Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2016

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

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Fond du Lac Resource Management Division, Technical Report #51
1854 Treaty Authority, Resource Management Division, Technical Report #17-06

March 2017

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 (*Sander vitreus*) 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 2016 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. 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 2016 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, another 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 2016 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 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 summer gill net assessments. In May, Fond du Lac used short-term gill nets to sample the walleye population in Eagle Lake, and obtain a second population estimate. Another

estimate was obtained by the MNDNR in the course of conducting their standard summer gill net surveys.

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 & yellow colors used in 2016) (Super Swiftachment Fasteners available from the Dennison Fastener Division, Framingham, Massachusetts). The reason for this was because after many years of clipping dorsal fin spines, it would be impossible to differentiate 2016 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

Eagle Lake (DOW 09-0057)

Electrofishing activities were conducted on Eagle Lake, Carlton County, on 18 – 20 April (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 5.2 (EF1, 18 April) to 183.0 (EF4, 20 April) adult walleye per hour of sampling (Figure 1). At a 95% confidence interval, mean CPUE for Eagle Lake, determined using each sampling station, was 94.8 ± 41.4 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Eagle Lake is presented in Figure 2. Walleye as large as 616 mm (24.3 inches) were observed in the survey.

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 618 (Table 2). The adjusted Petersen estimate is 596 ± 155, with a 6.0% 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.

In May, Fond du Lac personnel spent one week setting experimental gill nets for short periods of time (20 to 60 minutes), in an attempt to get an unbiased population estimate (Schwarz 2009). Gill nets

were constructed similar to those used in Mille Lacs Lake, and were 400 feet long, by 6 feet deep. Four 100-foot panels were tied into a single net, with mesh sizes of 1.25, 1.5, 2.0, and 2.5 inches, measured knot-to-knot, or bar. A total of 89 walleyes were sampled, 20 of which were recaptured from the spring marking runs. This Schumacher and Eschmeyer population estimate is 833 (Table 2). The adjusted Petersen estimate is 1864 ± 1107, with an 18.7% CV (Table 2). During summer 2016, the Minnesota Department of Natural Resources performed a standardized net assessment in Eagle Lake (MN DNR, Duluth Area Fisheries). Twenty-five (25) walleyes (> 275 mm) were sampled in the gill nets that would have been 254 mm during the April assessments. Six walleyes were observed to have the yellow floy tag from the spring sampling (Appendix 1). This Schumacher and Eschmeyer population estimate is 684 (Table 2). The adjusted Petersen estimate is 1616 ± 1554, with an 30.2% CV (Table 2).

Table 3 presents the age data for the walleye collected from Eagle Lake. Of the 435 unique fish sampled, 337 were assigned to ages 4 - 6. Total annual mortality (*A*) of the Eagle Lake population was estimated 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). *A* was estimated at 37.6% (Figure 3, blue line). Using catch curve analysis assumes that; 1) there are no aging errors; 2) constant recruitment; 3) Z is constant over time, and; 4) above a certain age (sexual maturity for this data set) all individuals within the population are equally vulnerable to the sampling gear (Smith et al., 2012). For our walleye surveys, generally male walleyes are fully mature and vulnerable by age 4 or 5. The data suggests that, if recruitment was constant (assumption 2), full recruitment may not have been observed until age-5 (Figure 3). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 25.6% (Figure 3, green triangles), lower than the estimates from the spring electrofishing assessment. Our spring estimate was made using 377 mature walleyes, age 5 – 14. The estimate from the gill and trap net assessment was made using 28 fish age 2 – 10.

Table 4 presents back-calculated lengths-at-age for walleye collected from Eagle 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 53.9 ± 4.0 (Table 5). Further, there is a large portion of the population less than 15.0 inches (46.1% of sample) that will be growing and recruiting into this "quality" 15-inch category over the next few years. The summer gill net PSD (60.0 ± 19.2) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.358, P>0.05, critical Chi-square value of 3.841). No significant differences were observed between any of the RSD metrics determined using electrofishing data or gill net data (Table 5).

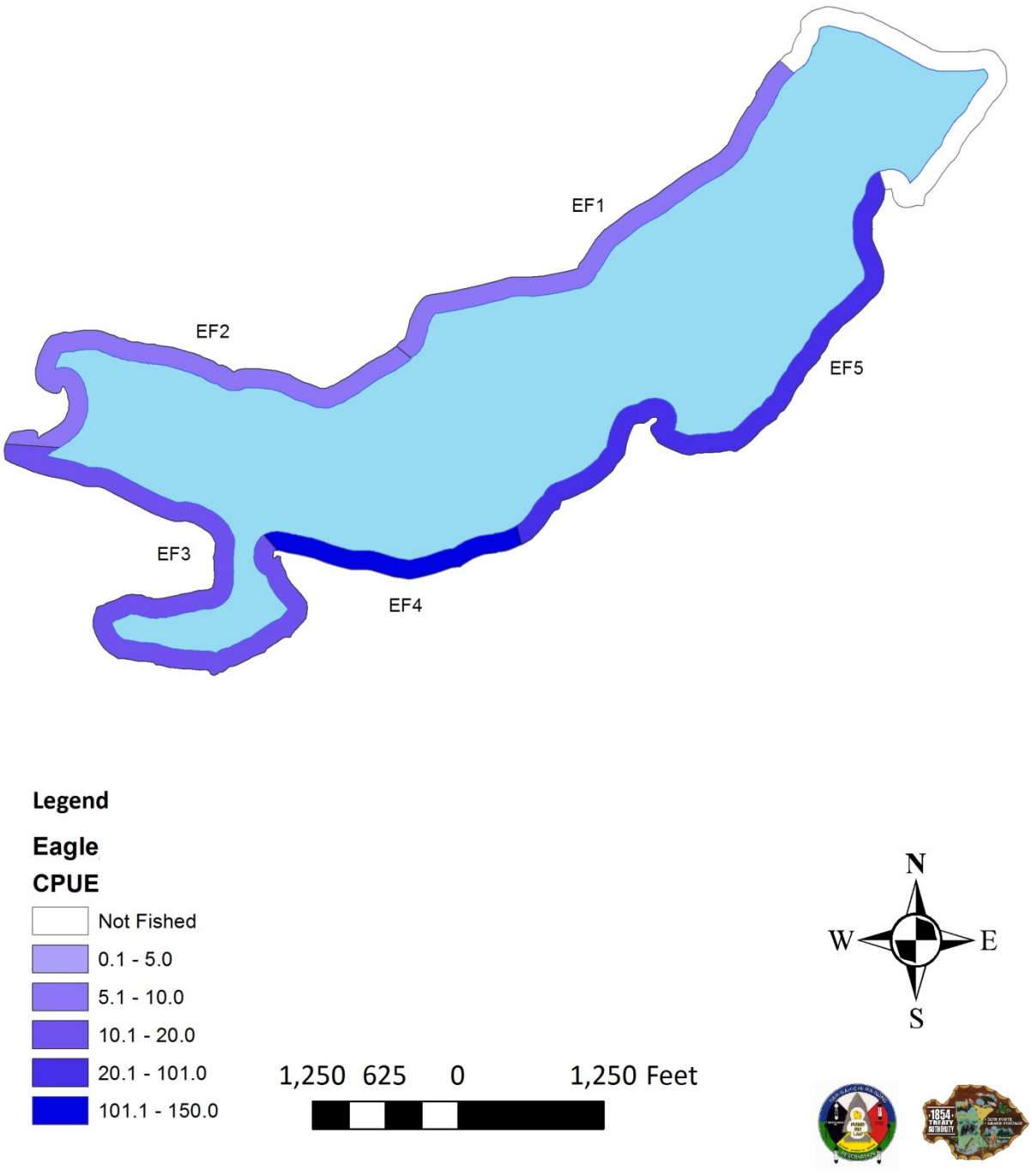

Figure 1. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Eagle Lake, Carlton County, during Spring 2016 electrofishing surveys.

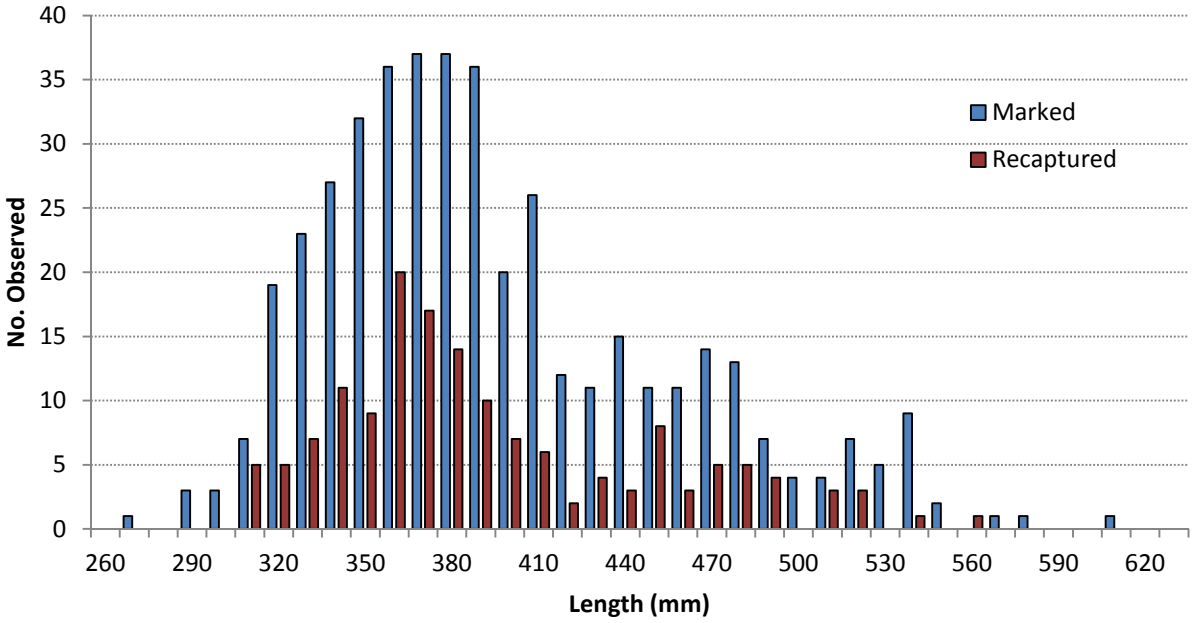

Figure 2. Length frequency distribution of walleye sampled from Eagle Lake, Carlton County, MN, during spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

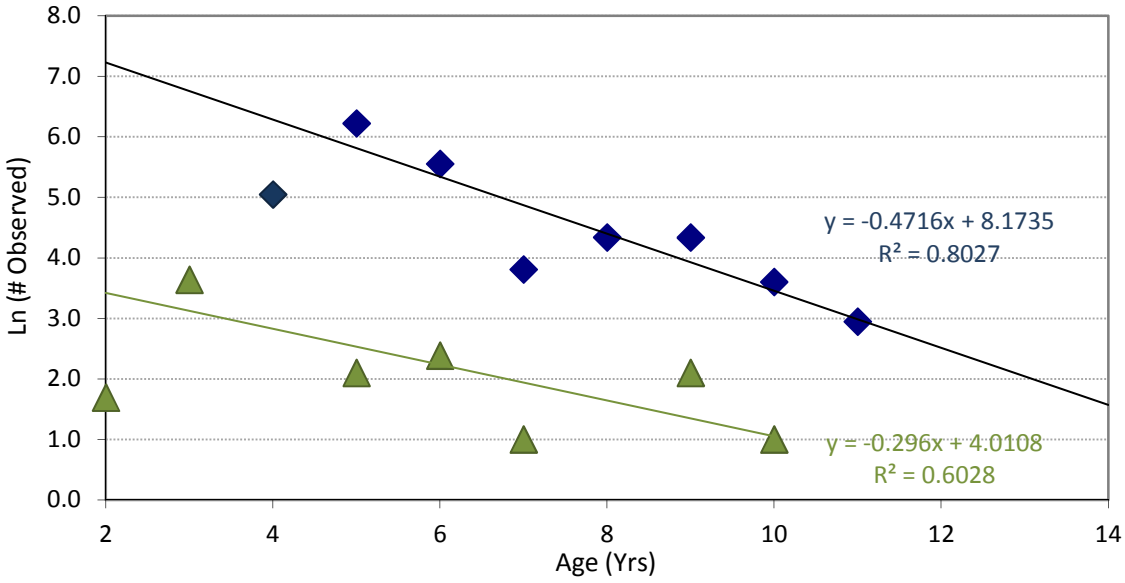

Figure 3. Catch curve analysis of walleyes in Eagle Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from April 2016 electrofishing data (blue diamonds) and summer MNDNR gill net data (green triangles).

Table 1. Summary of electrofishing activities on seven lakes within the 1854 Ceded Territory of Minnesota during spring 2016.

ID #	County	Lake	Area (Acres)	Max Depth (ft)	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)[2]	Amps[3]	# WAE[4]	CPUE WAE[5]
09-0057	Carlton	Eagle	389	35	4/18/2016	45	113	8652	884	4	133	55.3
					4/19/2016	45	123	8185	707	4	300	131.9
					4/20/2016	47	114	4883	707	4	155	114.3
69-0041	St. Louis	Bassett	403	21	4/21/2016	42	90	7693	884	4	30	14.0
					4/22/2016	47	93	6861	884	4	44	23.1
38-0686	Lake	N. McDougal	273	13	4/20/2016	41	16	8331	H (80%)	1	26	11.2
					4/21/2016	41	17	10203	H (80%)	1	54	19.0
					4/22/2016	42	14	11702	H (80%)	1	95	29.2
					4/23/2016	41	12	7055	H (60%)	1	65	33.2
38-0219	Lake	Silver Island	1239	16	4/24/2016	38	20	4956	H (50%)	1	21	15.3
					4/25/2016	36	21	5001	H (50%)	1	43	31.0
					4/26/2016	41	24 / 35	12246	H (50%)/1061	1 / 4	36	10.6
					4/27/2016	43	21	4587	H (90%)	1	12	9.4
16-0156	Cook	Two Island	754	27	5/2/2016	44	31	10985	1061	4	125	41.0
					5/3/2016	46	31	15422	H(50%)/1061	1 / 4	213	49.7
					5/4/2016	47	30	8895	H(50%)	1	237	95.9
16-0019	Cook	Tom	404	35	5/4/2016	42	23	9850	1061	4	257	93.9
					5/5/2016	45	24	7111	1061	3	189	95.7
					5/6/2016	48	24	7349	1061	3	186	91.1
16-0029	Cook	Devilfish	405	40	5/5/2016	48	13	10512	H (90%)	1	152	52.0
					5/6/2016	50	12	7821	H (100%)	1	126	58.0
					5/7/2016	50	19	4975	H (100%)	1	118	85.4

[1] Water conductivity measured in microSiemens / cm.

[2] Voltage is reported as actual voltage recorded from the SmithRoot Type VI-A, or as Low / High from the SmithRoot 5.0 GPP

[3] Amps are reported as from the 1854 Treaty Authority Boat / Fond du Lac Boat.

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

[5] 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 Eagle Lake (Carlton County), Bassett Lake (St. Louis County), North McDougal Lake (Lake County), and Silver Island, Two Island, Tom & Devilfish Lakes (Cook County), Spring 2016. Estimates are for walleye larger than 254 mm (10.0 inches). EF denotes population estimates determined from spring electrofishing data. ST_GN refers to population estimates determined from short term gill net samples collected in June, while GN refers to population estimates from samples collected during the MNDNR's summer netting assessments. GN/TN includes all of the MNDNR data from both the gill nets and trap nets.

Lake	Population Estimate[1]	No. / Acre	95% Confidence Limits Lower	Upper	Estimate[2]	C.V.[3]
Eagle – EF_{2016}	618	1.6	505	794	596 ± 155	6.0 %
Eagle – ST_GN_{2016}	833	2.1	455	4912	1864 ± 1107	18.7%
Eagle – GN_{2016}	684	1.8	458	1350	1616 ± 1554	30.2%
Eagle – GN/TN_{2016}	732	1.9	433	2351	2361 ± 2399	31.9%
Bassett – EF_{2016}	440	1.1	440	440	349 ± 1892	42.7%
Bassett – GN_{2016}	N/A	---	---	---	N/A	N/A
N.McDougal – EF_{2016}	846	3.1	690	1095	787 ± 574	22.9%
N.McDougal – GN_{2016}	1017	4.8	723	1715	1314 ± 1359	37.3%
N.McDougal – GN/TN_{2016}	979	3.6	750	1409	1126 ± 992	31.7%
Silver Island Lake – EF_{2016}	603	0.5	225	---	1222 ± 2642	67.9%
Silver Island Lake – GN_{2016}	1550	1.2	496	---	2438 ± 3310	48.9%
Silver Island Lake – GN/TN_{2016}	1327	1.1	504	---	1717 ± 1885	39.5%
Two Island Lake – EF_{2016}	1156	1.5	1131	1181	1150 ± 500	10.1%
Two Island Lake – GN/TN_{2016}	1532	2.0	800	17676	5210 ± 6435	38.8%
Tom Lake – EF_{2016}	1309	3.2	959	2062	1215 ± 518	9.9%
Tom Lake – GN_{2016}	1414	3.5	1046	2185	1887 ± 1407	23.4%
Tom Lake – GN/TN_{2016}	1601	4.0	1030	3588	2377 ± 1386	18.3%
Devilfish – EF_{2016}	360	0.9	349	371	362 ± 111	7.1%
Devilfish – GN_{2016}	395	1.0	274	709	849 ± 788	29.2%
Devilfish – GN/TN_{2016}	417	1.0	265	985	990 ± 850	27.0%

[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 Eagle Lake, Carlton County, spring 2016, based upon the number of fish sampled and aged per size category.

Length Group		N	Age											
Inches	mm	Sampled	4	5	6	7	8	9	10	11	12	13	14	
10	254													
10.5	267	1	1											
11	279	1	1											
11.5	292	4	4											
12	305	8	7	1										
12.5	318	21	15	6										
13	330	28	11	17										
13.5	343	41	18	14	9									
14	356	45		30	15									
14.5	368	45		34	11									
15	381	47		31	16									
15.5	394	35		23	12									
16	406	31		9	13	4	4							
16.5	419	15		9	4		2							
17	432	17		8	8	1								
17.5	445	13		4		3	3	3						
18	457	15				4	8		2					
18.5	470	24			2	2	7	13						
19	483	7			2	2		2	1					
19.5	495	5					1	1	3					
20.0	508	6						1	3	2				
20.5	521	11			2		2	2	2	4				
21.0	533	7					1.5	4	1.5					
21.5	546	5						2	1	1				
22.0	559													
22.5	572	2											2	
23.0	584													
23.5	597													
24.0	610	1										1		
TOTAL		435	57	185	95	17	28	28	14	7	0	1	2	0
			13.2%	42.6%	21.8%	3.8%	6.5%	6.5%	3.1%	1.6%	0.0%	0.2%	0.5%	0.0%

Table 4. Back-calculated lengths-at-age for walleye collected from Eagle Lake, Carlton County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	151	109	4.3
2	151	182	7.2
3	151	248	9.8
4	150	311	12.2
5	126	370	14.6
6	86	406	16
7	64	440	17.3
8	56	467	18.4
9	42	491	19.3
10	25	504	19.8
11	15	519	20.4
12	10	534	21
13	6	541	21.3
14	3	540	21.3

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence for Eagle Lake (Carlton County), Bassett Lake (St. Louis County), North McDougal Lake (Lake County), and Silver Island, Two Island, Tom & Devilfish Lakes (Cook County). 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
Eagle – EF_{2016}	53.9 ± 4.0	46.1 ± 4.0	47.1 ± 4.0	6.8 ± 2.0	0.0 ± 0.0
Eagle – GN_{2016}	60.0 ± 19.2	40.0 ± 19.2	48.0 ± 19.6	12.0 ± 12.7	0.0 ± 0.0
Bassett -- EF_{2016}	88.7 ± 7.4	11.3 ± 7.4	46.5 ± 11.6	33.8 ± 11.0	8.5 ± 6.5
Bassett – GN_{2016}	82.4 ± 18.1	17.6 ± 18.1	58.8 ± 23.4	17.6 ± 18.1	5.9 ± 11.2
N.McDougal – EF_{2016}	32.1 ± 5.9	67.9 ± 5.9	27.5 ± 5.6	4.2 ± 2.5	0.4 ± 0.8
N.McDougal – GN_{2016}	25.6 ± 13.7	74.4 ± 13.7	20.5 ± 12.7	2.6 ± 5.0	2.6 ± 5.0
Silver Island -- EF_{2016}	47.1 ± 9.6	52.9 ± 9.6	44.2 ± 9.6	2.9 ± 3.2	0.0 ± 0.0
Silver Island -- GN_{2016}	38.4 ± 10.3	61.6 ± 10.3	33.7 ± 10.0	4.6 ± 4.4	0.0 ± 0.0
Two Island -- EF_{2016}	55.0 ± 4.1	45.0 ± 4.1	43.6 ± 4.0	11.3 ± 2.6	0.0 ± 0.0
Two Island -- GN_{2016}	57.1 ± 13.0	42.8 ± 13.0	55.4 ± 13.0	1.8 ± 3.5	0.0 ± 0.0
Tom -- EF_{2016}	24.7 ± 3.6	75.3 ± 3.6	24.0 ± 3.6	0.4 ± 0.5	0.4 ± 0.5
Tom -- GN_{2016}	23.3 ± 12.6	76.7 ± 12.6	20.9 ± 12.2	0.0 ± 0.0	2.3 ± 4.5
Devilfish -- EF_{2016}	32.7 ± 5.6	67.3 ± 5.6	31.2 ± 5.5	0.4 ± 0.7	1.1 ± 1.2
Devilfish -- GN_{2016}	52.4 ± 21.4	47.6 ± 21.4	42.9 ± 21.2	4.8 ± 9.1	4.8 ± 9.1

Bassett Lake (DOW 69-0041)

Electrofishing activities were conducted on Bassett Lake, St. Louis County, on 21 – 22 April (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 0.0 (EF3, 21 April) to 86.6 (EF2, 21 April) adult walleye per hour of sampling (Figure 4). At a 95% confidence interval, mean CPUE for Bassett Lake, determined using each sampling station, was 27.6 ± 42.9 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Bassett Lake is presented in Figure 5. Walleye as large as 742 mm (29.2 inches) were observed in the survey. Additional species observed included northern pike and largemouth bass.

Walleyes larger than 254 mm were marked with a non-numbered orange floy tag *(note this is different than other lakes surveyed in 2016, where yellow tags were used)* along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 440 (Table 2). The electrofishing adjusted Petersen estimate is 349 ± 1892, with a 42.7% CV (Table 2). These are essentially useless PE's, given the small numbers of fish sampled and recaptured. The MNDNR did not sample any fish with a floy tag. Thus, no population estimates are available.

Table 6 presents the age data for the walleye collected from Bassett Lake. Total annual mortality (*A*) of the Bassett Lake population was estimated at 12.4%, 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 lower than most estimates of walleye populations. Table 7 presents back-calculated lengths-at-age for walleye collected from Bassett 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 88.7 ± 7.4 (Table 5). This suggests that the population structure is characterized by older, larger individuals, and suggests there may be problems with recruitment in this lake. The summer gill net PSD (82.4 ± 18.1) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.510, P>0.05, critical Chi-square value of 3.841). No significant differences were observed between any of the RSD metrics determined using electrofishing data or gill net data (Table 5).

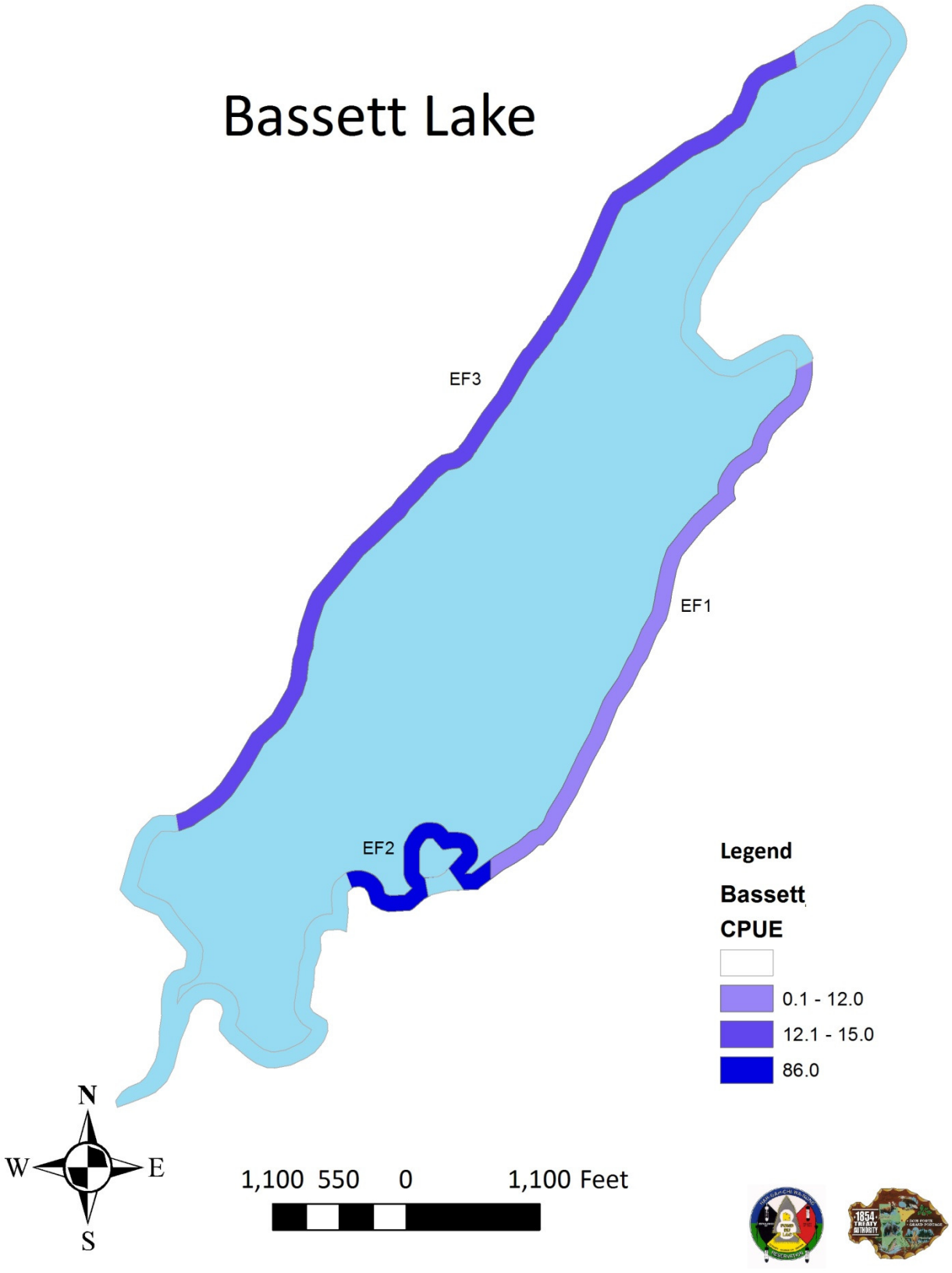

Figure 4. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Bassett Lake, St. Louis County, during Spring 2016 electrofishing surveys.

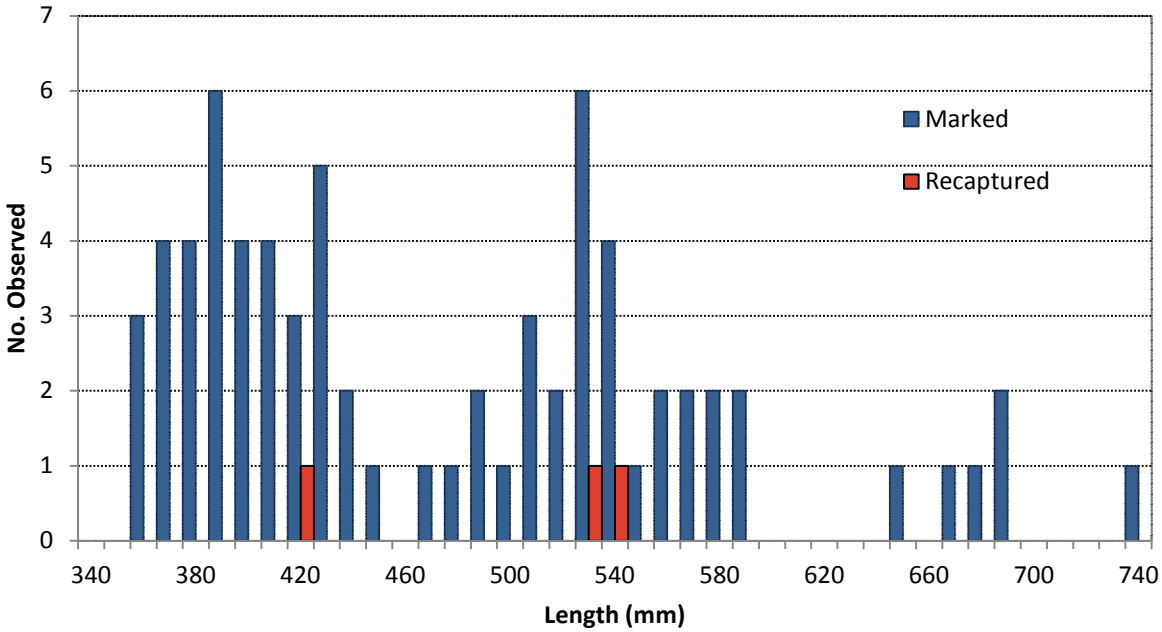

Figure 5. Length frequency distribution of walleye sampled from Bassett Lake, St. Louis County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

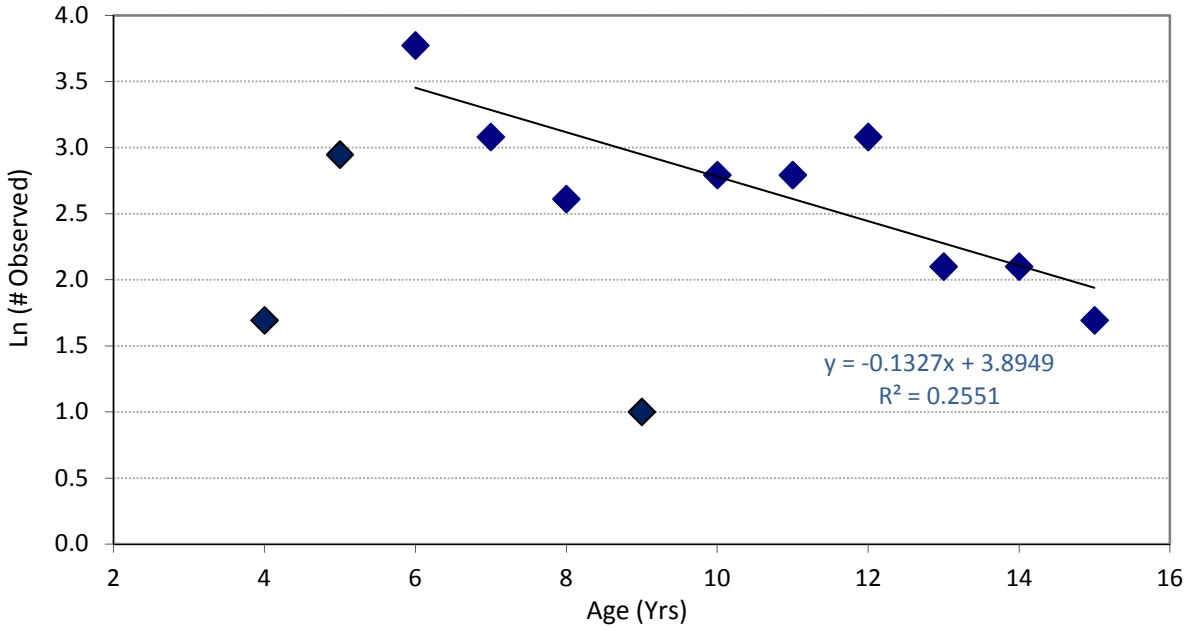

Figure 6. Catch curve analysis of walleyes in Bassett Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from April 2016 electrofishing data

Table 6. Age frequency distribution of walleye from Bassett Lake, Lake County, spring 2016, based upon the number of fish sampled and aged per size category.

Length Group		N	Age																
Inches	mm	Sampled	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
14	356	3		1	2													
14.5	368	5		3	1	1												
15	381	7		2	2		1											
15.5	394	6	1		4	1												
16	406	4	1	1	2													
16.5	419	6			1	2	2											
17	432	5			4	1												
17.5	445	1				1												
18	457																	
18.5	470	1				1												
19	483	3				1	2											
19.5	495	1									1							
20.0	508	3							2				1					
20.5	521	6						1		3	2							
21.0	533	8							2	2	1	1	1					
21.5	546	1									1							
22.0	559	3								1		1	1					
22.5	572	3							2		1							
23.0	584	2										1		1				
23.5	597																	
24.0	610																	
25.0	635																	
25.5	648	1									1							
26.0	660	1															1	
26.5	673	1												1				
27.0	686	2									1							1
29.0	737	1															1	
TOTAL		74	2	7	16	8	5	1	6	6	8	3	3	2	0	0	2	1
			2.7%	9.5%	21.6%	10.8%	6.8%	1.4%	8.1%	8.1%	10.8%	4.1%	4.1%	2.7%	0.0%	0.0%	2.7%	1.4%

Table 7. Back-calculated lengths-at-age for walleye collected from Bassett Lake, St. Louis County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	78	102	4.0
2	78	169	6.7
3	78	231	9.1
4	78	290	11.4
5	76	348	13.7
6	69	390	15.4
7	49	427	16.8
8	38	460	18.1
9	34	495	19.5
10	30	519	20.4
11	24	536	21.1
12	20	557	21.9
13	11	569	22.4
14	8	592	23.3
15	6	623	24.5
16	3	665	26.2
17	3	681	26.8
18	3	695	27.4
19	1	694	27.3

North McDougal Lake (DOW 38-0686)

Electrofishing activities were conducted on N. McDougal Lake, Lake County, on 20 – 23 April (Figure 7). 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 0.0 (EF3, EF4, & EF5) to 53.8 (EF_{River}, 22 April) adult walleye per hour of sampling (Table 1, Figure 7). At a 95% confidence interval, mean CPUE for N. McDougal Lake, determined using each sampling station, was 17.5 ± 7.0 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in N. McDougal Lake is presented in Figure 8. Walleye as large as 661 mm (26.0 inches) were observed in the survey. Additional species observed included bluegill, northern pike, white sucker, yellow perch, trout perch, burbot, and sculpin.

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 846 (Table 2). The electrofishing adjusted Petersen estimate is 787 ± 574, with a 22.9% CV (Table 2).

During summer 2016, the Minnesota Department of Natural Resources performed a standardized net assessment on N. McDougal Lake (MN DNR, Finland Area Fisheries). Twenty-nine (29) (> 274 mm) were sampled in the gill nets that would have been 254 mm during the April assessments. Four individuals were observed to have the yellow floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 1314 ± 1359, with a 37.3% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 1017 (Table 2). Thirty-five (35) walleyes in total were sampled between the gill nets and trap nets, with seven recaptured individuals observed. Population estimates are included in Table 2.

Table 8 presents the age data for the walleye collected from N. McDougal Lake. Of the 287 unique fish sampled, 224 were assigned to ages 3 – 8 (Table 8). Total annual mortality (*A*) of the N. McDougal Lake population was estimated at 30.5%, 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 9). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 23.5% (Figure 9), and was based on the aging of 48 walleyes age-2 and older. Table 9 presents back-calculated lengths-at-age for walleye collected from N. McDougal 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 is 32.1 ± 5.9 (Table 5). While low, there were a large number of individuals less than 15.0 inches (67.9% of sample) that will be growing and recruiting into this "quality" 15-inch category over the next few years. The summer gill net / trap net PSD (25.6 ± 13.7) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.649, *P*>0.05, critical Chi-square value of 3.841), but was only based upon 39 fish stock-sized or larger.

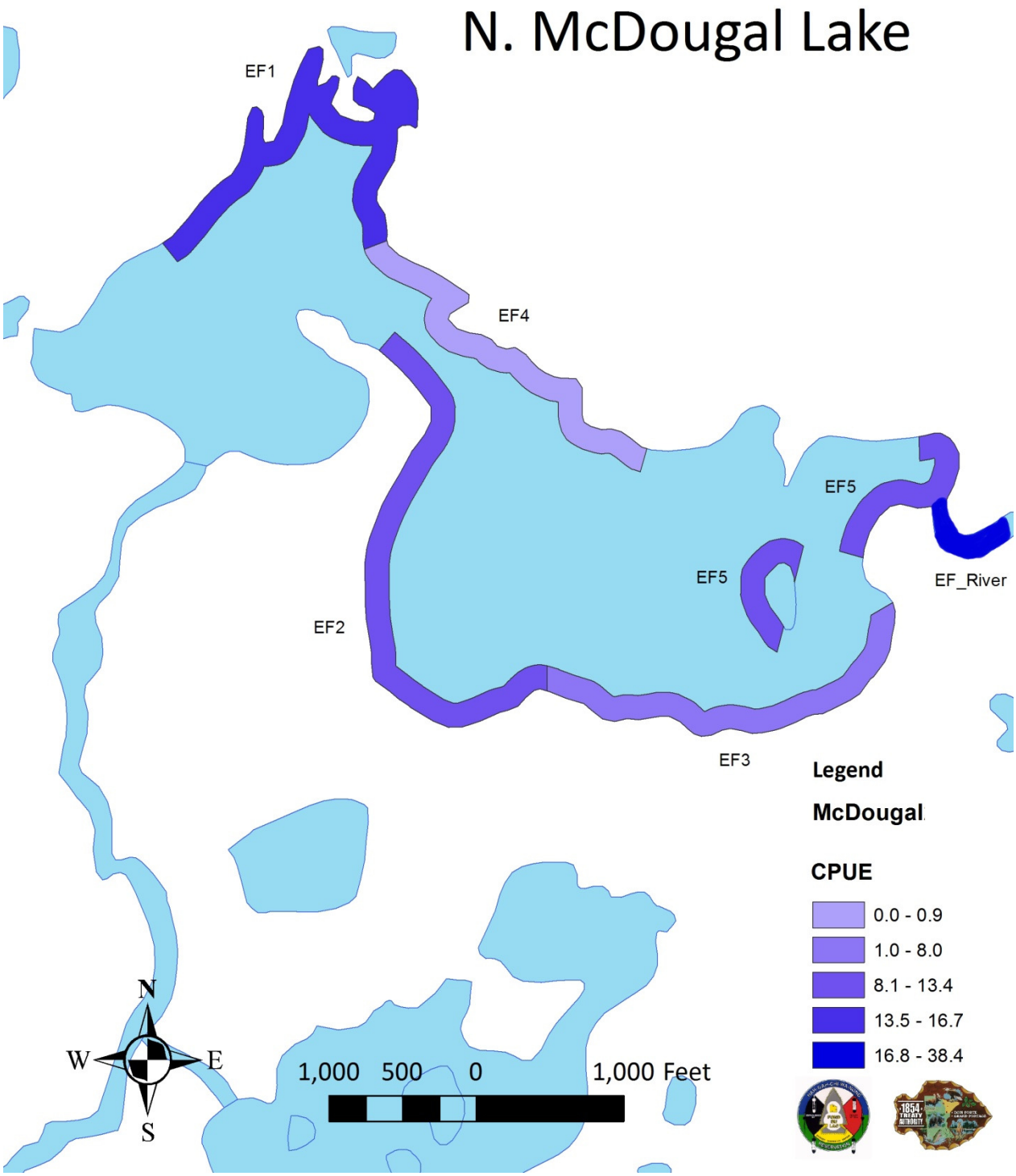

Figure 7. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station on North McDougal Lake, Lake County, during Spring 2016 electrofishing surveys.

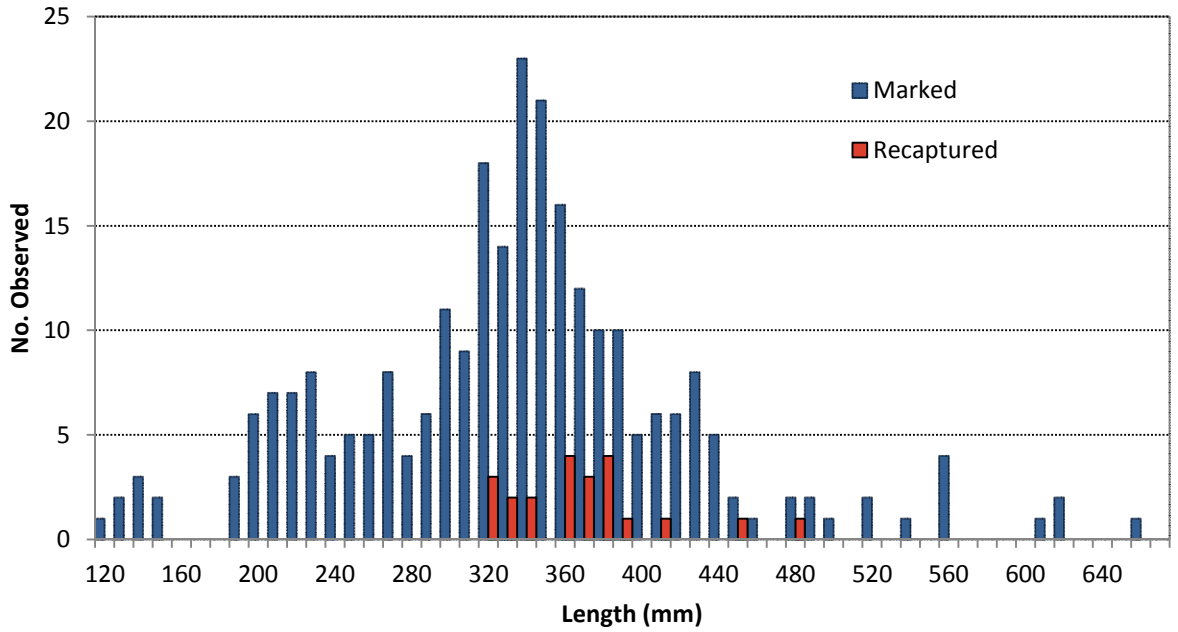

Figure 8. Length frequency distribution of walleye sampled from North McDougal Lake, Lake County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

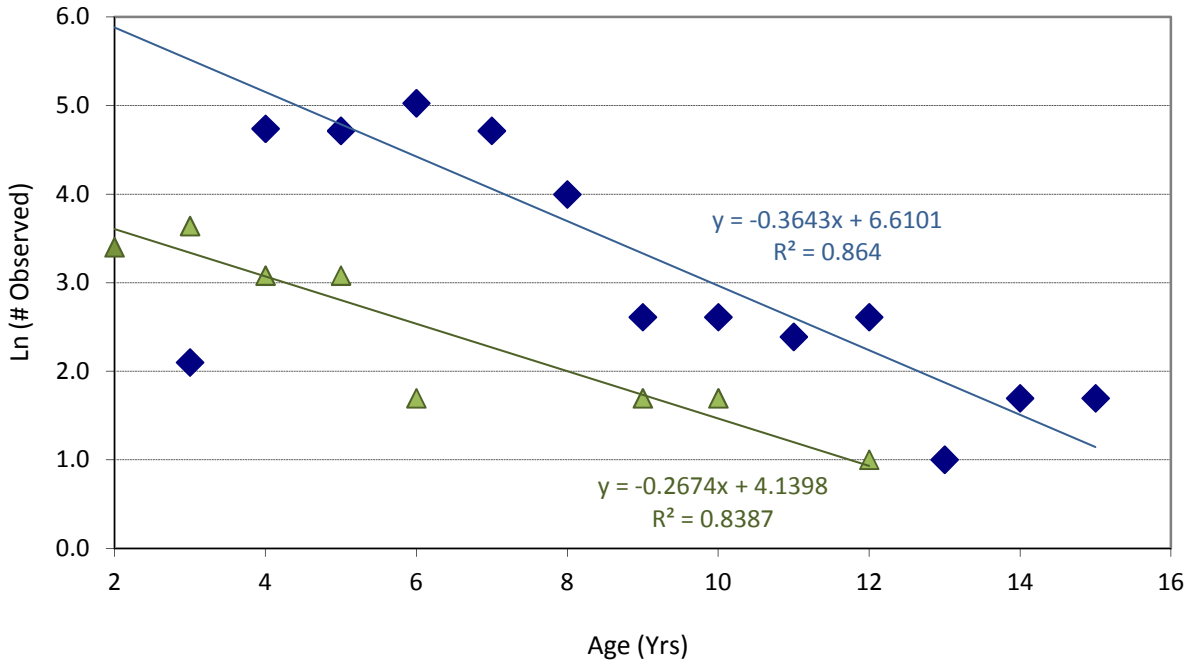

Figure 9. Catch curve analysis of walleyes in North McDougal Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from Spring 2016 electrofishing data (blue diamonds), and from summer 2016 gill net assessments by the MNDNR (green triangles).

Table 8. Age frequency distribution of walleye from North McDougal Lake, Lake County, spring 2016, 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	15	16
4.5	115	1															
5.0	127	2															
5.5	140	3															
6.0	152	2															
6.5	165																
7.0	178																
7.5	191	4															
8.0	203	10															
8.5	216	9															
9.0	229	10															
9.5	241	5		10													
10.0	254	7		5	2												
10.5	266.7	8		4	3		1										
11.0	279.4	5		4	1												
11.5	292.1	9		1	7	1											
12.0	304.8	13			11	2											
12.5	317.5	24			8	13		3									
13.0	330.2	22			4	9	4	4									
13.5	342.9	34			4	11	15	4									
14.0	355.6	25				4	17	4									
14.5	368.3	16			2		7	7									
15.0	381	18					8	6	2	2							
15.5	393.7	11					3	6	1		1						
16.0	406.4	8				1		1	4	2							
16.5	419.1	7							5	1	1						
17.0	431.8	10					1	4	5								
17.5	444.5	5						1	3		1						
18.0	457.2	1											1				
18.5	469.9																
19.0	482.6	4						1			1	1					
19.5	495.3	2									1	1					
20.0	508	1										1					
20.5	520.7	1											1				
21.5	546.1	1											1				
22.0	558.8	4										1	1	1		1	
24.0	609.6	1											1				
24.5	622.3	2													2		
26.0	660.4	1														1	
27.0	685.8	1															1
TOTAL		287	0	24	42	41	56	41	20	5	5	4	5	1	2	2	1
			0.0%	8.4%	14.6%	14.3%	19.5%	14.3%	7.0%	1.7%	1.7%	1.4%	1.7%	0.3%	0.7%	0.7%	0.3%

Table 9. Back-calculated lengths-at-age for walleye collected from North McDougal Lake, Lake County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	134	99	3.9
2	134	167	6.6
3	134	227	8.9
4	121	278	10.9
5	98	321	12.6
6	83	362	14.3
7	63	397	15.6
8	41	427	16.8
9	24	459	18.1
10	20	494	19.4
11	15	531	20.9
12	11	558	22
13	6	597	23.5
14	4	617	24.3
15	3	632	24.9
16	1	689	27.1

Silver Island Lake (DOW 38-0219)

Electrofishing activities were conducted on Silver Island Lake, Lake County, on 24 – 27 April (Figure 10). 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. CPUEs were low, ranging from 0.0 (EFA, EFC, & EF1) to 78.5 (EF4, 25 April) adult walleye per hour of sampling (Figure 10). At a 95% confidence interval, mean CPUE for Silver Island Lake, determined using each sampling station, was 15.4 ± 6.9 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Silver Island Lake is presented in Figure 11. Walleye as large as 627 mm (24.7 inches) were observed in the survey. Additional species observed included northern pike, white sucker, yellow perch, black crappie, rock bass, and trout perch.

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture

data. The electrofishing Schumacher and Eschmeyer population estimate is 603 (Table 2). The electrofishing adjusted Petersen estimate is 1222 ± 2642, with a 67.9% CV (Table 2). In a 2008 electrofishing survey, the Petersen estimate for the Silver Island population was 1693 ± 769 (Borkholder and Edwards 2009). During summer 2016, the Minnesota Department of Natural Resources performed a standardized net assessment on Silver Island Lake (MN DNR, Finland Area Fisheries). Sixty-eight (68) walleyes (> 274 mm) were sampled in the gill nets and trap nets that would have been 254 mm during the spring assessments. Two individuals were observed to have the yellow floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 2438 ± 3310, with a 48.9% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 1550 (Table 2). When the trap net data is added, the sample size goes up to 80 sampled walleyes, with four observed to have our floy tags. Population estimates are presented in Table 2.

Table 10 presents the age data for the walleye collected from Silver Island Lake. Total annual mortality (*A*) of the Silver Island Lake population was estimated at 26.8% (Figure 12). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 28.9% (Figure 12), and was based on the aging of 112 walleyes age-2 and older. Table 11 presents back-calculated lengths-at-age for walleye collected from Silver Island 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 is 47.1 ± 9.6 (Table 5). The PSD value calculated from the 2009 electrofishing assessments was 36.7 ± 3.7 (Borkholder and Edwards, 2009). The summer gill net PSD (38.4 ± 10.3) was not significantly different than the PSD estimate from the spring 2016 electrofishing survey (χ^2=2.854, P>0.05, critical Chi-square value of 3.841).

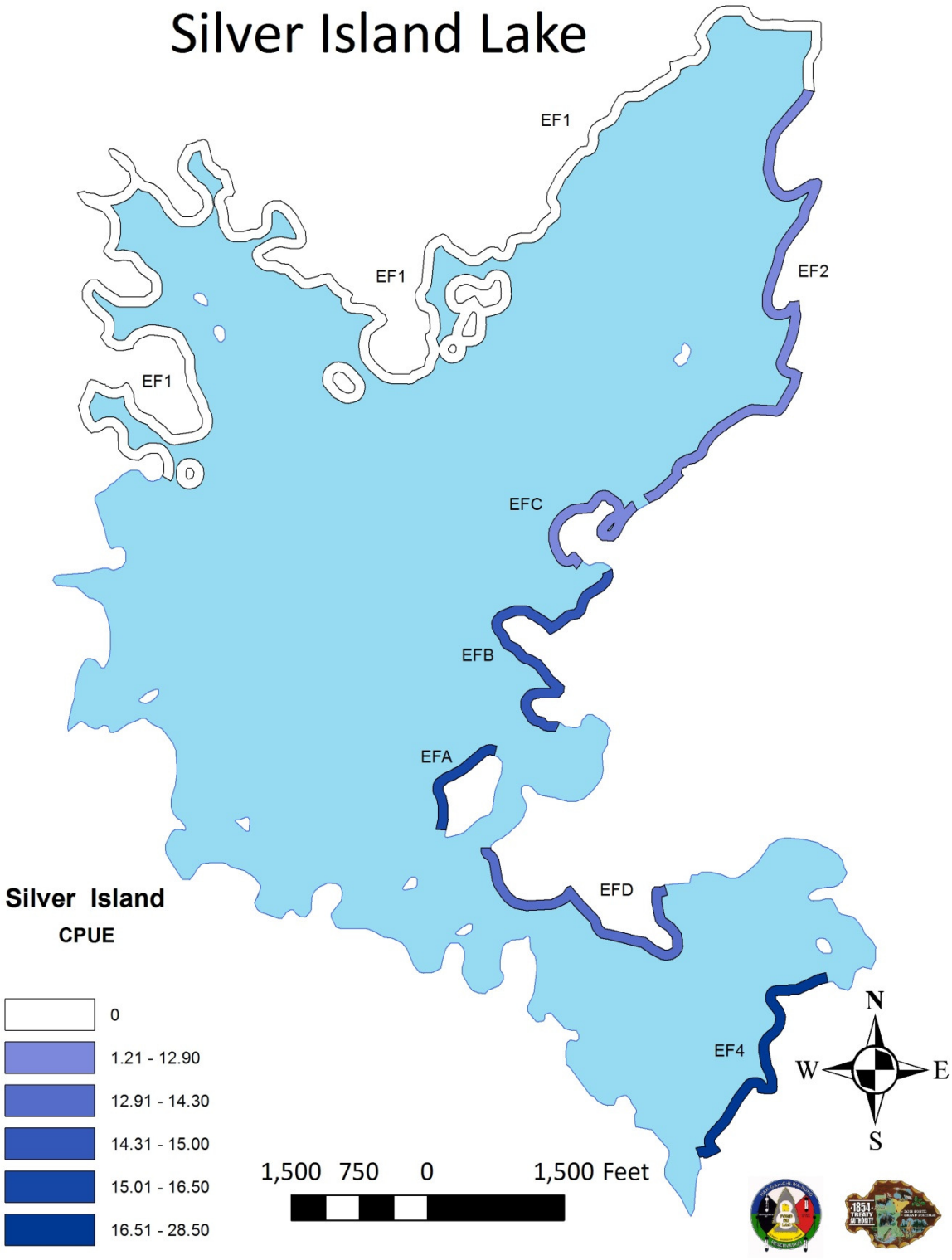

Figure 10. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Silver Island Lake, Lake County, during Spring 2016 electrofishing surveys.

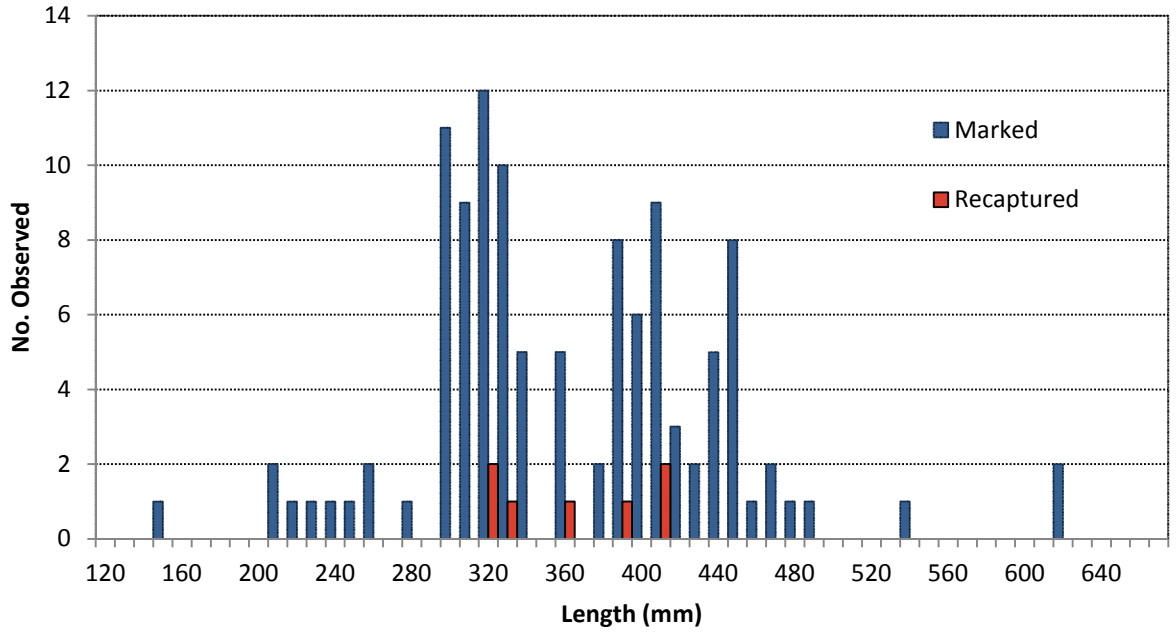

Figure 11. Length frequency distribution of walleye sampled from Silver Island Lake, Lake County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

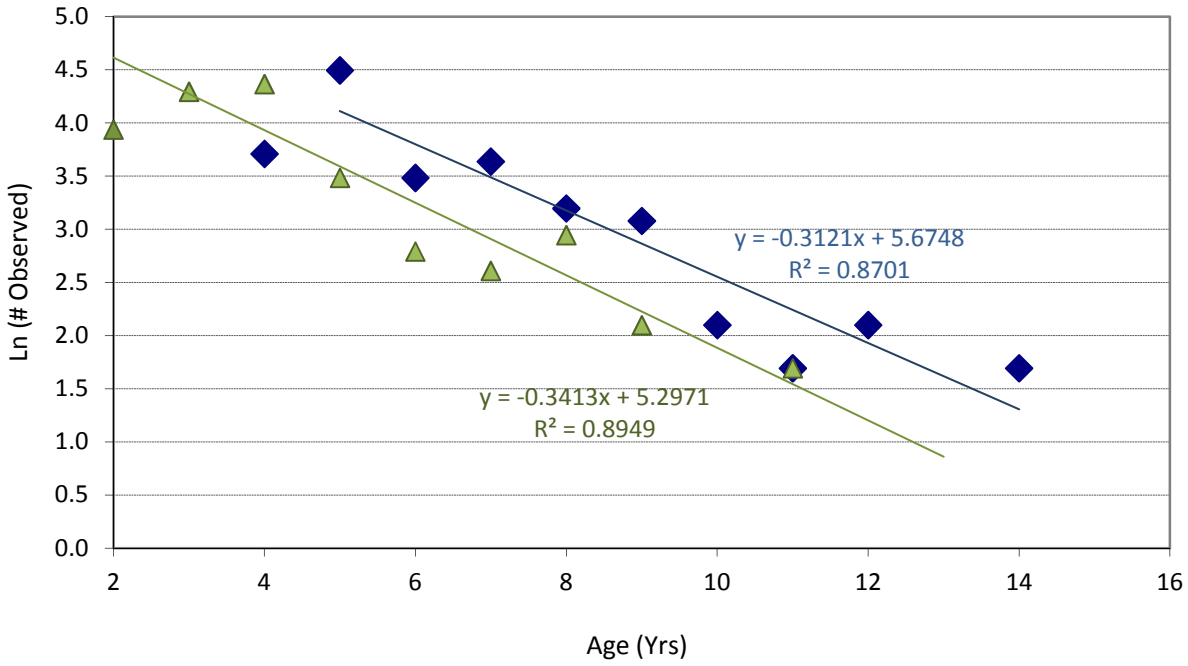

Figure 12. Catch curve analysis of walleyes in Silver Island Lake, 2016, showing instantaneous mortality (*Z)*. Estimates are made from Spring 2016 electrofishing data (blue diamonds), and from summer 2016 gill net assessments by the MNDNR (green triangles).

Table 10. Age frequency distribution of walleye from Silver Island Lake, Lake County, spring 2016, based upon the number o fish sampled and aged per size category

Length Group		N	Age										
Inches	mm	Sampled	4	5	6	7	8	9	10	11	12	14	17
6.0	152	1											
8.0	203												
8.5	216	3											
9.0	229	1											
9.5	241	2											
10.0	245	2	2										
10.5	257												
11.0	270	1	1										
11.5	282	4	2	2									
12.0	294	14	3	11									
12.5	306	14	7	7									
13.0	319	11		7	4								
13.5	331	4		2	2								
14.0	343	5		3	1	1							
14.5	355												
15.0	368	4			1	2	1						
15.5	380	12		1	4	1	4	1					
16.0	392	9				5	3			1			
16.5	404	3					1	1	1				
17.0	417	7				2		4	1				
17.5	429	6				3			1	1	1		
18.0	441	1						1					
18.5	453	3						1				2	
19.0	466												
19.5	478	1									1		
21.0	515	1									1		
24.5	600	2											2
TOTAL		111	15	33	12	14	9	8	3	2	3	2	2
			13.5%	29.7%	10.8%	12.6%	8.1%	7.2%	2.7%	1.8%	2.7%	1.8%	1.8%

Table 11. Back-calculated lengths-at-age for walleye collected from Silver Island Lake, Cook County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	77	99	3.9
2	77	163	6.4
3	77	224	8.8
4	76	276	10.9
5	71	324	12.8
6	50	359	14.1
7	41	385	15.1
8	32	402	15.8
9	24	421	16.6
10	17	433	17.1
11	11	460	18.1
12	8	485	19.1
13	4	509	20
14	4	527	20.8
15	2	595	23.4
16	2	613	24.1
17	2	627	24.7

Two Island Lake (DOW 16-0156)

Electrofishing activities were conducted on Two Island Lake, Cook County, on 2 - 4 May (Figure 13). 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. CPUEs ranged from 7.4 (EFD, 3 May) to 238.0 (EF4, 4 May) adult walleye per hour of sampling (Figure 13). At a 95% confidence interval, mean CPUE for Two Island Lake, determined using each sampling station, was 51.7 ± 17.1 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Two Island Lake is presented in Figure 14. Walleye as large as 623 mm (24.5 inches) were observed in the survey. Additional species observed included northern pike, white sucker, yellow perch, smallmouth bass, bluegill, and sculpin.

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 1156 (Table 2). The electrofishing adjusted Petersen estimate is 1150 ± 500, with a 10.1% CV (Table 2). During summer

2016, the Minnesota Department of Natural Resources performed a standardized net assessment on Two Island Lake (MN DNR, Grand Marais Area Fisheries). Fifty-one (51) walleyes (> 274 mm) were sampled in both the gill nets and trap nets, that would have been 254 mm during the spring assessments. Only four individuals were observed to have the yellow floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 5210 ± 6435, with a 38.8% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 1532 (Table 2).

Table 12 presents the age data for the walleye collected from Two Island Lake. Total annual mortality (*A*) of the Two Island Lake population was estimated at 34.3% (Figure 15). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 29.8% (Figure 15), and was based on the aging of 46 walleyes age-2 and older. Table 13 presents back-calculated lengths-at-age for walleye collected from Two Island 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 is 55.0 ± 4.1 (Table 5). The summer gill net PSD (57.1 ± 13.0) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.098, *P*>0.05, critical Chi-square value of 3.841.

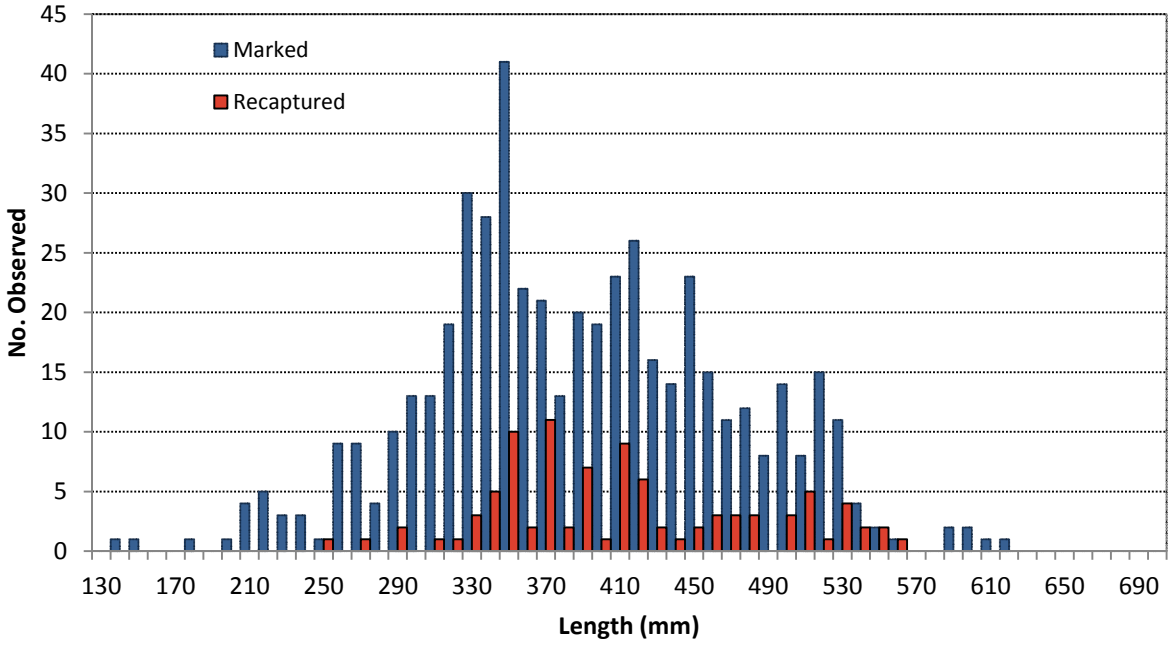

Figure 14. Length frequency distribution of walleye sampled from Two Island Lake, Cook County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

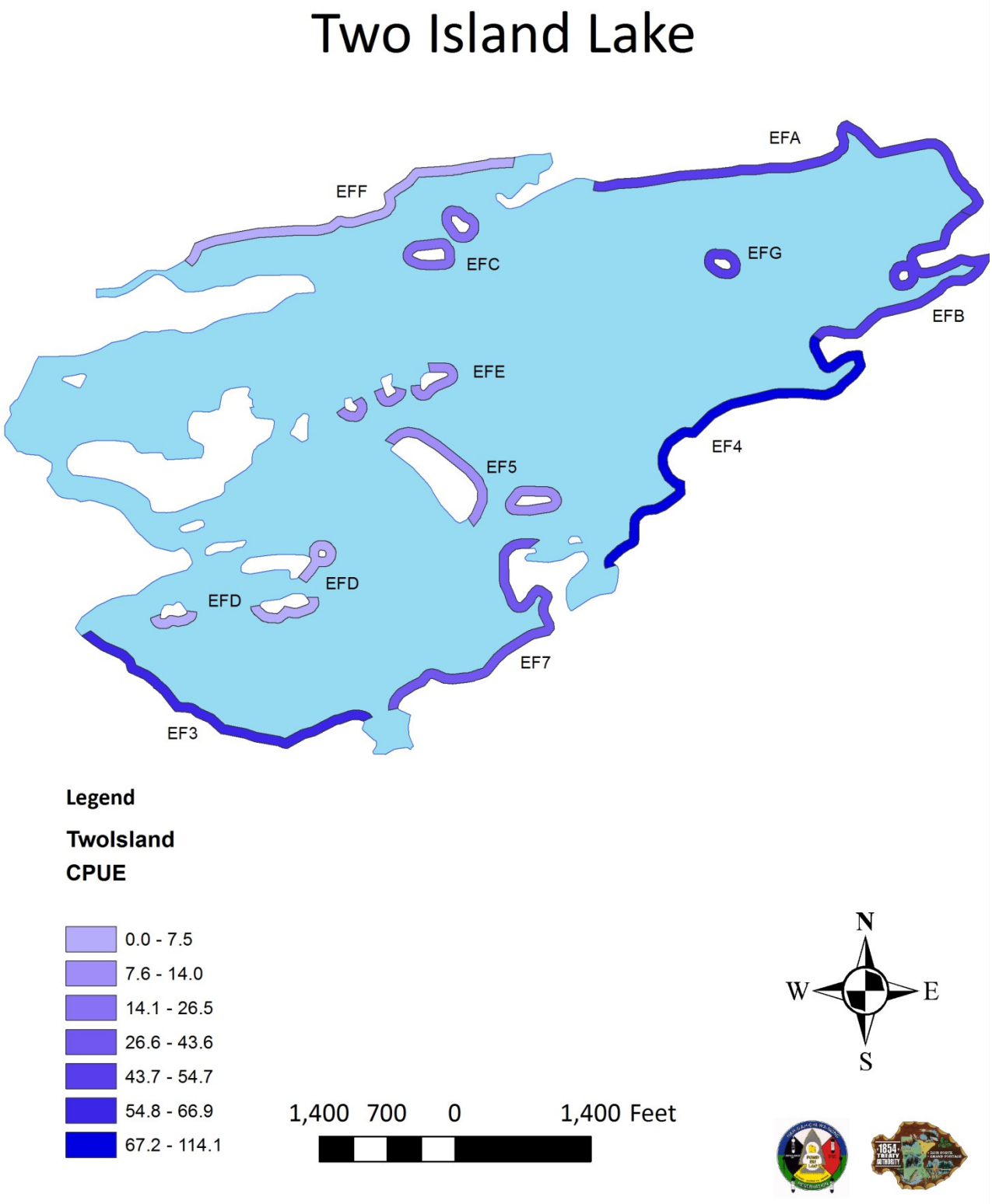

Figure 13. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Two Island Lake, Cook County, during Spring 2016 electrofishing surveys.

Table 12. Age frequency distribution of walleye from Two Island Lake, Cook County, spring 2016, 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
5.5	140	1												
6.0	152	1												
7.0	178	1												
7.5	191	1												
8.0	203	2												
8.5	216	7												
9.0	229	5												
9.5	241	1												
10.0	254	9	9											
10.5	267	10	10											
11.0	279	5	3	2										
11.5	292	18	8	10										
12.0	305	14	2	10	2									
12.5	318	27		24	3									
13.0	330	32		24		9								
13.5	343	48		14	34									
14.0	356	32			16	16								
14.5	368	27		3	12	12								
15	381	17			17									
15.5	394	28			25	3								
16	406	28			17	8	3							
16.5	419	30			4	26								
17	432	19			7	7	3		2					
17.5	445	26			3	8	5	10						
18	457	19				10	4	2	2					
18.5	470	17					9	7		1				
19	483	11			3			4	4					
19.5	495	15						2.5	3	6	3	3		
20.0	508	13					1		3	3	6			
20.5	521	17					3		5	2	5	3		
21.0	533	8						3	1	1		3		
21.5	546	3					1		1					
22.0	559	2							1		1			
22.5	572													
23.0	584													
23.5	597	4								1		1		1
24.0	610	1											1	
24.5	622	1												1
TOTAL		500	32	86	143	99	29	29	22	14	15	10	1	2
			6.4%	17.3%	28.6%	19.7%	5.9%	5.8%	4.3%	2.8%	3.0%	2.0%	0.2%	0.4%

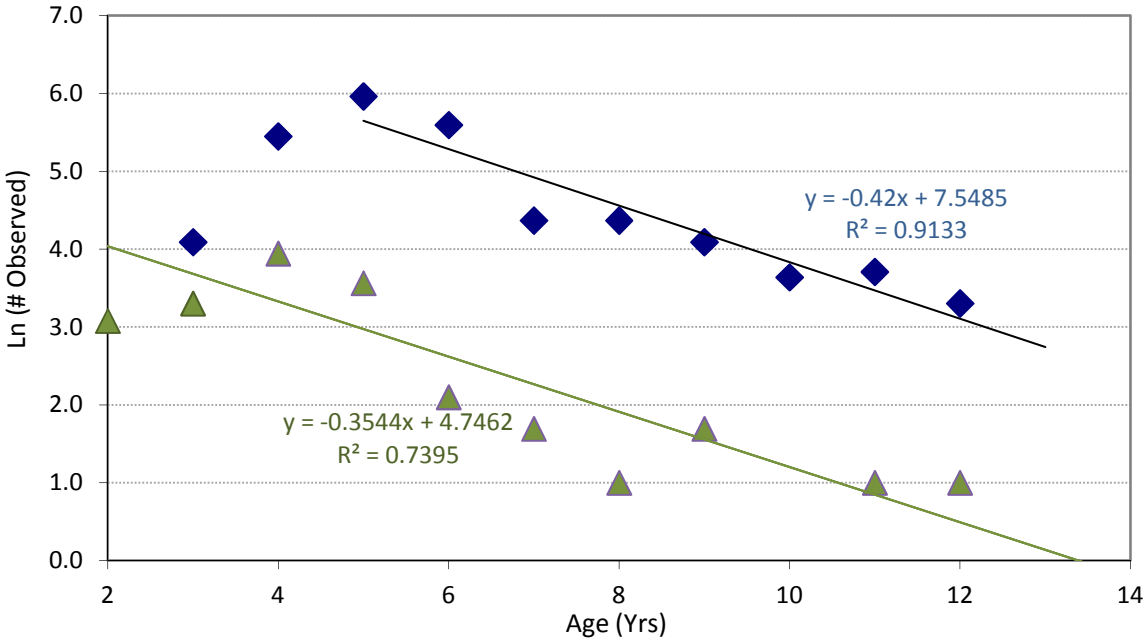

Figure 15. Catch curve analysis of walleyes in Two Island Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from Spring 2016 electrofishing data (blue diamonds), and from summer 2016 gill net assessments by the MNDNR (green triangles).

Table 13. Back-calculated lengths-at-age for walleye collected from Two Island Lake, Cook County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	198	102	4
2	198	181	7.1
3	198	259	10.2
4	175	328	12.9
5	146	387	15.2
6	101	428	16.9
7	72	462	18.2
8	56	481	18.9
9	40	499	19.7
10	28	513	20.2
11	20	527	20.7
12	10	547	21.5
13	4	572	22.5
14	3	576	22.7
15	1	515	20.3

Tom Lake (DOW 16-0019)

Electrofishing activities were conducted on Tom Lake, Cook County, on 4 - 6 May (Figure 16). 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. CPUEs ranged from 15.2 (EF5, 5 May) to 174.6 (EF2, 6 May) adult walleye per hour of sampling (Figure 15). At a 95% confidence interval, mean CPUE for Tom Lake, determined using each sampling station, was 83.6 ± 23.3 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Tom Lake is presented in Figure 17. Walleye as large as 716 mm (28.2 inches) were observed in the survey.

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 1309 (Table 2). The electrofishing adjusted Petersen estimate is 1215 ± 518, with a 9.9% CV (Table 2). During summer 2016, the Minnesota Department of Natural Resources performed a standardized net assessment on Tom Lake (MN DNR, Grand Marais Area Fisheries). Forty-one (41) walleyes (> 274 mm) were sampled in the gill nets that would have been 254 mm during the spring assessments. Eleven individuals were observed to have the yellow floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 1887 ± 1407, with a 23.4% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 1414 (Table 2). The population estimate from the 2006 electrofishing survey was 1492 ± 368 (Borkholder et al., 2007).

Table 14 presents the age data for the walleye collected from Tom Lake. Total annual mortality (*A*) of the Tom Lake population was estimated at 29.9% (Figure 18). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 25.2% (Figure 18). Table 15 presents back-calculated lengths-at-age for walleye collected from Tom 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 is 24.7 ± 3.6 (Table 5). The summer gill net PSD (23.3 ± 12.6) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.046, *P*>0.05, critical Chi-square value of 3.841.

Table 15. Back-calculated lengths-at-age for walleye collected from Tom Lake, Cook County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	136	98	3.9
2	136	176	6.9
3	134	243	9.6
4	104	300	11.8
5	72	336	13.2
6	60	363	14.3
7	46	387	15.2
8	41	409	16.1
9	30	426	16.8
10	17	458	18
11	12	489	19.3
12	10	511	20.1
13	5	586	23.1
14	3	652	25.7
15	2	687	27
16	1	673	26.5
17	1	686	27

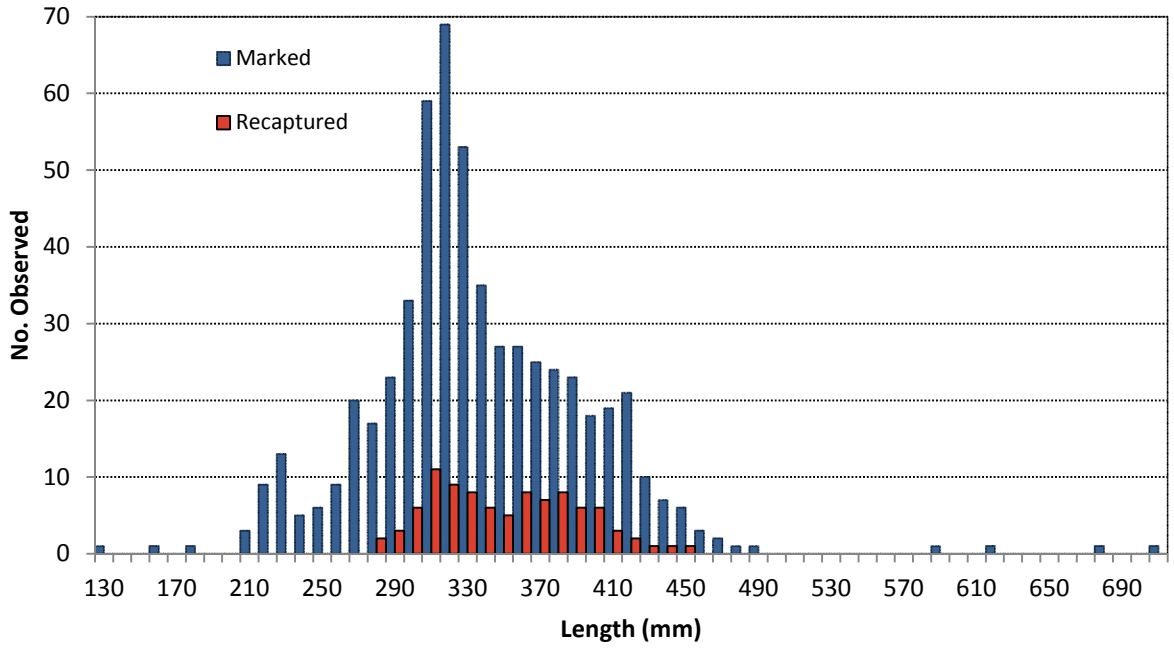

Figure 17. Length frequency distribution of walleye sampled from Tom Lake, Cook County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

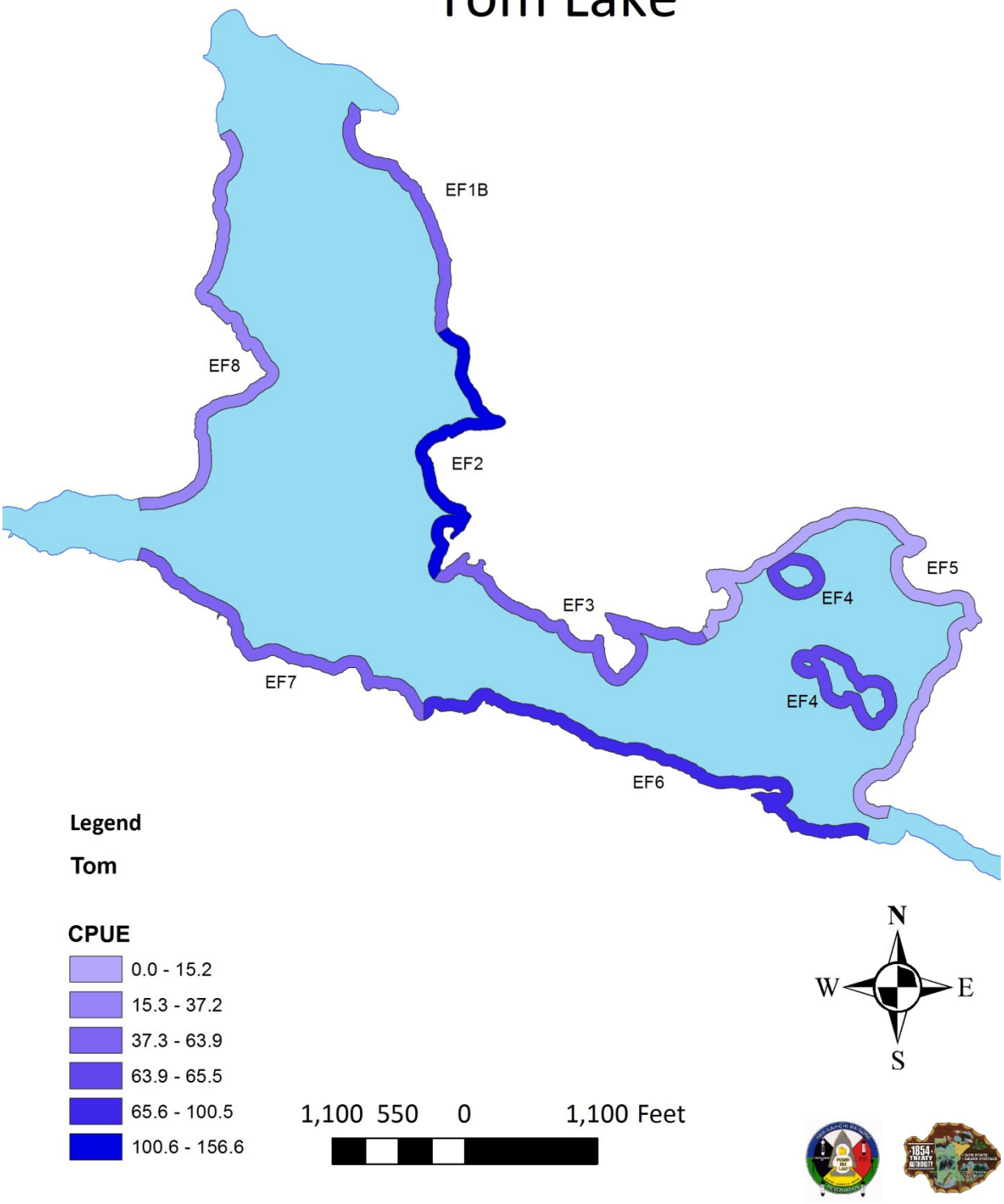

Figure 16. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Tom Lake, Cook County, during Spring 2016 electrofishing surveys.

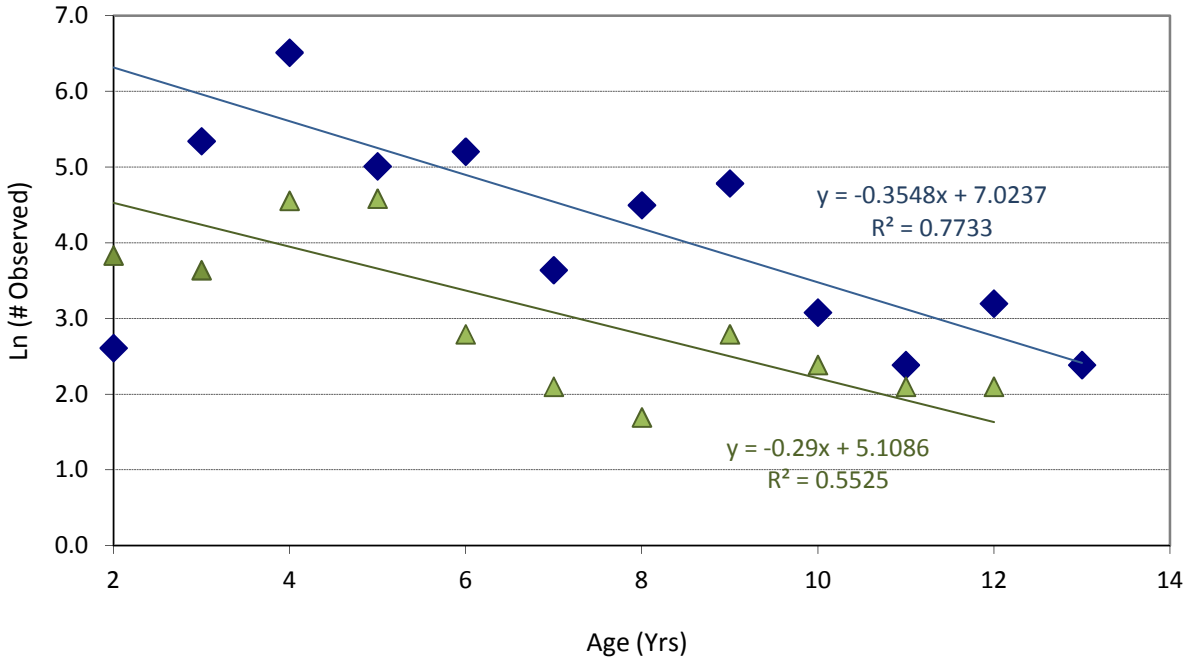

Figure 18. Catch curve analysis of walleyes in Tom Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from Spring 2016 electrofishing data (blue diamonds), and from summer 2016 gill net assessments by the MNDNR (green triangles).

Devilfish Lake (DOW 16-0029)

Electrofishing activities were conducted on Devilfish Lake, Cook County, on 5 - 7 May (Figure 19). 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. CPUEs ranged from 0.0 (EF6, 5 May) to 94.5 (EF1, 7 May) adult walleye per hour of sampling (Figure 19). At a 95% confidence interval, mean CPUE for Devilfish Lake, determined using each sampling station, was 54.7 ± 19.3 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Devilfish Lake is presented in Figure 20. Walleye as large as 720 mm (28.3 inches) were observed in the survey.

Table 14. Age frequency distribution of walleye from Tom Lake, Cook County, spring 2016, 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	15	17
5.0	127	1															
5.5	140																
6.0	152	1															
6.5	165																
7.0	178	1	1														
7.5	191																
8.0	203	2	2														
8.5	216	10	2	8													
9.0	229	13		13													
9.5	241	9		9													
10.0	254	8		6	2												
10.5	267	23		15	8												
11.0	279	27		12	15												
11.5	292	28		14	14												
12.0	305	67			67												
12.5	318	88			77		11										
13.0	330	59			49	10											
13.5	343	38			13	17	8										
14.0	356	35				19	16										
14.5	368	32				5	17		5	5							
15.0	381	31					8	11	8	4							
15.5	394	25			3		3	3	4	8	4						
16.0	406	22					4		7	11							
16.5	419	25				4			4	13			4				
17.0	432	9								2	3	3		2			
17.5	445	10							4	1	1		3				
18.0	457	3							1				1				
18.5	470	3										1	1				
19.0	483	1												1			
19.5	495	0															
23.0	584	1												1			
24.5	622	1													1		
27.0	686	1															1
28.0	711	1														1	
TOTAL		575	5	77	248	55	67	14	33	44	8	4	9	4	1	1	1
			0.9%	13.4%	43.1%	9.6%	11.7%	2.4%	5.7%	7.7%	1.4%	0.7%	1.6%	0.7%	0.2%	0.2%	0.2%

Walleyes larger than 254 mm were marked with a non-numbered yellow floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 360 (Table 2). The electrofishing adjusted Petersen estimate is 362 ± 111, with a 7.1% CV (Table 2). During summer 2016, the Minnesota Department of Natural Resources performed a standardized net assessment on Devilfish Lake (MN DNR, Grand Marais Area Fisheries). Twenty-one (21) walleyes (> 274 mm) were sampled in the gill nets that would have been 254 mm during the spring assessments. Six individuals were observed to have the yellow floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the summer and spring data is 849 ± 788, with a 29.2% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 395 (Table 2). With the addition of the State's trap net data, sample size increases to 32 sampled walleyes, with eight yellow tags observed. Population estimates are presented in Table 2. The population estimates from this electrofishing survey are approximately half of what was observed in 2012 (PE = 768 ± 420) (Borkholder et al., 2013).

Table 16 presents the age data for the walleye collected from Devilfish Lake. Total annual mortality (*A*) of the Devilfish Lake population was estimated at 31.4% (Figure 21). Total annual mortality (*A*) estimated using the MNDNR's gill net data was 22.4% (Figure 21), and was based on the aging of 30 walleyes age-5 and older. Table 17 presents back-calculated lengths-at-age for walleye collected from Devilfish 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 is 32.7 ± 5.6 (Table 5). The summer gill net PSD (52.4 ± 21.4) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=3.351, *P*>0.05, critical Chi-square value of 3.841), but was only based upon 21 fish stock-sized or larger. The PSD observed in the 2012 electrofishing survey was 12.2 ± 3.5 (Borkholder et al., 2013)

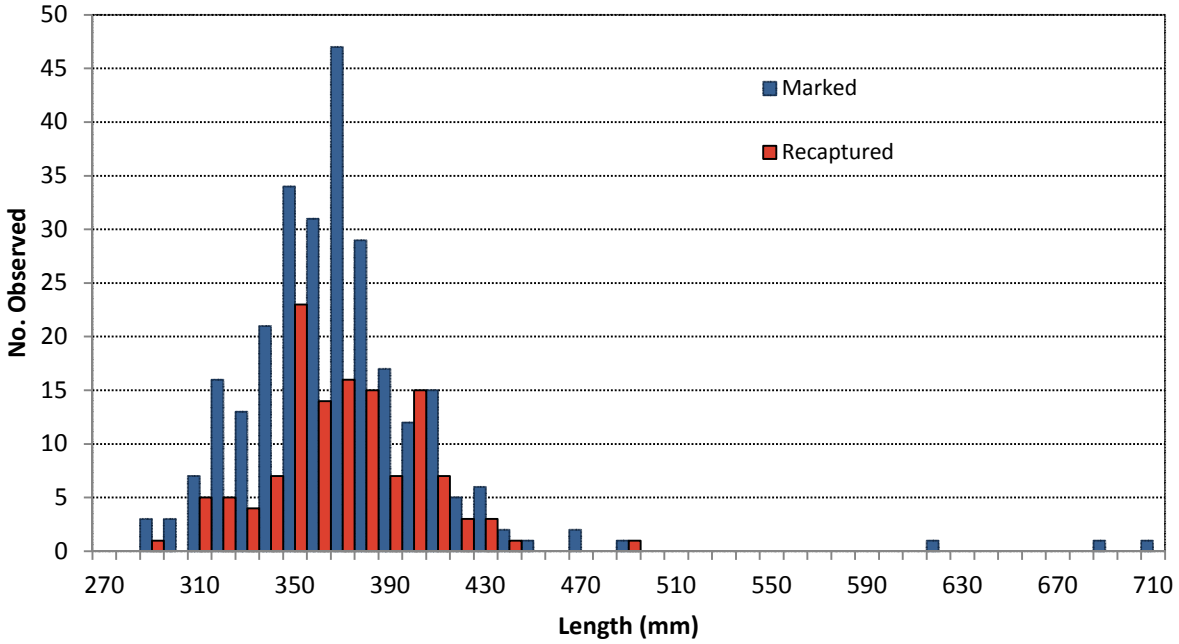

Figure 20. Length frequency distribution of walleye sampled from Devilfish Lake, Cook County, MN, during Spring 2016 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

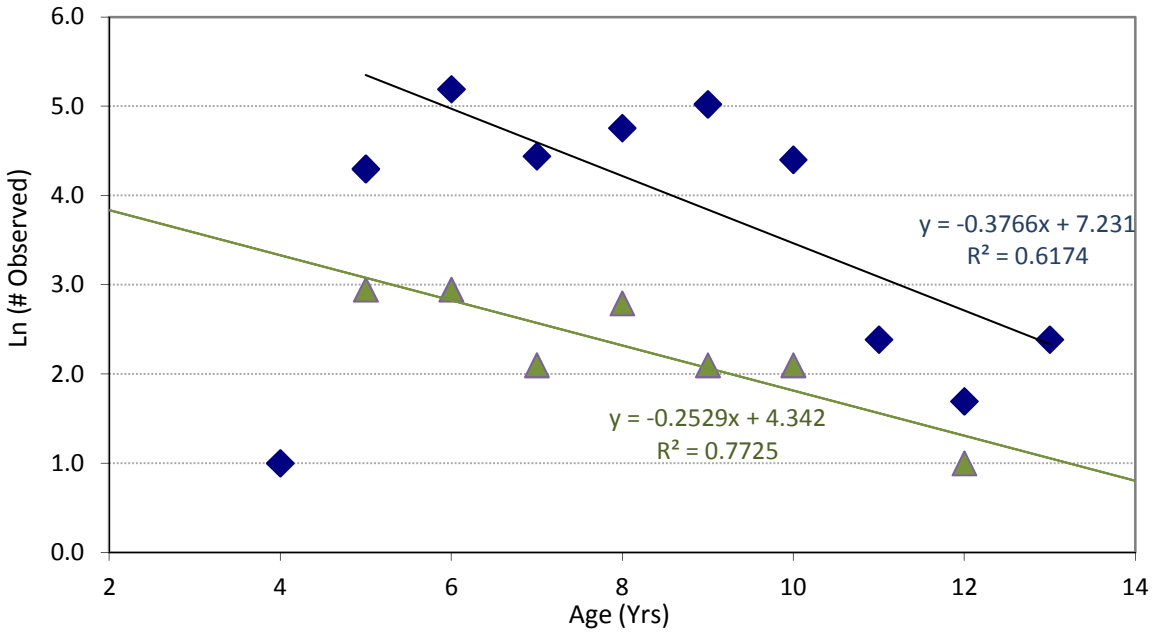

Figure 21. Catch curve analysis of walleyes in Devilfish Lake, 2016, showing instantaneous mortality (*Z*). Estimates are made from Spring 2016 electrofishing data (blue diamonds), and from summer 2016 gill net assessments by the MNDNR (green triangles).

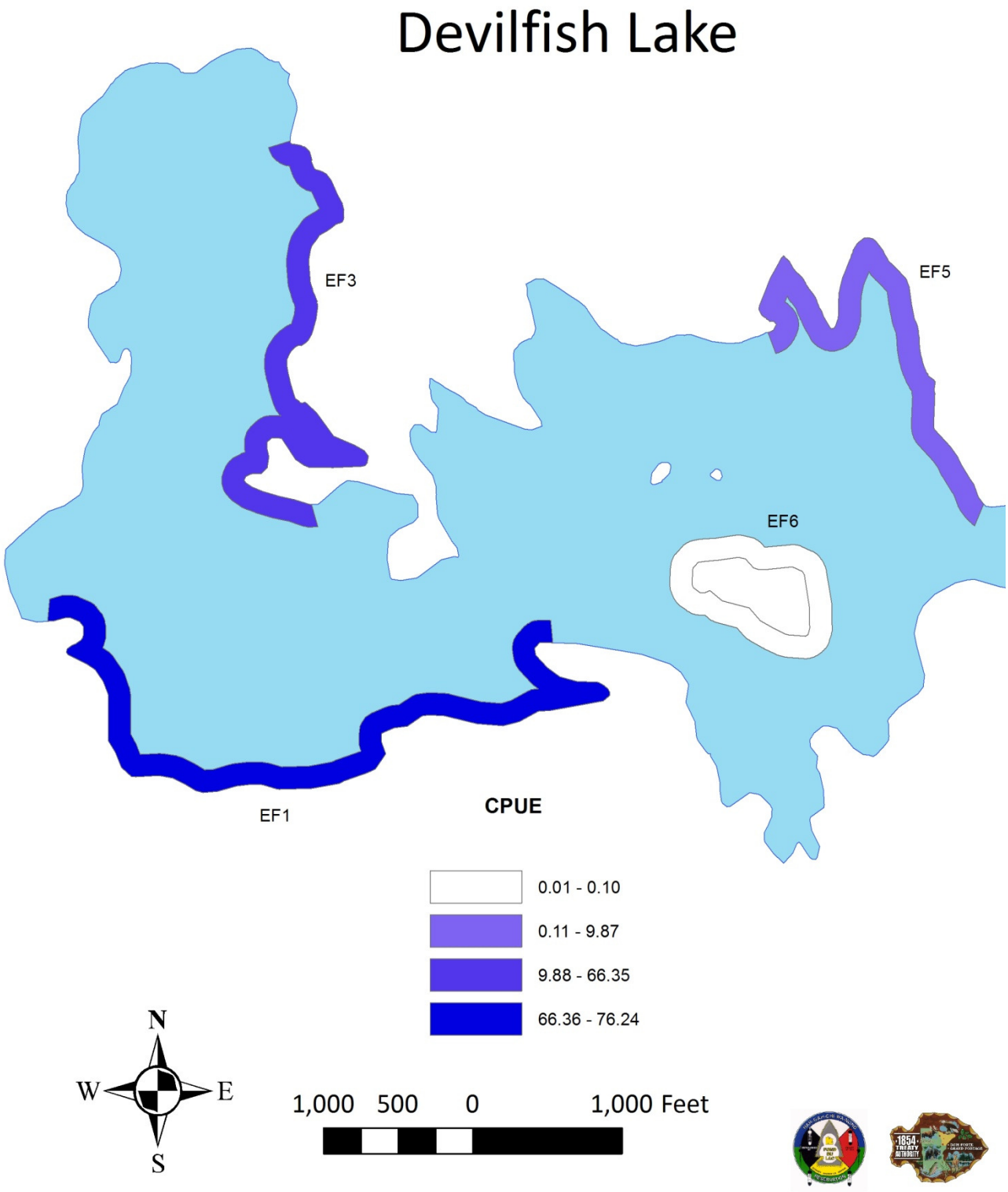

Figure 19. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Devilfish Lake, Cook County, during Spring 2016 electrofishing surveys

Table 16. Age frequency distribution of walleye from Devilfish Lake, Cook County, spring 2016, 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	15	16	19
10.0	254																
10.5	267																
11.0	279	1			1												
11.5	292	4		1	2	1											
12.0	305	5			3	2											
12.5	318	21			12	6			3								
13.0	330	18			9	6	3										
13.5	343	38				29	5			5							
14.0	356	39				10	3	13	6	6							
14.5	368	55				8	13	17	17								
15	381	31				4	4	9	9	4							
15.5	394	20					3	3	10	5							
16	406	16							7	7			2				
16.5	419	7						1	3	2				1.0%			
17	432	5								1	2		2				
17.5	445	2							1			1					
18	457																
18.5	470	2									2						
19	483	1					1										
19.5	495																
20.0	508																
20.5	521																
24.5	622	1										1					
27.5	699	1														1	
28.0	711	2															2
TOTAL		269	0	1	27	66	31	43	56	30	4	2	4	0	0	1	2
			0.0%	0.4%	10.0%	24.6%	11.6%	15.9%	20.8%	11.2%	1.5%	0.7%	1.5%	0.0%	0.0%	0.4%	0.7%

Table 17. Back-calculated lengths-at-age for walleye collected from Devilfish Lake, Cook County, Minnesota, Spring 2016.

Age Class	N	Length (mm)	Length (in)
1	98	83	3.2
2	98	142	5.6
3	98	204	8
4	98	258	10.1
5	97	300	11.8
6	85	333	13.1
7	66	356	14
8	57	376	14.8
9	45	395	15.6
10	25	417	16.4
11	13	459	18.1
12	9	484	19.1
13	6	487	19.2
14	3	569	22.4
15	2	657	25.9
16	2	682	26.8
17	1	683	26.9
18	1	702	27.7
19	1	713	28.1

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 6 September 2016. This 20°C threshold was exceeded on only Pike Lake (Table 18). All of the lakes were surveyed before the lakes cooled to below the 10°C lower threshold.

Table 18 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 0.0 fish per hour (Ninemile & Pike Lakes) to 585.3 fish per hour of electrofishing (Shagawa Lake) (Table 18). Catch rates were generally higher than normal, with six lakes having a CPUE greater than 100 age-0 fish / hour. CPUE for age-1 walleye ranged from 0.0 fish per hour (Wild Rice Lake) to 178.4 fish per hour of electrofishing (Crescent Lake) (Table 18). Figures 22 – 45 present length frequency data for each of the lakes surveyed. Table 19 presents the mean length for age-0 and age-1 individuals sampled during fall 2016 assessments. Mean lengths for age-0 walleye ranged from 108 mm (4.2 inches, Silver Island & Two Island Lakes) to 184 mm (7.2 inches, Cadotte Lake). Mean lengths for age-1 walleye ranged from 170 mm (6.7 inches, Windy Lake) to 252 mm (9.9 inches, Island Lake).

Wild Rice Lake Reservoir Largemouth Bass

Eighty-three (83) largemouth bass (*Micropterus salmoides*) were sampled in Wild Rice Lake during fall 2015 assessments (Borkholder et al. 2016), the highest catch rates since they were first observed in 2009. In 2016, only 12 largemouth bass were sampled (Figure 46). Lengths ranged from 81 mm to 123 mm.

Acknowledgments

The Fond du Lac Division of Resource Management and the 1854 Treaty Authority wish to acknowledge and thank the staff that assisted during field work in 2016; Darren Vogt, Jeffrey Flory, Allison Herreid, Kelsey Wenner, Tyler Kaspar, Andy Edwards, and Jamie McDermid (1854 Treaty Authority); Adam Thompson, John Goodreau, Lance Overland, Terry Perrault, & Charlie Nahgahnub (Fond du Lac Resource Management); Chris Beal, Jason Butcher, Jake Carleen, Darren Lilja, Ryan Pennisi, Amy Wilfahrt, Dave Grosshuesch, Jody Majewsky, Peg Robertson, Sarah Malick-Wahls, Emily Creighton, & Dan Ryan (U.S. Forest Service). Steve Persons and Mathew Weberg (MNDNR Grand Marais Area Office), Dean Paron and Dick Stern (MNDNR Finland Area Office), and Deserae Hendrickson and Dan Wilfond (MNDNR, Duluth Area Office) provided gill net data from the Minnesota Department of Natural Resources.

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Table 18. 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 2016.

	Temp	Temp	Age-0	Age-1	CPUE	CPUE

Lake	Date	(F)	(C)	Cond.[1]	Total[2]	Total[3]	Seconds	Age-0[4]	1+[5]
Ball Club	6-Sep	68	20.0	24.0	247	59	5611	158.5	37.9
Cadotte	28-Sep	57.7	14.3	25.0	322	18	7831	148.0	8.3
Caribou	8-Sep	68	20.0	66.0	777	121	7581	369.0	57.5
Cascade	22-Sep	60.1	15.6	25.0	18	38	5218	12.4	26.2
Crescent	20-Sep	62	16.7	29.2	432	160	3295	472.0	174.8
Crooked	23-Sep	61	16.1	48.0	53	2	4184	45.6	1.7
Devilfish	7-Sep	67	19.4	20.0	11	3	8361	4.7	1.3
Dumbbell	26-Sep	59	15.0	72.5	447	10	5073	317.2	7.1
Elbow	9-Sep	67	19.4	34.0	82	50	4668	63.2	38.6
Fourmile	21-Sep	60	15.6	48.0	41	69	5723	25.8	43.4
Harriet	19-Sep	63.6	17.6	55.0	67	22	5028	48.0	15.8
Island Reservoir	29-Sep	58.6	14.8	85.0	127	135	9021	50.7	53.9
Ninemile	23-Sep	61.6	16.4	52.1	0	29	5703	0.0	18.3
N. McDougal	26-Sep	55	12.8	63.0	8	16	4585	6.3	12.6
Pike	9-Sep	69.1	20.6	57.1	0	91	6568	0.0	49.9
Shagawa	27-Sep	59.7	15.4	96.0	1893	144	11643	585.3	44.5
Silver Island	20-Sep	62.3	16.8	41.0	28	24	5003	20.1	17.3
Tait	20-Sep	62	16.7	40.2	565	61	7499	271.2	29.3
Tom	7-Sep	67.9	19.9	37.6	1	146	6237	0.6	84.3
Two Island	22-Sep	62	16.7	30.4	64	91	5818	39.6	56.3
West Twin	8-Sep	66.8	19.3	30.5	49	37	4242	41.6	31.4
Whiteface Res.	28-Sep	59	15.0	62.3	30	14	8628	12.5	5.8
Wild Rice	16-Sep	65	18.3	134.6	1	0	4689	0.8	0.0
Wilson	19-Sep	64.5	18.1	47.1	154	36	6847	81.0	18.9
Windy	21-Sep	62.9	17.2	29.8	3	5	6784	1.6	2.7

[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 19. Mean length for age-0 and age-1 walleye sampled during fall 2016 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).

	Age-0 Mean	Age-1 Mean

Lake (County)	Date	Length (mm)	Length (mm)
Ball Club	6-Sep	113	206
Cadotte	28-Sep	184	205
Caribou	8-Sep	122	188
Cascade	22-Sep	131 (N=18)	218
Crescent	20-Sep	110	190
Crooked	23-Sep	142	235 (N=2)
Devilfish	7-Sep	107 (N=11)	203 (N=3)
Dumbbell	26-Sep	138	199 (N=10)
Elbow	9-Sep	108	186
Fourmile	21-Sep	143	212
Harriet	19-Sep	126	210
Island Reservoir	29-Sep	163	252
Ninemile	23-Sep	----	179
N. McDougal	26-Sep	134	215 (N=16)
Pike	9-Sep	----	186
Shagawa	27-Sep	119	217
Silver Island	20-Sep	140	208
Tait	20-Sep	113	225
Tom	7-Sep	138 (N=1)	198
Two Island	22-Sep	108	190
West Twin	8-Sep	132	207
Whiteface Res.	28-Sep	148	230 (N=14)
Wild Rice	16-Sep	143 (N=1)	----
Wilson	19-Sep	138	199
Windy	21-Sep	150 (N=3)	170 (N=5)

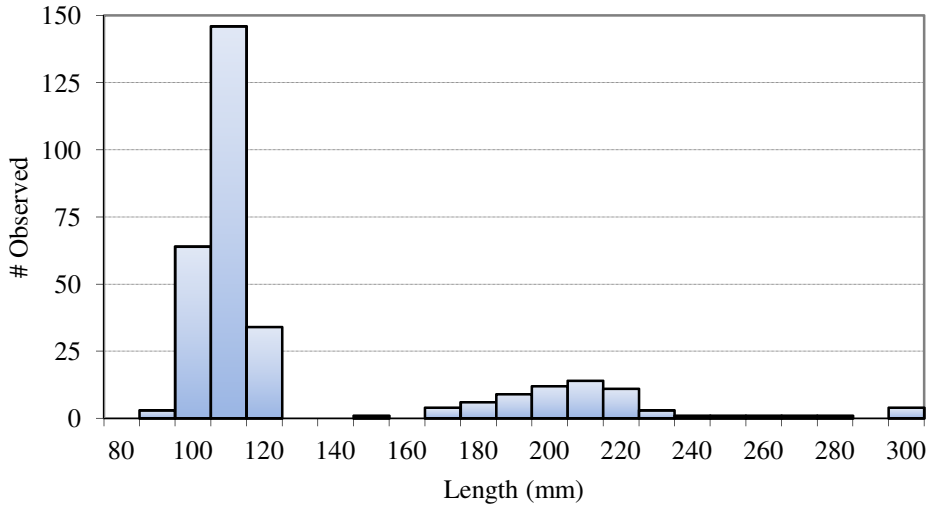

Figure 22. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2016 electrofishing assessments.

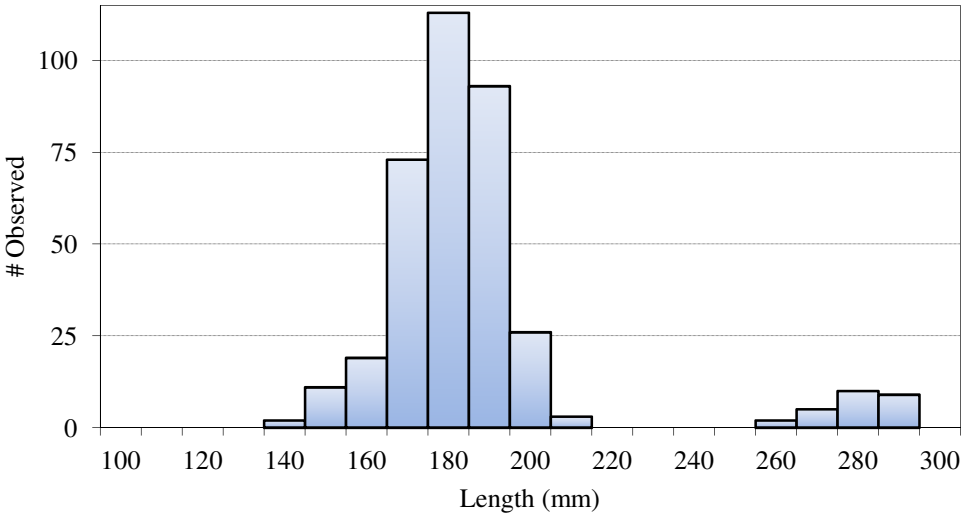

Figure 23. Length frequency distribution of walleye collected from Cadotte Lake, St. Louis County, during fall 2016 electrofishing assessments.

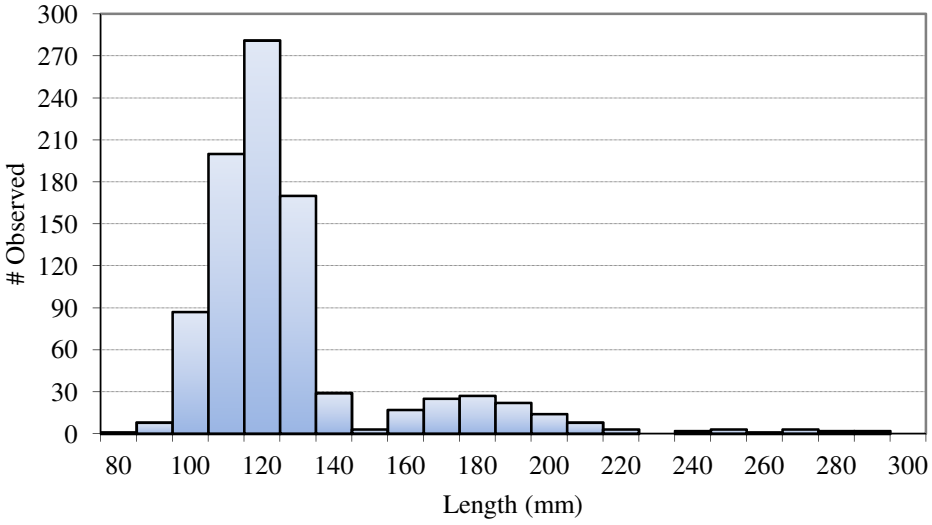

Figure 24. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2016 electrofishing assessments.

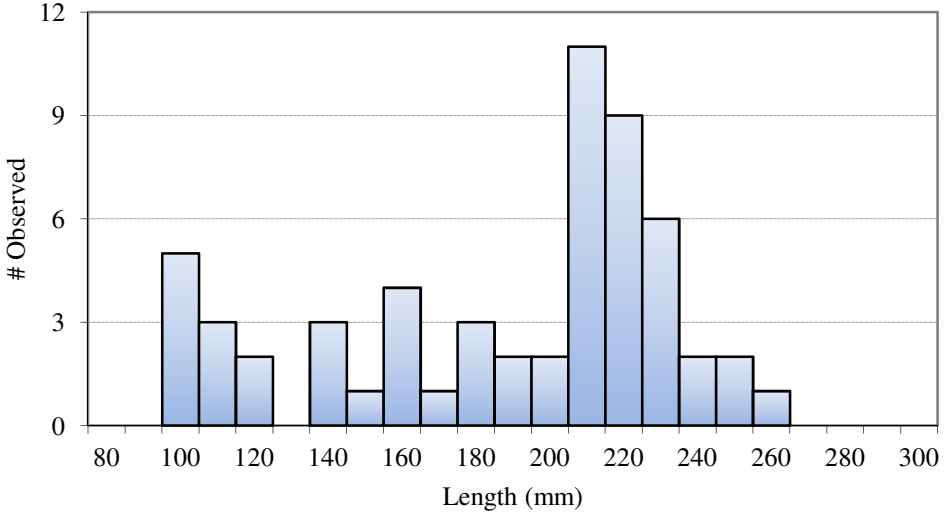

Figure 25. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2016 electrofishing assessments.

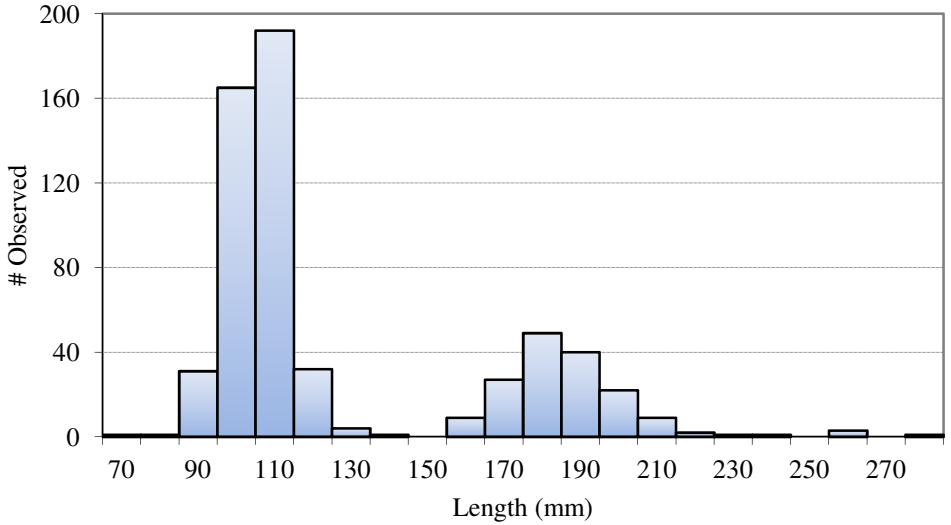

Figure 26. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2016 electrofishing assessments.

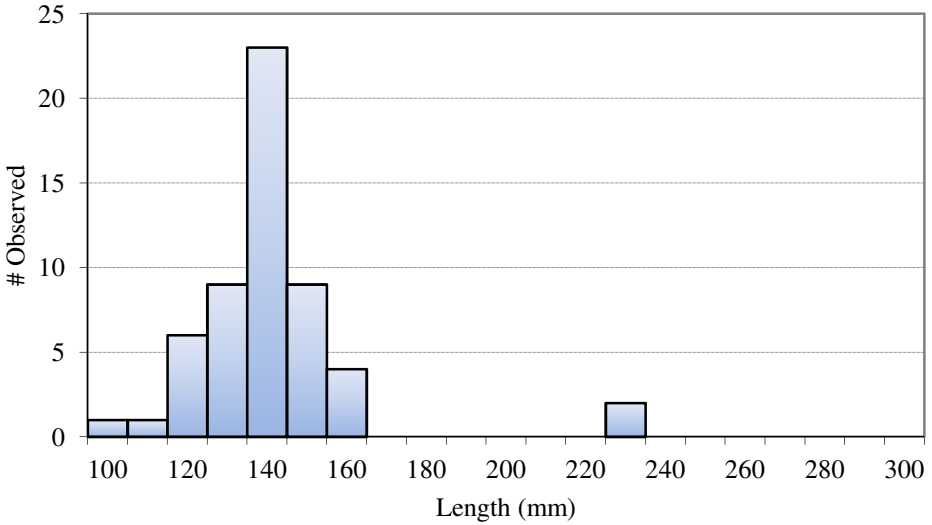

Figure 27. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2016 electrofishing assessments.

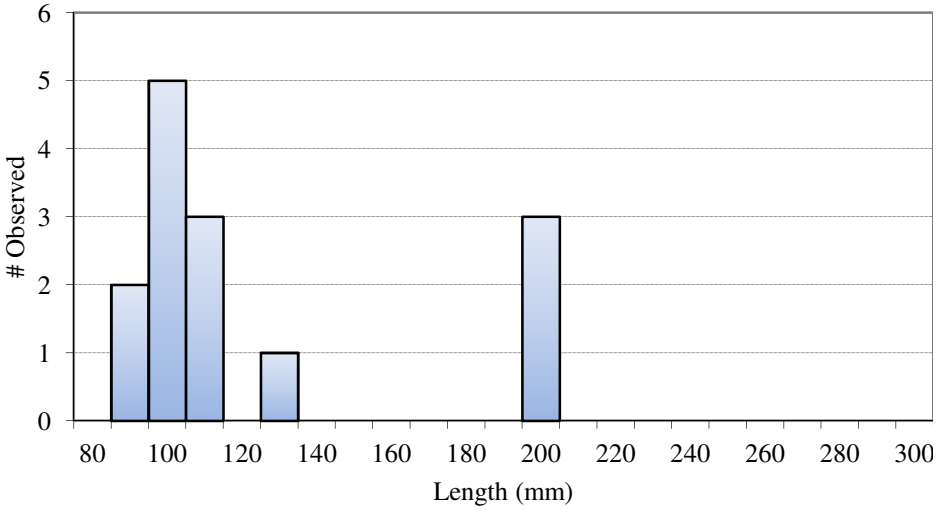

Figure 28. Length frequency distribution of walleye collected from Devilfish Lake, Cook County, during fall 2016 electrofishing assessments.

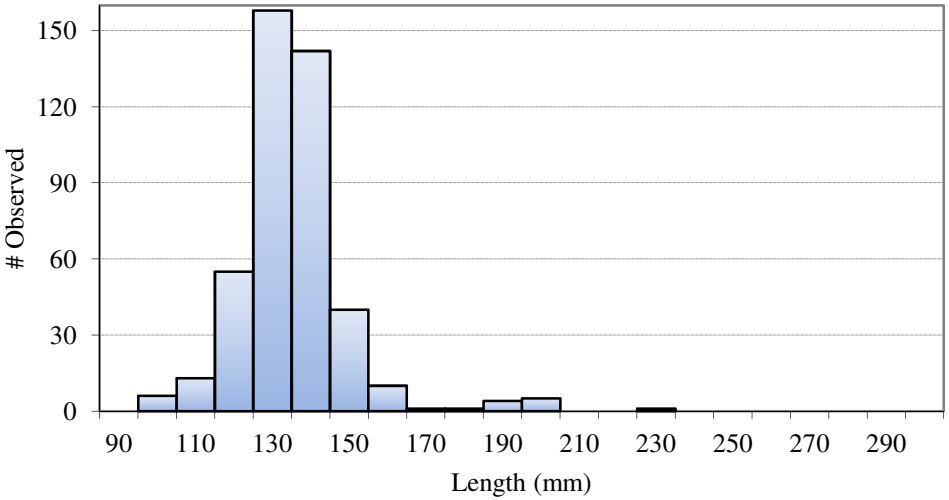

Figure 29. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2016 electrofishing assessments.

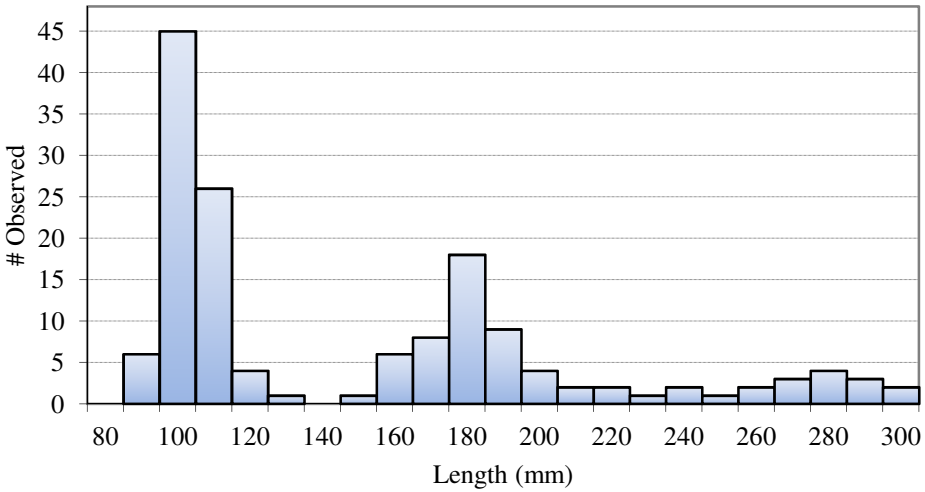

Figure 30. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2016 electrofishing assessments.

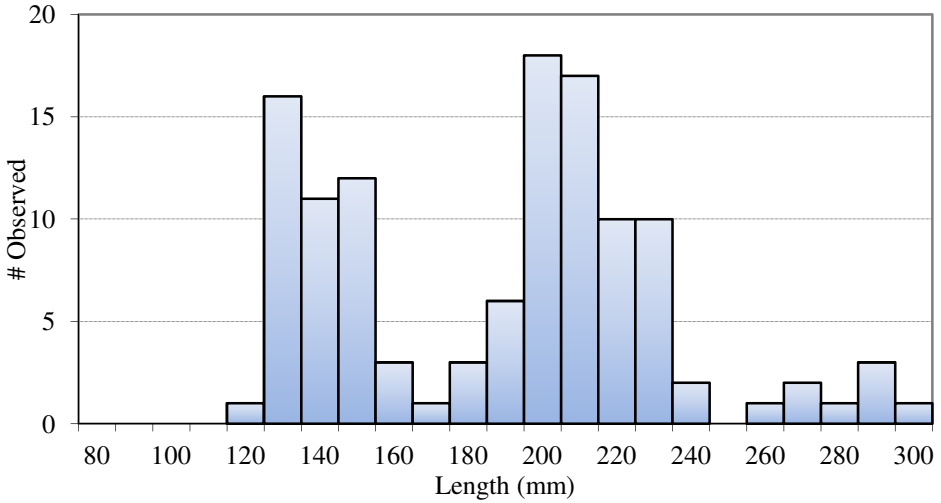

Figure 31. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2016 electrofishing assessments.

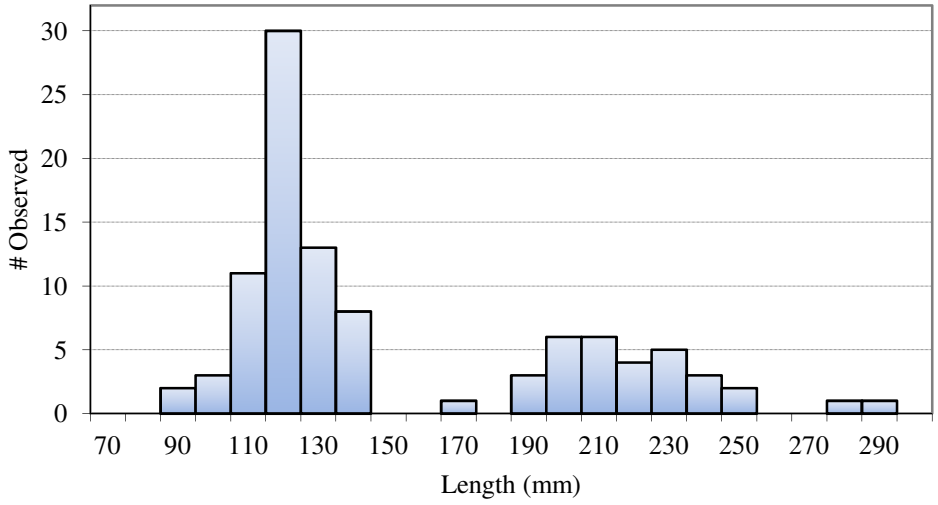

Figure 32. Length frequency distribution of walleye collected from Harriet Lake, Lake County, during fall 2016 electrofishing assessments.

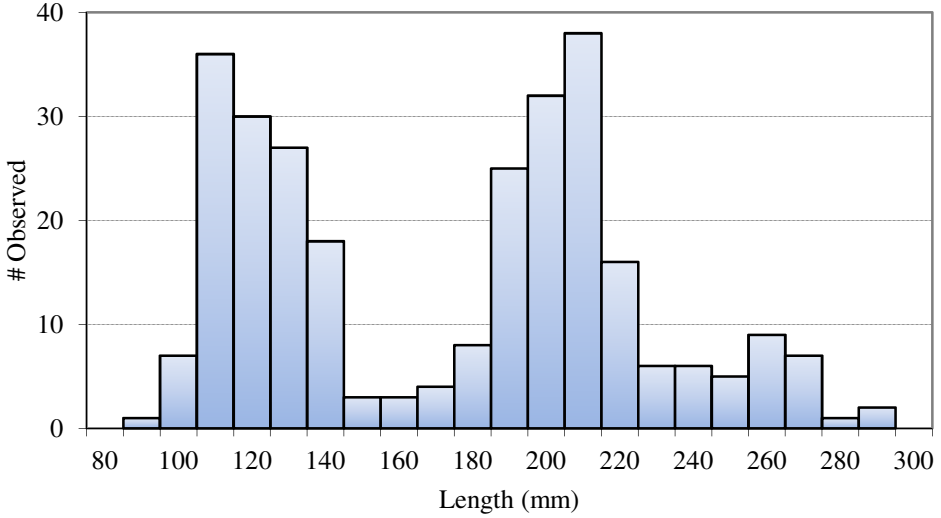

Figure 33. Length frequency distribution of walleye collected from Island Lake Reservoir, St. Louis County, during fall 2016 electrofishing assessments.

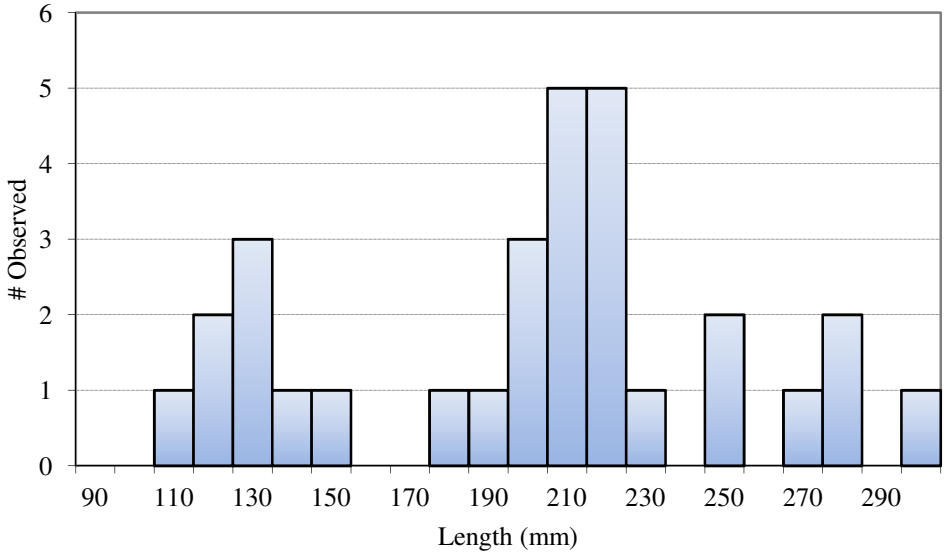

Figure 34. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2016 electrofishing assessments.

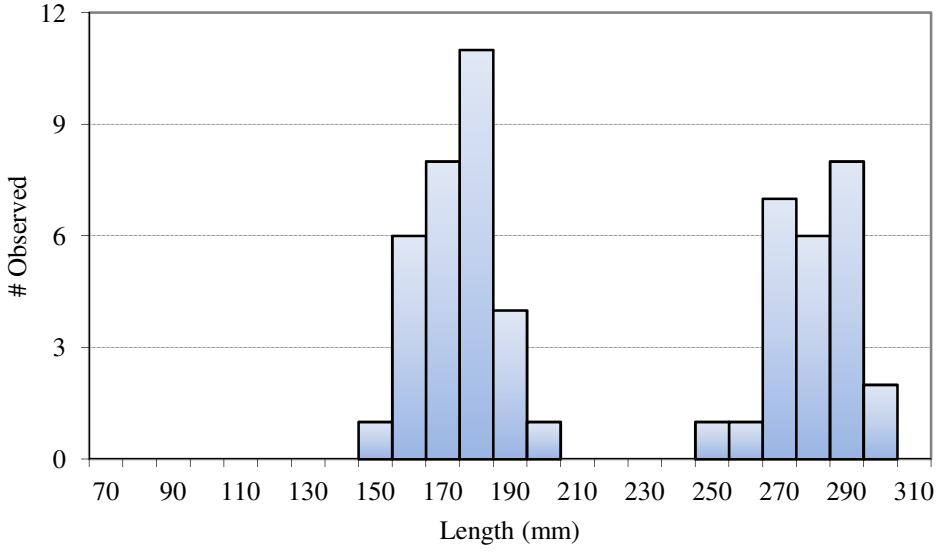

Figure 35. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2016 electrofishing assessments.

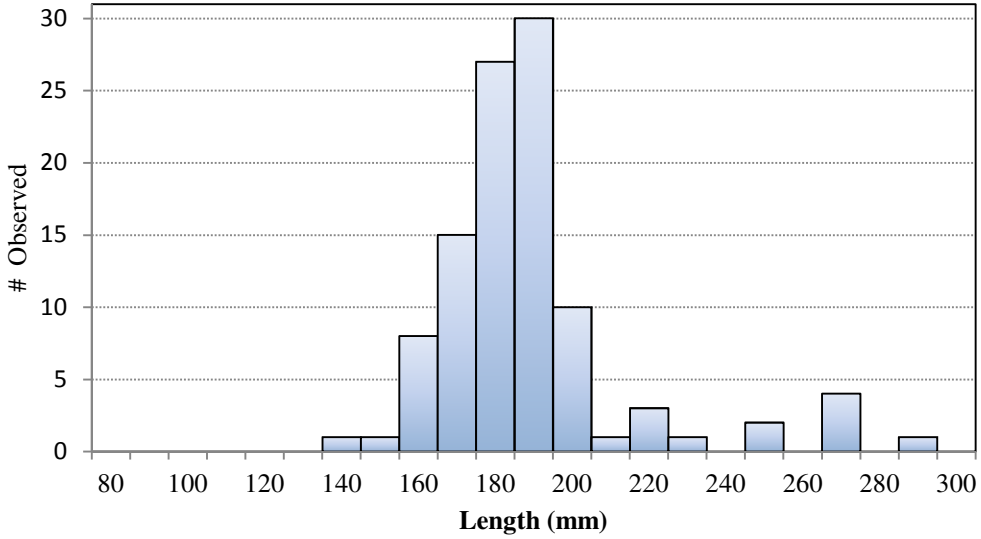

Figure 36. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2016 electrofishing assessments.

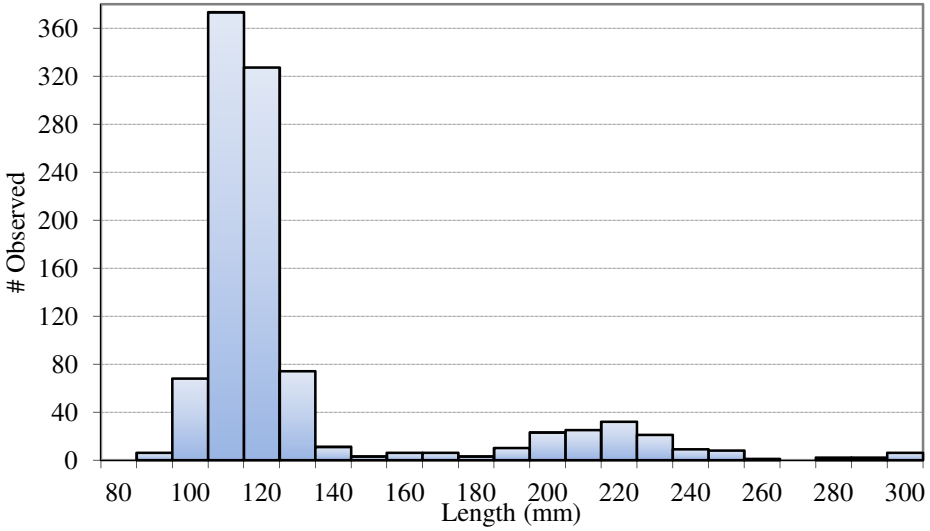

Figure 37. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2016 electrofishing assessments.

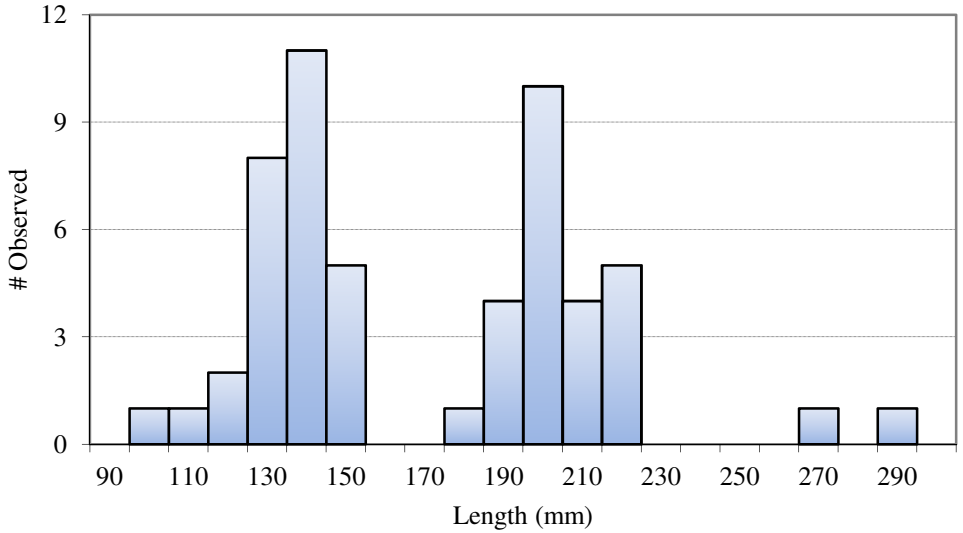

Figure 38. Length frequency distribution of walleye collected from Silver Island Lake, Lake County, during fall 2016 electrofishing assessments.

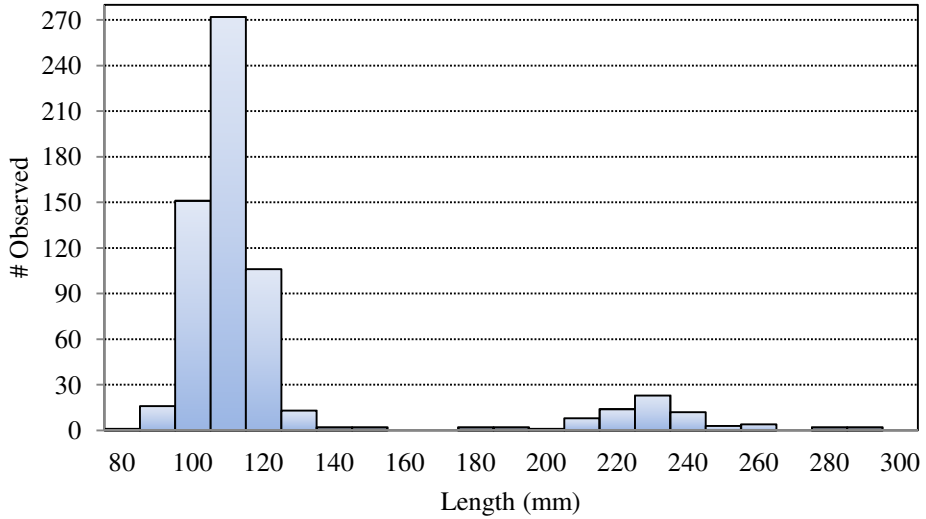

Figure 39. Length frequency distribution of walleye collected from Tait Lake, Cook County, during fall 2016 electrofishing assessments.

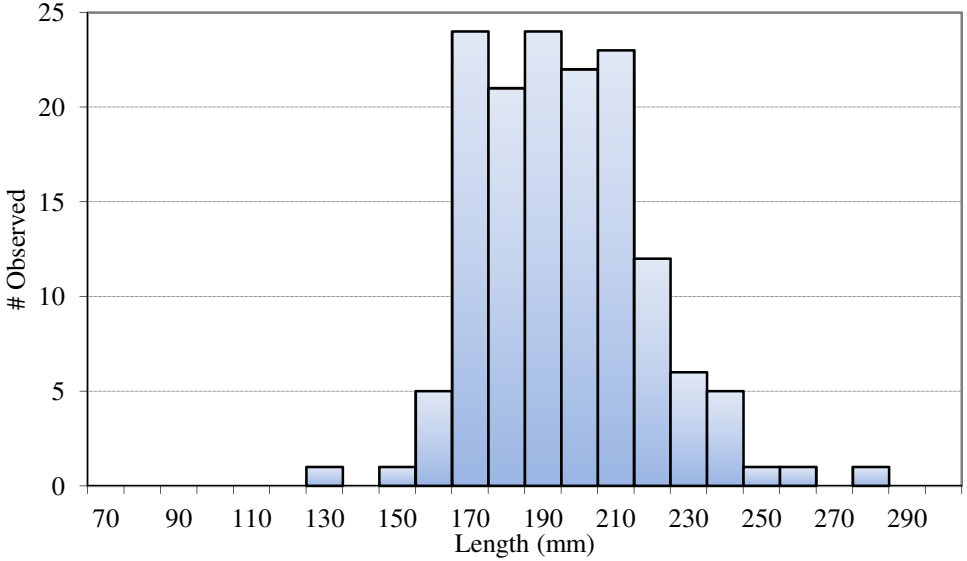

Figure 40. Length frequency distribution of walleye collected from Tom Lake Cook County, during fall 2016 electrofishing assessments.

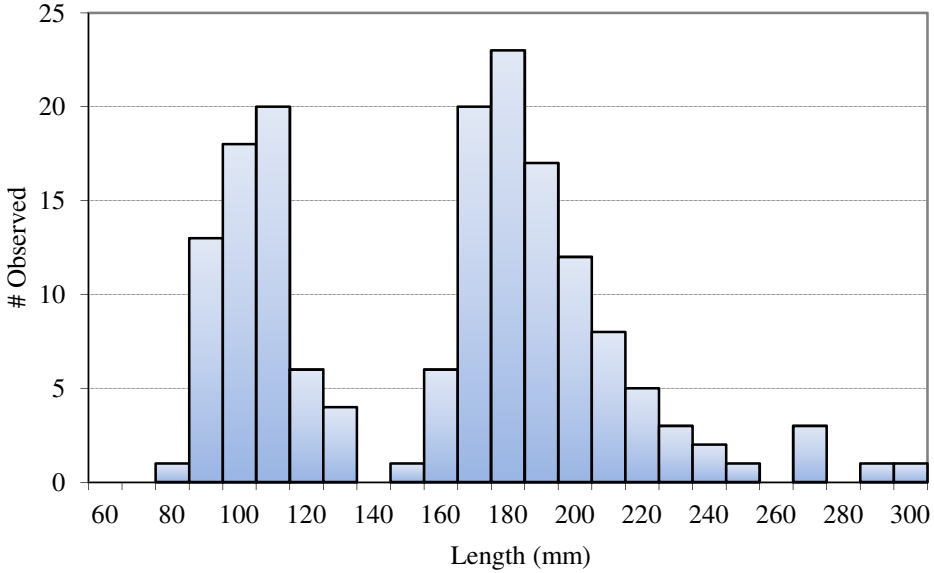

Figure 41. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2016 electrofishing assessments.

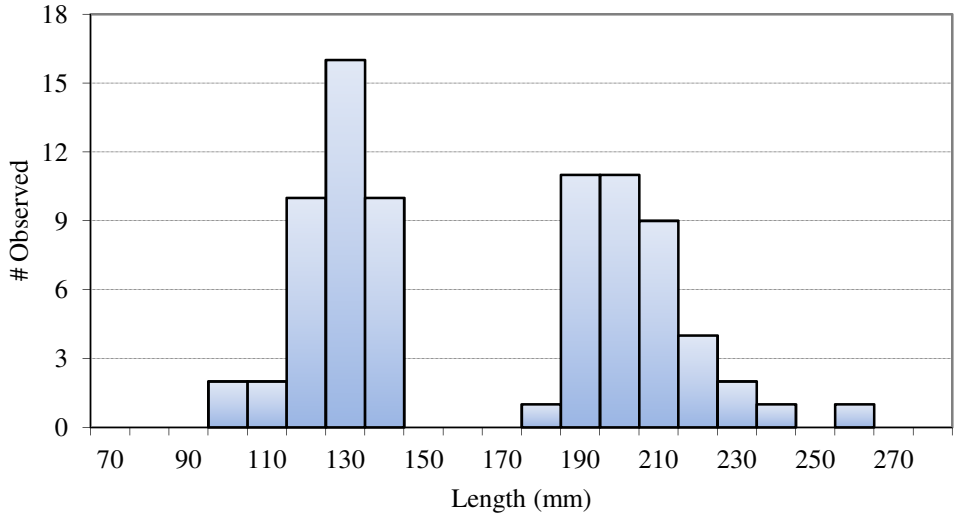

Figure 42. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2016 electrofishing assessments.

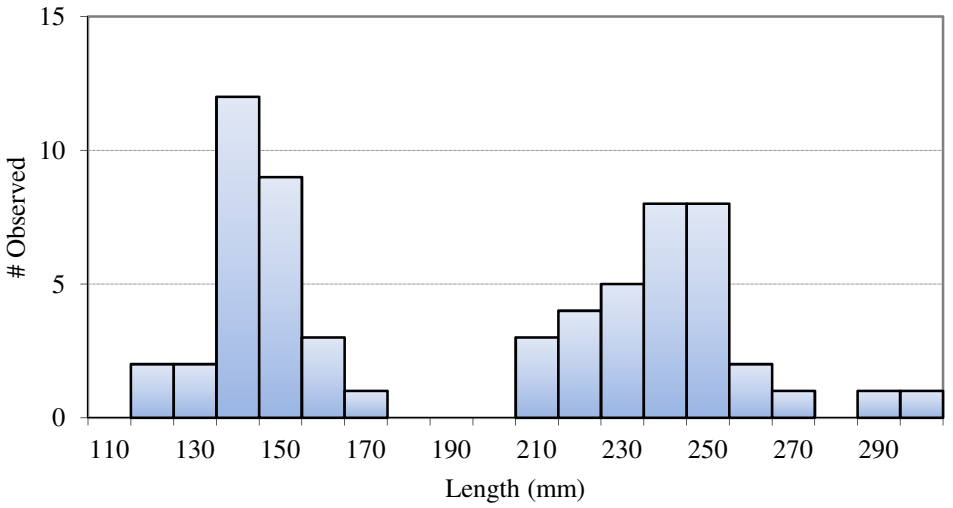

Figure 43. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2016 electrofishing assessments.

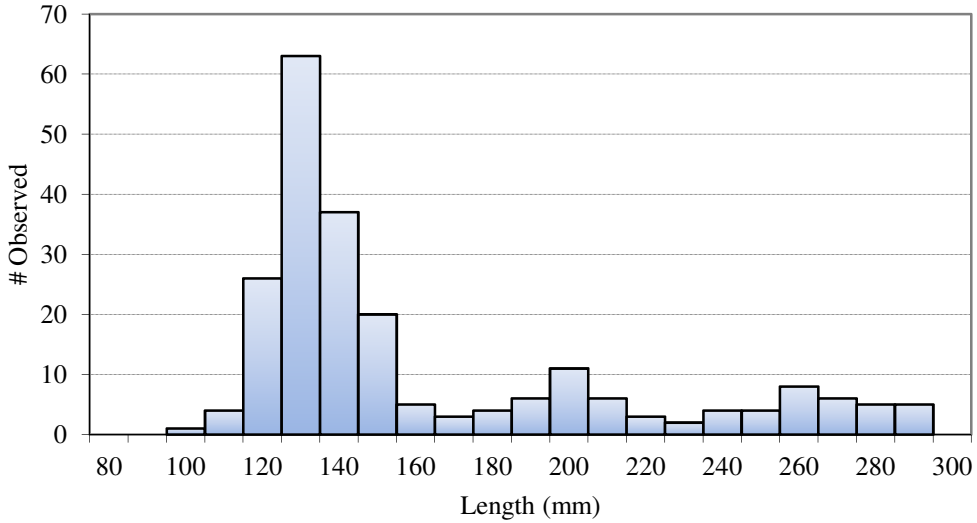

Figure 44. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2016 electrofishing assessments.

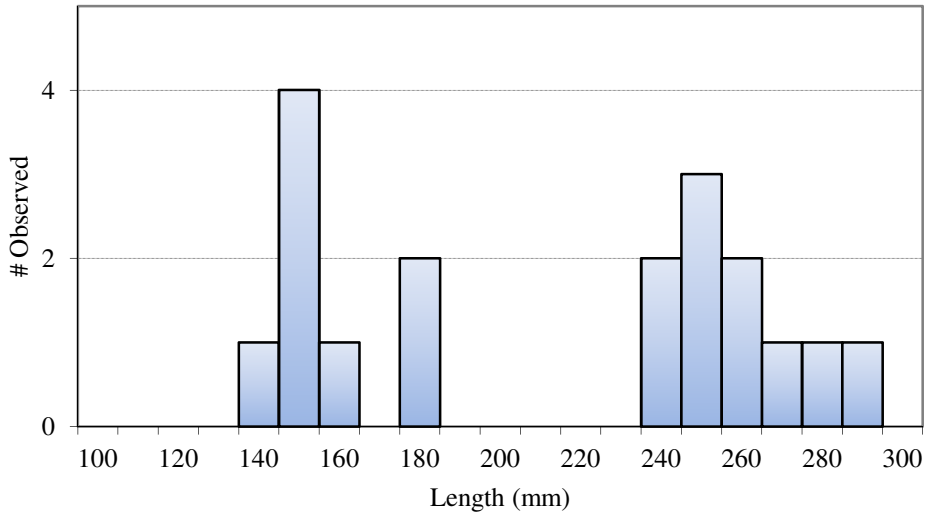

Figure 45. Length frequency distribution of walleye collected from Windy Lake, Lake County, during fall 2016 electrofishing assessments.

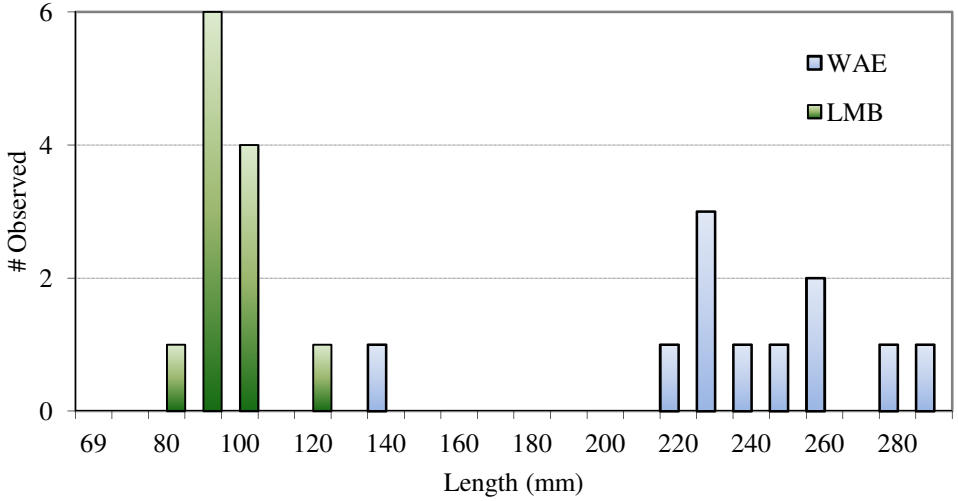

Figure 46. Length frequency distribution of walleye collected from Wild Rice Lake Resevoir, St. Louis County, during fall 2016 electrofishing assessments. Blue bars represent the walleye sampled while the green bars represent largemouth bass sampled.

Appendix 1. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2016 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
Eagle	18 April	---	133	0
	19 April	133	300	55
	20 April	377	155	98
	May GN	434	89	20
	MNDNR GN	434	25	6
	MNDNR GN / TN	434	37	6
Bassett	21 April	---	30	0
	22 April	30	44	3
	MNDNR GN	71	17	0
N.McDougal	20 April	---	26	0
	21 April	26	54	0
	22 April	80	95	9
	23 April	166	65	13
	MNDNR GN	218	29	4
	MNDNR GN / TN	218	35	7
Silver Island	24 April	---	21	0
	25 April	21	43	0
	26 April	64	36	7
	27 April	93	12	0
	MNDNR GN	105	68	2
	MNDNR GN / TN	105	80	4
Tom	4 May	---	236	0
	5 May	236	196	28
	6 May	404	200	66
	MNDNR GN	538	41	11
	MNDNR GN / TN	538	96	21
Two Island	2 May	---	136	0
	3 May	136	217	26
	4 May	327	241	68
	MNDNR GN / TN	500	51	4
Devilfish	5 May	---	152	0
	6 May	152	126	54
	7 May	224	118	73
	MNDNR GN	269	21	6
	MNDNR GN / TN	269	32	8