880					125	1250						2500
Sloans	09/09/09	SL-SB	5110					16	2500				97		2500
Sloans	11/05/09	SL-SL3	100						100						
Sloans	09/09/09	SL-SL4	2070						1250				500		324
Sloans	11/05/09	SL-SL4	100												30
Sloans	09/10/09	SL-SL5													
Sloans	11/05/09	SL-SL5	216			50						4			162
Sloans	10/01/10	SL-SL6	278			80		108	20	70					
Sloans	08/16/11	SL-SL1	856	100				6		650				100	
Vaughan	09/05/08	VL-SL1	408									408			
Vaughan	10/28/09	VL-SL1	0												
Vaughan	09/30/10	VL-SL2	26				8	18							
Vaughan	09/30/10	VL-SL1	0												
Vaughan	08/17/11	VL-SL1	160					160							
Provost	08/27/08	PROL-SL1	492		484							8			
Provost	10/27/09	PROL-SL1	10					10							
Provost	10/01/10	PROL-SL1	38		8			30							
Provost	08/15/11	PROL-SL1	450		260			190							
Nowlans	08/28/08	NL-SL	98100	840	1620							608	2		
Nowlans	08/28/08	NL-SL1	104000	28600	1230							272			73500
Nowlans	10/15/09	NL-SL1	120000					30				120000	20		
Nowlans	09/26/10	NL-SL1	24800	21600				74				3200			

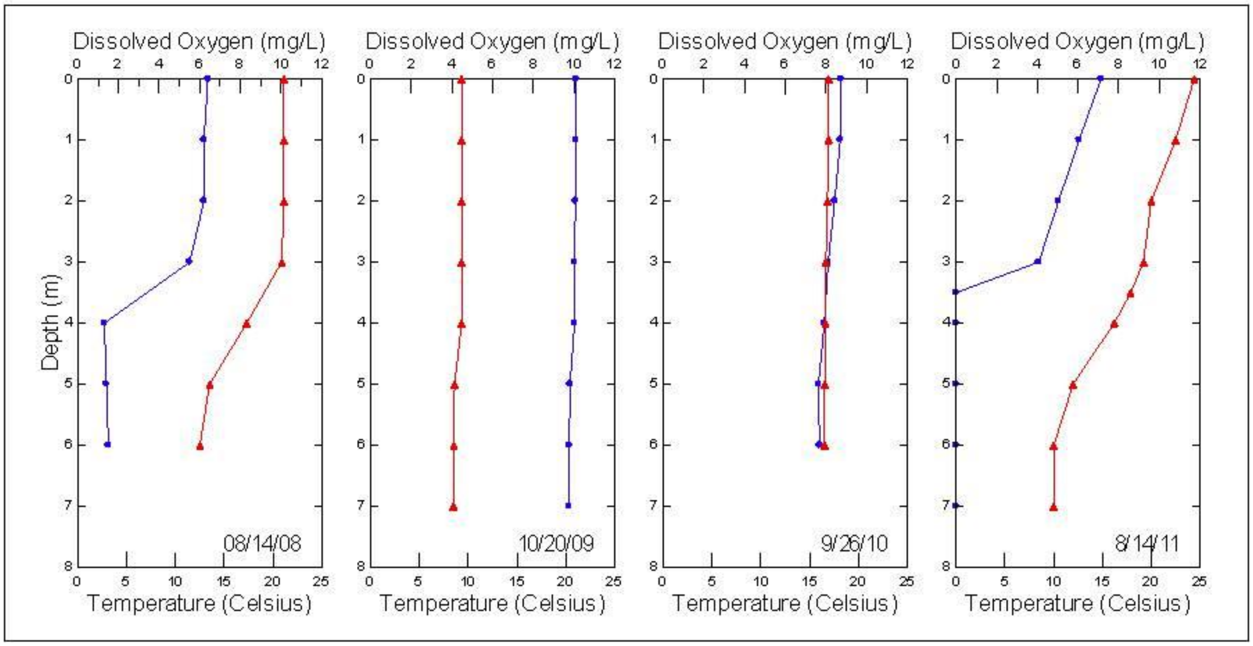
Appendix III (Con't.). Summary of Blue-green Algal Species Composition and Numbers

Lake	Date	Station	BGA (cells/ml)	Microcystis*	Anabaena*	Aphanocapsa	Oscillatoria*	Pseudoanabaena	Aphanothece	Gomphosphaeria	Spirulina	Aphanizomeneon*	Planktolyngbya	Aphanocapsa	Gomphosphaeris
Nowlans	08/28/08	NL-SL2	78800	16200	704							638			
Nowlans	10/15/09	NL-SL2	127000									122000		5000	
Nowlans	09/26/10	NL-SL2	57600	54100								3570			
Nowlans	08/28/08	NL-SL3	95600	17600	2000							640			75400
Nowlans	10/15/09	NL-SL3	175000									175000			
Nowlans	09/26/10	NL-SL3	16200	12400	20							3750			
Nowlans	09/26/10	NL-SL4	12300	9670	32			124				2460			
Nowlans	08/26/11	NL-SL1	78900	77500	186							120	1050		

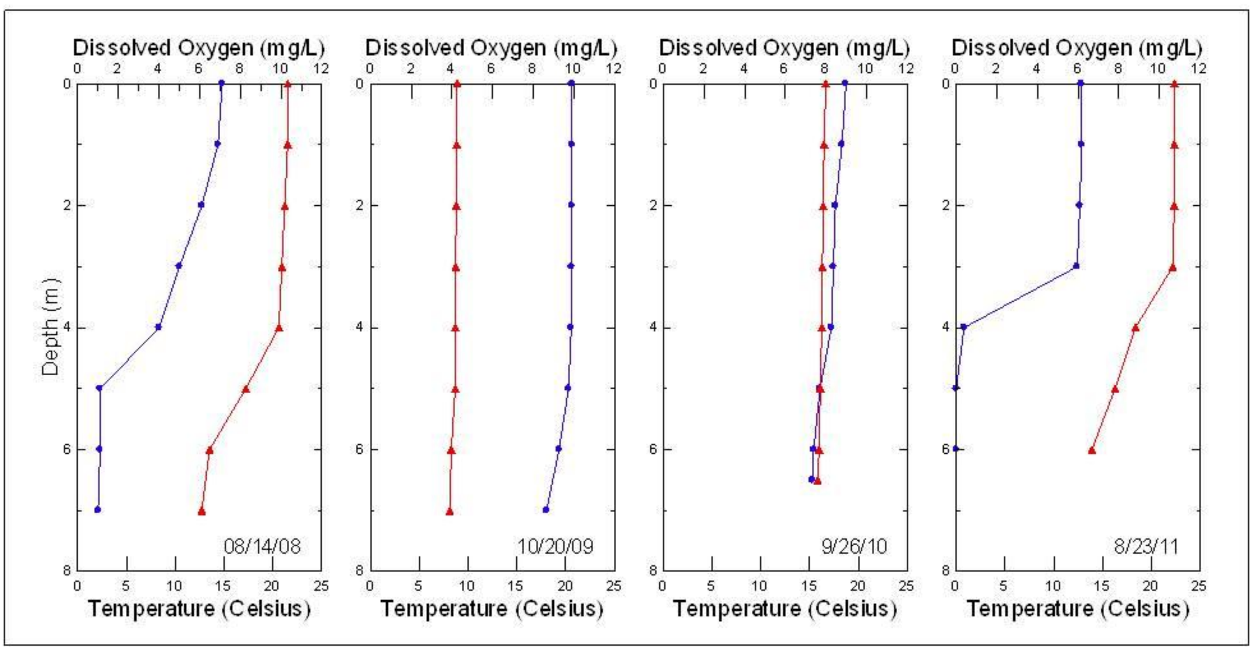
Appendix IV

Dissolved Oxygen (●) and Temperature (▲) Profiles

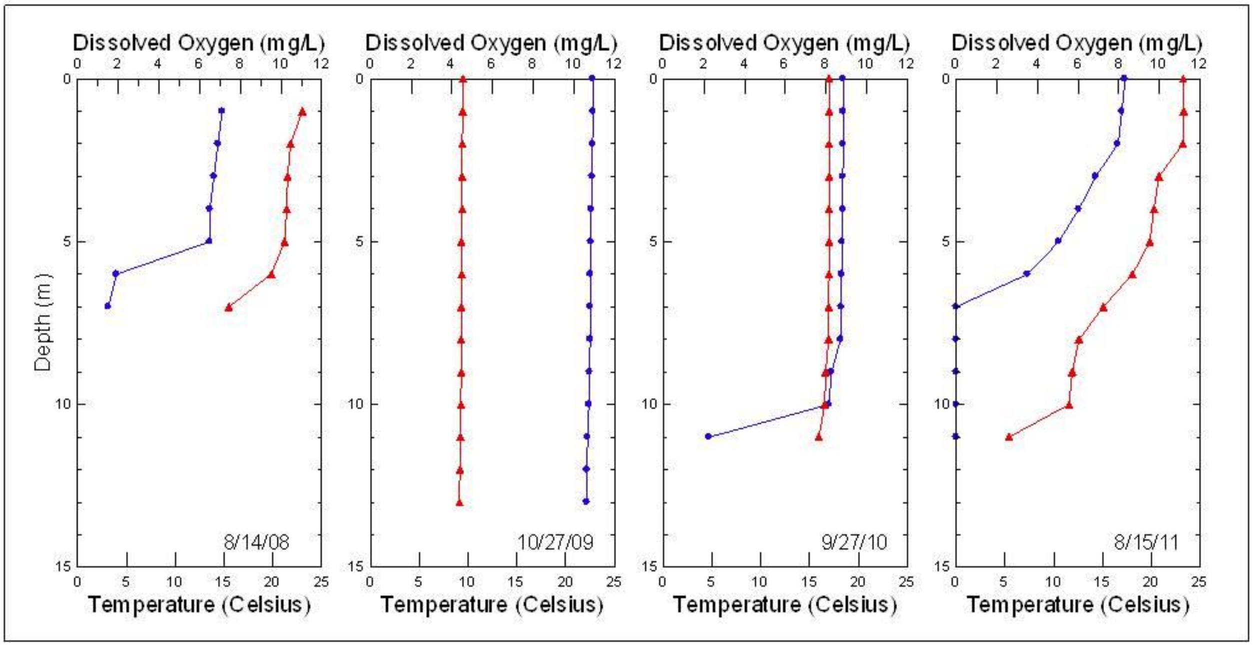
Hourglass Lake



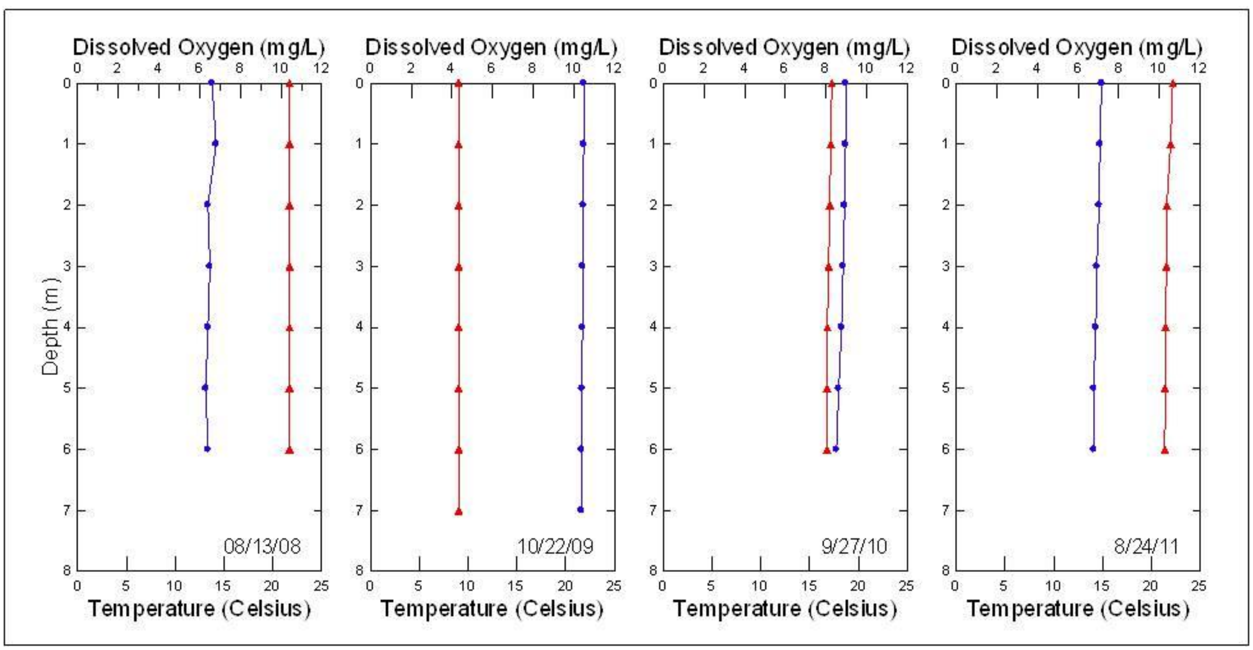
Placides Lake



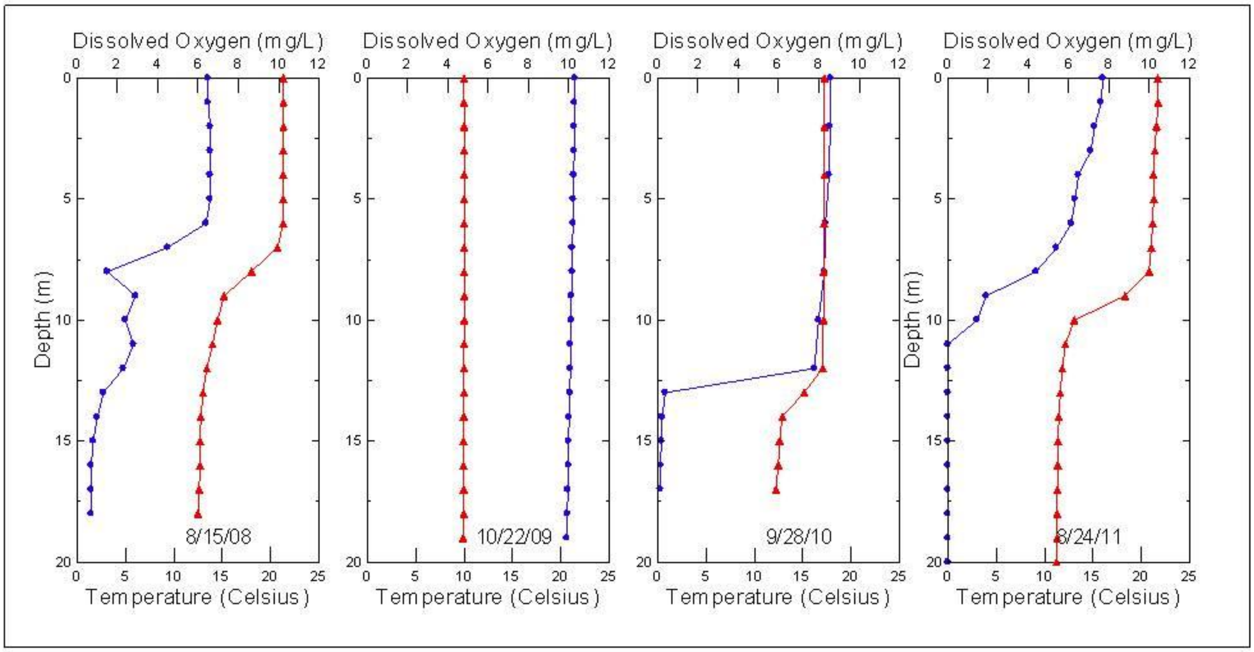
Porcupine Lake



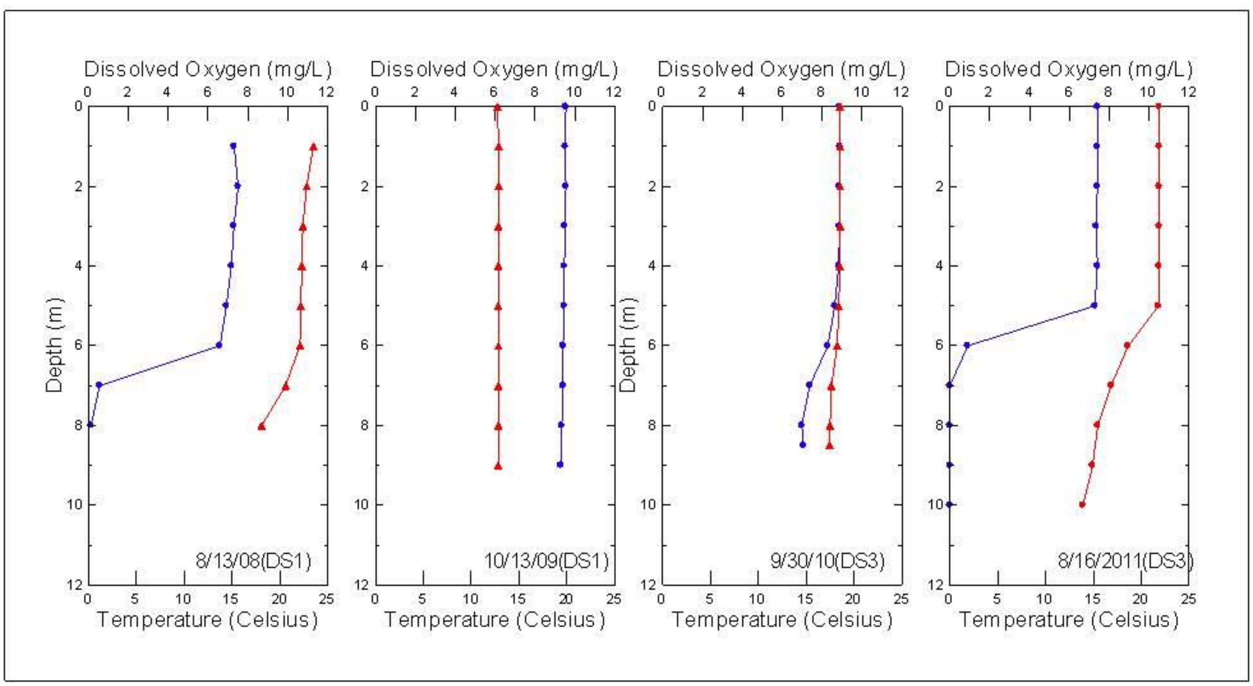
Parr Lake



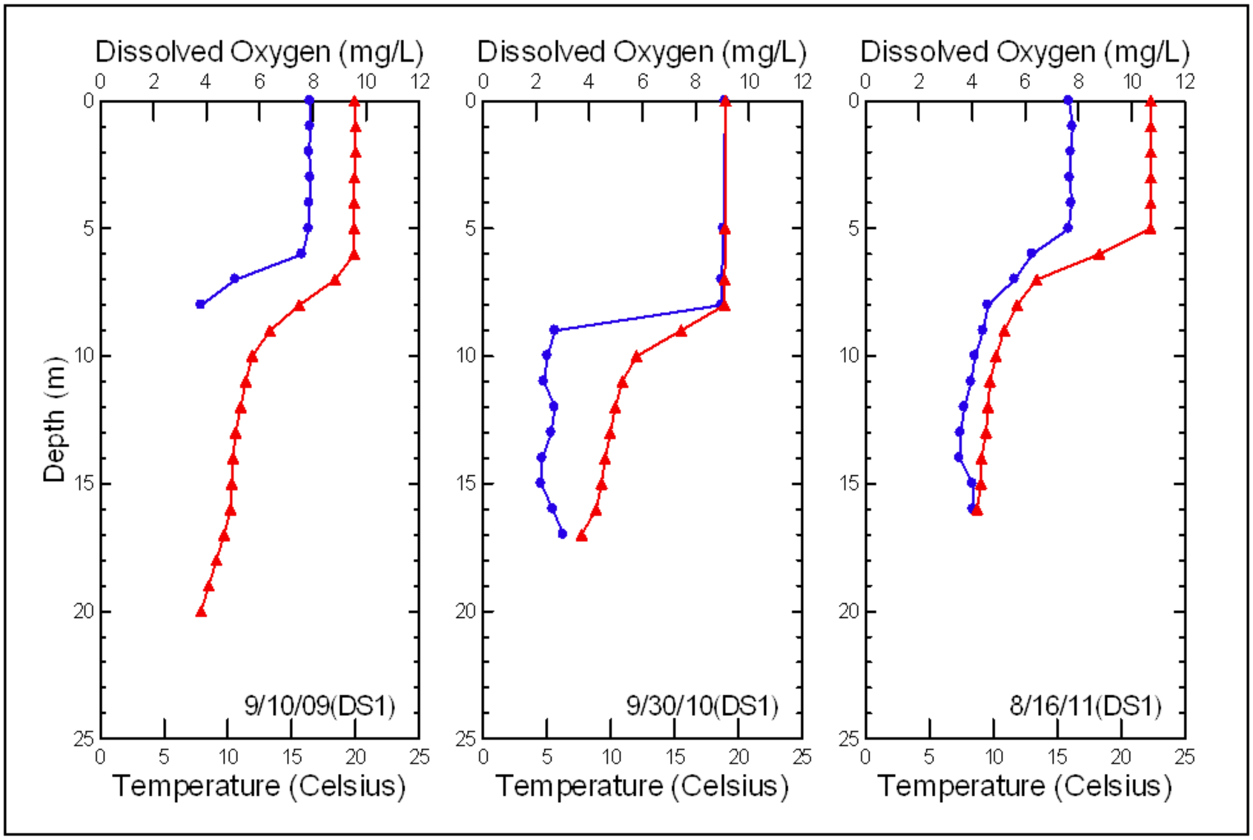
Ogden Lake



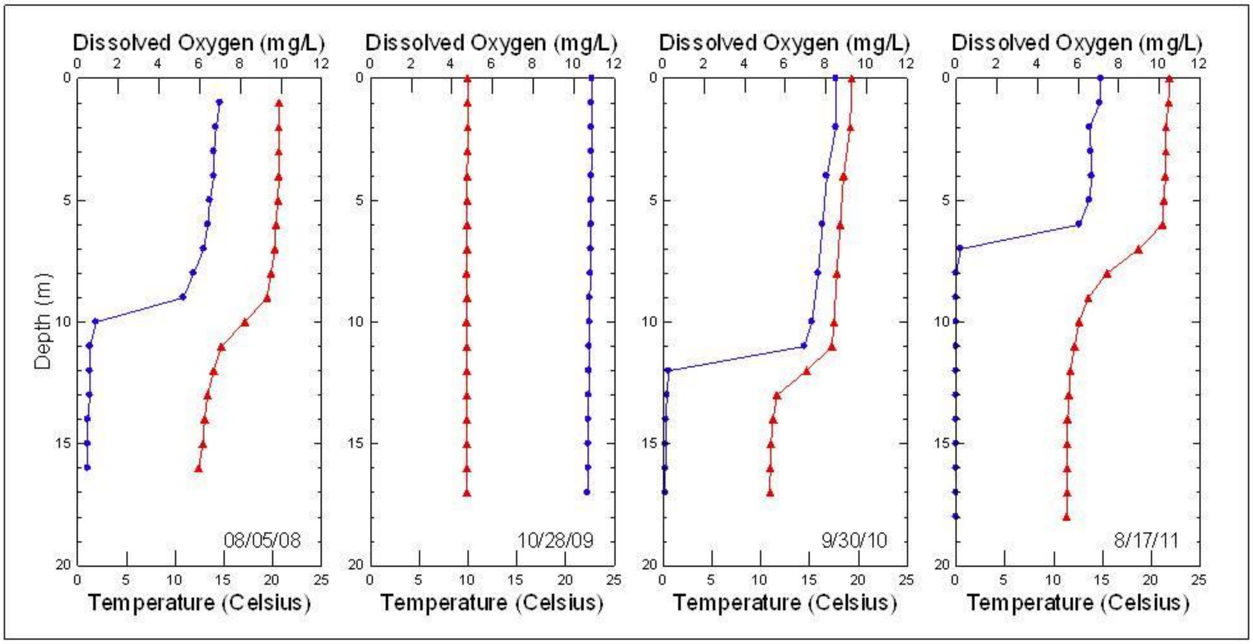
Fanning Lake



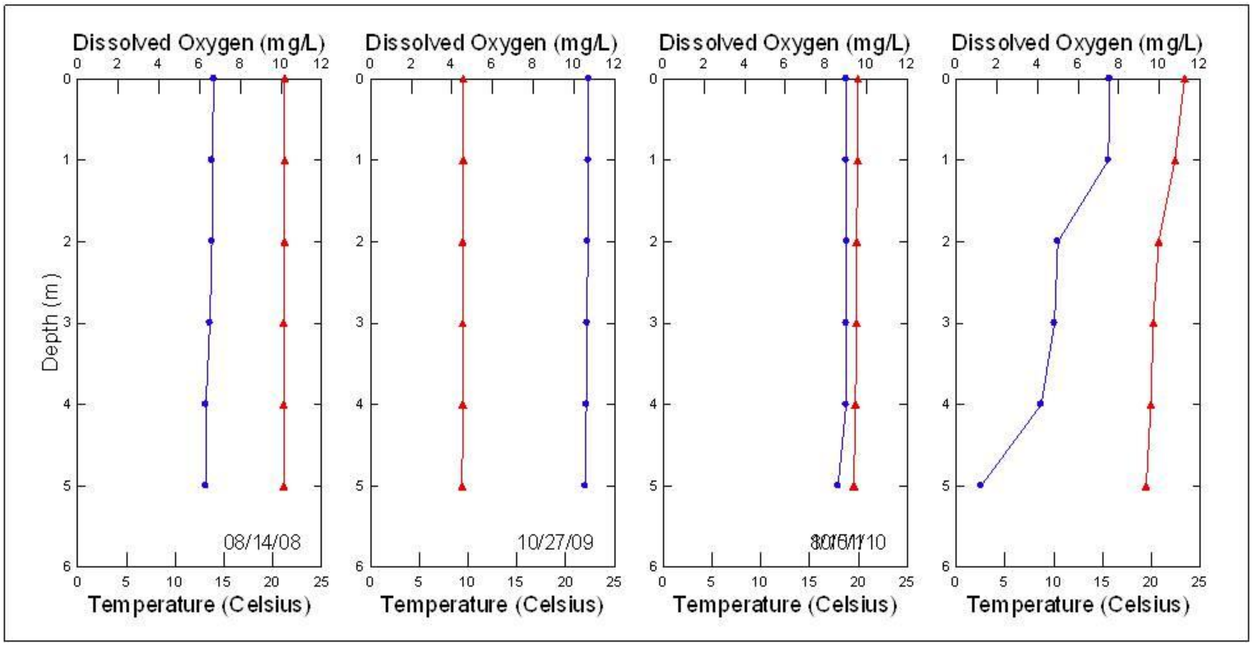
Sloans Lake



Vaughan Lake



Provost



Nowlans Lake