Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2008

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

Brian D. Borkholder [1] and Andrew J. Edwards [2]

[1] Fond du Lac Resource Management
1720 Big Lake Road
Cloquet, MN 55720
218-878-8004

[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 more than a decade (Borkholder 1994a and 1995). In order to maximize the number of fish handled and marked during the 2008 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 alone 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 (Frank Stone, U.S.F.W.S., Ashland F.R.O., personal communication).

The first objective of our assessments in 2008 was to obtain adult walleye population estimates (PE) during the spring spawning period using mark - recapture data. Our electrofishing PE estimates may be biased towards males in the populations, and thus, are no doubt conservative estimates. 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 2008 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. Lakes chosen for the 2008 spring survey were Caribou Lake (Grand Marais Area) and Silver Island Lake (Finland Area). The objective was to obtain adult walleye (*Sander vitreus*) population estimates using mark-recapture methods and determine the age structure and growth rates of each respective walleye population. Fin clipped walleye would then be available during the summer gill net assessments conducted by the DNR, thus providing a second population estimate.

Electrofishing was performed at night using boom-shocking boats equipped with Smith-Root Type VI-A 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 the sex determined (male, female, unknown) based upon visual identification of gametes. Walleye that had been fin clipped during any previous nights' collections were counted as recaptured fish (Appendix 1). All individuals (> 254 mm) were marked by the removal of the anal spine in Caribou Lake, and the third full dorsal fin spine in Silver Island Lake. 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^{TM} 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, per Duluth Area Fisheries (John Lindgren, MNDNR, personal communication).

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^{o}C and 10.0^{o}C (Borkholder and Parsons, 2001). Fall assessments began in the Grand Marais area on 2 September 2008. The 20^{o}C threshold was exceeded in only one of the lakes.

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, 2002a, 2003, & 2004). 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

Caribou Lake

Electrofishing activities were conducted on Caribou Lake from 9 - 11 May (Figure 1). Dates of electrofishing activities, mean water temperature, mean 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 for each night ranged from 68.2 to 93.4 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Caribou Lake, determined using each sampling station, was 80.0 ± 12.6 adult walleye (>254mm) per hour of sampling effort. Catch rates among the sampling stations were highest at EF2, EFA, and EFC, and lowest at EF3. Catch rates ranged from 23.9 adult walleye per hour (EF3, 10 May 2008) to 134.5 adults per hour (EFA, 11 May 2008) (Figure 1).

The length frequency of the walleye sampled is presented in Figure 2. Walleye as large as 667 mm (26.3 inches) were observed in the survey. Additional species observed included yellow perch, white sucker, smallmouth bass, black crappie, trout perch, and northern pike.

Table 2 presents various population estimates based upon mark-recapture data for both the spring electrofishing survey and the summer gill-net assessment. The Schumacker and Eschmeyer population estimate from the electrofishing data is 1238 (Table 2). The adjusted Petersen estimate is 1260 ± 401, with a 7.4% CV (Table 2). The 2008 population estimate of walleyes larger than 254 mm (10.0 inches) is much higher than that obtained in 2005, but very similar to the estimate obtained in 2003 (Table 2).

In July 2008, the Minnesota Department of Natural Resources performed a standardized net assessment on Caribou Lake (Steve Persons, MN DNR, Grand Marais Area Fisheries). Sixty walleyes (> 265 mm) were sampled in the gill nets that would have been 254 mm during the May assessments, with only seven of those observed to have a fin clip from the spring sampling. The adjusted Petersen

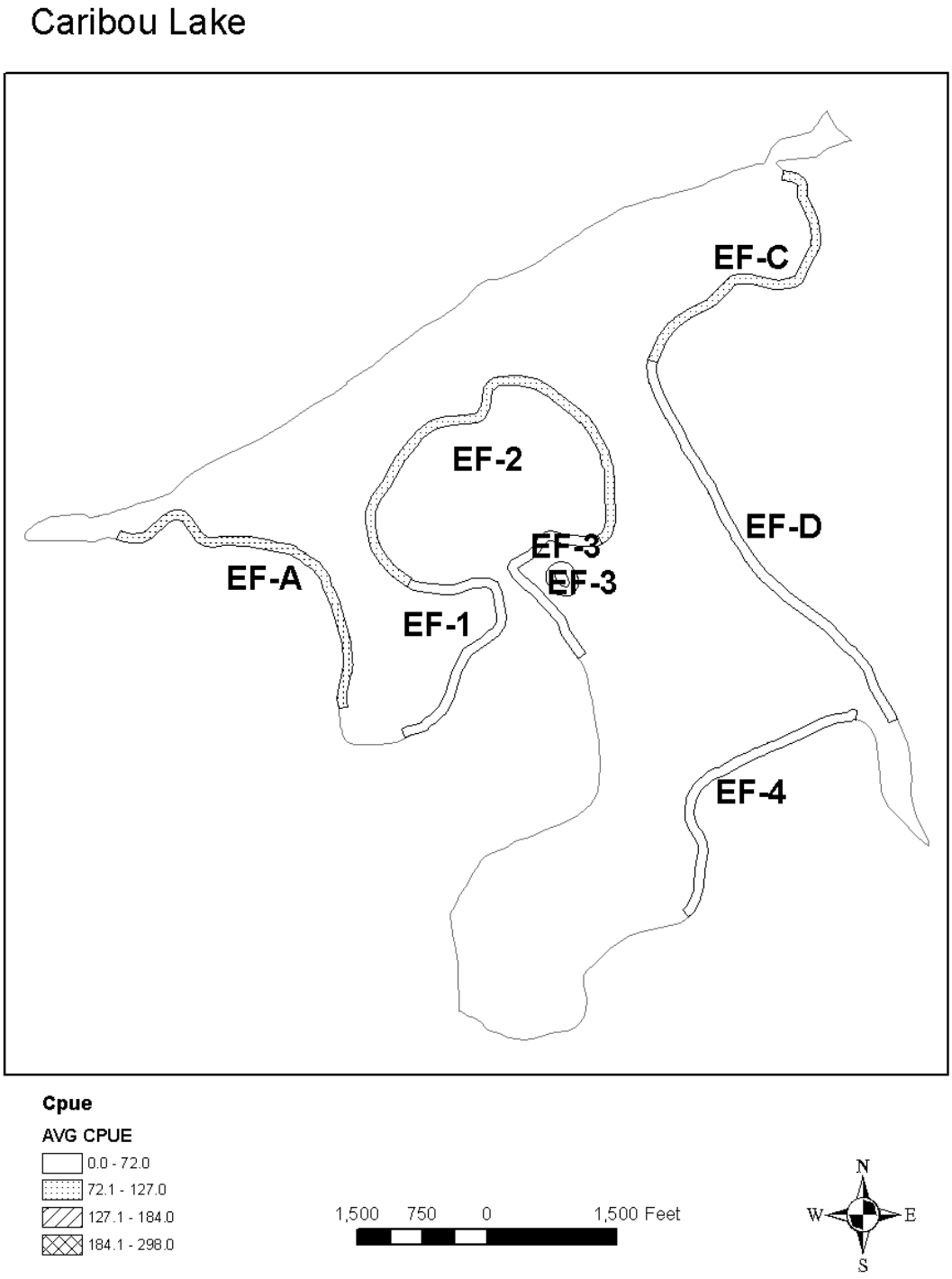

Figure 1. Catch per hour (CPUE) of adult walleyes on Caribou Lake, Cook County, during spring 2008 electrofishing surveys.

Table 1. Summary of electrofishing activities on two lakes surveyed within the 1854 Ceded Territory, Minnesota, during Spring 2008.

ID #	County	Lake	Area (Acres)	Max Depth	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)	Amps	# WAE[2]	CPUE WAE[3]
16-0360	Cook	Caribou	728	30.0	5/9/08	51	52.5	7898	884	4	205	93.4
					5/10/08	47	54.6	16414	884	4	311	68.2
					5/11/08	47.5	55.3	13679	884	4	314	82.6
38-0219	Lake	Silver Island	1102	15.0	5/7/08	44	33.6	8121	1061	2.7	291	129.0
					5/8/08	47	33.9	7130	1061	2.6	250	126.2
					5/9/08	47	34.1	6651	1061	2.7	217	117.5

[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)).

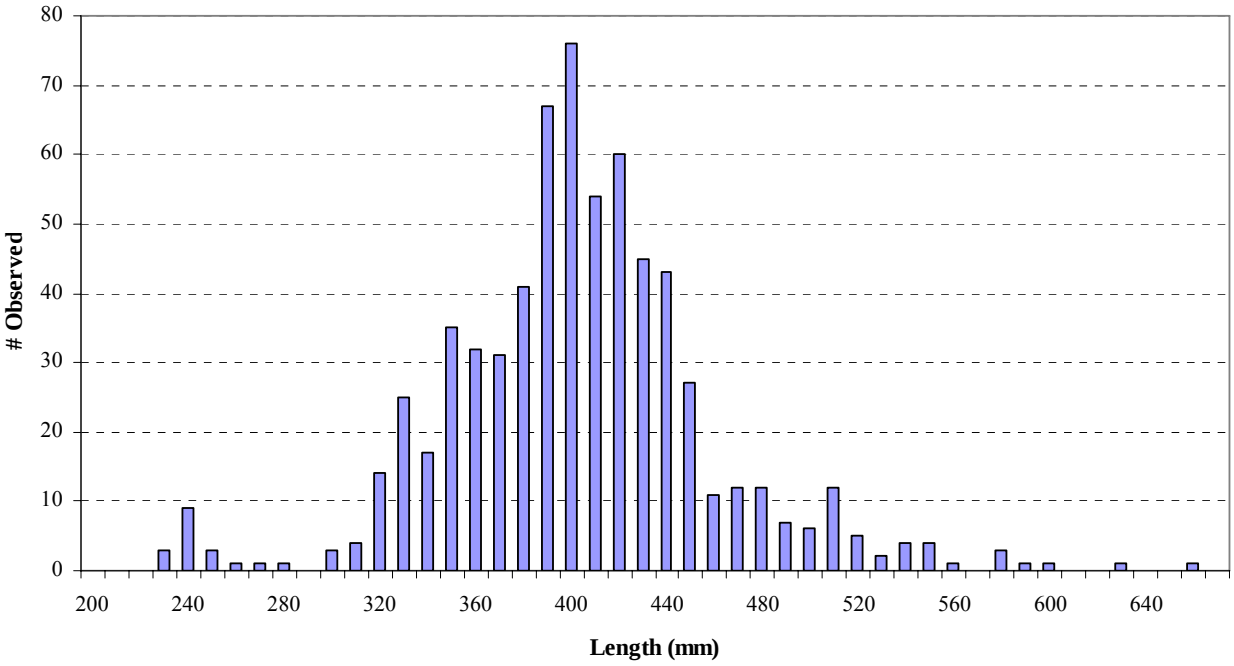

Figure 2. Length frequency distribution of walleye sampled from Caribou Lake, Cook County, MN, during spring 2008 electrofishing assessments. Bars do not include counts of recaptured individuals.

Table 2. Walleye population estimates for Caribou and Silver Island Lakes, May 2008. Estimates are for walleye larger than 254 mm (10.0 inches) in May. 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. Rows of shaded data indicate population estimates from previous surveys, and are presented for comparison purposes.

Lake	Population Estimate[1]	95% Confidence Limits Lower	Upper	Estimate[2]	C.V.[3]
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}	8404	4614	47774	3700 ± 2262	26.0%
Caribou – EF_{2003}	1027	Not Calculated due to a single *df*		1019 ± 1419	11.0%
S. Island – EF_{2008}	1586	1141	2601	1712 ± 785	10.7%
S. Island – GN_{2008}	2705	1145	----	9762 ± 8667	27.9%
S. Island – EF_{2003}	1137	----	----	1127 ± 530	10.9%
S. Island – GN_{2003}	2063	Not Calculated due to a single *df*		5179 ± 6137	27.5%

[1] Schumacher and Eschmeyer population estimate.
[2] Adjusted Petersen population estimate, with 95% confidence interval.
[3] Coefficient of variation for the Petersen estimate.

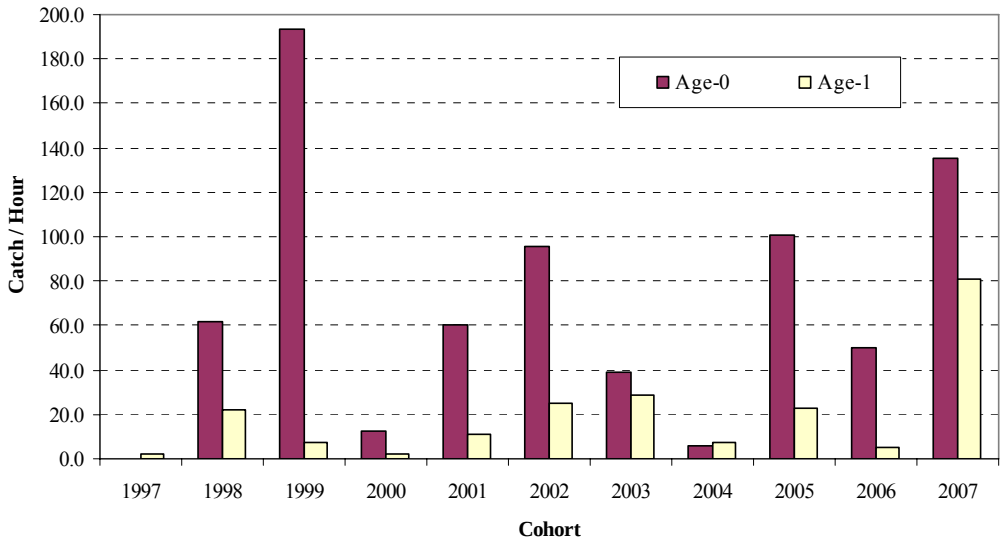

Figure 3. Catch per hour of age-0 and age-1 walleyes from Caribou Lake, from 1997 until 2007.

estimate using both the summer and spring data is 3729± 3686, with a 31.1% CV (Table 2). The Schumacker and Eschmeyer population estimate from the net data is 940 (Table 2).

Table 3 presents the age data for the walleye collected from Caribou Lake. Of the 662 unique fish sampled, 587 were assigned to ages 3 through 6. The 2005 (age-3), 2002 (age-6) and 2003 (age-5) year classes were observed to be stronger than normal during previous fall electrofishing surveys (Borkholder and Edwards 2006, 2004, & 2003) (Figure 3). Instantaneous mortality (*Z*) of the Caribou Lake population was estimated at 41.3% (Figure 4). Total annual mortality (*A*) was estimated to be 33.8%. Table 4 presents back-calculated lengths at age for walleye collected from Caribou Lake.

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 of 74.0 ± 3.3 (Table 5) suggests a balanced population, characterized by fish larger than 15.0 inches (Anderson and Weithman 1978). The summer gill net PSD (24.6 ± 10.8) is significantly different than the PSD estimate from the spring electrofishing survey (χ^2=64.8, P<0.05, critical Chi-square value of 3.841). No significant differences were observed in any of the RSD metrics between the electrofishing and gill net assessments during 2008 assessments (Table 5). PSD metrics calculated from the 2003 and 2005 electrofishing assessments are included for comparison (Borkholder and Edwards 2006 & 2004). Significant differences were observed between the 2008 PSD and both the 2003 and 2005 PSDs (χ^2=5.3, P<0.05, and χ^2=48.2, P<0.05, respectfully, critical Chi-square value of 3.841).

Table 4. Back-calculated lengths at age for walleye collected from Caribou Lake, Cook County, Minnesota, May 2008.

Age Class	N	Length (mm)	Length (in)
1	137	103	4.1
2	137	198	7.8
3	134	282	11.1
4	114	348	13.7
5	92	404	15.9
6	65	440	17.3
7	42	459	18.1
8	34	479	18.9
9	32	505	19.9
10	23	521	20.5
11	12	528	20.8
12	8	537	21.2
13	5	553	21.8
14	3	546	21.5
15	1	556	21.9
16	1	567	22.3
17	1	580	22.8
18	1	596	23.5
19	1	604	23.8

Table 3. Age frequency distribution of walleye from Caribou Lake, Cook County, spring 2008, based upon the number of fish sampled and aged per size category.

Length Group																
Inches	mm	N Sampled	2	3	4	5	6	7	8	9	10	11	12	13	14	19
10.0	254	2	2													
10.5	267	2	1	1												
11.0	279	1		1												
11.5	292	3		3												
12.0	305	3		3												
12.5	318	17		13	4											
13.0	330	30		13	13	4										
13.5	343	37		7	30											
14.0	356	39		10	10	19										
14.5	368	38			25	13										
15.0	381	63			21	42										
15.5	394	98				98										
16.0	406	71				53	18									
16.5	419	71				59	12									
17.0	432	60				38	22									
17.5	445	42				8	19		11		4					
18.0	457	13					10	3								
18.5	470	20				2	10	6		2						
19.0	483	9					5	3			1					
19.5	495	8					2				4			2		
20.0	508	14								6	3	2	2		2	
20.5	521	4								4						
21.0	533	5									2	2	2			
21.5	546	3						2				2				
22.0	559	2									1		1			
22.5	572	1													1	
23.0	584	3									1	1		1		
23.5	597	1														1
24.0	610	0														
24.5	622	0														
25.0	635	1									1					
26.0	660	1												1		
TOTAL		662	3	51	103	335	97	14	11	12	17	7	5	4	3	1

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence intervals for walleye sampled from Caribou (Cook Co.) and Silver Island Lakes (Lake Co.), 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
Caribou – EF_{2008}	74.0 ± 3.3	26.0 ± 3.3	68.7 ± 3.5	5.8 ± 1.7	0.3 ± 0.4
Caribou – GN_{2008}	24.6 ± 10.8	75.4 ± 10.8	21.3 ± 10.3	3.3 ± 4.5	0.0 ± 0.0
Caribou – EF_{2003}	67.6 ± 4.4	32.4 ± 4.4	66.2 ± 4.5	1.2 ± 1.0	0.2 ± 0.4
Caribou – EF_{2005}	54.0 ± 4.6	46.0 ± 4.6	45.8 ± 4.6	7.5 ± 2.4	0.7 ± 0.8
Silver Island -- EF_{2008}	36.7 ± 3.7	63.3 ± 3.7	34.4 ± 3.7	1.6 ± 1.0	0.8 ± 0.7
Silver Island -- GN_{2008}	23.1 ± 6.3	76.9 ± 6.3	18.5± 5.8	2.9 ± 2.6	1.7 ± 2.0
Silver Island -- EF_{2003}	45.4 ± 4.6	54.6 ± 4.6	42.8± 4.5	2.4 ± 1.4	0.2 ± 0.4

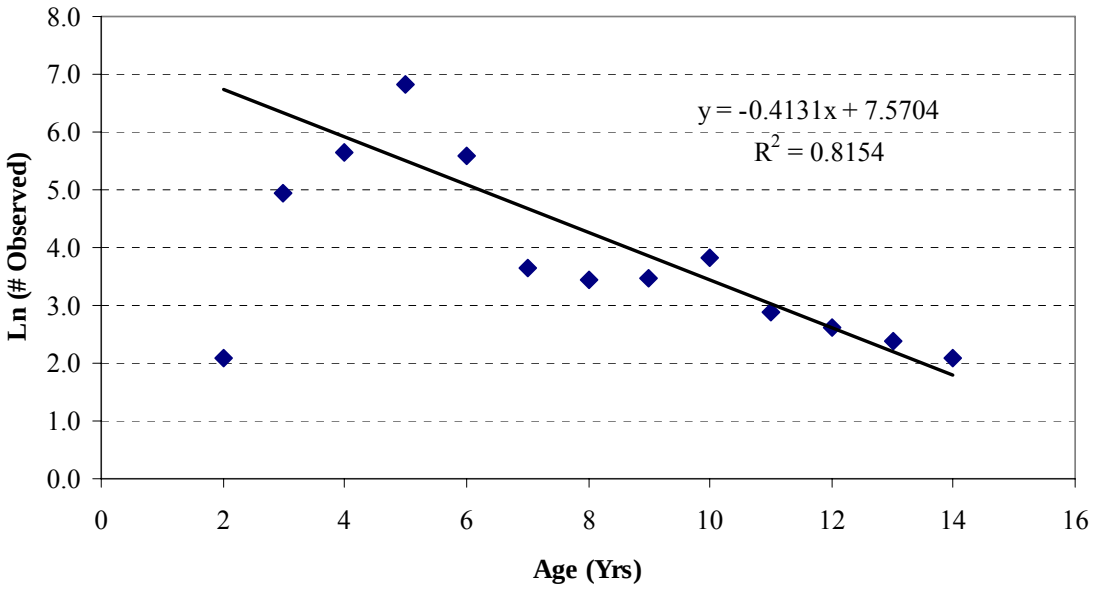

Figure 4. Instantaneous mortality (*Z*) of walleye from Caribou Lake. Estimates are made from May 2008 electrofishing data.

Silver Island Lake

Electrofishing activities were conducted on Silver Island Lake from 7 – 9 May (Figure 5). Dates of electrofishing activities, mean water temperature, mean 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 for each night ranged from 117.5 to 129.0 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Silver Island Lake, determined using each sampling station, was 125.1 ± 33.0 adults per hour of sampling effort. Additional species observed included yellow perch, white sucker, northern pike, rock bass, black crappie, trout perch, bluegill, burbot, tadpole madtom, logperch, and Johnny darter.

Catch rates ranged from 40.6 walleye / hour (EFD, 7 May) to 339.4 walleye / hour (EFA, 8 May). Areas characterized by soft bottom substrates were identified in past surveys. Walleyes were not using these areas of the lake for spawning activities. These areas were not surveyed in 2008, and are not labeled on the map (Figure 5).

The length frequency of the walleye sampled from Silver Island Lake is presented in Figure 6. Table 6 presents the age data for the walleye collected from Silver Island Lake. Of the 645 walleye sampled, 533 were assigned ages 4 – 6. Table 7 presents back-calculated lengths at age for walleye collected from Silver Island Lake. Instantaneous mortality (Z) for the Silver Island Lake walleye population is estimated at 53.7% (Figure 7). Total annual mortality (A) was estimated to be 41.6%. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 1586 (Table 2). The electrofishing adjusted Petersen estimate is 1712 ± 785, with a 10.7% CV (Table 2). In July 2008, the Minnesota Department of Natural Resources performed a standardized net assessment on Silver Island Lake (Al Anderson, MN DNR, Finland Area Fisheries). One hundred sixty-six walleyes (> 265 mm) were sampled in the gill nets that would have been 254 mm during the May assessments, with only ten of those observed to have a fin clip from the spring sampling. The adjusted Petersen estimate using both the summer and spring data is 9762 ± 8667, with a 27.9% CV (Table 2). The Schumacker and Eschmeyer population estimate from the net data is 2705 (Table 2).

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. The electrofishing PSD of 36.7 ± 3.7 (Table 5) suggests the population is balanced (Anderson and Weithman 1978), though significantly different than the PSD estimate from the 2003 survey (PSD_{2003} = 45.4, χ^2=8.424, P<0.05, Table 5), suggesting that the 2008 spawning population is characterized by smaller individuals than the 2003 spawning population. The gill net PSD of 23.1 ± 6.3 was significantly different from the electrofishing PSD estimate (χ^2=11.304, P<0.05, Table 5).

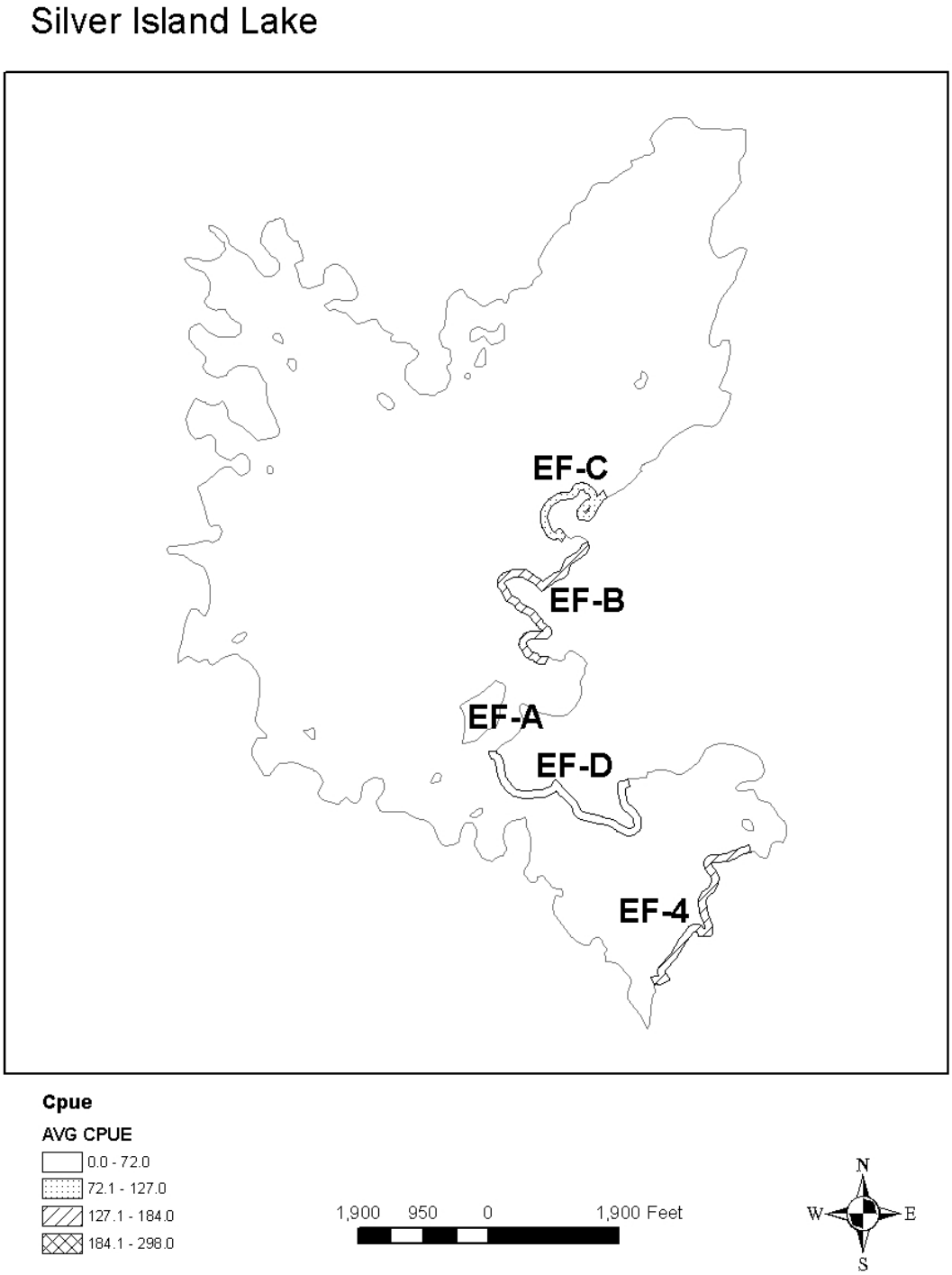

Figure 5. Catch per hour (CPUE) of adult walleyes on White Pine Lake, Cook County, during spring 2008 electrofishing surveys.

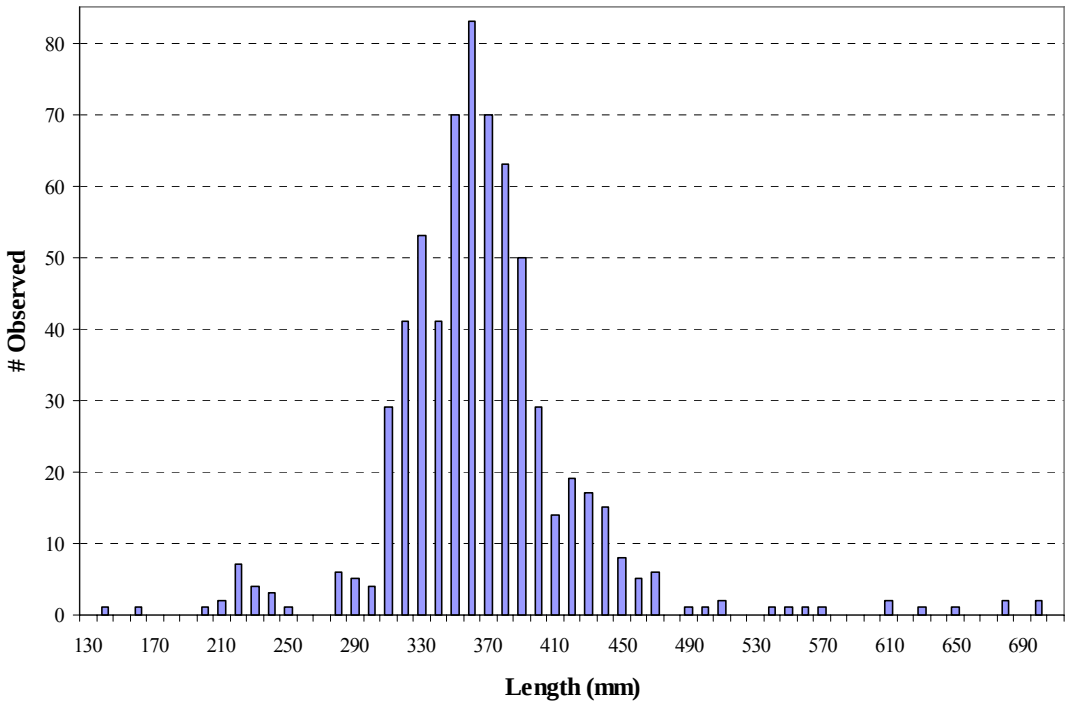

Figure 6. Length frequency distribution of walleye sampled from Silver Island Lake, Lake County, MN, during spring 2008 electrofishing assessments. Bars do not include counts of recaptured individuals.

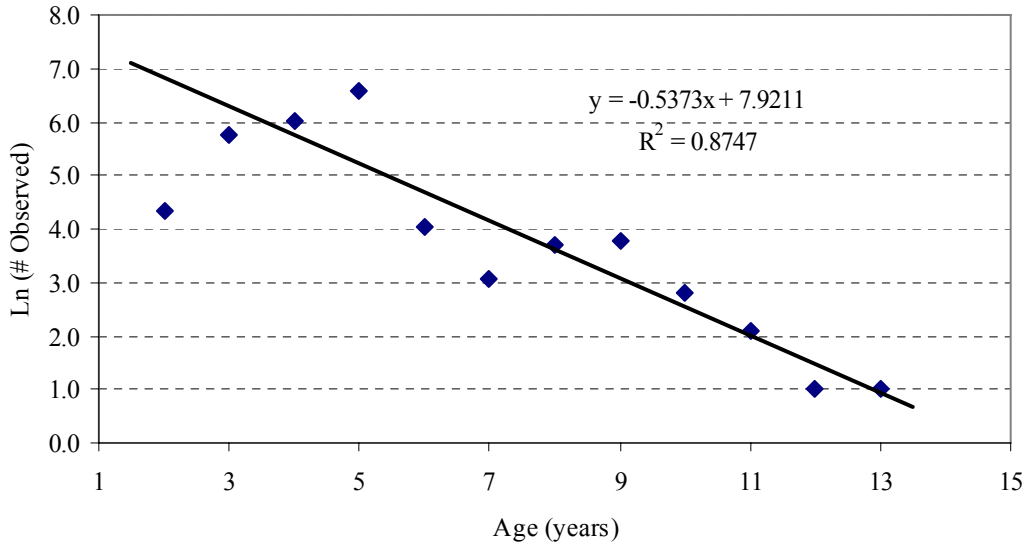

Figure 7. Instantaneous mortality (*Z*) of walleye from Silver Island Lake. Estimates are from May 2008 electrofishing data.

Table 6. Age frequency distribution of walleye from Silver Island Lake, Cook County, spring 2008, based upon the number of fish sampled and aged per size category.

Length Group																	
Inches	mm	N Sampled	3	4	5	6	7	8	9	10	11	12	13	14	15	16	19
10.0	254	1	1														
10.5	267																
11.0	279	7	7														
11.5	292	6	6														
12.0	305	24	8	16													
12.5	318	54	14	34	6												
13.0	330	57		41	16												
13.5	343	78		26	26	26											
14.0	356	95			48	47											
14.5	368	86			22	64											
15.0	381	79			14	65											
15.5	394	51			15	29	7										
16.0	406	21			2	15	2	2									
16.5	419	23				10	7		3		3						
17.0	432	20				6	3	5	3	3							
17.5	445	14				4	2		4	3		1					
18.0	457	7				1			1	4	1						
18.5	470	6						1	3	1		1					
19.0	483	1															
19.5	495																
20.0	508	3								1	1				1		
20.5	521																
21.0	533																
21.5	546	2							1	1							
22.0	559	2										1	1				
22.5	572																
23.0	584																
23.5	597																
24.0	610	2								2							
24.5	622	1									1						
25.5	647.7	1								1							
26.5	673.1	2													1	1	
27.5	698.5	2												1			1
TOTAL		645	28	117	149	267	21	8	15	16	6	3	1	1	2	1	1

Table 7. Back-calculated lengths at each age class for walleye collected from Silver Island Lake, Lake County, Minnesota, May 2008.

Age Class	N	Length (mm)	Length (in)
1	130	111	4.4
2	130	194	7.6
3	130	264	10.4
4	114	317	12.5
5	97	363	14.3
6	82	400	15.7
7	43	428	16.9
8	37	453	17.8
9	33	480	18.9
10	25	509	20
11	13	526	20.7
12	9	558	22
13	6	609	24
14	5	632	24.9
15	4	630	24.8
16	2	674	26.5
17	1	684	26.9
18	1	696	27.4
19	1	705	27.8

Fall Assessments

Table 8 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 0.0 fish per hour (Elbow Lake) to 420.6 fish per hour of electrofishing (Pike Lake) (Table 8). CPUE for age-1 walleye ranged from 2.1 fish per hour (Poplar Lake) to 105.5 fish per hour of electrofishing (Fourmile Lake) (Table 8). Figures 8 - 31 present length frequency data for each of the 24 lakes surveyed. Table 9 presents the mean length for age-0 and age-1 individuals sampled during fall 2008 assessments. Mean lengths for age-0 walleye ranged from 88 mm (3.5 inches, Ball Club Lake) to

140 mm (5.5 inches, Crooked Lake). Mean lengths for age-1 walleye ranged from 161 mm (6.3 inches, Elbow Lake) to 238 mm (9.4 inches, Ninemile Lake).

Since initiating a regular fall electrofishing program for age-0 and age-1 walleye in 1995, and excluding lakes in years of stocking by the MN DNR and results from this year's assessments, our mean $CPUE_{Age\text{-}0}$ is 83.3, and our mean $CPUE_{1+}$ is 31.1. Using the mean $CPUE_{Age\text{-}0}$ as one criterion, average or better 2008 year classes were observed in three of the lakes (Ninemile, Pike, & Shagawa Lakes, Table 8). Average or better 2007 year classes (age-1 walleye) were observed in ten of the lakes (Table 8). As data is collected in future MN DNR standard gill net surveys, we should gain further insight as to whether these presumed strong year classes are in fact well represented as adults.

Overall, mean lengths observed in 2008 were smaller than those observed during previous years' surveys. Several studies have suggested that age-0 walleye need to reach a certain critical size to have a chance at surviving their first winter (Forney 1976; Madenjian et al. 1991). Both Forney (1976) and Madenjian et al. (1991) attributed over-winter size-selected mortality of age-0 walleye to cannibalism. Forney (1976) suggested that this critical size is 175 mm (6.9 inches) in Oneida Lake, New York. If the bulk of the age-0 cohort exceeded this total length by the end of the growing season, the duration of their exposure to cannibalism would be reduced, and recruitment would be relatively high (Forney 1976). If first year growth was slower, age-0 walleye would be exposed to cannibalism by older walleye for longer periods of time.

The mean length of age-0 walleye observed since 1995 in our electrofishing assessments is 126 mm in lakes not stocked by the DNR with fingerling walleye prior to our assessments. Using the mean length criteria of 126 mm for average year classes, average or better 2008 year classes may be present in seven of the lakes surveyed (Table 9). In the future, we will be further investigating the predictive power mean length and CPUE of age-0 have on CPUE of 1+ the following sampling season in northern Minnesota lakes, with the goal of determining mean length and CPUE thresholds that can be used to predict year class strength. This will be possible as we continue to combine our electrofishing data with the State's gill net data for adults. Continued monitoring of walleye young-of-the-year and year-1 fish will give a better picture of recruitment patterns of walleye over time in these lakes, and give managers a better understanding of these walleye populations.

Acknowledgments

The Fond du Lac Division of Resource Management and the 1854 Treaty Authority wish to acknowledge and thank the Fond du Lac Fishery Technicians, and Tim Krohn (GIS Specialist); and Darren Vogt, Marne Kaeske, Zach Polaske, and Angela Aarhus-Ward, 1854 Treaty Authority, for their hard work in the field. Ken Gebhardt, U.S. Forest Service, provided field assistance himself, as well as Jason Butcher, Brent Flatten, Darren Lilja, and Dan Ryan. Steve Persons and Paul Eiler (Grand Marais Area Office), and Al Anderson and Don Smith (Finland Area Office) provided gill net data from the Minnesota Department of Natural Resources.

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Table 8. Total number and catch-per-unit-effort (CPUE) of age-0 and age-1 walleye collected by the 1854 Treaty Authority and the Fond du Lac Resource Management Division from 24 lakes within the 1854 Ceded Territory of Northeastern Minnesota during September 2008.

Lake	Date	Temp (F)	Temp (C)	Cond.[1]	YOY Total[2]	Age-1 Total[3]	Seconds	CPUE YOY[4]	CPUE 1+[5]
Ball Club	4-Sep	65	18.3	30.2	6	114	4716	4.6	87.0
Cadotte	11-Sep	60	15.6	32.7	36	43	7006	18.5	22.1
Caribou	5-Sep	65	18.3	63.1	48	138	6115	28.3	81.2
Cascade	9-Sep	60	15.6	27.0	100	63	5201	69.2	43.6
Crescent	5-Sep	66	18.9	30.9	17	22	3219	19.0	24.6
Crooked	23-Sep	61	16.1	46.7	31	30	4632	24.1	23.3
Devilfish	2-Sep	67	19.4	20.5	2	93	7855	0.9	42.6
Dumbbell	15-Sep	62	16.7	72.5	38	82	5611	24.4	52.6
Elbow	3-Sep	63	17.2	26.8	0	21	3667	0.0	20.6
Fourmile	24-Sep	59	15.0	53.0	88	184	6278	50.5	105.5
Homer	9-Sep	--	--	28.5	15	5	4866	11.1	3.7
Island Reservoir	12-Sep	67.5	19.7	74.5	35	217	10982	11.5	71.1
Ninemile	15-Sep	62	16.7	60.6	444	6	5777	276.7	3.7
N. McDougal	22-Sep	63	17.2	79.5	70	54	7192	35.0	27.0
Pike	8-Sep	66	18.9	58.4	825	50	7061	420.6	25.5
Shagawa	10-Sep	65	18.3	82.9	601	60	10243	211.2	21.1
Silver Island	9-Sep	60	15.6	26.3	35	17	5215	24.2	11.7
Tom	2-Sep	71	21.7	33.4	2	180	8362	0.9	77.5
Two Island	4-Sep	67	19.4	32.4	4	179	6994	2.1	92.1
West Twin	3-Sep	67	19.4	32.8	19	21	4942	13.8	15.3
Poplar	3-Sep	66.5	19.2	34.1	5	4	6961	2.6	2.1
Whiteface Res.	11-Sep	63	17.2	59.5	118	106	6909	61.5	55.2
Wilson	17-Sep	65	18.3	47.2	27	60	7173	13.6	30.1
Windy	16-Sep	63	17.2	30.9	9	46	6119	5.3	27.1

[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 2008 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.

Lake (County)	Date	Age-0 Mean Length (mm)	Age-1 Mean Length (mm)
Ball Club	4-Sep	88	177
Cadotte	11-Sep	114	225
Caribou	5-Sep	111	181
Cascade	9-Sep	116	188
Crescent	5-Sep	129	200
Crooked	23-Sep	140	200
Devilfish	2-Sep	102	179
Dumbbell	15-Sep	133	203
Elbow	3-Sep	0	161
Fourmile	24-Sep	110	178
Homer	9-Sep	129	229
Island Reservoir	12-Sep	106	176
Ninemile	15-Sep	129	238
N. McDougal	22-Sep	117	184
Pike	8-Sep	120	213
Shagawa	10-Sep	132	203
Silver Island	9-Sep	121	196
Tom	2-Sep	111	173
Two Island	4-Sep	111	171
West Twin	3-Sep	111	195
Poplar	3-Sep	117	186
Whiteface Res.	11-Sep	121	210
Wilson	17-Sep	111	193
Windy	16-Sep	129	206

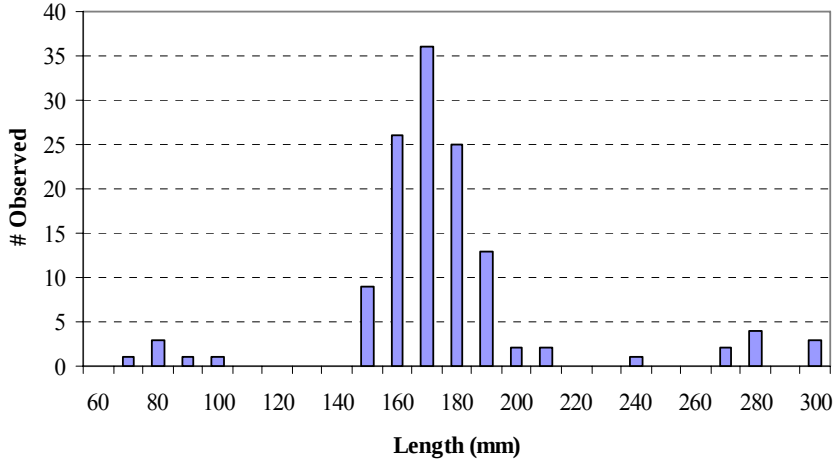

Figure 8. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2008 electrofishing assessments.

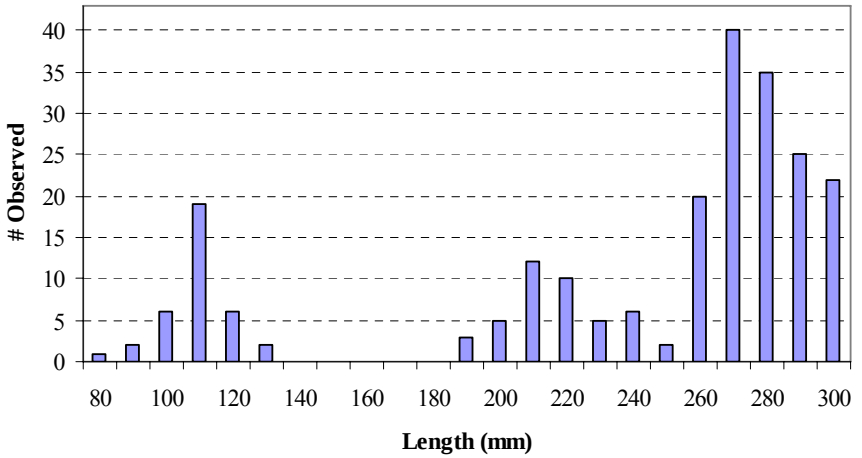

Figure 9. Length frequency distribution of walleye collected from Cadotte Lake, St. Louis County, during fall 2008 electrofishing assessments.

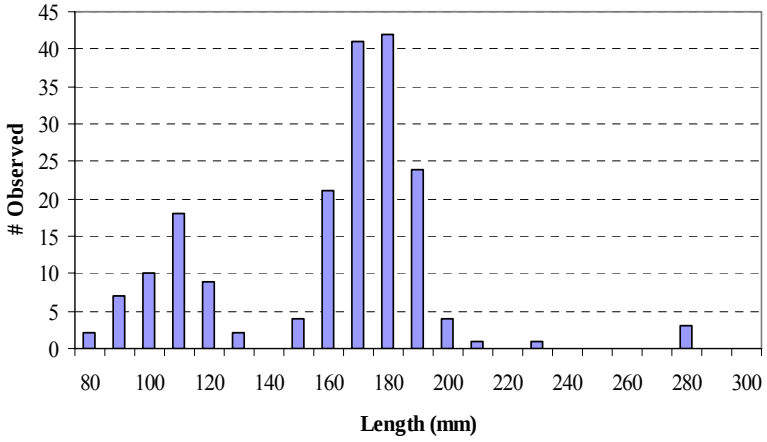

Figure 10. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2008 electrofishing assessments.

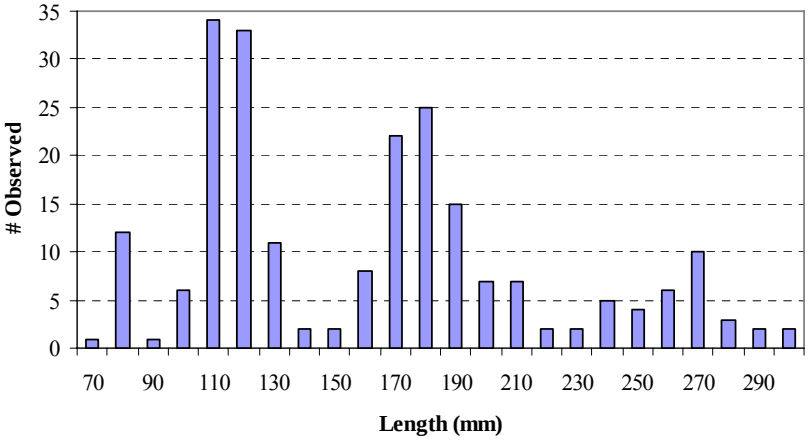

Figure 11. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2008 electrofishing assessments.

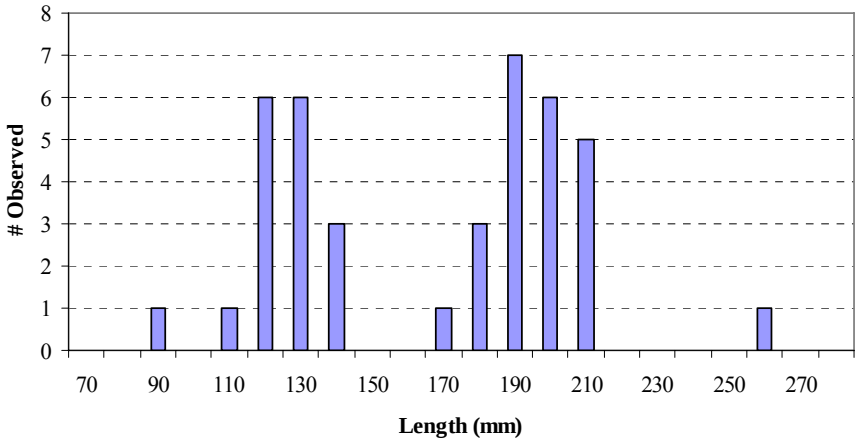

Figure 12. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2008 electrofishing assessments.

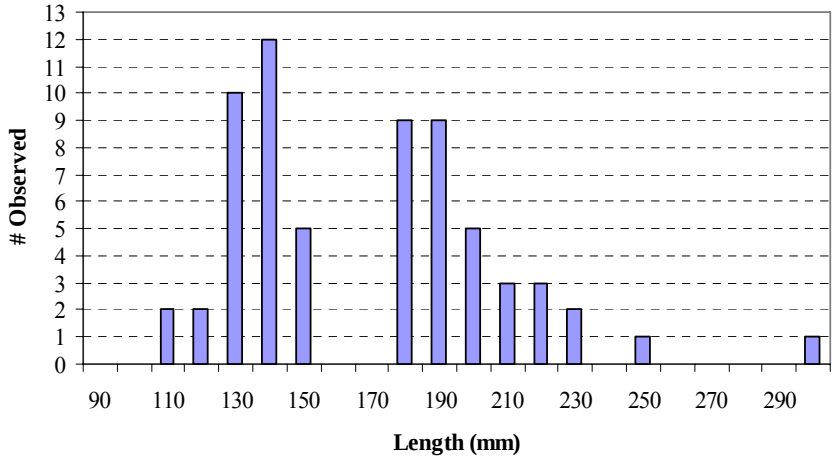

Figure 13. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2008 electrofishing assessments.

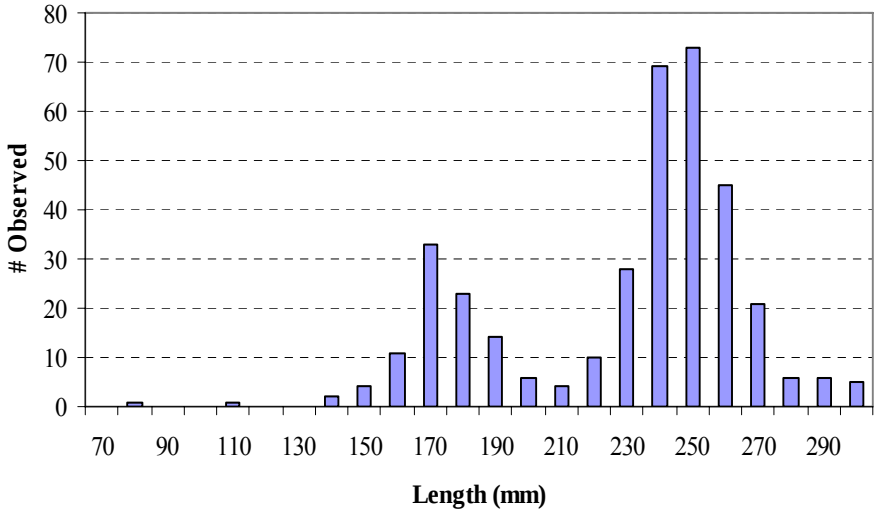

Figure 14. Length frequency distribution of walleye collected from Devilfish Lake, Cook County, during fall 2008 electrofishing assessments.

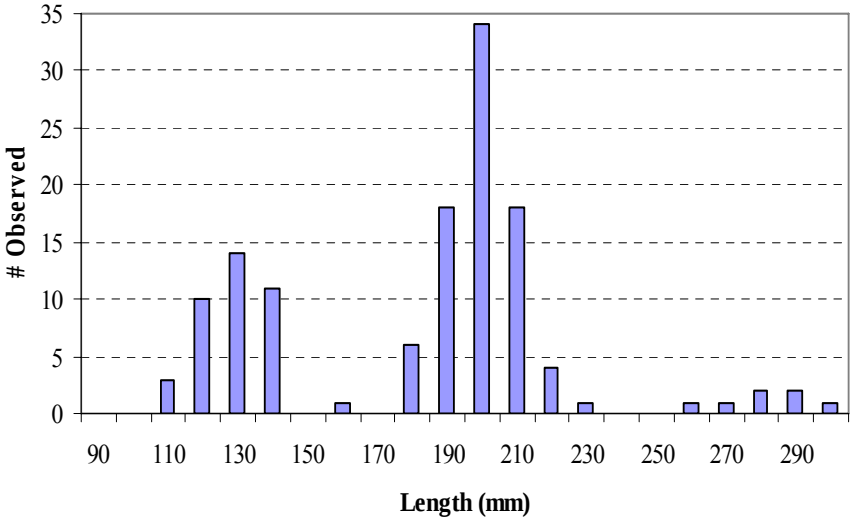

Figure 15. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2008 electrofishing assessments.

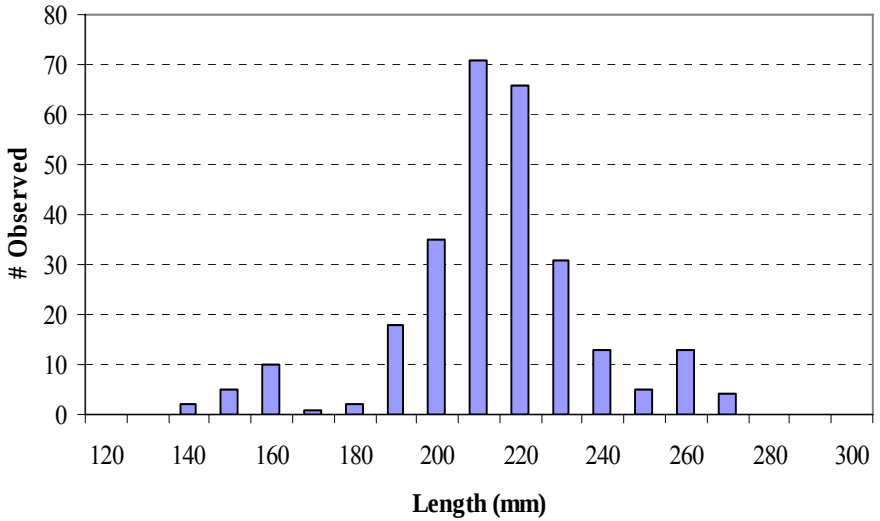

Figure 16. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2008 electrofishing assessments.

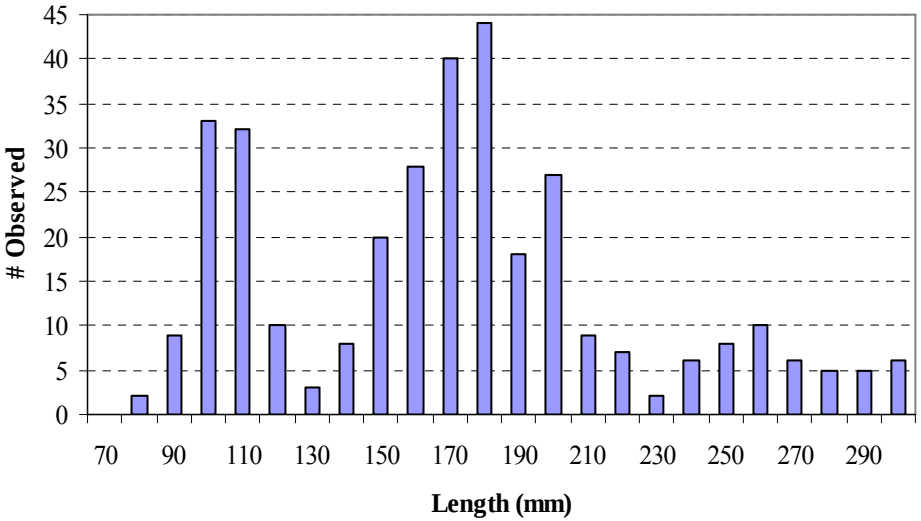

Figure 17. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2008 electrofishing assessments.

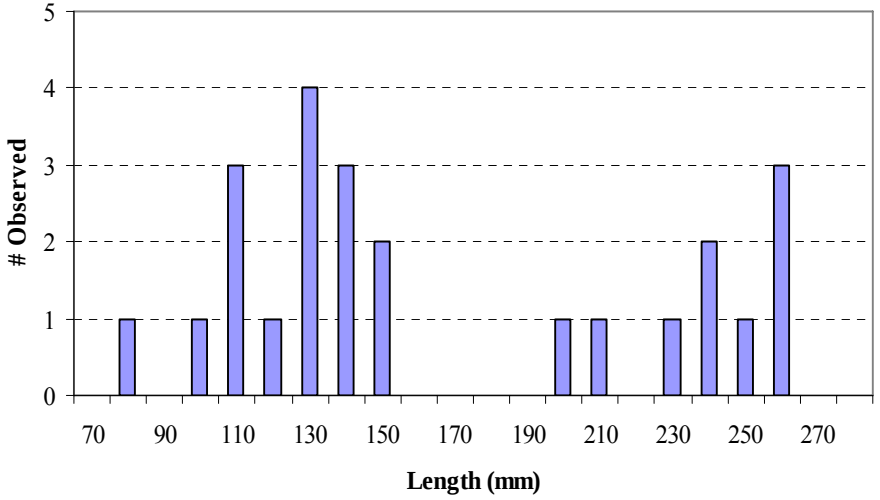

Figure 18. Length frequency distribution of walleye collected from Homer Lake, Cook County, during fall 2008 electrofishing assessments.

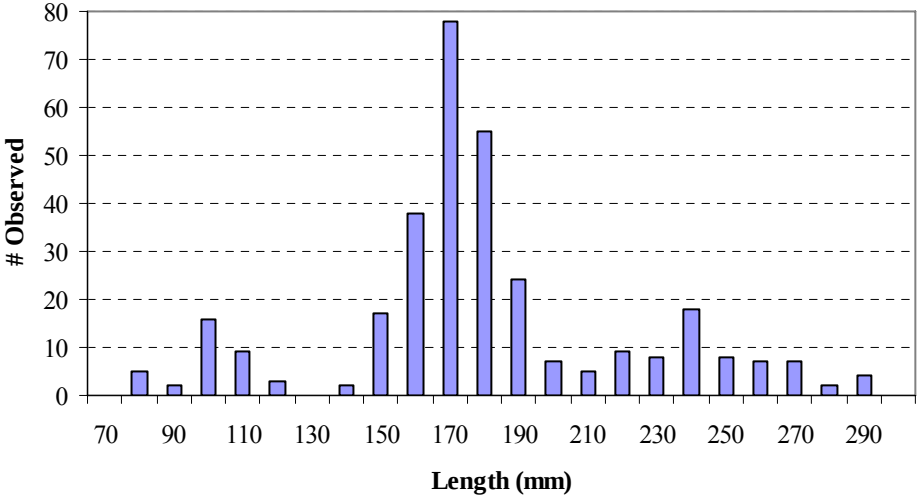

Figure 19. Length frequency distribution of walleye collected from Island Lake Res., St. Louis County, during fall 2008 electrofishing assessments.

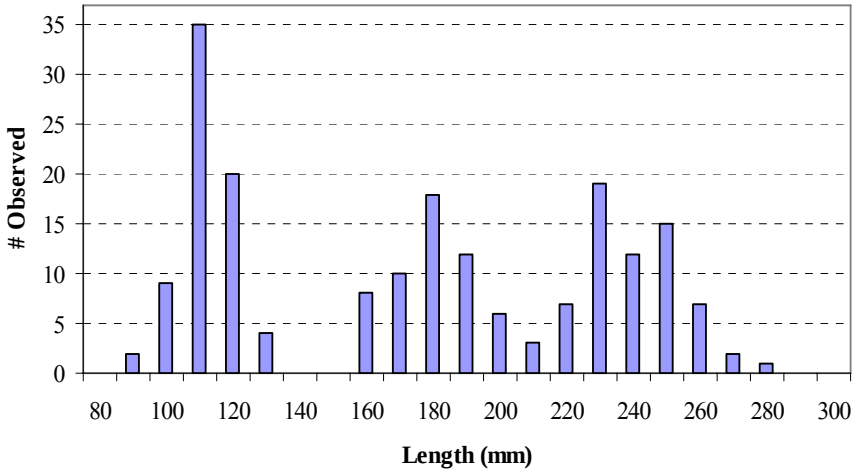

Figure 20. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2008 electrofishing assessments.

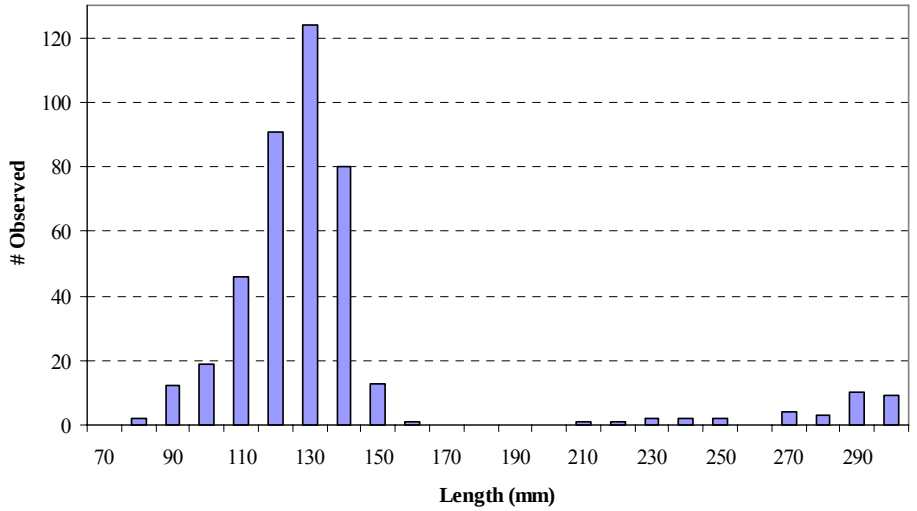

Figure 21. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2008 electrofishing assessments.

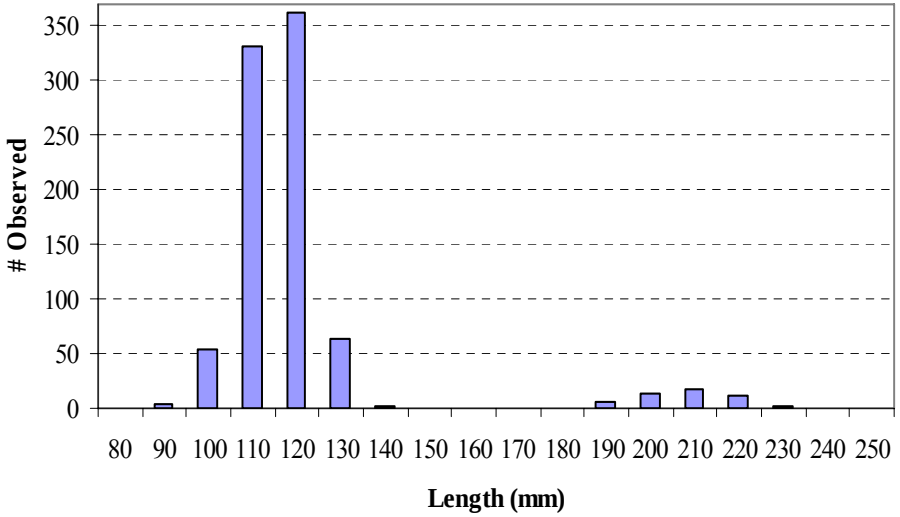

Figure 22. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2008 electrofishing assessments.

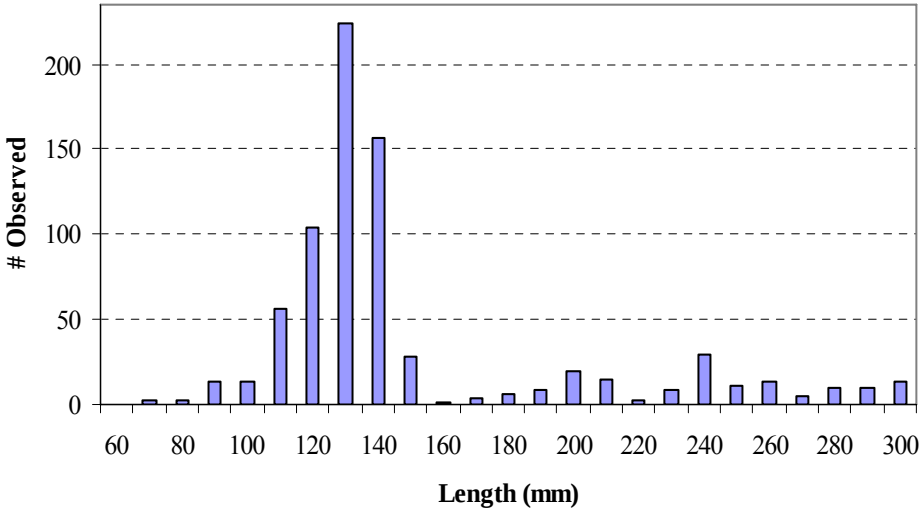

Figure 23. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2008 electrofishing assessments.

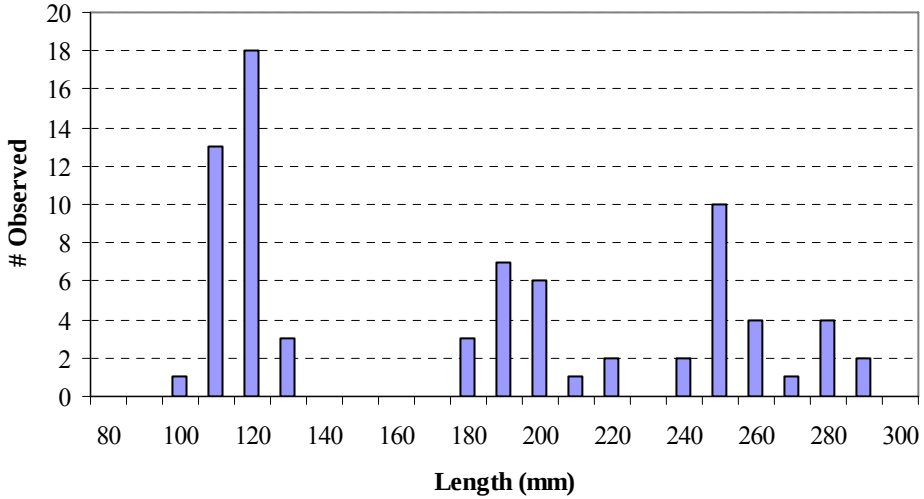

Figure 24. Length frequency distribution of walleye collected from Silver Island Lake, Cook County, during fall 2008 electrofishing assessments.

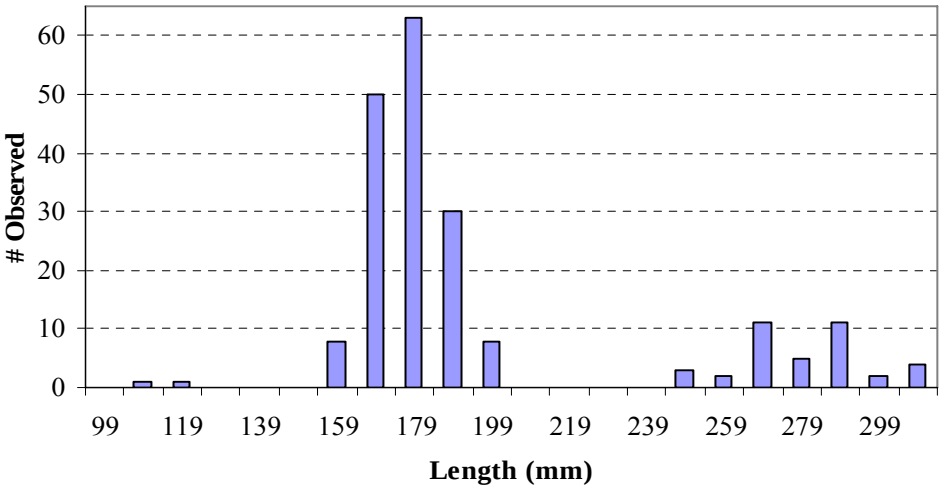

Figure 25. Length frequency distribution of walleye collected from Tom Lake, Cook County, during fall 2008 electrofishing assessments.

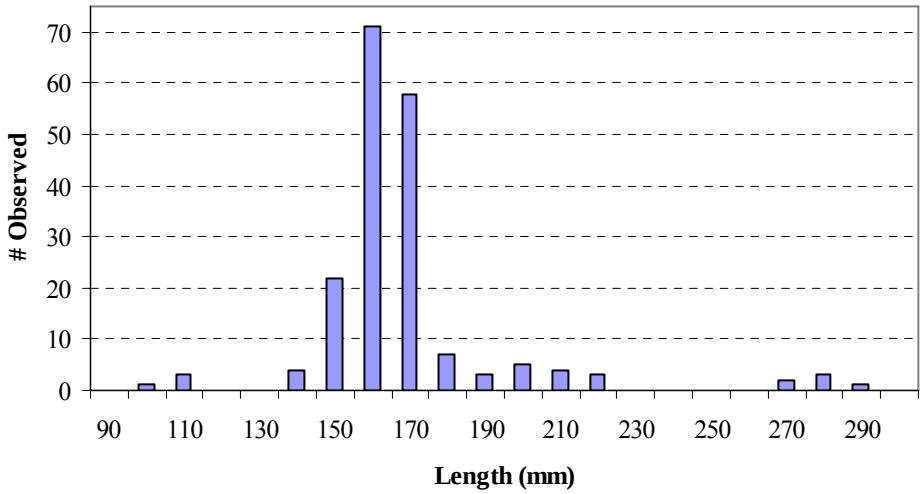

Figure 26. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2008 electrofishing assessments.

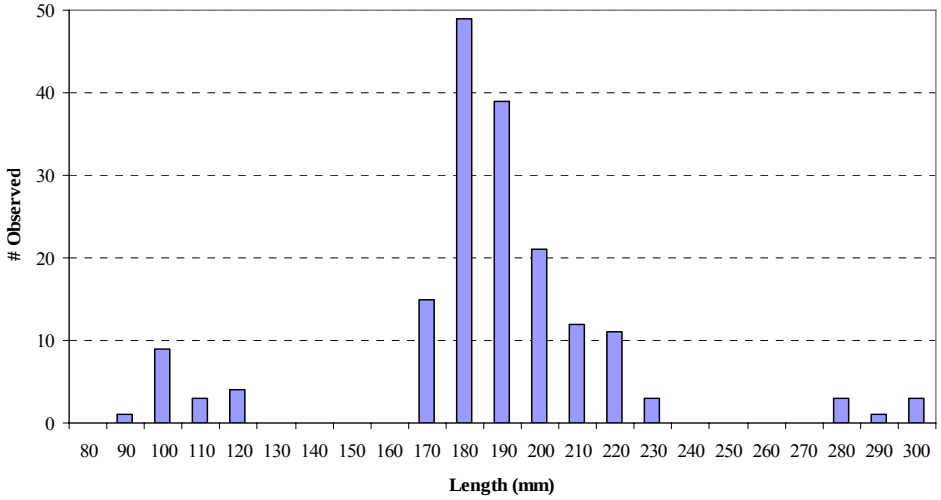

Figure 27. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2008 electrofishing assessments.

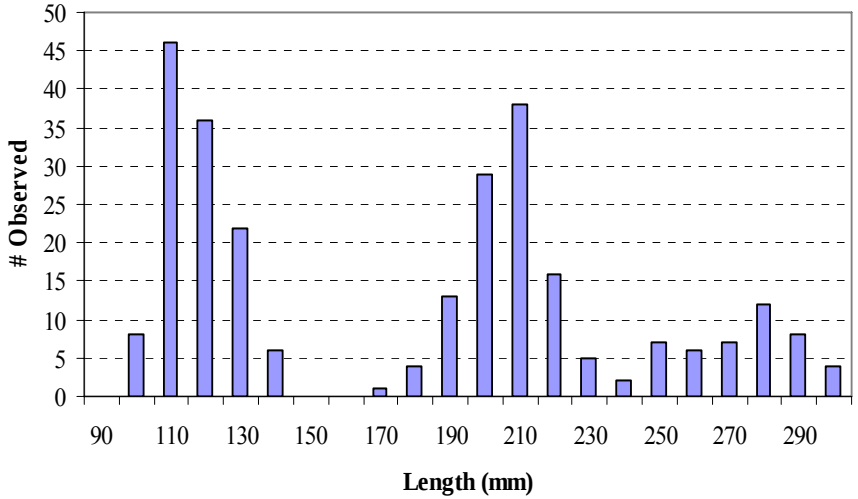

Figure 28. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2008 electrofishing assessments.

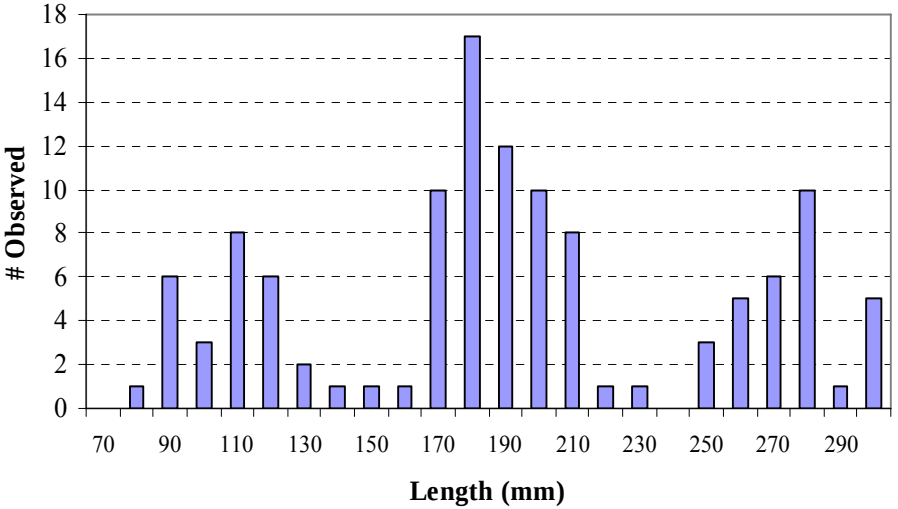

Figure 29. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2008 electrofishing assessments.

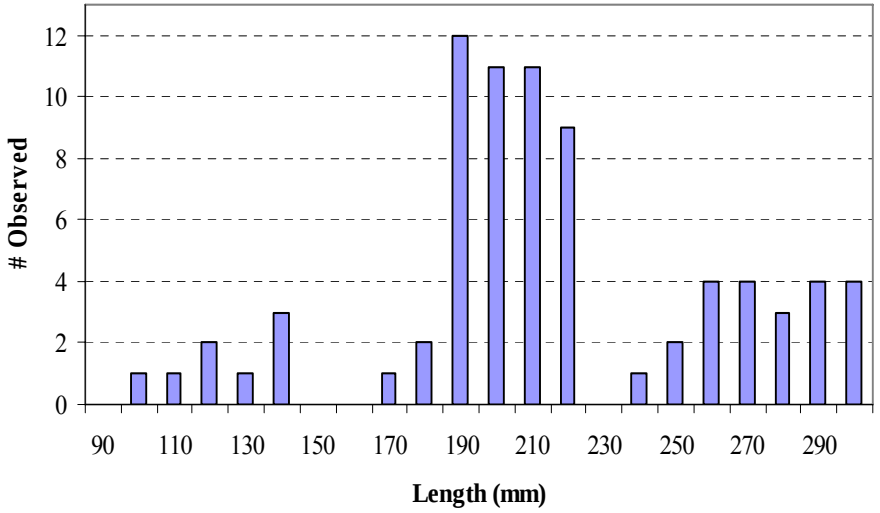

Figure 30. Length frequency distribution of walleye collected from Windy Lake, Lake County, during fall 2008 electrofishing assessments.

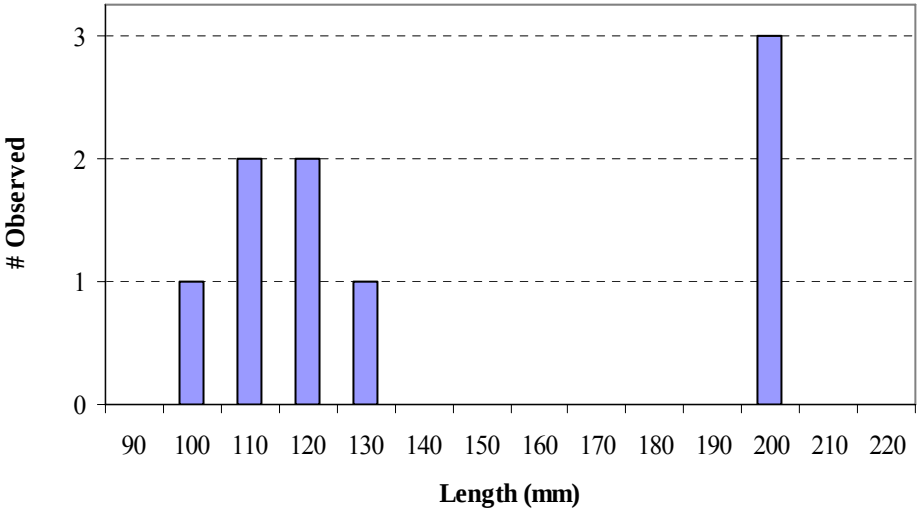

Figure 31. Length frequency distribution of walleye collected from Poplar Lake, Cook County, during fall 2008 electrofishing assessments.

Appendix 1. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2008 assessments in Caribou and Silver Island Lakes. Individual fish were marked by removal of a dorsal fin ray in Silver Island Lake, and the removal of the anal spine in Caribou Lake.

Lake	Date	Marked in Population	Daily Catch	Daily Recap
Caribou	9 May	--	205	--
	10 May	205	311	57
	11 May	402	314	114
	August GN	488	60	7
S. Island	7 May	--	291	--
	8 May	291	250	55
	9 May	486	217	61
	July GN	642	166	10