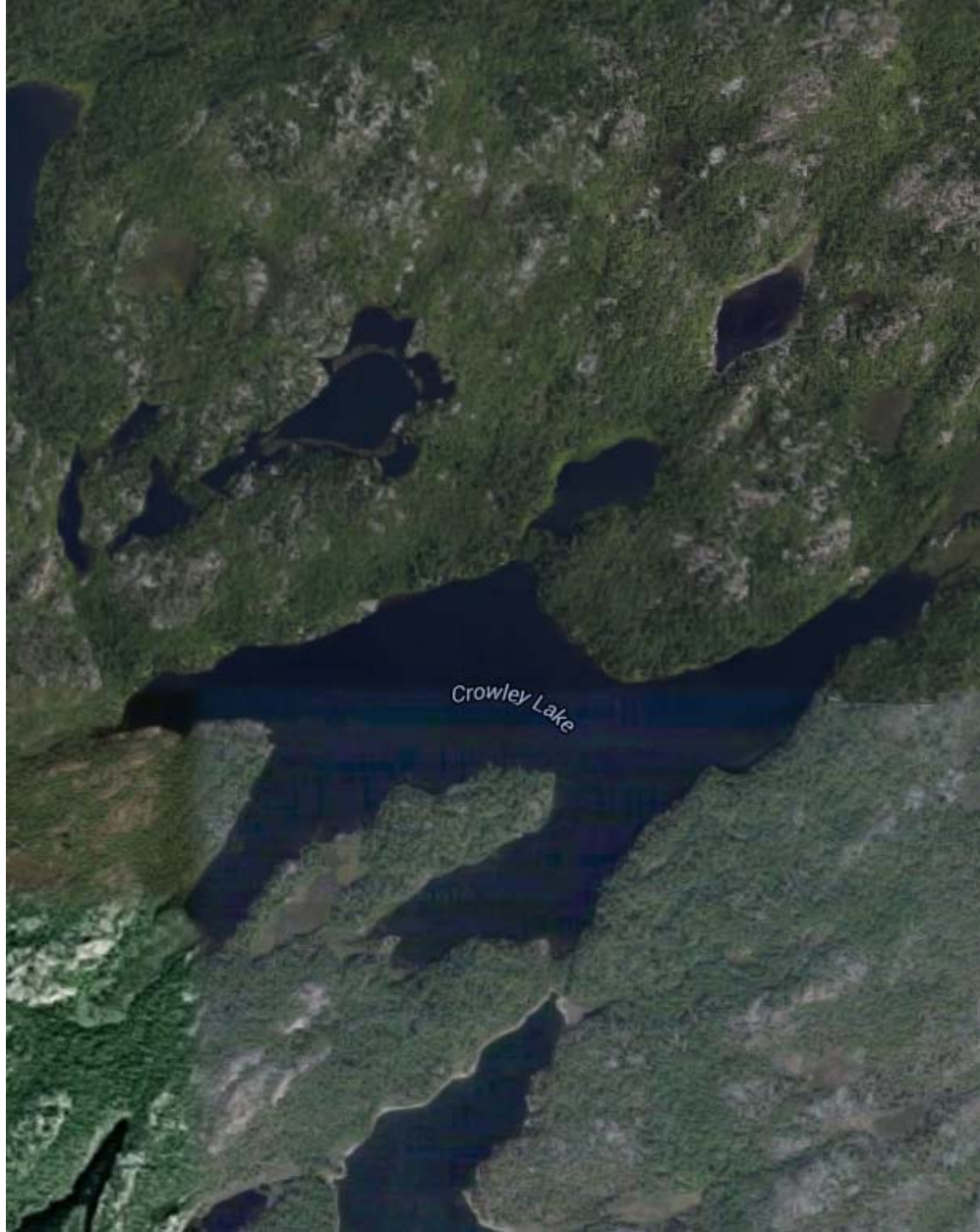


CROWLEY LAKE
URBAN LAKES FISHERIES STUDY 2014



Fisheries Assessment by:
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INTRODUCTION

Crowley Lake (46°23'07" N, 80°59'06" W) is a 43.5 ha lake located within the City of Greater Sudbury, in Broder township. It has one main basin with a maximum depth of 17.0 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1.

Crowley Lake is accessed by private road, off Kasten Lake Rd. It has only one seasonal resident, therefore it is unlikely that the lake receives heavy angling pressure.

Crowley Lake has been regularly studied as far back as 1990 when the lake had a pH reading of 5.88 (Keller *et al.*, 2004). Based on paleolimnological data (fossils in lake sediments) the lake has always supported a fish community (Uutala and Smol, 1996). When surveys began in 1990 it was dominated by yellow perch (*Perca flavescens*) and the occasional Iowa darter (*Etheostoma exile*) (Wright, 1995). Wright (1995) used mark recapture techniques to determine that Crowley had a perch density of 2,892 perch/ha in 1992, the highest density in any of her 6 study lakes. Regular fisheries index netting surveys of the perch population have occurred on Crowley Lake since 2004 (Cooperative Freshwater Ecology Unit, 2014). A significant reduction in the density of yellow perch occurred when the lake was stocked with 283 adult (average size 222 mm) smallmouth bass (*Micropterus dolomieu*) on June 20, 2008 as part of a food web research experiment (A. Luek and G. Morgan, unpublished data; Cooperative Freshwater Ecology Unit, 2008).

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

Township	Broder
Latitude/Longitude	46°23'07" N, 80°59'06" W
MNRF District	Sudbury
Watershed Code	2CF
Elevation (m)	273
Shoreline Development Factor	2.64
Number of Cottages/Lodges	1
Forest Type	Deciduous
Shoreline Type	Bedrock/sand
Lake Surface Area (ha)	43.5
Maximum Depth (m)	17.0
Mean Depth (m)	6.4
Volume (x10⁴m³)	272.9
Secchi (m)	5.13 (July 4, 2014)
Access	Private road off Kasten Lake Rd. approx. 12 km south of Sudbury.

METHODS

Fisheries Community Assessment

In 2014 the fish community of Crowley 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 Crowley Lake from July 2 to 5, 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 Crowley 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 Crowley 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 Crowley 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 Crowley Lake and picked by hand.

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Crowley Lake on July 4, 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 Crowley 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.

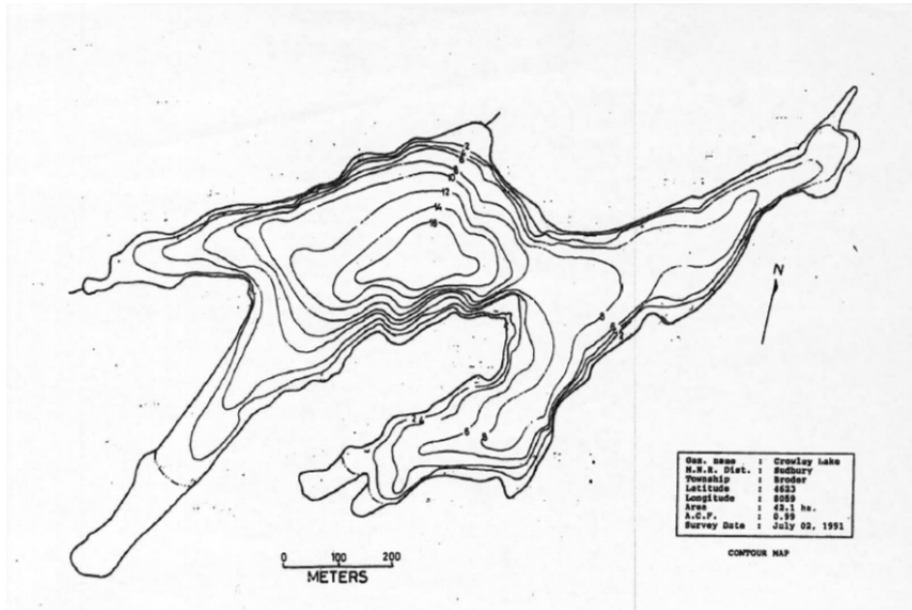


Figure 1 Bathymetric map of Crowley Lake.

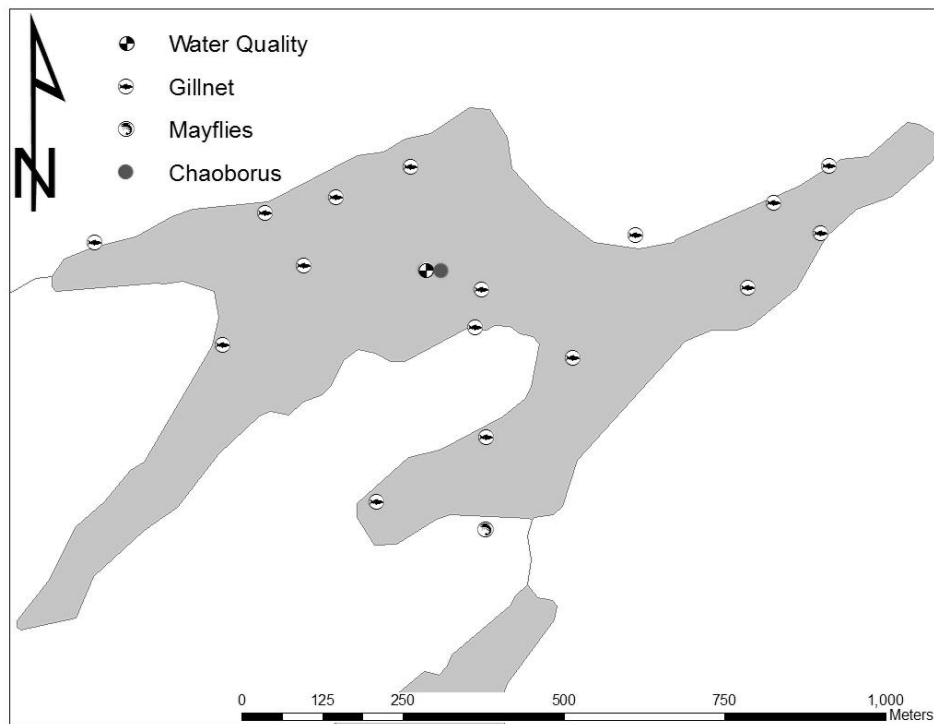


Figure 2 Outline map of Crowley Lake showing the location of sampling gear or collected organisms.

RESULTS AND DISCUSSION

Fisheries Community Assessment

During the July 2 to 5, 2014 netting survey, a total of 16 nets were set, catching only two species: smallmouth bass and yellow perch. Total catch, total weight (g) and catch-per-unit effort (CPUE) from the Nordic survey are presented in Table 2.

Table 2 Catch summary and CPUE for all species captured in Crowley Lake July 2 - 5, 2014. *Fish were not individually weighed. Total biomass for yellow perch from two nets not recorded in field notes.

Fish Species	Total Catch	Sample Size	Total Weight (g)	CPUE (fish/net)	CPUE (g/net)
Smallmouth Bass	74	73	36369.3	4.625	2273.0813
Yellow Perch *	86	82	-	5.375	-
Total	160	155	-	10	-

A total of 74 smallmouth bass were captured during the 2014 survey with total lengths ranging from 98 mm to 465 mm. A complete summary of morphological data for smallmouth bass from the 2014 Nordic survey is provided in Appendix I.

Yellow perch was still the most numerically abundant fish species found in Crowley Lake (Table 2) with total lengths ranging from 57 mm to 177 mm. A length frequency histogram for yellow perch can be seen in Figure 3.

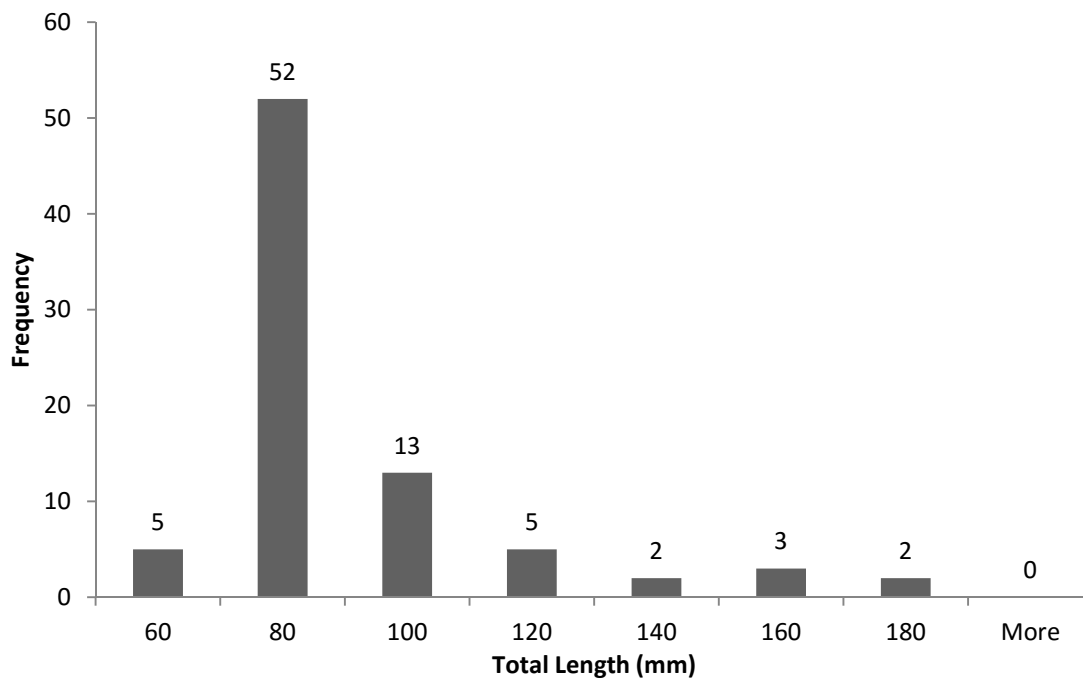


Figure 3 Length frequency histogram for yellow perch (n=86) captured in Crowley Lake July 2 - 5, 2014.

During the original 1991 urban lakes survey only yellow perch were caught in Crowley Lake with a total catch of 829 fish (Poulin *et al.*, 1991). Yellow perch remained the only species in Crowley Lake when the first Nordic survey was conducted in 2005 with a total catch of 1479 fish (Cooperative Freshwater Ecology Unit, 2014). The 2008 Nordic survey caught a total of 32 smallmouth bass which were a result of stocking initiatives earlier that year (Luek, unpublished data; Cooperative Freshwater Ecology Unit, 2008). A total of 32 bass were captured in 2009. In 2014, the smallmouth bass population had more than doubled, now accounting for 46% of the total catch but the vast majority of the biomass. The Species richness and proportion of total catch can be seen in Table 3.

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

Survey Type	Multi-Gear Survey 1991 ¹		Nordic 2005 ²		Nordic 2008 ²		Nordic 2009 ²		Nordic 2014	
Year	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Species	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Smallmouth Bass	-	-	-	-	32	4.82	21	2.99	74	46.25
Yellow Perch	829	100	1479	100	631	95.03	681	97	86	53.75
Iowa Darter	-	-	-	-	1	0.15	-	-	-	-
Total	829	100	1479	100	664	100	702	100	160	100
Species Richness	1		1		3		2		2	

Yellow perch accounted for the majority of the total biomass of Crowley Lake until 2009, after which smallmouth bass dominated. Total biomass data can be seen in Figure 5.

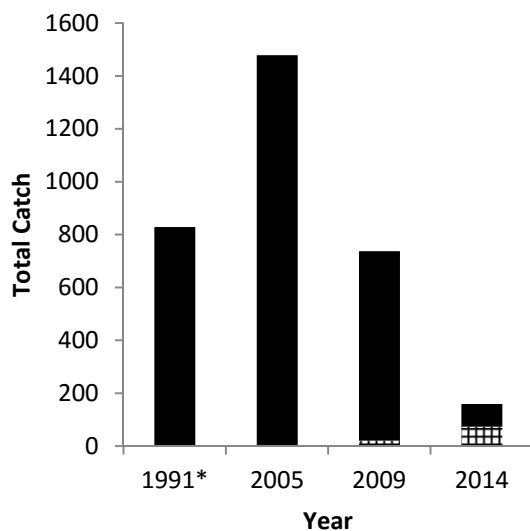


Figure 5 Total catch data for Crowley Lake (*Nordic method was not used during 1991 Urban Lakes Survey. Poulin *et al.*, 1991).

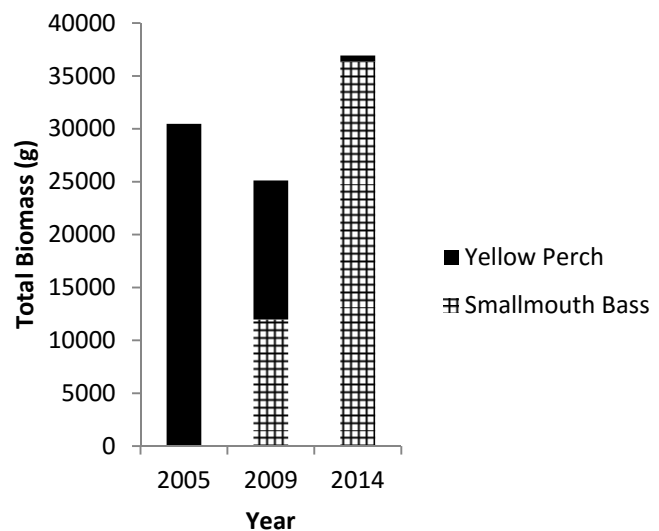


Figure 4 Total biomass (g) data for Crowley Lake.

Baseline Organisms

No clams, snails or plants were collected from Crowley Lake. A total of three incidental crayfish were captured in gillnets but none were found in the traps set around the lake. A total of 38 mayflies were captured at the south end of the lake, near the inflow. Eleven nighttime zooplankton hauls were conducted at Crowley Lake. A sufficient stable isotope sample (approx. 50-300 individuals) of *Chaoborus* sp. was collected.

Water Quality Assessment

At the time of the Nordic Index Netting survey, Crowley Lake was thermally stratified (Figure 6). Water temperatures ranged from 23.3 °C at the surface to 5.0 °C at 17.0 m. Dissolved oxygen levels ranged from 7.64 mg/L to 0.38 mg/L. The secchi water clarity was 5.13 m.

The water quality continues to improve in Crowley Lake (Table 4). Since 2003, pH has increased from 6.31 to 6.67. During this time, TIA alkalinity has also made similar improvements, increasing from 2.10 mg/L CaCO₃ to 3.03 mg/L CaCO₃. Concentrations of metals such as Nickel (Ni), Copper (Cu), and Aluminum (Al) have all decreased since 2003 as well.

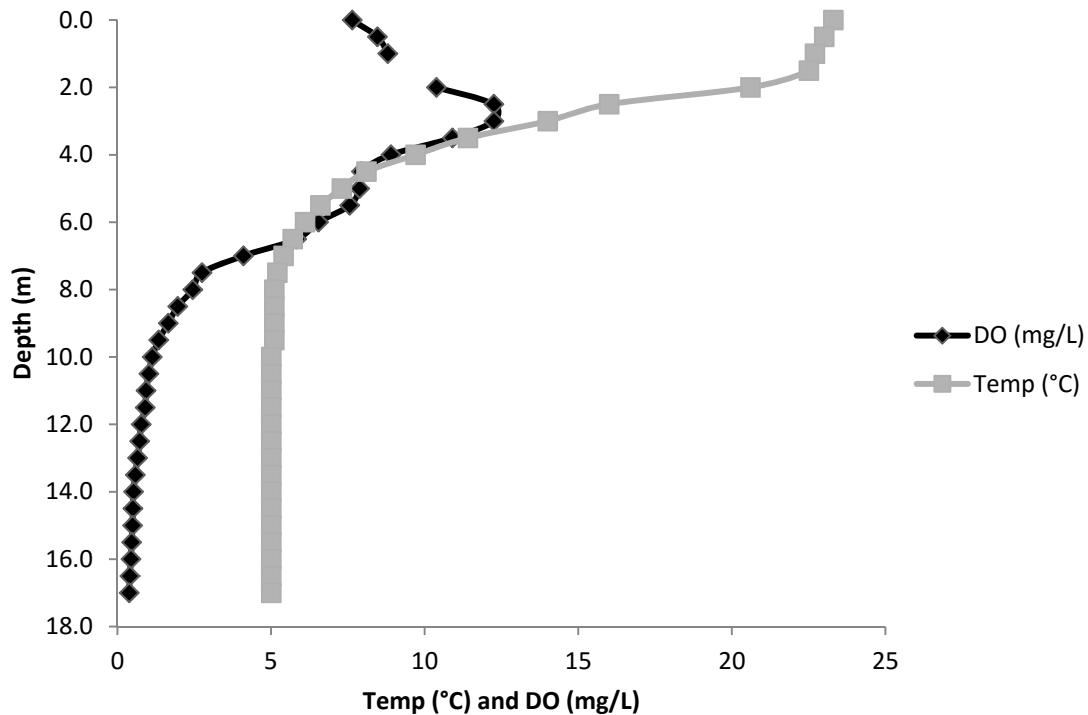


Figure 6 Temperature (°C) and dissolved oxygen (mg/L) profile for Crowley Lake, measured July 4, 2014.

In 2014, Crowley Lake had a circumneutral pH value of 6.67 and a TIA alkalinity measurement of 3.03 mg/L CaCO₃. Concentrations of metals such as Aluminum (18.9 µg/L) and Iron (20 µg/L) remain below the Ministry of Environment and Climate Change's (MOECC) criteria set by the Provincial Water Quality Objective (PWQO) to protect aquatic life. However,

concentrations of Nickel (37.8 µg/L) and Copper (7.9 µg/L) remain high (Ontario Ministry of Environment and Energy, 1994).

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

Parameter	PWQO ¹	Year		
		1990 ²	2003 ²	2014
pH	6.5-8.5	5.88	6.31	6.67
TIA Alkalinity (mg/L CaCO ₃)	-	1.69	2.10	3.03
Conductivity (µS/cm)	-	35.2	27.6	24.4
DOC (mg/L)	-	2.9	3.3	3.2
SO ₄ (mg/L)	-	11.94	7.85	5.5
Total Cu (µg/L)	5	14	11	7.9
Total Ni (µg/L)	25	89	55	38
Total Zn (µg/L)	30	9	6	3
Total Fe (µg/L)	300	110	49	20
Total Mn (µg/L)	-	71	32	8
Total Al (µg/L)	75	<50	26	19

CONCLUSIONS

Although water quality appears to have improved over the past 24 years, concentrations of Ni and Cu remain above the PWQO criteria for the protection of aquatic life. However, pH has improved to a circumneutral value of 6.67 and metal concentrations have declined by 58% for Ni and 43% for Cu. Clams and snails were not observed in the lake, however acid-sensitive mayflies appear to be common. Crowley Lake supports populations of two species of fish, including a growing population of smallmouth bass that appears to be rapidly reducing the population of the once abundant yellow perch.

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*) from Crowley Lake, July 2 - 5, 2014.

Species	Fish #	Fork Length (mm)	Total Length (mm)	Weight (g)	Sex		Maturity		Ageing Structure	Tissue
					1-Male 2-Female 9-Unknown		1-Immature 2-Mature 9-Unknown		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
Smallmouth Bass	16	251	264	250	2		2		A	1
Smallmouth Bass	17	254	269	243	1		2		A	1
Smallmouth Bass	18	198	209	110.8	1		1		A	1
Smallmouth Bass	19	238	252	200.3	2		9		A	1
Smallmouth Bass	20	293	310	342	1		2		A	1
Smallmouth Bass	21	300	317	416.8	2		2		A	1
Smallmouth Bass	22	192	199	96.5	2		1		A	1
Smallmouth Bass	23	416	433	1038.3	9		2		A	1
Smallmouth Bass	24	211	220	135.7	9		1		A	1
Smallmouth Bass	25	191	196	95.8	2		1		A	0
Smallmouth Bass	26	171	178	66.9	2		1		A	0
Smallmouth Bass	27	101	104	11.1	9		1		A	0
Smallmouth Bass	35	175	184	75.6	2		1		A	0
Smallmouth Bass	36	409	430	1092.7	1		2		A	1
Smallmouth Bass	37	355	375	689.6	2		2		A	0
Smallmouth Bass	38	421	437	1097.5	2		2		A	0
Smallmouth Bass	39	265	280	284.4	1		9		A	0
Smallmouth Bass	40	419	440	1137.7	1		2		A	0
Smallmouth Bass	41	422	444	969.6	2		2		A	0
Smallmouth Bass	42	321	337	475.5	2		2		A	0
Smallmouth Bass	43	334	353	638.5	1		2		A	0
Smallmouth Bass	44	326	344	484.3	1		2		A	0
Smallmouth Bass	45	342	360	578	2		2		A	0
Smallmouth Bass	46	335	353	575.1	2		2		A	0
Smallmouth Bass	47	247	261	234.3	1		2		A	0
Smallmouth Bass	48	250	261	222.5	2		2		A	0
Smallmouth Bass	49	100	105	13.7	9		1		A	0
Smallmouth Bass	50	111	115	19	2		1		A	0
Smallmouth Bass	77	339	356	559.6	1		2		A	1
Smallmouth Bass	78	425	445	1194.3	2		2		A	1
Smallmouth Bass	79	415	437	1048.1	2		2		A	1
Smallmouth Bass	80	357	369	714	2		2		A	1

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	Tissue
							Structure 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
Smallmouth Bass	81	342	361	563.5	1	2	A	1
Smallmouth Bass	82	364	386	720.8	2	2	A	1
Smallmouth Bass	83	200	211	126.9	2	1	A	0
Smallmouth Bass	89	445	465	1241.3	2	2	A	1
Smallmouth Bass	90	372	390	675.4	2	2	A	1
Smallmouth Bass	91	293	310	428	2	2	A	0
Smallmouth Bass	92	340	357	622.6	1	2	A	1
Smallmouth Bass	93	285	291	361.3	2	2	A	1
Smallmouth Bass	94	312	329	492.9	2	2	A	0
Smallmouth Bass	95	282	298	378.7	1	2	A	0
Smallmouth Bass	96	280	295	365.5	2	2	A	0
Smallmouth Bass	97	185	194	87.9	2	1	A	0
Smallmouth Bass	98	445	465	1349.9	2	2	A	0
Smallmouth Bass	99	191	202	118.4	9	9	A	0
Smallmouth Bass	100	332	350	552.7	1	2	A	0
Smallmouth Bass	101	96	98	11.7	2	1	A	1
Smallmouth Bass	102	113	116	23.8	9	1	A	0
Smallmouth Bass	103	304	320	448.8	2	2	A	0
Smallmouth Bass	111	440	465	1287.4	1	2	A	0
Smallmouth Bass	112	304	317	450.6	2	2	A	0
Smallmouth Bass	113	335	354	596.3	1	2	A	0
Smallmouth Bass	114	318	335	487.5	2	2	A	0
Smallmouth Bass	115	332	354	576.4	1	2	A	0
Smallmouth Bass	116	325	345	563.2	2	2	A	0
Smallmouth Bass	117	297	314	379.4	1	2	A	0
Smallmouth Bass	118	181	202	118.5	1	2	A	0
Smallmouth Bass	121	320	335	508.2	1	2	A	0
Smallmouth Bass	122	132	137	31.8	9	1	A	0
Smallmouth Bass	123	124	129	25.5	2	1	A	0
Smallmouth Bass	124	230	244	174.4	2	2	A	0
Smallmouth Bass	125	280	297	320.7	2	2	A	0
Smallmouth Bass	126	434	455	1195.5	2	2	A	0
Smallmouth Bass	127	428	450	1172.9	2	2	A	0
Smallmouth Bass	128	406	429	1011	1	2	A	0
Smallmouth Bass	129	200	201	106.2	1	1	A	0
Smallmouth Bass	130	368	387	746.1	1	2	A	0
Smallmouth Bass	131	421	439	1133.5	2	2	A	0

Species	Fish #	Fork Length (mm)	Total Length (mm)	Weight (g)	Sex		Maturity		Ageing Structure	Tissue	
					1-Male	2-Female	9-Unknown	1-Immature	2-Mature	9-Unknown	0-None
Smallmouth Bass	132	435	456	1164.2	1			2	A	0	
Smallmouth Bass	133	304	319	449.2	1			2	A	0	
Smallmouth Bass	134	166	175	72.9	2			1	A	0	
Smallmouth Bass	135	200	211	116.6	2			1	A	0	