DAISY LAKE

URBAN LAKES FISHERIES STUDY 2014

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INTRODUCTION

Daisy Lake (46°27'11" N, 80°52'56" W) is a 36.1 ha lake located within the City of Greater Sudbury, in Dill/Neelon township. It has two main basins with a maximum depth of 14.5 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1.

Daisy Lake is situated partially within the Daisy Lake Uplands Provincial Park and is accessed by Desloges Rd. There are no residents on Daisy Lake and until recently it received very little angling pressure.

Daisy Lake and its surrounding watershed have been regularly studied since 1984 when the lake had a pH reading of 4.5 (Kirk and Kenzie, 1990). As part of a restoration experiment in 1994 a 38 ha catchment area at the northeast end of the lake (known as Catchment J) was aerially limed with 410 tons of coarse dolomitic limestone, with an additional 54 tons of highly soluble pelletized fine dolomitic limestone added to 15 small wetland sites within the treated area in 1995 (Gunn *et al*., 2001). The Ministry of Natural Resources attempted to introduce splake (*Salvelinus fontinalis x Salvelinus namaycush*) in Daisy Lake in 2005 (Ontario Ministry of Natural Resources, 2013), however none have ever been caught during previous netting surveys (Cooperative Freshwater Ecology Unit, 2014).

In 2014, as part of the Urban Lakes Study, field crews from Laurentian University's Cooperative Freshwater Ecology Unit surveyed Daisy Lake, along with several other lakes around Greater Sudbury.

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

Township	Dill/Neelon
Latitude/Longitude	46°27'11" N, 80°52'56" W
MNRF District	Sudbury
Watershed Code	2DB
Elevation (m)	231
Shoreline Development Factor	2.59
Number of Cottages/Lodges	0
Forest Type	Birch transition
Shoreline Type	Bedrock
Lake Surface Area (ha)	36.1
Maximum Depth (m)	14.5
Mean Depth (m)	5.2
Volume ($x10^4 m^3$)	187.5
Secchi (m)	5.0 (July 10, 2014)
Access	Desloges Rd. to wetland at west end of Daisy Lake (approx. 10.5 km).

METHODS

Fisheries Community Assessment

In 2014 the fish community of Daisy 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).

A total of 16 multi-mesh gillnets were set in Daisy Lake from July 8 to 11, 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; 5 nets in 3.0 - 5.9 m; 3 nets in 6.0 – 11.9 m; 3 nets in 12.0 – 19.9 m). Figure 2 shows the locations of all gillnets set in Daisy 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 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 Daisy Lake for food web studies.

Clams and snails were targeted by visually scanning near-shore areas and picking the organism 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 Daisy Lake, and picking the organism 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 Daisy Lake and picked by hand.

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Daisy Lake on July 10, 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 22, 2014 from the surface of Daisy 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.

Sampling location for water quality can be seen in Figure 2.

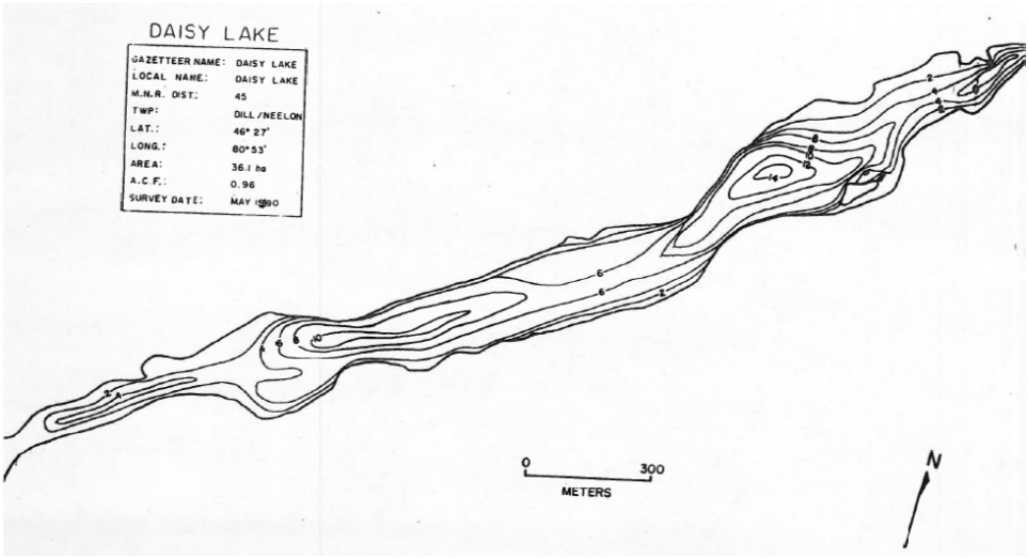

Figure 1 Bathymetric map of Daisy Lake (Kirk and Kenzie, 1990).

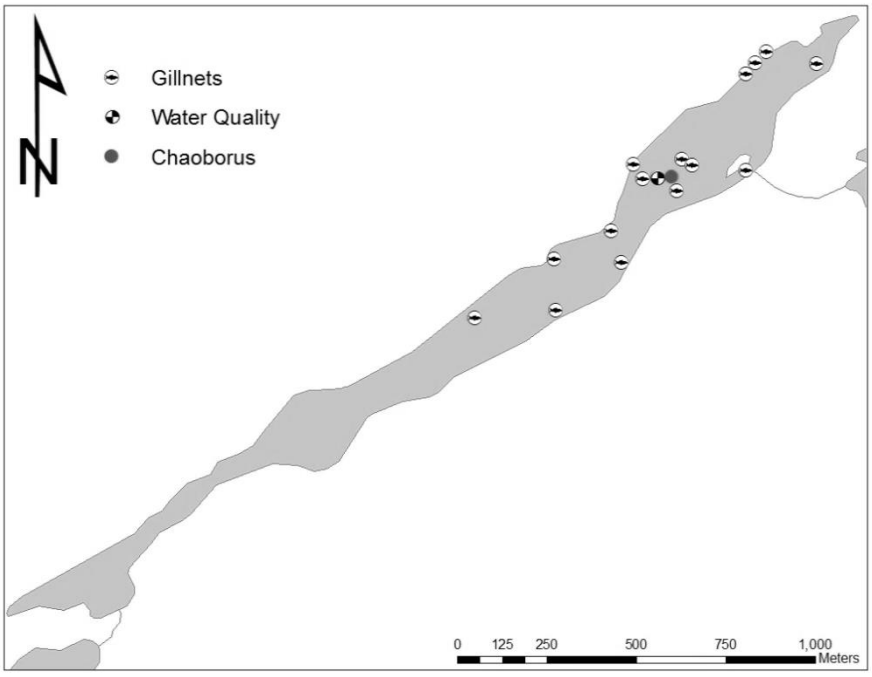

Figure 2 Outline map of Daisy Lake showing the location of sampling gear or collected organisms.

RESULTS AND DISCUSSION

Fisheries Community Assessment

During the July 8 to 11 netting survey, a total of 16 nets were set, catching a total of seven species: northern pike (*Esox lucius*), white sucker (*Catostomus commersonii*), brown bullhead (*Ameiurus nebulosis*), pumpkinseed (*Lepomis gibbosus*), smallmouth bass (*Micropterus dolomieu*), yellow perch (*Perca flavescens*), and walleye (*Sander vitreus*). White sucker and smallmouth bass were not observed in the previous Nordic survey in 2010 however one largemouth bass (*Micropterus salmoides*) was captured in 2010. Total catch, total weight (g) and catch-per-unit effort (CPUE) from the Nordic survey can be seen in Table 2.

Table 2 Catch summary and CPUE for all species captured in Daisy Lake July 8 - 11, 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)
Northern Pike	4	2	1423.5	0.25	89.0
White Sucker	1	1	1549.7	0.1	96.85
Brown Bullhead	19	19	2447.9	1.2	153.0
Pumpkinseed	3	3	87.9	0.2	5.5
Smallmouth Bass	5	5	2217.9	0.3	138.6
Yellow Perch*	438	411	4561.0	27.4	285.1
Walleye	40	40	8632.1	2.5	539.5
Grand Total	510	481	20920.0	31.875	1307.5

The two northern pike sampled during the survey had total lengths of 468 mm and 533 mm, and the five smallmouth bass had total lengths ranging from 200 mm to 467 mm. Walleye were the most abundant large-bodied sport fish caught during this netting survey (Table 2) with a total catch of 40 individuals, with total lengths ranging from 136 mm to 460 mm. A complete summary of morphological data for walleye from the 2014 Nordic survey can be seen in Appendix I.

Yellow perch was the most numerically abundant fish species found in Daisy Lake (Table 2) and ranged in total lengths from 23 mm to 184 mm. A length frequency histogram for yellow perch can be seen in Figure 3.

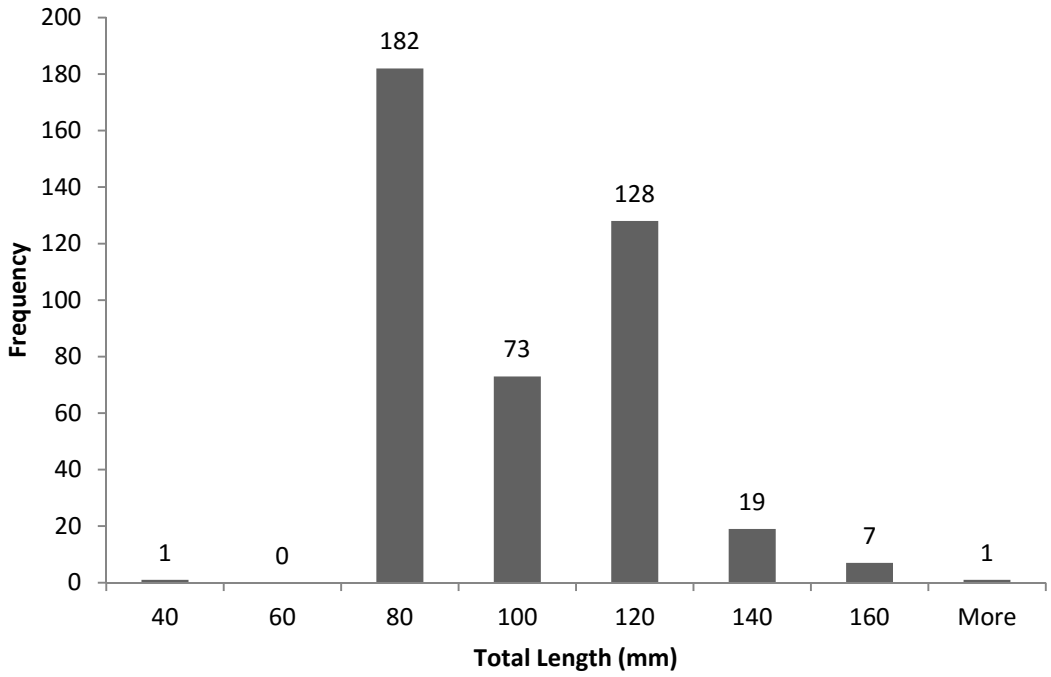

Figure 3 Length frequency histogram for yellow perch (n=411) captured in Daisy Lake July 8 - 11, 2014.

Central mudminnow was the only species caught during the 1990 urban lakes survey on Daisy Lake with a total catch of only two individuals (Poulin, *et al*., 1991). A considerably higher total catch of 1190 fish, and species richness of five species was recorded in the first Nordic survey conducted on Daisy Lake in 2005. Species richness has continued to improve since 2005 with the arrival of predatory sport fish species to the lake such as northern pike, smallmouth bass, largemouth bass and walleye. However, total catch of all fish appears to have declined since 2005 presumably because of the arrival of top predators. Yellow perch has been the most abundant species in Daisy Lake since Nordic surveys began (Cooperative Freshwater Ecology Unit, 2014). Species richness and proportion of total catch can be seen in Table 3.

Total catch and species richness has greatly improved since the 1990 urban lakes survey that employed the use of multi-mesh gillnets, small mesh trap nets and minnow traps (Kirk and Kenzie, 1990; Poulin *et al*., 1991). More recent Nordic Index Netting surveys indicate that yellow perch is the most abundant species in Daisy Lake (1140 in 2005; 1005 in 2010; 438 in 2014). Total catch data can be seen in Figure 4.

Yellow perch also accounted for the majority of the total biomass until 2014 when the other species took over. This includes an increase in walleye biomass from 2505.8 g in 2010 to 7999.1 g in 2014. Smallmouth bass (2217.9 g) were not observed in Daisy Lake prior to 2014 (Cooperative Freshwater Ecology Unit, 2014). Total biomass data can be seen in Figure 5.

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

Survey Type	Multi-Gear Survey		Nordic		Nordic		Nordic	
Year	1990[1]		2005[2]		2010[2]		2014	
Species	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Northern Pike	-	-	-	-	1	0.09	3	0.59
Central Mudminnow	2	100	-	-	-	-	-	-
White Sucker	-	-	4	0.34	-	-	1	0.2
Golden Shiner	-	-	-	-	-	-	-	-
Brown Bullhead	-	-	40	3.36	38	3.56	19	3.73
Pumpkinseed	-	-	5	0.42	19	1.78	3	0.59
Smallmouth Bass	-	-	-	-	-	-	5	0.98
Largemouth Bass	-	-	-	-	1	0.09	-	-
Yellow Perch	-	-	1140	95.8	1005	94.2	438	86.1
Walleye	-	-	-	-	3	0.28	40	7.86
Iowa Darter	-	-	1	0.08	-	-	-	-
Total	2	100	1190	100	1067	100	509	100
Species Richness	1		5		6		7	

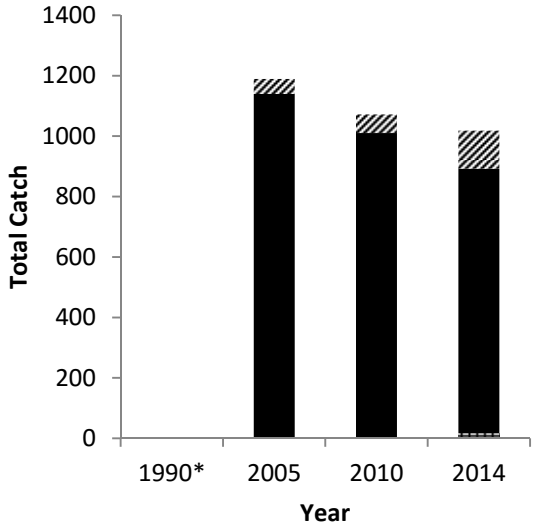

Figure 4 Historic total catch data for Daisy Lake (*Nordic method was not used during the 1990 urban lakes survey. Poulin *et al*., 1991).

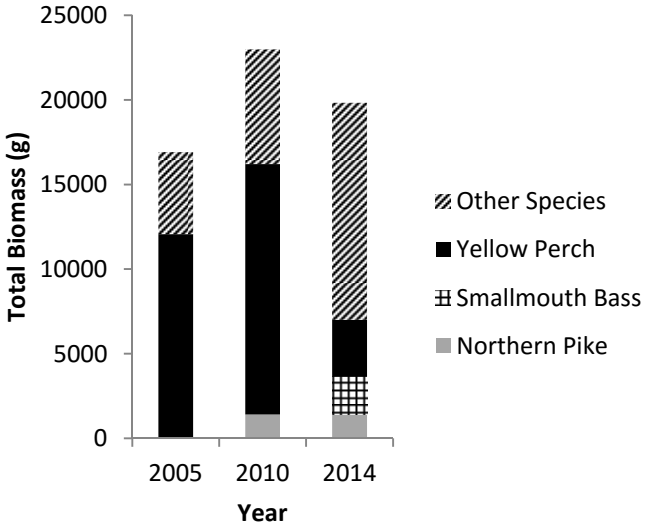

Figure 5 Historic total biomass (g) data for Daisy Lake.

Species diversity has steadily increased in Daisy Lake since Nordic surveys began. In 2005, five species were recorded in the lake, resulting in a "low" Shannon H Diversity value of 0.2033. Although species richness had increased to six in 2010, species diversity remained "low" at a

value of 0.2765. As of 2014, species richness has increased to seven. However, diversity is still classified as "low" with a value of 0.5747 (Morgan and Snucins, 2005). Species diversity values can be seen in Figure 6.

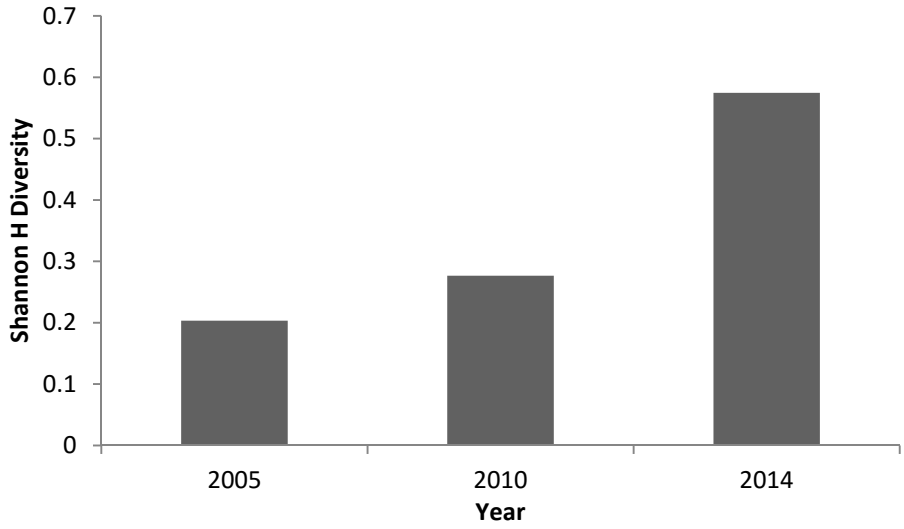

Figure 6 Historic species diversity (Shannon H Diversity) values for Daisy Lake.

Baseline Organisms

No clams, snails or crayfish were collected from Daisy Lake. A total of 50 mayflies and a bulk sample of five Pipewort (*Eriocaulon aquaticum*) were collected from Daisy Lake. Five nighttime zooplankton hauls were conducted at Daisy Lake on July 21, 2014.

Water Quality Assessment

At the time of the Nordic Index Netting survey, Daisy Lake was thermally stratified (Figure 7). Water temperatures ranged from 20.0 °C at the surface to 7.7 °C at 14.5 m. Dissolved oxygen levels ranged from 8.03 mg/L to 0.14 mg/L. Depth at the site of the temperature and dissolved oxygen profiles was 14.5 m and the secchi water clarity was 5.0 m.

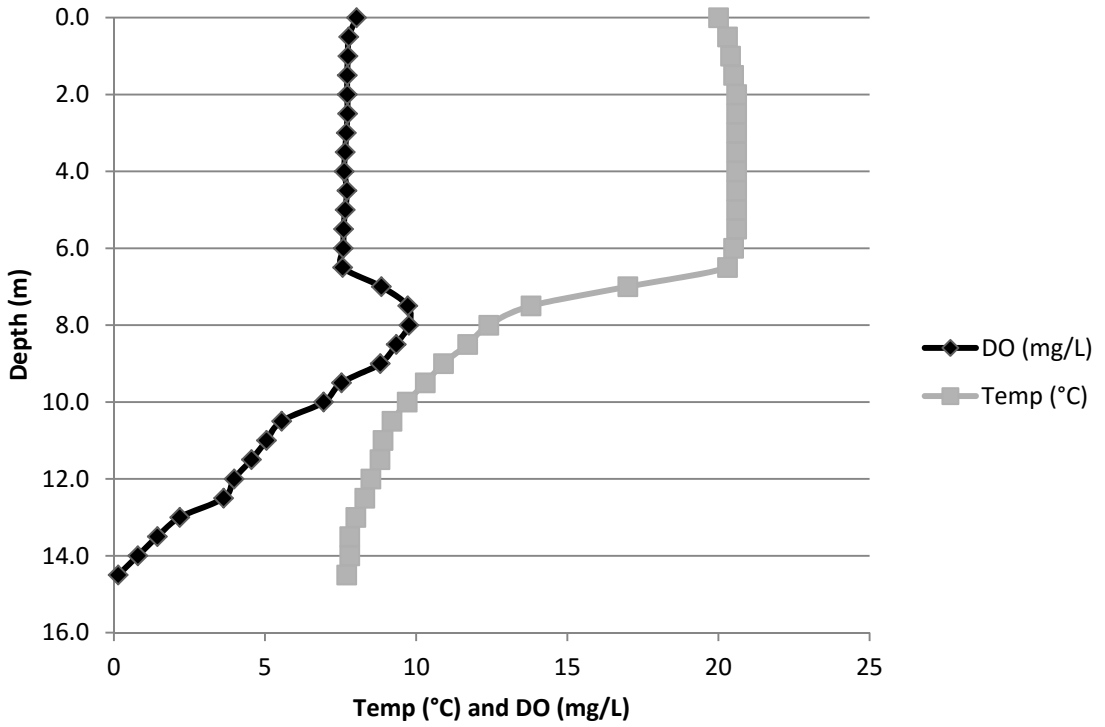

Figure 7 Temperature (°C) and dissolved oxygen (mg/L) profile for Daisy Lake, measured July 10, 2014.

The water quality of Daisy Lake continues to show signs of improvement. Since 2003, pH has increased from 6.20 to 6.89 (July 22, 2014), as has TIA alkalinity, which has increased from 2.02 mg/L $CaCO_3$ to 4.5 mg/L $CaCO_3$. Concentrations of metals such as Nickel (Ni), Copper (Cu), and Aluminum (Al) have continued to decrease during this time (Table 4). These improvements track the reductions in emissions from local smelters (Keller *et al*., 2007). However, Nickel (41.2 µg/L) and Copper (7.6 µg/L) concentrations remain above the criteria set by the Ministry of Environment and Climate Change's (MOECC) Provincial Water Quality Objective (PWQO), while those of Aluminum (10.2 µg/L) have decreased below these levels (Ontario Ministry of Environment and Energy, 1994).

Table 4 Water quality for Daisy Lake (T. Measurable trace amount: interpret with caution; 1. Ontario Ministry of Environment and Energy, 1994; 2. Kirk and Kenzie, 1990; 3. Keller *et al*., 2004)

Parameter	[1]PWQO	Year			
		[2]1984	[2]1990	[3]2003	2014
pH	6.5-8.5	4.5	4.67	6.20	6.89
TIA Alkalinity (mg/L $CaCO_3$)			60	2.02	4.5
Conductivity (µS/cm)			-0.98	35.4	37.5
True Colour (TCU)			[T]1.0		11.4
DOC (mg/L)			0.8	2.0	2.4
Ca (mg/L)			4.0	2.58	2.44
Mg (mg/L)			1.420	1.23	1.18
Na (mg/L)			1.42	1.09	1.65
K (mg/L)			0.550	0.420	0.34
SiO_3 (mg/L)			1.6	1.40	1.24
SO_4 (mg/L)			21.05	10.43	6.15
Total Cu (µg/L)	5		87.0	12	7.6
Total Ni (µg/L)	25		370.0	80	41.2
Total Zn (µg/L)	30		22.0	6	1.6
Total Fe (µg/L)	300		[T]25.0	36	20
Total Mn (µg/L)			200.0	24	8.1
Total Al (µg/L)	75		330.0	30	10.2

CONCLUSIONS

Although water quality appears to have greatly improved over three decades, concentrations of Ni and Cu remain above PWQO criteria for the protection of aquatic life (Ontario Ministry of Environment and Energy, 1994). However, as pH has increased to a circumneutral value of 6.89, metal concentrations have improved by 89% for Ni and 91% for Cu since 1984. Clams, snails and crayfish were not observed, however acid-sensitive mayflies appear to be quite common. Daisy Lake supports populations of seven fish species, including three major sport fish: northern pike, smallmouth bass, and, most recently, walleye. No information on how the walleye entered Daisy Lake exists, however it is believed that they may have migrated in from nearby Richard Lake to the southwest.

ACKNOWLEDGEMENTS

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REFERENCES

Appelberg M. 2000. Swedish standard methods for sampling freshwater fish with multi-mesh gillnets. Fiskeriverket Information 2000: 1 (3-32).

Cooperative Freshwater Ecology Unit. 2014. New NORDIC Database – 2007. [Microsoft Access Database]. Laurentian University, Sudbury, Ontario.

Gunn J, Sein R, Keller B, Beckett P. 2001. Liming of acid and metal contaminated catchments for the improvement of drainage water quality. Water, Air, and Soil Pollution 130. 1439-1444.

Keller W, Heneberry J, Gunn JM, Snucins E, Morgan G, Leduc J. 2004. Recovery of Acid and Metal-Damaged Lakes Near Sudbury Ontario: Trends and Status. Sudbury, Ontario. Cooperative Freshwater Ecology Unit. 53 pp.

Keller W, Yan ND, Gunn JM, Heneberry J. 2007. Recovery of acidified lakes: lessons from Sudbury, Ontario, Canada. Water, Air, and Soil Pollution: Focus 7: 317-122.

Kirk R, Kenzie M. 1990. Daisy Lake Urban Lakes Study. Unpublished report. Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury ON.

Morgan GE, Snucins E. 2005. Manual of Instructions and Provincial Biodiversity Benchmark Values: NORDIC Index Netting. Ontario, Canada: Queen's Printer for Ontario.

Ontario Ministry of Environment and Energy. 1994. Water Management Policies, Guidelines, and Provincial Water Quality Objectives. Queen's Printer for Ontario.

Ontario Ministry of Natural Resources. 2013. Sudbury & Espanola Zone 10 Fish Stocking List 2004-2013. [Microsoft Excel Workbook].

Poulin DJ, Gunn JM, Sein R, Laws KM. 1991. Fish Species Present in Sudbury Lakes: Results of the 1989-1991 urban lakes surveys. Unpublished report. Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ontario.

Selinger W, Lowman D, Kaufman S, Malette M. 2006. The Status of Lake Trout Populations in Northeastern Ontario (2000-2005). Unpublished report. Ontario Ministry of Natural Resources, Timmins, Ontario.

APPENDIX I

Morphological data for walleye (*Sander vitreus*) from Daisy Lake, July 8 - 11, 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
Walleye	13	400	420	712.3	1	2	A	1
Walleye	14	359	379	507.3	1	2	A	1
Walleye	65	180	191	57.9	2	1	A	1
Walleye	66	238	251	131.3	2	1	A	1
Walleye	67	235	250	131.1	2	1	A	1
Walleye	68	427	450	824.4	2	2	A	1
Walleye	180	374	394	561	2	2	A	1
Walleye	181	314	340	358.4	2	1	A	1
Walleye	182	361	379	558.4	2	1	A	1
Walleye	183	220	231	114.4	2	1	A	1
Walleye	184	229	245	125.1	2	2	A	1
Walleye	235	316	336	352.1	1	9	A	1
Walleye	236	231	242	120.5	9	1	A	1
Walleye	237	205	216	86	9	1	A	1
Walleye	238	124	136	16.6	2	1	A	1
Walleye	239	221	237	117.3	2	1	A	1
Walleye	240	195	208	77.2	2	1	A	1
Walleye	241	177	190	53.4	9	1	A	1
Walleye	242	197	211	77.8	2	1	A	1
Walleye	309	411	453	842.6	1	2	A	1
Walleye	310	236	250	134.2	2	1	A	1
Walleye	311	236	251	133.6	2	1	A	1
Walleye	312	211	225	88	2	1	A	0
Walleye	313	203	210	82.8	2	1	A	0
Walleye	314	182	195	57.4	2	1	A	0
Walleye	316	437	460	903.2	1	2	A	0
Walleye	317	245	257	156.7	2	2	2	0
Walleye	318	200	213	85.5	2	1	A	0
Walleye	319	215	227	108.5	2	1	A	0
Walleye	320	240	248	138	2	1	A	0
Walleye	321	164	176	46.5	1	1	A	0
Walleye	322	215	228	107.4	2	1	A	0
Walleye	323	188	203	68.3	1	1	A	0
Walleye	324	162	173	45.1	1	1	A	0

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
Walleye	325	164	175	41.3	2	1	A	0
Walleye	349	239	254	143.2	2	1	A	0
Walleye	350	239	255	144.5	2	2	A	0
Walleye	351	243	257	144.9	1	1	A	0
Walleye	352	168	183	50	2	1	A	0
Walleye	374	233	247	127.9	1	1	A	0