CLEARWATER LAKE

URBAN LAKES FISHERIES STUDY 2019

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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.)(Luelc *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 time 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 (m)	267
Shoreline Development Factor	1.61
Number of Cottages/Lodges	60
Forest Type	Birch transition
Shoreline Type	Bedrock/sand
Lake Surface Area (ha)	75.6
Maximum Depth (m)	21.5
Mean Depth (m)	8.4
Volume ($x10^4 m^3$)	642.0
Secchi (m)	4.0 (June 24, 2019)
Access	Public launch off Tilton Lake Rd.

Secchi reading was 5.35 m in 2014 – now 4.0 m 5 years later.

METHODS

Fisheries Community Assessment

In 2006 and 2014, the fish community of Clearwater Lake was sampled in 2014 according to the Nordic Index Netting protocol (Appelberg, 2000; Morgan and Snucins, 2005). This netting procedure was developed in Scandinavia and has been used extensively across northeastern Ontario since 1999 (Selinger *et al*., 2006) to assess the relative abundance and biomass of fish species and provide biological information on the population’s status (Morgan and Snucins, 2005).

In 2004, a new Ecological Framework for Fisheries Management (EFFM) was announced in Ontario (Sandstrom *et al*., 2018). The framework is referred to as the Broadscale Monitoring (BsM) protocol. The goal of the BsM protocol is to improve the way recreational fisheries are managed by considering a broader landscape approach rather than focusing on individual lake management (Sandstrom *et al*., 2018). Active management of lakes under the BsM protocol would therefore occur on a zone basis (Sandstrom *et al*., 2018). The BsM protocol includes a broad-scale fish community monitoring program which uses a combination of two types of gillnets: “Large mesh” gillnet that target fish larger than 20 cm in length and “Small mesh” gillnet that target smaller fish. The Large mesh gillnet (aka North American; NA1; 8 mesh sizes) is the standard net for angler harvested freshwater species in North America (Sandstrom *et al*., 2018). The Small mesh gillnet (aka Ontario Small mesh; ON2; 5 mesh sizes) was developed in Ontario, Canada and is a new standard (Sandstrom *et al*., 2018). In combination the large and 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 contours of the lake, describe physical characteristics, automate the stratified random distribution of net locations, and export all results into a comprehensive map, with accompanied spatial data for field technicians (Dunkley, 2016). In our 2019 survey a total of 45 nets were set in Clearwater Lake from August 22 to 26. This included 21 BsM nets as well as 24 Nordic nets. Nets were set for approximately 20 hours at randomly selected locations on the lake across multiple depth strata (BsM nets: 7 nets in 1-3 m; 6 nets in 3-6 m; 4 nets in 6-12 m; 4 nets in 12-20 m; Nordic nets: 7 nets in 1-3 m; 7 nets in 3-6 m; 5 nets in 6-12 m; 5 nets in 12-20 m). Figure 3 shows the locations of all gillnets set in Chief Lake during the 2019 BsM survey.

All fish captured were identified to species and tallied by net. Biological information such as fork and total length (mm), weight (g), sex and maturity, and stomach contents were recorded for all large-bodied species. Ageing structures were collected from all of these species, and a muscle tissue sample was collected from up to 20 individuals per species across a size range for contaminant and stable isotope analysis. All other fish were measured (total length only) and bulk weighed for each net. A bulk sample of up to 20 individuals per species was collected for contaminant and stable isotope analysis.

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. Clams and snails were targeted by visually scanning near-shore areas and picking the organisms by hand or with a dip net. Crayfish were targeted by setting three to five wire mesh minnow traps baited with canned cat food overnight in littoral areas. Heptageniid mayflies were targeted by turning over rocks and woody debris along the shore of Clearwater Lake and picking the organisms off the surface by hand or with a pair of tweezers. A bulk sample of up to five plants of the same species was targeted by visually scanning the near-shore areas of Clearwater Lake and picked by hand. Mid-lake hauls using a 30cm diameter zooplankton net (150µm mesh) were used to collect *Chaoborus sp.*

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Clearwater Lake on August 22, 2019, using a YSI Model 52 dissolved oxygen – temperature meter. Readings were taken at 1.0 m intervals through the water column.

Water samples were collected on July 10, 2019 from the surface (~0.5m) of Clearwater Lake. Samples were sent to the Ministry of Environment and Climate Change (MOECC) chemistry lab in Dorset, and analyzed for pH, conductivity, total inflection point alkalinity, dissolved organic carbon, metals and major ions. The sampling location for water quality can be seen in Figure 2.

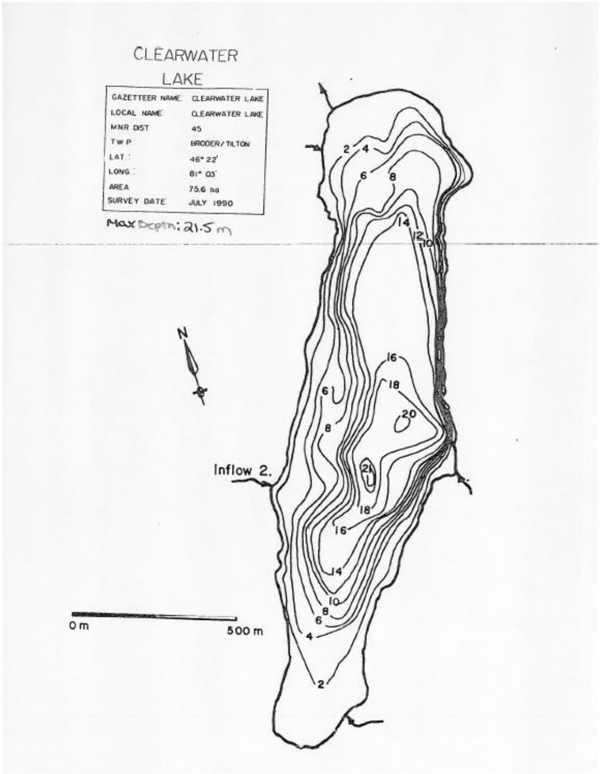

Figure 1 Bathymetric map of Clearwater Lake (Kirk, 1990).

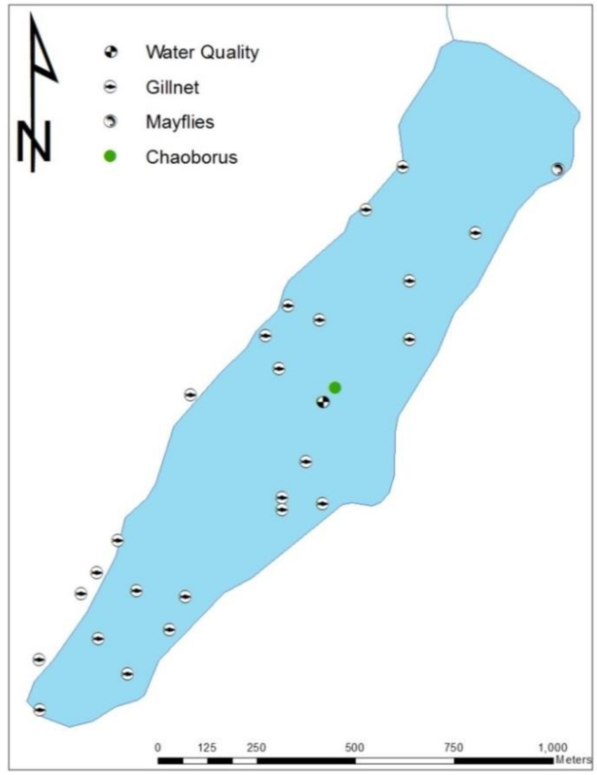

Figure 2 Outline map of Clearwater Lake showing the location of sampling gear or collected organisms.

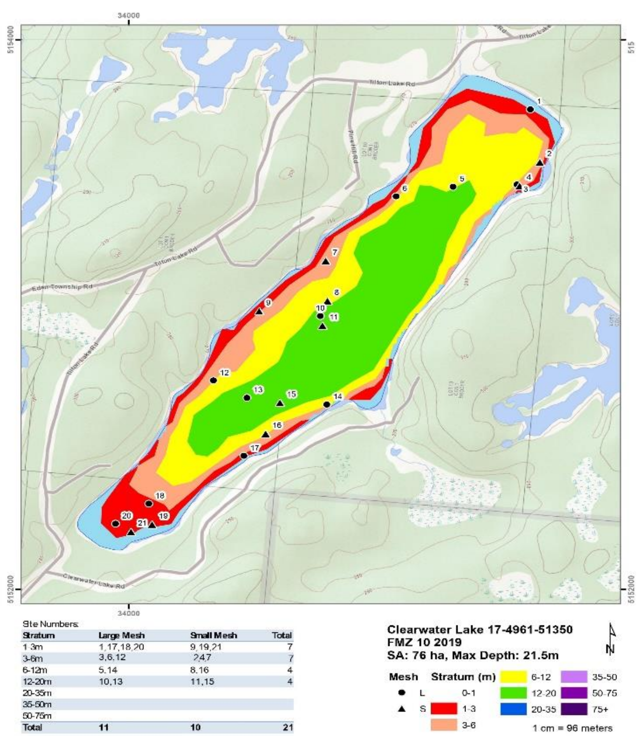

Figure 3 Map of Clearwater Lake showing the location of depth stratums and sampling sites during 2019 BsM survey.

Fisheries Community Assessment

<u>2019 BsM Netting Survey</u>

During the 2019 BsM netting survey conducted from August 22 to 26, a total of 21 nets were set, catching four different species: smallmouth bass (*Micropterus dolomieu*), yellow perch (*Perca flavescens*), pumpkinseed (Lepomis gibbosus) and brown bullhead (*Ameiurus nebulosus*). Total catch, total weight (g) and catch-per-unit effort (CPUE) from the BsM survey can be seen in Table 2.

Table 2 Catch summary and CPUE for all species captured in BsM 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 total net biomass for that species.

Fish Species	Total Catch	Sample Size	Total Weight (g)	CPUE (fish/net)	CPUE (g/net)
Pumpkinseed	1	1	18	0.046	0.86
Smallmouth Bass	79	57	28324	3.76	1349
Yellow Perch	30	26	677.6	1.25	32.3
Brown Bullhead	16	13	716	0.76	34.1
Grand Total	230	97	29735.6	5.82	1416.26

Smallmouth bass were the only predator species observed in Clearwater Lake during the BsM survey. A total of 79 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 56 mm to 504 mm (n=72). Smallmouth bass was the most abundant fish species found in Clearwater Lake (Table 2). A length frequency histogram for smallmouth bass can be seen in Figure 4. A complete summary of morphological data for smallmouth bass can be seen in Appendix I.

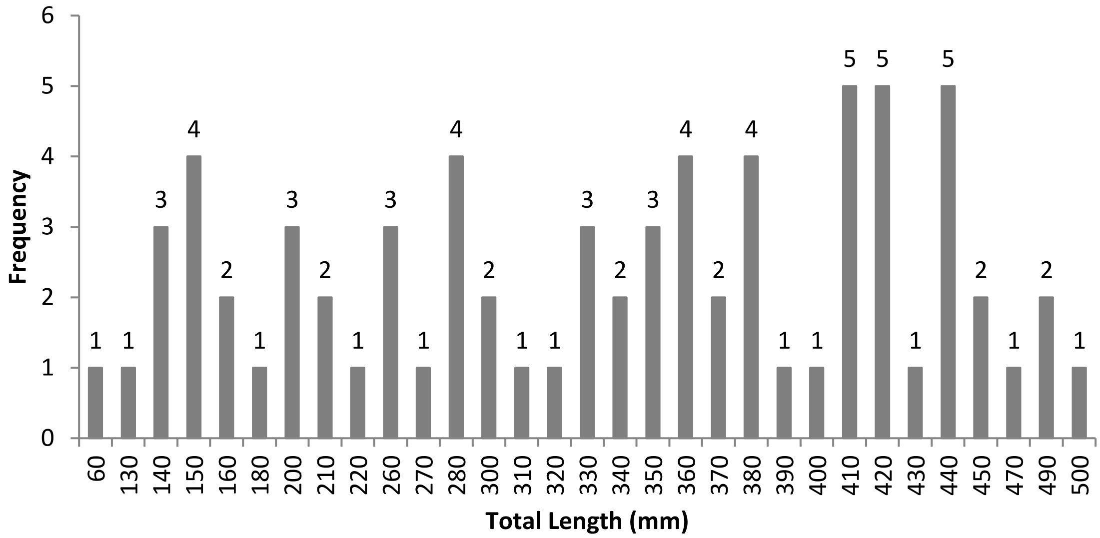

Figure 4 Length frequency histogram for smallmouth bass (n=72) captured in BsM nets in Clearwater Lake August 22 - 26, 2019.

2019 Nordic Netting Survey

During the 2019 Nordic survey conducted from August 22 to 26 a total 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 2014. 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 total net 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 66 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.

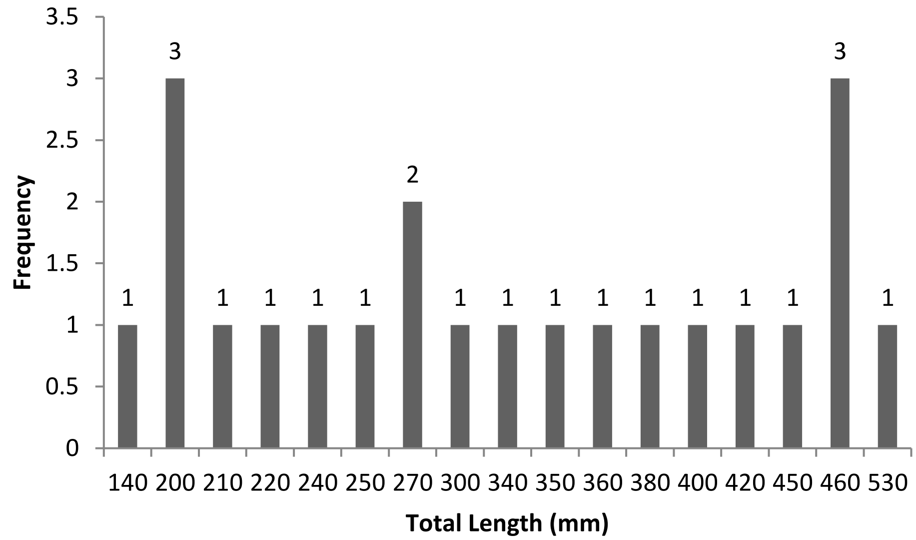

Figure 5 Length frequency histogram for smallmouth bass (n=22) captured in Nordic nets in Clearwater Lake August 22 - 26, 2019.

<u>History of Fish Community Change: 1990 – 2019</u>

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 (Luek *et al*., 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 richness and the proportion of total catch for Clearwater Lake.

Table 5 Species richness and proportion of total catch for Clearwater Lake (1. Poulin *et al*., 1991; 2. Cooperative Freshwater Ecology Unit, 2014).Note: not all the results from earlier surveys are shown.

Survey Type	**Multi-Gear Survey**		**Nordic**		**Nordic**		**Nordic**		**Nordic**		**Nordic**		**BsM**	
Year	**1990**		**2003**		**2004**		**2009**		**2014**		**2019**		**2019**	
Species	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Brown Bullhead	-	-	-	-	-	-	-	-	-	-	*15*	*6.52*	16	12.70
Fathead Minnow	-	-	67	4.31	18	0.95	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	20	1.29	6	0.32	19	1.35	5	0.54	11	4.78	1	0.79
Smallmouth Bass	-	-	1	0.06	-	-	-	-	32	3.46	66	28.70	79	62.70
Yellow Perch	-	-	1465	94.33	1861	98.7	1390	98.7	887	96	137	59.57	30	23.81
Lake Chub	-	-	-	-	-	-	-	-	-	-	1	0.43	-	-
Total	-	-	1553	100	1885	100	1409	100	924	100	230	100	126	100
Species Richness	**0**		**4**		**3**		**2**		**3**		**5**		**4**	

Yellow perch have accounted for most of the total biomass since 2003 (24926 grams in 2003; 29776 grams in 2004; 34699 grams in 2009; 14896 grams in 2014), this trend ended in 2019 with smallmouth bass representing the largest majority of total biomass (Nordic nets: 21654 grams; BsM nets: 28324 reams). The total catch of yellow perch in Nordic nets decreased from 887 in 2014 to 137 in 2019, representing a 146.5% decrease. Since 2014 an increase in smallmouth bass biomass has occurred, resulting in a decrease of yellow perch. Clearwater Lake biomass data can be seen in Figure 8.

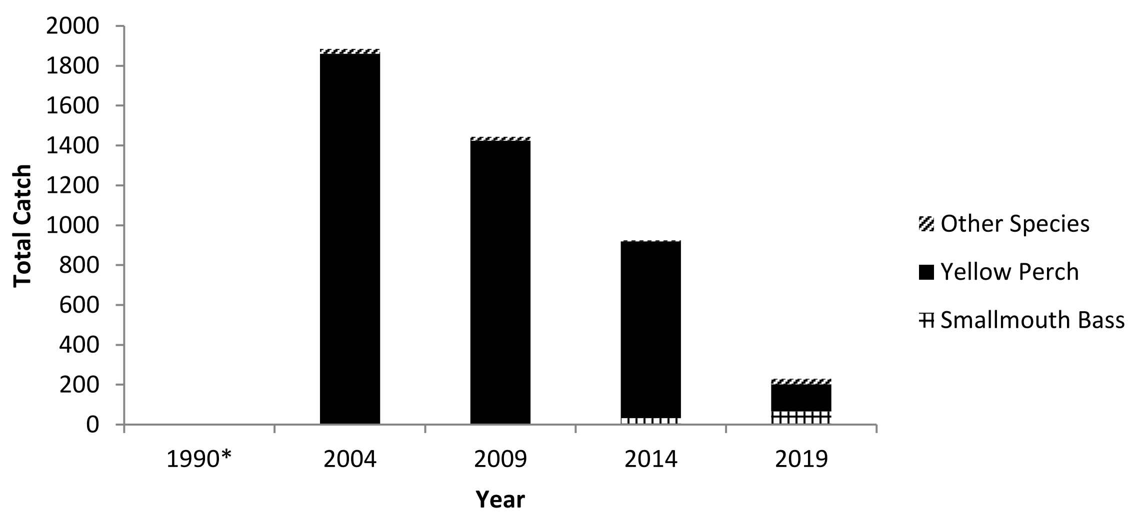

Figure 7 Total catch data for Clearwater Lake (*Nordic method was not used during the 1990 urban lakes survey. Poulin et al., 1991).

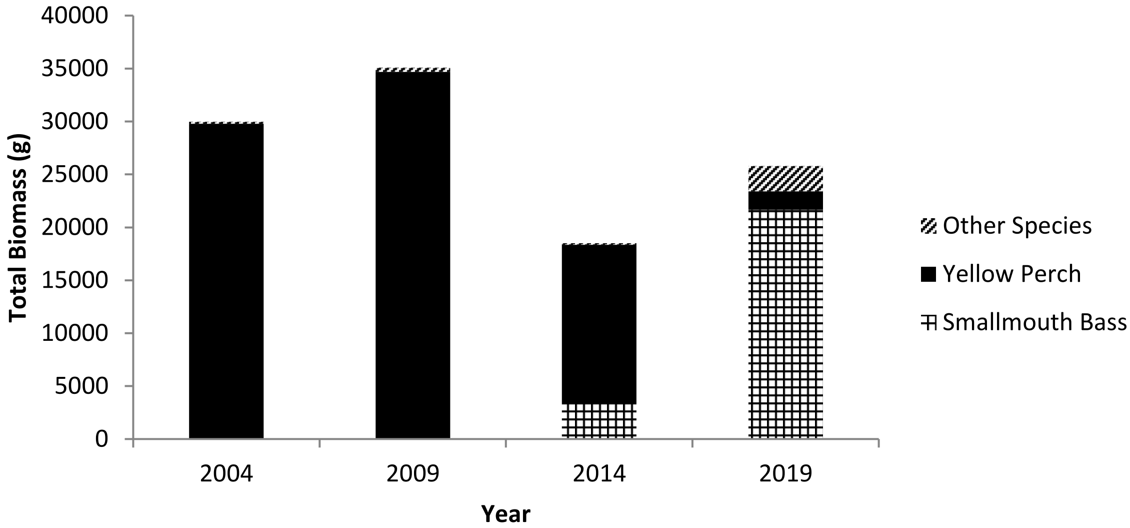

Figure 8 Total biomass data for Clearwater Lake.

In 2003 yellow perch were the most abundant species in Clearwater Lake, with small numbers of other species such as fathead minnow and pumpkin seed, 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 into 2019, with the Shannon H Diversity value increasing to 1.01 (0.94 in BsM netting survey). (Morgan and Snucins, 2005).

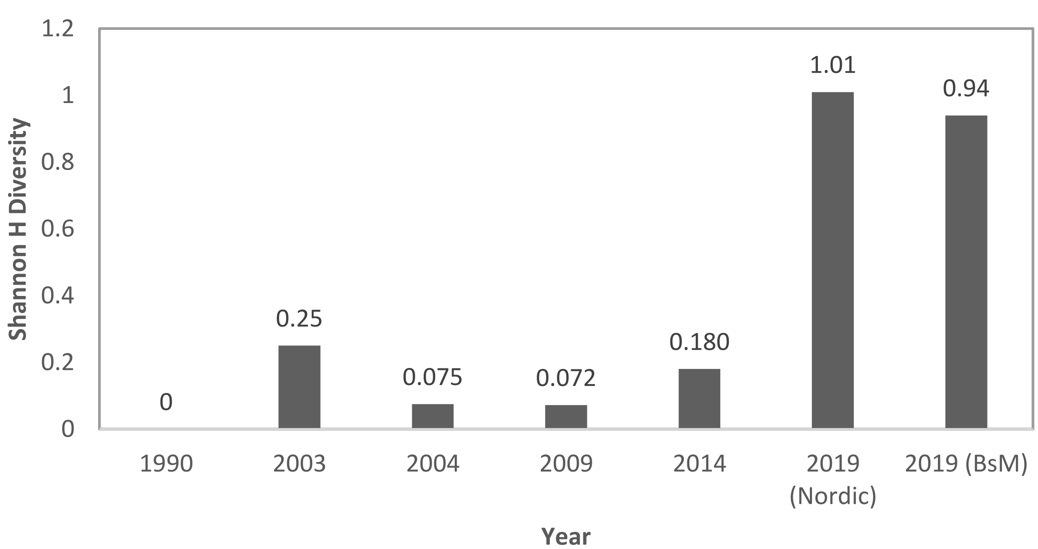

Figure 9 Species diversity (Shannon H Diversity) values from Chief Lake (Morgan and Snucins, 2005).

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 6.3 °C at 19 m. Dissolved oxygen levels ranged from 8.92 mg/L to 6.10 mg/L. Depth at the site of the temperature and dissolved oxygen profiles was 21.0 m and the secchi water clarity was 4 m.

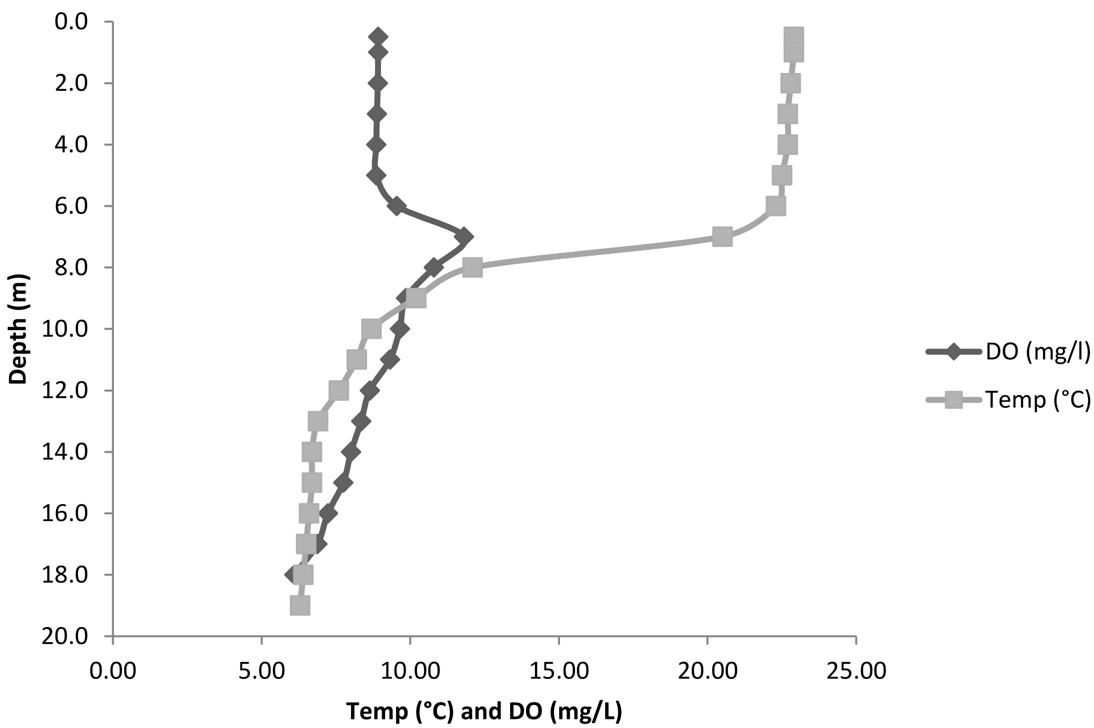

Figure 9 Temperature (°C) and dissolved oxygen (mg/L) profile for Clearwater Lake, measured August 22nd, 2019

Water Quality Improvements: 1990-2019

Water quality improvements continue to occur in Clearwater Lake (Table 6). Since 2003, pH has continued to increase to a value of 6.89. TIA alkalinity has improved over this time as well from 1.19 mg/L $CaCO_3$ to 3.52 mg/L $CaCO_3$. Concentrations of metals such as Nickel (Ni), Copper (Cu), Aluminum (Al) and Iron (Fe) continue to decrease which is likely a result of further reductions in emissions from local smelting operations (Keller *et al*., 2007).

As of July 10, 2019, Clearwater Lake has remained a near-neutral ph level of 6.94 and a positive TIA alkalinity value of 5.5 mg/L $CaCO_3$. Concentrations of Nickel (34.1 µg/L) and Copper (7 µg/L) remain above the Ministry of Environment and Climate Change's (MOECC) Provincial Water Quality Objective's (PWQO) criteria for the protection of aquatic life. Aluminum (18.3 µg/L) and Iron (20 µg/L) concentrations have slightly increased since 2014, however they still remained under the below criteria stated in the PWQO (Ontario Ministry of Environment and Energy, 1994).

Table 6 Water chemistry of Clearwater Lake (T. Traceable amount: interpret with caution; 1. Ontario Ministry of Environment and Energy, 1994; 2. Kirk, 1990; 3. Keller *et al*., 2004).

Parameter	**[1]PWQO**	**Year**							
		[2]1979	**[2]1981**	**[2]1982**	**[2]1989**	**[2]1990**	**[3]2003**	**[1]2014**	**[1]2019**
pH	6.5-8.5	4.41	4.52	4.48	4.8	4.71	6.33	6.89	6.94
TIA Alkalinity (mg/L $CaCO_3$)			-1.86	-1.90		-0.83	1.19	3.52	5.5
Conductivity (µS/cm)		85.0	76.0	78.00		84.0	61.0	56.7	51.3
True Colour (TCU)						[T]1.0		11.8	12.4
DOC (mg/L)			0.4			0.5	2.9	3.1	3.3
DIC (mg/L)			0.4					0.94	1.26
Ca (mg/L)		6.3	6.00	6.00		6.5	4.30	3.48	2.98
Mg (mg/L)		1.4	2.70	1.38		1.440	1.09	1.02	0.894
Na (mg/L)		1.7	2.00			3.22	4.00	4.13	3.88
K (mg/L)		0.70	0.55			0.630	0.575	0.6	0.475
SiO_3 (mg/L)		1.3	1.35			0.70	1.10	1.0	1.32
SO_4 (mg/L)		22.0	20.0	19.4		17.56	10.70	7.45	6.35
Total P (µg/L)	20	2.4	8.0				5	3.3	3.4
Total Cu (µg/L)	5	59.8	46.0	58.0	51	47.0	10	7.1	7
Total Ni (µg/L)	25	220	190.0	230.0	180	180.0	70	37.3	34.1
Total Zn (µg/L)	30	31.4	28.0	35.0		25.0	11	4.5	4.1
Total Fe (µg/L)	300	55.0	40.0	30.0		[T]46.0	15	10	20
Total Mn (µg/L)		282	286.0	279.0	280	290.0	26	3.9	5.5
Total Al (µg/L)	75	272	200.0	250.0	170	140.0	16.0	11.6	18.3

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's have increased. Clearwater lake appears to be following a pattern seen in several other Sudbury lakes where acid-tolerant perch arrive early and establish a large population that crashes when a predator like bass arrives (Lippert et al. 2007). It is assumed that smallmouth bass migrated in from nearby Lohi Lake as this lake was stocked with smallmouth bass in 2008 (Luek, unpublished data; Cooperative Freshwater Ecology Unit, 2008). Earliest observation of bass may have been the result of introductions by residents of the lake.

ACKNOWLEDGEMENTS

The urban lakes fisheries monitoring program in Sudbury is conducted by staff and students of the Cooperative Freshwater Ecology Unit with support from OMNRF, OMOECC, City of Greater Sudbury, Vale and Glencore. Over the past 25 years the program has been led by Rod Sein, Rob Kirk, George Morgan, Ed Snucins, Michelle Gillespie and John Gunn, with technical support by Jason Houle, Lee Haslam, Andrew Corston and dozens of students (includes graduate students: Andreas Luek, Kelly Lippert, Elizabeth Wright, Scott Kaufman) and summer assistants. Data from water quality monitoring was provided by OMOECC through the assistance of Jocelyne Heneberry, Bill Keller and John Bailey. We thank all who contributed, including the many land owners who provided access to these study lakes.

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APPENDIX I

Morphological data for smallmouth bass (*Micropterus dolomieu*) caught in BsM survey in Clearwater Lake, August 22 – 26, 2019.

Species	Fish #	Fork Length (mm)	Total Length (mm)	Weight (g)	Sex 1-Male 2-Female 9-Unknown	Maturity 1-Immature 2-Mature 9-Unknown	Ageing Structure 0-None 2-Scales 4-Pectoral Ray 7-Dorsal Spine A-Otolith B-Operculum D-Cleithrum	Tissue 0-None 1-Flesh 8-Stomach 9-Gonads A-Whole Fish X-Genetic
Smallmouth Bass	1	415	442	1060	2	20	A	1
Smallmouth Bass	2	423	441	1020	2	20	A	1
Smallmouth Bass	3	390	416	880	2	20	A	1
Smallmouth Bass	4	394	420	1000	2	20	A	1
Smallmouth Bass	5	351	374	640	2	20	A	1
Smallmouth Bass	6	292	413	-	2	20	A	-
Smallmouth Bass	7	425	442	-	2	20	A	-
Smallmouth Bass	8	354	375	-	2	20	A	-
Smallmouth Bass	9	344	361	-	2	20	A	-
Smallmouth Bass	10	359	376	-	1	20	A	-
Smallmouth Bass	11	362	381	-	1	20	A	-
Smallmouth Bass	12	336	350	-	2	20	A	-
Smallmouth Bass	13	310	327	-	1	20	A	-
Smallmouth Bass	14	285	300	-	1	20	A	-
Smallmouth Bass	15	304	320	-	2	20	A	-
Smallmouth Bass	16	315	330	-	2	20	A	-
Smallmouth Bass	17	335	353	-	1	20	A	-
Smallmouth Bass	60	170		-	-	-	-	-
Smallmouth Bass	18	335	470	-	2	20	A	-
Smallmouth Bass	19	464	485	-	2	20	A	-
Smallmouth Bass	20	265	284	-	1	10	A	-
Smallmouth Bass	21	373	386	-	1	20	A	-
Smallmouth Bass	22	210	218	-	1	10	A	-
Smallmouth Bass	30	401	419	1000	2	20	A	1
Smallmouth Bass	31	424	451	1180	1	20	A	1
Smallmouth Bass	32	391	408	900	1	20	A	1
Smallmouth Bass	33	329	341	495	1	20	A	1
Smallmouth Bass	34	318	336	510	1	20	A	1
Smallmouth Bass	66	156	-	-	-	-	-	-

Smallmouth Bass	67	148	-	-	-	-	-	-
Smallmouth Bass	68	145	-	-	-	-	-	-
Smallmouth Bass	69	151	-	-	-	-	-	-
Smallmouth Bass	70	190	200	89	-	-	-	-
Smallmouth Bass	71	194	204	100	-	-	-	-
Smallmouth Bass	37	335	354	495	2	20	A	-
Smallmouth Bass	38	335	371	575	2	20	A	-
Smallmouth Bass	39	389	413	850	2	20	A	-
Smallmouth Bass	40	403	424	1000	2	20	A	-
Smallmouth Bass	41	422	446	1100	2	20	A	-
Smallmouth Bass	35	400	424	920	1	20	A	1
Smallmouth Bass	36	462	489	1450	2	20	A	1
Smallmouth Bass	80	152	-	51	-	-	-	-
Smallmouth Bass	81	160	-	53	-	-	-	-
Smallmouth Bass	23	364	382	675	1	20	A	1
Smallmouth Bass	26	247	260	194	1	20	A	-
Smallmouth Bass	27	312	331	472	2	20	A	1
Smallmouth Bass	28	340	359	515	1	20	A	-
Smallmouth Bass	29	380	402	550	2	20	A	1
Smallmouth Bass	25	470	504	1650	2	20	A	-
Smallmouth Bass	24	386	405	850	2	20	A	1
Smallmouth Bass	46	341	360	545	1	20	A	1
Smallmouth Bass	42	200	209	102	2	10	A	1
Smallmouth Bass	43	246	261	213	2	20	A	1
Smallmouth Bass	44	290	311	350	2	20	A	1
Smallmouth Bass	45	414	440	1080	2	20	A	1
Smallmouth Bass	95	167	176	60	-	-	-	-
Smallmouth Bass	96	145	152	45	-	-	-	-
Smallmouth Bass	97	136	142	35	-	-	-	-
Smallmouth Bass	98	148	155	46	-	-	-	-
Smallmouth Bass	99	149	157	42	-	-	-	-
Smallmouth Bass	100	134	140	30	-	-	-	-
Smallmouth Bass	101	144	151	39	-	-	-	-
Smallmouth Bass	102	123	132	27	-	-	-	-
Smallmouth Bass	105	133	140	32	-	-	-	-
Smallmouth Bass	106	143	150	41	-	-	-	-
Smallmouth Bass	107	193	203	93	-	-	-	-
Smallmouth Bass	47	200	209	111	2	10	A	1
Smallmouth Bass	48	268	281	270	2	20	A	1
Smallmouth Bass	49	417	435	1080	2	20	A	1
Smallmouth Bass	50	247	263	196	2	20	A	1
Smallmouth Bass	51	267	280	288	1	20	A	1
Smallmouth Bass	52	286	300	355	2	20	A	1

Smallmouth Bass	53	270	284	274	1	20	A	1
Smallmouth Bass	123	146	151	38	-	-	-	-
Smallmouth Bass	54	328	349	525	1	20	A	1
Smallmouth Bass	55	387	410	850	2	20	A	1
Smallmouth Bass	56	403	429	998	2	20	A	1
Smallmouth Bass	126	49	56	47	-	-	-	-
Smallmouth Bass	57	259	271	238	2	10	A	1

APPENDIX II

Morphological data for smallmouth bass (*Micropterus dolomieu*) caught in Nordic survey in Clearwater Lake, August 22 – 26, 2019.

Species	**Fish #**	**Fork Length (mm)**	**Total Length (mm)**	**Weight (g)**	**Sex** 1-Male 2-Female 9-Unknown	**Maturity** 1-Immature 2-Mature 9-Unknown	**Ageing Structure** 0-None 2-Scales 4-Pectoral Ray 7-Dorsal Spine A-Otolith B-Operculum D-Cleithrum	**Tissue** 0-None 1-Flesh 8-Stomach 9-Gonads A-Whole Fish X-Genetic
Smallmouth Bass	20	140	-	120	-	-	-	-
Smallmouth Bass	21	140	-	120	-	-	-	-
Smallmouth Bass	22	200	-	120	-	-	-	-
Smallmouth Bass	23	270	-	120	-	-	-	-
Smallmouth Bass	56	130	-	157	-	-	-	-
Smallmouth Bass	57	190	-	157	-	-	-	-
Smallmouth Bass	1	210	219	132	1	10	A	1
Smallmouth Bass	2	328	343	520	1	20	A	1
Smallmouth Bass	3	335	352	360	1	20	A	1
Smallmouth Bass	4	236	250	174	2	20	A	1
Smallmouth Bass	66	160	-	420	-	-	-	-
Smallmouth Bass	67	270	-	420	-	-	-	-
Smallmouth Bass	68	360	-	420	-	-	-	-
Smallmouth Bass	69	260	-	420	-	-	-	-
Smallmouth Bass	70	360	-	420	-	-	-	-
Smallmouth Bass	75	127	-	73.8	-	-	-	-
Smallmouth Bass	76	135	-	73.8	-	-	-	-
Smallmouth Bass	77	147	-	73.8	-	-	-	-
Smallmouth Bass	78	196	-	73.8	-	-	-	-
Smallmouth Bass	79	134	-	73.8	-	-	-	-
Smallmouth Bass	80	197	-	73.8	-	-	-	-
Smallmouth Bass	81	196	-	73.8	-	-	-	-

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	197	87	-	-	-	-
Smallmouth Bass	11	438	460	1200	2	20	A	1
Smallmouth Bass	162	136	144	33	-	-	-	-
Smallmouth Bass	163	193	204	98	-	-	-	-
Smallmouth Bass	166	426	450	1140	-	-	-	-
Smallmouth Bass	167	140	-	47	-	-	-	-
Smallmouth Bass	168	162	-	62	-	-	-	-
Smallmouth Bass	12	229	236	162	-	20	A	1
Smallmouth Bass	13	254	271	234	-	20	A	
Smallmouth Bass	197	189	195	92	-	-	-	-
Smallmouth Bass	198	196	206	96	-	-	-	-

Smallmouth Bass	199	404	423	1000	-	-	-	-