WISCONSIN DEPARTMENT OF NATURAL RESOURCES

# Long Lake Fisheries Survey Report Chippewa County, Wisconsin 2021-2022

Waterbody Code: 2351400

*Photo Credit: Wisconsin DNR*

Joseph Gerbyshak
DNR Senior Fisheries Biologist
December 2024

# Table Of Contents

# Executive Summary

Long Lake is one of the premier waterbodies in Chippewa County from a quality fishery perspective, and it continues to change overtime. The amount of aquatic vegetation has increased substantially in recent years. Aquatic vegetation is a critical component of fish habitat, and the proliferation has likely influenced fish populations in Long Lake. Walleye natural reproduction has declined during the past 20 years and has been exceptionally low the past five years. Private and state funded walleye stocking has occurred intermittently since 2015. Despite the lack of natural reproduction, survey data indicates the adult population is still in a healthy state. Adult walleye density was estimated at 4.0 adults per acre in 2021. The muskellunge population size was estimated at 0.21 adults per acre in 2022, which is very similar to the previous population estimate in 2001 of 0.20 adults per acre. Muskellunge size structure appears to be stable as well with 22% of the muskellunge that were over 20" were also over 40". Smallmouth bass relative abundance is the highest it has been in the past three surveys although size structure has declined in recent surveys, which is likely a reflection of the changing habitat in Long Lake. During the 2021 survey, largemouth bass relative abundance was 63% higher than it was in 2008 but is lower than what it was during the 2016 survey, which is a positive note. Largemouth bass size structure was lower as well which likely can be attributed to manual removals and the liberalization of the harvest regulation. Northern pike were present in relatively low numbers, but size structure remained good with 53% of the fish greater than 14 inches also greater than 28 inches. Bluegill and black crappie catch rates were relatively high compared to previous surveys, but size structure was low. Long Lake has a history of poor bluegill size structure, and it appeared that there was a young, strong black crappie year class was present affecting size structure metrics.

## GLOSSARY

**PSD:** Proportional Stock Density – numerical description of population size structure. The percent of fish over a species-specific length standard when small fish, generally age-1, are disregarded. The higher the number, the greater proportion of large fish are present. Example for walleye: (# of fish ≥ 15 inches) / (# of fish ≥ 10 inches) X 100

**RSD:** Relative Stock Density – similar to a PSD, but a specific length is supplied. Example for walleye: RSD-20 = (# of fish ≥ 20 inches) / (# of fish ≥ 10 inches) X 100

**C.I.:** 95% confidence interval. There is a 95% certainty that the population estimate is between the upper and lower bounds given.

**CPUE:** Catch Per Unit Effort – generally given in catch per mile of electrofishing or catch per net lift.

# Introduction

Long Lake is a 1,052-acre natural lake located in northwest Chippewa County. Long Lake is connected to Herde Lake and Dark Lake through channels or narrows. These three waterbodies are treated as one for fisheries management purposes because of their connectivity and movement of fish between them. Long Lake has a maximum water depth of 101 feet, a mean depth of 20 feet, and a relatively complex shoreline that is 14 miles in length. Long Lake is considered a mesotrophic waterbody with an average secchi depth of 12.5 feet and a Trophic Status Index of 47 as measured in 2022. Long Lake is classified as a two-story lake, so a thermocline develops in the summer month generally around 20 feet of water. Because of good water quality and deep, cold water, a cisco (*Coregonus artedi*) population is present in Long Lake as confirmed in a 2013 survey.

The sport and panfishery in Long Lake is primarily comprised of walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu),* largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), muskellunge (*Esox masquinongy*), bluegill (*Lepomis macrochirus),* black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*).

Fish habitat changes in Long Lake over the past 60 years associated with the presence of an introduced species, the rusty crayfish (*Orconectes rusticus*), likely has had a direct effect on the dynamics of the fish community. Rusty crayfish are non-native to Wisconsin and were likely introduced into Long Lake through its use as fishing bait (Lorman 1980). Plant material makes up the majority of the diet of rusty crayfish, and they can eat twice as much plant biomass as some native crayfish species (Gunderson 1995). In the 1960s, rusty crayfish were on the increase in Long Lake, and during that timeframe residents noticed a decline in aquatic macrophyte populations in the lake (Konkel 2006). Rusty crayfish became so prolific in Long Lake that the 1974-1978 population was estimated at 5.2 million and the density on rock substrate was estimated at 51 crayfish per square meter (Magnuson et. al. 1975). By the mid-1970s, the amount of aquatic vegetation in Long Lake was limited to a few stands of bullrush and pickerelweed. In an effort to reestablish aquatic vegetation, a predator of crayfish, smallmouth bass, were stocked into Long Lake as a biological control. Five stocking events occurred from 1973-1975 which consisted of 159,165 fingerling (3”) smallmouth bass. The stocking was a success, and since then a quality smallmouth bass fishery has developed and the aquatic macrophyte community has rebounded. In 1986, only 6.5% of the littoral zone was vegetated (Konkel 2006), but a 2023 survey showed 61.5% of the littoral zone was vegetated. Aquatic vegetation is used as a critical habitat component for many fish species at various life stages, and it plays an important ecological role in the lake for many non-fish species. The recovery of the aquatic plant community and return to a more natural, historic state is a sign of a healthy lake ecosystem.

In an effort to improve fish habitat, a large-scale Fish Stick project was conducted by the Wisconsin Department of Natural Resources (DNR) in two phases. Phase I occurred in the February of 2014 along the east side of the DNR owned property on the big island on the north end of the lake. Trees were brought in from a nearby timber harvest, placed strategically along the shoreline, and cabled to shore. Phase II occurred in February of 2015 on the south end of the lake where trees were cut from the upland area, transported down the to the lake, placed along the shoreline, and cabled to shore. Both project locations increased the amount of nearshore woody habitat available for fish and other species.

There are two public boat landings present on Long Lake. One landing is located off of State Highway 40 near Morris-Erickson County Park and the other landing is located off of Basswood Road and 290th Avenue.

### SURVEY EFFORT

The purpose of this survey was to sample Long Lake under the DNR's tier 1 lake sampling protocol for public access lakes in Wisconsin. The primary goal was to complete a walleye population estimate in 2021 and muskellunge population estimate in 2022. Along with the population estimates, bass and panfish populations were assessed in the spring of 2021 during their spawning timeframe. Long Lake is also surveyed each fall to evaluate walleye natural reproduction. Data from these surveys were compared to historical data to evaluate trends over time and determine if future management actions are necessary. Long Lake is on a four-year survey rotation, and it is scheduled to be surveyed again in 2025. Aquatic plant survey data from 1986 to 2023 is also included in this report.

## Methods

**Fyke netting:** Six fyke nets were set shortly after ice out on April 1st and two more were added on April 4th. Fyke nets were lifted daily until removed on the 7th of April for a total of 42 net lifts.

Walleye captured with fyke nets, were measured for length, and marked with a left pectoral fin clip to facilitate a population estimate. The walleye population estimate was conducted in a one-year process where walleye were marked and recaptured all in the same year. Once approximately 10 percent of the population was believed to be marked, the fyke nets were removed. In order to get the information needed to estimate total abundance, a 'recap run' was conducted where the entire shoreline was electrofished and all adult walleye observed were captured. The ratio of marked (fin clipped) to unmarked walleye yields the information needed to calculate a total abundance estimate. For aging purposes scales and a dorsal spine were taken from five fish of each sex per half inch group from walleye.

Muskellunge were measured for length, weighed, and given a Passive Integrated Transponder (PIT) tag to mark fish for identification in future surveys. The muskellunge population estimate is a two-year process because muskellunge are net shy; once they are captured by a fyke net once, they tend to avoid fyke nets for the remainder of the year. To complete the population estimate, muskellunge were captured via fyke netting the following year, 2022, and the ratio of marked to unmarked fish provided the information needed to estimate abundance. Anal fin rays were taken for age estimation. In coordination with the DNR, members of the First WI Chapter of Muskies Inc. have an angler tagging program, which is cooperative project that allows trained anglers to PIT tag muskellunge. The angling data were integrated in with DNR data to provide a more precise population estimate.

All northern pike were measured for length and the first three anal fin rays for five fish from each inch class per sex were taken from for aging purposes. All bass were measured for length and a dorsal spine was taken from five per inch class for smallmouth bass. Twenty-five of each species of panfish were measured for length per net. Scales were taken for aging purposes from five of each half inch class of bluegill, black crappie and yellow perch. All other fish were identified and counted.

**Electrofishing**: Electrofishing surveys were conducted on the nights of April 8th and May 17th. The entire shoreline was sampled on the night of April 8th using a pulsed DC mini-boom shocker a pulsed DC maxi-boom shocker. The purpose of the sampling on 8th of April was to capture walleye to obtain the recapture data needed for a population estimate. All walleye were collected, measured and inspected for a left pectoral fin clip. The purpose of the sampling conducted on 17th of May was to capture centrarchids (bass, bluegill, crappie); this survey was broken into six runs. Three, 0.5-mile 'bass/panfish runs' in which all bass and panfish were collected and three 1.5-mile 'bass runs', where only bass were collected. For bass, aging structures were collected from five fish per inch group; scales were collected from fish less than 12 inches and dorsal spines were collected from fish greater than 12 inches. Scales were collected from panfish greater than three inches up to 5 per half inch group. One hundred of each fish species were measured for length and the rest were counted.

**Aquatic plant survey:** Rake sampling method was used where a long handled, steel, thatching rake was used to sample vegetation at each site. The rake was tossed off the boat at stratified, randomly selected locations, allowed to reach the bottom, and retrieved. The plants on the rake were identified and quantified.

**Data Analysis:** Spring fyke netting, electrofishing, and abundance estimate data from 2021 were compared to previous survey data. An age frequency histogram was developed for the walleye population. Catch per unit effort and size structure data were compared to past surveys. Length-at-age for various species was calculated from the data collected in 2021 and compared to the statewide average to determine relative growth rates. Stocking records for Long Lake are provided in Table 2.

# Results

## WALLEYE

In 2021, 529 walleye were marked with a left pectoral fin clip during the fyke netting portion of the survey. Three hundred forty-three were captured during the recapture electrofishing run of which 39 were marked yielding an estimate of an adult walleye population size of 4,251 (95% C.I. =3,084-5,419) or 4.0 fish per acre. In comparison, during the 2016 survey the population size of adult walleye was estimated at 3,545 (95% CI=3,059-4,031) or 3.4 fish per acre; during the 2012 survey the abundance estimate was 3,030 (95% C.I.=2,118-3,942) or 2.9 fish per acre; during the 2008 survey the abundance estimate was 7,083 (95% C.I.=5,188-8,978) or 6.7 per acre in 2008; during the 2000 survey the walleye population estimate was 5,397 (95% CI=4,188-6,605) or 5.1 per acre in 2000; and during the 1996 survey the abundance estimate was 6,541 (95% CI=6,017-7,066) 6.2 per acre.

Size structure has remained remarkably stable over the previous three surveys although there was a slight improvement in 2021. The mean length of walleye in the 2021 survey was 15.7 inches, the PSD was 59, the RSD-20 was 3.5, and walleye ranged from 11.7-27.7 inches (Figure 1). In 2016, the mean length of walleye was 15.5 inches, while the walleye PSD and RSD-20 values were 57 and 2.3, respectively, and the length ranged from 7.2-28.7 inches. The mean length of walleye in the 2012 survey was slightly smaller at 15.3 inches, while the walleye PSD and RSD-20 values were 62 and 2.5, respectively, and the length ranged from 7.2-25.2 inches. Out of the 872 walleye captured in this survey, 510 were male, 298 were female and 64 fish were of unknown sex for a male:female sex ratio of 1.7 (Figure 1).

Ten age classes were present in this survey ranging from 3-12 years of age (Figure 2). Total annual mortality for the walleye population was estimated at 52% (Figure 3). Walleye length at age was generally shorter than the statewide mean (Figure 4), but similar to the average for walleye populations in the Ceded Territory (Figures 5 & 6).

Fall electrofishing catch rates of age-0 walleye are used to measure reproductive success (Figure 7). From 1993-2004, catch rates averaged 67 fish per mile; however, from 2005 to 2024 the average catch rate has declined to 12 fish per mile. Fall electrofishing catch rates of age-1 walleye from 2014-2024 are shown in Figure 8. Walleye that make up the age-1 catch could be stocked or naturally reproduced whereas the age-0 catch is comprise of all naturally reproduced walleye because walleye have not yet been stocked at the time of the survey.

Stocking history for Long Lake from 2013-2024 is located in Table 2. Walleye were stocked into Long Lake in 2015 due to concerns with declining recruitment for the first time in recent history. Since then, large fingerling walleye have been stocked intermittently.

*Figure 1: Walleye Length Frequency Long Lake, Chippewa County, 2021.*

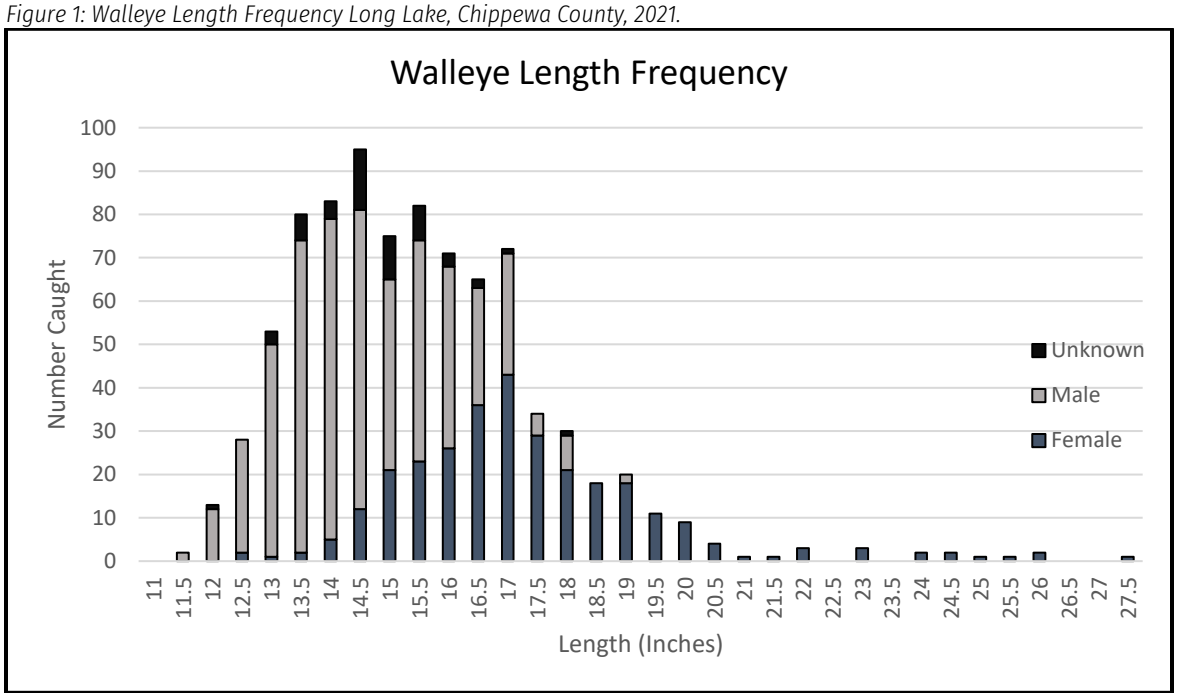



*Figure 2: Walleye Age Frequency Long Lake, Chippewa County, 2021.*

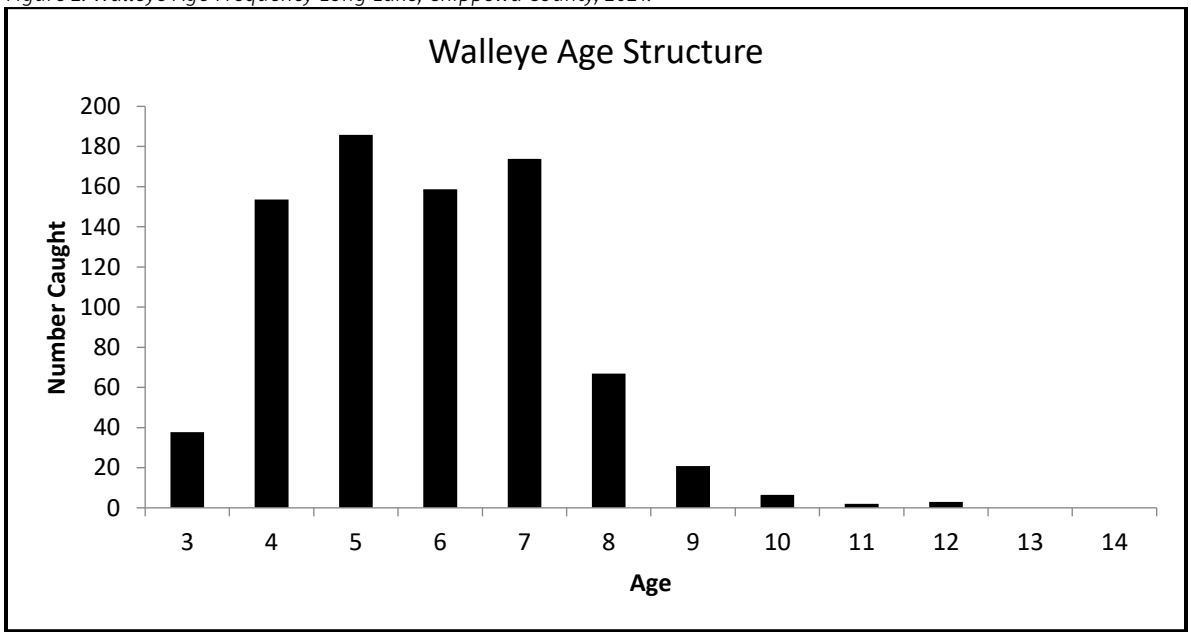


*Figure 3: Catch Curve for Walleye on Long Lake, Chippewa County, 2021. Total annual mortality was 52%.*

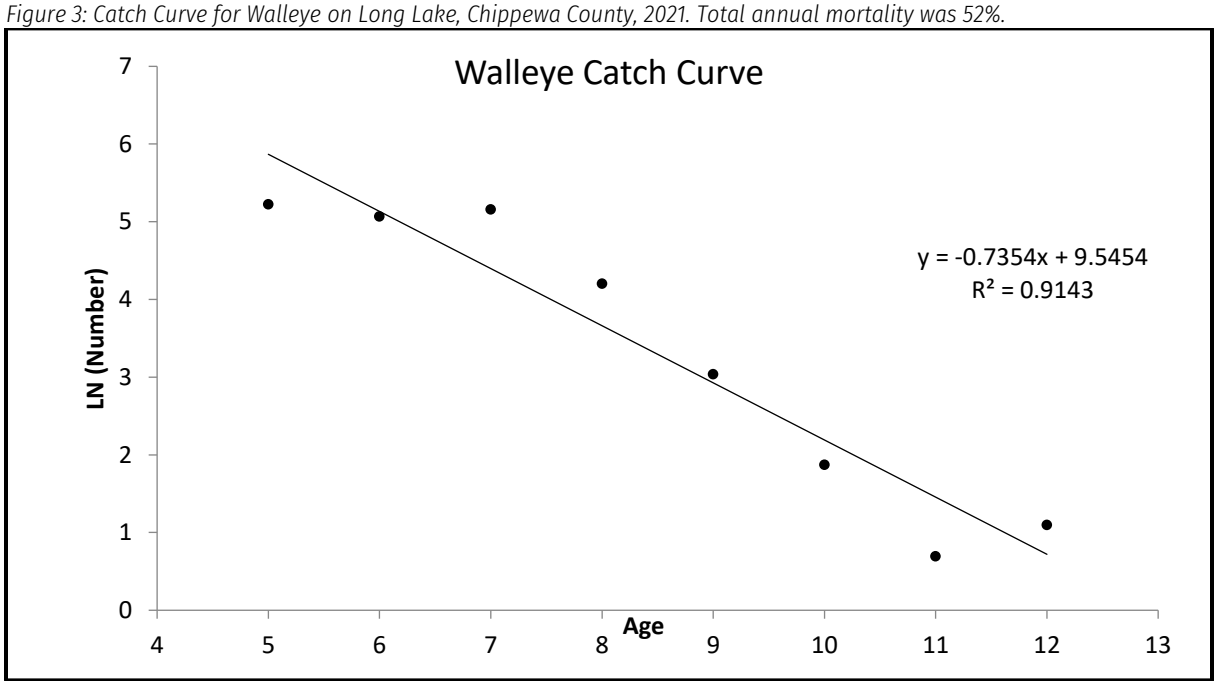



*Figure 4: Length at age for male and female walleye on Long Lake, Chippewa County, 2021 compared to the statewide average for male and female walleye combined.*

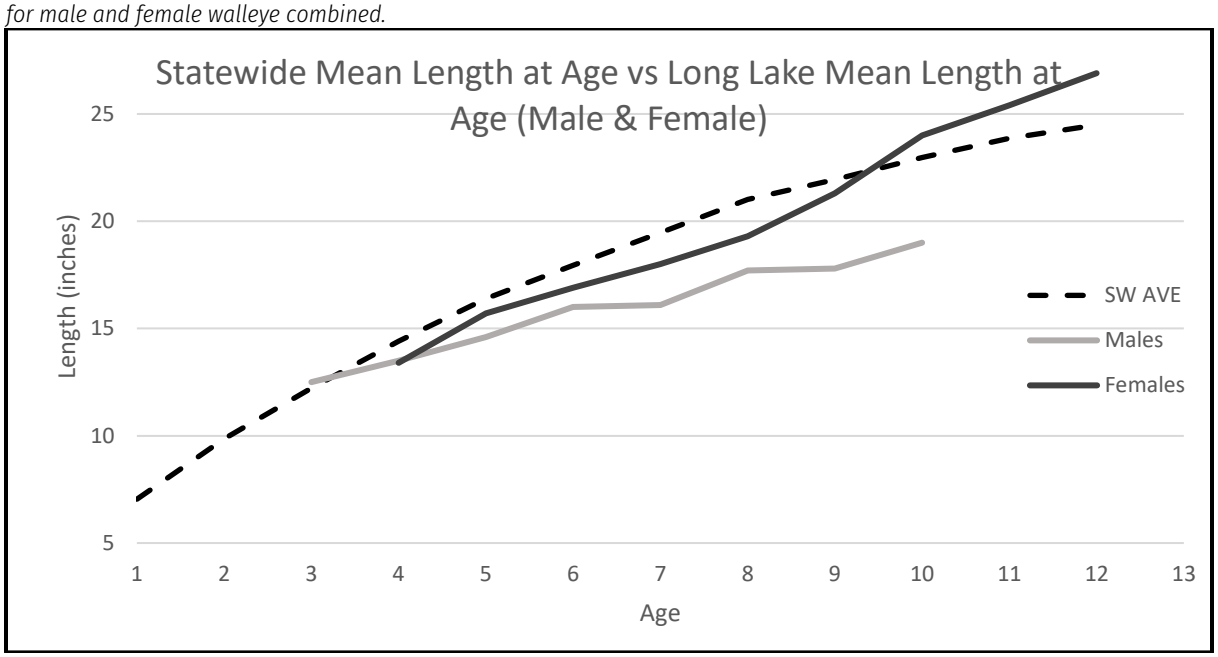


*Figure 5: Length at age for male walleye on Long Lake, Chippewa County, 2021 compared to the mean length at age for male walleye from the Ceded Territory.*

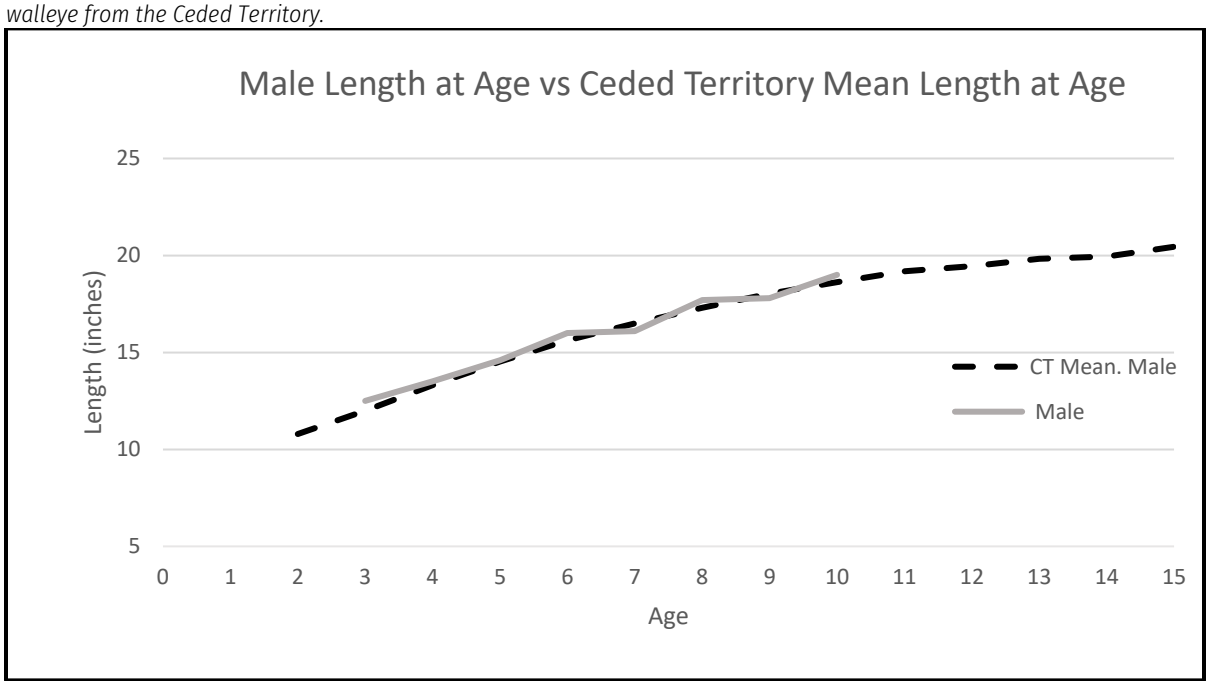



*Figure 6: Length at age for female walleye on Long Lake, Chippewa County, 2021 compared to the mean length at age for female walleye from the Ceded Territory.*

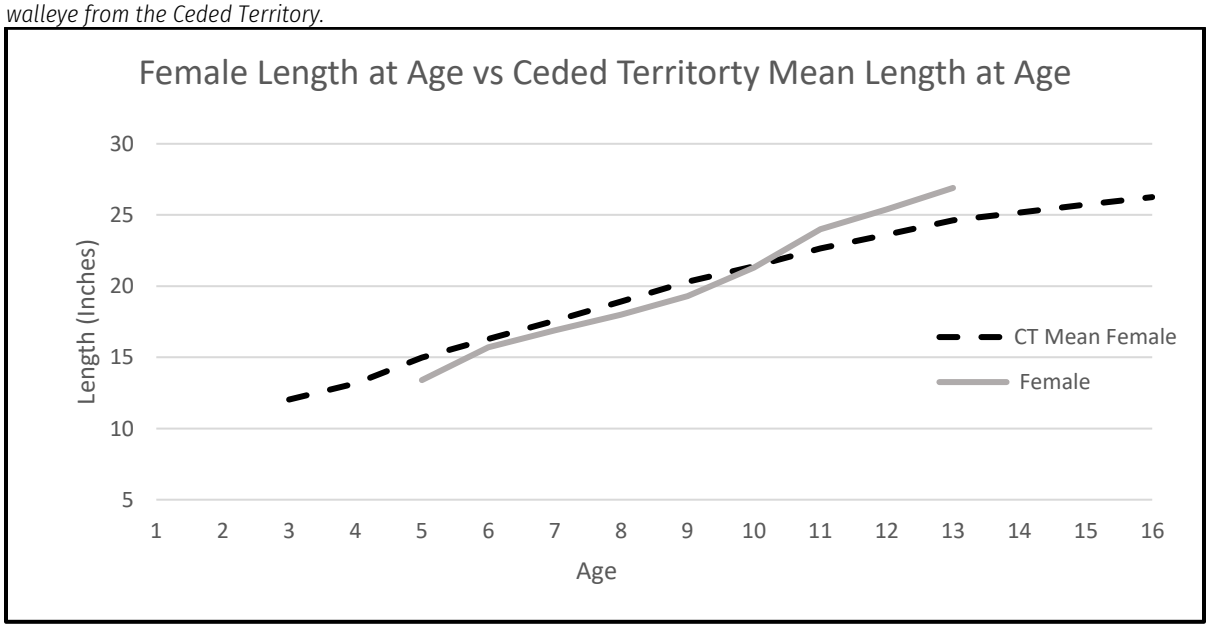


*Figure 7: Walleye age-0 catch rate (fish caught per mile of shoreline electrofished) Long Lake, Chippewa County, 1993-2024. Years without data (1996, 2003, 2006) no surveys were conducted.*

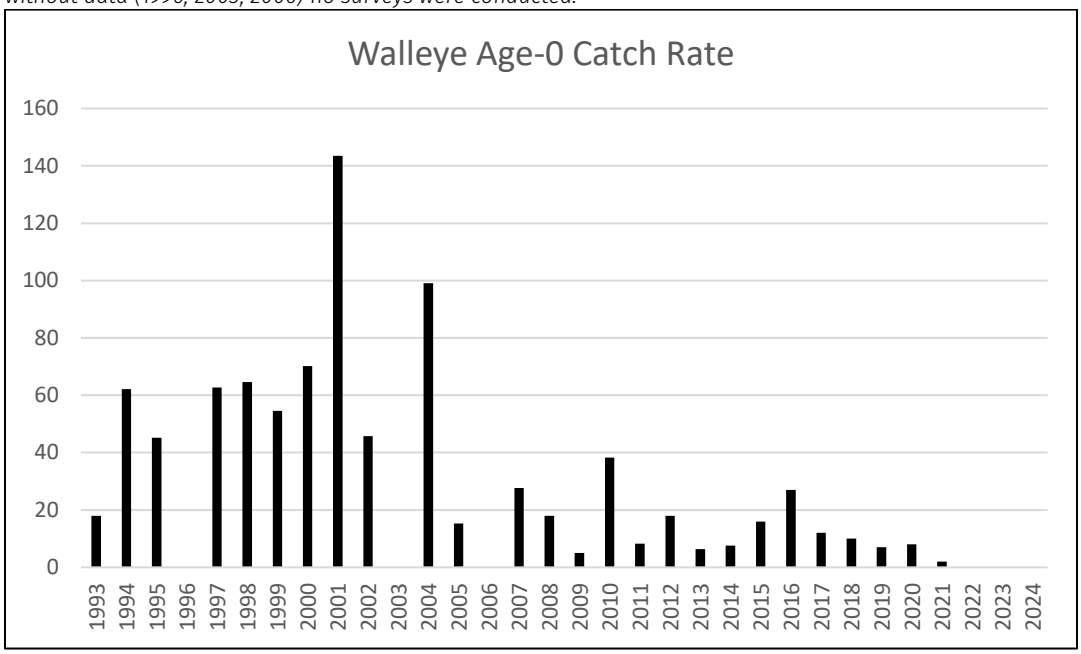
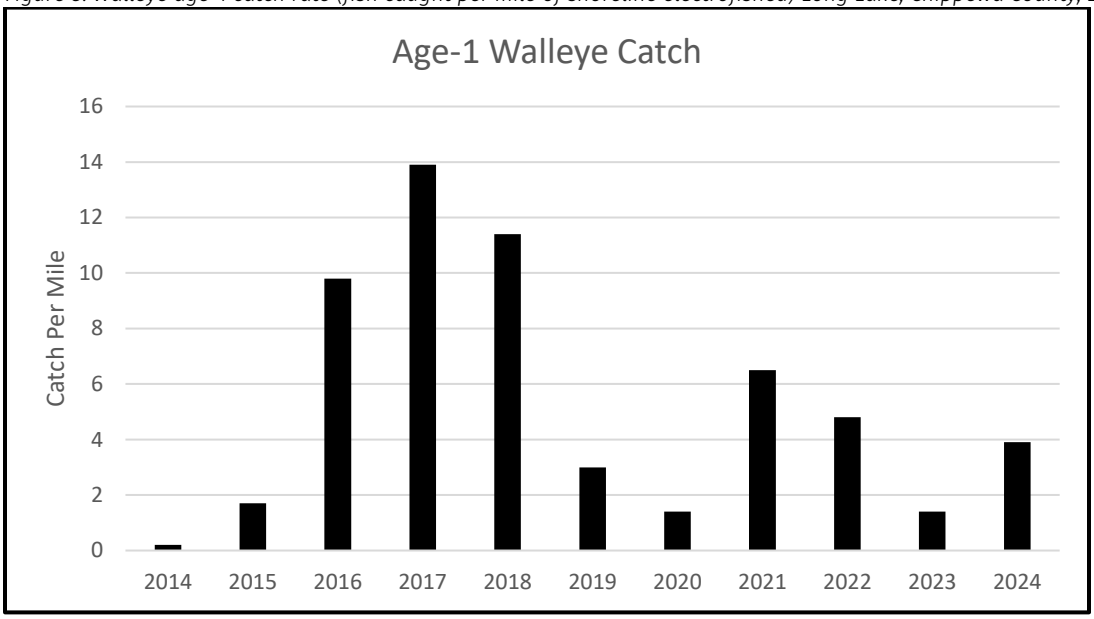



*Figure 8: Walleye age-1 catch rate (fish caught per mile of shoreline electrofished) Long Lake, Chippewa County, 2014-2024.*




## MUSKELLUNGE

In 2022, the adult (>30 inches) muskellunge population was estimated at 0.21 fish per acre or 224 fish (95% C.I.=120-497). Combining data collected by the DNR and Muskies Inc. from 2021 and 2022, the PSD was 86 and RSD-40 was 22 (Figure 9). The maximum length of Muskellunge measured was 46.1 inches. The previous adult muskellunge

population estimate was conducted in 2000 and 2001 and the population size was estimated at 0.20 fish per acre or 215 fish (95% C.I.=125-434). The PSD was 90 and the RSD-40 was 26. The largest muskellunge measured was 46.1 inches.

Muskellunge from eight age classes were captured in this survey ranging from 4-11 years of age. Musky length-at-age was above the mean for other musky populations in the state (Figures 10 & 11).

Muskellunge stocking records are presented in Table 2.

*Figure 9: Muskellunge Length Frequency Long Lake, Chippewa County, 2021 and 2022*

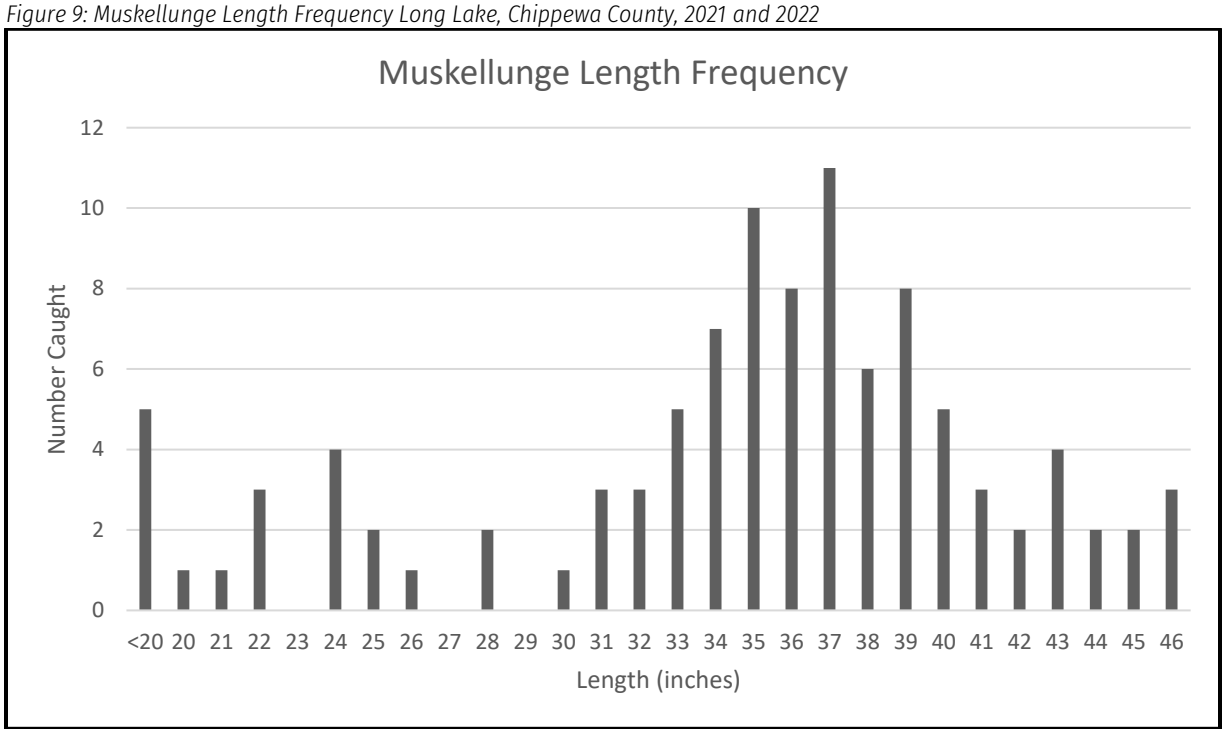


*Figure 10: Male muskellunge Length at age on Long Lake, Chippewa County, 2021 and 2022 compared to the statewide average for male muskellunge length-at-age.*

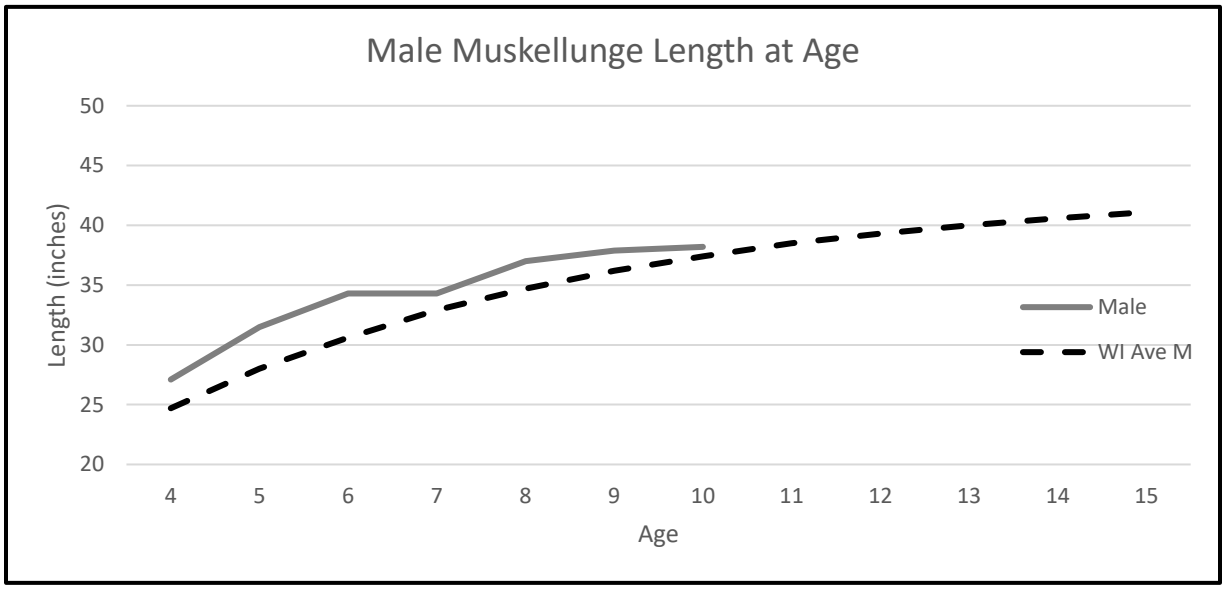
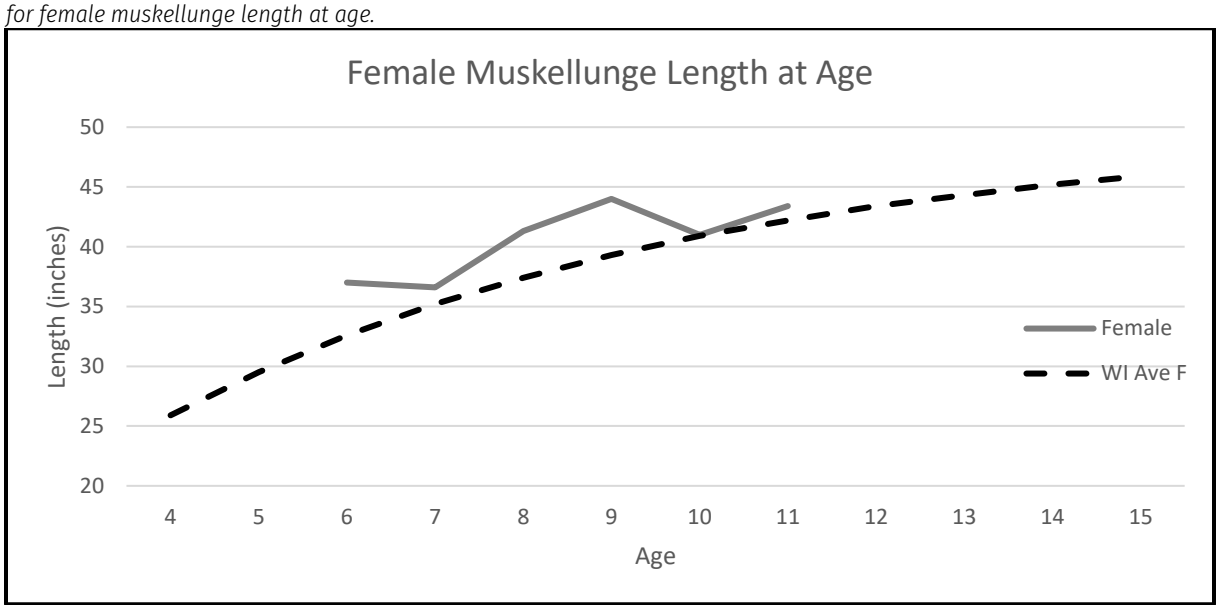



*Figure 11: Female muskellunge length at age on Long Lake, Chippewa County, 2021 and 2022 compared to the statewide average for female muskellunge length at age.*




## SMALLMOUTH BASS

Electrofishing CPUE in 2021 was 25 fish per mile, compared to 14.8 fish per mile in 2016 and 19.0 fish per mile in 2012. In 2021, the mean length of smallmouth bass caught was 13.0 inches (Range: 6.8-20.3 inches (Figure 12), similar to what was

observed in 2016, 12.9 inches (Range: 6.3-19.8 inches) but lower than in 2012, 14.6 inches (Range: 7.3-20.3 inches). Size structure in 2021 appears to have declined slightly relative to the previous two surveys. In 2021, the PSD was 72, and RSD-18 was 8, which is lower than what was observed in 2016 when the PSD and RSD-18 values were 82, and 11 respectively. In 2012, the size structure was much better as the PSD was 77 and RSD-18 was 26. Length-at-age of smallmouth bass was near the statewide average for most age groups. (Figure 13).

*Figure 12: Smallmouth Bass Length Frequency Long Lake, Chippewa County, 2021.*

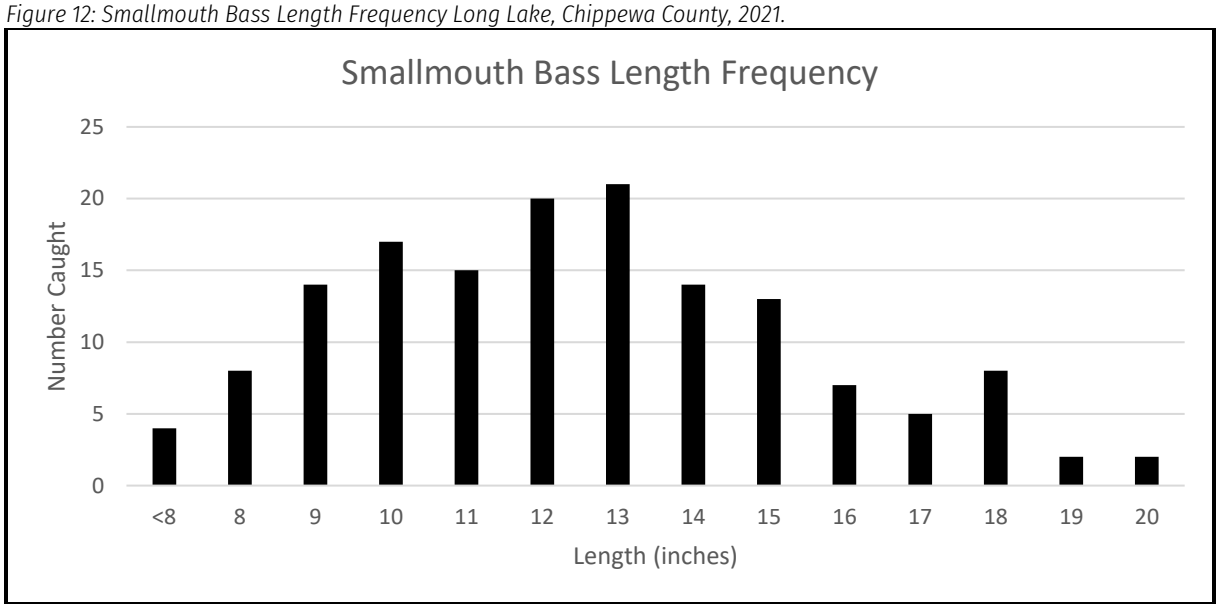
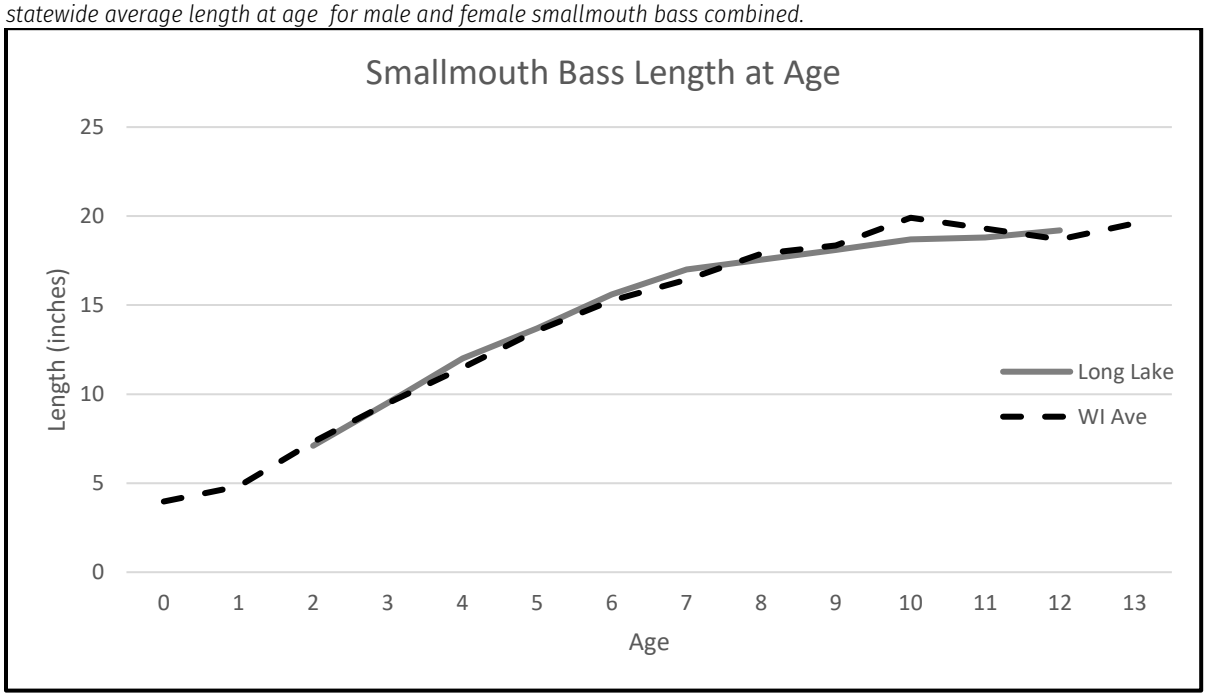



*Figure 13: Length at age for male and female smallmouth bass combined on Long Lake, Chippewa County, 2021 compared to the statewide average length at age for male and female smallmouth bass combined.*



## LARGEMOUTH BASS

Largemouth bass CPUE in 2021 was 16.8 fish per mile, which was lower than in the previous survey in 2016 of 27.8 fish per mile. The 2021 CPUE however was similar to what was caught in 2012 at 17.6 fish per mile. All three surveys were higher than the 2008 CPUE which was 10.3 per mile. In the 2021 survey, the mean length was 12.7 inches (range: 7.5-18.3 inches), the PSD was 64, and the RSD-16 was 10 (Figure 14). This is a slight improvement in size structure from the 2016 survey where the mean length was 12.5 inches (range: 7.3-20.8 inches), the PSD was 57 and the RSD-16 was 7. However, the 2012 survey had the best size structure relative to the previous two surveys where the mean length was 14. inches (range: 6.8-18.1 inches), the PSD was 81 and the RSD-16 was 38. The size structure in the 2008 survey was relatively poor with the mean size at 13.2 inches (range 4.6-17.2 inches), the PSD at 83, and RSD-16 at 4. Length at age was higher than the statewide average for the largemouth bass 6 years and younger and then dropped below the statewide average for older fish (Figure 15).

*Figure 14 Largemouth Bass Length Frequency Long Lake, Chippewa County, 2021.*

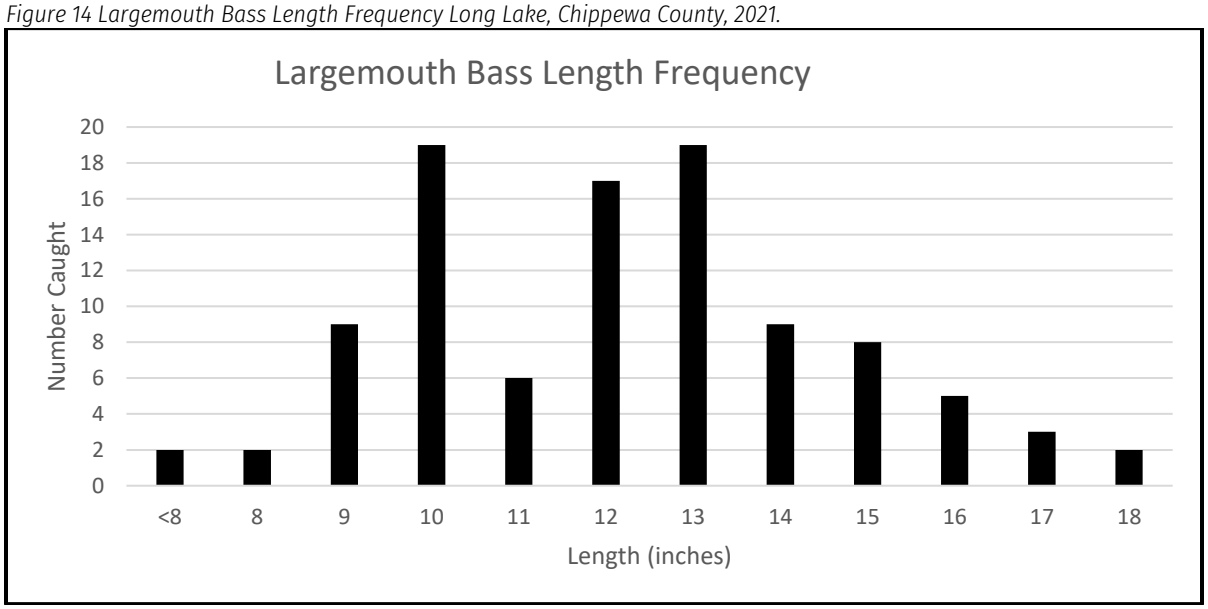
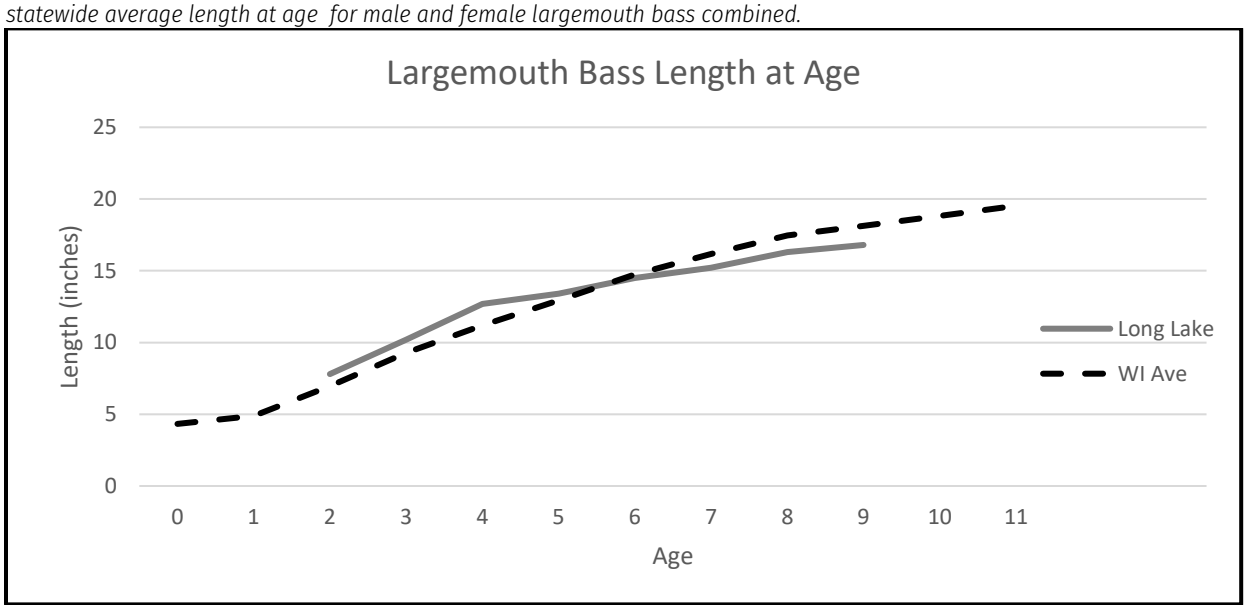


*Figure 15: Length at age for male and female largemouth bass combined on Long Lake, Chippewa County, 2021 compared to the statewide average length at age for male and female largemouth bass combined.*




## NORTHERN PIKE

In 2021, the mean catch was 0.50 northern pike per net lift compared to 0.18 in 2016, and 0.33 in 2012.

The size structure of northern pike remains good as confirmed by the 2021 survey with the mean size of 28.4 inches (range: 20.2-39.5 inches), the PSD was 95 and the RSD-28 was 53 (Figure 16). The size structure was similar in 2016 where mean length was 25.3 inches (range: 15.1-36.6”), the PSD was 100, and the RSD 28 was 42. In 2012 the size structure was better where the mean length was 30.2 (range: 11.4- 42.3”) the PDS was 90, and RDS-28 was 70. The length at age for all pike aged was well above the statewide average for northern pike length at age (Figure 17).

*Figure 16: Northern Pike Length Frequency Long Lake, Chippewa County, 2021.*

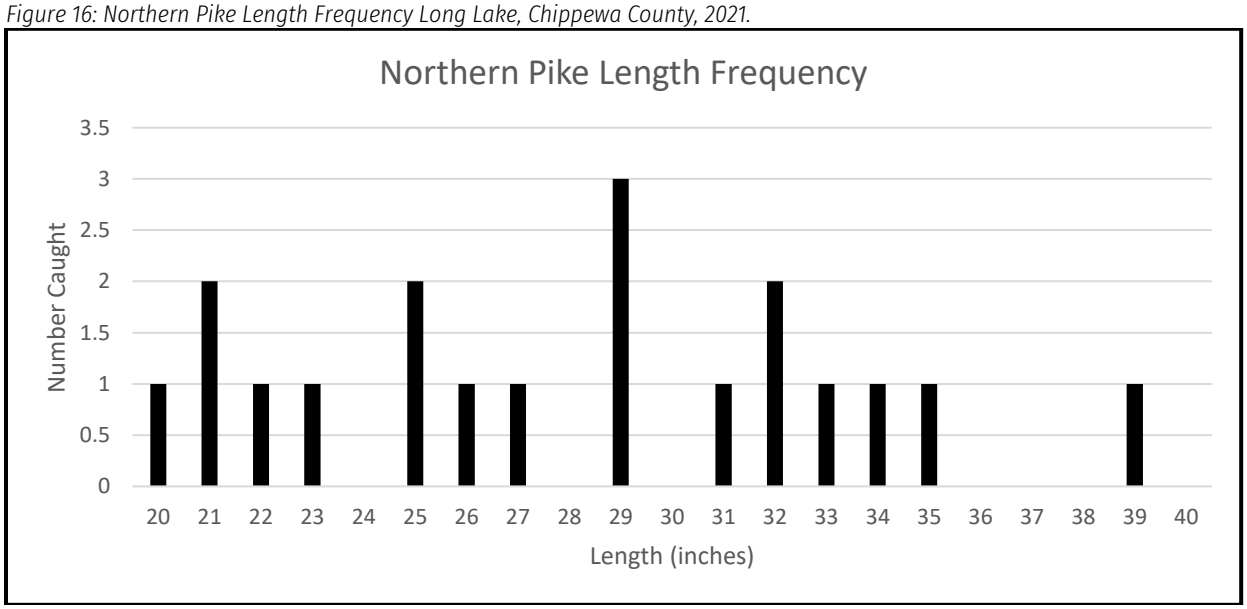
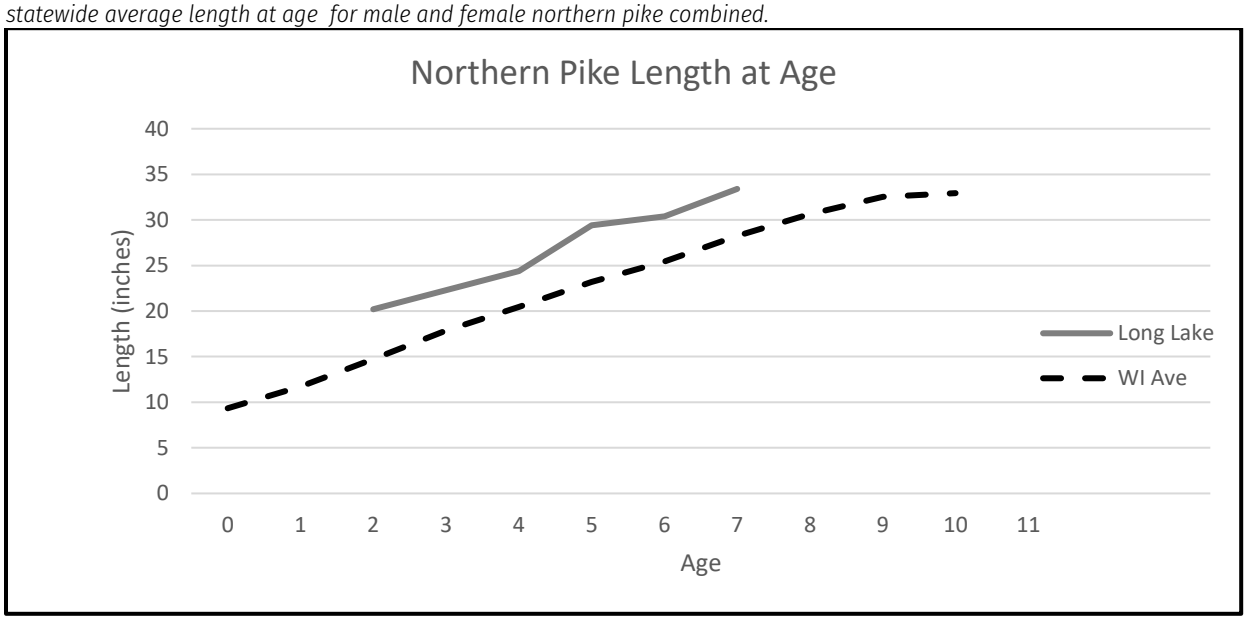



*Figure 17: Length at age for male and female northern pike combined on Long Lake, Chippewa County, 2021 compared to the statewide average length at age for male and female northern pike combined.*




## BLUEGILL

In 2021, the mean catch of bluegill was 69 per mile of shoreline electrofished, compared to 61 per mile in 2016 and 30 per mile in 2012. In 2021, the mean length of bluegill captured was 5.4 inches (range: 1.3-9.7”), the PSD was 43, and RSD-8 was 3 (Figure 18). In 2016, the size structure was relatively better when the mean length was 6.2 inches (range: 2.4-8.3 inches), the PSD was 63 and RSD-8 was 2. Bluegill size structure in 2012 was relatively poor, when the mean size was 5.5 inches (range:1.3-7.5

inches), the PSD was 41 and RSD-8 was 0. The growth rate was consistent with the statewide average (Figure 19).

*Figure 18: Bluegill length frequency Long Lake, Chippewa County, 2021.*

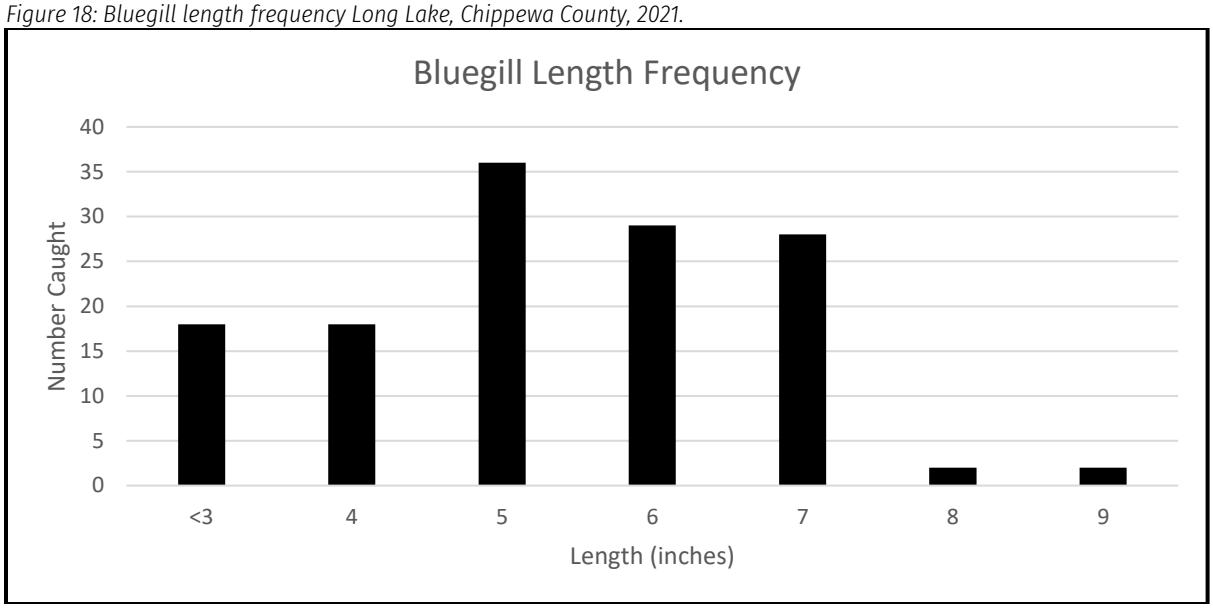
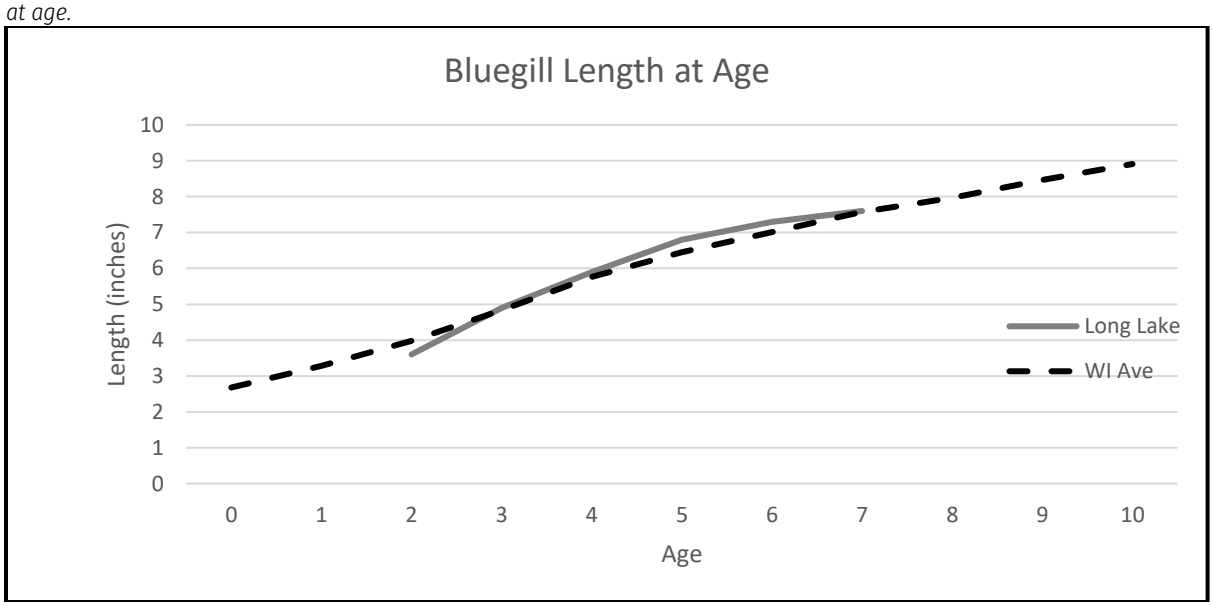



*Figure 19 Length at age for bluegill on Long Lake, Chippewa County, 2021, compared to the statewide average for bluegill length at age.*




## BLACK CRAPPIE

In 2021, the black crappie catch rate was 11.3 per mile of shoreline electrofished. The mean length was 7.6 inches (range: 4.4-13.4 inches), PSD was 61, and RSD-10 was 5.6 (Figure 20). In 2016, the catch rate was 8.6 per mile of shoreline electrofished. Despite the lower catch, the size structure was better with a mean length of 7.5 inches (range: 2.8-13.4 inches), the PSD was 71 and RSD-10 was 38. The catch rate in 2012 was relatively lower than the previous two surveys and was 2.7 per mile of

shoreline electrofished. The mean length was 9.7 inches (range: 8.2-11.3 inches). The PSD was 100 and RSD-10 was 50. Black crappie appear to be growing faster than the statewide average in Long Lake (Figure 21).

*Figure20: Black crappie length frequency Long Lake, Chippewa County, 2021.*

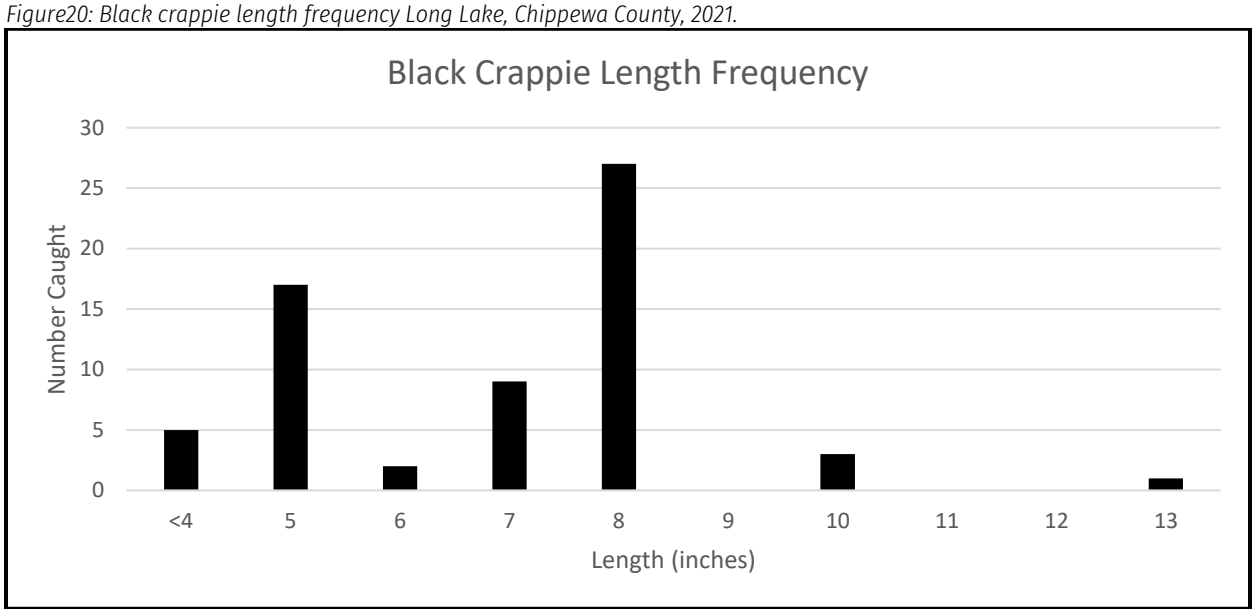
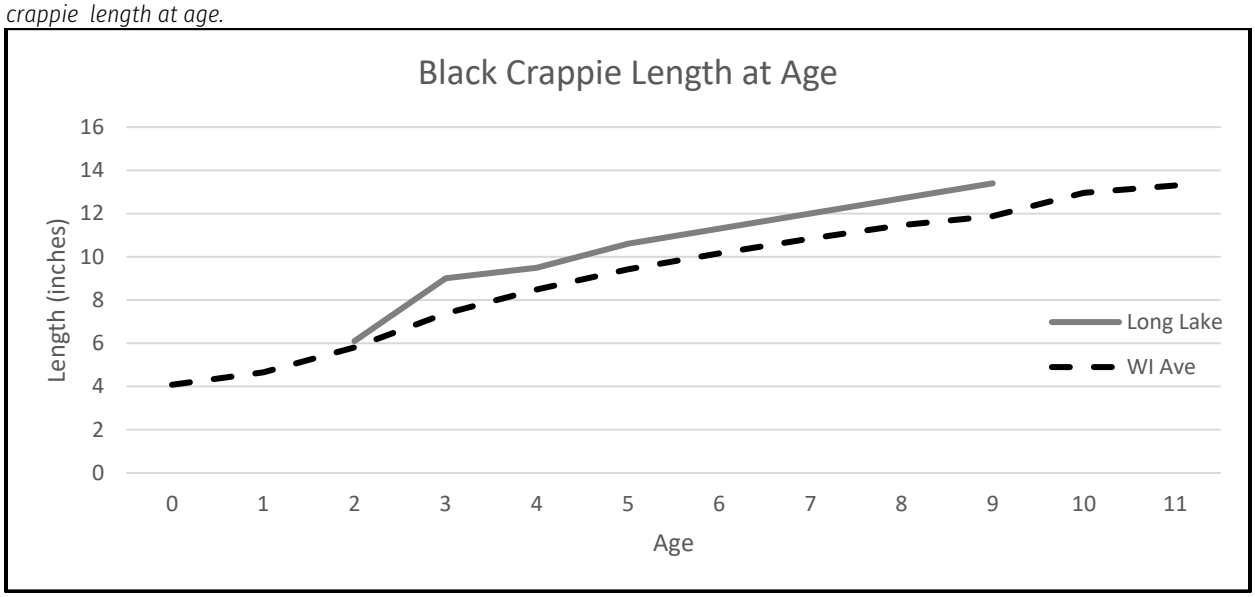



*Figure 21: Black crappie at age for bluegill on Long Lake, Chippewa County, 2021, compared to the statewide average for black crappie length at age.*

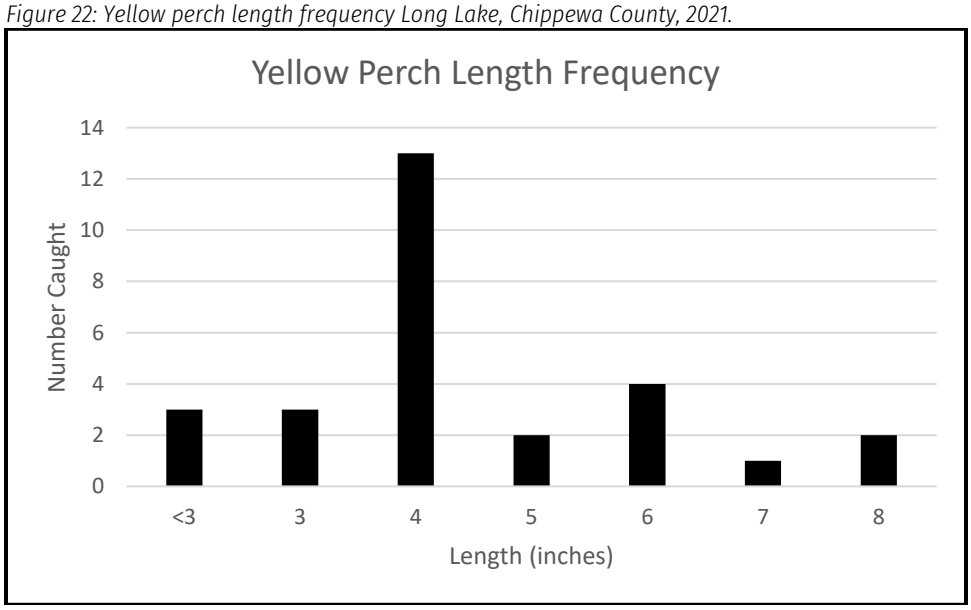



## YELLOW PERCH

In 2021, the catch rate was 16.1 yellow perch per net lift, while only 0.1 were caught per net lift in 2016 and data was not collected on yellow perch while netting 2012. Yellow perch size structure is poor in Long Lake. In 2021, the mean length of perch caught was 5.0 inches (range: 2.6-8.6 inches) while the PSD was 22 and the RSD-10 was 0 (Figure 22). Size structure was poor in 2016 as well when the mean size of perch captured was 4.4 inches (range: 2.6-9.7 inches). The PSD was 100 but the RSD-10 was

0. Size data was collected via electrofishing in 2012 and mean length of perch caught was 2.8 inches (range: 2.1-4.1 inches). The PSD and RSD-10 were both 0. Not enough yellow perch were aged to make conclusions about their growth rates.

*Figure 22: Yellow perch length frequency Long Lake, Chippewa County, 2021.*




## AQUATIC PLANTS

In the summer of 2023, a survey was conducted where a total of 874 sites were visited, 520 site were shallow enough to allow for plant growth, and 320 sites contained plants. Maximum water depth where plant growth occurred was 18.0 feet of water. The percent of the littoral zone (lake bottom capable of supporting aquatic plant growth) that was vegetated has steadily increased since the late 1980s (Figure 23). In 2023, 61.3% of the littoral zone was vegetated, which is over double what it was in 2016, and over an eight-fold increase since the 1986 survey. Only native plant species were found in the 2023 survey indicating that the newly vegetated area is an expansion of existing plant communities.

*Figure 23: Percent of littoral zone vegetated, Long Lake, Chippewa County, 1986-2023.*

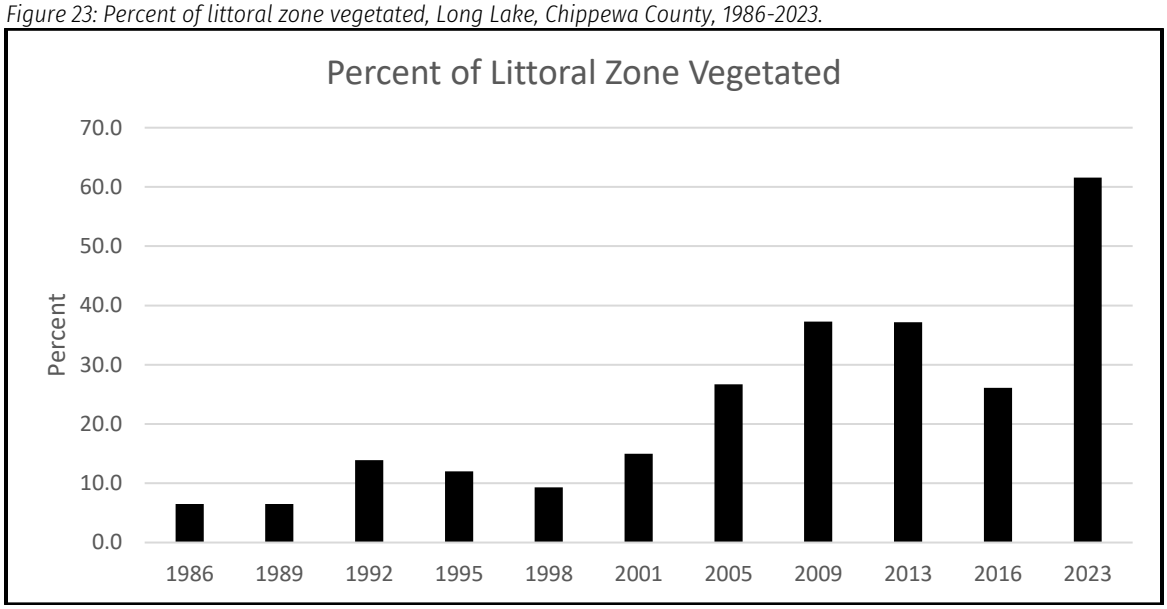



*Table 1: Total number of fish captured by species and gear in the spring of 2021 and 2022 on Long Lake, Chippewa County.*

| SPECIES | FYKE NET | E-FISHING | TOTAL |
|---|---|---|---|
| Black crappie | 137 | 17 | 154 |
| Bluegill | 125 | 104 | 229 |
| Largemouth bass | 10 | 102 | 112 |
| Muskellunge | 57 | 0 | 57 |
| Northern pike | 19 | 0 | 19 |
| Pumpkinseed | 1 | 3 | 4 |
| Rock bass | 105 | 10 | 115 |
| Smallmouth bass | 1 | 150 | 151 |
| Walleye | 554 | 371 | 925 |
| Warmouth | 0 | 1 | 1 |
| Yellow perch | 674 | 7 | 681 |

*Table 2: Stocking history  Long Lake, Chippewa County, 2013-2024. Note 2015 was the first-year walleye were stocked into Long Lake.*

| YEAR | SPECIES | STRAIN (STOCK) | AGE CLASS | NUMBER STOCKED | AVG LENGTH (IN) | SOURCE TYPE |
|---|---|---|---|---|---|---|
| 2013 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLING | 238 | 11.6 | DNR HATCHERY |
| 2015 | WALLEYE | MISSISSIPPI HEADWATERS | LARGE FINGERLING | 2784 | 5 | DNR PONDS |
| 2015 | WALLEYE | MISSISSIPPI HEADWATERS | LAREGE FINGERLING | 4000 | 6 | PRIVATE HATCHERY |
| 2015 | WALLEYE | MISSISSIPPI HEADWATERS | LARGE FINGERLING | 3271 | 7.7 | DNR HATCHERY |
| 2015 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLING | 526 | 12.4 | DNR HATCHERY |
| 2016 | WALLEYE | MISSISSIPPI HEADWATERS | LARGE FINGERLING | 4000 | 6 | PRIVATE HATCHERY |
| 2017 | WALLEYE | Upper Mississippi River | LARGE FINGERLING | 2995 | 9 | PRIVATE HATCHERY |
| 2017 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLING | 174 | 11.2 | DNR HATCHERY |
| 2018 | WALLEYE | MISSISSIPPI MAINSTEM | LARGE FINGERLING | 5875 | 6 | PRIVATE HATCHERY |
| 2019 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLING | 976 | 13 | DNR HATCHERY |
| 2020 | WALLEYE | MISSISSIPPI HEADWATERS | LARGE FINGERLING | 5000 | 8 | PRIVATE HATCHERY |
| 2021 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLING | 1048 | 14.4 | DNR HATCHERY |
| 2021 | WALLEYE | MISSISSIPPI HEADWATERS | LARGE FINGERLING | 5035 | 6.6 | DNR HATCHERY |
| 2023 | WALLEYE | CHIPPEWA/ST. CROIX | LARGE FINGERLINGS | 10470 | 6.7 | DNR HATCHERY |
| 2023 | MUSKELLUNGE | UPPER CHIPPEWA RIVER | LARGE FINGERLINGS | 500 | 11 | PRIVATE HATCHERY |

# Discussion

## WALLEYE

The adult walleye density of 4.0 adults per acre is surprising strong given the lack of natural reproduction in recent years. The adult walleye population estimate is on the higher end of what is typically seen on lakes with naturally reproducing walleye populations, which is between three and four adult walleye per acre. The density estimate is also higher than the previous two surveys 3.4 walleye per acre and 2.9 walleye per acre in 2016 and 2012 respectively, but it is not significantly higher. All of these recent estimates are lower than the abundance estimates in the 1990s and early 2000s, although not significantly. The increase in the population size of adult walleye in the 2021 survey is positive news; however, the declining natural reproduction is concerning for a self-sustaining population into the future. Future fish surveys will shed more light into the trends with walleye abundance.

In the 1990s and early 2000s Long Lake had consistently strong walleye natural reproduction and averaged 67 age-0 walleye per mile from 1993-2004, but since 2005 the average catch of age-0 walleye has only averaged 12 fish per mile. Over the past eight years (2017-2024), the average catch has been five per mile and has been trending downward (Figure 7). Long Lake is one of many lakes in northwestern Wisconsin and the upper Midwest that has declining walleye natural reproduction (Gostiaux et al. 2022; Honsey et al. 2020). Many research projects from different agencies, universities, and organizations have been dedicated to this subject, but it is still not fully understood why walleye recruitment declines are occurring. Large scale habitat changes with the resurgence of aquatic macrophytes are likely playing a role in reshaping the fish community in Long Lake and could be contributing to the declining recruitment phenomenon. Aquatic vegetation has become more abundant in Long Lake over the past two decades which favors species that prefer vegetated habitat such as largemouth bass and bluegill. Considering these species are better adapted for that specific type of habitat, they will have the competitory advantage for limited resources over other species (Hansen et al. 2018). Largemouth bass relative abundance has fluctuated but was 63% higher in 2021 than it was in 2008. Bluegill relative abundance has increased by 130% since 2012. Walleye natural reproduction and recruitment in Long Lake will continue to be monitored annually for the foreseeable future with a fall electrofishing survey.

As a result of the trend of poor year classes, in 2016 the walleye regulation was changed form a 14-18 inch protected slot with a sliding bag limit to an 18 inch minimum size limit with a three fish bag limit. The reasoning behind the regulation change was to protect more juvenile and adult walleye than the previous regulation with the goal of increasing the spawning stock to bolster natural reproduction. The 18 inch minimum size limit is undoubtably reducing recreational walleye harvest despite the absence of a creel survey data. Further evidence of the regulation's

effect is that the mean length, proportional stock density and relative stock density – 20 values are all higher than the previous survey. With the low level of natural reproduction, the 18 inch minimum size limit is the best fit for the population at this time, and if population attributes change, the walleye regulation will be reevaluated.

Despite poor age-0 walleye catches in fall surveys over the past decade, there are strong adult year classes present to sustain the population in near term (Figure 2). Age four through age seven were well represented in the adult walleye population which originated from the 2014-2017 year classes. At the time of the survey, younger year classes, less than age 4, were not fully mature, so they were not captured in the survey of the adult population. The 2014 year class (age-7 walleye) has done relatively well, considering age-0 walleye catch was low that year at 8 per mile, no walleye were stocked in 2014, and the age-1 catch in 2015 was only 1.7/mile. Despite the low indices collected from the 2014 year class that would indicate that it was unsuccessful and would not contribute much to the adult population, the age-7 adult year class was relatively large considering it has experienced several more years of annual mortality at a rate of 52% than the previous year classes. The 2015 year class (age-6) was a moderate at 16 per mile at age-0, and 10,055 walleye were stocked to supplement that year class. This resulted in an age-1 catch of 9.7 per mile in 2016 and a strong age-6 adult year class was observed in this survey. The 2016 age-0 year class was the strongest since 2010 and was supplemented with 4,000 additional large fingerling walleye which resulted in a 2017 age-1 catch of 13.9 per mile. Catches greater than 10 age-1's per mile are considered good and generally produce an adult year class, and it did with a strong age-5 year class observed in this survey. The age-4 year class was not fully mature as only seven age-4 mature females were caught. However, it appears to be a successful year class as 12 age-0's per mile were captured in 2017, and 3,000 additional large fingerling walleye were stocked that year, which resulted in an age-1 catch of 11.4/mile in 2018 indicating this it was fairly strong.

Looking forward to the future of the adult walleye population based on recruitment surveys and stocking history, smaller adult year classes are expected, which may result in a lower adult abundance. The 2018 year class was low at 10 age-0s per mile. This year class was supplemented with 6,000 large fingerling walleye, however the age-1 catch in 2019 was only 3 per mile. The 2019 year class did not fair much better with natural reproduction only producing 7 age-0s per mile. No stocking was conducted in 2019, and this produced an age-1 year catch of 1.4 per mile. The catch of age-0 fish in 2020 was 8.3 per mile, 5,000 large fingerling walleye were stocked that year, which produced a moderate catch of age-1 walleye at 6.5 per mile in 2021. Natural reproduction in 2021 was very low at 1.7 age-0 walleye per mile, but this year class was stocked with 5,035 large fingerling walleye which produced a moderate catch of 4.8 age-1 walleye per mile in 2022. During the 2023 fall survey, the age-1 catch of the 2022 year class was low at 1.4 per mile and the 2023 age-0 year class was nearly non-existent. This year class was supplemented with 10,520 large fingerling

walleye, so future surveys will help us evaluate the success of stocking on that year class.

When there is moderate natural reproduction supplemented with unmarked stocked fish, it is difficult to evaluate the contribution made to the population by stocking. However, when natural reproduction is very low to non-existent, stocking success can be evaluated based on the size of the age-1 year class, so the 2021 stocking event likely helped bolster that year class. The 2022 year class was nearly non-existent at 0.2 per mile and no stocking was conducted in 2022, but the age-1 catch in 2023 was 1.4 per mile, so this is evidence that basing year class strength conclusions on the age-0 catch from fall recruitment surveys may not be 100% effective. The increasing amount aquatic vegetation may be giving age-0 walleye more refuge habitat, which may be resulting in less effective age-0 surveys. Regardless, given the trend of declining natural reproduction, Long Lake now meets the DNR's eligibility criteria for stocking of large fingerling walleye. It is recommended for Long Lake to be stocked with large fingerling walleye on an alternate year basis at a rate of 10 per acre or 10,520 fish. However, stocking of DNR raised fish is contingent on funding and adequate hatchery production.

## MUSKELLUNGE

Long Lake is a classified as a Class B musky fishery based on its angling quality. The definition of a Class B fishery is "an intermediate class of water that provides good fishing. In general, angler success and catch rates may be somewhat less than in prime Class A waters." Class B waters represent 27% of all muskellunge waters in Wisconsin. The management objective for adult density in a Class B fishery is between 0.1-0.3 adults per acre. The reproductive category for Long Lake is a Category 2 which is defined as "the population has some natural reproduction; however some stocking occurs to supplement natural recruitment."

The muskellunge population in 2021 and 2022 was quite similar in terms of adult abundance and size structure compared to when it was surveyed over two decades earlier in 2000 and 2001. Adult (>30 inches) density was virtually identical at 0.21 per acre in 2022 compared to 0.20 in 2001. The density is in the middle of the management objective of 0.1-0.3 adults per acre for a Class B fishery. The growth rates were above the statewide average for both males and females indicating that the adult density is not too high for the lake.

Size structure measured by the proportional stock density (PSD) and relative stock density (RSD). PSD is the proportion of muskellunge larger than 20" that are also larger than 30 inches. RSD-40 is the proportion of muskellunge that are larger than 20 inches that are also larger than 40 inches. The PSD was 86 in 2021 and 2022, which is not far off the PSD in 2000 and 2001 which was 90. The RSD-40 was 22 and 26 during the 2021/2022 survey and 2000/2001 survey respectively. Along with the size structure indices being very similar, the maximum length was very close as well with

a 46.5 inches fish caught in the 2021/2022 survey and a 46.1 inches fish caught in the 2000/2001 survey.

The muskellunge population in Long Lake is sustained through stocking. The recommended stocking rate for maintenance of a Class B water is 1/acre or 1,052 large fingerlings (~12") on an alternate year basis. Stocking was far less than the recommended rate prior to 2019 due to muskellunge production issues in the hatchery system. Stocking was close to or at the recommended rate in 2019 and 2021, so the adult population may see a slight increase in size in the coming years.

There is muskellunge natural reproduction present in Long Lake as was apparent in the aging data where there were consistent year classes from age 4 to 11 indicating adult fish from non-stocked years. The presence of natural reproduction has the potential to compensate for the lack of stocked fish. The management recommendation is to continue to stock at one large fingerling per acre on an alternate year basis given adequate hatchery production.

First Wisconsin Chapter of Muskies Inc. (FWCMI) has been a partner in helping manage the musky population in Long Lake and I would like to thank them for their efforts. The FWCMI, along with collaboration with the DNR, implemented a volunteer angler tagging program in 2017. The value to that program was demonstrated during the muskellunge population estimate. Tagged muskellunge from this program led to increased precision in the estimate allowing for more confident management decisions. Additionally, this chapter has contributed funds, assisted with sampling, and coordinated stocking efforts.

## SMALLMOUTH BASS

Long Lake is known for its trophy smallmouth bass fishery, and it is managed accordingly with an 18" minimum length limit that has been in place since 1999. Relative abundance, measured by number caught per length of shoreline electrofished, was the highest it has been in the past three surveys at 25 per mile which is 67% higher than it was in the previous survey in 2016. Trophy sized fish are still present in the population; however, size structure has declined in recent surveys. The best indicator of trophy size structure is the RSD-18 which is the proportion of smallmouth bass over 7 inches that are also over 18 inches. In the 2021 survey, this value was 8 which is still in the acceptable range, but lower than it was in 2012 survey, when it was 26 which is considered exceptionally high. The decline of fish over 18 inches is likely due to environmental variables and not harvest by anglers considering the 18-inch minimum length limit, and the propensity for anglers to practice catch and release on large smallmouth bass.

There are a few explanations as to why smallmouth bass size structure has declined. First off, as noted in the introduction, smallmouth bass were originally stocked to reduce rusty crayfish abundance. Despite not having rusty crayfish abundance data

available, it can be inferred by the substantial increase in aquatic vegetation, that the rusty crayfish population is not as large as it once was. With less abundant prey available for smallmouth bass to consume, condition, growth, and ultimately the number of large fish in the population may decline. Secondly, the relative abundance is higher than the previous two surveys, which is a result of increased recruitment in the population. This could be driven by relatively more successful natural reproduction and/or better survival of juvenile fish in recent years. With an increase in density, competition for limited resources may be greater due to more smallmouth bass present, which could lead to a decrease is in condition, growth, and size structure. This phenomenon is referred to as 'density dependance' and is a natural control that keeps populations in balance with their environment. Eventually, the population will stabilize to match their environment and habitat conditions.

The smallmouth bass population is a still strong in terms of size and numbers. Smallmouth bass size structures is on the high end of acceptable range with a PSD at 72 (Gabelhouse 1984) and trophy fish were present with smallmouth bass over 20 inches captured in the survey. The smallmouth bass population will continue to be evaluated every four years with a spring electrofishing survey during the spawning timeframe, and it will be reevaluated if further management actions need to be taken at that time.

## LARGEMOUTH BASS

The relative abundance of largemouth bass has increased in recent surveys compared to the 2008 survey. Catch per mile sampled ranged from a low of 10.3 in 2008, then almost tripled to a high of 27.8 per mile in 2016. The increasing trend did not continue in the 2021 survey as the relative abundance was 16.8 fish per mile. With the expansion of aquatic macrophytes in Long Lake, it was expected that species that prefer vegetated habitat, like largemouth bass, would proliferate to utilize the newly available habitat. Considering the most recent aquatic plant survey was conducted in 2023 and an expansion of vegetation was documented, it will be interesting to see if the largemouth bass population follows suit and expands as well during the next fisheries survey in 2025.

In the late 2000s, many lakes in northwest Wisconsin experienced a trend of increasing largemouth bass populations coupled with a decreasing walleye populations in a relatively short timeframe, and the concern at the time was that the largemouth bass and walleye populations in Long Lake would quickly 'flip' as well. Therefore, after the 2012 survey, numerous management actions were taken to suppress in largemouth bass population. The Lower Long Lake Fishing Club funded a three-year largemouth bass removal project 2013-2015 where about 1,000 adult largemouth bass were removed annually and stocked into lakes that had recently winterkilled in the Chippewa County Forest. Additionally, in 2016, the largemouth bass regulation was changed from an 18-inch minimum length limit and one fish bag limit to a no-minimum length limit and a five fish bag limit in order to promote

harvest. Fortunately, Long Lake has not flipped from primarily walleye fishery to primarily largemouth bass fishery as was observed on other lakes which may partially be a result of these management actions.

Largemouth bass catch increased substantially in 2016 despite the removals the three previous years, which could be due to a compensatory response of increased recruitment because of the decline in abundance, but it is difficult to say. The size structure was high in the 2012 survey likely due to the restrictive regulation limiting harvest and the removals may have contributed to the decline in size structure observed from 2012 to 2016. The relatively lower size structure has remained fairly similar from 2016 to 2021 which may be due to increased angler harvest with the removal of a minimum length requirement and increased bag limit. The largemouth bass population is expected to respond to the changing habitat in Long Lake. Largemouth bass fishing regulations are liberal and future management actions are limited if the population continues to expand.

## NORTHERN PIKE

The northern pike population remains at a relatively low density compared to other fish species populations in Long Lake, but the size structures is considered very good. Catch per net lift increased in 2021, but still was only averaged one fish every other net. The increase could be due to more habitat availability from the expanding aquatic vegetation. The mean sized fish captured in 2021 was 28.4 inches, and 53% of the northern pike over 14 inches were also over 28 inches, which is very good to excellent size structure. Fish near trophy length were also present in the population with northern pike as large as 39.5 inches. The northern pike population provides a bonus fishery supplement other fishing opportunities in Long Lake.

## PANFISH

### BLUEGILL:

Bluegill relative abundance over the past two surveys was better than it was in 2012 by about two-fold. This could be due to the proliferation beneficial habitat in terms of aquatic vegetation. Size structure remains relatively poor as has been documented in the previous surveys with only 3% of bluegill over 3 inches also greater than 8 inches. The 10 fish panfish bag limit was implemented in 2000 in order to increase protection for these species when the amount of aquatic vegetation was low. Despite the increase in aquatic vegetation in recent decades, there are no plans to remove the current regulation as further harvest of larger bluegill may decrease the size structure further. Slow growth, as seen in some populations with fairly high densities, is not an issue with the Long Lake bluegill population.

### BLACK CRAPPIE:

Long Lake is well known for its quality black crappie fishery. In 2021, the catch was the highest in the past three surveys at 11.3 per mile and size structure was fairly

poor with 5.6% of the black crappie over 5 inches also greater than 10 inches. Black crappie are known for highly variable recruitment and are often referred to as having 'boom or bust' populations. Considering the relatively high catch rate and poor size structure, the population may be going through a period of strong recruitment with a higher number of young fish in the population. Growth rates are above the statewide average so slow growth is not a concern.

While netting for the muskellunge in 2022 to complete the population estimate, numerous nets contained large numbers of black crappie in the 10-12" range. Data was not collected on these fish because that was not to objective for the survey and time did not permit as multiple lakes were being surveyed simultaneously. These fish were captured when the water temperatures were warming, and black crappie were moving onto spawning habitat. After seeing catches like this, the possibility exists that a good portion of the black crappie population is missed during the bass/panfish electrofishing surveys. Regardless, there is a conservative regulation for panfish on Long Lake which keeps exploitation low.

**YELLOW PERCH:**

The yellow perch population compose a relatively small proportion of the panfish populations in Long Lake although it appears that the population may be on the increase. In 2021, there were 16.0 perch captured per net lift, which is much higher than the previous survey in 2016 where only 0.1 were captured per net lift. Size structure was poor with no perch over 10 inches captured as was the case in the previous surveys as well. Just because larger perch were not captured in the last survey does not mean they do not exist in the population, but they are likely not abundant in high numbers. Anglers may catch a larger fish from time to time, but it likely is not a regular occurrence. Yellow perch provide a good forage base for walleye, muskellunge, and northern pike, which is likely one of the reasons why few survive long enough to reach a desirable size for anglers.

# References

C. Gostiaux, Jason, et al. "Recruitment bottlenecks for age-0 Walleye in northern Wisconsin lakes." *North American Journal of Fisheries Management* 42.3 (2022): 507-522.

Gabelhouse Jr, Donald W. "A length-categorization system to assess fish stocks." *North American Journal of Fisheries Management* 4.3 (1984): 273-285.

Gunderson, J. "Rusty crayfish: a nasty invader." *Minnesota Sea Grant, Duluth, Minnesota* (1995).

Hansen, Gretchen JA, Stephen R. Midway, and Tyler Wagner. "Walleye recruitment success is less resilient to warming water temperatures in lakes with abundant largemouth bass populations." *Canadian Journal of Fisheries and Aquatic Sciences* 75.1 (2018): 106-115.

Honsey, Andrew E., Zachary S. Feiner, and Gretchen JA Hansen. "Drivers of walleye recruitment in Minnesota's large lakes." *Canadian journal of fisheries and aquatic sciences* 77.12 (2020): 1921-1933.

Konkel, Deborah. "Changes in the Aquatic Plant Community of Long Lake, Chippewa County, Wisconsin." (1986-2006).

Lorman, J. G. "Ecology of the crayfish Orconectes rusticus in Northern Wisconsin.(PhD)." *University of Wisconsin-Madison, Madison, WI* (1980).

Magnuson, J. J., et al. "Consideration of crayfish for macrophyte control." (1975): 66-74.

Pedersen, Eric J., et al. "Long-term growth trends in northern Wisconsin walleye populations under changing biotic and abiotic conditions." *Canadian Journal of Fisheries and Aquatic Sciences* 75.5 (2018): 733-745.