CLEARWATER LAKE
URBAN LAKES FISHERIES STUDY 2019

INTRODUCTION

Clearwater Lake (46°22'11" N, 81°03'04" W) is a 75.6 ha lake located within the City of Greater Sudbury, in Broder/Tilton township. It has one main basin with a maximum depth of 21.5 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1. Clearwater Lake can be accessed publicly at a gravel boat launch located at the north end of the lake, off Tilton Lake Rd. Clearwater Lake has approximately 60 homes and cottages around its shoreline, including a summer camp for children. It is unlikely that the lake receives angling pressure other than that by the occasional lake resident.

Clearwater Lake is one of the intensive monitoring lakes sampled by the Ontario Ministry of the Environment and Climate Change (OMOECC) through the Cooperative Freshwater Ecology Unit. It is recognized within the Official Plan of Sudbury as a principal monitoring lake for the city. It is the site of one the longest continuous acid rain monitoring program in the world. Clearwater has been recognized as an acidified lake for many decades. In 1956 lake residents attempted to neutralize the lake with crushed limestone. This resulted in an increase in pH for only a few weeks. Further attempts were made using calcium hydroxide ($Ca(OH)_2$) which resulted in an increase in pH to 7.0 until fall turnover. The lake was stocked in 1956 with dace (family Cyprinidae), and again in 1957 with fingerling smallmouth bass (*Micropterus dolomieu*) (Kirk, 1990). Despite these species introductions, fisheries assessments yielded no fish until the late 1990s when the first fathead minnow (*Pimephales promelas*), northern redbelly dace (*Phoxinus eos*) and brook stickleback (*Culaea inconstans*) were observed (Keller *et al.*, 2004). Yellow perch (*Perca flavescens*) was observed in September 2001 (J. Gunn pers. comm. (Luc *et al.*, 2010).

Clearwater lake was part of the urban lake programming in 1990 and had a Nordic Survey in 2006. In 2014, as part of the Urban Lakes Study, field crews from Laurentian University's Cooperative Freshwater Ecology Unit surveyed Clearwater Lake, along with several other lakes around Greater Sudbury. This research has continued through 2019, this with the addition of a Broadscale Monitoring (BsM) survey.

Table 1 Clearwater Lake location and physical description (Kirk, 1990).

Township	Broder/Tilton
Latitude/Longitude	46°22’11” N, 81°03’04” W
MNRF District	Sudbury
Watershed Code	2CF05
Elevation (	

small mesh gillnets have a length comparable to Nordic style “gang” net, which the standard in Europe (Sandstrom *et al.*, 2018). The BsM protocol is considered the optimum choice due to the compromise between North American and European standards (Sandstrom *et al.*, 2018). In addition, the separation of large and small net segments within the same gear offers the advantage of a being able to incorporate a more flexible project design to optimally meet survey needs (Sandstrom *et al.*, 2018). During the 2019 lake survey large and small mesh gillnets nets were spatially allocated as equally as possible to all regions of the lakes (Sandstrom *et al.*, 2018). This was done by incorporating the total surface area, max depth, and total amount of depth strata to divide the lake into a number of approximately equal sized areas (sectors) and randomly distribute the net locations to cover as much of these areas as possible (Sandstrom *et al.*, 2018). Previously this process was done manually, however in 2016 a data package was developed by the Ministry of Natural Resources and Forestry called the “Broad-scale Monitoring (BsM) Map Creation Package” to automate the entire procedure (Dunkley, 2016). The data package uses a series of python script tools to identify depth contou

Baseline Organisms

Attempts were made to collect samples of clams (n=10), snails (n=30), crayfish (n=20), Heptageniid mayflies (n=50), and aquatic plants from Clearwater Lake for food web studies.

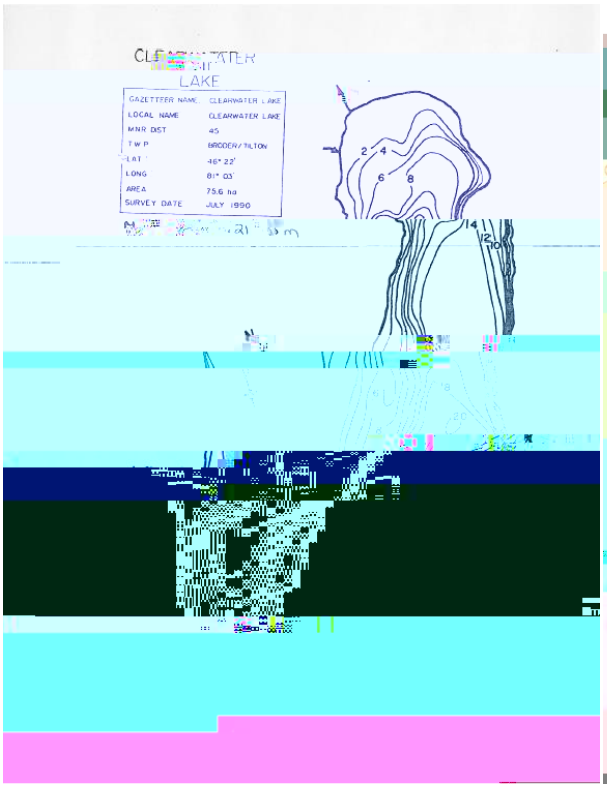

Figure 1 Bathymetric map of Clearwater Lake (Kirk, 1990).

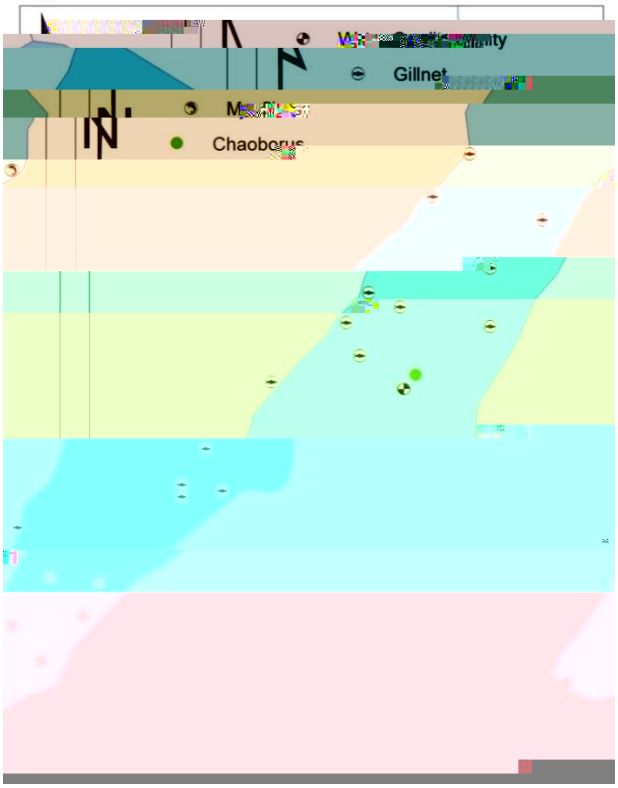

Figure 2 Outline map of Clearwater Lake showing the locati of sampling gear or collected organisms.

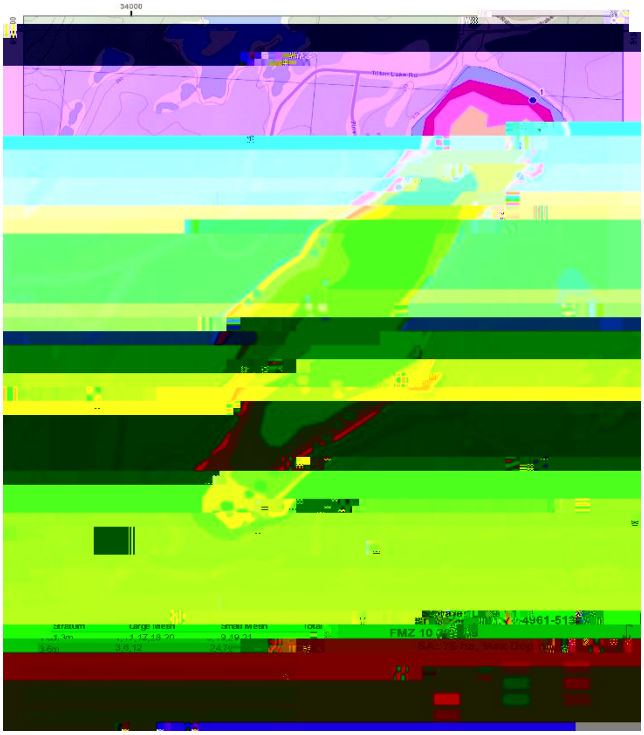

Figure 3 Map of Clearwater Lake showing the location of depth stratums and sampling sites during 2019 BsM survey

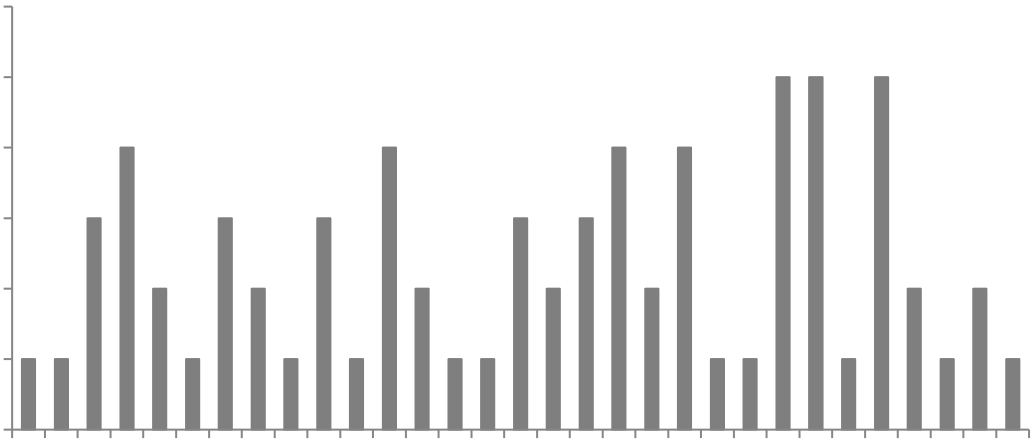

Figure 4 Length frequency histogram for smallmouth bass (n=72) captured in BsM nets in Clearwater Lake August 22-26, 2019.

2019 Nordic Netting Survey

During the 2019 Nordic survey conducted from August 22 to 26 a total of 24 nets were set, catching five different species: smallmouth bass (*Micropterus dolomieu*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), brown bullhead (*Ameiurus nebulosus*) and creek chub (*Semotilus atramaculatus*). Apart from brown bullhead and creek chub the species captured remained the same as in 2017. Total catch, total weight (g) and catch-per-unit effort (CPUE) from the Nordic survey can be seen in Table 3.

Table 3 Catch summary and CPUE for all species captured in Nordic nets in Clearwater Lake August 22nd to 26th, 2019. Fish were not individually weighed. Total weight (g) and CPUE (g/net) measurements are based on net total biomass for that species.

Fish Species	Total Catch	Sample Size	Total Weight (g)	CPUE (fish/net)	CPUE (g/net)
Pumpkinseed	11	11	390	0.46	16.25
Smallmouth Bass	66	63	21652.4	2.75	902.2
Yellow Perch	137	137	1759.6	5.71	73.32
Brown Bullhead	15	15	1984.8	0.63	82.7
Lake Chub	1	1	21	0.04	0.875
Grand Total	230	227	25807.8	9.47	1075.35

Smallmouth bass were the only predator species observed in Clearwater Lake during the Nordic netting survey. A total of 56 smallmouth bass (including many young-of-the-year bass) were captured during the 2019 survey, total length was not recorded for all smallmouth bass, recorded total lengths ranged from 144 mm to 528 mm (n=22). Smallmouth bass was the second most abundant fish species found in Clearwater Lake (Table 3). A length frequency histogram for smallmouth bass can be seen in Figure 5. A complete summary of morphological data for smallmouth bass can be seen in Appendix II.

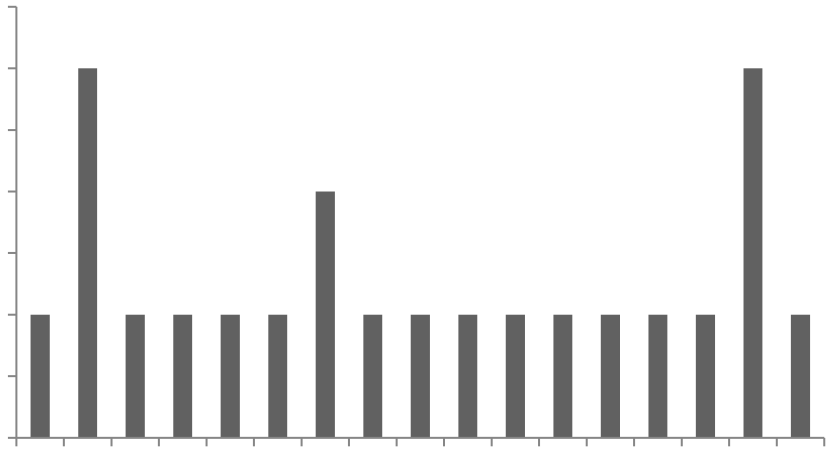

Figure 5 Length frequency histogram for smallmouth bass (n=22) captured in Nordic nets in Clearwater Lake August 22-26, 2019.

History of Fish Community Change 1990 – 2019

No fish were caught in Clearwater Lake during the 1990 Urban Lakes Survey and the lake was classified as fishless for nearly the next decade. The first Nordic survey was conducted in 2003, catching three small-bodied species (yellow perch, pumpkinseed and fathead minnow) and a single smallmouth bass. In 2003, yellow perch accounted for 94% of the total catch in Clearwater Lake. Since then, species richness declined to 3 in 2004 and to 2 in 2009, however it increased back to 3 in 2014. With the addition of species such as the brown bullhead and lake chub, species richness increased to 5 in 2019 (4 in the BsM survey). The first observation of smallmouth bass in Clearwater Lake (Keller et al., 2004; Cooperative Freshwater Ecology Unit, 2014) was in 2003, with occasional bass observed in 2005 and 2007 (Leuck, 2010; Cooperative Freshwater Ecology Unit 2014). We do not know where the first bass came from, but they presumably migrated downstream from Lohi Lake. The abundance of Smallmouth bass increased in 2014, accounting for 3% of the total catch and again in 2019, accounting for 28.7%

of the total catch (62.7% of the total catch in the 2019 BsM survey). Table 5 shows species

Figure 8 Total biomass data for Clearwater Lake.

In 2003 yellow perch were the most abundant species in Clearwater Lake, with small numbers of other species such as fathead minnow and pumpkinseed, accounting for a "low" Shannon Diversity Index value of 0.25. From 2003 to 2009 there was a reduction in species richness and quantity of yellow perch accounting for a decreased Shannon Diversity Index value of 0.072. In 2014, with an increased quantity of smallmouth bass and other species such as brown bullhead and lake chub, the Shannon H Diversity has improved to a value of 0.180. This trend continued

Baseline Organisms

No clams or snails were found at Clearwater Lake. A total of seven crayfish were captured in traps set at various locations across the lake. A total of 50 mayflies were captured at the northeast end of the lake. Twenty nighttime zooplankton hauls were conducted at Clearwater Lake on July 22, 2014. Approximately 20 Chaoborus sp. were collected. A bulk sample of five Pipewort (Eriocaulon aquaticum) was collected from Clearwater Lake.

Water Quality Assessment

At the time of the 2019 Nordic and BsM netting survey, Clearwater Lake was thermally stratified (Figure 6). Water temperatures ranged from 22.9 °C at the surface to 5.3 °C at 19 m. Dissolved oxygen levels ranged from 8.9 2 m. Dissolved

Water Quality Improvements 1990-2019

Water quality

CONCLUSIONS

The water quality of Clearwater Lake has shown considerable improvements over the past 35 years, including an increase in pH to a near neutral 6.94. Concentrations of Ni and Cu remain above the PWQO criteria for the protection of aquatic life. These concentrations have, however, declined by approximately 83% for Ni and 88% for Cu since 1979. Clams and snails were not observed in the lake; however, crayfish and acid sensitive mayflies are present and appear quite common. As of 2019, Clearwater Lake supports populations of five fish species. Since 2014 yellow perch total catch and total mass has steadily dropped, while smallmouth bass total mass increased.

REFERENCES

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Keller W, Heneberry J, Gunn JM, Snucins E, Morgan G, Leduc J. 2004. Recovery of Acid and Metal-

Smallmouth Bass	53	270	284	274	1	20	A	1
Smallmouth Bass	123	146	151	38	-	-	-	-

Smallmouth Bass	82	42	-	73.8	-	-	-	-
Smallmouth Bass	86	406	-	950	-	-	-	-
Smallmouth Bass	87	395	-	1000	-	-	-	-
Smallmouth Bass	88	394	-	590	-	-	-	-
Smallmouth Bass	89	200	-	140.8	-	-	-	-
Smallmouth Bass	90	245	-	140.8	-	-	-	-
Smallmouth Bass	91	203	-	140.8	-	-	-	-
Smallmouth Bass	92	254	-	140.8	-	-	-	-
Smallmouth Bass	93	187	-	140.8	-	-	-	-
Smallmouth Bass	94	267	-	292	-	-	-	-
Smallmouth Bass	95	295	-	140.8	-	-	-	-
Smallmouth Bass	96	179	-	140.8	-	-	-	-
Smallmouth Bass	97	213	-	140.8	-	-	-	-
Smallmouth Bass	98	141	-	140.8	-	-	-	-
Smallmouth Bass	99	152	-	140.8	-	-	-	-
Smallmouth Bass	110	376	400	387.5	-	-	-	-
Smallmouth Bass	111	342	363	387.5	-	-	-	-
Smallmouth Bass	112	141	-	387.5	-	-	-	-
Smallmouth Bass	113	196	-	387.5	-	-	-	-
Smallmouth Bass	134	144	-	-	-	-	-	-
Smallmouth Bass	135	156	-	-	-	-	-	-
Smallmouth Bass	136	152	-	-	-	-	-	-
Smallmouth Bass	5	254	270	226	2	20	A	1
Smallmouth Bass	6	289	304	325	2	20	A	1
Smallmouth Bass	7	358	375	690	2	20	A	1
Smallmouth Bass	8	435	462	1200	2	20	A	1
Smallmouth Bass	9	501	528	1675	1	20	A	1
Smallmouth Bass	10	430	455	1325	1	20	A	1
Smallmouth Bass	143	140	-	375	-	-	-	-
Smallmouth Bass	144	200	-	375	-	-	-	-
Smallmouth Bass	145	339	-	375	-	-	-	-
Smallmouth Bass	146	378	-	375	-	-	-	-
Smallmouth Bass	147	187	1945.7					

Smallmouth Bass	199	404	423	1000	-	-	-	-