Long Lake and Mud Lake Comprehensive Fishery Survey, Washburn County, Wisconsin

2015 - 2016

WBIC Long Lake – 2106800

WBIC Mud Lake - 2107700

Craig Roberts

Senior Fisheries Biologist

Wisconsin Department of Natural Resources

Northern Region – Spooner

2016

Executive Summary

A comprehensive survey of Long Lake and Mud Lake, Washburn County, was conducted during the 2015-2016 sampling season. The primary objectives of this study focused on assessing the gamefish and panfish populations in Long and Mud Lake.

The 2015 walleye population was estimated at 8,481 fish or 2.6 fish/acre. The population increased from the 2009 estimate of 2.1 fish/acre and is higher than the previous two surveys. The adult walleye density was higher than the Ceded Territory average for lakes that are sustained by stocking.

Northern pike, largemouth bass, smallmouth bass, black crappie, bluegill, and other panfish were also collected. A total of 403 northern pike were collected ranging from 10.0 to 38.0 inches. A total of 129 largemouth bass were collected and averaged 11.4 in. Eighteen smallmouth bass were collected and averaged 9.3 in. A total of 257 black crappie were collected while netting and averaged 8.0 in. Bluegill dominated the late spring electrofishing catch (65%), while rock bass were second most abundant (22%).

Management recommendations include: 1) The 18-inch minimum length limit is protecting female walleye until sexual maturity and should be maintained, 2) Based on good survival, extended growth walleye stocking should continue, 3) Northern pike have a stable population with no need for a regulation change, 4) Largemouth bass and smallmouth bass growth have improved and the no minimum regulation should stay in place, 5) The bluegill population should be monitored in response to fishing pressure/increased bass harvest, 6) Black crappie should be monitored in response to angling pressure, 7) Cisco research should continue on Long Lake, and 8) Prevention and monitoring of invasive species should continue on Long Lake, 9) Habitat preservation/reestablishment should be encouraged.

Introduction

Long Lake is a 3,290 acre drainage lake in southeastern Washburn County in the Red Cedar River sub-basin of the Chippewa River. It has a mean depth of 26 feet and a maximum depth of 74 feet. The main inlet to Long Lake is Slim Creek entering on the northeast corner of Long Lake. The main outlet of Long Lake is the Brill River which starts below the dam on the southeast corner of Long Lake. For management purposes, Long Lake and Mud Lake are considered a single waterbody whose water level is controlled by a dam on the outlet of Long Lake. The dam is owned and operated by Washburn County.

Trophic state index (TSI) is an index for evaluating the trophic state or nutrient condition of lakes (Carlson 1977; Lillie et al 1993). Long Lake is considered a mesotrophic or moderately productive lake according to its TSI index in 2015 (WDNR (online) 2015). Of five sites where water quality data is collected: three were mesotrophic (sites in the narrows, Grunhagen bay, and near the dam in the southern basin), while two were considered eutrophic (north end of southern basin and the northern basin).

The Long Lake fishery consists of these gamefish: walleye *Sander vitreus*, northern pike *Esox Lucius*, smallmouth bass *Micropterus dolomieu*, and largemouth bass *Micropterus salmoides*. Panfish present are bluegill *Lepomis macrochirus*, black crappie *Pomoxis negromaculatus*, pumpkinseed *Lepomis microlophus*, rock bass *Ambloplites rupestris*, and yellow perch *Perca flavescens*. Invasive species present include: banded mystery snail *Vivaparus georgianus*, Chinese mystery snail *Bellamy (Cipangopa ludina) chinensis*, and curly-leaf pond weed *Potamogeton crispus.*

Fish stocking has occurred in Long Lake since the 1930s. Walleye have been the most commonly stocked fish, but largemouth bass, smallmouth bass, northern pike, muskellunge,

sunfish, white sucker, and rainbow trout have also been stocked in the past. Wisconsin Department of Natural Resources (WDNR) has been the primary source of walleye (small fingerlings <4 in), but supplemental stocking has also been provided by the Long Lake Chamber of Commerce (large fingerlings ≥ 4in) and the St. Croix Chippewa Tribe (large and small fingerlings) (Appendix Table 1). Stocking was discontinued after 2011 to see if natural reproduction would be sufficient to sustain the walleye population. Long Lake was then added to the Wisconsin Walleye Initiative in 2013. This new program was designed to only stock extended growth fingerlings (> 6 in average). Long Lake is currently only receiving fingerlings from this program so WDNR can assess the extended growth fingerling stocking success.

Angling regulations have generally followed statewide or regional regulation changes until recently. For walleye, a 15 in minimum length limit was in effect from 1990 to 2010. In 2011, an 18 in minimum length limit with a daily bag limit of 3 was implemented for walleye. Largemouth and smallmouth bass had a 14 in minimum length limit from 1989 to 2005. This regulation was changed to a no minimum length limit in 2006 to address poor growth in both species. Fisheries management surveys have been conducted on the lake since 1957. WDNR walleye population estimates have occurred in 1978, 1994, 2001, and 2009. Data was also collected on other gamefish and panfish during these survey years. The 2015 comprehensive survey focused on assessing the gamefish and panfish populations in Long and Mud Lake.

Methods

Field Sampling

Spring sampling started in late March following Wisconsin DNR lake sampling protocol (Simonson et al. 2008) in Mud Lake. Northern pike and walleye sampling consisted of

fyke-net sampling. After ice out, fyke nets (4 x 6 ft frame) were set on 30 March. Nets were placed on shorelines favorable for northern pike spawning. Four nets were fished until 3 April for a total of 16 net nights. During this time, adult walleye were also marked with fin clips before all nets were moved to Long Lake (these fish were not included in the Long Lake population estimate).

Long lake fyke net sampling focused on walleye and northern pike. Black crappie data was also collected from a subset of fyke nets/sampling dates. Netting on Long Lake started 1 April and ran until 14 April for a total of 189 net nights. Walleye and northern pike were sampled during this entire period. Black crappie data was collected from a subset of nets on 4, 11, and 12 April. A recapture electrofishing run for walleye took place 14 April and the entire shoreline was sampled.

Late spring night electrofishing took place 1 June. Five two-mile gamefish stations were sampled with a focus on collecting largemouth and smallmouth bass on Long Lake. Each two mile station had a ½ mile index station embedded within it where panfish were collected in addition to bass. One two mile station (with a ½ mile panfish index) was also sampled in Mud Lake with a focus on bass and panfish.

Six mini-fyke nets (3 x 3 ft frame) were set on 26 August and run for one night. Juvenile and nongame fish species were targeted during this survey. Small-mesh panels on the front frame of the nets were used to exclude larger fish and turtles.

A walleye recruitment survey was conducted in the fall of 2015. Sampling took place once surface water temperature had dropped below 70° F. Walleye less than 12.0 in were collected in the sample. Six crews sampled the entire shoreline during this survey.

Age and Statistical Analysis

Scale samples were removed from walleyes, smallmouth bass, and largemouth bass less than 12 in, while dorsal spines were removed from larger walleyes, smallmouth bass, and largemouth bass for age analysis. Age interpretations on northern pike were not conducted due to the unreliability and difficulty of determining annuli. Casselman (1990) found this to be due to irregular growth and resorption or erosion on the midlateral region.

Size structure quality of species sampled was determined using the indices proportional stock densities (PSD) (Neumann et al. 2013). The PSD value for a species is the number of fish of a specified length and longer divided by the number of fish of stock length or longer, the result multiplied by 100. Catch per Unit Effort (CPE) was calculated as the number of fish captured divided by the appropriate unit of sampling effort for that species.

Creel Survey and Exploitation

A creel survey was conducted on Long Lake from 2 May 2015 to 6 March 2016. The survey took place in both open water and ice conditions. No data was collected during November when ice is unsafe for fishing. The survey used a random stratified roving access design (Beard et al. 1997). Angler directed effort (hrs), catch, harvest, and mean length of harvested fish was collected during the survey. The creel survey also recorded the number of marked walleye harvested. Using this data, recreational exploitation for walleye can be estimated by dividing the estimated number of marked fish harvested during the creel survey by the total number of marked fish (spring fyke-netting and electrofishing) (Ricker 1975). Tribal exploitation was calculated using the number of walleye harvested in the spring divided by the adult walleye population estimate (Ricker 1975).

Bass Tournament Data Collection and Analysis

Data was collected from adult largemouth and smallmouth bass from the Wisconsin Team Circuit Bass Tournament, which was held 9 August. All fish used in the sample were collected with hook and line around the lake and only fish greater than 14 in were registered at the tournament weigh-in. Lengths and aging structures were collected from each fish registered for the tournament.

Results

Early Spring Fyke-Netting and Electrofishing

Walleye. The 2015 walleye population was estimated at 8,481 fish (C.V. = .05) or 2.6 fish/acre. The population increased from the 2009 estimate of 2.1 fish/acre and is higher than the previous two surveys (Table 1). The adult walleye density was higher than the Ceded Territory average for lakes that are sustained by stocking (0.9/acre in Cichosz 2015). A total of 3,621 walleye were marked during netting and electrofishing. The catch per effort (CPE) was 14.2 fish/net for fyke-net sampling and 27.1 fish/mile for electrofishing. These catch rates are similar to 2009 (14.8/net night; 30.1 fish/mile).

Adult walleyes ranged in length from 12.2 to 30.0 in (Figure 1). The 2015 size structure was similar to the 2001 and 2009 survey (Figure 2). Mean length of male and female walleye were 16.6 in (standard deviation (SD) =1.4) and 20.0 in (SD=3.3), respectively. Overall average length of walleye increased from 16.5 in (SD=3.1) to 17.0 in (SD=1.5). PSD increased from 67 (2009) to 91 (2015), while PSD-20 dropped from 12 (2009) to 6 (2015). Male and female walleye mean length-at-age was comparable to past surveys and above Northwest Wisconsin averages (Figure 3 & 4).

Thirteen walleye were sampled during netting on Mud Lake. They ranged in length from 14.0 – 27.5 in (18.9 in average (avg)). Due to low sample size, PSD was not calculated for Mud Lake walleye.

Northern Pike. A total of 403 northern pike were collected in Mud Lake and Long Lake in 2015. They ranged in length from 10.0 to 38.0 in (Figure 5). Mean length of female and male northern pike was 22.6 in (SD=4.4) and 18.1 in (SD=2.5) in 2015, respectively. Overall average length was 20.6 in, which is greater than the two previous surveys (Figure 6). The overall catch rate was 2.0 fish/net night for Long and Mud Lake. Mud Lake's catch rate was 8.6 fish/net night, while Long Lake was 1.4 fish/net night. PSD and PSD-28 for pike was 42 and 5, when considering both Long and Mud Lake. PSD increased from 2009 (34), while PSD-28 stayed the same (5).

Black Crappie. A total of 257 black crappie were sampled in 2015, 22 were sampled using late-spring electrofishing and 235 were captured with fyke-nets. They ranged in length from 3.8 to 11.8 in and averaged 8.0 in (SD=2.7) (Figure 7). PSD-8 and 10 was 82 and 58, respectively showing excellent size structure for crappie collected. Age-3 to Age-5 black crappie grew an average of 1.6 in greater than the Northern Region averages (Figure 8).

Late Spring Electrofishing and Mini-fyke Netting

Largemouth Bass. A total of 129 largemouth bass were collected 1 June ranging from 6.5 - 17.5 in. They averaged 11.4 in, which is less than 2009 (12.2 in avg) and similar to 2001 (11.3 in avg; Figure 9). Largemouth bass PSD and PSD-15 decreased slightly in 2015 when compared to previous spring surveys (Table 2). Spring electrofishing catch rates decreased over fifty percent from 27.0 fish/mile in 2009 to 12.9 fish/mile in 2015.

Largemouth bass grew to up 1.2 in above the Northern Region average between age-2 and age-5 (Figure 10). Growth potential was greater in 2009, 2010, and 2015 than in 2004 (Figure11). Maximum potential length increased from 17.5 in in 2004 to 18.3 in 2015. Due to a lack of older fish captured in the spring sample, mortality estimates weren't calculated for largemouth bass in 2015.

Thirty-nine largemouth bass ranging from 6.7 to 19.9 in (11.8 in avg.) were captured in Mud Lake. PSD was not calculated for Mud Lake bass due to low sample size.

Smallmouth Bass. A total of 18 smallmouth bass were collected 1 June ranging from 5.5 – 13.0 in (9.3 in average length). Smallmouth bass catch rates were 1.8 fish/mile in 2015, similar to 1.3 fish/mile in 2009. PSD was not calculated for smallmouth bass due to small sample size. Smallmouth bass growth has improved in each survey since 2004 and was near the Northern Region average in 2015(Figure 12). No smallmouth bass were sampled during electrofishing in Mud Lake.

Panfish. Bluegill dominated the late spring electrofishing catch (65%), while rock bass were second most abundant (22%) (Figure 13). Size structure of bluegill has improved since the 2009 survey (Figure 14). Bluegill averaged 5.0 in (SD = 2.7) in 2015, which is very similar to 2009 (4.9 in avg) and the same as 2001 (5.0 in avg). Long Lake bluegill grew an average of 1.1 in slower than Northern Region averages (Figure 15). PSD and PSD-7 was 21 and 4. This is a slight decrease from 2009 (PSD=23;PSD-7=9).

Bluegill, pumpkinseed, and yellow perch were the only panfish species collected in Mud Lake during the survey. Bluegill were the most abundant with 110 fish captured at 5.5 in average (2.7 – 8.6 in). Pumpkinseed averaged 6.6 in (n = 11) and yellow perch averaged 5.8 in (n=15).

Nongame and juvenile gamefish. A total of 15 species were captured during the 2015 mini fyke netting survey (Table 3). The 2015 survey yielded three more fish species than 2013 and one less than 2001. Bluegill, bluntnose minnow, and smallmouth bass were the three most abundant species present. There was a decrease in abundance of yellow perch from 37.5% of the sample in 2013 to 0.8% in 2015. Bluegill increased from 21.1% to 69.7% mini-fyke net catch.

Fall Walleye Recruitment Survey

The catch rate of young-of-year (YOY) walleye was below the Ceded Territory average for stocked lakes (3.5 fish/mile in Cichocz 2015) at 2.5 fish/mile (Figure 16). This catch rate is slightly lower than the long term average for Long Lake of 3.2 fish/mile. The catch rate of 7.1 fish/mile for age-1 walleye was much higher than the long term average of 1.2 fish/mile (Figure 17).

Creel Survey and Walleye Exploitation

Anglers spent a total of 109,453 projected hours (33.3 hr/acre) fishing Long Lake from May 2015 to March 2016. The total projected pressure decreased from the previous two creel surveys (Table 4). Open water fishing accounted for 82% of the angler fishing pressure at 27.2 hr/acre, while ice fishing accounted for 18% or 6.1 hr/acre (Table 4). Anglers spent the most time fishing for bluegill (21%), followed by largemouth bass (20%), and walleye (18%) in 2015. In the previous creel survey, walleye were the most pursued (23%), followed by largemouth bass (20%), and smallmouth bass (15%) (Figure 18). Bluegill were the most harvested (47,743), followed by black crappie (15,072), and largemouth bass (3,580) (Figure 19). Harvest numbers for each species have varied among 1994, 2001, and 2015 surveys (Appendix Table 2).

Walleye angling exploitation was estimated at 3%, while tribal exploitation was estimated at 8%. The 2015 total walleye exploitation was estimated at 11%. Angling

exploitation has decreased since 1994 (23%) and 2001(8%), while tribal exploitation has been inconsistent (3% in 1994 and 12% in 2001). Total walleye exploitation has dropped since 1994 (25%) and 2001 (20%).

Bass Tournament Data

There were 35 largemouth bass ranging from 14.2 to 19.6 in (16.4 in avg.) and 29 smallmouth bass ranging from 14.8 to 19.1 in (17.1 in avg.) checked into the August Wisconsin Team Circuit tournament at Long Lake. Largemouth bass over age-5 grew up to 2.5 inches below Northern Region average (Figure 20). Smallmouth bass over age-5 grew near average except for age-9 fish (Figure 21).

Discussion

Long Lake is the largest lake in Washburn County and one of the most important fisheries in Washburn County. It provides angling opportunities for multiple gamefish and panfish species with bass, walleye, and panfish being the most pursued. The fishery receives more pressure on average than other lakes in Washburn County.

Long Lake's walleye population is now at similar levels found in 1978. Johannes (1979) estimated the adult walleye population to be between two to three fish per acre. Currently, the walleye population has been on an increasing trend, recovering from a population low of 1.3 fish/acre in 1998. The average size of adult walleye is currently near the legal length (16.5 inch average). Walleye fishing should allow for harvest on Long Lake for the next several fishing seasons with many fish growing to a harvestable size.

Natural walleye recruitment has continued to be low. A good year class for Long Lake is over 10 fish/mile. This rate would be considered too low in other Washburn County walleye

lakes with natural reproduction, but it is enough to help sustain Long Lake. These larger year classes in Long Lake are sporadic occurring every five to 13 years since 1978. However, these year classes often result in a large contribution to the adult population and therefore are very important for the future of the walleye fishery. Walleye growth remains strong in Long Lake with walleye growing much faster than other walleye lakes in the region.

Because of the sporadic nature of the natural recruitment year classes on Long Lake, supplemental stocking has occurred to bolster the walleye population during low recruitment years. Survival of these stockings is also sporadic in the past with some years being better than others. The most recent walleye initiative stocking had the most success with seven fish/ mile. This rate tied the highest recorded age-1 walleye catch rate ever for Long Lake. Historically, if fish survive to age-1 in Long Lake it usually translates to the adult walleye fishery (Johannes 1979).

Angling pressure for walleye has decreased since 1994 and 2001. Once the most pursued fish in Long Lake, it is now the third most popular fish among anglers. Angling exploitation has also decreased since 1994. Tribal exploitation has varied with no positive or negative trend (3-12%). The 18 inch minimum length limit, which took effect in the 2011 fishing season, may have impacted the number of anglers who want to pursue walleye and reduced angler harvest.

The largemouth bass growth and size structure have improved since the 2006 regulation change to no minimum length limit for bass. Fish under age-7 are growing at/above average, while older bass have below average growth. Since 2009, the catch rate for largemouth bass also decreased. There are a couple of possibilities that may have impacted the catch rate. First, sampling was conducted when the surface water temperature was 62° F, which is on the lower end of the recommended temperatures for electrofishing largemouth bass (55°-70° F in

Simonson 2008). The other possibility is increased harvest has decreased bass densities. Largemouth bass were the second most sought after species in Long Lake and more fish were harvested at a smaller average size in 2015. This fact demonstrates that anglers could and did harvest smaller bass.

Smallmouth bass sampling continues to be a challenge on Long Lake. In 2009 and this survey we got relatively low numbers of smallmouth bass. Sampling for larger adult smallmouth bass seems to be difficult due to spawn timing and the bathymetry of Long Lake. At the time of our spring electrofishing survey, smallmouth bass were present on main lake structure instead of shallow bays. Largemouth bass were present in both areas and therefore more available for sampling. We were able to get young smallmouth bass for aging purposes. Growth improved substantially between 2004 and 2015 for smallmouth bass with younger fish having average growth, whereas it was below average before the regulation change.

Another trend suggesting increased bass growth is larger average weight per bass weighed in for two different tournaments which fish long lake annually (Long Lake tournament data unpublished). The Wisconsin Team Circuit tournament and Price County Bass Anglers both have seen increases in average weight per bass weighed-in through time (0.7 lbs for Wisconsin Team Circuit, 0.4 lbs for Price County Bass Anglers). Multiple variables could affect this weight increase: angler skill, better fishing tackle, electronics, etc. But overall this data supports that bass growth has improved with the no minimum size limit change in 2006.

Both largemouth and smallmouth bass had a reduction in the average size harvested in 2015. This reduction can be attributed to the removal of a size limit which allowed anglers to keep smaller bass. Largemouth bass were the most harvested gamefish, while smallmouth bass

were third most harvested. This data suggests anglers are willing to keep both bass species present in Long Lake.

The northern pike population is very similar to other Washburn county lakes. Overall, the pike population seems to have remained stable since 2001 with similar catch rates and size structure. Pike fishing pressure is similar to 2001 and pike harvest decreased to 1% of the total creel harvest. At this time it seems that northern pike are low priority for anglers who fish Long Lake.

The panfish community is dominated by bluegill, rock bass, and black crappie. Bluegill remain the most abundant panfish. However, there were some discrepancies between our electrofishing sample and mean length harvested in the creel. During the creel, good numbers of seven through 10 in bluegill were harvested. These larger bluegill were not captured during late spring electrofishing. This difference was likely due to the littoral water temperature being 62° F, which is below the typical range for bluegill spawning (66° – 79° F in Ontario Freshwater Fishes Life History Database 2016).

Bluegill were the most harvested fish and estimated harvest numbers were similar to 1994. Long Lake seems to be capable of producing fish at a similar level to the past without causing recruitment issues. Based on this information the bluegill fishery seems stable with plenty of quality bluegill being harvested and good numbers of smaller fish recruiting into the system.

Black crappie have a stable population on Long Lake with good recruitment, excellent growth, and average size. Long Lake is known regionally for its crappie fishing and they were the second most targeted panfish species in the creel survey. The averages size of harvest has increased over an inch since the 1994 creel. This data matched lengths of fish captured in fyke-

nets. A majority of harvest was focused on age-4 and age-5 black crappie (10 – 11 in) and anglers may notice a gap with an apparent lower density of age-3 fish. The age-2 year class appears strong and should provide good recruitment for the crappie fishery.

Cisco are an important prey resource in Long Lake. WDNR fisheries research staff sampled Long Lake in 2011 finding a moderate abundance of cisco when compared with other Wisconsin lakes (21.0 cisco/net night; Lyons et al. 2013). Cisco are an energy rich prey item for the lake's adult walleye and northern pike (Bozek et al. 2011; Jacobson 1992). Cisco have also been shown as an important prey item influencing walleye growth in the Ceded Territory (Noring et al. unpublished data).

Long Lake is a large complex system with many factors potentially impacting the fish populations in the lake. However, it appears to have a stable fishery providing both quality fishing opportunities for gamefish and panfish at this time.

Summary and Management Recommendations

1) The walleye population has increased since 2009, but recruitment remains the main concern. Sporadic larger natural year classes and supplemental stocking currently support the walleye fishery. Long lake has the habitat to support better levels of natural reproduction and that should be the goal. The 18-inch minimum length limit is protecting female walleye until sexual maturity and increasing potential for better natural reproduction in long lake. It should stay in place for these reasons.
2) Based on current good survival, extended growth walleye stocking should continue if possible. Evaluation of the contribution to the adult walleye fishery will occur during the next survey in 2021.

3) Northern pike populations have remained stable and harvest has decreased since 2001. Harvest should not be limited due to decreased angler effort on Long Lake. The current regulation should stay in place.
4) Largemouth bass and smallmouth bass growth have improved since the 2006 regulation change to no minimum size limit on bass. Anglers are harvesting smaller bass, reducing densities, and creating better growth. This regulation should stay in place to continue this trend.
5) Bluegill sustain the most harvest of any fish species on Long Lake. However, their average size of harvest has increased through time and still supports good levels of recruitment. The current regulation is acceptable at this time. Future assessments should monitor for significant changes to size structure or recruitment failures from overfishing/ increased bass harvest.
6) Black crappie sustain the second most harvest and have also had an increase of average size harvested through time. Black crappie growth is well above average and recruitment seems strong. The crappie fishery should continue to be checked periodically with fyke-net sampling and a 10 fish bag limit considered if numbers fall or recruitment failures occur.
7) Research of the cisco population in Long Lake should continue due to their importance as a prey item for game fish in the lake.
8) Prevention and monitoring of invasive species should continue in the lake and at boat launches/accesses. Establishment of future invasive species could be detrimental to the system.

9) Efforts to increase habitat complexity in Long Lake should be strongly encouraged. Input of coarse woody debris, protection/promotion of aquatic vegetation, and maintenance or restoration of 35 ft. vegetative buffers are some examples of work that can increase habitat complexity.

Acknowledgements

I would like to thank Kent Bass, Eric Berge, and the Treaty Assessment crew who conducted the field work, aged fish, and entered data during this survey. I would also like to thank the Barron crew and GLIFWC, who assisted with walleye electrofishing. Last, I would like thank Matt Kufahl, who spent many hours on Long Lake interviewing anglers. Jeff Kampa provided a critical review of the manuscript.

References

Beard, T. D., Jr., S. W. Hewett, Q. Yang, R. M. King, and S. J. Gilbert. 1997. Prediction of angler catch rates based on walleye population density. North American Journal of Fisheries Management 17 (4): 621-627.

Bozek, M.A., T.J. Haxton, and J.K. Raabe. 2011. Walleye and sauger habitat. Pages 133 – 197 *in* B.A. Barton, editor. Biology, management, and culture of walleye and sauger. American Fisheries Society, Bethesda, Maryland.

Carlson, R. 1977. A trophic state index for lakes. Limonology and Oceanography 22:361-369.

Casselman, J.M. 1990. Growth and relative size of calcified structures of fish. Transactions of the American Fisheries Society 119:673-688.

Cichosz, T.A. 2015. Wisconsin Department of Natural Resources 2013-2014 Ceded Territory Fishery Assessment Report. Wisconsin Department of Natural Resources. Administrative Report 75, Madison.

Jacobson, P.C. 1992. Analysis of factors affecting growth of northern pike in Minnesota. Investigational Report 424. Minnesota Department of Natural Resources, Minneapolis, MN.

Johannes, S.I. 1979. Lake Survey – Long Lake, Washburn County. Wisconsin Department of Natural Resources internal report.

Lillie, R.A., S. Graham, and P. Rasmussen. 1993. Trophic state index equations and regional predictive equations for Wisconsin lakes. Bureau of Research – Wisconsin Department of Natural Resources, Research Management Findings, Number 35.

Lyons, J., J. Kampa, T. Parks, and G. Sass. 2015. The whitefishes of Wisconsin's lakes: The 2011-2014 Wisconsin Department of Natural Resources cisco and lake whitefish survey. Fisheries and Aquatic Research Section. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Neumann, R. M., C. S. Guy, and D. W. Willis. 2013. Length, weight, and associated indices. Pages 637-676 in A. V. Zale, D. L. Parrish, and T. M. Sutton, editors. Fisheries techniques, 3rd edition. American Fisheries Society, Bethesda, Maryland.

Ontario Freshwater Fishes Life History Database. 2016. At: http://www.ontariofishes.ca/home.htm .

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin. Fisheries Research Board of Canada 191. 382p.

Simonson, T., A. Fayram, J. Hennessy, and T. Treska. 2008. Fisheries Assessments - Lakes 2007-09 Sampling Procedures. Wisconsin DNR internal publication. Madison, WI.

WDNR (online) 2015. Citizen monitoring lake water quality database. Available from: http://dnr.wi.gov/lakes/CLMN.

Table 1. Walleye population estimates in Long Lake, Washburn County, Wisconsin. P.E. = population estimate, C.V. = Coefficient of Variation. * GLIWC estimates using different methods.

	1994	1998*	2001	2009	2015
P.E.	10,237	4,420	4,966	6,915	8,481
C.V.	0.09	0.07	0.07	0.07	0.05
fish/acre	3.1	1.3	1.5	2.1	2.6

Table 2. Largemouth bass PSD and PSD-15 values from fish collected during sampling on Mud Lake and Long Lake, Washburn County. Only fish captured during late-spring electrofishing were included in this analysis.

Parameter	1994	2001	2009	2015
PSD	76	42	56	50
PSD-15	5	7	15	9

Table 3. Relative catch (%) by species in mini-fyke net samples in2001, 2013, and 2015.

Fish Species	2001	2013	2015
BANDED KILLIFISH	0.2	-	0.1
BLACK BULLHEAD	1.6	-	-
BLACK CRAPPIE	0.1	-	-
BLACKCHIN SHINER	4.0	0.4	0.1
BLUEGILL	32.4	21.1	69.7
BLUNTNOSE MINNOW	17.0	26.8	23.8
BROOK SILVERSIDE	-	-	0.2
GREEN SUNFISH	0.1	0.3	0.1
IOWA DARTER	0.7	-	0.1
JOHNNY DARTER	0.3	0.2	-
LARGEMOUTH BASS	4.7	5.7	1.1
LOGPERCH	-	-	0.2
MIMIC SHINER	0.1	-	-
PUMPKINSEED	0.3	0.1	-
ROCK BASS	0.7	1.2	1.7
SMALLMOUTH BASS	0.2	6.7	1.7
TADPOLE MADTOM	-	0.1	0.1
WARMOUTH	-	0.1	-
WHITE SUCKER	-	-	0.1
YELLOW BULLHEAD	0.1	-	0.2
YELLOW PERCH	37.1	37.5	0.8

Table 4. Projected angler pressure (angler hrs) and angler hours/acre during the past three Wisconsin DNR creel surveys for Long Lake, Washburn County, Wisconsin.

Fishing Season	1994-1995	2001-2002	2015-2016
Open Water Projected Pressure	134,406	110,166	89,399
Ice Projected Pressure	39,548	26,364	20,054
Total Projected Pressure	173,954	136,530	109,453
Angler Hours/Acre	52.9	41.5	33.3

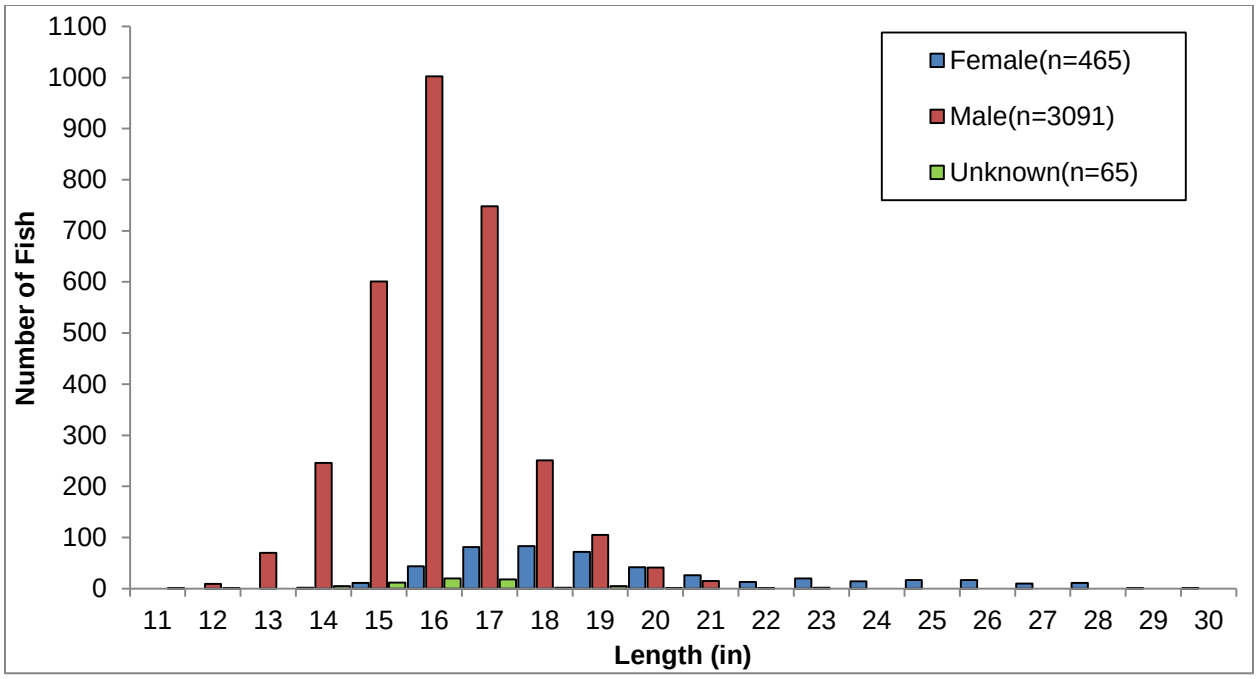

Figure 1. Length frequency of spawning walleye captured in spring 2016 in Long Lake, Washburn County, Wisconsin.

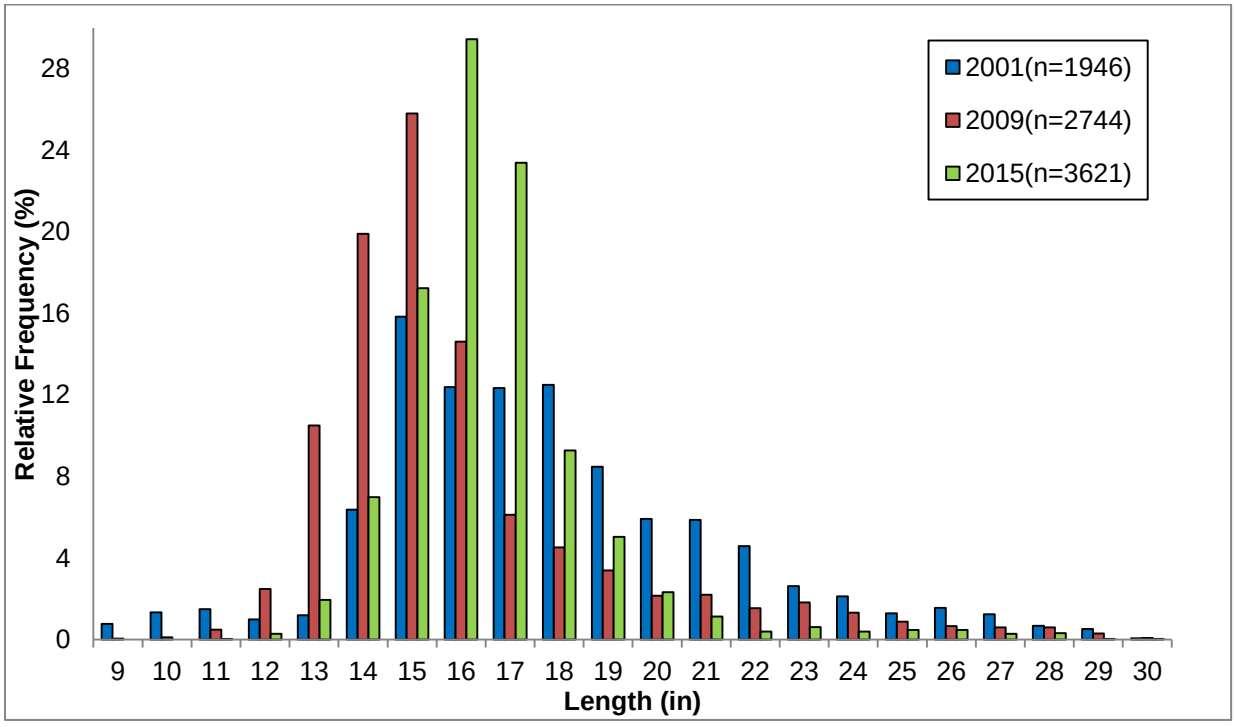

Figure 2. Relative length frequency of spawning walleye in Long Lake, Washburn County, Wisconsin.

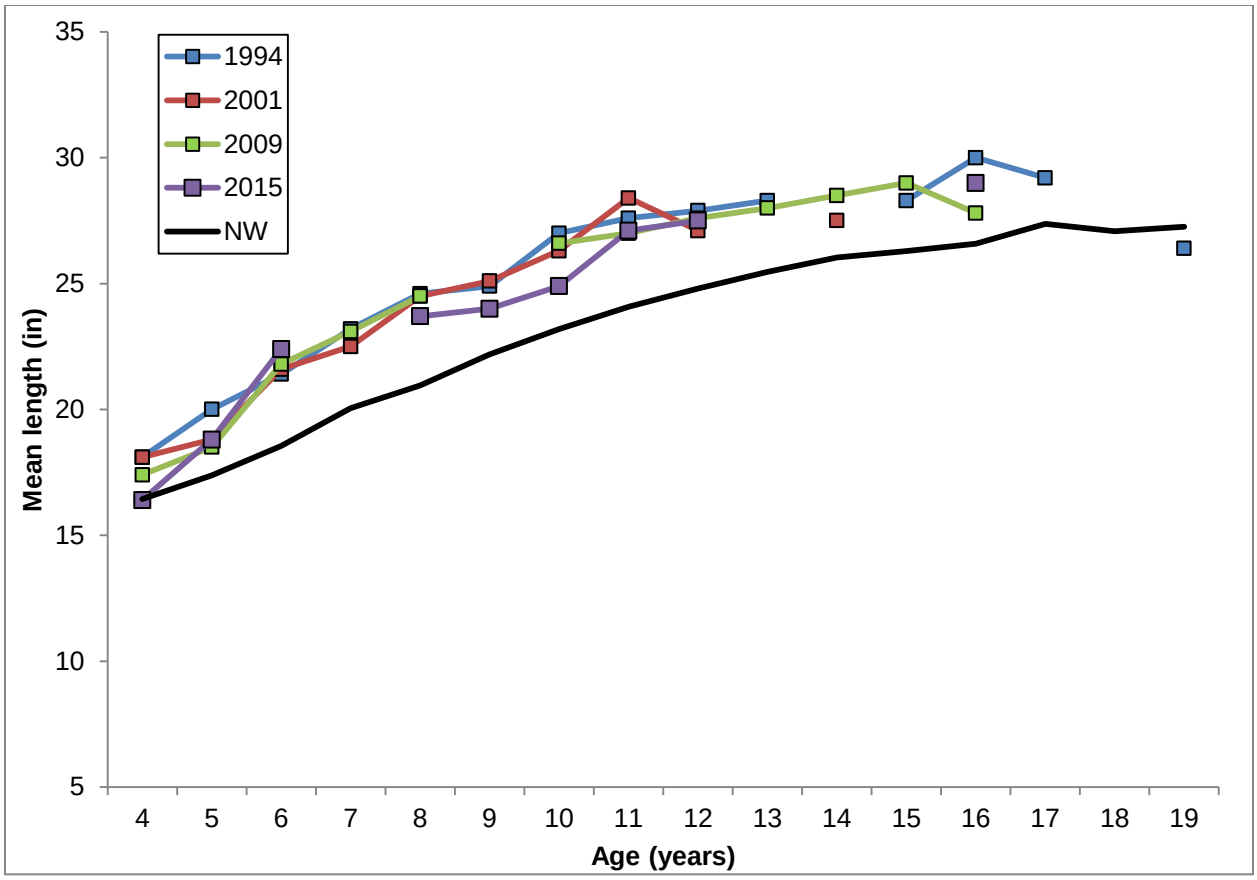

Figure 3. Mean length-at-age for female walleye in Long Lake, Washburn County, Wisconsin compared with the Northwest Wiscosin average (NW).

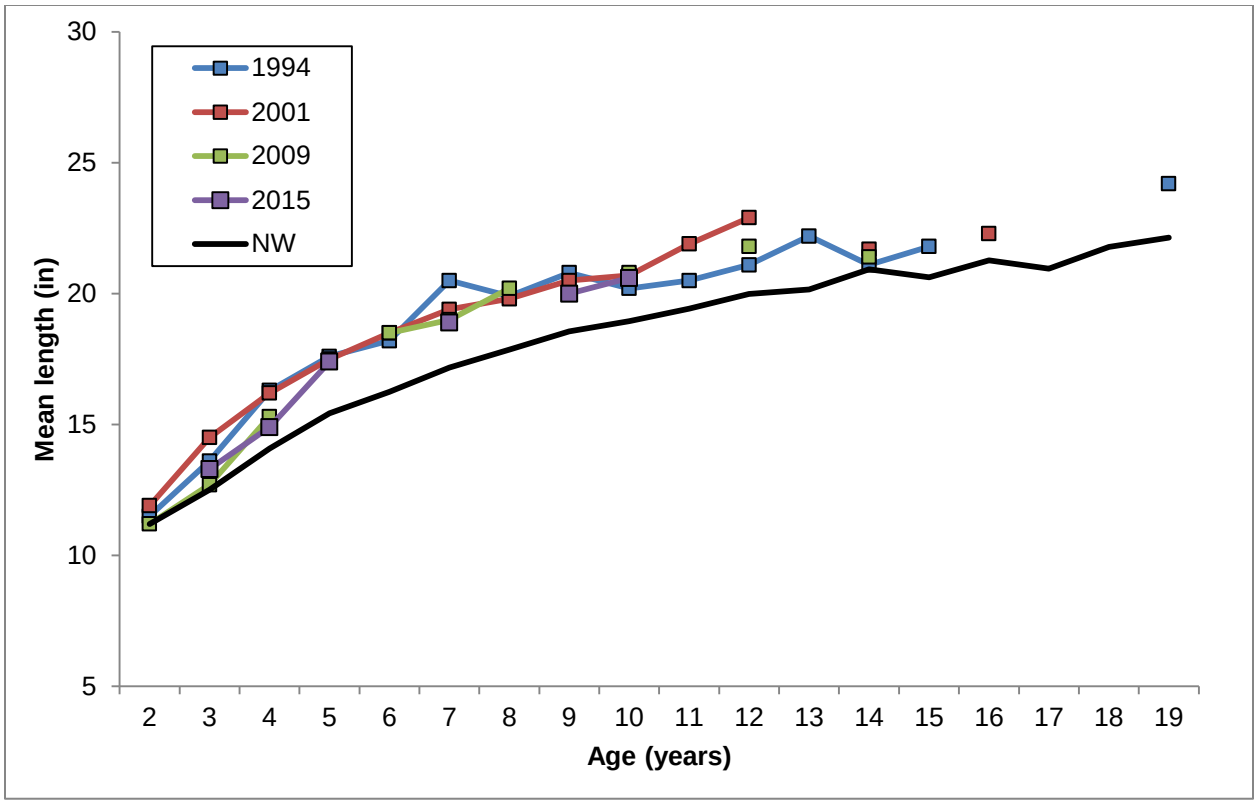

Figure 4. Mean length-at-age for male walleye in Long Lake, Washburn County, Wisconsin compared with the Northwest Wiscosin average (NW).

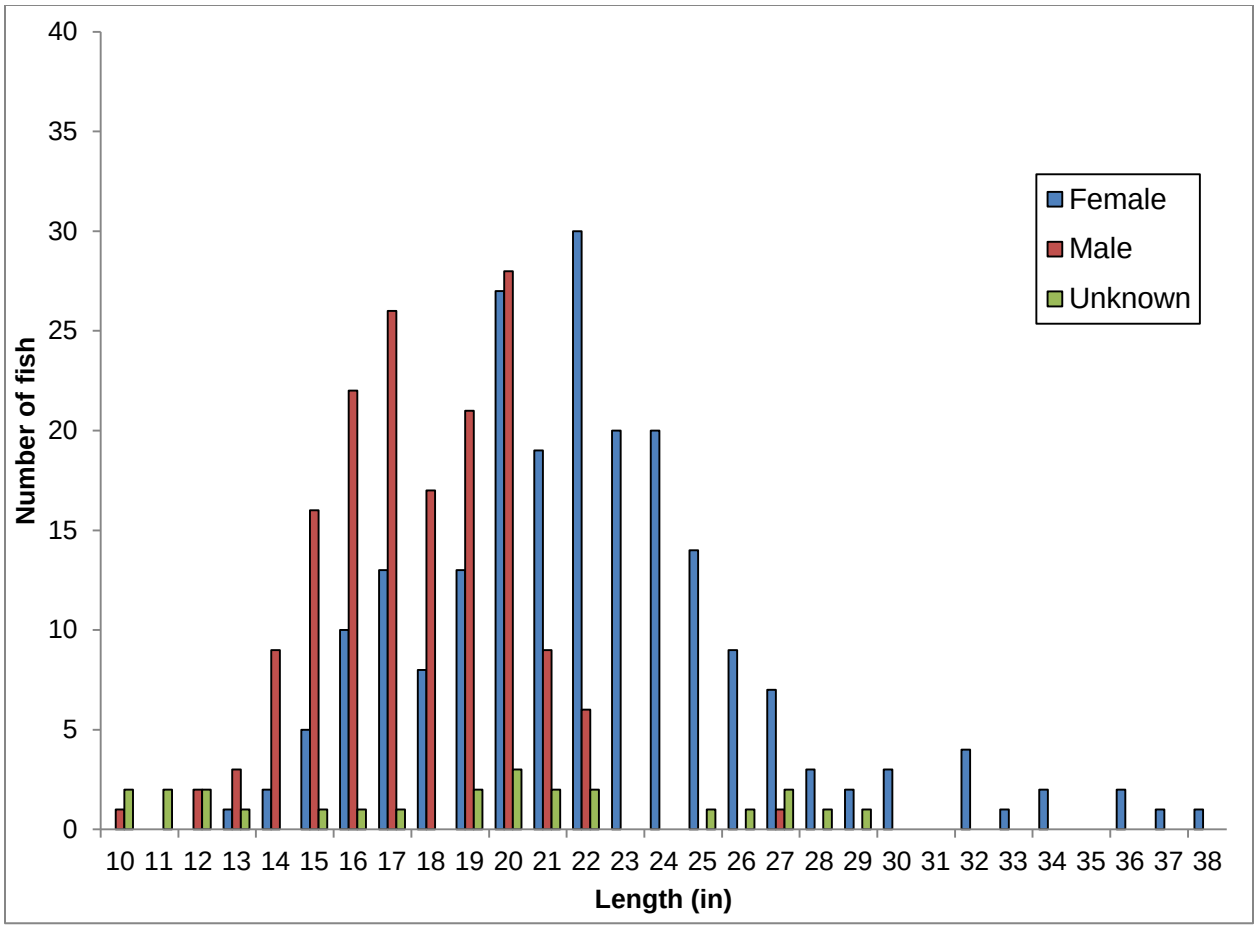

Figure 5. Length frequency of northern pike captured in spring 2015 in Mud and Long Lake, Washburn County, Wisconsin.

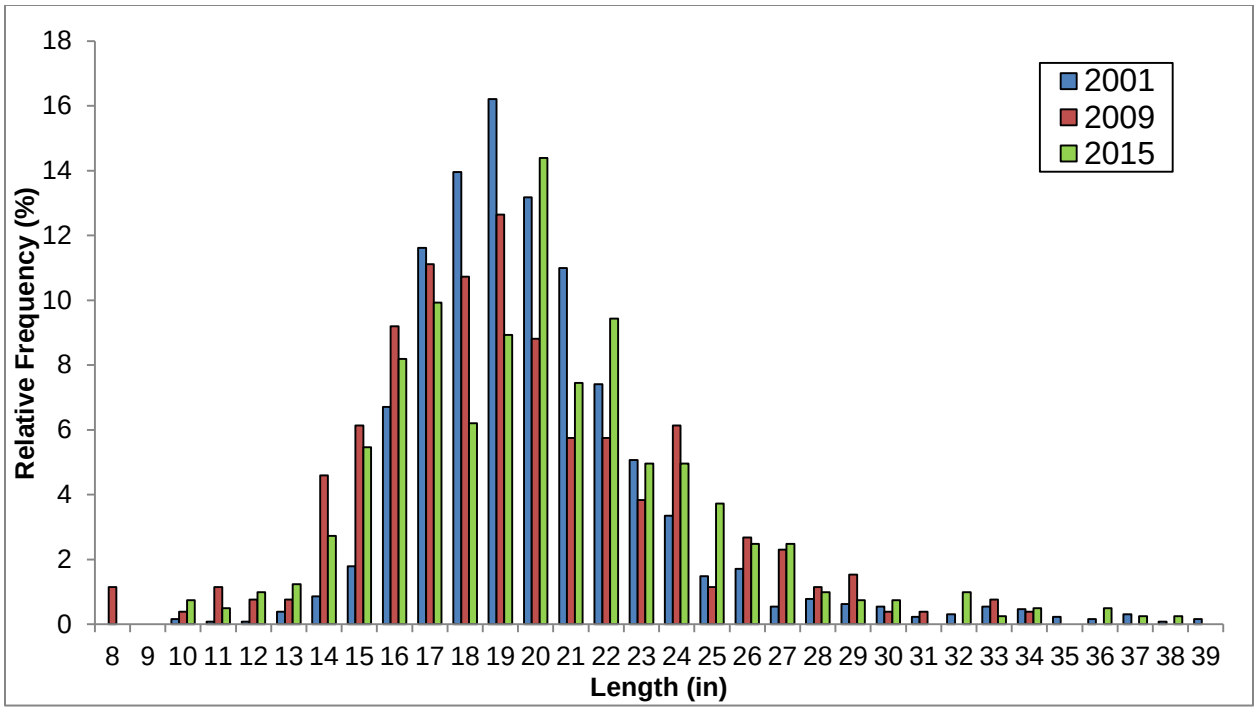

Figure 6. Relative frequency of northern pike captured in spring 2001, 2009, and 2015 in Mud and Long Lake, Washburn County, Wisconsin.

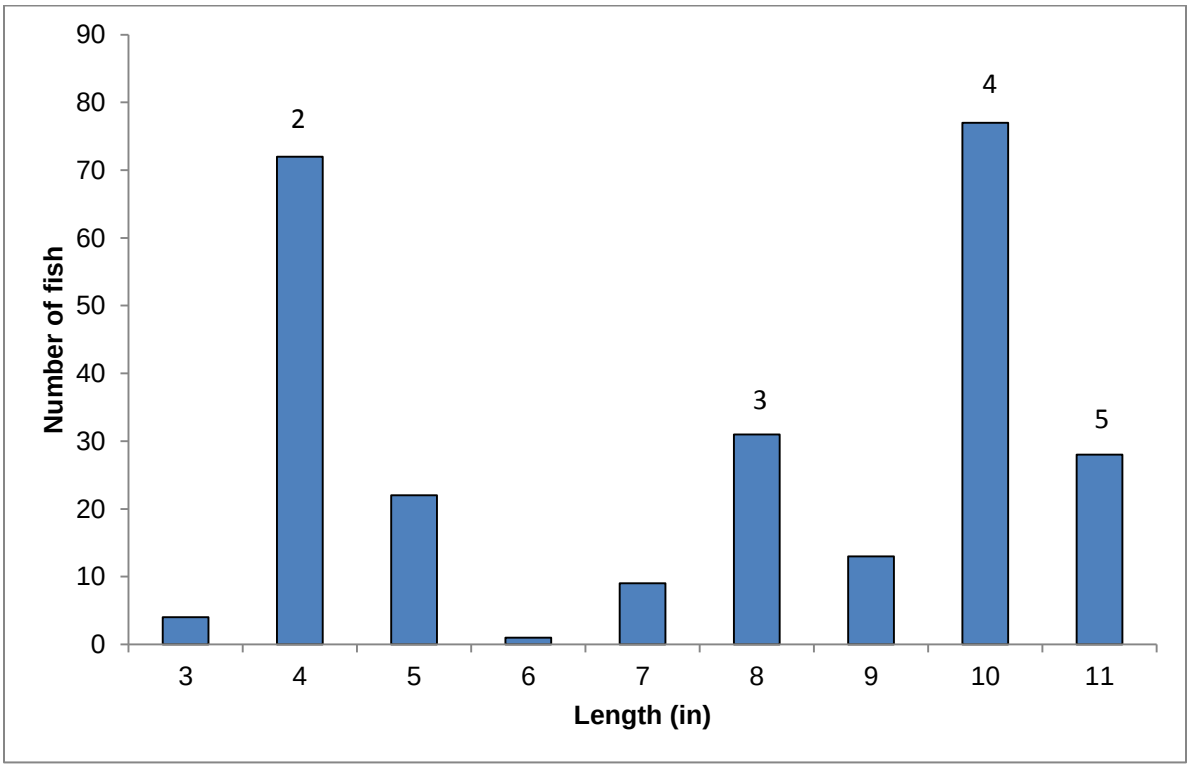

Figure 7. Length frequency of black crappie captured in spring 2015 in Long Lake, Washburn County, Wisconsin (n= 257). Numbers above lengths represent ages for each year class.

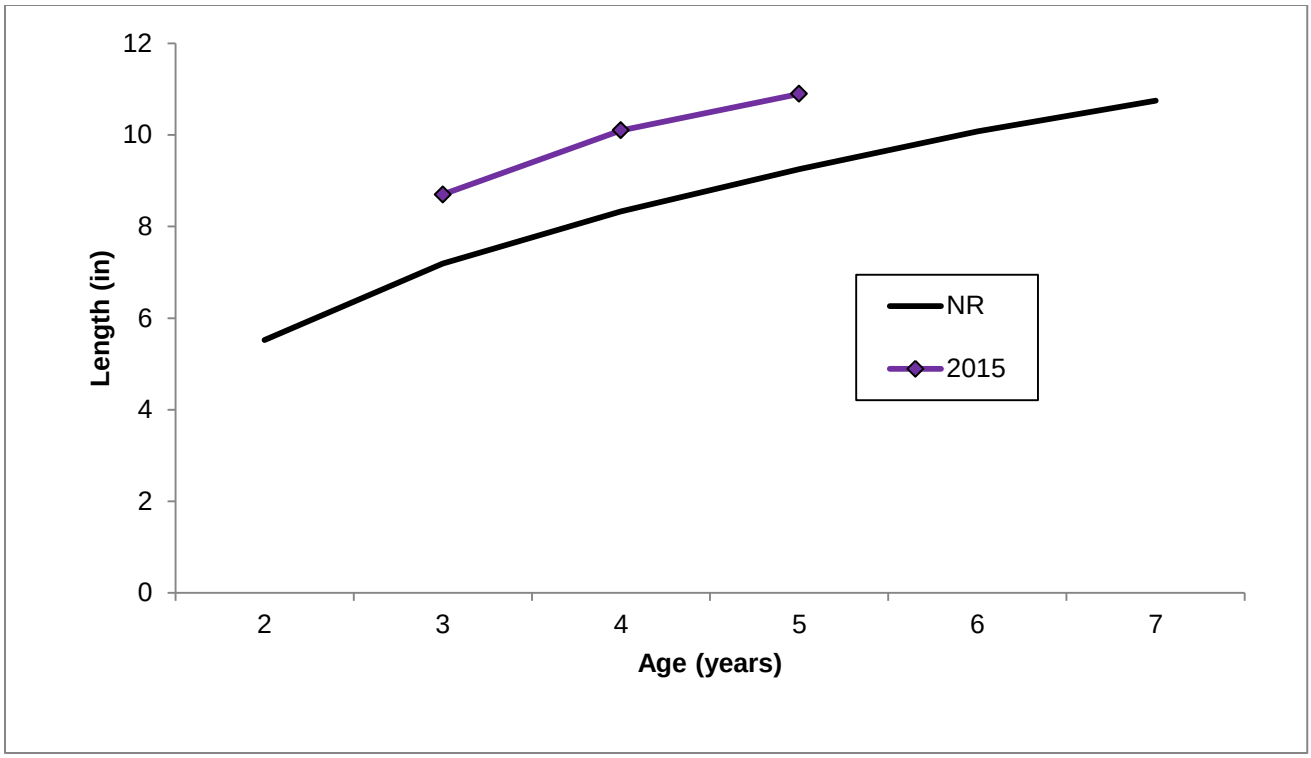

Figure 8. Mean length-at-age for black crappie in Long Lake, Washburn County, Wisconsin compared with the Northern Region average (NR).

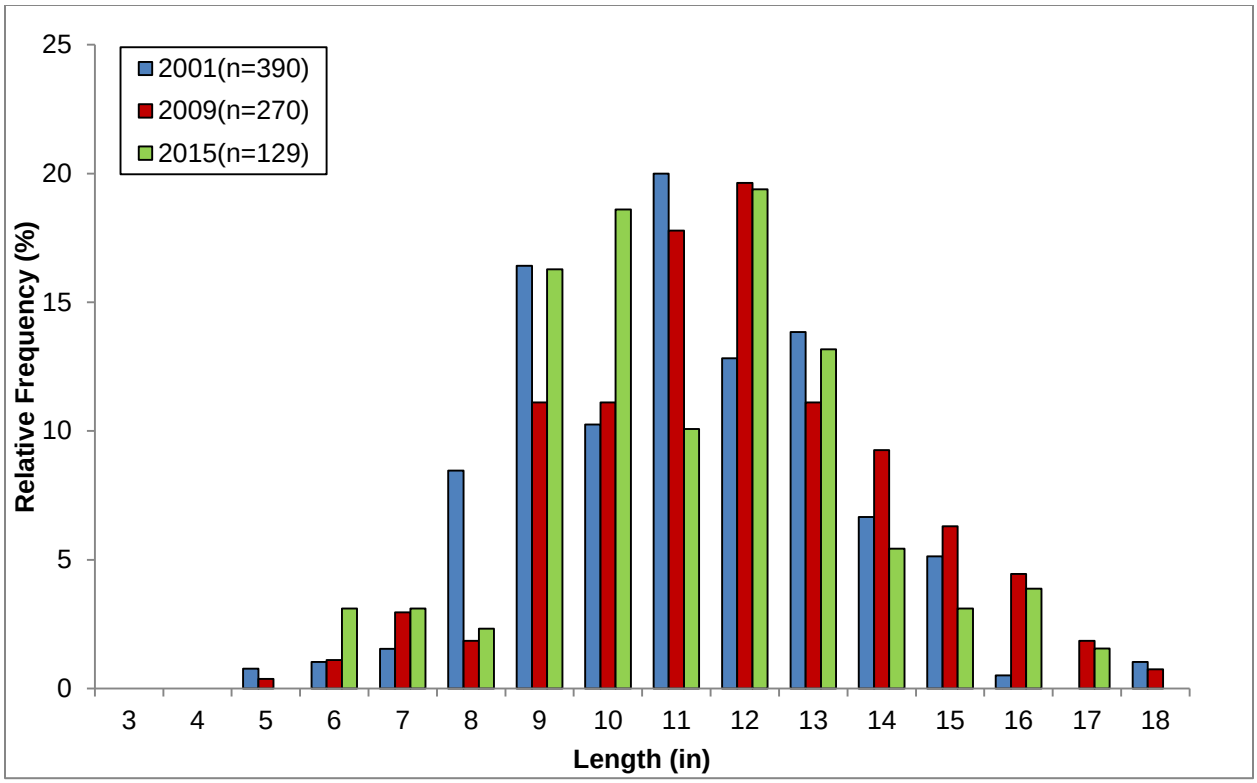

Figure 9. Relative frequency of largemouth bass captured in spring electrofishing in 2001, 2009, and 2015 in Long Lake, Washburn County, Wisconsin.

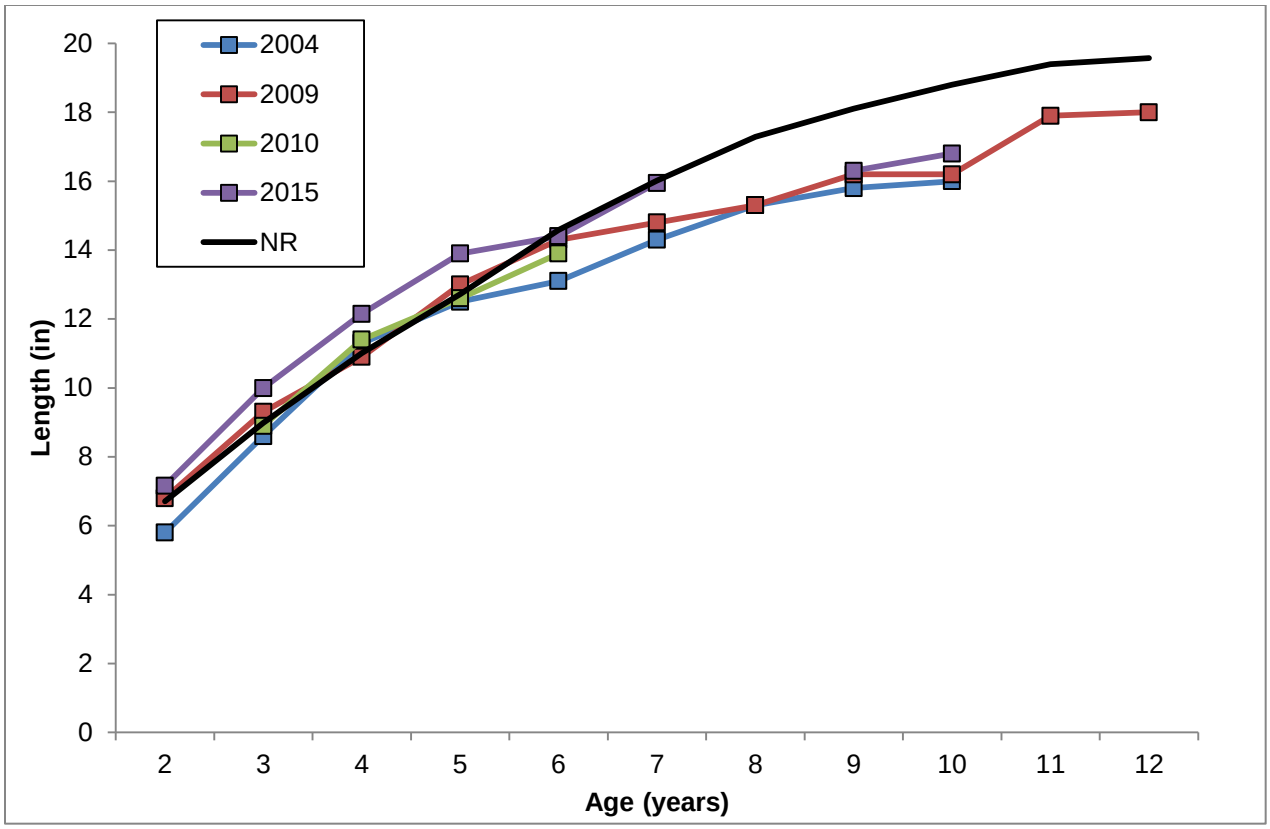

Figure 10. Mean length-at-age for largemouth bass in Long Lake, Washburn County, Wisconsin compared with the Northern Region Average (NR).

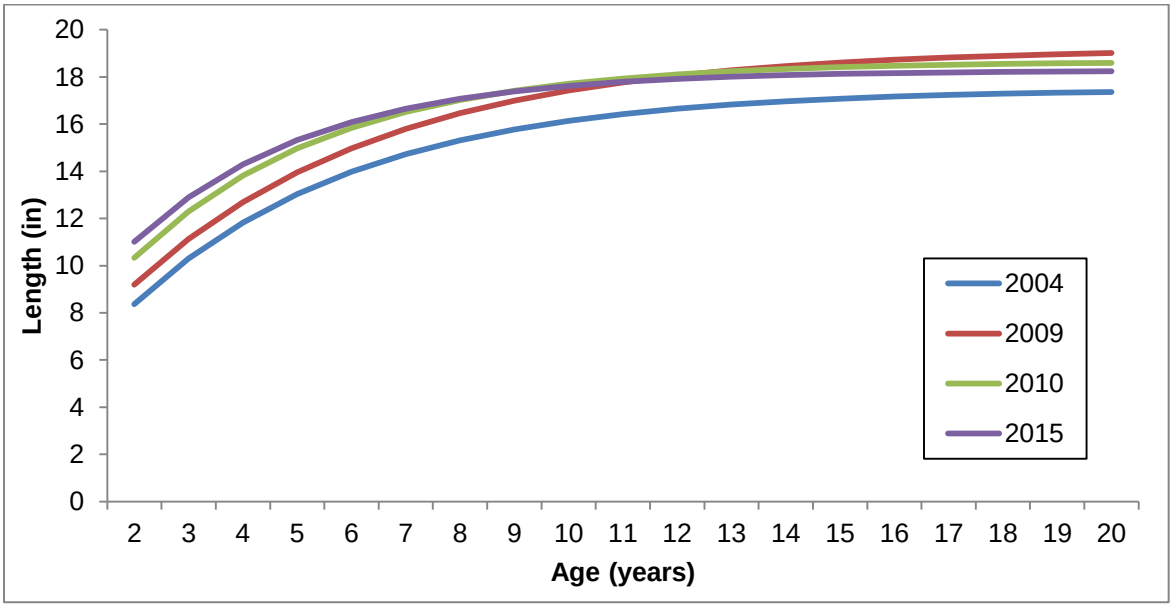

Figure 11. Growth potential using von Bertalanffy growth curves for largemouth bass captured during spring surveys in Long Lake, Washburn County, Wisconsin.

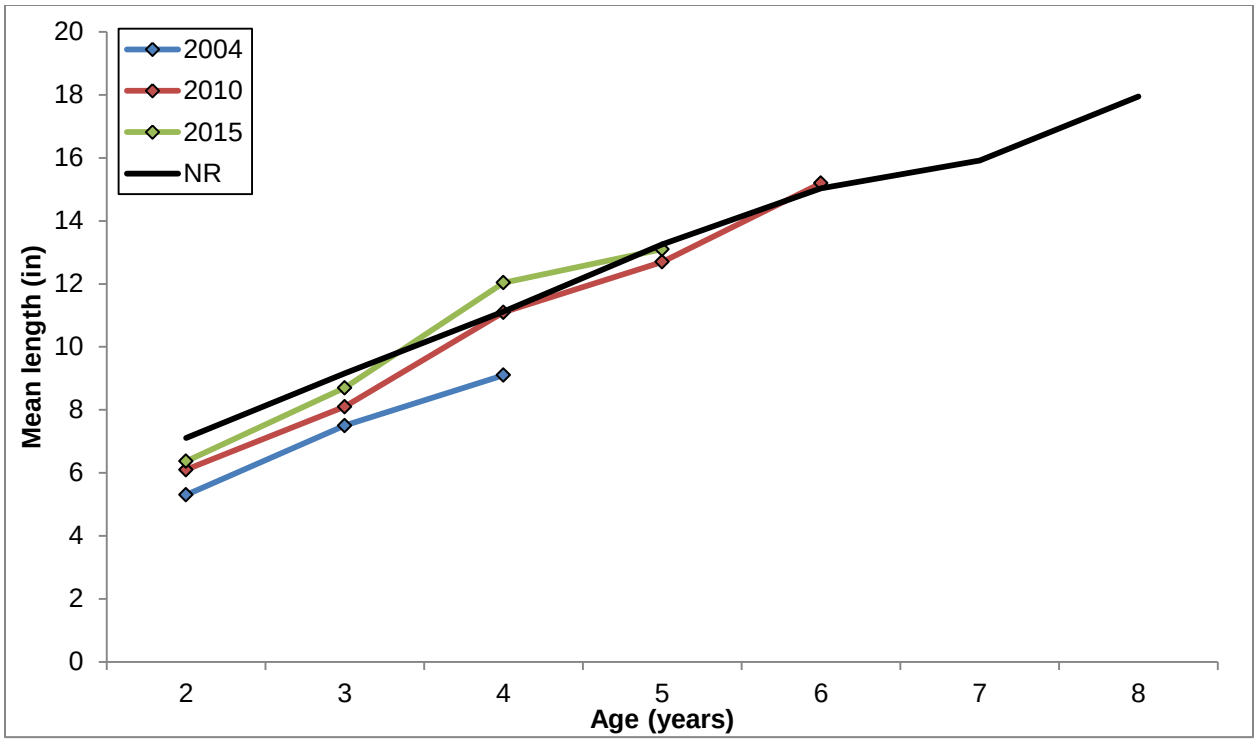

Figure 12. Mean length-at-age for smallmouth bass in Long Lake, Washburn County, Wisconsin compared with the Northern Region Average (NR).

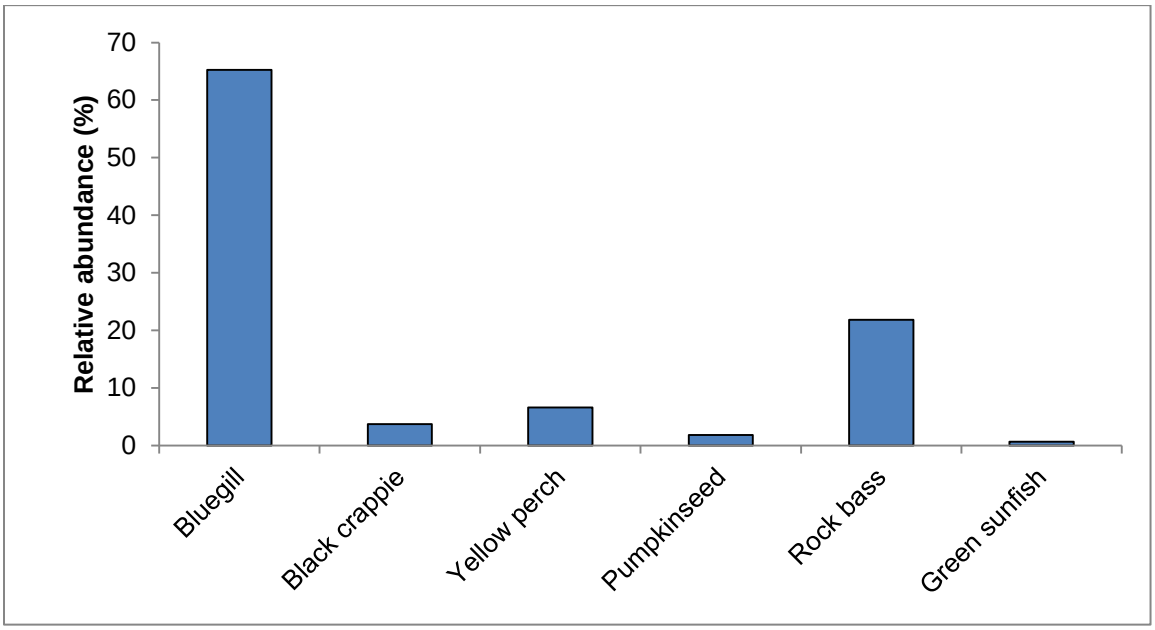

Figure 13. Relative abundance of panfish collected during 2015 late spring electrofishing on Long Lake, Washburn County, Wisconsin.

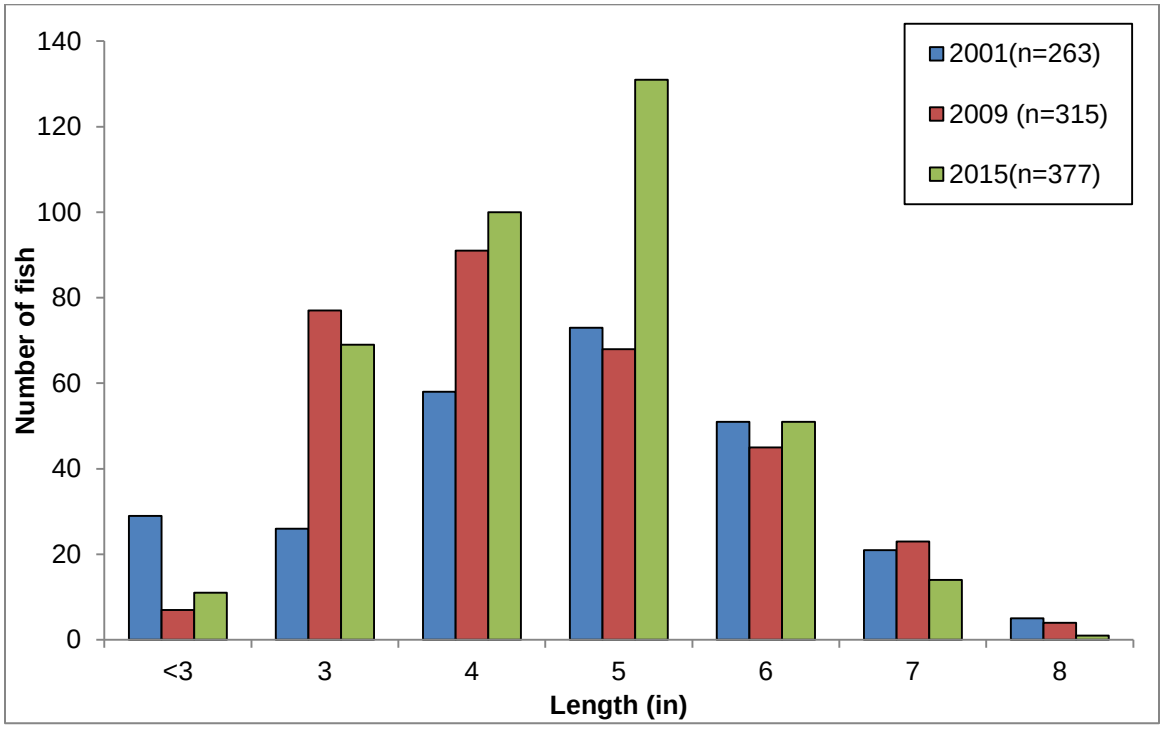

Figure 14. Length frequency of bluegill captured in Long Lake, Washburn County, Wisconsin.

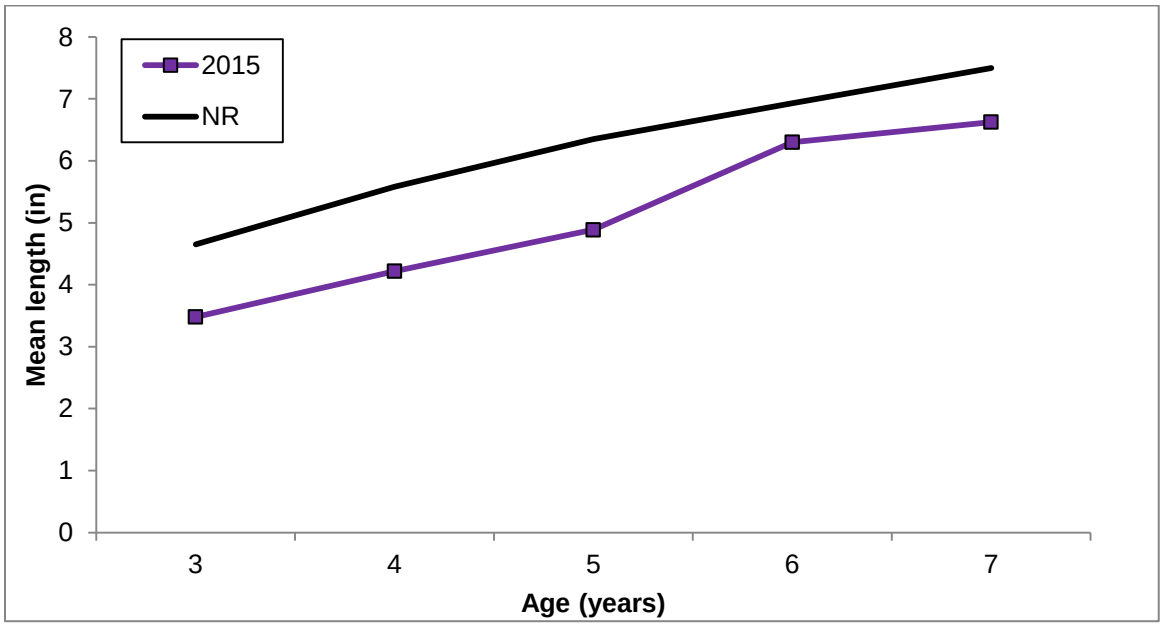

Figure 15. Mean length-at-age for bluegill in Long Lake, Washburn County, Wisconsin compared with the Northern Region average (NR).

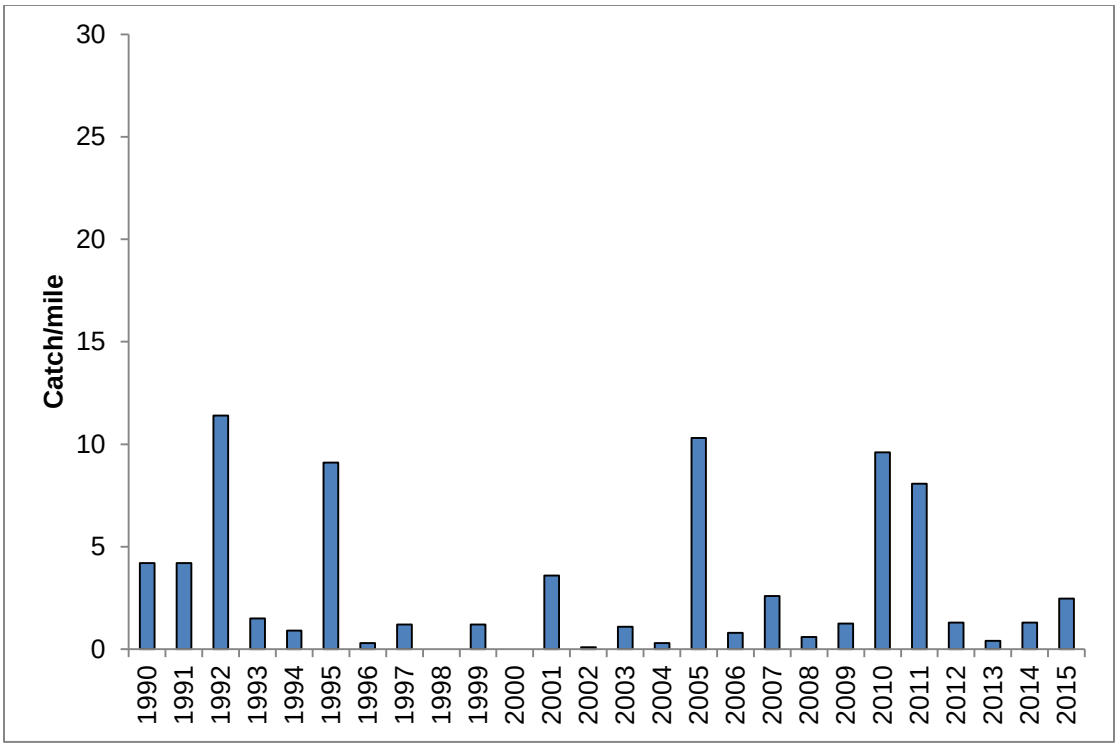

Figure 16. Young-of-year (YOY) walleye relative abundances determined by fall electrofishing surveys on Long Lake, Washburn County, Wisconsin.

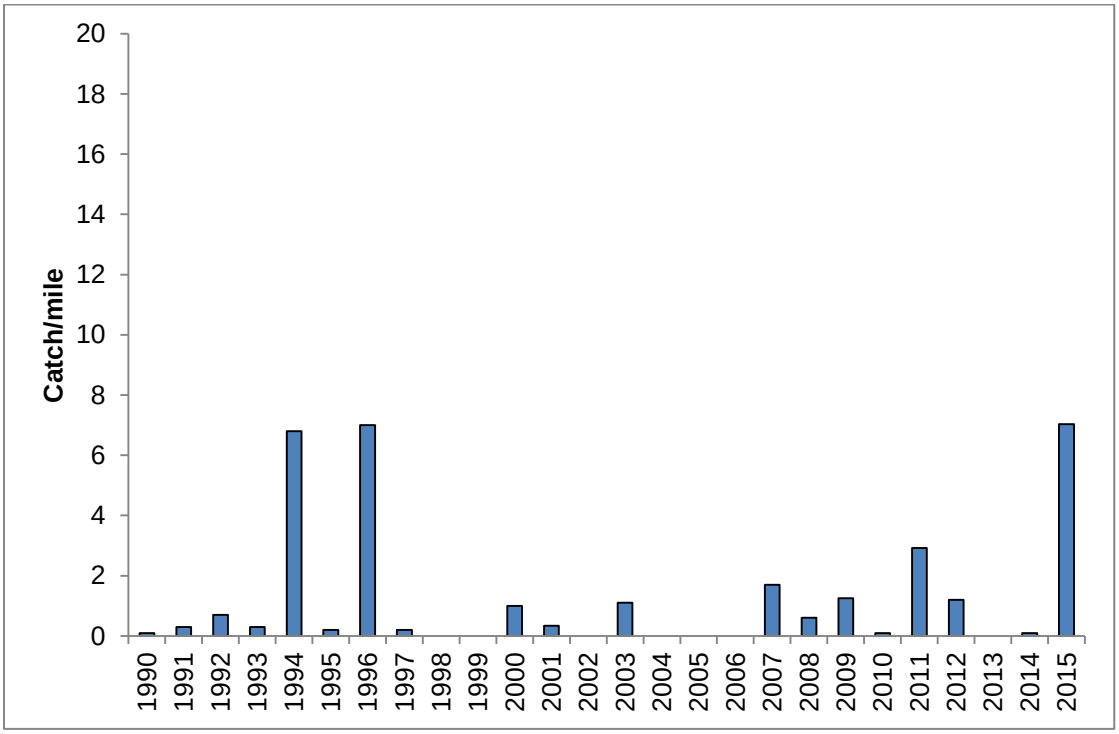

Figure 17. Age-I walleye relative abundances determined by fall electrofishing surveys on Long Lake, Washburn County, Wisconsin.

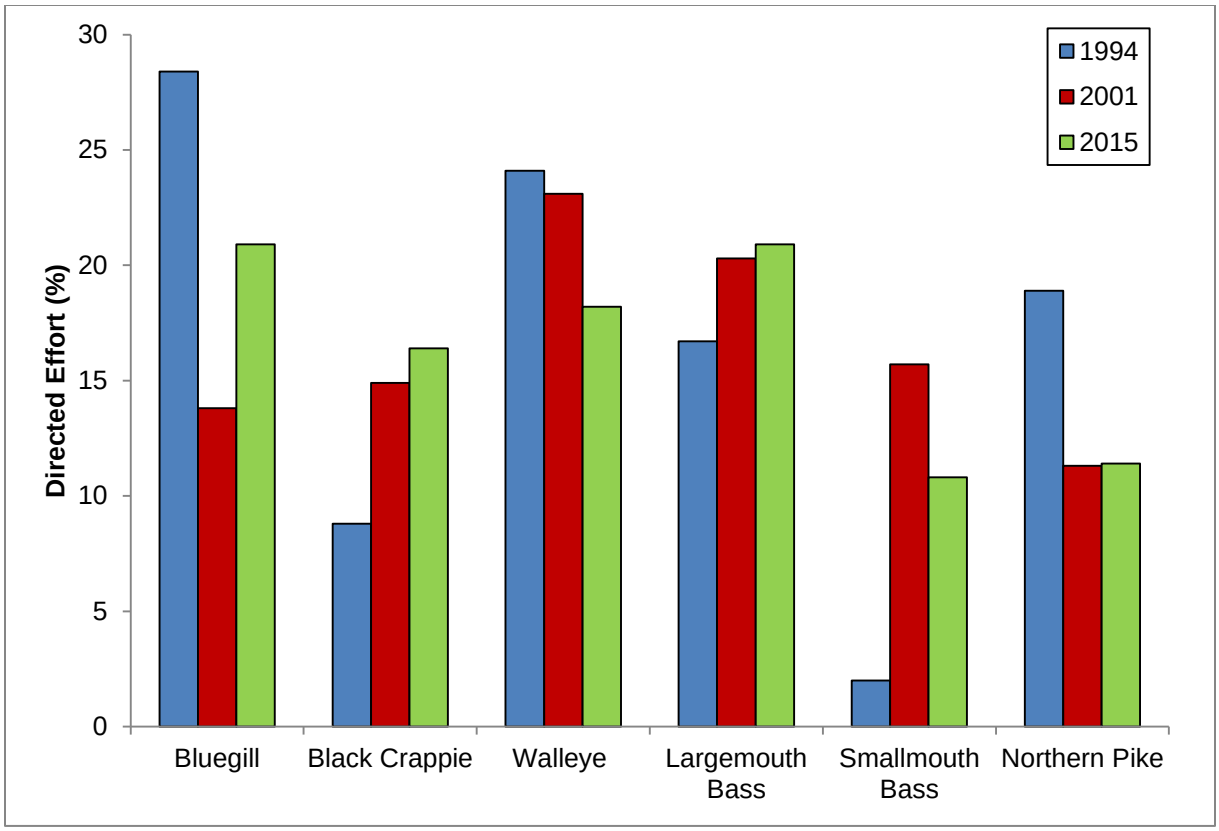

Figure 18. Estimated species directed effort (%) for sportfish and panfish in Long Lake, Washburn County for 1994, 2001, and 2015 fishing seasons.

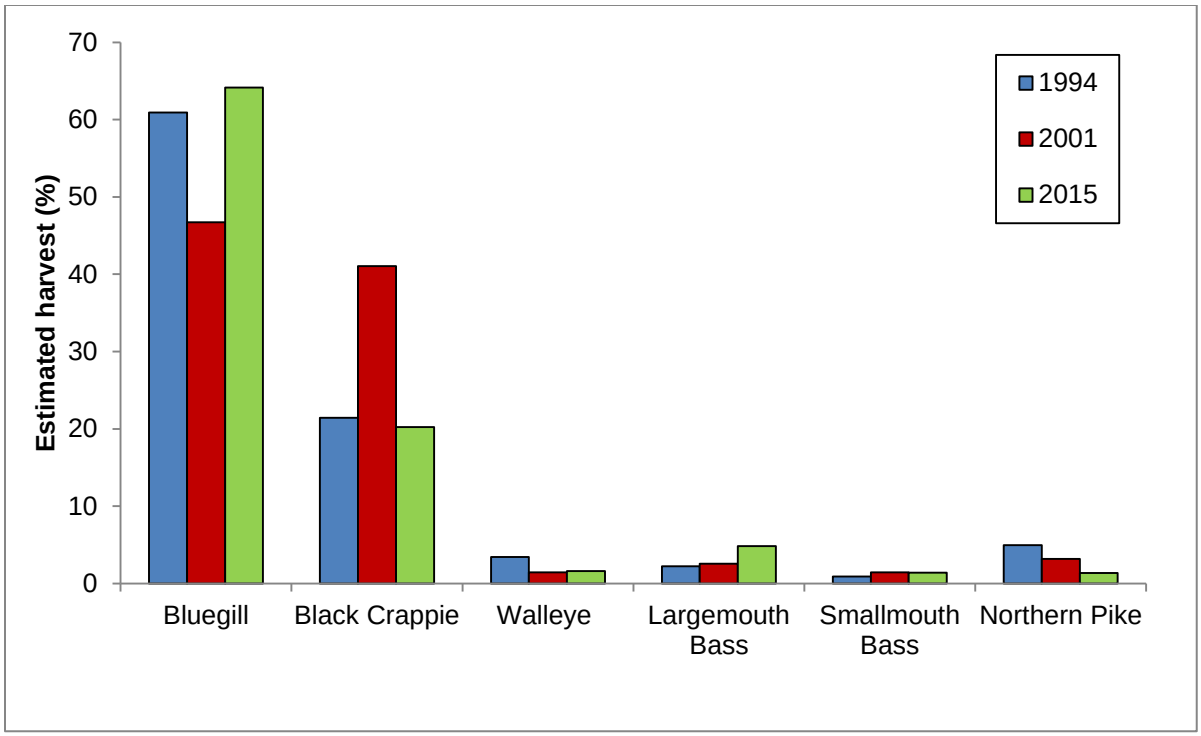

Figure 19. Estimated harvest (%) of sportfish and panfish in Long Lake, Washburn County, Wisconsin for 1994, 2001, and 2015 fishing seasons.

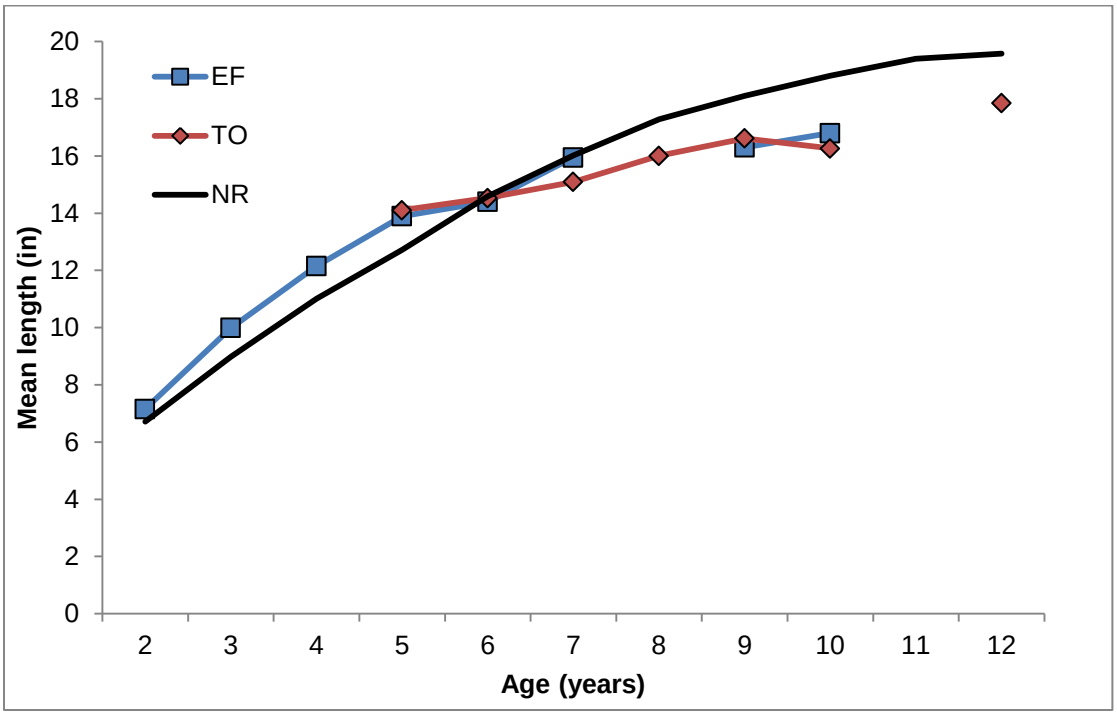

Figure 20. Mean length-at-age for largemouth bass collected from spring electrofishing (EF) and bass tournament data (TO) in Long Lake, Washburn County, Wisconsin compared with the Northern Region average (NR).

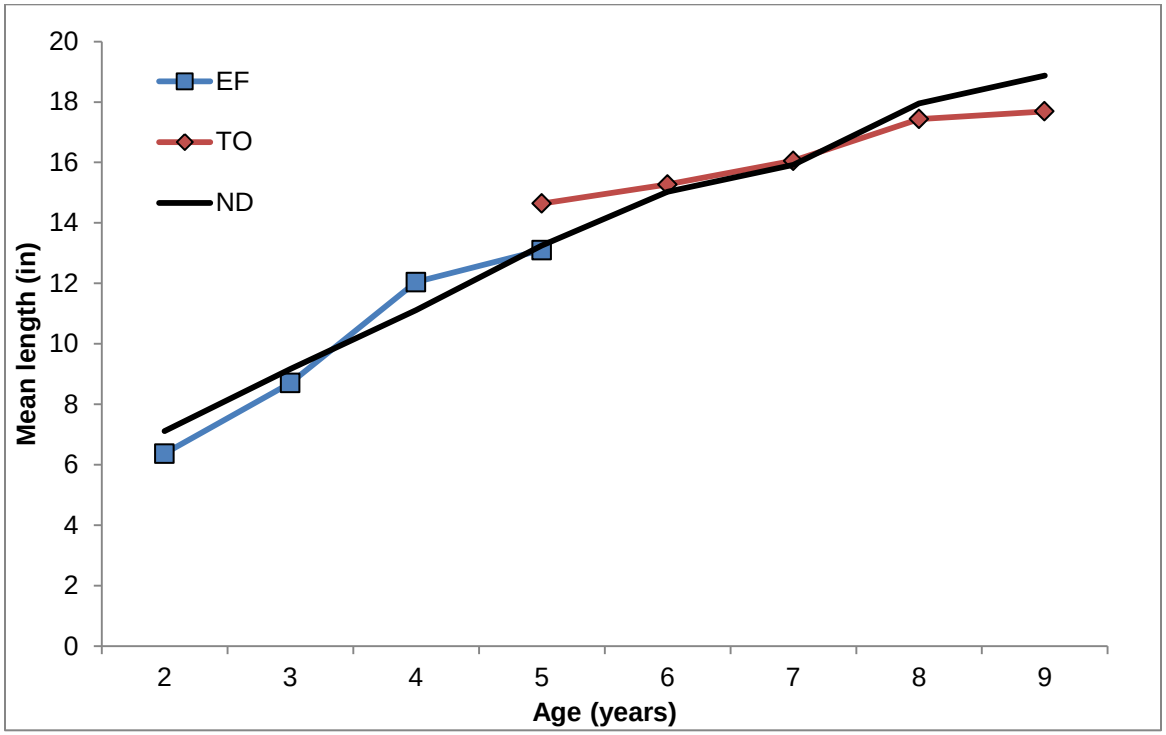

Figure 21. Mean length-at-age for smallmouth bass collected from spring electrofishing (EF) and bass tournament data (TO) in Long Lake, Washburn County, Wisconsin compared with the Northern Region average (NR).

Appendix Table 1. Walleye stocking by size, Long Lake, Washburn County, Wisconsin.

Year	Fry	Fingerling <4 in	Fingerling ≥4 in
1972	0	0	28,336
1973	0	0	7,265
1974	0	0	4,068
1975	0	49,156	0
1976	0	0	15,868
1977	0	15,337	370
1978	0	0	4,310
1979	0	0	0
1980	0	0	0
1981	0	50,000	0
1982	1,000,000	17,250	32,640
1983	0	46,938	1,850
1984	0	71,760	0
1985	0	11,954	29,890
1986	100,000	70,118	0
1987	0	0	0
1988	0	43,986	13,772
1989	0	60,775	0
1990	135,680 (T)	36,251	0
1991	0	24,658	0
1992	0	91,266 (T/DNR)	(P) 1,148
1993	0	100,538	(T) 3,273
1994	0	0	(P) 5,000
1995	0	132,660 (T/DNR)	5,877
1996	0	0	0
1997	0	126,549 (T/DNR)	(P) 5,000
1998	0	0	(P) 3,191
1999	0	185,118 (T/DNR)	1,500
2000	0	10,000 (P)	0
2001	0	314,135 (T/DNR)	(P) 1,000
2002	0	0	0
2003	0	277,160 (T/DNR)	(P) 5,033
2004	WW	0	(P) 5,000
2005	WW	97,739 (T)	(P) 5,500
2006	WW	0	0
2007	WW	21,406	(P) 3,003
2008	0	50,403 (T)	1,082
2009	WW	115,150	(P) 2,227

Fish stocked by DNR hatchery unless noted; P=private hatchery, T=tribal hatchery; WW=walleye wagon.

Appendix Table 1 continued. Walleye stocking by size, Long Lake, Washburn County, Wisconsin.

Year	Fry	Fingerling <4 in	Fingerling ≥4 in
2010	WW	0	0
2011	0	115,443	0
2012	0	0	0
2013	0	0	0
2014	0	0	34,779
2015	0	0	0

Fish stocked by DNR hatchery unless noted; P=private hatchery, T=tribal hatchery; WW=walleye wagon.

Appendix Table 2. Estimated harvest numbers by species for the 1994-95, 2001-2002, and 2015-2016 creel surveys. Numbers represent the entire fishing season.

Species	1994-1995	2001-2002	2015-2016
Bluegill	47,172	41,103	47,743
Black Crappie	16,601	36,115	15,072
Walleye	2,639	1,245	1,184
Largemouth Bass	1,721	2,244	3,580
Smallmouth Bass	701	1,256	1,035
Northern Pike	3,826	2,797	996