Spring Adult and Fall Juvenile Walleye Population Surveys within the 1854 Ceded Territory of Minnesota, 2019

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

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Introduction

Under the Treaty of 30 September 1854, the Fond du Lac, Grand Portage, and Bois Forte Bands of Chippewa entered into an agreement with the United States of America. Under this agreement, these three Bands retained certain hunting, fishing, and gathering rights in the land ceded under this treaty.

Along with the right to utilize a resource comes the responsibility to manage and monitor the resource. Bands have assumed an increased responsibility to monitor fish populations and to develop long-term databases to set harvest quotas and to monitor the effects of tribal harvest. Fishery assessment surveys by Native American organizations have been performed for many years in both reservation and ceded territory waters of Wisconsin, Michigan, and Minnesota. Fond du Lac and the 1854 Treaty Authority have been actively involved with fish assessments since 1994 (Borkholder 1994a).

The 1854 Treaty Authority and Fond du Lac Resource Management Division work to protect and enhance the natural resources of the 1854 Ceded Territory for the three Bands. Cooperating with local Minnesota Department of Natural Resources (DNR) offices, the 1854 Treaty Authority and Fond du Lac identify priority natural resource projects for areas within the Ceded Territory. One goal is to assist with walleye (*Sander vitreus*) assessments in the Ceded Territory. Walleye have always been a traditional subsistence resource for the Fond du Lac, Grand Portage, and Bois Forte Bands. Surveys have indicated that walleye are the primary game fish sought after by band members in the 1854 Ceded Territory (Borkholder 1994b; Vogt 2004; Kaeske 2009).

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 within Wisconsin (Ngu and Kmiecik 1993; Goyke et al. 1993 and 1994) and within Northeastern Minnesota since 1994 (Borkholder 1994a). In order to maximize the number of fish handled and marked during the 2019 spawning season, Fond du Lac and the 1854 Treaty Authority chose once again to utilize electrofishing gear for these surveys.

Population estimates can be made using mark - recapture data (Ricker 1975). In this type of assessment, fish are collected, marked (fin clips, tags, etc.), and returned to the water. Population estimates are based upon the ratio of marked fish to unmarked fish within subsequent recapture samples. Accurate estimates are obtained when a large portion of the population is marked, usually 10% to 30% (Meyer 1993).

Surveying adult walleye populations using just electrofishing gear will usually result in conservative estimates of the adult stock. Walleye spawn in shallow water, where they are vulnerable to electrofishing gear. Male walleyes remain in the shallow water following spawning and have an extended spawning period, while females retreat to deeper water (Meyer 1993). Thus, females are only vulnerable to the sampling gear for a short period of time. The Great Lakes Indian Fish and Wildlife Commission and the U.S. Fish and Wildlife Service utilize trap nets to aid in the sampling of walleye females, thus improving the accuracy of their population estimates. Given time and personnel constraints, we have chosen to accept conservative population estimates as a trade-off to the extra effort required to trap net for additional females.

The first objective of our assessments in 2019 was to obtain adult walleye population estimates (PE) during the spring spawning period using mark - recapture data. Our electrofishing PEs are likely biased towards males in the populations, and thus are presumed conservative estimates of population abundance. However, by cooperating with the MN DNR area offices, another PE is obtained using the State's summer gill net data, with which to compare to the spring-only electrofishing PE. An additional benefit of the spring electrofishing surveys is that it allows biologists to identify and determine key and critical spawning sites, i.e. where catch rates are the highest.

The second objective of our 2019 walleye surveys targeted juvenile (age-1) and young-of-the-year (age-0) individuals in the fall. The purpose for assessing age-0 and age-1 individuals is to evaluate recruitment and year-class strength, and to continue developing long-term data sets using this data.

Methods

Spring Assessments

Lakes within the 1854 Ceded Territory of Minnesota were identified by MN DNR Area Managers and Tribal biologists. The objective was to obtain adult walleye population estimates using mark-recapture methods and to determine the age structure and growth rates of the walleye population within the lakes surveyed. Tagged walleye would then be available during summer gill net assessments. A second population estimate was obtained by the MN DNR in the course of conducting their standard summer gill net surveys.

Electrofishing was performed at night using boom-shocking boats equipped with Smith-Root electrofisher units and two Smith-Root umbrella anode arrays (Smith-Root, Vancouver, WA). Pulsed direct current was used to minimize injuries to the fish. Surface water temperature was taken prior to the beginning of each night's assessment activity. Ambient water conductivity measurements were also taken in order to properly set electrofishing power settings.

Electrofishing surveys were planned to begin soon after ice-out and continued for as long as un-tagged walleye were abundant in the samples or when the percentage of recaptured individuals approached or exceeded 30%, normally 3 – 5 nights per lake. Adult and juvenile walleye immobilized by the electrofishing gear were collected. Collected fish were placed into a 90-gallon tank equipped with an aerator and given time to recover. Walleye were measured to the nearest millimeter (mm), examined for fin clips and / or floy tags, and the sex determined based upon visual identification of gametes. Walleye that had been floy-tagged during any previous nights' collections were counted as recaptured fish (Appendix 1). All individuals (> 254 mm) were marked using non-numbered colored floy tags (light blue color used in 2019) (Super Swiftachment Fasteners available from the Dennison Fastener Division, Framingham, Massachusetts). The reason for this recent change in marking was after many years of clipping dorsal fin spines, it would be impossible to differentiate 2019 marked fish from previously clipped individuals. A dorsal fin spine from five individuals per centimeter group and per sex was removed for age interpretations. Following marking and spine collection, walleyes were released away from the shoreline.

Mark and recapture data were used to calculate adult walleye population estimates using both the Schumacher and Eschmeyer formula for multiple recapture surveys and the adjusted Petersen Method for single census (Ricker 1975). The Schumacher and Eschmeyer formula was used to take advantage of multiple evenings of recapture data. Walleye less than 254 mm (10 inches, "stock" size defined by Anderson 1976 and 1978) were excluded from population estimates.

Spines from adults were cleaned using bleach to remove the layer of skin on the bone. Spines were set in epoxy resin and sectioned (0.3 to 0.5 mm thick) using a Buehler Isomet™ low speed bone saw. Spines were examined using a microfiche reader. Annual rings were counted (McFarlane and Beamish 1987), and marked on overhead transparency sheets. Each spine's annuli were digitized into a computer using the DisBCal89 program (Frie 1982). DisBCal89 was used to back-calculate length-at-age estimates, using no transformation and a standard intercept of 27.9 mm (MN DNR personal communication).

Fall Assessments

Presumed age-0 and age-1 walleye immobilized by the electrofishing gear were collected. Collected fish were placed into a 90-gallon tank of lake water and given time to recover. Walleye were measured to the nearest mm. Scales were taken for age analysis from five fish per cm group prior to release.

Sampling stations used were either those established during previous electrofishing surveys by the MN DNR or by Fond du Lac and the 1854 Treaty Authority. Sampling stations were repeated from previous years' surveys.

Walleyes were aged by counting annuli on scales viewed under a microfiche reader (Borkholder and Edwards 2001). Walleye ages were used to estimate CPUE (number of walleye / hour of electrofishing) of juvenile (age-1) and young-of-the-year (age-0) individuals.

Results and Discussion

Spring Assessments

Wild Rice Lake Reservoir (DOW 69-0371)

Electrofishing activities were conducted on Wild Rice Lake, St. Louis County, on 29 April thru 5 May (Figure 1). Dates of electrofishing activities, water temperature, water conductivity, shocking time, the voltage and amps, the number of walleye collected, and the number caught per hour of electrofishing (CPUE) are presented in Table 1. CPUE ranged from 0.0 (EFD & EF3, 29 April; EFD & EF9, 30 April; EF8, 1 May) to 202.8 (EF2, 3 May) adult walleye per hour of sampling (Figure 1). At a 95% confidence interval, mean CPUE for Wild Rice Lake, determined using each sampling station, was 66.7 ± 18.4 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Wild Rice Lake is presented in Figure 2. Walleye as large as 674 mm (26.5 inches) were observed in the survey. Additional species observed included yellow perch, northern pike, white sucker, bluegill, black crappie, and largemouth bass.

Walleyes larger than 254 mm were marked with a non-numbered light blue floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 3951 (Table 2). The adjusted Petersen estimate is 3586 ± 1581, with an 18.0% CV (Table 2). The population estimates presented in Table 2 represent the population abundance of walleye using the spawning habitat sampled (Figure 1), and are not estimates of the walleye population within the entire lake.

During summer 2019, the Minnesota Department of Natural Resources performed a standardized net assessment on Wild Rice Lake (MN DNR, Duluth Area Fisheries). 221 individuals (> 274 mm) were sampled in the gill nets that would have been 254 mm during the May assessments. This 275 mm threshold was determined in previous mark-recapture experiments using unique numbered floy tags (Borkholder et al. 2006). Twelve individuals were recapture that had the blue floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the spring and summer data is 14,925 ± 9153, with a 25.9% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 6013 (Table 2). 262 walleyes in total were sampled between the gill nets and trap nets, with 17 recaptured individuals observed. Population estimates are included in Table 2.

Table 3 presents the age data for the walleye collected from Wild Rice Lake. Of the 873 unique fish sampled, 575 (65.8%) were assigned to ages 4 & 5. Total annual mortality (*A*) of the Wild Rice Lake population was estimated using the equation $A = 1 - e^{(Z)}$, where *Z* is the slope of the catch-curve relationship, and an estimate of instantaneous total annual mortality (Figure 3) (Chapman and Robson 1960). Annual mortality (*A*) was estimated at 46.3% (Figure 3, blue line). Using catch curve analysis assumes that; 1) there are no aging errors; 2) constant recruitment; 3) Z is constant over time, and; 4) above a certain age (sexual maturity for this data set) all individuals within the population are equally vulnerable to the sampling gear (Smith et al., 2012). Total annual mortality (*A*) estimated using the MN DNR's gill net data was 36.1% (Figure 3, green triangles), lower than the estimates from the spring electrofishing assessment. Our spring estimate was made using 868 mature walleyes, aged 3 – 14. The estimate from the gill and trap net assessment was made using 201 fish aged 3 – 14.

Table 4 presents back-calculated lengths-at-age for walleye collected from Wild Rice Lake, as determined using dorsal fin spines.

Stock density indices are used to quantify the size structure of a population. Proportional stock density (PSD) was first proposed by Anderson (1976 and 1978), and is simply a measurement of the proportion of the fish observed larger than a predetermined "quality" length divided by the number of fish observed larger than a predetermined "stock" length. For walleye, "stock" length fish are those larger than 10.0 inches (254 mm), and "quality" length fish are those larger than 15.0 inches (381 mm). Gabelhouse (1984) proposed further separating "quality" fish into "preferred" (walleye > 20.0 inches / 508 mm), "memorable" (walleye > 25.0 inches / 635 mm), and "trophy" length fish (walleye > 30.0 inches / 762 mm), and calculating a relative stock density (RSD), or proportion, for each category. For example, RSD S-Q is the proportion of walleye in the sample between "stock" length (10.0 inches / 254 mm) and “quality” length (> 15.0 inches / 381 mm), divided by the total number of walleye sampled larger than 10.0 inches.

PSD and RSD values determined by our spring electrofishing sampling and summer gillnet survey are presented in Table 5. The electrofishing PSD was 60.0 ± 3.2 (Table 5). About 350 of the 873 fish sampled were larger than 10.0 inches (stock sized) and will be growing and recruiting into this “quality” 15-inch category over the next few years, assuming that angling (or natural) mortality doesn’t remove them before this. The summer gill net PSD (61.1 ± 5.8) was not significantly different than the PSD estimate from the spring electrofishing survey (χ^2=0.102, P>0.05, critical Chi-square value of 3.841) (Table 5).

Figure 4 shows historical data from Wild Rice Lake. Since 1994, PSDs within Wild Rice Lake have typically been estimated as high, in most years in excess of 60% (Figure 4). With the exception of the first electrofishing survey in 1994, all estimates since have had walleye densities of less than 1.5 adults per acre (Figure 4).

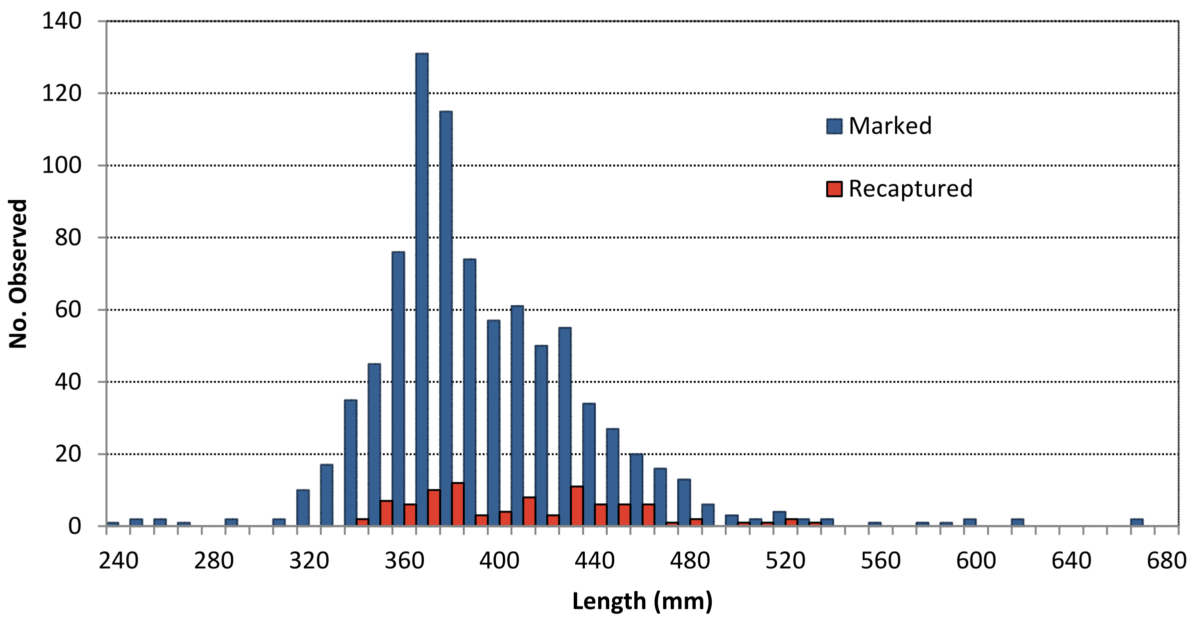

Figure 2. Length frequency distribution of walleye sampled from Wild Rice Lake, St. Louis County, during Spring 2019 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

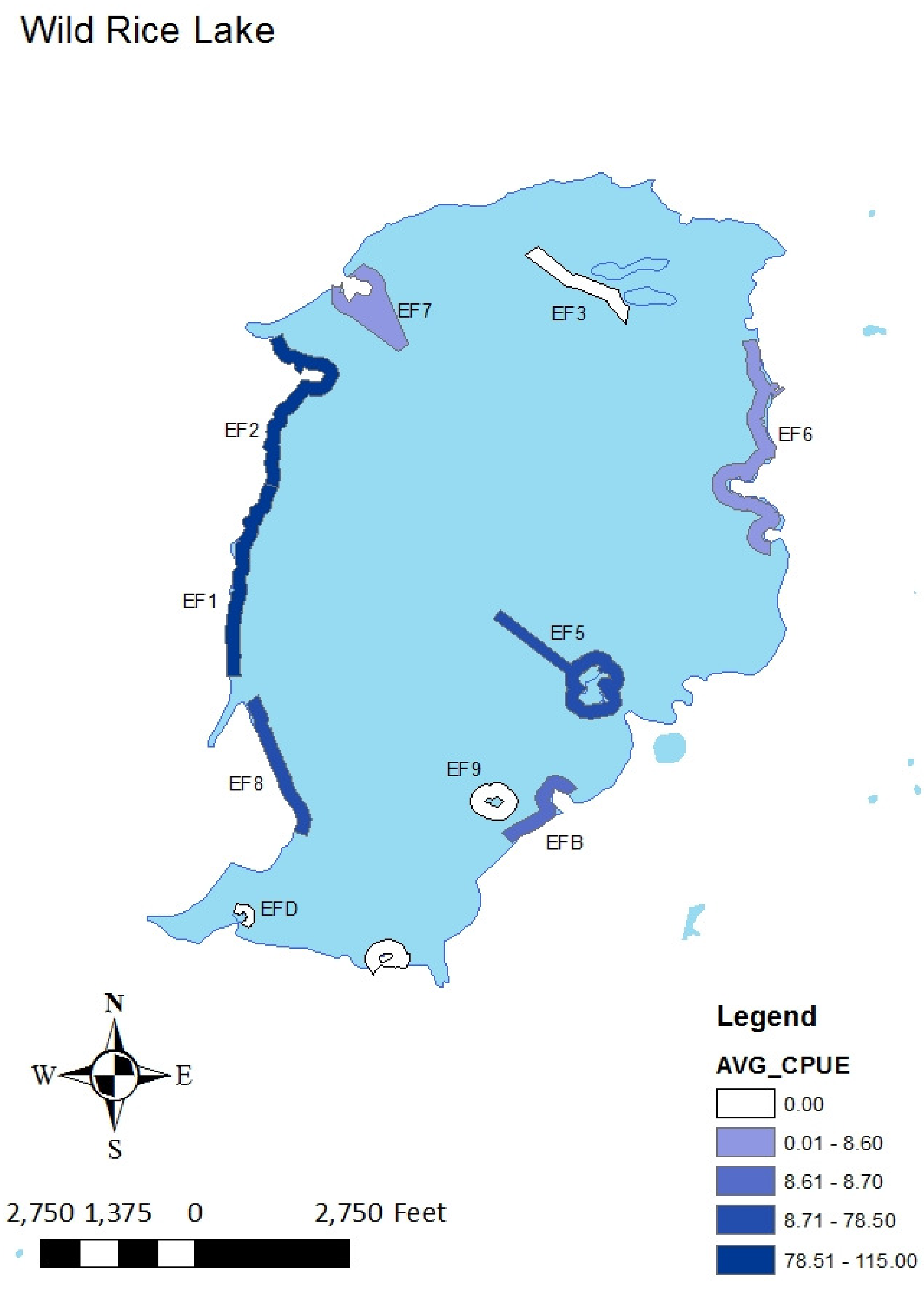

Figure 1. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Wild Rice Lake, St. Louis County, during Spring 2019 electrofishing surveys.

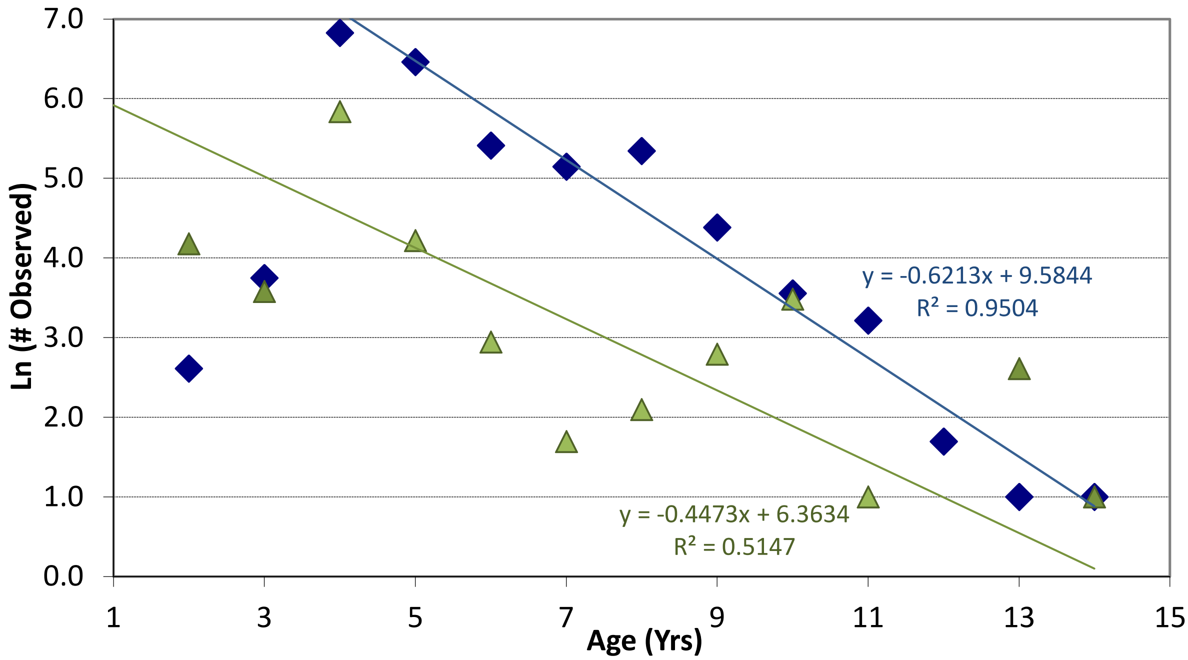

Figure 3. Catch curve analysis of walleyes in Wild Rice Lake, 2019, showing instantaneous mortality (*Z*). Estimates are made from May 2019 electrofishing data (blue diamonds) and summer MN DNR gill net data (green triangles).

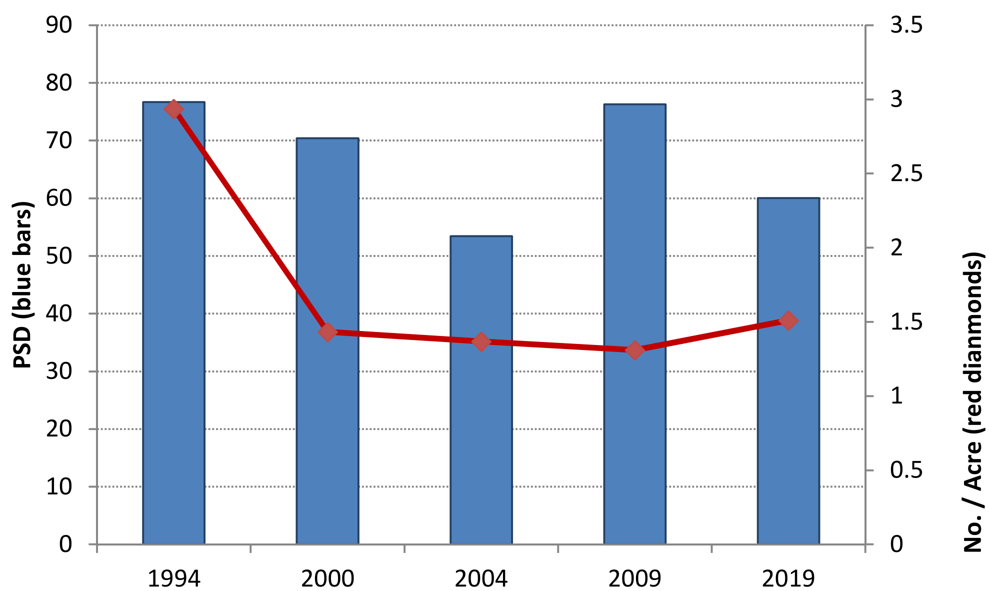

Figure 4. PSDs (blue bars) for walleye and adult walleye densities (no. / acre, red line) in Wild Rice Lake Reservoir as estimated during spring electrofishing surveys.

Table 1. Summary of electrofishing activities on two lakes within the 1854 Ceded Territory of Minnesota during spring 2019.

ID #	County	Lake	Area (Acres)	Max Depth (ft)	Date	Water Temp (F)	Conductivity[1]	Shocking Time (sec)	Voltage (PDC)[2]	Amps[3]	# WAE[4]	CPUE WAE[5]
69-0371	St. Louis	Wild Rice	2372	11	4/29/2019	40.3	97	8911	884 / Low	1.5 / 5	106	42.8
					4/30/2019	40.2	97	8297	707 / Low	1 / 4	102	44.2
					5/1/2019	37.7	94	4435	707 / Low	1 / 4	84	68.2
					5/2/2019	39.3	118	12431	707 / Low	0.75 / 4	198	57.3
					5/3/2019	43.2		4985	Low	0.5	185	133.6
					5/4/2019	47.5	122	5102	Low	0.5	187	131.9
					5/5/2019	49.8	123	4837	Low	0.5	103	76.6
38-0024	Lake	Crooked	272	18	5/8/2019	39.9	47	2121	884 / Low	1 / 4	66	112.0
					5/9/2019	40.6	47	5773	884	4	120	74.8
					5/10/2019	42.6	32	6906	884	4	250	130.3

1 Water conductivity measured in microSiemens / cm.
2 Voltage is reported as actual voltage recorded from the SmithRoot Type VI-A, or as Low / High from the SmithRoot 5.0 GPP
3 Amps are reported as from the 1854 Treaty Authority Boat / Fond du Lac Boat.
4 WAE = walleye. Numbers in column represent the number of "stock" sized walleye (>254mm (10 inches)) collected. Includes marked and recaptured individuals.
5 CPUE = catch per unit effort, computed as per hour (3600 sec) of electrofishing. Numbers in column represent CPUE for "stock" sized walleye (>254mm (10 inches)).

Table 2. Walleye population estimates for Wild Rice Lake Reservoir (St. Louis County) and Crooked Lake (Lake County), Spring 2019. Estimates are for walleye larger than 254 mm (10.0 inches). EF denotes population estimates determined from spring electrofishing data. GN refers to population estimates from samples collected during the MN DNR's summer netting assessments. GN/TN includes all of the MN DNR data from both the gill nets and trap nets.

Lake	Population Estimate[1]	No. / Acre	95% Confidence Limits Lower	95% Confidence Limits Upper	Estimate[2]	C.V.[3]
Wild Rice – EF_{2019}	3951	1.7	3743	4182	3586 ± 1581	18.0 %
Wild Rice – GN_{2019}	6013	2.5	3972	12,374	14,925 ± 9153	25.9%
Wild Rice – GN/TN_{2019}	6089	2.5	4088	11,929	12,770 ± 6687	22.1%
Crooked – EF_{2019}	394	1.4	391	397	388 ± 234	14.0%
Crooked – GN_{2019}	513	1.9	305	1605	861 ± 757	27.6%
Crooked – GN/TN_{2019}	530	1.9	304	2083	929 ± 826	27.9%

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

Table 3. Age frequency distribution of walleye from Wild Rice Lake, St. Louis County, Spring 2019, based upon the number of fish sampled and aged per size category.

Length Group		N	------------------------ Age ------------------------												
Inches	mm	Sampled	2	3	4	5	6	7	8	9	10	11	12	13	14
10.0	254	4	4												
10.5	267	1	1												
11.0	279														
11.5	292	2		2											
12.0	305	1		1											
12.5	318	14		3	9	2									
13.0	330	22		6	17										
13.5	343	56		4	40	12									
14.0	356	84			78	6									
14.5	368	165			121	33		11							
15.0	381	124			54	62		8							
15.5	394	79			21	42	4	4	8						
16.0	406	78				47	23			8					
16.5	419	61				9	19	9	23						
17.0	432	65				18	22	11	14						
17.5	445	35				2	9	11	9	4					
18.0	457	25				2	2	5	11		2	2			
18.5	470	24					3	3	10	5	2	2			
19.0	483	9						1		6		1			
19.5	495	5							1	2	1	1			
20.0	508	2								1	1				
20.5	521	5									4		1		
21.0	533	3								1	2				
21.5	546														
22.0	559	1								1					
22.5	572														
23.0	584	1										1			
23.5	597	3								1	1	1			
24.0	610														
24.5	622	2											1	1	
26.0	660	1													1
26.5	673	1										1			
TOTAL		873	5	16	339	235	82	63	77	29	13	9	2	1	1

Table 4. Back-calculated lengths-at-age for walleye collected from Wild Rice Lake, St. Louis County, Minnesota, Spring 2019.

Age Class	N	Length (mm)	Length (in)
1	218	118	4.6
2	218	215	8.5
3	213	291	11.5
4	205	352	13.9
5	148	391	15.4
6	106	421	16.6
7	84	443	17.5
8	66	467	18.4
9	39	501	19.7
10	22	527	20.7
11	11	554	21.8
12	4	598	23.5
13	2	639	25.2
14	1	670	26.4

Table 5. Proportional Stock Density (PSD) and Relative Stock Densities (RSD) with 95% confidence for Wild Rice Lake (St. Louis County), and Crooked Lake (Lake County). Values are for spring electrofishing (EF) and MN DNR gill netting (GN) and trap netting (TN) surveys conducted during the year indicated.

Lake	PSD	RSD S-Q	RSD Q-P	RSD P-M	RSD M-T
Wild Rice – EF_{2019}	60.0 $\pm$ 3.2	40.0 $\pm$ 3.2	57.8 $\pm$ 3.3	1.9 $\pm$ 0.9	0.2 $\pm$ 0.3
Wild Rice – GN_{2019}	56.8 $\pm$ 6.4	43.2 $\pm$ 6.4	46.7 $\pm$ 6.5	7.9 $\pm$ 3.5	2.2 $\pm$ 1.9
Wild Rice – GN/TN_{2019}	61.1 $\pm$ 5.8	38.9 $\pm$ 5.8	49.6 $\pm$ 6.0	9.6 $\pm$ 3.5	1.8 $\pm$ 1.6
Crooked – EF_{2019}	86.7 $\pm$ 4.7	13.3 $\pm$ 4.7	76.4 $\pm$ 5.8	9.8 $\pm$ 4.1	0.5 $\pm$ 1.0
Crooked – GN/TN_{2019}	59.5 $\pm$ 14.8	40.5 $\pm$ 14.8	47.6 $\pm$ 15.1	11.9 $\pm$ 9.8	0.0 $\pm$ 0.0

Crooked Lake (DOW 38-0024)

Electrofishing activities were conducted on Crooked Lake, Lake County, on 8 – 10 May (Figure 5). Dates of electrofishing activities, water temperature, water conductivity, shocking time, the voltage and amps, the number of walleye collected, and the number caught per hour of electrofishing (CPUE) are presented in Table 1. CPUE ranged from 17.8 (EF2/5, 9 May) to 87.9 (EF1, 9 May) adult walleye per hour of sampling (Figure 5). At a 95% confidence interval, mean CPUE for Crooked Lake, determined using each sampling station, was 49.5 ± 16.4 adult walleye (>254mm) per hour of sampling effort.

The length frequency of the walleye sampled in Crooked Lake is presented in Figure 6. Walleye as large as 646 mm (25.4 inches) were observed in the survey. Additional species observed included northern pike, white sucker, smallmouth bass, and yellow perch.

Walleyes larger than 254 mm were marked with a non-numbered blue floy tag along the distal portion of the soft dorsal fin. Table 2 presents the population estimates based upon mark-recapture data. The electrofishing Schumacher and Eschmeyer population estimate is 394 (Table 2). The electrofishing adjusted Petersen estimate is 388 ± 234, with a 14.0% CV (Table 2).

During summer 2019, the Minnesota Department of Natural Resources performed a standardized net assessment on Crooked Lake (MN DNR, Finland Area Fisheries). 37 individuals (> 274 mm) were sampled in the gill nets that would have been 254 mm during the May assessments. This 275 mm threshold was determined in previous mark-recapture experiments using unique numbered floy tags (Borkholder et al. 2006). Eight individuals were recapture that had the blue floy tag from the spring sampling (Appendix 1). The adjusted Petersen estimate using both the spring and summer data is 861 ± 757, with a 27.6% CV (Table 2). The Schumacher and Eschmeyer population estimate from this gill net data is 513 (Table 2). Forty walleyes in total were sampled between the gill nets and trap nets, with 8 recaptured individuals observed. Population estimates are included in Table 2.

Table 6 presents the age data for the walleye collected from Crooked Lake. Total annual mortality (A) of the Crooked Lake population was estimated at 27.1%, using the equation $A = 1 - e^{(Z)}$, where Z is the slope of the catch-curve relationship, and an estimate of instantaneous total annual mortality (Figure 7). Table 7 presents back-calculated lengths-at-age for walleye collected from Crooked Lake, as determined by aging dorsal fin spines.

PSD and RSD values determined by our spring electrofishing sampling is presented in Table 5. The electrofishing PSD was 86.7 ± 4.7 (Table 5). Crooked Lake has been surveyed six times since 1997 (Figure 8). Population estimates each year suggest a declining population of adult walleyes (red diamonds and trend line in Figure 8). Changes in stock structure (PSD; blue bars) are also presented over time. Fall electrofishing data suggests that reproduction doesn't appear to be limited, as evident by relatively high numbers of age-0 walleyes sampled in 2012, 2013, 2016, and 2019 (Figure 9). However, after a year, these same cohorts were not observed to be as abundant, suggesting that overwinter survival may be an issue in Crooked Lake. While total annual mortality of 27% doesn't seem alarmingly high, when coupled with inconsistent recruitment and the popularity of this lake amongst anglers, perhaps the decline in walleye density merits further investigation.

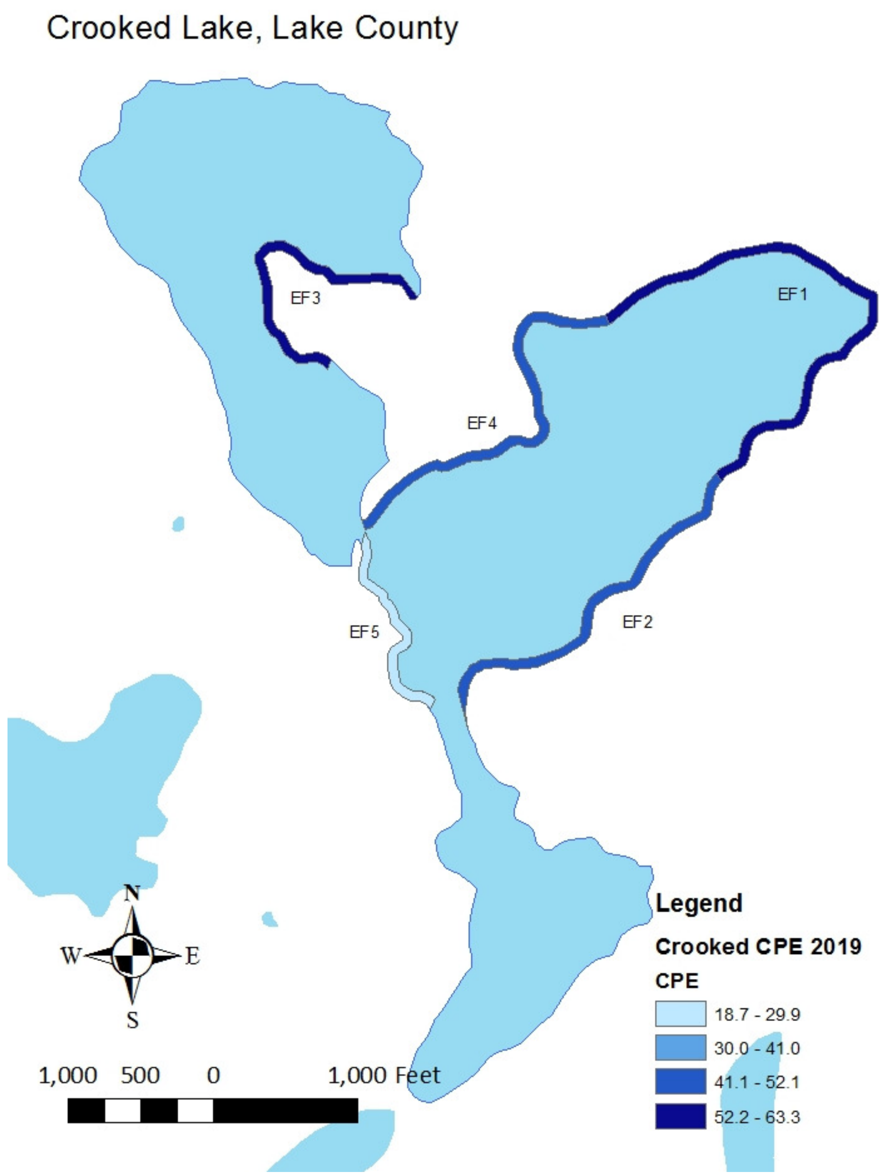

Figure 5. Catch per hour (CPUE) of adult walleyes (fish larger than 254 mm) by electrofishing station, on Crooked Lake, Lake County, during Spring 2019 electrofishing surveys.

Table 6. Age frequency distribution of walleye from Crooked Lake, Lake County, Spring 2019, based upon the number of fish sampled and aged per size category.

Length Group		N	------------------------ Age ------------------------										
Inches	mm	Sampled	2	3	4	5	6	7	8	9	10	11	12
11.5	292												
12.0	305	2		2									
12.5	318	1		1									
13.0	330	4		2	2								
13.5	343	1			1								
14.0	356	9			8	1							
14.5	368	10			8			2					
15.0	381	10			6	4							
15.5	394	10			3	7							
16.0	406	14			4	8	2						
16.5	419	19				8	6	6					
17.0	432	16					4	12					
17.5	445	27					7	17	3				
18.0	457	21					7	4	4	7			
18.5	470	20					3	5	10	3			
19.0	483	12						3	1	4	1		1
19.5	495	6					1		1	4			
20.0	508	4								3	1		
20.5	521	3								1		1	1
21.0	533	3						1	1	1			
21.5	546	1										1	
22.0	559	5								2	1	2	
22.5	572	2							1		1		
23.0	584	0											
23.5	597	1									1		
24.0	610	1									1		
24.5	622	0											
25.0	635	1											1
TOTAL		203	0	5	31	28	29	50	21	25	6	4	3

Table 7. Back-calculated lengths-at-age for walleye collected from Crooked Lake, Lake County, Minnesota, Spring 2019.

Age Class	N	Length (mm)	Length (in)
1	115	119	4.7
2	115	206	8.1
3	115	288	11.4
4	110	353	13.9
5	88	396	15.6
6	72	430	16.9
7	62	458	18
8	42	489	19.2
9	32	511	20.1
10	14	541	21.3
11	8	544	21.4
12	3	554	21.8

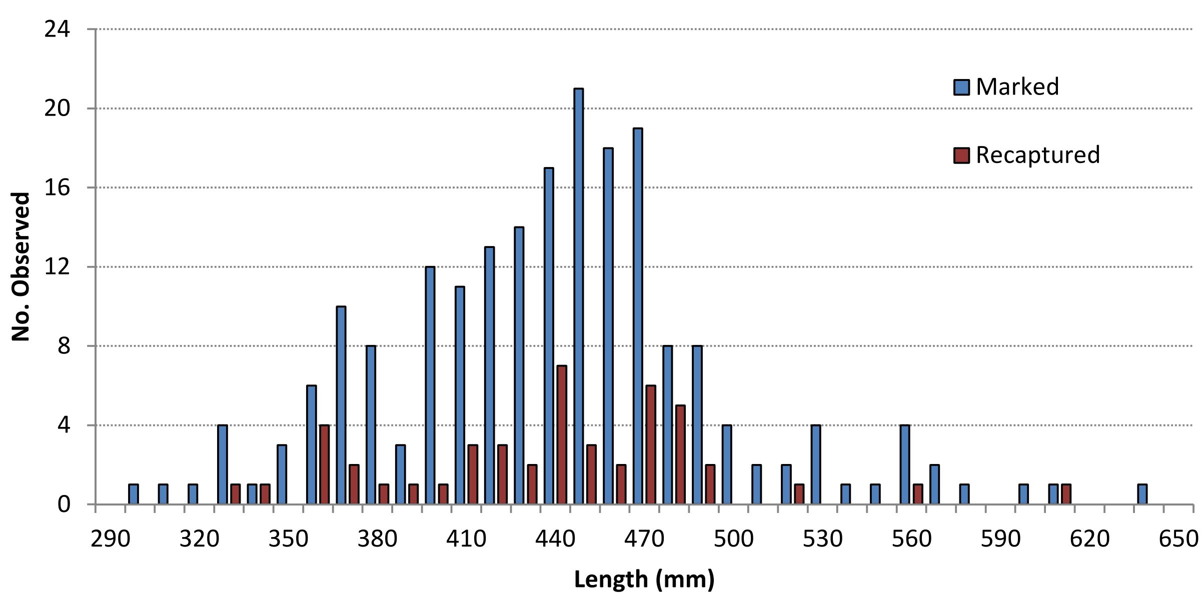

Figure 6. Length frequency distribution of walleye sampled from Crooked Lake, Cook County, MN, during Spring 2019 electrofishing assessments. Length frequency distribution of recaptured walleyes is shown in red bars.

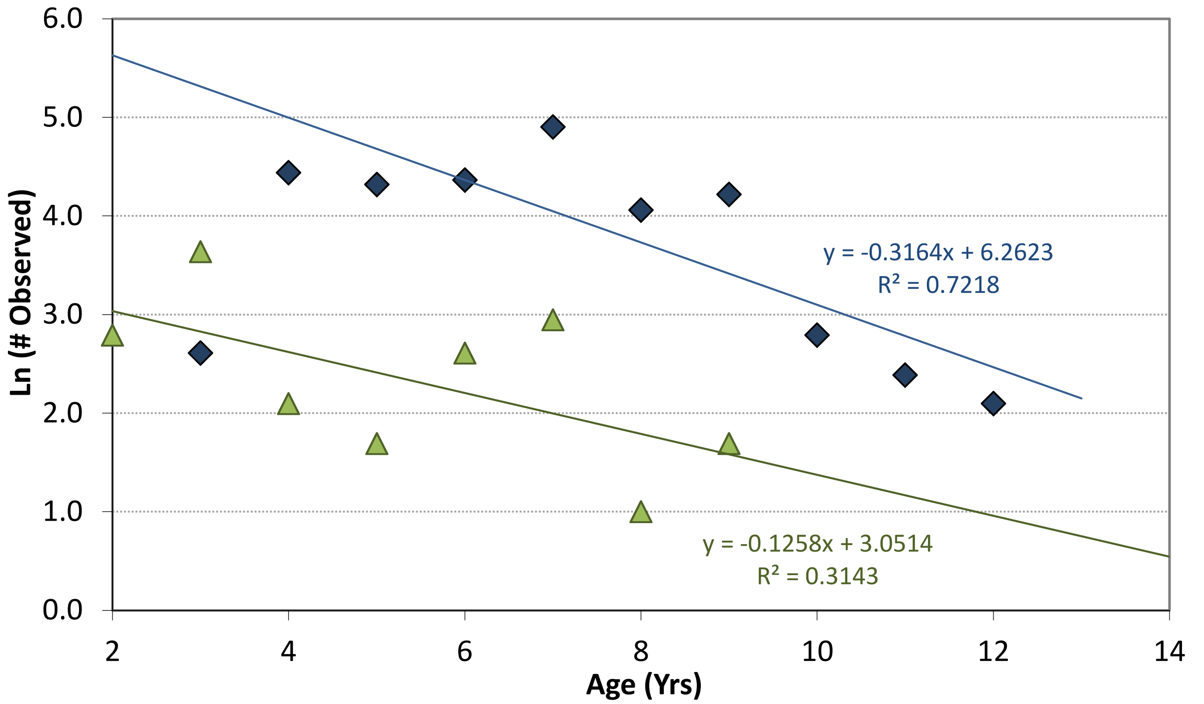

Figure 7. Catch curve analysis of walleyes in Crooked Lake, 2019, showing instantaneous mortality (*Z*). Estimates are made from May 2019 electrofishing data (blue diamonds) and summer gill net data (green triangles).

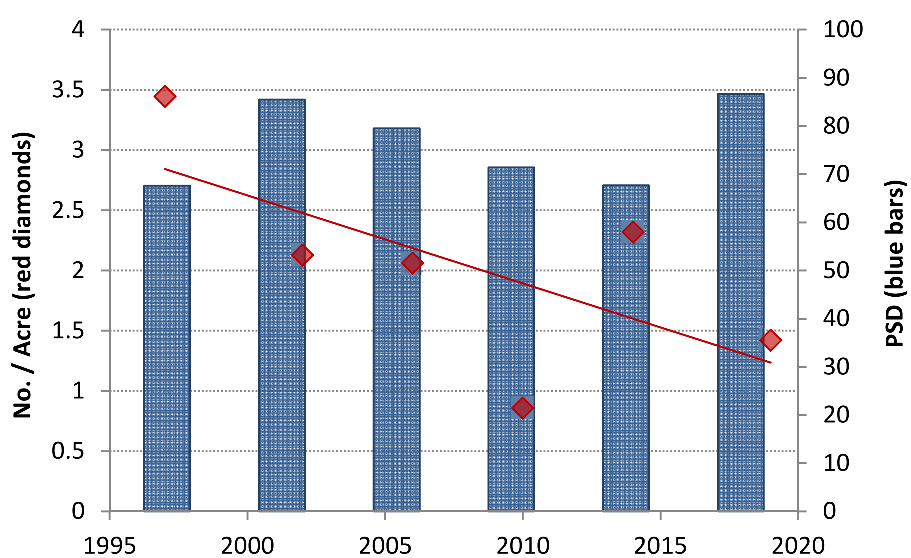

Figure 8. Long-term electrofishing data for Crooked Lake, presenting Peterson population estimates (red diamonds) and PSD estimates (blue bars) since the first electrofishing survey in 1997.

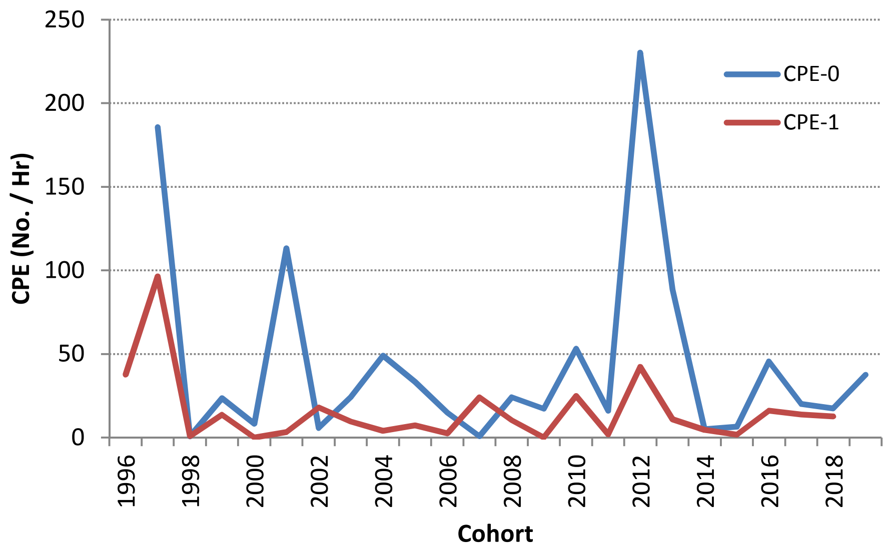

Figure 9. Catch rates (number per hour) of age-0 and age-1 walleyes sampled in the fall from Crooked Lake, Lake County, MN.

Fall Assessments

Catch per unit effort (CPUE) for age-0 walleye has been found to be the highest in the fall when water temperatures are between 20.0°C and 10.0°C (Borkholder and Parsons, 2001). Fall assessments began in the Grand Marais area on 3 September 2019. This 20°C threshold was only exceeded on one of the lakes this season (Wild Rice Lake, Table 8). All of the lakes were surveyed before the lakes cooled to below the 10°C lower threshold.

Table 8 presents a summary of each evening of electrofishing assessments. CPUE for age-0 walleye ranged from 0.0 fish per hour (Wild Rice Lake) to 323.6 fish per hour of electrofishing (Shagawa Lake). Of interest, MN DNR reports that Shagawa was stocked with 2.3 million walleye fry in May of 2019 (Edie Evarts, personal communication). CPUE for age-1 walleye ranged from 1.3 fish per hour (Dumbbell Lake) to 79.9 fish per hour of electrofishing (Elbow Lake) (Table 8). Table 9 presents the mean length for age-0 and age-1 individuals sampled during fall 2019 assessments. Mean lengths for age-0 walleye ranged from 95 mm (3.7 inches, Tom Lake) to 152 mm (6.0 inches, Cadotte Lake). Mean lengths for age-1 walleye ranged from 185 mm (7.3 inches, North McDougal Lake) to 245 mm (9.6 inches, West Twin Lake). Figures 10 – 33 present length frequency data for each of the lakes surveyed.

Historical catch rates for all of the lakes in our schedule are presented in figures 34 – 57. These figures present the age-0 and age-1 catch per hour for all years surveyed by both Fond du Lac and the 1854 Treaty Authority. This data is presented mostly for the various MN DNR area office staff to see in a single snapshot how lakes in their areas have historically produced seemingly strong and weak year classes of walleyes.

Wild Rice Lake Reservoir Largemouth Bass

This year, 132 largemouth bass (*Micropterus salmoides*) were sampled, with lengths ranging from 48 mm (1.9 in) to 376 mm (14.8 in) (Figure 32). Since they were first collected in 2009, the number of largemouth bass in the annual fall assessment has generally increased each year (Figure 58, displayed immediately following Figure 33).

Table 8. Total number and catch-per-unit-effort (CPUE) of age-0 and age-1 walleye collected from 25 lakes within the 1854 Ceded Territory of Northeastern Minnesota during Fall 2019.

Lake	Date	Temp (F)	Temp (C)	Cond.[1]	Age-0 Total[2]	Age-1 Total[3]	Seconds	CPUE Age-0[4]	CPUE 1+[5]
Ball Club	4-Sep	61.5	16.4	27.0	51	50	5029	36.5	35.8
Cadotte	16-Sep	62.0	16.6	29	349	9	7346	171.0	4.4
Caribou	6-Sep	63.0	17.2	69	215	51	6430	120.4	28.6
Cascade	10-Sep	59.0	15.0	24.0	260	104	11098	84.3	33.7
Crescent	10-Sep	60.6	15.9	29.2	8	21	3745	7.7	20.2
Crooked	13-Sep	55.9	13.3	42.0	50	17	4804	37.5	12.7
Dumbbell	13-Sep	57.2	14.0	71.4	11	2	5735	6.9	1.3
Elbow	5-Sep	60.3	15.7	36.0	31	98	4417	25.3	79.9
Fourmile	9-Sep	59.9	15.5	57.0	84	44	5418	55.8	29.2
Harriet	11-Sep	58.3	14.6	55.3	38	69	5330	25.7	46.6
Island Reservoir	17-Sep	61.7	16.5	78.1	136	139	11119	44.0	45.0
Ninemile	12&15-Sep	55.9	13.3	45.6	344	44	6236	198.6	25.4
N. McDougal	11-Sep	57.4	14.1	67.0	89	55	6747	47.5	29.3
Pike	5-Sep	63.0	17.2	53.3	49	3	6469	27.3	1.7
Shagawa	18-Sep	63.1	17.2	85.2	1110	12	12347	323.6	3.5
Silver Island	19-Sep	65.5	18.6	29	73	14	4561	57.6	11.1
Tait	3-Sep	60.2	15.7	33.0	162	104	9137	63.8	41.0
Tom	3-Sep	62.0	16.7	31.4	2	107	7963	0.9	48.4
Two Island	4-Sep	61.0	16.1	28.2	70	81	6420	39.3	45.4
West Twin	6-Sep	62.1	16.8	27.6	68	14	4758	51.5	10.6
Whiteface Res.	16-Sep	63.2	17.3	55.0	79	82	6799	41.8	43.4
Wild Rice	19-Sep	68.4	20.2	121.1	0	3	5180	0.0	2.1
Wilson	9 & 10-Sep	60.7	15.9	45.9	28	9	7381	13.6	4.4
Windy	11-Sep	59.2	15.2	27.2	18	34	7009	9.2	17.5

[1] Conductivity, measured in MicroSiemens / cm.
[2] Indicates the number of age-0, young-of-the-year, walleye collected in each sample.
[3] Indicates the number of age-1 juvenile walleye collected in each sample.
[4] Indicates the catch rate of age-0 fish (fish per hour, 3600 sec, of electrofishing on time).
[5] Indicates the catch rate of age-1 fish (fish per hour, 3600 sec, of electrofishing on time).

Table 9. Mean length for age-0 and age-1 walleye sampled during fall 2019 assessments within the 1854 Ceded Territory of Northeastern Minnesota. Numbers in parentheses indicate sample sizes, and are presented when mean lengths are based upon few individuals (N=<20).

Lake (County)	Date	Age-0 Mean Length (mm)	Age-1 Mean Length (mm)
Ball Club	4-Sep	102	210
Cadotte	16-Sep	152	218 (N=9)
Caribou	6-Sep	124	202
Cascade	10-Sep	117	215
Crescent	10-Sep	129 (N=8)	193
Crooked	13-Sep	137	203 (N=17)
Dumbbell	13-Sep	132 (N=11)	234 (N=2)
Elbow	5-Sep	115	196
Fourmile	9-Sep	138	227
Harriet	11-Sep	116	175
Island Reservoir	17-Sep	109	188
Ninemile	12&15-Sep	114	224
N. McDougal	11-Sep	116	185
Pike	5-Sep	101	220 (N=3)
Shagawa	18-Sep	117	218 (N=12)
Silver Island	19-Sep	134	219 (N=14)
Tait	3-Sep	111	212
Tom	3-Sep	95 (N=2)	205
Two Island	4-Sep	111	194
West Twin	6-Sep	139	245 (N=14)
Whiteface Res.	16-Sep	125	212
Wild Rice	19-Sep	---	238 (N=3)
Wilson	9 &10-Sep	128	198 (N=9)
Windy	11-Sep	131 (N=18)	230

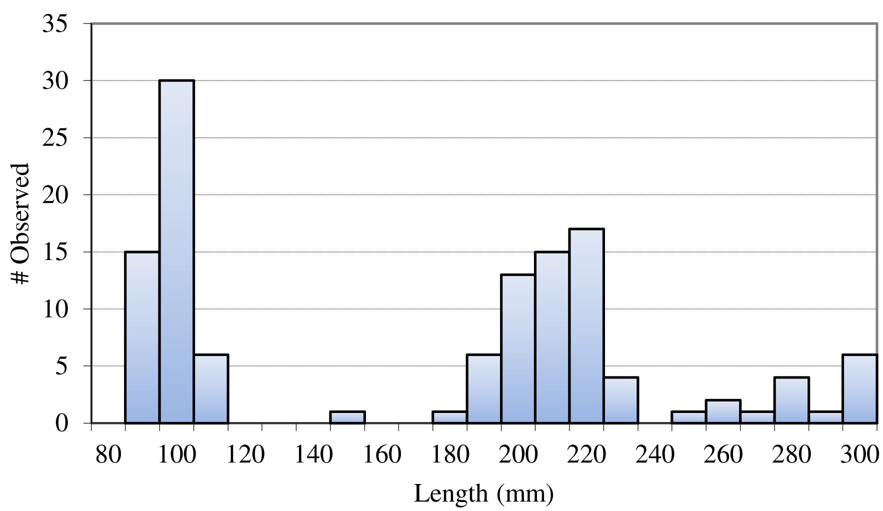

Figure 10. Length frequency distribution of walleye collected from Ball Club Lake, Cook County, during fall 2019 electrofishing assessments.

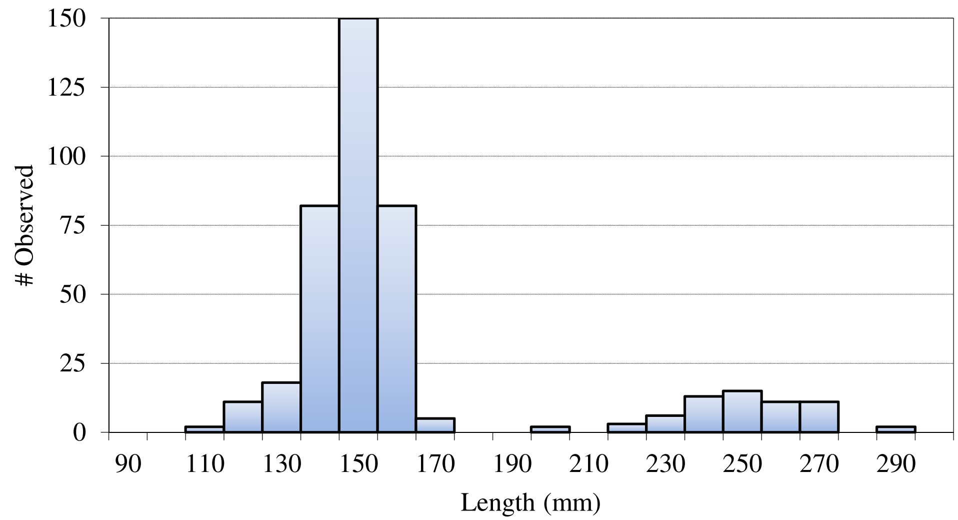

Figure 11. Length frequency distribution of walleye collected from Cadotte Lake, St. Louis County, during fall 2019 electrofishing assessments.

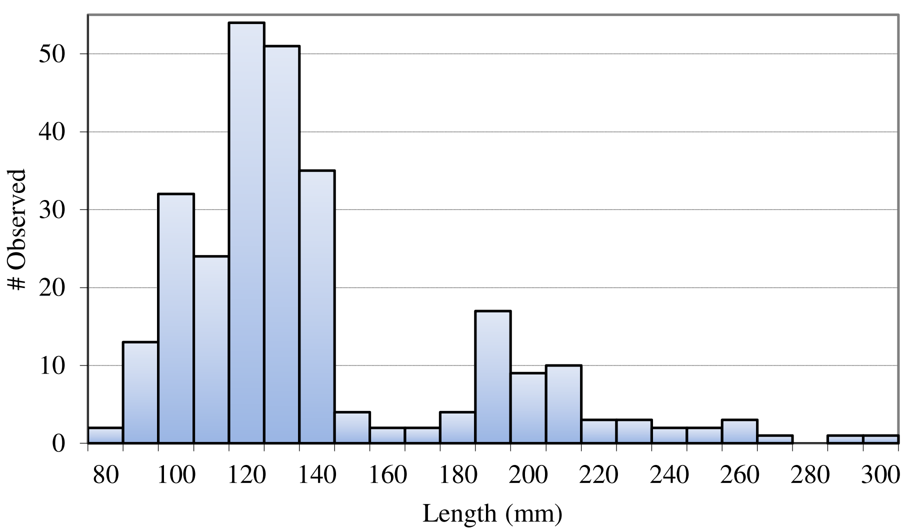

Figure 12. Length frequency distribution of walleye collected from Caribou Lake, Cook County, during fall 2019 electrofishing assessments.

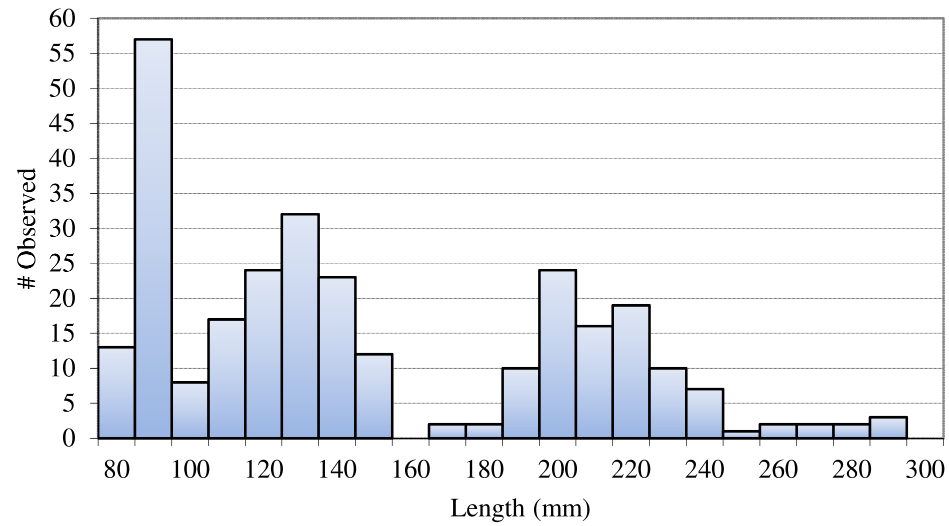

Figure 13. Length frequency distribution of walleye collected from Cascade Lake, Cook County, during fall 2019 electrofishing assessments.

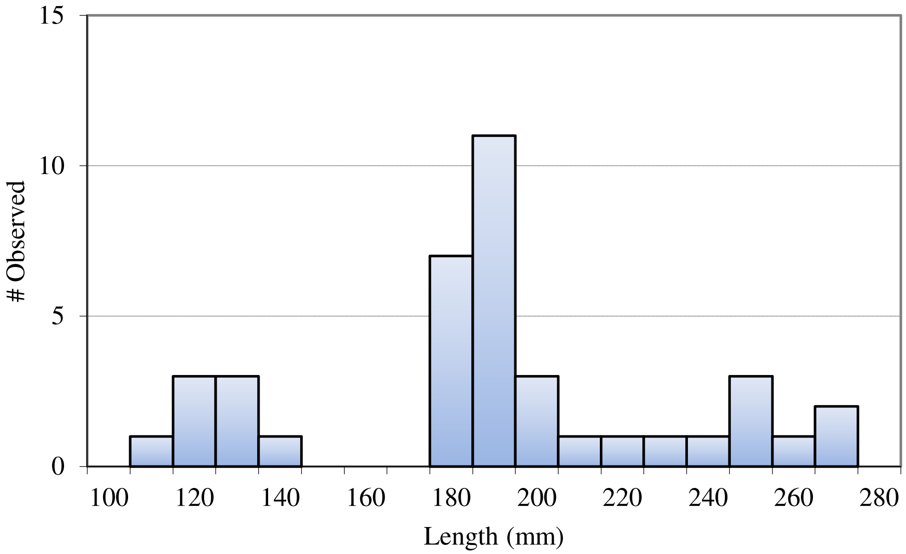

Figure 14. Length frequency distribution of walleye collected from Crescent Lake, Cook County, during fall 2019 electrofishing assessments.

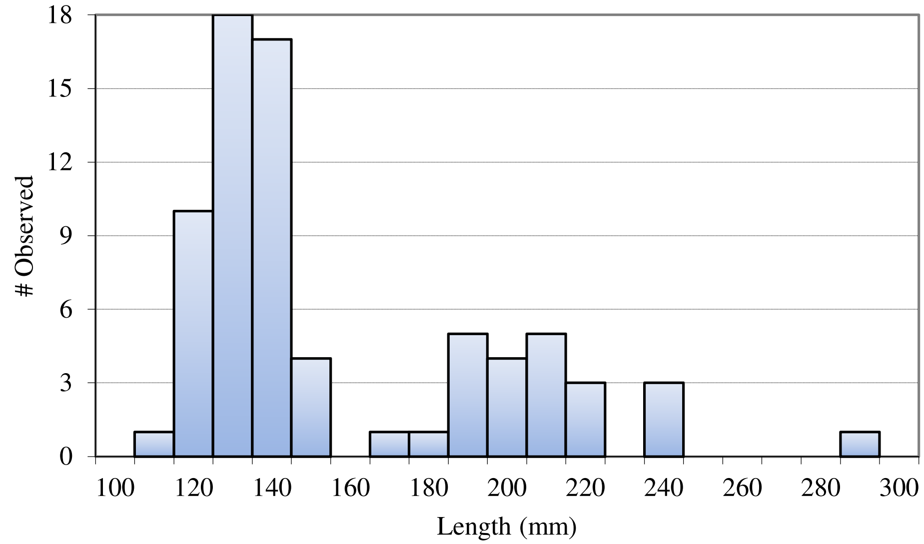

Figure 15. Length frequency distribution of walleye collected from Crooked Lake, Lake County, during fall 2019 electrofishing assessments.

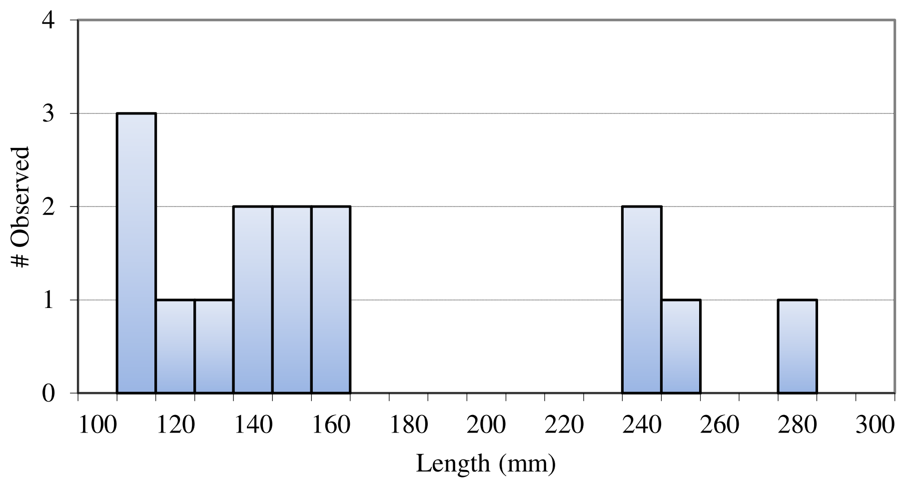

Figure 16. Length frequency distribution of walleye collected from Dumbbell Lake, Lake County, during fall 2019 electrofishing assessments.

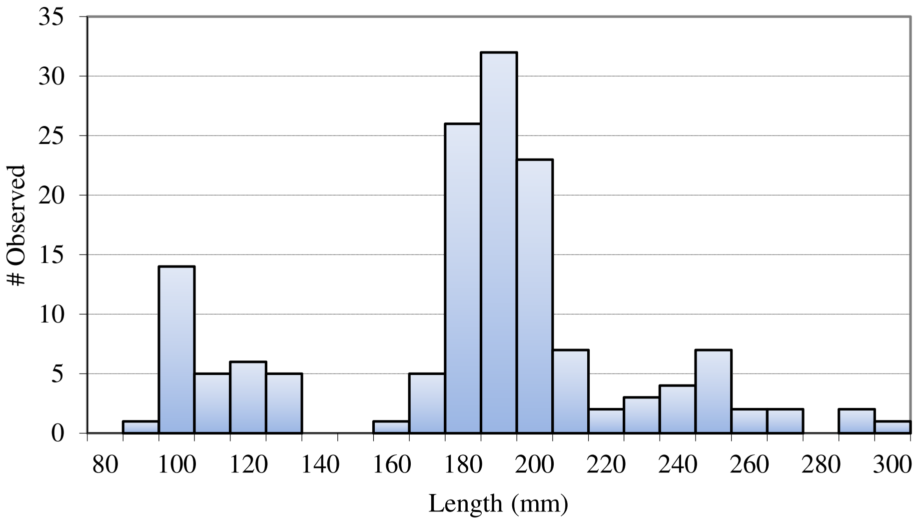

Figure 17. Length frequency distribution of walleye collected from Elbow Lake, Cook County, during fall 2019 electrofishing assessments.

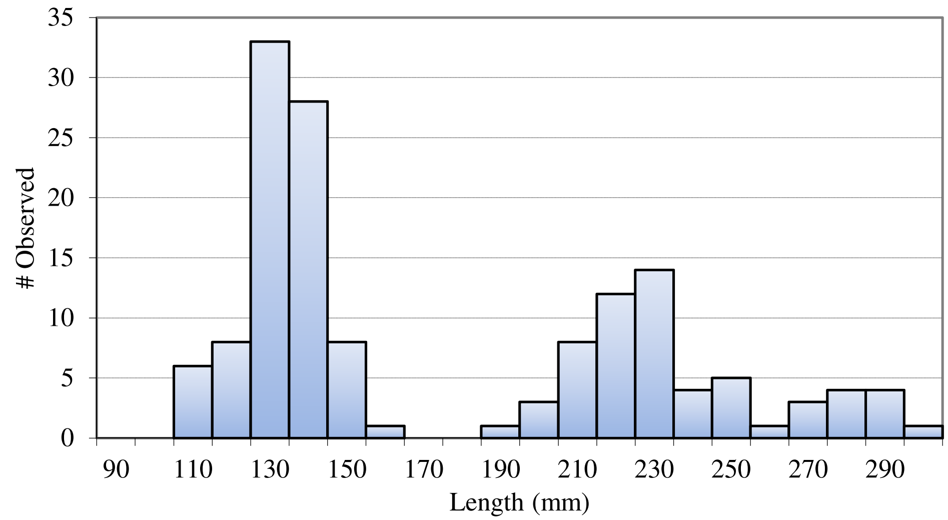

Figure 18. Length frequency distribution of walleye collected from Fourmile Lake, Cook County, during fall 2019 electrofishing assessments.

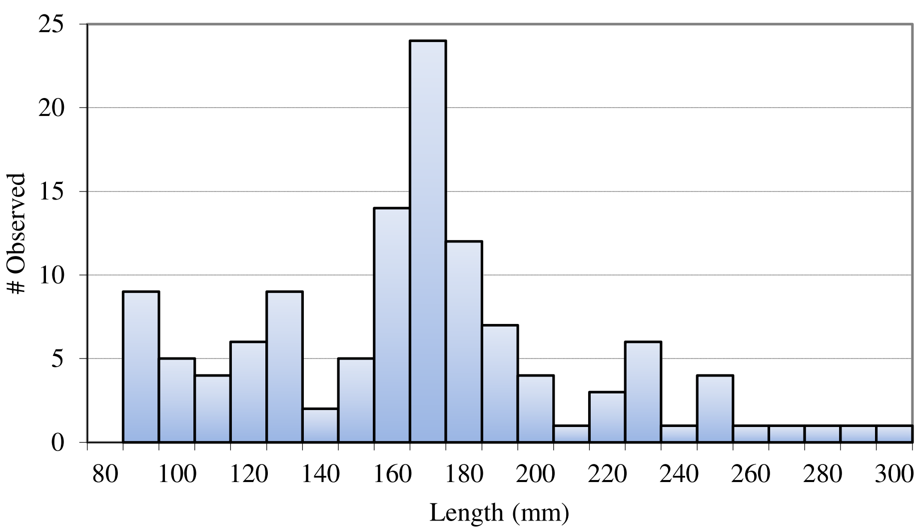

Figure 19. Length frequency distribution of walleye collected from Harriet Lake, Lake County, during fall 2019 electrofishing assessments.

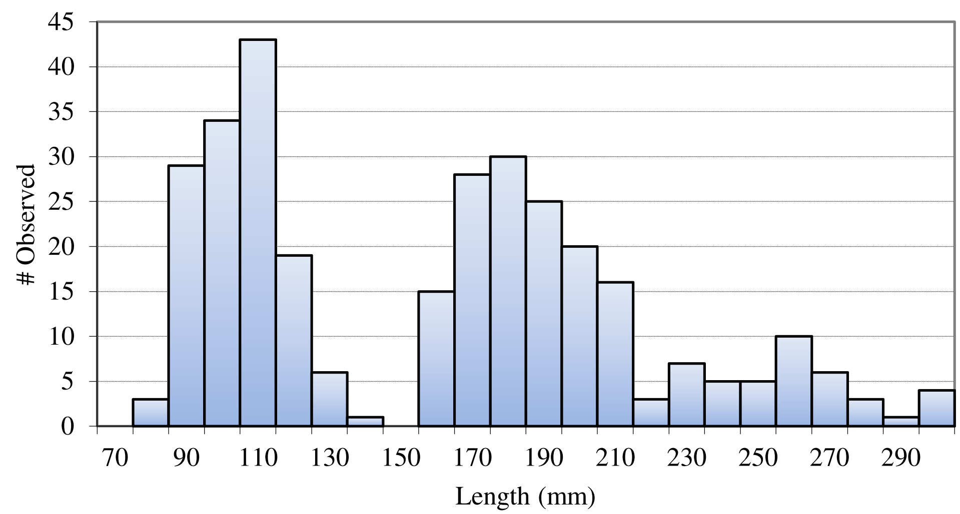

Figure 20. Length frequency distribution of walleye collected from Island Lake Reservoir, St. Louis County, during fall 2019 electrofishing assessments.

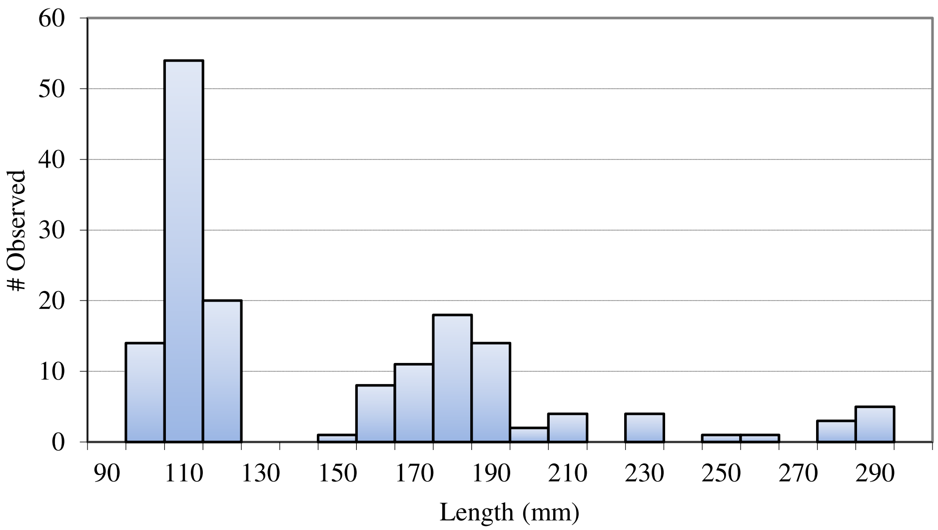

Figure 21. Length frequency distribution of walleye collected from North McDougal Lake, Lake County, during fall 2019 electrofishing assessments.

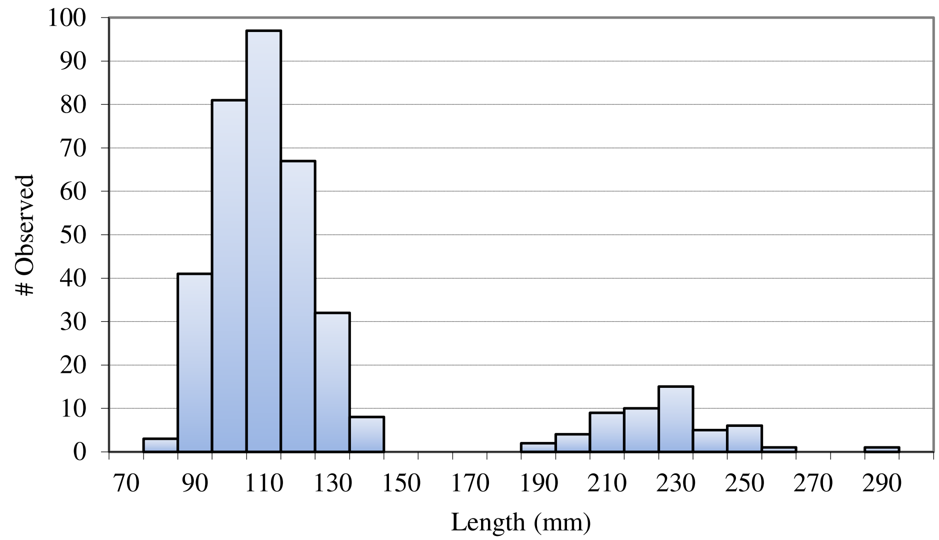

Figure 22. Length frequency distribution of walleye collected from Ninemile Lake, Lake County, during fall 2019 electrofishing assessments.

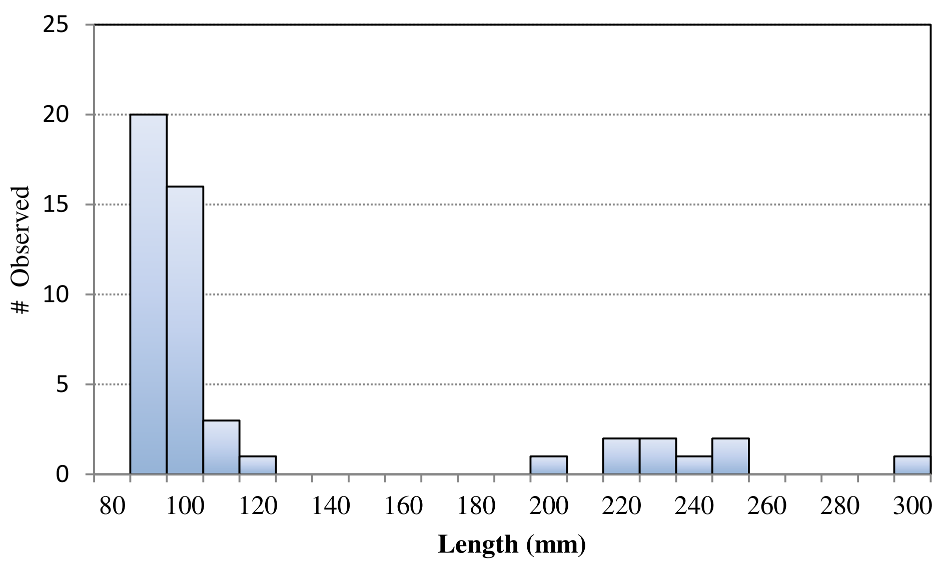

Figure 23. Length frequency distribution of walleye collected from Pike Lake, Cook County, during fall 2019 electrofishing assessments.

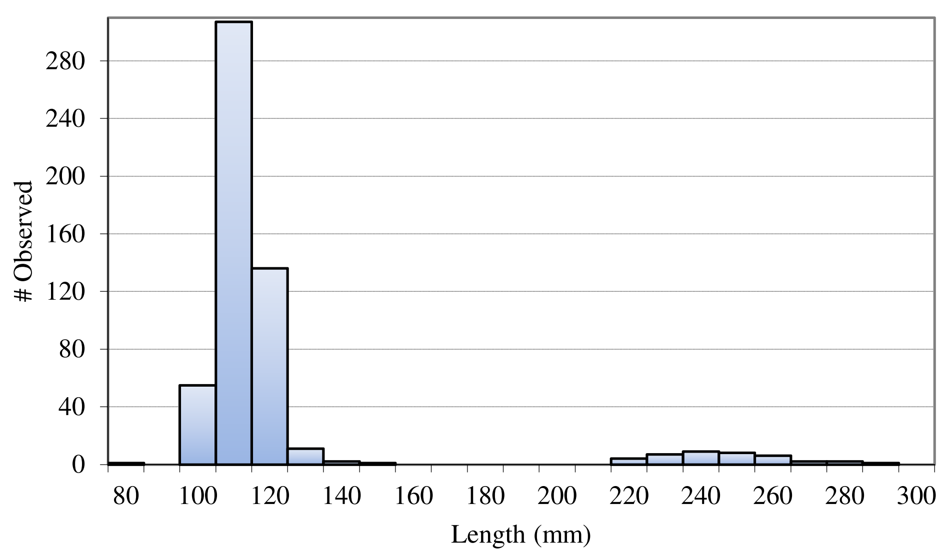

Figure 24. Length frequency distribution of walleye collected from Shagawa Lake, St. Louis County, during fall 2019 electrofishing assessments.

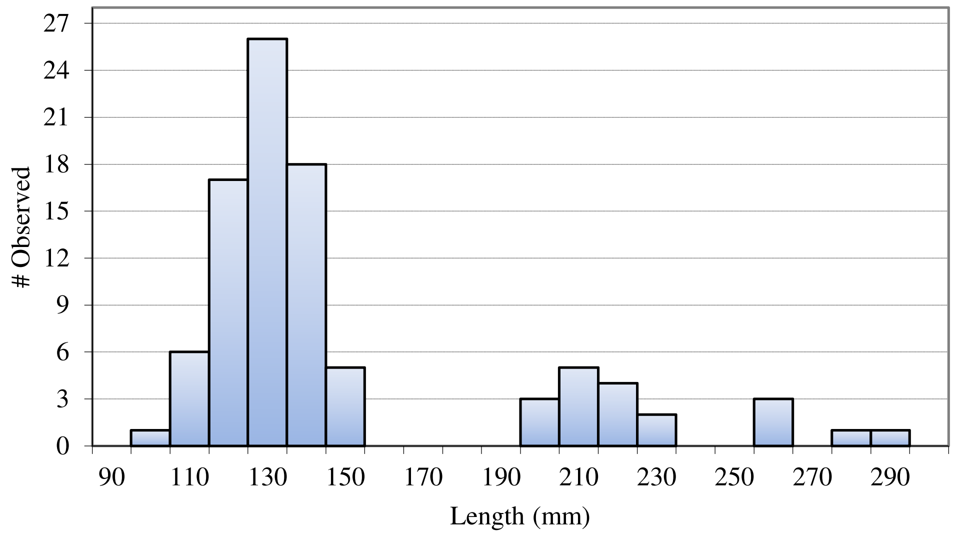

Figure 25. Length frequency distribution of walleye collected from Silver Island Lake, Lake County, during fall 2019 electrofishing assessments.

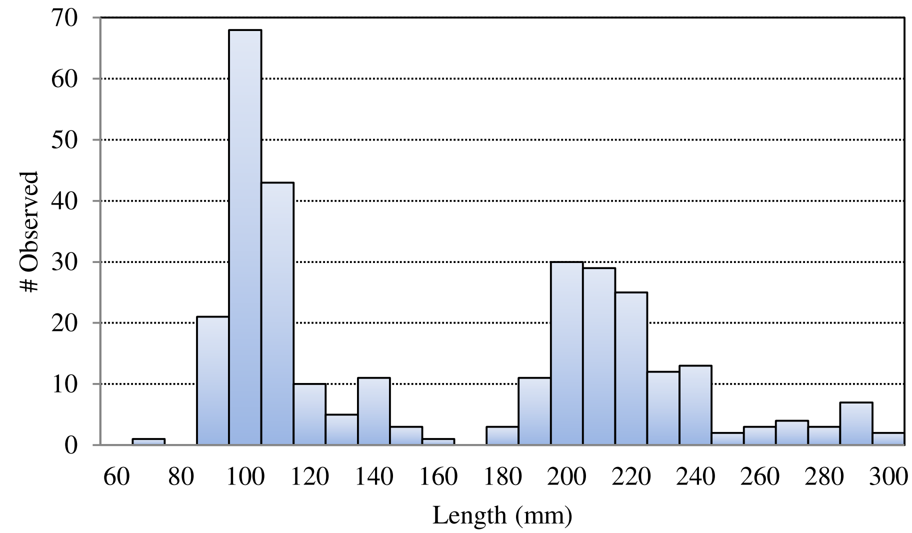

Figure 26. Length frequency distribution of walleye collected from Tait Lake, Cook County, during fall 2019 electrofishing assessments.

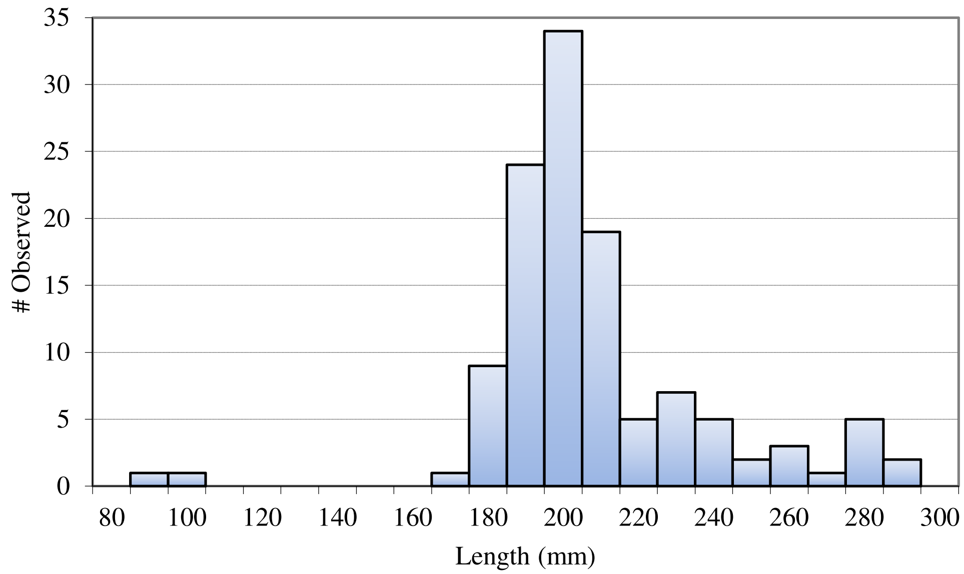

Figure 27. Length frequency distribution of walleye collected from Tom Lake Cook County, during fall 2019 electrofishing assessments.

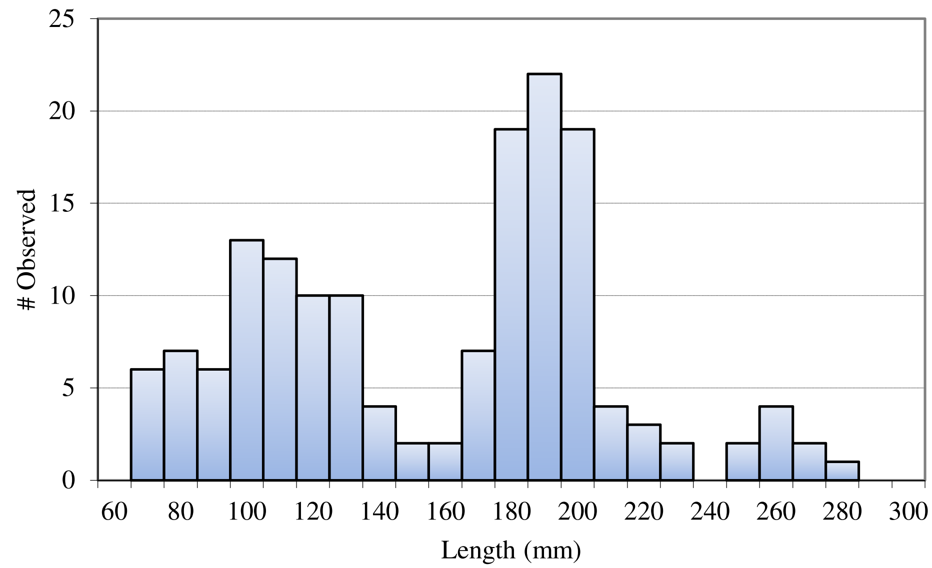

Figure 28. Length frequency distribution of walleye collected from Two Island Lake, Cook County, during fall 2019 electrofishing assessments.

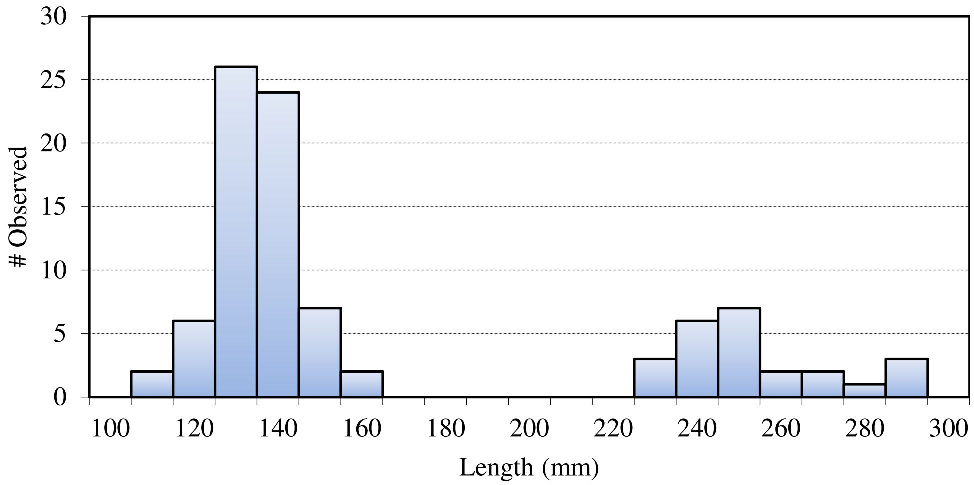

Figure 29. Length frequency distribution of walleye collected from West Twin Lake, Cook County, during fall 2019 electrofishing assessments.

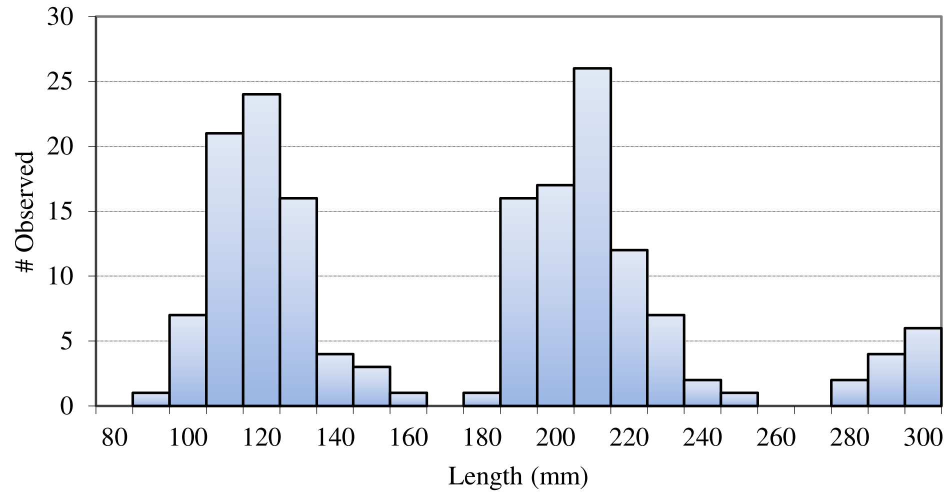

Figure 30. Length frequency distribution of walleye collected from Whiteface Reservoir, St. Louis County, during fall 2019 electrofishing assessments.

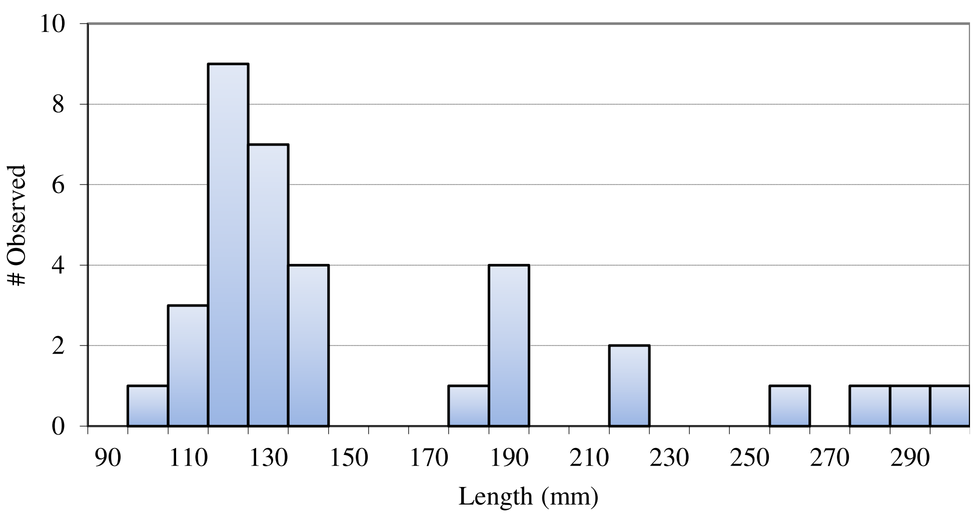

Figure 31. Length frequency distribution of walleye collected from Wilson Lake, Lake County, during fall 2019 electrofishing assessments.

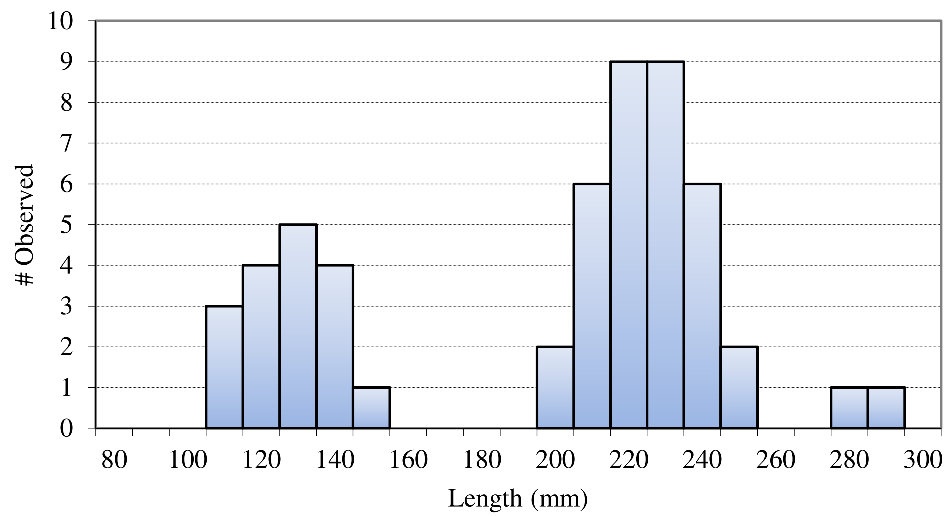

Figure 32. Length frequency distribution of walleye collected from Windy Lake, Lake County, during fall 2019 electrofishing assessments.

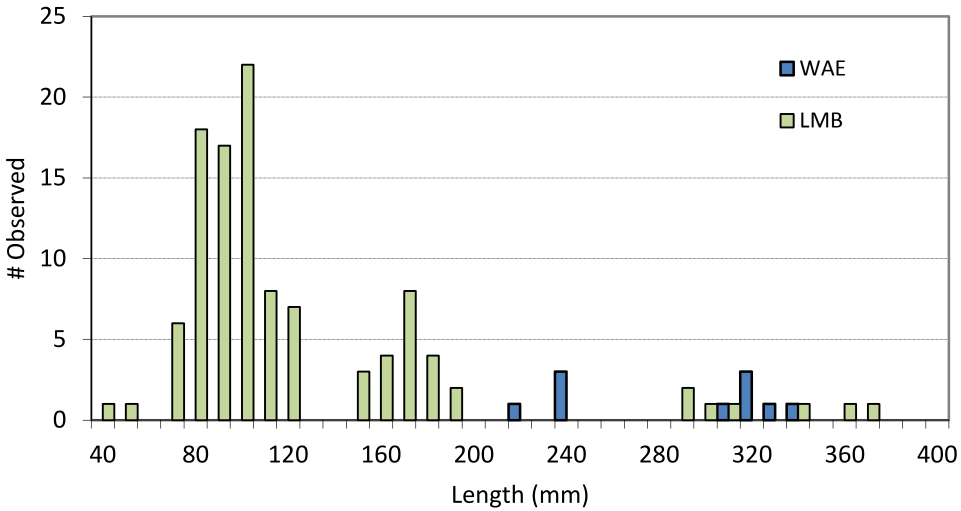

Figure 33. Length frequency distribution of walleye & largemouth bass collected from Wild Rice Lake Reservoir, St. Louis County, during fall 2019 electrofishing assessments. Blue bars represent the walleye sampled while the green bars represent largemouth bass sampled.

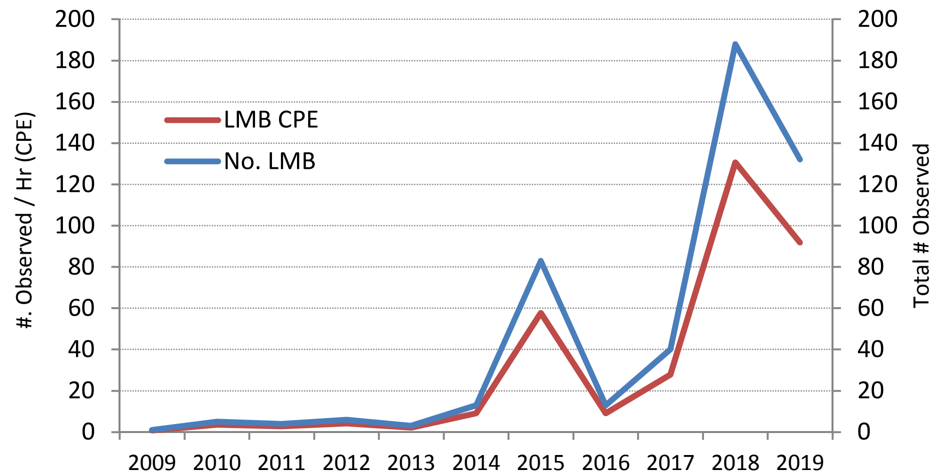

Figure 58. Largemouth bass collected (Total and CPE) from Wild Rice Lake Reservoir, St. Louis County, during fall electrofishing assessments since they were first observed in 2009. Note that netters reported missing “lots” of bass in this survey.

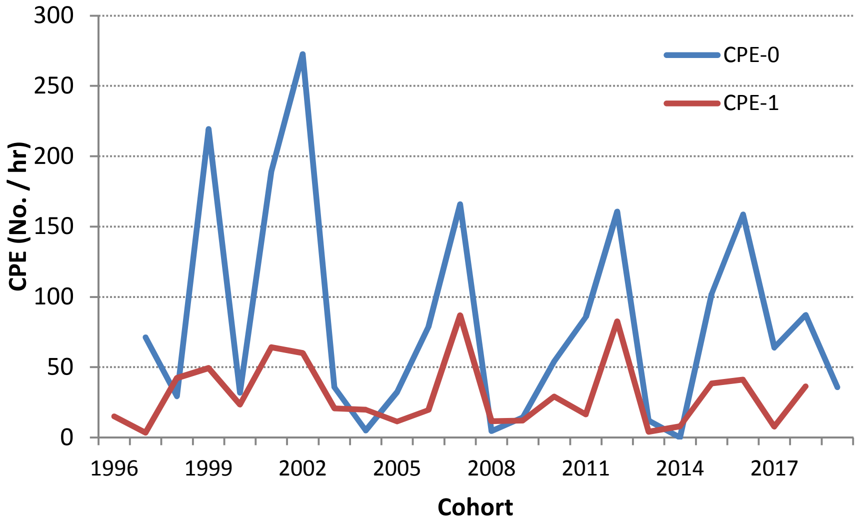

Figure 34. Walleye age-0 and age-1 electrofishing CPE, Ball Club Lake, Cook County, 1997-2019.

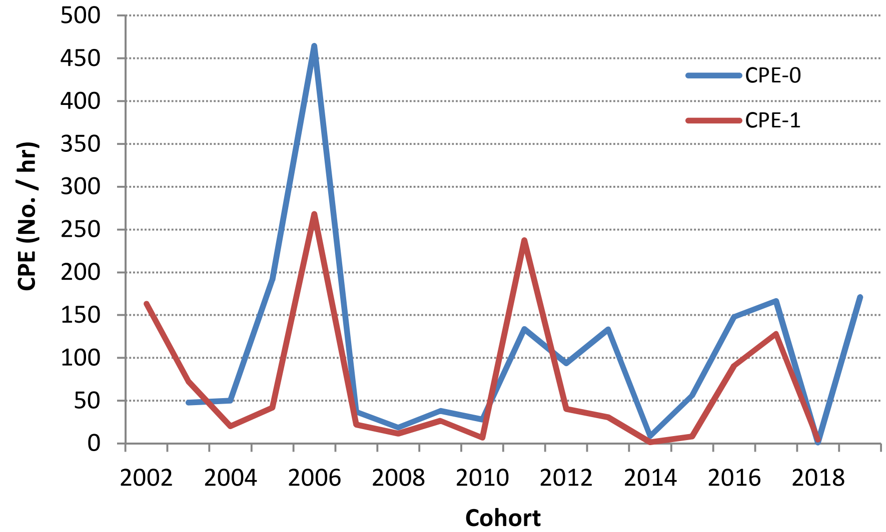

Figure 35. Walleye age-0 and age-1 electrofishing CPE, Cadotte Lake, St. Louis County, 2003-2019.

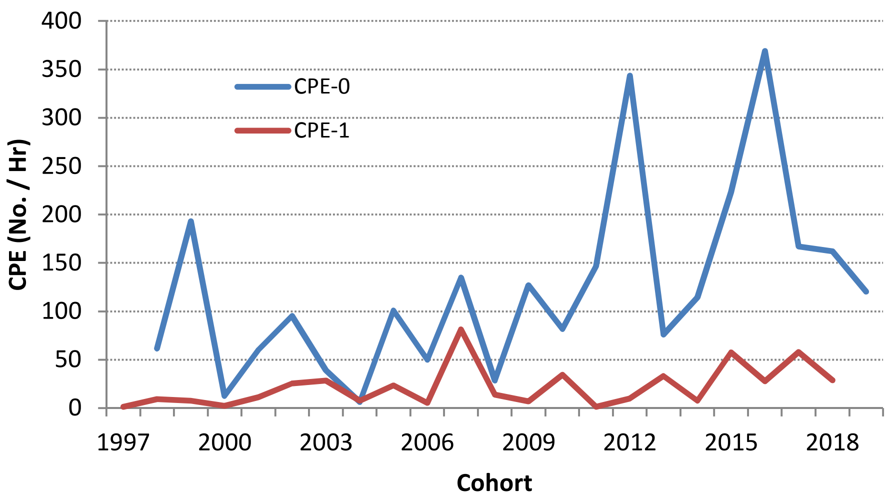

Figure 36. Walleye age-0 and age-1 electrofishing CPE, Caribou Lake, Cook County, 1998-2019.

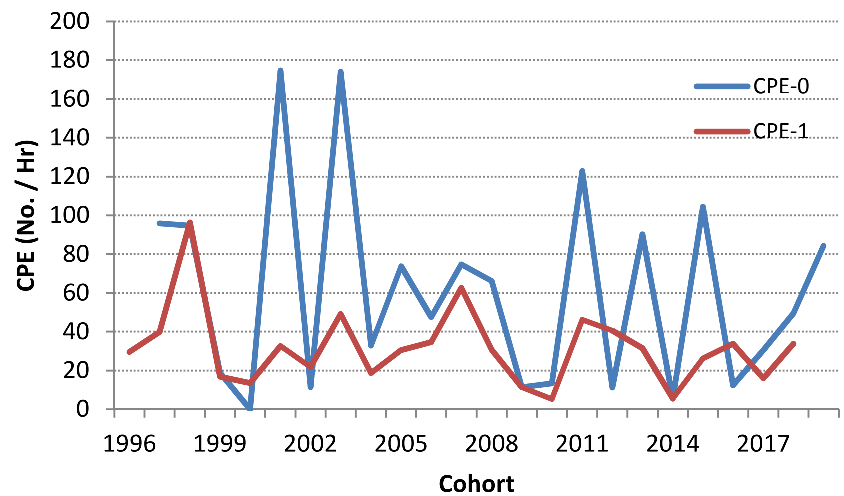

Figure 37. Walleye age-0 and age-1 electrofishing CPE, Cascade Lake, Cook County, 1997-2019.

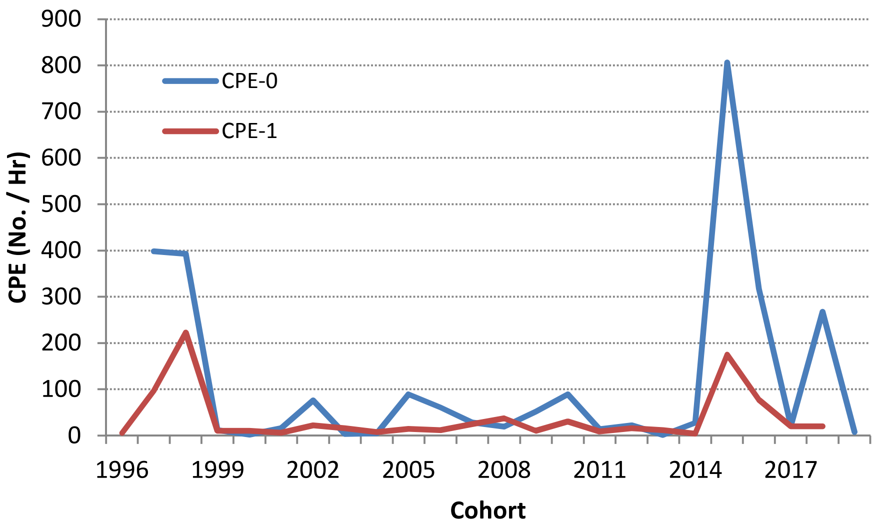

Figure 38. Walleye age-0 and age-1 electrofishing CPE, Crescent Lake, Cook County, 1997-2019.

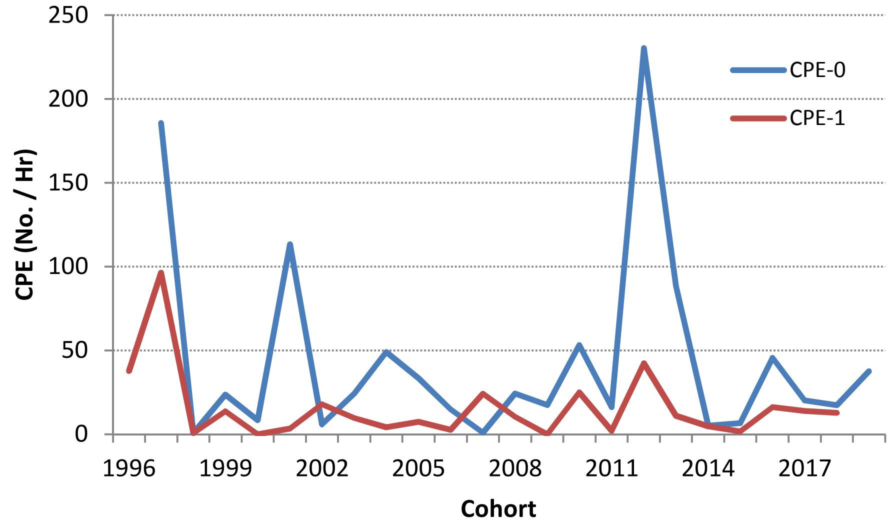

Figure 39. Walleye age-0 and age-1 electrofishing CPE, Crooked Lake, Lake County, 1997-2019.

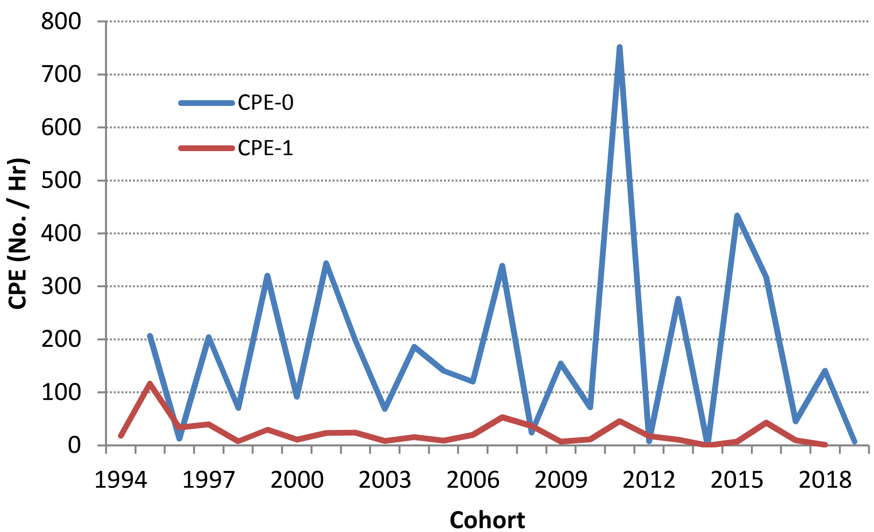

Figure 40. Walleye age-0 and age-1 electrofishing CPE, Dumbbell Lake, Lake County, 1995-2019.

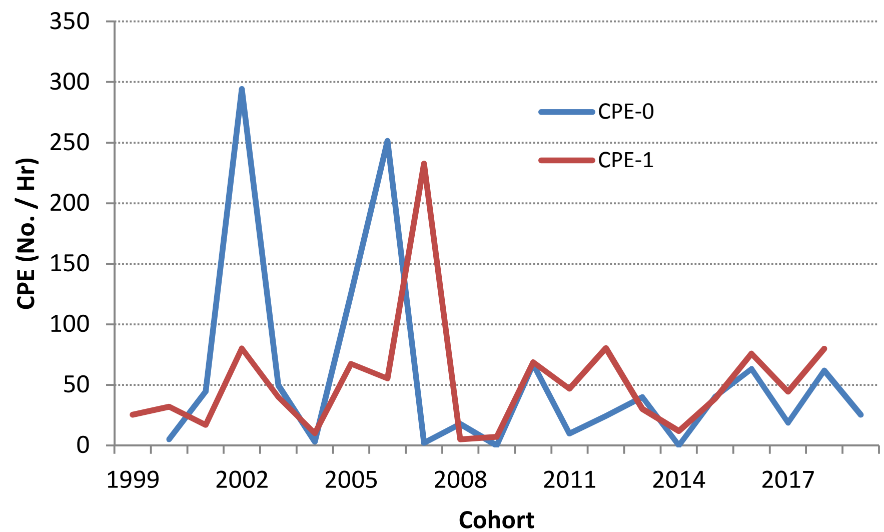

Figure 41. Walleye age-0 and age-1 electrofishing CPE, Elbow Lake, Cook County, 2000-2019.

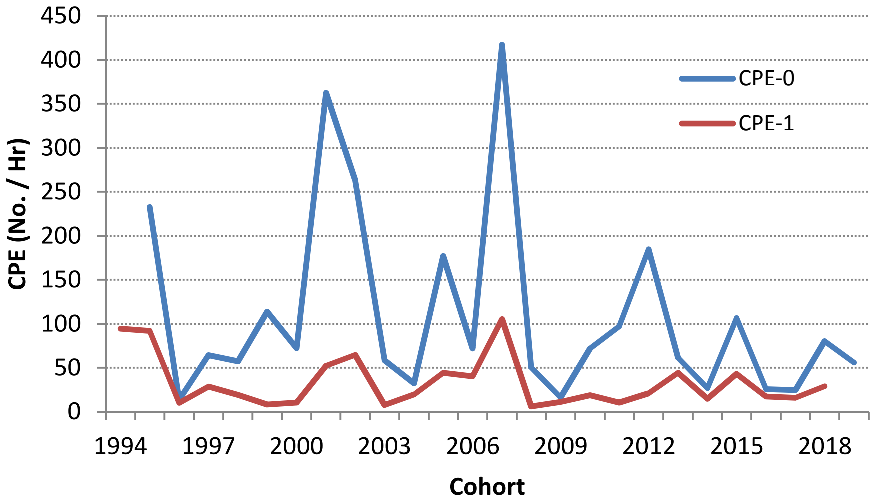

Figure 42. Walleye age-0 and age-1 electrofishing CPE, Four Mile Lake, Lake County, 1995-2019.

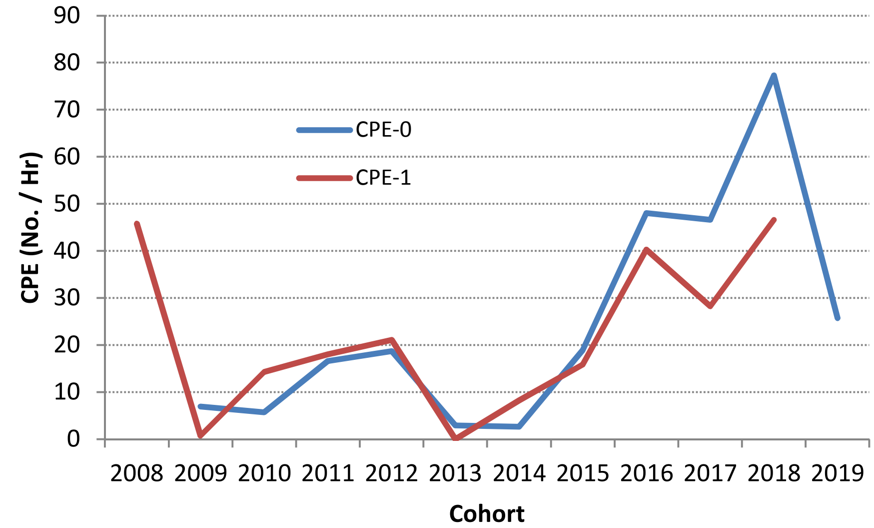

Figure 43. Walleye age-0 and age-1 electrofishing CPE, Harriet Lake, Lake County, 2009-2019.

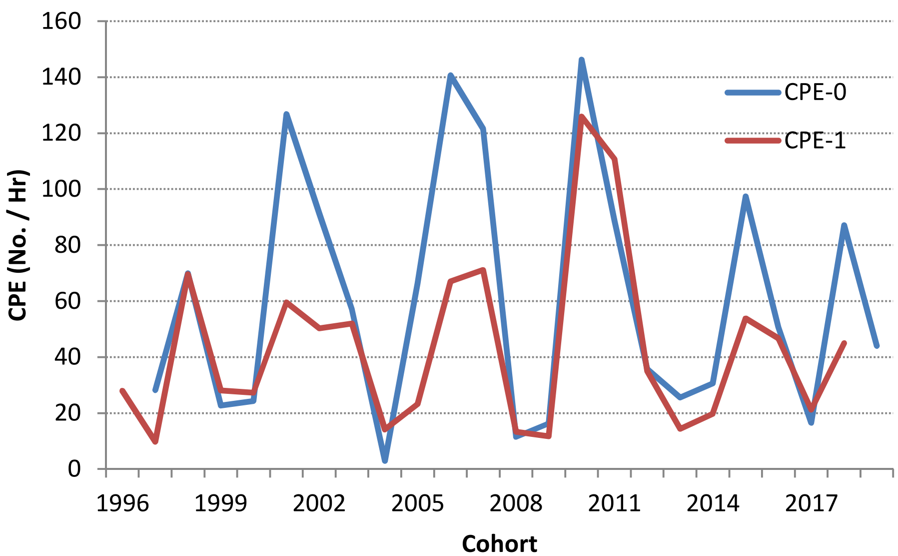

Figure 44. Walleye age-0 and age-1 electrofishing CPE, Island Lake, St. Louis County, 1997-2019.

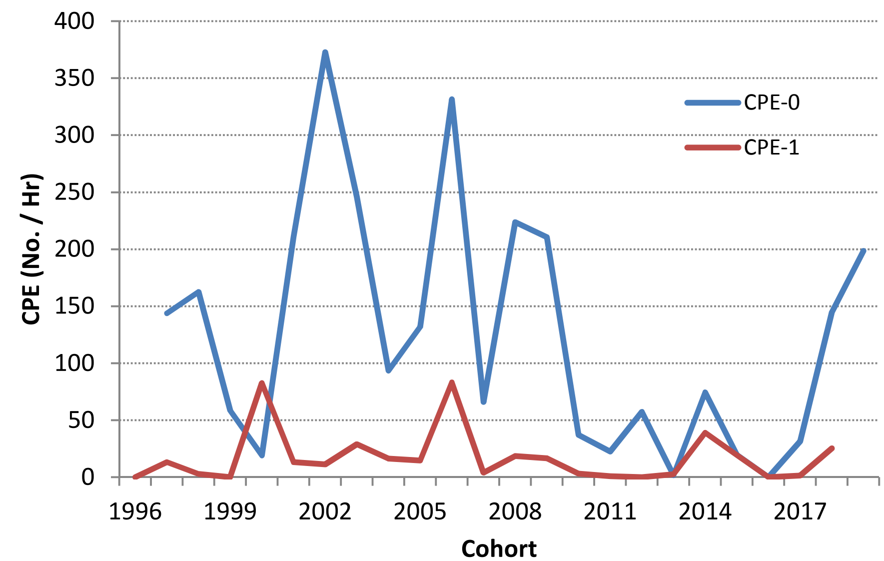

Figure 45. Walleye age-0 and age-1 electrofishing CPE, Ninemile Lake, Lake County, 1997-2019.

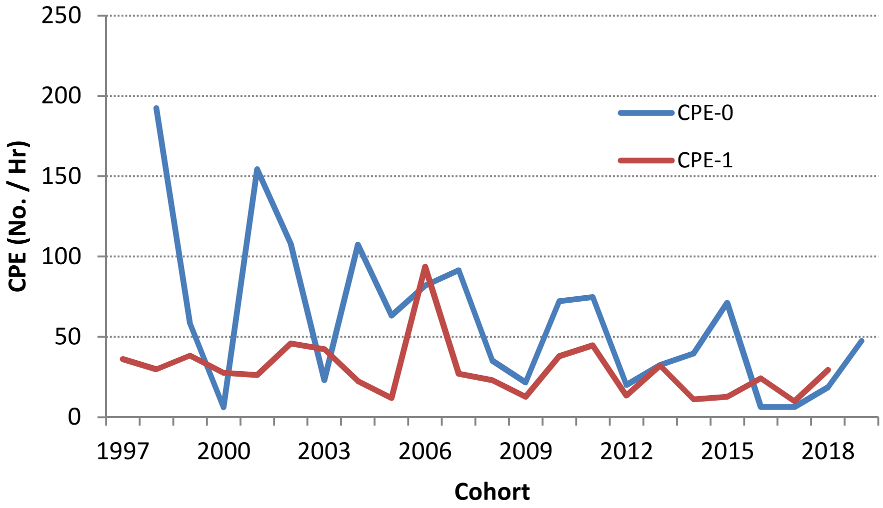

Figure 46. Walleye age-0 and age-1 electrofishing CPE, North McDougal Lake, Lake County, 1998-2019.

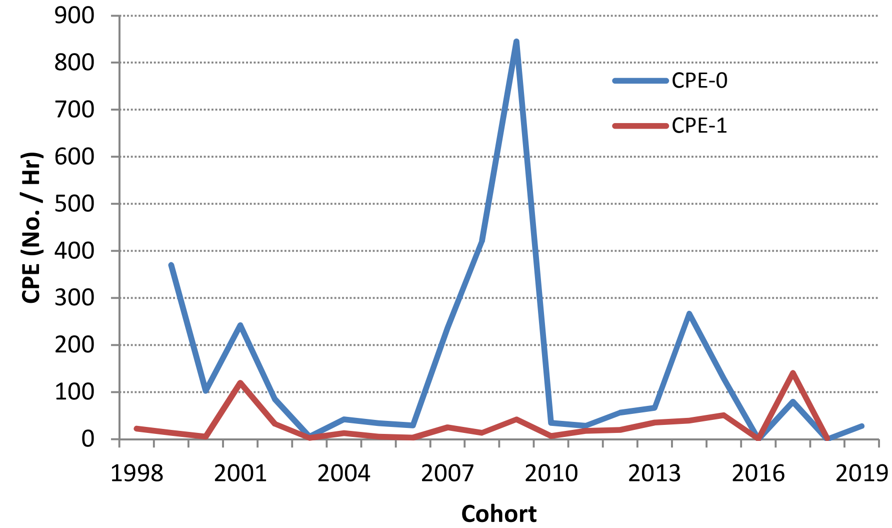

Figure 47. Walleye age-0 and age-1 electrofishing CPE, Pike Lake, Cook County, 1999-2019.

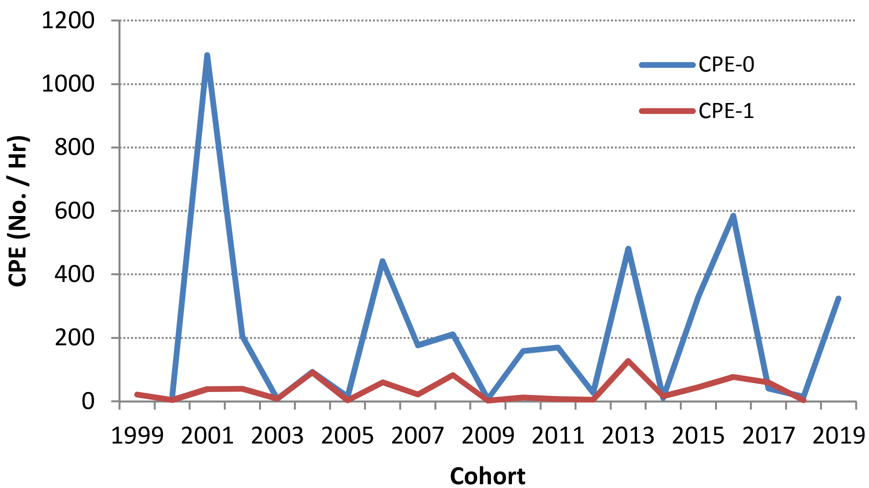

Figure 48. Walleye age-0 and age-1 electrofishing CPE, Shagawa Lake, St. Louis County, 2000-2019.

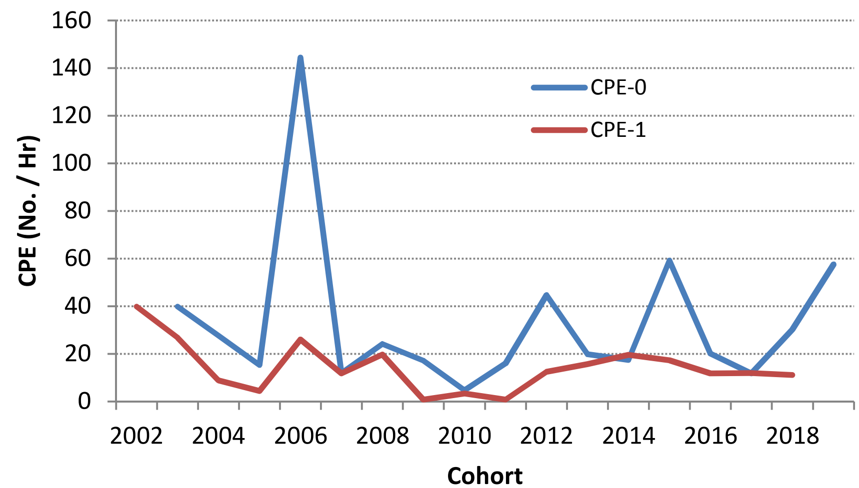

Figure 49. Walleye age-0 and age-1 electrofishing CPE, Silver Island Lake, Lake County, 2003-2019.

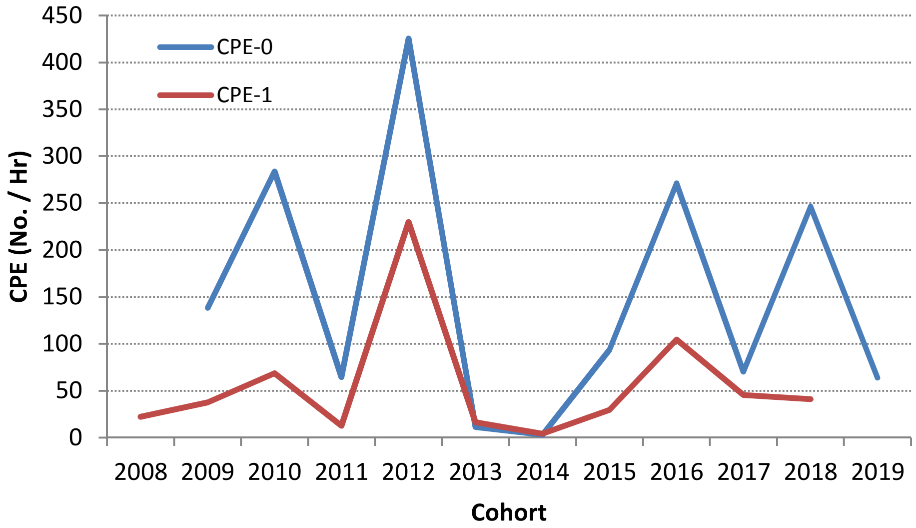

Figure 50. Walleye age-0 and age-1 electrofishing CPE, Tait Lake, Cook County, 2009-2019.

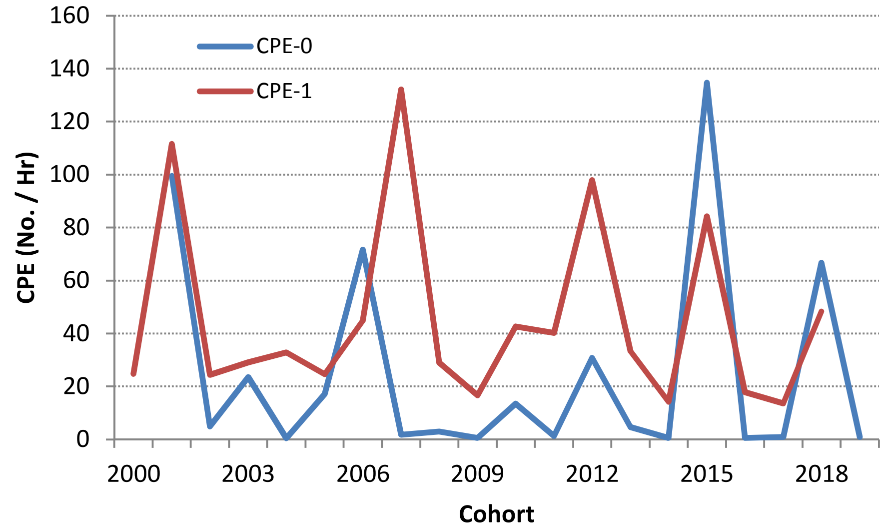

Figure 51. Walleye age-0 and age-1 electrofishing CPE, Tom Lake, Cook County, 2001-2019.

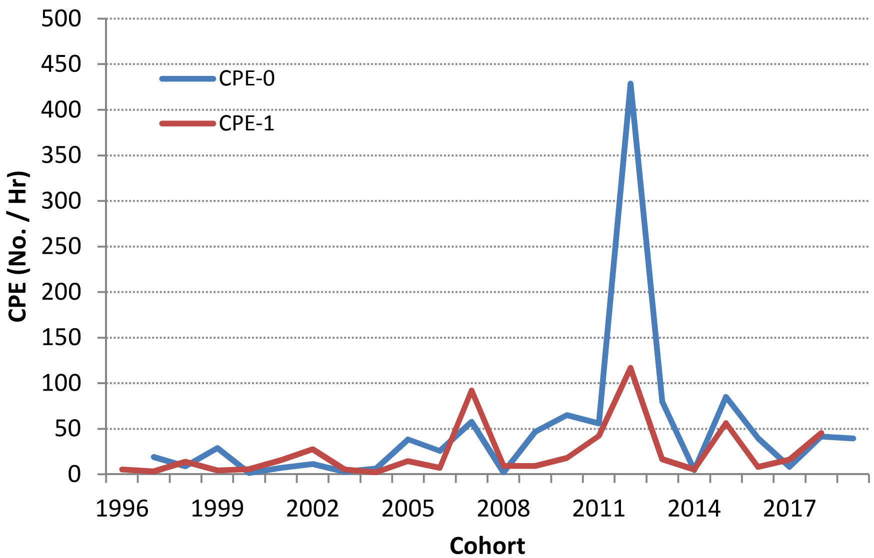

Figure 52. Walleye age-0 and age-1 electrofishing CPE, Two Island Lake, Cook County, 1997-2019.

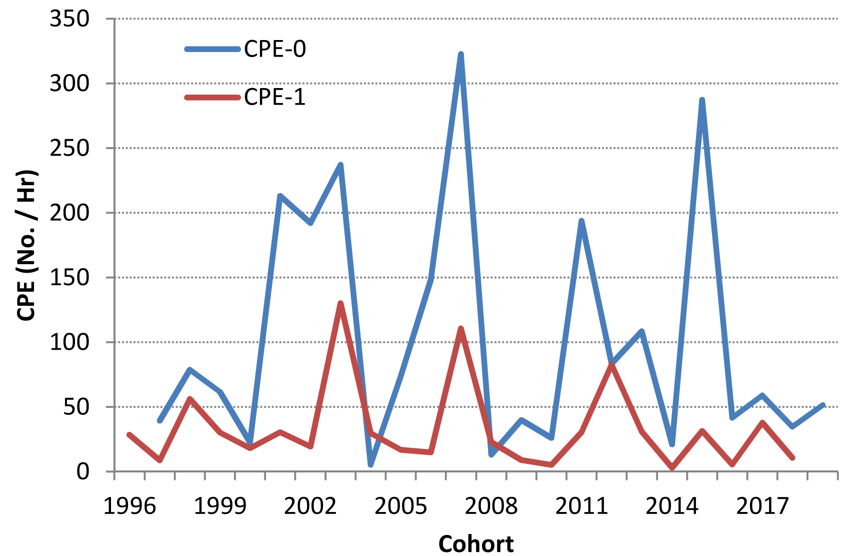

Figure 53. Walleye age-0 and age-1 electrofishing CPE, West Twin Lake, Cook County, 1997-2019.

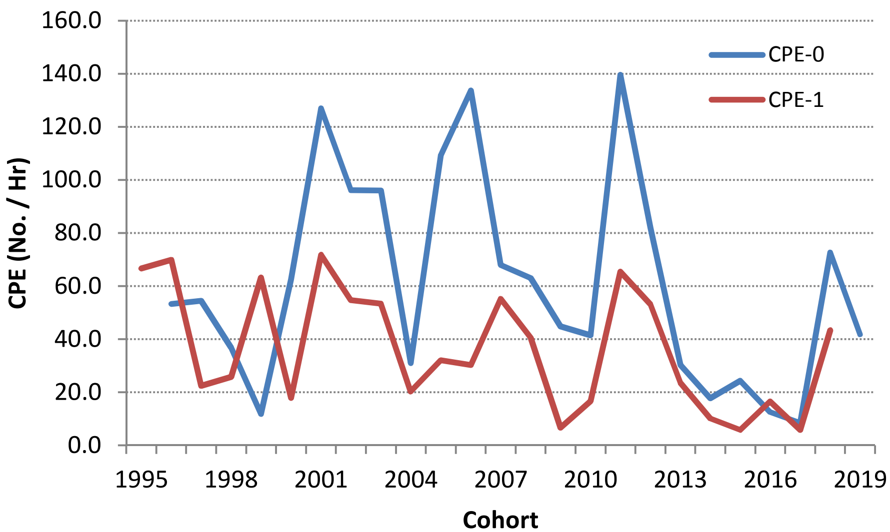

Figure 54. Walleye age-0 and age-1 electrofishing CPE, Whiteface Reservoir, St. Louis County, 1996-2019.

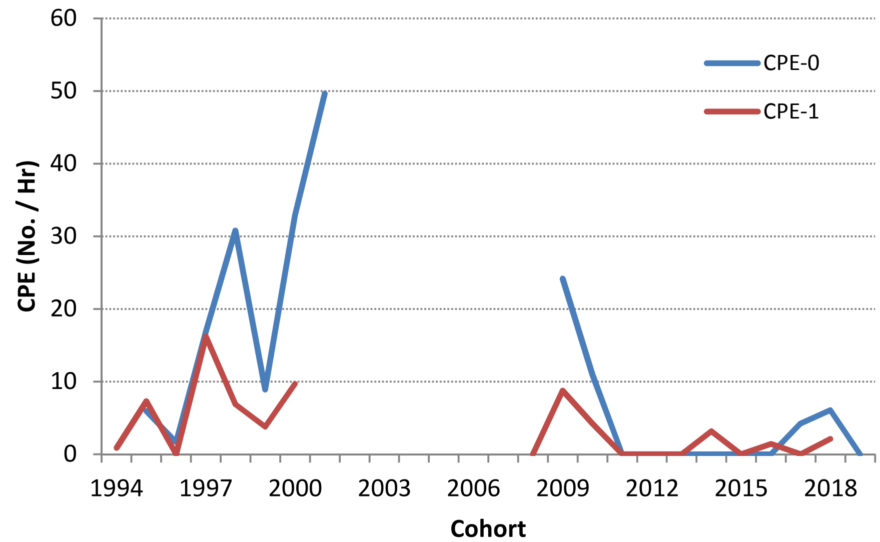

Figure 55. Walleye age-0 and age-1 electrofishing CPE, Wild Rice Lake, St. Louis County, 1995-2019.

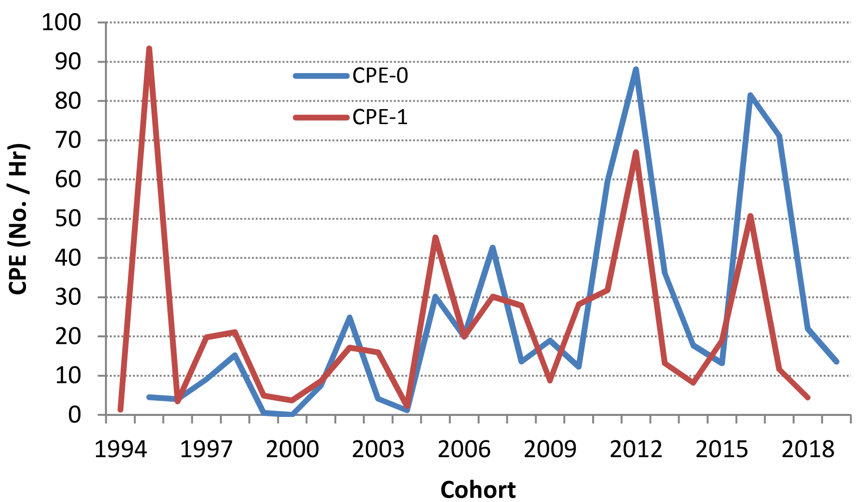

Figure 56. Walleye age-0 and age-1 electrofishing CPE, Wilson Lake, Lake County, 1995-2019.

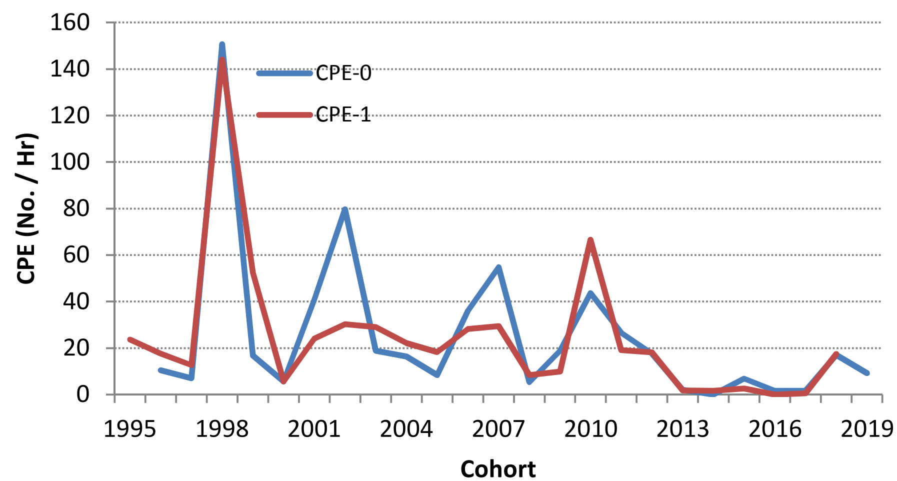

Figure 57. Walleye age-0 and age-1 electrofishing CPE, Windy Lake, Lake County, 1996-2019.

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Appendix 1. Nightly Mark / Recapture Data for walleye > 254 mm sampled during spring 2019 assessments in the 1854 Ceded Territory, and for walleye > 274mm observed in MN DNR summer gill net assessments.

Lake	Date	Marked in Population	Daily Catch	Daily Recap
Wild Rice	29 April	---	106	0
	30 April	106	102	2
	1 May	206	84	4
	2 May	286	198	13
	3 May	471	185	21
	4 May	635	187	30
	5 May	792	103	22
	MN DNR GN	873	221	12
	MN DNR GN / TN	873	262	17
Crooked	8 May	---	66	0
	9 May	66	120	20
	10 May	166	64	27
	MN DNR GN	203	37	8
	MNDNR GN / TN	203	40	8