Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2006

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

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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 rights 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 2006 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 2006 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.

The second objective for our spring 2006 assessments was to address a concern amongst Tribal fisheries managers. Past surveys in the Ceded Territory have identified several lakes where the size structure of the resident walleye population suggests an unbalanced population, characterized by smaller adults and periodic recruitment. For example, looking at just two lakes in our data base, and comparing the length frequency distribution for Crescent Lake to that of Elbow Lake, a shift is indicated towards smaller individuals in the Crescent Lake population, with a mean length of 320 mm verses a mean length of 408 mm for the Elbow Lake population (Borkholder and Edwards 2003 and 2001). Back-calculated lengths-at-age studies for both populations have indicated very similar growth curves (Borkholder and Edwards 2003 and 2001). Catch curve analysis indicates that mortality is much higher for the Crescent Lake population, nearly 60%, versus the 26% mortality estimate observed for Elbow Lake (unpublished data). Our objective is to estimate the fishing component of total mortality, i.e. exploitation. Three lakes were chosen for tagging in 2006: Island Lake Reservoir (Duluth) as a control representing a balanced walleye population, and Fourmile and Crooked Lakes (Finland) representing unbalanced walleye populations. During spring 2006 assessments, numbered floy tags were attached to all walleye larger than 254 mm (10 inches). During the Island Lake Reservoir tagging portion of this study, MN DNR provided two crews that set and pulled trapnets to increase the number of tagged individuals, while FDL provided one trap net crew. In addition, MNDNR crews assisted with the electrofishing portion of the tagging.

MN DNR personnel conducted a subsequent creel survey on each of the three lakes. Creel clerks

were instructed to look for tags in harvested walleyes. In addition, anglers were able to deposit tags from harvested walleyes in locked boxes at each of the public landings. Tag return data will be used for an additional population estimate, in addition to providing estimates of angler exploitation.

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 final portion of our 2006 walleye surveys targeted juvenile (age-1) and young-of-the-year (age-0) individuals in the fall. The purpose for assessing juvenile and fingerling 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 tagging study for 2006 were Island Lake Reservoir (Duluth Area), and Crooked and Fourmile Lakes (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. Tagged walleye would then be available during the summer gill net assessments conducted by the DNR, thus providing a second population estimate. Further, creel clerks assigned to each of these three lakes would be looking for tagged walleye in the anglers' creels. The data from tag returns would be used for yet a third population estimate, as well as future estimates of fishing mortality, or exploitation. Tom Lake (Grand Marais Area) was added to this year's assessment for population data only, and not included for the tagging portion of the study.

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 floy tags, and the sex determined (male, female, unknown) based upon visual identification of gametes. Walleye that had been tagged during any previous nights' collections were counted as recaptured fish. Unmarked individuals (>

254 mm) were tagged with a uniquely numbered floy tag. A dorsal fin spine from five individuals per centimeter group per sex was removed and placed in a labeled envelope for later aging in the lab. Following tagging 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.

Individual fish capture histories were possible with the numbered tags applied during spring assessments. Program MARK (www.cnr.colostate.edu/~gwhite/software.html) was used to analyze encounter / re-encounter histories of these fish. The electrofishing data was analyzed using a closed capture model, where survival was assumed to be 100% over the short time interval of the electrofishing assessment. This same assumption was made when analyzing the MNDNR's gill net data, in spite of the fact that walleyes were encountered in the creel prior to the gill net survey. We assumed that angler selectivity was equal for tagged and untagged individuals. Thus, the population estimates derived from the gill net data represent the population size at the time of marking, during spring 2006.

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, 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°C and 10.0°C (Borkholder and Parsons, 2001). Warm summer and fall weather required that we postpone our start date by one week from our historical average start date. Fall assessments began in the Grand Marais area on 5 September 2006. Even with the late start, the 20°C threshold was exceeded in five 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 yearling (age-0) individuals.

Results and Discussion

Spring Assessments

Island Lake Reservoir

Electrofishing activities were conducted on Island Lake Reservoir from 17 to 25 April (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 85.7 to 190.7 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Island Lake, determined using each sampling station, was 131.1 ± 11.4 adults per hour and 151.0 ± 14.6 total walleye per hour of sampling effort. Catch rates among the sampling stations were consistently high, with the exception of a station of sand in the West basin, and a few areas up near the Boulder Lake dam. Catch rates ranged from 0.0 adult walleye per hour (EFSand, 24 April 2006) to 504.0 adults per hour (SEF9, 23 April 2006) (Figure 1).

The length frequency of the walleye sampled is presented in Figure 2. Walleye as large as 776 mm (30.6 inches) were observed in the survey. Additional species observed included yellow perch, white sucker, northern pike, smallmouth bass, burbot, trout perch, rock bass, and red horse.

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 12,356 (Table 2). The adjusted Petersen estimate is 139,000 ± 128,000, with a 49.4% CV (Table 2). No weight should be placed upon the Petersen estimate, as it is based solely upon the last evening's sampling when most of the lake was not sampled, and the number of recaptured individuals was very low. Using the closed Petersen model in Program MARK, an electrofishing PE of 15,660 ± 459 was obtained.

In July 2006, the Minnesota Department of Natural Resources performed a standardized net assessment on Island Lake Reservoir (John Lindgren, MN DNR, Duluth Area Fisheries). Of 100 walleye (> 267 mm) sampled in the gill nets that would have been 254 mm during the April assessments (Figure

Figure 1a. Catch per hour of adult walleye on Island Lake (west basin), St. Louis County, during spring 2006 electrofishing surveys.

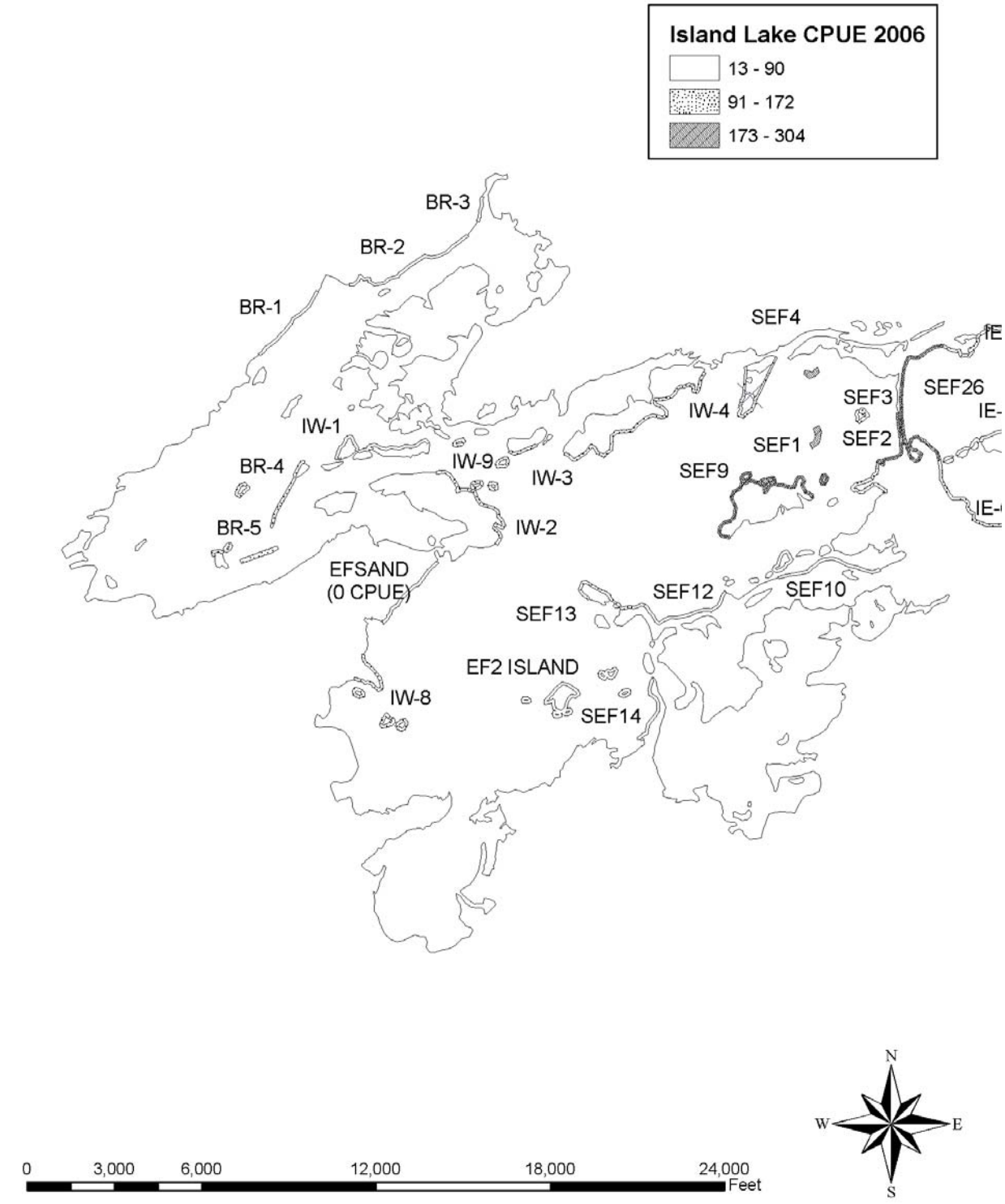


Figure 1b. Catch per hour of adult walleye on Island Lake (east basin), St. Louis County, during spring 2006 electrofishing surveys.

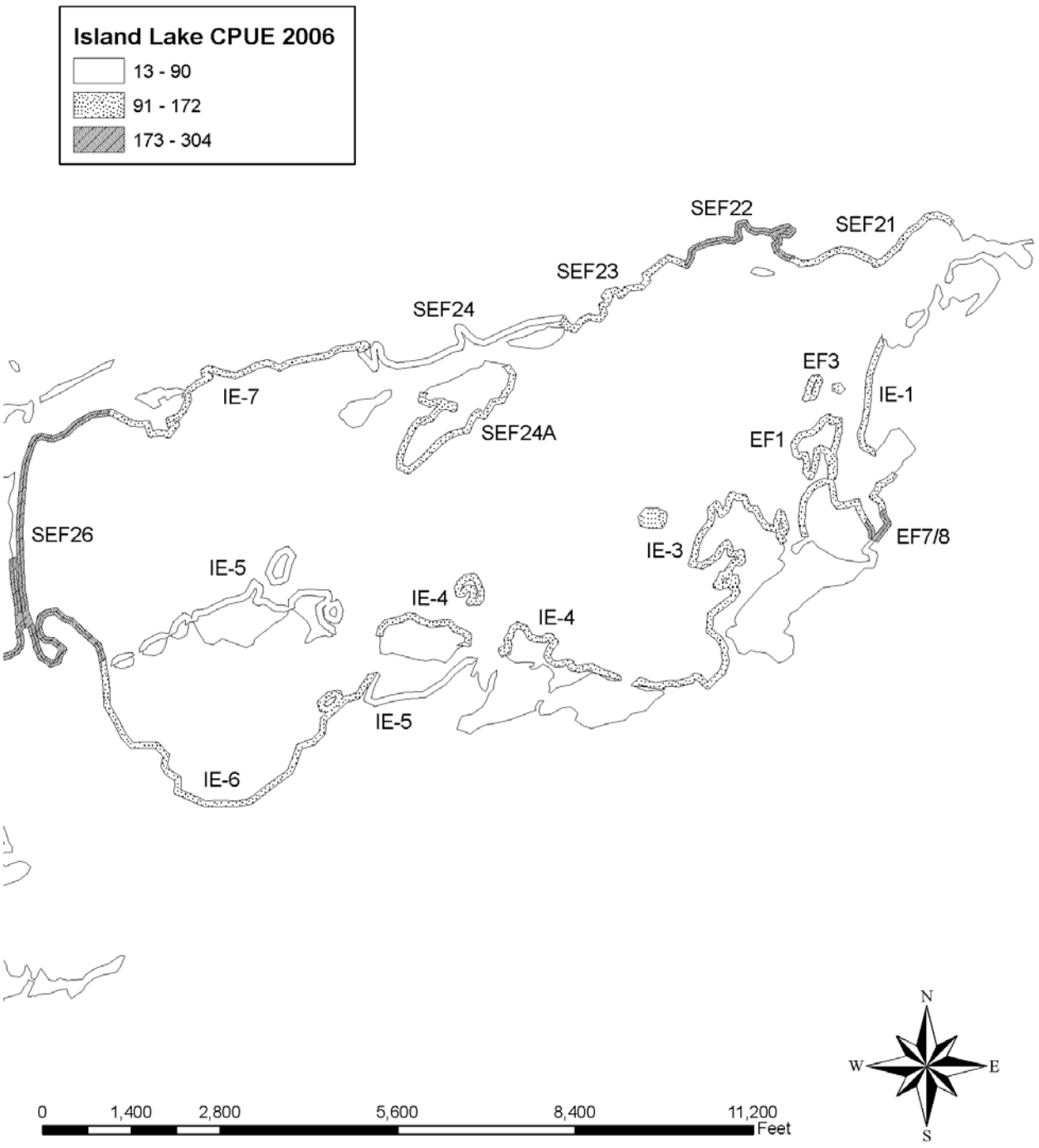


Table 1. Summary of electrofishing activities on four lakes surveyed within the 1854 Ceded Territory, Minnesota, during spring 2006.

ID #	County	Lake	Area (Acres)	Max Depth	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)	Amps	# WAE[2]	CPUE WAE[3]
69-0372	St. Louis	Island	8111.9	94.0	4/17/06	47	61.7	24417	884	4	581	85.7
					4/18/06	47	63.8	19970	884	4	813	146.6
					4/19/06	47	65.3	24431	884	4	908	133.8
					4/20/06	48	61.8	25265	884	4	803	114.4
					4/21/06	50		17666	680 / 850	3	661	134.7
					4/22/06			14617			668	164.5
					4/23/06	52		17251	850	3	646	134.8
					4/24/06	50		9853	850	3	522	190.7
					4/25/06	50	81.5	3505	884	3.5	119	122.2
38-0024	Lake	Crooked	283.0	18.0	4/21/06	50	35.4	6387	1061	3.5	145	81.7
					4/22/06	53	35.7	5566	1061	3.5	160	103.5
					4/23/06	59	35.6	5572	1061	3.5	170	109.8
					4/25/06	45	54.7	7667	1061	5	198	93.0
16-0639	Cook	Fourmile	572.0	19.5	4/21/06	47	41.7	10528	1061	4	216	73.9
					4/22/06	44	42.5	12605	1061	4	476	135.9
					4/23/06	51	42.8	11858	1061	4	277	84.1
					4/24/06	43	54.7	8490	1061	4	374	158.6
16-0019	Cook	Tom	576.0	35.0	4/27/06	48	30.7	8702	1061	3	274	113.4
					4/28/06	49	31.6	7241	1061	3	408	202.8
					4/29/06	50	30.7	7220	1061	2.5	425	211.9

[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 unmarked 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)). This CPUE represents the mean CPUE for each night over all stations sampled.

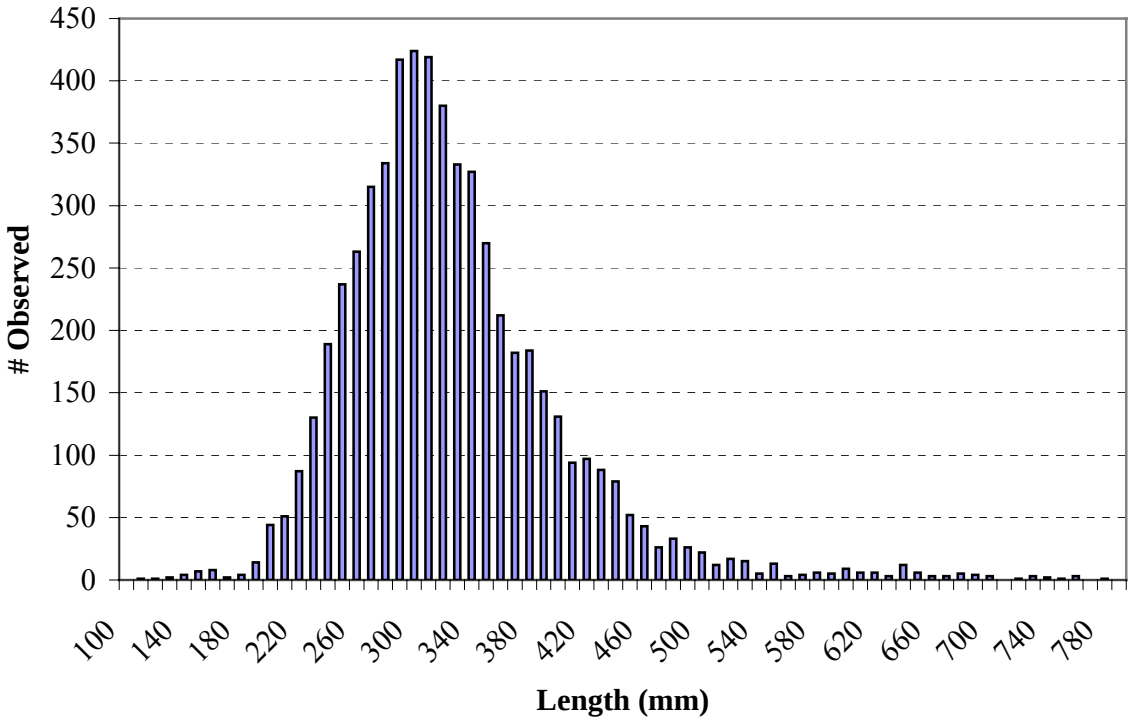


Figure 2. Length frequency distribution of walleye sampled from Island Lake Reservoir, St. Louis County, MN, during spring 2006 electrofishing assessments. Bars do not include counts of recaptured individuals.

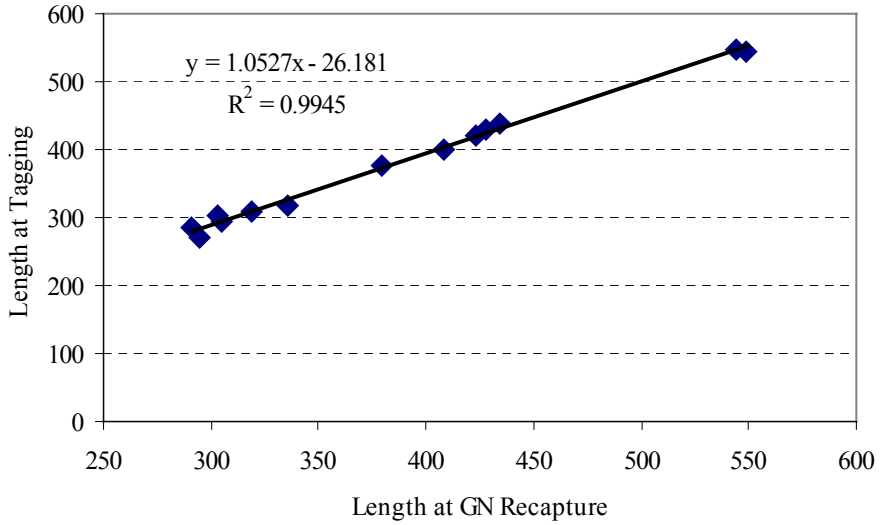


Figure 3. Growth of individually tagged walleye from Island Lake Reservoir, 2006. Lengths are those observed during tagging in April 2006, compared to those tagged individuals observed by the MN DNR during the net survey in June 2006.

Table 2. Walleye population estimates for Island Lake Reservoir (St. Louis County), Crooked and Fourmile Lakes (Lake County), and Tom Lake (Cook County), April 2006. Estimates are for walleye larger than 254 mm (10.0 inches) in April. 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]	Closed Petersen $p_1, p_2=p_2^*$, etc.
Island Lake – EF_{2006}	12,356	7903	28,295	139,000 ± 128,000	49.4%	15,660 ± 459
Island Lake – GN_{2006}	12,905	8369	28169	37,434 ± 23,074	27.3%	16,196 ± 474
Crooked – EF_{2006}	548	501	606	561 ± 100	5.6%	550 ± 19
Crooked – GN_{2006}	683	425	1731	3055 ± 2247	26.5%	673 ± 26
Crooked – EF_{2002}	575	554	599	579 ± 118	6.4%	N/A
Crooked – GN_{2002}	663	363	3763	1632 ± 1356	26.1%	N/A
Fourmile – EF_{2006}	1448	1345	1568	1413 ± 180	4.0%	1456 ± 41
Fourmile – GN_{2006}	1638	1148	2857	5303 ± 3212	21.8%	1617 ± 47
Fourmile – EF_{2001}	895	638	1500	838 ± 237	6.6%	N/A
Fourmile – GN_{2001}	1081	659	3000	2800 ± 2315	26.0%	N/A
Tom – EF_{2006}	1531	1278	1918	1486 ± 365	5.7%	N/A
Tom – GN_{2006}	1744	1397	2319	3335 ± 2041	19.2%	N/A
Tom – GN/TN_{2006}	1964	1273	4286	4185 ± 2202	16.5%	N/A

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

3), only 11 were observed to have a tag from the spring sampling. The adjusted Petersen estimate using both the summer and spring data is 37,434 ± 23,074, with a 27.3% CV (Table 2). The Schumacker and Eschmeyer population estimate from the gill net data is 12,905 (Table 2). Program MARK provided a closed Petersen population estimate of 16,196 ± 474 (Table 2).

Table 3 presents the age data for the walleye collected from Island Lake Reservoir. Of the 5742 unique fish sampled, 4332 were assigned to ages 3 through 5. The 2001, 2002, and 2003 year classes were observed to be stronger than normal during previous fall electrofishing surveys (Borkholder and Edwards 2002b, 2003, & 2004). Total mortality (*Z*) of the Island Lake Reservoir population was estimated at 61.1% (Figure 4). Future analysis of the angler data will partition mortality estimates into angling and natural mortality rates. Table 4 presents back-calculated lengths at age for walleye collected from Island Lake Reservoir.

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 19.9 ± 1.1 (Table 5) suggests smaller 10.0 – 14.9 inch fish dominate the population (Anderson and Weithman 1978). The summer gill net PSD (13.6 ± 6.4) is not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=2.689, 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 2006 assessments (Table 5). PSD metrics calculated from 1998 electrofishing data (PSD = 62.8) (Borkholder and Edwards 1999) and 2006 (PSD = 19.9) electrofishing surveys were significantly different (χ^2=251.1 P>0.05, critical Chi-square value of 3.841). This difference is largely attributable to the strong 2001, 2002, and 2003 year classes that are in the 10.0 to 14.9 inch group (Table 3). This data might suggest that mortality is too high in the larger size classes, e.g. angling mortality. Of the 4981 unique individuals larger than 10.0 inches observed, 3988 of them were stock sized (<15.0 inches). Our creel survey data collected during the 2006 angling season might help explain if it is angling mortality. At the time of this report, that data was not available. It may simply be several strong year classes recruiting into the fishery. A population survey conducted in 4 to 7 years might be able to differentiate between excessive angling mortality and recruitment into the fishery. If it is recruitment, anglers could anticipate good walleye angling over the next few years.

Table 3. Age frequency distribution of walleye from Island Lake Reservoir, St. Louis County, April 2006, based upon the number of fish sampled and aged per size category.

Length Group			AGE												
Inches	mm	N Sampled	3	4	5	6	7	8	9	10	11	12	13	14	15
8	203	80													
8.5	216	154													
9	229	232													
9.5	241	294	294												
10	254	374	374												
10.5	267	416	288	128											
11	279	505	373	132											
11.5	292	550	183	340	26										
12	305	509	117	313	78										
12.5	318	459	40	319	100										
13	330	397		275	122										
13.5	343	313		104	209										
14	356	245		41	191		14								
14.5	368	220		44	176										
15	381	194		10	146	19	19								
15.5	394	140		9	88	44	0								
16	406	128			60	60	8								
16.5	419	106			24	71		12							
17	432	93			14	47	23	9							
17.5	445	60			5	19	16	16		3					
18	457	40				10	12	12		4		2			
18.5	470	39			2	5	17	11	3	2					
19	483	35			1	4	9	10	6	4					
19.5	495	17				2	10	4	1						
20	508	20					11	1	5		1	1			
20.5	521	17					9	6	2						
21	533	7					1	5	1						
21.5	546	11					2	4	3		1				
22	559	5						3	2						
22.5	572	9						3	2	3					
23	584	7						2	2	2	1				
23.5	597	8							6	2					
24	610	8						1		6	1				
24.5	622	10							6	4					
25	635	9							2	5	1	1			
25.5	648	5								4		1			
26	660	4								1	1		1	1	
26.5	673	8								1	5	2			
27	686	3										3			
28	711	3									1		2		
28.5	724	3											3		
29	737	1											1		
29.5	749	3											2		1
30.5	775	1													1
TOTALS		5742	1376	1715	1241	281	151	100	43	41	12	11	9	1	2

Table 4. Back-calculated lengths at age for walleye collected from Island Lake Reservoir, St, Louis County, Minnesota, April 2006.

Age Class	N	Length (mm)	Length (in)
1	471	103	4.1
2	471	191	7.5
3	471	265	10.4
4	426	325	12.8
5	358	383	15.1
6	272	433	17.0
7	221	475	18.7
8	156	515	20.3
9	100	561	22.1
10	64	598	23.5
11	31	634	25.0
12	20	660	26.0
13	11	713	28.1
14	5	715	28.1
15	2	768	30.2

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

Lake	PSD	RSD S-Q	RSD Q-P	RSD P-M	RSD M-T
Island Lake – EF_{2006}	19.9 ± 1.1	80.1 ± 1.1	17.1 ± 1.0	2.0 ± 0.4	0.8 ± 0.2
Island Lake – GN_{2006}	13.6 ± 6.4	86.3 ± 6.4	10.0 ± 5.6	1.8 ± 2.5	0.9 ± 1.8
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
Fourmile Lake – EF_{2006}	49.1 ± 3.1	50.9 ± 3.1	48.2 ± 3.1	0.7 ± 0.5	0.2 ± 0.3
Fourmile Lake – GN_{2006}	45.3 ± 13.4	54.7 ± 13.4	45.3 ± 13.4	0.0 ± 0.0	0.0 ± 0.0
Tom Lake -- EF_{2006}	19.2 ± 2.6	80.8 ± 2.6	18.3 ± 2.6	0.7 ± 0.6	0.2 ± 0.3
Tom Lake -- GN_{2006}	22.6 ± 10.4	77.4 ± 10.4	21.0 ± 10.1	1.6 ± 3.1	0.0 ± 0.0

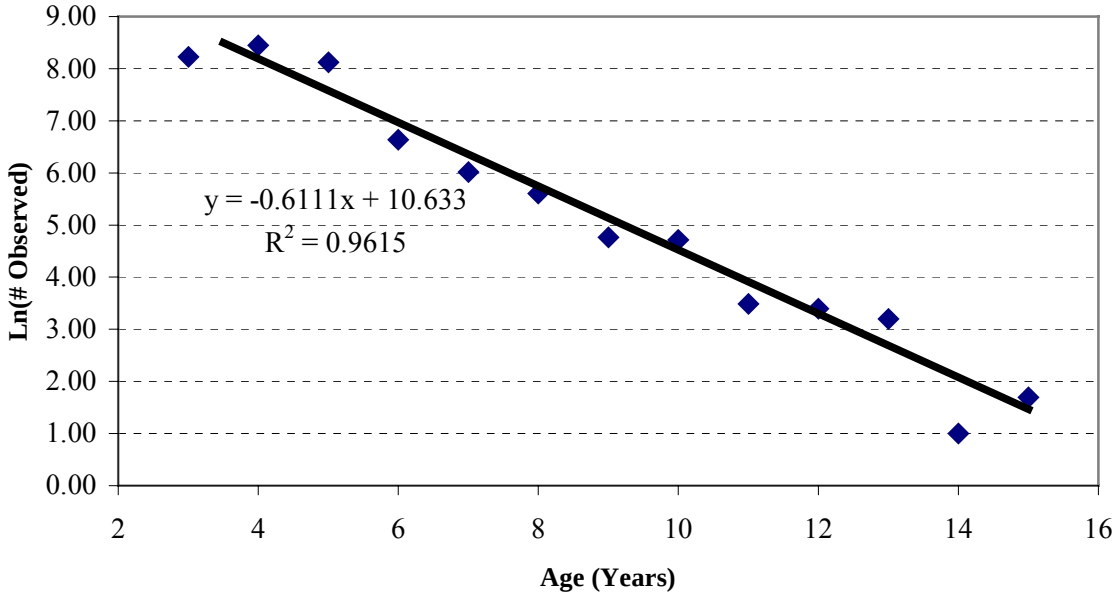


Figure 4. Total mortality (Z) of walleye from Island Lake Reservoir. Estimates are from April 2006 electrofishing data.

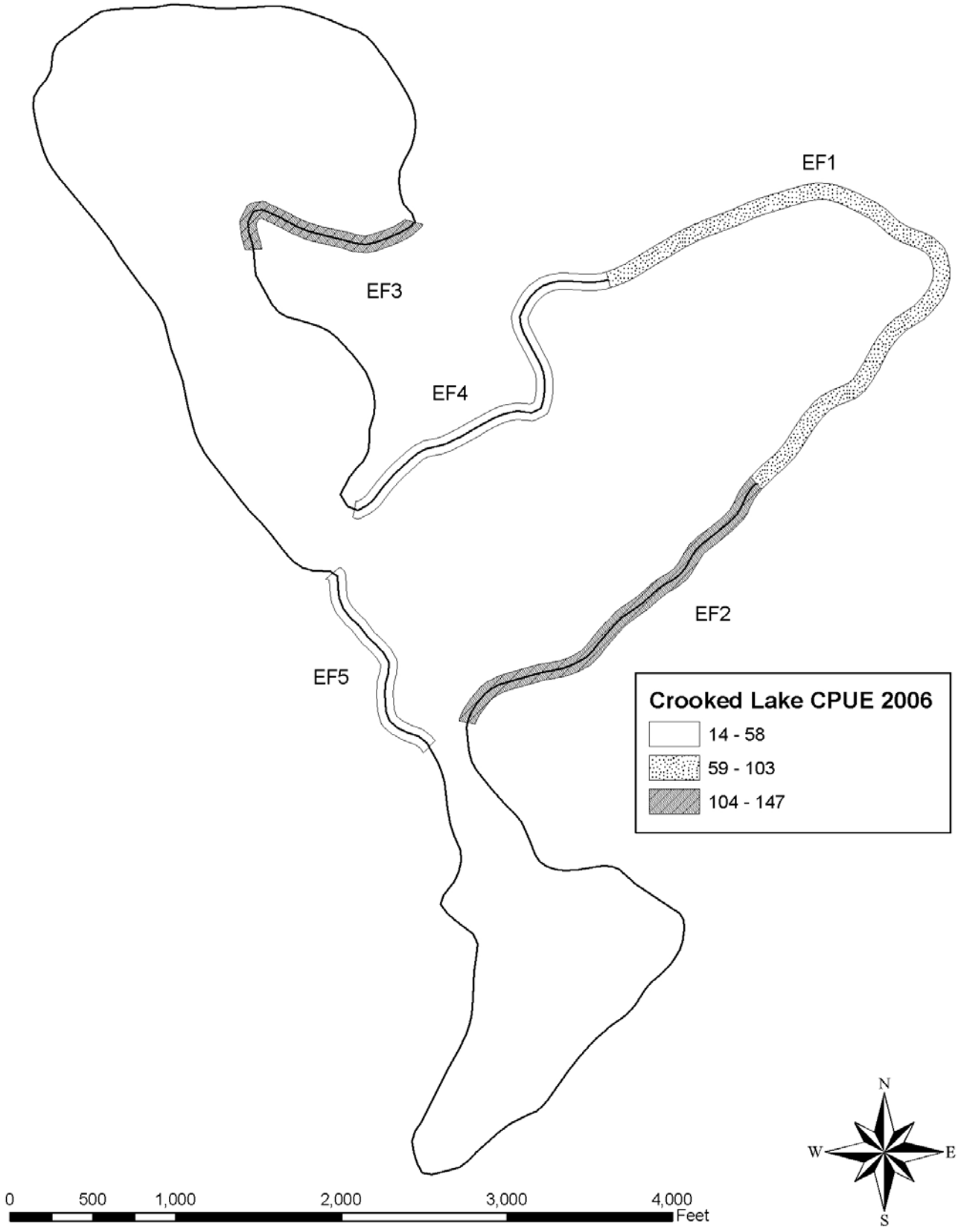
Crooked Lake

Electrofishing activities were conducted on Crooked Lake from 21 through 25 April (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 was relatively high, ranging from 81.7 to 109.8 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Crooked Lake, determined using each sampling station, was 95.7 ± 16.0 adults per hour and 96.0 ± 16.4 total walleye per hour of sampling effort. Additional species observed included yellow perch, white sucker, smallmouth bass, and *Esox* species (presumed northern pike and muskie).

Catch rates among the sampling stations varied. Catch rates were highest every night in the shallow bay at EF3. CPUE was also consistently high at EF1 and EF2. Areas characterized by soft bottom substrates were not surveyed in 2006, and are not labeled on Figure 5. We did not sample these stations since our last survey in 2002 found that walleyes were not using these areas of the lake for spawning activities.

The length frequency of the walleye sampled from Crooked Lake is presented in Figure 6. Table 6 presents the age data for the walleye collected from Crooked Lake. Table 7 presents back-calculated lengths at age for walleye collected from Crooked Lake. Total instantaneous mortality (*Z*) for the Crooked Lake walleye population is estimated at just under 36% (Figure 8).

Figure 5. Catch per hour of adult walleye on Crooked Lake, Lake County, during spring 2006 electrofishing surveys.



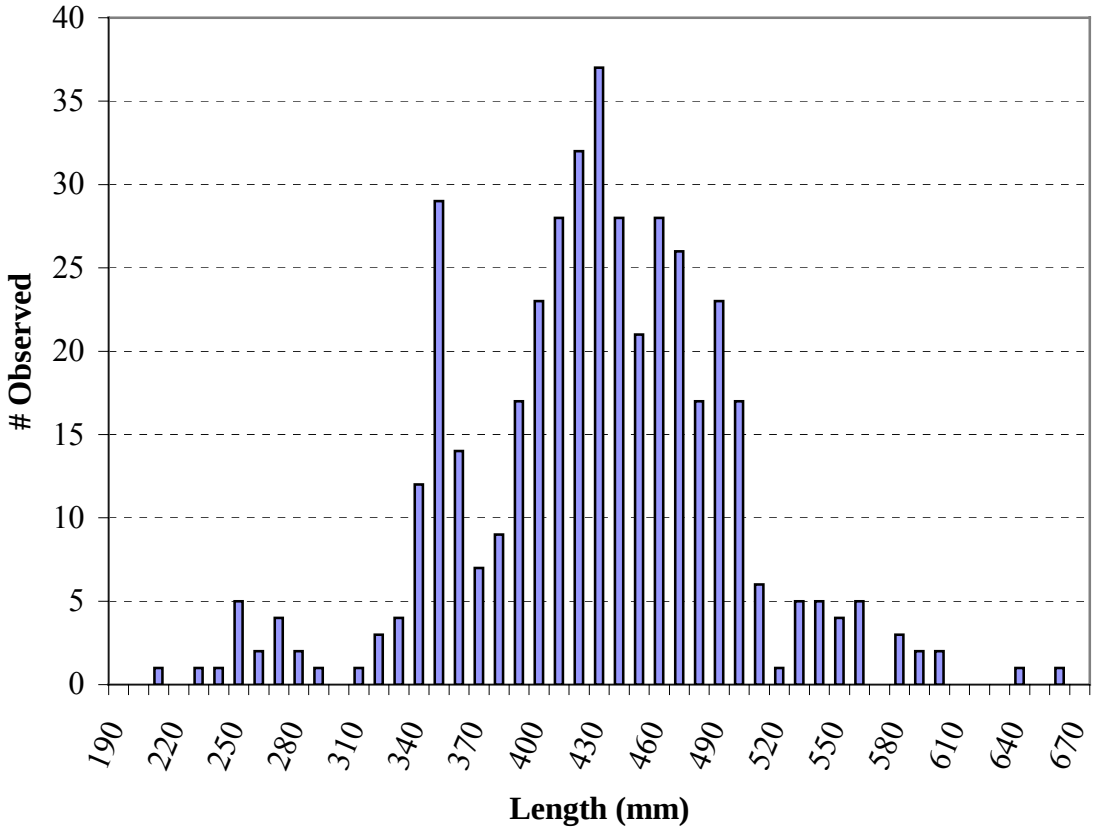


Figure 6. Length frequency distribution of walleye sampled from Crooked Lake, Lake County, MN, during spring 2006 electrofishing assessments. Bars do not include counts of recaptured individuals.

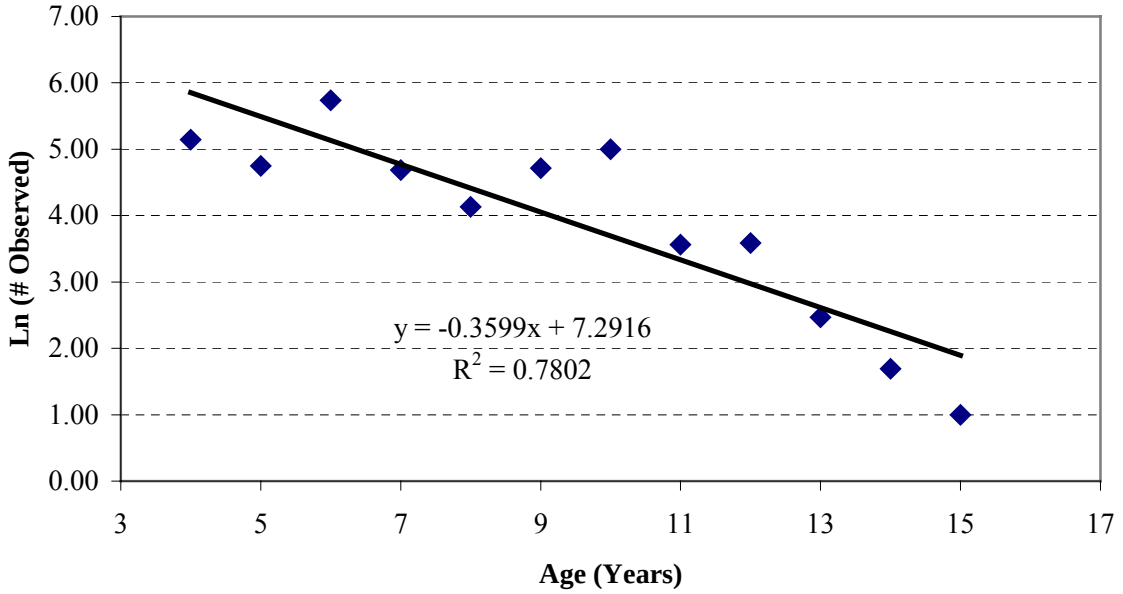


Figure 7. Total mortality (*Z*) of walleye from Crooked Lake. Estimates are from April 2006 electrofishing data.

Table 6. Age frequency distribution of walleye from Crooked Lake, Lake County, spring 2006, based upon the number of fish sampled per size category.

Length Group			AGE												
Inches	mm	N Sampled	3	4	5	6	7	8	9	10	11	12	13	14	15
10	254	5	5												
10.5	267	3	2	1											
11	279	1	1												
11.5	292														
12	305	3		3											
12.5	318	5		5											
13	330	19		19											
13.5	343	30		30											
14	356	13		4	7	2									
14.5	368	9		1	7	1									
15	381	24			11	13									
15.5	394	28			11	14	4								
16	406	42			4	29	8								
16.5	419	43			3	23	10		3	3					
17	432	38				22	3	5	3	5					
17.5	445	34				7	11	9	2	5					
18	457	25				3	3	4	9	6					
18.5	470	31						3	14	8	6				
19	483	22							7	4	2	7	2		
19.5	495	14								9		5			
20	508	3								2		1			
20.5	521	8						1	2	2	1		1		
21	533	3									1	1		1	
21.5	546	7					1		1	3	2				
22	559	1								1					
22.5	572	3								2	1				
23	584	3								3					
23.5	597	1												1	
24	610														
24.5	622														
25	635	1											1		
25.5	648	1													1
TOTAL		420	8	63	43	114	40	23	41	55	13	13	4	2	1

Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 548 (Table 2). The electrofishing adjusted Petersen estimate is 561 ± 100, with a 5.6% CV (Table 2). The closed Petersen model from Program MARK

provided a PE of 550 ± 19 adult spawning walleyes. The 2006 estimates are essentially the same as those obtained in 2002 (Table 2), suggesting the population has changed little over the last four years (Borkholder and Edwards 2003).

In August 2006, the Minnesota Department of Natural Resources performed a standardized net assessment on Crooked Lake (Don Smith, MN DNR, Finland Area Fisheries). Of the 86 walleye larger than 299 mm sampled (individuals that would have been at least 254 mm in April, Figure 7) in gill nets, 10 were observed to have a tag. The adjusted Petersen estimate from the summer data is 3055 ± 2247, with a 26.6% CV, and the Schumacher and Eschmeyer estimate is 683 (Table 2). The closed Petersen model from Program MARK provided a PE of 673 ± 26 adult spawning walleyes. The 2006 gill net population estimates have large confidence intervals. The data does suggest, however, that the population has changed little since 2002 (Table 2) (Borkholder and Edwards 2003).

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. The electrofishing PSD of 79.0 ± 3.9 (Table 5) suggests the population is balanced (Anderson and Weithman 1978), with a large portion of quality-length fish (RSD Q-P = 71.7 ± 4.3).

Significant differences in the PSD estimates were observed between the electrofishing and gill net assessments (χ^2=14.48, P<0.05, Table 5). The PSD for the Crooked Lake population obtained from the 2006 gill net data was 58.67 ± 11.14, with the RSD S-Q (41.33 ± 11.14) and the RSD Q-P (45.33 ± 11.27). The gill net data (RSD S-Q = 41.33) suggests that there is a larger proportion of 10 - 15 inch walleye recruiting into the fishery than is suggested by the electrofishing data (RSD S-Q = 21.0) (χ^2= -3.80 P<0.05, Table 5). Presumably many of these smaller fish may not have been mature and spawning in April, and thus were not vulnerable to our electrofishing gear. Our fall electrofishing surveys suggest that there should be relatively strong 2003 and 2004 year classes recruiting into the population. These two and three year old fish probably were not vulnerable to our electrofishing gear, due to behavioral differences and not participating in the spawning event.

Our estimate of total mortality (36%) is not as high as we estimated in 2002 (Borkholder and Edwards 2003). In this survey, fish were observed as old as 15 years (Table 6). Length data (Figure 6), however, might suggest that angling pressure may still be high, as only 31 individuals were sampled larger than 20.0 inches (RSD P-M = 6.9, RSD M-T = 0.5, Table 5). There may have been some weak year classes over the last decade that made our original estimates of mortality too high. This issue will be addressed once all of the angler tag return data has been analyzed.

Table 7. Back-calculated lengths at each age class for walleye collected from Crooked Lake, Lake County, Minnesota, April 2006.

Age Class	N	Length (mm)	Length (in)
1	188	115	4.5
2	188	207	8.1
3	182	295	11.6
4	156	358	14.1
5	130	409	16.1
6	92	438	17.2
7	77	462	18.2
8	66	485	19.1
9	46	505	19.9
10	19	514	20.2
11	11	522	20.6
12	6	552	21.7
13	4	593	23.3
14	1	625	24.6
15	1	657	25.9

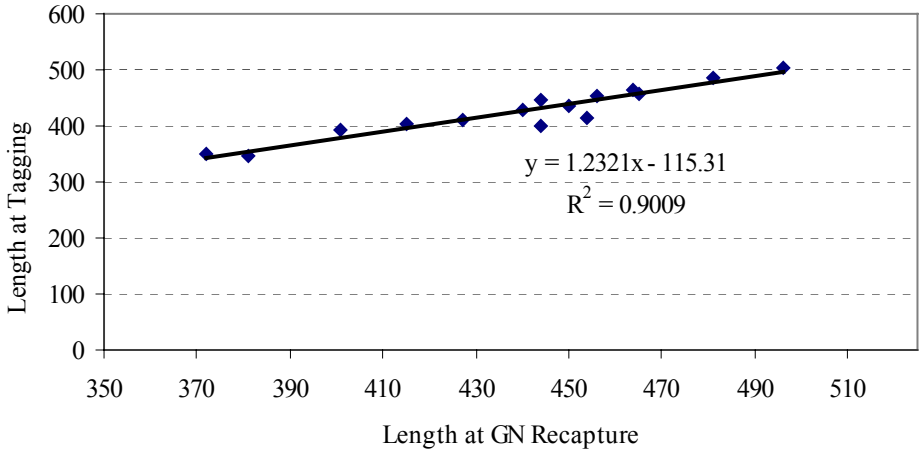


Figure 7. Growth of individually tagged walleye from Crooked Lake, 2006. Lengths are those observed during tagging in April 2006, compared to those tagged individuals observed by the MN DNR during the net survey in August 2006.

Fourmile Lake

Electrofishing activities were conducted on Fourmile Lake from 21 through 24 April (Figure 9). Table 1 presents mean water temperature, conductivity, number of walleye sampled, and CPUE for walleye. CPUEs for each night ranged from 73.9 to 158.6 adult walleyes per hour of on-time. At an 80% confidence interval, mean CPUE for Fourmile Lake, determined using catch data from each sampling station, was 112.2 ± 22.2 adults per hour and 113.0 ± 22.0 total walleye per hour of sampling effort. Length frequency data of walleye collected is presented in Figure 10. Additional species observed included yellow perch, white sucker, northern pike, and blacknose shiner.

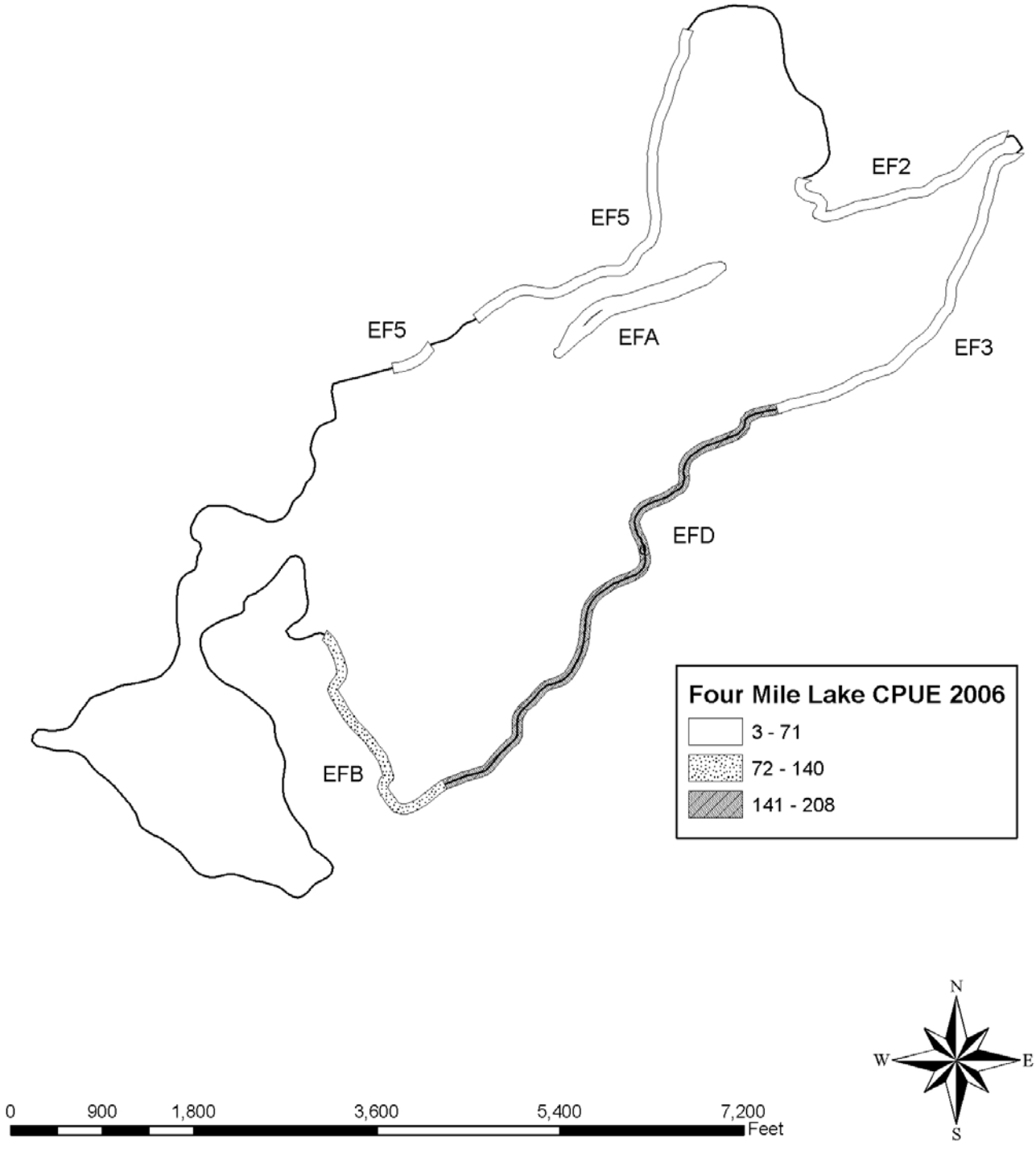
Table 8 presents the age frequency distribution for Fourmile Lake in April 2006. The large number of age-4 and age-5 walleye observed correspond to two very strong year-classes observed during fall assessments (Borkholder and Edwards 2002 & 2003). Back-calculated length-at-age estimates are presented in Table 9. Total instantaneous mortality was estimated to be 48.1% (Figure 11).

Table 2 presents the population estimates based upon electrofishing mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 1448 (Table 2). The electrofishing adjusted Petersen estimate is 1413 ± 180, with a 4.0% CV (Table 2). The closed Petersen model estimates 1456 ± 41 (Table 2).

In August 2006, the Minnesota Department of Natural Resources performed a standardized net assessment on Fourmile Lake (Don Smith, MN DNR, Finland Area Fisheries). Of the 83 walleye larger than 295 mm sampled (individuals that would have been 254 mm in April, Figure 12) in the gill nets, 15 were observed to have a tag. The adjusted Petersen estimate from the summer data is 5303 ± 3212, with a 21.8% CV, and the Schumacher and Eschmeyer estimate is 1638 (Table 2). The closed Petersen estimate is 1617 ± 47 adult spawning walleyes.

In 2001, we performed similar spring electrofishing assessments on Fourmile Lake. The Schumacker and Eschmeyer population estimate calculated in 2001 was 895, and the Petersen estimate of 838 (CV 6.6%) (Borkholder and Edwards 2002). Estimates from the 2001 gill net assessment were 1081 and 2800 (CV 26.0%), respectfully. Comparing our 2001 estimates with those from this year's assessments, it appears that the abundance of spawning adult walleye has increased substantially. Catch curve analysis indicates that total mortality may be as high as 48.1% (R^2 = .899) (Figure 11). Future analysis of the angler data collected this past summer will partition estimates of total mortality into angling and natural mortality rates.

Figure 9. Catch per hour of adult walleye on Crooked Lake, Lake County, during spring 2006 electrofishing surveys.



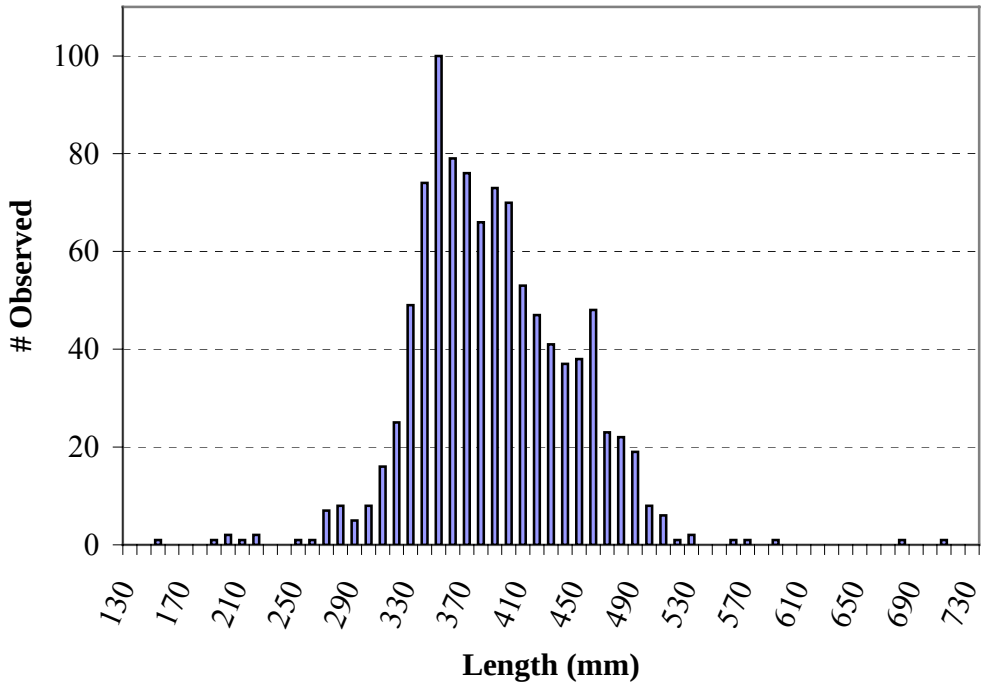


Figure 10. Length frequency distribution of walleye sampled from Fourmile Lake, Cook County, MN, during spring 2006 electrofishing assessments. Bars do not include counts of recaptured individuals.

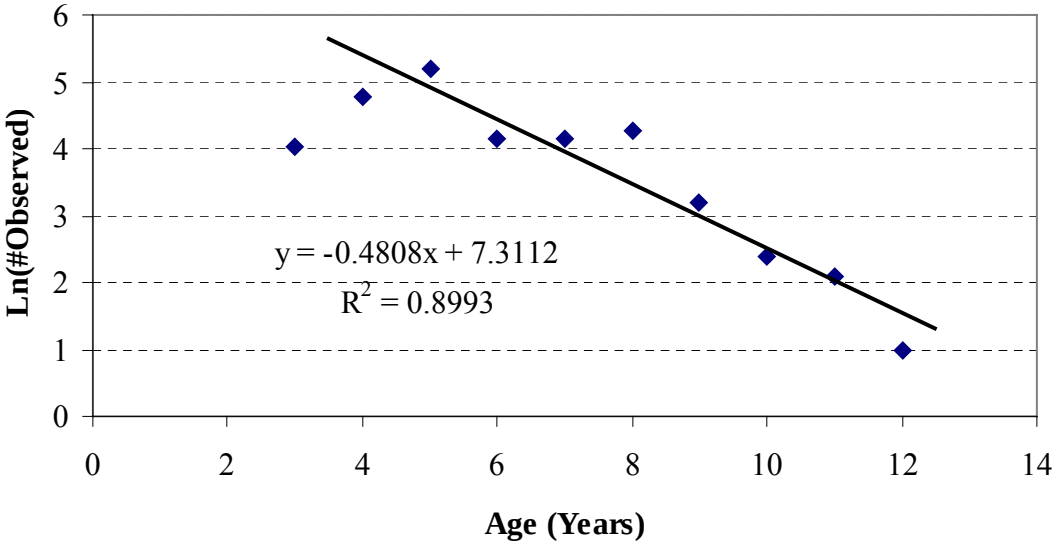


Figure 11. Total mortality (*Z*) of walleye from Fourmile Lake. Estimates are from April 2006 electrofishing data.

Table 8. Age frequency distribution of walleye from Fourmile Lake, Cook County, spring 2006, based upon the number of fish sampled and aged per size category.

Length Group			Age											
Inches	mm	N Sampled	3	4	5	6	7	8	9	10	11	12	17	18
10	254	5	4	1										
10.5	267	11	11											
11	279	6	6											
11.5	292	11	6	5										
12	305	30	10	20										
12.5	318	56		56										
13	330	97		97										
13.5	343	121		109	12									
14	356	101		30	71									
14.5	368	76		19	57									
15	381	96			86	10								
15.5	394	76		5	61	10								
16	406	62			47	16								
16.5	419	52			24	24	3							
17	432	49			5	16	22	5						
17.5	445	53			7	10	23	10	3					
18	457	40				0	22	18						
18.5	470	32				2	9	13	8					
19	483	13				1	1	6	3	1				
19.5	495	11						5	1	2	2			
20	508	2								1	1			
20.5	521	2						2						
21	533	1							1					
21.5	546	1						1						
22	559													
22.5	572													
23	584	1										1		
23.5	597													
24	610													
24.5	622													
26.5	673	1											1	
														1
27.5	699	1												
TOTAL		1007	37	342	370	89	82	60	16	5	3	1	1	1

Table 9. Back-calculated lengths at age for walleye collected from Fourmile Lake, Cook County, Minnesota, April 2006.

Age Class	N	Length (mm)	Length (in)
1	223	108	4.2
2	223	199	7.8
3	223	276	10.9
4	202	336	13.2
5	157	385	15.2
6	92	415	16.3
7	68	445	17.5
8	45	468	18.4
9	19	479	18.8
10	10	498	19.6
11	6	519	20.4
12	3	557	21.9
13	2	573	22.6
14	2	593	23.3
15	2	615	24.2
16	2	645	25.4
17	2	675	26.6
18	1	705	27.8

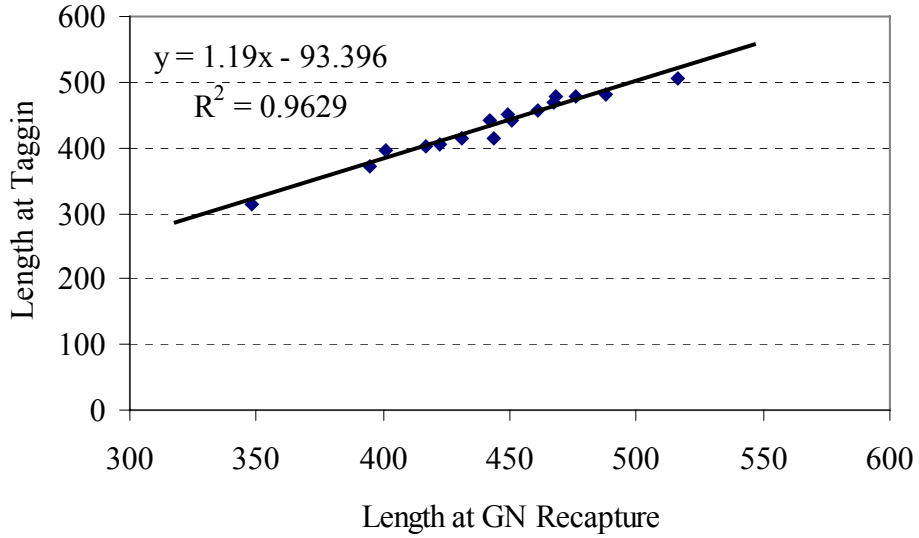


Figure 12. Growth of individually tagged walleye from Fourmile Lake, 2006. Lengths are those observed during tagging in April 2006, compared to those tagged individuals observed by the MN DNR during the net survey in August 2006.

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. The PSD estimated from the spring electrofishing survey is 49.1 ± 3.1. Very few individuals (N=9) were observed in the population larger than 20.0 inches (RSD P-M = 0.7, RSD M-T = 0.2, Table 5, Figure 10). Samples collected by electrofishing during spring 2001 (PSD_{2001}= 70.5 ± 3.9) (Borkholder and Edwards 2002) and again in 2006 (PSD_{2006} = 49.1 ± 3.1) were significantly different (χ^2 = 65.16, P<0.05, critical Chi-square value of 3.841) (Table 5). The 2001 sample appeared to have a higher proportion of "quality" length walleye than the 2006 sample, which was dominated by "stock" sized walleyes in the 10 – 15 inch range. Our fall assessment data, as well as the age data from this spring (Table 8), suggests strong 2001 and 2002 year classes are recruiting into the spawning population, and presumably into the angler's creel.

The 2005 metrics illustrate that there are a lot more fish in the 10.0 to 14.9 inch range (RSD_{2006} S-Q = 50.9) this year than what was observed in 2001 (RSD_{2001} S-Q = 29.5, Borkholder and Edwards 2002). This corresponds well to the relatively strong 2002 and 2003 year-classes observed during fall recruitment surveys (Borkholder and Edwards 2002 & 2003). PSD values will no doubt increase in the future as walleye continue growing.

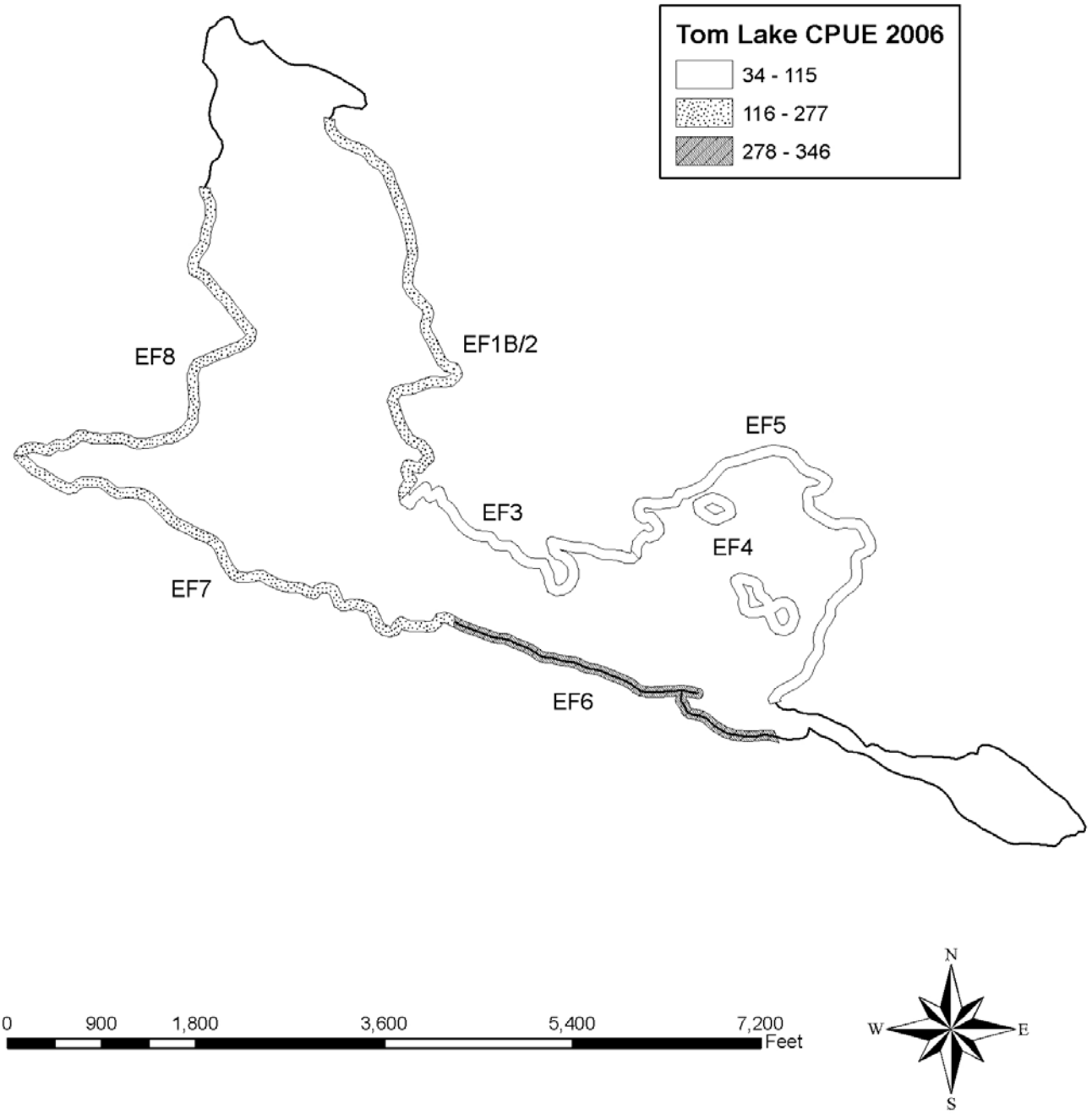
The PSD value from the MN DNR's 2006 gill net assessment is 45.3 ± 13.4 (Table 5), and is not significantly different than that calculated using the 2006 electrofishing (χ^2 = 0.287, P>0.05, critical Chi-square value of 3.841) (Table 5). Within the gill net sample of 87 fish larger than 10 inches, 43 of these were smaller than 15 inches (RSD S-Q = 54.7, Table 5). The majority of these fish are no doubt from the strong 2002 and 2003 year-classes discussed above, and will soon be recruiting to "quality" sized individuals (> 15.0 inches).

Between both of the two gear types in 2006, only 9 individuals (N_{total} = 1136) sampled were larger than 508 mm (20.0 inches). This may reflect a situation where either mortality (angling harvest) is cropping out the larger individuals from the population, or food resources are limited. Growth rates at the earliest ages do not appear to be too slow, relative to other area populations, thus suggesting that angling mortality might be limiting this population. This will be addressed using the tag return and creel survey data from this past angling season, to be analyzed when the study is completed following the 2006 angling year.

Tom Lake

Electrofishing activities were conducted on Tom Lake between 27 and 29 April (Figure 13). 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 was quite high, ranging between 113.4 and 211.9 adult walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Tom Lake,

Figure 13. Catch per hour of adult walleye on Tom Lake, Cook County, during spring 2006 electrofishing surveys.



determined using each sampling station, was 172.2 ± 35.7 adults per hour and 182.0 ± 35.3 total walleye per hour of sampling effort. Additional species observed included yellow perch, white sucker, whitefish, burbot and northern pike.

Catch rates among the sampling stations varied, but were generally quite high. Areas characterized by soft bottom substrates were not surveyed in 2006, and are not labeled on Figure 13. We did not sample these stations since previous surveys suggested that walleyes were not using these areas of the lake for spawning activities.

The length frequency of the walleye sampled from Tom Lake is presented in Figure 14. Table 10 presents the age data for the walleye collected from Tom Lake. Table 11 presents back-calculated lengths at age for walleye collected from Tom Lake. Of the walleye sampled larger than 10.0 inches, 40.4% of those were assigned to the 2001 year class (age 5). Since beginning our fall surveys on Tom Lake, the 2001 year class remains the strongest we have observed (CPUE Age-0 = 92.7 fish / hour, (Borkholder and Edwards 2002b); CPUE Age-1 = 110.1 fish / hour (Borkholder and Edwards 2003)). The age data suggests that walleye in Tom Lake either are fully recruited into the spawning population by age 5 (Figure 15), or the 2001 year class is just that much stronger than the 2002 and 2003 year classes. Catch curve analysis suggests that total mortality *Z* of the Tom Lake population is 48.45% (Table 15), which is lower than other populations we have observed in Northeast Minnesota.

Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 1531 (Table 2). The electrofishing adjusted Petersen estimate is 1486 ± 365, with a 5.7% CV (Table 2). We were not able to use Program MARK to analyze the Tom Lake data as we did not use individually numbered tags, and thus do not have individual capture histories. The 2006 data suggests that the population size of walleyes in Tom Lake is much higher that it was in 2001 (Borkholder and Edwards 2002), when we estimated the population at around 700 individuals.

In July 2006, the Minnesota Department of Natural Resources performed a standardized net assessment on Tom Lake (Steve Persons, MN DNR, Grand Marais Area Fisheries). Of the 72 walleye larger than 280 mm sampled (individuals estimated to have been at least 254 mm in April) sampled from the gill nets, 18 were observed to have a clipped dorsal fin ray. The adjusted Petersen estimate from the summer data is 3335 ± 2041, with a 19.2% CV, and the Schumacher and Eschmeyer estimate is 1744 (Table 2). Using the gill net and trap net data from Tom Lake, 134 walleye larger than 280 mm were sampled, and 27 were observed to have a clipped dorsal fin ray. The adjusted Petersen estimate from the summer data is 4185 ± 2202, with a 16.5% CV, and the Schumacher and Eschmeyer estimate is 1964 (Table 2).

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. The PSD estimated from the spring electrofishing survey is 19.2 ± 2.6. The majority of the sampled walleyes were "stock" size, between 10.0 and 14.9 inches (RSD S-Q = 80.8 ± 2.6). Very few individuals (N=11) were observed in the population larger than 20.0 inches (RSD P-M = 0.7, RSD M-T = 0.2, Table 5). PSD and RSD values estimated from the gill net sample were not significantly different than those estimated from the spring electrofishing survey (Table 5). This low PSD is probably a function of the high proportion of "stock" sized from the very strong 2001 year class (age 5) and the apparently strong 2002 year class (age 4) (Table 10), and not a function of over-harvest of the larger individuals.

Samples collected by electrofishing during spring 2001 (PSD_{2001}= 48.3 ± 4.8) (Borkholder and Edwards 2002) and again in 2006 (PSD_{2006} = 19.2 ± 2.6) showed significant differences in PSD values between the two years (χ^2 = 115.8, P<0.05, critical Chi-square value of 3.841) (Table 5). The 2001 sample appeared to have a higher proportion of "quality" length walleye than the 2006 sample. Only 8 walleye sampled in 2006 were larger than 20 inches (Table 10), which is exactly what we observed in 2001 (Borkholder and Edwards 2002). We have fall age-0 data going back as far as 2000. We have no way of knowing whether the lack of these older year classes observed in the 2006 sample (Table 10) is due to poor spawning and recruitment during the years preceding 2000, or due to excessive angling mortality recently. The age data (Table 10) suggests that Tom Lake walleye mature and essentially stop growing, as ages were observed in walleyes less than 20.0 inches up to 14 years.

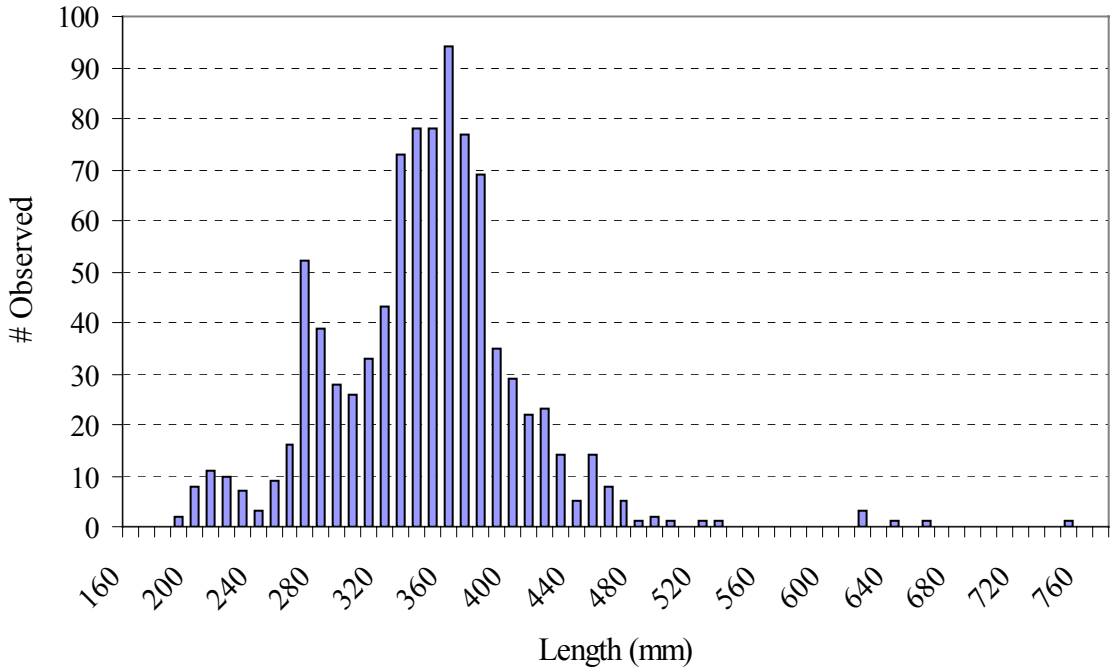


Figure 14. Length frequency distribution of walleye sampled from Tom Lake, Cook County, MN, during spring 2006 electrofishing assessments. Bars do not include counts of recaptured individuals.

Table 10. Age frequency distribution of walleye from Tom Lake, Cook County, spring 2006, based upon the number of fish sampled and aged per size category. Fish smaller than 10 inches were excluded from analysis.

Length Group																
Inches	mm	N Sampled	3	4	5	6	7	8	9	10	11	12	13	14	15	19
10.0	254	39	39													
10.5	267	60	60													
11.0	279	39	33	6												
11.5	292	35	10	20	5											
12.0	305	43		43												
12.5	318	90		45	45											
13.0	330	89		20	59	10										
13.5	343	121		19	74	28										
14.0	356	99		14	57	14	14									
14.5	368	87			68	6	6	6								
15.0	381	41			15	11	4	11								
15.5	394	40			19	5	0	12	5							
16.0	406	27			5		5	12	2	2						
16.5	419	15			2		5	3	3		2					
17.0	432	12						5	3	5						
17.5	445	11			2		2	3	3	0			2			
18.0	457	9						2		3	1	1	1			
18.5	470	2										1	1			
19.0	483	2								1				1		
19.5	495	0														
20.0	508	1													1	
20.5	521	1						1								
24.0	610	3								1		2				
24.5	622	1									1					
25.5	648	1														
29.0	737	1														1
TOTAL		869	142	166	351	74	36	56	17	12	4	4	4	1	1	1

Table 11. Back-calculated lengths at age for walleye collected from Tom Lake, Cook County, Minnesota, April 2006.

Age Class	N	Length (mm)	Length (in)
1	171	94	3.7
2	171	174	6.8
3	171	249	9.8
4	150	307	12.1
5	129	352	13.9
6	76	375	14.8
7	65	401	15.8
8	56	423	16.6
9	32	447	17.6
10	23	478	18.8
11	14	504	19.8
12	11	521	20.5
13	6	498	19.6
14	3	546	21.5
15	2	597	23.5
16	1	697	27.4
17	1	716	28.2
18	1	732	28.8
19	1	745	29.3

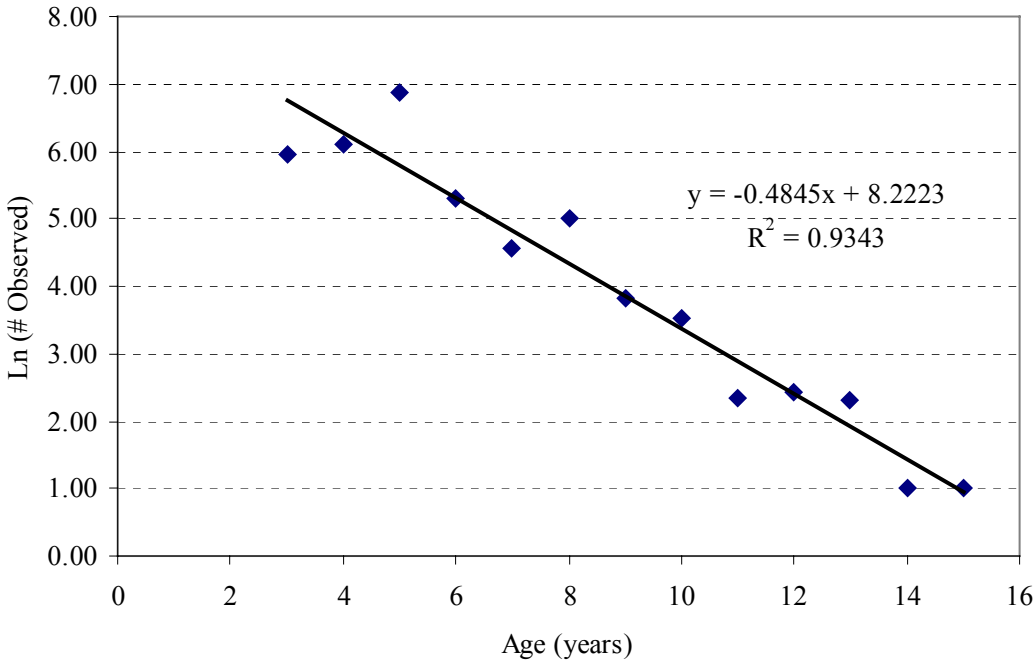


Figure 15. Total mortality (*Z*) of walleye from Tom Lake. Estimates are from April 2006 electrofishing data.

Fall Assessments

Table 12 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 5.0 fish per hour (Homer Lake) to 464.7 fish per hour of electrofishing (Cadotte Lake) (Table 12). CPUE for age-1 walleye ranged from 1.8 fish per hour (Ball Club Lake) to 73.8 fish per hour of electrofishing (Devilfish Lake) (Table 12). Figures 16 - 38 present length frequency data for each of the 23 lakes surveyed. We failed to include Poplar in the 2006 surveys due to strong storms. Table 13 presents the mean length for age-0 and age-1 individuals sampled during fall 2006 assessments. Mean lengths for age-0 walleye ranged from 102 mm (4.0 inches, Elbow Lake) to 174 mm (6.8 inches, Homer Lake). Mean lengths for age-1 walleye ranged from 196 mm (7.7 inches, Elbow Lake) to 275 mm (10.8 inches, Cadotte 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 78.4, and our mean $CPUE_{1+}$ is 35.2. Using the mean $CPUE_{Age\text{-}0}$ as one criterion, average or better 2006 year classes were observed in twelve of the lakes (Table 12). Average or better 2005 year classes (age-1 walleye) were observed in five of the lakes (Table 12). 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 2006 were larger than those observed during previous years' surveys. This is no doubt a result of the warmer than average summer experienced in northern Minnesota. 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 125 mm in lakes not stocked by the DNR with fingerling walleye prior to our assessments. Using the mean length criteria of 125 mm for average year classes, average or better 2006 year classes may be present in all but four of the lakes surveyed (Table 13). 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 Sonny Myers, Darren Vogt, and Angela Aarhus, 1854 Treaty Authority, for their hard work in the field. Duluth Area Fisheries provided two electrofishing boats and crews, and a trap net boat and crew for the tagging portion of the study within Island Lake Reservoir. Steve Persons and Paul Eiler (Grand Marais Area Office), Don Smith (Finland Area Office) and Deserae Hendrickson and Al Anderson (Duluth Area Office) provided gill net data from the Minnesota Department of Natural Resources.

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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 23 lakes within the 1854 Ceded Territory of Northeastern Minnesota during fall 2006.

Lake	Date	Temp (F)	Temp (C)	Cond.[1]	YOY Total[2]	Age-1 Total[3]	Seconds	CPUE YOY[4]	CPUE 1+[5]
Ball Club	6 Sept	67	19.4	29.4	102	2	4065	90.3	1.8
Cadotte	18 Sept	62	16.7	38.5	1128	93	8739	464.7	38.3
Caribou	8 Sept	66	18.9	65.3	85	39	6130	49.9	22.9
Cascade	12 Sept	63	17.2	29.7	76	47	5676	48.2	29.8
Crescent	8 Sept	67	19.4	32.5	66	16	3901	60.9	14.8
Crooked	20 Sept	58	14.4	54.3	17	8	3900	15.7	7.4
Devilfish	5 Sept	72	22.2	20.1	240	167	8142	106.1	73.8
Dumbbell	21 Sept	62	16.7	76.0	187	14	5624	119.7	9.0
Elbow	11 Sept	63	17.2	41.5	330	90	4754	249.9	68.2
Fourmile	19 Sept	58	14.4	51.3	131	88	6642	71.0	47.7
Homer	12 Sept	64	17.8	30.1	7	9	5041	5.0	6.4
Island Reservoir	14 Sept	67	19.4	79.8	412	80	10,567	140.4	27.3
Ninemile	20 Sept	57	13.9	62.9	560	24	6083	331.4	14.2
N. McDougal	21 Sept	57	13.9	61.3	125	18	5482	82.1	11.8
Pike	12 Sept	65	18.3	58.5	50	10	6270	28.7	5.7
Shagawa	13 Sept	71	21.7	96.2	1582	24	12,898	441.6	6.7
Silver Island	11 Sept	65	18.3	46.2	164	5	4089	144.4	4.4
Tom	5 Sept	69	20.6	36.5	157	76	7889	71.6	34.7
Two Island	6 Sept	70	21.1	34.0	46	26	6449	25.7	14.5
West Twin	7 Sept	71	21.7	32.1	175	20	4247	148.3	17.0
Whiteface Res.	15 Sept	66	18.9	56.4	270	65	7294	133.3	32.1
Wilson	20 Sept	58	14.4	47.1	41	95	7398	20.0	46.2
Windy	21 Sept	62	16.7	33.4	53	27	5302	36.0	18.3

[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 2006 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 (Cook)	9 Sept	126	254 *(N = 2)*
Cadotte (St. Louis)	16 Sept	157	275
Caribou (Cook)	8 Sept	135	236
Cascade (Cook)	12 Sept	121	215
Crescent (Cook)	10 Sept	140	225
Crooked (Lake)	27 Sept	143	240 *(N = 8)*
Devilfish (Cook)	6 Sept	108	210
Dumbbell (Lake)	20 Sept	155	238
Elbow (Cook)	8 Sept	102	196
Fourmile (Cook)	26 Sept	146	226
Homer (Cook)	12 Sept	174 *(N = 7)*	234 *(N = 9)*
Island Lake Reservoir (St. Louis)	14 Sept	139	230
Ninemile (Lake)	21 Sept	136	244
N. McDougal (Lake)	25 Sept	129	228
Pike (Cook)	11 Sept	115	214
Shagawa (St. Louis)	13 Sept	155	269
Silver Island (Cook)	11 Sept	129	221 *(N = 5)*
Tom (Cook)	6 Sept	128	238
Two Island (Cook)	7 Sept	124	220
West Twin (Cook)	8 Sept	145	254
Whiteface Res. (St. Louis)	15 Sept	148	234
Wilson (Lake)	18 Sept	149	212
Windy (Lake)	19 Sept	160	258

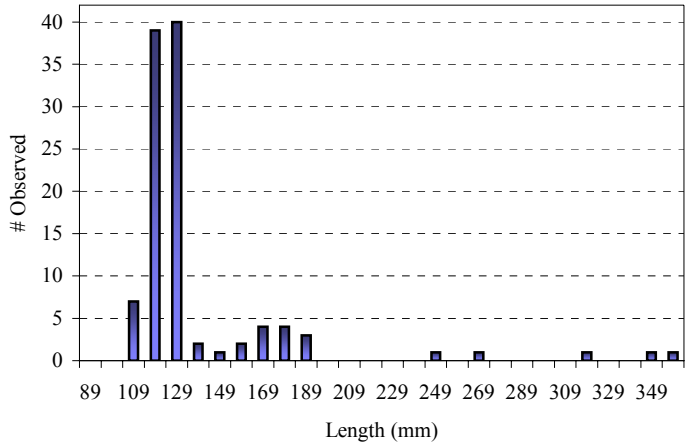

Figure 16. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2006 electrofishing assessments.

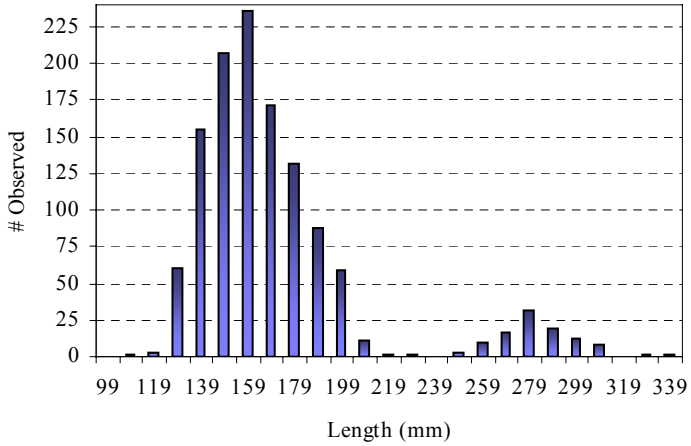

Figure 17. Length frequency distribution of walleye collected from Cadotte Lake, St. LouisCounty, during fall 2006 electrofishing assessments.

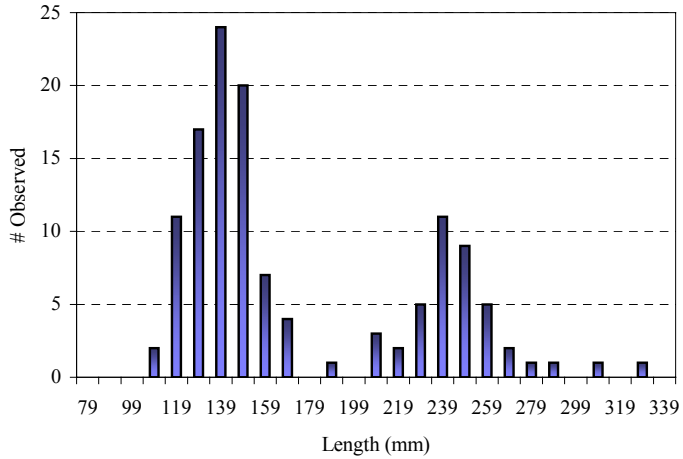

Figure 18. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2006 electrofishing assessments.

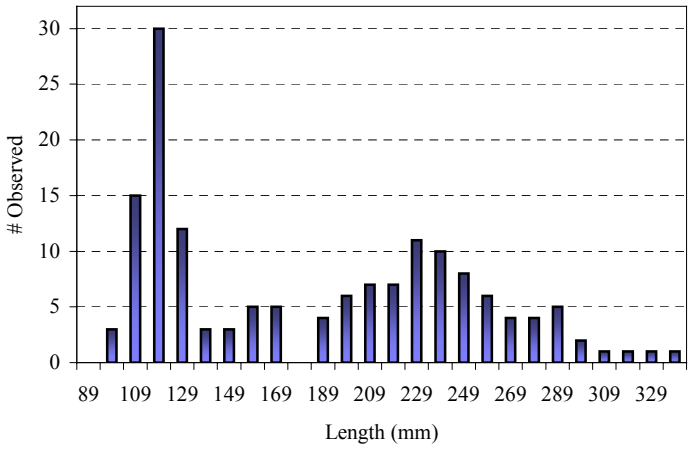

Figure 19. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2006 electrofishing assessments.

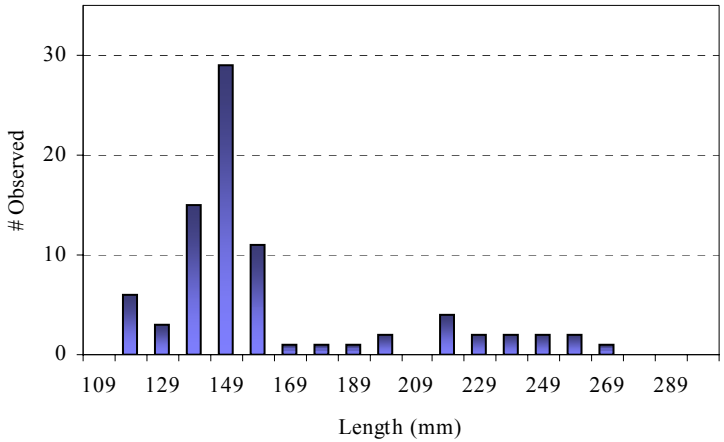

Figure 20. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2006 electrofishing assessments.

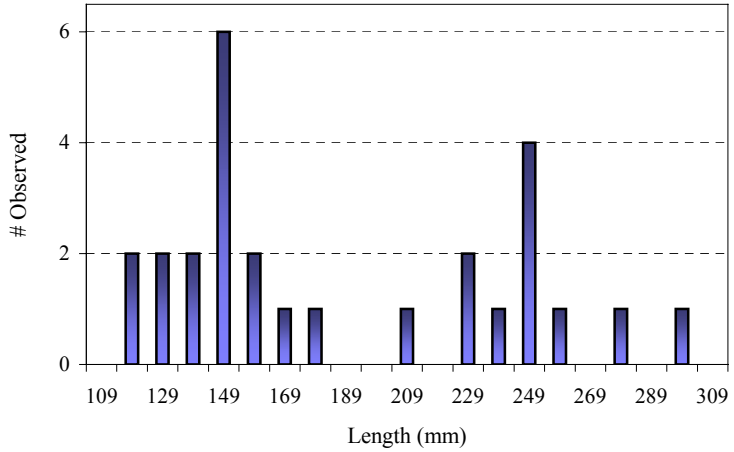

Figure 21. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2006 electrofishing assessments.

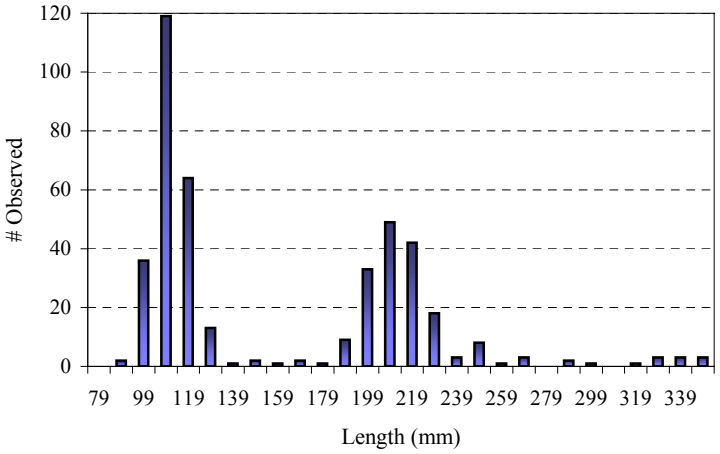

Figure 22. Length frequency distribution of walleye collected from Devilfish Lake, Cook County, during fall 2006 electrofishing assessments.

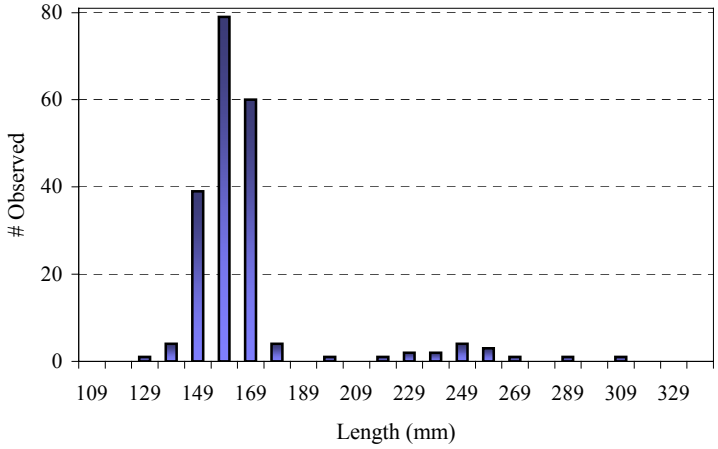

Figure 23. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2006 electrofishing assessments.

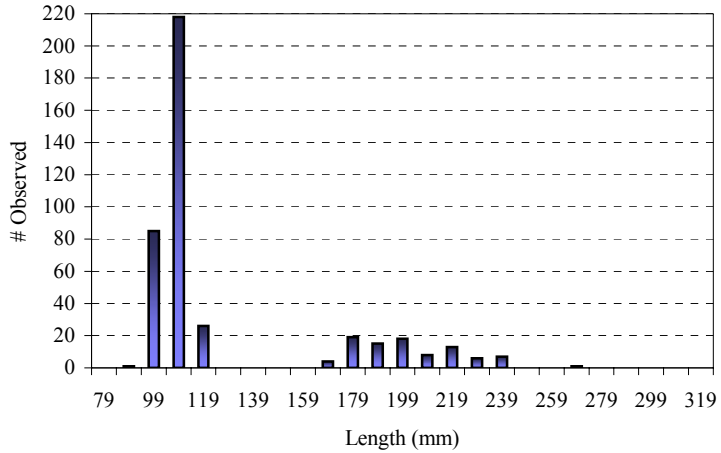

Figure 24. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2006 electrofishing assessments.

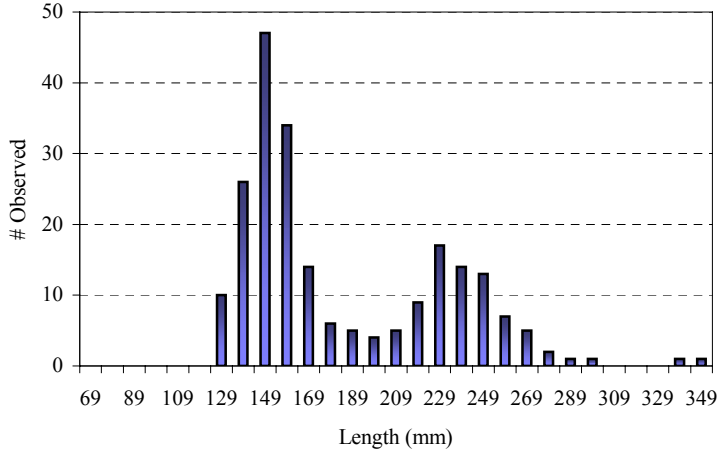

Figure 25. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2005 electrofishing assessments.

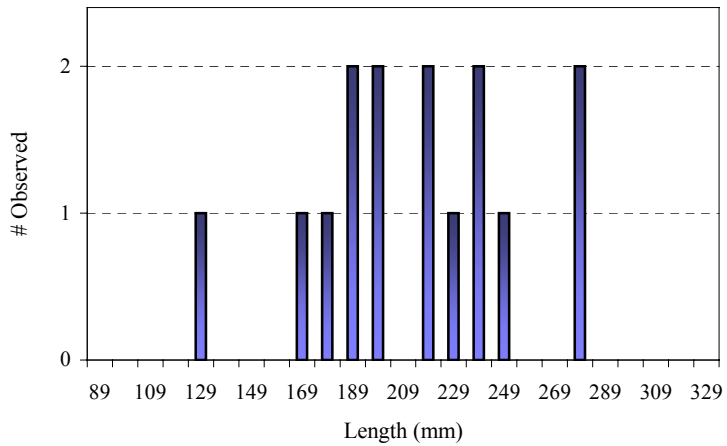

Figure 26. Length frequency distribution of walleye collected from Homer Lake, Cook County, during fall 2006 electrofishing assessments.

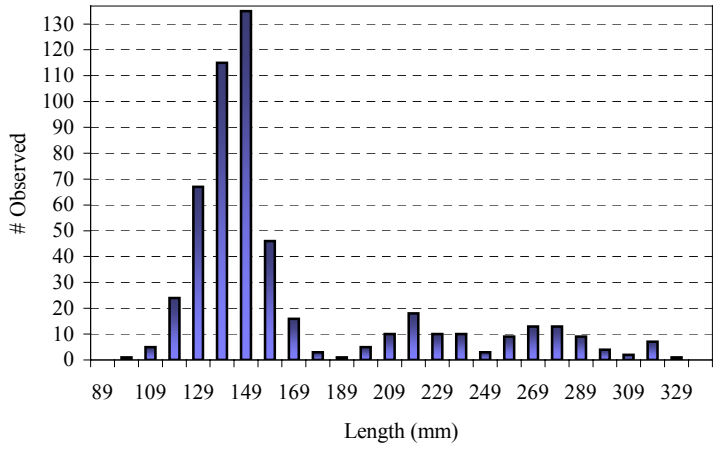

Figure 27. Length frequency distribution of walleye collected from Island Lake Res., St. Louis County, during fall 2006 electrofishing assessments.

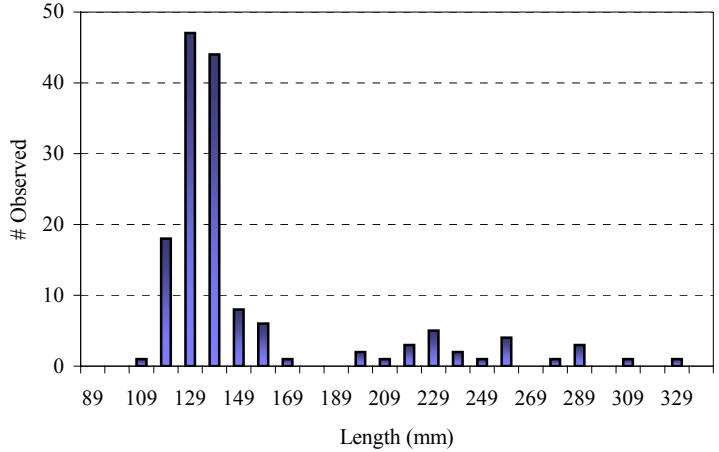

Figure 28. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2006 electrofishing assessments.

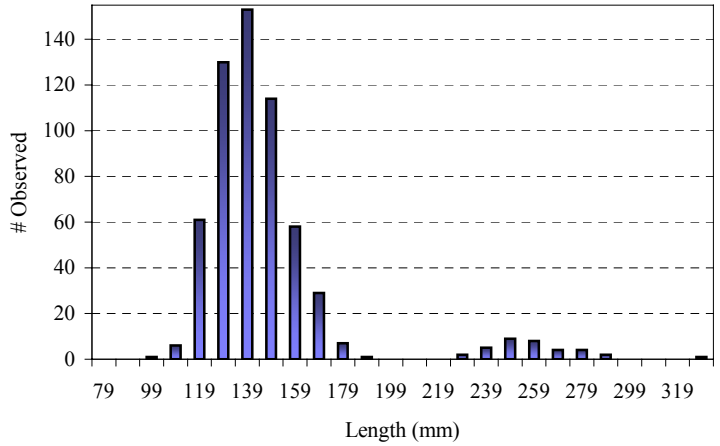

Figure 29. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2006 electrofishing assessments.

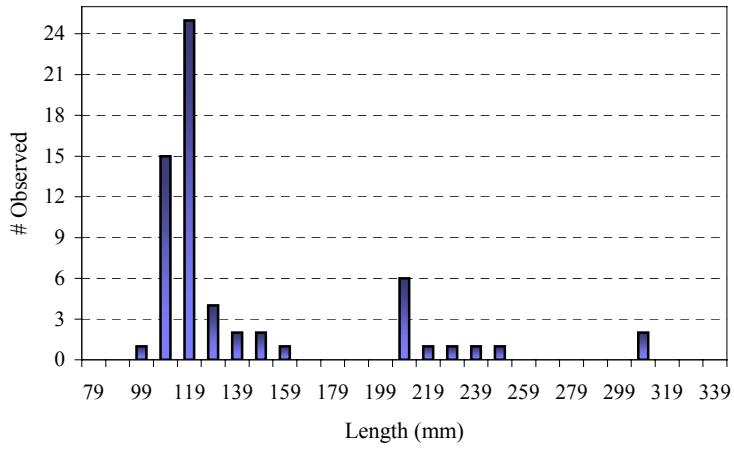

Figure 30. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2006 electrofishing assessments.

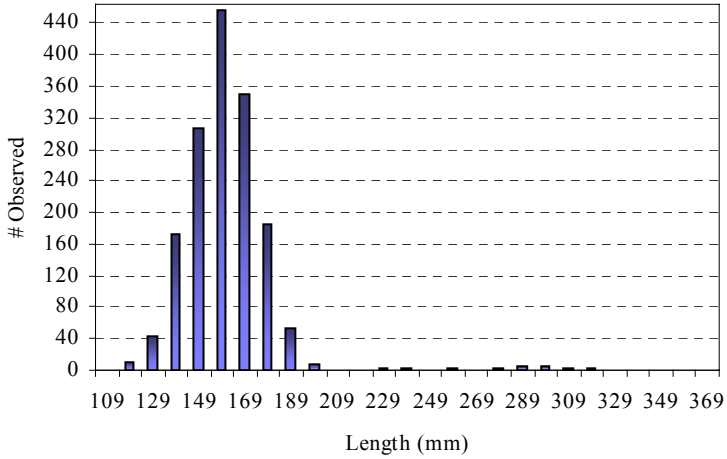

Figure 31. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2006 electrofishing assessments.

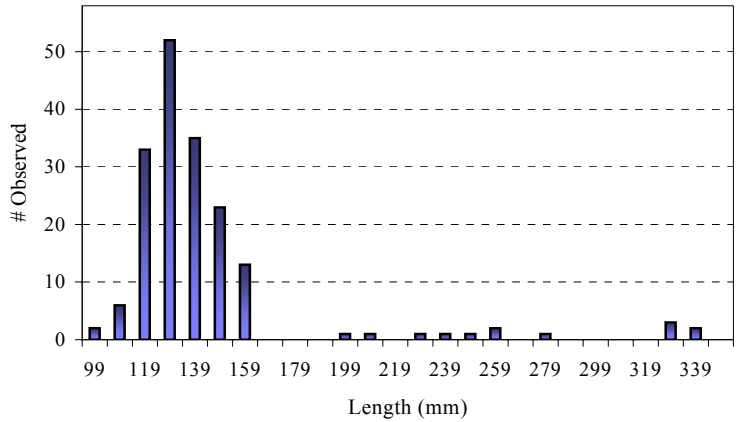

Figure 32. Length frequency distribution of walleye collected from Silver Island Lake, Cook County, during fall 2006 electrofishing assessments.

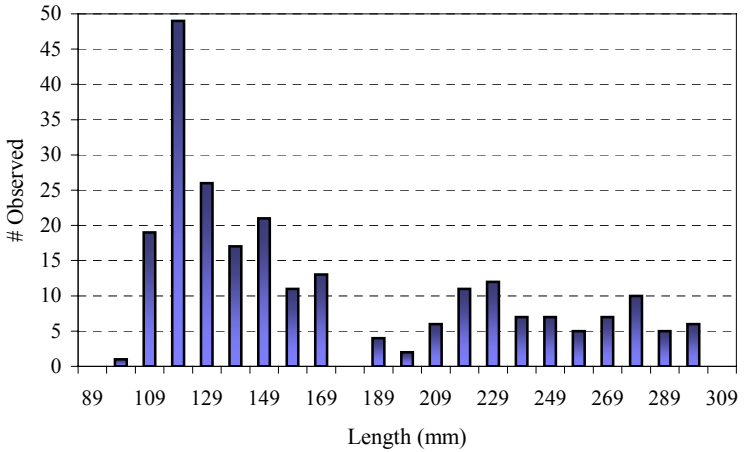

Figure 33. Length frequency distribution of walleye collected from Tom Lake, Cook County, during fall 2006 electrofishing assessments.

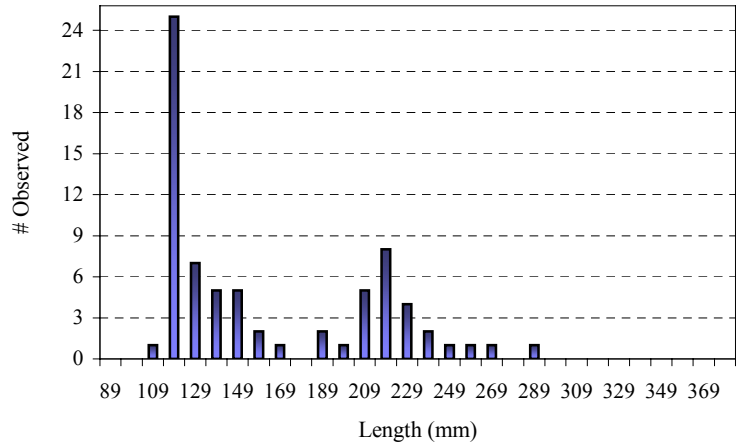

Figure 34. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2006 electrofishing assessments.

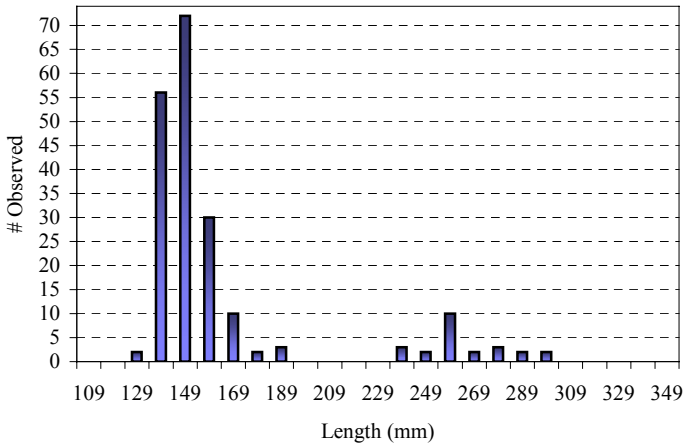

Figure 35. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2006 electrofishing assessments.

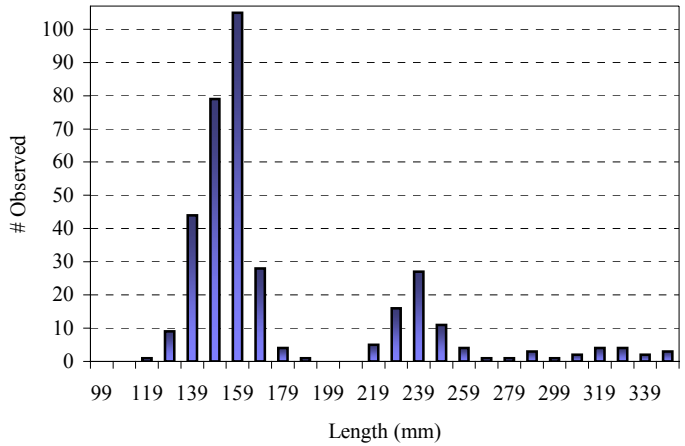

Figure 36. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2006 electrofishing assessments.

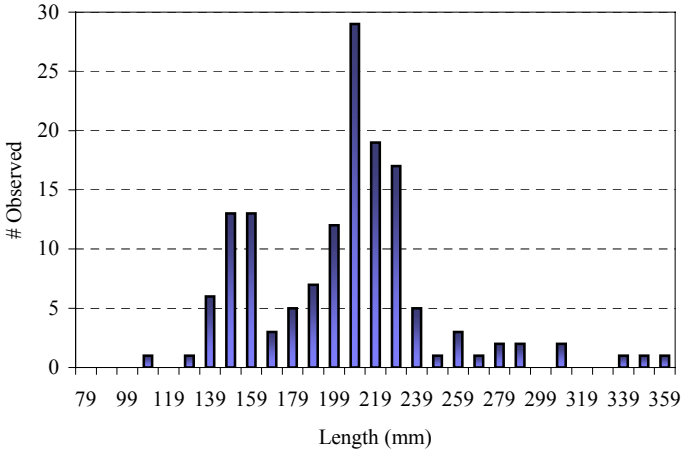

Figure 37. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2006 electrofishing assessments.

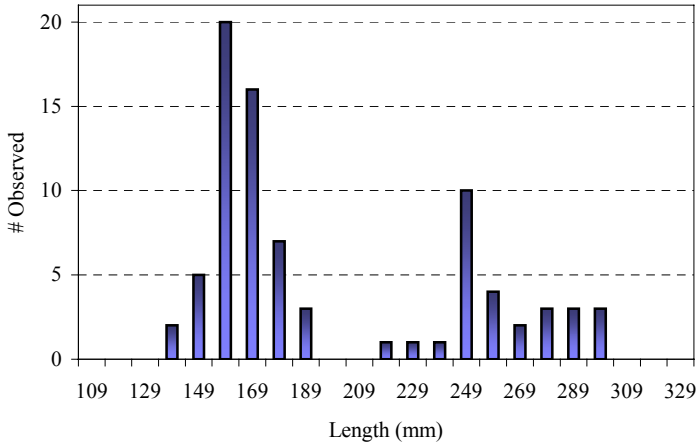

Figure 38. Length frequency distribution of walleye collected from Windy Lake County, during fall 2006 electrofishing assessments.

Appendix 1. Length frequency distributions for the marked and recaptured walleye sampled during spring 2006 assessments in Island Lake Reservoir (St. Louis County), Crooked Lake (Lake County) and Fourmile and Tom Lakes (Cook County). Numbers represent all fish marked and recaptured throughout the entire survey, i.e. multiple nights.

Island Lake Reservoir, St. Louis County			Crooked Lake, Lake County	
Length (mm)	# Marked	# Recaptured	# Marked	# Recaptured
250	0	0	0	0
260	191	6	2	0
270	315	12	4	0
280	334	19	2	0
290	417	33	1	0
300	424	51	0	0
310	419	67	1	0
320	380	75	3	0
330	333	75	4	0
340	327	77	12	2
350	270	82	29	16
360	212	42	14	7
370	182	51	7	7
380	184	56	9	2
390	151	51	17	15
400	131	26	23	11
410	94	23	28	15
420	97	23	32	26
430	88	26	37	22
440	79	21	28	15
450	52	19	21	14
460	42	15	28	15
470	26	3	26	22
480	33	8	17	5
490	26	9	23	16
500	22	6	17	15
510	12	1	6	5
520	17	4	1	1
530	15	2	5	6
540	5	0	5	1
550	13	0	4	2
560	3	2	5	3
570	4	1	0	0
580	6	1	3	0
590	5	0	2	0
600	9	0	2	0
610	6	0	0	0
620	6	1	0	0
630	3	0	0	0
640	12	1	1	1
650	6	1	0	0
660	3	1	1	0
670	3	2	0	0
680	5	1		
690	4	0		
700	3	0		
710	0			
720	1			
730	3			
740	2			
750	1			
760	3			
770	0			
780	1			
790	0			

Appendix 1. Continued.

	Fourmile Lake, Cook County		Tom Lake, Cook County	
Length (mm)	# Marked	# Recaptured	# Marked	# Recaptured
250	0	0	0	0
260	1	0	12	0
270	7	0	53	0
280	6	0	40	1
290	5	0	29	1
300	8	0	27	1
310	16	4	35	2
320	25	10	51	8
330	49	22	100	27
340	74	21	104	26
350	100	45	112	34
360	79	42	126	32
370	76	44	106	29
380	67	45	93	24
390	73	36	42	7
400	70	41	38	9
410	53	21	32	10
420	47	26	31	8
430	42	21	17	3
440	37	16	9	4
450	38	14	16	2
460	48	20	9	1
470	23	14	9	4
480	22	8	1	0
490	19	6	4	2
500	8	2	2	1
510	6	0	0	0
520	1	0	1	0
530	2	0	1	0
540	0	0	0	0
550	0	0	0	0
560	1	0	1	1
570	1	0	0	0
580	0	0	0	0
590	1	0	0	0
600	0	0	0	0
610	0	0	0	0
620	0	0	3	0
630	0	0	0	0
640	0	0	1	0
650	0	0	0	0
660	0	0	1	0
670	0	0	0	0
680	1	0	0	0
690	0	0	0	0
700	0	0	0	0
710	1	0	0	0
720			0	0
730			0	0
740			1	0

Appendix 2. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2006 assessments in Island Lake (St. Louis County), Crooked Lake (Lake County) and Fourmile and Tom Lakes (Cook County). Individual fish in Tom Lake were marked solely by removal of a dorsal fin ray, whereas individuals from the other lakes were also tagged with a numbered floy tag.

Lake	Date	Marked in Population	Daily Catch	Daily Recap
Island	17 April	--	597	--
	18 April	597	743	52
	19 April	1287	813	125
	20 April	1975	697	186
	21 April	2486	476	213
	22 April	2739	521	164
	23 April	3086	571	77
	24 April	3570	465	53
	25 April	3972	116	2
	TOTALS	4056		
Crooked	21 April	--	145	--
	22 April	145	158	38
	23 April	265	162	84
	25 April	343	198	121
	TOTALS	420		
Fourmile	21 April	--	216	--
	22 April	216	494	63
	23 April	647	314	136
	24 April	825	442	258
	TOTALS	1009		
Tom	27 April	--	274	--
	28 April	274	409	62
	29 April	621	425	177
	TOTALS	869		