

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Fisheries Survey Report for Cedar Lake
Polk and St. Croix County, Wisconsin 2025
WATERBODY IDENTIFICATION CODE 2615100



Photo Credit: Dustin Schurrer

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Executive Summary

Cedar Lake is a large eutrophic drainage lake located northwest of the town of Star Prairie on the St. Croix-Polk County border. The lake contains a diverse fishery and supports heavy angling pressure. Cedar Lake is on a 4-year sampling rotation, with the last survey in 2021. A comprehensive fisheries survey was conducted in the spring of 2025. Fyke nets and boat electrofishing were used to determine the status of the fishery. The adult walleye population remains at relatively low levels but appears to have stabilized likely due to stocking. Muskellunge, northern pike, bluegill and black crappie were present in moderate densities. Muskellunge exhibited excellent size structure and good growth rates. The size structure of bluegill improved from previous surveys. Growth rates of black crappie were slow due to two strong year classes. Walleye natural recruitment has declined throughout the past decade and continues to be non-existent which has resulted in reduced adult densities. The stocking of large fingerlings has maintained an adult population and is therefore recommended to continue until the survival and contribution of stocked fish can be better evaluated. Large fingerling muskellunge should continue to be stocked on a biennial basis at a rate of 0.5 fish per acre and evaluation of the effects of this reduced stocking rate can be evaluated in the 2029 survey. Fisheries habitat improvements are recommended to enhance nearshore habitat and help reduce shoreline erosion.

Introduction

Cedar Lake is a 1,107-acre eutrophic drainage lake located on the St. Croix and Polk County line approximately seven miles north of New Richmond. The lake has a maximum depth of 38 feet and 6.4 miles of shoreline. Water levels are subject to artificial fluctuation by manipulation of a low head dam at the south end of the lake. There are three public accesses located on the lake (Figure 1). The south access lane is open only in winter to the public for drive-on traffic. There is an unimproved carry-in access in the southwest bay. The northeast public boat landing consists of a single ramp with overflow parking available across 10th Avenue in the old Cedar Lake Schoolhouse parking lot. Cedar Lake is surveyed on a four-year rotation. Cedar Lake is in the Ceded Territory and is a popular destination for both recreational angling and Ojibwe spring spearfishing. Aquatic invasive species include curly-leaf pondweed, Eurasian watermilfoil, Chinese mystery snail and rusty crayfish. In addition to habitat changes resulting from invasive species, alum treatments have been implemented by the lake district since 2017 in an effort to improve water quality and a total of 400 fish cribs have been installed from 2004 to 2014.

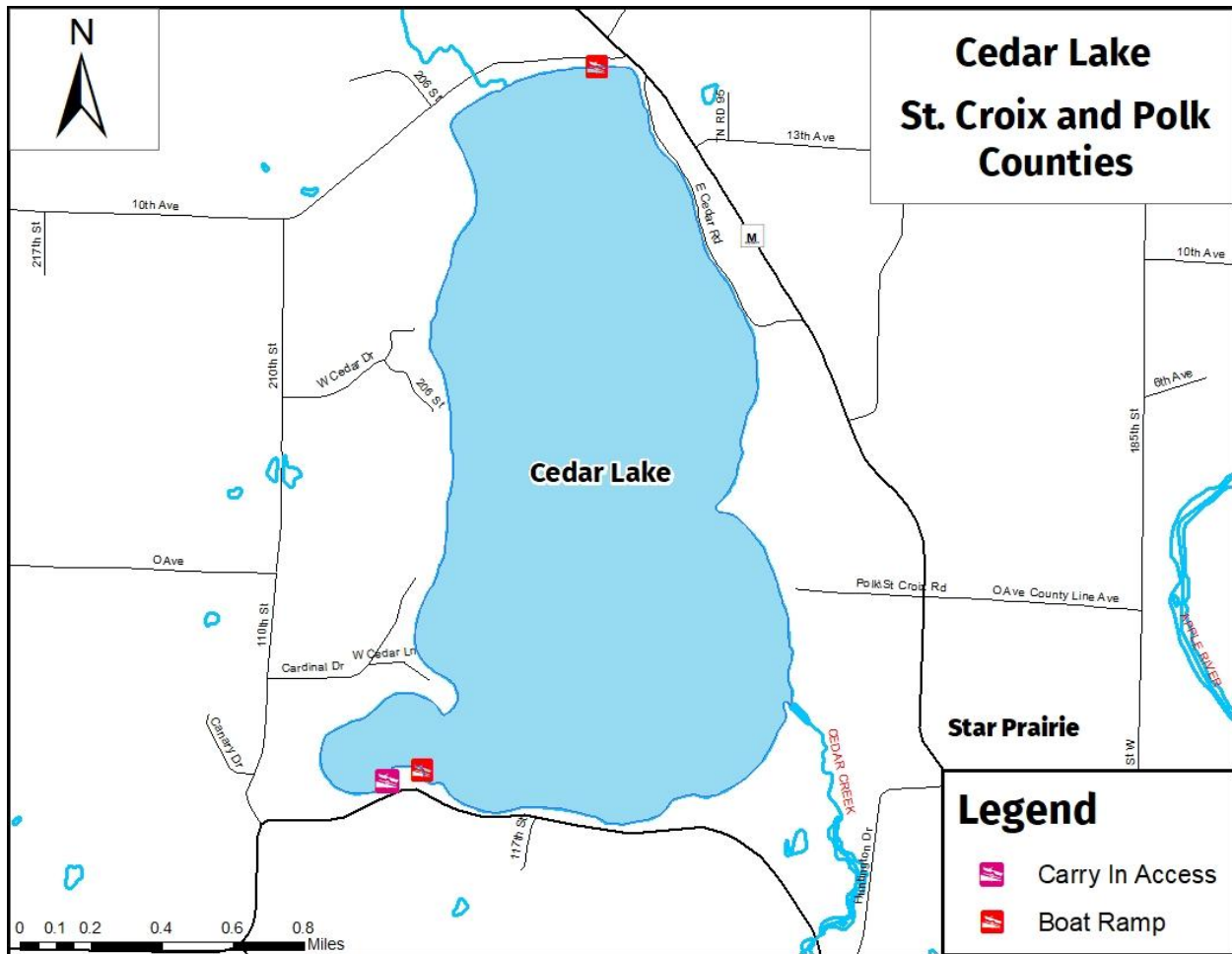


Figure 1. Map of Cedar Lake and its access points.

The lake is classified as a Complex-Warm-Dark lake in Wisconsin’s lakes classification system used to compare lakes with similar trophic status, thermal regime and fish community (Rypel 2019). Historically, Cedar Lake consisted of a simpler fish community in the early 20th century, which was composed of cisco, white bass and centrarchids in low abundance. Walleye were introduced and stocked annually in the lake as early as the 1930s. Walleye were dependent on stocking for most of the 20th century until the 1990s when natural recruitment became very successful, and stocking was discontinued. Natural recruitment was strong up until 2011 and has not recovered since. To address the lack of recruitment, stocking began again in 2019 for the first time in decades. Currently, muskellunge and northern pike are common. Largemouth bass, bluegill and black crappie have experienced sharp increases in their populations in the past decade and white bass and smallmouth bass are present in low abundance. Cedar Lake is stocked with approximately 1,000 large fingerling muskellunge on a biennial basis in odd years, and the lake is now stocked with extended growth walleye in odd years at a rate of 15 per acre (Table 1). Cedar Lake is currently classified as a Class A1 muskellunge lake. Class A waters are considered premier muskellunge waters with the highest quality fishing opportunities. The Class A waters are divided into two different classes. Class A1 waters are known as the “trophy waters” because of their ability to produce large muskellunge with relatively low abundance of muskellunge overall. Class A2 waters are considered to provide the most

consistent angling action with the potential to produce large fish. These lakes have higher relative abundance but large fish make up a smaller percentage of the population compared to the A1 waters.

Table 1. Fish stocking history in Cedar Lake since 2005.

YEAR	SPECIES	AGE CLASS	NUMBER STOCKED
2005	MUSKELLUNGE	LARGE FINGERLING	998
2007	MUSKELLUNGE	LARGE FINGERLING	533
2009	YELLOW PERCH	ADULT	25
2009	MUSKELLUNGE	LARGE FINGERLING	1000
2011	MUSKELLUNGE	LARGE FINGERLING	1000
2013	MUSKELLUNGE	LARGE FINGERLING	1000
2015	MUSKELLUNGE	LARGE FINGERLING	996
2017	MUSKELLUNGE	LARGE FINGERLING	178
2019	WALLEYE	LARGE FINGERLING	15680
2019	MUSKELLUNGE	LARGE FINGERLING	500
2021	WALLEYE	LARGE FINGERLING	18468
2021	MUSKELLUNGE	LARGE FINGERLING	334
2022	MUSKELLUNGE	LARGE FINGERLING	560
2023	WALLEYE	LARGE FINGERLING	16794
2023	MUSKELLUNGE	LARGE FINGERLING	554
2025	MUSKELLUNGE	LARGE FINGERLING	553
2025	WALLEYE	LARGE FINGERLING	17612

Methods

SAMPLING

Cedar Lake was surveyed in the spring of 2025 using fyke nets and electrofishing gear to assess the status of the fish community. Immediately after ice out on March 30th, 12 fyke nets (3x6 ft, 0.75-inch mesh and 4x6 ft, 0.5-inch nylon mesh) were set to target walleye, muskellunge and northern pike for the early spring netting survey (SN1). Nets were lifted daily for 10 days for a total of 96 net nights. All walleye were marked with fin clips and muskellunge were marked with fin clips and PIT tags. Immediately following the netting survey, an early spring electrofishing (SEI) survey was conducted for the recapture survey for walleye to obtain a population estimate. Additionally, after water temperature reached 55 °F, a late spring electrofishing (SEII) survey was conducted to target bass and panfish species. The entire shoreline was divided into three stations that were approximately 2 miles in length each. Within each of these stations, a 0.5-mile substation was sampled for all fish species. All common carp observed during these substations were counted to obtain relative abundance estimates. Only gamefish species were captured within the remaining 1.5-mile stations. In the fall, after water temperature dropped below 70 °F, a fall electrofishing survey (FE) was conducted on the entire shoreline to sample young-of-year (YOY) walleye. Spring electrofishing was conducted with a pulsed DC miniboom shocker with two booms and one dip netter while the fall electrofishing survey was conducted with a pulsed DC maxi-boom shocker with two booms and one dip netter.

All gamefish were counted and measured and a subsample of five per 0.5-inch length group of both sexes (if possible) were weighed and aging structures were removed for age analysis in the lab. Gender was determined for each walleye, muskellunge and northern pike. Dorsal spines were removed from walleye for aging. Otoliths were removed from largemouth bass, bluegill, black crappie and yellow perch and anal fin rays were removed from muskellunge. Cleithra were removed from a subsample of northern pike in the 18-18.9-inch range.

ANALYSIS

Data analysis included calculation of catch rates for each species (catch per unit effort; CPUE) as a measure of relative abundance. A population estimate was conducted for the adult walleye population, including mature males, females and unknown sex fish larger than 15 inches, using the Peterson method with the Chapman modification of population estimation with the formula:

$$N^* = \frac{(M+1)(C+1)}{R+1}$$

where M equals the number of fish marked, C equals the sample taken for the census and R equals the number of recaptured fish in a sample and N is the size of the population at time of marking.

Condition was estimated by computing relative weight (Wr) for each fish based on length and weight where a value of 100 or higher indicates very good condition and values less than that resulting in poorer condition (Wege and Anderson 1978). Size structure of each species was evaluated visually with length frequency distributions and by computing Proportional Size Distribution (PSD) which is a measure of the proportion of fish equal to or larger than stock size and equal to or larger than quality size fish in the population. PSD-20 was also calculated for walleye and PSD-28 was calculated for northern pike as a measure of the proportion of fish in the population larger than preferred size. PSD was also calculated for muskellunge using 30 inches as minimum stock size. PSD-38, PSD-42 and PSD-45 were also calculated for muskellunge and compared to quartiles that have been calculated for A1 muskellunge lakes in Wisconsin. Growth rates were calculated using the von Bertalanffy growth equation (Bertalanffy 1938) and mean length at age analysis was compared to other lakes within the same lakes classification. Recruitment was evaluated through residual analysis where the sign and magnitude of residuals from a catch-curve regression indicate relative year-class strength. Larger, positive residuals indicate years of higher recruitment and negative residuals indicate years of poorer recruitment. Growth rates of northern pike were estimated by calculating the mean age for 18-18.9 inch male and female northern pike and compared to statewide percentiles of growth rates for both sexes.

Results

WALLEYE

A total of 409 walleye were captured during the ten-day netting survey. Catch rates of adult walleye were relatively low at 1.9 fish per net-night which was near the 25th percentile for catch rates compared to lakes in the same lakes classification. The population estimate was 1.1 adult walleye per acre or 1,157 fish, but the estimate had low precision (CV = 0.46; 95% confidence interval; CI = 103 - 2,211 fish). Despite this, the walleye population estimate

was similar to the 2021 estimate (Figure 2). The female population estimate resulted in 0.3 per acre (CV = 0.64) or 280 fish, while males were estimated at 0.7 per acre (CV = 0.18) or 806 fish. Ages of walleye collected during the spring survey ranged from age 3 to age 14 and represented the 2022-2011 year classes (Figure 3).

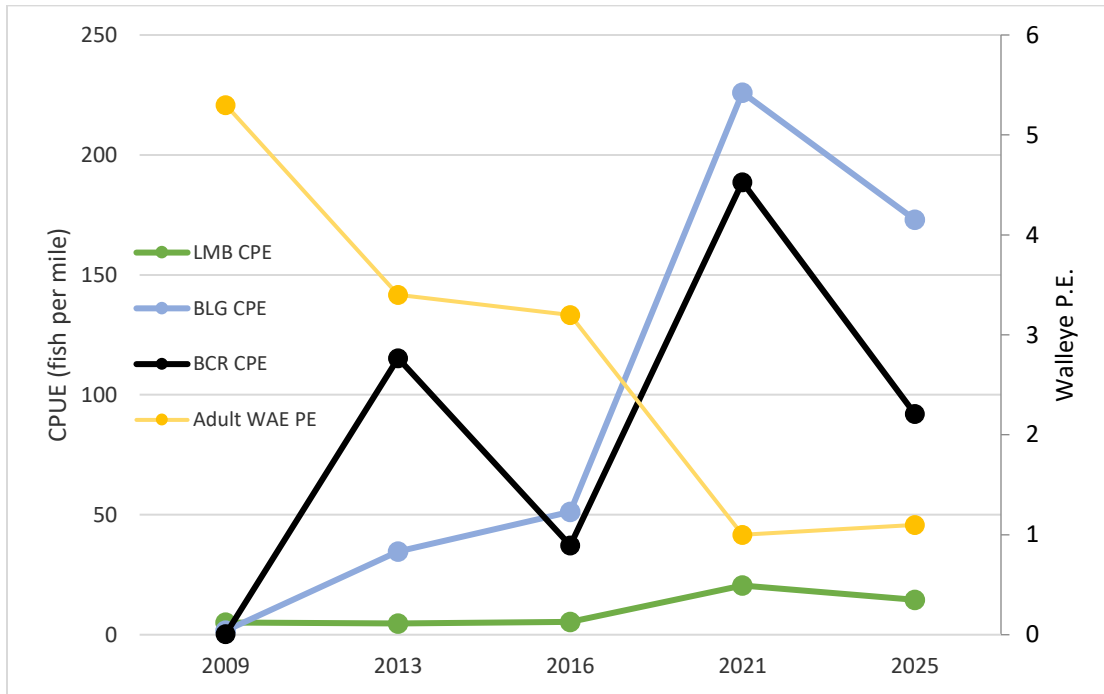


Figure 2. Catch rates (CPUE) of largemouth bass (LMB), bluegill (BLG), black crappie (BCR) and population estimates of adult walleye (WAE) from 2009-2025 in Cedar Lake, St. Croix and Polk counties.

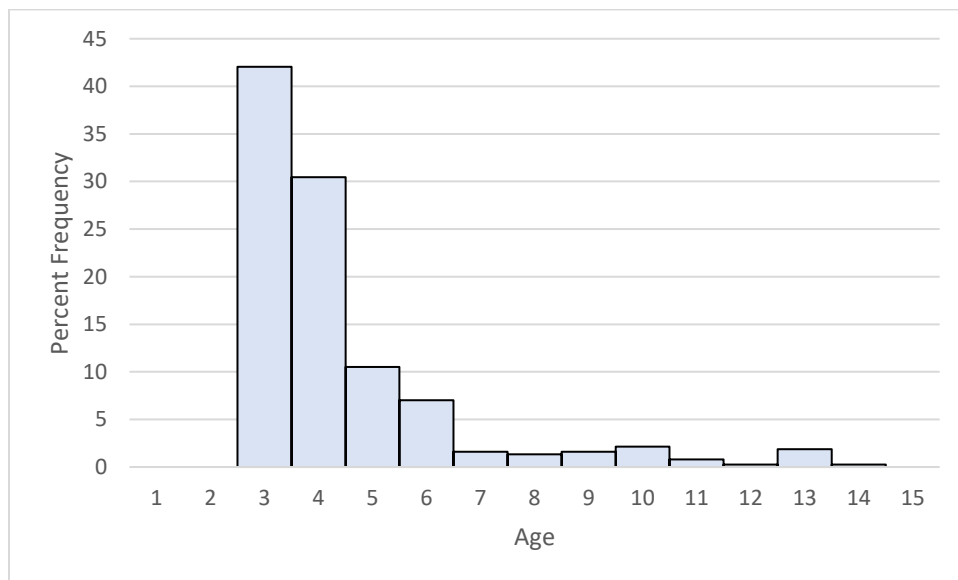


Figure 3. Age frequency distribution of walleye collected during the SNI and SEI surveys in 2025 in Cedar Lake.

Maximum age of walleye during the survey was 14 years old and mean age of mature fish was 5.4 years old. Walleye recruitment was somewhat variable and residual analysis estimated two weak year classes with negative residuals less than -0.5 which included the age-7 and age-8 year classes (2018, 2017; Figure 3). Stronger year classes with stronger positive residuals were the age-3, age-4 and age-10 year classes (2022, 2021 and 2019).

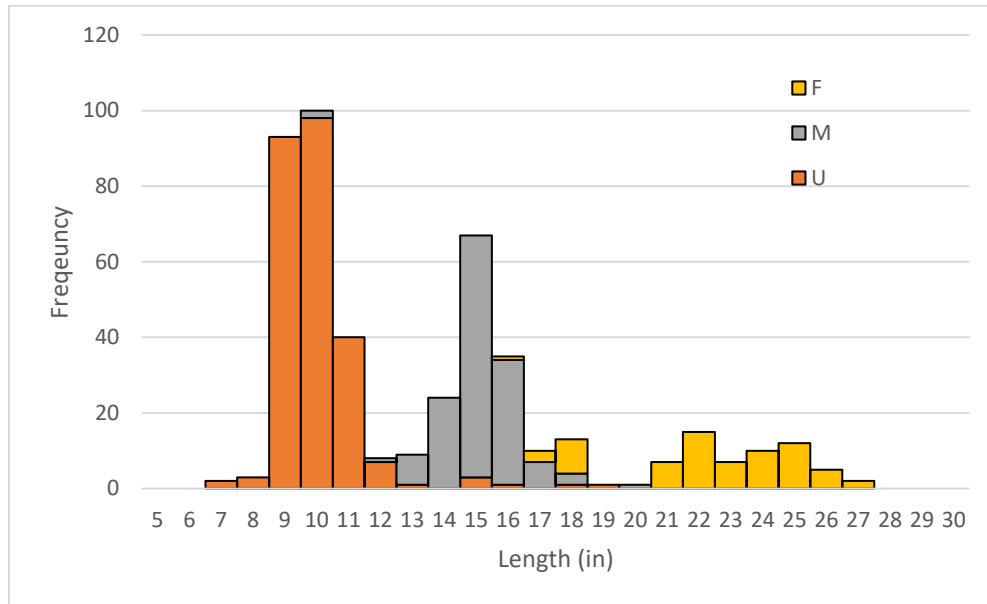


Figure 4. Length frequency distribution of walleye by gender (F-females; M-males; U-unknown sex) collected from Cedar Lake, Polk and St. Croix counties, during the SNI and SEI surveys in 2025.

Adult walleye ranged in length from 10.8 to 27.4 inches with a mean length of 16.6 inches (Figure 4). Walleye were in excellent condition and had a W_r of 99. The size structure of walleye from the SN1 survey resulted in a PSD-15 of 50 and a PSD-20 of 14. Growth of walleye was similar to Wisconsin lakes in the same lake class. Sex specific growth rates differed considerably with immature fish and males exhibiting slightly slower growth rates relative to females but were similar to the statewide average (Figure 5). Males and immature fish represented ages 3-7 while female ages ranged from ages 4-14. Female growth rates were faster than the statewide average for all ages represented and the mean length at age averaged 3.5 inches per year greater than males (Figure 5). The male to female sex ratio was 5:1 during the SNI and SEI surveys. The total annual mortality of adult walleye was 39.7% ($r^2=0.89$, $n=363$, $P=0.0001$; Figure 6).

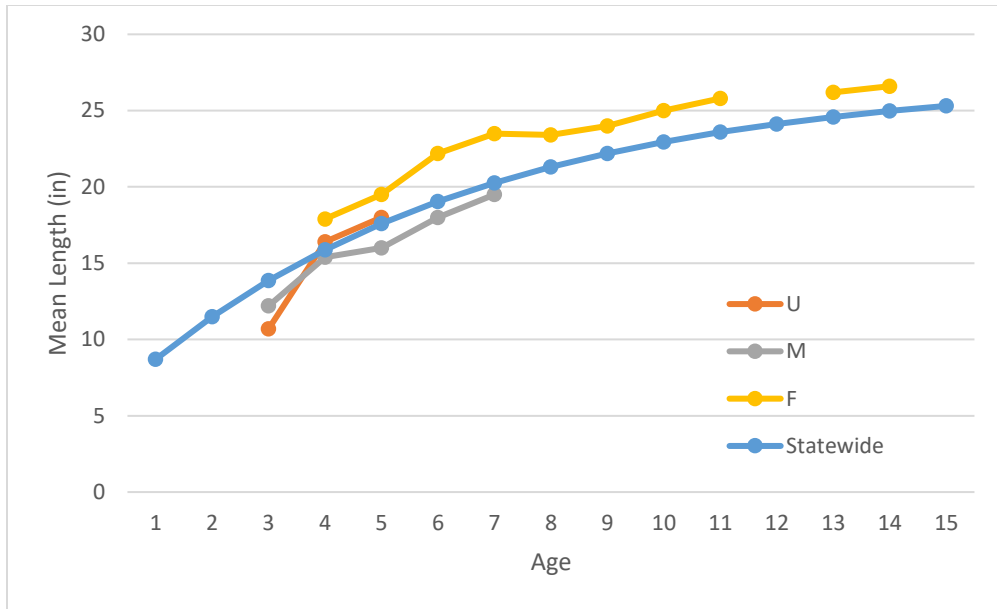


Figure 5. Mean length at age of walleye by gender (U-unknown sex; M-males; F-females) collected during SNI and SEI surveys in Cedar Lake, Polk and St. Croix counties in 2025 and mean length at age of walleye from Complex-Warm-Dark lakes across Wisconsin.

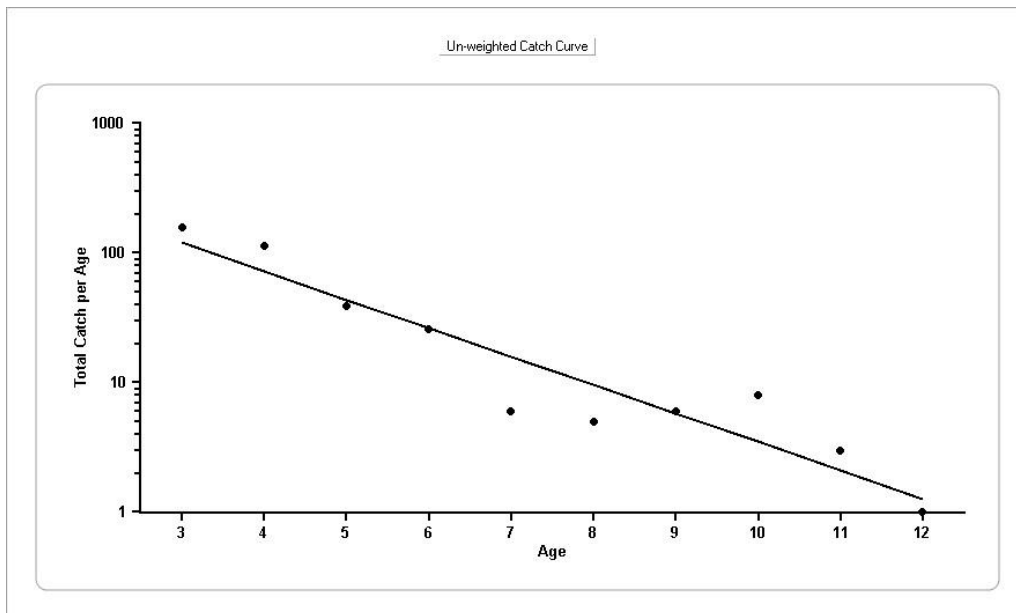


Figure 6. Adult walleye catch per age collected during SNI and SEI surveys of Cedar Lake, St. Croix and Polk counties in 2025.

The fall young-of-year sampling resulted in the capture of zero young-of-year walleye and zero age-1 fish (Figure 7).

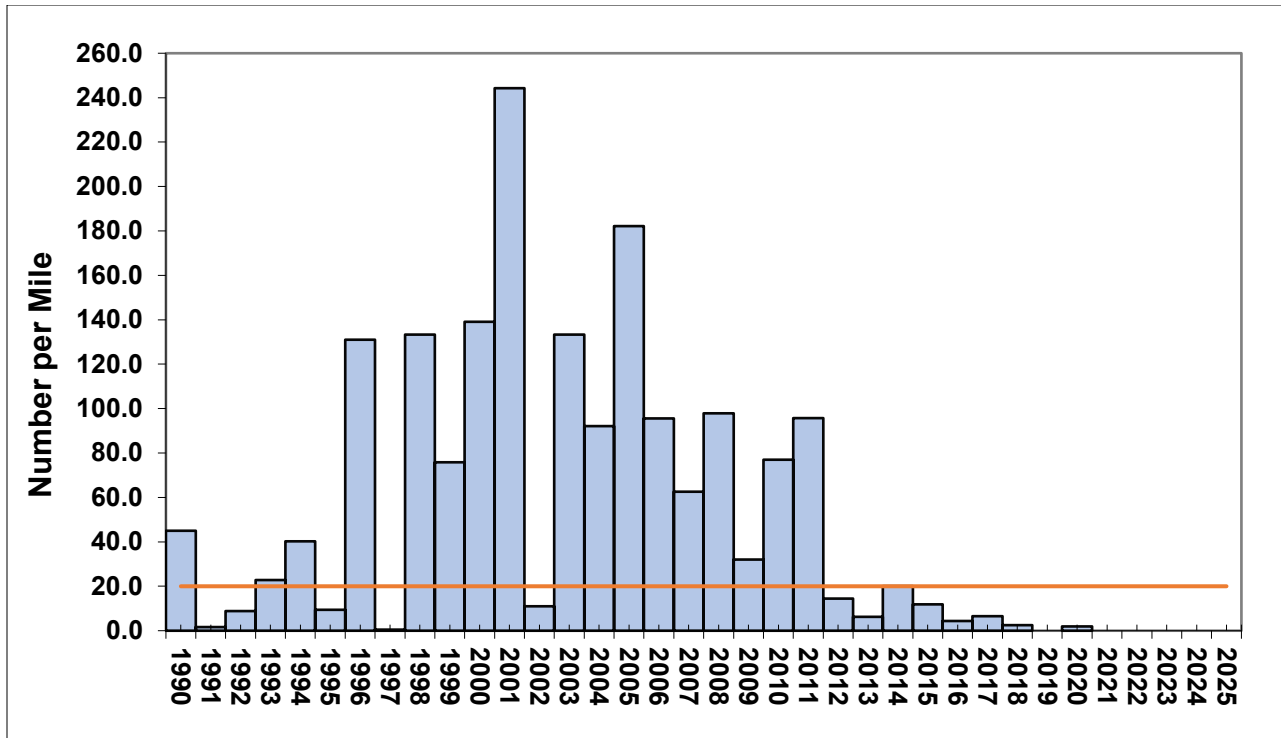


Figure 7. Relative abundance (CPUE; fish per mile) of young-of-year walleye collected from Cedar Lake from 1990 to 2025 during FE surveys. The orange line represents 20 fish per mile which is the general level of juvenile catch rates that will yield a significant year class.

MUSKELLUNGE

Muskellunge were abundant during the 2025 netting survey in which 52 fish were captured, tagged and marked. This resulted in a catch rate of 0.54 fish per net-night which was near the 50th percentile in similar lakes across Wisconsin. Catch rates of muskellunge were considerably lower than the 2021 and 2022 surveys which resulted in CPUEs of 0.92 and 1.8 fish per net-night, respectively. Catch rates during the current survey were within the median quartile for Class A2 (trophy) muskellunge lakes. The CPUE of juvenile (<20 inches) muskellunge was 1.3 per mile (75th percentile) during the fall survey and was similar to 2021 estimates, however, these may have been from stocking. Muskellunge from the spring survey ranged in length from 11.9 to 46.1 inches with a mean length of 26.7 inches (Figure 8). Maximum observed length of muskellunge in Cedar Lake was similar to the maximum length predicted for the size of the lake. A total of 24 juvenile fish or fish of unknown gender were captured during the spring survey and ranged in length from 11.0 to 22.5 inches.

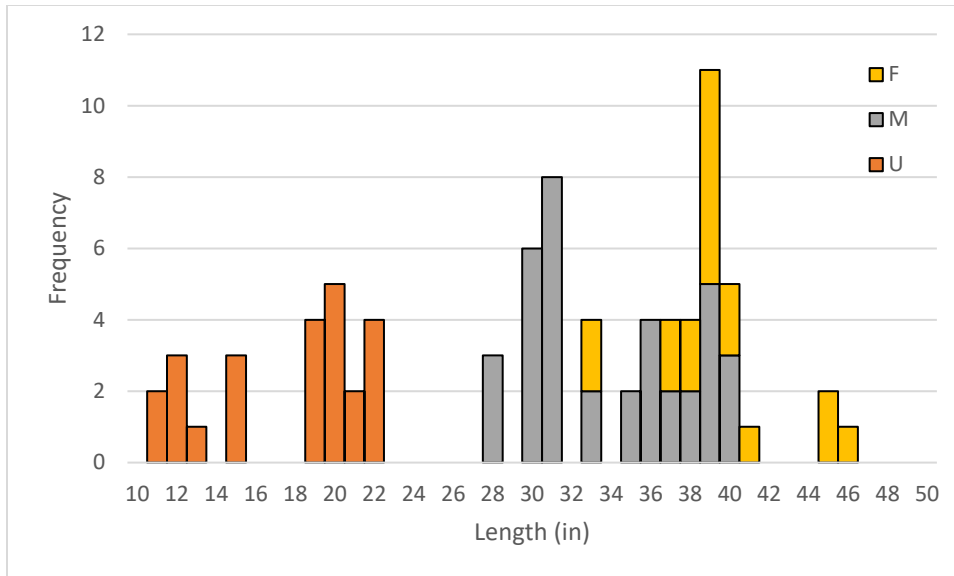


Figure 8. Length frequency distribution of muskellunge by gender (F-females; M-males; U-unknown sex) collected during the SNI survey of Cedar Lake in Polk and St. Croix counties in 2025.

The male to female sex ratio was approximately 4:1. The mean length of females (39.6 inches) was greater than the mean length of males (34.4 inches). Muskellunge had excellent size structure with a PSD-38 value of 47, PSD-42 value of 7 and PSD-45 value of 5. Muskellunge were in good condition with a mean relative weight of 106. Overall, mean lengths at age of muskellunge were similar to the statewide median and females grew faster than males (Figure 9). Maximum age of muskellunge was 12. Age analysis of muskellunge resulted in the vast majority of fish produced within stocked years with large year classes of age-4 and age-6 fish from the 2019 and 2021 stocking events (Figure 10). Few fish resulted from non-stocked years as apparent via age and length analysis; however, low levels of natural reproduction are apparent due to the presence of age-1 fish in the SN1 sample which ranged in length from 11.9 to 15.7 inches.

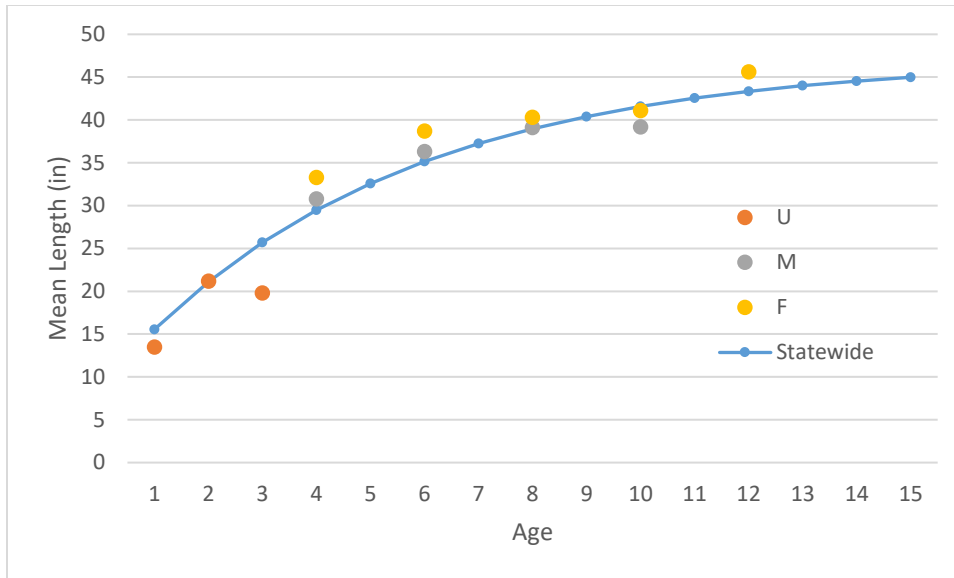


Figure 9. Mean length at age of muskellunge by gender (U-unknown sex; M-males; F-females) collected during the SNI survey in Cedar Lake, Polk and St. Croix counties in 2025 and mean length at age of muskellunge from Complex-Warm-Dark lakes across Wisconsin (statewide).

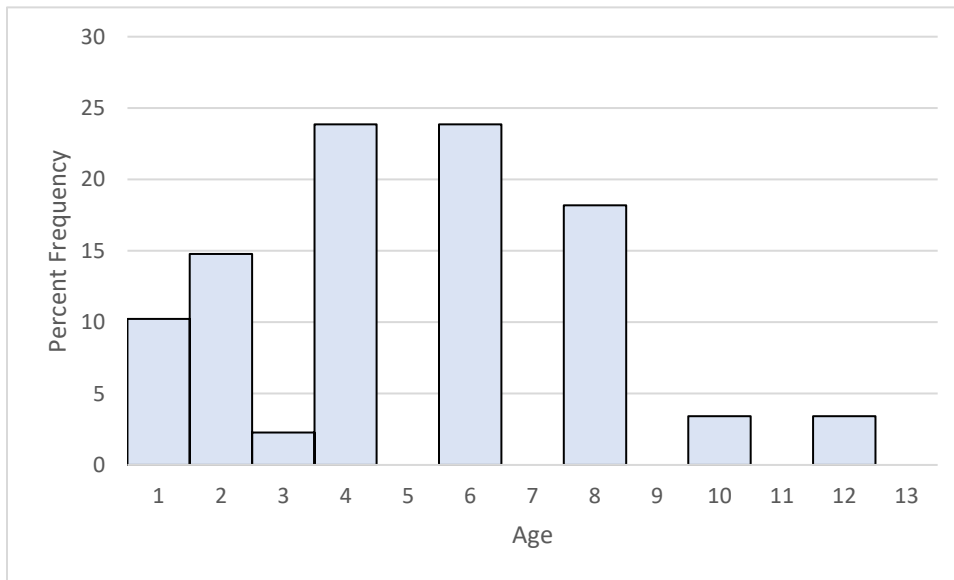


Figure 10. Age frequency distribution of muskellunge collected during the SNI survey in Cedar Lake in Polk and St. Croix counties during 2025 surveys.

LARGEMOUTH AND SMALLMOUTH BASS

A total of 317 largemouth bass were caught throughout the surveys and 93 were captured during the SEII electrofishing survey, which resulted in a catch rate of 14.5 per mile or the 25th percentile for lakes in the same lakes classification. Lengths of largemouth bass ranged from 3.0 to 18.5 inches with a mean length of 8.1 inches (Figure 11). Largemouth bass had a balanced size structure with a PSD value of 37 and an PSD-14 of 20. Growth rates of largemouth bass were comparable to statewide mean lengths at age for similar lakes, with fish reaching 14 inches in approximately 5 years, which is slightly slower than growth

documented in 2021 (14 inches in 4.5 years; Figure 12). Largemouth bass were in excellent condition and had a Wr of 109. In terms of recruitment, largemouth bass had inconsistent recruitment with several weak or missing year classes (ages 7 & 8; Figure 13). Mortality of largemouth bass appears high based on age frequency analysis. Smallmouth bass were present in high abundance with a total of 23 captured and a CPUE of 3.6 fish per mile (75th percentile) during the SEII electrofishing survey and mean length of fish captured was 16.1 inches and lengths ranged from 10.5 to 19.0 inches.

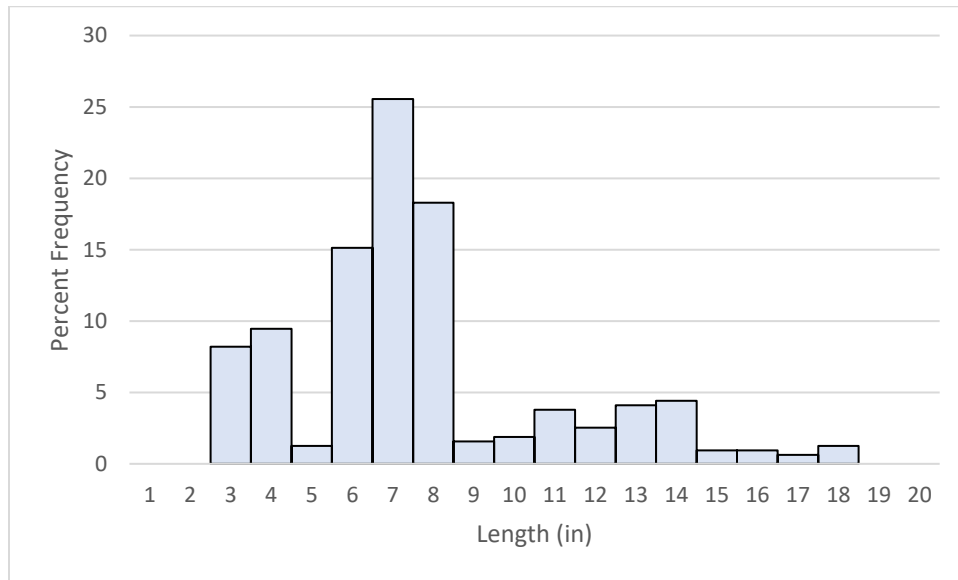


Figure 11. Length frequency distribution of largemouth bass collected during the SEII survey of Cedar Lake in Polk and St. Croix counties in 2025.

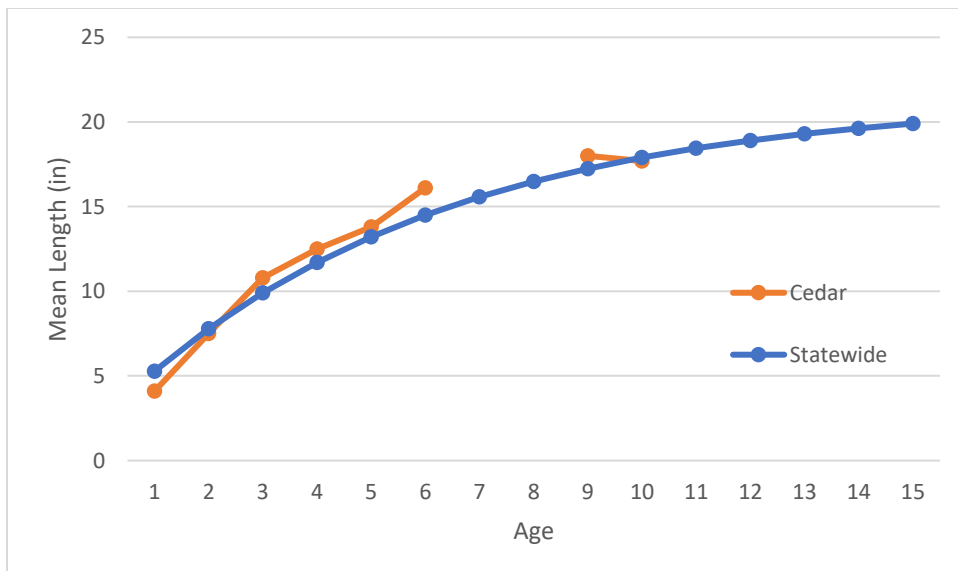


Figure 12. Mean length at age of largemouth bass collected during the SEII survey of Cedar Lake, Polk and St. Croix counties in 2025 and mean length at age of largemouth bass from Complex-Warm-Dark lakes across Wisconsin (statewide).

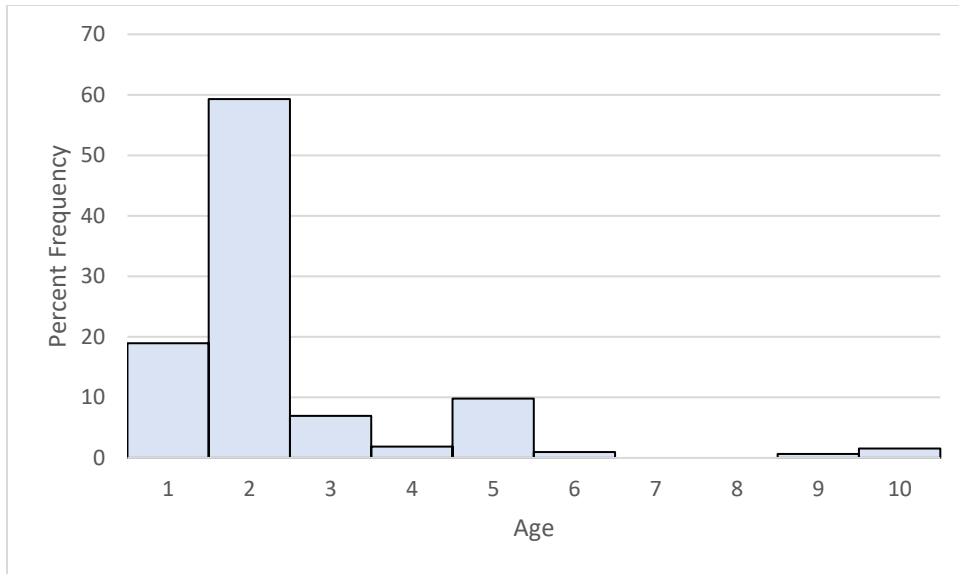


Figure 13. Age frequency distribution of largemouth bass collected during the SEII survey of Cedar Lake in Polk and St. Croix counties during 2025 surveys.

NORTHERN PIKE

Northern pike were surveyed during the SN1 survey and a total 161 fish were sampled which resulted in a catch rate of 1.7 fish per net-night which was near the 50th percentile for similar Wisconsin lakes. Lengths of northern pike ranged from 8.8 to 33.9 inches with a mean length of 19.3 inches (Figure 14), which was similar to 2021. The size structure of northern pike improved from the 2021 survey with a PSD-21 of 45 and an PSD-28 value of 10. The male: female sex ratio was 2:1 and females ranged in length from 14.2 to 33.9 inches and males exhibited a similar length distribution. Northern pike growth rates as indexed by mean age at 18.0-18.9 inches for male and female northern pike were relatively fast with mean age of females within this length bin at 2 years of age (90th percentile) and mean age of males at 3 years of age (66th percentile). The Wr of northern pike was high at 123.

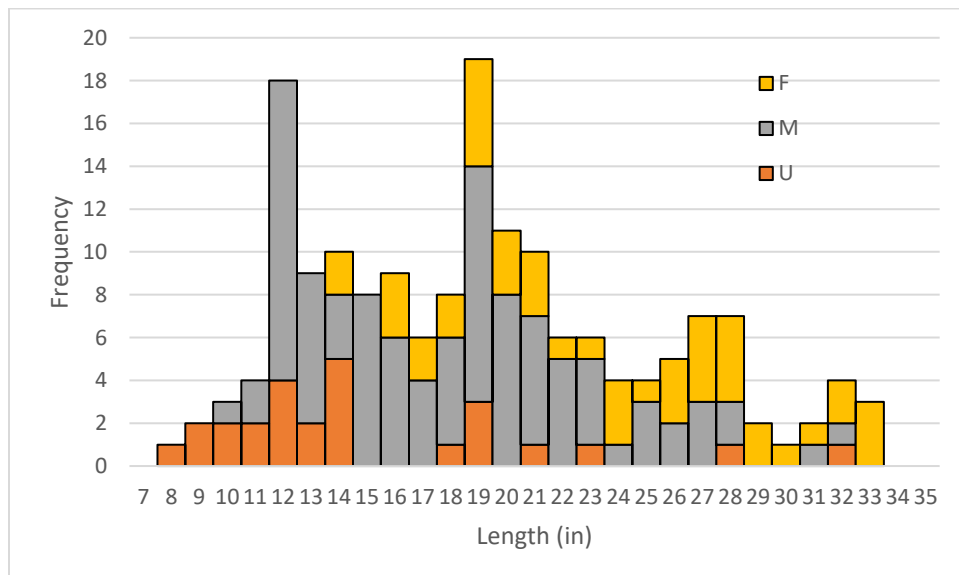


Figure 14. Length frequency distribution of northern pike by gender (F-females; M-males; U-unknown sex) collected during the SNI survey of Cedar Lake, Polk and St. Croix counties, spring 2025.

BLUEGILL

Bluegill were the most abundant panfish species captured during the SEII survey with a catch rate of 173 per mile or near the 50th percentile for lakes of the same classification. The average catch rate of bluegill from the previous four surveys was 78 per mile (Figure 2). Bluegill ranged in length from 2.6 to 10.2 inches with a mean length of 6.3 inches which is above the 99th percentile for mean size of bluegill from similar Wisconsin lakes (Figure 15). Bluegill size structure was good with a PSD-6 of 56. Bluegill growth rates were similar to the statewide mean with fish growing slightly faster than the statewide rates and reached 7 inches in 4 years (Figure 16) which is also slightly faster than 2021 growth rates when it took bluegill 5 years to reach that length. Age analysis revealed relatively consistent recruitment. The age-2, age-3 and age-5 year classes were very strong with a weak age-4 year class (Figure 17). The age-1 year class may not have been fully recruited to our gear at the time of sampling. Bluegill were in excellent condition with a Wr of 103.

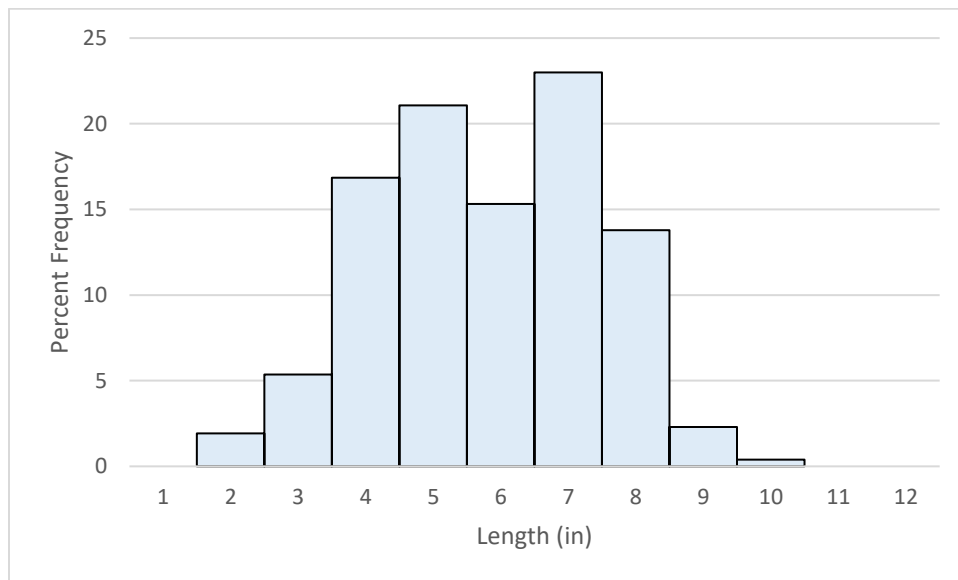


Figure 15. Length frequency distribution of bluegill collected during the SEII survey of Cedar Lake, Polk and St. Croix counties, spring 2025.

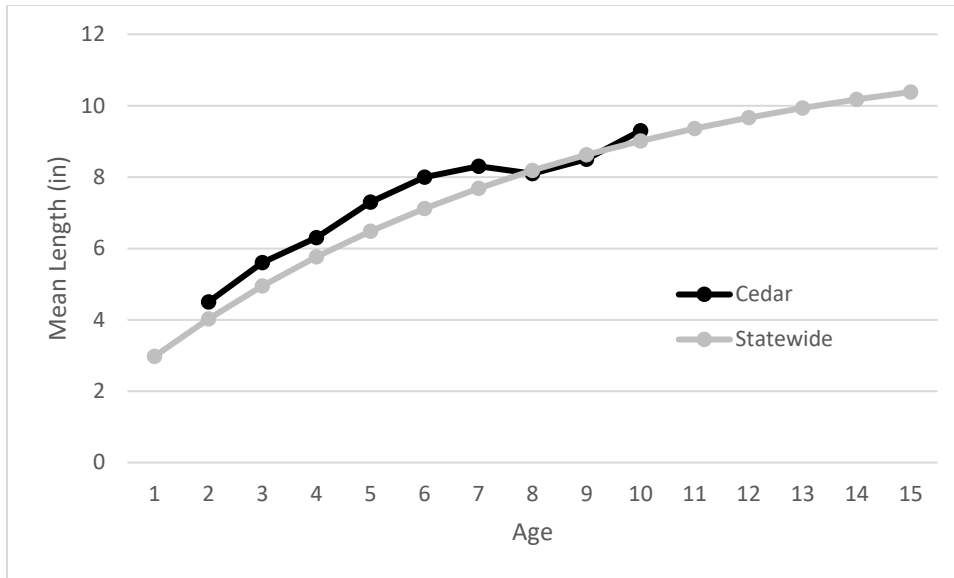


Figure 16. Mean length at age of bluegill collected during the SEII survey of Cedar Lake, Polk and St. Croix counties in 2025 and mean length at age of bluegill from Complex-Warm-Dark lakes across Wisconsin (statewide).

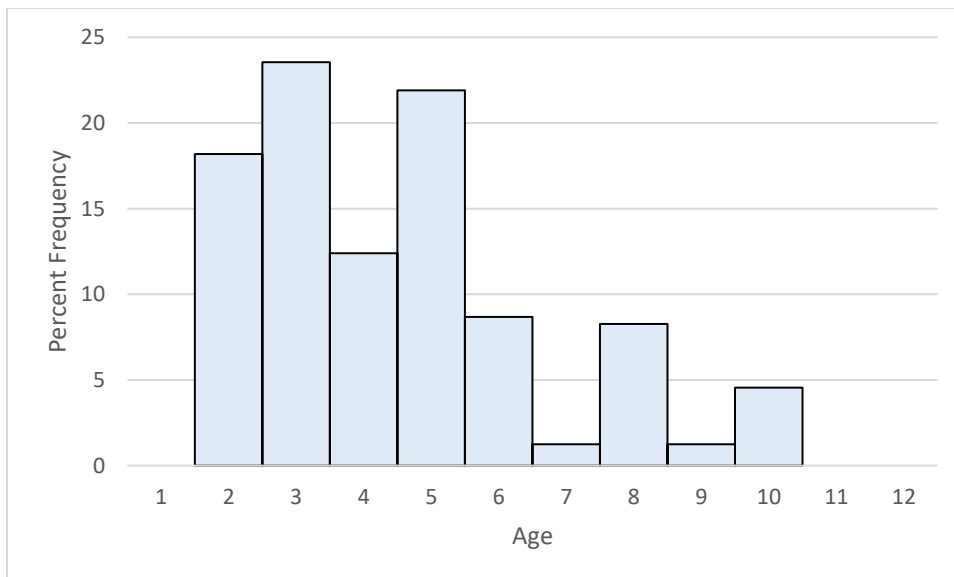


Figure 17. Age frequency distribution of bluegill collected during the SEII survey of Cedar Lake in Polk and St. Croix counties during 2025 surveys.

BLACK CRAPPIE

Black crappie were abundant during the SEII survey and represented a large proportion of the total catch. Catch rates or relative abundance of black crappie was 92 fish per mile during the electrofishing survey and 8.3 fish per net-night (50th percentile) during the netting portion of the survey. These catch rates were similar to the average of the past three surveys (113 fish per mile) and less than the 2021 estimate of 189 fish per mile (Figure 2). Black crappie lengths ranged from 4.1 to 11.1 inches with a mean length of 9.2 inches (Figure 18). The PSD of black crappie was 88. Growth rates of black crappie were similar to the statewide median length at age for younger fish (ages 2-5), but growth slowed considerably

for fish older than age 7 (Figure 19). On average, it takes black crappie approximately 5 years to reach 9 inches and 8 years to reach 10 inches in Cedar Lake (Figure 19). According to age analysis, black crappie recruitment is erratic with several weak year classes and one missing year class (age-6 fish; 2019-year class). Crappie production and recruitment was strong during the years of 2020 and 2016 (Figure 20). Black crappie were in good condition with a Wr of 109.

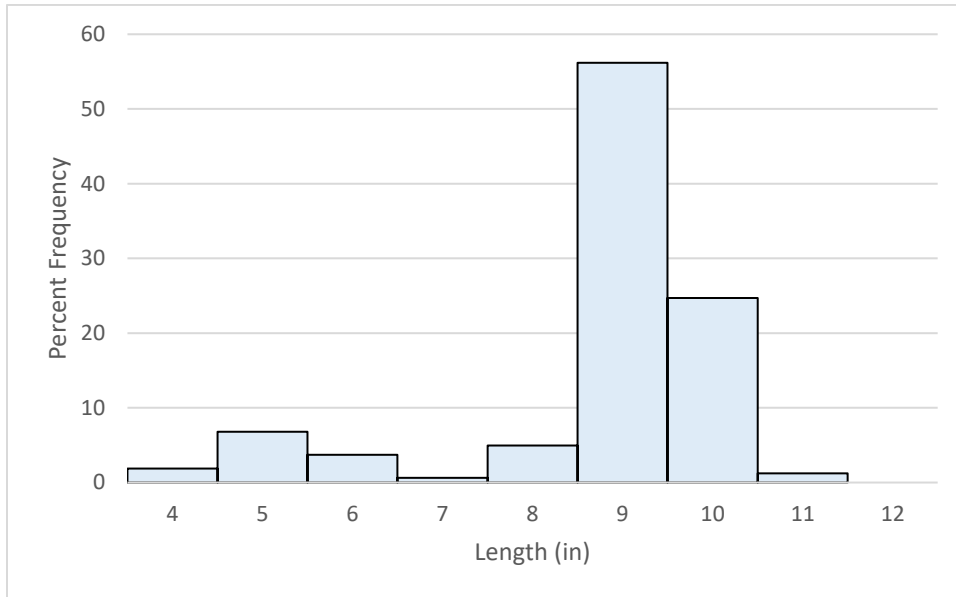


Figure 18. Length frequency distribution of black crappie collected during SNI and SEII surveys of Cedar Lake, Polk and St. Croix counties, spring 2025.

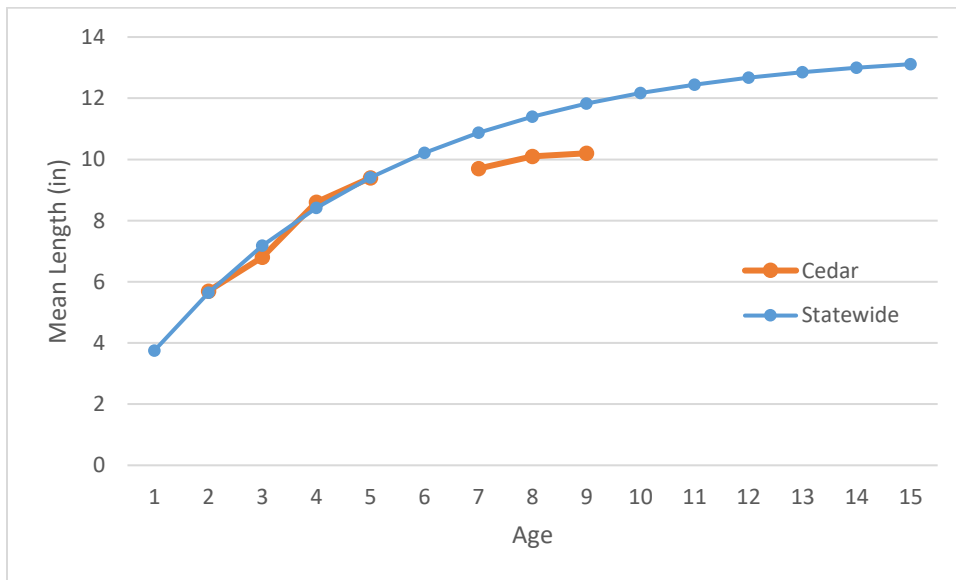


Figure 19. Mean length at age of black crappie collected during SNI and SEII surveys of Cedar Lake, Polk and St. Croix counties in 2025 and mean length at age of bluegill from Complex-Warm-Dark lakes across Wisconsin (statewide).

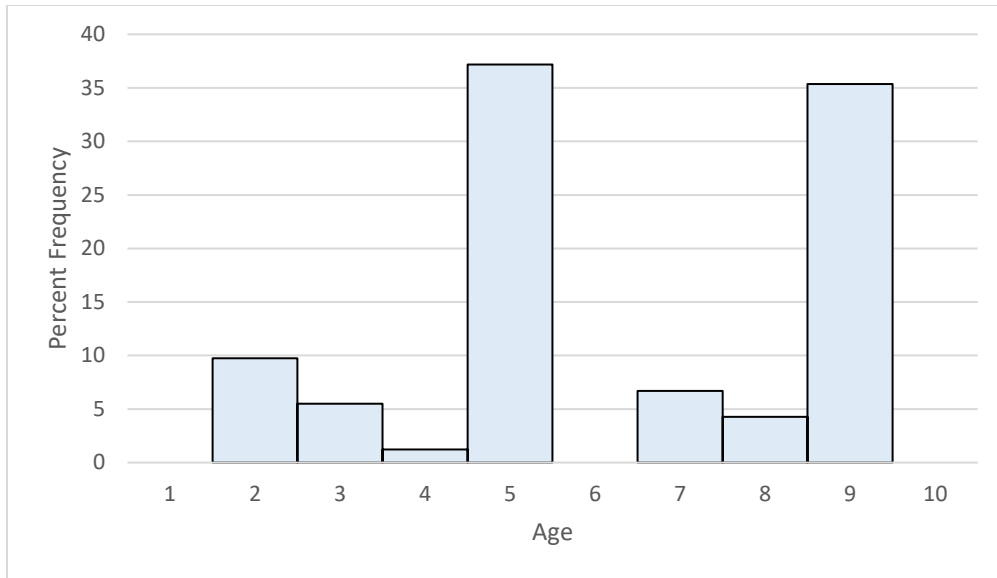


Figure 20. Age frequency distribution of black crappie collected during SNI and SEII surveys of Cedar Lake in Polk and St. Croix counties during the 2025 surveys.

YELLOW PERCH

Yellow perch were not effectively surveyed in 2025 with only 34 yellow perch captured during the netting survey and 20 captured during the electrofishing portion for catch rates of 0.4 fish per net-night and 13.3 per mile. Fish ranged in length from 3.0 to 10.0 inches with a mean length of 6.2 inches (Figure 21). Growth of yellow perch was faster than the statewide average at ages 1-3 by 1.5 inches on average. Condition of yellow perch was very good with a Wr of 99. No further analysis was conducted for yellow perch due to the small sample size.

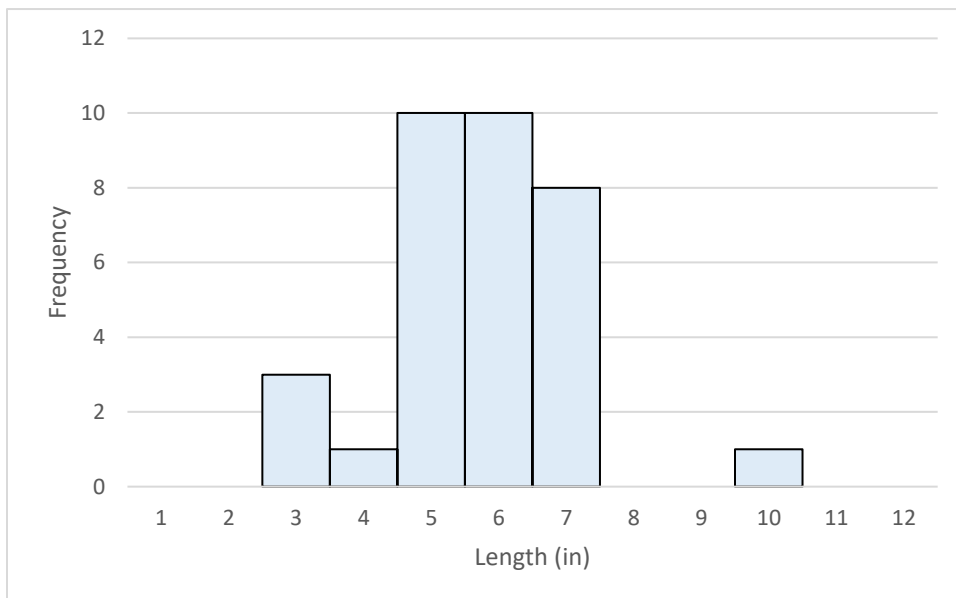


Figure 21. Length frequency distribution of yellow perch collected during SNI and SEII surveys of Cedar Lake, Polk and St. Croix counties, spring 2025.

Discussion

While walleye were previously the dominant gamefish species within Cedar Lake, the population has since experienced sharp declines in natural recruitment and subsequent adult abundance. Walleye had been stocked in Cedar Lake since the early 20th century with inconsistent success. The walleye population then became self-sustaining with natural recruitment and stocking ceased in the 1970s and 1980s. Natural recruitment was low from 1990 to 1995 but sustained the population. From 1996 to 2011 the walleye population was thriving with strong natural recruitment, and adult population estimates were high at 5.3 per acre in 2009. Since then, surveys have documented a steady decline in adult densities with the population not producing a significant year class since 2011. The lack of successful natural recruitment has driven the decline in the adult population but the mechanism(s) influencing this are unknown and likely complicated. This trend of declining walleye recruitment and abundance has been documented on other lakes in Polk County over the past several decades (Benike 2005a, 2005b, 2006 and 2009) and throughout the upper Midwest (Raabe et al. 2020). The lake has undergone substantial changes within the last several decades including shoreline development and protection, reduction in nearshore woody habitat, aquatic plant community alterations, fish crib installation and more recently alum treatments. These changes coupled with the effects of a warming climate may have influenced fish community changes which include the increase in centrarchid populations and decline in coolwater species populations.

Walleye populations across the northern Great Lakes states have been experiencing declines as well in once viable and strong naturally reproducing populations. Research of potential drivers or factors affecting walleye declines is ongoing and findings have revealed complicated results with many factors likely playing a role (Hansen et al. 2015a, 2015b, 2017, 2019; Embke et al. 2019). Studies have documented that recruitment bottlenecks likely happen during the first summer of life. Extreme temporal changes in the timing of lake warm up following ice off and the timing of the spawn have been found to be correlated with the strength of subsequent year classes (Feiner et al. 2023; Feiner et al. 2025). The longer growing season and increase in average growing degree days each year may also play a role in benefiting warmwater species to the detriment of coolwater species (Hansen et al. 2017; Broda et al. 2022; Embke et al. 2022). Many lakes with declining walleye populations have also experienced dramatic increases in centrarchid populations. Specifically, within Cedar Lake, factors that may affect walleye in addition to other species include the increase in shoreline stabilization because of lakeshore erosion. Shoreline stabilization with the use of riprap or seawalls has become increasingly prevalent and can reduce the recruitment of natural substrates of gravel and cobble into the lake that historically provided excellent walleye spawning habitat. Shoreline development and the removal of nearshore woody habitat may also be detrimental to many fish species as well as the removal and destruction of native aquatic vegetation.

Because of the decline in walleye recruitment, biennial extended growth fall fingerling stocking began in 2019 at a rate of 15 per acre. According to our survey, the resulting year classes from the 2019 and 2021 stockings likely had good survival and produced relatively strong year classes. Stocking should continue for the immediate future until we can fully evaluate stocking survival and adult contribution when a minimum of three stocked year classes reach adult age classes during the next survey and/or natural recruitment has

returned. Based on this survey, stocking has maintained an adult population. The current walleye fishing regulation is protecting the majority of the large females within the population (20-24 inches) which are essential for increased reproduction and population rebounds. However, because of the small and declining population, very limited harvest is encouraged by all anglers. Total annual mortality of adults was approximately 40% and angler exploitation was 35%. This exploitation rate is at the upper limit reference point for Ceded Territory walleye exploitation rates which aims for the total allowable catch to not exceed 35% of the adult population. Sass and Shaw (2018) found that this exploitation rate was likely too liberal and that a more sustainable exploitation rate for Ceded Territory walleye populations was approximately 15-18%. Several other studies have suggested that exploitation rates >20% reduced adult walleye densities to less than a desirable or sustainable level (Baccante and Colby 1996; Rypel et al. 2015; Tsehaye et al. 2016). However, these exploitation estimates are recommended to sustain naturally reproducing walleye populations and to limit the risk of recruitment overfishing. The walleye population in Cedar Lake is currently only sustained by stocking as evidenced by the lack of age-0 fish in fall surveys since 2012. If natural recruitment is unlikely to return and the ultimate goal of stocking walleye is to provide a recreational and traditional spearing fishery, then higher rates of exploitation may be warranted to maximize yield and use of the stocked fishery. With recreational anglers encouraged to limit the harvest of walleye, tribal spearing safe harvest quotas were also reduced beginning in the 2023 season. The reduction in tribal safe harvest levels was based on continued failed natural recruitment and low adult population estimates. The number of walleye harvested by spearing has been very low during the past several seasons.

Adult muskellunge abundance has declined since 2021, but adults are still present in moderate abundance. Abundance of muskellunge is currently moderately high compared to other Class A1 muskellunge lakes in Wisconsin. The current population continues to exhibit excellent size structure and condition with growth rates comparable to statewide growth rates in similar lakes. However, size structure of musky appeared to have declined slightly from 2021-2022. There appears to be small contributions from non-stocked years, potentially indicating small amounts of natural reproduction. Genetic parentage analysis may be a useful tool to validate the influence of potential natural reproduction versus stocking. Hatchery stocking shortages occurred in 2017, 2019 and 2021 which is likely the cause of the weaker year classes of muskellunge since 2015. Because the 2021 population estimate was higher than the target value of 0.3 per acre for Class A1 Muskellunge lakes coupled with excellent growth rates, the muskellunge stocking rate was reduced from 1 fish per acre to 0.5 fish per acre in 2022. Continued monitoring of the population will evaluate effects of the stocking reduction and determine if the size structure can be further improved.

Northern pike abundance has remained relatively stable throughout recent surveys. The current survey documented a slight increase in abundance, but similar size structure compared to 2021. Overall, northern pike exhibited good growth rates and condition, fairly stable recruitment and moderate abundance.

Largemouth bass abundance within Cedar Lake was moderate in the 2025 survey and has declined from the previous survey. Prior to the two recent surveys, largemouth bass relative

abundance averaged five fish per mile from 2009 to 2016 while the 2021 survey documented a four-fold increase from the previous average. This is consistent with other area lakes where increases in largemouth bass abundance has coincided with declines in walleye abundance (Benike 2005a, 2005b, 2006 and 2009). Causative factors for these changes are not well understood. Largemouth bass exhibited good size structure but PSD values have declined from 2021; this is likely due to natural fluctuations. With abundant forage and moderate densities, the largemouth bass population has the potential to produce a trophy fishery if densities remain low to moderate.

Overall panfish abundance was high during the survey; however, catch rates of all three species (bluegill, black crappie and yellow perch) were lower than during the 2021 survey. Catch rates of bluegill and black crappie were moderate and yellow perch was low. However, catch rates of bluegill were still substantially higher than the long-term average in Cedar Lake of 78 per mile. Catch rates of black crappie were similar to the long-term average of 113 per mile. Bluegill size structure improved significantly in terms of mean size and PSD while growth rates were also slightly faster than during the previous survey. Black crappie were less abundant than in 2021 which likely had positive impacts on the overall population by reducing intraspecific competition. Size structure in terms of PSD was high but this was likely due to the lack of small individuals in the sample because of the skewed population towards two large adult year classes. Recruitment was extremely erratic and the population was largely made up of the age-5 and age-9 year classes. This is consistent with the majority of black crappie populations in which recruitment is heavily influenced by many environmental factors including water level fluctuations, water temperature changes during the spawn and alterations in habitat (Hooe 1991; Allen and Miranda 1998; Maceina and Stimpert 1998). These large year classes have likely negatively impacted growth rates as evidenced by low mean length at age for these older year classes. Growth rates between the ages of 5 and 9 were very slow and fish did not reach 10 inches until age 8. Yellow perch were present in low abundance which was similar to previous surveys other than 2021. This was likely due to the timing of the survey not coinciding with perch being vulnerable to survey gears. Further surveys are needed to determine if these low catch rates are a sampling artifact or due to actual population declines. All three panfish species are likely subject to high angling pressure and harvest which can be the cause of limited size structures or declines in catch rates of larger individuals.

Cedar Lake has undergone substantial changes and alterations within the past couple of decades and the fish community has responded with its own changes. Natural recruitment of walleye continues to be non-existent along with many other walleye populations across the upper Midwest. Habitat alterations within Cedar Lake include the installation of seawalls and riprap, reduction in nearshore woody habitat, installation of 400 offshore fish cribs, alum treatments and fluctuations in the aquatic plant community. Because of the many variables in habitat changes and water quality occurring simultaneously and the unknown timing in the response of the fish community, detecting the mechanisms with the largest impacts is difficult. Approximately 400 fish cribs were installed from 2004 to 2013 in offshore areas of 14-20 feet depths. The cribs are located outside of the littoral zone which is the zone that is naturally occupied by the majority of fish species during the productive times of year. It is still unknown how fish cribs influence or benefit individual fish species and population level effects. Installation of nearshore woody habitat in the form of tree

drops and fish sticks would benefit fish communities by offering natural habitat in the littoral zone. This habitat type is severely lacking within the lake and would also help to naturally slow shoreline erosion and stabilize aquatic vegetation beds. With almost the entire shoreline of the lake developed, this type of habitat is generally undesired by landowners but should be considered for erosion reduction and habitat benefits.

The effects of alum treatments on fish populations has been documented in the literature with mixed results. Studies documented significant declines in macroinvertebrate densities directly following alum treatments (Pilgrim and Brezonik 2005; Steinman and Ogdahl 2008) and declines in yellow perch condition (Smeltzer 1990). A major concern with alum treatments is the alteration of aquatic habitats by fluctuating water clarity which can cause aquatic macrophytes to occupy varying depths. Increased water clarity can also reduce preferred habitats used by walleye because of the reduction in thermal optical habitat (Hansen et al. 2019). Several studies have documented that increasing water clarity and temperatures have been associated with walleye declines and increases in centrarchid populations in many North American lakes (Robillard and Fox 2006, Hansen et al. 2015a; Irwin et al. 2016). With increasing summer water temperatures, lengthening of growing seasons and increased water clarity, walleye are likely to experience extreme reductions in available preferred habitats which can lead to declines in carrying capacity and yield of the population (Lester et al. 2004).

Moving forward with regional declines in walleye populations that are likely to be heavily impacted by a warming climate, decisions of whether to resist changes, accept changes or direct the changes (RAD framework, WDNR) must be made. According to climate modeling, Cedar Lake may contain a persistent walleye population in the future but is unlikely to regain natural recruitment. The lake should continue to be stocked with extended growth fall fingerling walleye to determine if stocking can aid in the rebound of the population and natural recruitment can be restored. Muskellunge stocking should continue on a biennial basis at a rate of 0.5 fish per acre in order to attempt to produce a lower density population with higher trophy potential. Nearshore woody habitat projects are highly encouraged to improve habitat and reduce shoreline erosion in place of hard armoring with the use of rip-rap. Panfish continuously experience high harvest pressure in both the winter and summer fishing seasons. Consideration may be given to more restrictive experimental panfish regulations in order to protect larger individuals within the populations and distribute available fish to a larger group of anglers. Continued monitoring of the fish population is essential for adaptive management strategies and future success of the fishery.

Recommendations

1. Continue to monitor and estimate the adult walleye population density during future surveys on a 4-year rotation to assess population density, size structure and effects of stocking.
2. Continue fall juvenile walleye electrofishing surveys to monitor walleye natural recruitment and stocking survival.
3. Estimate the size of the adult muskellunge population during the 2029 survey.
4. Continue to encourage nearshore habitat improvements in the form of fish sticks and tree drops to maintain and improve littoral habitats.

5. Continue to support and encourage Best Management Practices within the watershed to aid in improvements in water quality.

References

- Allen, M.S. and L.E. Miranda. 1998. An age-structured model for erratic crappie fisheries. *Ecological Modelling* 107: 289-303.
- Baccante, D.A., and P.J. Colby. 1996. Harvest, density, and reproductive characteristics of North American Walleye populations. *Annales Zoologici Fennici* 33:601-615.
- Benike, H. 2005a. Treaty Assessment Survey, Half Moon Lake, Polk County, Wisconsin 2001. Wisconsin Department of Natural Resources, Internal Fisheries Management Report. Barron Field Office.
- Benike, H. 2005b. Treaty Assessment Survey, Big Butternut Lake, Polk County Wisconsin 2003. Wisconsin Department of Natural Resources, Internal Fisheries Management Report. Barron Field Office.
- Benike, H. M. 2006. Changes in the Gamefish Community of a Small Northwestern Wisconsin Lake Over a 25-Year Period. Ward Lake, Polk County, Wisconsin. Wisconsin Department of Natural Resources Internal Fisheries Management Report. Barron Field Office.
- Benike, H. 2009. Treaty Assessment Survey, Magnor Lake, Polk County Wisconsin 2007. Wisconsin Department of Natural Resources, Internal Fisheries Management Report. Barron Field Office.
- Bertalanffy, L, von. 1938. A quantitative theory of organic growth. *Human Biology* 10:181-213.
- Broda, S.P., Feiner, Z.S., Mrnak, J.T., Shaw, S.L., and Sass, G.G. 2022. Black crappie influences on walleye natural recruitment in northern Wisconsin lakes. *North American Journal of Fisheries Management*, 42:1202–1214.
- Embke H.S., Rypel A.L., Carpenter S.R., Sass G.G., Ogle D., Cichosz T., Hennessy J., T.E. Essington, M.J. Vander Zanden. 2019. Production dynamics reveal hidden overharvest of inland recreational fisheries. *Proc Natl Acad. Sci.* 116(49):24676–24681.
- Embke, H.S., S.R. Carpenter, D.A. Isermann, G. Coppola, T.D. Beard, Jr and A.J. Lynch. 2022. Resisting ecosystem transformation through an intensive whole-lake fish removal experiment. *Fisheries Management and Ecology*, 29: 364–377.
- Feiner, Z.S., M. Barta, G. Sass, J. Reed, T. Cichosz, A. Shultz and M. Luehring. 2023. Walleye spawning, ice phenology, and covariate data for Upper Midwestern Lakes: 1939-2019. Environmental Data Initiative.
- Feiner, Z.S., S.L. Shaw and G.G. Sass. 2025. Understanding shifting cues for walleye spawning phenology and recruitment in a changing climate. *Canadian Journal of Fisheries and Aquatic Sciences* 82:1-10.

Hansen, J.F., G.G. Sass, J.W. Gaeta, G.A. Hansen, D.A. Isermann, J.O. Lyons and M.J. Vander Zanden. 2015a. Largemouth Bass management in Wisconsin: intraspecific and interspecific implications of abundance increases. In American Fisheries Society Symposium (Vol. 82, pp. 193-206).

Hansen J.F., G.G. Sass, J.W. Gaeta, G.A. Hansen, D.A. Isermann, J. Lyons, M.J. Vander Zanden. 2015b. Largemouth bass management in Wisconsin: intra- and inter-specific implications of abundance increases In: Tringali MD, Long JM, Birdsong TW, Allen MS, (eds). Black bass diversity: multidisciplinary science for conservation. P. 193–206. American Fisheries Society, Symposium 82: Bethesda (MA).

Hansen G.J.A., Read J.S., J.F. Hansen, L.A. Winslow. 2017. Projected shifts in fish species dominance in Wisconsin lakes under climate change. *Glob Change Biol.* 23(4): 1463–1476.

Hansen, G.J.A., S.R. Midway, and T. Wagner. 2018. 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: 106–115.

Hansen, G.J.A., L.A. Winslow, J.S. Read, M. Trembl, P.J. Schmalz and S.R. Carpenter. 2019. Water clarity and temperature effects on walleye safe harvest: and empirical test of the safe operating space concept. *Ecosphere* 10(5).

Hooe, M.L. 1991. Crappie biology and management. *North American Journal of Fisheries Management* 11: 483-484.

Irwin, B. J., L.G. Rudstam, J.R. Jackson, A.J. Vandevalk and J.L. Forney. 2016. Long-term trends in the fish community of Oneida Lake: analysis of the zebra mussel invasion. Oneida Lake: long-term dynamics of a managed ecosystem and its fisheries. American Fisheries Society, Bethesda, Maryland, 375-396.

Lester, N.P., A.J. Dextrase, R.S. Kushneriuk, M.R. Rawson and P.A. Ryan. 2004. Light and temperature: key factors affecting walleye abundance and production. *Transactions of the American Fisheries Society*, 133: 588-605.

Maceina, M.J. and M.R. Stimpert. 1998. Relations between reservoir hydrology and crappie recruitment in Alabama. *North American Journal of Fisheries Management* 18: 104-113.

Pilgrim, K.M. and P.L Brezonik. 2005. Treatment of lake inflows with alum for phosphorus removal. *Lake and Reservoir Management* 21: 1-9.

Raabe, J.K., J.A. VanDeHey, D.L. Zentner, T.K. Cross and G.G. Sass. 2020. Walleye inland lake habitat: considerations for successful natural recruitment and stocking in North Central North America. *Lake and Reservoir Management* 34:4, 335-359.

Robillard, M.M and M.G. Fox. 2006. Historical changes in abundance and community structure of warmwater piscivore communities associated with changes in water clarity,

nutrients, and temperature. *Canadian Journal of Fisheries and Aquatic Sciences* 63: 789-809.

Rypel, A.L., D. Goto, G.G. Sass and M.J. Vander Zanden. 2015. Production rates of walleye and their relationship to exploitation in Escanaba Lake, Wisconsin, 1965-2009. *Canadian Journal of Fisheries and Aquatic Sciences* 72:834-844.

Rypel, A.L., T.D. Simonson, D.L. Oele, J.D.T. Griffin, T.P. Parks, D. Seibel, C.M. Roberts, S. Toshner, L.S. Tate and J. Lyons. 2019. Flexible classification of Wisconsin lakes for improved fisheries conservation and management. *Fisheries* 44:225–238.

Sass, G.G. and S.L. Shaw. 2018. Walleye population responses to experimental exploitation in a Northern Wisconsin Lake. *Transactions of the American Fisheries Society* 147:869-878.

Smeltzer, E. 1990. A Successful Alum/Aluminate Treatment of Lake Morey, Vermont. *Lake and Reservoir Management* 6:1, 9-19.

Steinman, A.D. and M. Ogdahl. 2008. Ecological effects after an alum treatment in Spring Lake, Michigan. *Journal of Environmental Quality* 37: 22-29.

Tsehaye, I., B.M. Roth and G.G. Sass. 2016. Exploring optimal walleye exploitation rates for northern Wisconsin Ceded Territory lakes using a hierarchical Bayesian age-structured model. *Canadian Journal of Fisheries and Aquatic Sciences* 73:1413-1433.

Wege, G.W. and R.O. Anderson. 1978. Relative weight (W_r): a new index of condition for largemouth bass. In: *New Approaches to the Management of Small Impoundments*. (Novinger, G.D. and J.G. Dillard, Eds.). pp. 79-91. Bethesda, MD: North Central Division, American Fisheries Society, Special Publication No. 5.