Walleye Population Surveys on Six Lakes within the 1854 Ceded Territory of Minnesota, Spring 2000

A Joint Effort of the 1854 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 are taking an increased responsibility to monitor fish populations and to develop long term data bases 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 (Newman 1992; Stone 1992; Stone and Slade 1992; Goyke et al. 1993 and 1994; Ngu and Kmiecik 1993; and Borkholder 1994, 1995, and 1996).

The 1854 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 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.

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 the sampling of 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; Borkholder 1994 and 1995). In order to rapidly sample fish populations, Fond du Lac and the 1854 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 in the recapture sample. Accurate estimates are obtained when a large portion of the population are marked, usually 10% to 30% (Meyer 1993).

Surveying 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 walleye remain in the shallows 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. Population estimates based upon electrofishing data alone, where females are not as vulnerable to the sampling gear, 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).

For this survey, adult walleye population estimates were made using mark - recapture data. Due to personnel and time constraints, trap netting was not used. Thus, our estimates might be biased towards males in the populations. A second benefit of these surveys is that it allows us to identify and determine key and critical spawning sites, i.e. where catch rates are the highest.

Methods

Six lakes within the 1854 Ceded Territory of Minnesota were selected for night time electrofishing surveys (Table 1). Prairie Lake (DOW# 69-0848) is located south of Floodwood in St. Louis County. Wild Rice Lake Reservoir (DOW# 69-0371) is part of the MN Power reservoir system, located approximately 10 miles north of Duluth in St. Louis County. North McDougal Lake (DOW# 38-0686) is located west of Isabella, on County Road 1, in Lake County, and drains into the Stoney River system. Dumbbell Lake (DOW# 38-0393) is located east of Isabella, on Forest Service Road 172, in Lake County. Elbow Lake (DOW# 16-0096) is located on Forest Service Road 154, in Cook County, north of Grand Marais. Gunflint Lake (DOW# 16-0356) and Little Gunflint Lake (DOW# 16-0330), are located on the Canadian Border, near the end of the Gunflint Trail in Cook County. The objective was to obtain adult walleye (*Stizostedion vitreum*) population estimates using mark-recapture methods and determine the age structure and growth rates of the respective walleye populations. Marked walleye would then be available during the summer gill net assessments conducted by the DNR, thus giving us a second population estimate.

Electrofishing was performed at night using two boom shocking boats, both equipped with a Smith-Root Type VI-A electrofisher unit and two Smith-Root umbrella anode arrays (Smith-Root, Vancouver, WA). Pulsed direct current (P-DC) was used to minimize injuries to the fish. Surface water temperature was taken at the beginning of each evening. Ambient water conductivity measurements were taken using either a Hanna HI8733 conductivity meter (Ben Meadows Co., Atlanta, GA) or a Fisher Scientific Digital Conductivity Meter.

Electrofishing surveys were planned to begin soon after ice-out, and continue for as long as 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 revive. Walleye were measured to the nearest millimeter (mm), examined for previous marks, and the sex determined (male, female, unknown) based upon visual identification of gametes. Walleye that had been marked during any previous nights' collections were counted as recaptured fish. Unmarked individuals were marked by the removal of the second full dorsal fin ray. The dorsal fin spine from five individuals per centimeter group per sex was kept and placed in a labeled envelope for aging. 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). Previous walleye surveys have traditionally utilized the adjusted Peterson formula (Goyke et al. 1993 and 1994, and Ngu and Kmiecik 1993). We decided to also use the Schumacher and Eschmeyer formula to take advantage of multiple evenings of recapture data. Walleye less than 300mm (12 inches) were excluded.

Spines from adults were cleaned using bleach to remove the layer of skin on the bone. Spines were set in epoxy resin and 0.3 to 0.5 mm thin sections made 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 then used to back calculate length at age estimates, using no transformation and a standard intercept of 27.9 mm, as per Duluth Area Fisheries (John Lindgren, personal communication).

Results and Discussion

Prairie Lake

Electrofishing activities were conducted on Prairie Lake on 4 and 9 - 12 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 8.16 to 150.10 adults per hour and 8.16 to 151.66 total walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Prairie Lake, determined using each sampling station, was 67.36 ± 23.98 adults per hour and 68.60 ± 24.22 total walleye per hour of sampling effort. The length frequency of the walleye sampled is presented in Figure 2. Additional species observed included yellow perch, northern pike, bowfin, tullibee, and white sucker.

Catch rates of adult walleye were highest along stations EF3, EF3/4, and EFC. Few walleye were sampled along stations EF1, EF4, EFA, EFB, and EFD (Figure 1).

Table 2 presents the population estimates based upon mark-recapture data. The Schumacker and Eschmeyer population estimate from electrofishing data is 1202, with upper and lower 95% confidence limits of 1714 and 925, respectively (Table 2). The adjusted Petersen estimate is 1092 ± 269, with a 12.6% CV (Table 2). It should be noted that the entire shoreline was sampled throughout this survey, unlike some lakes. As noted in the Introduction, this population estimate is also biased towards males, as females are not sampled as frequently as males due to behavioral differences. In August 2000, the Minnesota Department of Natural Resources performed a standardized net assessment on Prairie Lake (John Lindgren and Pete Rust, MN DNR, Duluth). Population estimates derived from the gill net data are based upon 18 walleyes sampled, of which 4 were observed to have our mark from the spring. The Schumacker and Eschmeyer population estimate from the gill net data is 1271, with upper and lower 95% confidence limits of 1786 and 986, respectively (Table 2). The adjusted Petersen estimate is 1562 ± 1073, with a 35.0% CV (Table 2). These population estimates agree quite favorably with those from the spring assessments.

Table 3 presents the expanded age frequency distribution for the walleye collected from Prairie Lake. Table 4 presents back-calculated lengths at each age class for walleye collected from Prairie Lake. Estimates for age 3 were smaller than the mean length-at-age observed in our collections. Lee's phenomenon (Lee 1912) might partially explain this, where back-calculated lengths of older fish are smaller than the mean lengths observed in the population. Alternatively, the smaller individuals of that age class may not been present in the shallows during the spawning season, and were thus not sampled by our equipment. Back-calculated estimates for ages 4 and older generally agree with those observed in our collection.

Table 2. Walleye population estimates for Prairie Lake, Carlton County; Wild Rice Lake, St. Louis County; Dumbbell Lake, Lake County; and Elbow and Gunflint Lakes, Cook County, Minnesota, for Spring 2000. Estimates are for walleye larger than 300 mm (12.0 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.

Lake	Population Estimate #1[1]	95% Confidence Limits Upper	Lower	Population Estimate #2[2]	C.V.[3]
Prairie - EF	1202	1714	925	1088 ± 268	12.6%
Prairie - GN	1271	1786	986	1562 ± 1073	35.0%
Wild Rice - EF	3283	3523	3074	3255 ± 696	10.9%
Wild Rice - GN	4290	8263	2897	9109 ± 4525	25.3%
Dumbbell - EF	260	360	203	264 ± 111	21.4%
Dumbbell - GN	595	4789[4]	317	1401 ± 1075	39.1%
Elbow - EF	550	550[5]	550	538 ± 173	16.4%
Elbow - GN	813	2768[4]	476	1628 ± 1211	38.0%
Gunflint - EF	1010	1034	987	517 ± 484	26.2%

[1] Schumacher and Eschmeyer population estimate.
[2] Adjusted Petersen population estimate.
[3] Coefficient of variation for the Petersen estimate.
[4] On Dumbbell and Elbow Lakes, 80% confidence intervals were calculated as the number of walleyes in the gill nets was too low to calculate 95% confidence intervals.
[5] Upper and Lower Confidence Intervals are the same due to only one degree of freedom.

Table 4. Back-calculated lengths at each age class for walleye collected from Prairie Lake, St. Louis County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	104	115	4.4
2	104	202	7.9
3	102	282	11.0
4	82	340	13.3
5	54	385	15.2
6	36	427	16.7
7	13	470	18.4
8	6	494	19.4

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence intervals for walleye sampled from Eagle Lake, Carlton County, Windy and Gegoka Lakes, Lake County, and Pike Lake, Cook County, Minnesota. Values are for spring electrofishing (EF) in 2000 and MN DNR gill netting (GN) during summer 2000, except for the 1994 electrofishing (EF) sample from Wild Rice Lake.

Lake	PSD	RSD S-Q	RSD Q-P	RSD P-M	RSD M-T
Prairie - EF	30.33 ± 4.08	69.67 ± 4.08	29.71 ± 4.05	0.61 ± 0.69	0.00 ± 0.00
Prairie - GN	27.78 ± 20.69	72.22 ± 20.69	27.78 ± 20.69	0.00 ± 0.00	0.00 ± 0.00
Wild Rice - EF_{2000}	69.45 ± 2.94	30.55 ± 2.94	67.76 ± 2.98	1.69 ± 0.82	0.00 ± 0.00
Wild Rice-GN_{2000}	51.76 ± 7.51	48.24 ± 7.51	44.12 ± 7.46	7.06 ± 3.85	0.00 ± 0.00
Wild Rice - EF_{1994}	76.10 ± 4.03	23.90 ± 4.03	74.25 ± 4.13	1.39 ± 1.11	0.46 ± 0.64
McDougal - EF	5.26 ± 5.80	94.74 ± 5.80	5.26 ± 5.80	0.00 ± 0.00	0.00 ± 0.00
McDougal - GN	13.33 ± 17.20	86.67 ± 17.20	13.33 ± 17.20	0.00 ± 0.00	0.00 ± 0.00
Dumbbell - EF	61.59 ± 8.11	38.41 ± 8.11	23.91 ± 7.12	32.61 ± 7.82	5.07 ± 3.66
Dumbbell - GN	26.58 ± 9.74	73.42 ± 9.74	15.19 ± 7.91	8.86 ± 6.27	2.53 ± 3.46
Elbow - EF	66.80 ± 5.95	33.20 ± 5.95	62.24 ± 6.12	4.56 ± 2.64	0.00 ± 0.00
Elbow - GN	83.78 ± 11.88	16.22 ± 11.88	56.76 ± 15.96	24.32 ± 13.82	2.70 ± 5.23
Gunflint - EF	87.32 ± 4.56	12.68 ± 4.56	18.54 ± 5.32	50.24 ± 6.84	14.15 ± 4.77
Gunflint - GN	45.95 ± 16.06	54.05 ± 16.06	27.03 ± 14.31	10.81 ± 10.01	5.41 ± 7.29

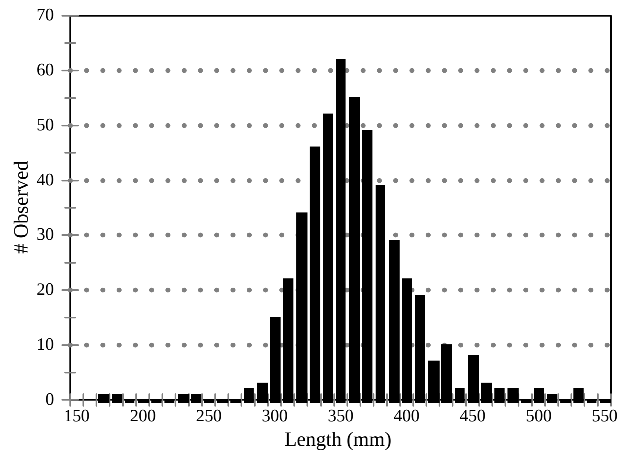

Figure 2. Length frequency distribution of walleye sampled from Prairie Lake, Carlton County, MN, during Spring 2000 electrofishing assessments.

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 are presented in Table 5. The electrofishing PSD of 30.33 ± 4.08 (Table 5) suggests the population is balanced (Anderson and Weithman 1978), though this PSD is at the low end of the range for balanced populations. RSD values (Table 5) indicate that the majority of the walleye sampled are in the 254 mm to 380 mm range (10.0 to 14.9 inch) (RSD S-Q = 69.67 ± 4.08, Table 5), with the majority of the remaining individuals in the 381 mm to 507 mm range (15.0 to 19.9 inch) (RSD Q-P = 29.71 ± 4.05, Table 5). This suggests that if growth is not limited a large proportion of the walleye population will soon be entering the “quality” length category. This also assumes that fishing mortality is not too high and these fish are not removed, which might explain the lack of “memorable” and “trophy” sized individuals. The PSD value from the summer gill net data was 27.78 ± 20.6, and was not significantly different from the electrofishing PSD value (χ^2 = 0.05, P > 0.05, critical Chi-square value of 3.841). In addition, no significant differences were observed in any of the RSD metrics, though the gill net data is based upon 18 walleye larger than the “stock” size of 254 mm (10.0 inches). Gilliland (1985) reported that the PSD value determined from a sample of 150 largemouth bass was essentially the same as the PSD value determined from a sample of 500 individuals. Care needs to be taken when interpreting a PSD value based upon such a low sample size.

Wild Rice Lake

Electrofishing activities were conducted on Wild Rice Lake on 11 - 14, and 17 April (Figure 3). 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 36.71 to 115.26 adults per hour and 39.27 to 124.39 total walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Wild Rice Lake, determined using each sampling station, was 85.97 ± 15.06 adults per hour and 91.91 ± 15.11 total walleye per hour of sampling effort. The length frequency of the walleye sampled is presented in Figure 4. Additional species observed included yellow perch, northern pike, white sucker, bluegill, rock bass, pumpkinseed, and crappie.

Catch rates among the sampling stations varied. Catch rates were highest along the three island stations EF3, EF5, and EF7; and along stations EF6 and EFB. Catch rates were lowest along the mucky portions of the lake (EFA, EF5A, and EF8), and along EF1, EF4, and EFC (Figure 3).

Table 2 presents the four population estimates based upon mark-recapture data. The electrofishing Schumacker and Eschmeyer population estimate is 3283, with upper and lower 95% confidence limits of 3523 and 3074, respectively (Table 2). The electrofishing adjusted Petersen estimate is 3255 ± 696, with a 10.9% CV (Table 2). Our sampling covered most of the habitat probably used by spawning walleyes.

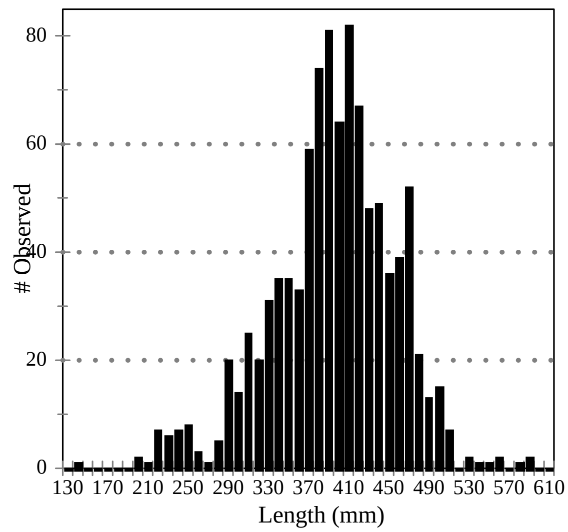

Figure 4. Length frequency distribution of walleye sampled from Wild Rice Lake, St. Louis County, MN, during Spring 2000 electrofishing assessments.

In August 2000, the Minnesota Department of Natural Resources performed a standardized net assessment on Wild Rice Lake (John Lindgren and Pete Rust, MN DNR, Duluth Area Fisheries). Of the 128 walleye sampled, 12 were observed to have the mark from the spring sampling. The summer Schumacker and Eschmeyer population estimate is 4290, with upper and lower 95% confidence limits of 8263 and 2897, respectively (Table 2). The adjusted Petersen estimate for the summer is 9109 ± 4525, with a 25.3% CV (Table 2).

In 1994, we performed similar spring electrofishing assessments on Wild Rice Lake (Borkholder 1994). The Schumacker and Eschmeyer population estimate we calculated in 1994 was 8259, with upper and lower 95% confidence limits of 14,701 and 7136, respectively. The 1994 adjusted Petersen estimate was 6505 ± 4712, with a 37.0% CV. Comparing our 1994 estimates with those from the year 2000 assessments, it appears that the abundance of spawning adult walleye may have declined somewhat since 1994. Significant differences were observed in the Schumacher and Eschmeyer estimates, but not in the Petersen estimate. The only difference between the 1994 and 2000 surveys was the addition of a second electrofishing boat, and the subsequent addition of several more sampling stations.

Table 6 presents the age data for the walleye collected from Wild Rice Lake. Of the 970 fish sampled, 75.3% (730) were assigned to ages 4, 5, and

6. Table 7 presents back-calculated lengths at each age class for walleye collected from Wild Rice Lake. Back-calculated estimates for ages 1 through 12 generally agree with those observed in our collection. Sample sizes for the oldest age groups were low.

Samples collected by electrofishing during spring 1994 and again in 1999 (PSD_{1994} = 76.10 ± 4.03, PSD_{2000} = 69.45 ± 2.94) showed significant differences in PSD values between the two years (χ^2 = 6.43, $P < 0.05$, critical Chi-square value of 3.841) (Table 5). While this difference is significant, it is relatively small, and the PSD values from both years suggest that there is a high proportion of "quality" length walleye (381 mm; 15.0 inches) relative to all walleye > 254 mm (10.0 inches). No significant differences in any RSD values were observed between the 1994 and 2000 samples.

Comparing the two gear types in 2000, i.e. gill nets and electrofishing, significant differences in the proportion of "quality" length fish were observed (Table 5). The 2000 spring electrofishing ($PSD_{Electro\ 2000}$ = 69.45) sampled a higher proportion of walleye larger than 381 mm (15.0 inches) compared to the 2000 summer gill net assessments ($PSD_{Gill\ Net\ 2000}$ = 51.76) (χ^2=20.31, $P < 0.05$, critical Chi-square value of 3.841). While the argument can be made that spring electrofishing targets only the larger individuals in the population, we did sample 61 walleye smaller than 300 mm (12.0 inches) in 2000. There were no significant differences observed in any of the relative stock density (RSD) indices during 2000 assessments (RSD P-M, χ^2 = 4.49, $P >$ 0.05, critical Chi-square value of -1.6449, one-tailed test) (RSD M-T, χ^2 = 2.36, $P < 0.05$, critical Chi-square value of -1.6449, one-tailed test) (Table 5), suggesting no differences in the proportion of "preferred" (> 508 mm, 20 inches) and "memorable" (> 635 mm, 25 inches) length fish between the two gear types. There is probably some bias using both sampling gears, which will need to be addressed in later years once we have several additional paired samples.

North McDougal Lake

A single evening of assessment activity was spent on North McDougal Lake, 24 April 2000. Sampling was conducted along the entire shoreline (Figure 5). Table 1 presents mean water temperature, conductivity, number of walleye sampled, and CPUE for walleye. A total of 213 walleye were sampled, with 22 of the individuals larger than 300 mm (12 inches) (Table 1). Catch per hour of electrofishing was calculated at 7.39 adult walleye per hour and 71.56 total walleye per hour of sampling (Table 1). At an 80% confidence

Table 7. Back-calculated lengths at each age class for walleye collected from Wild Rice Lake Reservoir, St. Louis County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	197	119	4.7
2	197	218	8.5
3	177	300	11.8
4	150	360	14.1
5	118	405	16.0
6	82	440	17.3
7	47	463	18.2
8	40	486	19.0
9	26	502	19.8
10	13	521	20.4
11	4	540	21.2
12	2	592	23.2

interval, mean CPUE for North McDougal Lake, determined using catch data from each sampling station, was 7.12 ± 4.77 adults per hour and 65.96 ± 21.53 total walleye per hour of sampling effort. Length frequency data of walleye collected is presented in Figure 6. Additional species observed included large numbers of trout perch, some yellow perch, white sucker, northern pike, rock bass, and burbot. Catch rates for walleye of all sizes, while poor in comparison to the other lakes, were the highest along station EFY and EFZ (Figure 5). During assessments, we observed many stunned adult walleye floating downstream in the Stony River. We were unable to access the downstream portions of this river, and feel that this may be an area used by spawning walleye in North McDougal Lake.

Table 8 presents the age frequency distribution. Back-calculated length-at-age estimates are presented in Table 9, and generally agree with observed lengths during our survey. Due to only a single evening of survey efforts, population estimates are not available. In addition, during summer assessments by the MN DNR, no recaptured walleye were observed in the gill nets. Following spring surveys, only 22 walleye were fin-clipped, which is too low for any reasonable chance of observing any recaptured individuals.

PSD and RSD values determined by our spring electrofishing sampling are presented in Table 5. Care needs to be taken when interpreting this data as the electrofishing PSD was determined from 54 individuals larger than stock size (254 mm, 10.0 inches), and the gill net PSD was determined from 15 individuals. Surveys sampling 54 and 15 walleye are probably not enough for

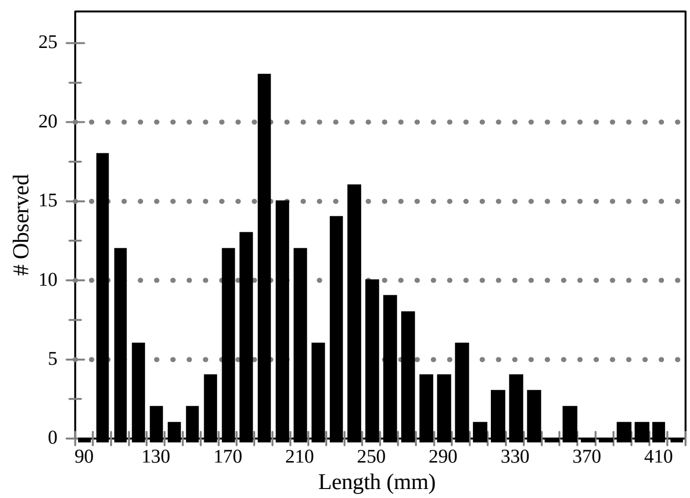

Figure 6. Length frequency distributiuon of walleye sampled from McDougal Lake, Lake County, MN, during Spring 2000 electrofishing assessments.

Table 9. Back-calculated lengths at each age class for walleye collected from North McDougal Lake, Lake County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	149	119	4.6
2	141	197	7.8
3	80	252	9.9
4	33	303	11.8
5	12	349	13.7
6	2	366	14.3
7	1	370	14.6
8	1	416	16.4

reliable PSD estimates, especially when the spring surveys probably did not effectively sample the adult walleye spawning downstream in the Stony River.

Dumbbell Lake

Three evenings of sampling were conducted on Dumbbell Lake, 25, 26, and 28 April (Figure 7). Table 1 presents the statistics for each evening of sampling. A total of 134 adult walleye (181 total walleye) were collected (Table 1). Catch per hour of electrofishing effort for each night ranged from 10.12 to 21.12 adults per hour and 12.53 to 27.84 total walleye per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for Dumbbell

Lake, determined using catch data from each sampling station, was 12.85 " 3.12 adults per hour and 17.07 " 3.97 total walleye per hour of sampling effort. While catch rates for adult walleye were not high in any of the stations compared to other lakes, the highest catch rates were observed along stations EF1A, EF1C, and EFZ (Figure 7). Figure 8 shows a length frequency histogram for the walleye sampled. Additional species observed included adult and juvenile muskie, white sucker, yellow perch, and large numbers of juvenile smallmouth bass.

Table 2 presents the population estimates based upon mark-recapture data. The Schumacker and Eschmeyer population estimate (walleye > 305mm) based upon electrofishing samples is 260, with upper and lower 95% confidence limits of 360 and 203, respectively. The Petersen estimate is 264 ± 111, with a 21.4% CV (Table 2). This population estimate is only of the walleye using the sampled shorelines for spawning during our assessments, which included most of the lake except for the far southwest shoreline, which was still ice-covered during our surveys.

During the summer, the Minnesota Department of Natural Resources performed a standardized net assessment on Dumbbell Lake (Steve Persons and Ron Van Bergen, MN DNR, Finland Area Fisheries). Of the 61 walleye sampled larger than 305 mm (12 inches) in gill nets, 4 were observed to have the mark

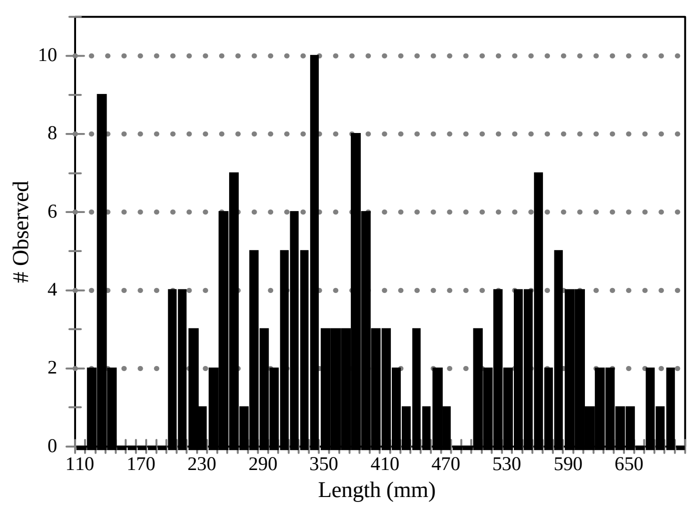

Figure 8. Length frequency distribution of walleye sampled from Dumbbell Lake, Lake County, MN, during Spring 2000 electrofishing assessments.

from the spring. Due to such low numbers of recaptured individuals, 80% confidence intervals had to be calculated for the Schumacher and Eschmeyer estimate, giving a population estimate of 595 adults, with upper and lower limits of 4789 and 317 individuals, respectively, and a Petersen estimate of 1401 ± 1075, with a CV of 39.1% (Table 2).

Table 10 presents the age frequency distribution for Dumbbell Lake. Table 11 presents the back-calculated lengths at age for the walleye collected from Dumbbell Lake. The back-calculated lengths are smaller for ages 1 and 2 than those observed in this sample, but generally agree with those observed for ages 3 and older.

PSD and RSD values determined by our spring electrofishing sampling and the summer gill net survey conducted by the MN DNR are presented in Table 5. Significant differences in PSD values between the two

samples were observed (χ^2 = 24.65, $P < 0.05$, Critical Chi-square value of 3.841). The electrofishing PSD of 61.59 (Table 5) suggests the population is balanced, while the gill net PSD of 26.58 ± 9.74 suggests the population is characterized by smaller "stock" to "quality" length individuals (254 mm to 378 mm; 10.0 to 14.9 inches). Gill net RSD values (Table 5) indicates most of the fish are in the smaller "stock" length classes, with relatively few individuals sampled in the "quality", "preferred", and "memorable" length categories. The differences between electrofishing and gillnetting RSD Q-P (χ^2=-4.96, $P < 0.05$, Critical Chi-square value of -1.6449, one-tailed test) and RSD P-M (χ^2=-4.15, $P < 0.05$, Critical Chi-square value of -1.6449, one-

Table 11. Back-calculated lengths at each age class for walleye collected from Dumbbell Lake, Lake County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	141	114	4.4
2	140	192	7.5
3	129	259	10.2
4	105	321	12.6
5	90	380	14.9
6	55	437	17.2
7	47	491	19.3
8	46	530	20.8
9	38	558	21.9
10	23	583	22.9
11	10	606	23.8
12	3	657	25.9
13	1	632	24.9

tailed test) were significant, but not between electrofishing and gillnetting RSD M-T metrics. Neither the electrofishing nor gill net surveys sampled many walleye, so reported PSD values may need to be interpreted with caution. In this sampling effort, the data again suggests that either electrofishing might be targeting the larger individuals of the population, or the gill nets are failing to do so. The larger individuals are obviously present in the population, but were not observed in the gill net survey in the same proportion as was observed in the spring surveys. We need to be addressing this issue in further surveys and research.

Elbow Lake

Sampling was conducted for two evenings on Elbow Lake, 27 and 28 April (Figure 9). Water temperatures, conductivity, and CPUE data are presented in Table 1. A total of 244 adult walleye were collected (291 total walleye). At an 80% confidence interval, mean CPUE for Elbow Lake, determined using each sampling station, was 45.67 ± 18.70 adults per hour and 53.69 ± 18.97 total walleye per hour of sampling effort. Catch rates for adult walleye were extremely poor in the mucky bay portion of the lake (EF3, EFX, and EFW), and in EFY (Figure 9). Stations EF1, EF2, an EFZ had very good catch rates. Figure 10 shows the length frequency histogram for the walleye sampled. Additional species observed included northern pike, yellow perch, white sucker, and bluegill.

Table 12 presents the age frequency distribution for Elbow Lake. Table 13 presents the back-calculated length at age for the walleye collected. With the exception of age-1, back-calculated length-at-age estimates generally agree with the lengths observed in this sample. Length-at-age estimates for age-3 and age-4 individuals were in the range of observed lengths, though the estimates were on the low side.

Table 2 presents the population estimates based upon mark-recapture data. The Schumacker and Eschmeyer population estimate from electrofishing samples is 550, with no upper and lower 95% confidence limits due to only one night of sampling. The Petersen estimate is 538 ± 173, with a 16.4% CV (Table 2). The entire shoreline was sampled on the first night. Subsequent night’s activities focused on the areas with the highest catch rates, particularly EF1, EF2 and EFZ (Figure 9). The population estimates are for these areas only, and not the entire lake, though only small numbers of walleye were sampled at the other stations. From the gill net survey data, 36 walleye were sampled, with 4 recaptured individuals observed. The two population estimates were 813 (80% confidence limits of 2768 and 476) and 1628 ± 1211, with a 38.0% CV (Table 2).

PSD and RSD values determined by our spring electrofishing sampling and the summer gill net survey conducted by the MN DNR are presented in Table 5. The electrofishing PSD of 66.80 ± 5.95 does suggest the population is balanced, and dominated by 381 mm to 508 mm individuals (15 to 20 inch) (RSD Q-P of 62.24 ± 6.12) (Table 5). The PSD value determined from summer gill net data was 83.78 ± 11.88, with an RSD Q-P of 56.76 ± 15.96 also indicating the population is dominated by 381 mm to 508 mm (15 to 20 inch) individuals (Table 5). Significant differences in the two PSD values were detected (χ^2 = 4.33, $P < 0.05$, critical Chi-square value of 3.841), though are probably meaningless as the gill net PSD value was determined from a sample of 37 walleye.

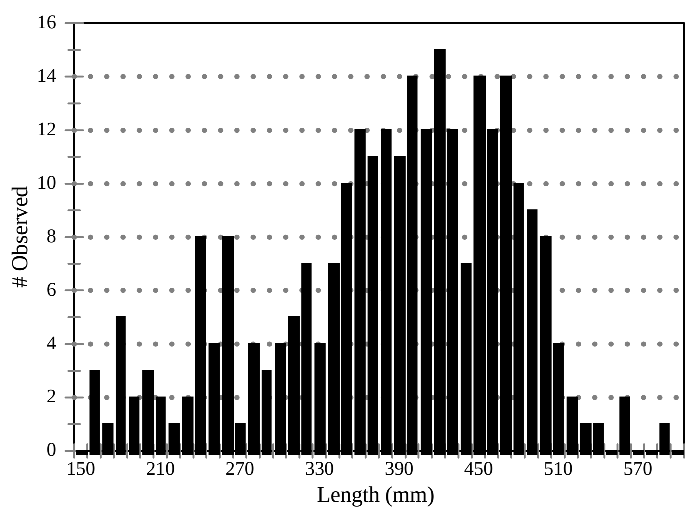

Figure 10. Length frequency distribution of walleye sampled from Elbow Lake, Cook County, MN, during Spring 2000 electrofishing assessments.

Gunflint and Little Gunflint Lakes

Sampling was conducted for three evenings on Gunflint and Little Gunflint Lakes, 29 April, and 2 and 3 May (Figures 11A and 11B). Water temperatures, conductivity, and CPUE data are presented in Table 1. A total of 212 adult walleye were collected (220 total walleye), with catch rates ranging from 1.73 to 34.49 adults per hour of sampling (Table 1). At an 80% confidence interval, mean CPUE for both lakes, determined using each sampling station, was 15.98 ± 4.92 adults per hour and 16.73 ± 5.10 total walleye per

Table 13. Back-calculated lengths at each age class for walleye collected from Elbow Lake, Cook County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	181	121	4.7
2	177	200	7.8
3	158	270	10.6
4	135	336	13.2
5	98	378	14.8
6	67	404	15.9
7	49	431	16.9
8	44	460	18.0
9	35	477	18.7
10	20	481	18.9
11	17	497	19.6
12	7	508	20.0
13	1	560	22.0

Table 15. Back-calculated lengths at each age class for walleye collected from Gunflint and Little Gunflint Lakes, Cook County, Minnesota, Spring 2000.

Age Class	N	Length (mm)	Length (in)
1	196	119	4.6
2	196	217	8.5
3	189	323	12.7
4	167	416	16.4
5	150	486	19.1
6	127	539	21.1
7	80	567	22.2
8	73	599	23.5
9	58	626	24.6
10	27	635	24.9
11	19	663	26.0
12	17	687	27.0
13	12	709	27.8
14	7	729	28.7
15	5	735	28.9
16	2	736	28.9
17	2	751	29.5
18	1	767	30.2
19	1	785	30.9

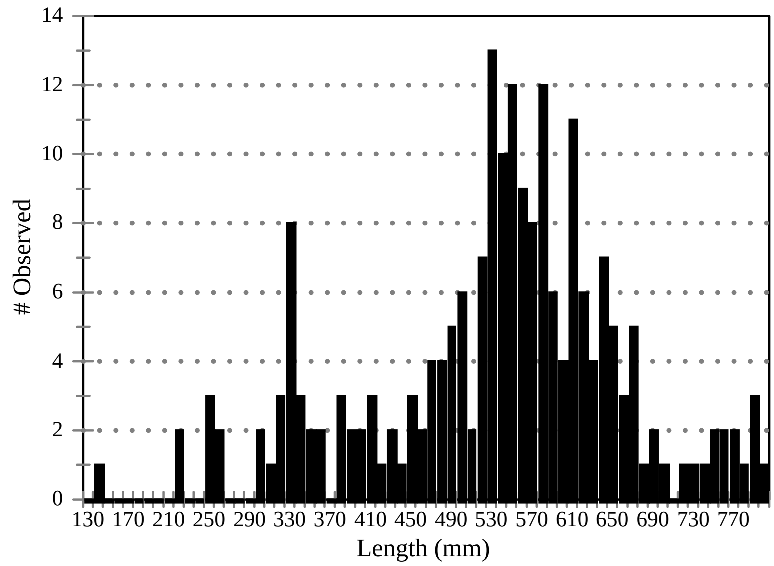

Figure 12. Length frequency distribution of walleye sampled from Gunflint and Little Gunflint Lakes, Cook County, MN, during Spring 2000 electrofishing assessments.

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hour of sampling effort. Catch rates were not very high along any of the sampling stations, but were the highest in the area of the Cross River (EFCro, Figure 11A) and where the North Lake feeds into Little Gunflint Lake (EF-San, Figure 11B). Few walleye were observed along any of the main lake sampling stations, even though decent walleye spawning habitat was observed in several areas (Figure 11A). Figure 12 shows the length frequency histogram for the walleye sampled. Additional species observed included yellow perch, white sucker, smallmouth bass, burbot, northern pike, smelt, trout perch, sculpin, and shiner species. Table 14 presents the age distribution for Gunflint and Little Gunflint Lakes. Table 15 presents the back-calculated length at age for the walleye collected.

Table 2 presents the population estimates based upon mark-recapture data. The Schumacker and Eschmeyer population estimate from electrofishing was 1010, with 95% confidence intervals of 1034 and 987. The Petersen estimate is 517 ± 484 with a 26.2% CV. These population estimates only reflect the areas in and around the Cross River and fish using the rapids emptying into Little Gunflint Lake. They are not an accurate estimate of the walleye population in these two lakes. During the summer, the Minnesota Department of Natural Resources performed a standardized net assessment on Gunflint Lake (Steve Persons, MN DNR, Grand Marais Area Fisheries). Of the 37 walleye sampled in their gill nets larger than 254 mm (10.0 inches) (73 total walleye), no recaptured walleye were observed. No population estimates are possible.

PSD and RSD values determined by our spring electrofishing sampling and the summer gill net survey conducted by the MN DNR are presented in Table 5. The electrofishing PSD of 87.32 ± 4.56 (Table 5) is high, and suggests the population is characterized by large individuals. RSD values indicate that there is an abundance of 508 mm to 635 mm (20 to 25 inch) spawning walleye in the population (RSD P-M of 50.24 ± 6.84). Walleye as large as 801 mm (31.5 inches) were sampled during the spring survey. The gill net PSD of 45.95 ± 16.06 (Table 5) suggests a balanced population, and a higher relative abundance of the smaller “stock” to “quality” length individuals (254 mm - 378 mm; 10.0 - 14.9 inches) than what was observed during spring sampling efforts ($RSD_{Gill\ Net}$ S-Q of 54.05 ± 16.06) (Table 5). Significant differences in PSD values between the two samples were observed (χ^2 = 34.85, $P < 0.05$, Critical Chi-square value of 3.841). The differences between electrofishing and gill-netting RSD Q-P (χ^2 = -5.90, $P < 0.05$, Critical Chi-square value of -1.6449, one-tailed test) and RSD P-M (χ^2 = -5.73, $P < 0.05$, Critical Chi-square value of -1.6449, one-tailed test) were significant, but not between the electrofishing and gillnetting RSD M-T metric. The gill net sample was based upon 37 fish while the electrofishing sample was calculated using 205 fish. Significant differences between the two gear types need to be interpreted with care, as the number of fish sampled using gill nets probably is not enough to make accurate inferences as to the size structure of the walleye stock in Gunflint and Little Gunflint Lakes.

Use of Gill Nets and Electrofishing

There has been much discussion concerning the use of electrofishing for sampling adult walleye, and the obvious male bias. There is no question that electrofishing does sample a disproportionately larger number of males than females. Our data from 1994 through 2000 certainly confirms this. But we do not know the true proportion of female walleye in any population. The magnitude of this bias is therefore largely unknown. However, another concern brought up in discussions with other biologists is that electrofishing selectively targets larger walleye, producing a bias here. The larger walleyes in any population are the females, which are not sampled as often as the males. However, we do sample reasonable numbers of the larger males, in excess of 500 mm (20.0 inches). And certainly most of our sampling efforts target the larger members of the population that have reached spawning size. Spring electrofishing does not effectively sample the age-1 and age-2 individuals, which are not present in the shallow water habitats when the adults are spawning. We do not feel this is a problem, as the objective of the spring survey is to target the stock sized and larger individuals that are spawning. Electrofishing is entirely effective in sampling the age - 0 and age - 1 individuals in the fall, which is when we target them with fall assessments.

The problem that needs to be addressed is the differences between the use of gill net and electrofishing data sets in determining stock structure, i.e. PSD and RSD values (Table 5). Differences observed this year may not be real, however. With the only exception of Wild Rice Lake, PSD values from gill net data were all derived from small sample sizes, between 15 and 79 individuals. The authors recognize the need for long term data sets to monitor populations, i.e. summer gill net data, but there appears to be utility in supplementing this data with a different gear type that might offer additional information on the size structure and age composition of the populations because of larger sample sizes. We suggest that in the near future, efforts begin that will address the uses of both gear types, and means by which to combine data sets into a single picture of the population.

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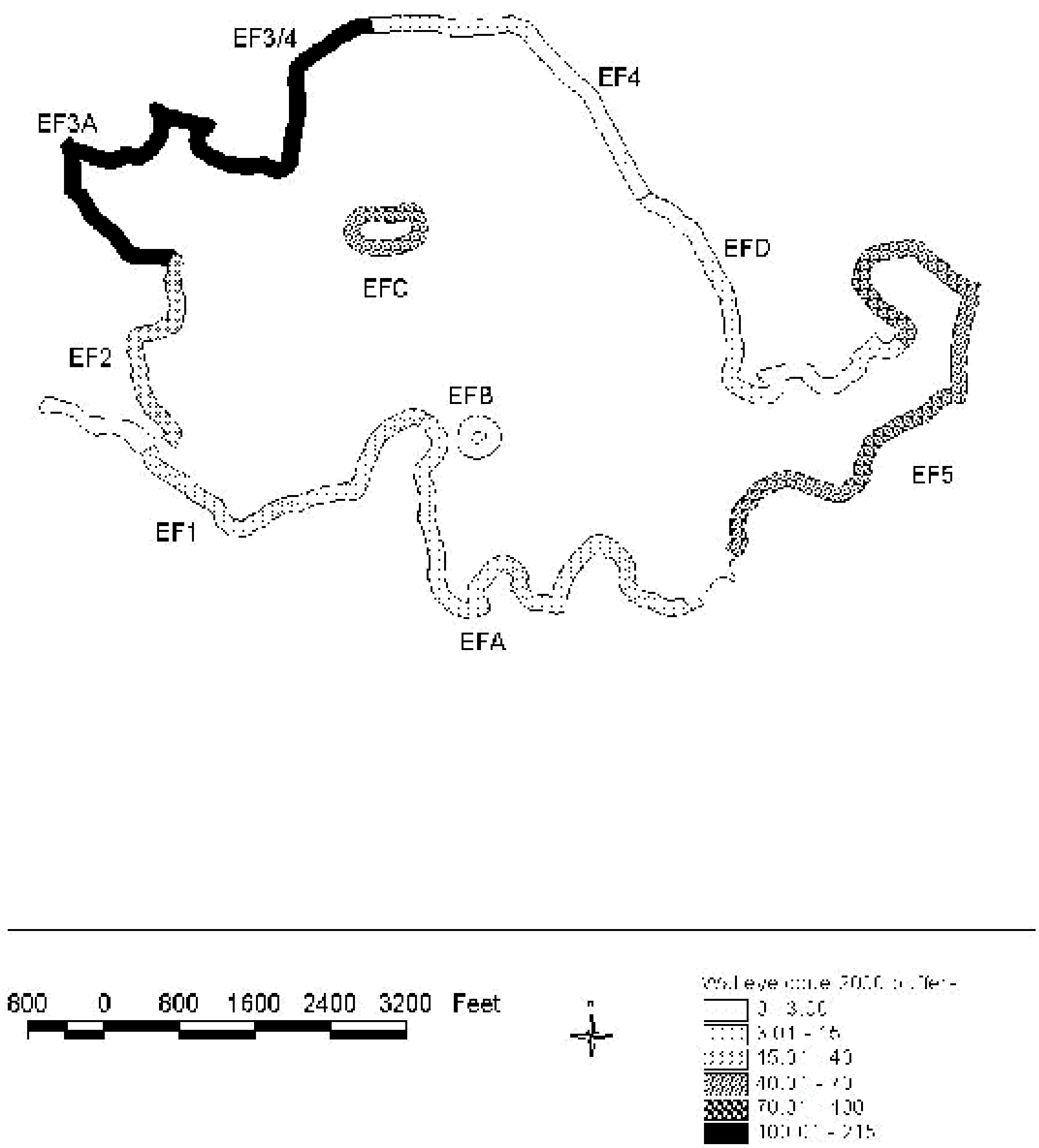

Figure 1 - Prairie Lake Walleye CPUE 2000 zones

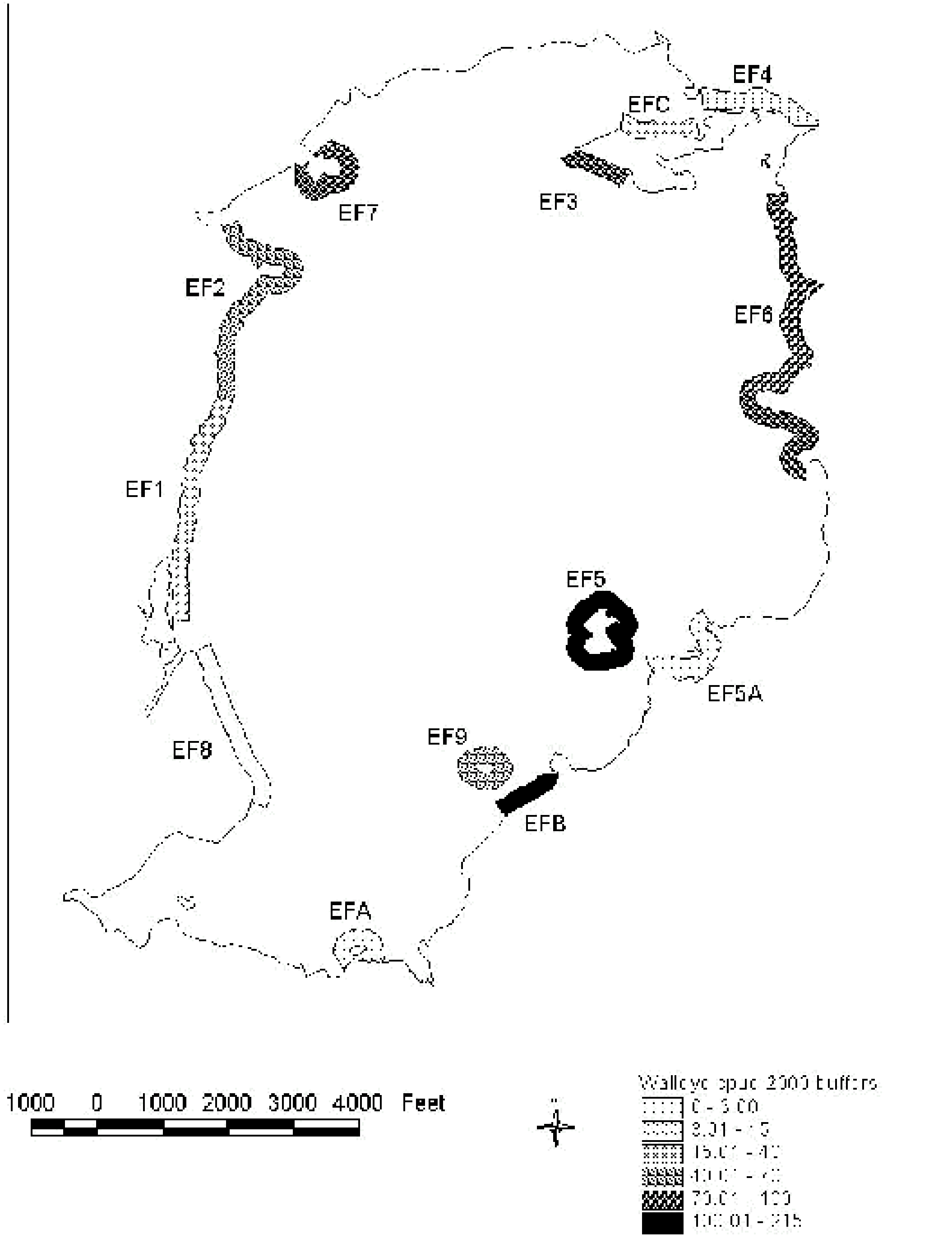

Figure 3 - Wild Rice Lake Walleye CPUE 2000 zones

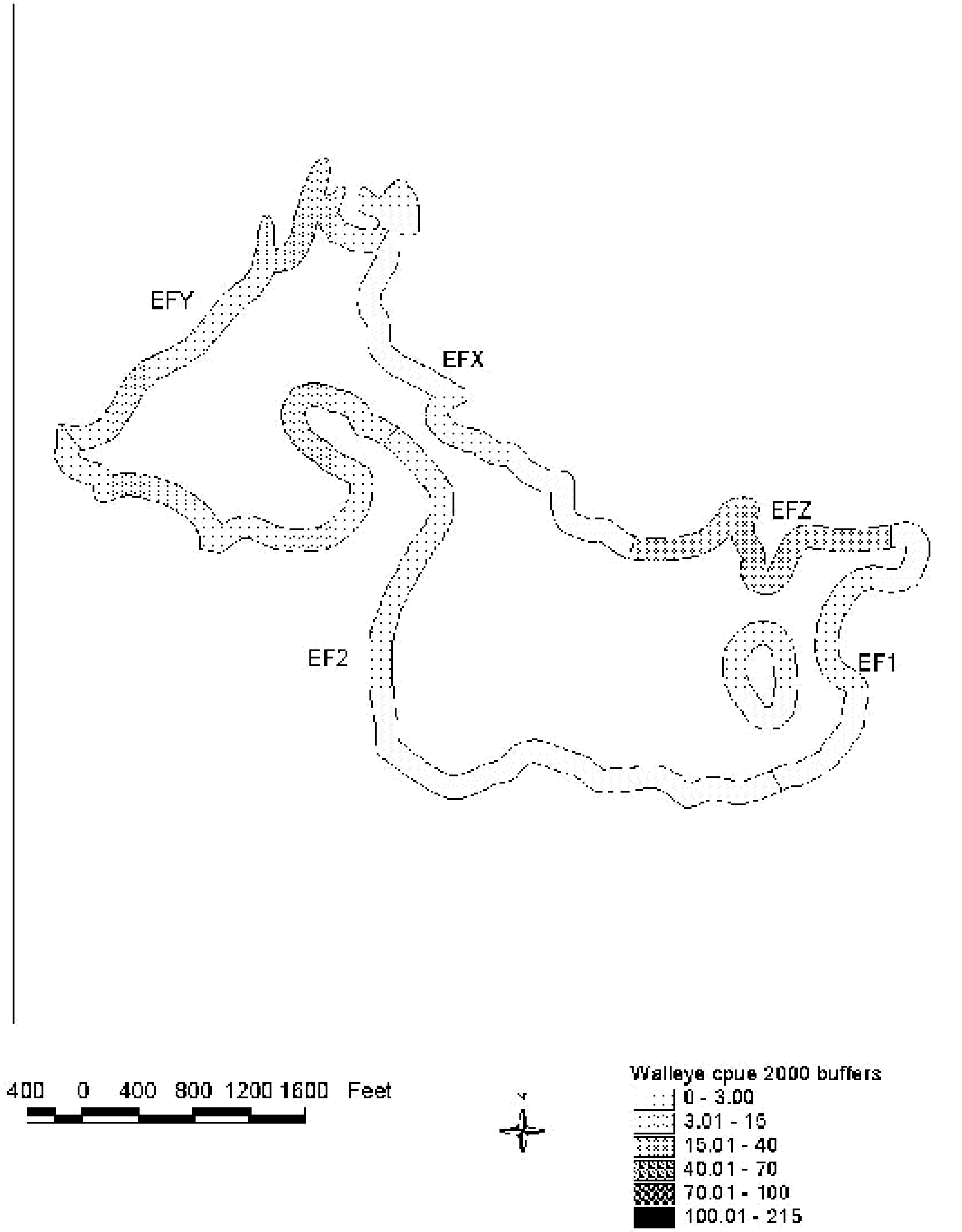

Figure 5 - North McDougal Lake Walleye CPUE 2000 zones

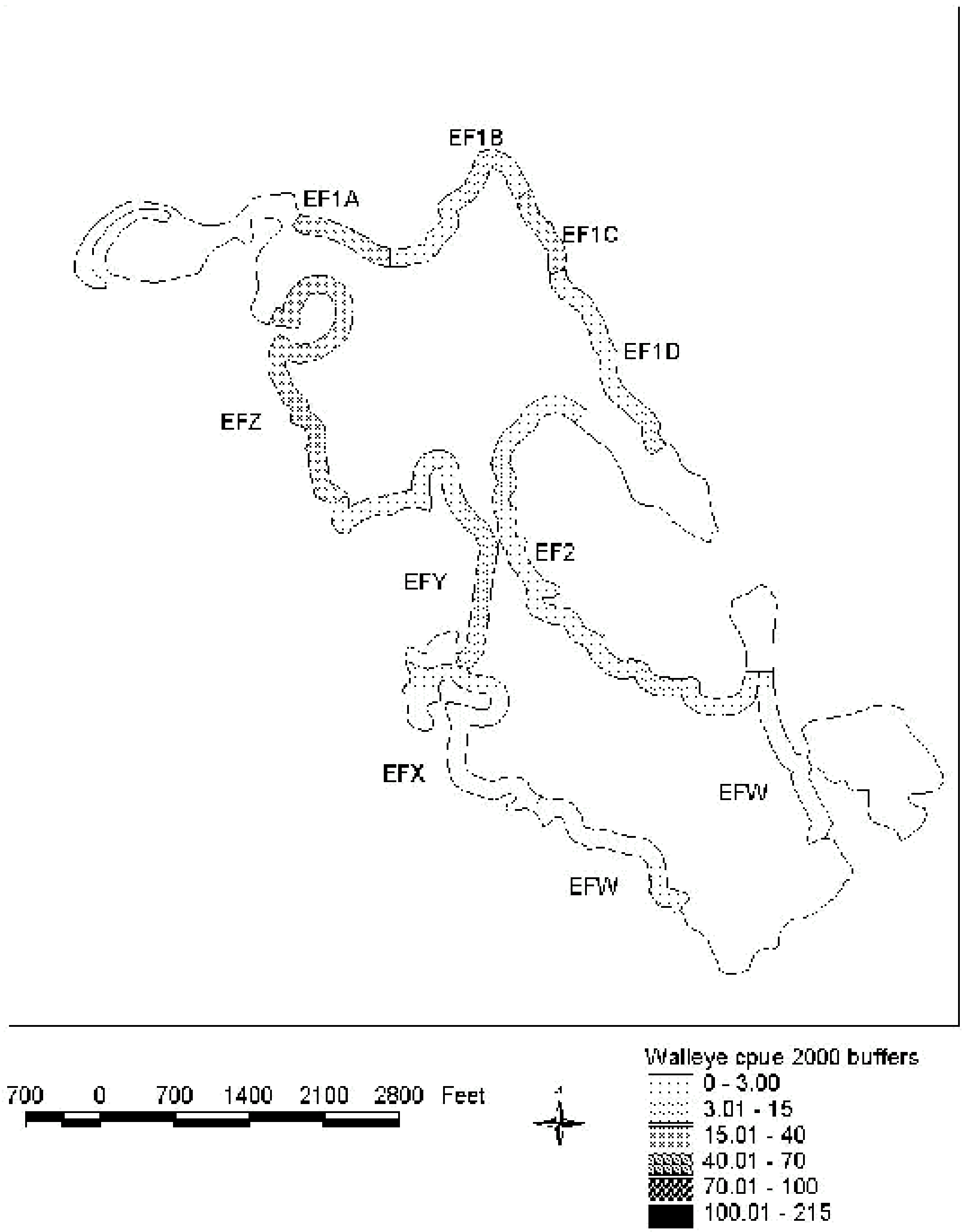

Figure 7 - Dumbbell Lake Walleye CPUE 2000 zones

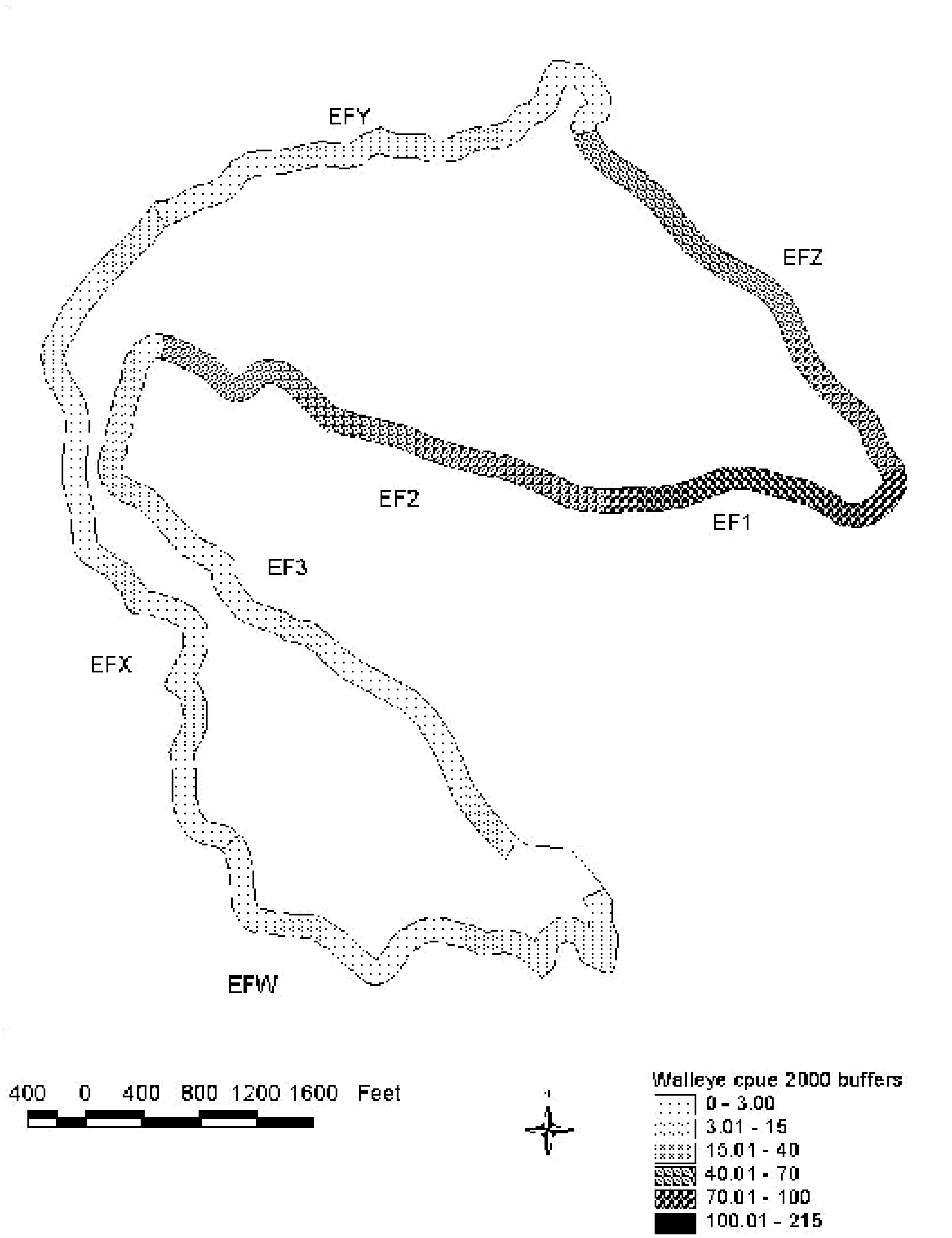

Figure 9 - Elbow Lake Walleye CPUE 2000 zones

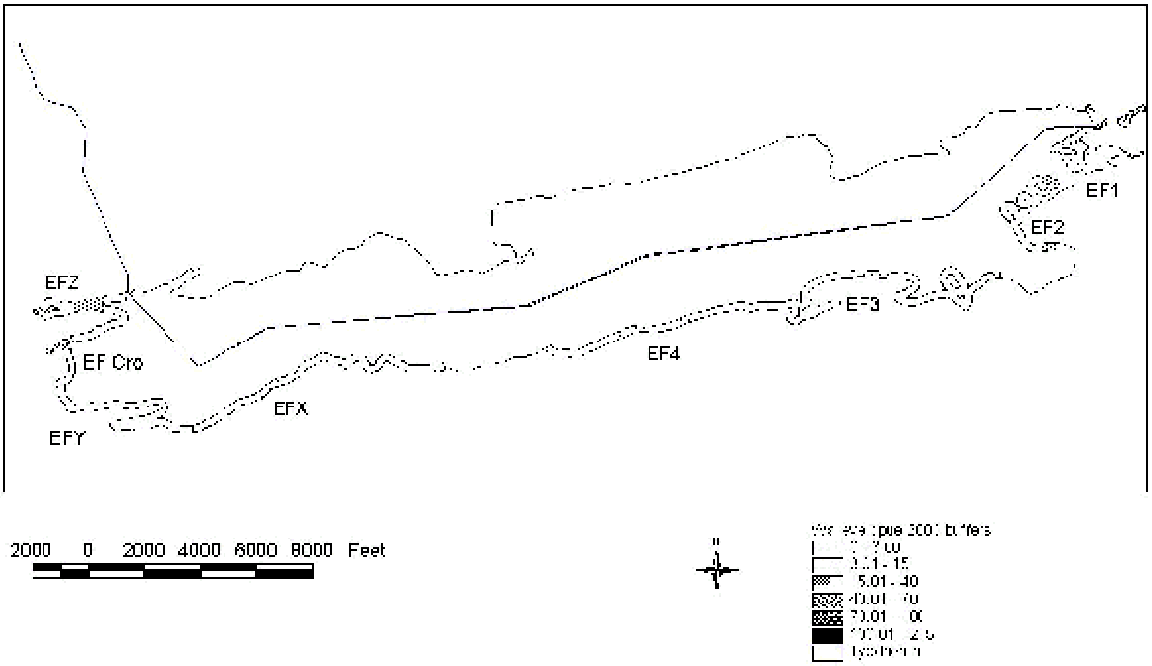

Figure 11A - Gunflint Lake Walleye CPUE 2000 zones

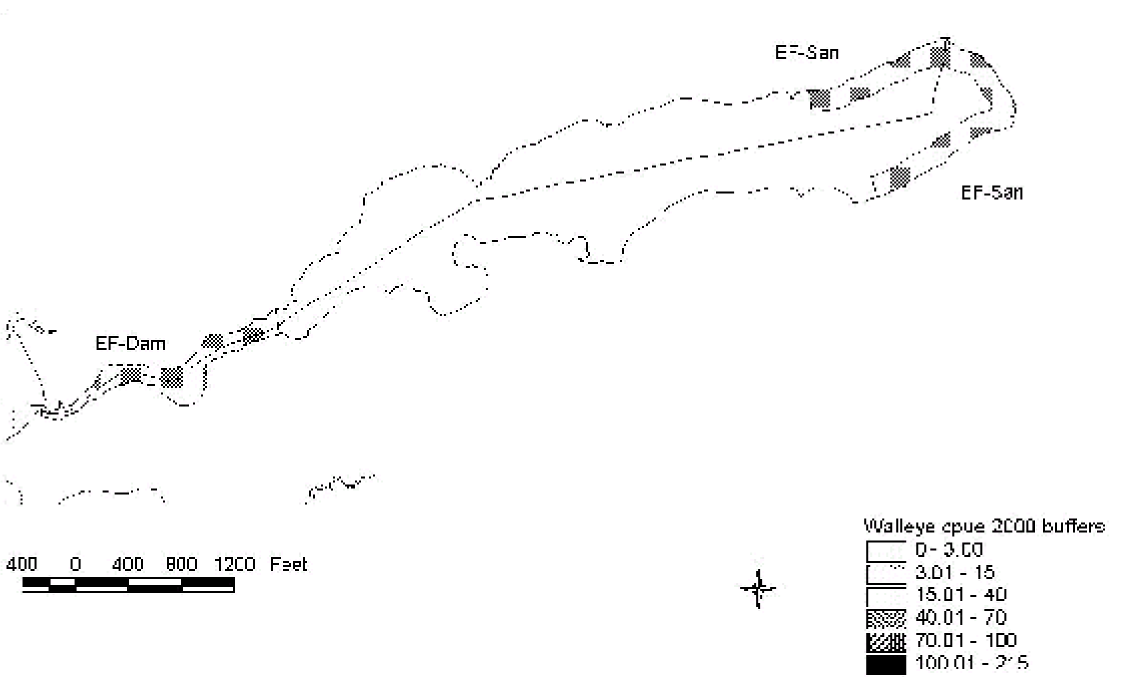

Figure 11B - Little Gunflint Lake Walleye CPUE 2000 zones