Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2010

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

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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 2010 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.

The first objective of our assessments in 2010 was to obtain adult walleye population estimates (PE) during the spring spawning period using mark - recapture data. Our electrofishing PEs may be biased towards males in the populations, and thus, are presumed conservative estimates of population abundance. However, by cooperating with the MN DNR area offices, a second PE is obtained using the State's summer gill net data, with which to compare to the spring-only electrofishing PE. An additional benefit of the spring electrofishing surveys is that it allows biologists to identify and determine key and critical spawning sites, i.e. where catch rates are the highest.

The second objective of our 2010 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 2010 spring survey were Prairie and Fish Lakes (Duluth Area), Crooked Lake (Finland Area), and Elbow Lake (Grand Marais 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 MNDNR, 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 fifth full dorsal fin. 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

Catch per unit effort (CPUE) for age-0 walleye has been found to be the highest in the fall when water temperatures are between 20.0°C and 10.0°C (Borkholder and Parsons, 2001). Fall assessments began in the Grand Marais area on 7 September 2010. Due to a cooler autumn, the 20°C threshold was not exceeded on any 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, 2000a, 2002a, 2003, 2004, & 2010). 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

Prairie Lake

Electrofishing activities were conducted on Prairie Lake Reservoir on 5 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. Only a single evening of electrofishing was performed on Prairie due to warm water temperatures and a lack of spawning walleyes. CPUE ranged from 0.0 (EFC) to 52.4 (EF3-3/4) adult walleye per hour of sampling (Table 1, Figure 1). At an 80% confidence interval, mean CPUE for Prairie Lake, determined using each sampling station, was 20.4 ± 19.6 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled is presented in Figure 2. Walleye as large as 622 mm (24.5 inches) were observed in the survey. Incidentally, 3 of the 5 largest walleyes sampled in 2010 were recaptured individuals from previous surveys. Additional species observed included northern pike.

No population estimates were obtained for Prairie Lake. We only sampled one evening, and thus did not perform a recapture run. MN DNR personnel sampled 31 walleyes in their gill net survey over the summer (35 total walleyes including trap nets). No recaptured individuals were observed in the summer survey.

Table 3 presents the age data for the walleye collected from Prairie Lake. Of the 68 unique fish sampled, 39 were assigned to ages 4 and 5. Instantaneous mortality (Z) of the Prairie Lake population was estimated at 40.6% (Figure 4). Total annual mortality (A) was estimated to be 33.4%. Table 4 presents back-calculated lengths at age for walleye collected from Prairie 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 35.3 ± 11.4 (Table 5) suggests a population characterized by fish smaller than 15.0 inches (Anderson and Weithman 1978). The summer gill net PSD (16.7 ± 14.9) is not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=2.9, P>0.05, critical Chi-square value of 3.841), although this is probably due to a low sample size in the MNDNR gill net survey (N = 24 fish larger than 10.0 inches). No significant differences were observed in any of the RSD metrics between the electrofishing and gill net assessments during 2010 assessments (Table 5).

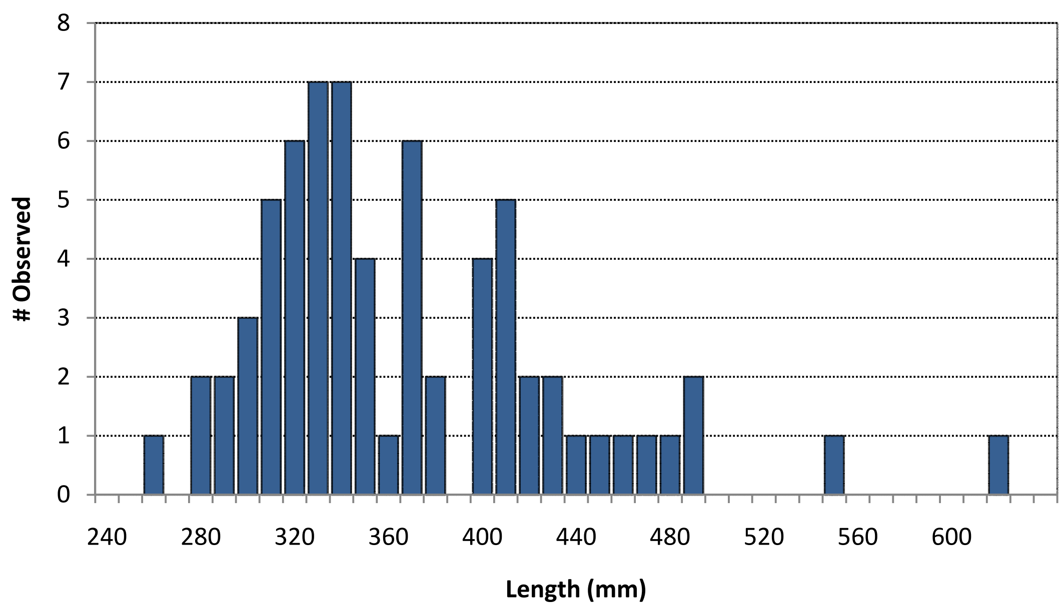

Figure 2. Length frequency distribution of walleye sampled from Prairie Lake, St. Louis County, MN, during spring 2010 electrofishing assessments.

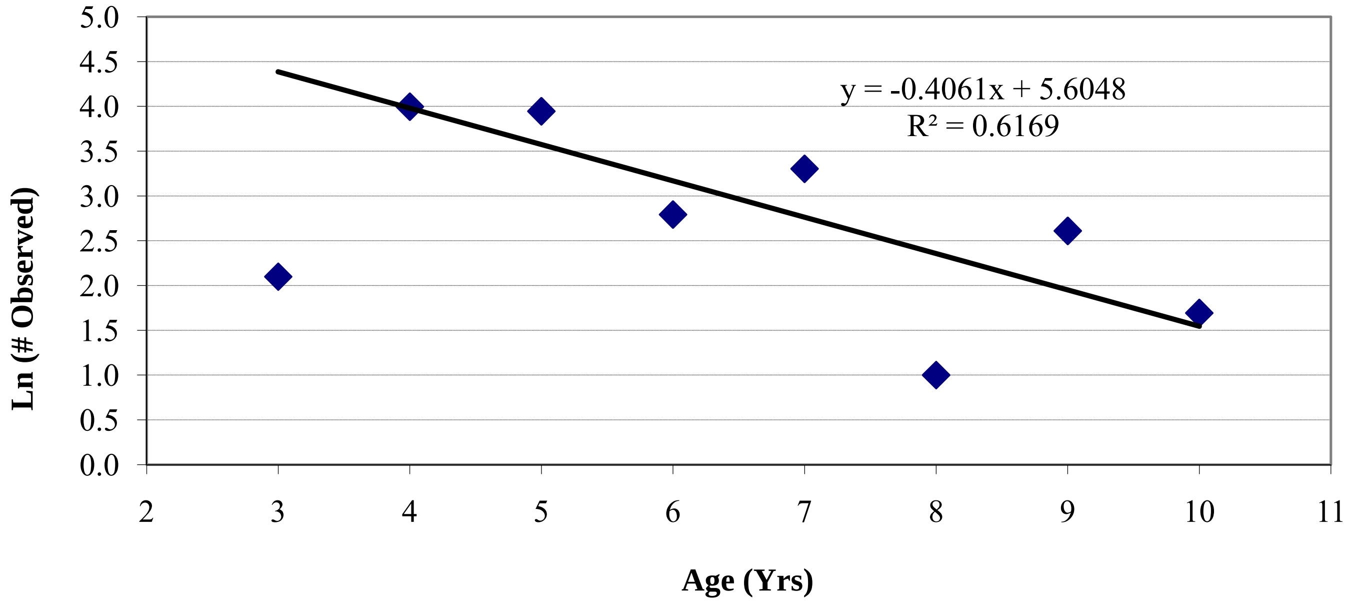

Figure 3. Instantaneous mortality (*Z*) of walleye from Prairie Lake. Estimates are made from April 2010 electrofishing data.

Table 4. Back-calculated lengths at age for walleye collected from Prairie Lake, St. Louis County, Minnesota, April 2010.

Age Class	N	Length (mm)	Length (in)
1	60	106	4.2
2	60	183	7.2
3	60	250	9.8
4	57	303	11.9
5	39	341	13.4
6	25	382	15
7	19	418	16.5
8	10	445	17.5
9	9	472	18.6
10	4	446	17.6
11	3	462	18.2
12	2	478	18.8
13	2	489	19.3

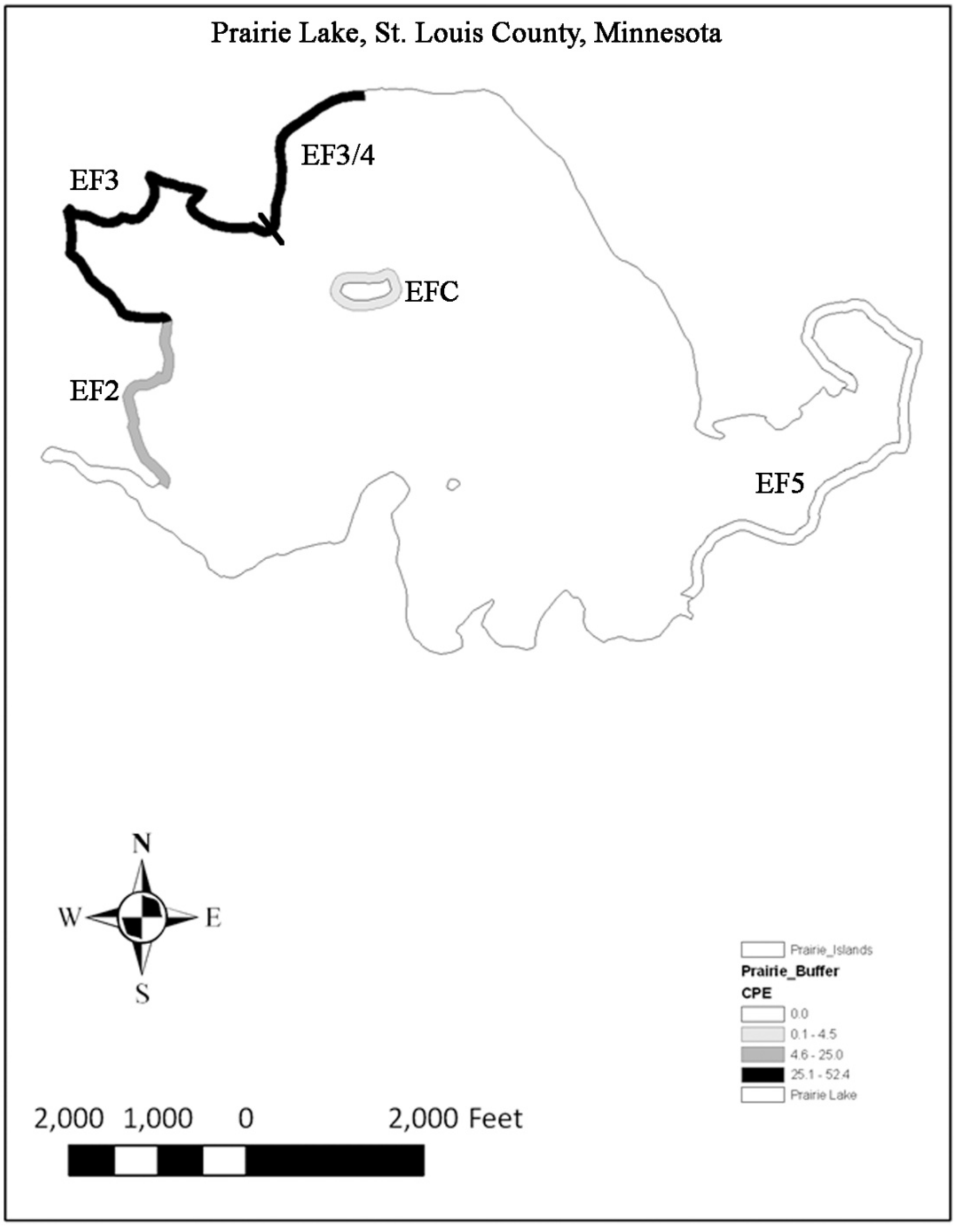

Figure 1. Catch per hour (CPE) of adult walleyes on Prairie Lake, St. Louis County, during spring 2010 electrofishing surveys.

Table 1. Summary of electrofishing activities on four lakes surveyed within the 1854 Ceded Territory, Minnesota, during Spring 2010.

ID #	County	Lake	Area (Acres)	Max Depth	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)	Amps	# WAE[2]	CPUE WAE[3]
69-0848	St. Louis	Prairie	848	47	4/05/2010	47	117.5	7509	354	3.5	68	32.6
38-0048	St. Louis	Fish Lake	3525	36	4/6/2010	43	131.2	16,900	884 / Low (38%)[4]	5 / 1.2	947	201.7
		Reservoir			4/7/2010	42	129.8	15,023	884 / Low (38%)[4]	5 / 1.2	884	211.8
					4/8/2010	42	131.2	6770	Low (38%)[4]	5 / 1.2	416	221.2
38-0024	Lake	Crooked	272	18	4/9/2010	42	51.9	5496	High (38%)[4]	1.0	42	27.5
					4/13/2010	43	46.9	6722	High (38%)[4]	1.4	112	60.0
					4/15/2010	47	48.8	5612	High (38%)[4]	1.2	131	84.0
16-0096	Cook	Elbow	437	9	4/10/2010	44	32.3	4979	High (40%)[4]	1.0	264	154.7
					4/11/2010	43	33.2	5430	High (40%)[4]	1.3	280	185.6
					4/12/2010	43.5	49.9	5325	High (41%)[4]	1.1	214	144.7

1 Water conductivity measured in microSiemens / cm.

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

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

4 The 1854 Treaty Authority began using a new Smith-Root controller in 2009, that does not indicate actual voltage, but rather HIGH or LOW, and a % Power, which is reported. Voltage reported would be that of the Fond du Lac vessel.

Table 2. Walleye population estimates for Fish, Crooked, and Elbow Lakes, Spring 2010. Estimates are for walleye larger than 254 mm (10.0 inches). EF denotes population estimates determined from spring electrofishing data. GN refers to population estimates determined from gill net samples collected in the summer following marking with the electrofishing surveys. Rows of shaded data indicate population estimates from previous surveys, and are presented for comparison purposes.

Lake	Population Estimate[1]	95% Confidence Limits Lower	95% Confidence Limits Upper	Estimate[2]	C.V.[3]
Fish Lake – EF_{2005}	4798	4313	5405	4822 ± 575	3.7%
Fish Lake – GN_{2005}	8607	5951	15544	31,995 ± 26,934	30.3%
Fish Lake – EF_{1999}	4918	4435	5518	4694	5.1%
Fish Lake – EF_{2010}	3291	2640	4369	3022 ± 616	4.7%
Fish Lake – GN_{2010}	3718	2201	11,969	133,760 ± 404,303	70.2%
Crooked – EF_{2006}	548	501	606	561 ± 100	5.6%
Crooked – GN_{2006}	683	425	1731	3055 ± 2247	26.5%
Crooked – EF_{2002}	575	554	599	579 ± 118	6.4%
Crooked – GN_{2002}	663	363	3763	1632 ± 1356	26.1%
Crooked – EF_{2010}	235	222	250	233 ± 100	10.0%
Crooked – GN_{2010}	445	192	---	996 ± 748	23.6%
Elbow – EF_{2004}	664	664[4]	664[4]	661 ± 265	9.3%
Elbow – EF_{2010}	1353	1070	1841	1265 ± 456	8.4%
Elbow – GN_{2010}	1650	887	11887	13,860 ± 24,877	56.4%

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 Prairie Lake, St. Louis County, spring 2010, 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	13
10.0	254	0									
10.5	267	1	1								
11.0	279	3	2	1							
11.5	292	2		2							
12.0	305	7		6	1						
12.5	318	8		3	4	1					
13.0	330	9		5	4						
13.5	343	6			6						
14.0	356	2		1		1					
14.5	368	8		2	4	2					
15.0	381	0									
15.5	394	3				1	2				
16.0	406	6				1	5				
16.5	419	3					1	1	1		
17.0	432	1					1				
17.5	445	2								2	
18.0	457	1							1		
18.5	470	1							1		
19.0	483	2									2
19.5	495	1					1				
20.0	508	0									
20.5	521	0									
21.0	533	0									
21.5	546	0									
22.0	559	1							1		
22.5	572	0									
23.0	584	0									
23.5	597	0									
24.0	610	1							1		
24.5	622	0									
TOTAL		68	3	20	19	6	10	1	5	2	2

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence intervals for walleye sampled from Prairie and Fish Lakes (St. Louis Co.), Crooked Lake (Lake Co.), and Elbow Lake (Cook 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
Prairie – EF_{2010}	35.3 ± 11.4	64.7 ± 11.4	32.4 ± 11.1	2.9 ± 4.0	0.0 ± 0.0
Prairie – GN_{2010}	16.7 ± 14.9	83.3 ± 14.9	16.7 ± 14.9	0.0 ± 0.0	0.0 ± 0.0
Fish – EF_{2010}	40.8 ± 2.3	59.1 ± 2.3	38.5 ± 2.2	2.1 ± .7	0.2 ± 0.2
Fish – GN_{2010}	68.0 ± 10.6	32.0 ± 10.6	64.0 ± 10.9	1.3 ± 2.6	2.7 ± 3.6
Fish Lake – EF_{2005}	46.3 ± 1.9	53.7 ± 1.9	43.1 ± 1.9	2.9 ± 0.6	0.3 ± 0.2
Fish Lake – GN_{2005}	45.3 ± 8.6	54.7 ± 8.6	32.8 ± 8.1	12.5 ± 5.7	0.0 ± 0.0
Crooked – EF_{2010}	71.4 ± 6.3	28.6 ± 6.3	59.3 ± 6.8	11.6 ± 4.4	0.5 ± 1.0
Crooked – GN_{2010}	54.4 ± 11.0	45.6 ± 11.0	43.0 ± 10.9	10.1 ± 6.6	1.3 ± 2.5
Crooked Lake – EF_{2006}	79.0 ± 3.9	21.0 ± 3.9	71.7 ± 4.3	6.9 ± 2.4	0.5 ± 0.7
Crooked Lake – GN_{2006}	58.7 ± 11.1	41.3 ± 11.1	45.3 ± 11.3	13.3 ± 7.7	0.0 ± 0.0
Elbow – EF_{2010}	25.4 ± 3.5	74.6 ± 3.5	16.5 ± 3.0	7.1 ± 2.1	1.8 ± 1.1
Elbow – GN_{2010}	34.9 ± 14.2	65.1 ± 14.2	20.9 ± 12.2	11.6 ± 9.6	2.3 ± 4.5
Elbow – EF_{2004}	82.4 ± 4.3	17.6 ± 4.3	74.8 ± 4.9	7.6 ± 3.0	0.0 ± 0.0
Elbow – GN_{2004}	69.6 ± 18.8	30.4 ± 18.8	43.5 ± 20.3	21.7 ± 16.9	4.4 ± 8.3

Fish Lake

Electrofishing activities were conducted on Fish Lake from 6 – 8 April (Figure 5). 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 for each night was consistently high, more than 200 adult walleye per hour of sampling (Table 1). Catch rates ranged from 40.3 walleye / hour (EF3, 6 April) to 286.4 walleye / hour (EFB, 6 April) (Figure 4). At an 80% confidence interval, mean CPUE for Fish Lake, determined using each sampling station, was 163.6 ± 21.2 adults per hour of sampling effort. Sampling stations were those identified during previous surveys, where large spawning congregations were known to occur.

Additional species observed included yellow perch, white sucker, northern pike, black crappie, largemouth bass, and bluegill.

The length frequency of the walleye sampled from Fish Lake is presented in Figure 5. Table 6 presents the age data for the walleye collected from Fish Lake. Of the 1812 walleye sampled, 1426 were assigned ages 4 - 6. Table 7 presents back-calculated lengths at age for walleye collected from Fish Lake. Instantaneous mortality (Z) for the Fish Lake walleye population is estimated at 49.6% (Figure 6). Total annual mortality (A) is estimated at 39.1%. These estimates are close to what was estimated after the 2005 survey, when instantaneous mortality (Z) was estimated at 56.7%, and total annual mortality at 43.2% (Borkholder and Edwards 2006).

Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 3291 (Table 2). The electrofishing adjusted Petersen estimate is 3022 ± 616, with a 4.7% CV (Table 2). These estimates represent the population abundance of walleye using the sampled areas for spawning, and are not estimates of the walleye population within the entire Fish Lake. During summer 2010, the Minnesota Department of Natural Resources performed a standardized net assessment on Fish Lake (MN DNR, Duluth Area Fisheries). Seventy-five walleyes (> 264 mm) were sampled in the gill nets that would have been 254 mm during the May assessments. No individuals were observed to have the clipped dorsal fin ray from the spring sampling. The adjusted Petersen estimate using both the summer and spring data is 133,760 ± 404,303, with a 70.2% CV (Table 2). By not sampling any marked individuals in the summer survey, this resulting PE is largely useless. The Schumacker and Eschmeyer population estimate from the net data is 3718 (Table 2). The estimates from our electrofishing survey are lower than those observed in 2005 (Borkholder et al., 2006) and in 1999 (Borkholder and Edwards 2000b) (Table 2).

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. The electrofishing PSD of 40.8 ± 2.3 (Table 5) suggests the population is balanced (Anderson and Weithman 1978). The gill net PSD of 68.0 ± 10.6 was significantly different from the electrofishing PSD estimate (χ^2=21.8, P<0.05, critical Chi-square value of 3.841) (Table 5), but was also based upon a much lower sample size. PSD metrics calculated from the 2005 assessments are included for comparison (Borkholder and Edwards 2006). Significant differences were observed between the 2010 PSD and the 2005 PSD (χ^2=12.9, P<0.05, critical Chi-square value of 3.841). This would suggest that the stock structure may have changed over the last decade, when more quality to preferred length walleye were observed in the 2005 survey.

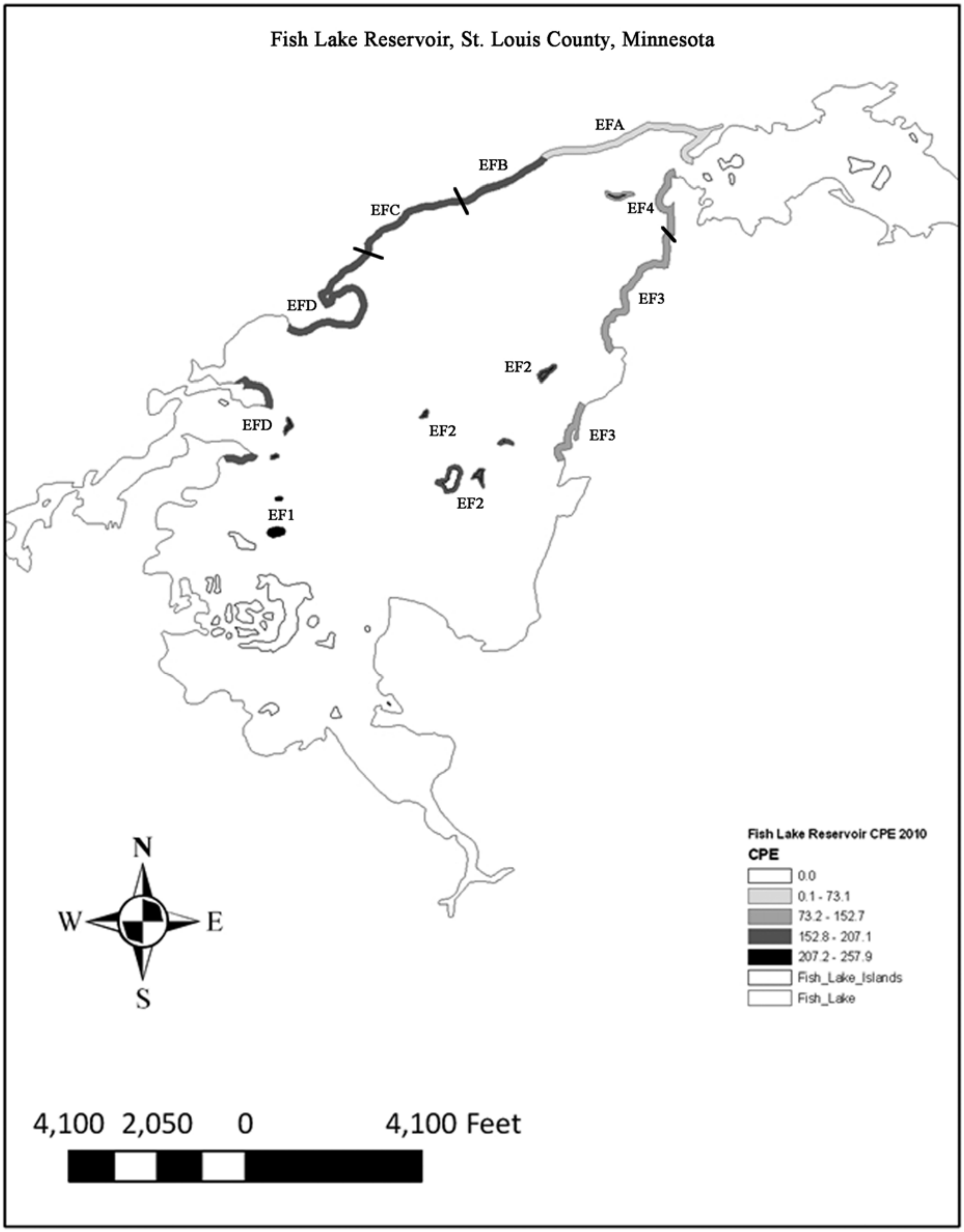

Figure 4. Catch per hour (CPE) of adult walleyes on Fish Lake, St. Louis County, during spring 2010 electrofishing surveys.

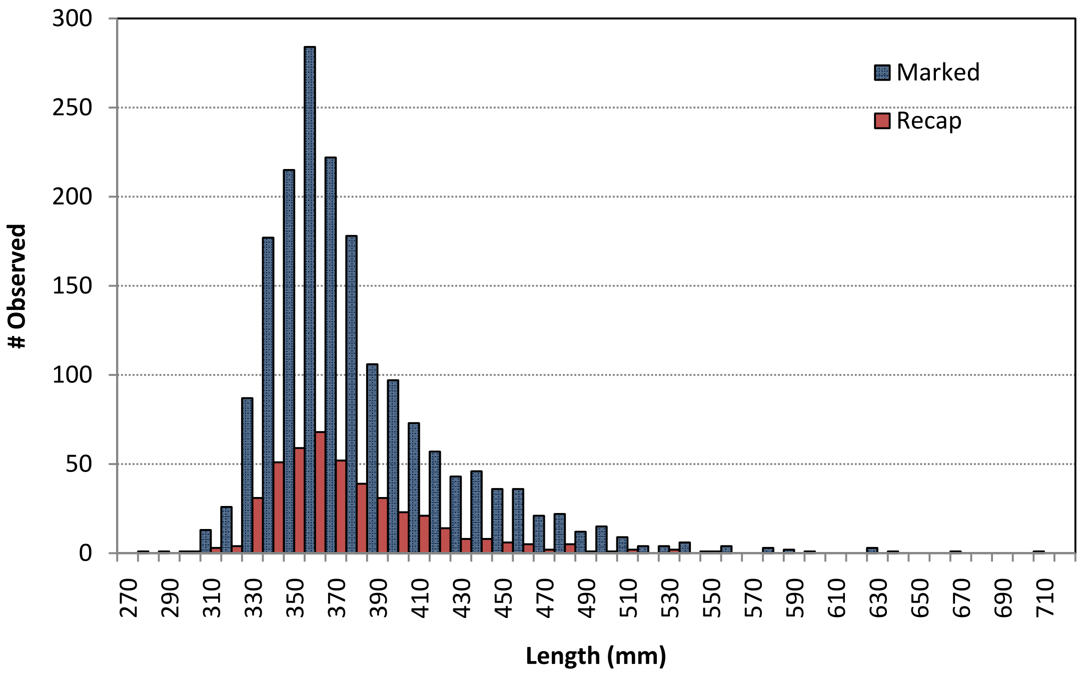

Figure 5. Length frequency distribution of walleye sampled from Fish Lake, St. Louis County, during spring 2010 electrofishing surveys. Blue bars represent unmarked walleyes observed, while red bars represent the length frequency of the recaptured walleyes observed.

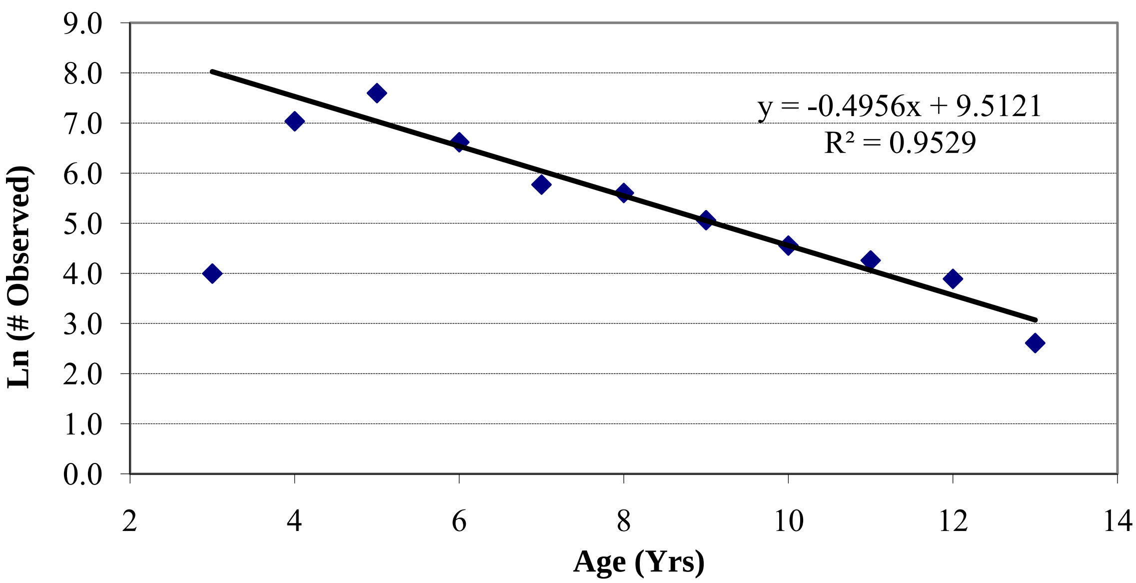

Figure 6. Instantaneous mortality (*Z*) of walleye from Fish Lake. Estimates are from April 2010 electrofishing data.

Table 6. Age frequency distribution of walleye from Fish Lake, St. Louis County, spring 2010, 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
11.0	279	1	3												
11.5	292	1	1												
12.0	305	10	7	3											
12.5	318	43	9	32		2									
13.0	330	131		91	40										
13.5	343	250		125	125										
14.0	356	349		145	175	29									
14.5	368	285		22	241	22									
15.0	381	194			97	97									
15.5	394	119			17	43	34	17		8					
16.0	406	98			28	35	35								
16.5	419	68			10	24	19	10	5						
17.0	432	57				11	11	23	8	4					
17.5	445	47				8	3	14	14	3	6				
18.0	457	46				2	9	11	9	9	4	2			
18.5	470	31					6	9	4	4	3	4			
19.0	483	21						6	6	2	4	3			
19.5	495	18				1		3	5	1	5	1	1	1	
20.0	508	12						1	3	3	1	3	1		
20.5	521	5				1			1			1	2		
21.0	533	8					1	4	1					1	1
21.5	546	1									1				
22.0	559	5						2			1	2			
22.5	572	3							1	1					
23.0	584	0													
23.5	597	3							1						2
24.0	610	0													
24.5	622	2										2			
25.0	635	2									1		1		
26.5	673	1													1
27.5	699	1												1	
TOTAL		1812	20	418	733	275	118	100	58	35	26	18	5	3	4

Table 7. Back-calculated lengths at each age class for walleye collected from Fish Lake, St. Louis County, Minnesota, April 2010.

Age Class	N	Length (mm)	Length (in)
1	272	111	4.4
2	272	195	7.7
3	272	267	10.5
4	264	328	12.9
5	230	374	14.7
6	188	410	16.1
7	153	437	17.2
8	126	460	18.1
9	87	476	18.7
10	57	489	19.3
11	42	510	20.1
12	25	530	20.9
13	12	561	22.1
14	7	590	23.2
15	4	606	23.9

Crooked Lake

Electrofishing activities were conducted on Crooked Lake between 9 – 15 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. Based upon previous surveys, areas characterized by soft muck bottom types were not sampled (Figure 7). CPUE for each night ranged from 27.5 to 84.0 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Crooked Lake, determined using each sampling station, was 46.2 ± 9.3 adult walleye (>254mm) per hour of sampling effort. Catch rates ranged from 3.5 adult walleye per hour (EF4, 9 April) to 101.4 adults per hour (EF3, 15 April) (Figure 7). Additional species observed included white sucker, smallmouth bass, yellow perch, sculpin, and northern pike.

The length frequency of the walleye sampled is presented in Figure 8. Table 8 presents the age data for the walleye collected from Crooked Lake. Greater than 76% of the fish were assigned as ages 3 – 7 (Table 8). More than half of the fish (52.0%) were assigned to the youngest ages (3 – 5). Of note, strong year classes have not been observed in Crooked Lake during fall age-0 and age-1 assessments since 1997 and 2000 (Figure 9). Table 9 presents back-calculated lengths at age for walleye collected from Crooked Lake. Incidentally, 37 adult walleyes were observed that were recaptured individuals from previous surveys, including eleven tagged individuals from the 2006 tagging survey. Lengths at tagging and recapture are shown in Table 10, although three of the tags were not legible. Thus, only eight individuals are shown in Table 10. Instantaneous mortality (*Z*) of the Crooked Lake population was estimated at only 27.5% (Figure 10). Total annual mortality (*A*) was estimated to be 24.1%.

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 235 (Table 2). The adjusted Petersen estimate is 233 ± 100, with a 10.0% CV (Table 2). The 2010 population estimate of walleyes larger than 254 mm (10.0 inches) is much lower than that estimated in 2006 and 2002 (Table 2). Estimates of total mortality (Figure 10) are actually lower than expected, given the apparent decline in population abundance (Table 2) and low numbers of older aged individuals (Table 8). Lack of consistent recruitment over the last several years might be making estimates of mortality appear lower than they really are.

During summer 2010, the Minnesota Department of Natural Resources performed a standardized net assessment on Crooked Lake (MN DNR, Finland Area Fisheries). Seventy-eight walleyes (> 265 mm) were sampled in the gill nets that would have been 254 mm during the April assessments, with thirteen of those observed to have a fin clip from the spring sampling. The adjusted Petersen estimate using both the summer and spring data is 996 ± 748, with a 23.6% CV (Table 2). The Schumacker and Eschmeyer population estimate from the net data is 445 (Table 2). As observed in the electrofishing PE's (Table 2), the gill net PEs calculated in 2010 are lower than both the 2002 and 2006 estimates.

The relationship between age-0 and age-1 fall electrofishing data and 2010 adult walleye age data is presented in Figure 11, for ages 3 - 9. Weak relationships were observed between the adult data and the age-0 and age-1 data for the older data, ages 10+ through the 1996 cohort. This suggests that the use of this older data to forecast adult populations in Crooked Lake may be limited. However, when using more recent data, the 2000 cohort through the 2007 cohort, the data suggests that the use of fall age-1 electrofishing assessment data can be used to forecast strong and weak year classes once they recruit into the adult population (Figure 11).

PSD and RSD values determined by our spring electrofishing sampling and summer gillnet survey are presented in Table 5. The electrofishing PSD of 73.9 ± 6.8 (Table 5) suggests a population characterized by larger individuals, larger than 15.0 inches (Anderson and Weithman 1978). The summer gill net PSD (54.4 ± 11.0) is significantly different than the PSD estimate from the spring electrofishing survey (χ^2=7.3, 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 2010 assessments (Table 5). PSD metrics calculated from the 2006 electrofishing assessments are included for comparison (Borkholder et al., 2007). Significant differences were observed between the 2010 PSD and the 2006 PSD (χ^2=4.5, P<0.05, critical Chi-square value of 3.841), and between the 2010 RSD Q-P and the 2006 RSD Q-P (χ^2=-2.11, P<0.05, critical Chi-square value of -1.64). This is largely attributable to many more individuals observed in 2006 between 15.0 and 20.0 inches, than what was observed in our 2010 survey. Our fall assessment data does not identify any particularly strong year classes in the last ten years, but rather inconsistent to poor reproduction (Figure 9). We may be starting to observe reduced population abundance due to inconsistent recruitment over the last decade.

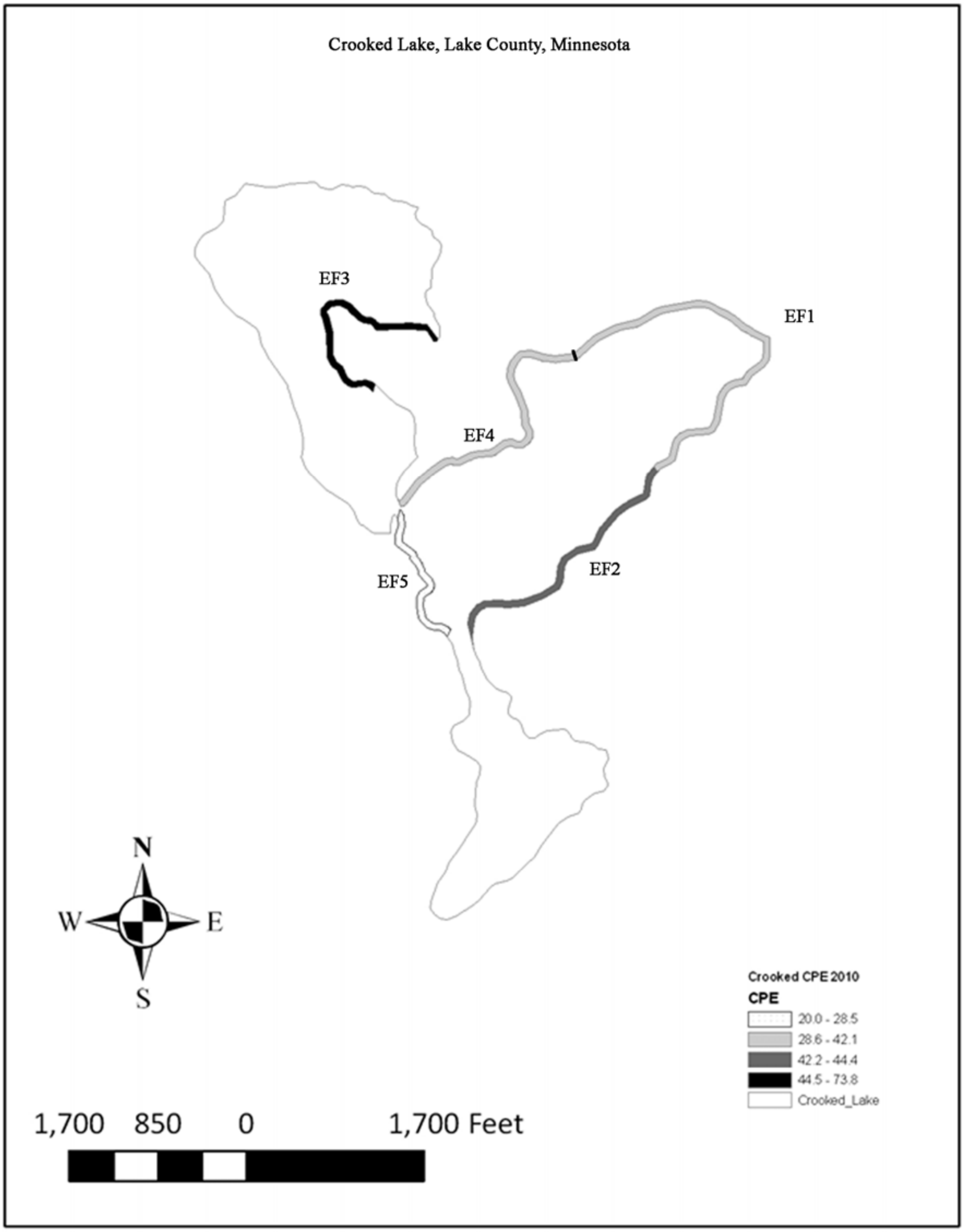

Figure 7. Catch per hour (CPUE) of adult walleyes on Crooked Lake, Lake County, during spring 2010 electrofishing surveys.

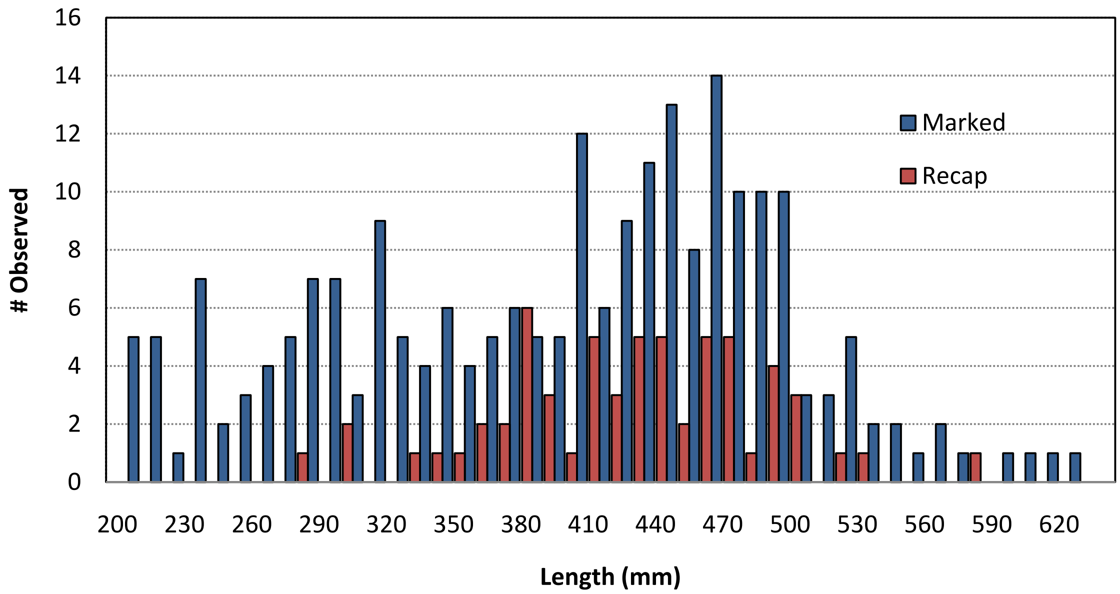

Figure 8. Length frequency distribution of walleye sampled from Crooked Lake, Lake County, MN, during spring 2010 electrofishing assessments. Blue bars represent sample of marked individuals. Recaptured individuals were measured and are shown using the red bars.

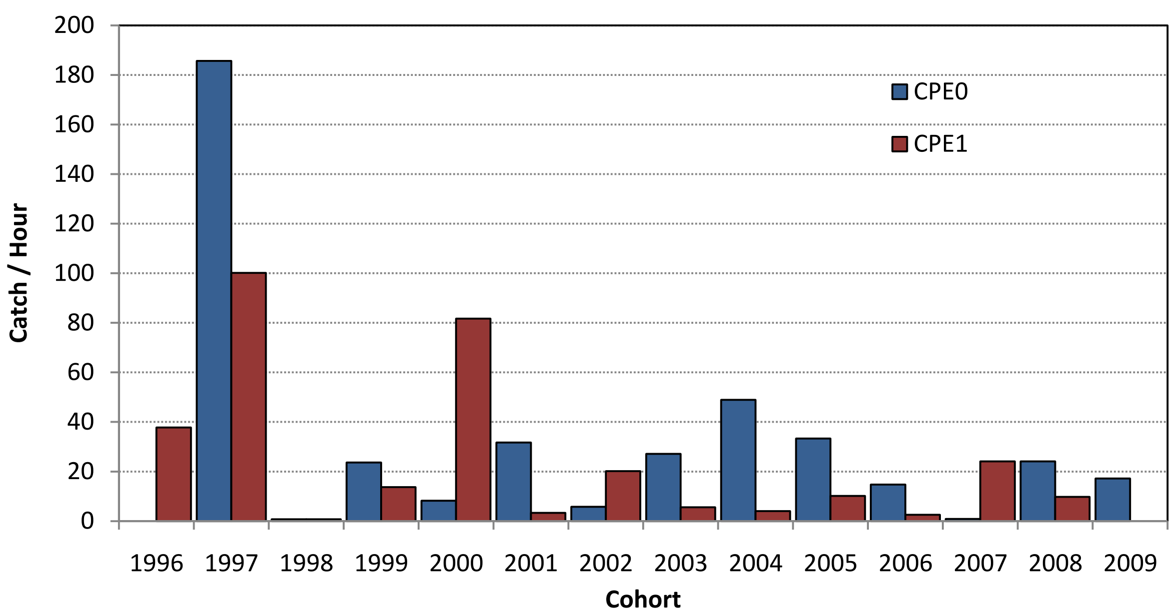

Figure 9. Catch per hour of age-0 and age-1 walleyes in Crooked Lake, from 1996 through 2009.

Table 8. Age frequency distribution of walleye from Crooked Lake, Lake County, spring 2010, 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
10.0	254	2	2										
10.5	267	5	5										
11.0	279	7	7										
11.5	292	8	8										
12.0	305	7	6	1									
12.5	318	10	6	4									
13.0	330	7	2	5									
13.5	343	5	2	3									
14.0	356	6		6									
14.5	368	5		5									
15.0	381	9		8	1								
15.5	394	6		6									
16.0	406	13			5	8							
16.5	419	6			4	1	1						
17.0	432	16			8	8							
17.5	445	15			5	3	7						
18.0	457	10			1		6	3					
18.5	470	18			6	1		6	5				
19.0	483	13				3	4		5		1		
19.5	495	12				2	2	2	4			2	
20.0	508	4				2	1		1				
20.5	521	6					1	1			2	2	
21.0	533	4							2	2			
21.5	546	2						1				1	
22.0	559	2						1	1				
22.5	572	1									1		
23.0	584	1							1				
23.5	597	1							1				
24.0	610	1											1
24.5	622	1								1			
25.5	597	2									1		
TOTAL		204	38	38	30	28	22	14	20	3	5	5	1

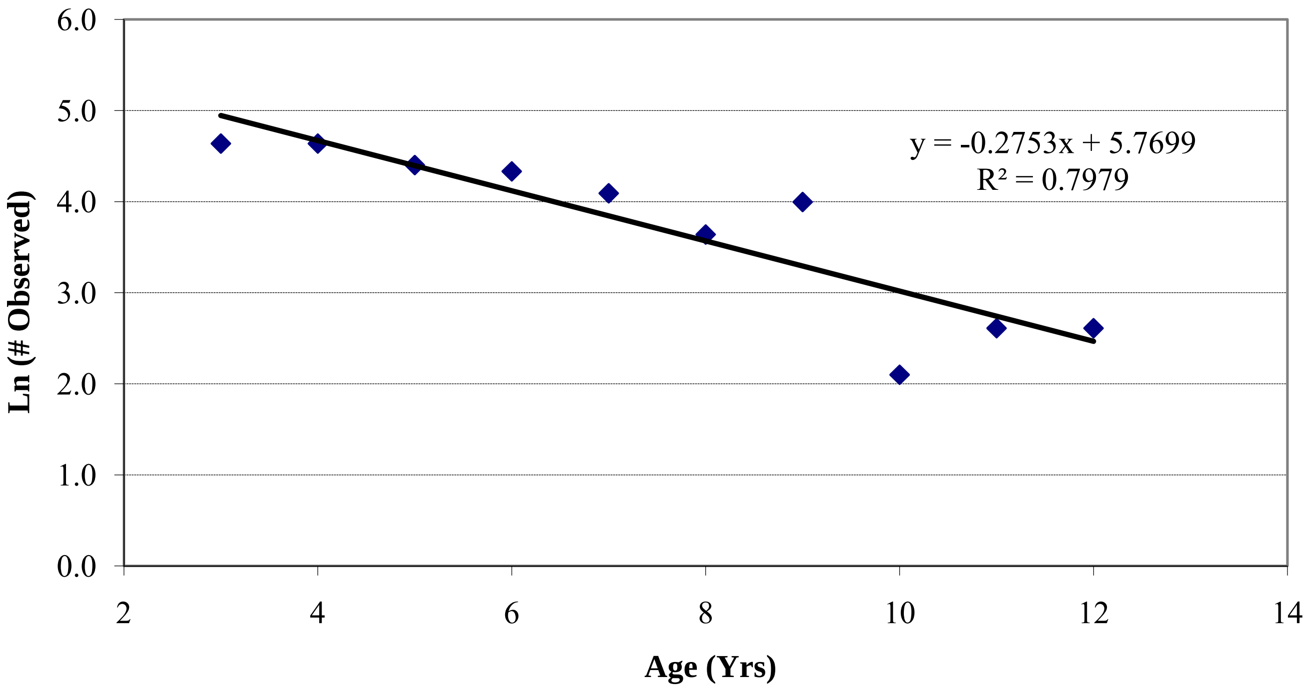

Figure 10. Instantaneous mortality (*Z*) of walleye from Crooked Lake. Estimates are from April 2010 electrofishing data.

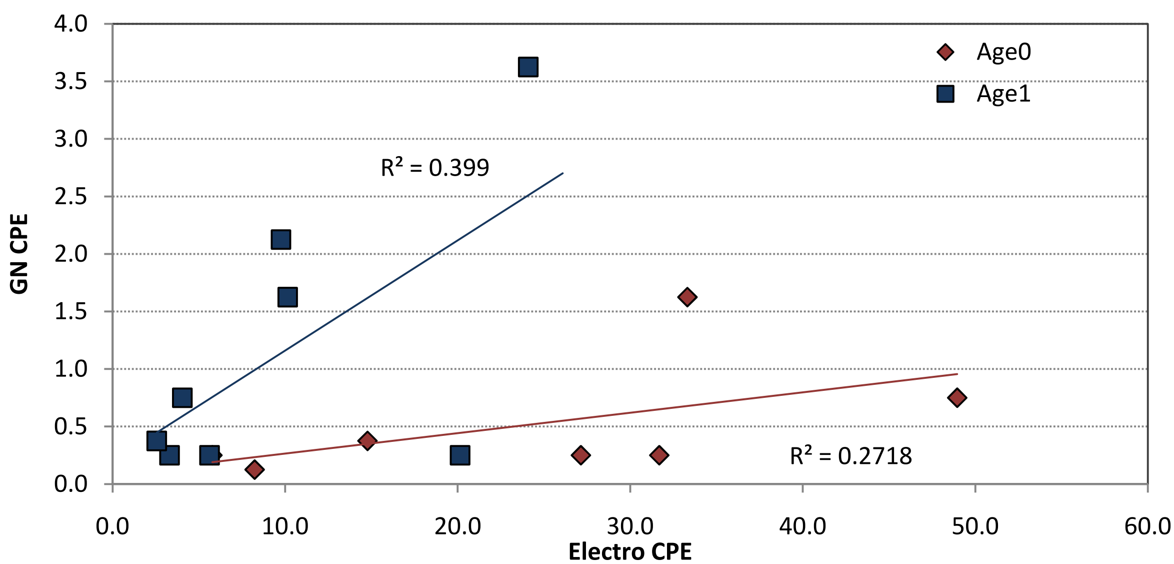

Figure 11. Relationship between fall electrofishing catch rates (#/hr) of age-0 and age-1 walleyes, and the subsequent catch of the same cohorts as adults in the MN DNR gill nets in Crooked Lake. Cohorts selected for analysis are from the 2000 year class through the 2007 year class.

Table 9. Back-calculated lengths at each age class for walleye collected from Crooked Lake, Lake County, Minnesota, April 2010.

Age Class	N	Length (mm)	Length (in)
1	166	109	4.3
2	166	198	7.8
3	166	289	11.4
4	129	362	14.3
5	94	414	16.3
6	75	444	17.5
7	57	466	18.3
8	41	486	19.1
9	30	507	20.0
10	14	523	20.6
11	11	530	20.9
12	6	532	20.9
13	1	610	24.0

Table 10. Length at marking in 2006, and subsequent length at recapture in 2010 of eight walleyes sampled in Crooked Lake, Lake County, April 2010.

2006 Length (inches)	2010 Length (inches)	Growth	Tag #
16.2	18.6	2.4	193603
13.6	21.1	7.5	187138
13.7	18.2	4.5	187274
17.9	18.7	0.8	187144
15.6	18.1	2.5	187362
16.9	18.1	1.2	187489
16.5	18.9	2.4	187498
16.1	19.0	2.9	187461

Elbow Lake

Electrofishing activities were conducted on Elbow Lake on 10 – 12 April (Figure 12). 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 for each night was very high, greater than 144 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Elbow Lake, determined using each sampling station, was 172.7 ± 21.2 adult walleye (>254mm) per hour of sampling effort. Catch rates ranged from 107.7 adult walleye per hour (EF2, 12 April) to 264.6 adults per hour (EF1, 11 April) (Figure 12). It should be noted that only the three stations indicated on the map were surveyed in 2010 (Figure 12). Based upon past surveys, walleyes are known to not use the rest of the lake for spawning activities.

The length frequency of the walleye sampled is presented in Figure 13. Walleyes less than 10.0 inches accounted for a large portion of the catch (N = 227). Forty-eight walleyes were observed with old marks (healed dorsal fin clips). Additional species observed were northern pike, yellow perch, and bluegill.

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 1353 (Table 2). The adjusted Petersen estimate is 1265 ± 456, with an 8.4% CV (Table 2). This is double the estimates from the 2004 survey.

Table 11 presents the age data for the walleye collected from Elbow Lake. Half (53.2%) of the fish sampled were assigned to age-3. Instantaneous mortality (Z) of the Elbow Lake population was estimated at 51.8% (Figure 14). Total annual mortality (A) was estimated to be 40.4%. This estimate used walleyes aged 3 – 9. If all of the data is used, ages up to 15 years, then the estimate of Z declines to 28.8%, with an estimate of total annual mortality of 25.0%. Table 12 presents back-calculated lengths at age for walleye collected from Elbow Lake.

In August 2010, the Minnesota Department of Natural Resources performed a standardized net assessment on Elbow Lake (MN DNR, Grand Marais Area Fisheries). Forty three (43) walleyes (> 265 mm) were sampled in the gill nets that would have been 254 mm during the April assessments, with only a single individual observed to have the fin clip from the spring sampling. The adjusted Petersen estimate using both the summer and spring data is 13,860 ± 24,877, with a 56.4% CV (Table 2), which is largely a useless estimate due to the lack of recaptured individuals. The Schumacker and Eschmeyer population estimate from the net data is 1650 (Table 2).

The relationship between age-0 and age-1 fall electrofishing data and 2010 adult walleye age data is presented in Figure 15, for ages 3 - 10. Weak relationships were observed between the adult data and the age-0 and age-1 data for the older data. This suggests that the use of this older age-0 and age-1 electrofishing data to forecast adult populations in Elbow Lake may be limited. However, when using more recent data, it appears that the use of fall electrofishing assessment data can be used to forecast strong and weak year classes once they recruit into the adult population (Figure 15).

PSD and RSD values determined by our spring electrofishing sampling and summer gillnet survey are presented in Table 5. The electrofishing PSD of 25.4 ± 3.5 (Table 5) suggests a population characterized by smaller individuals. The summer gill net PSD (34.9 ± 14.2) is not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=1.88, 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 2010 assessments (Table 5).

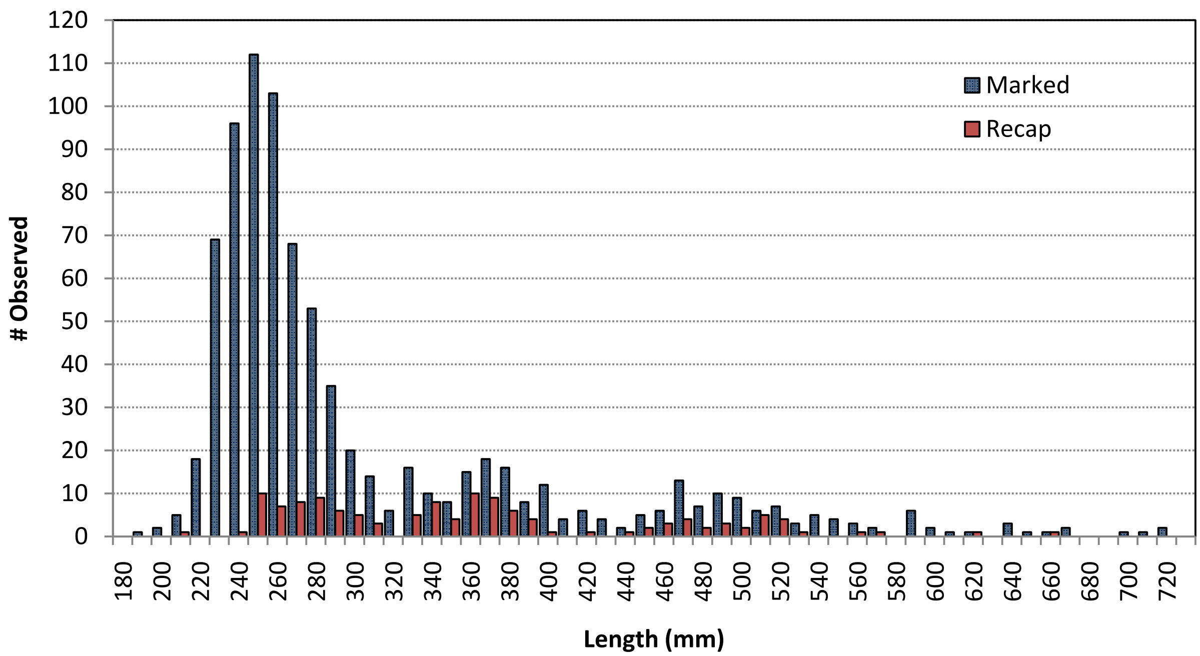

Figure 13. Length frequency distribution of walleye sampled from Elbow Lake, Cook County, MN, during spring 2010 electrofishing assessments. Blue bars represent unmarked walleyes observed, while red bars represent the length frequency of the recaptured walleyes observed.

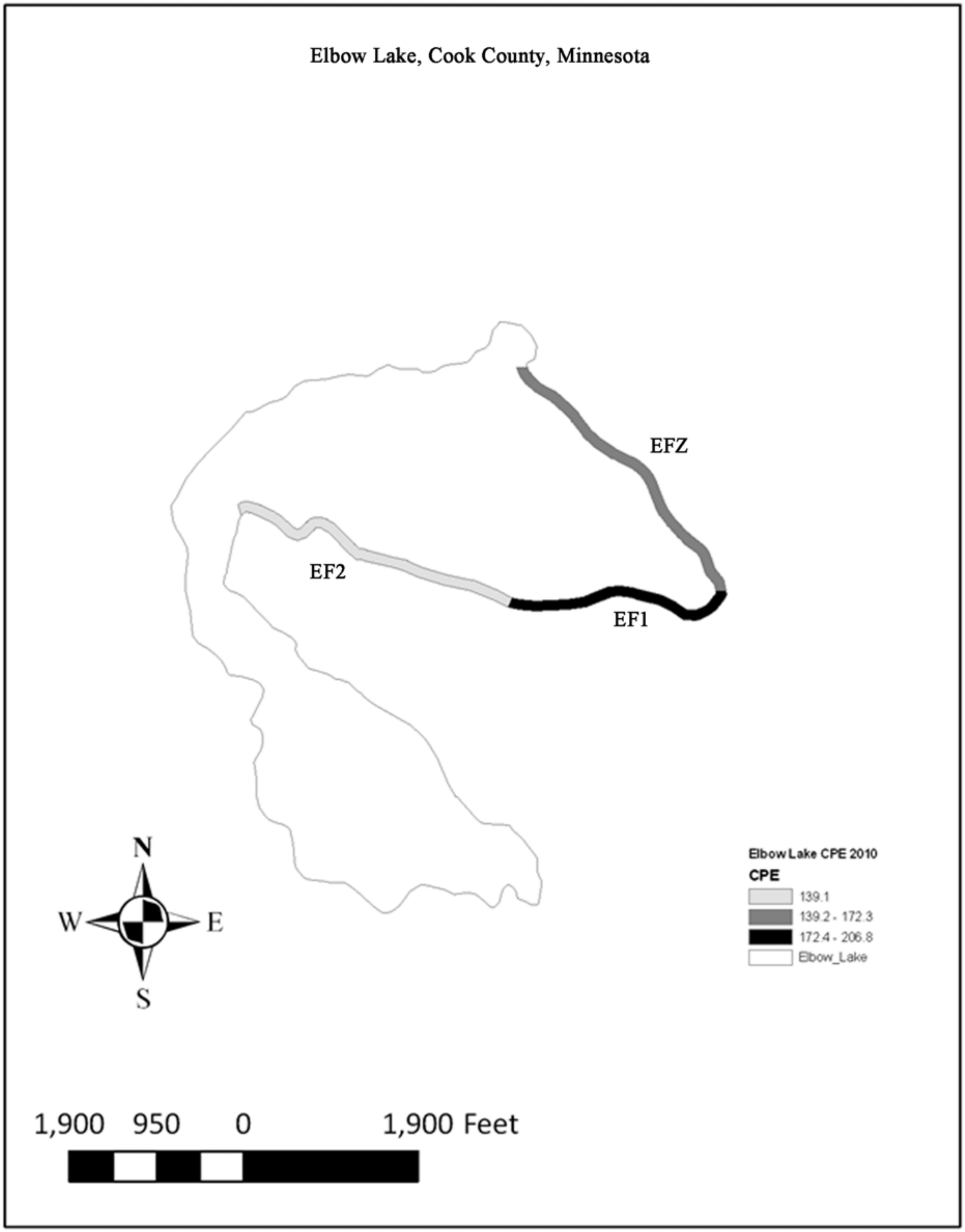

Figure 12. Catch per hour (CPE) of adult walleyes on Elbow Lake, Cook County, during spring 2010 electrofishing surveys.

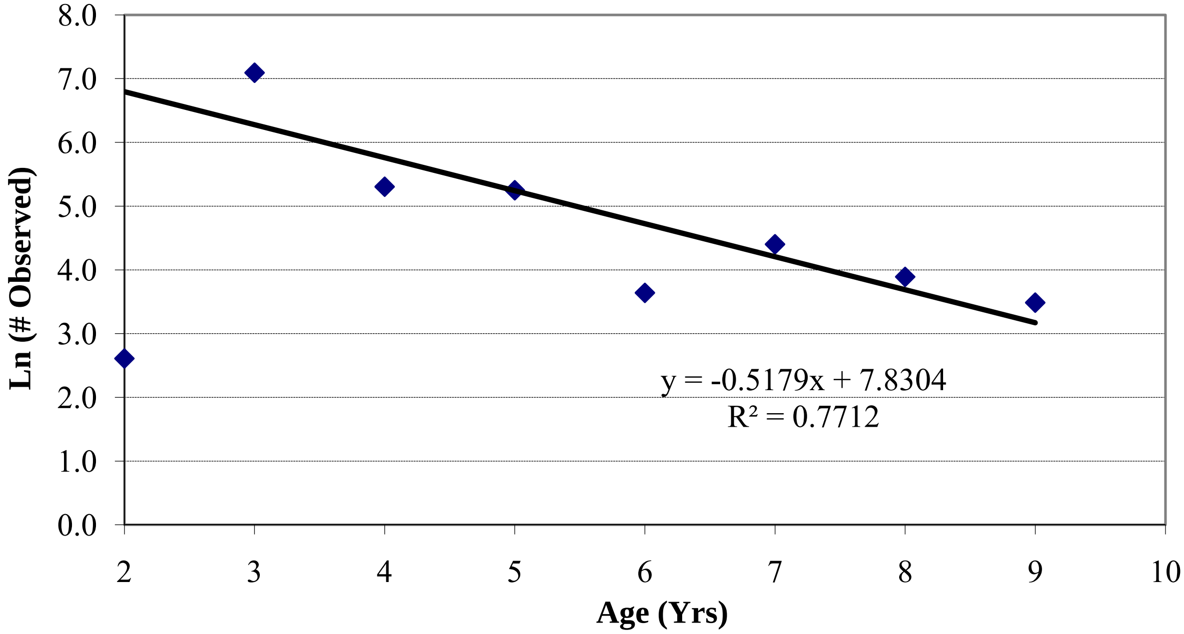

Figure 14. Instantaneous mortality (*Z*) of walleye from Elbow Lake. Estimates are from April 2010 electrofishing data.

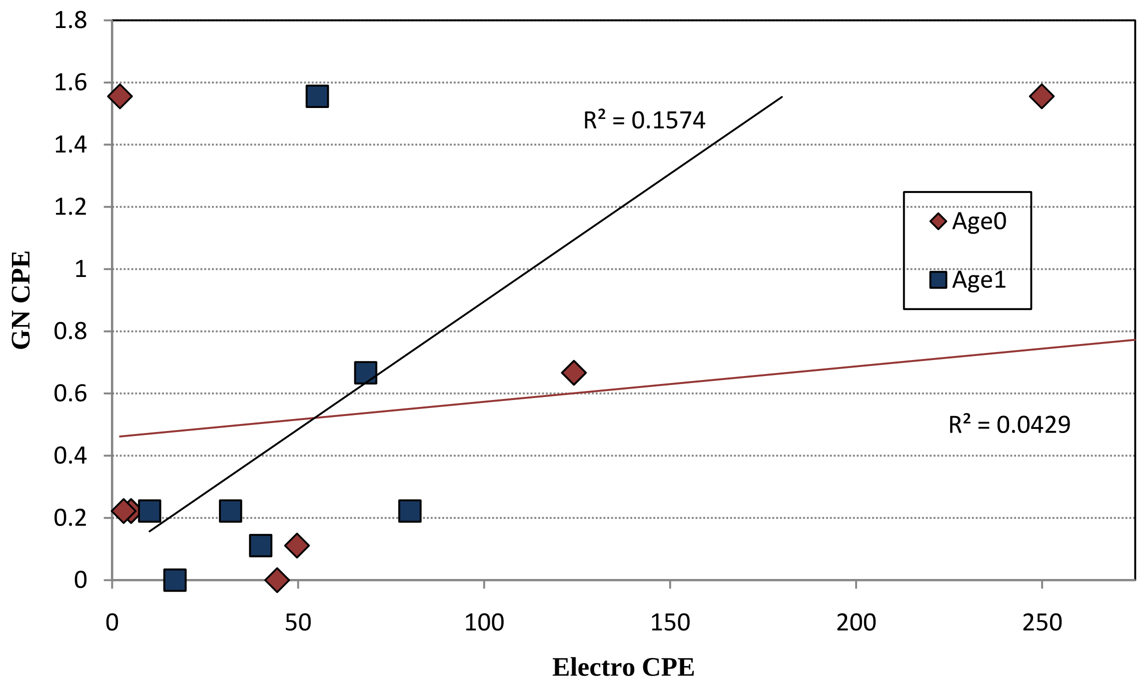

Figure 15. Relationship between fall electrofishing catch rates (#/hr) of age-0 and age-1 walleyes, and the subsequent catch of the same cohorts as adults in the MN DNR gill nets in Elbow Lake. Cohorts selected for analysis are from the 2000 year class through the 2007 year class.

Table 10. Age frequency distribution of walleye from Elbow Lake, Cook County, spring 2010, 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	18	23
7.5	191	1																	
8.0	203	5	5																
8.5	216	15																	
9.0	229	93																	
9.5	241	113		113															
10.0	254	150		150															
10.5	267	97		97															
11.0	279	68		68															
11.5	292	26		10	16														
12.0	305	26		5	19	2													
12.5	318	8			8														
13.0	330	18			14	2		2											
13.5	343	13			6	7													
14.0	356	17			4	13													
14.5	368	21			5	16													
15.0	381	17				13	2	2											
15.5	394	16			2	6	4	4											
16.0	406	10				6	3	1											
16.5	419	8				3	3	3											
17.0	432	4				1		1	1	1									
17.5	445	5						3	1		1								
18.0	457	7						3	1	2	1								
18.5	470	15						8	4		3								
19.0	483	8				1			3	2	2								
19.5	495	15					1		6	3	2	1		1		1			
20.0	508	8					1			1	4	1				1			
20.5	521	7						1			1		4				1		
21.0	533	7							1		2	1		2			1		
21.5	546	5						1	1		1		1		1				
22.0	559	3						1				1		1					
22.5	572	4											1	1		2			
23.0	584	4								1	1	1							
23.5	597	5								2			1		2				
24.0	610	1											1						
24.5	622	1												1					
25.0	635	2													2				
25.5	648	2									1				1				
26.0	660	1													1				
26.5	673	2												1			1		
27.5	699	1													1				
28.0	711	2																1	1
28.5	724	1														1			
TOTAL		832	5	443	74	70	14	30	18	12	19	5	8	7	8	5	3	1	1

Table 11. Back-calculated lengths at each age class for walleye collected from Elbow Lake, Cook County, Minnesota, April 2010.

Age Class	N	Length (mm)	Length (in)
1	200	102	4.0
2	200	188	7.4
3	199	260	10.2
4	168	319	12.6
5	136	373	14.7
6	102	413	16.3
7	92	446	17.6
8	72	475	18.7
9	59	497	19.6
10	49	516	20.3
11	35	535	21.1
12	30	556	21.9
13	24	578	22.8
14	17	600	23.6
15	9	586	23.1
16	4	607	23.9
17	1	697	27.4
18	1	712	28.0

Fall Assessments

Table 12 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 0.0 fish per hour (Homer Lake) to 283.3 fish per hour of electrofishing (Tait Lake) (Table 12). CPUE for age-1 walleye ranged from 0.0 fish per hour (Homer and Crooked Lakes) to 42.2 fish per hour of electrofishing (Pike Lake) (Table 12). Figures 16 – 41 present length frequency data for each of the lakes surveyed. Table 13 presents the mean length for age-0 and age-1 individuals sampled during fall 2010 assessments. Mean lengths for age-0 walleye ranged from 106 mm (4.2 inches, Harriet Lake) to 178 mm (7.0 inches, Cadotte Lake). Mean lengths for age-1 walleye ranged from 164 mm (6.5 inches, Devilfish Lake) to 261 mm (10.4 inches, Wild Rice Lake).

The difference between the 2010 observed CPE and each lake's historical mean, i.e. $CPE0_{2010} - CPE0_{Mean\ (Year\ 1\ thru\ 2009)}$ by lake, is graphed in Figure 42. Positive values indicate more age-0 walleyes were observed in 2010 relative to the lake's overall average, while negative values indicate fewer observed than normal. Overall, most lakes had fewer age-0 walleyes than historical averages. The same was observed when analyzing the age-1 data (Figure 42). 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 2010 were larger than historically observed in each lake (Table 14, Figure 42), likely due to the warm 2010 summer, and longer growing season. Another possibility is the presumed smaller year classes, as estimated by CPE, lead to lower intraspecific competition, and thus better growth rates. 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 naturally-produced year classes, average or better 2010 year classes may be present in fifteen of the lakes surveyed (Table 14). Looking at each lake's historical mean length for age-0 and age-1 walleyes, and subtracting the historical mean from the observed 2010 mean length for age-0 and age-1 walleyes, it appears as though walleye growth rates in NE Minnesota were higher than normal for both age-0 and age-1 walleyes. (Figure 42). 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

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Table 12. 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 26 lakes within the 1854 Ceded Territory of Northeastern Minnesota during September 2010.

Lake	Date	Temp (F)	Temp (C)	Cond.[1]	Age-0 Total[2]	Age-1 Total[3]	Seconds	CPUE Age-0[4]	CPUE 1+[5]
Ball Club	8-Sep	58	14.4	26.5	71	16	4725	54.1	12.2
Cadotte	16-Sep	55	12.8	36.3	53	50	6823	28.0	26.4
Caribou	10-Sep	58	14.4	62.5	167	14	7355	81.7	6.9
Cascade	14-Sep	56	13.3	25.1	20	17	5412	13.3	11.3
Crescent	9-Sep	62	16.7	30.8	80	9	3222	89.4	10.1
Crooked	23-Sep	52	11.1	48.3	64	0	4327	53.2	0.0
Devilfish	11-Sep	60	15.6	20.8	1	5	7142	0.5	2.5
Dumbbell	19-Sep	59	15.0	76.9	99	10	5029	70.9	7.2
Elbow	9-Sep	56	13.3	37.7	76	8	4179	65.5	6.9
Fourmile	21-Sep	56	13.3	55.8	129	21	6458	71.9	11.7
Harriet	22-Sep	58	14.4	58.3	8	1	5071	5.7	0.7
Homer	12-Sep	60	15.6	26.2	0	0	4090	0.0	0.0
Island Reservoir	17-Sep	61	16.1	91.5	401	34	9822	147.0	12.5
Ninemile	19-Sep	57	13.9	66.6	51	23	4955	37.1	16.7
N. McDougal	20-Sep	55	12.8	73.5	114	20	5693	72.1	12.6
Pike	13-Sep	63	17.2	57.3	63	78	6649	34.1	42.2
Shagawa	15-Sep	61	16.1	95.0	457	5	10416	157.9	1.7
Silver Island	13-Sep	56	13.3	41.8	6	1	4593	4.7	0.8
Tait	9-Sep	57	13.9	44.3	553	72	7028	283.3	36.9
Tom	7-Sep	61	16.1	36.4	26	32	6926	13.5	16.6
Two Island	14-Sep	58	14.4	30.7	119	17	6575	65.2	9.3
West Twin	10-Sep	60	15.6	32.6	27	9	3612	26.9	9.0
Whiteface Res.	16-Sep	61	16.1	68.7	68	11	5900	41.5	6.7
Wild Rice	18-Sep	59	15.0	131.8	15	13	4936	10.9	9.5
Wilson	20-Sep	57	13.9	45.9	15	10	4103	13.2	8.8
Windy	21-Sep	57	13.9	31.7	64	15	4795	48.1	11.3

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 13. Mean length for age-0 and age-1 walleye sampled during fall 2010 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	8-Sep	121	216
Cadotte	16-Sep	178	257
Caribou	10-Sep	122	220
Cascade	14-Sep	123	219
Crescent	9-Sep	114	235
Crooked	23-Sep	172	
Devilfish	11-Sep	118 (1)	164 (5)
Dumbbell	19-Sep	148	201
Elbow	9-Sep	116	222
Fourmile	21-Sep	149	226
Harriet	22-Sep	106	196 (1)
Homer	12-Sep		
Island Reservoir	17-Sep	144	207
Ninemile	19-Sep	169	236
N. McDougal	20-Sep	148	215
Pike	13-Sep	135	200
Shagawa	15-Sep	135	230 (5)
Silver Island	13-Sep	152 (6)	232 (1)
Tait	9-Sep	116	206
Tom	7-Sep	120	198
Two Island	14-Sep	111	206
West Twin	10-Sep	143	219
Whiteface Res.	16-Sep	170	235
Wild Rice	18-Sep	166	261
Wilson	20-Sep	130	192
Windy	21-Sep	144	219

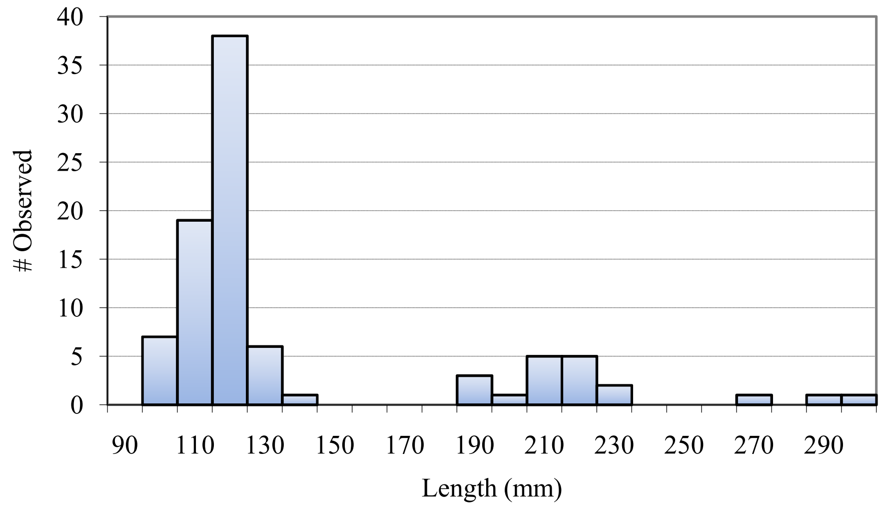


Figure 16. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2010 electrofishing assessments.

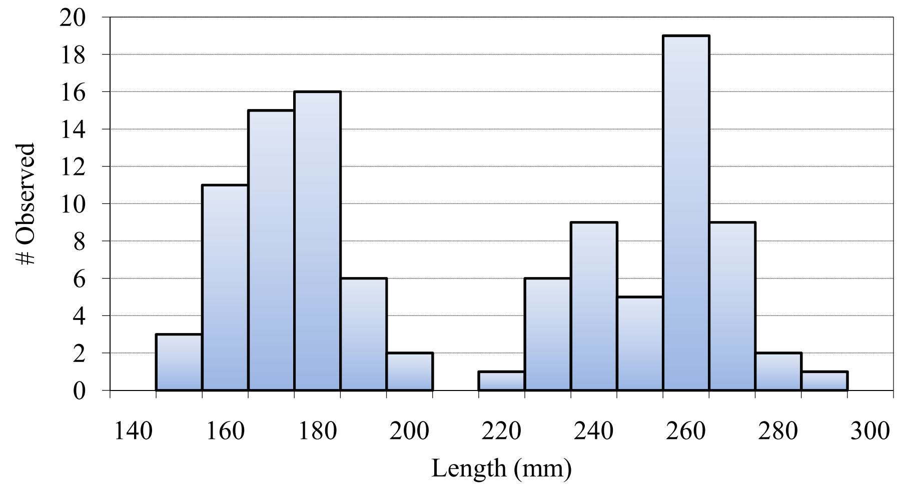


Figure 17. Length frequency distribution of walleye collected from Cadotte Lake, St. Louis County, during fall 2010 electrofishing assessments.

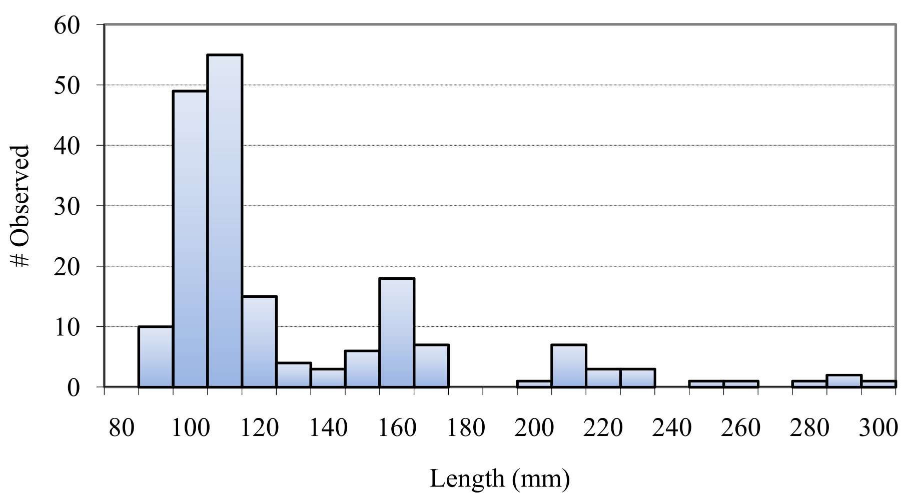


Figure 18. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2010 electrofishing assessments.

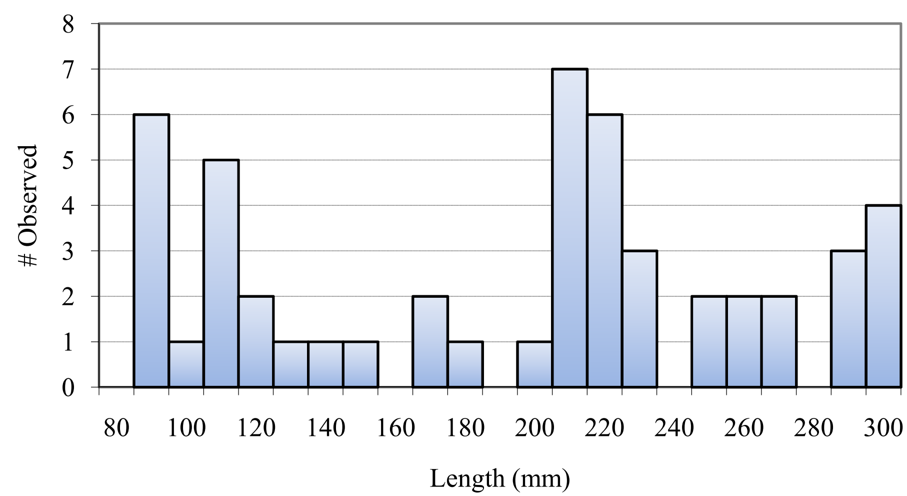


Figure 19. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2010 electrofishing assessments.

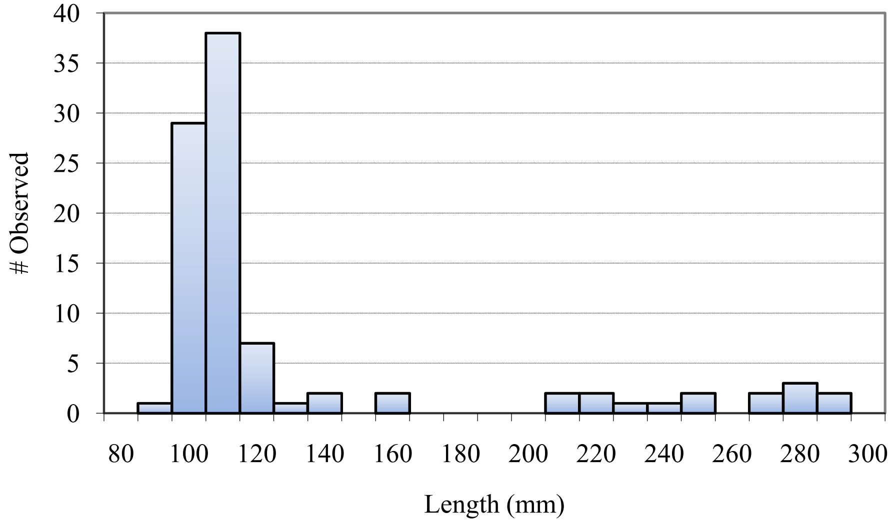


Figure 20. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2010 electrofishing assessments.

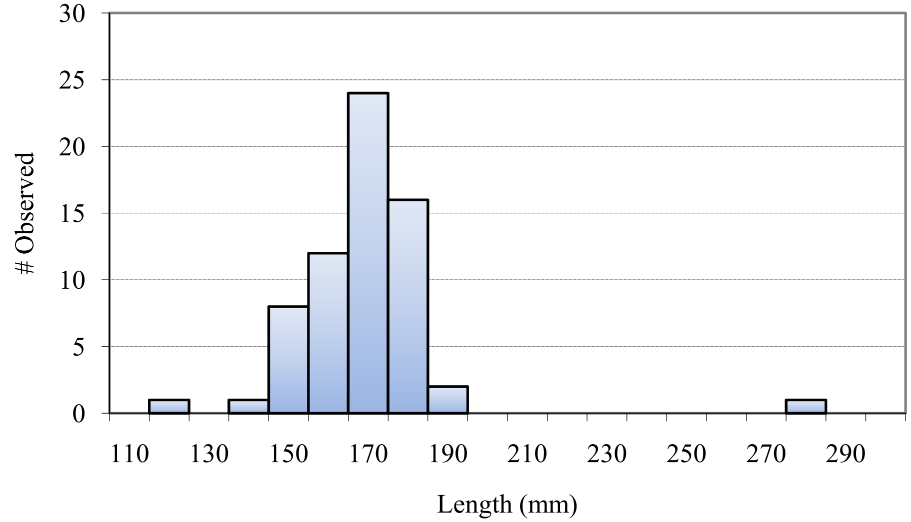


Figure 21. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2010 electrofishing assessments.

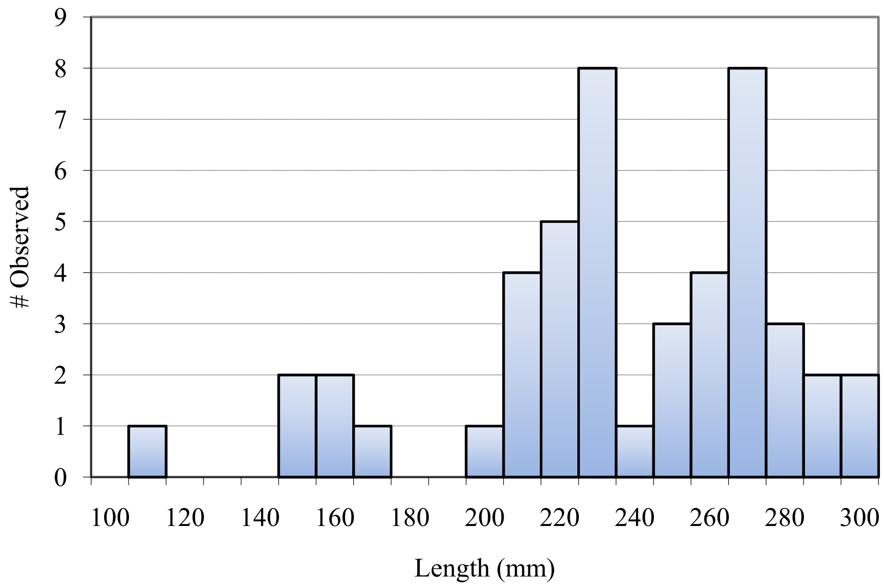


Figure 22. Length frequency distribution of walleye collected from Devilfish Lake, Cook County, during fall 2010 electrofishing assessments.

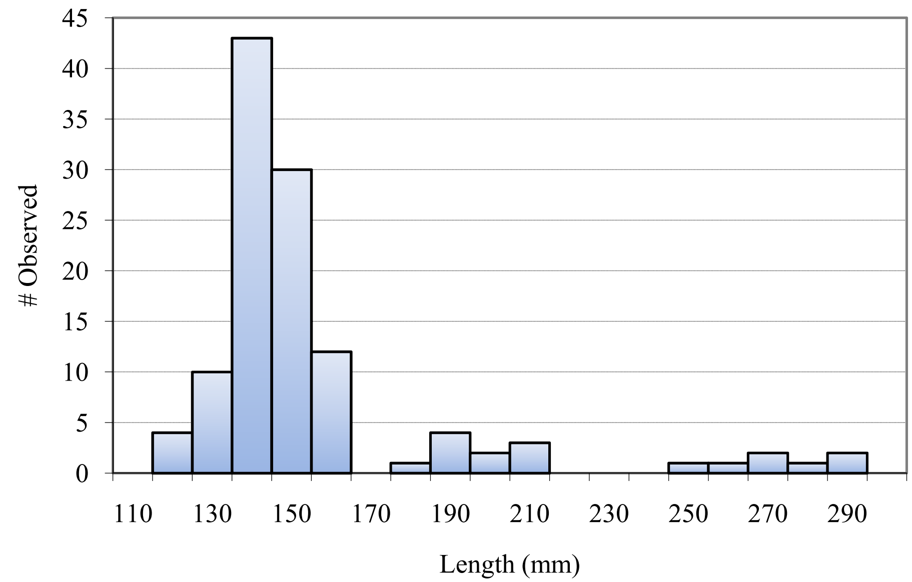


Figure 23. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2010 electrofishing assessments.

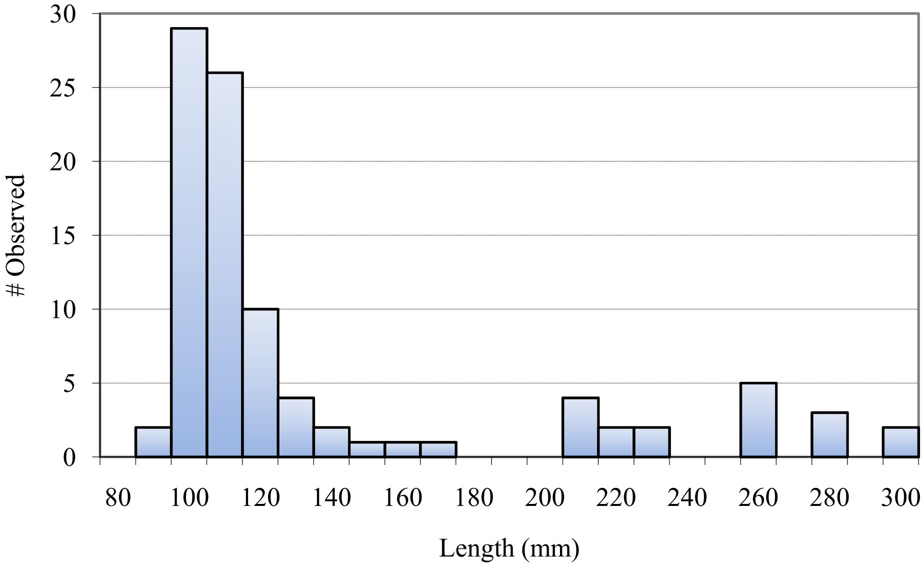


Figure 24. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2010 electrofishing assessments.

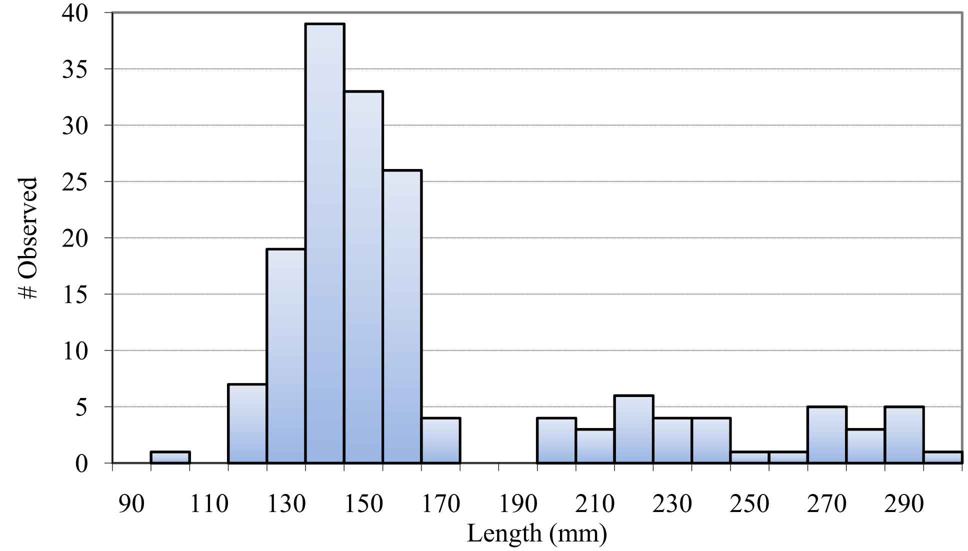


Figure 25. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2010 electrofishing assessments.

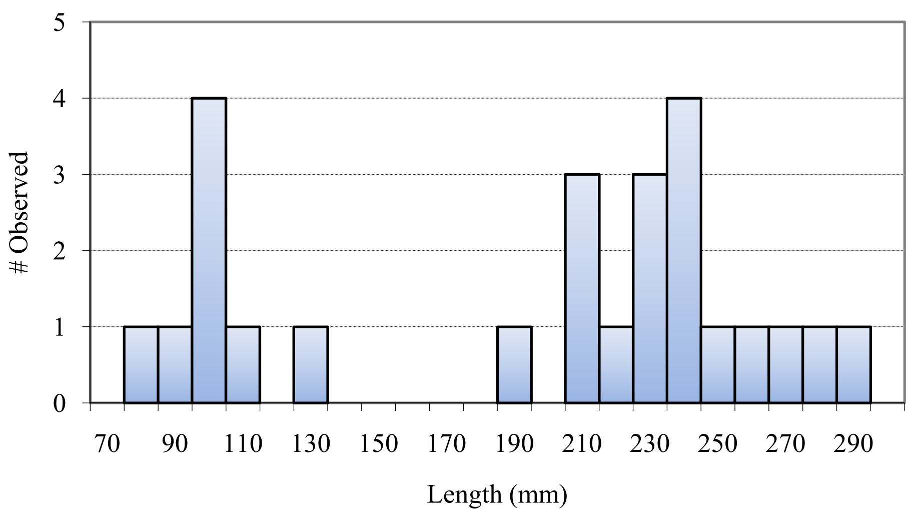


Figure 26. Length frequency distribution of walleye collected from Harriet Lake, Lake County, during fall 2010 electrofishing assessments.

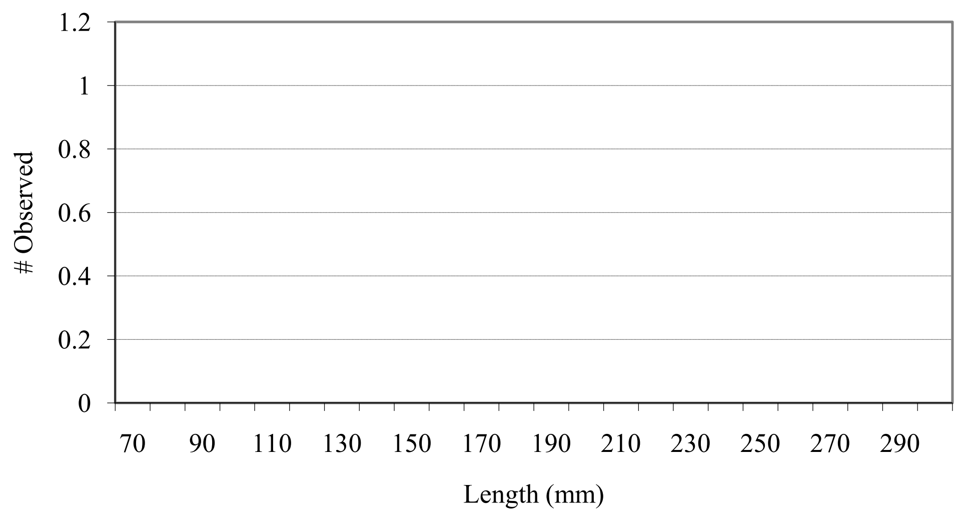


Figure 27. Length frequency distribution of walleye collected from Homer Lake, Cook County, during fall 2010 electrofishing assessments. Zero walleyes were observed in Homer Lake in 2010.

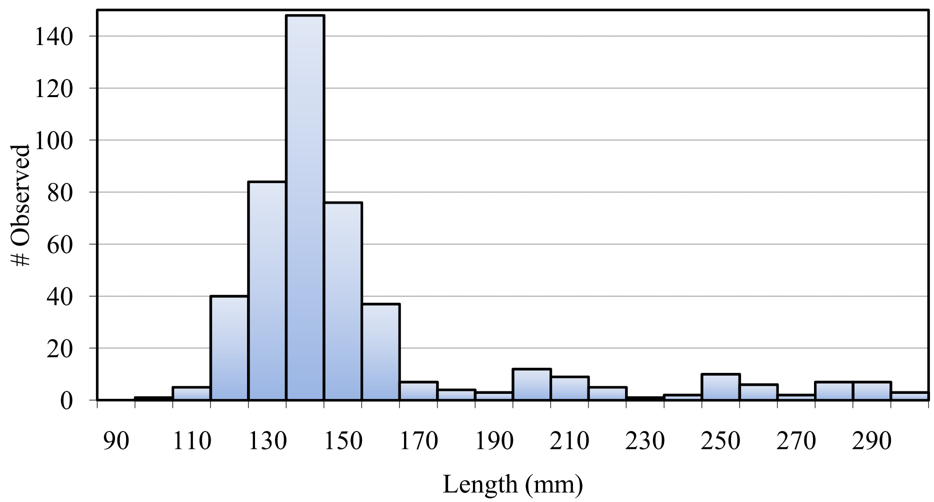


Figure 28. Length frequency distribution of walleye collected from Island Lake Res., St. Louis County, during fall 2010 electrofishing assessments.

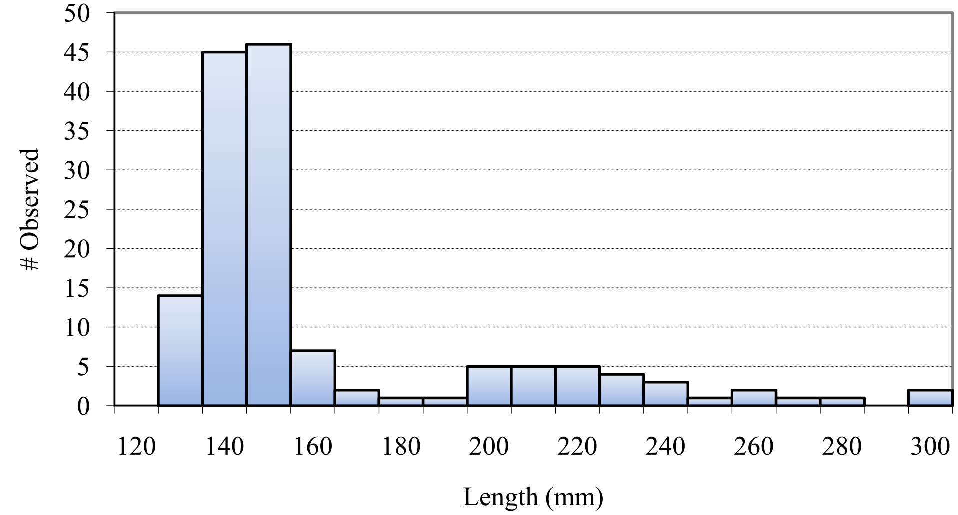


Figure 29. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2010 electrofishing assessments.

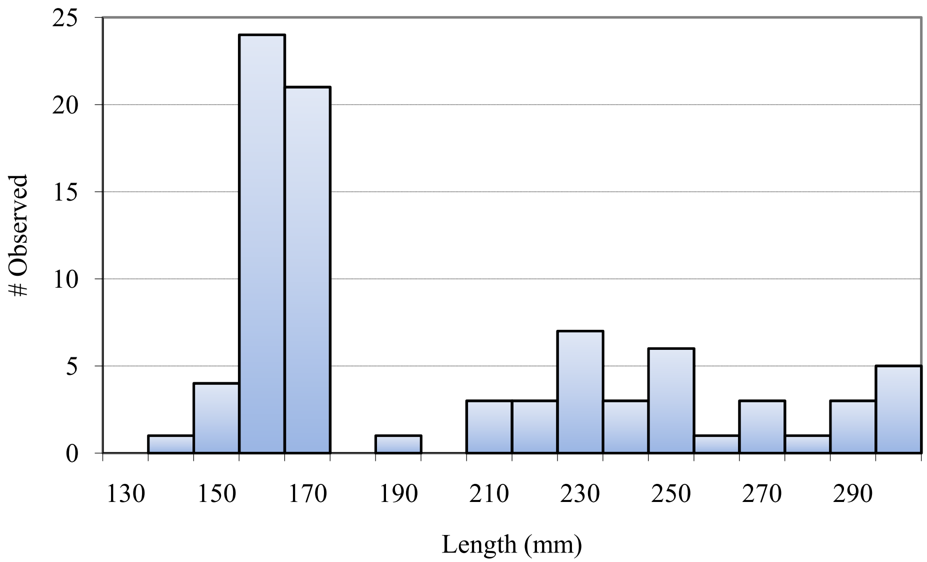


Figure 30. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2010 electrofishing assessments.

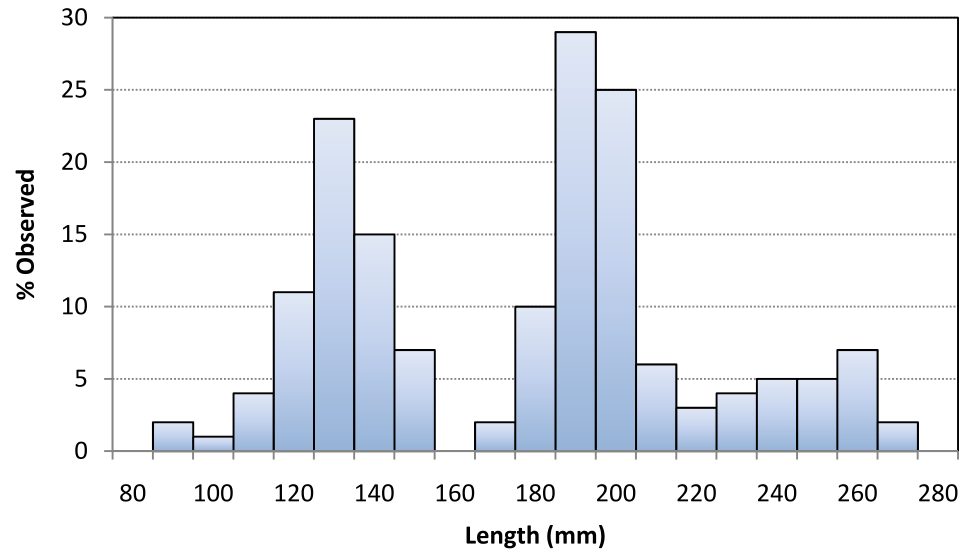


Figure 31. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2010 electrofishing assessments.

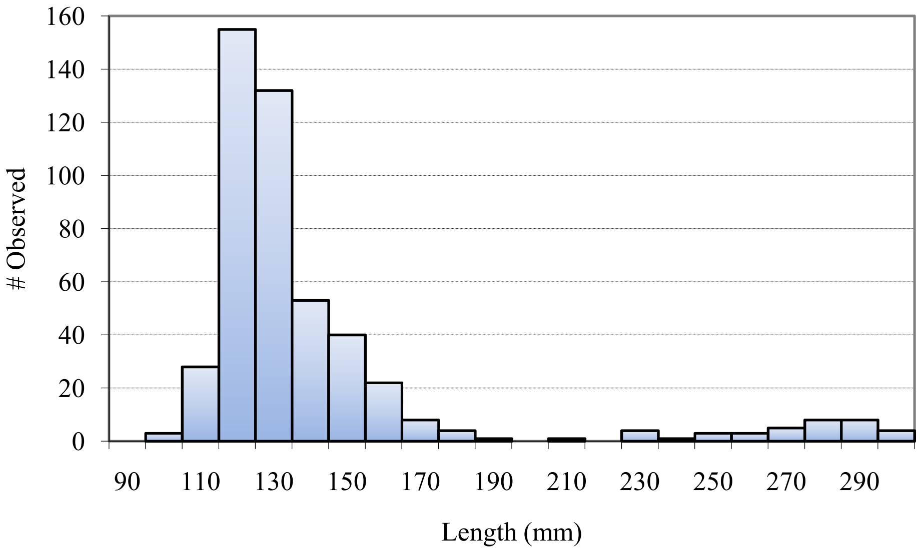


Figure 32. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2010 electrofishing assessments.

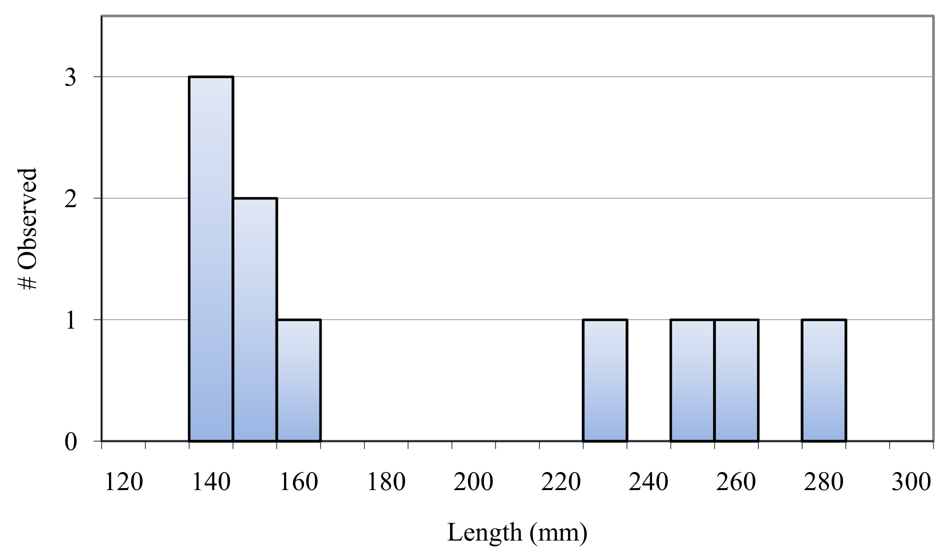


Figure 33. Length frequency distribution of walleye collected from Silver Island Lake, Lake County, during fall 2010 electrofishing assessments.

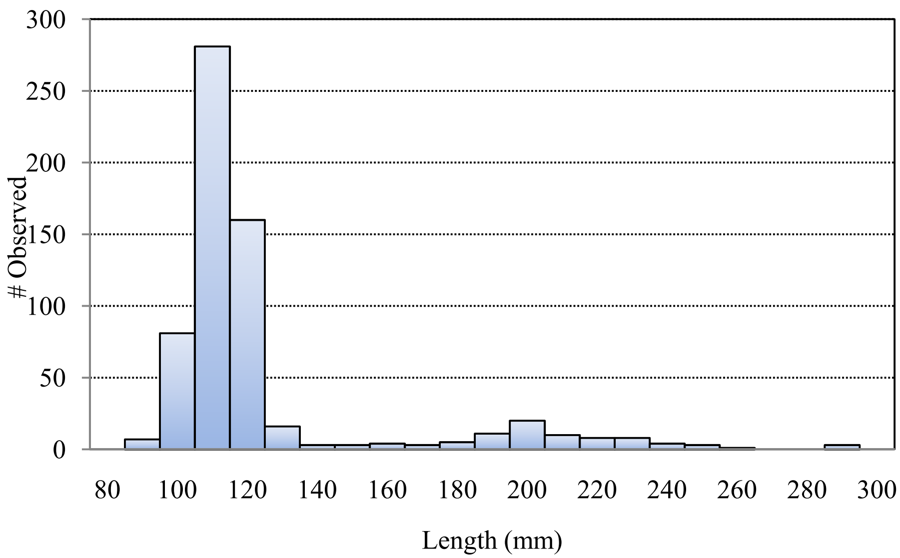


Figure 34. Length frequency distribution of walleye collected from Tait Island Lake, Cook County, during fall 2010 electrofishing assessments.

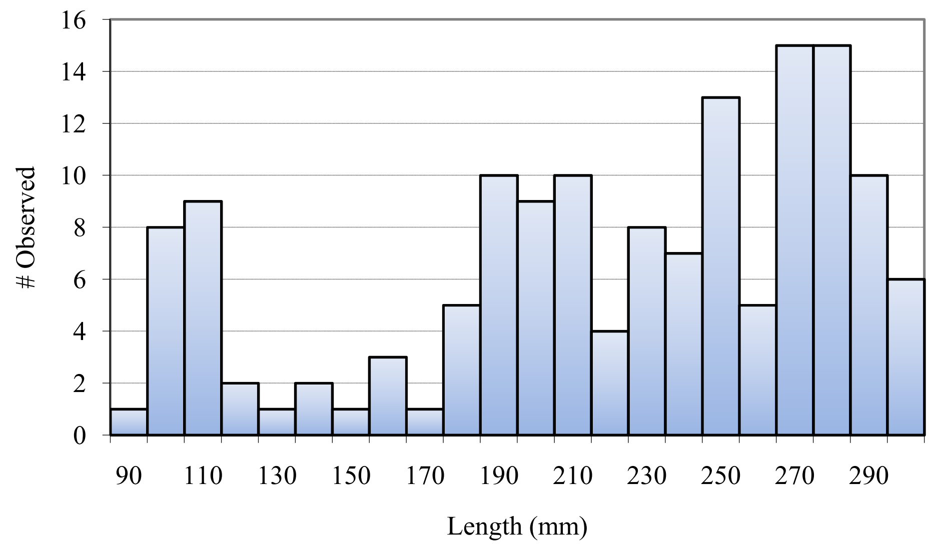


Figure 35. Length frequency distribution of walleye collected from Tom Lake Cook County, during fall 2010 electrofishing assessments.

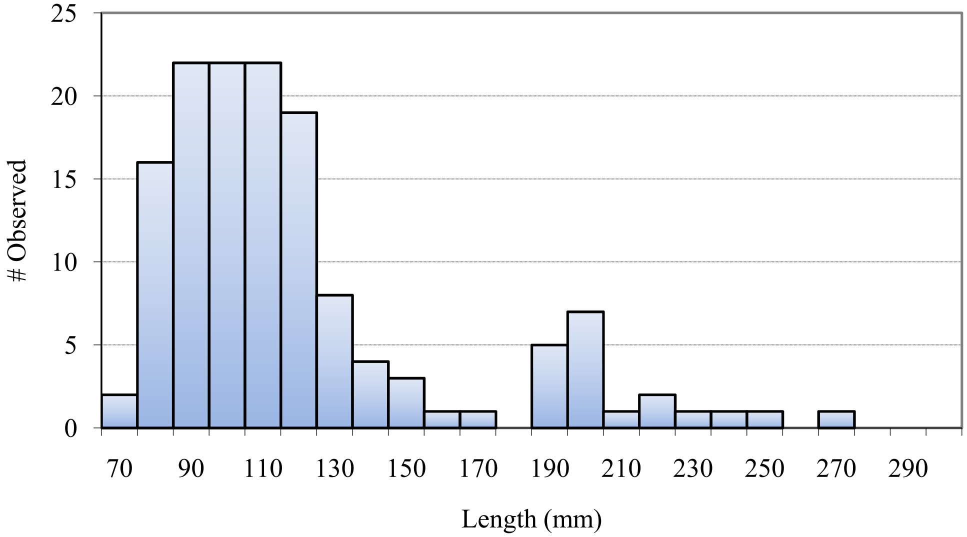


Figure 36. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2010 electrofishing assessments.

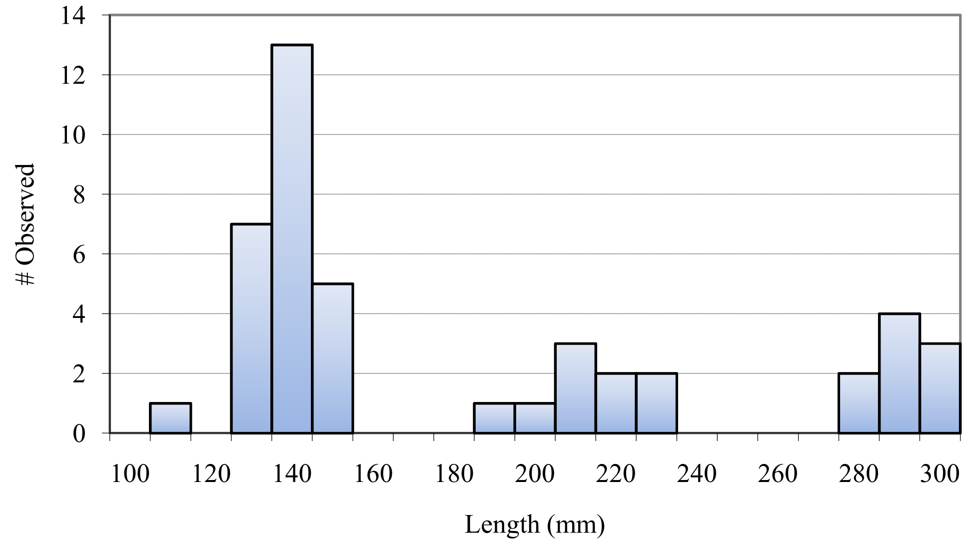


Figure 37. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2010 electrofishing assessments.

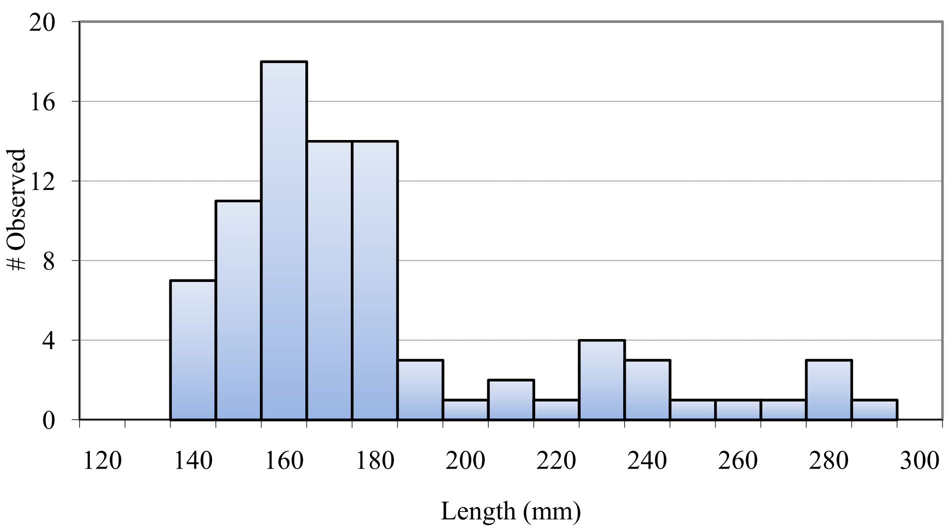


Figure 38. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2010 electrofishing assessments.

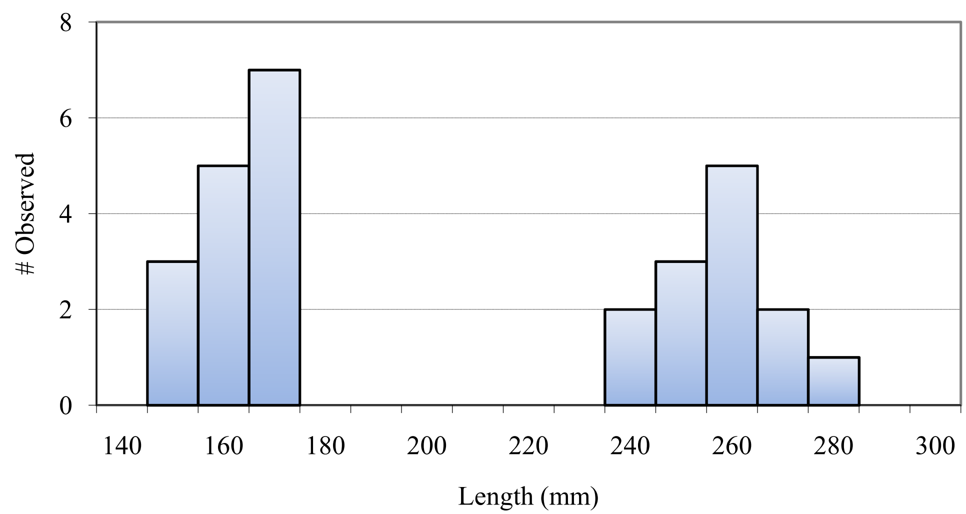


Figure 39. Length frequency distribution of walleye collected from Wild Rice Lake Reservoir, St. Louis County, during fall 2010 electrofishing assessments.

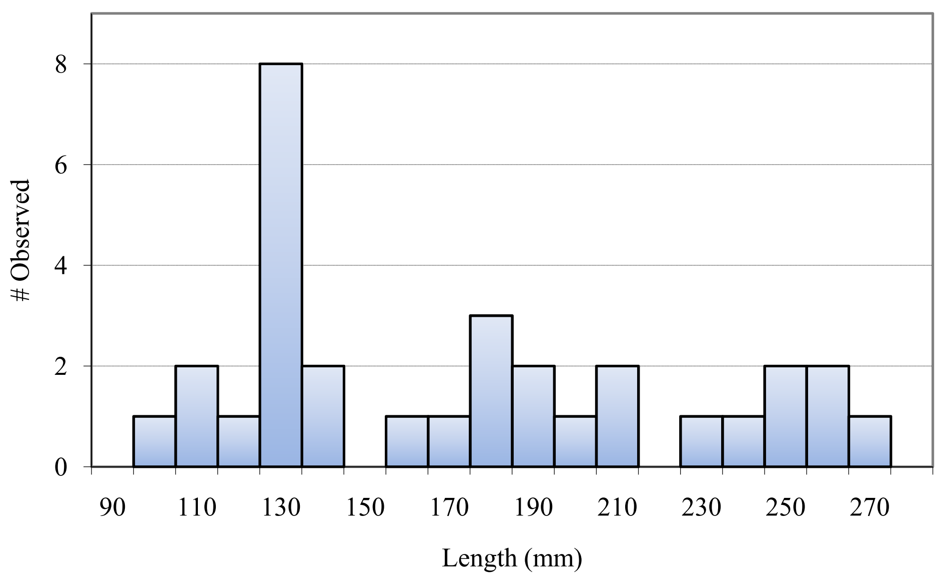


Figure 40. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2010 electrofishing assessments.

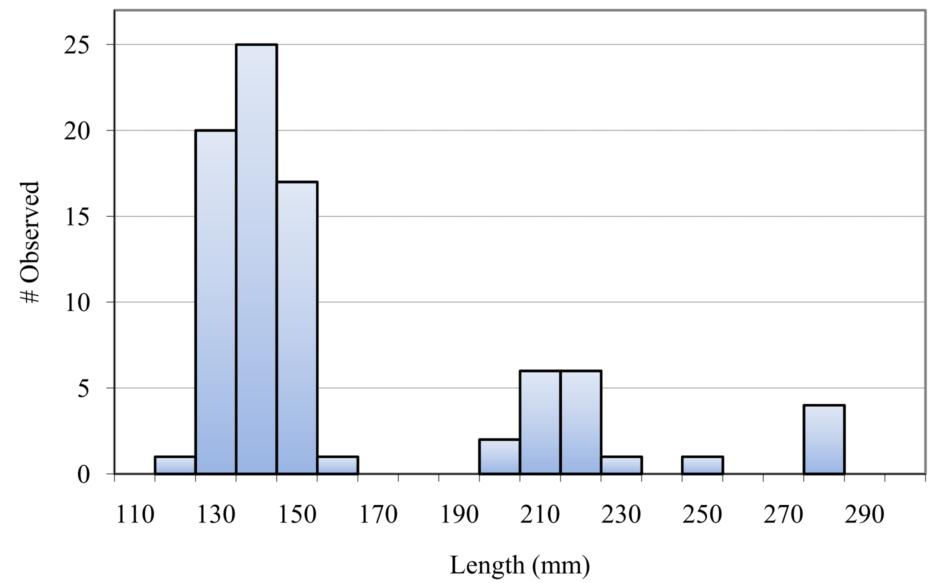
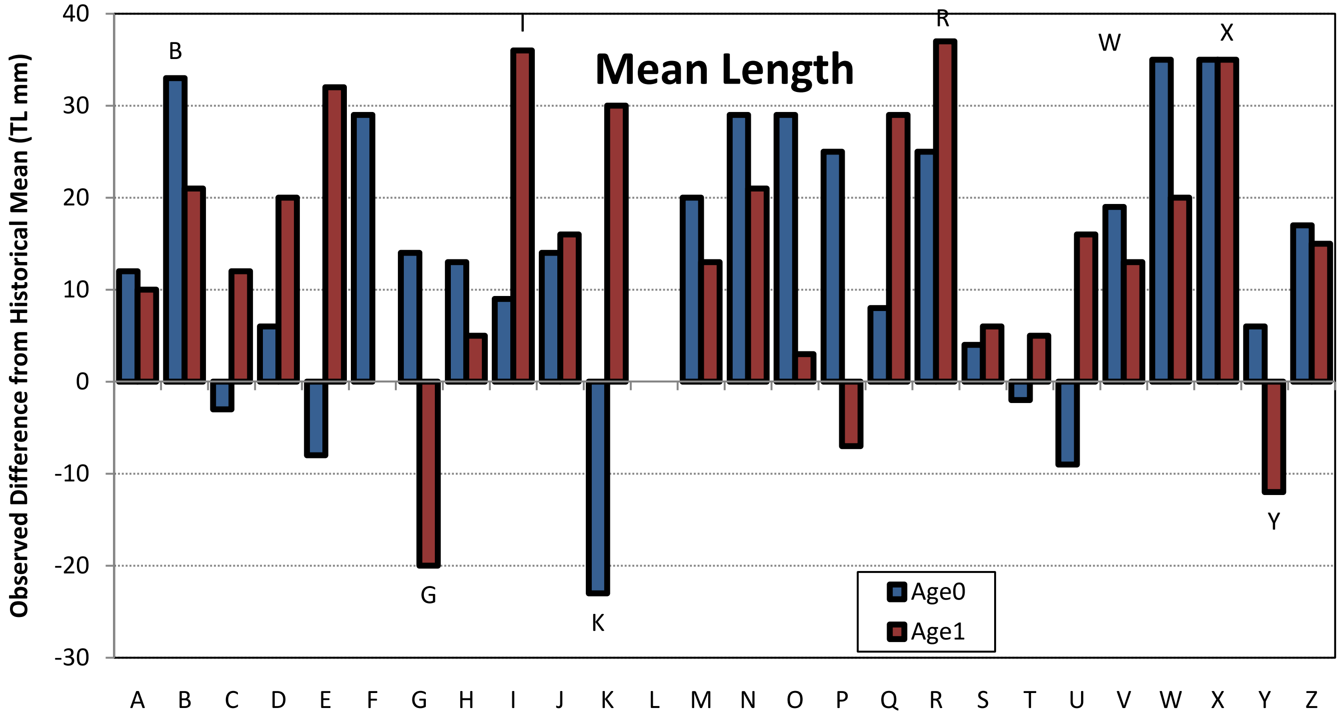


Figure 41. Length frequency distribution of walleye collected from Windy Lake, Lake County, during fall 2010 electrofishing assessments.



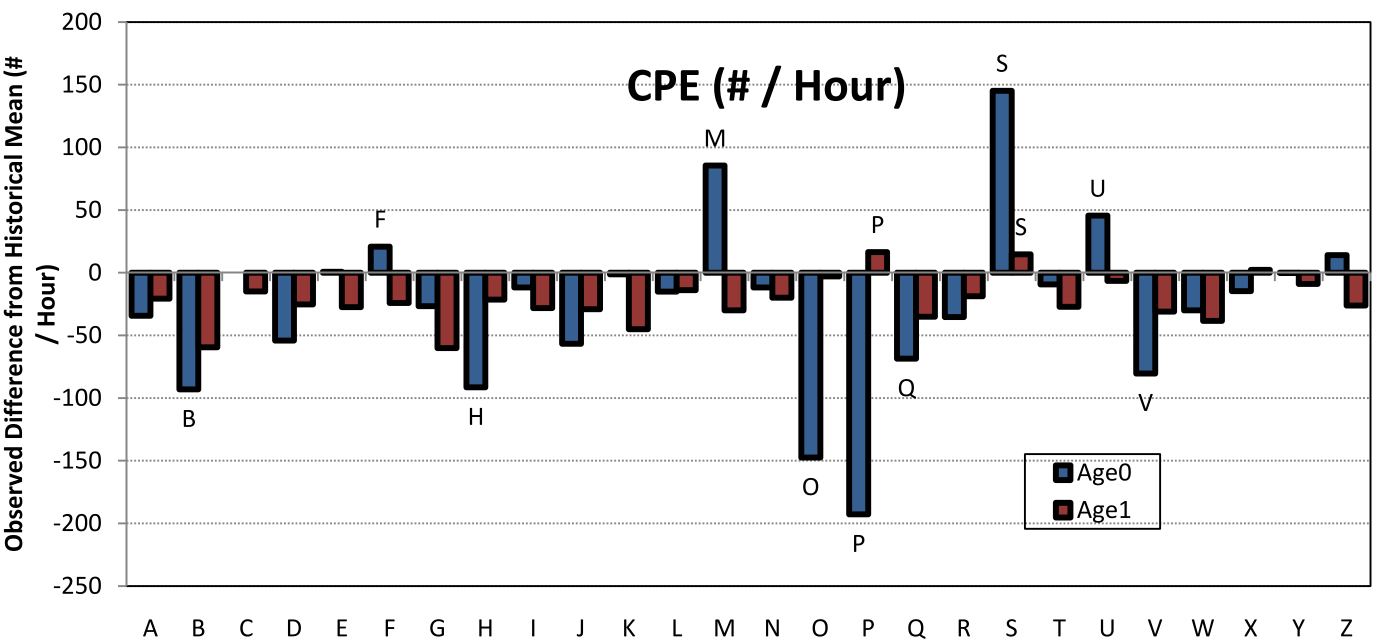


Figure 42. Plots of the differences between 2010 observed mean lengths (mm) and observed mean CPEs (# / hour) by lake and mean historical mean lengths and mean CPEs for age-0 and age-1 walleyes for each lake sampled during fall 2010. Each lake will have an age-0 and an age-1 point. A few data points are labeled as examples.

A - Ball Club	H - Dumbbell	N - N. McDougal	U - Two Island
B - Cadotte	I - Elbow	O - Ninemile	V - West Twin
C - Caribou	J - Fourmile	P - Pike	W - Whiteface
D - Cascade	K - Harriet	Q - Shagawa	X - Wild Rice
E - Crescent	L - Homer	R - Silver Island	Y - Wilson
F - Crooked	M - Island	S - Tait	Z - Windy
G - Devilfish		T - Tom	

Appendix 1. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2010 assessments in Prairie, Fish, Crooked, and Elbow Lakes, and observed in MN DNR summer gill net assessments.

Lake	Date	Marked in Population	Daily Catch	Daily Recap
Prairie	5 April	--	68	--
	MNDNR GN	68	23	0
Fish	6 April	--	947	--
	7 April	940	884	224
	8 April	1557	416	214
	MNDNR GN	1759	75	0
Crooked	9 April	--	42	--
	13 April	42	96	16
	15 April	122	86	45
	MNDNR GN	163	84	13
Elbow	9 May	--	264	--
	10 May	264	280	45
	11 May	499	214	84
	MNDNR GN	629	43	1