

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Comprehensive Fishery Survey of Fox Lake, Dodge County, Wisconsin 2019

Waterbody Identification Code 835800



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Executive Summary

In 2019, a comprehensive fishery survey was conducted on Fox Lake using a variety of sampling methods throughout the open water period in an attempt to sample the major components of the fishery. The objectives of the survey were to 1) assess the status of the northern pike (*Esox lucius*), walleye (*Sander vitreus*), largemouth bass (*Micropterus salmoides*) and panfish populations, 2) attain a population estimate for northern pike and walleye, and 3) update management recommendations for the fishery of Fox Lake. The results of the 2019 survey were compared to lakes with similar characteristics and the prior comprehensive fishery surveys conducted on Fox Lake in 2013 and 2007.

Based on 2019 survey results, Fox Lake continues to offer quality fishing opportunities for northern pike, walleye, largemouth bass, bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*). The survey yielded few northern pike over the 32-inch minimum length limit (1.8%) but showed a fair number of quality northern pike over 21 inches for a proportional stock density (PSD) of 80 compared to 87 in 2013 and 81 in 2007. A northern pike population estimate was obtained for both Mill Creek and lake wide. The Mill Creek population estimate was 9,333 fish (95% CI = 7,845-13,091) or 3.4 northern pike/acre (95% CI = 3.0-4.0 northern pike/acre). The lake-wide population estimate was 15,120 fish (95% CI = 13,521-17,150), or 5.6 northern pike/acre (95% CI = 5.0-6.3 northern pike/acre). The high catch rate of 48/net night lake wide and a modest number of recaptured fish indicates that Fox Lake currently supports a robust northern pike population. Future spring surveys should focus on attaining another northern pike population estimate and conducting age and growth analysis to further evaluate regulation options and determine if density-dependent growth issues exist.

The 2019 survey produced an adult walleye population estimate of 11,535 fish (95% CI = 9,469-14,279), or 4.3 walleye/acre (95% CI = 3.5-5.3 walleye/acre). Walleye showed good size structure, maintained by small fingerling stocking at 35/acre in alternate, odd years. Catch rates of adult walleye were down (23.4 walleye/net night) from 2013 (135 walleye/net night) and 2007 (45 walleye/net night). The average length was 19.7 inches compared to 15.9 in 2013 and 16.3 in 2007. Fall electrofishing (FE) catch rates of young-of-the-year (YOY) walleye were 69.7/mile in 2019, which was much higher than 6.6/mile in 2013 and 7.7/mile in 2007. The previous high FE catch rate was 42.4/mile in 2009. This shows a high survival of stocked fish through their first fall.

Largemouth bass catch rates from spring electrofishing surveys increased from 15.4 largemouth bass/mile with a proportional size distribution (PSD) of 73 in 2013 to 19.9 per mile and a PSD of 81 in 2019. Despite indications of angler harvest of legal-sized (18-inch) largemouth bass, the population continues to be self-sustaining, and no management action is needed at this time.

The bluegill population continues to be self-sustaining as well, with a PSD of 53 and 75.5 bluegill/mile sampled during the 2019 spring electrofishing (SEII) survey versus a PSD of 71 and 79.0 bluegill/mile in 2013. Future spring surveys should continue to monitor largemouth bass and bluegill community trends in size structure, abundance and growth to evaluate the need for potential regulation changes.

Current Wisconsin Department of Natural Resources (DNR) sampling protocols do not accurately capture yellow perch (*Perca flavescens*) or black crappie. Angler concerns over the population decline of these species should lead to more intensive sampling in the next survey to address the potential impacts and develop science-based decisions on their management.

MANAGEMENT RECOMMENDATIONS:

1. Maintain an adult walleye density of at least 4/acre and continue the 18-inch minimum length, three fish daily bag limit to protect the population.
2. Monitor the walleye population and reevaluate size structure, relative abundance and growth in the next comprehensive fishery survey. Conduct a population estimate.
3. Monitor the northern pike population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey. Monitor adult northern pike density, age and relative weight to determine if density dependent growth issues exist. Conduct a local Mill Creek and lake-wide population estimate of northern pike.
4. Monitor the bluegill population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey.
5. Monitor the largemouth bass population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey.
6. Monitor the yellow perch population to evaluate size structure, abundance, growth, length at age and relative weight in the next comprehensive fishery survey to identify if a regulation change is warranted.
7. Monitor the black crappie population to evaluate size structure, abundance, growth, length at age and relative weight in the next comprehensive fishery survey to identify if a regulation change is warranted.
8. Monitor the relative abundance of the common carp (*Cyprinus carpio*) population, via catch rates, in the next comprehensive fishery survey.
9. Conduct a lake-wide creel survey to estimate angler exploitation of all fish species in Fox Lake.

Introduction

Fox Lake is a 2713-acre drainage lake with a maximum depth of 19 feet located in northwestern Dodge County (Figure 1). Alto Creek, Cambria Creek and Drew Creek feed the lake, and Mill Creek drains it. The Fox Lake Dam is located on the outlet channel and is used to control water levels in the lake. There is residential development along the southwest, west and north shorelines. The remaining shoreline is generally wetland fringe, and much of the surrounding land use is agricultural. The lake primarily has a muck bottom but also has areas of more coarse material, such as sand and gravel.

One measure of a lake's health is the trophic state, which relates to the amount of algae in the water. The average summer trophic state for Fox Lake for the last five years was Eutrophic (score 66) and was determined using chlorophyll data. For a shallow lowland lake, this trophic state is considered "fair." Shallow lowland lakes do not stratify, or form separate layers of water, during summer months and have watersheds greater than 4 square miles in area. Documented aquatic invasive species include: common carp, curly-leaf pondweed (*Potamogeton crispus*), Eurasian watermilfoil (*Myriophyllum spicatum*), hybrid Eurasian/northern watermilfoil (*Myriophyllum spicatum X sibiricum*), purple loosestrife (*Lythrum salicaria*), freshwater jellyfish (*Craspedacusta sowerbii*), rusty crayfish (*Orconectes rusticus*) and zebra mussel (*Dreissena polymorpha*).

Public boat access with parking is available at Clausen Park in the City of Fox Lake on the Mill Creek outlet and at Town Park in the northwest corner of the lake near the Cambria Creek inlet. Suitable public access and fair water quality provide recreational opportunities for both anglers and recreational boaters. Recreational use is heavy year-round, especially during summer weekends. The fishery is an important resource for anglers throughout Dodge and surrounding counties. Largemouth bass, northern pike and walleye are the dominant gamefish species; muskellunge (*Esox masquinongy*) are also present. Bluegill are the principal panfish species, but black crappie, pumpkinseed (*Lepomis gibbosus*), and yellow perch are also common. Fox Lake receives small fingerling northern pike at 10/acre each year and walleye small fingerlings at 35/acre every other year. The Fox Lake Preservation Organization also stocks yellow perch, black crappie and muskellunge.

The significance of the fishery and high, year-round public use justifies regular monitoring of the fish community to assess management options and maximize the potential of the fishery. The last comprehensive fish survey was conducted in 2013. The objectives of the 2019 survey were to 1) assess the status of the northern pike, walleye, largemouth bass and panfish populations, 2) attain a population estimate for northern pike and walleye, and 3) update management recommendations for the fishery of Fox Lake. The results of the 2019 survey were compared to lakes with similar characteristics and the prior comprehensive fishery surveys conducted on Fox Lake in 2013 and 2007.

Methods

Seventeen white nylon fyke nets (0.75-inch bar mesh, 3 x 6-foot frames) were set on Fox Lake to target spawning northern pike and walleye during Spring Netting I (SNI). Nets were checked daily from March 21 to April 16 for a total effort of 72 net nights. All gamefish sampled were measured to the nearest 0.1 inch, and weight was taken to the nearest 0.06 pound on a subsample of northern pike, muskellunge and walleye. In order to attain northern pike and walleye population estimates, all northern pike and walleye sampled were marked: males received a left pectoral fin clip, females a right pectoral fin clip, and those of unknown sex received a top caudal clip. All largemouth bass were marked with a top caudal fin clip to eliminate duplicate counts. Throughout the survey, northern pike and walleye were examined for marks and noted as recaptures if marks were found. Additionally, age structures were removed from northern pike, walleye, bluegill and yellow perch according to standard sampling protocols for age and growth estimates. These protocols include removing an anal fin ray from northern pike, a dorsal spine from walleye greater than 12 inches in length and a scale sample from walleye less than 12 inches in length. Aging structures were collected until five structures were collected for each species and each sex for every half-inch increment. A subsample of bluegill, black crappie and yellow perch were measured to the nearest 0.1 inch. Other fish species encountered were identified to species and counted.

Spring electrofishing (SEI) using a Wisconsin Department of Natural Resources (DNR) standard pulsed direct current (PDC) boom shocker boat was conducted at night on April 16. Five stations for a total of 4.0 miles were sampled. The objective of SEI was to count and measure adult walleye and identify walleye marked with fin clips during SNI to facilitate the calculation of a population estimate. Walleye sampled were measured to the nearest 0.1 inch. Aging structures were collected until five structures were collected for each species and each sex for every half-inch increment. SEI sampling used two dippers, two probes (each with eight droppers) and a dip net bar mesh of 0.375 inches.

Spring Centrarchid Electrofishing (SEII) using a DNR standard PDC boom shocker boat was conducted at night on May 20 and May 22, targeting largemouth bass and panfish species. SEII sampling included four stations (0.5 miles each), where all fish were sampled for a total of 2 miles of effort. An additional four stations (1.5 miles each) were sampled, where only gamefish were sampled for a total of 6 miles of effort. At stations targeting all species, all fish were collected, and gamefish and panfish were measured to the nearest 0.1 inch. Other fish were identified to species and counted. At stations targeting only gamefish, all gamefish sampled were measured to the nearest 0.1 inch. All gamefish were examined for the presence of fin clip marks from SNI. SEII sampling used two dippers, two probes (each with eight droppers) and a dip net bar mesh of 0.375 inches.

Fall electrofishing (FE) using a DNR standard PDC boom shocker boat was conducted at night on Oct. 28 to assess the abundance of young-of-the-year (YOY) and juvenile walleye. FE focused on sampling the shorelines of Elmwood, Brushwood and McFetridge islands for a total of 1.7 miles of effort. An additional 2.0-mile station was sampled along the north shore of the lake for a total of 3.7 miles of effort. A similar FE survey of the same island shorelines was conducted on Oct. 8, 2018, with 1.85 miles of sampling effort. However, high water temperatures and low water quality and clarity with dense algae greatly affected catch rates. A second attempt at FE of the same shorelines was made on Oct. 24 and 25 in 2018, after water temperatures had declined. Two 2-mile stations comprised of a 0.5-mile catch-all station and a 1.5-mile gamefish only station were sampled. During FE sampling, only walleye were sampled and were measured to the nearest 0.1 inch.

Fyke net total catch and catch per unit of effort (CPUE) (#/net night) were calculated for muskellunge, walleye and northern pike (see Appendix 1 for 2019 catch results). A multiple recapture population estimate (Schnabel Method) was used for adult northern pike with 95% confidence intervals for both the localized Mill Creek population and a lake-wide population. A single recapture population estimate (Petersen Method) was used for adult walleye with 95% confidence intervals. SEI total catch and CPUE (#/mile) were calculated for largemouth bass and all panfish species sampled (Appendix 1). Length frequency histograms were constructed for walleye, northern pike, largemouth bass, bluegill, yellow perch, black crappie and muskellunge to assess size structure. Catch curves were calculated for walleye and yellow perch.

Relative weight, the ratio of a fish's weight to the weight of a standard fish of the same length, based on a scale of 100, was used to assess the body condition of northern pike and walleye. Mean relative weight (W_r) was calculated by length group as an index of northern pike and walleye condition using a standard length-at-weight equation (Willis, 1989). Average relative weight was calculated for each species and each sex separately when sex data were available. Relative weight values between 75 and 100 indicate normal weight for a given length. A relative weight value greater than 100 indicates that a fish is in excellent condition. A relative weight value of less than 75 indicates that a fish is in poor condition.

Proportional size distribution (PSD) was calculated for northern pike, walleye, largemouth bass, bluegill and black crappie to assess population size structure. Stock lengths are based on standardized lengths for each species: northern pike (14 inches), walleye (10 inches), largemouth bass (8 inches), bluegill (3 inches) and black crappie (5 inches). The quality lengths used were northern pike (21 inches), walleye (15 inches), largemouth bass (12 inches), bluegill (6 inches) and black crappie (8 inches). Proportional size distribution-preferred (PSD-P) was also calculated for northern pike, walleye, largemouth bass, bluegill and black crappie to assess the proportion of fish in the population that are a preferred length by anglers. These are based on standardized lengths for each species: northern pike (28 inches), walleye

(20 inches), largemouth bass (15 inches), bluegill (8 inches) and black crappie (10 inches) (Anderson and Neuman, 1996).

Growth information from northern pike, walleye, bluegill and yellow perch was obtained according to established protocols for each species and included fin rays, dorsal spines and scale samples collected throughout the comprehensive fishery survey. Growth data from Fox Lake was compared to average statewide growth rates utilized in the DNR Fisheries Management Database.

Results and Discussion

NORTHERN PIKE

In the 2019 SNI, 3,471 northern pike were sampled for a catch rate of 48.2 northern pike/net night. This catch rate was well above average (95th percentile) compared to lakes with similar characteristics (warm water temperatures and turbid water) across the state. Lengths ranged from 9.8 inches to 36.3 inches, with an average length of 23.7 inches (Figure 2). In the 2013 SNI, 873 northern pike were sampled for a catch rate of 9.3 northern pike/net night. This catch rate was well above average (95th percentile) compared to lakes with similar characteristics across the state. Lengths ranged from 14.6 to 37.5 inches, with an average length of 25.7 inches (Figure 3). The percentage of northern pike over the 32-inch minimum length limit has decreased since prior surveys (2% in 2019, 4.1% in 2013 and 9% in 2007). No creel data is available to estimate harvest levels of northern pike by anglers that may be leading to the decrease in fish over the minimum length limit as demonstrated in the length frequency histograms for 2019 and 2013.

A localized Mill Creek and lake-wide northern pike population estimates were calculated in 2019 to provide the most accurate population size assessment. The Mill Creek population estimate was 9,333 fish (95% CI = 7,845-13,091) or 3.4 northern pike/acre (95% CI = 3.0-4.0 northern pike/acre). The lake-wide population estimate was 15,120 fish (95% CI = 13,521-17,150), or 5.6 northern pike/acre (95% CI = 5.0-6.3 northern pike/acre). The high catch rate of 48/net night lake wide and a modest number of recaptured fish indicates a significant population. This indicates that Fox Lake currently supports a robust northern pike population. Future SNI surveys should focus on replicating the Mill Creek and lake-wide northern pike population estimates and conducting age and growth analyses to identify whether management changes are warranted with regard to the slightly elevated 2019 population size estimate.

The mean length at age of Fox Lake northern pike in 2019 was compared to the statewide and Southern District (SD) averages. Age and growth analyses of the northern pike in Fox Lake indicated growth was higher than the statewide average and closely resembled the SD average (Figure 4).

The northern pike population in Fox Lake has been regulated under a protective harvest regulation of a 32-inch minimum length limit and a one fish daily bag limit since 1997. In 2019, northern pike PSD was 80, indicating a decent population size structure with a large proportion of quality-size northern pike (equal to or greater than 21 inches) present. Historically, northern pike PSD values have been similar to those found in 2019 (86 in 2013, 81 in 2007). In 2019, northern pike PSD-P was 11, indicating a smaller proportion of preferred-size northern pike (equal to or greater than 28 inches) compared to previous surveys (27 in 2013, 25 in 2007). Northern pike body condition was excellent, as suggested by W_r values that ranged from 75 to 139, with a mean of 103 ($n = 270$). Sex-specific W_r for females was excellent and ranged from 101 to 126, with a mean of 108 ($n = 144$). Male sex-specific W_r was good and ranged from 92 to 107, with a mean of 99 ($n = 127$). This indicates that the forage base is adequate to maintain the three top predator species (northern pike, walleye and largemouth bass), and density-dependent factors may not currently be affecting the size structure of northern pike in Fox Lake.

In 2013, northern pike body condition was lower than in 2019, but W_r were still good, ranging from 59 to 136 with a mean value of 96 ($n=467$). Sex-specific W_r for females was excellent and ranged from 93 to 130, with a mean of 102 ($n = 241$). Male sex-specific W_r was good and ranged from 84 to 121, with a mean of 94 ($n= 222$).

WALLEYE

In the 2019 SNI, 1,687 walleye were sampled for a catch rate of 23.4 walleye/net night from the fyke nets specifically targeting walleye. This catch rate is well above average compared to lakes with similar characteristics across the state. Lengths ranged from 9.6 to 28.3 inches, with an average length of 19.7 inches (Figure 5). In 2013 SNI, 6,635 walleye were sampled for a catch rate of 135 walleye/net night from the fyke nets specifically targeting walleye. Lengths ranged from 10.7 to 28.2 inches, with an average length of 15.9 inches (Figure 6). While the 2019 SNI walleye catch rate was lower than in the 2013 SNI, catch rates for both survey years are well above average when compared to lakes with similar characteristics across the state.

The Petersen population estimate for adult walleye in 2019 was 11,535 fish (95% CI = 9,469-14,279), or 4.3 walleye/acre (95% CI = 3.5-5.3 walleye/acre), which was much lower than the 2013 population estimate of 11.0 walleye/acre. Walleye size structure has shifted substantially from the 2019 and 2013 surveys. In 2019, walleye PSD was 97 and PSD-P was 39. In 2013, PSD was 47 and PSD-P was 8. While PSD was higher in 2019, quality-sized walleye (equal to or greater than 15 inches) were common in both survey years. However, PSD-P was much higher in 2019 than in 2013, indicating that the proportion of preferred-size (equal to or greater than 20 inches) walleye was higher in 2019. The length frequency histograms do not indicate a dramatic decline in the number of walleye over the current 18-inch minimum length limit. Therefore, angler exploitation is currently not a likely factor driving the walleye size structure in Fox Lake.

The mean length at age of Fox Lake walleye in 2019 was compared to the statewide and SD averages (Appendix 2). Age and growth analyses indicated that walleye growth in Fox Lake was similar to the statewide average for fish up to age 6. However, the growth rate was below the statewide average for age-7 to age-9 fish, with the growth rate increasing in age-11 and older fish (Figure 7). The increased growth of age-11 and older fish, specifically females, may be due to inaccurate aging from limitations of the dorsal spine structure used for aging. Aging accuracy with dorsal spines often decreases in age-7 and older fish; however, older fish are often under-aged, and in this case, under-aging would inflate growth rates. Another way to compare age data across years is to estimate the mean age at specified length intervals for each sex and express the result as a percentage; the higher the percentage, the faster the growth rate. Typical parameters include a mean age at 15.0 to 15.9 inches for males and a mean age at 18.0 to 18.9 inches for females. In 2019, the results were 54% for males and 38% for females, indicating that males in the population had average growth rates and females had slightly below average growth rates in 2019. In 2013, the results were 70% for males and 47% for females, indicating that males in the population grew faster than average and females grew close to average (Table 1). As mentioned above, this is most likely due to more accurate aging techniques, indicating that the walleye population in Fox Lake has average to less than average growth versus a true decline in growth rates.

Supporting this assumption is that the mean walleye condition factor was slightly higher in 2019 (100) compared to the 2013 mean (97). Both are within the range found in healthy populations. This suggests that the forage base is adequate to maintain the three top predator species (northern pike, walleye and largemouth bass).

Walleye body condition was good as suggested by W_r values that ranged from 77 to 124, with a mean of 100 ($n = 166$). Sex-specific W_r for females was excellent and ranged from 65 to 124, with a mean of 101 ($n = 102$). Male sex-specific W_r was good and ranged from 65 to 123, with a mean of 90 ($n = 198$).

Total annual mortality was estimated using a catch curve of age-10 fish and older (Figure 8). Compared to other estimates for walleye, the calculated 32% annual mortality for Fox Lake is relatively low. In midwestern North America, total annual mortality for walleye has been reported to range from 31-70%, and the estimated fishing mortality from the catch curve is 12%. (Schneider 1978). Creel data is not available for Fox Lake, so estimates of exploitation are not currently available.

The walleye fishery in Fox Lake continues to see mixed recruitment through stocking and natural reproduction. FE surveys indicate continued recruitment of year classes into the population. In slower-growing populations with mixed recruitment, the total length of age-0 and age-1 fish can overlap. This has been noted during several FE surveys of Fox Lake. Ten inches is typically considered the cutoff point for this age-class difference in the past. To help answer the question of overlap, a total of 176

walleye from 6.6 to 12.3 inches (fifty-six walleye less than 10.0 inches and 120 walleye greater than 10.0 inches) were collected during the 2018 FE, and otoliths were extracted for age analysis. There was some overlap of age-0 and age-1 walleye indicated in the 9-inch range. When averaged, the fall age-0 walleye were 8.8 inches, and the age-1 walleye were 10.7 inches. Age analysis from the 2019 SNI (Figure 3) shows true age-1 walleye at 9.6 inches. It is reasonable to assume that these fish could reach 10.7 inches by fall to validate what was estimated from the 2018 FE for length at age-1 walleye. This data suggests the use of 9.5 inches as the cutoff point between age-0 and age-1 walleye in Fox Lake sampled in FE, if length overlap seems evident and an aging subsample is not available.

Past FE surveys have shown successful but varied recruitment of walleye as well (Appendix 3). Stocking of small fingerling walleye at 35/acre occurs in alternate, odd years in Fox Lake. Survival of these stocked fish can be assessed from the catch rates of YOY walleye found in FE surveys in stocked years. Fox Lake was stocked in June of 2019 with 105,000 small fingerling walleye. In the 2019 FE, 258 YOY walleye (4.5 to 8.5 inches) were sampled for a catch rate of 69.7/mile. The robust catch rate of YOY walleye in the fall indicates high survival of stocked fish to contribute to a substantial year class in the future. In most years where there is a stocking event of small fingerling, the YOY per mile catch rate is significantly higher than years when no stocking occurs. Fox Lake does receive private stocking of large fingerling walleye in even years at 1.0 to 1.5 per acre. There is some limited natural reproduction that occurs in Fox Lake as documented by the 7.4 YOY/mile catch rate from the 2007 FE. No walleye stocking occurred that year due to Viral Hemorrhagic Septicemia (VHS) issues.

No changes to walleye stocking rates or management were recommended as part of the 2013 comprehensive fishery survey, and it appears that changes in the walleye population since that time still do not warrant changes to size or bag limits. However, with the average length of walleye being above the 18-inch minimum length limit and the assumed heavy angling pressure, there could be future negative impacts to the size structure and density of the population. Future SNI surveys should focus on attaining walleye population estimates, size structure data and conducting age and growth analysis to identify if management changes should be considered to protect the species.

LARGEMOUTH BASS

A total of 159 largemouth bass were sampled in the 2019 SEII for a catch rate of 19.9 largemouth bass/mile (49.4 largemouth bass/hour). This catch rate is below average compared to lakes with similar characteristics across the state. Lengths ranged from 6.3 to 18.8 inches, with an average length of 14.6 inches (Figure 9).

A total of 123 largemouth bass were sampled in the 2013 SEII for a catch rate of 15.4 largemouth bass mile (27.6 largemouth bass/hour). This catch rate is below average

compared to lakes with similar characteristics across the state. Lengths ranged from 7.9 to 19.2 inches, with an average length of 13.7 inches. Largemouth bass catch rates are known to be variable but are often the only measure of abundance available given the difficulty in obtaining a true population estimate.

In 2019, largemouth bass PSD was 81 and PSD-P was 40. In 2013, PSD was 84 and PSD-P was 32. This indicates that both quality-size largemouth bass (equal to or greater than 12 inches) and preferred-size (equal to or greater than 15 inches) largemouth bass were common in the population during both survey years.

The current 18-inch minimum length limit, one fish daily bag limit regulation for largemouth bass in Fox Lake has been in place since 1997. Few fish greater than 18 inches were sampled during both surveys indicating that angler harvest may be impacting the largemouth bass population. A largemouth bass population estimate and age and growth estimates were not conducted as part of the 2019 comprehensive fishery survey. However, a population estimate, as well as age and growth estimates, should be conducted during the next comprehensive fishery survey and compared to statewide and regional averages. A catch curve should be conducted to estimate total annual mortality. If feasible, a whole lake creel survey would be ideal for estimating true angler exploitation of all fish species in Fox Lake.

BLUEGILL

In the 2019 SNI, 1,879 bluegills were sampled for a catch rate of 26 bluegills/net night. Lengths ranged from 3.8 to 8.7 inches, and the average length was 6.5 inches. In the 2013 SNI, 1,107 bluegills were sampled for a catch rate of 9.8 bluegills/net night. Lengths ranged from 2.8 to 8.8 inches, with an average length of 5.3 inches.

In the 2019 SEII, 151 bluegills were sampled for a catch rate of 75.5 bluegills/mile (182.2 bluegills/hour). This catch rate is below average when compared to lakes with similar characteristics across the state. Lengths ranged from 2.7 to 7.7 inches, with an average length of 6.0 inches (Figure 10).

In 2013 SEII, 158 bluegills were sampled for a catch rate of 79.0 bluegills/mile (144.4 bluegills/hour). This catch rate is below average compared to lakes with similar characteristics across the state. Lengths ranged from 1.8 to 9.0 inches, with an average length of 6.2 inches. Bluegill catch rates were very similar between survey years, indicating a stable population.

In 2019, bluegill PSD was 53 and PSD-P was 1. In 2013, PSD was 71 and PSD-P was 3. This indicates that while quality-size bluegill (equal to or greater than 6 inches) were abundant, the proportion of preferred-size bluegill (equal to or greater than 8 inches) was very low in both survey years. In 2007, bluegill PSD was 29 and PSD-P was 0.

Local anglers reference Fox Lake as an excellent lake for bluegill harvest opportunities. It is possible that the bluegill population may not be effectively sampled using electrofishing gear, given the abundant aquatic vegetation present in the littoral zone of the lake. However, the downward trend in size structure and the intense angling pressure the lake receives should be monitored in future comprehensive fishery surveys, and a more protective regulation should be proposed if the trend continues.

YELLOW PERCH

A total of 358 yellow perch were sampled in the 2019 SNI for a catch rate of 5.0 yellow perch/net night. This catch rate is above average (75th percentile) compared to lakes with similar characteristics across the state. However, fish were not individually identified with a fin clip mark; therefore, individual yellow perch may have been netted multiple times. Yellow perch lengths ranged from 4.7 inches to 8.6 inches, with an average length of 6.9 inches (Figure 11). A total of 156 yellow perch were sampled in the 2013 SNI for a catch rate of 1.4 yellow perch/net night. This catch rate is average compared to lakes with similar characteristics across the state. Lengths ranged from 4.9 to 11 inches, and the average length was 7.2 inches. In the 2007 SNI, 6,135 yellow perch were sampled for a catch rate of 28 yellow perch/net night. This catch rate is well above average (90th percentile) compared to lakes with similar characteristics across the state.

A total of 28 yellow perch were sampled in the 2019 SEII for a catch rate of 14 yellow perch/mile (32.5 yellow perch/hour) (Figure 12). Lengths ranged from 2.8 inches to 7.0 inches, with an average length of 4.2 inches. In 2013, two yellow perch were sampled in SEII for a catch rate of 2 yellow perch/mile (4 yellow perch/hour). The average length was 5.8 inches.

PSD and PSD-P could not be calculated from SEII data in both survey years due to the small sample size. Yellow perch populations in Fox Lake appear to be better sampled during SNI than SEII or other electrofishing surveys. The 2019 SNI data indicates a PSD of 18 and a PSD-P of 0 compared to 2013 where PSD was 25 and PSD-P was 1. PSD and PSD-P values indicate the population lacked both quality-size (equal to or greater than 8 inches) and preferred-size (equal to or greater than 10 inches) yellow perch in both survey years.

As part of a statewide yellow perch study through the University of Wisconsin-Stevens Point Cooperative Fishery Research Unit, length, weight, sex and age data were taken from a random subsample of 139 yellow perch. Total annual mortality (44%) was estimated with a catch curve of age-3 and older yellow perch (Figure 13). Estimated fishing mortality was calculated at 24%. Changes to the yellow perch population should be a primary focus of the next comprehensive fishery survey as the species is an important food source and is heavily targeted by anglers year-

round. If changes occur in the recommended sampling protocols for yellow perch, future surveys should focus on improved capture methods.

BLACK CRAPPIE

In the 2019 SNI, 181 black crappies were sampled for a catch rate of 2.5 black crappies/net night. This catch rate is slightly below average compared to lakes with similar characteristics across the state. Lengths ranged from 3.7 to 12.2 inches, and the average length was 9.3 inches (Figure 14). In the 2013 SNI, 2,133 black crappies were sampled for a catch rate of 18.9 black crappies/net night. This catch rate is above average compared to lakes with similar characteristics across the state. Lengths ranged from 2.7 to 11.6 inches, with an average length of 8.2 inches. In the 2007 SNI, 12,830 black crappies were sampled for a catch rate of 57.8 black crappie/net night. This catch rate is well above average (90th percentile) compared to lakes with similar characteristics across the state.

In 2019, black crappie PSD was 93 and PSD-P was 39, indicating that the population was comprised of a large proportion of quality-size (greater than or equal to 8 inches) and preferred-size (greater than or equal to 10 inches) black crappies. In 2013, black crappie PSD was 77 and PSD-P was 2, indicating that the population in 2013 was comprised of a large proportion of quality-size (greater than or equal to 8 inches) black crappies, but few of preferred-size (greater than or equal to 10 inches). Black crappie PSD in 2007 was 69 and PSD-P was 31.

Although black crappie are not specifically managed, they are highly sought after by anglers. Like yellow perch in Fox Lake, fyke nets tend to capture black crappies more effectively than electrofishing. Analysis of age and growth metrics of black crappies should be included in the next comprehensive fishery survey to better understand the population dynamics of this important species in Fox Lake.

MUSKELLUNGE

In the 2019 SNI, 20 muskellunge were sampled for a catch rate of 0.5 muskellunge/net night. Lengths ranged from 32.4 to 47.0 inches, and the average length was 40.0 inches (Figure 15). In the 2013 SNI, 13 muskellunge were sampled for a catch rate of 0.5 muskellunge/net night. Lengths ranged from 25.8 to 46.0 inches, with an average length of 37.3 inches. In the 2007 SNI, 69 muskellunge were sampled for a catch rate of 0.3 muskellunge/net night.

Fox Lake supports a low-density muskellunge population. Muskellunge were initially stocked as an additional top predator to help control common carp and bullhead populations during the decades where rough fish overpopulation was an issue. The DNR ceased stocking muskellunge in Fox Lake in 2001. The Fox Lake Property Owners have stocked fingerling (12-inch average length) muskellunge at low densities in various years.

Future comprehensive fishery surveys should include age and growth metrics to further understand the population dynamics of this top predator's role in the fishery of Fox Lake.

COMMON CARP

In the 2019 SNI, 19 common carp were sampled for a catch rate of 0.26 common carp/net night. In the 2013 SNI, 12 common carp were sampled for a catch rate of 0.11 common carp/net night. In 2007 SNI, 36 common carp were sampled for a catch rate of 0.16 common carp/net night.

In the 2019 SEII, two common carp were sampled for a catch rate of 1.0 common carp/mile (2.3 common carp/hour). This catch rate is below average compared to lakes with similar characteristics across the state. In the 2013 SEII, 30 common carp were sampled for a catch rate of 30.0 common carp/mile (30.0 common carp/hour). This catch rate is above average compared to lakes with similar characteristics across the state.

Common carp catch rates are currently within normal parameters and in line with historic catch rates for SNI of Fox Lake (0.36 common carp/net night in 2001 and 1.50 common carp/net night in 1995). Natural reproduction of common carp is likely occurring each year. However, a combination of high-density top predator and high-density panfish populations is likely suppressing recruitment of common carp through predation on juvenile common carp and common carp eggs, respectively. No management changes are currently recommended, but the relative abundance of the common carp population should be monitored, via catch rates, in future comprehensive fishery surveys.

Management Recommendations

Fox Lake continues to offer quality fishing opportunities for northern pike, walleye, largemouth bass, bluegill and black crappie. The 2019 survey yielded few northern pike over the 32-inch minimum length limit but did show a fair number of quality fish over 21 inches. The high catch rate and modest recapture rate indicate a significant population size. Future SNI surveys should focus heavily on replicating the Mill Creek and lake-wide northern pike population estimates and conducting age and growth analyses to further evaluate regulation options and determine if density-dependent growth issues exist.

The 2019 survey produced an adult walleye population estimate of 4.3 walleye/acre with good size structure and continued recruitment from alternate, odd-year small fingerling stocking. Angler exploitation is currently not likely a driving factor of walleye size structure or density in Fox Lake at this time, and no changes to the regulation are necessary.

Despite indications of angler harvest of legal-sized largemouth bass, the population continues to be self-sustaining, and no management action is needed at this time. The panfish population continues to be self-sustaining as well, but high angler harvest and/or inadequate sampling technique have resulted in few quality-sized panfish. Future SNI surveys should monitor panfish community trends in size structure, abundance and growth to evaluate the need for regulation changes.

Management recommendations include:

1. Maintain an adult walleye density of at least 4/acre and continue the 18-inch minimum length, three fish daily bag limit to protect the population.
2. Monitor the walleye population and reevaluate size structure, relative abundance and growth in the next comprehensive fishery survey. Conduct a population estimate.
3. Monitor the northern pike population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey. Monitor adult northern pike density, age and relative weight to determine if density dependent growth issues exist. Conduct a local Mill Creek and lake-wide population estimate of northern pike.
4. Monitor the bluegill population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey.
5. Monitor the largemouth bass population and reevaluate size structure, abundance and growth in the next comprehensive fishery survey.
6. Monitor the yellow perch population to evaluate size structure, abundance, growth, length at age and relative weight in the next comprehensive fishery survey to identify if a regulation change is warranted.
7. Monitor the black crappie population to evaluate size structure, abundance, growth, length at age and relative weight in the next comprehensive fishery survey to identify if a regulation change is warranted.
8. Monitor the relative abundance of the common carp population, via catch rates, in the next comprehensive fishery survey.
9. Conduct a lake-wide creel survey to estimate angler exploitation of all fish species in Fox Lake.

Appendices

Appendix 1. Catch per unit effort for spring fyke net (SNI) and spring electrofishing (SEII) samples from Fox Lake, Dodge County in 2019.

Species	Fyke Net Results			Electrofishing Results		
	Number (#)	#/net night	Ave. Length (in.)	Number (#)	#/mile	Ave. Length (in.)
Black Crappie	181	2.5	9.4	3	1.5	3.6
Bluegill	1879	26.1	6.6	151	75.5	6.0
Largemouth Bass	77	1.1	16.6	159	19.9	14.5
Northern Pike	3471	48.2	23.8	2	0.25	31.0
Muskellunge	20	0.30	39.8	---	---	---
Pumpkinseed	---	---	---	4	2.0	5.1
White Crappie	1	---	---	---	---	---
Walleye	1687	23.4	19.8	587	146.8	16.8
Yellow Perch	358	5.0	7.0	28	14.0	4.5

Appendix 2. Walleye length at age determined using dorsal spines collected from Fox Lake in 2019. Statewide and South District (SD) average length were gathered from spring (January-May) surveys.

	Age (observed annuli)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Statewide	7.6	11.8	13.6	15.0	16.4	17.9	19.1	20.2	21.1	21.9	22.8	23.4	23.9
South District	9.1	12.1	14.1	16.2	17.3	18.3	19.1	19.9	21.3	21.9	23.2	23.6	24.7
Fox Lake	9.6	10.9	14	14.6	16	17.3	17.5	18.5	19.4	21.6	23.6	25.8	26.4

Appendix 3. Fall electrofishing summary for young-of-the-year (YOY) walleye catch from Fox Lake, Dodge County 2013-2019.

Year	# YOY	MILES	CPE	Stocked
2013	75	3.26	23.0	X
2014	27	3.8	7.1	
2015	5	3.79	1.3	X
2016	7	3.78	1.9	
2017	110	11.85	9.3	X
2018	30	9.85	3.0	
2019	258	3.7	69.7	X

Tables

Table 1. Walleye mean age at length for Fox Lake, Dodge County in 2019 and corresponding percentages using males 15.0-15.9 inches and females 18.0-18.9 inches.

PERCENTILE	10	25	33	50	66	75	90
Males 15-15.9	7.00	6.00	5.69	4.96	4.36	4.00	3.64
Females 18-18.9	8.00	7.33	7.00	6.07	5.47	5.00	4.43
		2019					
		LENGTH	AVG AGE	PERCENTILE			
	Males	15	4.80	54%			
	Females	18	6.75	38%			
		2013					
		LENGTH	AVG AGE	PERCENTILE			
	Males	15	4.21	70%			
	Females	18	6.25	47%			

Figures

Figure 1. Contour map of Fox Lake in Dodge County, Wisconsin.

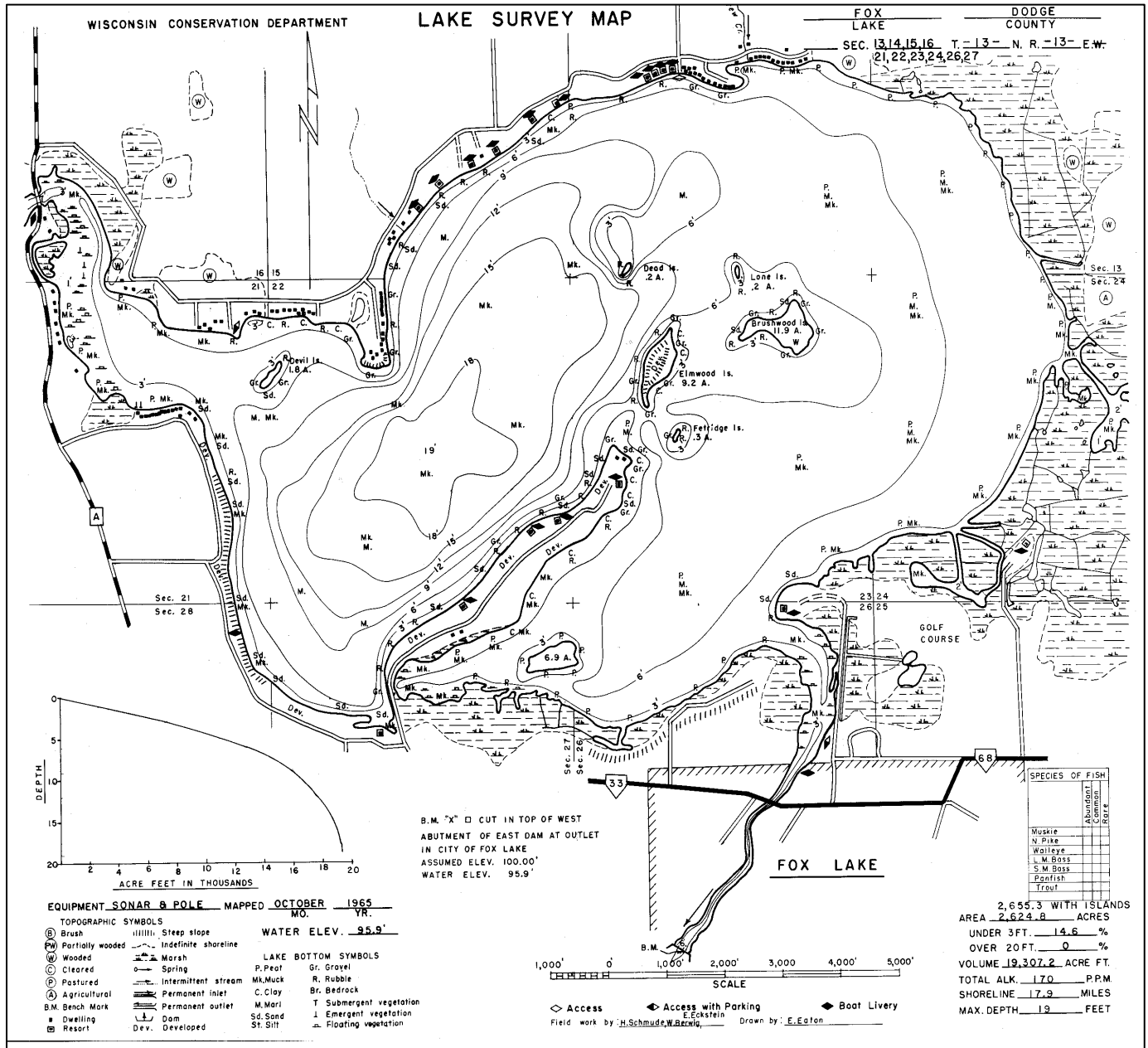


Figure 2. Length-frequency histogram of male, female and unknown sex northern pike sampled during the 2019 spring fyke netting (SNI) surveys of Fox Lake, Dodge County, WI.

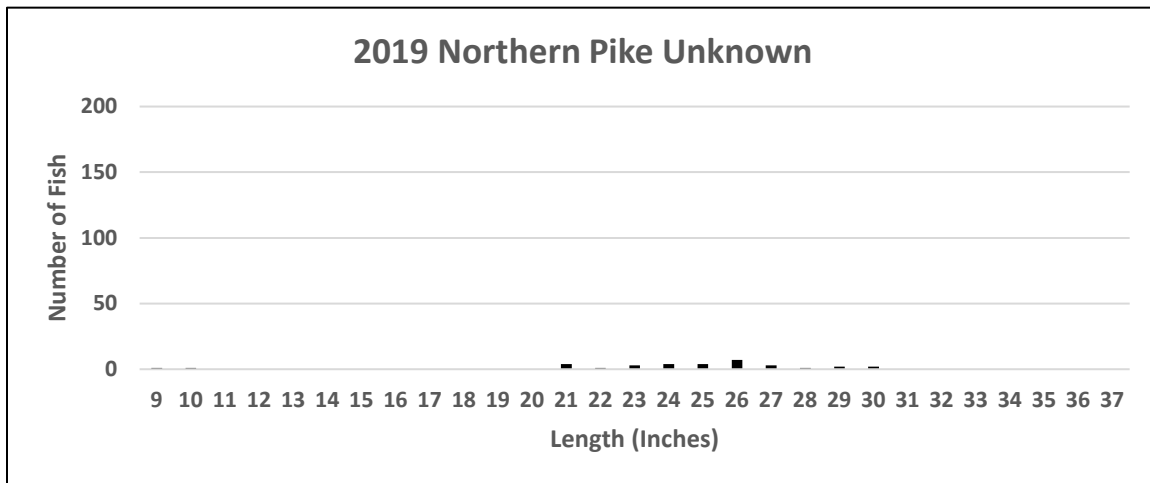
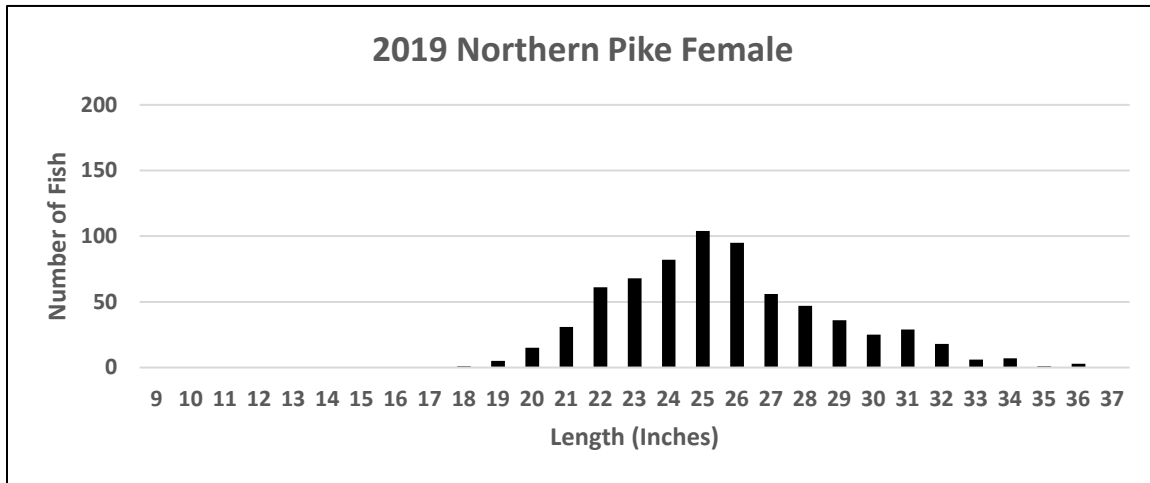
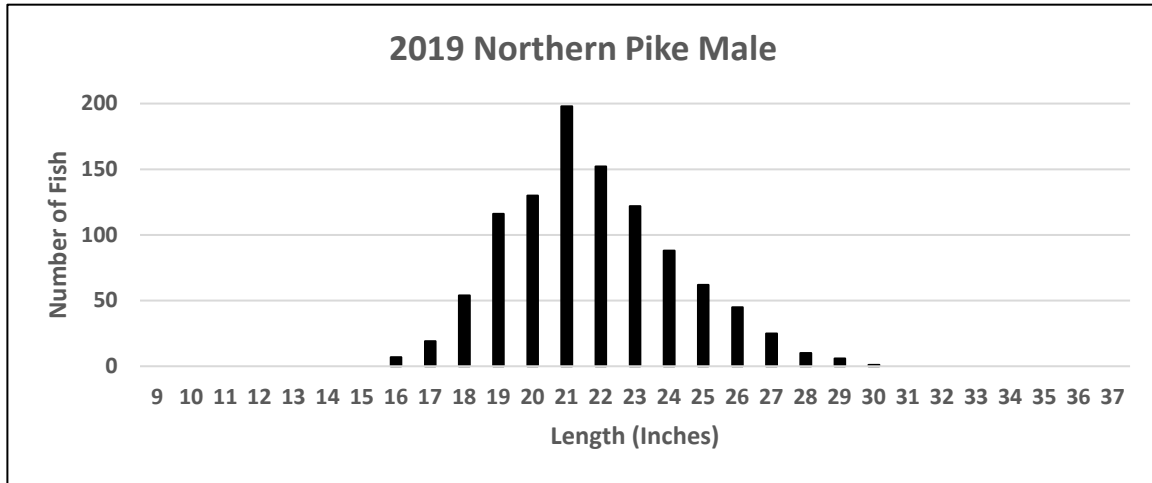


Figure 3. Length-frequency histogram of male, female and unknown sex northern pike sampled during the 2013 spring fyke netting (SNI) surveys of Fox Lake, Dodge County, WI.

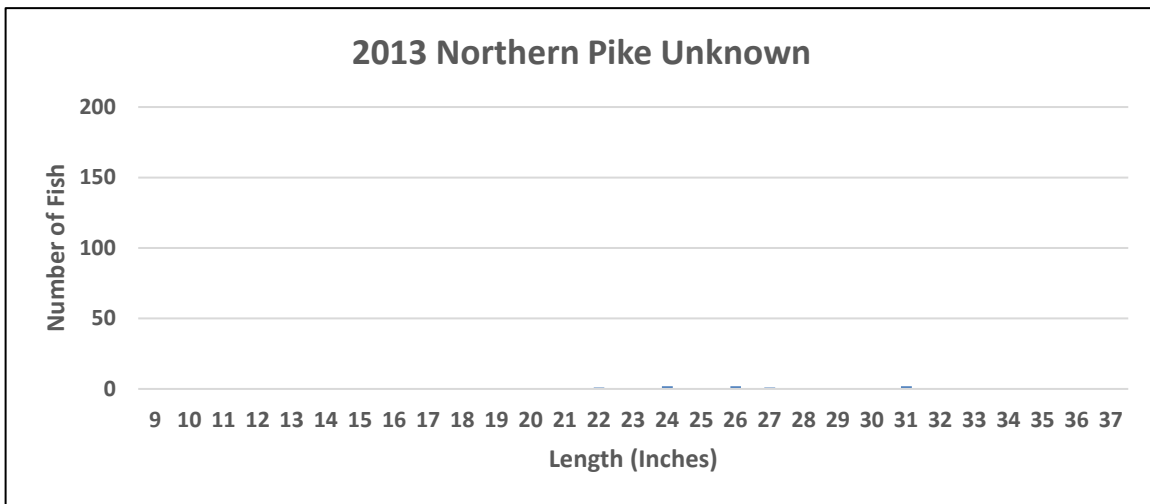
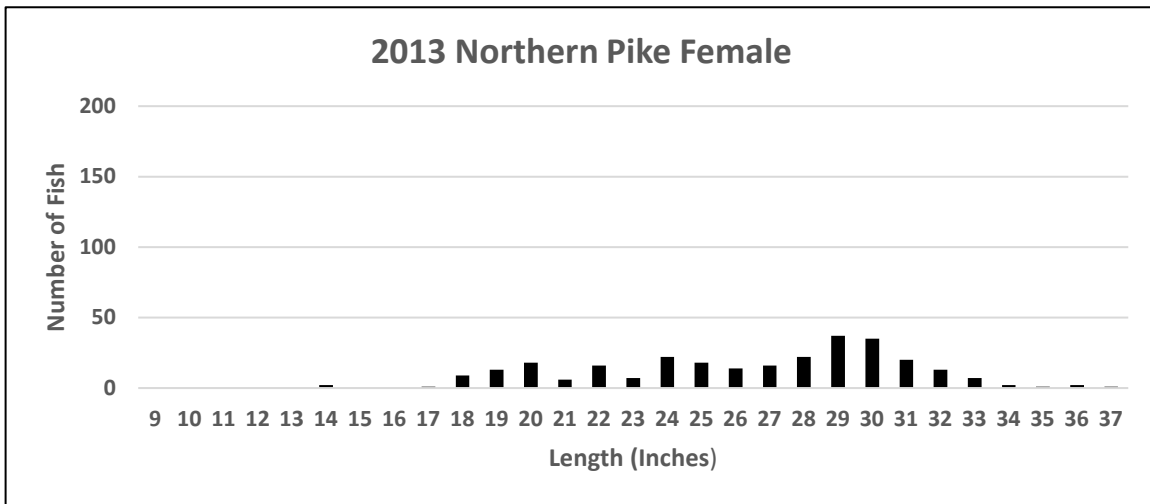
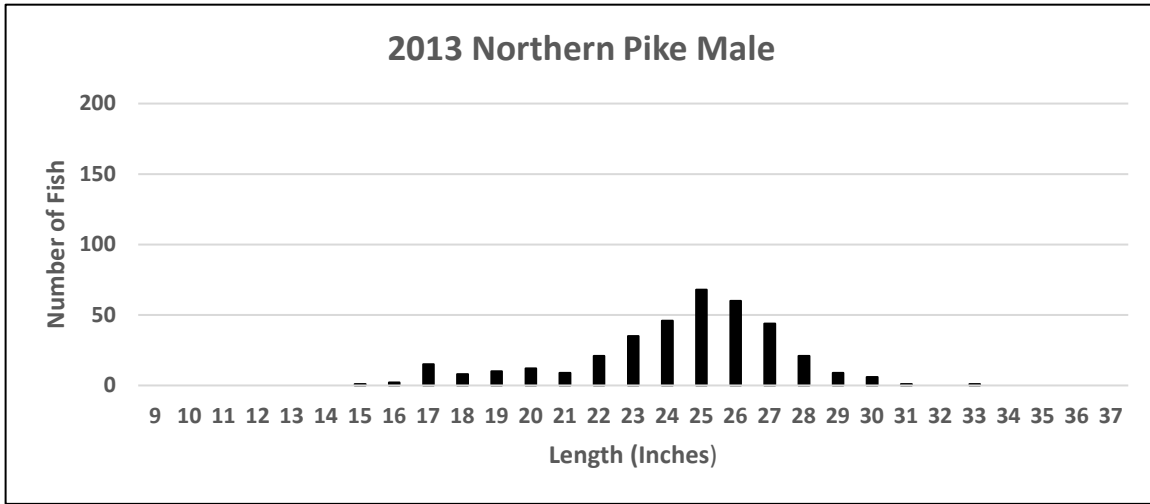


Figure 4. Northern pike mean length at age determined using anal fin rays collected during spring fyke netting (SNI) surveys of Fox Lake, Dodge County in 2019 compared to the statewide mean length at age from spring (January-May) surveys and the Southern District average.

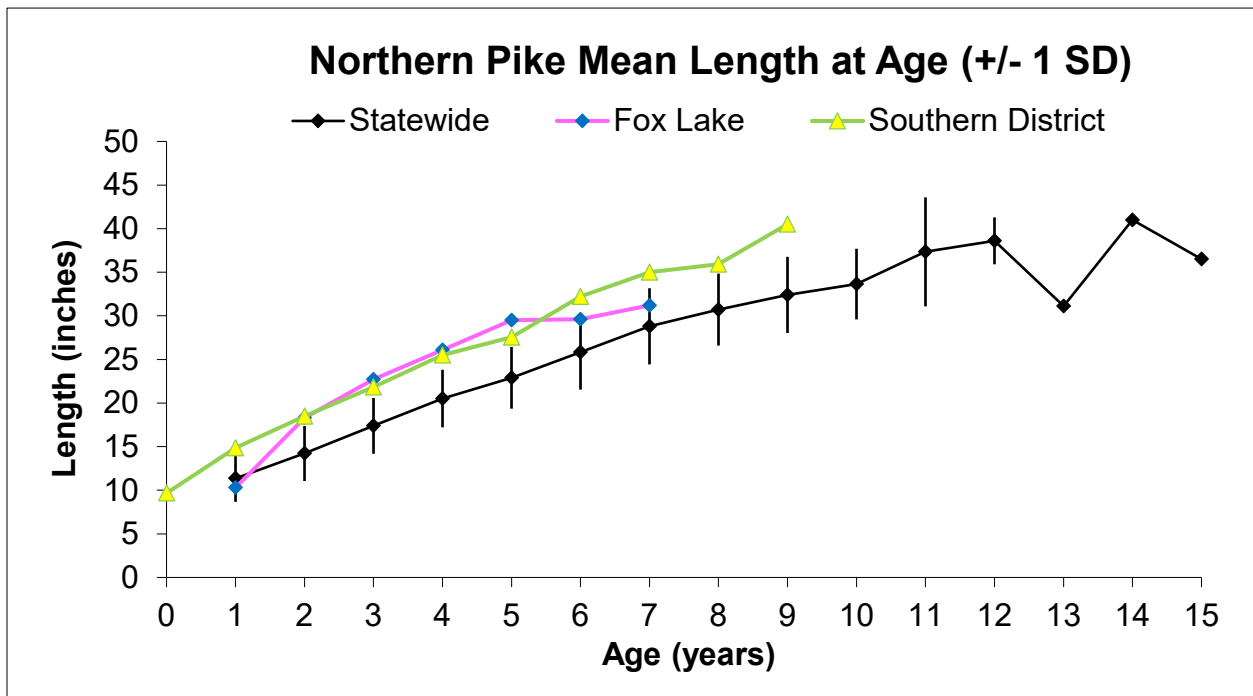


Figure 5. Length-frequency histograms of male, female and unknown sex walleye sampled during the 2019 spring fyke netting (SNI) surveys of Fox Lake, Dodge County, WI.

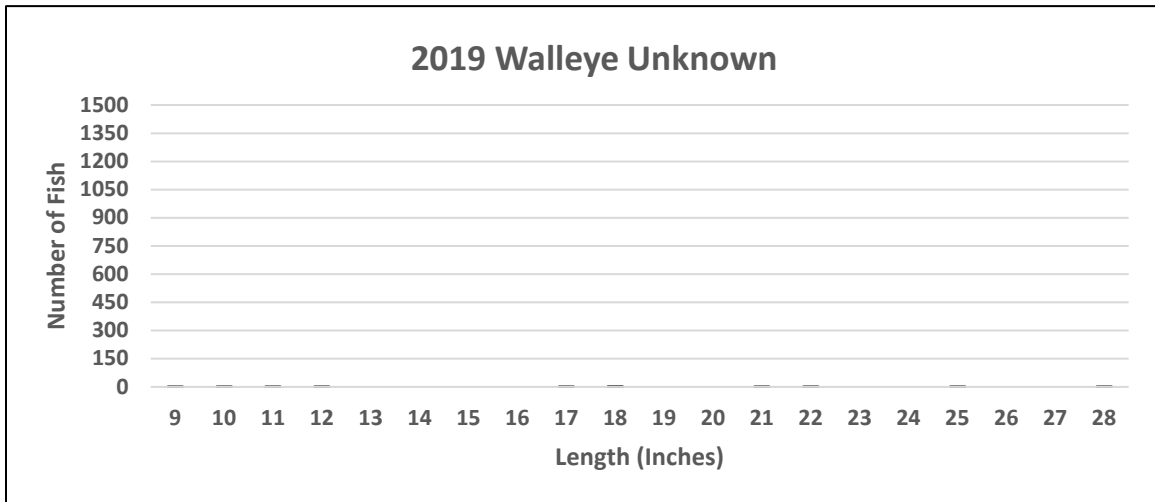
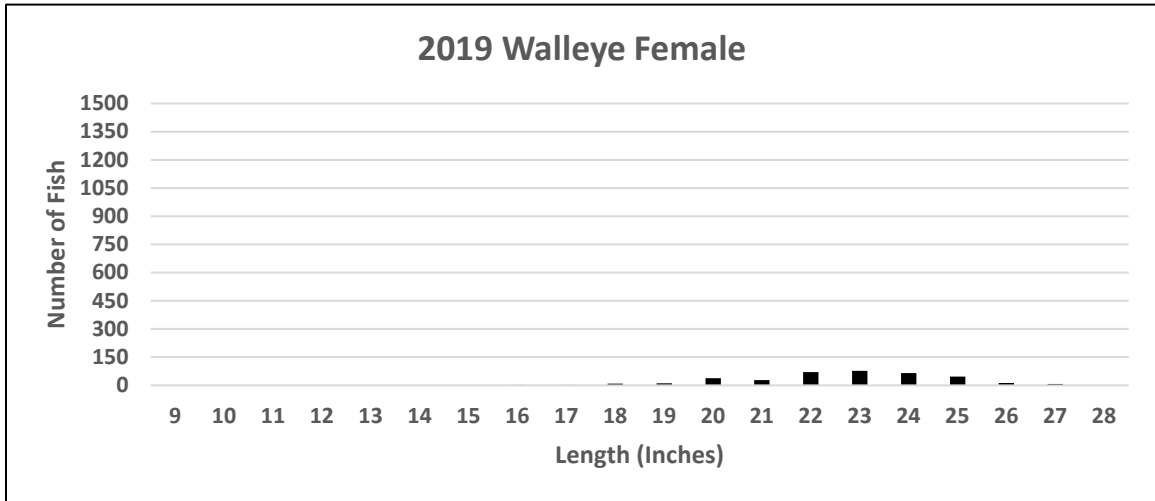
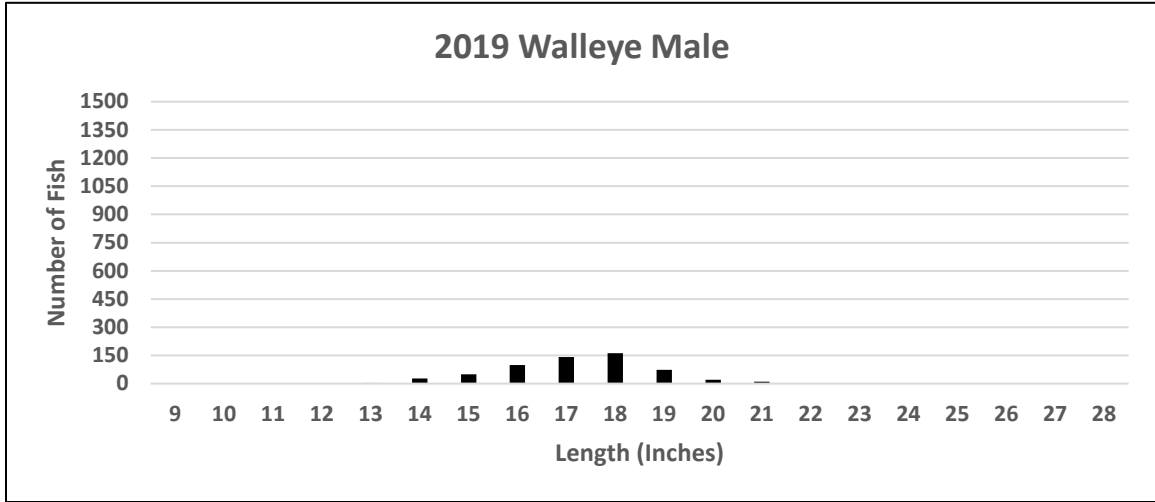


Figure 6. Length-frequency histograms of male, female and unknown sex walleye sampled during the 2013 spring fyke netting (SNI) surveys of Fox Lake, Dodge County, WI.

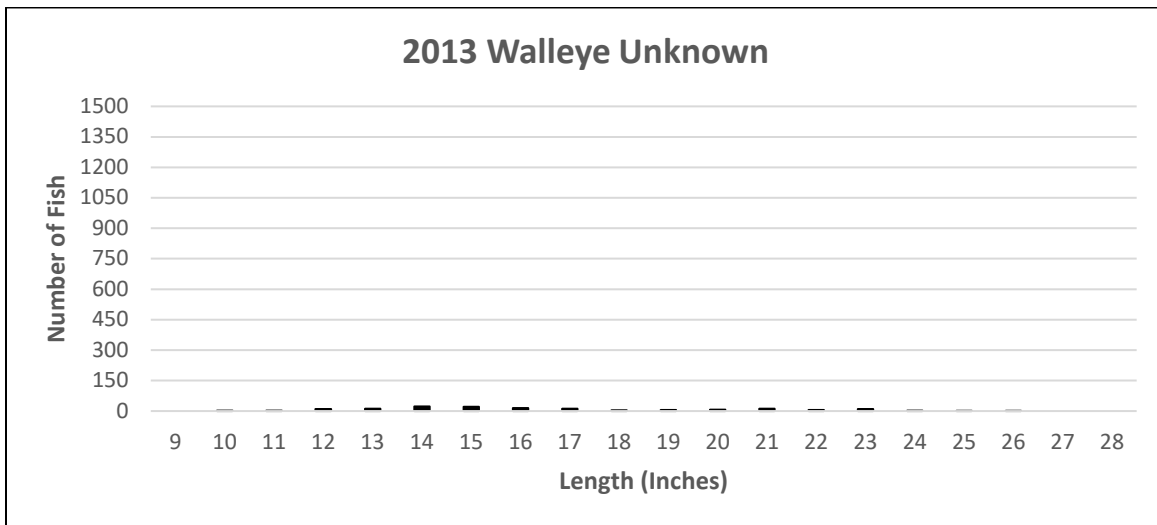
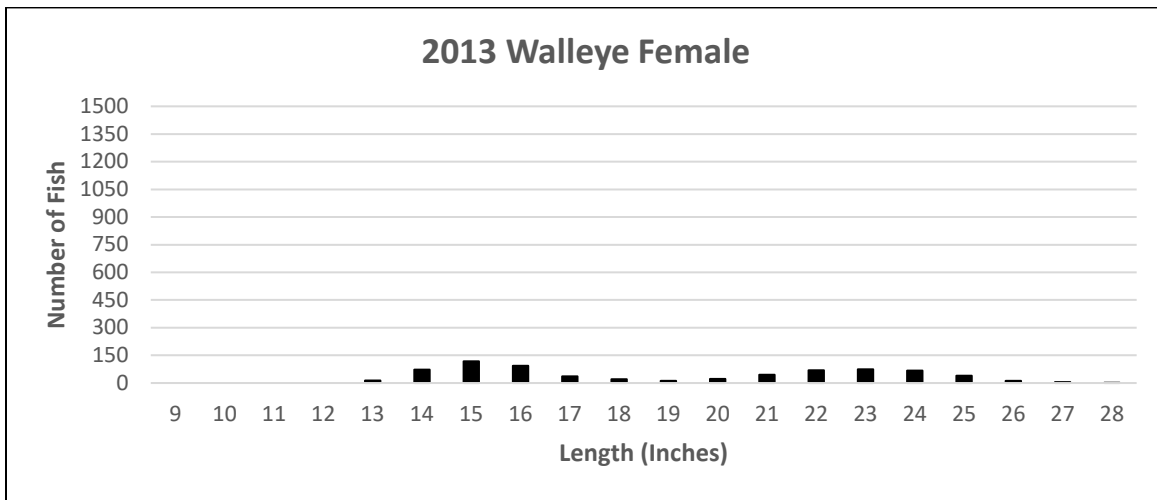
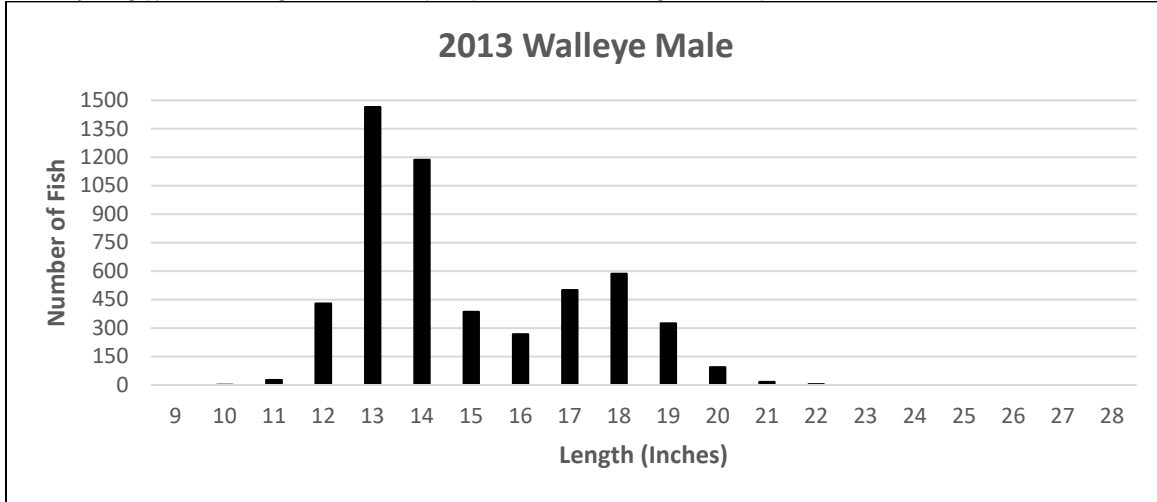


Figure 7. Walleye mean length at age determined using dorsal spines collected during the spring fyke netting (SNI) survey of Fox Lake, Dodge County, WI.

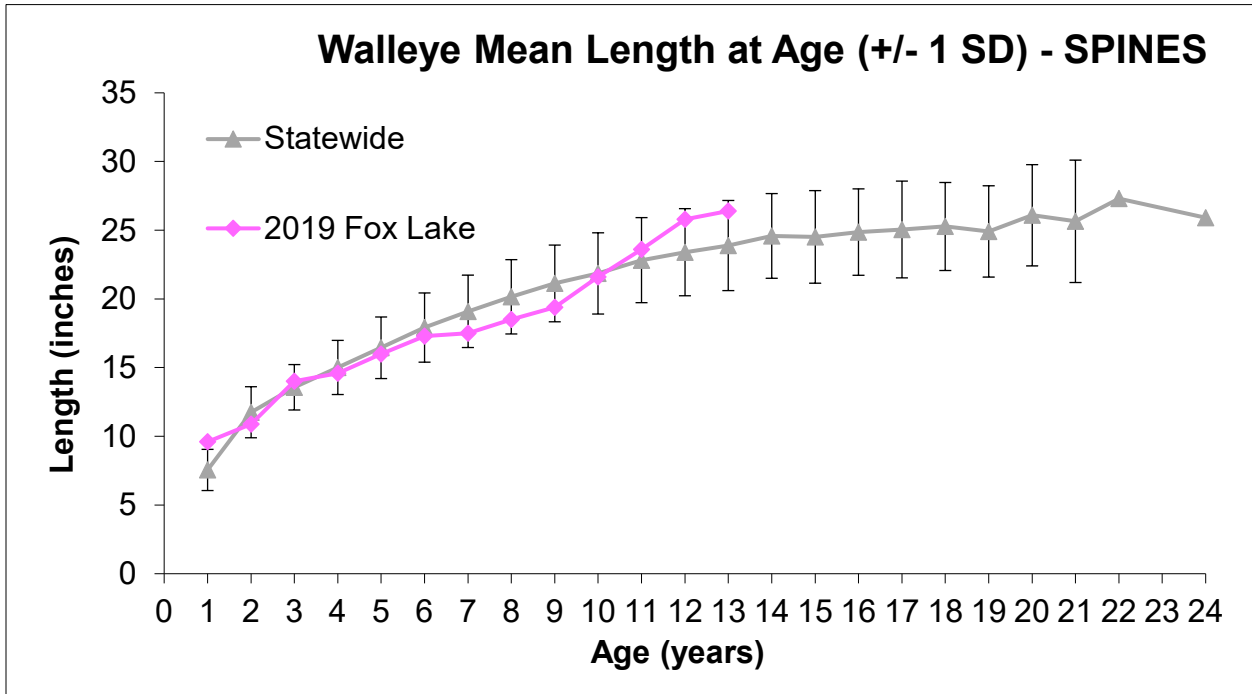


Figure 8. Walleye catch curve for Fox Lake, Dodge County in 2019 calculated from fish sampled during 2019 spring fyke netting (SNI) surveys. $Z=0.39$, $S=0.68$, $A=0.32$, $F=0.12$

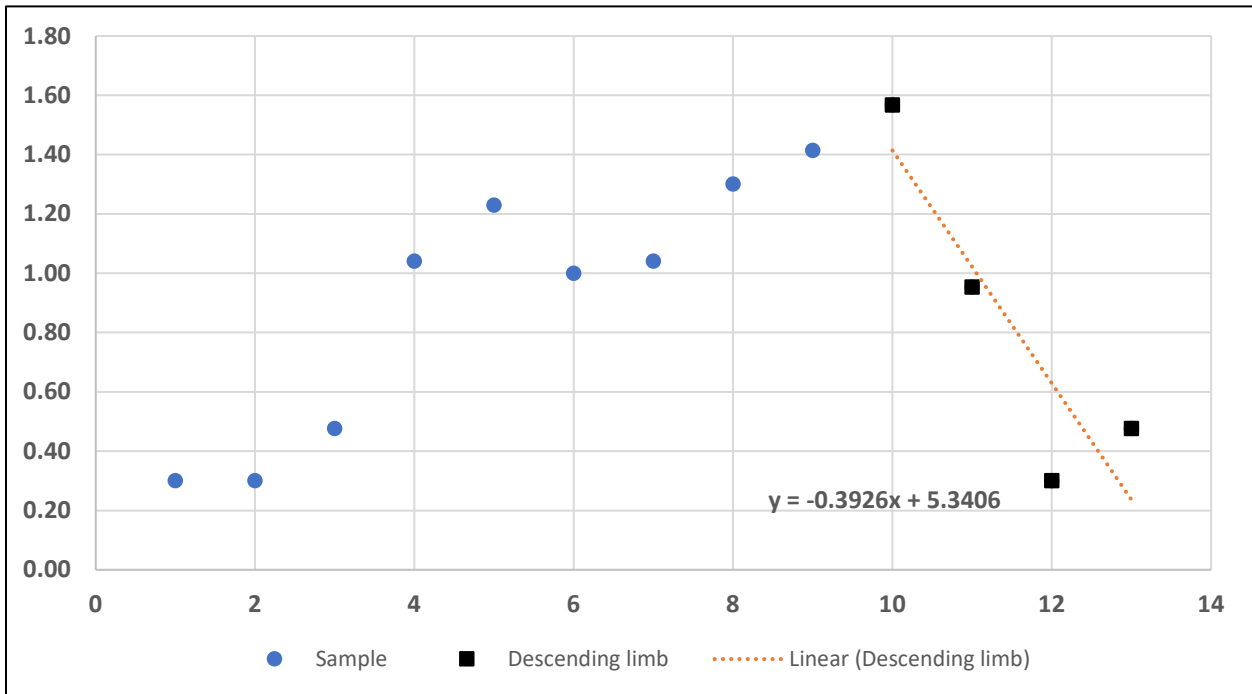


Figure 9. Length-frequency histogram of largemouth bass sampled during 2019 and 2013 spring electrofishing (SEII) surveys of Fox Lake, Dodge County, WI.

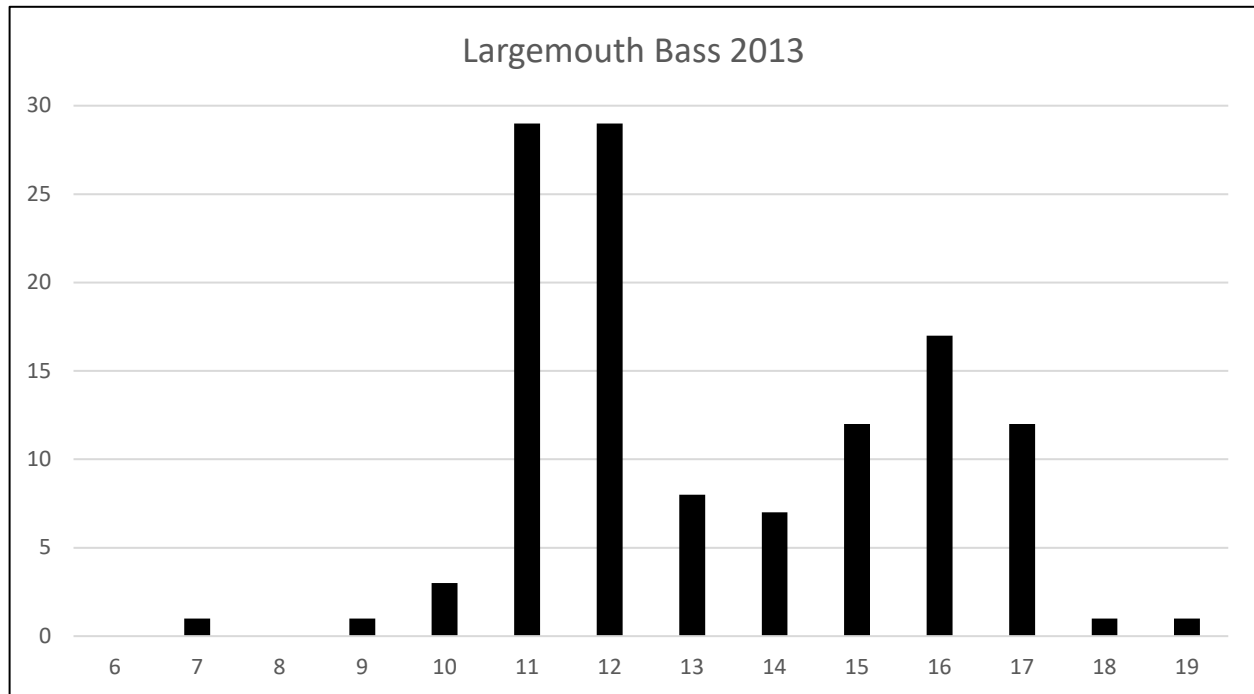
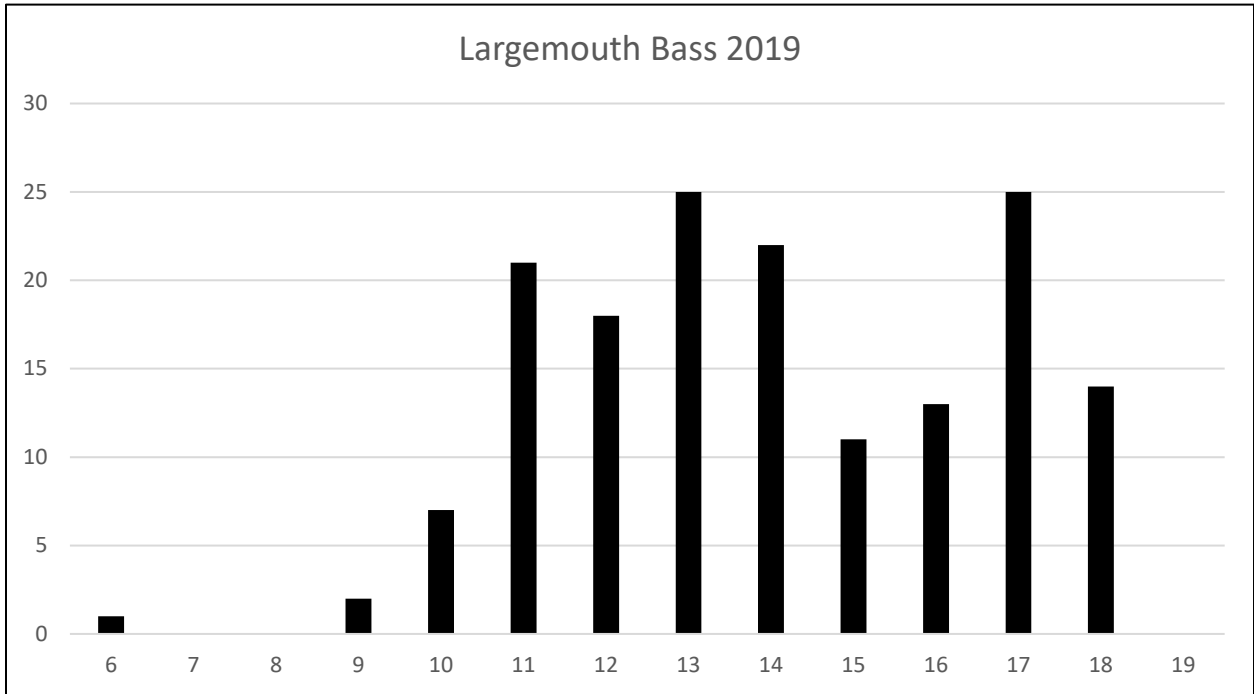


Figure 10. Length-frequency histograms of bluegill sampled during 2019 and 2013 spring electrofishing (SEII) of Fox Lake, Dodge County, WI.

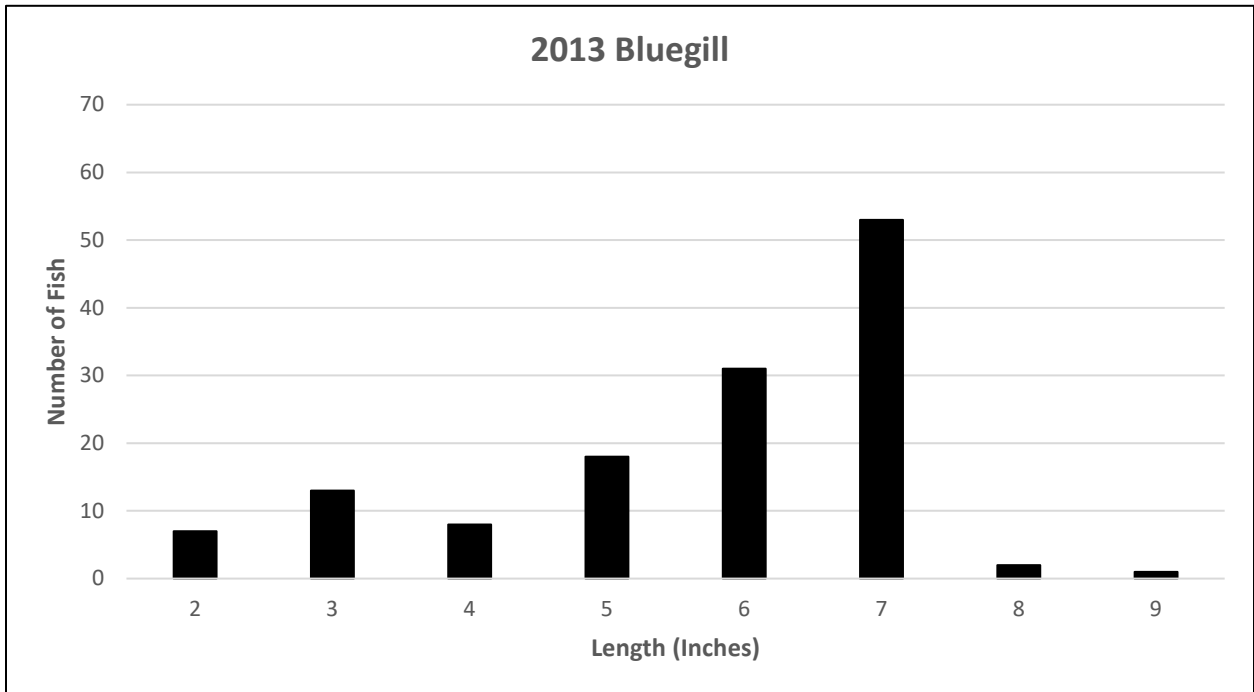
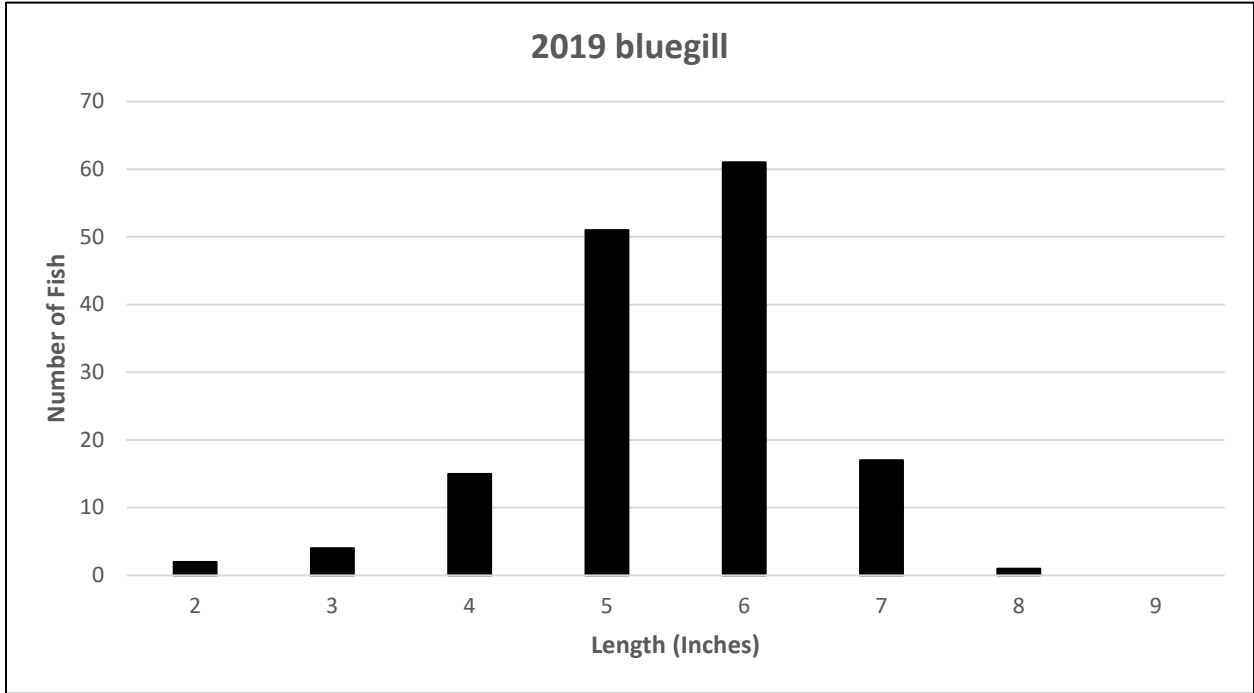


Figure 11. Length-frequency histograms of yellow perch sampled during 2019 and 2013 spring fyke netting surveys (SNI) of Fox Lake, Dodge County, WI.

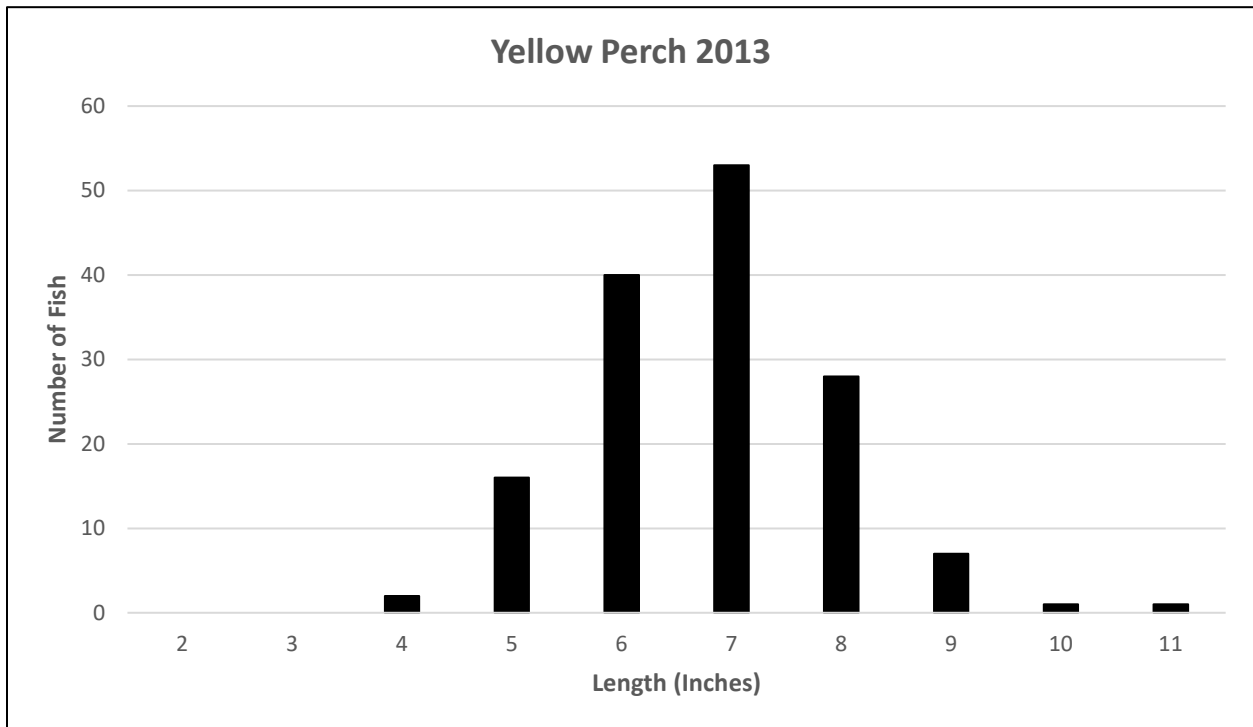
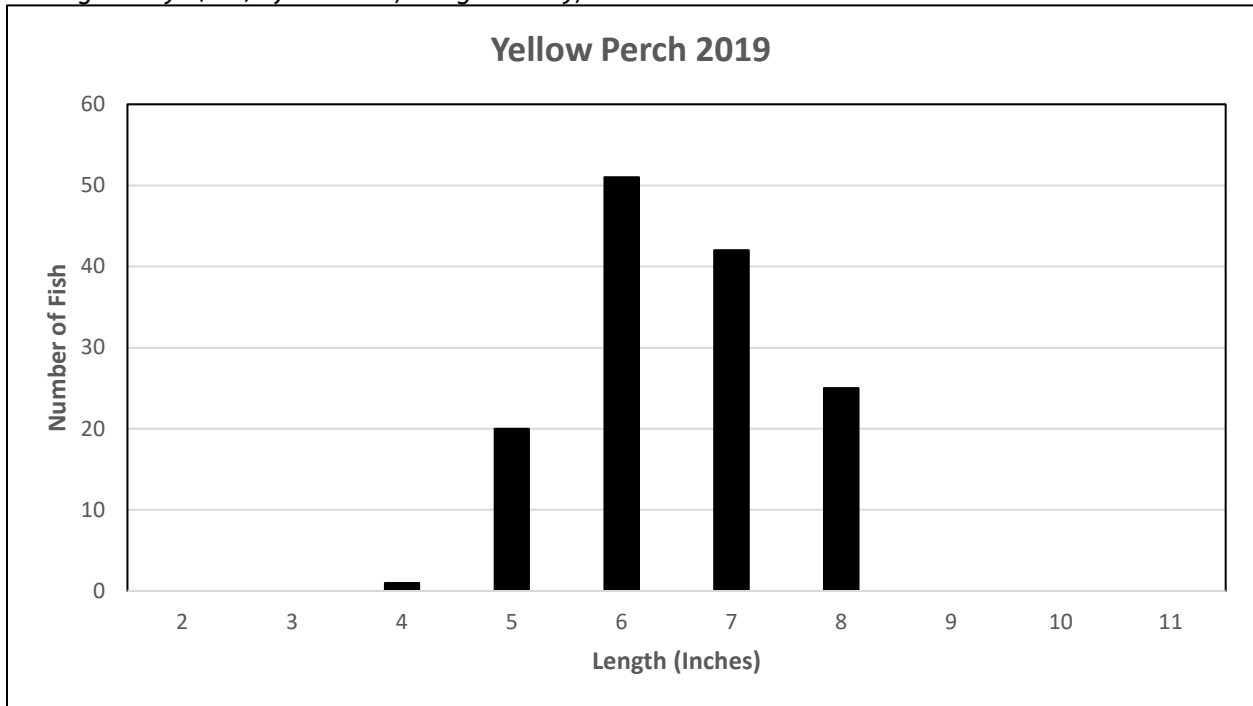


Figure 12. Length-frequency histogram of yellow perch sampled during 2019 spring electrofishing (SEII) of Fox Lake, Dodge County, WI.

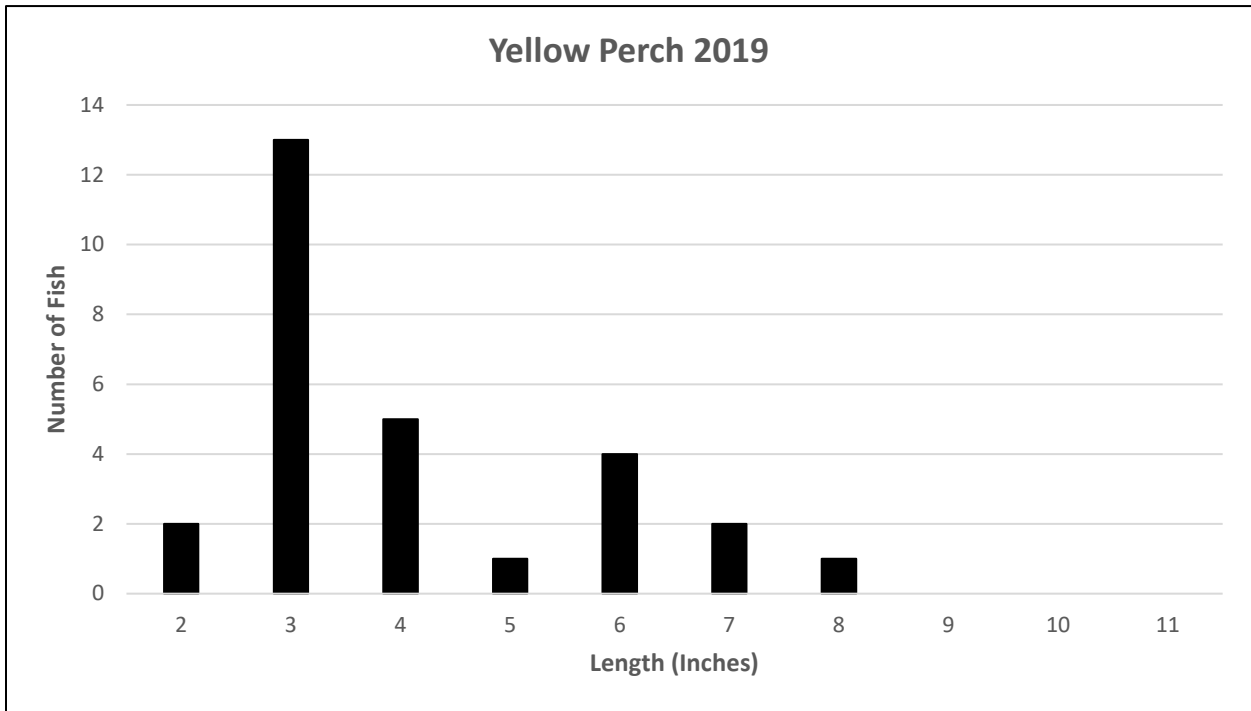


Figure 13. Yellow perch catch curve for Fox Lake, Dodge County in 2019 calculated from fish captured during fyke netting. $Z=0.59$, $S=0.56$, $A=0.44$, $F=0.24$

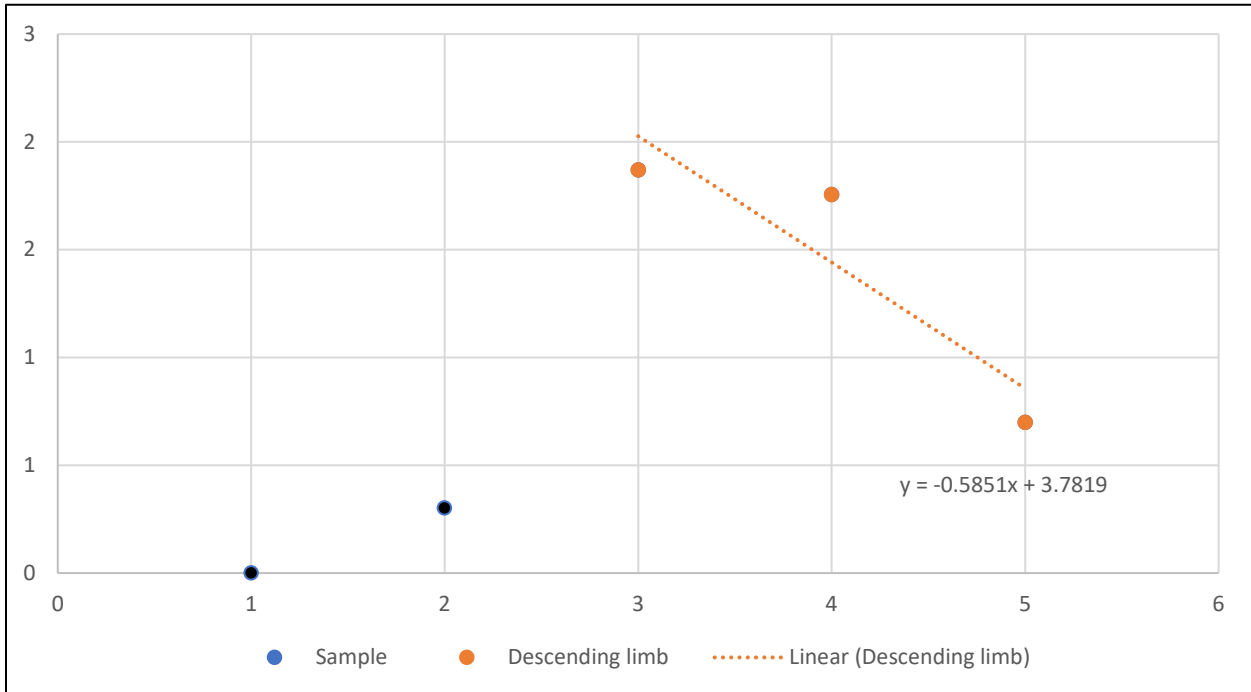


Figure 14. Length-frequency histograms of black crappie sampled in the 2019 and 2013 spring fyke netting survey (SNI) of Fox Lake, Dodge County, WI.

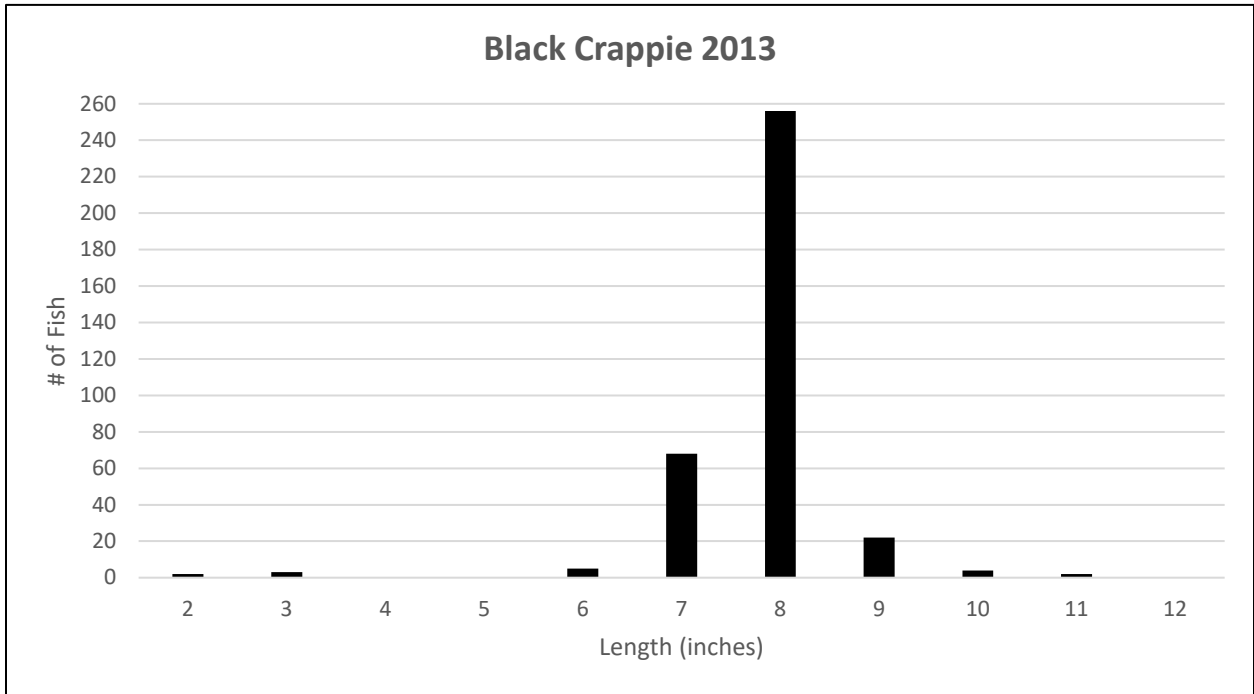
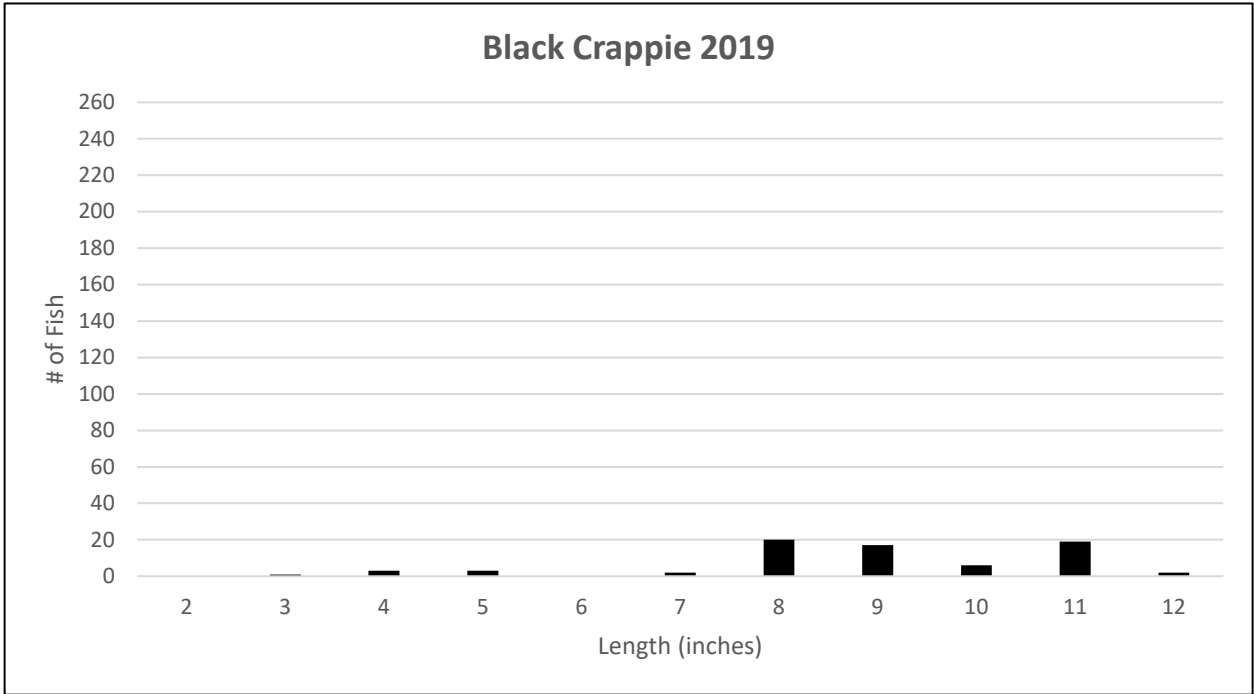
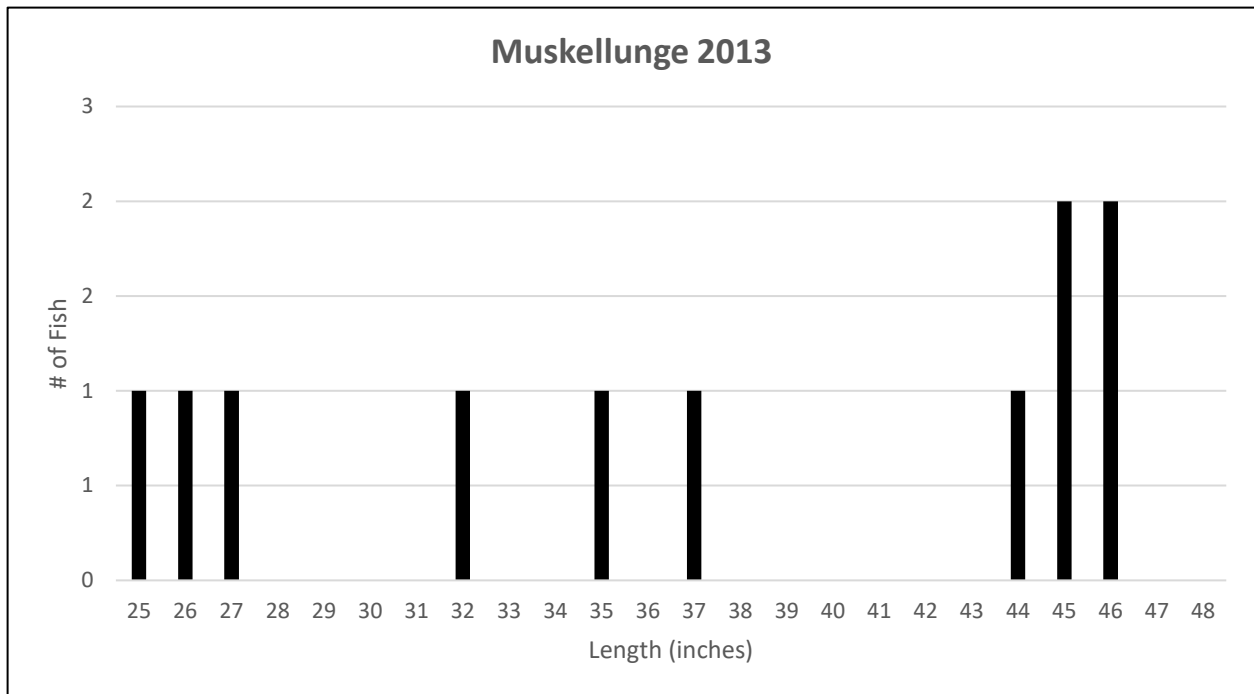
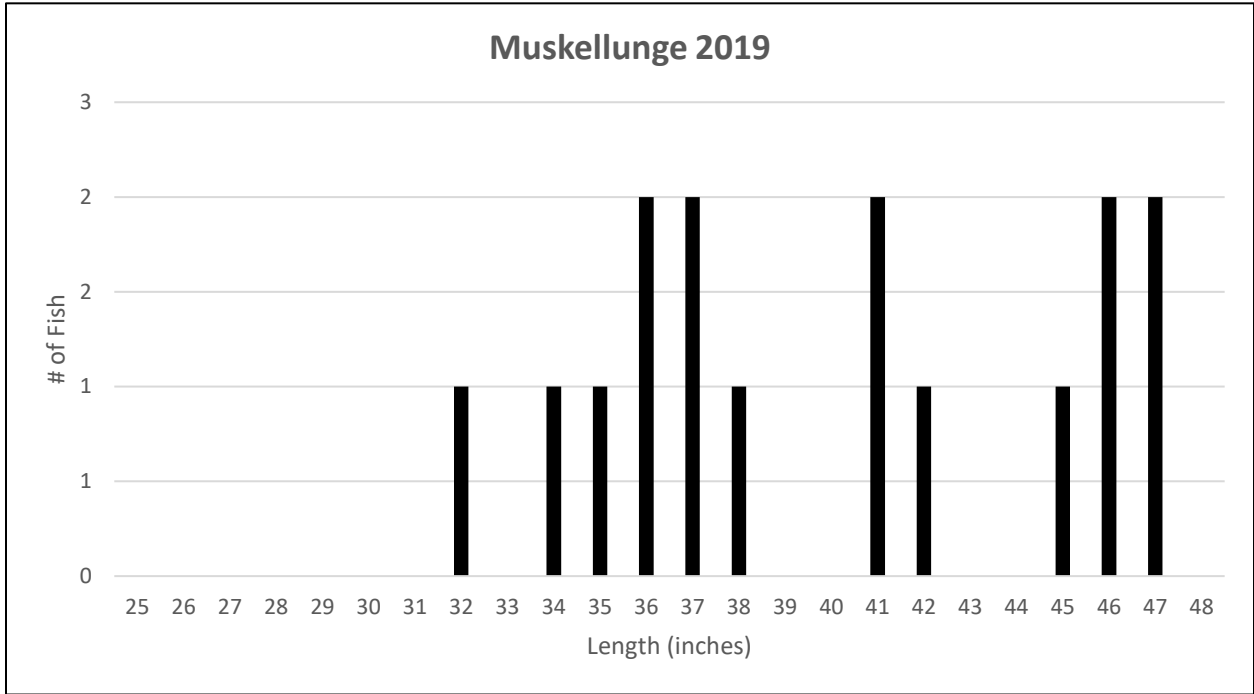


Figure 15. Length-frequency histograms of muskellunge sampled in 2019 and 2013 spring fyke netting surveys (SNI) of Fox Lake, Dodge County, WI.



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References

Anderson, R.O. and R.M. Neumann. (1996) Length, Weight and Associated Structural Indices. Pages 447-482 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Hansen, G.J.A., Gaeta, J.W., Hansen, J.F & Carpenter, S.R. (2015) Learning to Manage and Managing to Learn: Sustaining Freshwater Recreational Fisheries in a Changing Environment. Fisheries 40(2):56-64.

Murphy, B.R., and D.W. Willis (1996) Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Schneider, J. C. (1978) Selection of minimum size limits for walleye fishing in Michigan. American Fisheries Society Special Publication 11:398-407.

Willis, D.W. 1989. Proposed standard length-weight equation for northern pike. North American Journal of Fisheries Management 9:203-208.