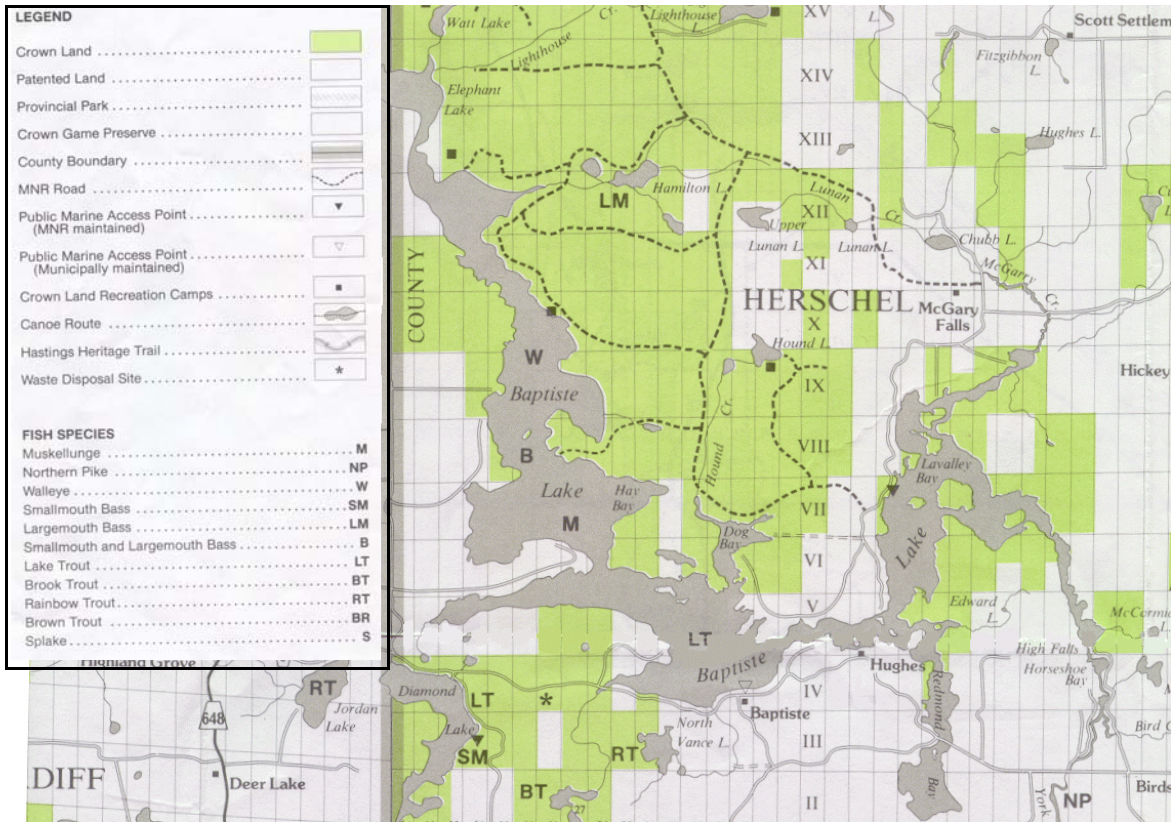
BAPTISTE LAKE

Water Quality Report



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LOCATION

County:..... Hastings
Township:..... Municipality of Hastings Highlands
Formerly ..... Herschel Township
Watershed: ..... Madawaska River
Latitude: .....N 45° 07.00'
Longitude: .....W 78° 03.00'
Topographic Sheet:..... 31F/4 Bancroft

MORPHOMETRY

Surface Area: .....2125 ha.
Watershed Area: ..... km^2
Shoreline Length: ..... 62.0 km
Maximum Depth: ..... 31.4 m
Mean Depth: ..... 5.3 m
Total Volume: .....106,861,093 m^3

SHORELINE DEVELOPMENT

Residences:
permanent (2004).....114
seasonal (2004) 640
Vacant Lots of Record: (1977).....164
Tourist Establishments:**(1977)**
number 15
rooms/cabins 113
campsites .....n/a
Conservation/Picnic Areas:(1977) .....n/a
% Crown Shoreline:(1977) 50

Baptiste Lake

Baptiste Lake is located in the former Township of Herschel in the Municipality of Hastings Highlands, County of Hastings. Baptiste Lake is composed of a number of bays/basins, of which the main basin (BAP-01) and Lavalley Bay (BAP-02) have been extensively studied by the Ministry of the Environment (MOE). Historically, water quality data dates back to the 1970s and a thorough analysis of the lake was done by the Ministry of the Environment (MOE) as part of an enhanced lake monitoring program in 1997. Most recently, the MOE collected water quality data in 2000 and again in 2006. In addition, lake data has also been collected under the Lake Partner Program.

Water levels on Baptiste Lake are regulated by a Ministry of Natural Resources dam located at the outflow to the York River. The Baptiste Lake fish community reportedly includes lake trout, lake whitefish, cisco, walleye, muskellunge, common white sucker, brown bullhead, burbot, rock bass, pumpkinseed, smallmouth bass, largemouth bass, northern pike, and yellow perch.

During 2000 and 2006 a water quality survey was conducted in the Main Basin (BAP-01) and Lavalley Bay (BAP-02). Water quality parameters, as well as oxygen and temperature profiles were measured in the deepest part of these basins. Water samples were collected from the euphotic zone (two times the Secchi depth which is determined to be the maximum depth to which sunlight penetrates) and from one metre off bottom (MOB) (assess the potential for nutrient release from bottom sediments). The 2000 and 2006 sampling was conducted to monitor general water quality parameters, but also for the specific purpose of monitoring the status of oxygen habitat. The results of this sampling are presented in detail below and will be used to assess general water quality as well as the trophic status (nutrient status: oligotrophic lakes being relatively nutrient poor and eutrophic lakes being nutrient enriched) of the lake as well as the status of cold water habitats.

This report will detail the results of the 2000 and 2006 water quality survey (with an emphasis on the 2006 results) and will make some general comparisons between available historical data and the 2006 data. Comparisons will also be made with Provincial Water Quality Objectives (PWQO) where they exist.

Water Chemistry Analysis

The following gives a brief description of the water quality parameters which form the basis of the water quality monitoring program conducted by the Ministry and provides a brief interpretation on the results obtained by the 2000 and 2006 sampling events. Water chemistry data for the 2000 and 2006 sampling events is presented in Appendix A (Table A1 and Table A2).

Clarity (Secchi Depth)

Water clarity is the parameter of which people are most aware. Clarity is affected by suspended particles (sediment, algae, etc.) and the natural colour of the water. Water clarity is measured by using a Secchi disc which is lowered into the water to determine the depth to which light

penetrates and is therefore a good indication of how far down in the water column phytoplankton and vascular plants may grow. Clarity can also be used to get a sense of trophic status (oligotrophic – Secchi depth > 5 m; mesotrophic – Secchi depth 3 – 5 m; eutrophic – Secchi depth < 3 m).

In 2000/2006, Secchi depths for Baptiste Lake indicate that the lake is mesotrophic. Secchi depths ranged from a depth of 3.4 to 3.65 m in the main basin and between 3.5 m and 4 m in Lavalley Bay. By comparison, in 1988 Secchi depth ranged from 3.2 to 4.9 in Lavalley Bay and in 1997 Secchi depth ranged from 4.0 to 5.5 in the main basin. Use of a Secchi is somewhat subjective and the results can be influenced by the amount of natural light, wave action, boat drift, etc.; however, the data suggests that there has been a slight decrease in water clarity over time, particularly in the main basin.

Dissolved Oxygen Profile/Temperature Profile

Oxygen levels are most critical for the protection of cold water fish species like lake trout. Oxygen profiles are completed to determine if oxygen depletion is a factor with respect to ecosystem health and to assist in the management of cold water species.

Certain fish species like lake trout have very specific habitat requirements. Lake trout require water temperatures below 15 ^{o}C and oxygen concentrations above 4 mg/L (useable habitat); the optimal habitat is found at temperatures below 10 ^{o}C and oxygen concentrations above 6 mg/L. Excessive nutrients and the resulting algae/plant growth/decomposition can cause a decrease in deep-water oxygen levels, and therefore reduce the availability of lake trout habitat.

The PWQO for oxygen indicates that oxygen concentrations should not go below 6 mg/L at water temperatures of 10 ^{o}C or colder. The PWQO do however recognize that oxygen concentrations in some hypolimnetic (lower portion of a lake which is located below the metalimnion or thermalcline) waters is naturally lower than the objective, and that some sensitive biological communities may require more stringent criteria.

The 2006 temperature and oxygen profiles can be found in Appendix B. Graph B1 shows that the Main Basin is a strongly stratified basin with a relatively deep epilimnion (warm layer of the lake located above the metalimnion). The dissolved oxygen profile (Graph B2) shows that the dissolved oxygen content decreases dramatically through the metalimnion where it then increases slightly before decreasing near the bottom of the hypolimnion. As shown in Appendix C, the 2006 data indicates that the hypolimnion in the Main Basin (BAP-01) was found to contain both optimum (Graph C1) and useable (Graph C2) lake trout habitat during the July survey, but only usable habitat was found during the September survey.

Graph B3 shows that Lavalley Bay is a strongly stratified basin with a relatively deep epilimnion. The dissolved oxygen profile (Graph B4) shows that the dissolved oxygen content decreases dramatically through the metalimnion where it then increases slightly before decreasing near the bottom of the hypolimnion. In Lavalley Bay (BAP-02), the hypolimnion was found to contain, on average, no optimal lake trout habitat, with some usable habitat found

during July. However, this usable habitat had disappeared prior to the September survey.

Table 1 (below) compares the percentage of optimal and usable habitat found in the main basin between 1977 and 2006. The percentage of optimal and usable habitat has also been displayed in a graph format (see Appendix C). Table 1 and Graphs C1 and C2 compare the volume of optimal and usable habitat to the total lake volume. Table 1 and Graphs C1 and C2 represent the actual percentage of habitat that is available in the entire lake for lake trout, based on their theoretical oxygen and temperature requirements, and therefore may not accurately represent the actual available habitat. The data indicates that the amount of optimal habitat is greatest in the spring and decreases to, in most years, zero, during the late summer period, where it again increases in the fall. This trend is also prevalent for usable habitat as well, except that where optimal habitat decreases to zero during late summer, some usable habitat remains through the critical summer period. The data suggests that, on a monthly/annual basis, the percentage of optimal and usable habitat has been fairly consistent over time.

Table 1 Percentage of Optimal and Usable Lake Trout Habitat: Main Basin

Month	Year	% Optimal	% Usable
May	1977	100	100
May	1984	100	100
June	1977	22	30
June	1985	20	30
July	1977	0	26
July	1984	17	26
July	1985	17	30
July	2006	20	30
Aug	1977	0	21
Aug	1984	0	22
Aug	1985	0	23
Aug	2000	6	16
Sept	1983	0	26
Sept	1984	0	22
Sept	2000	16	20
Sept	2006	0	12
Oct	1977	91	92
Oct	1983	0	98
Nov	1977	96	97

The preferred and currently used (by MNR and MOE) method for determining the state of the lake trout habitat is by assessing the mean volume-weighted hypolimnetic dissolved oxygen (MVWHDO) content. This can be done on a basin by basin basis by calculating the average dissolved oxygen content within the volume of water with a suitable temperature range for lake trout. In 2000 and 2006 the late summer critical period MVWHDO concentration for the Main Basin is 5.24 mg/L and 4.57 mg/L respectively. In 2006, the late summer critical period

MVWHDO concentration was 1.14 mg/L for Lavalley Bay.

The Ministry of Natural Resources has established a dissolved oxygen criterion of 7 mg/L for the protection of lake trout habitat. The 7 mg/L criterion for the late summer critical period MVWHDO has been used by the MOE in determining the capacity of certain lakes (those managed for lake trout) for additional development.

TP (Total Phosphorus, Phosphate)

Total phosphorus (TP) is a measure of the combined amounts of all forms of phosphorus and is commonly viewed as the best indicator of trophic status as it is typically the limiting growth factor in freshwater aquatic ecosystems. Elevated phosphorus levels lead to increased foaming, increased aquatic vascular plant growth, and may result in excessive algae production. In addition to aesthetic concerns, high concentrations of algae and aquatic plants lead to excessive oxygen depletion in the deeper portions of a lake. The PWQO sets two thresholds for phosphorus. Lakes that are naturally at or below 0.01 mg/L for the ice free period should remain below this limit; lakes that are above 0.01 mg/L but below 0.02 mg/L should remain below this level to prevent nuisance concentrations of algae from occurring.

With respect to trophic status, lakes with phosphorus levels less than .01 mg/L are considered to be oligotrophic. Those with phosphorus levels between .01 mg/L and .02 mg/L are considered to be mesotrophic, and those with phosphorus levels greater than .02 mg/L are considered to be eutrophic.

For the Main Basin 2006 sampling shows that TP levels remain consistently below 0.01 mg/L in the euphotic and hypolimnetic zones and are at levels which are consistent with oligotrophic lakes. In 2006, TP levels in the main basin averaged less than 0.01 mg/L which is below the PWQO.

With the exception of the spring (surface) TP concentration of 0.02 mg/L, 2006 Lavalley Bay TP levels remained similar within both the euphotic and hypolimnetic zones at levels which reflect oligotrophic conditions, and which are on average, below the PWQO for phosphorus.

By comparison, TP levels measured in the Main Basin in 1997 were also measured consistently below 0.01 mg/L. In 2000, Main Basin TP was slightly elevated above the 2006 levels, particularly during the September survey. Generally, there does not appear to be a significant increase in TP levels between 1997 and 2006 in the main basin.

pH

The PWQO indicates that water should be maintained between a pH of 6.5 and 8.5 in order to protect aquatic life. Photosynthesis fixes or removes carbon dioxide. Carbon dioxide in water forms a week carbonic acid. Therefore the more productive the lake, the higher the pH. Lakes which have high alkalinity can neutralize acids and therefore pH levels are usually above 7.0.

The 2006 sampling period showed that lake pH ranged from a low of 6.42 to 7.53 which meets the PWQO. By comparison, pH values averaged 7.3 in 1997, 7.13 in 2000, and 7.0 for 2006; suggesting that pH levels have remained fairly consistent over time.

Alkalinity

The PWQO for alkalinity indicates the alkalinity should not be decreased by more than 25% of natural ambient concentrations. Lakes with less than 10 mg/L may be susceptible to acidification and those with concentrations greater than 25 mg/L are considered not to be sensitive to acidification. In highly productive lakes, the alkalinity will rise in the epilimnium as a result of photosynthetic activity.

In 2006, Lake Alkalinity ranged from 12 to 16.8 with levels being consistent between the main basin and Lavalley Bay. Alkalinity levels were slightly higher in the euphotic zone than those measured near the bottom, and generally indicate that the lake may be slightly sensitive to acidification. By comparison, the average alkalinity measured in 1997 was 13 mg/L.

Nitrogen (Ammonium, Nitrite, Nitrite + Nitrate, Total Kjeldahl (TKN))

There are five major forms of nitrogen in fresh water; organic nitrogen (TKN), ammonium, ammonia, nitrate, and nitrite. Of these, only ammonia, nitrate, and nitrite are readily available to aquatic plants. As such, these three, plus TKN which is a measurement of organic nitrogen are usually analyzed as part of water monitoring programs.

Ammonia, which is a by-product of decomposition, is found in most healthy systems at low concentrations, usually less than 1.0 mg/L. In eutrophic lakes and in oxygen depleted lake bottoms, ammonia concentrations can increase and become lethal to some organisms.

Nitrate is available for plants and can be used to help determine trophic status as well. In healthy lakes typical concentrations are below 0.05 mg/L. Nitrate levels may be reduced in the epilimnium due to demand and uptake by algae. A PWQO of 3.0 mg/L has been proposed for nitrate.

TKN concentrations are higher in eutrophic lakes because the nitrogen is tied up in the algae. TKN in un-impacted surface water is usually less than 0.05 mg/L.

Ammonium nitrogen is a transient form of ammonia created under anoxic conditions. In a healthy system, nitrite is typically found at concentrations of less than .005 mg/L and occurs as a transient form of nitrogen between ammonia and nitrate under aerobic conditions.

In 2006, Main Basin, total ammonia was consistently below 0.05 mg/L, while nitrate levels varied throughout the year with values in the euphotic zone ranging from below 0.01 mg/L to 0.021 mg/L and values in the hypolimnion ranging from 0.25 mg/L to 0.27 mg/L. Nitrite levels were generally below .005 mg/L. TKN levels ranged from 0.27 mg/L to 0.5 mg/L. In 1997,

nitrate levels ranged between 0.02 mg/L to 0.24 mg/L indicating a slight decrease over time. In 1997, TKN ranged from 0.26 mg/L to 0.34 mg/L, slightly less than current levels. The 2002 sampling results were consistent with those measured during the 2006 sampling event.

The 2006 results (ammonia, nitrate, nitrite, and TKN) for Lavalley Bay were consistent with the results found in the Main Basin.

Overall, total ammonia was found to be less than 1.0 mg/L, nitrate levels were below 0.05 mg/L and below the proposed PWQO, and nitrite was measured below 0.005 mg/L, indicating good water quality conditions.

Total Nitrogen: Total Phosphorus (TN:TP ratio)

Total nitrogen is the total of all the forms of nitrogen present. TP is a measure of total phosphorus. The ratio of TN:TP can be used to determine which element is limiting the growth of primary producers. A higher ratio indicates that phosphorus is the limiting factor. TN:TP ratios below 20:1 may result in an increased risk of algal blooms.

During 2006, the Main Basin TN:TP ratio was highly variable ranging from a low of 33:1 in the euphotic zone to a high of 81:1 in the Main Basin, and between 60:1 and 112:1 in Lavalley Bay. The results from the 2006 sampling suggest that phosphorus is limiting the growth of primary producers in the Main Basin and in Lavalley Bay, and that the risk of algal blooms was low.

The results from the 1997 monitoring program indicated a range between 30:1 and 83:1 in the Main Basin.

Carbon (Total Dissolved and Inorganic)

Total organic carbon (TOC) consists of both dissolved and organic carbon and is composed of humic substances and degraded plant and animal materials. TOC can be used as a measure of eutrophication. TOC in natural waters ranges from 1 to 30 mg/L, the higher values being indicative of eutrophication. Values less than 3 mg/L are considered to represent oligotrophic conditions.

During 2006, the Main Basin TOC values ranged from 7.8 to 8.9 mg/L; in Lavalley Bay the TOC values ranged from 8.2 mg/L to 9.3 mg/L. By comparison, in 1997 Main Basin TOC levels ranged from 6.6 mg/L to 8.2 mg/L. The data suggests mesotrophic conditions.

Conclusions

The late summer critical period MVWHDO indicates that Baptiste Lake experiences MVWHDO concentrations of less than 7 mg/L during the critical late summer period. The data also indicates that optimal lake trout habitat becomes substantially reduced during the late summer

period and that lake trout habitat is limited to usable (less than optimal habitat) habitat only; which also decrease substantially over the critical summer period. Based on the 2006 data, there was no optimal lake trout habitat available at the time of the July sampling period and there was no lake trout habitat (optimal or useable) available during the late summer critical period in Lavalley Bay. As a result, Baptiste Lake west of Lots 16 and 17, (former) Herschel Township is considered to be at capacity and any new development should be reviewed by the Ministry.

Overall, water chemistry data indicates that Baptiste Lake is mesotrophic bordering on oligotrophic and that lake water quality has not changed substantially between 1997 and 2006, however, there appears to be a slight decrease in water clarity (as measured by Secchi depth) over the period of record.

Special Note: *Water quality data can vary substantially from month to month and year to year. Where possible, the above noted analysis was based on comparisons between similar months, however, in some cases, water quality data can vary substantially within a particular month, particularly when the lake stratifies/de-stratifies. Climatic changes can also affect the ability to make multi-year comparisons.*

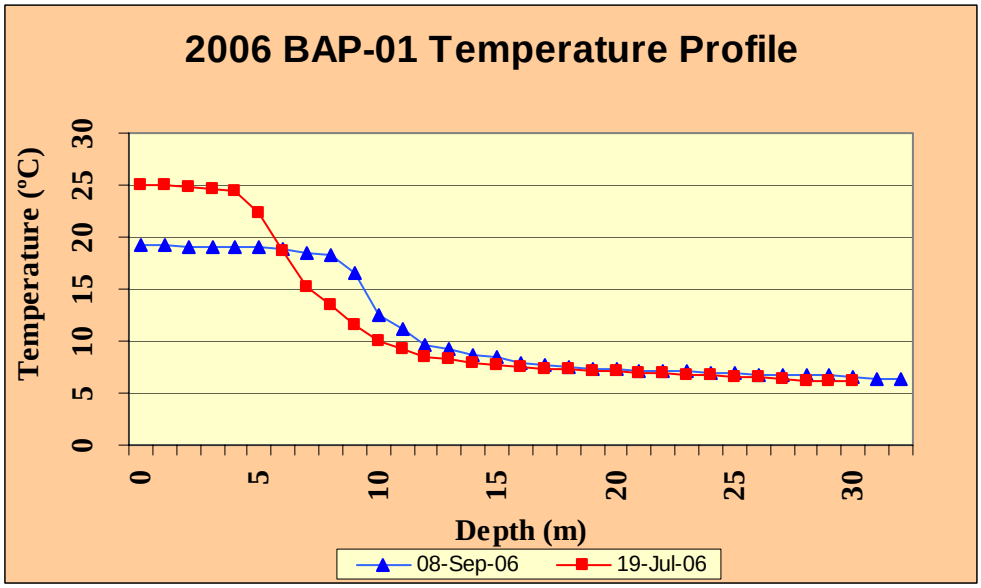
APPENDIX A CHEMISRTY DATA

Table A1 2006 Baptiste Lake Water Chemistry (all values mg/L unless noted)

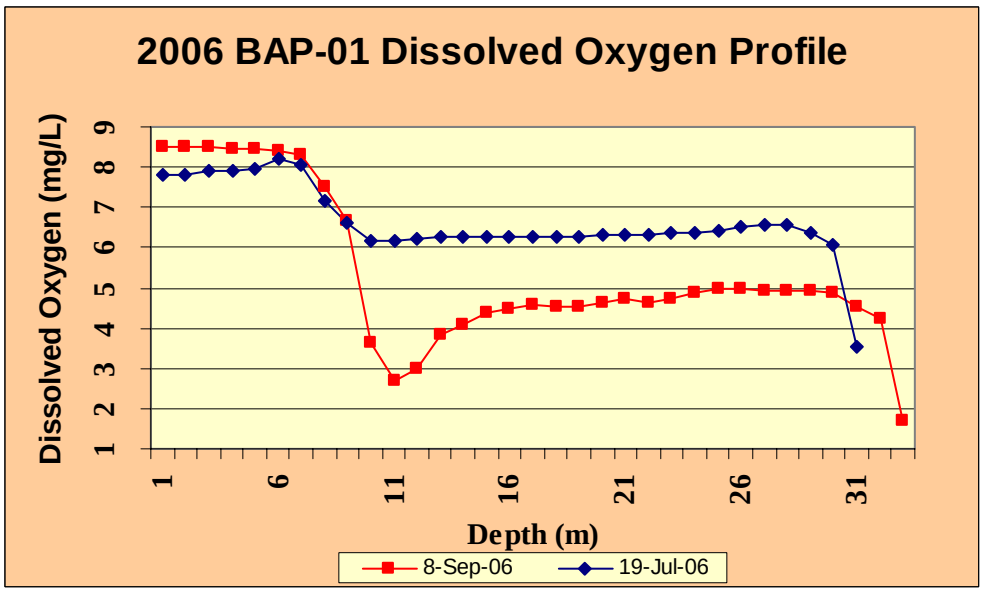
PARAMETER	25-May-06	25-May-06	20-Jul-06	20-Jul-06	20-Jul-06	20-Jul-06	08-Sep-06	08-Sep-06	08-Sep-06	08-Sep-06
	West Basin	Lavalley Bay	West Basin	West Basin	Lavalley Bay	Lavalley Bay	West Basin	West Basin	Lavalley Bay	Lavalley Bay
	BAP-01	BAP-02	BAP-01 EUP	BAP-01 MOB	BAP-02 EUP	BAP-02 MOB	BAP-01 EUP	BAP-01 MOB	BAP-02 EUP	BAP-02 MOB
Secchi Disk (m)	3.65	3.5	3.65		4		3.65		3.5	
Total Phosphorus	< 0.01	0.02	0.007	0.017	0.006	0.012	0.005	0.007	0.003	0.013
Ammonia- Nitrogen	< 0.05	< 0.05	0.023	0.006	0.034	0.012	0.008	0.002	0.008	0.002
Nitrite-Nitrogen	< 0.1	< 0.1	0.004	0.005	0.005	0.001	0.002	0.003	0.002	0.003
Nitrate- Nitrogen	< 0.1	< 0.1	0.021	0.274	0.031	0.353	0.003	0.25	0.003	0.289
Total Kjeldahl Nitrogen	0.4	0.5	0.31	0.28	0.32	0.36	0.31	0.27	0.32	0.3
Dissolved Organic Carbon	5.4	5.2	5	4.7	5.2	4.9	5.7	5.1	5.8	5.4
Dissolved Inorganic Carbon	3.2	3.3	2.8	3.2	3	3.4	3.2	3.7	3.1	3.9
pH	6.42	6.34	7.11	6.96	7.09	6.89	7.53	7.23	7.46	6.97
Alkalinity (as $CaCO_3$)	12	12	15.2	14.6	15.3	14.6	16.6	14.4	16.2	16.8
Conductivity (µmho/cm)	45	46	49	50	49	50	50	49	50	52
Calcium	5.3	5.44	5.6	5.85	5.85	5.55	5.8	5.45	5.55	5.75
Magnesium	0.88	0.89	0.94	0.94	0.98	0.96	1	0.94	1.04	0.98
Hardness	17	17	18	18.4	18.6	17.8	18.6	17.6	18.2	18.4
Total Suspended Solids	0.4	0.5	0.9	1.7	0.9	2.4	0.7	1.7	0.9	2.9
Total Dissolved Solids	3.2	3.3	32	32	32	33	33	32	33	34
Carbonate (as $CaCO_3$)	< 3	< 3								
Bicarbonate (as $CaCO_3$)	12	12								

APPENDIX B OXYGEN-TEMPERATURE PROFILES

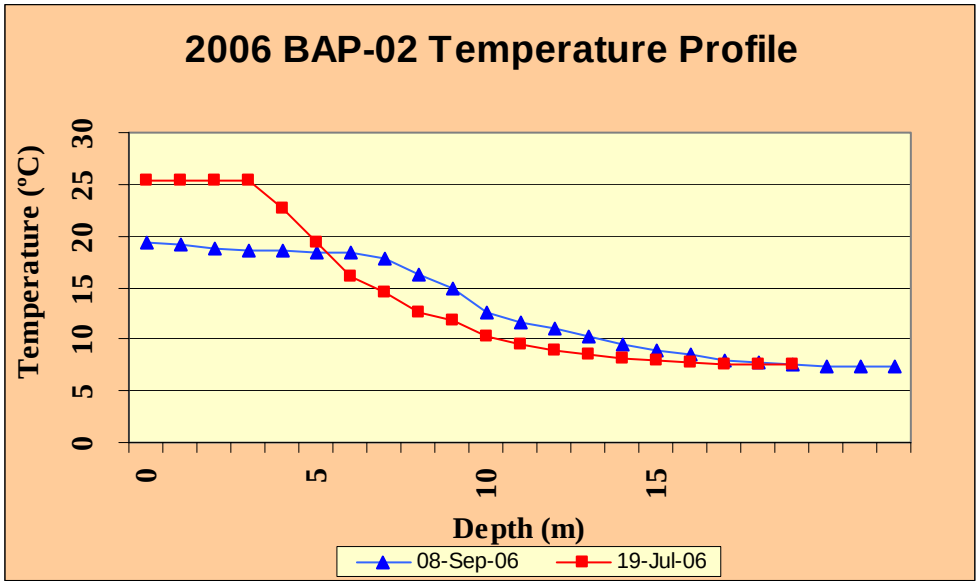
Graph B1 Main Basin Temperature Profile



Graph B2 Main Basin Dissolved Oxygen Profile



Graph B3 Lavalley Bay Temperature Profile



Graph B4 Lavalley Bay Dissolved Oxygen Profile

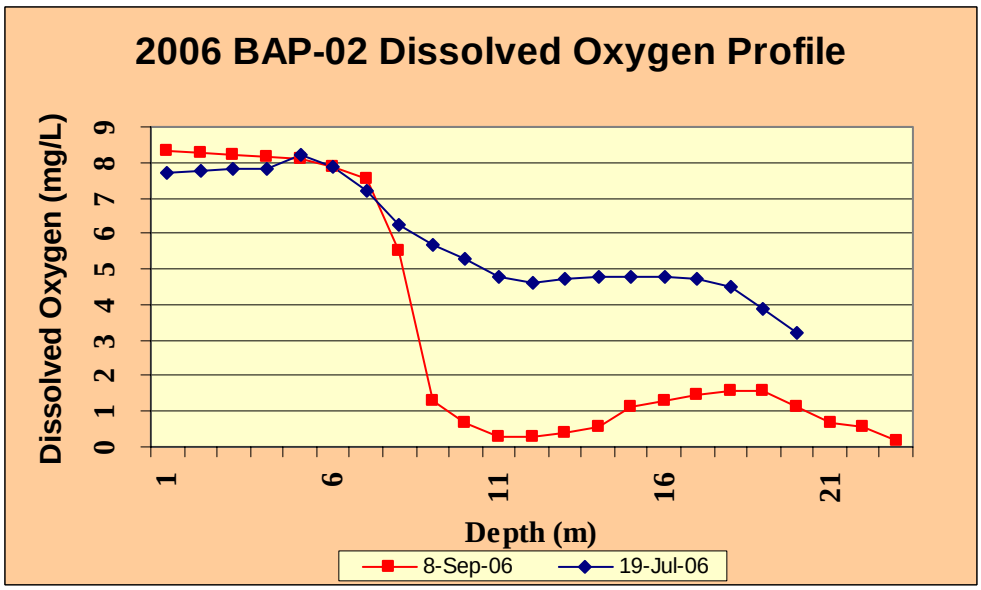


TABLE B1 2006 Main Basin Temperature/Dissolved Oxygen Data

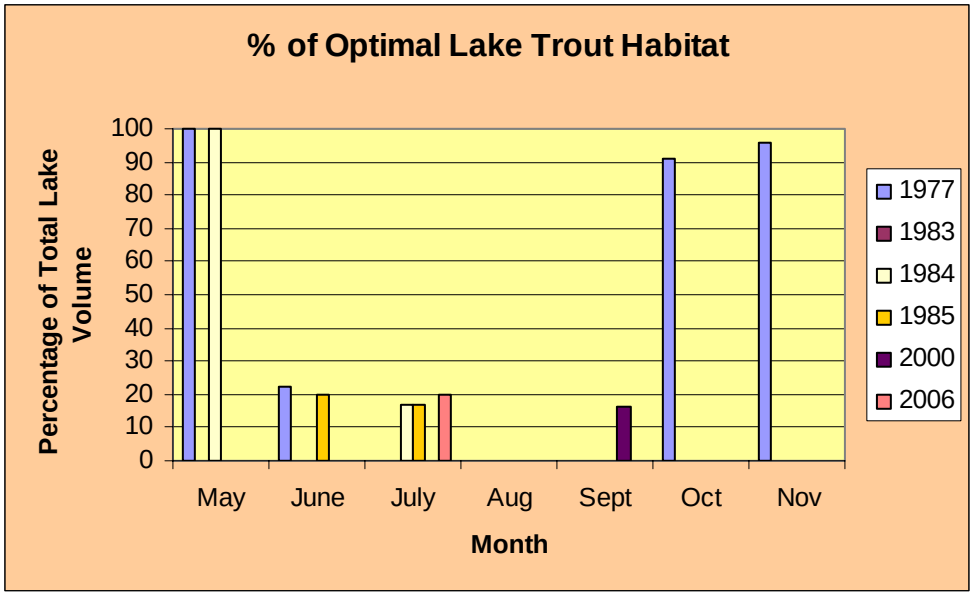
Main Basin (BAP-01) July 19, 2006			Main Basin (BAP-01) Sept. 8, 2006		
Depth	Temp. (°C)	DO Conc (mg/L)	Depth	Temp. (°C)	DO Conc (mg/L)
0	24.99	7.80	0	19.21	8.50
1	25.04	7.83	1	19.16	8.49
2	24.79	7.90	2	19.11	8.48
3	24.61	7.92	3	19.06	8.47
4	24.45	7.94	4	18.98	8.44
5	22.36	8.22	5	18.95	8.40
6	18.59	8.06	6	18.83	8.29
7	15.12	7.18	7	18.46	7.49
8	13.38	6.63	8	16.55	3.64
9	11.54	6.19	9	11.16	3.00
10	10.09	6.18	10	9.14	4.06
11	9.17	6.21	11	8.38	4.48
12	8.47	6.29	13	7.69	4.52
13	8.20	6.29	14	7.46	4.52
14	7.81	6.29	15	7.32	4.65
15	7.62	6.29	16	7.24	4.72
16	7.49	6.27	17	7.18	4.64
17	7.40	6.27	18	7.08	4.75
18	7.33	6.28	19	7.02	4.86
19	7.16	6.30	20	6.95	5.00
20	7.09	6.31	21	6.85	4.99
21	7.02	6.33	22	6.77	4.92
22	6.88	6.36	23	6.76	4.92
23	6.79	6.39	24	6.75	4.93
24	6.71	6.44	25	6.74	4.89
25	6.61	6.51	26	6.57	4.52
26	6.50	6.56	27	6.43	4.22
27	6.35	6.55	27.5	6.27	1.72
28	6.20	6.38			
29	6.12	6.08			
30	6.11	3.51			

TABLE B2 2006 Lavalley Bay Temperature/Dissolved Oxygen Data

Lavalley Bay (BAP-02) July 19, 2006			Lavalley Bay (BAP-02) Sept. 8, 2006		
Depth	Temp. (°C)	DO Conc (mg/L)	Depth	Temp. (°C)	DO Conc (mg/L)
0	25.27	7.72	0.0	19.27	8.34
1	25.35	7.75	1.0	19.18	8.28
2	25.36	7.80	2.0	18.70	8.21
3	25.30	7.81	3.0	18.59	8.17
4	22.58	8.24	4.0	18.53	8.09
5	19.26	7.88	5.0	18.43	7.88
6	16.11	7.22	6.0	18.30	7.56
7	14.60	6.27	7.0	16.32	1.31
8	12.58	5.71	8.0	12.61	0.28
9	11.75	5.32	9.0	10.96	0.37
10	10.30	4.78	10.0	9.52	1.13
11	9.55	4.61	11.0	8.60	1.45
12	8.94	4.71	12.0	8.00	1.60
13	8.49	4.78	13.0	7.76	1.60
14	8.21	4.77	14.0	7.64	1.13
15	8.00	4.80	15.0	7.43	0.70
16	7.78	4.75	16.0	7.39	0.56
17	7.64	4.52	17.0	7.38	0.16
18	7.50	3.87			
19	7.47	3.18			

APPENDIX C Available Optimal and Usable Lake Trout Habitat

Graph C1 % of Total Lake Volume Which is Available as Optimal Lake Trout Habitat



Graph C2 % of Total Lake Volume Which is Available as Usable Lake Trout Habitat