

CHIEF LAKE
URBAN LAKES FISHERIES STUDY 2014



Fisheries Assessment by:
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INTRODUCTION

Chief Lake (46°21'41" N, 81°01'06" W) is a 115.2 ha lake located partially within the City of Greater Sudbury, in Broder/Tilton township. It is comprised of three basins and has a maximum depth of 34.0 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1.

Chief Lake is accessed by private road and has two seasonal residents with cottages on the lake. The lake is a year-round fish sanctuary therefore angling for any species is prohibited (Government of Ontario, 2014)

Historic information on Chief Lake appears to be limited, however verbal accounts suggest that it supported native lake trout (*Salvelinus namaycush*) in the 1950s (Sonoski, personal communication, 2014). The City of Greater Sudbury began monitoring phosphorus levels of Chief Lake, as well as other lakes in the area, as early as 1992 as part of their Lake Water Quality Program (Greater Sudbury, 2012). Chief Lake was stocked on June 5, 2008 with adult (6 – 7 years old; approx. 2.5 kg each), endangered Iroquois Bay, Great Lakes strain of lake trout by the Ministry of Natural Resources (MNR) (Selinger, personal communication, 2014). Chief Lake was chosen for these fish because they were too large to be kept in a culture facility and the MNR was looking for an empty, former lake trout lake to put them in. A similar stocking effort occurred in 1995 when approximately 500 Iroquois Bay strain lake trout were stocked in Great Mountain Lake, an acid-damaged, former lake trout lake in Killarney Provincial Park (Gunn, personal communication, 2015).

In 2014, as part of the Urban Lakes Study, field crews from Laurentian University's Cooperative Freshwater Ecology Unit surveyed Chief Lake, along with several other lakes around Greater Sudbury. The lake was part of the urban lake programming in 1990 and also had a Nordic Survey in 2006.

METHODS

Fisheries Community Assessment

The fish community of Chief Lake in 2014 was sampled 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).

Table 1 Chief Lake location and physical description (Poulin *et al.*, 1991).

Township	Broder/Tilton
Latitude/Longitude	46°21'41" N, 81°01'06" W
MNRF District	Sudbury
Watershed Code	2CF
Elevation (m)	261
Shoreline Development Factor	-
Number of Cottages/Lodges	2
Forest Type	Deciduous
Shoreline Type	Bedrock/boulder
Lake Surface Area (ha)	115.2
Maximum Depth (m)	34
Mean Depth (m)	9.9
Volume ($\times 10^4 \text{m}^3$)	1134.8
Secchi (m)	5.42 (June 18, 2014)
Access	Private road off Chief Lake Rd. approx. 14 km south of Sudbury.

A total of 40 multi-mesh gillnets were set in Chief Lake from June 17 to 24, 2014. Nets were set for approximately 12 hours at randomly selected locations on the lake across multiple depth strata (7 nets in <3.0 m; 7 nets in 3.0 - 5.9 m; 10 nets in 6.0 – 11.9 m; 8 nets in 12.0 – 19.9 m; 8 nets in 20.0 – 34.9 m). Figure 2 shows the locations of all gillnets set in Chief Lake during the 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 of each 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 Chief 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 Chief 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 Chief Lake and picked by hand.

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Chief Lake on June 18, 2014, using a YSI Model 52 dissolved oxygen – temperature meter. Readings were taken at 0.5 m intervals through the water column.

Water samples were collected on July 15, 2014 from the surface of Chief Lake. Samples were sent to the Ministry of Environment and Climate Change (MOECC) chemistry lab in Dorset, and analyzed for pH, conductivity, total inlection point alkalinity, dissolved organic carbon, metals and major ions. Sampling location for water quality can be seen in Figure 2.

RESULTS AND DISCUSSION

Fisheries Community Assessment

During the June 17 to 24 netting survey, a total of 40 nets were set, catching a total of six different species: lake trout (*Salvelinus namaycush*), golden shiner (*Notemigonus crysoleucas*), creek chub (*Semotilus atramaculatus*), pumpkinseed (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), and Iowa darter (*Etheostoma exile*). Total catch, total weight (g) and catch-per-unit effort (CPUE) from the 2014 Nordic survey can be seen in Table 2.

Table 2 Catch summary and CPUE for all species captured in Chief Lake June 17 - 24, 2014. * 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)
Lake Trout	2	2	874.7	0.05	21.8675
Golden Shiner	4	3	34.4	0.1	0.86
Creek Chub	4	4	88.6	0.1	2.215
Pumpkinseed*	32	30	538.6	0.8	13.465
Yellow Perch*	1390	1266	11636.3	34.75	290.9075
Iowa Darter*	10	10	13.9	0.25	0.3475
Total	1442	1315	13186.5	36.05	329.6625

A total of two lake trout were captured during the survey with total lengths of 255 mm and 451 mm, neither of the fish had fin clips and the smaller of the fish was immature, confirming that the Iroquois Bay stocked fish had successfully reproduced in this once too acid lake (Figure 3). A complete summary of morphological data for lake trout can be seen in Appendix I.

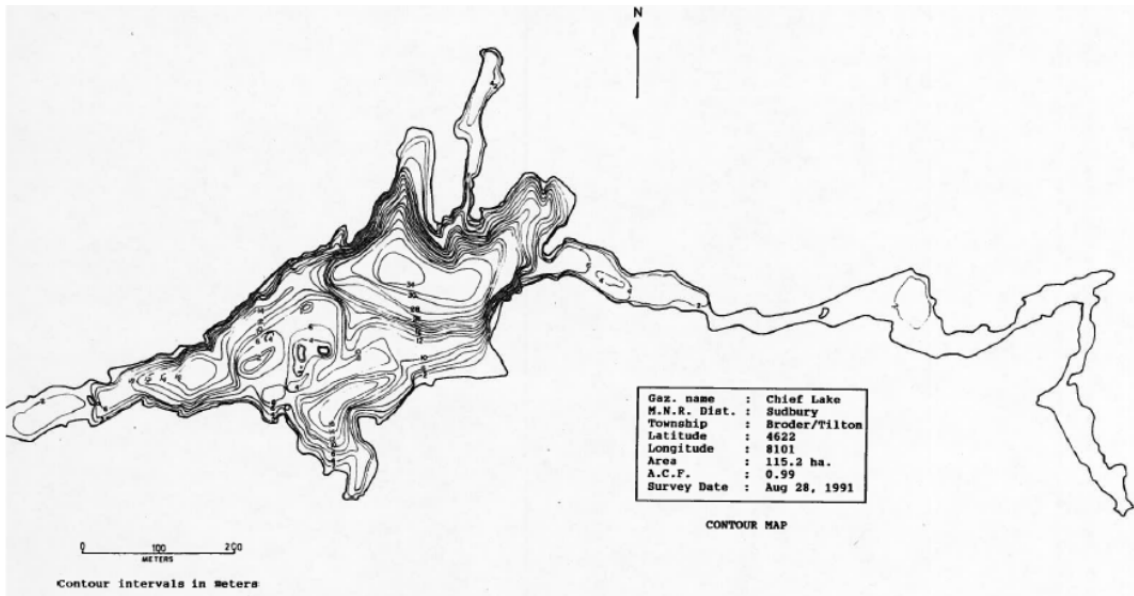


Figure 1 Bathymetric map of Chief Lake.

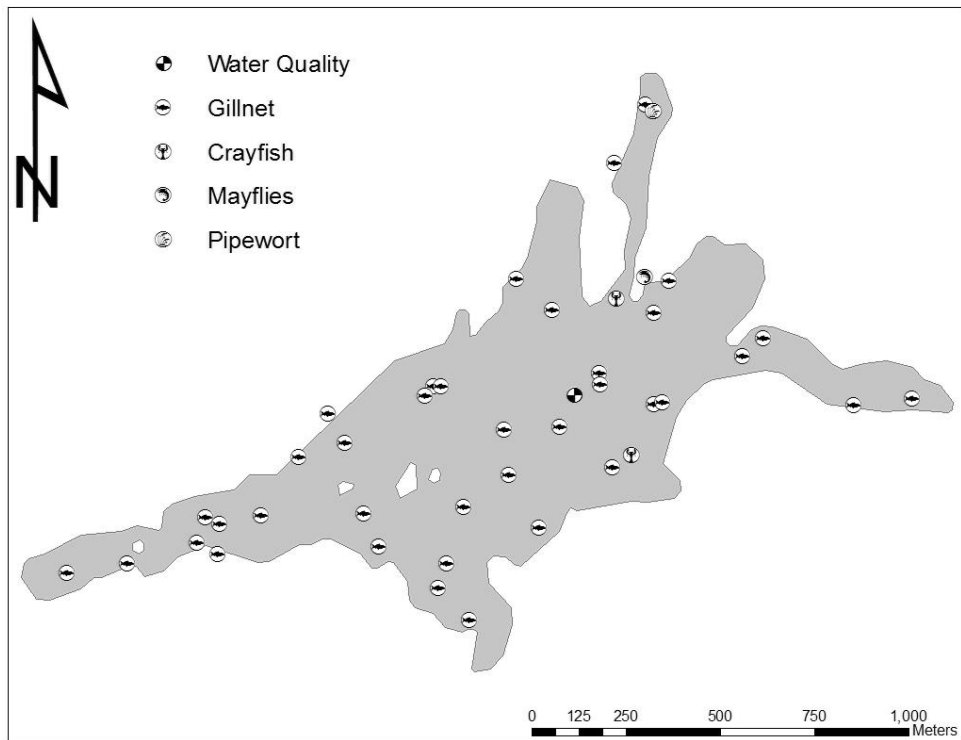


Figure 2 Outline map of Chief Lake showing the location of sampling gear or collected organisms.



Figure 3 Photo of the immature lake trout from Chief Lake in 2014.

Yellow perch was the dominant fish species found in Chief Lake (Table 2) with total lengths ranging from 23 mm to 218 mm. A length frequency histogram for yellow perch can be seen in Figure 4.

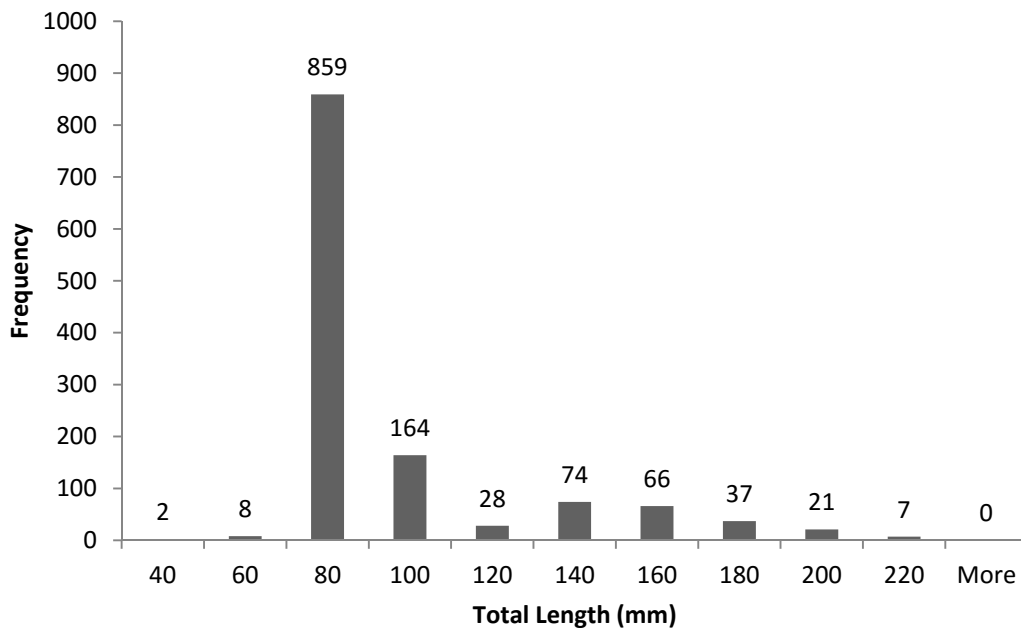


Figure 4 Length frequency histogram for yellow perch (n=1266) captured in Chief Lake June 17 - 24, 2014.

Only central mudminnow (*Umbra limi*) existed in the lake during the 1991 Urban Lakes Survey with a total catch of 61 fish at the time (Poulin *et al.*, 1991). In 2006, when Chief Lake was surveyed using the Nordic protocol for the first time, yellow perch was the only species recorded

with a total catch of 1553 individuals (Cooperative Freshwater Ecology Unit, 2014). Species richness had significantly increased by 2014 when six species had been observed with a total catch of 1442 fish. Yellow perch was the most abundant species observed during this survey, accounting for 96% of the total catch (Figure 5). Species richness and proportion of total catch can be seen in Table 3.

Table 3 Species richness and proportion of total catch for Chief Lake (1. Poulin *et al.*, 1991; 2. Cooperative Freshwater Ecology Unit, 2014).

Survey Type	Multi-Gear Survey		Nordic		Nordic	
Year	1990 ¹		2006 ²		2014	
Species	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Lake Trout	-	-	-	-	2	0.14
Central Mudminnow	61	100	-	-	-	-
Golden Shiner	-	-	-	-	4	0.28
Creek Chub	-	-	-	-	4	0.28
Pumpkinseed	-	-	-	-	32	2.22
Yellow Perch	-	-	1553	100	1390	96.39
Iowa Darter	-	-	-	-	10	0.69
Total	61	100	1553	100	1442	100
Species Richness	1		1		6	

Yellow perch accounted for the majority of the total biomass in Chief Lake in 2014 with a total weight of 11636 g. This is followed by that of two lake trout with a total weight of 875 g. Total biomass data can be seen in Figure 6.

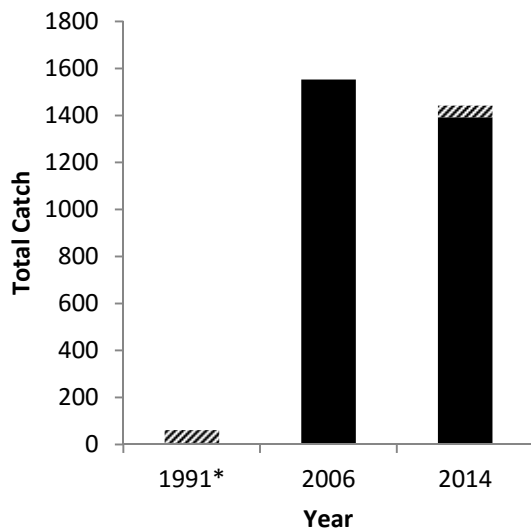


Figure 5 Total catch data from Chief Lake (*Nordic method was not used during the 1991 Urban Lakes Fishery Survey. Poulin et al. 1991)

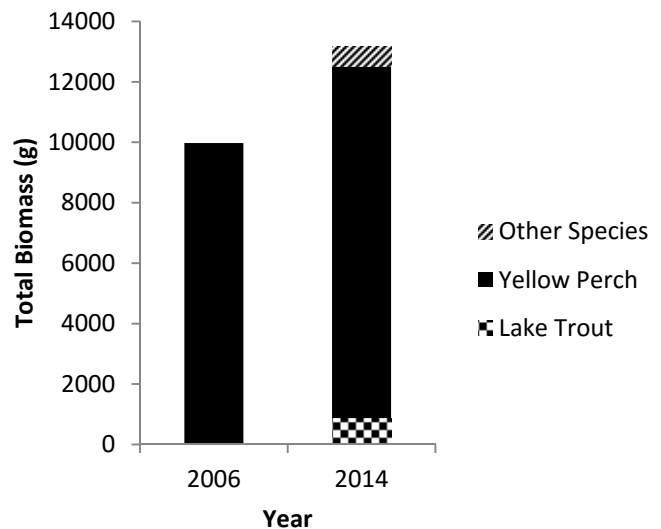


Figure 6 Total biomass (g) data from Chief Lake.

Since yellow perch was the only species caught during the 2006 Nordic survey, species diversity equals zero. As of 2014, with the addition of five different species, Shannon H Diversity has improved to a “low” value of 0.1962 (Morgan and Snucins, 2005).

Baseline Organisms

No clams or snails were found at Chief Lake. A total of 50 mayflies were captured at the northwest end of the lake. A total of 20 crayfish were captured in traps set near large boulders at the north and south ends of the lake. A bulk sample of five Pipewort (*Eriocaulon aquaticum*) was collected at the access point, at the extreme north end of Chief Lake.

Water Quality Assessment

At the time of the Nordic Index Netting survey, Chief Lake was thermally stratified (Figure 7). Water temperatures ranged from 19.0 °C at the surface to 4.4 °C at 26.5 m. Dissolved oxygen levels ranged from 8.8 mg/L to 5.5 mg/L. Depth at the site of the temperature and dissolved oxygen profiles was 34.0 m and the secchi water clarity was 5.42 m. Wind was high at the time the profiles were being measured therefore it was difficult to record readings past 26.5 m as the boat had drifted from the original site.

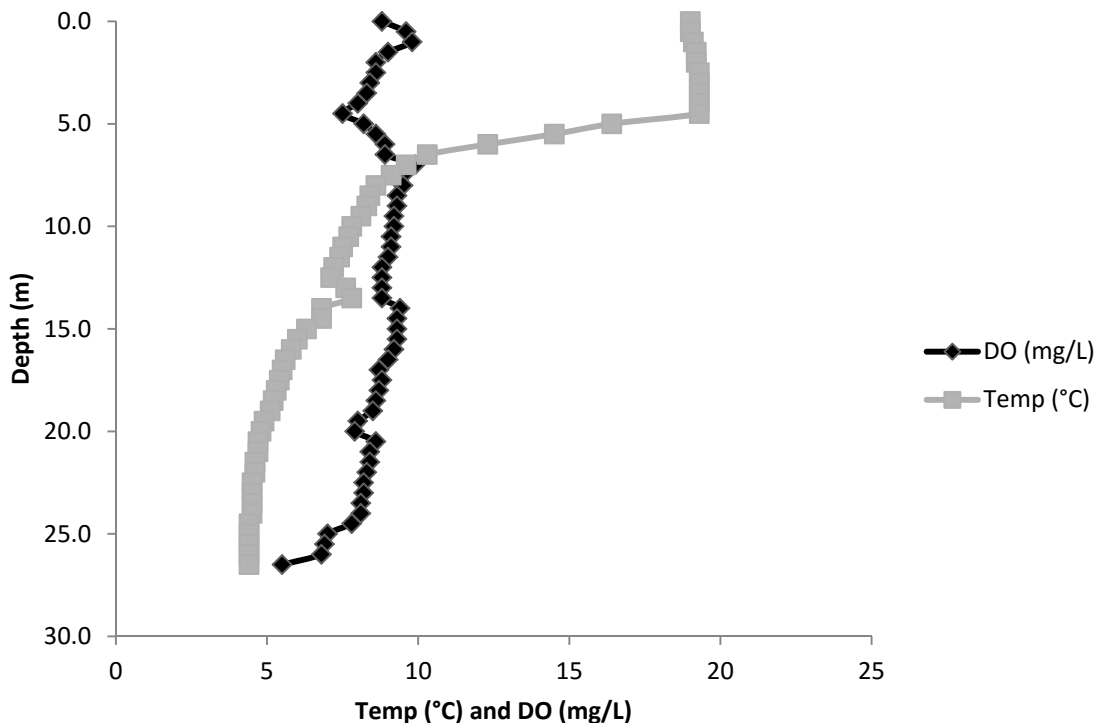


Figure 7 Temperature (°C) and dissolved oxygen (mg/L) profile for Chief Lake, measured June 18, 2014.

Chief Lake was a very acid (pH 4.8) and metal contaminated lake in 1990 (Table 4). The metals and acidity have declined with reduced emissions from local smelters (Keller *et al.*, 2007).

As of July 15, 2014, Chief Lake is still considered acidic with a pH value of 5.87. Nickel (47.9 µg/L) and Copper (7.3 µg/L) concentrations are above criteria set by the Ministry of Environment and Climate Change's (MOECC) Provincial Water Quality Objective (PWQO) for the protection of aquatic life. Aluminum (46 µg/L), Iron (30 µg/L) and Zinc (5 µg/L) concentrations are below these criteria (Ontario Ministry of Environment and Energy, 1994).

Table 4 Water chemistry from Chief Lake (1. Ontario Ministry of Environment and Energy, 1994; 2. Watson 1992).

Parameter	PWQO ¹	Year	
		1990 ² /91	2014
pH	6.5-8.5	4.8	5.87
TIA Alkalinity (mg/L CaCO ₃)	-	-1.5	0.805
Conductivity (µS/cm)	-	4.0	20
DOC (mg/L)	-	0.7	2.9
SO ₄ (mg/L)	-	12.2	5.35
Total P (µg/L)	20	-	3.3
Total Cu (µg/L)	5	31	7.3
Total Ni (µg/L)	25	120	47.9
Total Zn (µg/L)	30	17.0	5.4
Total Fe (µg/L)	300	40.0	30
Total Mn (µg/L)	-	130	29.9
Total Al (µg/L)	75	180	45.9

CONCLUSIONS

Although concentrations of Cu and Ni remain above the criteria for the protection of aquatic life (Ontario Ministry of Environment and Energy, 1994) the current pH of Chief Lake is now above the pH level (pH5.5) for natural reproduction of lake trout (Beggs and Gunn, 1986). It is therefore very promising to see the first evidence of reproducing lake trout in this lake six years after initial stocking efforts took place. Lake trout is considered a primary indicator of overall lake health (Ryder and Edwards, 1985). As the water quality of this lake will likely continue to improve over time, further management efforts may be required in order to reestablish a full population of lake trout (Gunn and Mills, 1998). In addition, Chief Lake also supports populations of five other fish species. Clams and snails were not observed, however crayfish and acid-sensitive mayflies appear quite common.

ACKNOWLEDGEMENTS

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APPENDIX I

Morphological data for lake trout (*Salvelinus namaycush*) from Chief Lake, June 17 - 24, 2014.

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	Tissue
							0-None 2-Scales 4-Pectoral Ray 7-Dorsal Spine A-Otolith B-Operculum D-Cleithrum	0-None 1-Flesh 8-Stomach 9-Gonads A-Whole Fish X-Genetic
Lake Trout	543	394	431	735.1	1	2	A	1X
Lake Trout	805	233	255	139.6	2	1	A	1X