WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Fishery Survey Report for Lake Nebagamon, Douglas County, Wisconsin 2022-2023

Waterbody Code: 2865000

LOGAN CUTLER
DNR Fisheries Biologist
Bayfield & Douglas Counties (Inland Waters)

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Executive Summary

A comprehensive fish survey with an angler creel survey was conducted on Lake Nebagamon from May 2022 to March 2023 to assess the status of the fishery. A primary goal of this survey was to estimate adult walleye abundance, size structure and exploitation and evaluate the effectiveness of walleye stocking efforts.

Anglers spent an estimated 7,790 hours fishing on Lake Nebagamon in 2022-2023, which is less than half of what was estimated in 2005 and 1998. Anglers directed the most effort targeting walleye, but also had considerable effort for smallmouth bass and black crappie. Over time, anglers are spending more time targeting smallmouth and largemouth bass on Lake Nebagamon and less time targeting yellow perch and northern pike.

Walleye adult abundance and natural recruitment have increased since the 2014 survey, and growth rates and size structure remain good. Walleye stocking has been relatively unsuccessful, costing approximately $340 per age-5 fish. Despite poor returns of stocked fish, adult abundance improved over the last decade. However, this improvement seems to be largely from increased natural recruitment. Since natural recruitment is sufficient to sustain a healthy walleye population, walleye stocking should be discontinued and only reinstated if the average age-0 walleye fall electrofishing catch rate from the previous four years is <8 fish/mile and there are no individual year classes ≥15 fish/mile in the last four years.

Bluegill and black crappie both have low-density populations with good size structure. High abundance of northern pike provides anglers with a great harvest opportunity. Smallmouth bass are plentiful with high size structure providing one of the area's best fisheries for catch-and-release anglers and some harvest opportunity.

Introduction

Lake Nebagamon is a 914-acre drainage lake located in eastern Douglas County with an average depth of 20 feet and a maximum depth of 56 feet. The lake has inlets from Minnesuing Creek to the southwest and an unnamed creek connected to Steele and Little Steele Lakes to the northwest. The outlet is on the east side of the lake (Nebagamon Creek) and meets the Brule River approximately 4 miles east of Lake Nebagamon and eventually drains into Lake Superior. There is a public boat landing on the north end of the lake in the Village of Lake Nebagamon. Wisconsin Department of Natural Resources (DNR) fisheries management staff surveyed Lake Nebagamon in 2022 to assess the status of the fishery and evaluate the success of walleye large fingerling stocking since 2011.

Lake Nebagamon is moderately productive (mesotrophic) and is classified as a complex-cool-clear lake based on fish species, water temperature and clarity (Rypel et al. 2019). The watershed (21,924 acres) is primarily forest (66%) with wetlands (13%),

surface waters (8%) and other natural land cover types. Developed lands within the watershed include agriculture (2%) and urban (6%; Midwest Glacial Lakes Conservation Planner). Since 2012, significant effort has been put forth by the Nebagamon Lake Association and DNR to improve fish habitat along the shoreline. Most of this work has been through Fish Sticks projects within the Wisconsin Healthy Lakes program to create food, shelter and spawning habitat for fish, insects and other wildlife. The DNR Lake Page for Lake Nebagamon provides additional information on lake characteristics such as substrate types, bathymetry and invasive species present.

FISHING REGULATIONS

The Lake Nebagamon fishery has historically been managed with statewide size and bag limits for all species except walleye. Going back to 1990, anglers were allowed 2 or 3 walleye per day, with a minimum length limit of 15 inches. In 2014, the minimum length limit for walleye was increased to 18 inches to increase size structure, abundance and natural recruitment by allowing all female walleye to spawn at least once before being vulnerable to angler harvest.

STOCKING

Walleye stocking has occurred on Lake Nebagamon since 1934 with notable gaps in stocking from 1963 to 1986 and 2006 to 2011 when the population was maintained through natural recruitment. In 2011, DNR, the Red Cliff Band of Lake Superior Chippewa and the Nebagamon Lake Association began stocking large fingerling (6-8 inch) walleye due to poor success of fry and small fingerlings (Toshner 2016). Since 2013, large fingerling walleye have been stocked every other year at a rate of 15 fish/acre (Table A1).

Methods

FISH SURVEY

Survey methods followed standard DNR Treaty comprehensive assessment protocols (Cichosz 2021). Sampling consisted of fyke net and electrofishing surveys in spring and an additional electrofishing survey in fall. All fish captured during these surveys were identified to species, counted and measured to the nearest 0.1 inch. Additional details about these standard DNR surveys are listed in the appendix (Table A2). Fyke nets were set immediately after ice-out for the early spring netting survey (SN1) to mark walleye with fin clips. This was followed by an early spring electrofishing survey (SE1) of the entire shoreline targeting walleye, some of which had been marked with a fin clip during the SN1 survey. The number of walleye captured in these surveys were used to calculate a population estimate of adult walleye using the Lincoln-Peterson estimator with Chapman modification (Ricker 1975):

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

where N = population estimate, M = number of fish marked during the SN1, C = total number of fish captured during the SE1 and R = number of marked fish captured during the SE1. Male, female and immature walleye ≥15 inches were included in the population estimate. To estimate age and model growth, aging structures were collected from five walleye of each sex per 0.5-inch length bin. Dorsal spines were used to age walleye ≥12 inches, and scales were used for fish <12 inches.

Catch rates (fish/net-night) of black crappie and northern pike were calculated from the SN1 survey to index the relative abundance of these species. A few weeks after the completion of the SE1 survey, gamefish and panfish were targeted using a late spring electrofishing survey (SE2) consisting of three randomly distributed two-mile-long shoreline stations. Within each station, all species were targeted in a 0.5-mile section, and only gamefish were targeted in the remaining 1.5 miles. Catch rates (fish/mile) were calculated as an index of relative abundance for bluegill and smallmouth bass in the SE2 survey. Size structure for each species was visualized using length frequency histograms and quantified using the proportional size distribution (PSD) metric:

$$PSD = \frac{\#\ of\ fish \geq given\ length\ category}{\#\ of\ fish \geq stock\ length} * 100.$$

For PSD evaluations, length categories established for North American freshwater fish species were used (Gabelhouse 1984; Appendix Table A3). The PSD results were only included when ≥30 individuals were sampled.

To evaluate walleye recruitment, a fall electrofishing survey (FE1) was conducted. The number of age-0 walleye (fish born that spring) captured per mile of shoreline electrofished was calculated to index the relative abundance of that year class. To evaluate walleye stocking success, large fingerlings stocked in 2012, 2013, 2015 and 2017 had a fin clipped before stocking to differentiate them from naturally recruited fish. The contribution of stocking was estimated at age-1 using the number of clipped (stocked) and unclipped (natural) age-1 walleye in the FE1 survey the year following stocking and converted to density (age-1/acre) using the Shaw-index (Shaw and Sass 2020). Survival was estimated by multiplying the density of stocked age-1 by the lake area (914 acres) and dividing by the number stocked.

Adult walleye contribution from stocking and natural reproduction was also estimated using the proportion of clipped (stocked) and unclipped (natural) fish from each year class in the SN1 and SE1 surveys and an age-length key. These proportions were multiplied by the age-specific population estimate to estimate the number of stocked walleye at each age. Survival was estimated by dividing the age-specific stocked population estimate by the number stocked. Cost per adult at each age was

estimated by multiplying the number stocked by the cost per stocked large fingerling ($1.06) and dividing by the age-specific stocked population estimate.

To evaluate trends through time, results were compared to previous surveys conducted on Lake Nebagamon in 1994, 1998, 2004, 2014 and 2016 when possible. To determine the status of Lake Nebagamon relative to similar lakes, walleye PSD was compared to complex-cool-clear lakes with a combination of stocking and natural walleye recruitment. Similarly, catch rate and PSD of other species were compared to the complex-cool-clear lake class.

CREEL SURVEY

An angler creel survey was conducted during the 2022-2023 fishing season (May 2022-March 2023) following standard DNR treaty comprehensive assessment protocols (Cichosz 2021). Angler metrics of species-specific fishing effort, catch rates, harvest/acre and average length of harvested fish were estimated. Angler exploitation of walleye was calculated by dividing the estimated number of angler-harvested marked walleye by the total number of walleye marked during the spring surveys in 2022. Exploitation of walleye by tribal spearing was calculated by dividing the total number of spear-harvested walleye by the walleye population estimate. Total walleye exploitation was calculated by adding angling and spearing exploitation. These results were compared to results from previous creel surveys conducted on Lake Nebagamon in 1994, 1998 and 2005 to evaluate trends through time. To determine the status of Lake Nebagamon relative to similar lakes, these results were compared to other creel surveys in the Ceded Territory during the same time frame.

Results

CREEL SURVEY

Anglers spent an estimated 7,790 (12.8 hours/acre) hours fishing on Lake Nebagamon in 2022, which was much lower than previous estimates of 15,725 hours in 2005 and 16,100 hours in 1998, and well below the Douglas and Bayfield County average of 30.7 hours/acre since 2010. Anglers targeted walleye most often, with an estimated 4,435 hours or 38% of the total directed (species specific) effort, but many also targeted smallmouth bass (2,380 hours, 20% of total directed effort) and black crappie (1,439 hours, 12.3% of total directed effort; Figure 1). Over time, Lake Nebagamon anglers are spending more time targeting smallmouth and largemouth bass, but less time targeting yellow perch and northern pike (Figure 1).

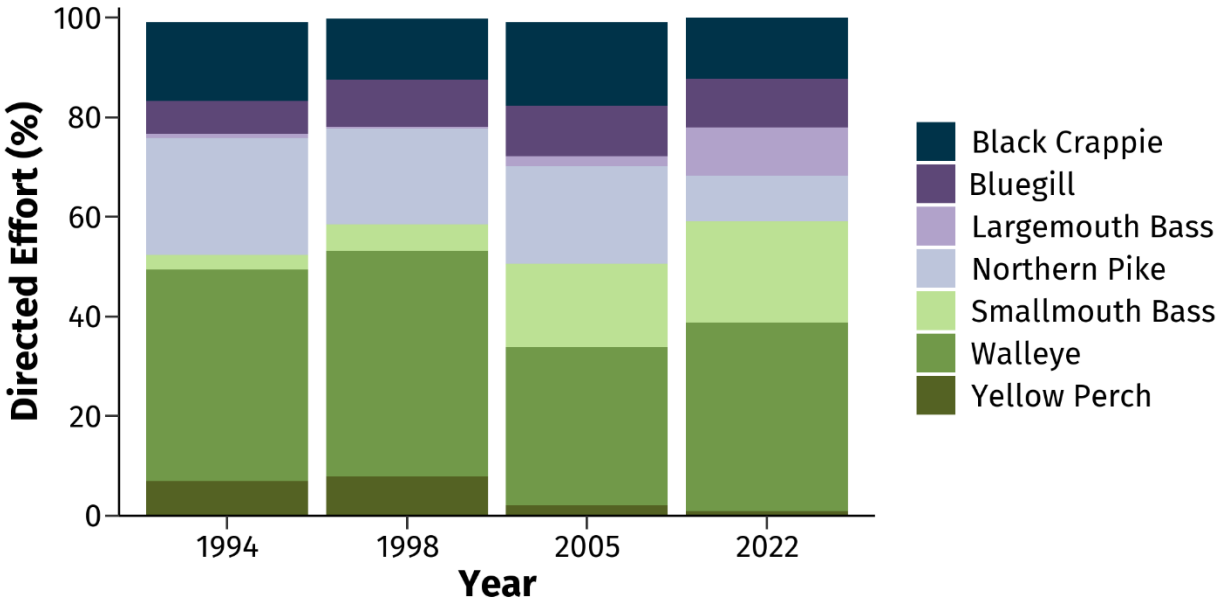

Figure 1. Percent of the total directed angling effort on Lake Nebagamon by species in 1994, 1998, 2005 and 2022. Species with less than 2% of directed effort removed for clarity.

WALLEYE

FISH SURVEY

The adult walleye population in Lake Nebagamon was estimated to be 1,471 fish (95% CI = 1221-1721) or 1.6 adults/acre (95% CI = 1.3-1.9; Figure 2). This density was slightly higher than the 2014 estimate of 1.3 adults/acre, but still below the previous target of 3 adults/acre (Figure 2). Walleye captured during the early spring fyke net survey (SN1) ranged from 5.6 to 26.2 inches, with 33% of the fish ≥ 18 inches (minimum length limit; Figure 3). The largest male sampled was 20.3 inches, and the largest female sampled was 26.2 inches. The PSD-15 in the SN1 survey was 83, which was lower than in 2014 (94) but near the average for complex-cool-clear lakes with a combination of stocking and natural walleye recruitment (Figure 4). For walleye to reach 18 inches in Lake Nebagamon, it takes about 5 years for females and about 7 years for males (Figure 5).

The catch rate of age-0 walleye during the fall 2022 electrofishing survey was 22 fish/mile and followed the trend of overall increasing walleye recruitment in Lake Nebagamon since 2013 (Figure 6). Stocked fish made up 61% and 42% of age-1 walleye during the 2014 and 2016 FE1 surveys, and survival to age-1 was 8.1% both years. Clipped fish were not recorded during the 2013 or 2018 FE1 surveys, so stocked age-1 contribution and survival could not be evaluated for the 2012 and 2017 stockings.

During the 2022 SN1 and SE1 surveys, stocked walleye with fin clips were ages 5, 7, 9 and 10, encompassing the majority of adult walleye in Lake Nebagamon. Only four age-10 walleye were captured, so they were removed from these analyses. Stocked walleye made up 15%, 18% and 65% of the age-5, 7 and 9 year classes. Survival was

0.3%, 0.4% and 0.5%, costing $340, $286 and $232 per adult from the age-5, 7 and 9 year classes, respectively.

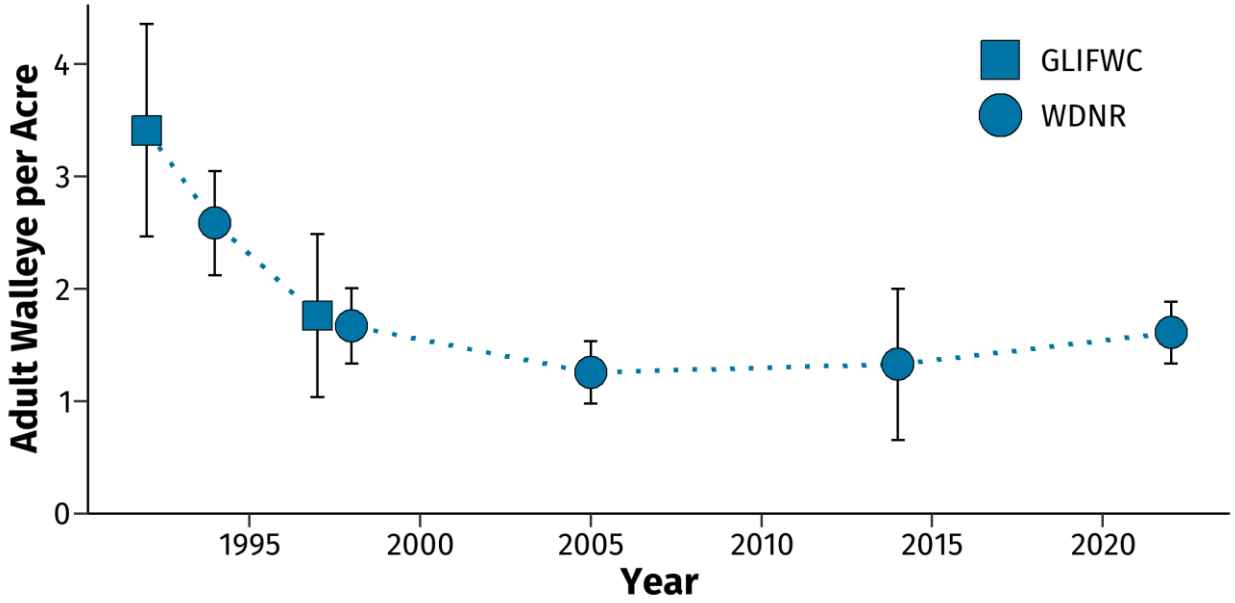

Figure 2. Adult walleye density estimates (adult fish/acre) with 95% confidence intervals from DNR (circles) and Great Lakes Indian Fish and Wildlife Commission (GLIFWC; squares) mark recapture surveys on Lake Nebagamon from 1992 to 2022.

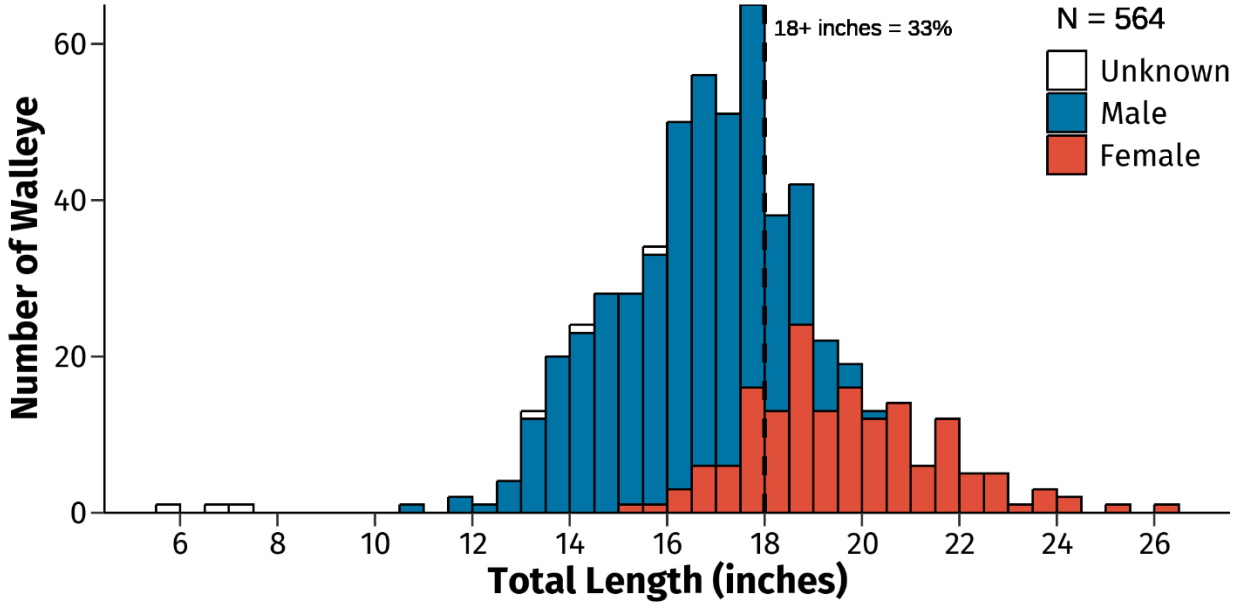

Figure 3. Length frequency histogram of female (red), male (blue) and unknown sex (white) walleye captured during the early spring fyke net survey (SN1) on Lake Nebagamon in 2022 with recaptured fish removed. Thirty-three percent of the fish were ≥ the 18-inch minimum length limit (vertical dashed line).

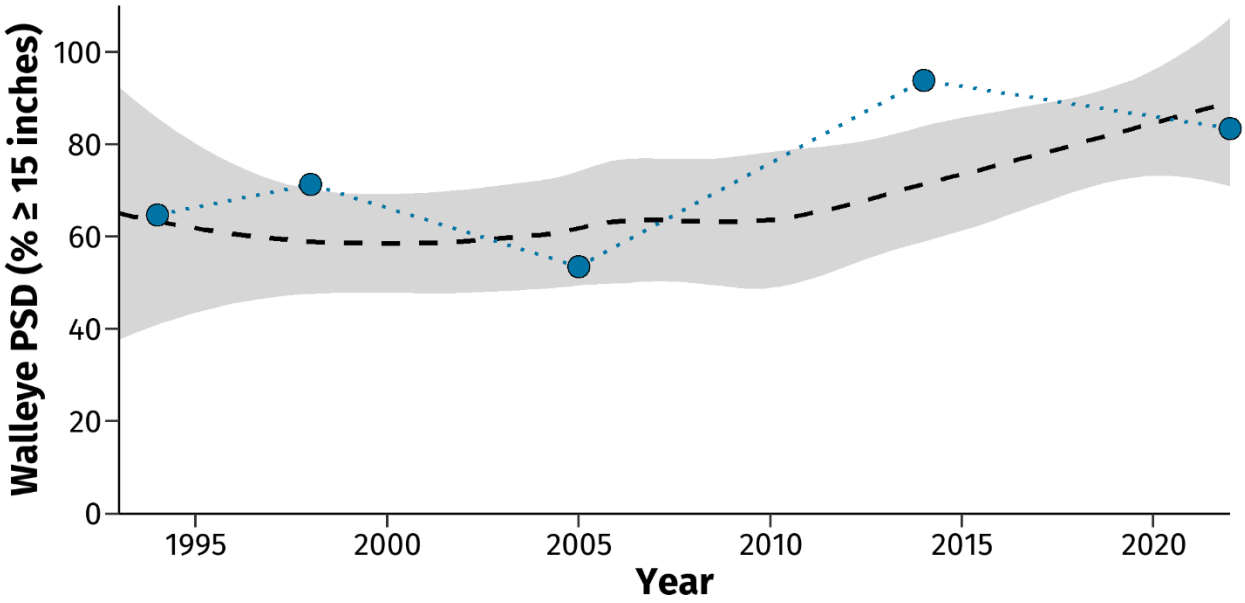

Figure 4. Proportional size distribution (PSD, % ≥ 15 inches) of walleye captured during the early spring fyke net survey (SN1) on Lake Nebagamon (blue circles) in 1994, 1998, 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes with a combination of stocking and natural walleye recruitment were used to provide a comparison.

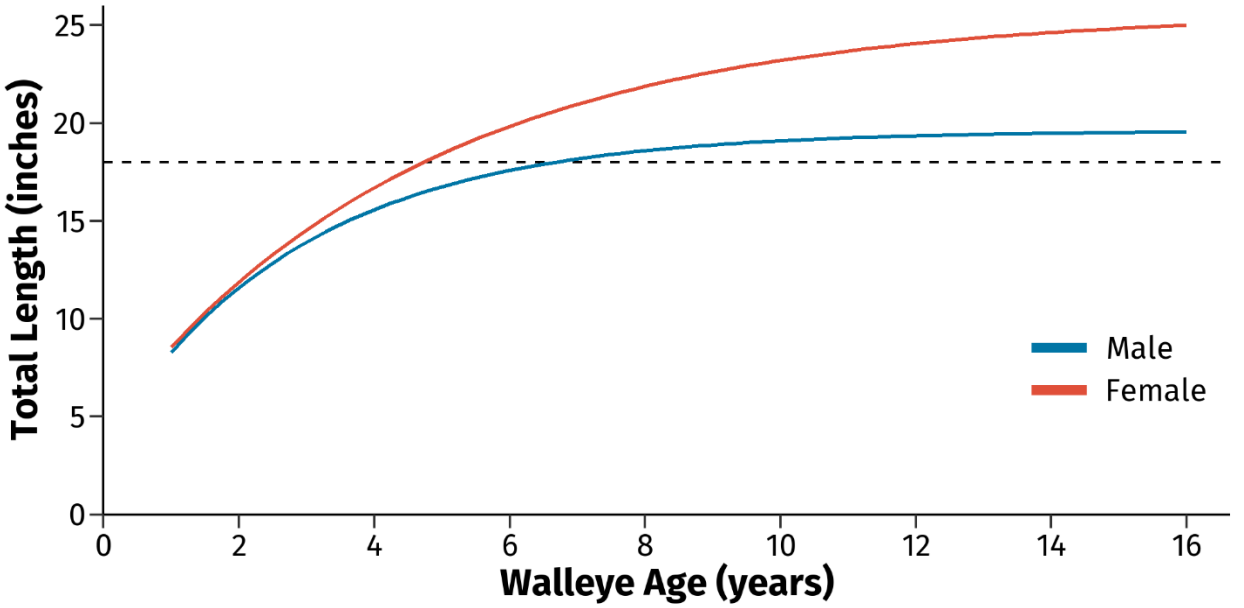

Figure 5. Von Bertalanffy growth curves of male (blue line) and female (red line) walleye captured during spring fyke net and electrofishing surveys on Lake Nebagamon in 2022. The horizontal dashed line represents the minimum length limit.

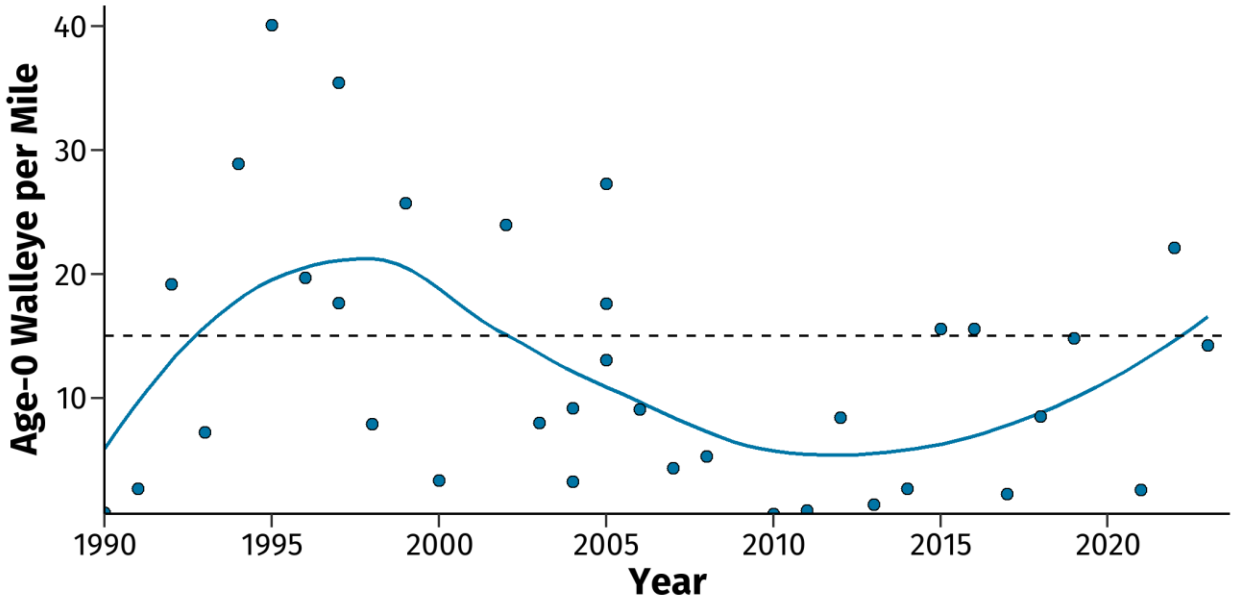

Figure 6. Number of age-0 walleye captured per mile (blue circles) during fall electrofishing surveys on Lake Nebagamon since 1988 with smoothed running mean trend line (blue line). The horizontal dashed line represents adequate natural reproduction to produce a significant year class of walleye.

CREEL SURVEY

Walleye angling effort was 4.9 hours/acre in 2022, which was lower than in 2005 (7.5) and 1998 (12.5) and followed the trend of other Ceded Territory creel surveys (Figure 7, left panel). However, the angler catch rate was 0.4 walleye/hour, which was higher than the 2005 (0.3) and 1998 (0.3) surveys and higher than most Ceded Territory creel surveys (Figure 7, middle panel). Angler harvest was 0.1 walleye/acre in 2022 which was lower than in 2005 (0.4) and 1998 (0.8) and lower than the average of Ceded Territory creel surveys (Figure 7, right panel).

The walleye angling exploitation rate was 4% in 2022, which was lower than in 2005 (14%) and 1998 (15%) and lower than the average of Ceded Territory creel surveys (Figure 8, left panel). Walleye exploitation by tribal spearing was 7% in 2022, which was higher than in 2005 and 1998 (1%), but similar to the Ceded Territory average (Figure 8, middle panel). In total, approximately 11% of Lake Nebagamon walleye were harvested in 2022, which was lower than in 2005 (15%) and 1998 (16%) and lower than the average of Ceded Territory creel surveys (Figure 8, right panel).

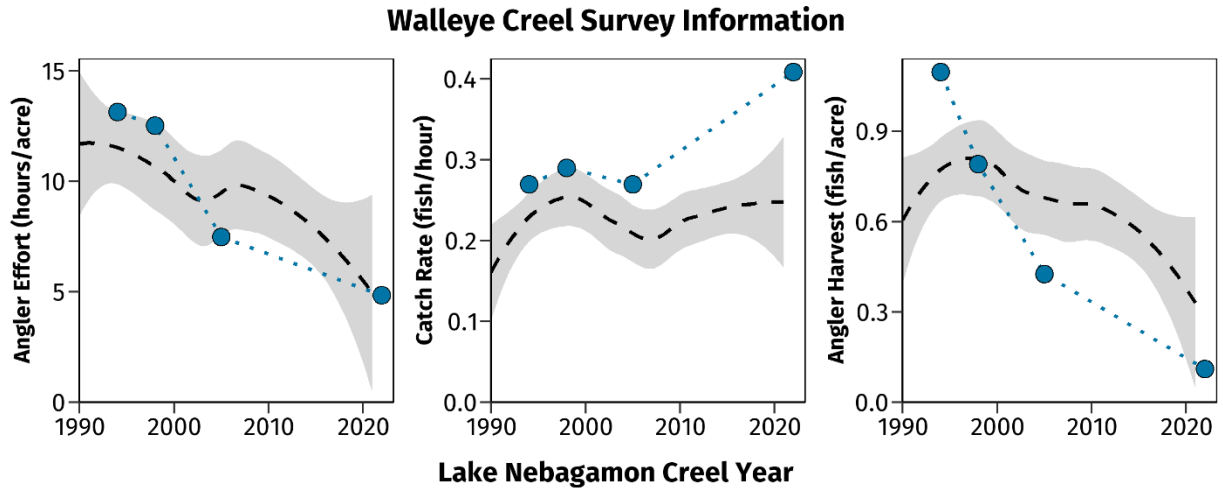

Figure 7. Walleye angler effort (left), catch rate (middle) and angler harvest (right) on Lake Nebagamon (blue circles) in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

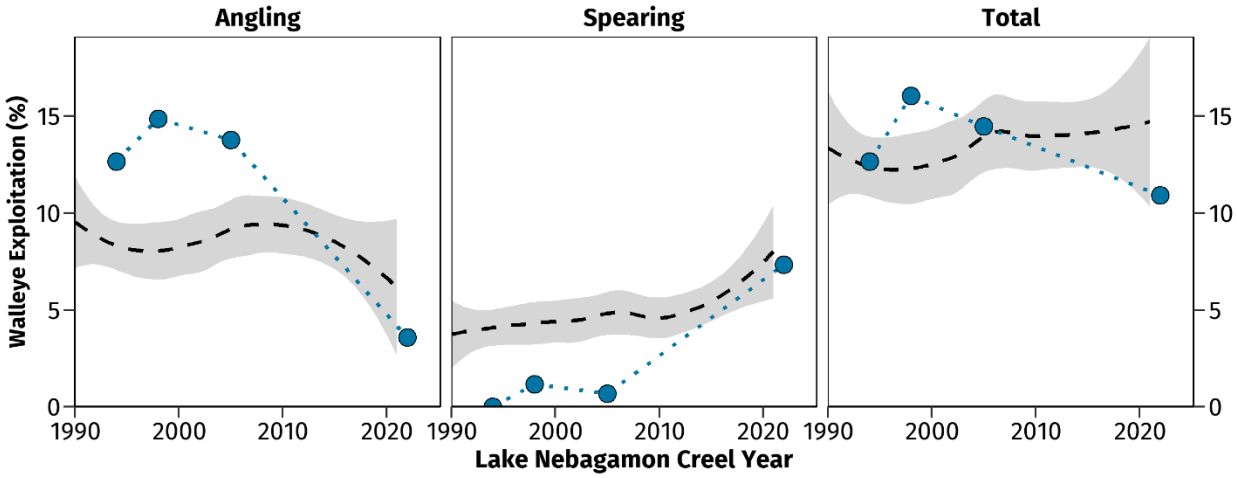

Figure 8. Angling (left), spearing (middle) and total (right) walleye exploitation (% of the adult population harvested) on Lake Nebagamon (blue circles) in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

BLACK CRAPPIE

FISH SURVEY

The black crappie catch rate on Lake Nebagamon was 0.7 fish/net-night in the SN1 survey, which was higher than in 2014 (0.4) but below average for complex-cool-clear lakes (Figure 9). Black crappie captured in this survey ranged from 3.7 to 13.8 inches (Figure 10).

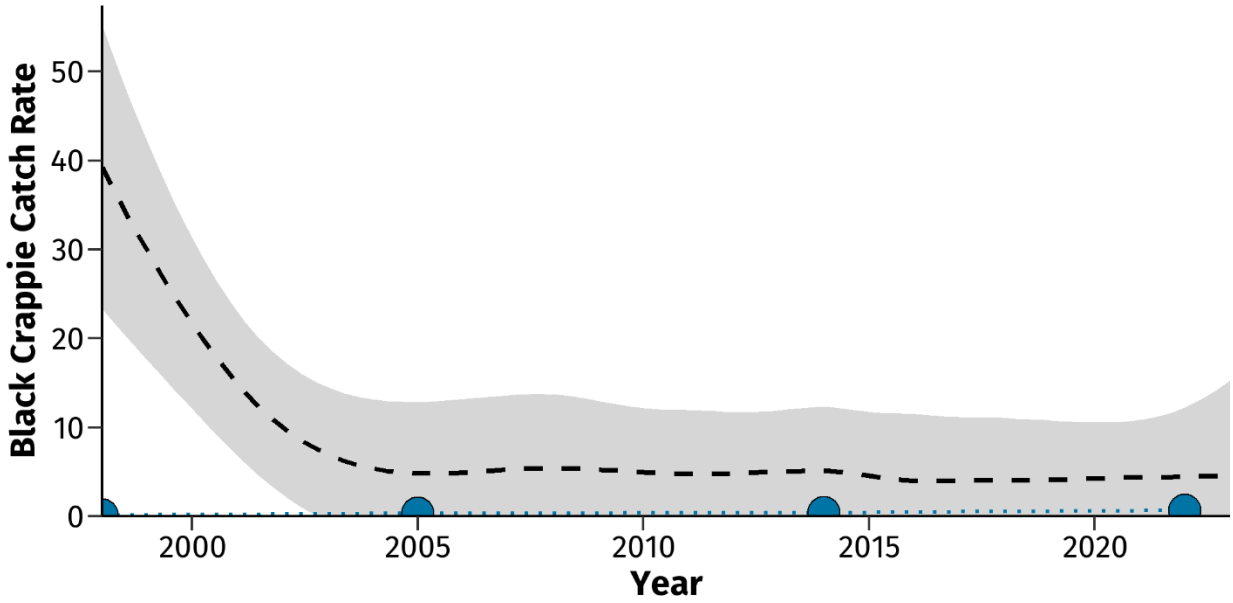

Figure 9. Black crappie catch rate (fish/net-night) during the early spring fyke net survey (SN1) on Lake Nebagamon (blue circles) in 1998, 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

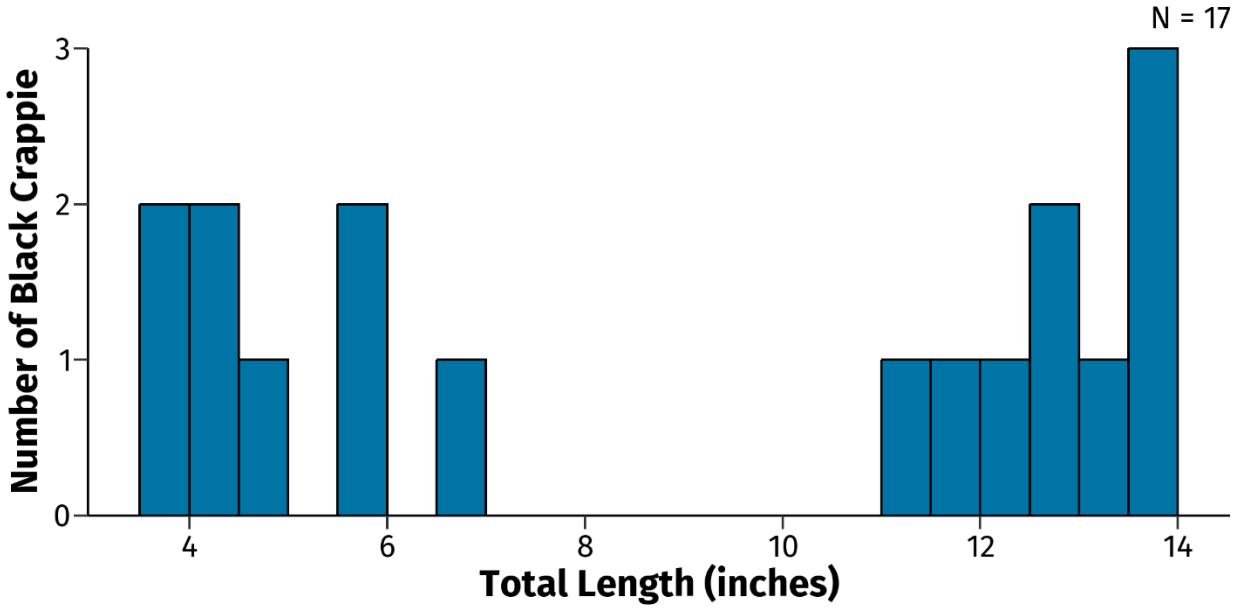

Figure 10. Length frequency histogram of black crappie captured during the early spring fyke net survey (SN1) on Lake Nebagamon in 2022.

CREEL SURVEY

Black crappie were the third most targeted species on Lake Nebagamon in 2022 with 1,439 hours, or 12.3% of the total directed effort (Figure 1). Estimated angling effort targeting black crappie in 2022 was 1.6 hours/acre, which was lower than in 2005 (4.0) and below average for Ceded Territory creel surveys (Figure 11, top left panel). The angler catch rate was 0.6 black crappie/hour in 2022, which was higher than in 2005

(0.5) and 1998 (0.2) and near the average of Ceded Territory creel surveys (Figure 11, top right panel). Estimated angler harvest was 0.3 black crappie/acre in 2022 which was lower than in 2005 (1.3) and below average for Ceded Territory creel surveys (Figure 11, bottom left panel). The average length of harvested black crappie was 11.1 inches in 2022, which was larger than previous creel surveys (10.4 to 10.6 inches) and above average for Ceded Territory creel surveys (Figure 11, bottom right panel).

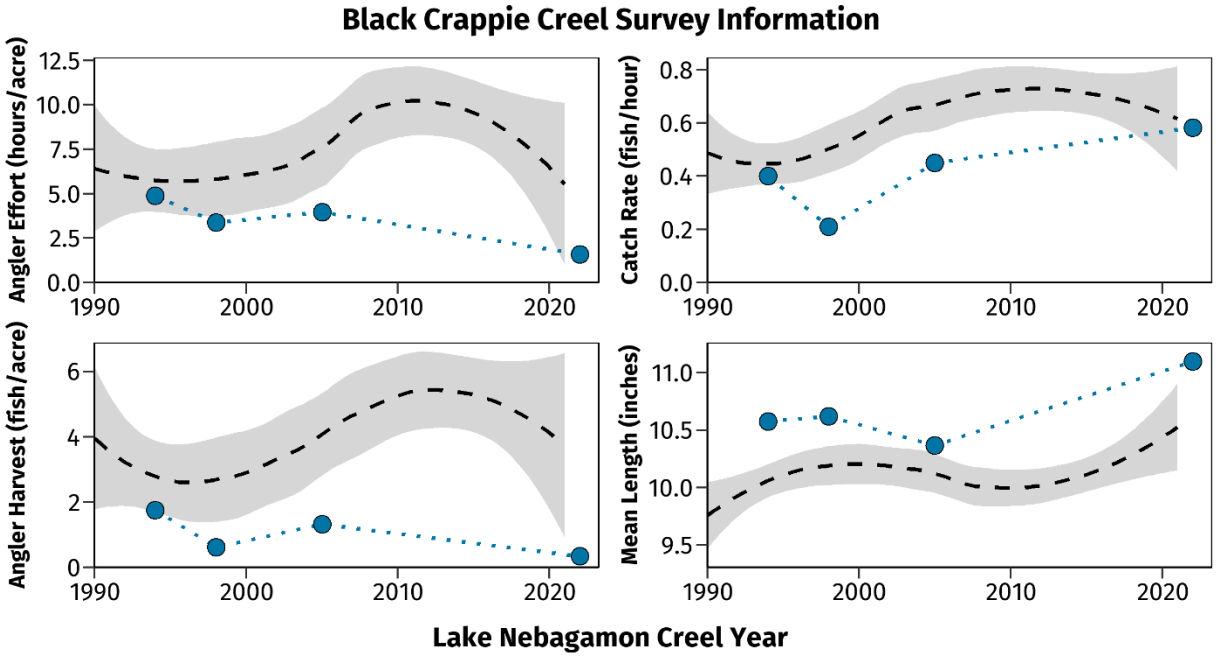

Figure 11. Black crappie effort (top left), catch rate (top right), angler harvest (bottom left) and mean length of harvest (bottom right) on Lake Nebagamon (blue circles) in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

BLUEGILL

FISH SURVEY

The bluegill catch rate was 19 fish/mile in the SE2 survey, which was lower than in 2014 (35) and well below average for complex-cool-clear lakes (Figure 12). Bluegill captured during this survey ranged from 3.8 to 9.3 inches (Figure 13).

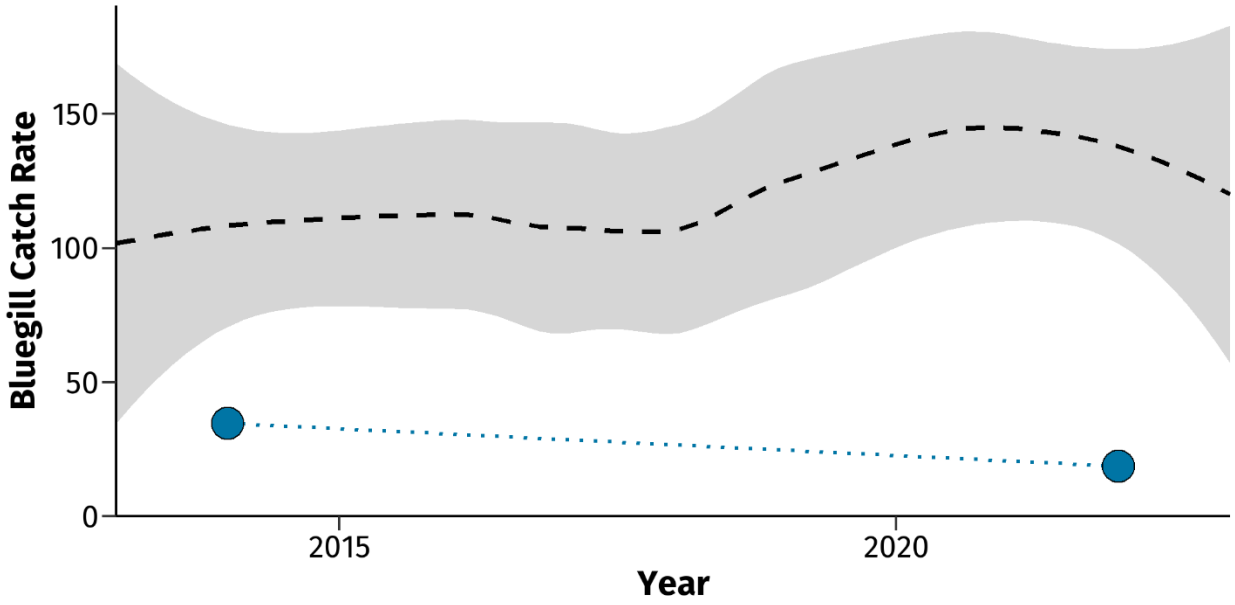

Figure 12. Bluegill catch rate (fish/mile) during the late spring electrofishing survey (SE2) on Lake Nebagamon (blue circles) in 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

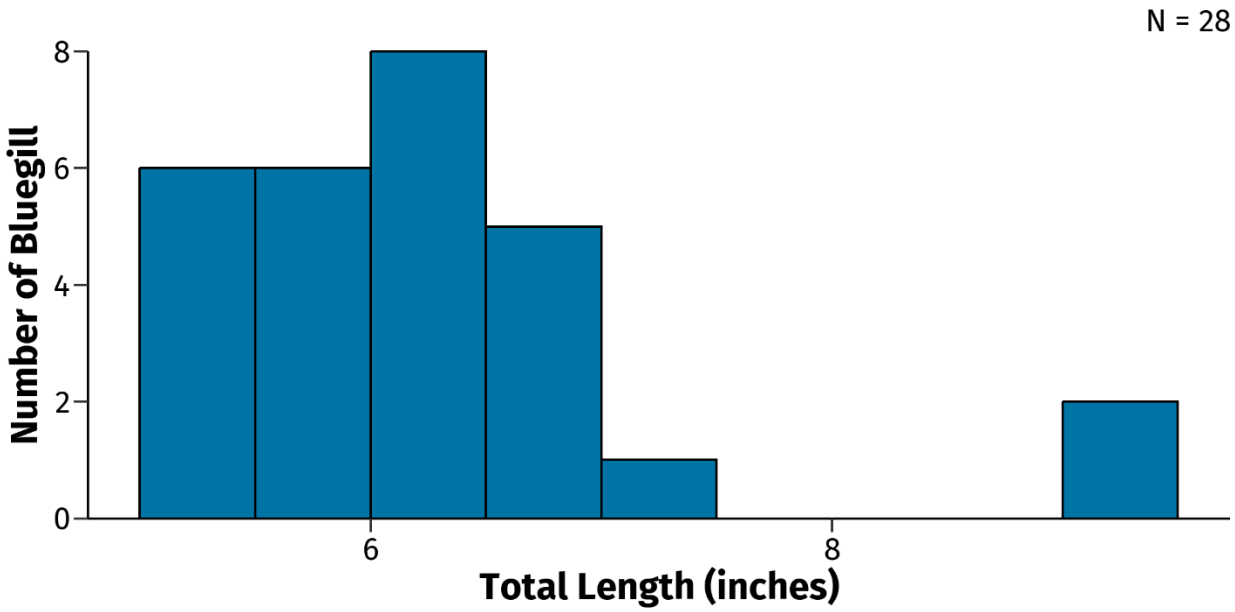

Figure 13. Length frequency histogram of bluegill captured during the late spring electrofishing survey (SE2) on Lake Nebagamon in 2022.

CREEL SURVEY

Bluegill were the fourth most targeted species on Lake Nebagamon in 2022 with 1,144 hours, or 9.76% of the total directed effort (Figure 1). Estimated angling effort targeting bluegill in 2022 was 1.3 hours/acre, which was lower than in 2005 (2.4) and lower than the average of Ceded Territory creel surveys (Figure 14, top left panel). The catch rate was 0.9 bluegill/hour in 2022, which was lower than in 2005 (1.3) and below

average for Ceded Territory creel surveys (Figure 14, top right panel). Estimated angler harvest was 0.2 bluegill/acre in 2022 which was lower than in 2005 (1.3) and near the average of Ceded Territory creel surveys (Figure 14, bottom left panel). The average length of harvested bluegill was 8.2 inches in 2022, which was greater than the 2005 (7.5 inches) and 1998 (7.3 inches) surveys and well above the average for Ceded Territory creel surveys (Figure 14, bottom right panel).

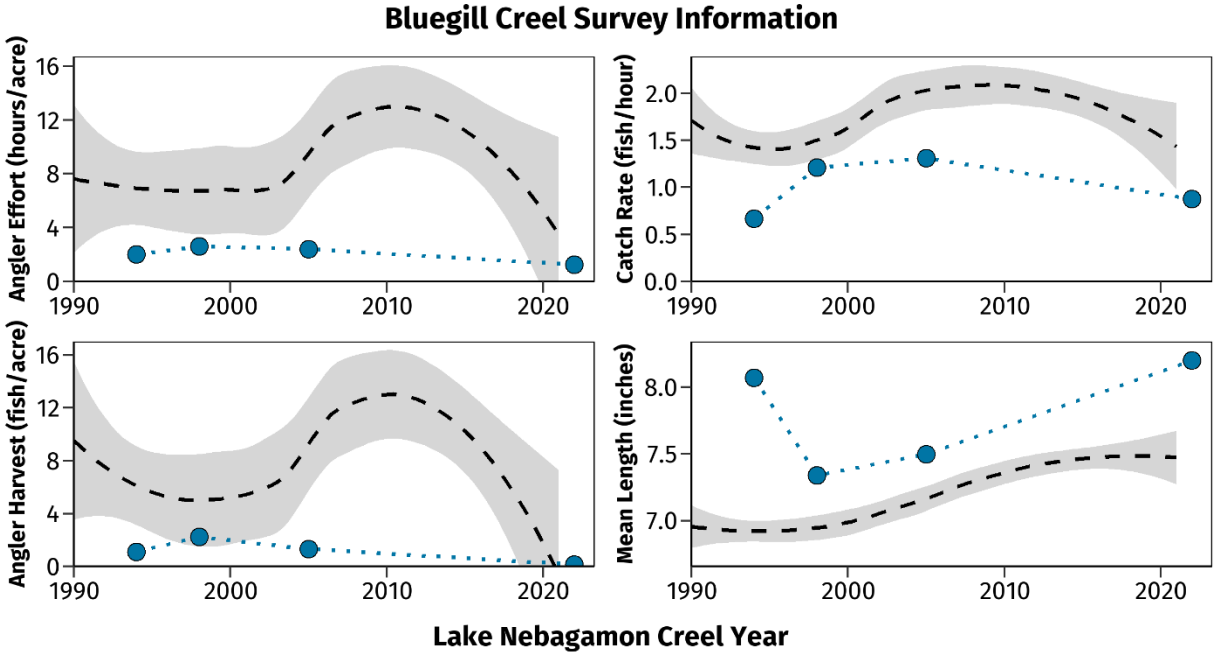

Figure 14. Bluegill effort (top left), catch rate (top right), angler harvest (bottom left) and mean length of harvest (bottom right) on Lake Nebagamon (blue circles) in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

NORTHERN PIKE

FISH SURVEY

The northern pike catch rate was 8.6 fish/net-night during the SN1 survey, which was higher than in 2014 (4.0), but near the average for complex-cool-clear lakes (Figure 15). Northern pike captured in this survey ranged from 12.2 to 26.0 inches (Figure 16) and the PSD-21 was 47, which was lower than in 2014 (71) and near the average of complex-cool-clear lakes (Figure 17).

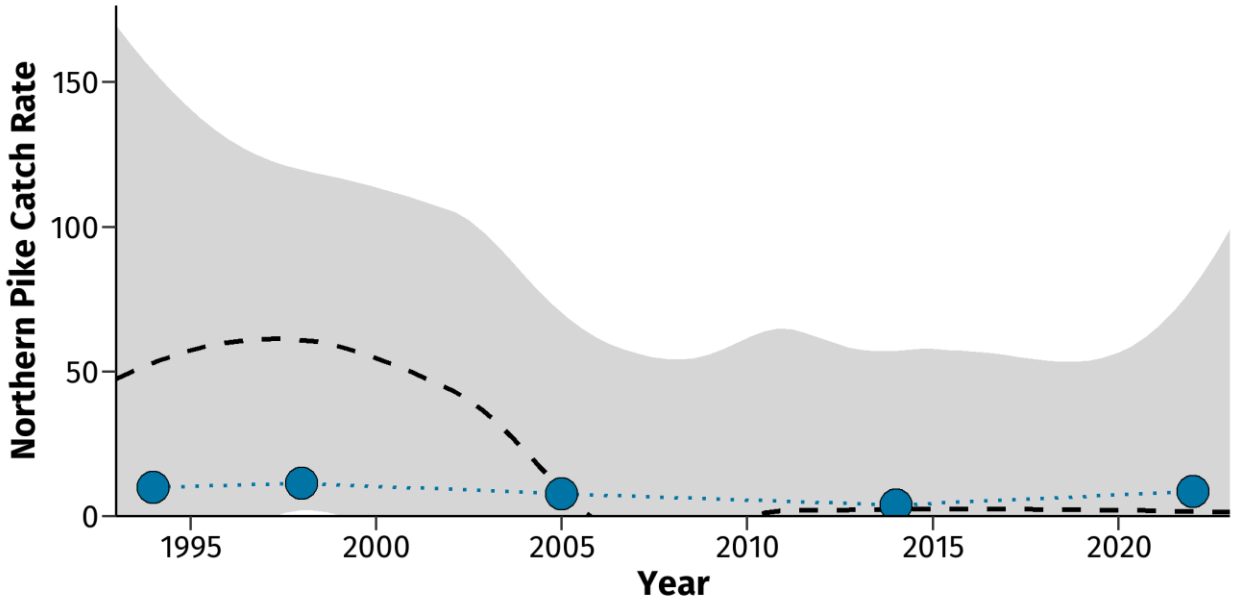

Figure 15. Northern pike catch rate (fish/net-night) during the early spring fyke net survey (SN1) on Lake Nebagamon (blue circles) in 1994, 1998, 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

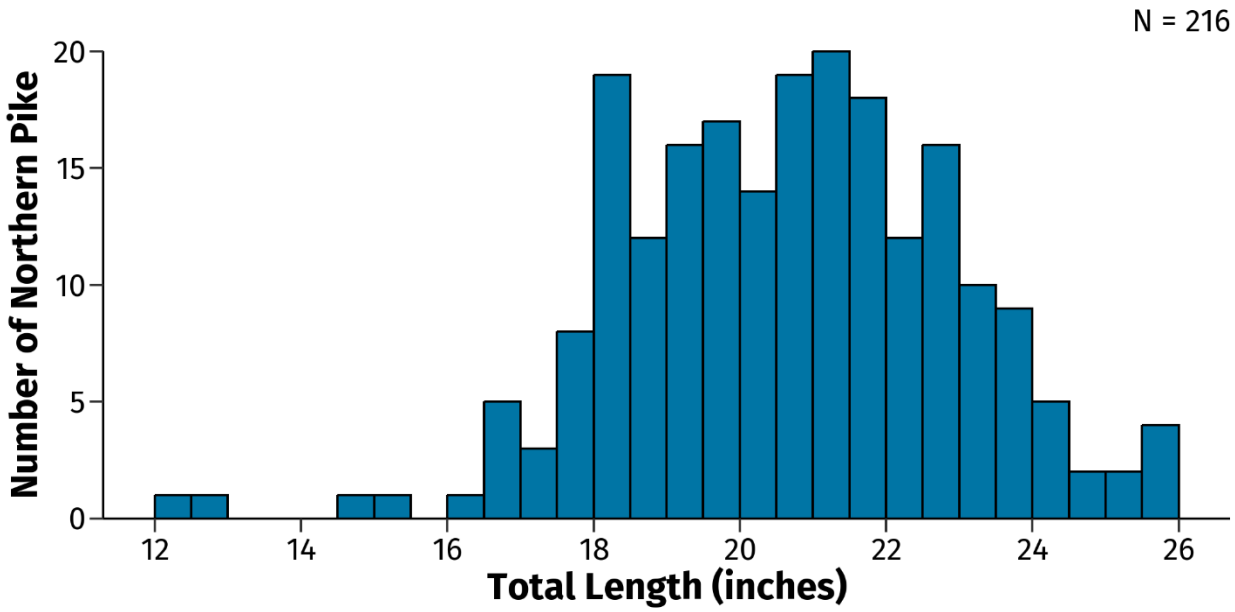

Figure 16. Length frequency histogram of northern pike captured during the early spring fyke net survey (SN1) on Lake Nebagamon in 2022.

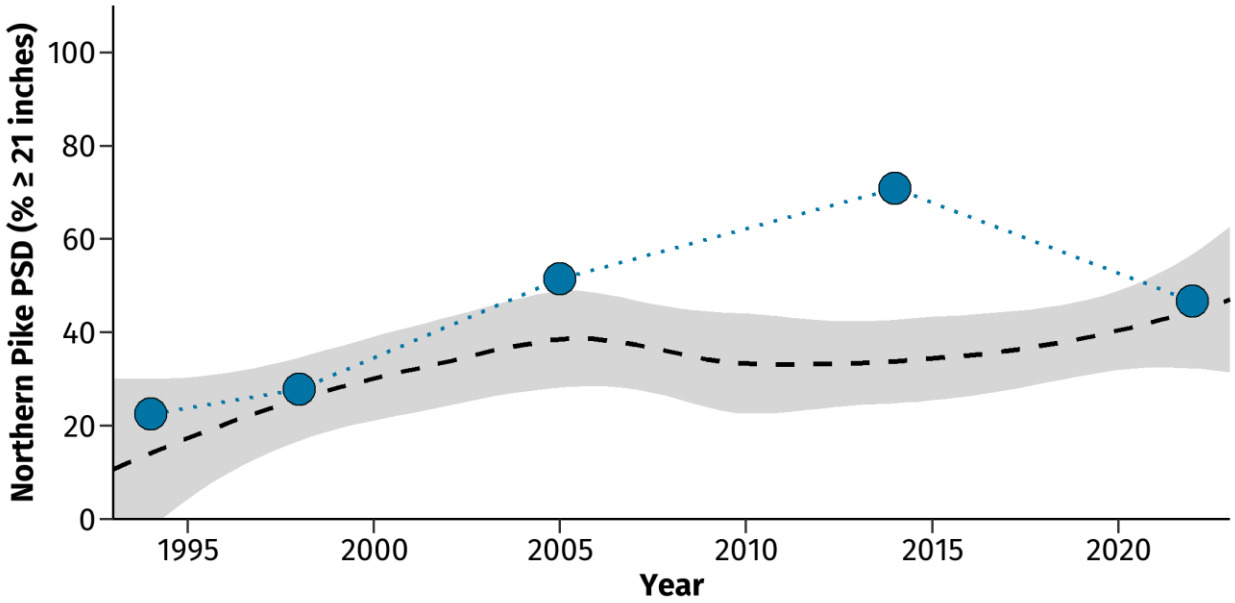

Figure 17. Proportional size distribution (PSD; % ≥ 21 inches) of northern pike captured during the early spring fyke net survey (SN1) on Lake Nebagamon (blue circles) in 1994, 1998, 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

CREEL SURVEY

Northern pike were the sixth most targeted species on Lake Nebagamon in 2022 with 1,079 hours, or 9.21% of the total directed effort (Figure 1). Estimated angling effort targeting northern pike in 2022 was 1.2 hours/acre, which was lower than in 2005 (4.6) and followed the declining trend in Ceded Territory creel surveys (Figure 18, top left panel). The angler catch rate was 0.3 northern pike/hour in 2022, which was higher than in 2005 (0.1) and well above average for Ceded Territory creel surveys (Figure 18, top right panel). Estimated angler harvest was minimal with less than 0.1 northern pike/acre harvested in 2022 which was lower than in 2005 (0.3) but followed the declining trend in Ceded Territory creel surveys (Figure 18, bottom left panel).

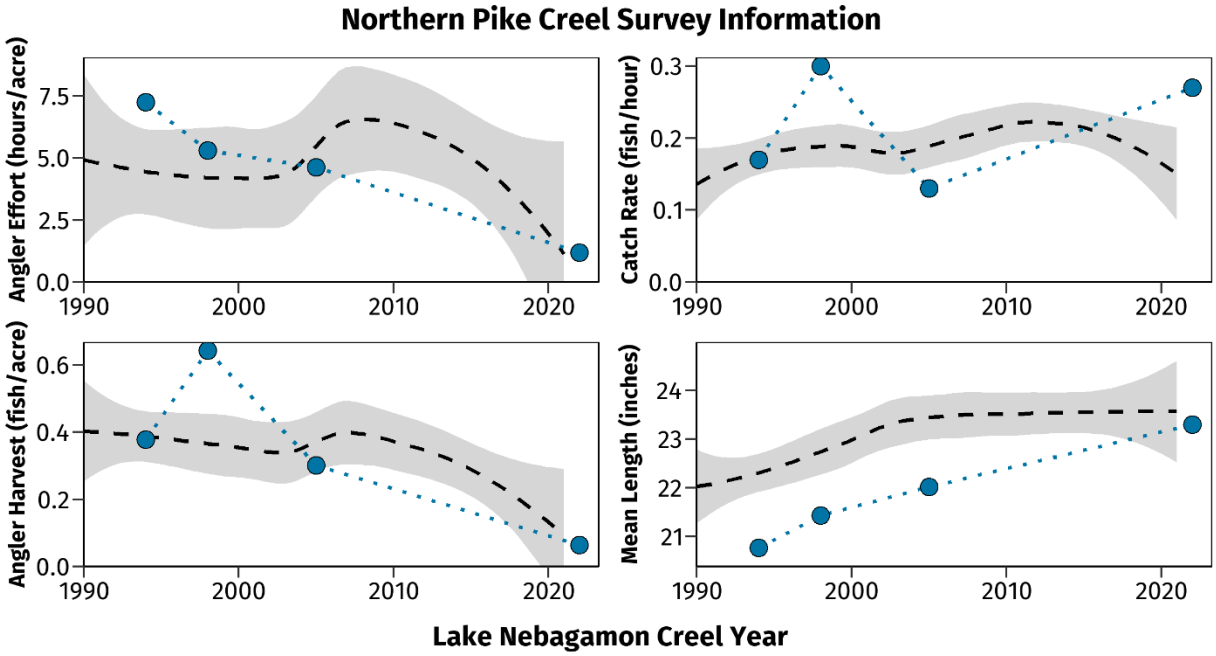

Figure 18. Northern pike effort (top left), catch rate (top right), angler harvest (bottom left) and mean length of harvest (bottom right) on Lake Nebagamon in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

SMALLMOUTH BASS

FISH SURVEY

The smallmouth bass catch rate was 13.0 fish/mile during the SE2 survey, which was higher than in 2014 (6.0) and above the average for complex-cool-clear lakes (Figure 19). Smallmouth bass captured in this survey ranged from 6.7 to 20.7 inches (Figure 20) and the PSD-11 was 91, which was higher than in 2014 (78) and 2005 (79) and well above the average for complex-cool-clear lakes (Figure 21).

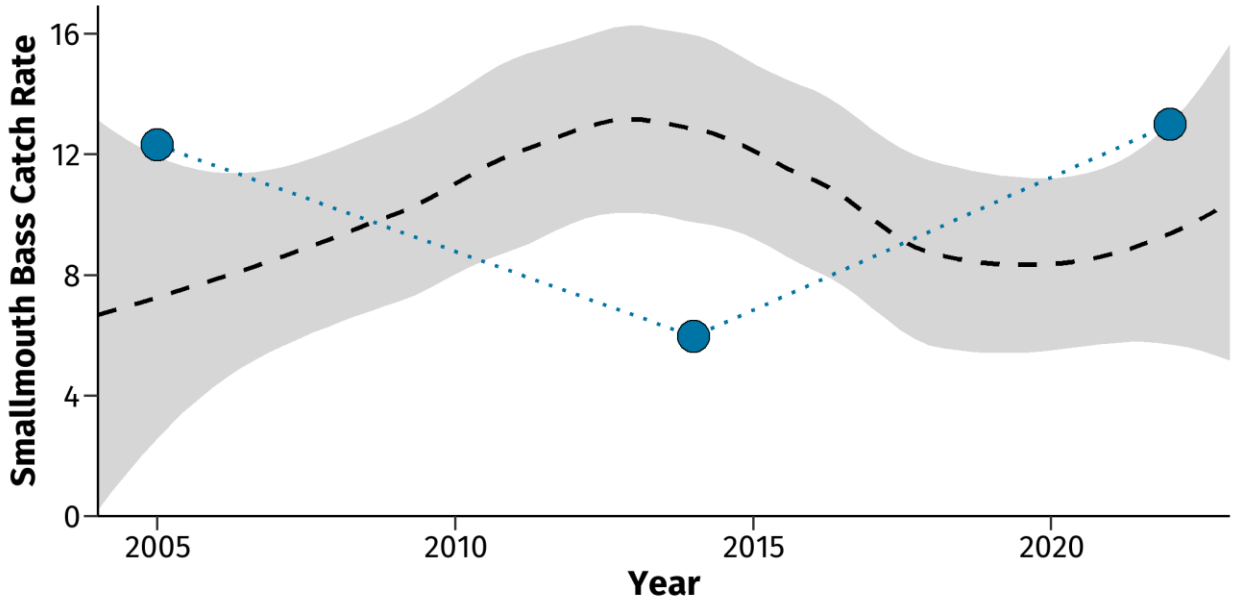

Figure 19. Smallmouth bass catch rate (fish/mile) during the late spring electrofishing survey (SE2) on Lake Nebagamon (blue circles) in 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

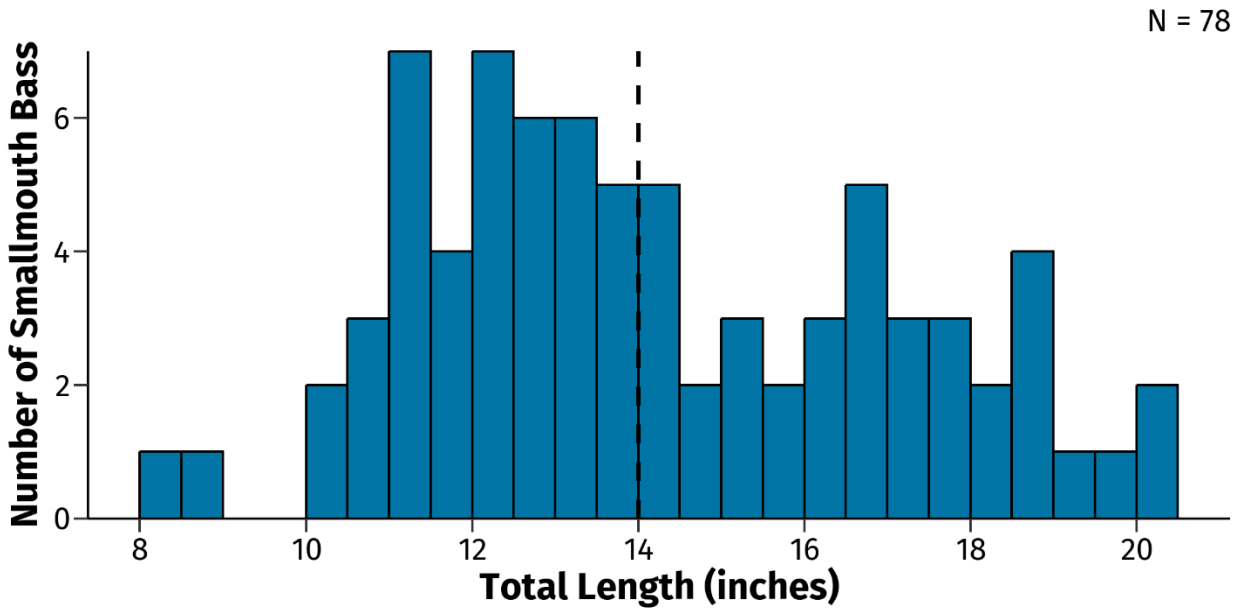

Figure 20. Length frequency histogram of smallmouth bass captured during the late spring electrofishing survey (SE2) on Lake Nebagamon in 2022. The vertical dashed line represents the minimum length limit.

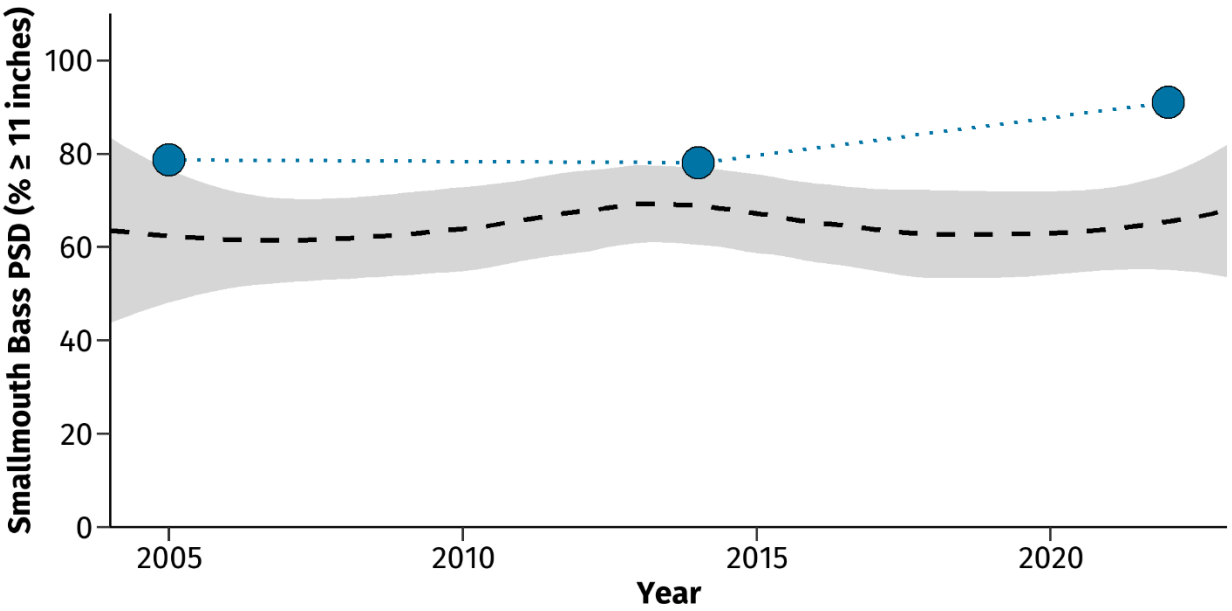

Figure 21. Proportional size distribution (PSD; % ≥ 11 inches) of smallmouth bass captured during the late spring electrofishing survey (SE2) on Lake Nebagamon (blue circles) in 2005, 2014 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of complex-cool-clear lakes were used to provide a comparison.

CREEL SURVEY

Smallmouth bass were the second most targeted species on Lake Nebagamon in 2022 with 2,380 hours, or 20.3% of the total directed effort (Figure 1). Estimated angling effort targeting smallmouth bass in 2022 was 2.6 hours/acre, which was lower than in 2005 (3.9) but near the average from Ceded Territory creel surveys (Figure 22, top left panel). Angler catch rate was 0.43 smallmouth bass/hour in 2022, which was higher than in 2005 (0.39) and 1998 (0.33) and near the average for Ceded Territory creel surveys (Figure 22, top right panel). Estimated angler harvest was minimal with less than 0.1 smallmouth bass/acre harvested in 2022, which was lower than in 2005 (0.1) and below average for Ceded Territory creel surveys (Figure 22, bottom left panel).

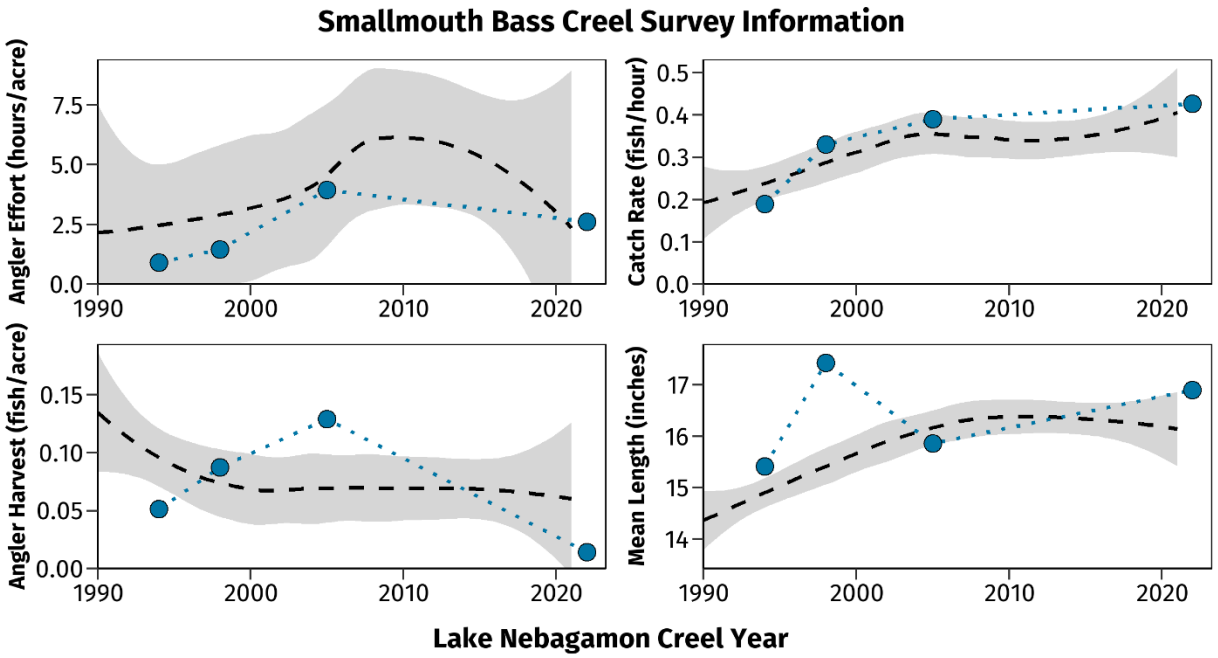

Figure 22. Smallmouth bass effort (top left), catch rate (top right), angler harvest (bottom left) and mean length of harvest (bottom right) on Lake Nebagamon in 1994, 1998, 2005 and 2022. Running average (dashed line) and 95% confidence interval (shaded area) of creel surveys from Ceded Territory lakes were used to provide a comparison.

OTHER SPECIES

Other species captured during Lake Nebagamon 2022 fyke net and electrofishing surveys included 273 white sucker, 153 yellow perch, 39 rock bass, 20 yellow bullhead, 7 largemouth bass, 2 pumpkinseed, 1 brown trout and 1 creek chub. Yellow perch ranged from 2.4 to 7.8 inches and likely serve as an important food source for predators (e.g., walleye, smallmouth bass, northern pike). Largemouth bass ranged from 11.7 to 18 inches.

Discussion

Fisheries in Lake Nebagamon appear to be healthy and provide diverse angling opportunities. Despite productive walleye, smallmouth bass, northern pike, bluegill, and black crappie fisheries, angling effort has declined over 50% since 2005. Walleye received the most directed effort during the angler creel survey, which aligns with the recent angler preference survey where anglers showed a preference for walleye over all other species in Lake Nebagamon (Lawson 2021). Smallmouth bass and largemouth bass were a major component of the creel survey, and received nearly a third of angler effort but both species received much less interest during the angler preference survey (Lawson 2021).

The 2022 surveys on Lake Nebagamon provide a unique opportunity for walleye stocking evaluation, as the lake has substantial stocking and natural reproduction,

and four fin-clipped stocked year classes of adult walleye during the population estimate. Although stocked walleye appear to be important initially, making up approximately half of age-1 fish collected during fall electrofishing surveys, natural recruits perform better later in life, with stocked fish making up less than 20% of the ages 5 and 7. The age-9 year class was more supported by stocking (65%), but aligned with a particularly low age-0 naturally reproduced year class, indicating that stocking may be best suited for filling in missing year classes. Evaluation of nearby lakes indicate similarly high cost of age-5 stocked walleye with Lake Owen, Crystal Lake, and Lake Nebagamon all around $300-400 per age-5, Upper Eau Claire Lake at $500-1000 per age-5 and with Diamond Lake as the most cost effective of the lakes evaluated at approximately $100 per age-5 (Shaikh, *unpublished data*). In all cases, substantial investment is required for even marginal returns in adult population abundance. Additionally, since Lake Nebagamon has natural reproduction, any success of stocked fish may be suppressing natural recruits rather than adding to natural recruitment. Despite poor returns of stocked fish, adult abundance and natural recruitment have improved over the last decade, which is the most desirable scenario. Overall, natural recruitment of walleye appears to be the main source of adult walleye in Lake Nebagamon. Since recent levels of natural reproduction are sufficient to sustain a healthy walleye population, walleye stocking should be discontinued. Annual fall electrofishing surveys will continue to monitor walleye recruitment. If at any point the average age-0 walleye fall electrofishing catch rate from the previous four years is <8 fish/mile and there are no individual year classes ≥15 fish/mile in the last four years, walleye stocking should be reinstated. These benchmarks were chosen based on the historical age-0 fall electrofishing catch rates and the age structure of the adult population. If in place previously, stocking would have been initiated from 2009 through 2015 when natural recruitment was low. A four-year average allows for timely action if natural recruitment has been low or declining for only 2 or 3 years yet still represents most of the year classes that will make up the future adult population as nearly 60% of the adult population in 2022 were age 5 through age 8. Also if there is a strong year class ≥15 fish/mile then stocking would be stopped which is important to prevent stocking on top of an abundant natural year class. In addition to walleye recruitment the adult walleye population will be assessed in future population estimate surveys to further evaluate the fishery and guide management decisions.

The 18-inch minimum length limit for walleye was implemented in 2014 to allow female walleye to spawn at least once before being vulnerable to angler harvest. Since then, walleye abundance has slightly increased while other nearby walleye populations have declined (e.g., Diamond Lake, Pike Chain, Lower Eau Claire Lake). However, walleye abundance remains below the previous target of 3 adults/acre. This target may no longer be realistic for Lake Nebagamon, as it has not been achieved since the early 1990s despite more restrictive angling regulations and increased stocking efforts. A more realistic target for Lake Nebagamon is 1.5 to 2.0 adults/acre moving forward, which should create a balance of number and size of fish that was indicated in the 2021 angler preference survey (Lawson 2021). Walleye harvest has

also declined in recent years, which is likely caused by the over 50% decline in angler effort and the increased protection from the 18-inch minimum length limit. Most anglers indicated that <10% of the walleye they caught were >18" in the 2021 angler preference survey (Lawson 2021), but the 2022 SN1 survey found 33% of walleye were >18". This difference is likely a result of the additional year for walleye to grow past 18" or potentially differences in size selectivity of angling versus fyke netting.

Lake Nebagamon continues to provide low density fisheries for large bluegill and black crappie. Harvest of bluegill and black crappie remains well below the Ceded Territory average and mean size at harvest continues to increase. As a result, more restrictive regulations to limit angler harvest of panfish is unlikely to benefit the bluegill and black crappie populations. The 2021 angler preference survey found that anglers desire a higher abundance of moderate-sized bluegill and black crappie compared to what is currently available in Lake Nebagamon (Lawson 2021). However, Lake Nebagamon has typically had low density, high size structure panfish populations and lakes with a balance of size and number of panfish are available nearby (e.g., Lake Minnesuing) while low density, high size structure panfish populations are much less common. As a result, maintaining the current bluegill and black crappie population characteristics may be best for creating diverse fisheries within the region. The abundance of small yellow perch likely serves as an important prey source for walleye, northern pike, smallmouth bass and largemouth bass in Lake Nebagamon, and anglers showed little desire for yellow perch in the 2021 angler preference survey (Lawson 2021).

Northern pike catch rate and size are near the average for complex-cool-clear lakes and provide anglers with another harvest opportunity. Smallmouth bass have remained in high abundance while size structure has continued to improve. Increased harvest of smaller-sized northern pike and smallmouth bass would help to meet angler desires of lower density, higher size structure populations (Lawson 2021). Currently, Lake Nebagamon provides one of the area's best smallmouth bass angling opportunities for catch-and-release and some harvest. Although anglers are spending more time targeting largemouth bass, catches remain rare for anglers and in the fishery survey.

Management Recommendations

1. **Discontinue stocking of large fingerling walleye.**
   Walleye stocking since 2011 has contributed minimally to the overall fishery while natural walleye recruitment has improved. As such, stocking should be halted and only reinstated if the average age-0 walleye fall electrofishing catch rate from the previous four years is <8 fish/mile and there are no individual year classes ≥15 fish/mile in the last four years.

2. **Retain the 18-inch minimum length limit on walleye.**

The current regulation allows female walleye to spawn at least once before being vulnerable to angler harvest.

3. **Maintain statewide regulations for panfish.**
   These surveys indicated that panfish harvest is low and size structure continues to improve. Bluegill and black crappie are unlikely to benefit from more restrictive panfish regulations.

4. **Continue annual fall electrofishing surveys to assess walleye recruitment and complete a comprehensive fishery assessment in 2028.**
   Recurring monitoring is critical to evaluating stocking needs and regulation changes.

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Appendix

Table A1. Stocking history of walleye on Lake Nebagamon since 1990.

YEAR	WALLEYE	
	Number Stocked	Size
2021	14,768	Large fingerling
2019	14,782	Large fingerling
2017	14,268	Large fingerling
2015	14,783	Large fingerling
2013	13,708	Large fingerling
2012	7,367	Large fingerling
2011	5,390	Large fingerling
2006	40,118	Small fingerling
2005	500,000	Fry
2004	610,000	Fry
2003	670	Large fingerling
2003	500,000	Fry
2002	300	Large fingerling
2002	45,700	Small fingerling
2001	45,700	Small fingerling
2001	500,000	Fry
2000	500,000	Fry
1999	45,700	Small fingerling
1997	45,700	Small fingerling
1995	22,795	Small fingerling
1993	45,100	Small fingerling
1992	44,950	Small fingerling
1991	14,600	Small fingerling

Table A2. Standard DNR surveys for inland lakes, gear used and target water temperature and species.

SURVEY	GEAR	TARGET WATER TEMPERATURE (°F)	TARGET SPECIES
Early spring netting (SN1)	Fyke net	40-50	Walleye Muskellunge Northern pike Black crappie
Early spring electrofishing (SE1)	Boat electrofisher	45-50	Walleye
Late spring netting (SN2)	Fyke net	50-55	Muskellunge Northern pike Black Crappie
Late spring electrofishing (SE2)	Boat electrofisher	55-70	Bass and panfish
Fall electrofishing (FE1)	Boat electrofisher	50-65	Juvenile walleye

Table A3. Length categories for species of interest captured in Lake Nebagamon, Douglas County, WI.

SPECIES	LENGTH CATEGORY (inches)				
	Stock	**Quality**	**Preferred**	**Memorable**	**Trophy**
Walleye	10	15	20	25	30
Black crappie	5	8	10	12	15
Bluegill	3	6	8	10	12
Northern pike	14	21	28	34	44
Smallmouth bass	7	11	14	17	20