BRODILL LAKE

URBAN LAKES FISHERIES STUDY 2014

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INTRODUCTION

Brodill Lake (46°22'18" N, 80°56'39" W) is a 112.1 ha lake located partially within the City of Greater Sudbury, in Dill/Broder/Secord township. It is comprised of two main basins separated by a shallow, narrow channel, and has a maximum depth of 36 m (Figure 1). A complete summary of physical characteristics can be seen in Table 1.

Brodill Lake is accessed by private road. There is very little accessible Crown Land around Brodill Lake, therefore it is unlikely to receive angling pressure other than by the two seasonal residents on the lake.

Documented history of Brodill Lake appears to be limited. The lake was surveyed as part of the Sudbury Urban Lakes Study that occurred from 1989 to 1991 (Poulin *et al*., 1991). The earliest documented water samples were collected in 1990 when the lake had a pH of 5.42 (Keller *et al*., 2004). A multi-gear fish survey in 1991 concluded that only yellow perch (*Perca flavescens*) existed in the lake (Poulin *et al*., 1991). Although no written records exist, there are verbal accounts of the lake once being inhabited by lake trout (*Salvelinus namaycush*) (Toivonen, personal communication, 2014). Ministry of Natural Resources and Forestry (MNRF) records indicate that Brodill Lake has never been stocked (Ontario Ministry of Natural Resources, 2013).

In 2014, as part of the Urban Lakes Study, field crews from Laurentian University's Cooperative Freshwater Ecology Unit surveyed Brodill Lake, along with several other lakes around Greater Sudbury. This is the first fisheries index netting survey in the history of Brodill Lake (Cooperative Freshwater Ecology Unit, 2014).

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

Township	Dill/Broder/Secord
Latitude/Longitude	46°22'18" N, 80°56'39" W
MNRF District	Sudbury
Watershed Code	2DB
Elevation (m)	241
Shoreline Development Factor	3.17
Number of Cottages/Lodges	2
Forest Type	Mixed forest.
Shoreline Type	Bedrock/boulder
Lake Surface Area (ha)	112.1
Maximum Depth (m)	36.0
Mean Depth (m)	9.6
Volume ($x10^4 m^3$)	1061.1
Secchi (m)	3.8 (June 24, 2014)
Access	Private road off Kasten Lake Rd, ~ 15km south of Sudbury.

METHODS

Fisheries Community Assessment

In 2014 the fish community of Brodill 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 40 multi-mesh gillnets were set in Brodill 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 Brodill 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 Brodill 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 Brodill 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 Brodill Lake and picked by hand.

Water Quality Assessment

A dissolved oxygen (mg/L) and temperature (°C) profile was measured in the main basin of Brodill Lake on June 24, 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 16, 2014 from the surface of Brodill 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.

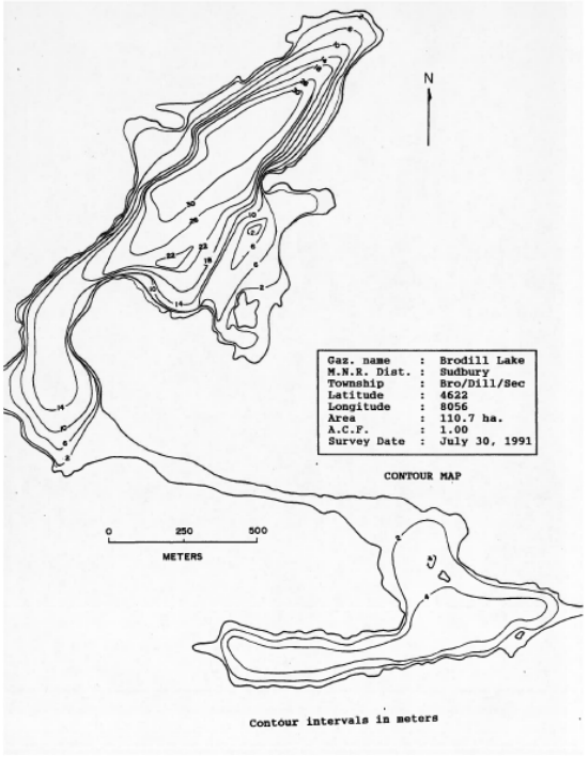

Figure 1 Bathymetric map of Brodill Lake.

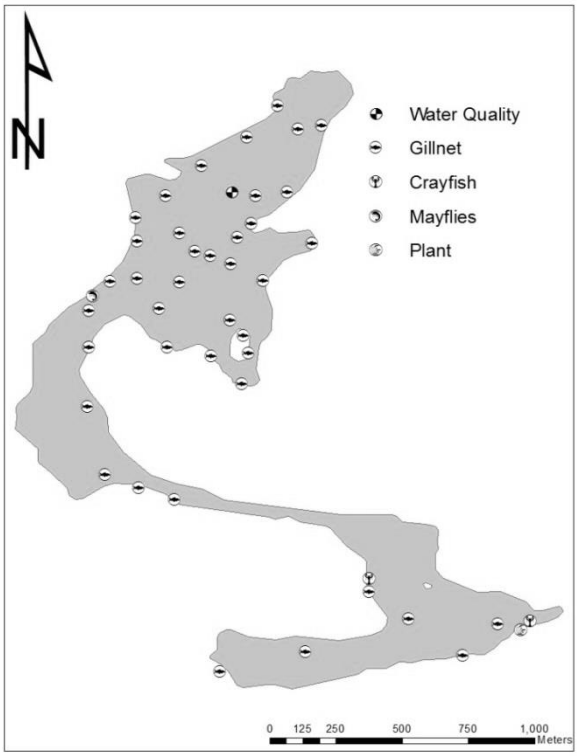

Figure 2 Outline map of Brodill Lake showing the location of sampling gear and collected organisms.

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 seven different species: central mudminnow (*Umbra limi*), white sucker (*Catostomus commersonii*), golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbosus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), and yellow perch. 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 Brodill Lake June 17 - 24, 2014. *Fish were not individually weighed. Total weight (g) and CPUE (g/net) are based on total net biomass for that species.

Fish Species	Total Catch	Sample Size	Total Weight (g)	CPUE (fish/net)	CPUE (g/net)
Central Mudminnow	2	2	16.1	0.05	0.4025
White Sucker	12	11	8246.4	0.3	206.16
Golden Shiner	41	39	427.1	1.025	10.6775
Pumpkinseed*	52	51	804.9	1.3	20.1225
Smallmouth Bass	44	42	14595.9	1.1	364.8975

Largemouth Bass	1	1	45.9	0.025	1.1475
Yellow Perch*	1085	1064	24663.2	27.05	616.58
Total	1237	1210	48799.5	30.85	1220

The 44 smallmouth bass sampled during the Nordic survey had total lengths ranging from 103 mm to 491 mm. Only one largemouth bass was captured during this survey, measuring a total length of 151 mm. A complete summary of morphological data for smallmouth and largemouth bass can be seen in Appendix I.

Yellow perch was the dominant fish species found in Brodill Lake (Table 2) with total lengths ranging from 53 mm to 245 mm. A length frequency histogram for yellow perch can be seen in Figure 3.

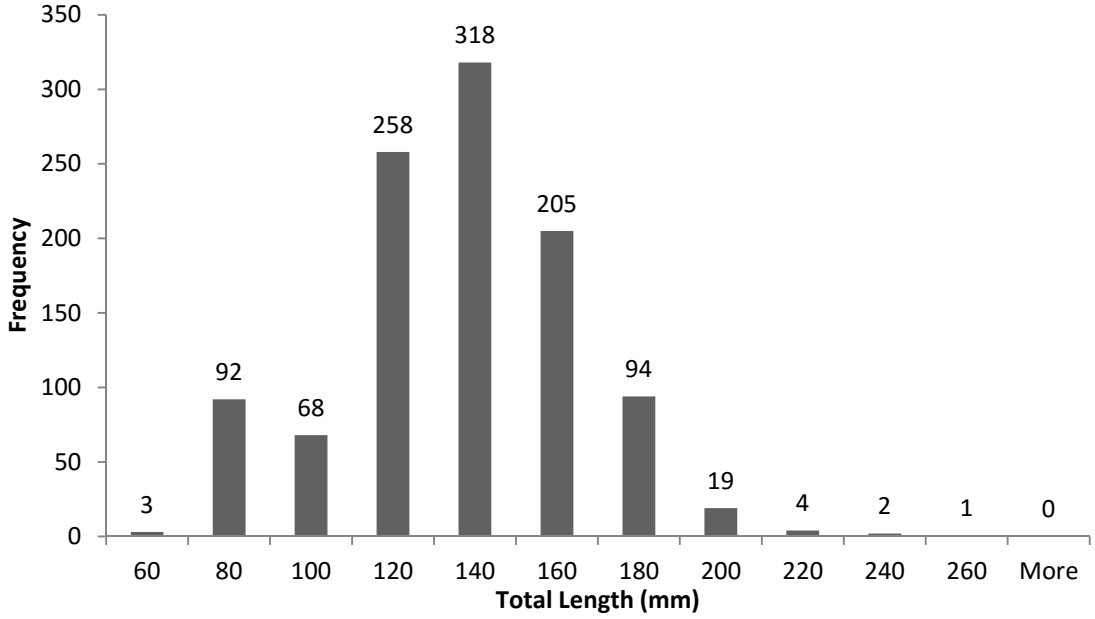

Figure 3 Length frequency histogram for yellow perch (n=1064) captured in Brodill Lake June 17 - 24, 2014.

Only yellow perch existed in the lake during the 1991 Urban Lakes Survey, prior to the use of the Nordic protocol. A total catch of 1090 fish was recorded at the time (Poulin *et al*., 1991). The more recent 2014 Nordic survey indicates that yellow perch is still the numerically most abundant species in Brodill Lake, accounting for 88% of the total catch. Species richness has however greatly improved since 1991 with a total of seven documented species. Species richness and proportion of total catch can be seen in Table 3.

Yellow perch also account for the majority of the total biomass in Brodill Lake (Figure 4). Total biomass data from the 2014 Nordic Index Netting survey can be seen in Figure 5.

Table 3 Species richness and proportion of total catch for Brodill Lake (1. Poulin *et al.*,1991).

Survey Type	**Multi-Gear Survey**		**Nordic**	
Year	**1991**[1]		**2014**	
Species	***n***	**%**	***n***	**%**
Central Mudminnow	-	-	2	0.16
White Sucker	-	-	12	0.97
Golden Shiner	-	-	41	3.31
Pumpkinseed	-	-	52	4.20
Smallmouth Bass	-	-	44	3.56
Largemouth Bass	-	-	1	0.08
Yellow Perch	1090	100	1085	87.71
Total	**1090**	**100**	**1237**	**100**
Species Richness	1		7	

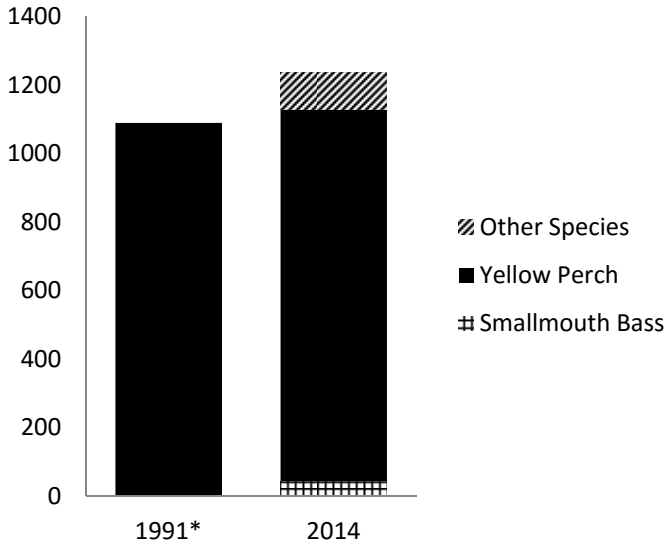

Figure 4 Total catch from Brodill Lake (*Nordic method was not used during the 1991 Urban Lakes Survey. Poulin *et al.*, 1991).

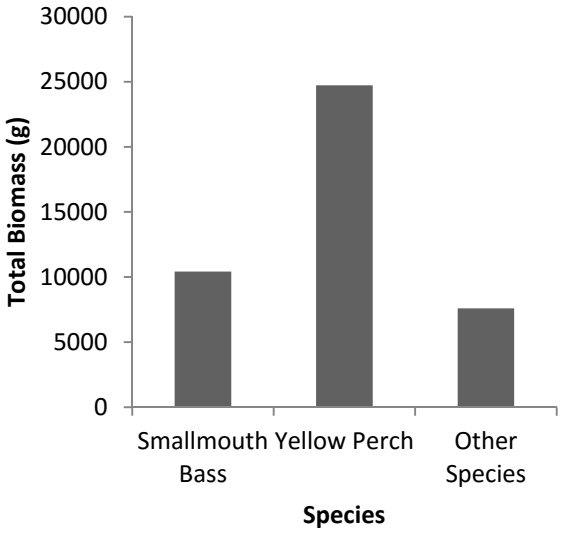

Figure 5 Total biomass (g) from Brodill Lake, July 17 – 24, 2014 (no biomass data exists from 1991 urban lakes survey).

Unlike the Nordic Index Netting protocol, the Urban Lakes Survey that was conducted on Brodill Lake in 1991 did not use a standardized netting method. Therefore species diversity was unable to be calculated. However, with only one species living in the lake at the time, the Shannon H Diversity value would equal zero. With six new species recorded in Brodill Lake, the 2014 Nordic survey resulted in a "low" Shannon H Diversity value of 0.5409 (Morgan and Snucins, 2005).

Baseline Organisms

No clams or snails were found at Brodill Lake. A total of 30 mayflies were captured at the west end of the north basin. Three incidental crayfish were captured in gillnet #5 and one crayfish was captured in one of the traps. All crayfish were found in the littoral zone of the southern basin, near the outflow of Brodill Lake. A bulk sample of five Pipewort (*Eriocaulon aquaticum*) was collected from the southern basin of Brodill Lake, near the outflow.

Water Quality Assessment

At the time of the Nordic Index Netting survey, Brodill Lake was thermally stratified (Figure 6). Water temperatures ranged from 24.0 °C at the surface to 4.4 °C at 36.0 m. Dissolved oxygen levels ranged from 8.9 mg/L to 0.8 mg/L. The secchi water clarity was 3.8 m. At the time the profiles were being measured, an unexplained malfunction occurred with the dissolved oxygen meter resulting in no measurements at the 2.5 m and 3.0 m intervals.

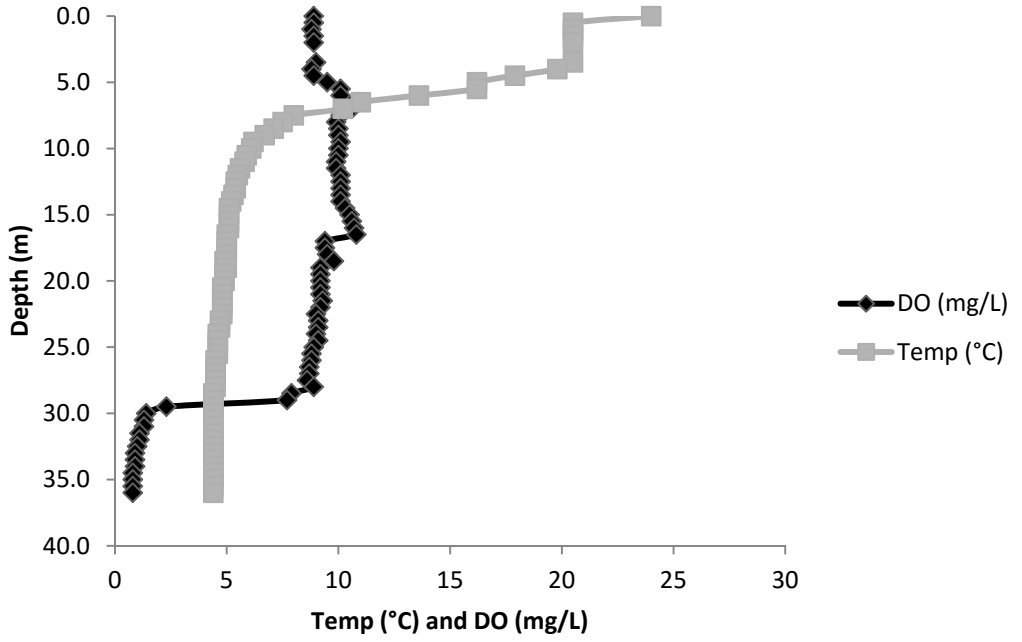

Figure 6 Temperature (°C) and dissolved oxygen (mg/L) profile for Brodill Lake, measured June 24, 2014.

The water quality of Brodill Lake appears to have considerably improved since 1990 (Table 4). Over this time period, the pH has increased from 5.42 (Keller *et al*., 2004) to 6.41. Conductivity has decreased from 42.3 µS/cm to 23.2 µS/cm over the past two decades, as have concentrations of metals such as Copper (Cu), Nickel (Ni), Aluminum (Al), Iron (Fe) and Zinc (Zn). These improvements are likely a result of reduced emissions from local smelters (Keller *et al*., 2007).

As of July 16, 2014, Brodill Lake remains slightly acidic with a pH of 6.41. Cu (8.1 µg/L) and Ni (44.6 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. Al (33 µg/L), Fe (40 µg/L) and Zn (6.2 µg/L) concentrations are below these criteria (Ontario Ministry of Environment and Energy, 1994).

Table 4 Water chemistry from Baby 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	5.42	6.05	6.41
TIA Alkalinity (mg/L CaCO3)	-	2.72	0.94	1.64
Conductivity (µS/cm)	-	42.3	27.2	23.2
DOC (mg/L)	-	-	-	3.4
SO4 (mg/L)	-	12.20	8.17	5.65
Total Cu (µg/L)	5	19	9	8.1
Total Ni (µg/L)	25	100	56	44.6
Total Zn (µg/L)	30	12	14	6.2
Total Fe (µg/L)	300	<80	60	40
Total Mn (µg/L)	-	89	44	20.5
Total Al (µg/L)	75	<100	47	33

CONCLUSIONS

Although water quality appears to have improved since 1990, concentrations of Cu and Ni remain above the criteria for the protection of aquatic life (Ontario Ministry of Environment and Energy, 1994). Metal concentrations have, however, declined by 57% for Cu and 55% for Ni since 1990. Clams and snails were not observed in the lake, however acid-sensitive mayflies appear common. Brodill Lake supports populations of seven fish species, including smallmouth bass and the occasional largemouth bass. No information exists on how the bass entered Brodill Lake, however it is assumed that they may have migrated in from nearby Kasten (Bibby) Lake to the west. Current pH of the lake suggests that species such as lake trout could survive and reproduce naturally (Beggs and Gunn, 1986).

ACKNOWLEDGEMENTS

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APPENDIX I

Morphological data for smallmouth (*Micropterus dolomieu*) and largemouth bass (*M. salmoides*) from Brodill 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 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
Smallmouth Bass	2	291	305	405.7	1	2	A	1
Smallmouth Bass	3	161	170	58.3	2	1	A	1
Smallmouth Bass	4	150	158	47.8	2	1	A	1
Smallmouth Bass	224	160	166	55.4	2	1	A	1
Smallmouth Bass	226	147	153	37.8	1	2	A	1
Smallmouth Bass	227	161	170	53.3	1	2	A	1
Smallmouth Bass	228	177	185	76.7	1	2	A	1
Smallmouth Bass	229	270	282	262.7	2	2	A	1
Smallmouth Bass	231	279	293	303.1	2	2	A	1
Smallmouth Bass	336		296		9	9	0	0
Smallmouth Bass	337		304		9	9	0	0
Smallmouth Bass	348	325	337	595.7	2	2	A	1
Smallmouth Bass	349	302	314	504.1	1	2	A	1
Smallmouth Bass	350	296	309	413.3	2	2	A	1
Smallmouth Bass	351	300	315	464.9	2	2	A	1
Smallmouth Bass	379	176	183	77	1	1	A	1
Smallmouth Bass	380	190	199	94.9	1	2	A	1
Smallmouth Bass	381	268	280	292.7	2	2	A	1
Smallmouth Bass	382	275	289	309.3	2	2	A	1
Smallmouth Bass	383	250	290	354.4	2	2	A	1
Smallmouth Bass	384	289	300	381.5	2	2	A	1
Smallmouth Bass	516	286	300	399.9	1	2	A	1
Smallmouth Bass	608	184	192	95.5	1	2	A	1
Smallmouth Bass	609	303	315	432.87	1	2	A	1
Smallmouth Bass	610	311	328	463.9	2	2	A	1
Smallmouth Bass	611	296	316	429.4	1	2	A	1
Smallmouth Bass	678	135	142	29.1	2	1	A	0
Smallmouth Bass	679	99	103	13	9	1	0	0
Smallmouth Bass	680	190	200	95.7	2	2	A	0
Smallmouth Bass	681	469	491	1824.8	2	2	A	1
Smallmouth Bass	682	285	296	375.5	1	2	A	1
Smallmouth Bass	683	290	299	381.3	2	2	A	1
Smallmouth Bass	684	285	296	399.5	1	2	A	1
Smallmouth Bass	685	271	284	336.3	1	2	0	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
Smallmouth Bass	687	289	300	381.3	1	2	A	0
Smallmouth Bass	688	290	303	402.4	1	2	A	0
Smallmouth Bass	865	290	305	403.8	2	2	A	1
Smallmouth Bass	866	298	312	441.9	2	2	A	0
Smallmouth Bass	867	423	445	1510.1	2	2	A	1
Smallmouth Bass	1045	300	315	492.9	1	2	A	0
Smallmouth Bass	1046	172	180	75.8	9	9	A	0
Smallmouth Bass	1047	165	173	58.3	2	1	A	0
Largemouth Bass	338	145	151	45.9	9	9	0	A