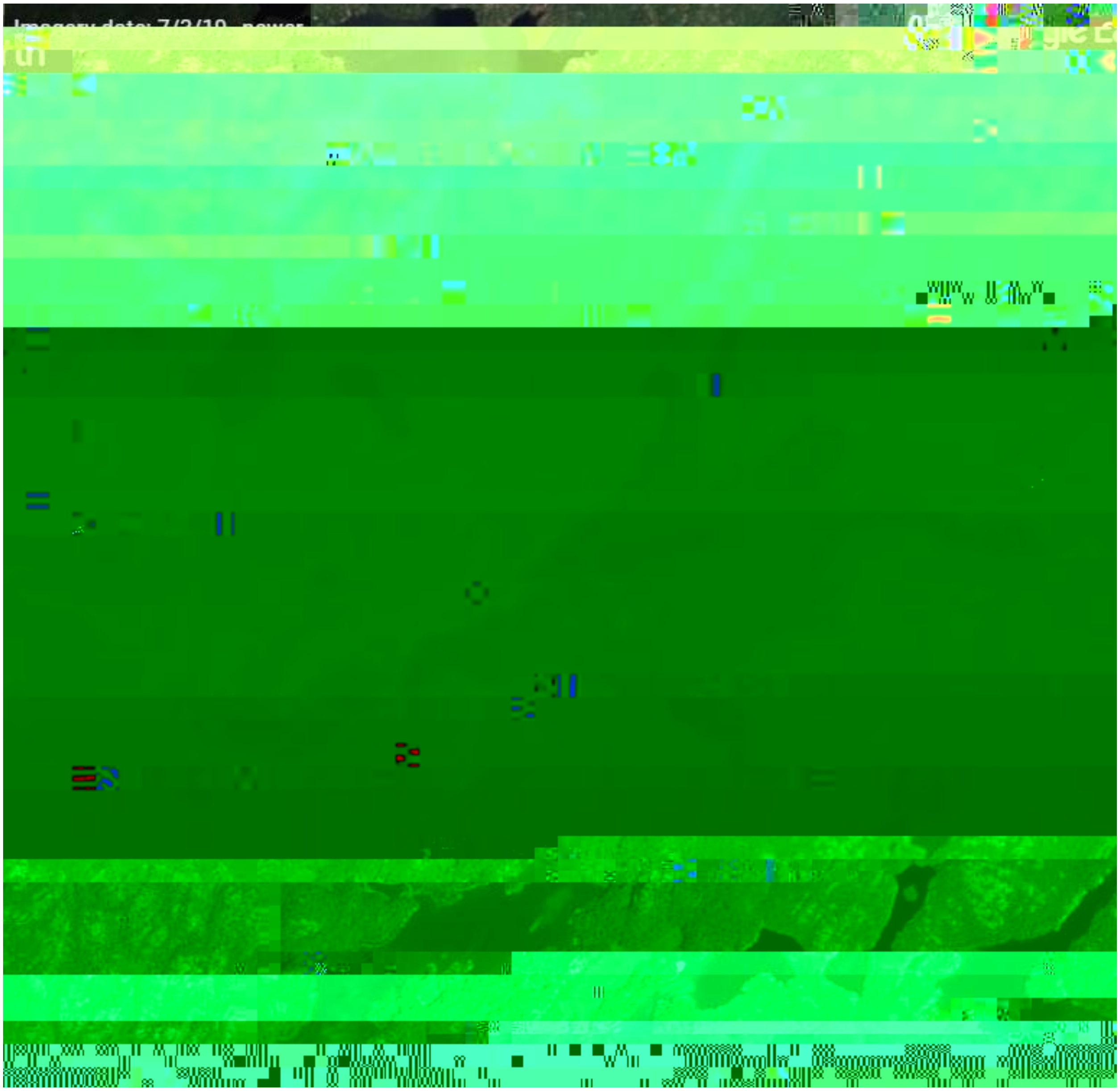
CHIEF LAKE

URBAN LAKES FISHERIES STUDY 2019/2021



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CHIEF LAKE

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URBAN LAKES FISHERIES STUDY

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 (x$10^4$$m^3$)	1134.8
Secchi (m)	4.0 (June 24, 2019)
Access	Private road off Chief Lake Rd. approx. 14 km south of Sudbury.

Secchi reading was 5.42 m in 2014 – now 4.0 m 5 years later.

METHODS

Fisheries Community Assessment

In 2006 and 2014, the fish community of Chief Lake 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).

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 and 2021 BsM surveys 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

Baseline Organisms (2019/2021)

Attempts were made to collect samples of clams (n=10), snails (n=30), crayfish (n=20), and Heptageniid mayflies (n=50) 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. 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

Figure 1 Photo of an immature lake trout from

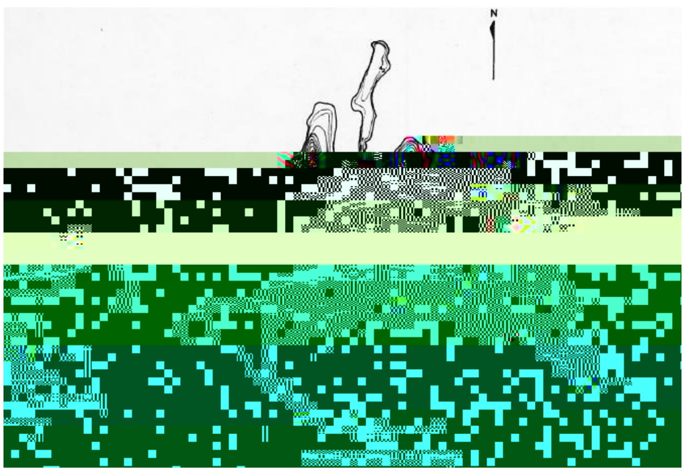

Figure 3 Bathymetric map of Chief Lake.

Figure 4. Map of Chief Lake showing the location of depth stratums and sampling sites in 2019.

Yellow perch was the dominant fish species found in Chief Lake (Table 3) with total lengths ranging from 50 mm to 190 mm (in 2019). A length frequency histogram for yellow perch caught in 2019 can be seen in Figure 5.

Figure 5 Length frequency histogram for yellow perch

Central Mudminnow	61	100	-	-	-	-	-	-	-	-
Golden Shiner	-	-	-	-	4	0.28	-	-	-	-
Creek Chub	-	-	-	-	4	0.28	17	4.58	38	7.45
Pumpkinseed	-	-	-	-	32	2.22	17	4.58	36	7.06
Yellow Perch	-	-	1553	100	1390	96.39	302	81.40	365	71.57
Iowa Darter	-	-	-	-	10	0.69	11	2.96	5	0.98
Total	**61**	**100**	**1553**	**100**	**1442**	**100**	**371**	**100**	**510**	**100**
Species Richness	1		1		6		7		6	

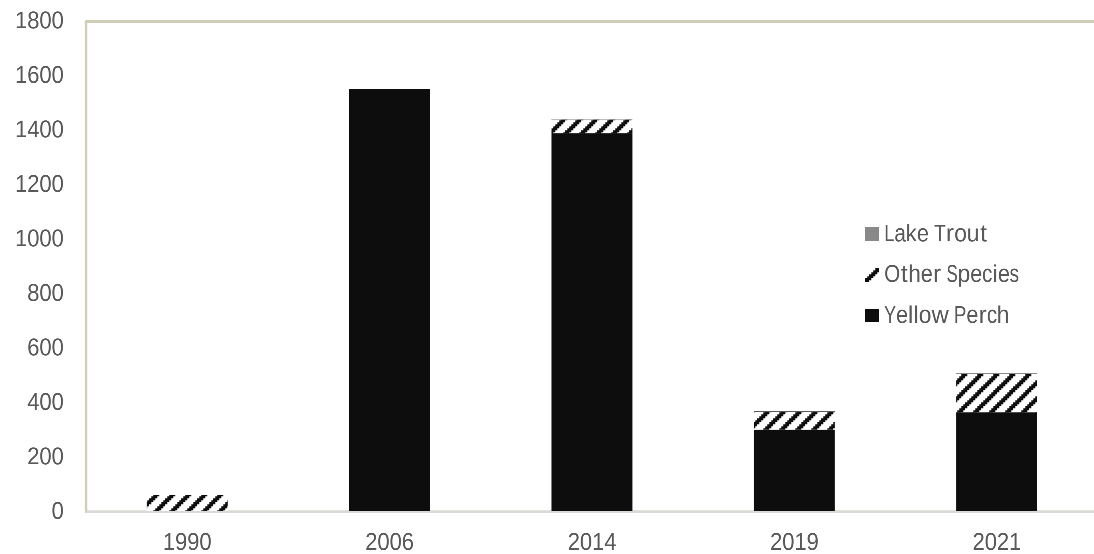

Figure 6 Total catch data from Chief Lake (1990 – Multi-Gear Survey; 2006 & 2014 – NORDIC Survey; 2019 – BsM Survey).

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 had improved to a “low” value of 0.196, and now has climbed to 0.771 in 2019 (Morgan and Snucins, 2005). Although species richness went back to six in 2021, diversity continues to improve with species abundance (evenness), resulting in a new value of 0.965.

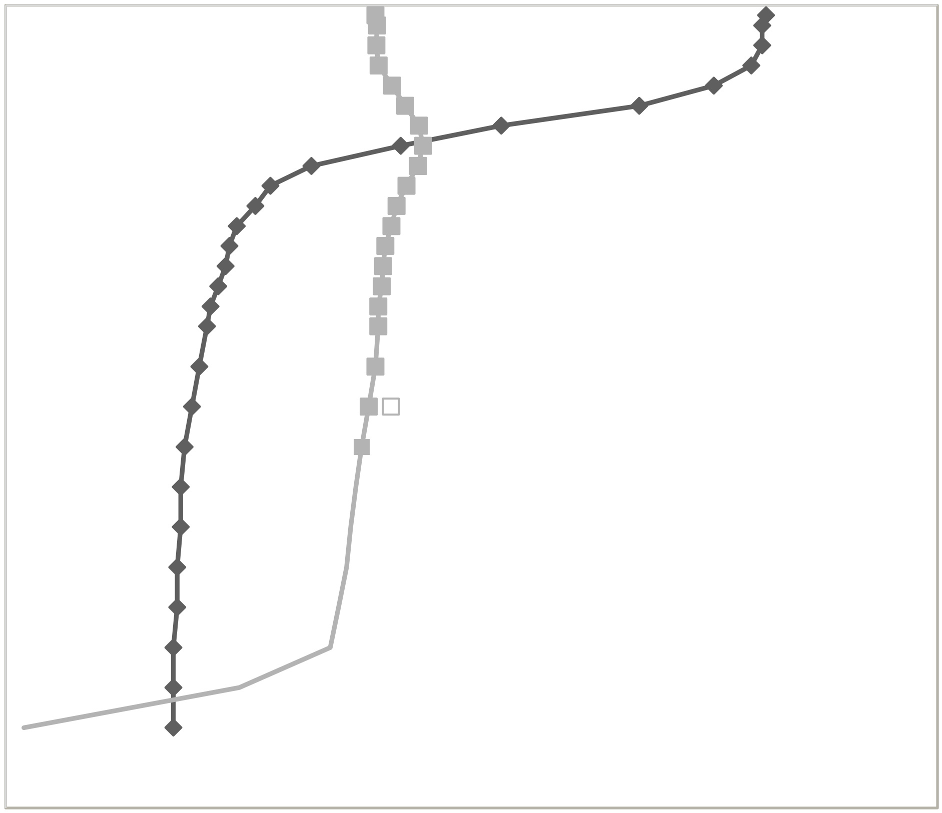

Figure 8. Temperature (°C) and dissolved oxygen (mg/L) profile for Chief Lake, measured June 24, 2019.

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 June 2019, Chief Lake had a pH value of 6.25, increasing from 5.87 in 2014. Nickel (38.6 µg/L) and Copper (6.5 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 (42.9 µg/L), Iron (30 µg/L) and Zinc (4.3 µg/L) concentrations are below these criteria (Ontario Ministry of Environment and Energy, 1994).

*Copper PWQO has recently undergone an interim change based on new research suggesting that TIA Alkalinity $CaCO_3$ (mg/L) will depict the quantity of Total Cu that should be present (Canadian Council of Ministers of the Environment, 1998). In previous reports, 5 µg/L was the standard total Cu value for protection of aquatic life and now an interim change to the PWQO states that at a low TIA Alkalinity value 0-20 mg/L of $CaCO_3$ should not have Total Cu readings greater than 1 μg/L. Anything greater than 20 mg/L of $CaCO_3$ continues to have the 5 μg/L standard.

Table 2 Water chemistry from Chief Lake (1. Ontario Ministry of Environment and Energy, 1994; 2. Watson 1992; 3. Chief Lake Urban Fisheries Study 2019).

Parameter	PWQO[1]	Year		
		1990[2]/91	2014[3]	2019[3]
pH	6.5-8.5	4.8	5.87	6.25
TIA Alkalinity (mg/L $CaCO_3$)	-	-1.5	0.805	1
Conductivity (μS/cm)	-	4	20	17.2
DOC (mg/L)	-	0.7	2.9	3.2
SO_4 (mg/L)	-	12.2	5.35	4.25
Total Ca (mg/L)	-	-	1.38	1.3
Total P (μg/L)	20	-	3.3	4
Total Cu (μg/L)	1, 5	31	7.3	6.5
Total Ni (μg/L)	25	120	47.9	38.6
Total Zn (μg/L)	30	17	5.4	4.3
Total Fe (μg/L)	300	40	30	30
Total Mn (μg/L)	-	130	29.9	22.4
Total Al (μg/L)	75	180	45.9	42.9

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 pH in 2014 of Chief Lake exceeded the pH level (pH 5.5) for natural reproduction of lake trout, and in 2019 the pH surpassed the threshold to sustain sensitive species (pH 6.0)

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