Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2014

A Joint Effort of the 1854 Treaty Authority and the
Fond du Lac Resource Management Division

Brian D. Borkholder [1], Nick Bogyo[2], Sean Thompson[1], and Andrew J. Edwards [2]

[1] Fond du Lac Resource Management
1720 Big Lake Road
Cloquet, MN 55720
218-878-7104

[2] 1854 Treaty Authority
4428 Haines Road
Duluth, MN 55811-1524
218-722-8907

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Introduction

Under the Treaty of 30 September 1854, the Fond du Lac, Grand Portage, and Bois Forte Bands of Lake Superior Chippewa entered into an agreement with the United States of America. Under this agreement, these three Bands retained certain hunting, fishing, and gathering rights in the land ceded under this treaty.

Along with the right to utilize a resource comes the responsibility to manage and monitor the resource. Bands have assumed an increased responsibility to monitor fish populations and to develop long-term databases to set harvest quotas and to monitor the effects of tribal harvest. Fishery assessment surveys by Native American organizations have been performed for many years in both reservation and ceded territory waters of Wisconsin, Michigan, and Minnesota. Fond du Lac and the 1854 Treaty Authority have been actively involved with fish assessments since 1994 (Borkholder 1994a).

The 1854 Treaty Authority and Fond du Lac Resource Management Division work to protect and enhance the natural resources of the 1854 Ceded Territory for the three Bands. Cooperating with local Minnesota Department of Natural Resources (DNR) offices, the 1854 Treaty Authority and Fond du Lac identify priority natural resource projects for areas within the Ceded Territory. One goal is to assist with walleye assessments in the Ceded Territory. Walleye have always been a traditional subsistence resource for Fond du Lac and the Lake Superior Chippewa Bands. A 1994 survey conducted by Fond du Lac indicated that walleye were the primary game fish sought by Fond du Lac band members in the 1854 Ceded Territory (Borkholder 1994b).

Three techniques are typically utilized for the sampling of adult fish populations from within inland bodies of water; gill nets, trap (fyke) nets, and electrofishing gear. Gill nets are typically set for longer periods of time (10 - 18 hours), and can result in high fish mortality. Trap nets have been used for the sampling of adult walleye populations, but catch rates are low compared to electrofishing (Goyke et al. 1993 and 1994). Electrofishing is an effective and rapid method for sampling large areas, and has been used to sample walleye populations by other Native American agencies (Ngu and Kmiecik 1993; Goyke et al. 1993 and 1994) and within Northeastern Minnesota for many years (Borkholder 1994a and 1995). In order to maximize the number of fish handled and marked during the 2014 spawning season, Fond du Lac and the 1854 Treaty Authority chose once again to utilize electrofishing gear for these surveys.

Population estimates can be made using mark - recapture data (Ricker 1975). In this type of assessment, fish are collected, marked (fin clips, tags, etc.), and returned to the water. Population

estimates are based upon the ratio of marked fish to unmarked fish within subsequent recapture samples. Accurate estimates are obtained when a large portion of the population is marked, usually 10% to 30% (Meyer 1993).

Surveying adult walleye populations using just electrofishing gear will usually result in conservative estimates of the adult stock. Walleye spawn in shallow water, where they are vulnerable to electrofishing gear. Male walleyes remain in the shallow water following spawning and have an extended spawning period, while females retreat to deeper water (Meyer 1993). Thus, females are only vulnerable to the sampling gear for a short period of time. Population estimates based solely upon spring electrofishing data will be conservative estimates, lower than the true population size. The Great Lakes Indian Fish and Wildlife Commission and the U.S. Fish and Wildlife Service utilize trap nets to aid in the sampling of walleye females, thus improving the accuracy of their population estimates. Given time and personnel constraints, we have chosen to accept conservative population estimates as a trade-off to the extra effort required to trap net for additional females.

The first objective of our assessments in 2014 was to obtain adult walleye population estimates (PE) during the spring spawning period using mark - recapture data. Our electrofishing PEs may be biased towards males in the populations, and thus, are presumed conservative estimates of population abundance. However, by cooperating with the MN DNR area offices, a second PE is obtained using the State's summer gill net data, with which to compare to the spring-only electrofishing PE. An additional benefit of the spring electrofishing surveys is that it allows biologists to identify and determine key and critical spawning sites, i.e. where catch rates are the highest.

The second objective of our 2014 walleye surveys targeted juvenile (age-1) and young-of-the-year (age-0) individuals in the fall. The purpose for assessing age-0 and age-1 individuals is to evaluate recruitment and year-class strength, and to continue developing long-term data sets using this data.

Methods

Spring Assessments

Lakes within the 1854 Ceded Territory of Minnesota were identified during meetings between MNDNR Area Managers and Tribal biologists. The objective was to obtain adult walleye (*Sander vitreus*) population estimates using mark-recapture methods and to determine the age structure and growth rates of the walleye population within the lakes surveyed. Fin clipped and colored floy-tagged walleye would then be available during the summer gill net assessments conducted by the MNDNR, thus providing a second population estimate.

Electrofishing was performed at night using boom-shocking boats equipped with Smith-Root electrofisher units and two Smith-Root umbrella anode arrays (Smith-Root, Vancouver, WA). Pulsed direct current was used to minimize injuries to the fish. Surface water temperature was taken prior to the beginning of each night's assessment activity. Ambient water conductivity measurements were taken using either a Hanna HI8733 conductivity or a Fisher Scientific Digital Conductivity Meter.

Electrofishing surveys were planned to begin soon after ice-out, and continue for as long as un-tagged walleye were abundant in the samples or when the percentage of recaptured individuals approached or exceeded 30%. Adult and juvenile walleye immobilized by the electrofishing gear were collected. Collected fish were placed into a 90-gallon tank equipped with an aerator and given time to recover. Walleye were measured to the nearest millimeter (mm), examined for fin clips and / or floy tags, and the sex determined (male, female, unknown) based upon visual identification of gametes. Walleye that had been floy-tagged during any previous nights' collections were counted as recaptured fish (Appendix 1). All individuals (> 254 mm) were marked using non-numbered colored floy tags (orange color for 2014) (Super Swiftachment Fasteners available from the Dennison Fastener Division, Framingham, Massachusetts). The reason for this was because of many years of clipping dorsal fin spines would make it impossible to differentiate 2014 marked fish from previously clipped individuals. A dorsal fin spine from five individuals per centimeter group and per sex was removed and placed in a labeled envelope for later aging in the lab. Following marking and spine collection, walleyes were released away from the shoreline.

Mark and recapture data were used to calculate adult walleye population estimates using both the Schumacher and Eschmeyer formula for multiple recapture surveys and the adjusted Petersen Method for single census (Ricker 1975). The Schumacher and Eschmeyer formula was used to take advantage of multiple evenings of recapture data. Walleye less than 254 mm (10 inches, "stock" size defined by Anderson 1976 and 1978) were excluded from population estimates.

Spines from adults were cleaned using bleach to remove the layer of skin on the bone. Spines were set in epoxy resin and sectioned (0.3 to 0.5 mm thick) using a Buehler Isomet™ low speed bone saw. Spines were examined using a microfiche reader. Annual rings were counted (McFarlane and Beamish 1987), and marked on overhead transparency sheets. Each spine's annuli were digitized into a computer using the DisBCal89 program (Frie 1982). DisBCal89 was used to back-calculate length-at-age estimates, using no transformation and a standard intercept of 27.9 mm.

Fall Assessments

Presumed age-0 and age-1 walleye immobilized by the electrofishing gear were collected. Collected fish were placed into a 90-gallon tank of lake water and given time to recover. Walleye were measured to the nearest mm. Scales were taken for age analysis from five fish per cm group prior to release.

Sampling stations used were either those established during previous electrofishing surveys by the MN DNR or by Fond du Lac and the 1854 Treaty Authority (Borkholder 1996, 1997, and 1998; Borkholder and Edwards 1999, 2000, 2002, 2003, 2004, 2010, & 2011). Sampling stations were repeated from previous years' surveys.

Walleyes were aged by counting annuli on scales viewed under a microfiche reader (Borkholder 1996 and 1997). Walleye ages were used to estimate CPUE (number of walleye / hour of electrofishing) of juvenile (age-1) and young-of-the-year (age-0) individuals.

Results and Discussion

Spring Assessments

Crooked Lake (DOW 38-0024)

Spring 2014 was the second consecutive spring with very late ice-out. According to the State's Climate Journal, (http://www.dnr.state.mn.us/climate/journal/2014_ice_out_recap.html), most lakes within the State lost their ice nine days later than their respective median ice-out dates. Electrofishing activities were conducted on Crooked Lake, Lake County, on 15 – 18 May (Figure 1). Dates of electrofishing activities, water temperature, water conductivity, shocking time, the voltage and amps, the number of walleye collected, and the number caught per hour of electrofishing (CPUE) are presented in Table 1. CPUE ranged from 9.5 (EF3, third pass of the evening, 16 May) to 190.9 (EF1, 18 May) adult walleye per hour of sampling (Table 1, Figure 1). At a 95% confidence interval, mean CPUE for Crooked Lake, determined using each sampling station, was 86.3 ± 26.2 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Crooked Lake is presented in Figure 2. Walleye as large as 700 mm (27.6 inches) were observed in the survey. Incidentally, 23 walleyes were observed to have dorsal fin clips from previous surveys, and two individuals still retained a numbered floy tag applied in the 2006 survey (Appendix 2). One walleye was observed to be missing five (5) dorsal spines, indicating that this fish had been sampled many times by biological crews (Appendix 3). Additional species observed included northern pike, muskellunge, white sucker, and yellow perch.

Walleyes larger than 254 mm were marked with a non-numbered orange floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 617 (Table 2). The adjusted Petersen estimate is 631 ± 148, with a 7.4% CV (Table 2). The population estimates presented in Table 2 represent the population abundance of walleye using the sampled areas for spawning (Figure 1), and are not estimates of the walleye population within the entire lake. During summer 2014, the Minnesota Department of Natural Resources performed a standardized net assessment in Crooked Lake (MN DNR, Finland Area Fisheries). Sixty-eight (68) walleyes (> 275 mm) were sampled in the gill nets that would have been 254 mm during the May assessments. Eleven individuals were observed to have the orange floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 2358 ± 1650, with a 25.2% CV (Table 2). The Schumacker and Eschmeyer population estimate from this gill net data is 805 (Table 2). When MNDNR trap data is included with the gill net data, 74 walleyes (> 275 mm) were sampled, with 13 individuals observed with the orange floy tag. An adjusted Petersen estimate of 2196 ± 1420 adult walleye (23.3% CV) was calculated using the gill net and trap net samples. The Schumacker and Eschmeyer estimate is 813. The EF estimates from this survey may be slightly higher than those observed in 2010, but are consistent with estimates from 2006 and 2002 (Table 2) (Borkholder and Edwards 2011 and 2003; Borkholder et al. 2007).

Table 3 presents the age data for the walleye collected from Crooked Lake. Of the 581 unique fish sampled, 428 were assigned to ages 4, 5, & 6. Total annual mortality (*A*) of the Crooked Lake population was estimated at 43.6%, using the equation $A = 1 - e^{(Z)}$, where *Z* is the slope of the catch-curve relationship, and an estimate of instantaneous total annual mortality (Figure 3) (Chapman and Robson 1960). This is much higher than the estimate made during the 2006 survey of 30.2% (Borkholder et al. 2007). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 32.3% (Figure 3), lower than the estimate from the spring electrofishing assessment. Our spring estimate was made using 514 mature walleyes, age 4 – 14. The estimate from the gill net assessment was made using 62 fish aged 3 – 8. Table 4 presents back-calculated lengths-at-age for walleye collected from Crooked Lake, as determined using dorsal fin spines.

Stock density indices are used to quantify the size structure of a population. Proportional stock density (PSD) was first proposed by Anderson (1976 and 1978), and is simply a measurement of the proportion of the fish observed larger than a predetermined "quality" length divided by the number of fish observed larger than a predetermined "stock" length. For walleye, "stock" length fish are those

larger than 10.0 inches (254 mm), and "quality" length fish are those larger than 15.0 inches (381 mm). Gabelhouse (1984) proposed further separating "quality" fish into "preferred" (walleye > 20.0 inches / 508 mm), "memorable" (walleye > 25.0 inches / 635 mm), and "trophy" length fish (walleye > 30.0 inches / 762 mm), and calculating a relative stock density (RSD), or proportion, for each category. For example, RSD S-Q is the proportion of walleye in the sample between "stock" length (10.0 inches / 254 mm) and "quality" length (> 15.0 inches / 381 mm), divided by the total number of walleye sampled larger than 10.0 inches.

PSD and RSD values determined by our spring electrofishing sampling and summer gillnet survey are presented in Table 5. The electrofishing PSD was 67.7 ± 4.9 (Table 5). Further, there is a large portion of the population less than 15.0 inches (32.3% of sample) that will be growing and recruiting into this "quality" 15-inch category over the next few years. The summer gill net PSD (36.1 ± 10.3) was significantly different than the PSD estimate from the spring electrofishing survey (χ^2=26.4, P<0.05, critical Chi-square value of 3.841).

PSD metrics calculated from the 2006 electrofishing assessments are included for comparison (Table 5) (Borkholder et al. 2007). Significant differences were observed between the 2014 PSD and the 2006 PSD (χ^2=14.04, P<0.05, critical Chi-square value of 3.841), and between the RSD Q-P metrics of the two assessments (χ^2=-3.75, P<0.05, critical Chi-square value of -1.64). This is largely attributable to many more individuals observed in 2006 between 15.0 and 20.0 inches, than what was observed in our 2014 survey.

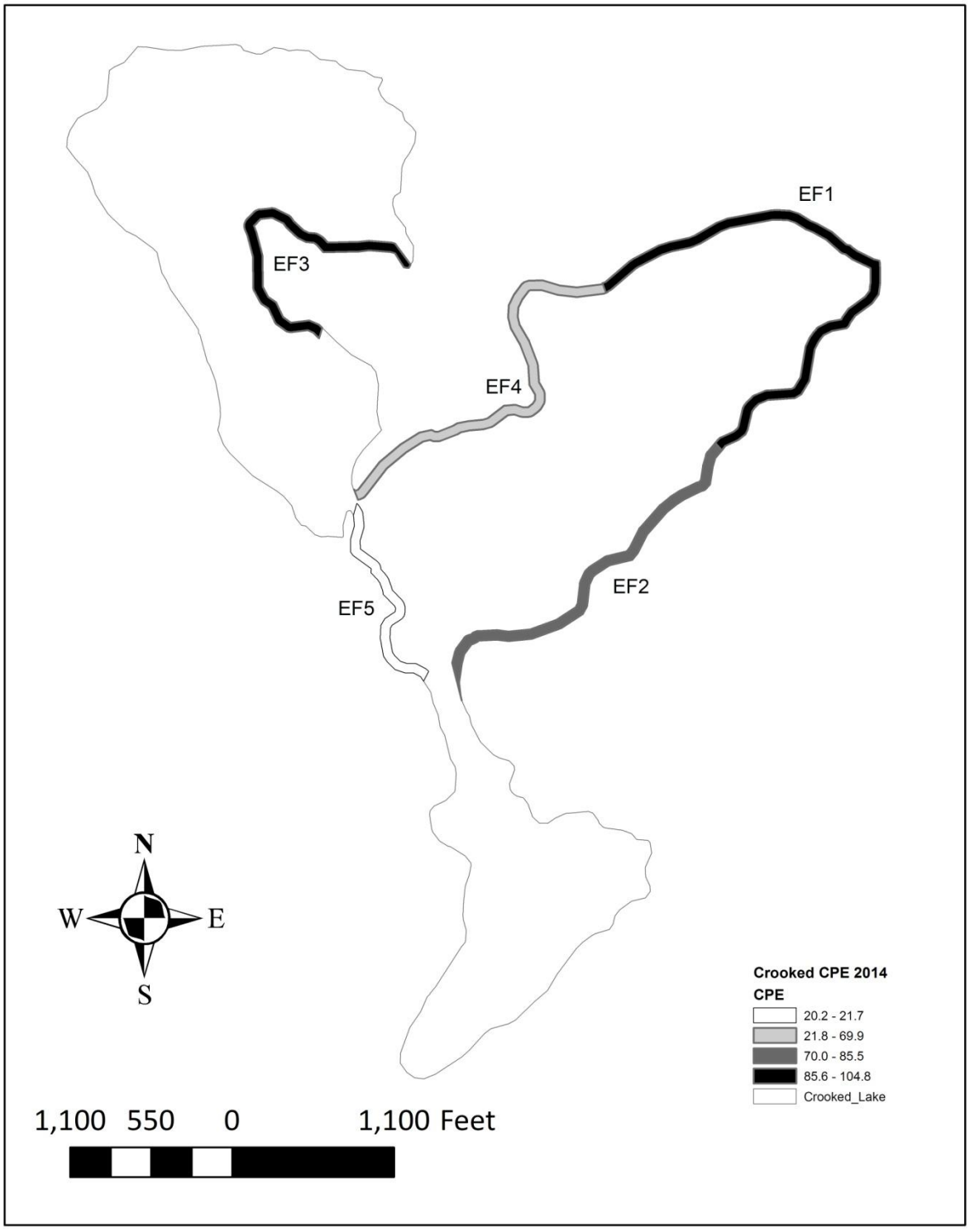

Figure 1. Catch per hour (CPE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Crooked Lake, Lake County, during May 2014 electrofishing surveys.

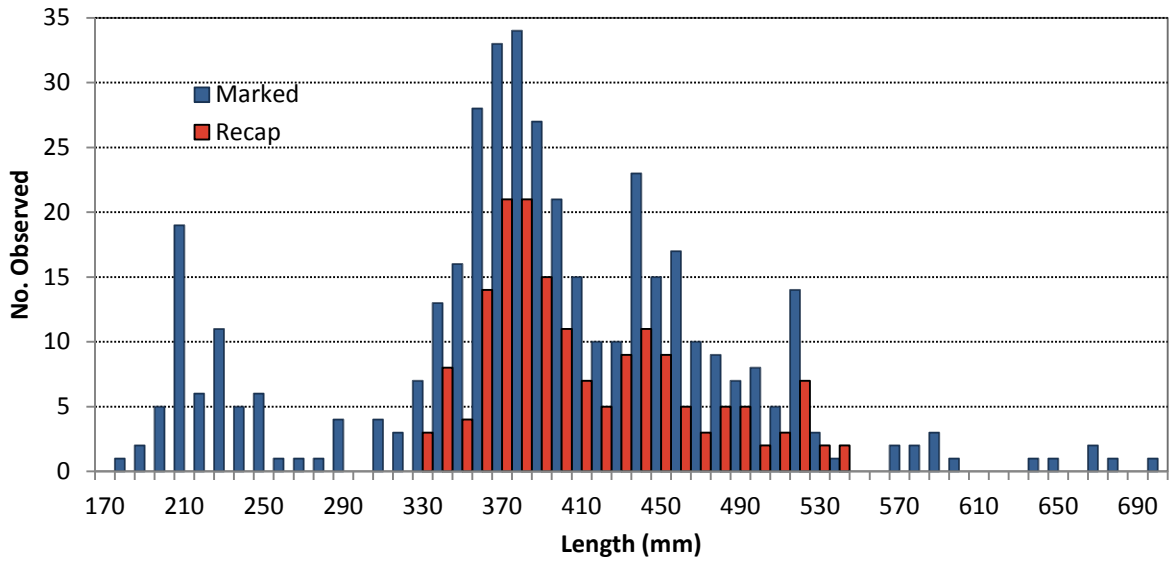

Figure 2. Length frequency distribution of walleye sampled from Crooked Lake, Lake County, MN, during spring 2014 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

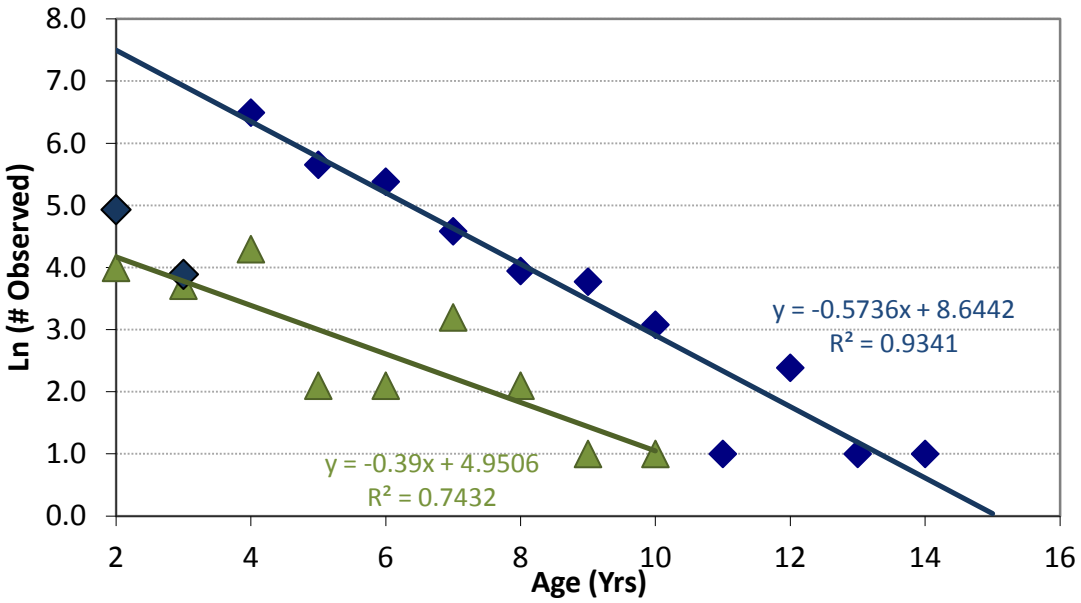

Figure 3. Catch curve analysis of walleyes in Crooked Lake, 2014, showing instantaneous mortality (*Z*). Estimates are made from May 2014 electrofishing data (blue diamonds), and from summer 2014 gill net assessments by the MNDNR (green triangles).

Table 1. Summary of electrofishing activities on Crooked and Caribou Lakes, Cook County, Minnesota, during May 2014.

ID #	County	Lake	Area (Acres)	Max Depth (ft)	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)	Amps	# WAE[2]	CPUE WAE[3]
38-0024	Lake	Crooked	272	18	5/15/2014	38	47.2	1518	707	4	54	128.1
					5/16/2014	39.8	47.2	9625	707	4	150	56.1
					5/17/2014	44.5	47.0	10654	707	4	218	73.7
					5/18/2014	47.0	47.0	4823	707	4	159	118.7
16-0360	Cook	Caribou	721	30	5/18/2014	44	46.4	10240	884	4.5	191	67.1
					5/19/2014	44.8	47	21374	884	5	312	52.5
					5/20/2014	48.2	51.2	14763	884	5	249	60.7

[1] Water conductivity measured in microSiemens / cm.

[2] WAE = walleye. Numbers in column represent the number of "stock" sized walleye (>254mm (10 inches)) collected. Includes marked and recaptured individuals.

[3] CPUE = catch per unit effort, computed as per hour (3600 sec) of electrofishing. Numbers in column represent CPUE for "stock" sized walleye (>254mm (10 inches)).

Table 2. Walleye population estimates for Crooked and Caribou Lakes, May 2014. Estimates are for walleye larger than 254 mm (10.0 inches). EF denotes population estimates determined from spring electrofishing data. GN refers to population estimates determined from gill net samples collected in the summer following marking with the electrofishing surveys. GN/TN includes all of the MNDNR data from both the gill nets and trap nets. Rows of shaded data indicate population estimates from previous surveys, and are presented for comparative purposes.

Lake	Population Estimate[1]	95% Confidence Limits Lower	Upper	Estimate[2]	C.V.[3]
Crooked – EF_{2014}	617	520	757	631 ± 148	7.4 %
Crooked – GN_{2014}	805	487	2315	2358 ± 1650	25.2 %
Crooked – GN/TN_{2014}	813	493	2320	2196 ± 1420	23.3%
Crooked – EF_{2010}	235	222	250	233 ± 100	10.0%
Crooked – GN_{2010}	445	192	---	996 ± 748	23.6%
Crooked – EF_{2006}	548	501	606	561 ± 100	5.6%
Crooked – GN_{2006}	683	425	1731	3055 ± 2247	26.5%
Crooked – EF_{2002}	575	554	599	579 ± 118	6.4%
Crooked – GN_{2002}	663	363	3763	1632 ± 1356	26.1%
Caribou – EF_{2014}	727	619	879	871 ± 213	5.7%
Caribou – GN_{2014}	784	545	1397	2100 ± 2958	32.7%
Caribou – GN/TN_{2014}	790	545	1436	2025 ± 2651	30.4%
Caribou – EF_{2008}	1238	1082	1446	1260 ± 401	7.4%
Caribou – GN_{2008}	940	509	6153	3729 ± 3686	31.1%
Caribou – EF_{2005}	574	509	658	585 ± 137	5.5%
Caribou – GN_{2005}	840	461	4777	3700 ± 2262	26.0%
Caribou – EF_{2003}	1027	Not Calculated due to a single *df*		1019 ± 1419	11.0%

1 Schumacher and Eschmeyer population estimate.
2 Adjusted Petersen population estimate, with 95% confidence interval.
3 Coefficient of variation for the Petersen estimate.
4 Unable to calculate upper and lower confidence limits with one degree of freedom (1 *df*)

Table 3. Age frequency distribution of walleye from Crooked Lake, Lake County, May 2014, based upon the number of fish sampled and aged per size category.

Length Group		N	Age												
Inches	mm	Sampled	2	3	4	5	6	7	8	9	10	11	12	13	14
7.0	178	1	1												
7.5	191	3	3												
8.0	203	15	15												
8.5	216	13	13												
9.0	229	14	14												
9.5	241	7	4	3											
10	254	3	1	2											
10.5	267	1		1											
11	279	1		1											
11.5	292	4		4											
12	305	3		3											
12.5	318	4		4											
13	330	17			17										
13.5	343	26			26										
14	356	46			31	15									
14.5	368	64			64										
15	381	68			58	10									
15.5	394	44			31	13									
16	406	33			11	17	6								
16.5	419	20			5	12	3								
17	432	33				13	20								
17.5	445	34				7	13	14							
18	457	27				10	10	7							
18.5	470	19				5	8	6							
19	483	17				3	10		2	2					
19.5	495	11					1	4	2		2		1		
20.0	508	12					2	2	9						
20.5	521	21					7	2	5	4	4				
21.0	533	5								5					
21.5	546	1									1				
22.0	559														
22.5	572	3							1	2					
23.0	584	2								1			1		
23.5	597	3						1		1	1				
24.0	610														
25.0	635	1											1		
25.5	648	1												1	
26.0	660														
26.5	673	2								1			1		
27.0	686	1													1
27.5	699	1										1			
	TOTAL	581	51	18	243	105	80	36	19	16	8	1	4	1	1
			8.8%	3.1%	41.8%	18.1%	13.8%	6.2%	3.3%	2.8%	1.4%	0.2%	0.7%	0.2%	0.2%

Table 4. Back-calculated lengths-at-age for walleye collected from Crooked Lake, Lake County, Minnesota, May 2014.

Age Class	N	Length (mm)	Length (in)
1	226	123	4.9
2	226	214	8.4
3	200	301	11.8
4	183	373	14.7
5	128	425	16.7
6	93	461	18.1
7	57	491	19.3
8	35	516	20.3
9	24	550	21.7
10	14	567	22.3
11	7	602	23.7
12	6	611	24
13	2	659	26
14	1	689	27.1

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence intervals for walleye sampled from Crooked (Lake County) and Caribou Lakes (Cook County), Minnesota. Values are for spring electrofishing (EF) and MN DNR gill netting (GN) surveys conducted during the year indicated.

Lake	PSD	RSD S-Q	RSD Q-P	RSD P-M	RSD M-T
Crooked – EF_{2014}	67.7 ± 4.9	32.3 ± 4.9	57.0 ± 5.1	9.0 ± 3.0	1.7 ± 1.3
Crooked – GN_{2014}	36.1 ± 10.3	63.9 ± 10.3	33.7 ± 10.2	2.4 ± 3.3	0.0 ± 0.0
Crooked Lake – EF_{2006}	79.0 ± 3.9	21.0 ± 3.9	71.7 ± 4.3	6.9 ± 2.4	0.5 ± 0.7
Crooked Lake – GN_{2006}	58.7 ± 11.1	41.3 ± 11.1	45.3 ± 11.3	13.3 ± 7.7	0.0 ± 0.0
Caribou -- EF_{2014}	77.3 ± 3.6	22.7 ± 3.6	69.1 ± 4.0	8.0 ± 2.3	0.2 ± 0.4
Caribou -- GN_{2014}	37.5 ± 16.8	62.5 ± 16.8	31.2 ± 16.1	6.2 ± 8.4	0.0 ± 0.0
Caribou -- EF_{2008}	51.9 ± 3.8	48.1 ± 3.8	51.5 ± 3.8	0.4 ± 0.5	0.0 ± 0.0
Caribou -- GN_{2008}	24.6 ± 10.8	75.4 ± 10.8	21.3 ± 10.3	3.3 ± 4.5	0.0 ± 0.0

Caribou Lake (DOW 16-0360)

Electrofishing activities were conducted on Caribou Lake, Cook County, on 18 - 20 May (Figure 4). Dates of electrofishing activities, water temperature, water conductivity, shocking time, the voltage and amps, the number of walleye collected, and the number caught per hour of electrofishing (CPUE) are presented in Table 1. CPUE ranged from 5.2 (EF-D, 18 May) to 112.0 (EF2, 20 May) adult walleye per hour of sampling (Table 1, Figure 4). At a 95% confidence interval, mean CPUE for Caribou Lake, determined using each sampling station, was 58.6 ± 15.6 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Caribou Lake is presented in Figure 5. Walleye as large as 636 mm (25.0 inches) were observed in the survey. Additional species observed included northern pike, white sucker, smallmouth bass, black crappie, and yellow perch.

Walleyes larger than 254 mm were marked with a non-numbered orange floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 727 (Table 2). The electrofishing adjusted Petersen estimate is 871 ± 213, with a 5.7% CV (Table 2). The population estimates presented in Table 2 represent the population abundance of walleye using the sampled areas for spawning (Figure 4), and are not estimates of the walleye population within the entire lake. During

summer 2014, the Minnesota Department of Natural Resources performed a standardized net assessment on Caribou Lake (MN DNR, Grand Marais Area Fisheries). Twenty-three (23) walleyes (> 275 mm) were sampled in the gill nets that would have been 254 mm during the May assessments. Five individuals were observed to have the orange floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 2100 ± 2958, with a 32.7% CV (Table 2). The Schumacker and Eschmeyer population estimate from this gill net data is 784 (Table 2). The EF estimates from this survey are lower than those observed in 2008 (Borkholder and Edwards 2009), and consistent with trends that the MNDNR have observed in recent gill net surveys (S. Persons, MNDNR, unpublished data).

Table 6 presents the age data for the walleye collected from Caribou Lake. Of the 752 unique fish sampled, 632 were assigned to ages 3 – 6 (Table 6). Total annual mortality (*A*) of the Caribou Lake population was estimated at 36.5%, using the equation $A = 1 - e^{(Z)}$, where *Z* is the slope of the catch-curve relationship, and an estimate of instantaneous total annual mortality (Figure 6). This is similar to the estimation made during the 2008 survey of 33.8% (Borkholder and Edwards 2009). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 25.6% (Figure 6), and was based on the aging of 48 walleyes age-2 and older, with half of those individuals assigned age-2. Table 7 presents back-calculated lengths-at-age for walleye collected from Caribou Lake, as determined by aging dorsal fin spines.

PSD and RSD values determined by our spring electrofishing sampling and summer gillnet survey are presented in Table 5. The electrofishing PSD of 77.3 ± 3.6 (Table 5). A large number of individuals less than 15.0 inches (22.7% of sample) that will be growing and recruiting into this "quality" 15-inch category over the next few years. The summer gill net PSD (37.5 ± 16.8) was significantly different than the PSD estimate from the spring electrofishing survey (χ^2=25.5, *P*<0.05, critical Chi-square value of 3.841). Significant differences were also observed in the RSDS-Q (χ^2= -5.05) metric between the electrofishing and gill net assessments during 2014 assessments (*P*<0.05, critical Chi-square value of - 1.64) (Table 5).

PSD metrics calculated from the 2008 electrofishing assessments are included for comparison (Table 5) (Borkholder et al. 2007). No significant differences were observed between the 2014 PSD and the 2008 PSD (χ^2=1.69, *P*>0.05, critical Chi-square value of 3.841), or between the RSD Q-P metrics of the two assessments (χ^2= -1.30, *P*>0.05, critical Chi-square value of -1.64). This suggests that the population structure has changed little between the two assessments.

Fall Assessments

Catch per unit effort (CPUE) for age-0 walleye has been found to be the highest in the fall when water temperatures are between 20.0°C and 10.0°C (Borkholder and Parsons, 2001). Fall assessments began in the Grand Marais area on 7 September 2014. This 20°C threshold was not exceeded in 2014 (Table 6). All of the lakes were surveyed before the lakes cooled to below the 10°C lower threshold.

Table 8 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 0.0 fish per hour (Ball Club, Devilfish, Dumbbell, Elbow, Wild Rice, & Windy Lakes) to 266.8 fish per hour of electrofishing (Pike Lake) (Table 8). Ninemile was stocked with walleye fry in May 2014, which were observed at a higher catch rate than what was observed in most of the other lakes in 2014 (74.8 age-0 / hr) (D. Paron, MNDNR, personal communication). CPUE for age-1 walleye ranged from 0.0 fish per hour (Devilfish, Harriet, and Wild Rice Lakes) to 126.8 fish per hour of electrofishing (Shagawa Lake) (Table 8). Shagawa Lake was stocked in 2013 with 2.3 million fry, which seemingly contributed to the high catch rates (Borkholder et al. 2014). Figures 7 – 30 present length frequency data for each of the lakes surveyed. Table 9 presents the mean length for age-0 and age-1 individuals sampled during fall 2014 assessments. Mean lengths for age-0 walleye ranged from 99 mm (3.9 inches, Tom and Harriet Lakes) to 156 mm (6.1 inches, Cadotte Lake). Mean lengths for age-1 walleye ranged from 168 mm (6.6 inches, Shagawa Lake) to 256 mm (9.9 inches, Ninemile Lake).

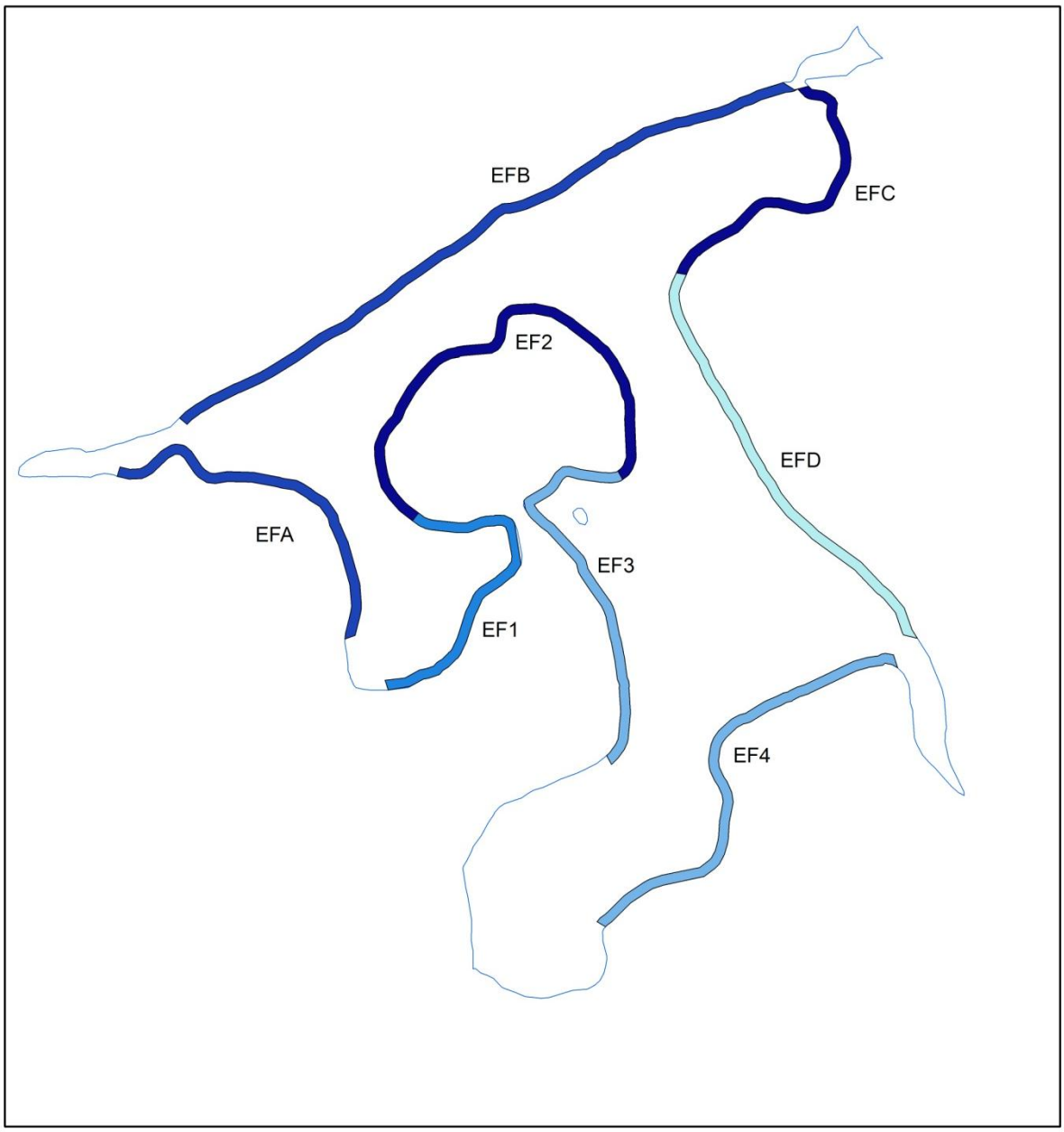

Figure 4. Catch per hour (CPE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Caribou Lake, Cook County, during May 2014 electrofishing surveys.

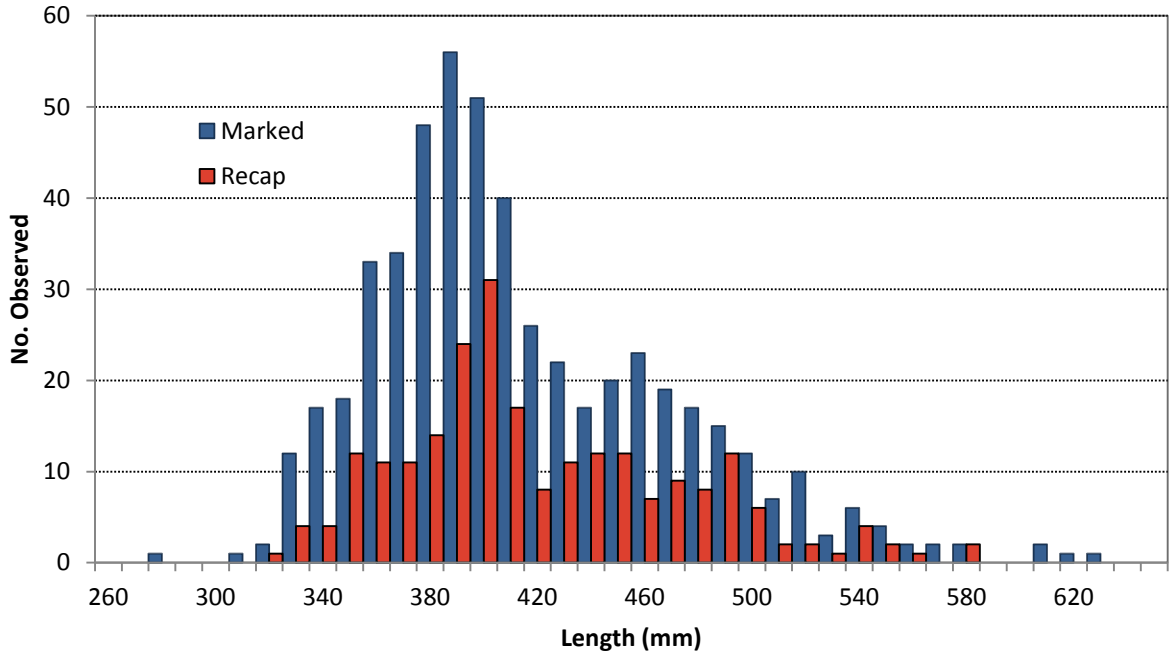

Figure 5. Length frequency distribution of walleye sampled from Caribou Lake, Cook County, MN, during May 2014 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

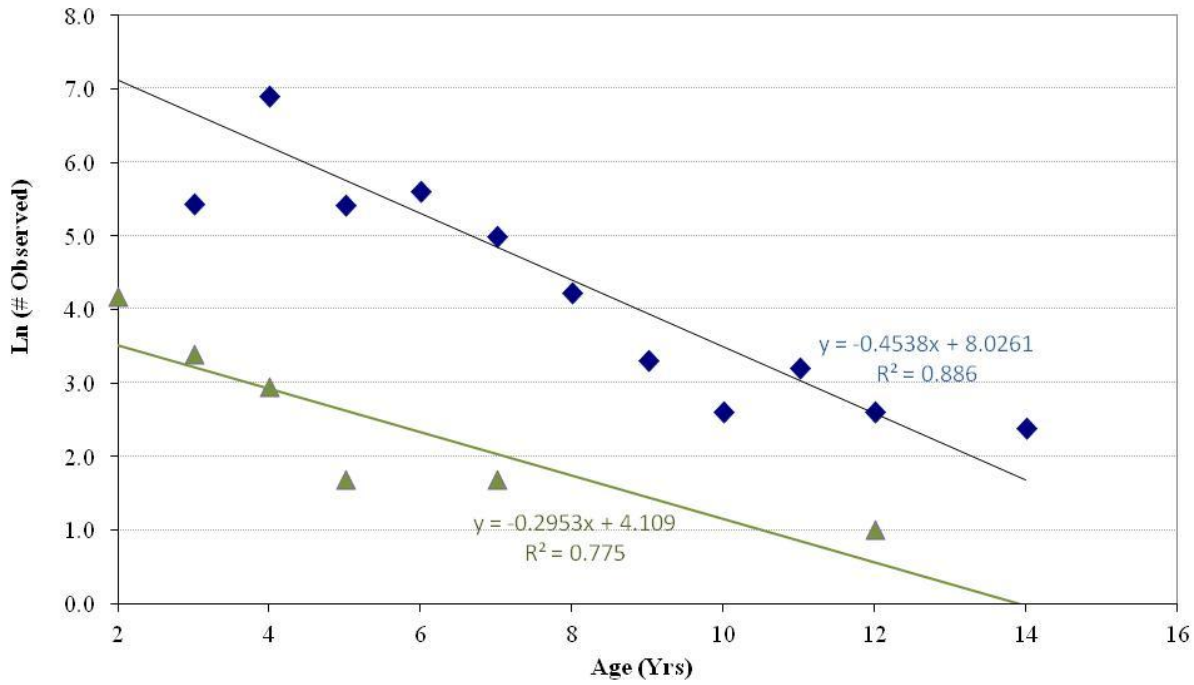

Figure 6. Catch curve analysis of walleyes in Caribou Lake, 2014, showing instantaneous mortality (*Z)*. Estimates are made from May 2014 electrofishing data (blue diamonds), and from summer 2014 gill net assessments by the MNDNR (green triangles).

Table 6. Age frequency distribution of walleye from Caribou Lake, Lake County, May 2014, based upon the number of fish sampled and aged per size category.

Length Group		N	Age											
Inches	mm	Sampled	3	4	5	6	7	8	9	10	11	12	13	14
11	279	1	1											
11.5	292													
12	305	1	1											
12.5	318	5	5											
13	330	18	18											
13.5	343	40	33	8										
14	356	48	10	38										
14.5	368	50	16	34										
15	381	98		98										
15.5	394	96		87										
16	406	85		69	16									
16.5	419	42		22	14	6								
17	432	37		9	28									
17.5	445	45			17	21		7						
18	457	34			6	28								
18.5	470	38				12	18	8						
19	483	34				14	18	2						
19.5	495	22				9	13							
20.0	508	15			2	6	3		5					
20.5	521	11				4	2	1		1		2		
21.0	533	13						3		3	3			3
21.5	546	6									5	2		
22.0	559	3						3						
22.5	572	2						1	1					
23.0	584	4							4					
23.5	597	0												
24.0	610	2								1	1			
24.5	622	1												1
25.0	635	1										1		
TOTAL		752	84	365	83	100	54	25	10	5	9	5	0	4
			11.2%	48.5%	11.0%	13.3%	7.2%	3.3%	1.3%	0.7%	1.2%	0.7%	0.0%	0.5%

Table 7. Back-calculated lengths-at-age for walleye collected from Caribou Lake, Cook County, Minnesota, May 2014.

Age Class	N	Length (mm)	Length (in)
1	136	122	4.8
2	136	214	8.4
3	136	306	12
4	120	373	14.7
5	86	422	16.6
6	71	461	18.1
7	51	485	19.1
8	38	505	19.9
9	27	522	20.6
10	21	534	21
11	14	538	21.2
12	9	543	21.4
13	3	552	21.7
14	3	568	22.4
15	1	551	21.7

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Table 8. Total number and catch-per-unit-effort (CPUE) of age-0 and age-1 walleye collected from 25 lakes within the 1854 Ceded Territory of Northeastern Minnesota during Fall 2014.

Lake	Date	Temp (F)	Temp (C)	Cond.[1]	Age-0 Total[2]	Age-1 Total[3]	Seconds	CPUE Age-0[4]	CPUE 1+[5]
Ball Club	14-Sep	64	17.8	21.0	0	4	3490	0.0	4.1
Cadotte	29-Sep	59	15.0	57.0	11	40	4688	8.4	30.7
Caribou	12-Sep	56	13.3	63.0	156	45	4912	114.3	33.0
Cascade	11-Sep	56	13.3	24.0	7	34	3996	6.3	30.6
Crescent	7-Sep	66	18.9	28.6	30	13	3904	27.7	12.0
Crooked	26-Sep	60	15.6	44.0	5	11	3616	5.0	11.0
Devilfish	10-Sep	54	12.2	10.0	0	0	5441	0.0	0.0
Dumbbell	26-Sep	62	16.7	75.8	0	16	5275	0.0	10.9
Elbow	9-Sep	64	17.8	30.0	0	28	3461	0.0	29.1
Fourmile	25-Sep	61	16.1	44.0	31	51	4140	27.0	44.3
Harriet	23-Sep	56	13.3	55.0	3	0	4155	2.6	0.0
Island Reservoir	1-Oct	60	15.6	78.7	81	38	9518	30.6	14.4
Ninemile	23-Sep	60	15.6	61.8	119	4	5726	74.8	2.5
N. McDougal	22-Sep	59	15.0	59.0	54	44	4922	39.5	32.2
Pike	11-Sep	61	16.1	55.3	574	75	7744	266.8	34.9
Shagawa	29-Sep	61	16.1	87.4	28	358	10166	9.9	126.8
Silver Island	24-Sep	55	12.8	31.0	20	18	4138	17.4	15.7
Tait	24-Sep	58	14.4	37.8	7	37	8191	3.1	16.3
Tom	9-Sep	65	18.3	32.4	1	70	6486	0.6	38.9
Two Island	8-Sep	65	18.3	28.7	8	28	6128	4.7	16.4
West Twin	8-Sep	64	17.8	31.2	28	41	4767	21.1	31.0
Whiteface Res.	29-Sep	62	16.7	58.6	34	45	6880	17.8	23.5
Wild Rice	18-Sep	58	14.4	111.7	0	0	4970	0.0	0.0
Wilson	22-Sep	59	15.0	45.8	35	26	7111	17.7	13.2
Windy	25-Sep	59	15.0	28.5	0	3	6318	0.0	1.7

[1] Conductivity, measured in MicroSiemens / cm.
[2] Indicates the number of age-0, young-of-the-year, walleye collected in each sample.
[3] Indicates the number of age-1 juvenile walleye collected in each sample.
[4] Indicates the catch rate of age-0 fish (fish per hour, 3600 sec, of electrofishing on time).
[5] Indicates the catch rate of age-1 fish (fish per hour, 3600 sec, of electrofishing on time).

Table 9. Mean length for age-0 and age-1 walleye sampled during fall 2014 assessments within the 1854 Ceded Territory of Northeastern Minnesota. Numbers in parentheses indicate sample sizes, and are presented when mean lengths are based upon few individuals (N=<20).

Lake (County)	Date	Age-0 Mean Length (mm)	Age-1 Mean Length (mm)
Ball Club	14-Sep	N/A	194 (N=4)
Cadotte	29-Sep	156 (N=11)	245
Caribou	12-Sep	138	213
Cascade	11-Sep	132 (N=7)	196
Crescent	7-Sep	130	221 (N=13)
Crooked	26-Sep	140 (N=5)	197 (N=11)
Devilfish	10-Sep	N/A	N/A
Dumbbell	26-Sep	N/A	214 (N=16)
Elbow	9-Sep	N/A	187
Fourmile	25-Sep	133	202
Harriet	23-Sep	99 (N=3)	N/A
Island Reservoir	1-Oct	116	178
Ninemile	23-Sep	131	256 (N=4)
N. McDougal	22-Sep	129	180
Pike	11-Sep	139	209
Shagawa	29-Sep	134	168
Silver Island	24-Sep	134 (N=20)	191 (N=18)
Tait	24-Sep	138 (N=7)	175
Tom	9-Sep	99 (N=1)	184
Two Island	8-Sep	114 (N=8)	188
West Twin	8-Sep	120	192
Whiteface Res.	29-Sep	143	227
Wild Rice	18-Sep	N/A	N/A
Wilson	22-Sep	121	190
Windy	25-Sep	N/A	199 (N=3)

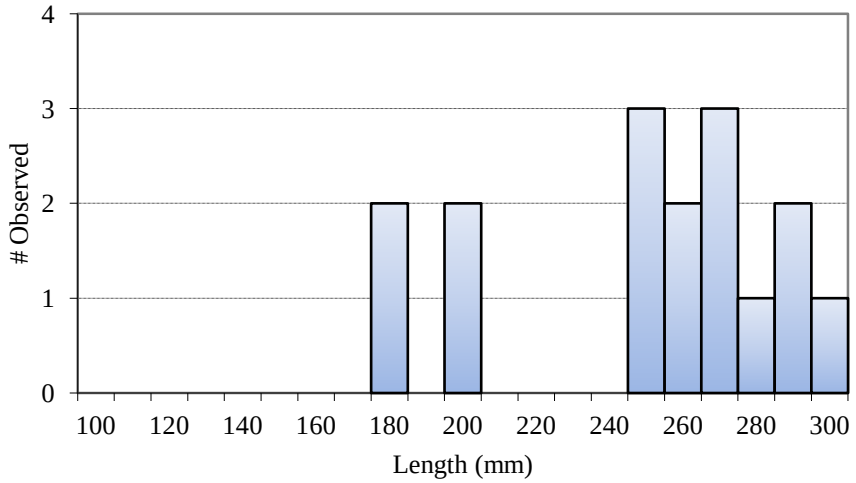

Figure 7. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2014 electrofishing assessments.

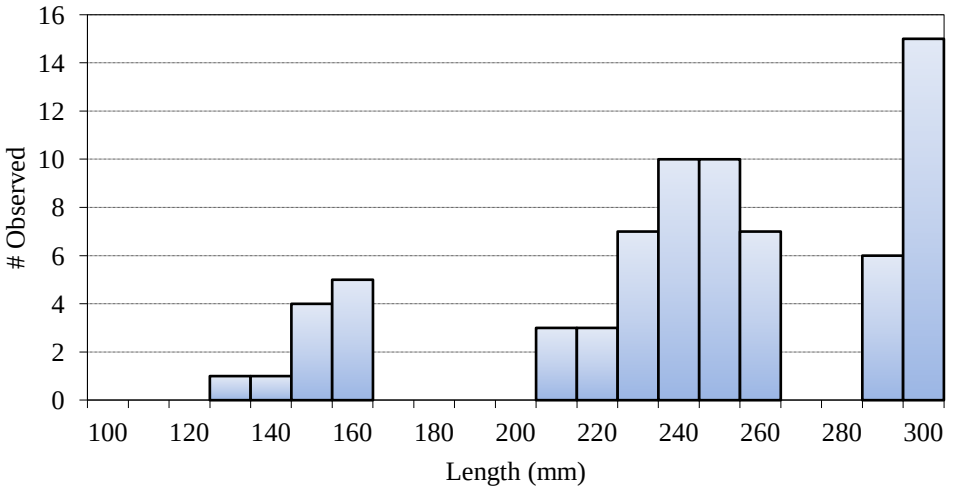

Figure 8. Length frequency distribution of walleye collected from Cadotte Lake, St. Louis County, during fall 2014 electrofishing assessments.

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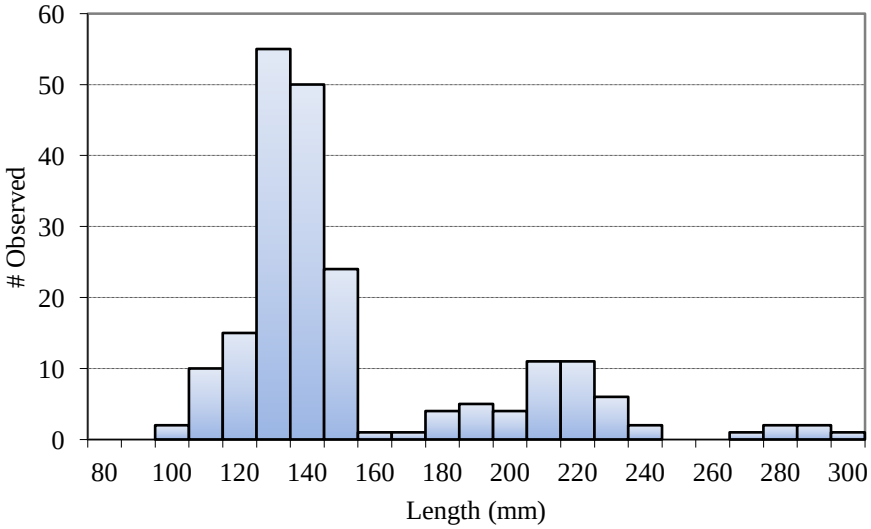

Figure 9. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2014 electrofishing assessments.

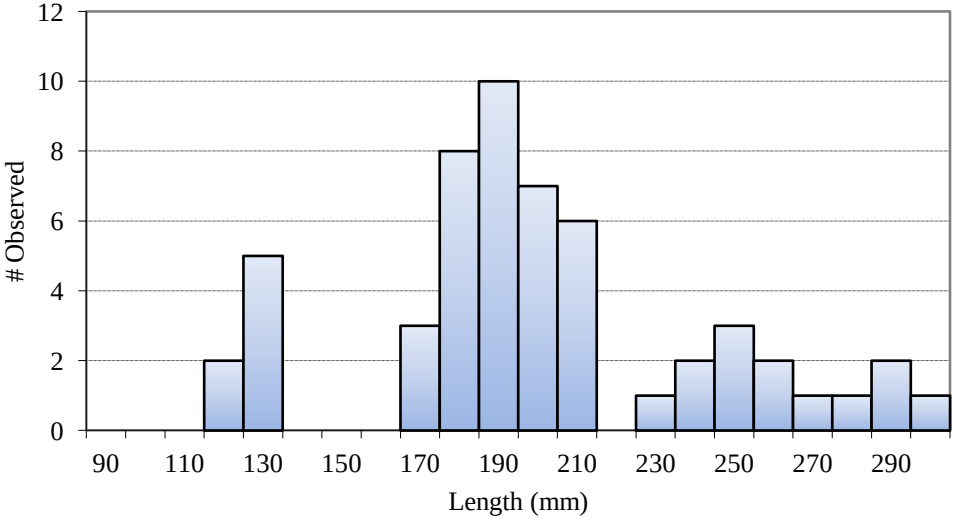

Figure 10. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2014 electrofishing assessments.

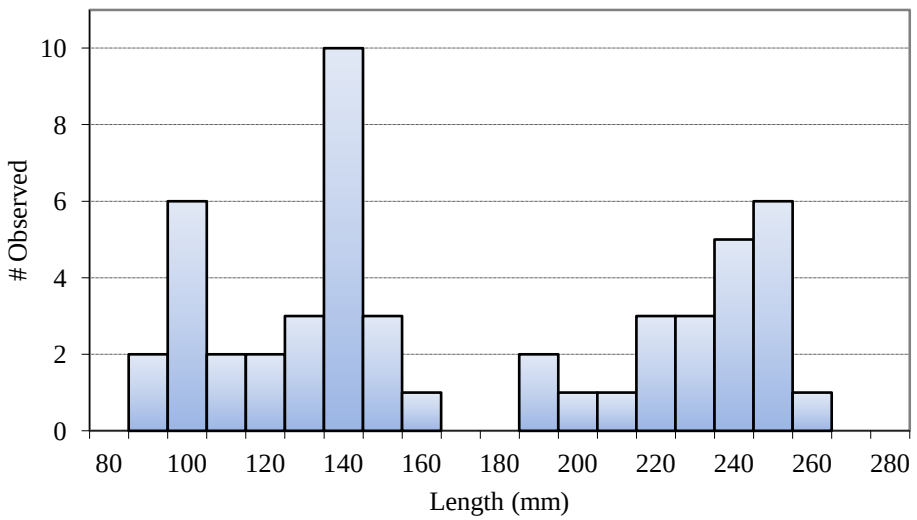

Figure 11. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2014 electrofishing assessments.

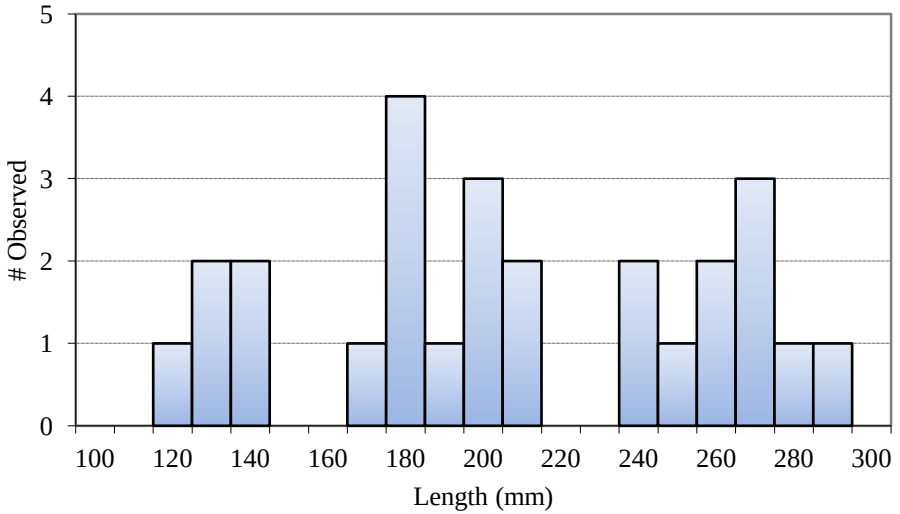

Figure 12. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2014 electrofishing assessments.

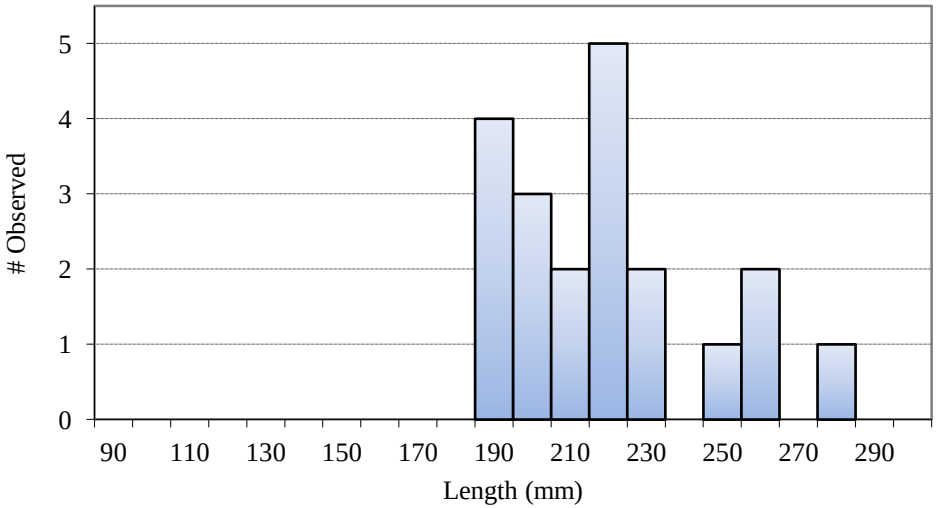

Figure 13. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2014 electrofishing assessments.

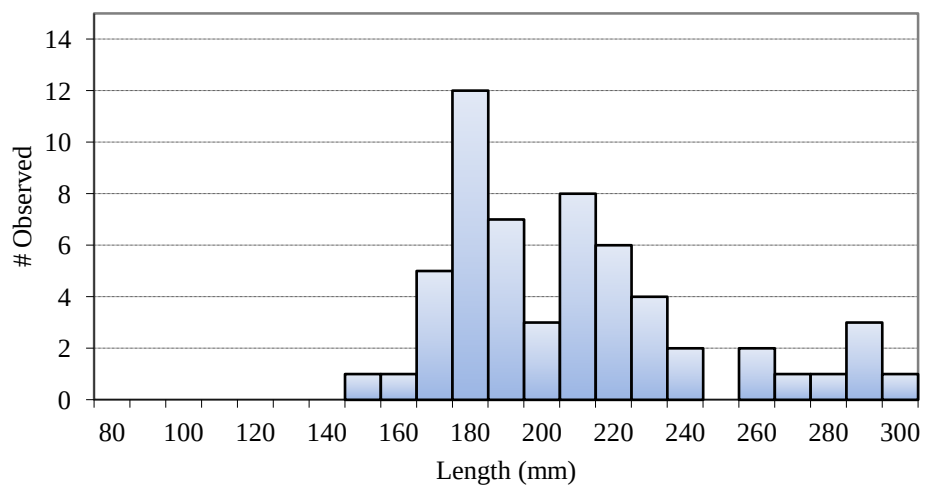

Figure 14. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2014 electrofishing assessments.

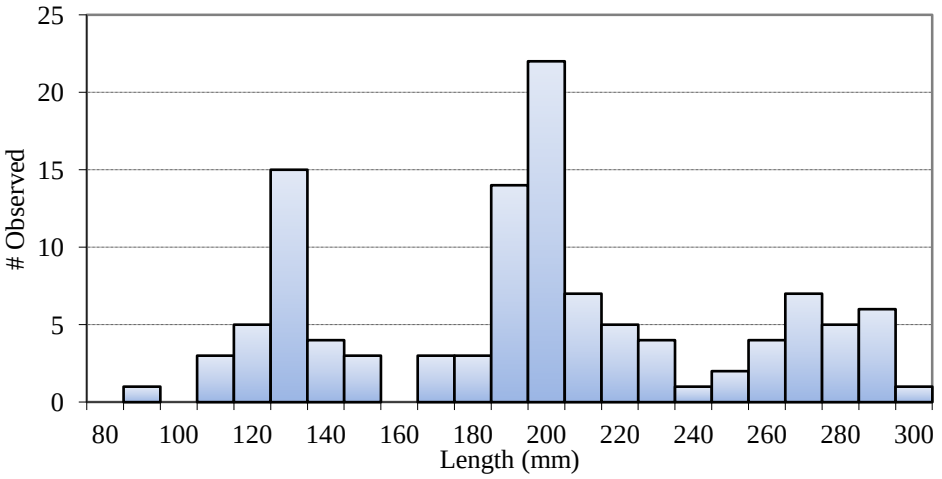

Figure 15. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2014 electrofishing assessments.

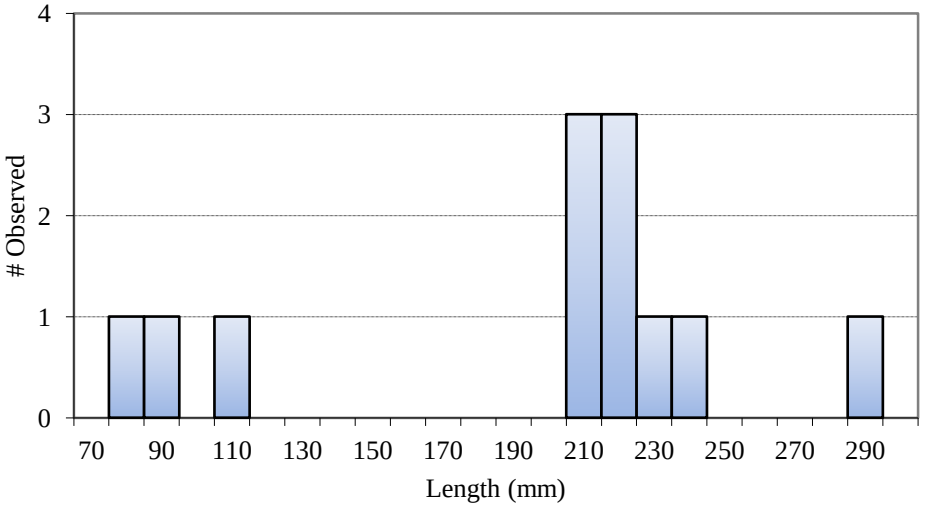

Figure 16. Length frequency distribution of walleye collected from Harriet Lake, Lake County, during fall 2014 electrofishing assessments.

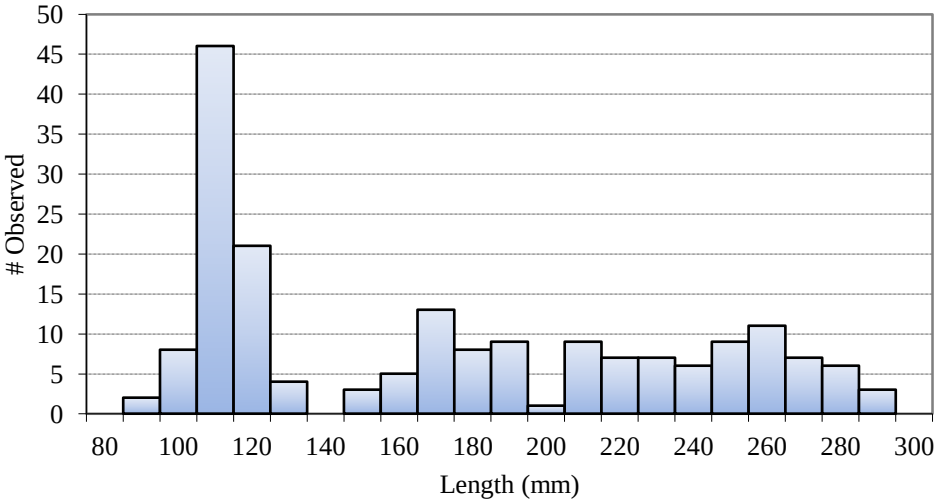

Figure 17. Length frequency distribution of walleye collected from Island Lake Reservoir, St. Louis County, during fall 2014 electrofishing assessments.

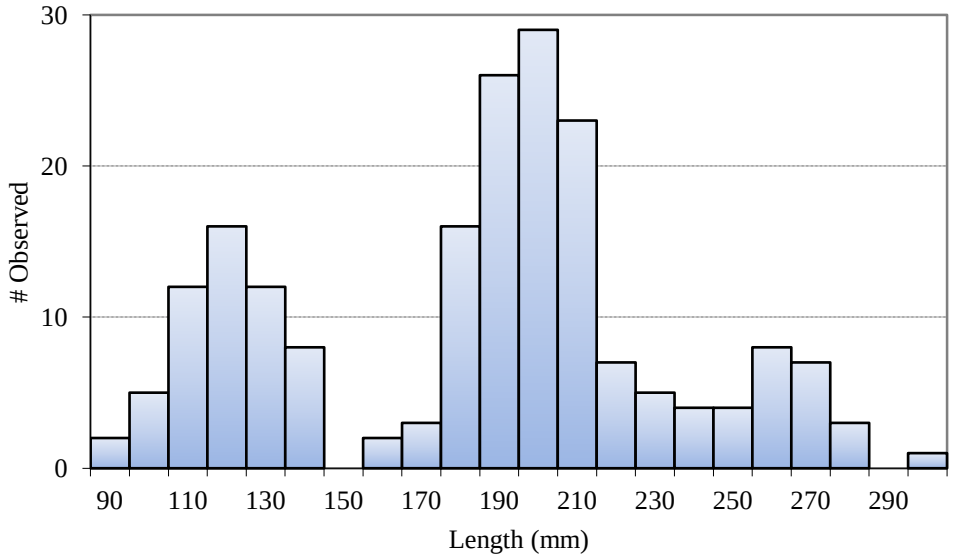

Figure 18. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2014 electrofishing assessments.

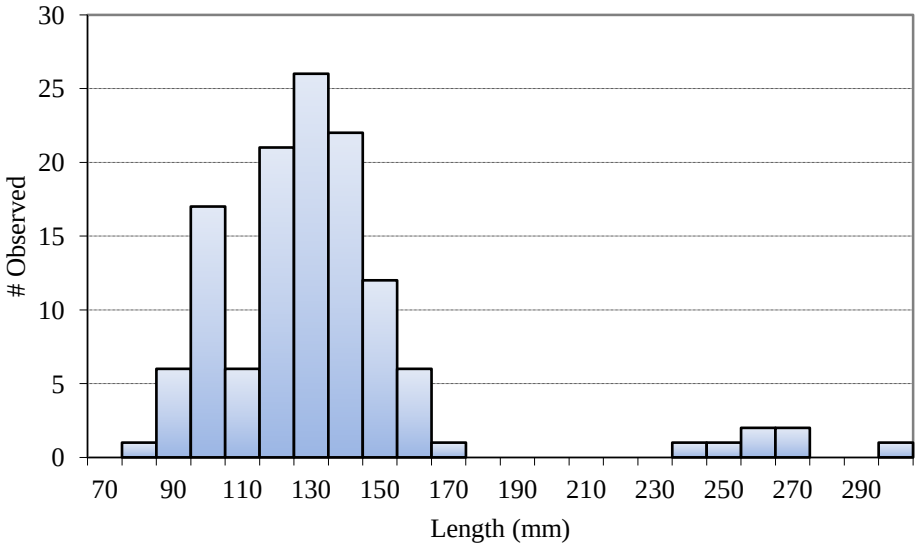

Figure 19. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2014 electrofishing assessments.

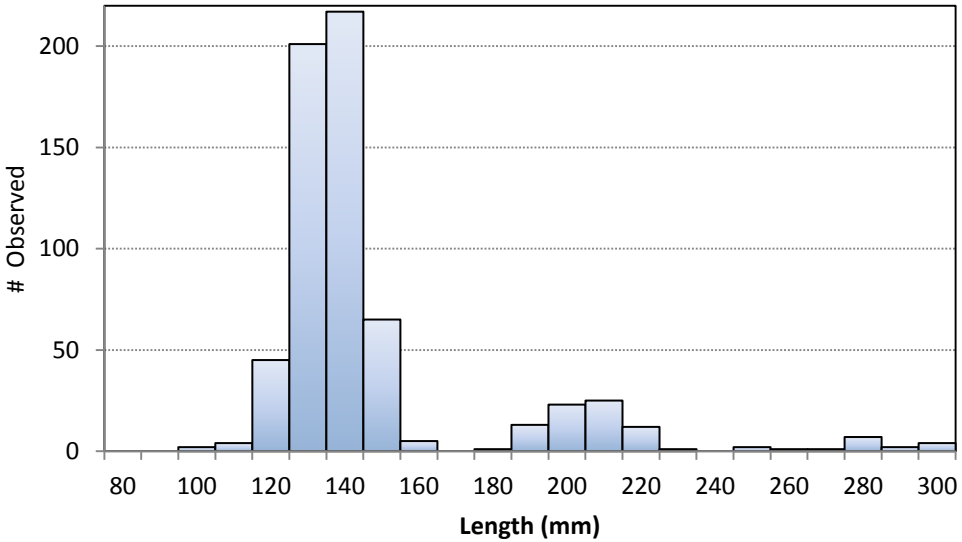

Figure 20. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2014 electrofishing assessments. Note y-axis is % observed.

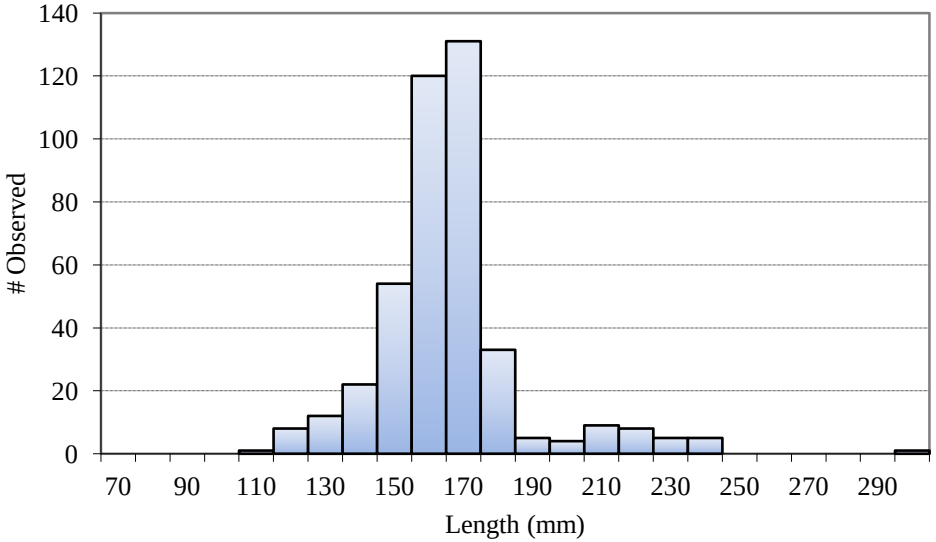

Figure 21. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2014 electrofishing assessments. Note y-axis is log scale.

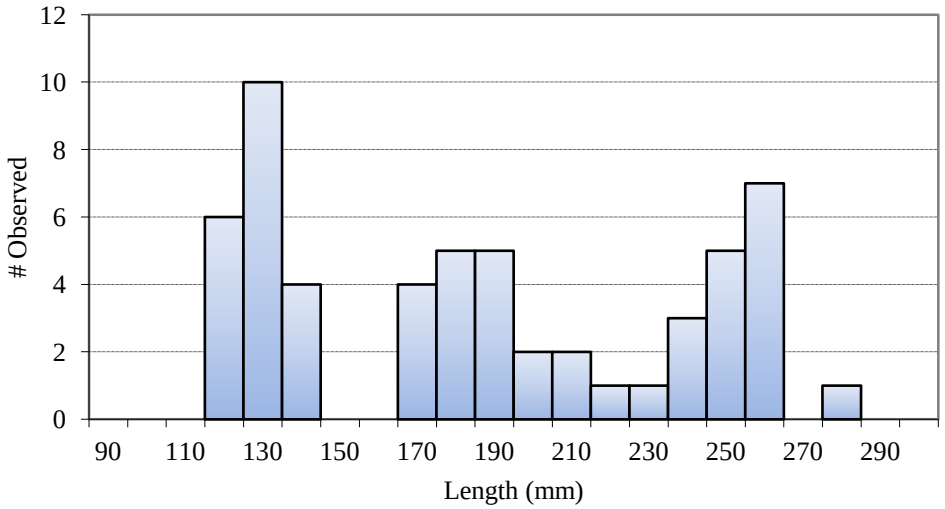

Figure 22. Length frequency distribution of walleye collected from Silver Island Lake, Lake County, during fall 2014 electrofishing assessments.

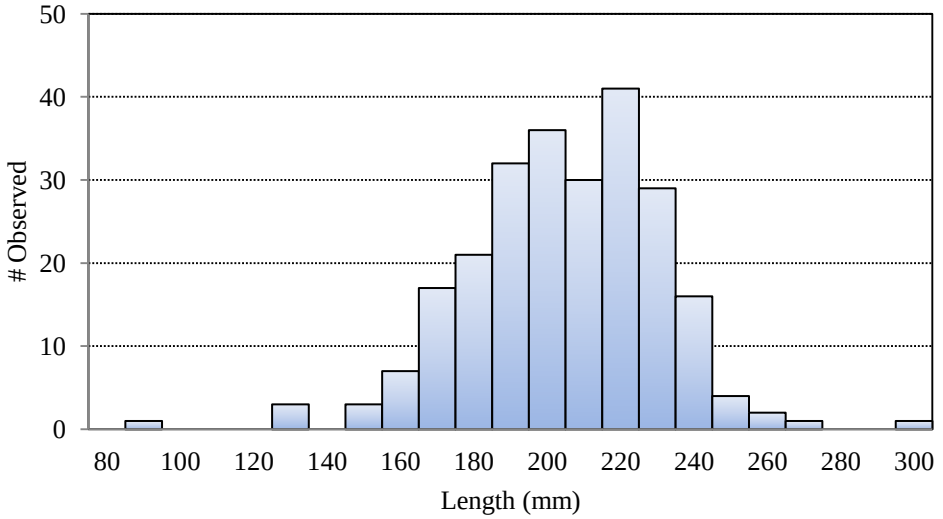

Figure 23. Length frequency distribution of walleye collected from Tait Lake, Cook County, during fall 2014 electrofishing assessments.

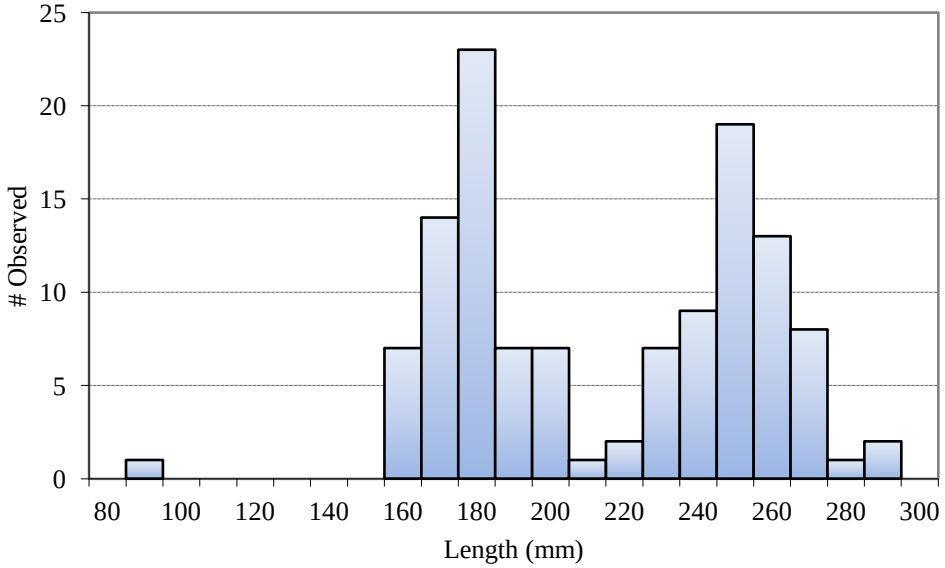

Figure 24. Length frequency distribution of walleye collected from Tom Lake Cook County, during fall 2014 electrofishing assessments.

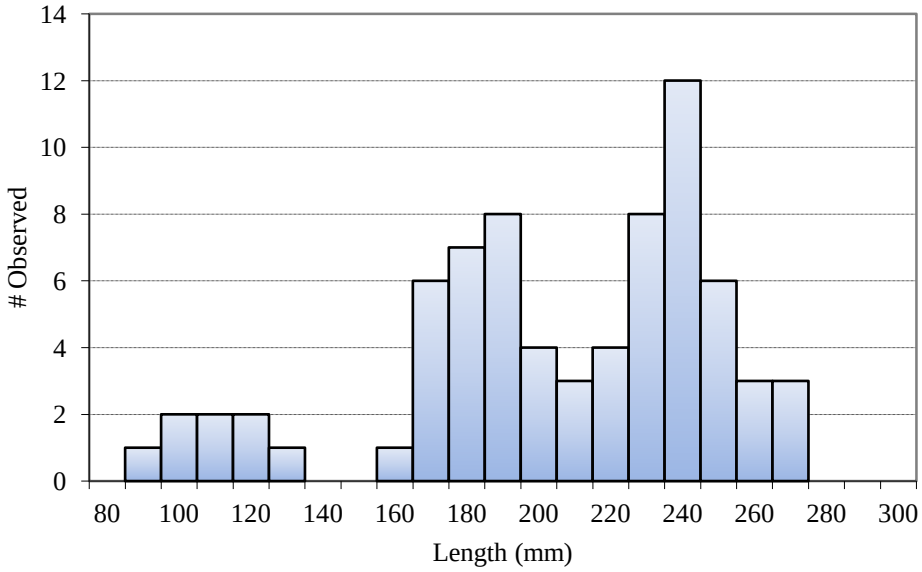

Figure 25. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2014 electrofishing assessments.

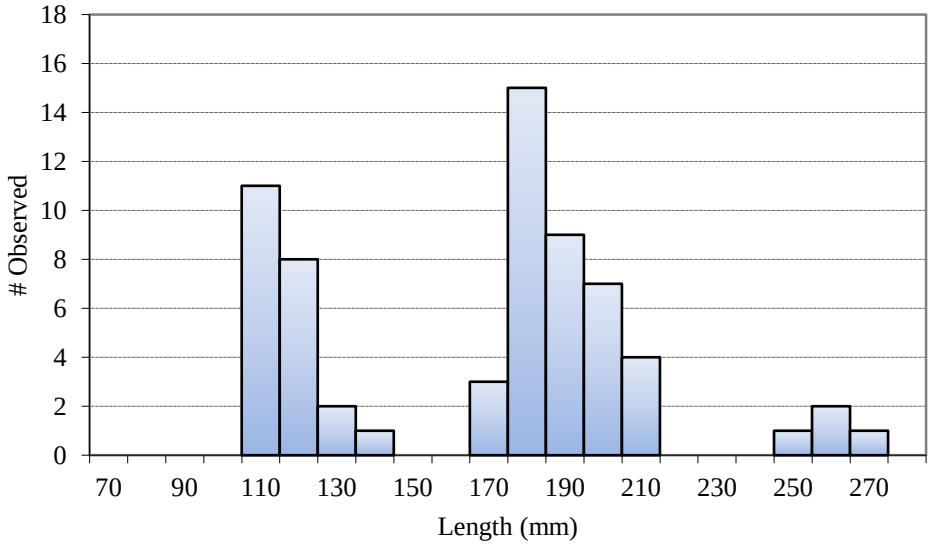

Figure 26. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2014 electrofishing assessments.

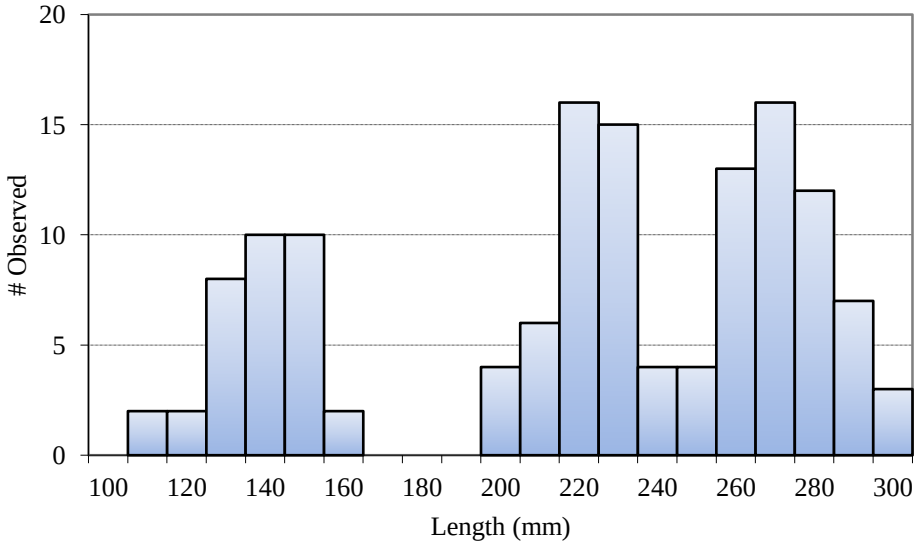

Figure 27. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2014 electrofishing assessments.

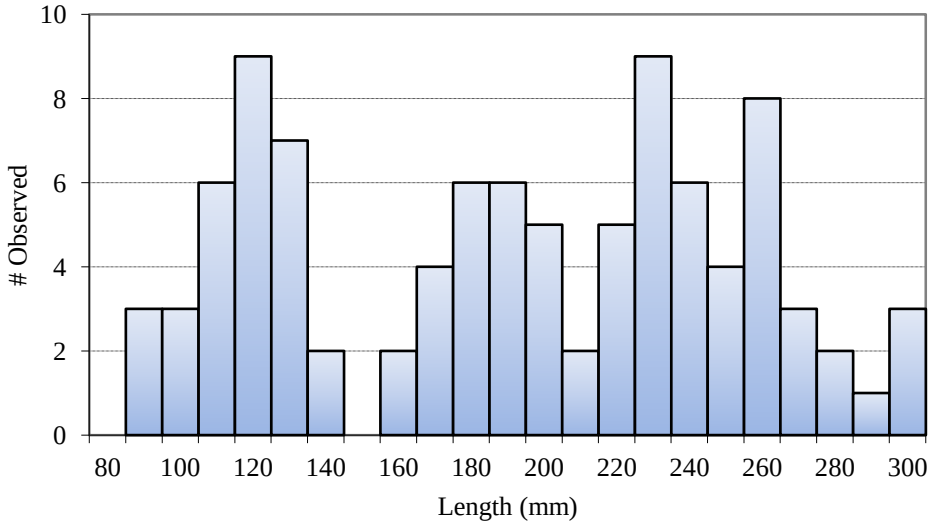

Figure 28. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2014 electrofishing assessments.

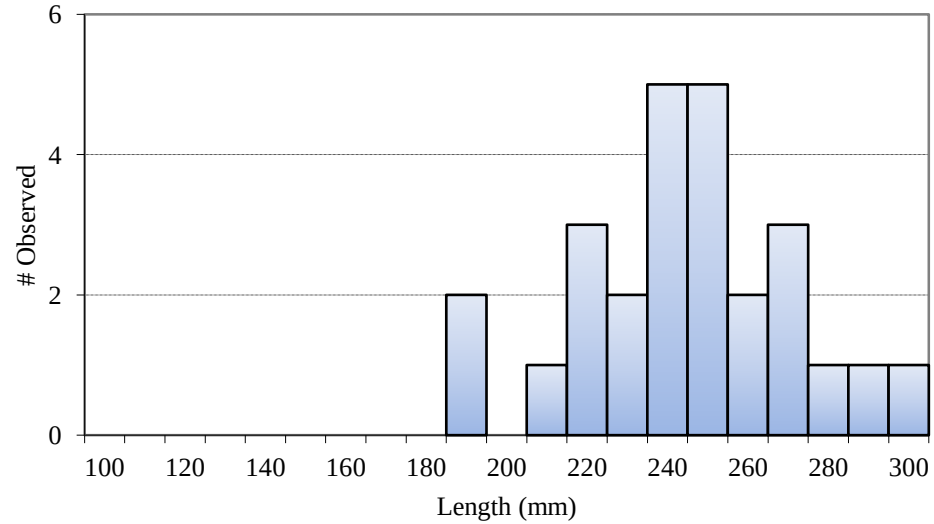

Figure 29. Length frequency distribution of walleye collected from Windy Lake, Lake County, during fall 2014 electrofishing assessments.

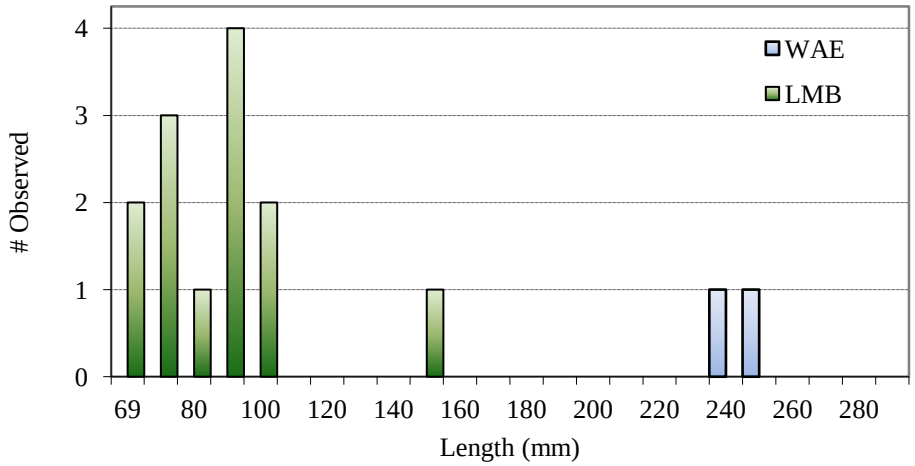

Figure 30. Length frequency distribution of walleye collected from Wild Rice Lake Resevoir, St. Louis County, during fall 2014 electrofishing assessments. Blue bars represent the two walleye sampled while the green bars represent largemouth bass sampled.

Appendix 1. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2014 assessments in the 1854 Ceded Territory, and for walleye > 275mm observed in MN DNR summer gill net assessments.

Lake	Date	Marked in Population	Daily Catch	Daily Recap
Crooked	15 May	---	54	0
	16 May	54	150	23
	17 May	181	218	65
	18 May	334	159	84
	MNDNR GN	409	68	11
	MNDNR GN / TN	409	74	13
Caribou	18 May	---	191	0
	19 May	191	312	91
	20 May	412	249	137
	MNDNR GN	524	23	5
	MNDNR GN / TN	524	26	6

Appendix 2. Tag return data for walleyes sampled in Crooked Lake, May 2014.

Date Tag Applied	Tag No. Applied	Length at Tagging (mm)	Date Recaptured	Length at Recapture (mm)
4/22/2006	F187140	475	5/16/2014	521
4/23/2006	F187274	349	5/18/2014	517

Appendix 3. Image of a walleye sampled on 16 May, 2014 from Crooked Lake, Lake County, that was missing five (5) dorsal fin spines.