Survey of the water quality and aquatic community of wetlands in Blackstone Lake Aug 30-31, 2005

By

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On Aug 30 and 31, 2005, we sampled three wetlands of Blackstone Lake to assess the quality of their fish habitat. Unlike more than 75 wetlands that we had surveyed routinely throughout eastern Georgian Bay and the North Channel between 2003 and 2005, wetlands in Blackstone Lake are atypical in that they are not directly linked to the waters of Georgian Bay. As part of this assessment, special nets are placed in aquatic vegetation and are left overnight to sample the fish. In such sampling, we often catch several species of turtles even though they are not the target species. In addition, we identify all submergent, emergent and floating aquatic plants that are encountered in the wetland by canoe. In three open-water sites, we also collect water samples using standardized protocols to determine the concentration of primary nutrients, planktonic algae and suspended solids in the water column. Certain physico-chemical characteristics of the water (e.g. ambient temperature and dissolved oxygen concentration, water turbidity, pH, etc.) are also collected at the open-water site with multi-parameter probes.

Water Quality

We collected water at three sites in shallow, open-water areas, and these were called "BK1 (Ludwig)", "BK2 (Lawson)" and "BK3 (Oldfield)" (see Fig. 1). Water depths in these areas were generally less than 1 m. Appropriate information from the wetland surveys were used to generate Water Quality Index (WQI) scores for each site. The WQI (Chow-Fraser 2006) is an objective way to determine the extent of disturbance on the wetland originating from human disturbance. Details on how the water-quality samples were collected, processed and analyzed are in Appendix 1.

All three sites had excellent water-quality characteristics, and had WQI scores of 2.46, 2.45 and 2.42 for BK1, BK2 and BK3, respectively, indicating no human-induced pollution. These high scores put wetlands in Blackstone Lake in the "excellent" category (WQI scores from +2 to +3). To put these results in perspective, compared with 82 other wetlands that were sampled in Lake Huron between 1998 and 2005, the wetlands of Blackstone Lake ranked 2^{nd} to 4^{th}, and were 3 of only 12 sites that had an "excellent" designation. The waters of Blackstone Lake are naturally brown-coloured (dystrophic) because of humic substances from the Pre-Cambrian Shield, and this prevents light from penetrating very deep into the water column. Despite this, the water has very little suspended particles (algae or sediment) and is exceptionally clear (low turbidity values ranging from 0.63 to 1.06). Another characteristic of dystrophic water is the relatively low conductivity (approximately 55 μS/cm) compared with that of Georgian Bay waters (typically above 150 μS/cm).

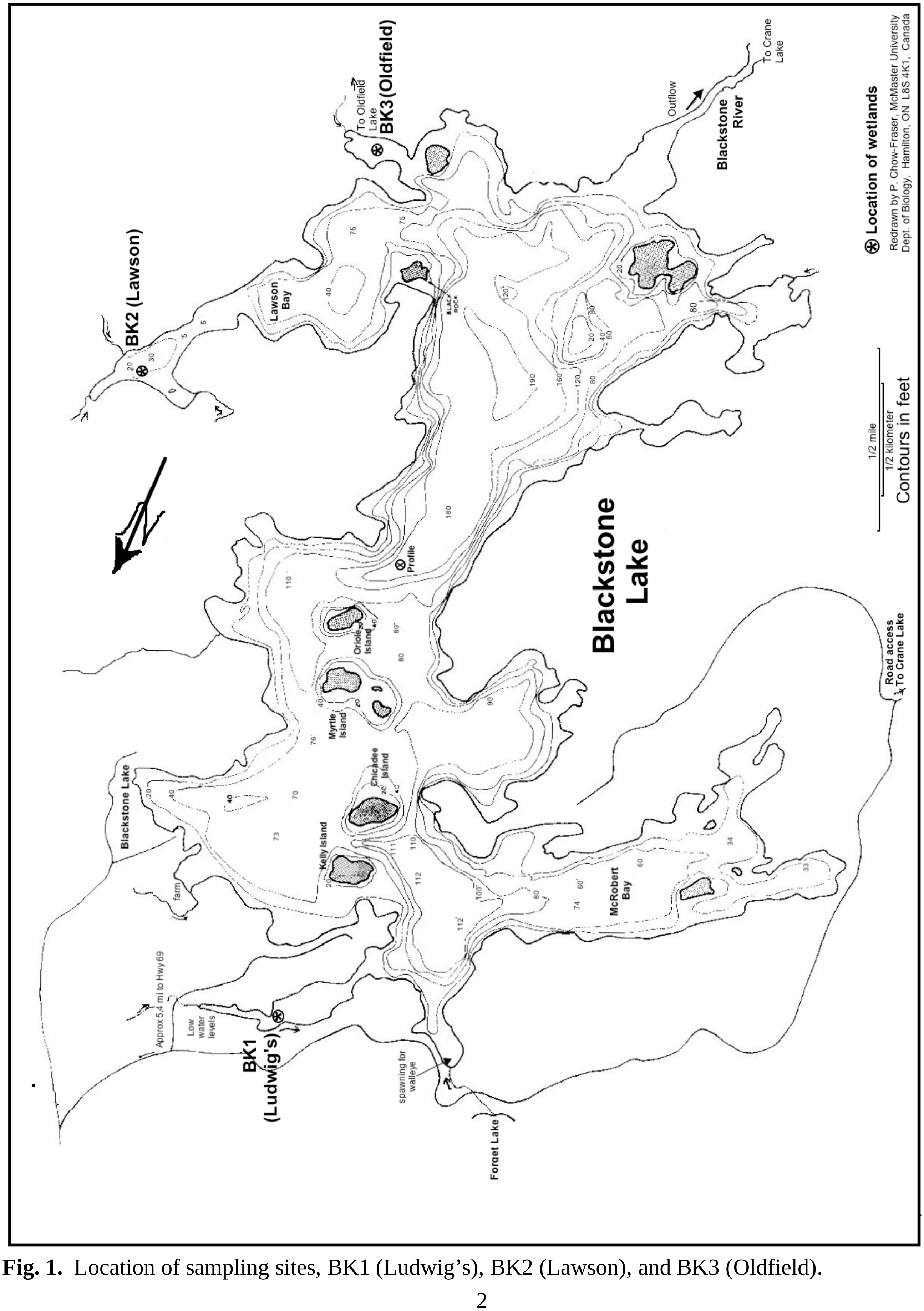

Fig. 1. Location of sampling sites, BK1 (Ludwig's), BK2 (Lawson), and BK3 (Oldfield).

Physico-chemical characteristics of the water column were also taken at a deep-water site marked as "Profile" (168 ft) (Fig. 1). We were able to measure the top 25 m of the water or roughly half of the column (maximum depth of >190 ft or 58.5 m) at meter intervals down to 12 m. There is a layer of water between 6 and 12 m referred to as the *metalimnion* (see Fig. 2). This is the portion of the water column where temperature changed rapidly with depth—changing from 21° to 6.7°C between 6 and 12 m, respectively (Fig. 2a). The two layers above and below are referred to as the *epilimnion* (top) and the *hypolimnion* (bottom), where temperatures are isothermal (same temperature). The mean epilimnetic temperature was approximately 23°C, while the mean hypolimnetic temperature was approximately 5.5°C. This type of thermal stratification is very common in late summer for north temperate lakes. It is also common to observe a peak in dissolved oxygen concentrations in mid-metalimnion (Fig. 2c), corresponding to increased photosynthetic activity of the phytoplankton. Algae tend to accumulate there because they are not eaten by the zooplankton. The pH of the water in the hypolimnion is a result of respiration from decomposing material that fall from the epilimnion and is trapped there (Fig 2d). It is not unusual to see a range of pH values from 7 to 8 as one ascends the water column from the hypolimnion to the epilimnion. Conductivity generally stayed the same throughout the column, ranging from 50 at the epilimnion to slightly lower values of 46 µS/cm in the metalimnion and hypolimnion (Fig. 2b).

Aquatic Plant Community

We surveyed the submersed and floating plant communities at two sites (BK2 and BK3) and also identified emergent plants near the edge (Table 1). No attempt was made to identify all the wet meadow and sedge species since this is outside the scope of our routine survey. Aquatic plants range in habit from those that spend most of their life cycle submersed in water (submergent), to those that have some parts floating on the water surface (floating), to those that have most of the plants emerge above the water surface (emergent). Of these, submergent plants are the most dependent on water clarity, and are therefore good indicators of water polluted by excessive nutrients and sediment caused by human activities. Generally, the more diverse the submergent community, the better the wetland.

There was a very diverse community of submergent plants in the wetlands of Blackstone Lake. We identified 15 species that spend most or part of their life submerged in water, including two bladderworts that are rare, and only found in very low-nutrient sites (*Utricularia intermedia* and *U. purpurea*). The water lobelia (*Lobelia dortmanna*) is also rare and fragile, and requires very clear water to survive. Similarly, freshwater sponge was found at one site, and is considered an indicator of excellent water quality. Other submergent species that are found commonly in other wetlands include grassy arrowhead (*Sagittaria graminea*), short-spike water milfoil (*Myriophyllum sibiricum*), slender water nymph (*Najas flexilis*) and several species of pondweed (*Potamegton pusillus, P. spirillus*, *P. epihydrus*, and *P. natans*).

Plants that can float on the water surface are less vulnerable to poor water quality, and are therefore not very useful indicators of water clarity. However, some species cannot tolerate high nutrients, including one of the five species that was found in Blackstone Lake., the floating burreed (*Sparganium fluctuans*). There were 4 other floating species, including water shield (*Brasenia schreberi*), common yellow pond lily (*Nuphar variegata*), the fragrant white lily

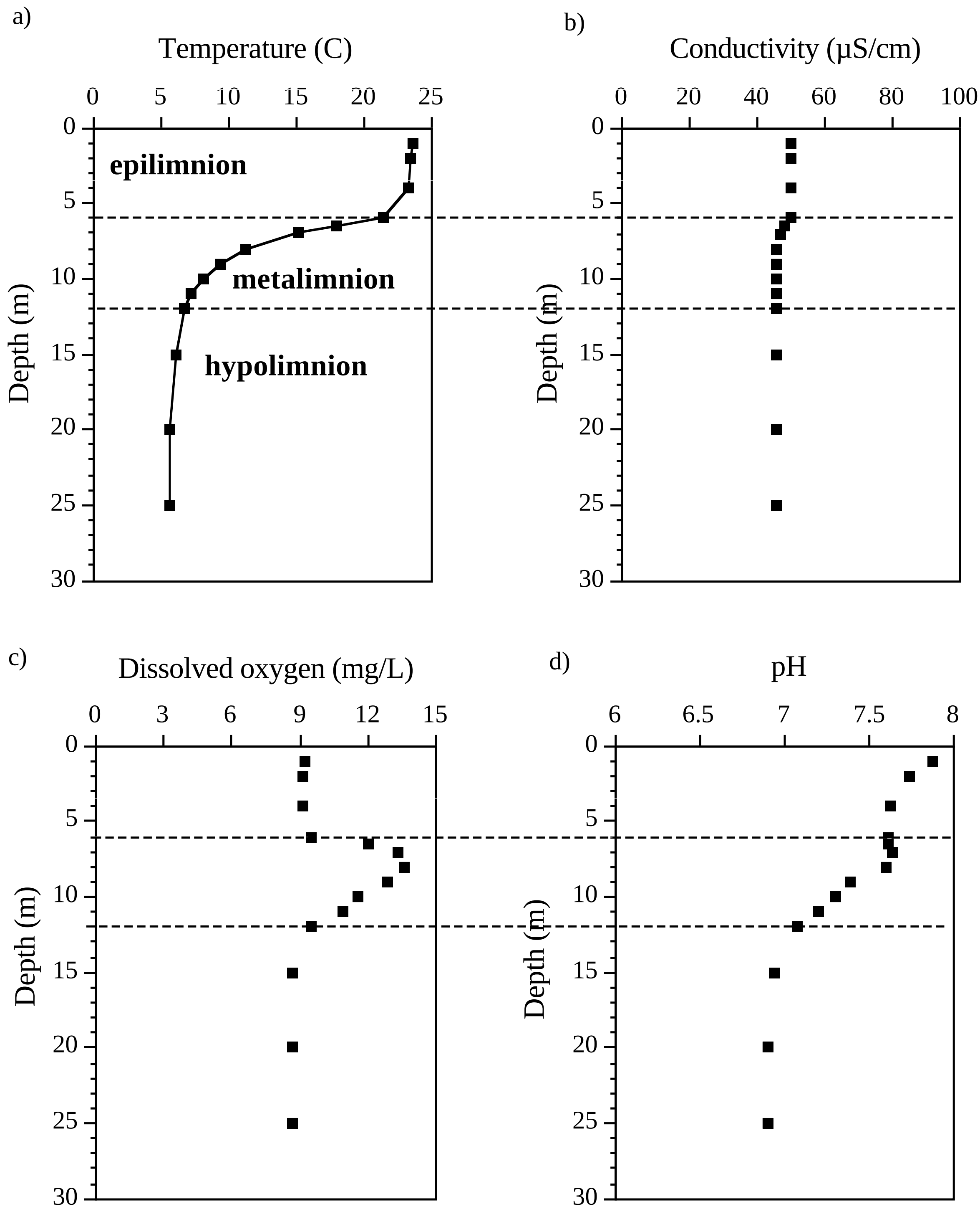

Fig. 2. Depth profiles of a) temperature, b) conductivity, c) dissolved oxygen and d) pH at a deep site in Blackstone L. The dotted lines delineate the metalimnion, which separates the epilimnion and the hypolimnion.

Table 1. Summary of aquatic plants found at the two sites in Blackstone Lake during the August 2005 survey

Scientific name	Common name	Type	Site BK2	Site BK3
Eleocharis robbinsii	Robbins' spike-rush	emergent	✓	✓
Equisetum fluviatile	water horsetail	emergent	✓	✓
Eriocaulon aquaticum	pipewort	emergent	✓	✓
Pontederia cordata	pickerelweed	emergent	✓	✓
Scirpus sp.	bulrush	emergent	✓	✓
Sagittaria species	Arrowhead species	emergent	✓	✓
Sparganium androcladum	Branched bureed	emergent	✓	✓
Sparganium sp.	burreed	emergent	-	✓
Typha sp.	cattail	emergent	✓	-
Brasenia schreberi	water shield	floating	✓	-
Nymphoides cordata	little floating hearts	floating	✓	✓
Nuphar pumila	least yellow lily	floating	-	✓
Nuphar variegata	common yellow pond lily	floating	-	✓
Nymphaea odorata	fragrant water lily (white)	floating	✓	-
Sagittaria graminea	grassy arrowhead	submerged edge	✓	-
Lobelia dortmanna	water lobelia	submergent	-	✓
Myriophyllum sibiricum	short-spike (common) water milfoil	submergent	✓	-
Najas flexilis	slender water nymph	submergent	✓	-
Nitella sp.	stonewort	submergent	✓	✓
Potamogeton pusillus	"slender" pondweed	submergent	✓	-
Potamogeton spirillus	Northern snailseed pondweed	submergent	✓	-
Scirpus subterminalis	Water bulrush, swaying rush	submergent	✓	✓
sponges	sponges	submergent	✓	-
Utricularia intermedia	flatleaved bladderwort	submergent	-	✓
Utricularia purpurea		submergent	✓	✓
Potamogeton epiphydrus	ribbon-leaf pondweed	submergent/ floating	✓	-
Potamogeton natans	broad-leaved pondweed	submergent/ floating	✓	✓
Sparganium fluctuans	floating burreed	submergent/ floating	✓	✓
Utricularia vulgaris	common bladderwort	submergent/ floating	✓	✓
		WMI score	**3.82**	**4.00**

(*Nymphaea odorata*), and little floating hearts (*Nymphoides cordata*). We also identified 9 species of emergent plants that included arrowhead (*Sagittaria sp.*), the rare Robbins' spikerush (*Eleocharis robbinsii*), pickerelweed (*Pontederia cordata*), a species of bulrush (*Scirpus sp*), Branched burreed (*Sparganium androcladum*), a cattail sp. (*Typha sp.*), water horsetail (*Equisetum flluviatile*) and pipewort *(Eriocaulun aquaticum*).

As mentioned earlier, aquatic plants can be useful indicators of water quality in wetlands. Croft and Chow-Fraser (2006, in submission) have developed the Wetland Macrophyte Index (WMI; see Appendix 1) to rank the quality of coastal wetlands of the Great Lakes. Data from this survey were used to calculate a WMI score, and we obtained a score of 3.82 and 4.00 for BK2 and Bk3, respectively. As yet, no formal categories have been assigned to WMI values; however, in a survey of 195 sites surveyed between 1996 and 2005, Croft and Chow-Fraser found only 5 sites with WMI scores higher than 3.82. Therefore, similar to the WQI scores, WMI scores of Blackstone Lake are indicative of exceptionally high quality.

<u>Wetland Fish Commmunity</u>

Fish assemblages can also be used to reflect the environmental quality of wetlands. Seilheimer and Chow-Fraser (2006) have developed the Wetland Fish Index (WFI) to rank the quality of Great Lakes coastal wetlands based on abundance of particular indicator species. Seilheimer and Chow-Fraser has shown that the WFI score is significantly related to the WQI score for 40 wetlands in Lakes Erie and Ontario. During the August survey in 2005, we set three paired fykenets in Blackstone Lake, 2 in BK2 (1 large and 1 small set), and 1 in BK3 (1 large) (see Photo 1 and Appendix 1 for complete details on how the nets were set). Because of their small size, we could not set all three pairs of fykenets in each wetland, as is customary in the coastal wetland survey of eastern Georgian Bay.

There were 9 species of fish caught in both wetlands (Table 2). There were more fish caught in BK2 than in BK3. Some of the small fish such as blacknose shiner (*Notropis heterolepis*) tend to school, and are often caught together in one net, but despite their large numbers, they accounted for very little of the overall fish biomass in BK2. The 16 largemouth bass (*Micropterus salmoides*) together accounted for close to 70% of the total biomass, while the brown bullhead accounted for another 21%. Therefore, with regard to community dynamics, both the number and size of the species in question are important. Similarly, in BK3, the most abundant fish were rockbass (*Ambloplites rupestris*) which only accounted for 23% of the total biomass, while the 5 largemouth bass accounted for 43%.

With respect to using fish as indicators of wetland quality, however, size is not as important a consideration. Species such as largemouth bass or pumpkinseed are ubiquitous and can tolerate a certain amount of water-quality impairment, provided there are submergent plants in the water. However, a species such as the common shiner or rockbass cannot tolerate poor water quality, even when there are submergent plants. Hence, the presence of the latter indicates that the water is not disturbed. The fish assemblages found in BK2 and BK3 were used to calculate WFI (AB) scores of 3.42 and 3.51, respectively. Although no formal "quality" categories have been ascribed to these scores, values between 3.30 and 3.60 tend to be associated with good-quality sites that have not yet shown signs of human impact. Only 25% of the 109 sites surveyed by Seilheimer and Chow-Fraser from 2001 to 2005 have scores above 3.60, and for the most part, these wetlands have WQI scores that range from very good to excellent conditions. We did not find northern pike, smallmouth bass or bowfin, which occur commonly in coastal Great Lakes wetlands, but this may be due to the limited time we had to conduct the survey.

Table 2. Summary of fish caught in fykenets at BK2 and BK3 in Blackstone Lake during August 2005. Data are presented according to descending order of abundance in BK2. WFI (AB) score is calculated as per Seilheimer and Chow-Fraser (2006) (see Appendix 1). Numbers in bracket are the total weight (g) for each species.

Scientific name	Common name	Site	
		BK2	BK3
Notropis heterolepis	blacknose shiner	**54** (73)	--
Lepomis gibbosus	pumpkinseed	**31** (325)	**4** (102)
Micropterus salmoides	largemouth bass	**16** (3484)	**5** (1691)
Notemigonus crysoleucas	golden shiner	**16** (35)	**3** (17)
Ameiurus nebulosus	brown bullhead	**8** (1045)	**6** (1088)
Luxilus cornutus	common shiner	**3** (4.5)	**4** (23)
Perca flavescens	yellow perch	**3** (7.5)	**4** (100)
Lepomis sp.	sunfish	**2** (5.3)	--
Ambloplites rupestris	rockbass	**1** (55.3)	**8** (892)
	WFI(AB) score	**3.42**	**3.51**

Overall assessment

Based on water-quality characteristics (WQI scores), diversity of submersed aquatic plants (WMI scores), and the community of fish (WFI scores), wetlands of Blackstone Lake do not show any signs of human disturbance. BK1 appears to be showing some stress due to low water levels (which were mostly below 1.0 m), and this should be investigated further. The scope of this report does not permit analysis of the fish community in the deeper water, but it is clear that the lake has ample habitat for cold-water fish. Since the survey we conducted targeted fish that were associated with wetlands, we did not encounter muskies, walleye or trout.

Acknowledgements

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Appendix 1

Methods:

Water Quality Data

Field Sampling

For each site, water samples were collected from an open water site located at least 10 m from the edge of the emergent aquatic vegetation for analysis of planktonic algae, primary nutrients and suspended solids; in wetlands where submergent vegetation is present throughout, they were sampled in the deeper areas with very little submergent vegetation. This minimized contamination of water samples with benthic algae (either epiphytic or periphytic). Water samples were collected with a 1-L Van Dorn bottle deployed at mid-depth, and dispensed into clean Nalgene bottles (acid-washed and rinsed with deionized water) for nutrient analyses. Samples for chlorophyll analyses were stored in opaque Nalgene bottles. All samples were kept in sample jars and frozen until analysis (usually within 1 month of collection).

Temperature (**TEMP**; °C), conductivity (**COND**; $\mu S \cdot cm^{-1}$), dissolved oxygen (DO; mg/L), and turbidity (**TURB**; NTU) were measured 10 m from the submergent vegetation with a YSI 6600 multi-parameter probe attached to a 650 Display (YSI, Yellow Springs, Ohio, USA). We used the Hach 2100 Portalab to measure water turbidity in triplicate from water samples collected with the Van Dorn sampler. All sites were georeferenced with a GPS unit (4- to 6-m accuracy).

Laboratory processing and analysis

Samples for chlorophyll-a (**CHL**) content of phytoplankton were first filtered through 0.45-µm GF/C filters, then stored frozen in tin foil until analysis. At the time of analysis, frozen filters were unwrapped and placed in 10 mL of 90% reagent-grade acetone for 24-48 h (American Public Health Association 1992). Triplicate samples were centrifuged, and chlorophyll-a content were determined by measuring fluorescence with a Turners Design Fluorometer before and after acidification (to account for phaeophytin pigments). Following digestion in potassium persulfate in an autoclave, samples for total phosphorus (**TP)** and soluble reactive phosphorus (**SRP**) were measured in triplicate according to the molybdenum blue method of Murphy and Riley (1962). Total Kjeldahl nitrogen (TKN), total nitrate nitrogen **(TNN**) and total-ammonia nitrogen (**TAN**) were measured with Hach protocols and reagents (Hach Company 1989) using a Hach DR2500 spectrophotometer (Hach, Loveland, Colorado, U.S.A.). Total nitrogen (**TN**) were calculated by addition of TKN and TNN.

Water samples for total suspended solids (**TSS**; mg/L) determination were filtered through pre-weighed GF/C filters and kept frozen until processing. Filters were first dried at 100 °C for 1 h, dried in a dessicator with calcium sulphate for another hour, and then weighed to determine TSS. Loss on ignition was determined after combustion at 550 °C for 20 min followed by drying in the dessicator for an hour. Weight of the combusted filter was assumed to be total inorganic suspended solids (**ISS**; mg/L) whereas difference in the weight of the filter before and after combustion was assumed to be total organic suspended solids (TOSS; mg/L).

Fish community

Field Sampling

To survey the fish community, we used three pairs of fyke nets, two pairs of large (13-mm and 4-mm bar mesh, 4.25-m length, 1 X 1.25-m front opening) and one pair of small (4-mm bar mesh, 2.1-m length, 0.5 X 1.0-m front opening) nets at each site (see Photo 1). These were set parallel to the emergent zone at the 1-m and 0.5-m depth contour, respectively. The paired nets were positioned face-to-face with a 7-m lead connecting them, while 2.5-m wings were set off the front openings at a 45° angle. Whenever possible, nets were set within submergent vegetation, but when there was too little vegetation or when appropriate depths were not available, the nets were set near the emergent vegetation. The nets were left overnight (20-24 h) and all fish present in the nets the next day were collected, sized, enumerated and identified according to Scott and Crossman (1998). Unknown species (i.e. small cyprinids) were frozen and identified later with a dissecting microscope. All other individuals were released live at the site.

To the extent possible, wetland fishing occurred in areas that best represented the distribution of habitat and variations in conditions. Criteria included appropriate depth, and proximity to emergent vegetation and the likelihood of submergent vegetation being present at some point during the summer, even though little or no submergent plants may have been observable at the time of sampling.

Estimation of fish weight

Weights of fish were calculated from lengths based on published relationships (Schneider et al. 2000). Appendix Table 1 summarizes the regression coefficients used in this study.

Aquatic plant surveys

Plant data used for development of the WMI were collected between 1996 and 2005, although the majority was collected between 2000-2005. On each sampling occasion in a wetland, the aquatic-plant community was surveyed as follows (usually between late June and late August). In wadeable water, emergent plants would be surveyed by walking along random transects parallel to the shoreline within the flooded zone. Some submergent taxa could be identified within these transects, but majority of these were surveyed with quadrats (0.75m x 0.75m) from a canoe or boat, within the vicinity where fykenets had been set contemporaneously to survey the fish community. Depending on the size and complexity of the wetland, these surveys would take from 20 minutes to several hours to complete. Generally, 10 to 15 quadrats would be sampled in each wetland and only the occurrence of species was noted—i.e. we did not estimate percent cover of particular species within the quadrats. The focus of the survey was to identify submergent, emergent and floating plants that serve as fish habitat; therefore, species associated with wet meadow were largely ignored. Plants were identified (to species where possible, and otherwise to genus) according to Voss (1972), Newmaster et al (1997) or Crow and Hellquist (2000).

Formulas for calculating indices

Water Quality Index (WQI) (Chow-Fraser 2006)

Chow-Fraser (2006) provided various equations to calculate WQI based on 5 to 12 parameters. In this paper, the 12-parameter was used, and the following equation was employed.

WQI score = -(0.3154965 * log **TURB**) –(0.3656606 * log**TSS**)-(0.3554498 * log **ISS**)
-(0.3760789 * log **TP**)-(0.1876029 * log **SRP**)-(0.0732574 * log **TAN**)
-(0.2016657 * log **TNN**)-(0.2276255 * log **TN**)-(0.5711395 * log **COND**)
-(1.1659027 * log **TEMP**)-(4.3562126 * **log pH**) -(0.2287166 * **log CHL**)-10.0239684

In all cases, the data were first $\log_{10}$transformed. See above for explanation of the abbreviations for parameters.

<u>Wetland Fish Index (WFI)</u> (Seilheimer and Chow-Fraser 2006)

The general formula used to generate the WFI score is shown below, where the are two parameters, optimum (U-value) and tolerance (T-value), which are generated from a Canonical Correspondence Analysis:

$$WFI = \left(\frac{\sum_{i=1}^{n} YiTiUi}{\sum_{i=1}^{n} YiTi} \right)$$

Where: Y_i = abundance or presence/absence of the species (if present, value=1; if absent, value=0)
T_i = value from 1-3 or niche breadth of species *i*
U_i = value from 1-5, tolerance of species *i* to degradation

The U and T values for all plant taxa are shown in Table 2 in Appendix 1.

<u>Wetland Macrophyte Index (WMI)</u> (Croft and Chow-Fraser, in submission)

The general formula used to generate the WMI score is shown below, where the are two parameters, optimum (U-value) and tolerance (T-value), which are generated from a Canonical Correspondence Analysis:

$$WMI = \left(\frac{\sum_{i=1}^{n} YiTiUi}{\sum_{i=1}^{n} YiTi} \right)$$

Where: Y_i = if the species is present, this value is 1; if absent, it is 0
T_i = value from 1-3 or niche breadth of species *i*

U_i = value from 1-5, tolerance of species *i* to degradation

The U and T values for all plant taxa are shown in Table 3 in Appendix 1.

Appendix 1 Table 1. Summary of slopes and intercepts of regression equation used to calculate fish weight from fish length (modified from Schneider et al. 2000). The regression equation is: log W = log a + b·log L where W=weight (g), L=total length (mm).

Common Name	Scientific Name	Code	Intercept (a)	Slope of (b)
Alewife	*Alosa pseudoharengus*	ALPS	-5.29	3.06
Rock bass	*Ambloplites rupestris*	AMRU	-4.81	3.05
Brown Bullhead	*Ameiurus nebulosus*	AMNE	-4.61	2.88
Bowfin	*Amia calva*	AMCA	-4.90	2.96
American Eel	*Anguilla rostrata*	ANRO	-6.94	3.47
Fourspine Stickleback	*Apeltes quadracus*	APQU	-5.03	2.99
Freshwater Drum	*Apoldinotus grunniens*	APGR	-5.44	3.20
Goldfish	*Carassius auratus*	CAAU	-4.44	2.91
Longnose Sucker	*Catostomus catostomus*	CACA	-5.05	3.06
White Sucker	*Catostomus commersoni*	CACO	-4.97	3.00
Mottled Sculpin	*Cottus bairdi*	COBA	-5.30	3.25
Slimy Sculpin	*Cottus cognatus*	COCO	-5.30	3.25
Lake Chub	*Couesius plumbeus*	COPL	-5.27	3.17
Brook Stickleback	*Culaea inconstans*	CUIN	-5.03	2.99
Common Carp	*Cyprinus carpio*	CYCA	-4.44	2.84
Gizzard Shad	*Dorosoma cepedianum*	DOCE	-5.08	3.04
Redfin Pickerel	*Esox a. americanus*	ESAA	-5.29	3.01
Grass Pickerel	*Esox a. vermiculatus*	ESAV	-5.29	3.01
Northern Pike	*Esox lucius*	ESLU	-5.61	3.14
Muskellunge	*Esox masquinongy*	ESMA	-6.44	3.44
Rainbow Darter	*Etheostoma caeruleum*	ETCA	-5.40	3.20
Iowa Darter	*Etheostoma exile*	ETEX	-5.49	3.24
Least Darter	*Etheostoma microperca*	ETMI	-5.49	3.24
Johnny Darter	*Etheostoma nigrum*	ETNI	-5.40	3.20
Banded Killifish	*Fundulus diaphanus*	FUDI	-5.57	3.33
Threespine Stickleback	*Gasterosteus aculeatus*	GAAC	-5.03	2.99
Ruffe	*Gymnocephalus cernuus*	GYCE	-5.38	3.22
Brassy Minnow	*Hybognathus hankinsoni*	HYHA	-5.71	3.39
Black Bullhead	*Icalurus melas*	ICME	-4.61	2.89
Channel Catfish	*Icalurus punctatus*	ICPU	-5.81	3.28
Brook Silverside	*Labisesthes sicculus*	LASI	-5.12	2.96
Spotted Gar	*Lepisoteus oculatus*	LEOC	-5.4	2.98
Longnose Gar	*Lepisoteus osseus*	LEOS	-7.07	3.51
Green Sunfish	*Lepomis cyanellus*	LECY	-5.07	3.16
Pumpkinseed	*Lepomis gibbonus*	LEGI	-5.11	3.21
Bluegill	*Lepomis macrochirus*	LEMA	-5.10	3.17
Longear Sunfish	*Lepomis megalotis*	LEME	-5.04	3.16
Common Shiner	*Luxilus cornutus*	LUCO	-5.61	3.32
Smallmouth Bass	*Micropterus dolomieu*	MIDO	-4.91	3.03

Largemouth Bass	*Micropterus salmoides*	MISA	-5.17	3.13
White Perch	*Morone americana*	MOAM	-5.38	3.22
Silver Redhorse	*Moxostoma anisurum*	MOAN	-4.45	2.78
White Bass	*Morone chrysops*	MOCH	-5.02	3.03
Shorthead Redhorse	*Moxostoma macrolepidotum*	MOMA	-4.81	2.94
Round Goby	*Neogobius melanostomus*	NEME	-5.30	3.27
Golden Shiner	*Notemigonus crysoleucas*	NOCR	-5.25	3.08
Emerald Shiner	*Notropis atherinoides*	NOAT	-4.71	2.73
Common Shiner	*Notropis cornutus*	NOCO	-5.61	3.32
Blacknose Shiner	*Notropis heterolepis*	NOHE	-5.03	2.99
Blackchin Shiner	*Notropis heterondon*	NOHN	-5.03	2.99
Spottail Shiner	*Notropis hudsonius*	NOHU	-5.03	2.99
Spotfin Shiner	*Notropis spilopterus*	NOSP	-5.03	2.99
Sand Shiner	*Notropis straminuus*	NOST	-5.03	2.99
Mimic Shiner	*Notropis volucellus*	NOVO	-5.03	2.99
Tadpole Madtom	*Noturus gyrinus*	NOGY	-5.04	3.10
Rainbow Trout	*Oncorhynchus mykiss*	ONMY	-5.15	3.05
Chinook Salmon	*Oncorhynchus tshawytscha*	ONTS	-5.31	3.11
Rainbow Smelt	*Osmerus mordax*	OSMO	-5.12	2.96
Yellow Perch	*Perca flavescens*	PEFL	-5.33	3.17
Log Perch	*Percina caprodes*	PECA	-5.49	3.24
Sea Lamprey	*Petromyzon marinus*	PEMA	-4.70	2.63
Trout-perch	*Percopsis omiscomaycus*	PEOM	-4.97	3.00
Northern Redbelly Dace	*Phoxinus eos*	PHEO	-5.03	3.08
Bluntnose Minnow	*Pimephales notatus*	PINO	-5.71	3.39
Fathead Minnow	*Pimephales promelas*	PIPR	-5.03	3.08
White Crappie	*Pomoxis annularis*	POAN	-5.82	3.38
Black Crappie	*Pomoxis nigromaculatus*	PONI	-5.24	3.18
Round Whitefish	*Prosopium cylindraceum*	PRCY	-5.58	3.19
Ninespine Stickleback	*Pungitius pungitius*	PUPU	-5.03	2.99
Longnose Dace	*Rhinichthys cataractae*	RHCA	-5.03	3.08
Walleye	*Sander vitrius*	SAVI	-5.14	3.04
Rudd	*Scardinius erythrophthalmus*	SCER	-4.44	2.90
Creek Chub	*Semotilus atromaculatus*	SEAT	-4.85	2.92
Pearl Dace	*Semotilus margarita*	SEMA	-5.03	3.08
Central Mudminnow	*Umbra limi*	UMLI	-4.85	2.92
Cyprinid	*Notropis sp.*	UNCY	-5.03	2.99
Bullhead	*Icalurus sp.*	UNIC	-4.61	2.89
Sunfish	*Lepomis sp.*	UNLE	-5.11	3.21

Appendix 1 Table 2. **"U" and "T"** values for fish species based on presence/absence data (P/A) and abundances (AB). U values were assigned from the species' position on the first canonical axis and the T values were assigned based on the weighted standard deviation of the first axis species scores. Species that only occurred in 2 sites were given T value of 1. Modified from Seilheimer and Chow-Fraser (2006) to include data from Georgian Bay, the North Channel and Lake Superior (Seilheimer and Chow-Fraser, in submission).

			Presence/Absence		Abundance	
Code	common name	Scientific Name	U	T	U	T
CACA	longnose sucker	*Catostomus catostomus*	5	3	5	3
ETEX	iowa darter	*Etheostoma exile*	5	3	5	3
LEME	longear sunfish	*Lepomis megalotis*	5	3	5	3
LEOS	longnose gar	*Lepisoteus osseus*	5	3	5	3
NOHN	blackchin shiner	*Notropis heterondon*	5	3	5	3
NOVO	mimic shiner	*Notropis volucellus*	5	3	5	3
PHEO	northern redbelly dace	*Phoxinus eos*	5	3	5	3
APQU	fourspine stickleback	*Apeltes quadracus*	5	1*	4	1*
PRCY	round whitefish	*Prosopium cylindraceum*	5	1*	4	1*
SEMA	pearl dace	*Margariscus margarita*	5	1*	4	1*
COBA	mottled sculpin	*Cottus bairdi*	4	3	4	3
COCO	slimy sculpin	*Cottus cognatus*	4	3	4	3
ESAA	redfin pickerel	*Esox americanus*	4	3	4	3
ESMA	muskellunge	*Esox masquinongy*	4	3	4	3
FUDI	banded killifish	*Fundulus diaphanus*	4	3	4	3
GYCE	ruffe	*Gymnocephalus cernuus*	4	3	4	3
LUCO	common shiner	*Luxilus cornutus*	4	3	5	3
MOAN	silver redhorse	*Moxostoma anisurum*	4	3	4	3
MOMA	shorthead redhorse	*Moxostoma macrolepidotum*	4	3	4	2
OSMO	rainbow smelt	*Osmerus mordax*	4	3	4	3
PEOM	trout-perch	*Percopsis omiscomaycus*	4	3	4	3
PUPU	ninespine stickleback	*Pungitius pungitius*	4	3	4	3
SAVI	walleye	*Sander vitreus*	4	3	4	3
AMCA	bowfin	*Amia calva*	4	2	4	2
ESLU	northern pike	*Esox lucius*	4	2	4	2
LASI	brook silverside	*Labidesthes sicculus*	4	2	4	2
MIDO	smallmouth bass	*Micropterus dolomieu*	4	2	4	2
NOGY	tadpole madtom	*Noturus gyrinus*	4	2	4	2
NOHE	blacknose shiner	*Notropis heterolepis*	4	2	4	2
NOST	sand shiner	*Notropis stamineus*	4	2	3	2
UMLI	central mudminnow	*Umbra limi*	4	2	4	2
AMRU	rockbass	*Ambloplites rupestris*	4	1	4	2
ETMI	least darter	*Etheostoma microperca*	4	1*	5	1*
AMME	black bullhead	*Ameiurus melas*	3	2	3	2
CUIN	brook stickleback	*Culaea inconstans*	3	2	3	2
ETNI	johnny darter	*Etheostoma nigrum*	3	2	3	2
LEGI	pumpkinseed	*Lepomis gibbonus*	3	2	3	2

MISA	largemouth bass	*Micropterus salmoides*	3	2	3	2
NOAT	emerald shiner	*Notropis atherinoides*	3	2	3	2
NOCR	golden shiner	*Notemigonus crysoleucas*	3	2	3	2
PECA	logperch	*Percina caprodes*	3	2	4	2
PEFL	yellow perch	*Perca flavescens*	3	2	3	2
PONI	black crappie	*Pomoxis nigromaculatus*	3	2	3	2
AMNE	brown bullhead	*Ameiurus nebulosus*	3	1	2	1
CACO	white sucker	*Catostomus commersoni*	3	1	3	2
LEMA	bluegill	*Lepomis macrochirus*	3	1	3	1
PINO	bluntnose minnow	*Pimephales notatus*	3	1	4	2
SEAT	creek chub	*Semotilus atromaculatus*	3	1	3	1
ALPS	alewife	*Alosa pseudoharengus*	2	2	1	2
GAAC	threespine stickleback	*Gasterosteus aculeatus*	2	2	2	1
CYCA	common carp	*Cyprinus carpio*	2	1	1	1
CYSP	spotfin shiner	*Cyprinella spilopterus*	2	1	1	1
NOHU	spottail shiner	*Notropis hudsonius*	2	1	2	1
PIPR	fathead minnow	*Pimephales promelas*	2	1	2	1
APGR	freshwater drum	*Aplodinotus grunniens*	1	2	1	2
CAAU	goldfish	*Carassius auratus*	1	2	1	2
DOCE	gizzard shad	*Dorosoma cepedianum*	1	2	1	2
HYHA	brassy minnow	*Hybognathus hankinsoni*	1	2	1	2
ICPU	channel catfish	*Icalurus punctatus*	1	2	1	2
LECY	green sunfish	*Lepomis cyanellus*	1	1	1	1
MOAM	white perch	*Morone americana*	1	1	1	2
POAN	white crappie	*Pomoxis annularis*	1	1	1	1
MOCH	white bass	*Morone chrysops*	1	1*	1	1*
ONTS	chinook salmon	*Oncorhynchus tshawytscha*	1	1*	2	1*

Appendix 1 Table 3. Summary of U and T values for all taxa included in this study, organized according to habit type (emergent, floating and submergent). Common names and species codes are also included for convenience. See text for explanation of U and T values. Percent occurrence indicates the percentage of wetlands (n=178) in which the species in question occurred.

Code	Taxon	Common name	U value	T value	Percent occurrence
Emergent					
ELAC	*Eleocharis acicularis*	needle spike rush	4	3	9.1
ELSM	*Eleocharis smallii*	marsh spike rush	4	2	32.9
EQFL	*Equisetum fluviatile*	water horsetail	4	2	6.8
ERAQ	*Eriocaulon aquaticum*	pipewort	5	3	17.6
LYSA	*Lythrum salicaria*	Purple loosestrife	1	1	21.6
PLAM	*Polygonum amphibium*	water smartweed	1	1	8.0
PLSP	*Polygonum sp.*	smartweed	1	1	4.5
POCO	*Pontederia cordata*	pickerelweed	3	2	48.3
SGCU	*Sagittaria cuneata*	small arrowhead	3	1	9.7
SGLA	*Sagittaria latifolia*	broad arrowhead	2	1	33.6
SGSP	*Sagittaria sp.*	Arrowhead species	2	1	6.8
SCAC	*Scirpus acutus*	hardstem bulrush	4	2	30
SCAM	*Scirpus americanus*	three-square bulrush	5	3	5.1
SCSP	*Scirpus sp.*	bulrush	4	1	31.8
SCVA	*Scirpus validus*	softstem bulrush	4	1	21.6
SPAD	*Sparganium androcladum*	Branched bureed	4	3	2.3
SPAN	*Sparganium angustifolium*	narrow-leaf burreed	5	1	1.7
SPCL	*Sparganium chlorocarpum*	greenfruit burreed	2	2	2.3
SPEM	*Sparganium emersum*	unbranched burreed	1	2	2.5
SPEU	*Sparganium eurycarpum*	giant burreed	3	2	10.8
SPSP	*Sparganium sp.*	burreed	2	2	15.3
TYAN	*Typha angustifolia*	narrow-leaf cattail	1	1	21.0
TYLA	*Typha latifolia*	broadleaf cattail	3	2	16.5
TYSP	*Typha sp.*	cattail	1	1	23.3
TYXG	*Typha x glauca*	hybrid cattail	1	2	7.4
UTCO	*Utricularia cornuta*	horned bladderwort	5	3	1.7
Floating					
BRSC	*Brasenia schreberi*	water shield	4	1	21
EICR	*Eichhornia crassipes*	water hyacinth	1	1	0.6
HYMO	*Hydrocharis morsus-ranae*	frogbit	1	2	11.4
LEMI	*Lemna minor*	lesser duckweed	1	1	11.4
LETR	*Lemna trisulca*	ivy duckweed	2	2	7.4
NELU	*Nelumbo lutea*	american lotus	1	1	1.2
NUAD	*Nuphar advena*	spatterdock	1	3	4.5
NUVA	*Nuphar variegata*	common yellow pond lily	2	1	56.7
NYOD	*Nymphaea odorata*	fragrant water lily (white)	2	1	66.5
NMCO	*Nymphoides cordata*	little floating hearts	5	3	2.8

PIST	*Pistia stratiotes*	water lettuce	1	1	0.6
PONA	*Potamogeton natans*	broad-leaved pondweed	2	1	30.7
SPFL	*Sparganium fluctuans*	floating burreed	4	2	17.6
SPIR	*Spirodela polyrhiza*	Greater duckweed	1	1	5.1
TRNA	*Trapa natans*	water chestnut	1	1	0.6
WOLF	*Wolffia sp.*	watermeal	1	2	1.7
Submergent					
BIBE	*Bidens beckii*	water marigold	4	2	22.7
CABO	*Cabomba*	fanwort	1	1	4.5
CASP	*Callitriche sp.*	water starwort	4	2	10.2
CEDE	*Ceratophyllum demersum*	coontail	1	1	45.5
CHSP	*Chara sp.*	muskgrass	3	2	55.1
ELCA	*Elodea canadensis*	canadian waterweed	2	1	63.6
HIVU	*Hippuris vulgaris*	mare's tail	3	3	1.7
ISSP	*Isoetes sp.*	quillwort	4	3	12.5
LODO	*Lobelia dortmanna*	water lobelia	5	2	6.3
MYAL	*Myriophyllum alterniflorum*	alternate water milfoil	5	3	7.4
MYHE	*Myriophyllum heterophyllum*	two-leaf water milfoil	3	2	8.0
MYSI	*Myriophyllum sibiricum*	common water milfoil	3	2	35.8
MYSC	*Myriophyllum spicatum*	eurasian water milfoil	1	1	30.7
MYTE	*Myriophyllum tenellum*	slender water milfoil	4	3	8.5
MYVE	*Myriophyllum verticillatum*	whorled water milfoil	4	1	0.6
MYSP	*Myrophyllum sp.*	water milfoil	1	1	30.1
NAFL	*Najas flexilis*	slender water nymph	3	2	51.7
NEAQ	*Neobeckia aquatica*	North Amer Lake-Cress	5	3	1.1
NISP	*Nitella sp.*	stonewort	3	1	13.1
POAM	*Potamogeton amplifolius*	large-leaved pondweed	4	2	25.0
POCR	*Potamogeton crispus*	curly-leaf pondweed	1	1	25.6
POEP	*Potamogeton epiphydrus*	ribbon-leaf pondweed	4	3	10.8
POFR	*Potamogeton friesii*	Fries' Pondweed	2	1	1.1
POGR	*Potamogeton gramineus*	variable pondweed	4	2	29.5
POIL	*Potamogeton illinoensis*	Illinois pondweed	3	2	8.0
POOB	*Potamogeton obtusifolius*	Bluntleaf pondweed	2	1	0.6
PO SLEN	*Potamogeton pusillus*	"slender" pondweed	2	1	2.3
PORI	*Potamogeton richardsonii*	clasping-leaved pondweed	3	2	64.8
PORO	*Potamogeton robbinsii*	fern-leaf pondweed	4	2	25.0
POSP	*Potamogeton sp.*	pondweed	1	2	21.0
POSR	*Potamogeton spirillus*	Northern snailseed pondweed	5	2	14.2
POVA	*Potamogeton vaseyi*	Vaseyi pondweed	2	1	0.6
POZO	*Potamogeton zosteriformis*	flat-stemmed pondweed	3	1	38.1
RALO	*Ranunculus longirostris*	buttercup, crowfoot	2	1	16.5
RASP	*Ranunculus sp*	Crowfoot	2	1	1.1
SGGR	*Sagittaria graminea*	grassy arrowhead	4	3	5.7
SCSU	*Scirpus subterminalis*	Water bulrush	5	2	13.6
SPON	Fresh water sponges	sponges	5	3	9.7

STPE	*Stuckenia pectinata*	sago pondweed	1	1	37.5
STVA	*Stuckenia vaginata*	sheathed pondweed	2	1	0.6
UTGE	*Utricularia geminiscapa*	hidden fruit bladderwort	5	3	1.1
UTGI	*Utricularia gibba*	humbed bladderwort	5	2	1.1
UTIN	*Utricularia intermedia*	flatleaved bladderwort	3	2	5.1
UTMI	*Utricularia minor*	lesser bladderwort	5	2	1.7
UTPU	*Utricularia purpurea*	purple bladderwort	5	2	1.7
UTSP	*Utricularia sp.*	bladderwort	1	2	4.0
UTVU	*Utricularia vulgaris*	common bladderwort	3	2	30.0
VAAM	*Vallisneria americana*	tape grass, eel grass	3	1	64.2
ZIPA	*Zizania sp.*	wild rice	4	2	30.1
ZODU	*Zosterella dubia*	water stargrass	2	2	5.7

Appendix 2

Wetland: **BK1 (Ludwig's Bay)** Date: 08/29/2005
Latitude: 45.24777 Longitude: -79.89470

Water Quality Summary: WQI score of 2.446 Excellent

Parameter	Unit	Value
Depth	cm	100
Turbidity	FTU	0.75
Secchi	cm	Bottom
Temperature	°C	24.25
pH		8.19
Dissolved Oxygen	mg/L	9.35
Conductivity	µS/cm	52
Light Extinction		1.180
Chlorophyll	µg/L	2.4
Total Suspended Solids	mg/L	0.76
Total Phosphorus	µg/L	21.3
Total Dissolved Phosphorus	µg/L	n/a
Soluble Reactive Phosphorus	µg/L	4.3
Total Ammonia Nitrogen	mg/L	0.001
Total Nitrate Nitrogen	mg/L	0.100
Total Nitrogen	mg/L	10

Aquatic Vegetation Summary:

Emergents		Submergents		Floating	
Species	Common Name	Species	Common Name	Species	Common Name
Eleocharis robbinsii	Robbins' spike-rush	*Lobelia dortmanna*	Water lobelia	*Nymphoides cordata*	Little floating hearts
Equisetum fluviatile	Water horsetail	*Nitella sp.*	Stonewort	*Nuphar pumila*	Least yellow lily
Eriocaulon aquaticum	Pipewort	*Potamogeton natans*	Broad-leaved pondweed	*Nuphar variegata*	Common yellow pond lily
Scirpus sp.	Bulrush	*Scirpus subterminalis*	Water bulrush, swaying rush		
Sagittaria species	Arrowhead species	*Sparganium fluctuans*	Floating burreed		
Sparganium androcladum	Branched bureed	*Utricularia intermedia*	Flatleaved bladderwort		
Sparganium sp.	Burreed	*Utricularia purpurea*			
Sparganium species					

Wetland: **BK2 (Lawson's Bay)** Date: 08/29/2005
Latitude: 45.23063 Longitude: -79.86096

Water Quality Summary: WQI score of 2.456 Excellent

Parameter	Unit	Value
Depth	cm	270
Turbidity	FTU	1.06
Secchi	cm	bottom
Temperature	℃	24.29
pH		8.00
Dissolved Oxygen	mg/L	8.51
Conductivity	µS/cm	53
Light Extinction		2.64
Chlorophyll	µg/L	1.17
Total Suspended Solids	mg/L	0.77
Total Phosphorus	µg/L	25.6
Total Dissolved Phosphorus	µg/L	n/a
Soluble Reactive Phosphorus	µg/L	1.8
Total Ammonia Nitrogen	mg/L	0.001
Total Nitrate Nitrogen	mg/L	0.200
Total Nitrogen	mg/L	10

Aquatic Vegetation Summary: WMI score of 3.82

Emergents		Submergents		Floating	
Species	Common Name	Species	Common Name	Species	Common Name
Eleocharis robbinsii	Robbins' spike-rush	*Myriophyllum sibiricum*	Short-spike (common) water milfoil	*Brasenia schreberi*	Water shield
Equisetum fluviatile	Water horsetail	*Najas flexilis*	Slender water nymph	*Nymphoides cordata*	Little floating hearts
Eriocaulon aquaticum	Pipewort	*Nitella sp.*	Stonewort	*Nymphaea odorata*	Fragrant water lily (white)
Pontederia cordata	Pickerelweed	*Potamogeton pusillus*	"Slender" pondweed		
Scirpus sp.	Bulrush	*Potamogeton epiphydrus*	Ribbon-leaf pondweed		
Sagittaria species	Arrowhead species	*Potamogeton natans*	Broad-leaved pondweed		
Sparganium androcladum	Branched bureed	*Potamogeton spirillus*	Northern snailseed pondweed		

Typha sp.	Cattail	*Scirpus subterminalis*	Water bulrush, swaying rush		
		Sagittaria graminea	Grassy arrowhead		
		Sparganium fluctuans	Floating burreed		
		sponges	sponges		
		Utricularia purpurea	Purple bladderwort		
		Utricularia vulgaris	Common bladderwort		

Fish Summary:

In the following, all fish lengths are measured in cm. "Extra fish" refers to fish that have been tallied without accompanying length measurements. Weights of fish are in g.

Fyke Nets

Set	Latitude	Longitude
1 (BK2)	45.23126	-79.86168
2 (BK2)	45.23109	-79.86126

Set	Fyke Size	Mesh Size	Common Name	Length	Weight	Extra Fish
1	SM	east	blacknose shiner	60	1.91	
1	SM	east	blacknose shiner	61	2.01	
1	SM	east	blacknose shiner	65	2.43	
1	SM	east	blacknose shiner	57	1.64	
1	SM	east	blacknose shiner	53	1.32	
1	SM	east	blacknose shiner	58	1.73	
1	SM	east	blacknose shiner	60	1.91	
1	SM	east	brown bullhead	192	95.96	
1	SM	east	brown bullhead	182	82.24	
1	SM	east	largemouth bass	77	5.38	
1	SM	east	largemouth bass	47	1.15	
1	SM	east	largemouth bass	68	3.65	
1	SM	east	largemouth bass	61	2.60	
1	SM	east	pumpkinseed	62	4.40	
1	SM	east	rockbass	140	55.34	
1	SM	west	blacknose shiner	39	0.53	
1	SM	west	blacknose shiner	54	1.40	
1	SM	west	brown bullhead	168	65.28	
1	SM	west	pumpkinseed	66	5.38	
1	SM	west	pumpkinseed	99	19.76	
1	SM	west	pumpkinseed	72	7.11	
1	SM	west	pumpkinseed	78	9.19	
1	SM	west	pumpkinseed	90	14.55	
1	SM	west	pumpkinseed	112	29.37	
1	SM	west	pumpkinseed	84	11.66	

1	SM	west	pumpkinseed	62	4.40	
1	SM	west	pumpkinseed	94	16.73	
1	SM	west	pumpkinseed	78	9.19	
1	SM	west	pumpkinseed	61	4.17	
1	SM	west	pumpkinseed	84	11.66	
1	SM	west	pumpkinseed	54	2.82	
1	SM	west	pumpkinseed	67	5.64	
1	SM	west	pumpkinseed	64	4.87	
1	SM	west	pumpkinseed			4
1	SM	west	yellow perch	79	4.85	
2	LG	LARGE	brown bullhead	290	315.34	
2	LG	LARGE	brown bullhead	230	161.56	
2	LG	LARGE	largemouth bass	457	1411.36	
2	LG	LARGE	largemouth bass	185	83.44	
2	LG	LARGE	largemouth bass	306	402.60	
2	LG	LARGE	largemouth bass	394	887.51	
2	LG	LARGE	largemouth bass	300	378.42	
2	LG	LARGE	largemouth bass	233	171.67	
2	LG	LARGE	largemouth bass	210	124.03	
2	LG	SMALL	blacknose shiner	66	2.54	
2	LG	SMALL	blacknose shiner	50	1.11	
2	LG	SMALL	blacknose shiner	57	1.64	
2	LG	SMALL	blacknose shiner	54	1.40	
2	LG	SMALL	blacknose shiner	50	1.11	
2	LG	SMALL	blacknose shiner	51	1.18	
2	LG	SMALL	blacknose shiner	48	0.98	
2	LG	SMALL	blacknose shiner	51	1.18	
2	LG	SMALL	blacknose shiner	49	1.04	
2	LG	SMALL	blacknose shiner	46	0.86	
2	LG	SMALL	blacknose shiner	52	1.25	
2	LG	SMALL	blacknose shiner	68	2.78	
2	LG	SMALL	blacknose shiner	50	1.11	
2	LG	SMALL	blacknose shiner	46	0.86	
2	LG	SMALL	blacknose shiner	47	0.92	
2	LG	SMALL	blacknose shiner			30
2	LG	SMALL	brown bullhead	174	72.24	
2	LG	SMALL	brown bullhead	195	100.35	
2	LG	SMALL	brown bullhead	225	151.64	
2	LG	SMALL	common shiner	51	406.35	
2	LG	SMALL	common shiner	54	441.21	
2	LG	SMALL	common shiner	60	513.50	
2	LG	SMALL	golden shiner	57	1.46	
2	LG	SMALL	golden shiner	62	1.89	
2	LG	SMALL	golden shiner	90	5.96	
2	LG	SMALL	golden shiner	57	1.46	
2	LG	SMALL	golden shiner	64	2.09	
2	LG	SMALL	golden shiner	62	1.89	
2	LG	SMALL	golden shiner	58	1.54	

2	LG	SMALL	golden shiner	67	2.40	
2	LG	SMALL	golden shiner	54	1.24	
2	LG	SMALL	golden shiner	64	2.09	
2	LG	SMALL	golden shiner	62	1.89	
2	LG	SMALL	golden shiner	67	2.40	
2	LG	SMALL	golden shiner	71	2.87	
2	LG	SMALL	golden shiner	61	1.80	
2	LG	SMALL	golden shiner			2
2	LG	SMALL	largemouth bass	60	2.47	
2	LG	SMALL	largemouth bass	47	1.15	
2	LG	SMALL	largemouth bass	63	2.87	
2	LG	SMALL	largemouth bass	72	4.36	
2	LG	SMALL	largemouth bass	53	1.67	
2	LG	SMALL	pumpkinseed	48	1.93	
2	LG	SMALL	pumpkinseed	80	9.97	
2	LG	SMALL	pumpkinseed	68	5.92	
2	LG	SMALL	pumpkinseed	93	16.17	
2	LG	SMALL	pumpkinseed	100	20.41	
2	LG	SMALL	pumpkinseed	66	5.38	
2	LG	SMALL	pumpkinseed	54	2.82	
2	LG	SMALL	pumpkinseed	95	17.31	
2	LG	SMALL	pumpkinseed	122	38.64	
2	LG	SMALL	pumpkinseed	57	3.36	
2	LG	SMALL	pumpkinseed	66	5.38	
2	LG	SMALL	sunfish	34	0.64	
2	LG	SMALL	sunfish	63	4.63	
2	LG	SMALL	yellow perch	50	1.14	
2	LG	SMALL	yellow perch	55	1.54	

Wetland: **BK3 (Oldfield Outlet)** Date: 08/29/2005
Latitude: 45.21824 Longitude: -79.86969

Water Quality Summary: WQI score of 2.422 Excellent

Parameter	Unit	Value
Depth	cm	120
Turbidity	FTU	0.63
Secchi	cm	bottom
Temperature	℃	22.59
pH		7.71
Dissolved Oxygen	mg/L	8.70
Conductivity	µS/cm	50
Light Extinction		1.53
Chlorophyll	µg/L	1.26
Total Suspended Solids	mg/L	0.91
Total Phosphorus	µg/L	15.86
Total Dissolved Phosphorus	µg/L	n/a
Soluble Reactive Phosphorus	µg/L	1.84
Total Ammonia Nitrogen	mg/L	0.001
Total Nitrate Nitrogen	mg/L	0.150
Total Nitrogen	mg/L	10

Aquatic Vegetation Summary: WMI score of 4.00

Emergents		**Submergents**		**Floating**	
Species	**Common Name**	**Species**	**Common Name**	**Species**	**Common Name**
Sparganium androcladum	burreed	*Lobelia dortmanna*	water lobelia	*Nymphoides cordata*	little floating hearts
Eleocharis robbinsii	Robbins' spike-rush	*Nitella sp.*	stonewort	*Nuphar pumila*	least yellow lily
Equisetum fluviatile	water horsetail	*Scirpus subterminalis*	Water bulrush, swaying rush	*Nuphar variegata*	common yellow pond lily
Eriocaulon aquaticum	pipewort	*Utricularia intermedia*	flatleaved bladderwort		
Pontederia cordata	pickerelweed	*Utricularia purpurea*			
Scirpus sp.	bulrush	*Potamogeton natans*	broad-leaved pondweed		
Sagittaria sp.	Arrowhead species	*Sparganium fluctuans*	floating burreed		
		Utricularia vulgaris	common bladderwort		

Fish Summary:

In the following, all fish lengths are measured in cm. “Extra fish” refers to fish that have been tallied without accompanying length measurements. Weights of fish are in g.

Fyke Nets

Set	Latitude	Longitude
3 (BK3)	45.21807	-79.86909

Set	Fyke Size	Mesh Size	Common Name	Length	Weight	Extra Fish
3	LG	LG	largemouth bass	295	359.04	
3	LG	LG	largemouth bass	330	509.83	
3	LG	LG	largemouth bass	380	792.57	
3	LG	LG	pumpkinseed	116	32.87	
3	LG	LG	rockbass	182	123.32	
3	LG	LG	rockbass	215	205.15	
3	LG	LG	rockbass	210	190.92	
3	LG	LG	rockbass	140	55.34	
3	LG	LG	rockbass	148	65.57	
3	LG	SM	brown bullhead	240	182.67	
3	LG	SM	brown bullhead	238	178.31	
3	LG	SM	brown bullhead	228	157.54	
3	LG	SM	brown bullhead	286	302.95	
3	LG	SM	brown bullhead	245	193.87	
3	LG	SM	brown bullhead	174	72.24	
3	LG	SM	common shiner	87	876.81	
3	LG	SM	common shiner	77	735.44	
3	LG	SM	common shiner	76	721.72	
3	LG	SM	common shiner	90	920.68	
3	LG	SM	golden shiner	89	5.76	
3	LG	SM	golden shiner	86	5.18	
3	LG	SM	golden shiner	88	5.57	
3	LG	SM	largemouth bass	125	24.49	
3	LG	SM	largemouth bass	77	5.38	
3	LG	SM	pumpkinseed	90	14.55	
3	LG	SM	pumpkinseed	100	20.41	
3	LG	SM	pumpkinseed	117	33.79	
3	LG	SM	rockbass	185	129.64	
3	LG	SM	rockbass	125	39.15	
3	LG	SM	rockbass	160	83.20	
3	LG	SM	yellow perch	164	49.27	
3	LG	SM	yellow perch	116	16.42	
3	LG	SM	yellow perch	100	10.26	
3	LG	SM	yellow perch	130	23.58	

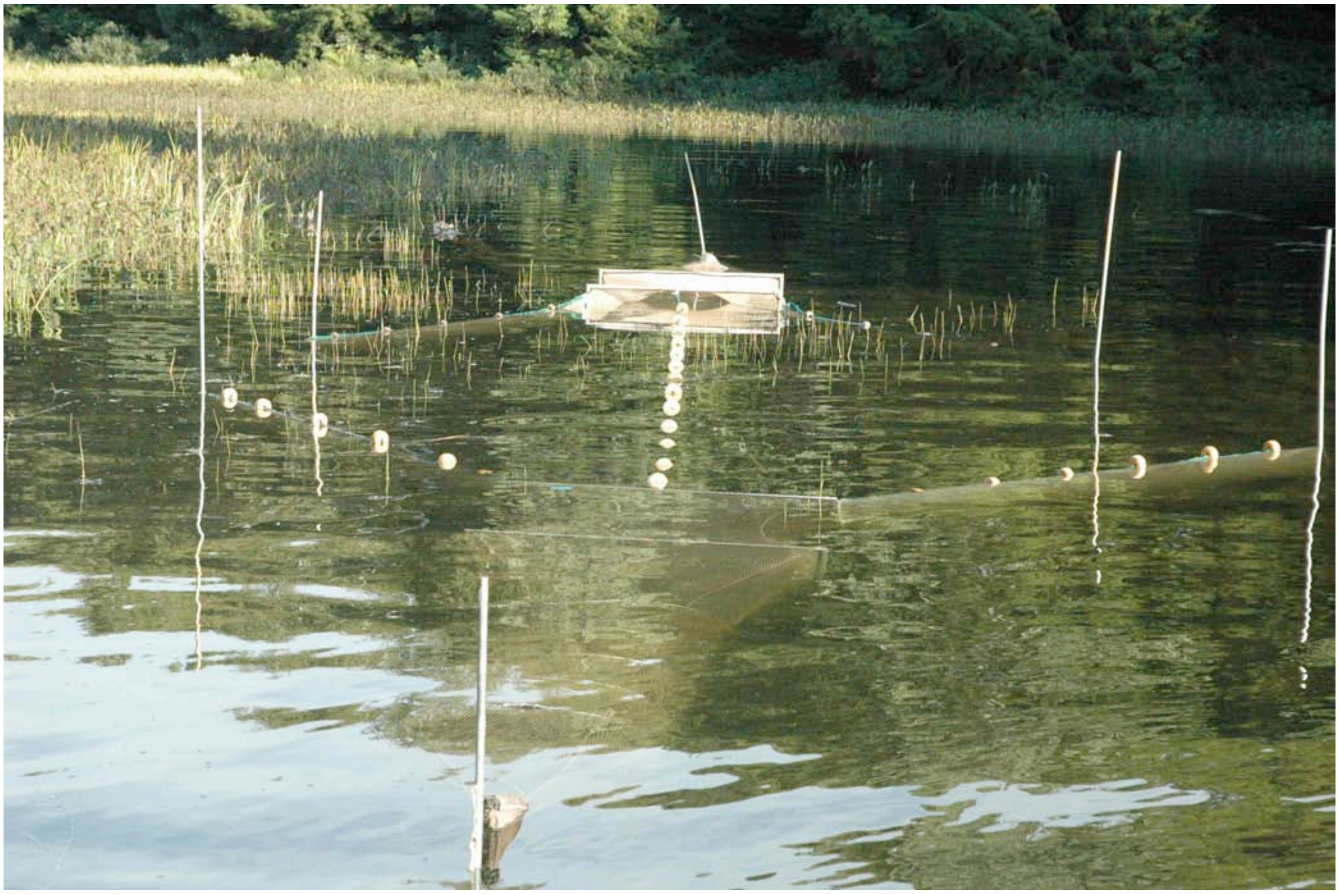

Photo 1. Photo showing the orientation of fyke nets set in Blackstone Lake.