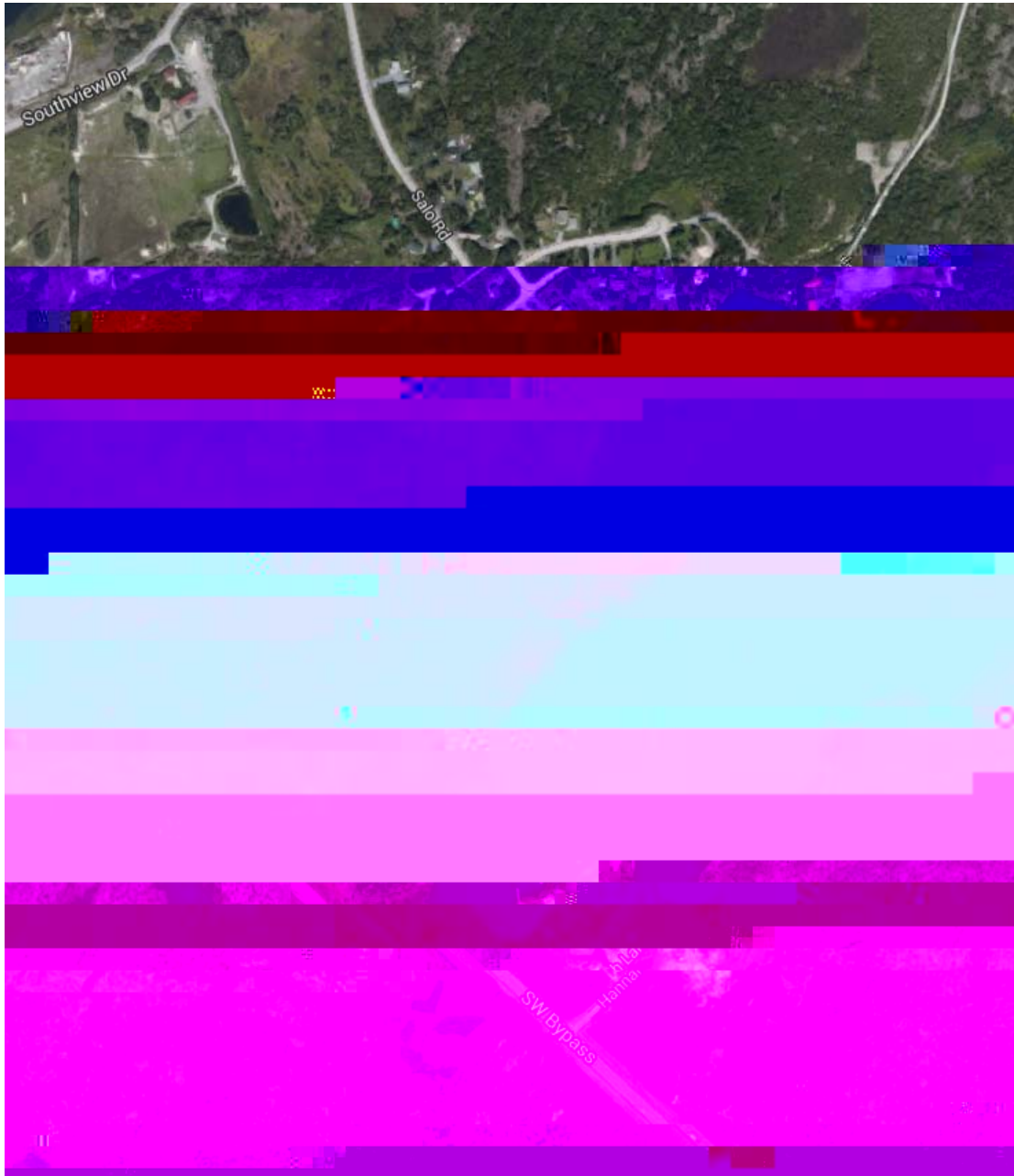# HANNAH LAKE

URBAN LAKES FISHERIES STUDY 2014

Fisheries Assessment by:
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HANNAH LAKE
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INTRODUCTION

Hannah Lake (46°26'33" N, 80°02'19" W) is a 27.7 ha lake located within the City of Greater Sudbury, in Broder township. It has one main basin with a maximum depth of 8.1 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1.

Hannah Lake is accessed by private road off Southview Dr. There are about 17 residences around the shoreline of Hannah Lake, including the Hannah Lake Bible Camp. There is no public access to the lake, and very little evidence of any angling pressure.

Hannah Lake has been intensely studied and monitored as early as 1974 when the lake had a pH of 4.29 and nickel and copper concentrations were greater than 1000 µg/L. Hannah lake is one of the intensive monitoring lakes of OMOECC at the Co-op Unit, it is also recognized in the Official Plan of the city of Greater Sudbury as a "monitoring lake". Due to its proximity to the Copper Cliff smelter, Hannah Lake was once considered one of the most atmospherically contaminated lakes in the city (Yan *et al*, 1996). Hannah Lake was treated with 13.0 T of $Ca(OH)_2$ and 7.5T of $CaCO_3$ in 1975 which resulted in an increase in pH and a decline in metals (Scheider *et al*, 1975; Dillon *et al*, 1979). The surrounding watershed of Hannah Lake was treated in the early 1980s with dolomitic limestone and fertilizers as part of the Greening of Sudbury initiative (Ontario Ministry of the Environment, 1982), which, in combination with a decline in local industrial emissions, resulted in a decline in metal concentrations and a stabilization of pH at a circumneutral level in Hannah. The first observation of fish in Hannah was a single northern redbelly dace (*Chrosomus eos*) in 1984 (Ed. Snucins pers. comm). Yellow perch (*Perca flavescens*) colonized at approximately the same time (e.g. plexiglass trap caught 381 perch in 1986; OMNR data) and were abundant when the lake was surveyed in 1990 (Poulin *et al*, 1991). Quantitative Nordic index netting surveys began in 2003 (Cooperative Freshwater Ecology Unit, 2014). Hannah Lake was stocked with 184 smallmouth bass (*Micropterus dolomieu*) in 2006 as part of a whole-lake piscivorous fish manipulation experiment led by A. Luek and G. Morgan (Luek *et al*, 2010).

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

Township	Broder
Latitude/Longitude	46°26'33" N, 80°02'19" W
MNRF District	Sudbury
Watershed Code	2CF

Shoreline Type	Bedrock/sand
Lake Surface Area (ha)	27.7
Maximum Depth (m)	8.1
Mean Depth (m)	4.0
Volume (x10^{4}m^3)	105.0
Secchi (m)	3.4 (July 6, 2014)
Access	Private drive off of Southview Dr.

METHODS
Fisheries Community Assessment

The fish community of Hannah 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).

A total of 16 multi-mesh gillnets were set in Hannah Lake from July 5 - 8, 2014. Nets were set for approximately 12 hours at randomly selected locations on the lake across multiple depth strata (5 nets in <3.0 m; 6 nets in 3.0 - 5.9 m; 5 nets in 6.0 – 11.9 m). Figure 2 shows the locations of all gillnets set in Hannah 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 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

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Hannah Lake on August 6, 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 August 6, 2014 from the surface of Hannah 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 and inorganic carbon, metals and major ions.

The sampling location for water quality can be seen in Figure 2.

Figure 1 Bathymetric map of Hannah Lake.

Figure 2 Outline map of Hannah Lake showing the locations of sampling gear or collected organisms.

RESULTS AND DISCUSSION

Fisheries Community Assessment

The Nordic survey captured four species northern pike (Esox lucius), pumpkinseed (Lepomis gibbosus), smallmouth bass (Micropterus dolomieu) and yellow perch (Perca flavescens). Other species observations from previous netting surveys include brown bullhead (Ameiurus nebulosis), walleye (Sander vitreus) and Iowa darter (Etheostoma exile) were not captured in

Baseline Organisms

No clams or snails were collected from Hannah Lake. Approximately 30 mayflies were captured from Hannah Lake at the northeast shore where water exits the lake. A total of nine crayfish were caught in traps set at various locations around Hannah Lake.   Twenty-four nighttime zooplankton hauls were conducted at Daisy Lake on July 22, 2014.   A sufficient stable isotope sample (approx. 50-300 individuals) of Chaoborus sp. was collected. No aquatic plants were collected from Hannah Lake.

Water Quality Assessment

At the time of the Nordic Index Netting survey, Hannah Lake was thermally stratified but lacked a prominent hypolimnion (Figure 6). Water temperatures ranged from 20.8 °C at the surface to 12.2 °C at 8.0 m. Dissolved oxygen levels ranged from 8.37 mg/L to 0.31 mg/L. Depth at the site of the temperature and dissolved oxygen profiles was 8.1 m and the secchi water clarity was 3.4 m.
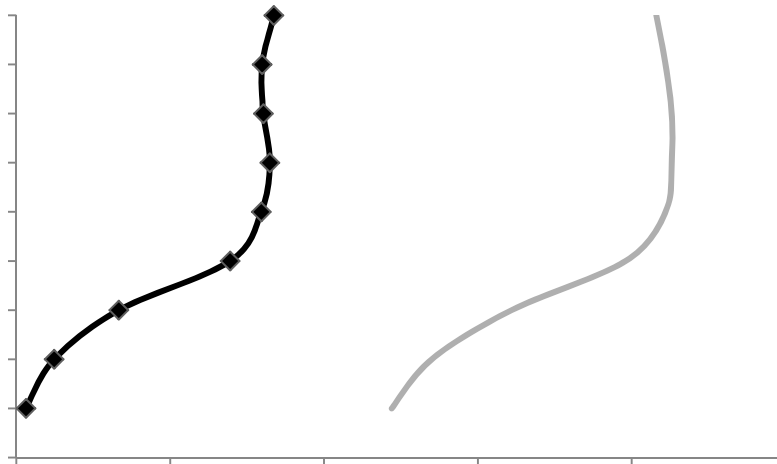

Figure 6 Temperature (°C) and dissolved oxygen (mg/L) profile for Hannah Lake, measured July 10, 2014.

Hannah Lake has undergone considerable recovery since 1974, and has continued to do so since 2003 with a slight increase in pH to 7.84. TIA alkalinity has also increased during this time to 22.4 mg/L CaCO$_3$. Concentrations of metals such as Copper (Cu), Nickel (Ni) and Aluminum (Al) have declined over time as well. These improvements are likely a result of the neutralization experiments that occurred in the mid-1970s and early 1980s (Uutala and Smol, 1996), as well as reductions in emissions from local smelters (Keller *et al*, 2007).

As of August 6, 2014, Hannah Lake has sustained a neutral pH level of 7.84 and an increase in TIA alkalinity to 22.4 mg/L CaCO$_3$. Metal concentrations continue to decrease. However, 5

Copper (11.3 µg/L) and Nickel (35.2 µg/L) concentrations remain 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 has decreased below this level (Ontario Ministry of Environment and Energy, 1994).

Table 4 Water chemistry of Hannah Lake (1. Ontario Ministry of Environment and Energy, 1994; 2. Yan *et al*, 1996; 3. Keller *et al*, 2004)

Parameter	PWQO[1]	Year			
		1974[2]	1990[3]	2003[3]	2014
pH	6.5-8.5	4.29	7.06	7.25	7.84
TIA Alkalinity (mg/L $CaCO_3$)	-	-	12.10	16.93	22.4
Conductivity (µS/cm)	-	-	359.0	190.0	379
True Colour (TCU)	-	-	-	-	20.9
DOC (mg/L)	-	-	3.8	3.6	3.8
Ca (mg/L)	-	11.4	13.40	10.60	9.52
Mg (mg/L)	-	-	4.56	3.57	3.52
Na (mg/L)	-	-	44.60	62.80	40.5
K (mg/L)	-	-	1.980	1.660	1.49
SiO_3 (mg/L)	-	-	0.38	0.26	0.36
SO_4 (mg/L)	-	-	28.98	16.60	11.4
Total Cu (µg/L)	5	1108	64	22	11.3
Total Ni (µg/L)	25	1865	180	111	35.2
Total Zn (µg/L)	30	-	11	3	0.6
Total Fe (µg/L)	300	-	290	114	60
Total Mn (µg/L)	-	-	38	70	13
Total Al (µg/L)	75	-	200	13	6.4

CONCLUSIONS

The history of this lake's chemical and biological recovery provides abundant examples of the benefits of reducing and controlling SO_2 emissions (Keller *et al*, 2007). Although the water quality of Hannah Lake has made considerable improvements over the past 40 years, concentrations of Ni and Cu remain above PWQO criteria for the protection of aquatic life (Ontario Ministry of Environment and Energy, 1994). However, pH has improved from 4.29 to 7.84, and metal concentrations have declined by 99% for Cu and 98% for Ni. Clams and snails were not observed, however crayfish and acid-sensitive mayflies appear to be common. Hannah Lake is a shallow, urban lake that supports populations of four species, including two species of sport fish: northern pike and smallmouth bass.

ACKNOWLEDGEMENTS

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APPENDIX I

Morphological data for northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*) from Hannah Lake, July 5 - 8, 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 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
Northern Pike	2	601	643	1517.9	2	2	A, D	1
Northern Pike	3	691	734	1951.9	2	2	A, D	1
Northern Pike	4	290	314	168.4	9	1	A, D	1
Northern Pike	81	690	737	2145.1	2	2	A, D	1
Northern Pike	201	646	682	1654.1	2	2	A, D	1
Northern Pike	422	270	294	165.6	1	1	A, D	1
Northern Pike	438	453	483	651.8	2	2	A, D	1
Northern Pike	571	615	654	1725.4	1	2	A, D	1
Northern Pike	739	702	747	2656.7	2	2	A, D	1
Northern Pike	740	266	285	125	9	1	A, D	1
Northern Pike	824	430	459	512.8	1	9	A, D	1
Smallmouth Bass	1	452	478	1620.7	2	2	A	1
Smallmouth Bass	74	441	469	1415.5	2	2	A	1
Smallmouth Bass	75	461	482	1627.2	2	2	A	1