Yellowstone Lake, Lafayette County
2018-2019 Surveys
(WBIC: 903700)

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WILDLIFE & SPORT FISH RESTORATION

Executive Summary

A comprehensive fisheries survey was conducted on Yellowstone Lake during the spring and fall of 2018 and spring of 2019. Surveys included spring fyke netting one (SN1) in 2018 from March 26 to April 13 targeting walleye, spring fyke netting 2 (SN2) targeting muskellunge from April 23 to May 3, spring electrofishing one (SE1) targeting walleye for recaptures on April 19, spring electrofishing two (SE2) targeting bass and panfish on May 8, and fall electrofishing (FE) targeting walleye and muskellunge recruitment on October 15. During 2019 only SN1 and SN2 surveys were conducted for muskellunge recapture.

Muskellunge were present in low numbers with an adult population estimate of 99 which is 0.22 per acre. Catch per unit effort (CPUE), experssed as number of fish per net night, was 0.54. Median CPUE is 0.325 for Wisconsin's complex warm dark lakes classification. Growth is above the statewide average with muskellunge reaching 38 inches at age 7. In 2018, muskellunge ranged in size from 10.4 to 47.7 inches total length with a mean of 34.2.

Walleye were present in good numbers with a population estimate of 1,955 which is 4.3 per acre for all mature walleye. CPUE, expressed as fish per net night, was 7.32, which exceeds the 75th percentile of 5.77 for Wisconsin's complex warm dark lakes classification. Growth for walleye is above the statewide average reaching 25 inches by age 10. Males ranged in total length from 7.0 to 23.7 with a mean of 15.3. Females ranged in length from 14.5 to 29.0 inches with a mean of 23.3. Walleye of unknown gender ranged in total length from 6.7 to 15.7 inches with a mean of 12.0.

Largemouth bass were not as abundant as in previous years' surveys. CPUE, experessed as number of fish per mile of electrofishing, was 22.75 in 2018. This is down from the CPUE of 76 in 2012 and 38.6 in 2015. There appears to be a downward trend in largemouth bass relative abundance. The median CPUE for Wisconsin's complex dark lakes classification is 17.4. Largemouth bass sampled during SE2 ranged in size from 11.1 to 21 inches with a mean of 14.6.

Channel catfish were abundant with a CPUE of 4.88 channel catfish per net night. Channel catfish ranged in total length from 10.0 to 29.5 with a mean of 16.6. Channel catfish under 17 inches made up 71 percent of the sample. There is still a small population of flathead catfish being sustained in the lake. Five flathead catfish were sampled in 2019. Total length ranged from 23.3 to 39.5 with a mean of 33.4.

Bluegill relative abundance was low with CPUE of 74 bluegill per mile of electrofishing. The median CPUE for Wisconsin's complex dark lakes classification is 116.99. Bluegill ranged in total length from 4.4 to 8.2 inches with a mean of 6.9. Growth was above the statewide average reaching 8 inches at age 5.

Black crappie were abundant with a CPUE ranging from 0.125 to 24.33 crappie per net night. Black crappie ranged in total length from 6.8 to 12.4 inches with a mean of 9.6. Growth was above the statewide average reaching 11 inches at age 5.

Overall the lake supports a fishable population for many species, however there is a downward trend in abundance for muskellunge, walleye, largemouth bass and bluegill. There is an abundant population of channel catfish and black crappie. Stocking rates for muskellunge and walleye have decreased while bass and bluegill have weak recruitment with very few young fish represented in our samples. Escapement over the spillway is another factor that may be contributing to lower abundance of muskellunge and walleye. Abundance of common carp was not documented. Their abundance appears to be high according to field observations from staff and anglers. Renewing carp removal projects to reduce biomass, improve water clarity and littoral zone habitat for bass and bluegill is recommended. Yellowstone Lake has a cyclic history transforming from a desirable fishery to one dominated by carp. It appears that the lake is headed in the direction of a non-desired fishery again. Further studies are needed to document the biomass of carp, abundance of aquatic macrophytes, reproductive success of largemouth bass & bluegill, presence of crayfish, and escapement of fish over the spillway, particularly muskellunge. Annual water quality sampling shows a trend of increasing phosphorus in the lake and a decrease in secchi depths. Efforts should be made to work with the County on a watershed improvement project.

Introduction

Yellowstone Lake is well known among anglers for producing large size game fish. Especially for musky anglers after producing a 57 inch catch and release unlimited line class record in 2007. The lake is also becoming increasingly popular with bass anglers having the first tournaments scheduled in 2016. Beginning in 2010 the Wisconsin Department of Natural Resources initiated surveys to define the status of the game fish population in Yellowstone Lake. The current survey rate is once every 4 years and will include at minimum an ice out spring fyke net survey, two spring electrofishing surveys, and a fall electrofishing survey for relative abundance, population estimates of select species, size structure, age & growth, and condition. This report summarizes fyke net and electrofishing surveys the Wisconsin Department of Natural Resources fisheries management staff conducted during the 2018 and 2019 field seasons. The data recorded describes population abundances (relative abundance or population estimates), size structure, condition, and age & growth. Species targeted were muskellunge, largemouth bass, smallmouth bass, channel catfish, flathead catfish, walleye, bluegill, and black crappie.

The fisheries lake management plan developed in 1997 by WDNR staff, local townships, businesses, and conservation groups recommended implementation of 6 core management practices (Van Dyck, 1997).

- Stock large predator fish
- Establish regulations to protect large predator fish

- Remove nuisance species (common carp & bullheads)
- Increase aquatic macrophytes
- Install best management practices within watershed to reduce sedimentation
- Implement slow no wake boating to reduce erosion from wave action.

Slow no wake was the only recommendation not implemented. The Fayette Township governs the boating regulations for Yellowstone Lake and the slow no wake ordinance was rejected by the township in the late 1990's.

Yellowstone Lake is managed for high numbers of predators to keep rough fish and benthivorus fish numbers low. Bio-manipulation is a primary management strategy prescribed for Yellowstone Lake. Common carp are considered nuisance species which can significantly increase chlorophyll, phosphorus, and nitrogen. Common carp are believed to inhibit aquatic macrophyte growth. The high biomass of carp may interfere with the production and recruitment of desirable species, particularly centrarchid species: bluegill, largemouth bass, and smallmouth bass. Part of the bio-manipulation of Yellowstone Lake includes the removal of common carp. Rough fish removal projects were conducted from 1998 thru 2007 with 33 to 395 lbs/acre/year of common carp removed. In the fall of 2018 and early summer of 2019, approximately 4,000lbs of common carp were removed with the help of local volunteers. Gill nets, trammel nets, and electrofishing are the most efficient methods for removing rough fish. Because of the large amounts of fallen trees, stumps, and fish cribs, seining is not an efficient method of rough fish removal.

Current management items of concern for Yellowstone Lake are:

- Nutrient loading, sedimentation, & turbidity,
- Abundance of common carp
- Low densities of aquatic macrophytes
- Low natural recruitment of largemouth bass and bluegill
- Escapement of muskellunge over the spillway

Location

Yellowstone Lake (WBIC: 903700) is located in northeast Lafayette County within the Township of Fayette just east of the Village of Fayette. Latitude 42.76445 N and Longitude 89.97175 W. Yellowstone Lake is an impoundment of the Yellowstone River (WBIC: 902500). Constructed in 1954, it was developed as a local recreational opportunity for southern Wisconsin.

Access

Yellowstone Lake is bordered by Yellowstone Lake State Park and State Wildlife Area. Public access is allowed along the entire shoreline. Much of the access is located on the north side of the lake within Yellowstone Lake State Park. There are two paved boat launches, a gravel carry in launch, five disabled angler fishing pads, and just over 1.5 miles of accessible shore fishing.

Lake Characteristics
Yellowstone Lake is classified as complex warm dark under Wisconsin's current lake classification system. The physical characteristics of Yellowstone have changed over the years largely due to the addition of 2 sub-impoundments and the deposition of sediment. Sedimentation and the building of 2 levees have led to the decrease of surface area and miles of shoreline (table 1). Sedimentation has decreased the depth of the lake throughout. Recent core samples have shown up to 72 inches of modern deposits in the upper end of the lake.

Yellowstone is a shallow hypereutrophic lake with an upper watershed having mostly agriculture use. During the periods shortly after ice out and late fall the water clarity is good with sechhi depths up to 2.5 feet recorded. During the summer months, algae blooms combined with re-suspension of sediment from precipitation, rough fish, wind, and recreational boating lead to low water clarity. Sechhi depths less than 1.5 feet are common during high turbidity periods. Currently total phosphorus levels range from 66 to 236 milligrams per liter.

Littoral zone habitats consist of shallow tree falls, aquatic macrophytes, natural rock, and rip-rap. Macrophytes are present mostly in low densities however there are areas of the lake in which they are considered to be in high density. Tree falls are abundant along much of southern shoreline. Woody habitat was also increased with the installation of 42 fish cribs in the lower portions of the lake. Rip-rap is present along the dam, much of the north shore and along the impoundment levees. Natural rock habitat occurs along the southeast portions of the lake as the shoreline approaches the dam. Sandstone is the predominate rock type with some limestone present.

Yellowstone Lake is classified as A1 muskellunge water. Class A1 waters are best known as trophy waters for their ability to consistently produce large muskellunge, but overall abundance of muskellunge may be relatively low. Angling action can be inconsistent, but the average size of fish caught is larger.

Fish species
Fish species currently documented in Yellowstone Lake are muskellunge, northern pike, largemouth bass, smallmouth bass, walleye, channel catfish, flathead catfish, brown bullhead, black bullhead, bluegill, green sunfish, pumpkinseed sunfish, hybrid sunfish, black crappie, golden shiner, white sucker, fathead minnows, common carp, bigmouth buffalo, and bowfin.

Regulations
The primary goal of regulations set on Yellowstone Lake is to protect large predator fish to help control the recruitment of common carp, bullhead catfish, and rusty crayfish. Because of this, there is an aggregate bag limit of 2 in total for walleye, largemouth bass, and smallmouth bass. A secondary goal is to maintain trophy size sportfish for anglers to catch and enjoy. Yellowstone Lake regulation for muskellunge is a 50 inch minimum

with a daily bag limit of 1. The current size regulation for walleye is a harvest slot limit. Walleye between 15 inches and 18 inches total length may be kept. The current size regulation for largemouth bass is a harvest slot limit. Largemouth bass between 12 inches and 15 inches total length may be kept. The current regulation for panfish is a daily bag limit of 25 with no size limit. The current regulation for channel catfish and flathead catfish is an aggregate daily bag limit of 10 with no size restriction.

Stocking

Muskellunge and walleye are the two species stocked to maintain fishable populations. No stocking is required for largemouth bass, smallmouth bass, panfish species, and catfish species as they reproduce naturally and recruit to the fishery. The previous 10 years of stocking history for all species are listed in table 2

Yellowstone Lake receives an annual stocking rate of 0.5 musky per acre which is 225 large fingerling muskellunge. Yellowstone lake is within the genetic management zone of universal receptor. Strain may be unspecified. Most recent stocking events have been of the Upper Wisconsin or Chippewa strain raised at the Wild Rose state fish hatchery. Starting in 2013 all large fingerling muskellunge stocked have been injected with a Passive Integrated Transponder (PIT) tag. PIT tags are coded with a numeric sequence unique to individual fish. This allows for age and growth determinations as well as data for evaluating movement and escapement over the dam. In 2012, the muskellunge stocked from Wild Rose fish hatchery were fed a diet of pellets only and were stocked at a smaller size than normal.

Walleye have been stocked at various rates and sizes over the last 10 years. It is currently stocked every other year with 15,890 small fingerling walleye which is a rate of 35/acre. Most recent strains stocked have been the Upper Rock-Fox River strain raised at the Lake Mills state fish hatchery. It is recommended to switch the strain to Mississippi Main Stem

Methods

Field work

Fyke netting protocol was repeated for both years (2018–2019) of the survey. Fyke net frames measure 4 feet high and 6 feet wide. They are double throated with a ¾ inch bar mesh. Nets were set at ice out each year until a desired number of targeted fish were captured. Fyke nets were set perpendicular to the shore with the lead staked at the shore. Pot ends of the nets were anchored with a flute style anchor. Nets were lifted every 24 hours for the duration of the survey. Coordinates for the 2018 net locations are listed in table 3 and coordinates for the 2019 net locations are listed in table 4.

In 2018, spring netting 1 (SN1) was from March 26 to April 13, 2018. The primary objective for this sampling period is to capture, measure, and mark adult walleye for use in estimating their abundance. The secondary objective is to

measure and, if needed, mark other gamefish. Because of their low density muskellunge were also targeted during this effort. Other species targeted for aging structures during this effort included largemouth bass, channel catfish, bluegill, and black crappie. Total netting effort during SN1 was 159 net nights. Walleye and Muskellunge were both targeted the full 159 net nights.

Spring netting 2 (SN2) was from April 23 to May 03, 2018. The primary objective for this sampling period is to capture, measure, and mark adult muskellunge for use in estimating their abundance. The secondary objective is to measure and, if needed, mark, and take aging structures from other gamefish. Other species targeted for aging structures during this effort included largemouth bass, channel catfish, bluegill, and black crappie. Total netting effort during SN2 was 262 net nights. Six to 9 nets were fished at 15 different locations. During SN2, muskellunge were targeted for all 262 net nights.

In 2019, SN1 and SN2 were combined for a total effort of 262 net nights for muskellunge. Nets were set on April 4, 2019 and pulled on May 2, 2019. The primary goal for this survey was to recapture marked fish from 2018 fyke net surveys.

Spring electrofishing 1 survey was conducted on April 19, 2018 using a boom electrofishing boat with dual rings (6 droppers per ring). Current was pulsed DC with a duty cycle of 25 and pulse rate of 60. Volts measured 225 and amps 14. Two dippers netted fish with a net mesh size of 0.375 inches. Where navigable, the shoreline was sampled for a total effort of 135 minutes and 2 miles. The primary goal for this survey is to count and measure adult walleye and recapture marked walleye from SN1 netting.

Spring electrofishing 2 survey was conducted on May 8th, 2018 using a boom electrofishing boat with dual rings (6 droppers per ring). Current was pulsed DC with a duty cycle of 25 and pulse rate of 58. Volts measured 220 and amps 22. Two dippers netted fish with a net mesh size of 0.375 inches. Where navigable, the shoreline was sampled for a total effort of 120 minutes and 3 miles. Gamefish were collected for the total effort. Panfish were collected for an effort of 37 minutes and 1 mile. The primary goal of this survey is to count and measure adult bass and panfish, as well as recapture marked Largemouth Bass from SN1 and SN2 surveys to conduct population estimate.

Fall juvenile survey was conducted on October 15th, 2018 using a boom electrofishing boat with dual rings (6 droppers per ring). Current was pulsed DC with a duty cycle of 25 and pulse rate of 57. Volts measured 145 and amps 16. Two dippers netted fish with a net mesh size of 0.375 inches. Where navigable, the shoreline was sampled for a total effort of 171.44 minutes and 5 miles. Gamefish were collected for the total effort. Panfish were not collected. Survey is intended to provide an indication of bass, walleye, and muskellunge recruitment using young of the year catch rate.

For all game and panfish species, total length to 1/10 of an inch was measured. Weight was taken from all muskellunge. Subsamples of weight, minimum of 250 fish, for all other species were taken to the nearest 1/10 of a pound. Muskellunge, largemouth bass,

and walleye were marked to conduct mark and recapture population estimates. PIT tag numbers were recorded as the capture and recapture data for muskellunge. Mature walleye and largemouth bass were marked with a top caudal clip. Musky ≥30 inches and walleye ≥15 inches or sexually mature were marked during the 2018 ice out fyke netting survey. Largemouth bass ≥8 inches were marked during the ice out fyke netting and spring electrofishing 1 surveys.

Muskellunge age was determined using PIT tag data from known age fish at time of stocking or recapture of previously aged individuals. Age was only used from the 2018 sample for muskellunge. Channel catfish were aged using the proximal section of a dorsal spine. A target of 10 channel catfish per inch group was set for age evaluation. An image of a pectoral spine cross section is displayed in figure 1. The outside edge of the ray was counted as an annulus. Walleye age was estimated by counting annuli from dorsal fin ray sections. Dorsal rays were collected during the netting and electrofishing surveys. A target of 10 male and 10 female walleye per inch group was set for age evaluation. An image of a cross section is displayed in figure 2. The outside edge of the ray was counted as an annulus. Largemouth bass and smallmouth bass age was estimated counting annuli from dorsal fin ray sections. A target of 10 per inch group was set for age evaluation. An image of the cross section is displayed in figure 3. The outside edge of the ray was counted as an annulus. Bluegill and black crappie age was estimated using the sagittal otolith. A target of 5 fish per half inch group was set for age evaluation.

Data analysis

Length data was analyzed for minimum, maximum, mean size, and proportional size distributions. Proportional size distributions (PSD) can be defined as the proportion of a particular fish size in a stock. Proportional size distributions were calculated for muskellunge, walleye, largemouth bass, channel catfish, bluegill, and black crappie. Muskellunge proportional size distributions were based upon the lengths of 30 inches for stock sized muskellunge as outlined by the Wisconsin Department of Natural Resources fisheries management handbook. Walleye, bass, panfish, and catfish proportional size distributions were based on the length categorization system to assess fish stocks as described by Gablehouse, 1984 North American Journal of Fisheries Management.. Length categories by species used in the calculation of proportional size distributions are listed in Table 15.

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Weight data was analyzed for minimum, maximum, mean and relative weights. Relative weights for muskellunge, walleye, largemouth bass, smallmouth bass, channel catfish, bluegill, and black crappie were downloaded using the reporting function located in the Wisconsin Department of Natural Resources fisheries management data base.

Relative abundance defined as number of fished captured per net night was determined for muskellunge, channel catfish, black crappie, and walleye. Relative abundance given as number of fish captured per mile of electrofishing was determined for largemouth bass and bluegill.

Abundance as a population estimate was determined for muskellunge using Bailey's modification of the Peterson method with an equation M(C+1)/(R+1). Abundance as a population estimate for walleye was determined using the Chapman modification of the Peterson method with the equation N=(M+1)(C+1)/R+1 where N is the estimated population at time of marking, M is the number of marked fish, C is the number of fish captured for census, and R is the number of recapture marks in the sample. A goal of 10% of the total population was defined as the minimum number to mark for the population estimates

Age of fish was determined using appropriate structures. Dorsal spine was used for largemouth bass and walleye, otoliths for bluegill and black crappie, and pectoral spine for channel catfish. Muskellunge age was determined using PIT tag data of known aged fish and previously aged fish. Subsamples of 10 per inch group were aged for all species with panfish having 5 per half inch bin aged. Ages were then assigned to ll fish not aged using an age length key. This data was used to calculate minimum age, maximum age, mean age, mean length at age, age frequency, and predicted growth models. Predicted growth model was run for all species with age data using the von Bertalanffy growth equation $E[L|t] = L_\infty(1-e^{-K(t-t_0)})$. Where $E[L|t]$ is the predicted average length at age t. L_∞ is the asymptotic average length. K is the growth rate coefficient. The age when the average length was 0 is represented by t_0.

Water quality monitoring

Water temperature was the only water quality parameter recorded during the fisheries surveys.

Surface water temperature was recorded at each net during each lift. In 2018 the mean surface water temperature was 41.2˚F with a low of 38°F on March 27th and a high of 57°F on April 27th. In 2019 the mean surface water temperature was 48.0°F with a low of 41°F on April 12th and a high of 59°F on April 24th.

Surface temperatures during the electrofishing surveys were 42°F on April 19, 2018, 70°F on May 8, 2018, and 49.6° F on October 15, 2019.

Phosphorus, total Kjeldahl-N, and secchi depth data were thru the Wisconsin Department of Natural Resources Long-Term Trend Monitoring Program and the Long Term Trend Water Quality program. These programs collect annual water quality samples from the surface at the deep hole of the lake near the dam. Total Kjeldahl Nitrogen was collected once per year. Total phosphorus samples and secchi depths are recorded in the spring and monthly through the summer when possible. Water samples are collected and delivered to the Wisconsin State Lab of Hygiene.

Results

Species present in samples were muskellunge, northern pike, largemouth bass, smallmouth bass, walleye, channel catfish, flathead catfish, brown bullhead, black bullhead, bluegill, green sunfish, pumpkinseed sunfish, hybrid sunfish, black crappie, golden shiner, white sucker, fathead minnows, common carp, bigmouth buffalo, and bowfin. Number, catch rates and population estimates, if applicable, for targeted species are described in detail within that species section. Catch rates for targeted species are also listed in table 14.

Muskellunge

In 2018 there were 82 individual muskellunge netted, 25 males and 49 females and 8 of unknown gender. Total catch per effort was 0.54 muskellunge per net night. Total length in inches ranged 10.4 to 47.7 with a mean of 34.2. Weight in pounds ranged 0.1 to 31.0 with a mean of 11.8. The sample has a mean relative weight index of 91.1 with a range of 58.0 to 121.0. Length frequency of the muskellunge sampled in 2018 is displayed in figure 4.

In 2019 there were 29 individual muskellunge netted, 8 males, 19 females and 2 of unknown gender. Twenty-three were recaptures from 2018. All but one were greater than 32 inches. There was one male that was 24 inches in 2018 recapped at 28 inches in 2019. Total catch per effort was 0.19 muskellunge per net night. Total length in inches ranged 28.0 to 48.0 with a mean of 37.3. Weight in pounds ranged 6.2 to 31.2 with a mean of 14.3. The sample has a mean relative weight index of 90.9 with a range of 68 to 108. Length frequency of the muskellunge sampled in 2019 is displayed in figure 4. Relative weights of all muskellunge sampled from Yellowstone Lake are displayed in figure 5.

The median catch per effort defined as muskellunge per net night for complex warm dark lakes is 0.33. In 2018, Yellowstone was above the statewide median at 0.54. It was below the statewide median in 2019 with a catch per effort of 0.19. Starting in 2011 the catch per effort for Yellowstone has ranged from 0.19 (2019) to 1.49 (2014) with a mean of 0.73. Yellowstone muskellunge catch per effort compared to lakes classified as complex warm dark is displayed in figure 6.

The 50^{th} percentile relative weight for class A1 muskellunge waters statewide is 92. Yellowstone Lake falls slightly below with an overall mean relative weight of 91. The lake is meeting its potential for maintain muskellunge in good condition.

In 2018, proportional size distributions (PSD) for muskellunge of 38 inches (PSD_{38}) was 24.1 and PSD 42 inches (PSD_{42}) was 17.7. Proportional size distribution for muskellunge of 50 inches (PSD_{50}) was 0. In 2015 the PSD_{38} was 27.6 and the PSD_{42} was 20.7. The PDS_{50} remained at 0. A summary of PSD values is given in table 5.

Seventy-nine individual muskellunge were marked. A goal of 79 individual muskellunge was established for the 2019 recapture survey. Only 29 individual muskellunge were examined for recapture marks. Twenty-three were recaptured from 2018. The adult muskellunge population was estimated at 99 (0.22 per acre) for adult muskellunge. Coefficient of variation was 9%. The 2014-2015 estimate was 129 adult muskellunge at 0.32 per acre.

Age was determined for 72 muskellunge (41 females, 22 males, and 9 unknown). Forty-eight of the 72 musky were of known age from stocking. Muskellunge were aged from 1 to 12 years. Mean length at age, all gender, ranged from 11.0 inches at age 1 to 44.0 inches at age 12. Yellowstone Lake muskellunge mean length at age was above the statewide mean. This can be viewed in figure 7 where the mean length at age for Yellowstone Lake muskellunge (all gender) are displayed with the statewide muskellunge mean length at age (all gender). Minimum, maximum, and mean length at age for Yellowstone Lake muskellunge are listed in table 6. An age frequency distribution is displayed in figure 8. Age three and four musky make up 61.1 percent of the sample collected. The von Bertalanffy predicted growth model (L_t=45.17(1-exp(-0.3053(t-0.4344))) for muskellunge is displayed in figure 9. Length infinity is 45.17.

Walleye

In 2018 there were 1,238 individual walleye netted (863 males, 214 females and 161 of unknown gender) and electrofishing sampled 247 walleye (238 males, 7 females, and 2 unkown). Of the 247 walleye sampled during the spring I electrofishing survey, 105 were recaptures from the spring I fyke net survey. Total catch per effort netting was 7.32 walleye per net night. Males ranged in total length from 7.0 to 23.7 with a mean of 15.3. Females ranged in length from 14.5 to 29.0 inches with a mean of 23.3. Walleye of unknown gender ranged in total length from 6.7 to 15.7 inches with a mean of 12.0. Electrofishing sampled walleye in similar proportions and distributions as netting. Length frequencies for walleye sampled netting and electrofishing in 2018 are displayed in figure 10.

Weight in pounds ranged 0.08 to 10.69 with a mean of 2.2. The sample has a mean relative weight index of 89.2 with a range of 47 to 135. Relative weights of walleye sampled from Yellowstone Lake are displayed in figure 11.

The median catch per effort defined as walleye per net night for complex warm dark lakes is 2.01. In 2018, Yellowstone was above the statewide median at 7.32 (Figure 12). The 2004 and 2014 catch per effort were 17.02 and 78.32 respectively.

Proportional size density for walleye 15 inches or greater (PSD_{15}) was 45, down from 84 in 2014. The PSD for preferred size of 20 inches (PSD_{20}) was 24, up from 9 in 2014. Proportional size distribution for memorable sized of 25 inches (PSD_{25}) was 6, up from 1 in 2014. Proportional size distribution for trophy sized walleye of 30 inches (PSD_{30}) was 0, no change from 2014. A summary of proportional size distributions is given in table 7.

Eight hundred forty-two mature walleye were marked. Walleye were considered mature if they had gamete production or were over 15 inches total length. Of the marked walleye, 644 were known males and 167 were known females. Two hundred forty-seven individual mature walleye were examined for recapture marks during spring electrofishing 1. One hundred five were recaptured from the netting survey. The mark and recapture population estimate was 1,955 (4.3 per acre) for all mature walleye. This falls within our management goal of 4 to 6 per acre. Coefficient of variation was 7.3%.

Age was determined for 291 walleye (106 females, 119 males, and 66 unknown) from dorsal spines. Age was also assigned using an age length key to an additional 695 walleye. Walleye ranged in age from 1 to 10 years. Because no fish were stocked in 2014 or 2016 ages 2 and 4 are absent from the population. Mean length at age, all gender, ranged from 7.4 inches at age 1 to 25.5 inches at age 10. Yellowstone Lake walleye mean length at age is below the statewide mean for ages 1 thru 3. Yellowstone Lake mean length at age is above the statewide mean for ages 4 thru 10. This can be viewed in figure 13 where the mean length at age for Yellowstone Lake walleye (all gender) are displayed with the statewide walleye mean length at age (all gender). Statewide mean length at defined from aging dorsal spines are displayed. Minimum, maximum, and mean length at age for Yellowstone Lake walleye are listed in table 8. An age frequency distribution is displayed in figure 14. Age 3 walleye are the most abundant followed by ages 5 and 8 respectively. The von Bertalanffy predicted growth model (L_t=31.1626(1-exp(-0.1602(t-0.6119))) for walleye is displayed in figure 15.

Largemouth bass

In 2018 there were 91 individual largemouth bass sampled during the spring electrofishing II survey. Largemouth bass ranged in total length from 11.1 to 21 inches with a mean of 14.6. Length frequency of largemouth bass sampled during the spring electrofishing II survey is displayed in figure 16. Weight in pounds ranged 0.04 to 7.72 with a mean of 2.26. The sample has a mean relative weight index of 104 with a range of 59 to 142. Largemouth bass relative weights are displayed in figure 17.

The median catch per mile for largemouth bass for complex warm dark lakes is 17.37. In 2018, Yellowstone was above the statewide median at 22.75 bass per mile of electrofishing. Yellowstone catch rates 2012, 2014, and 2015 were 76.56, 38.0, and 38.64 per mile of electrofishing respectively. The mean catch per effort from 2012 to 2018 was 43.99 per mile of electrofishing. There is a decreasing trend from 2012 to 2018. Yellowstone largemouth bass catch per effort compared to lakes classified as complex warm dark is displayed in figure 18.

The proportional size distribution for 12 inch bass (PSD_{12}) in 2018 was 95. That is up from 81 in 2014. The PSD_{15} for preferred size of 15 inches was 53. That is down slightly from 57 in 2014. Proportional size distribution for largemouth bass of 18 inches (PSD_{18}) was 18. That is up from 13 in 2014. A summary of PSD values is given in table 9.

Ages of 96 largemouth bass were determined from dorsal spines. Age length key was used to assign ages to 131 additional largemouth bass. Largemouth bass ranged in age from 1 to 10 years. Mean length at age, all gender, ranged from 4.5 inches at age 1 to 21 inches at age 12. Yellowstone Lake largemouth bass mean length at age is above the statewide mean. This can be viewed in figure 19. Minimum, maximum, and mean length at age for Yellowstone Lake largemouth bass are listed in table 10. Ages 4 thru 6 make up 82 percent of the sample. Number of bass per age group is displayed in figure 20. The von Bertalanffy predicted growth model (L_t=21.28577(1-exp(-0.2823(t-0.0594))) for largemouth bass is displayed in figure 21.

Smallmouth bass

Smallmouth bass are present in the Yellowstone Lake and Yellowstone River system. They are more common in the lake during late fall and over winter. As waters warm in the spring they migrate up the Yellowstone River. They are not present in fishable numbers and are considered a bonus species for anglers.

In 2018 there were 47 individual smallmouth bass sampled. Smallmouth bass ranged in total length from 8.2 to 18.4 inches with a mean of 14.0. Length frequency of all smallmouth bass sampled in 2018 is displayed in figure 22.

Weight in pounds ranged 0.22 to 2.98 with a mean of 1.60. The sample has a mean relative weight index of 88 with a range of 60 to 108. Smallmouth bass relative weights are displayed in figure 23.

Catfish species

Yellowstone lake supports 4 species of catfish: channel catfish, flathead catfish, brown bullhead, and black bullhead. Channel catfish is the only species with numbers to support a fishable population. Once abundant and considered nuisance species, the brown and black bullhead are present in low numbers and show up in anglers creel as by-catch. Flathead catfish, Mississippi River strain, were introduced in the early 2000's via a stocking of 500lbs of adults purchased from a commercial fisherman. Initially thought not to have survived, adults and immature flathead catfish have been sampled in the previous two surveys. They are present in low numbers. Anglers have reported catching adult flathead catfish on occasion. Natural recruitment of flathead catfish has been documented with the presence of immature individuals.

There were 1,055 channel catfish sampled during the 2018 and 2019 spring fyke net surveys. Mean catch per effort was 4.88 channel catfish per net night. Channel catfish ranged in total length from 10.0 to 29.5 with a mean of 16.6 inches. Channel catfish under 17 inches made up 71 percent of the sample. Length frequency for channel catfish is displayed in figure 24.

Weight in pounds ranged 0.22 to 11.66 with a mean of 1.90. The sample has a mean relative weight index of 82 with a range of 48 to 172. Relative weights of channel catfish are displayed in figure 25.

Proportional size density for channel catfish 16 inches or greater (PSD_{16}) was 47. The PSD for preferred size of 24 inches (PSD_{24}) was 8. Proportional size distribution for memorable sized of 28 inches (PSD_{28}) was 1. Proportional size distribution for trophy sized catfish of 36 inches (PSD_{36}) was 0.

There were 5 flathead catfish sampled in 2019. Total length ranged from 23.3 to 39.5 with a mean of 33.4. Weight in pounds ranged from 4.64 to 26.9 with a mean of 17.0.

Age was determined for 155 channel catfish using pectoral spines. Age length key was used to assign ages to 893 additional channel catfish. Ages ranged from 3 to 14 years. Mean length at age ranged from 13.0 inches at age 3 to 26.6 inches at age 14. Yellowstone Lake channel catfish mean length is at or above the statewide mean length for ages 4 thru 12. Yellowstone Lake mean length at age is below the statewide mean for ages 3 ,13 and 14. This can be viewed in figure 26 where the mean length at age for Yellowstone Lake channel catfish are displayed with the statewide mean length at age. Minimum, maximum, and mean length at age for Yellowstone Lake channel catfish are listed in table 11. An age frequency distribution is displayed in figure 27. Age 5 channel catfish are the most abundant. The von Bertalanffy predicted growth model (L_t=26.52019(1-exp(-0.2934(t-0.8196))) for channel catfish is displayed in figure 28.

Bluegill

In 2018 there were only 74 individual bluegill sampled during the spring electrofishing II run. Bluegill ranged in total length from 4.4 to 8.2 inches with a mean of 6.9. Length frequency of bluegill sampled during the spring electrofishing II run in 2018 is displayed in figure 29. Weight in pounds ranged 0.05 to 0.71 with a mean of 0.27. The sample has a mean relative weight index of 94 with a range of 26 to 131. Bluegill relative weights are displayed in figure 30.

The median catch per effort for bluegill for complex warm dark lakes is 116.99 per mile of electrofishing. In 2018, Yellowstone was below the statewide median at 74 per mile of electrofishing. Yellowstone catch rates 2012, 2014, and 2018 were 146.67, 58.67, and 74 per mile of electrofishing respectively. The mean catch per effort from 2012 to 2018 was 93.11 per mile of electrofishing. There was a decreasing trend from 2012 to 2018. Yellowstone bluegill catch per effort compared to lakes classified as complex warm dark is displayed in figure 31.

The proportional size distribution for bluegill 6 inches and greater, $PSD_{6,}$ in 2018 was 86. PSD_8 for preferred size of 8 inches was 6. PSD_{10} for memorable size of 10 inches was 0.

Bluegill age was determined for 47 individuals. Age length key was used to assign ages to additional 153 bluegill. Ages ranged from 2 to 7 years. Mean length at age ranged from

5.0 inches at age 2 to 9.2 inches at age 7. Yellowstone Lake bluegill mean length at age is above the statewide mean. This can be viewed in figure 32. Minimum, maximum, and mean length at age for Yellowstone Lake bluegill are listed in table 12. Age 4 made up 64.5 percent of the sample. The number of bluegill per age group is displayed in figure 33. The von Bertalanffy predicted growth model (L_t=9.9143(1-exp(-0.3555(t-0.9719))) for bluegill is displayed in figure 34.

Black Crappie

In 2018 there were 977 black crappie sampled during the fyke net survey. Catch per unit effort ranged from 0.125 to 24.33 per net night with an overall catch per effort of 4.8 crappie per net night. Black crappie ranged in total length from 6.8 to 12.4 inches with a mean of 9.6. Length frequency of all black crappie sampled in 2018 is displayed in figure 35. Weight in pounds ranged 0.05 to 1.53 with a mean of 0.54. The sample has a mean relative weight index of 103 with a range of 69 to 158. Black crappie relative weights are displayed in figure 36.

The proportional size distribution for crappie 8 inches and greater, PSD_8, in 2018 was 99. PSD_{10} for preferred size of 10 inches was 19. PSD_{12} for memorable size of 12 inches was 0.20.

Black crappie age was determined for 49 individuals. Age length key was used to assign ages to additional XX black crappie. Age from 2 to 5 years. Mean length at age ranged from 7.7 inches at age 2 to 11.1 inches at age 5. Yellowstone Lake black crappie mean length at age is above the statewide mean. This can be viewed in figure 37. Minimum, maximum, and mean length at age for Yellowstone Lake black crappie are listed in table 13. The number of black crappie per age group is displayed in figure 38. The von Bertalanffy predicted growth model (L_t=13.1151(1-exp(-0.3191(t-1.6825))) for black crappie is displayed in figure 39.

Water Quality

Recently there have been anecdotal accounts by anglers that algae blooms have been increasing and lasting longer. There have also been reports of decreased water clarity. Field observations made by Wisconsin Department of Resources staff have verified these accounts. Algae blooms last well into the fall and water clarity does appear to be decreasing. Mean total phosphorus and total Kjeldahl nitrogen trends are increasing over time (1998 to present). Mean total phosphorus ranged 79.25 to 181.5 micrograms per liter with a mean of 127.66. Total Kjeldahl nitrogen ranged 1.11 to 2.36 milligrams per liter with a mean of 1.59. Figures 40 and 41 graph the trends of mean total phosphorus and total Kjeldahl nitrogen.

With decreased water clarity the amount of rooted aquatic vegetation appears to be decreasing as well. Mean secchi depth measurements have decreased over time (1997 to present). Mean secchi depths have ranged from 1.00 to 3.56 feet with a mean of 2.24. Mean secchi depth readings are graphed in figure 42.

Discussion

Yellowstone lake supports a fishable population for bass, muskellunge, walleye, catfish and panfish. However, there is a downward trend in abundance for muskellunge, walleye, largemouth bass and bluegill. Muskellunge number per acre has dropped from 0.30 in 2014 to 0.22. Walleye number per acre has dropped from 7.1 in 2014 to 4.3. CPUE for bass has dropped from a high of 76.52 fish per mile of electrofishing in 2012 to 22.75 fish per mile of electrofishing. CPUE for bluegill has dropped from a high of 146.67 fish per mile of electrofishing in 2012 to 74 fish per mile of electrofishing. It should be noted that this is a slight increase from the 2014 sample where the CPUE was 58.67 fish per mile of electrofishing.

Musky management should continue for Yellowstone Lake. It has become popular among muskellunge anglers particularly after producing a 57 inch catch and release unlimited line class record in 2007. Musky exhibit good growth and size structure. Growth rates are above the statewide average. Muskellunge reach 38 inches at age 7. As mentioned earlier muskellunge abundance has decreased from 0.30 per acre to 0.22 per acre. This may be attributed to escapement of muskellunge over the spillway and reduced stocking rate from 1 to 0,5 musky per acre. The spillway structure allows for surface flow over the dam. There is no barrier preventing muskellunge from leaving the lake. While no official survey has been conducted in the Yellowstone River below the dam, anglers report annual catches of adult muskellunge within the spillway area. Dam escapement can lead to a smaller size structure and 20% loss of the adult population in a single season (Wolter, 2012). Water levels have been above normal flowing over all 5 spillways since 2014. The spring of 2020 was the first spring in which water was only flowing over one spillway. In 2019, 114 muskellunge were stocked in the Yellowstone River 0.8 miles upstream of the lake and 113 were stocked on the main body of the lake. Future PIT tag recaptures will be analyzed to determine if muskellunge stocked in the river will have a lower percentage of escapement compared to those stocked in the main lake body.

Numerous walleye are present within the harvest slot available for angler harvest and large walleye are abundant to help maintain predation on benthivores such as the common carp. Walleye do not naturally reproduce and are stocked at a rate of 35 small fingerlings per acre. . Stocked fish are surviving and creating a recreational opportunity for walleye in Yellowstone Lake. With the turbid water and low abundance of largemouth bass, small fingerlings survive to produce a walleye fishery.

Largemouth bass were not as abundant as in previous years surveys. The harvest slot regulation is working well with a good size structure present. Proportional size distribution for largemouth bass of 18 inches (PSD_{18}) was 18. That is up from 13 in 2014. Age 1 and 2 bass only made up 3 percent of the ample. This may be an indication of missing to failed recruitment. With the abundance of carp in the lake, areas critical for spawning centrarchids are being disturbed. Littoral habitat appears degraded with turbid water and lack of aquatic macrophytes.

Channel catfish are abundant. The increased abundance of channel catfish may be a result of the decrease in largemouth bass and walleye. Recruitment is irregular with year classes low to missing. The current channel catfish population is supported by the age 5 cohort. This cohort made up 68% of the sample. Catfish growth rates are good, equaling the statewide growth rates through age 5 and surpassing statewide growth rates age 6 and above.

Bluegill relative abundance was low to moderate. Age and 2 bluegill make up 15 percent of the ample. This may be an indication of missing to failed recruitment. With the abundance of carp in the lake, areas critical for spawning centrarchids are being disturbed. Littoral habitat appears degraded with turbid water and lack of aquatic macrophytes. Age 4 bluegill are 65% of the sample ranging in size from 6.5 to 8.2 inches. They appear to be supporting the current fishery harvest by anglers. Once this age 4 cohort has passed through the fishery, there may not be another cohort to sustain a desirable bluegill fishery.

Black crappie were abundant. With boom or bust year classes and the common occurrence of columnaris bacteria, black crappie have always been cyclic in Yellowstone Lake. Currently the age 3 and 4 cohorts make up 97.7% of the sample. Once these year classes move through the fishery, the crappie population may see a significant drop in abundance until there is another strong year class.

Annual water quality sampling shows a trend of increasing phosphorus in the lake and a decrease in secchi depths. Algae blooms have become more common on Yellowstone. They appear to be starting earlier in the year and lasting longer into the fall. Increased phosphorus may be due to the increased biomass of carp and possibly watershed runoff coming in via the Yellowstone River.

Common carp abundance appears to be high. This through observations from field staff and anglers. Carp are observed in the large schools during the summer and pre winter feeding. Common carp are currently considered a nuisance species. It is common knowledge that common carp can significantly increase chlorophyll, phosphorus, and nitrogen. Common carp are also believed to inhibit aquatic macrophyte growth. The high biomass of carp may interfere with the production and recruitment of desirable species, particularly centrarchid species: bluegill, largemouth bass, and smallmouth bass. Carp were removed from 1998 thru 2007 with 33 to 395 lbs/acre/year of common carp removed. In the fall of 2018 and early summer of 2019, approximately 4,000lbs of common carp were removed with the help of local volunteers. It appears that the density of predatory fish are such that they are not able to keep detrimental fish in check.

With the increase in phosphorus, turbidity, and abundance of carp there appears to be a reciprocal decrease of centrarchid recruitment and aquatic macrophyte abundance. Work will be needed to focus on habitat improvement. This would include improving water quality, reducing carp biomass, and increasing aquatic macrophyte densities within the littoral zone. Partnerships with local and county entities should focus on watershed improvement with improved land use practices and nutrient management.

Management Recommendations

Musky

Goal: Trophy opportunity and biomanipulation to help reduce numbers of benthivores and planktivores. Maintain A1 muskellunge designation.

Objectives

- Maintain a muskellunge population density of 0.25 to 0.5 fish per acre
- Maintain Proportional Size Distribution -38 inches (PSD-38) of 30 or greater .
- Reduce escapement, if it truly is a problem

Strategies

- Stock large fingerlings at 0.5 per acre every year
- Maintain 50 inch minimum size limit with daily bag limit of 1

Additional recommended strategies:

- Continue PIT tagging stocked muskellunge
- Study escapement of adult muskellunge over dam

Walleye

Goal: Trophy opportunity and biomanipulation to help reduce numbers of benthivores and planktivores.

Objectives

- Maintain a walleye density greater than 4 per acre
- Maintain Proportional Size Distribution-15 inches (PSD_{15}) of 40 or greater.

Strategies

- Stock small fingerlings at 35 per acre every other year
- Maintain 15 to 18 inch harvest slot limit with aggregate bag limit of 2

Largemouth bass

Goal: Trophy opportunity and biomanipulation to help reduce numbers of benthivores and planktivores.

Objectives

- Maintain largemouth bass CPUE at or above 37 per mile.
- Maintain Proportional Size Distribution-15 inches (PSD_{15}) of 45 or greater.

Strategies

- Maintain 15 to 18 inch harvest slot limit with aggregate bag limit of 2

Additional recommended strategies:

- Improve littoral zone habitat

Channel catfish

Goal: Provide harvest opportunities for channel catfish

Objectives

- Maintain relative abundance above 3 channel catfish per net night
- Maintain Proportional Size Distribution-15 inches (PSD_{15}) of 45 or greater.

Strategies

- Maintain current regulation with a daily bag limit of 10 and no size restriction.

Panfish

Goal: Provide harvest opportunities for bluegill and black crappie

Objectives

- Maintain bluegill Proportional Size Distribution-6 inches (PSD_6) of 50 or greater.
- Maintain bluegill electrofishing catch per effort 54 per mile or greater.
- Maintain black crappie Proportional Size Distribution-8 inches (PSD_8) of 50 or greater
- Maintain black crappie Proportional Size Distribution-8 inches (PSD_8) of 50 or greater.

Strategies

- Maintain current regulation with a daily bag limit of 25 panfish

Additional recommended strategies:

- Improve littoral zone habitat with increased number of aquatic macrophytes

Water Quality and Habitat

Recommendations

1) Assess biomass of carp
2) Meet with county on initiation of watershed improvement project

References

Gablehouse, D.W. Jr., A length categorization system to assess fish stocks. *North American Journal of Fisheries Management*. 4: 273-285 (1984).

Van Dyck, E., Wisconsin Department of Natural Resources Yellowstone Lake Management Report. 1997.

Wolter, M.H. (2012) *The effects of temperature, latitudinal origin, and dam escapement on management of muskellunge*. (Masters thesis) University of Illinois, Urbana-Champaign: United States

Figure 1. Pectoral spine cross section of Yellowstone Lake channel catfish used for age and growth analysis.

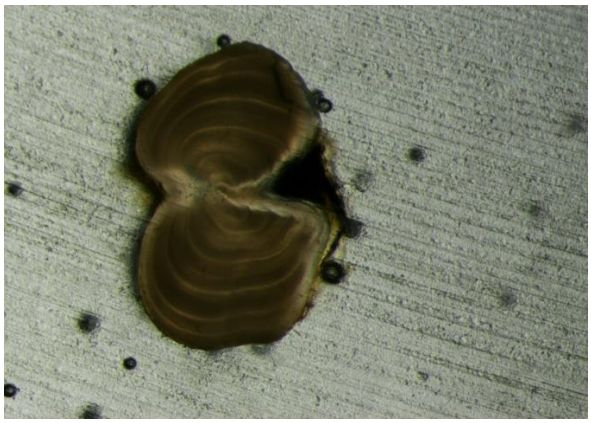


Figure 2. Dorsal ray cross section of Yellowstone Lake walleye used for age and growth analysis.

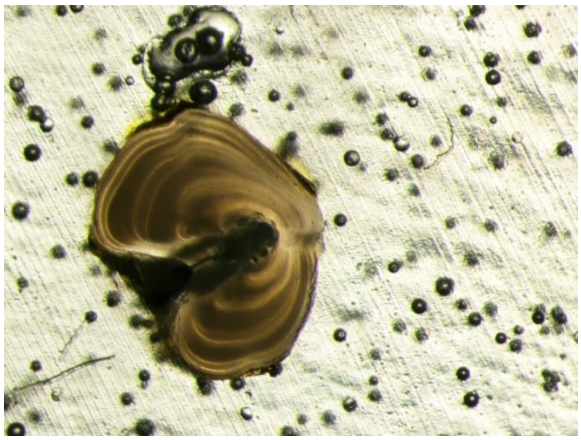


Figure 3. Dorsal ray cross section of Yellowstone Lake largemouth bass used for age and growth analysis.

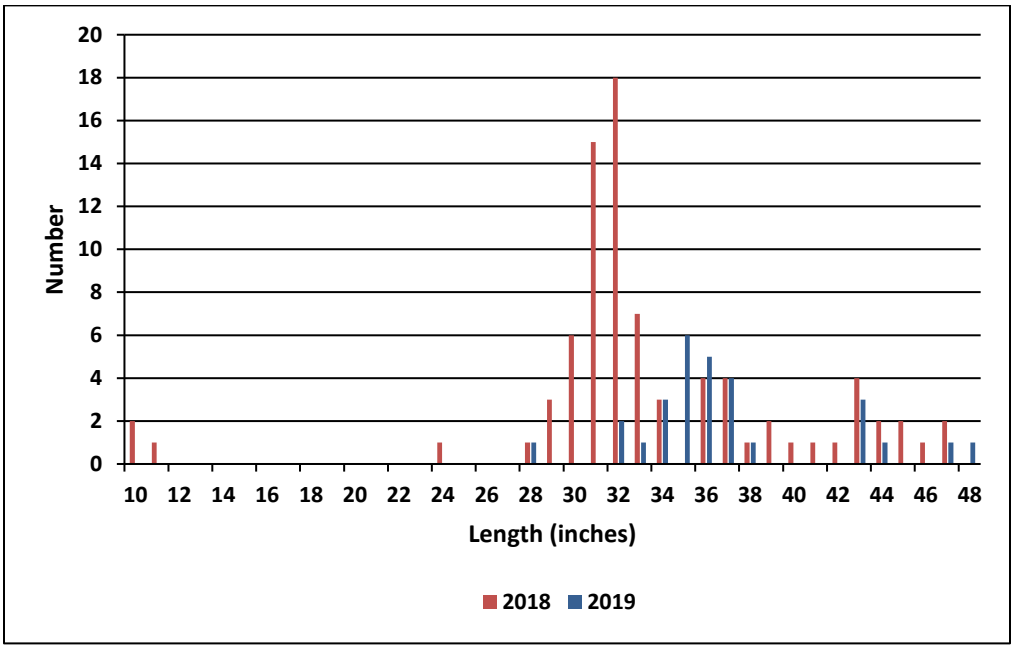


Figure 4. Length frequency of muskellunge, 2018 and 2019 fyke net surveys

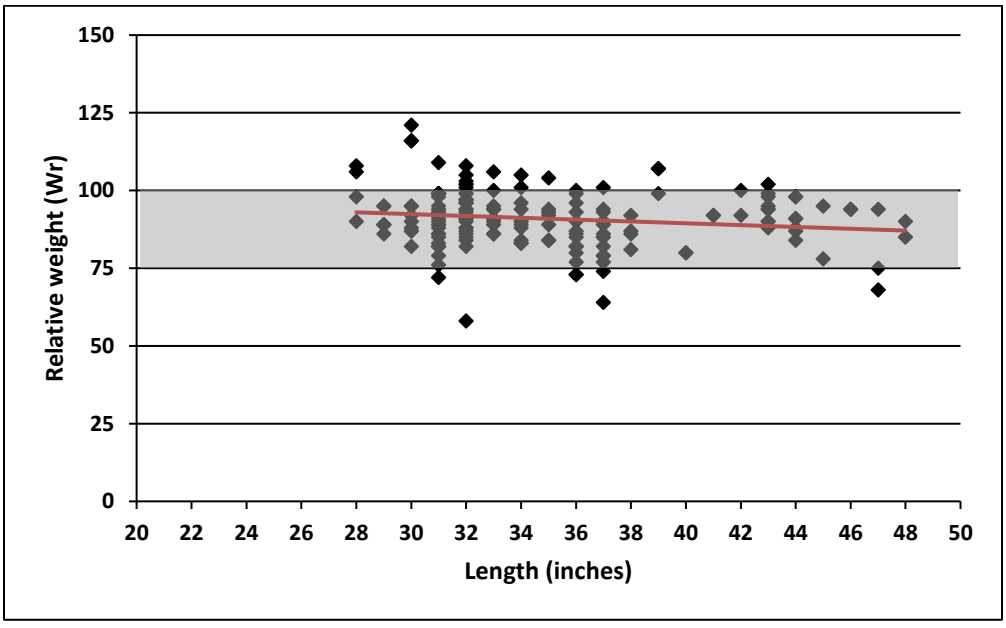
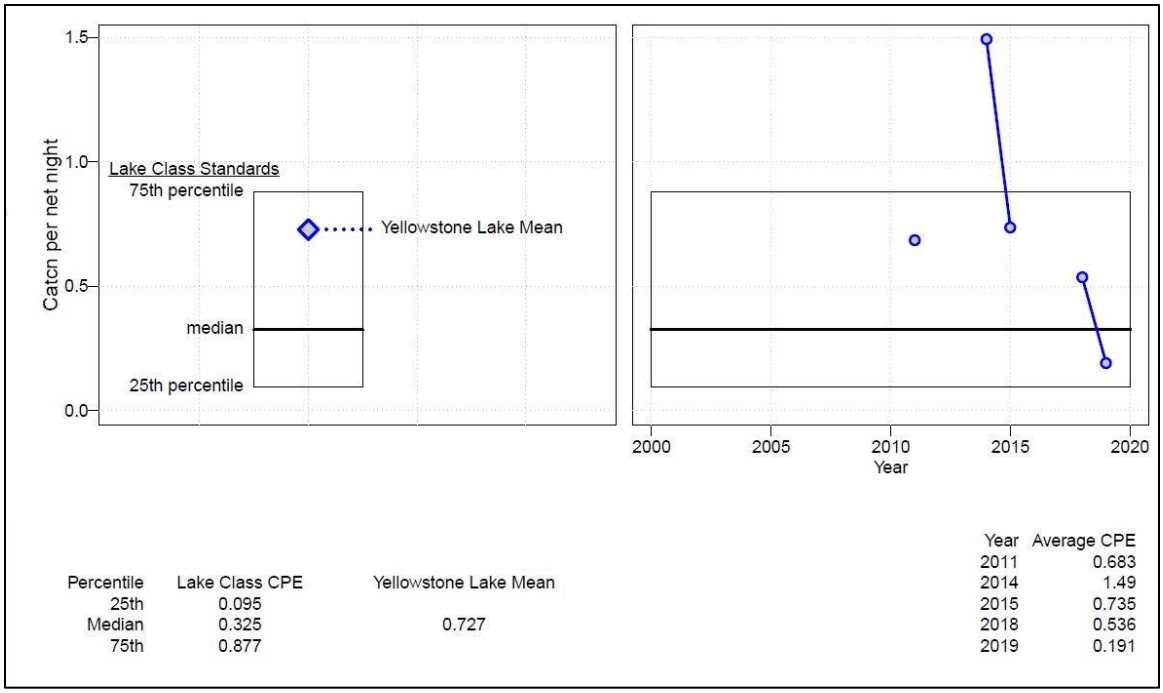


Figure 5. Relative weight of muskellunge (all gender), 2018 and 2019



Percentile	Lake Class CPE	Yellowstone Lake Mean
25th	0.095	
Median	0.325	0.727
75th	0.877	

Year	Average CPE
2011	0.683
2014	1.49
2015	0.735
2018	0.536
2019	0.191

Figure 6. Yellowstone Lake muskellunge catch per effort plotted with the 25th, 50th, and 75th percentiles for Wisconsin's complex warm dark lakes.

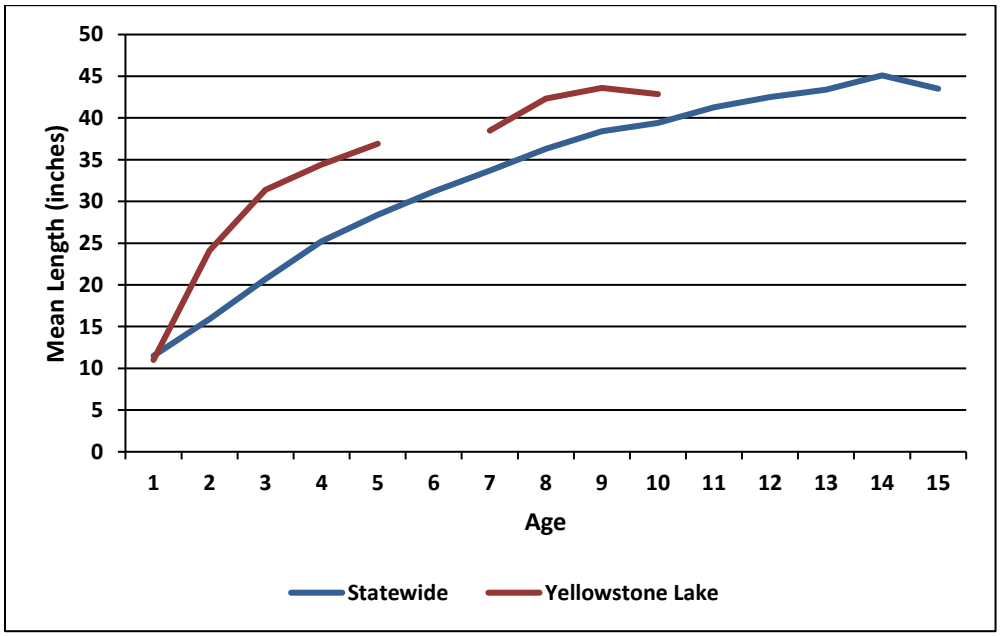


Figure 7. Muskellunge mean length at age from Yellowstone Lake and statewide.

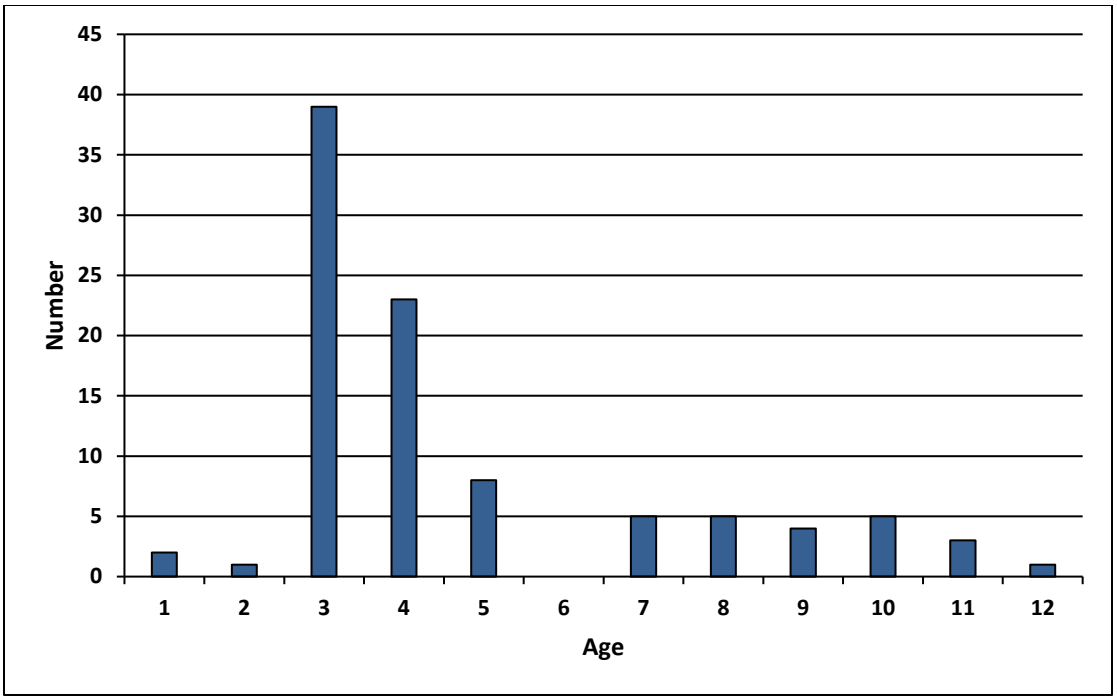


Figure 8. Number of muskellunge per age group, 2018

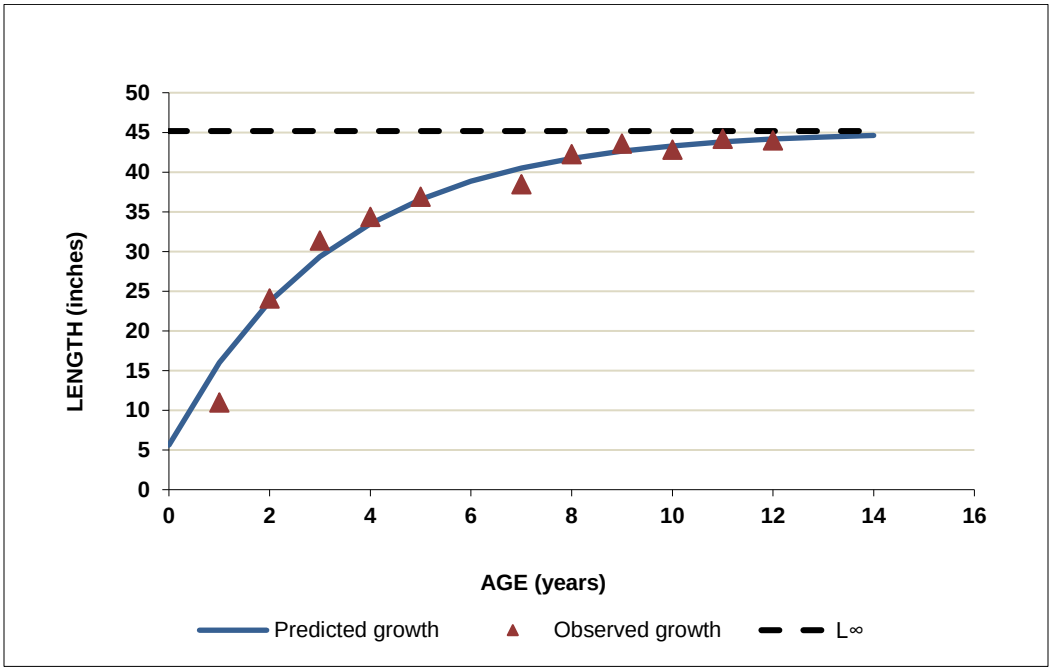


Figure 9. von Bertalanffy predicted growth model for Yellowstone Lake muskellunge 2018, $L_\infty = 45.17$

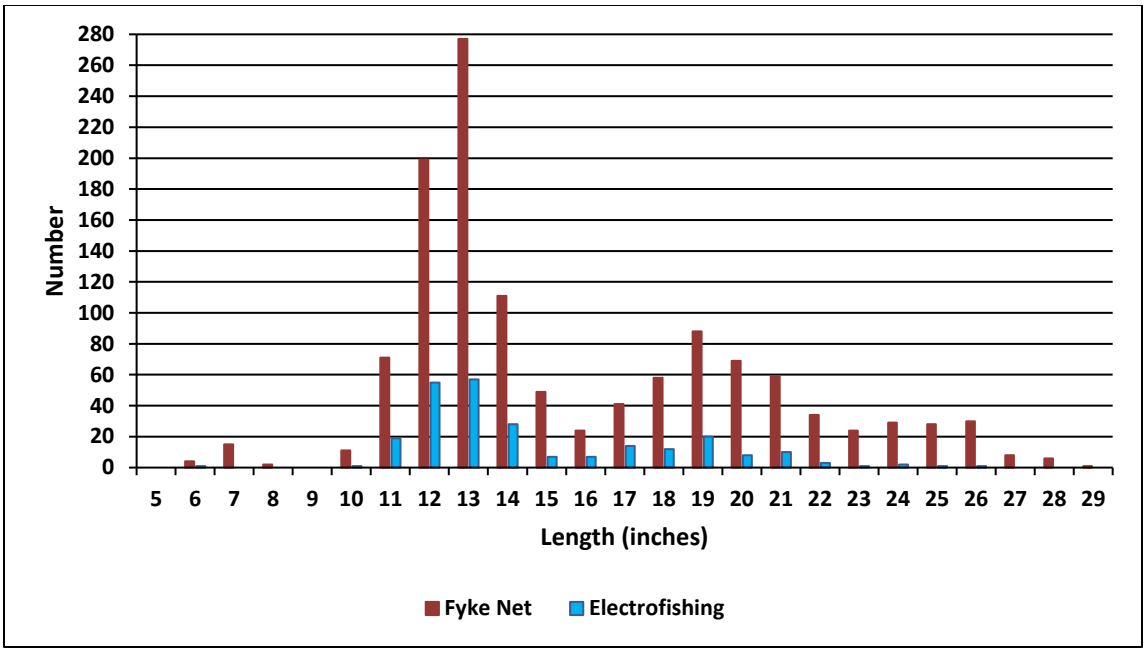


Figure 10. Length frequency of walleye, fyke net survey & spring electrofishing 1 survey

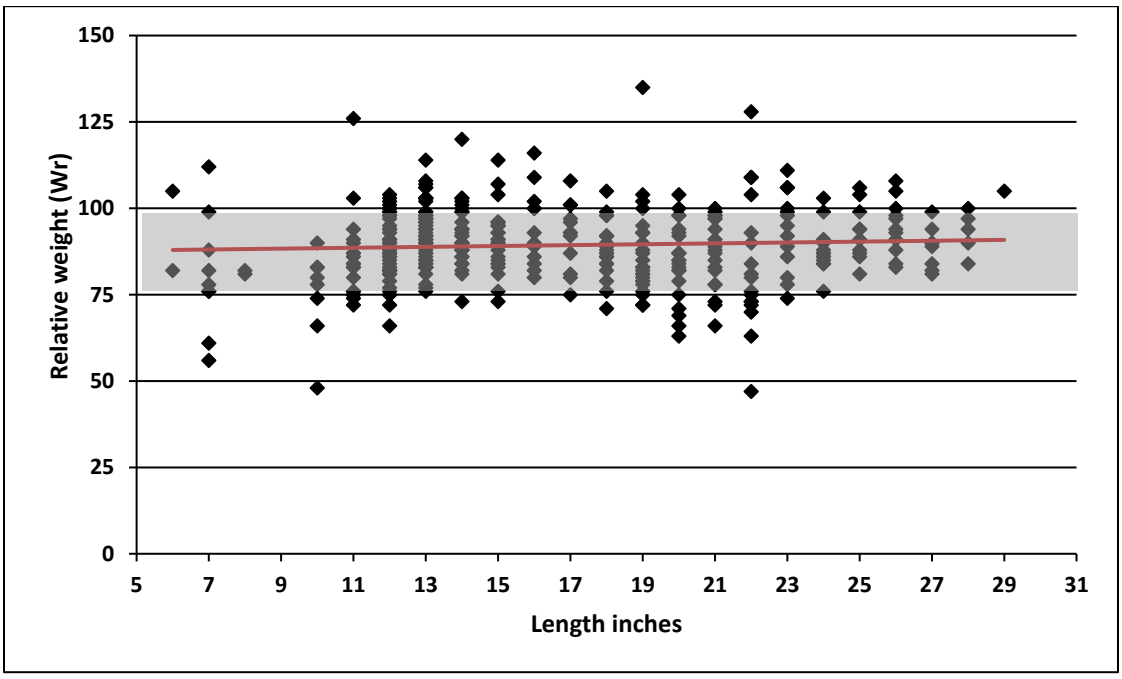


Figure 11. Relative weight of walleye (all gender)

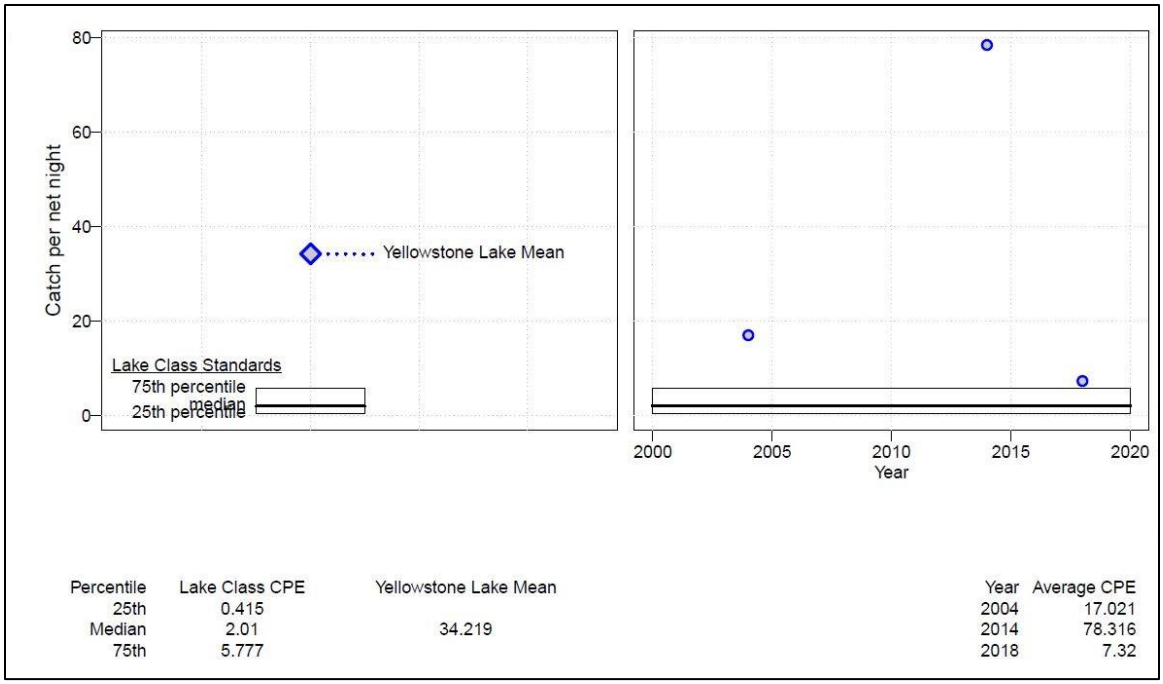


Figure 12. Yellowstone Lake walleye catch per effort plotted with the 25th, 50th, and 75th percentiles for Wisconsin's complex warm dark lakes.

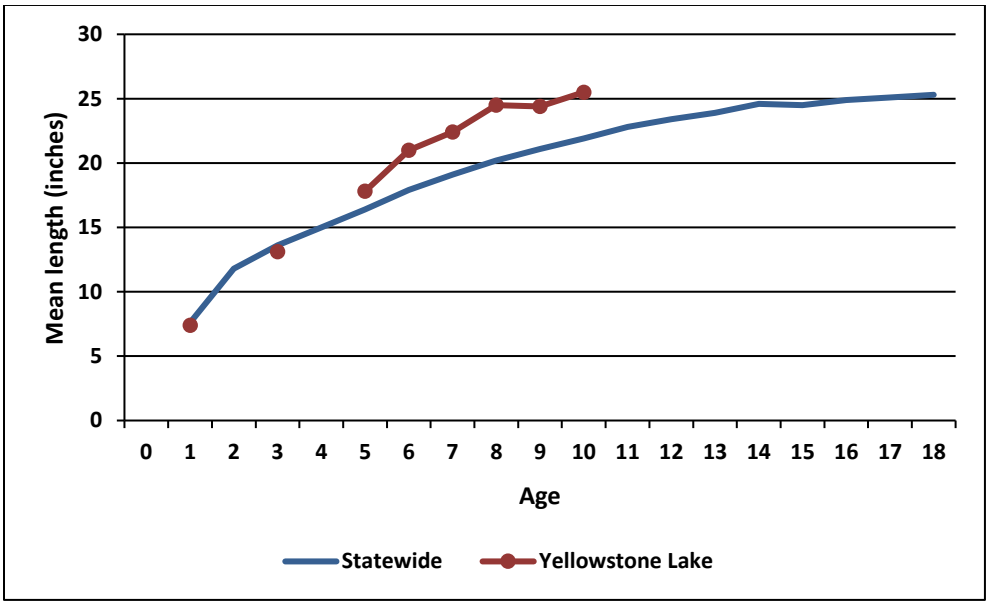


Figure 13. Walleye mean length at age from Yellowstone Lake and statewide

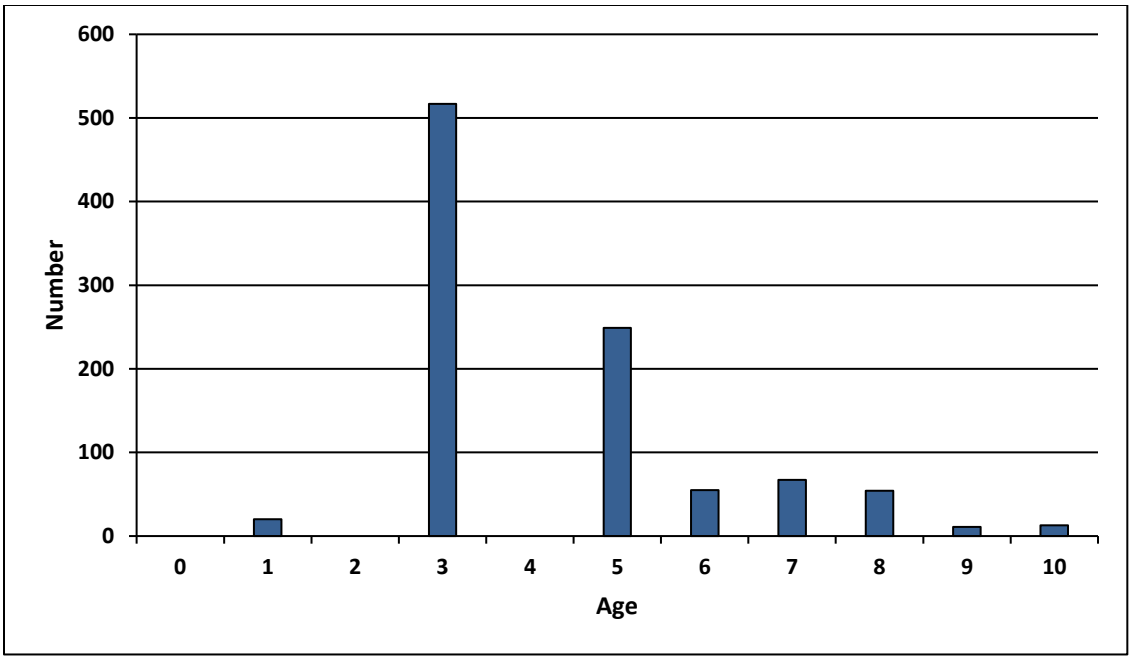


Figure 14. Walleye number per age group

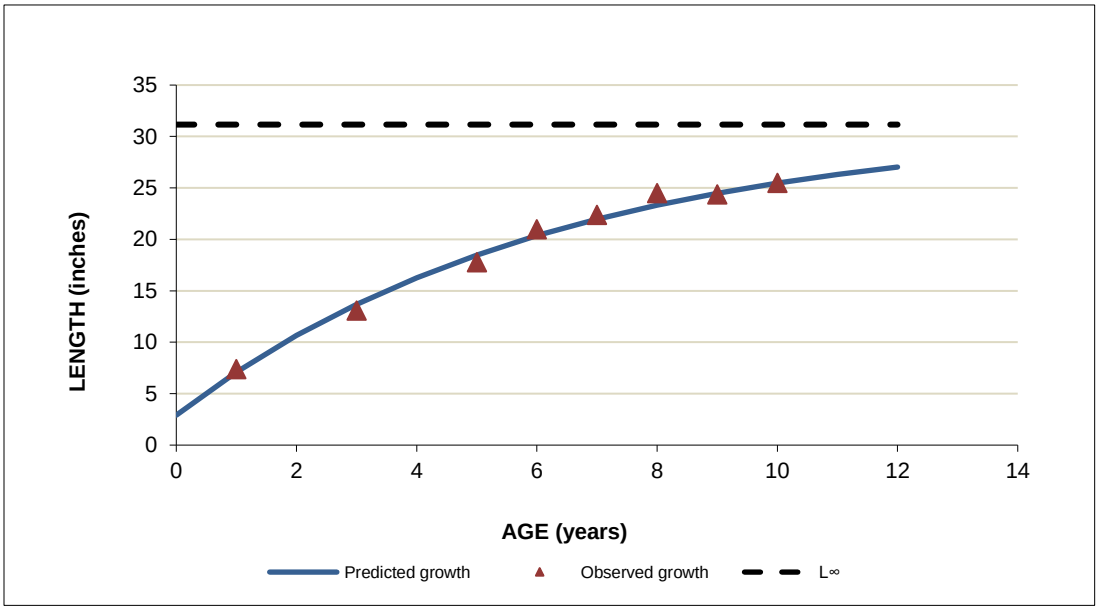


Figure 15. von Bertalanffy predicted growth model for Yellowstone Lake walleye, L_∞ = 31.16

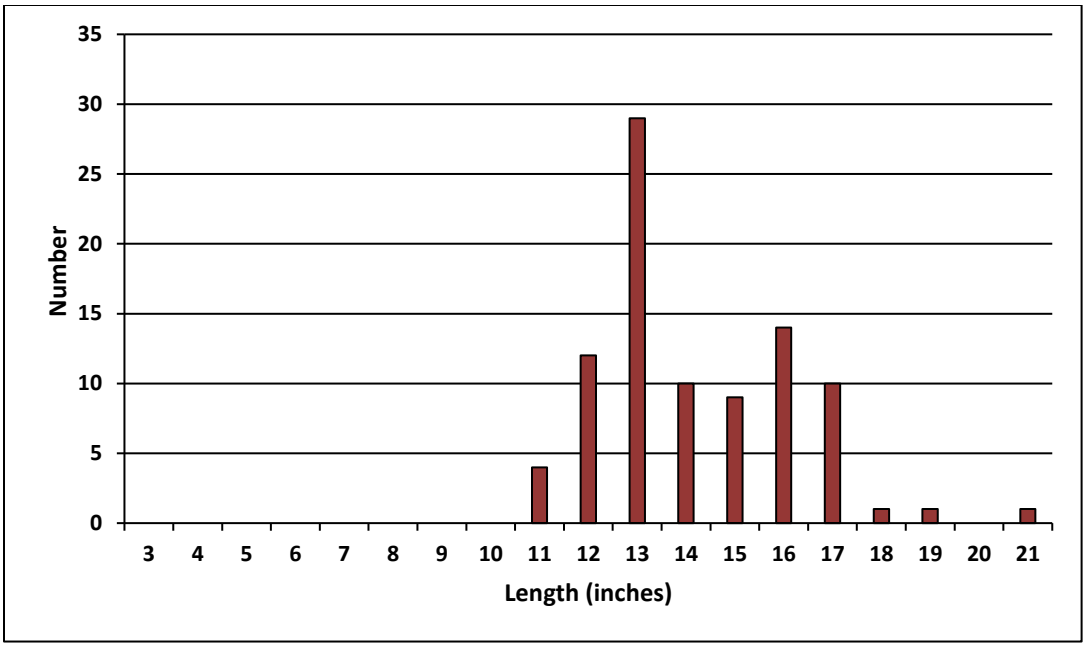


Figure 16. Length frequency of largemouth bass, spring electrofishing II survey

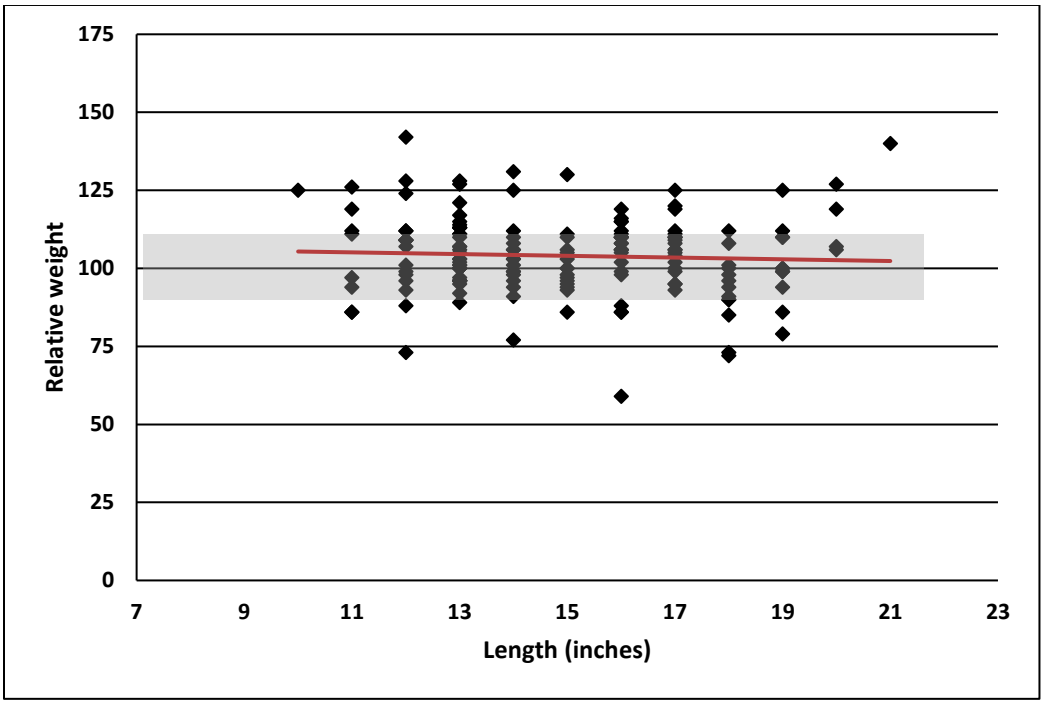


Figure 17. Relative weight of largemouth bass

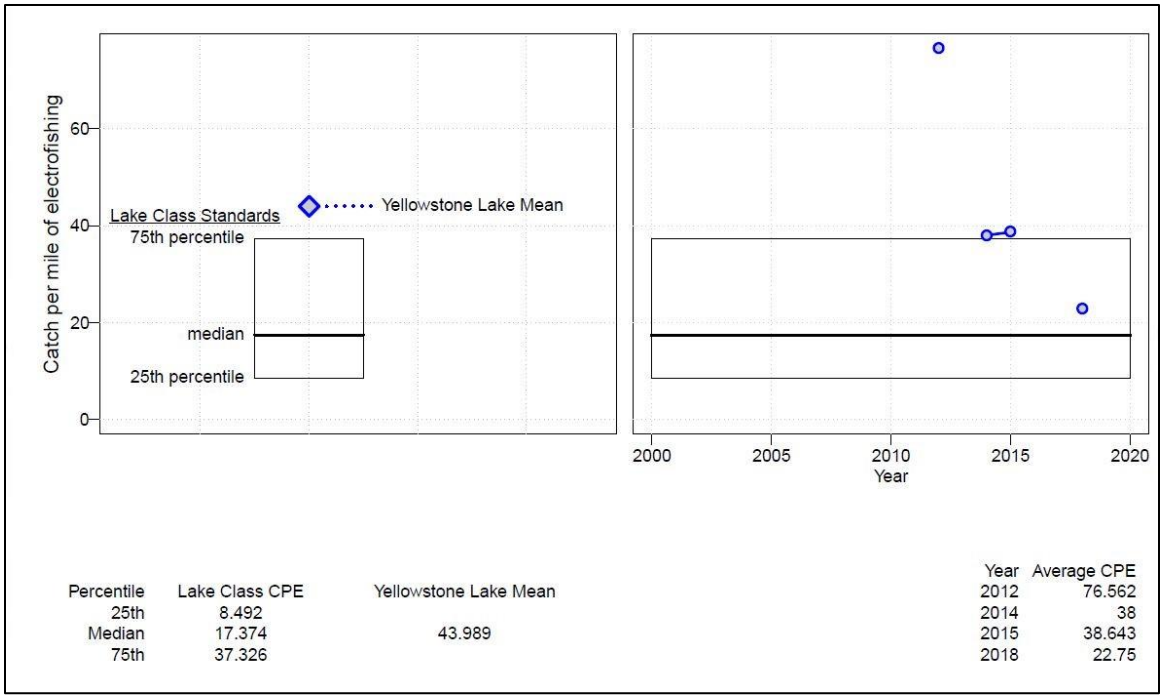


Figure 18. Yellowstone Lake largemouth bass catch per effort plotted with the 25th, 50th, and 75th percentiles for Wisconsin's complex warm dark lakes.

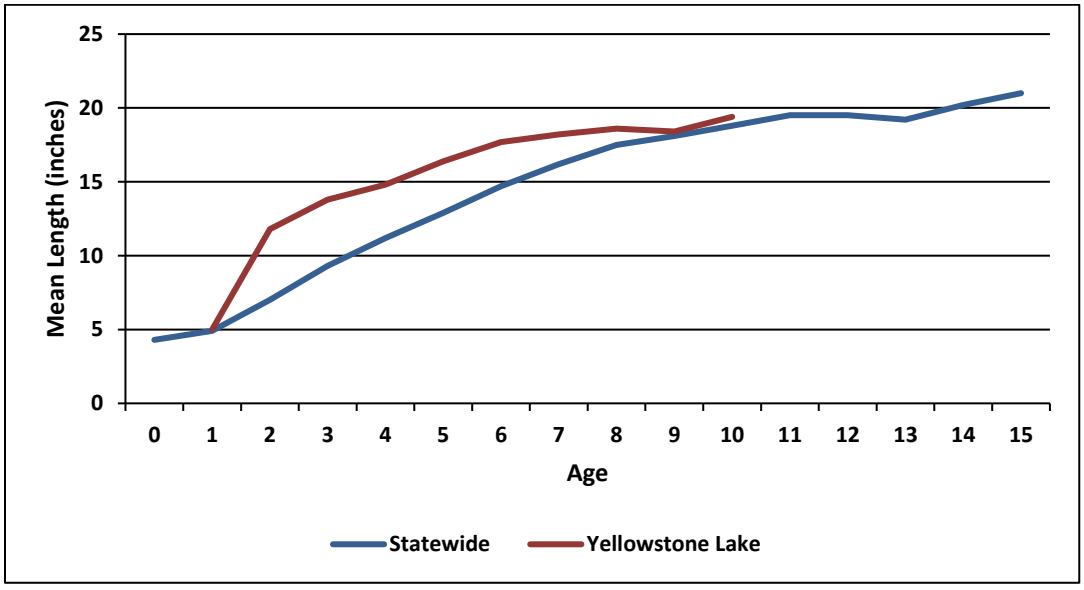


Figure 19. Largemouth bass mean length at age from Yellowstone Lake and statewide

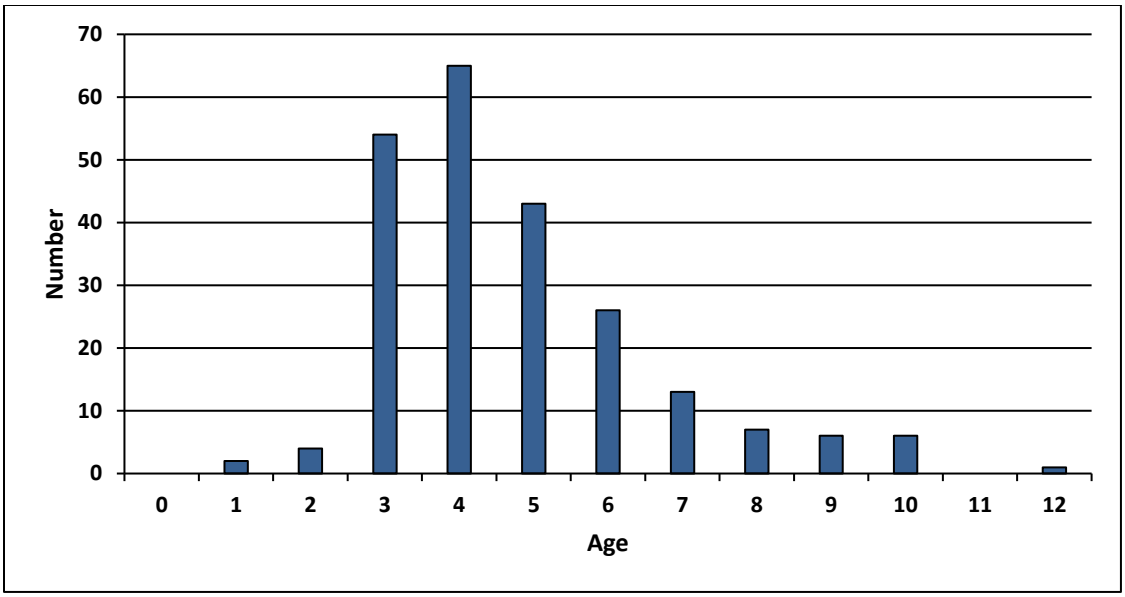


Figure 20. Largemouth bass number per age group

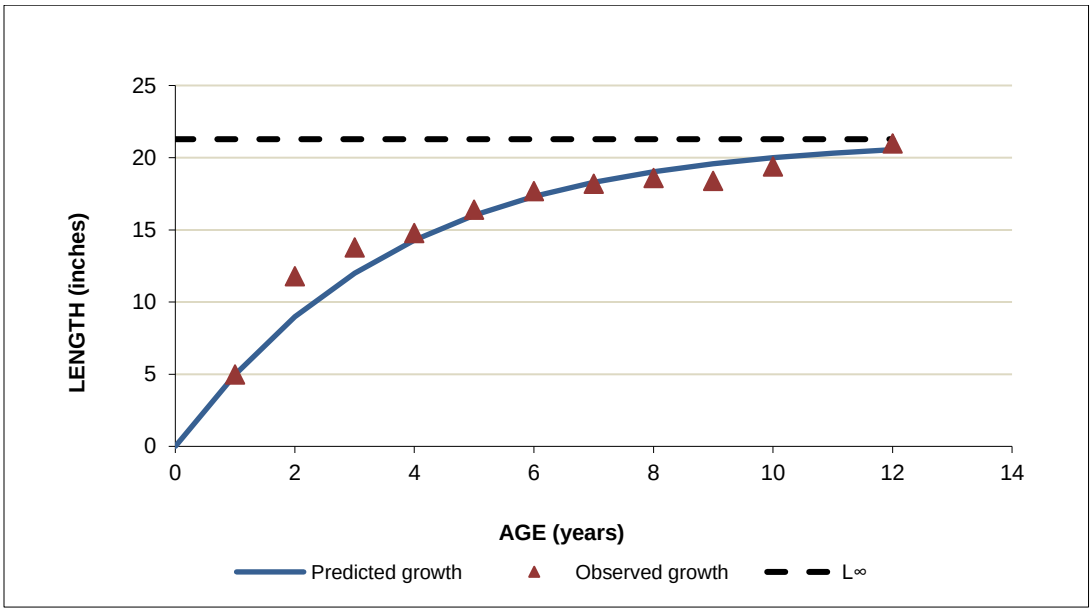


Figure 21. von Bertalanffy predicted growth model for Yellowstone Lake largemouth bass, $L_\infty = 22.36$

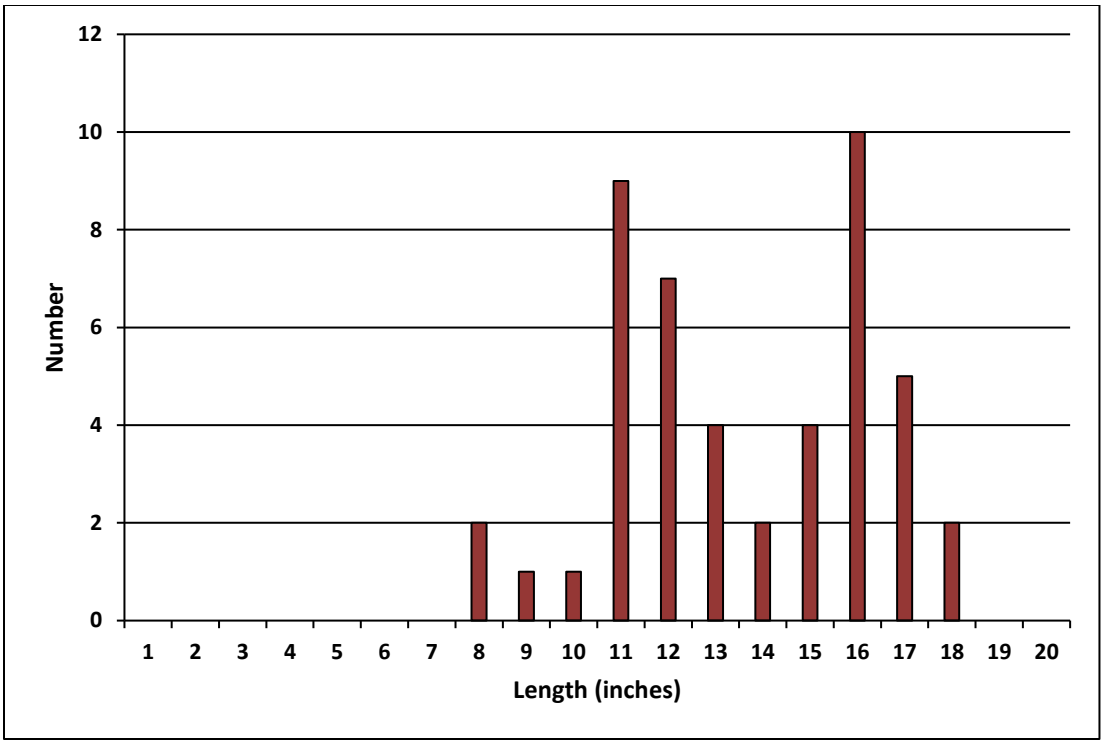


Figure 22. Length frequency of smallmouth bass 2018

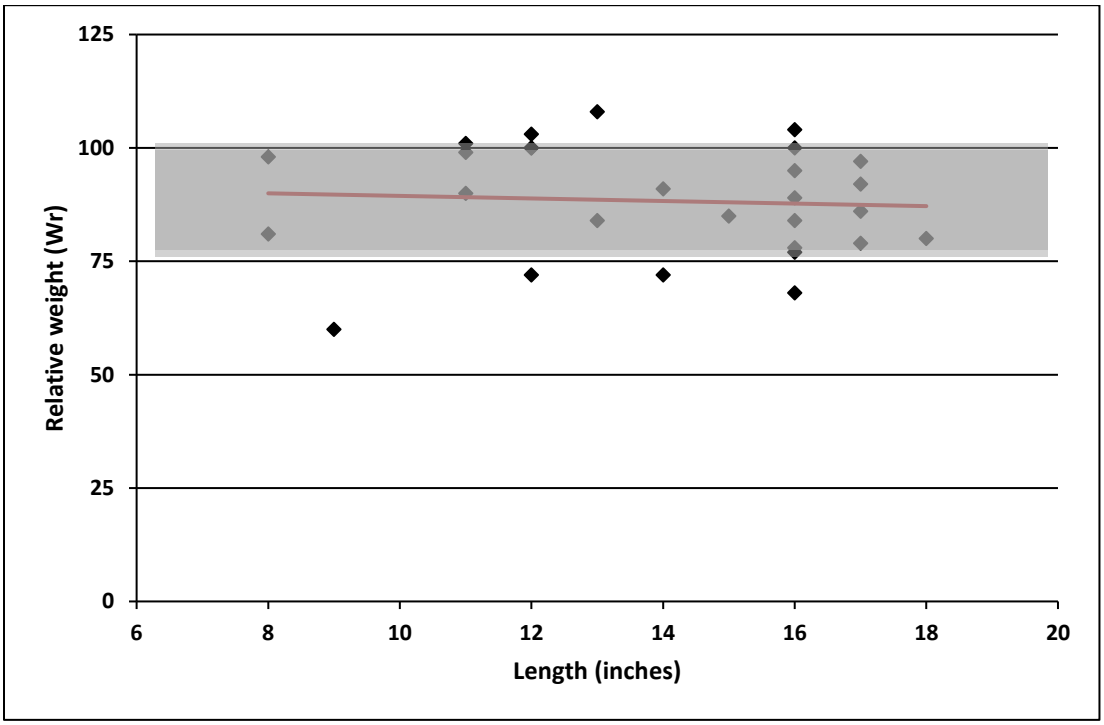


Figure 23. Relative weight of smallmouth bass

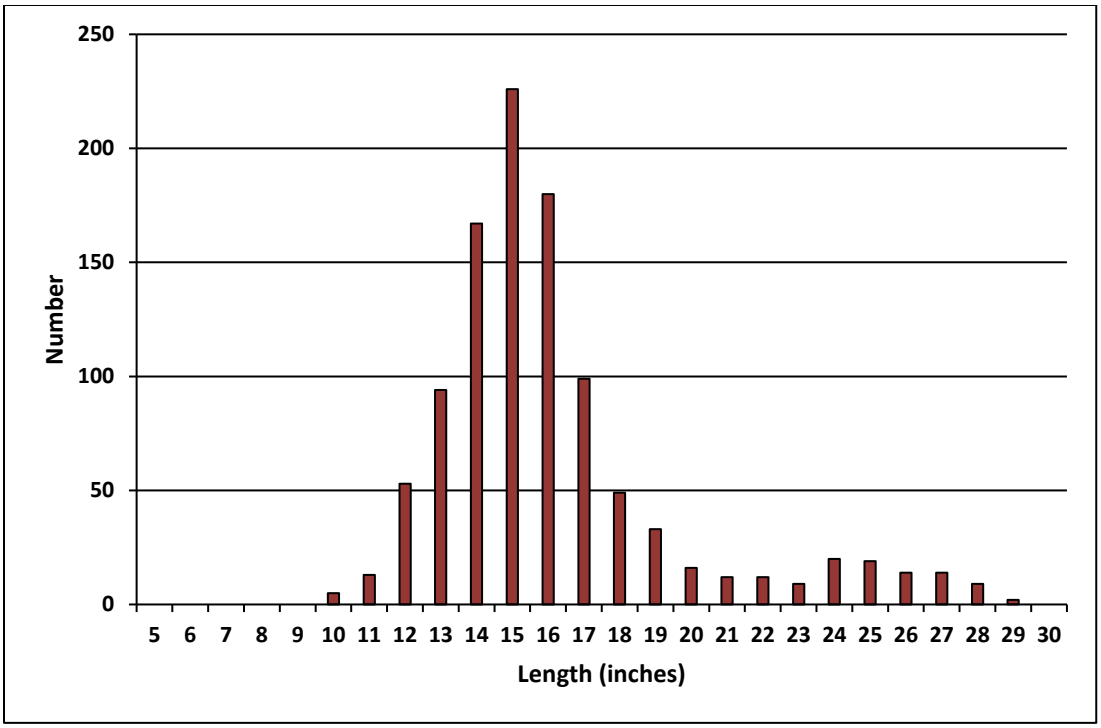


Figure 24. Length frequency of channel catfish 2018 fyke net survey

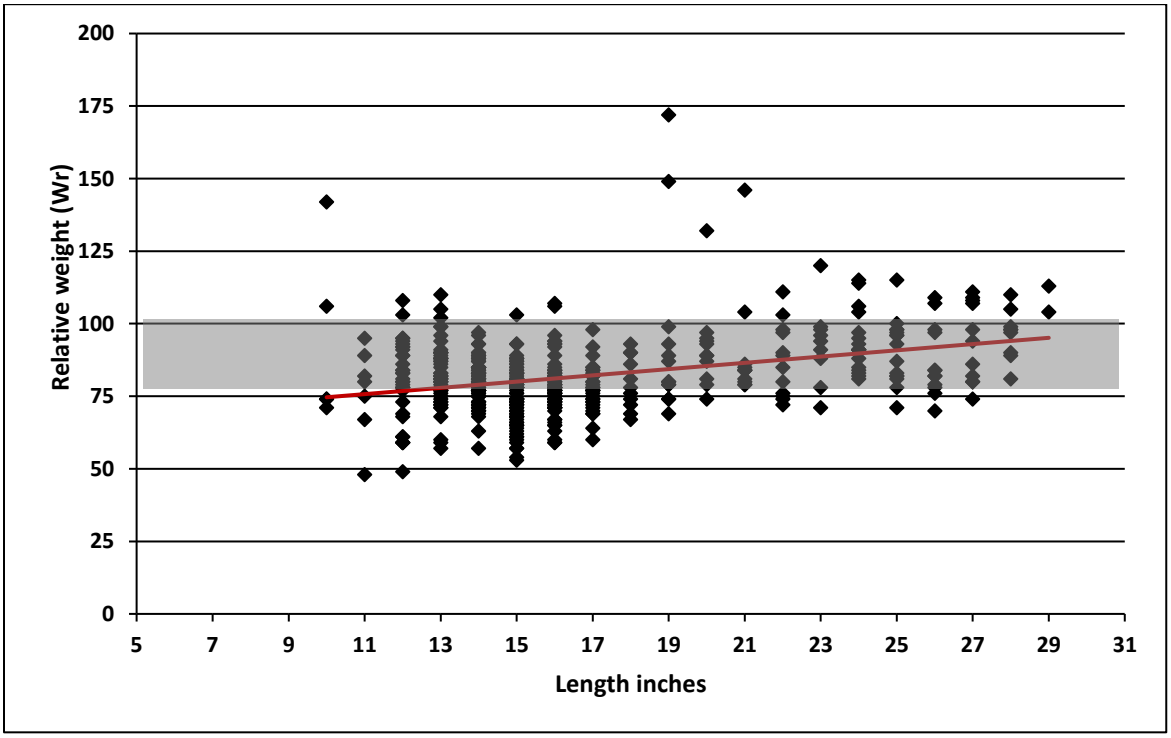


Figure 25. Relative weight of channel catfish

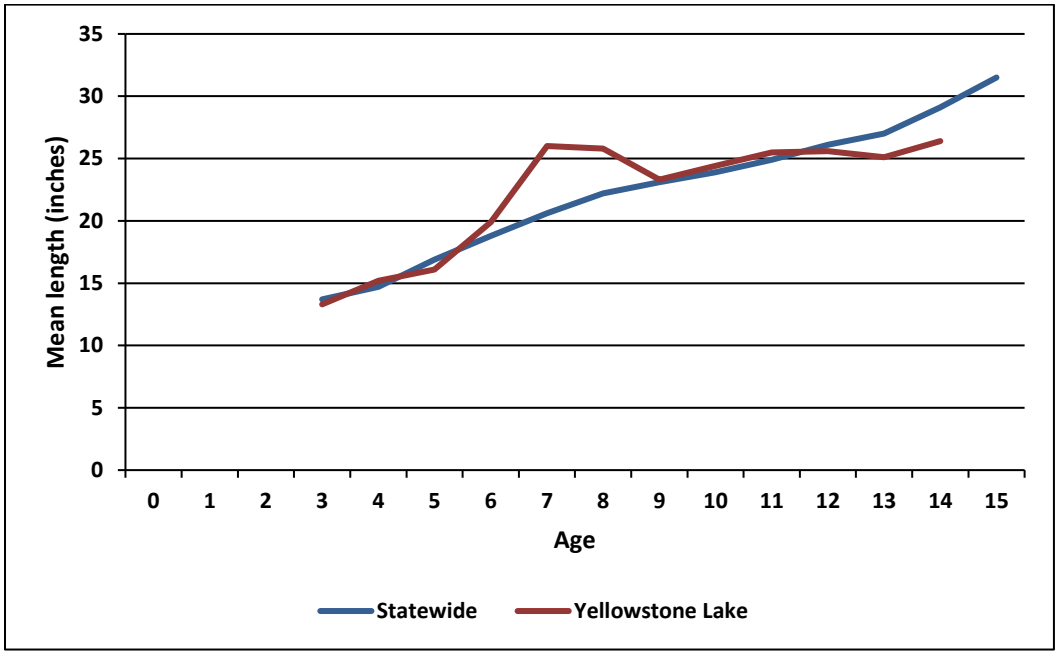


Figure 26. Channel catfish mean length at age from Yellowstone Lake and statewide

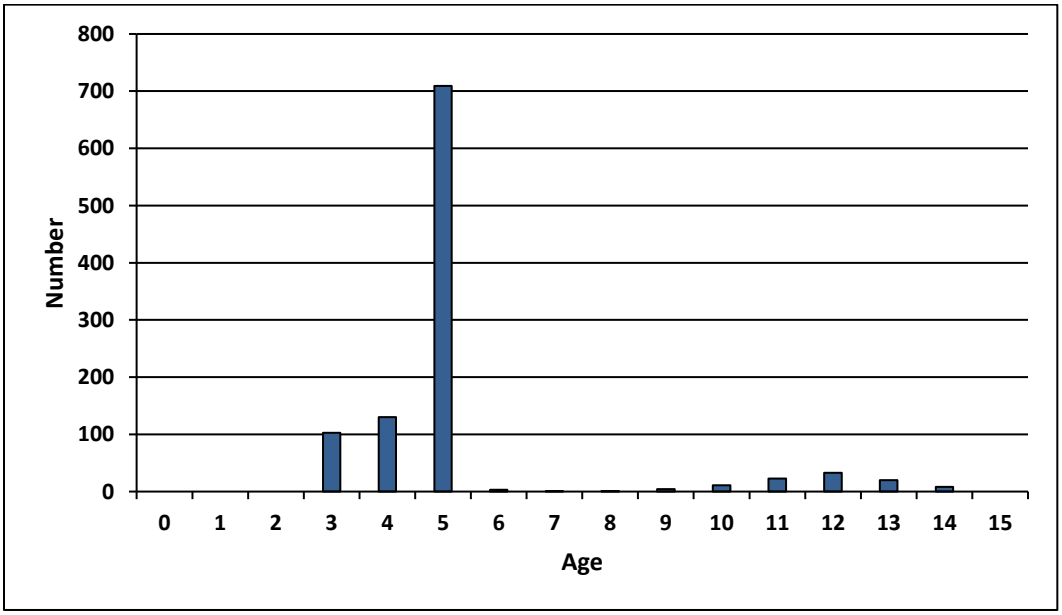


Figure 27. Channel catfish number per age group, 2018

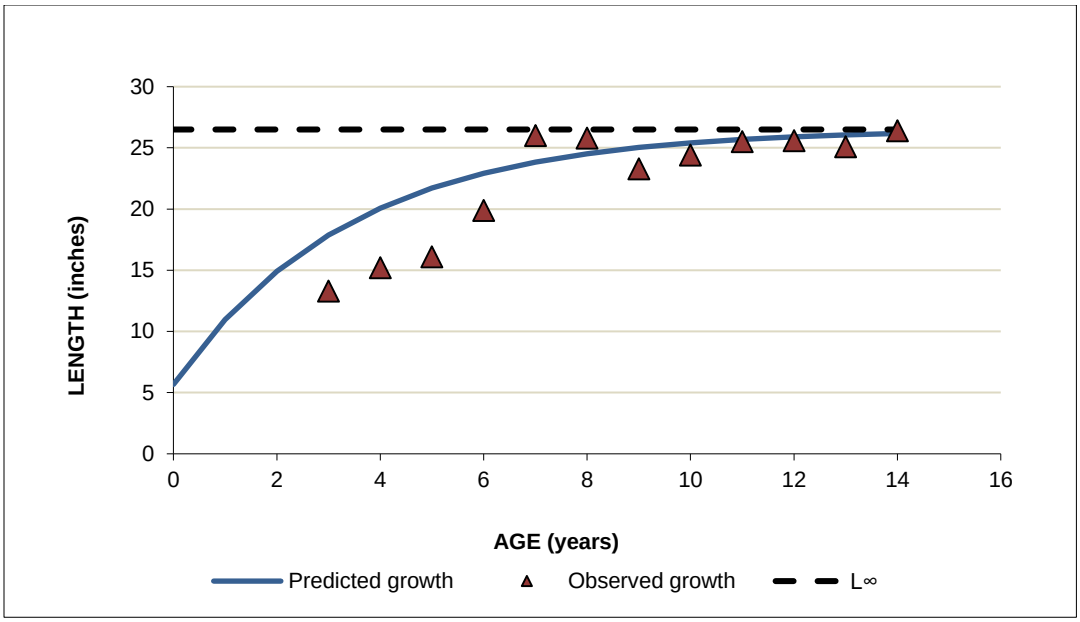


Figure 28. von Bertalanffy predicted growth model for Yellowstone Lake channel catfish, $L_\infty = 26.52$

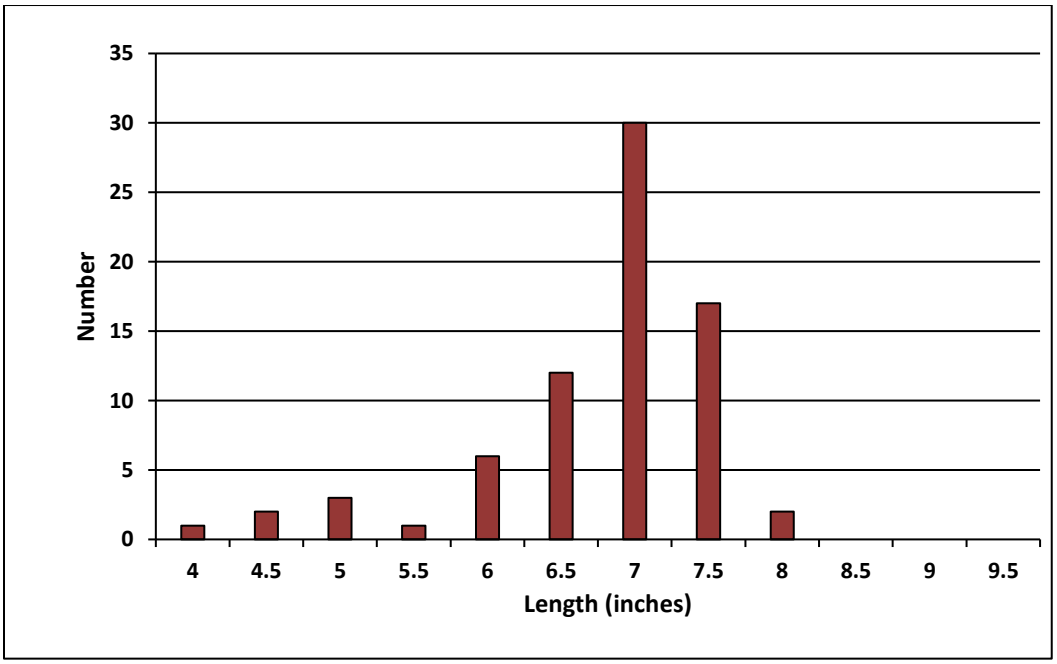


Figure 29. Length frequency of bluegill 2018, spring electrofishing II survey

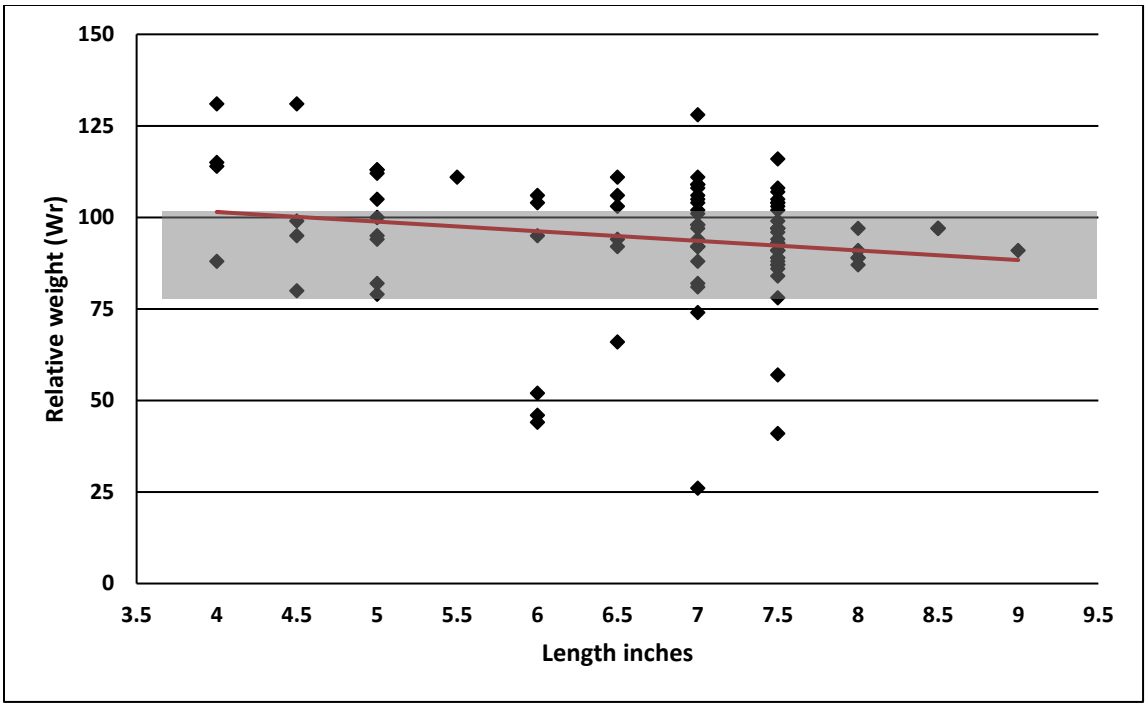


Figure 30. Relative weight of bluegill

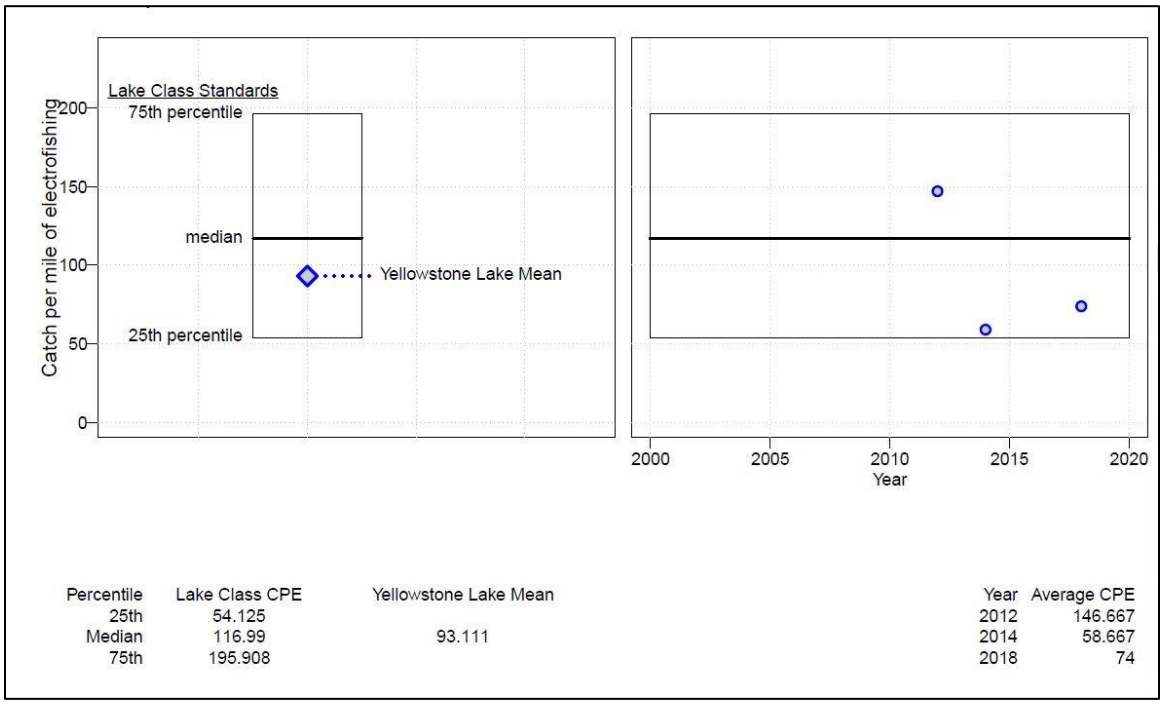


Figure 31. Yellowstone Lake bluegill catch per effort plotted with the 25th, 50th, and 75th percentiles for Wisconsin's complex warm dark lakes.

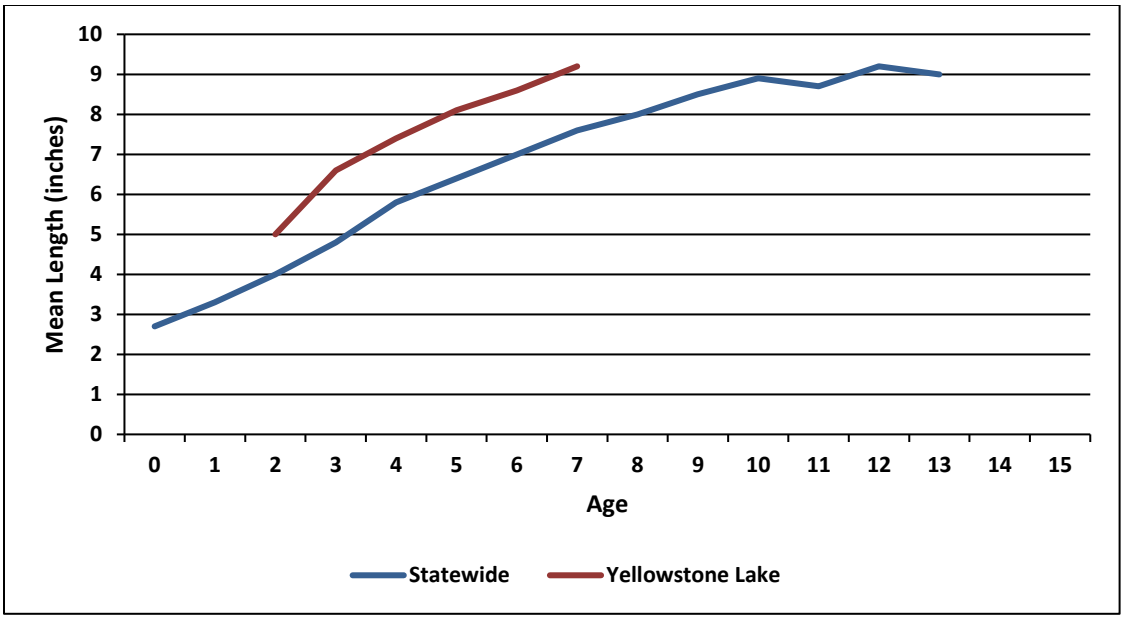


Figure 32. Bluegill mean length at age from Yellowstone Lake and statewide

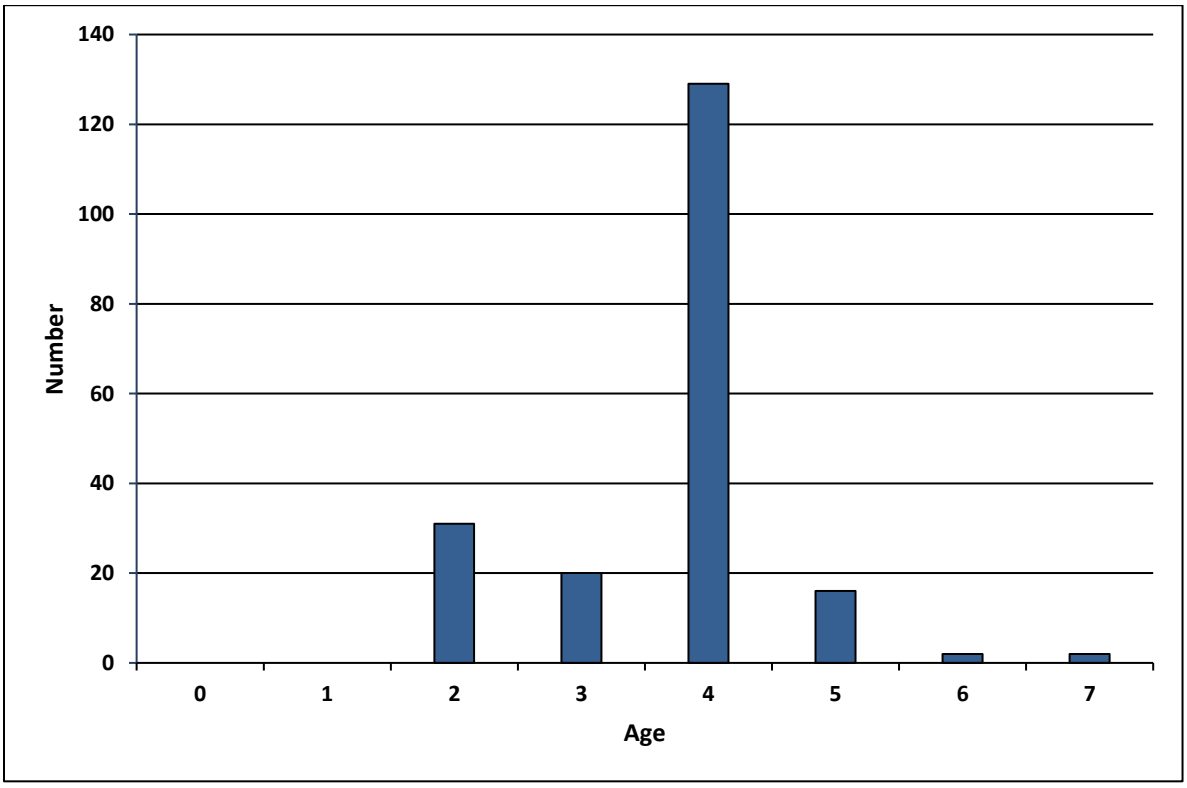


Figure 33. Bluegill number per age group, 2018

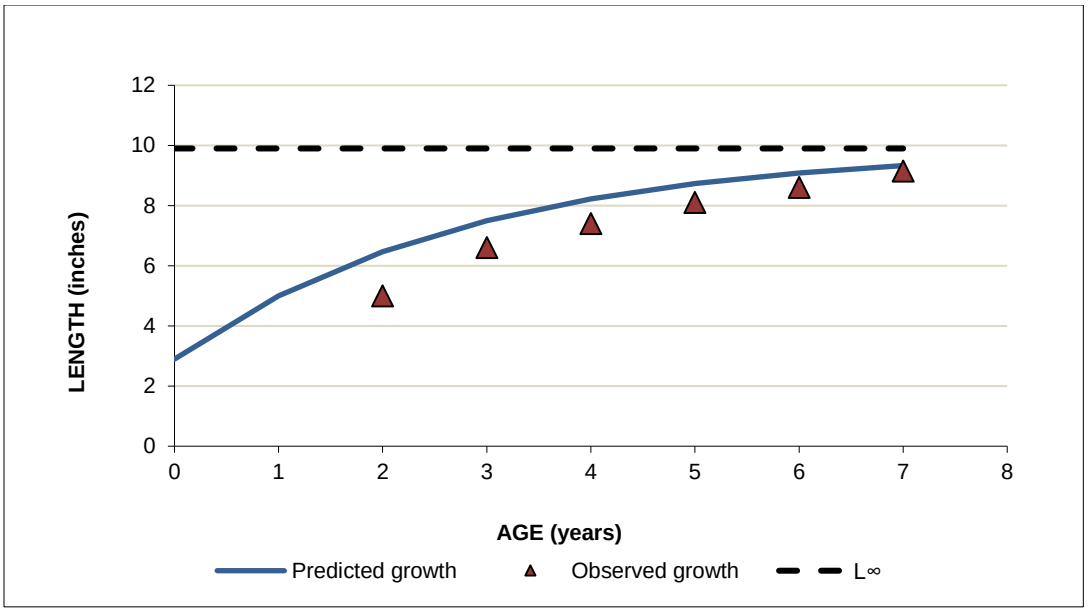


Figure 34. von Bertalanffy predicted growth model for Yellowstone Lake bluegill, L_∞ = 9.91

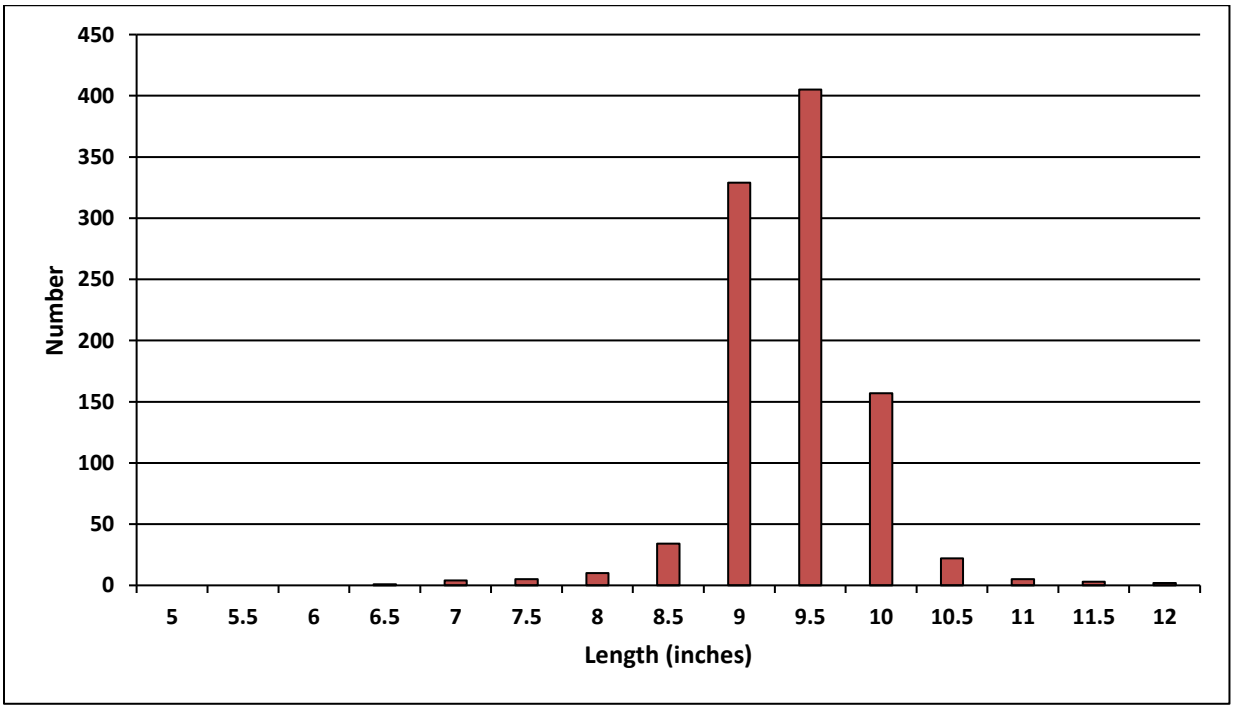


Figure 35. Length frequency of black crappie 2018

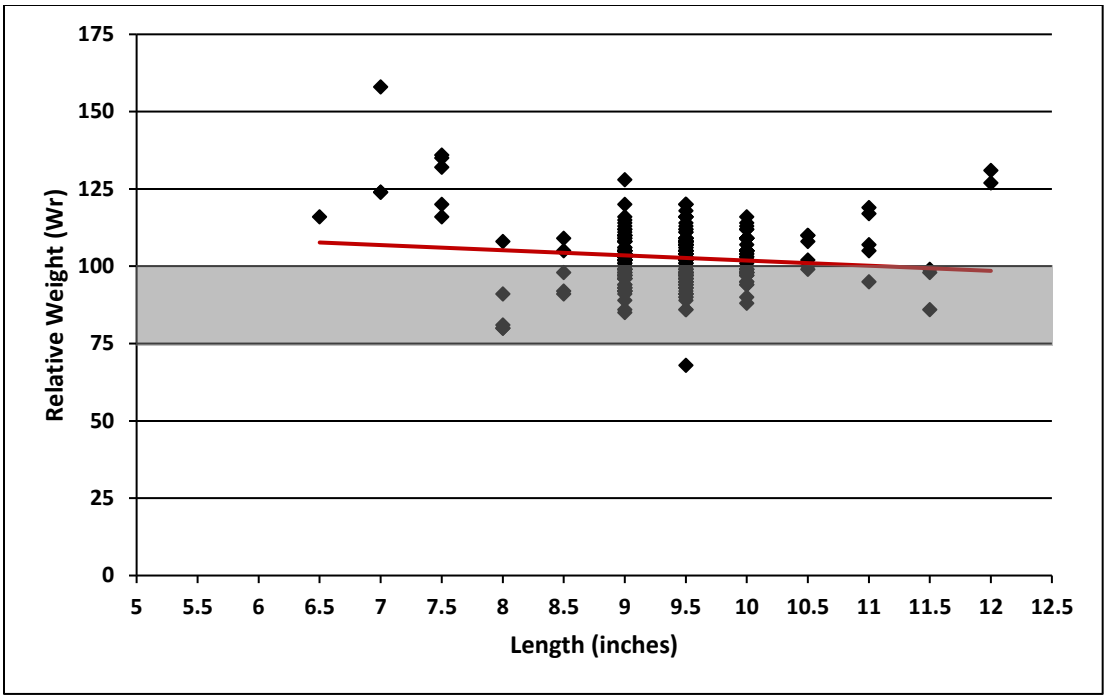


Figure 36. Relative weight of black crappie

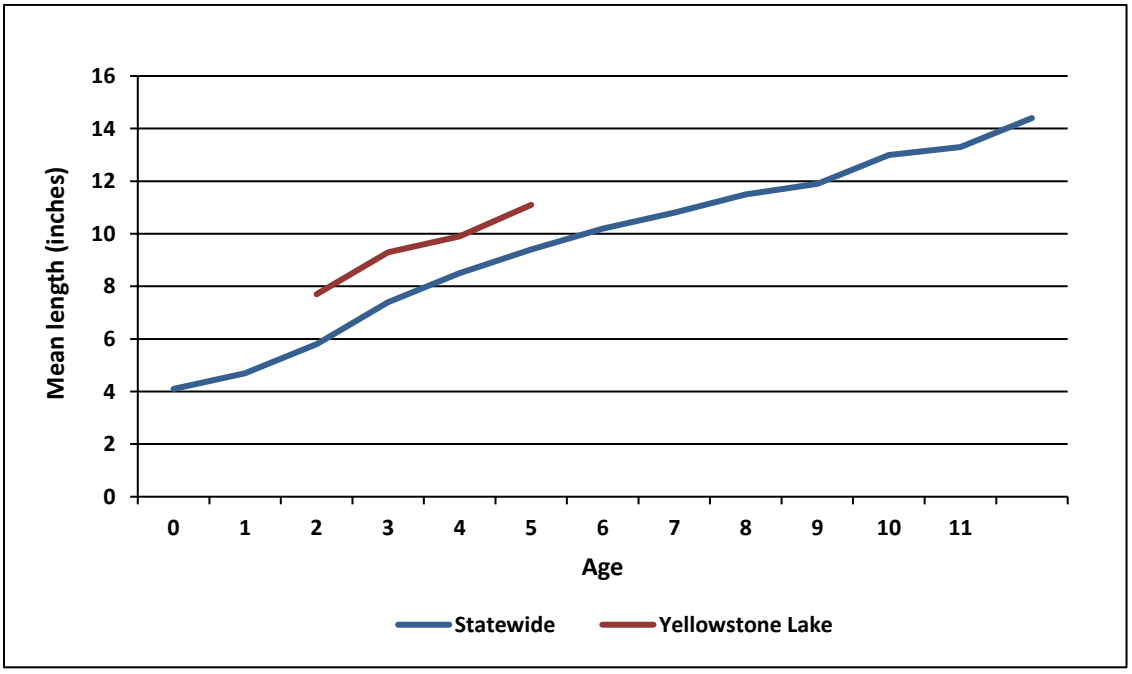


Figure 37. Black crappie mean length at age from Yellowstone Lake and statewide

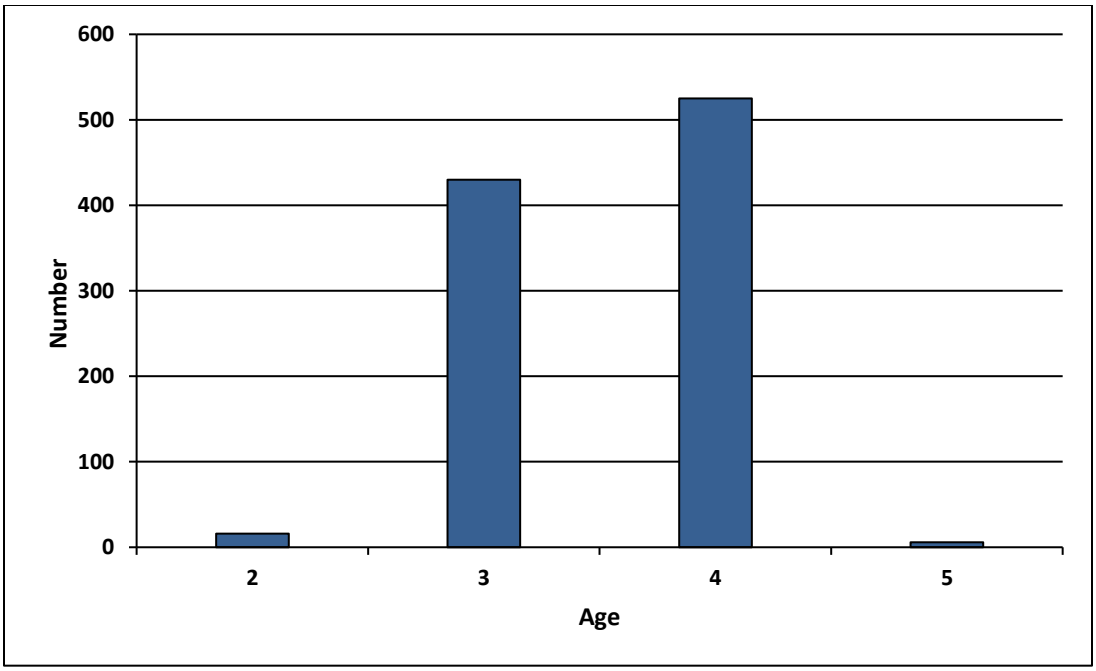


Figure 38. Black crappie number per age group, 2018

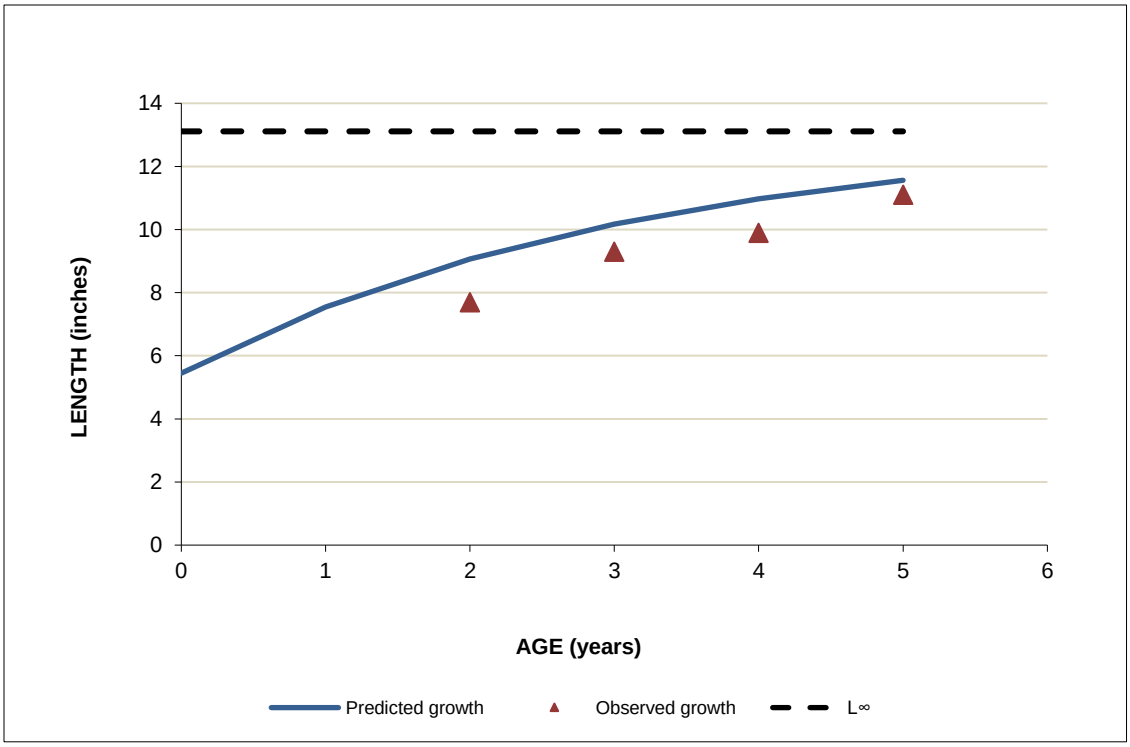


Figure 39. von Bertalanffy predicted growth model for Yellowstone Lake black crappie, $L_\infty = 13.11$

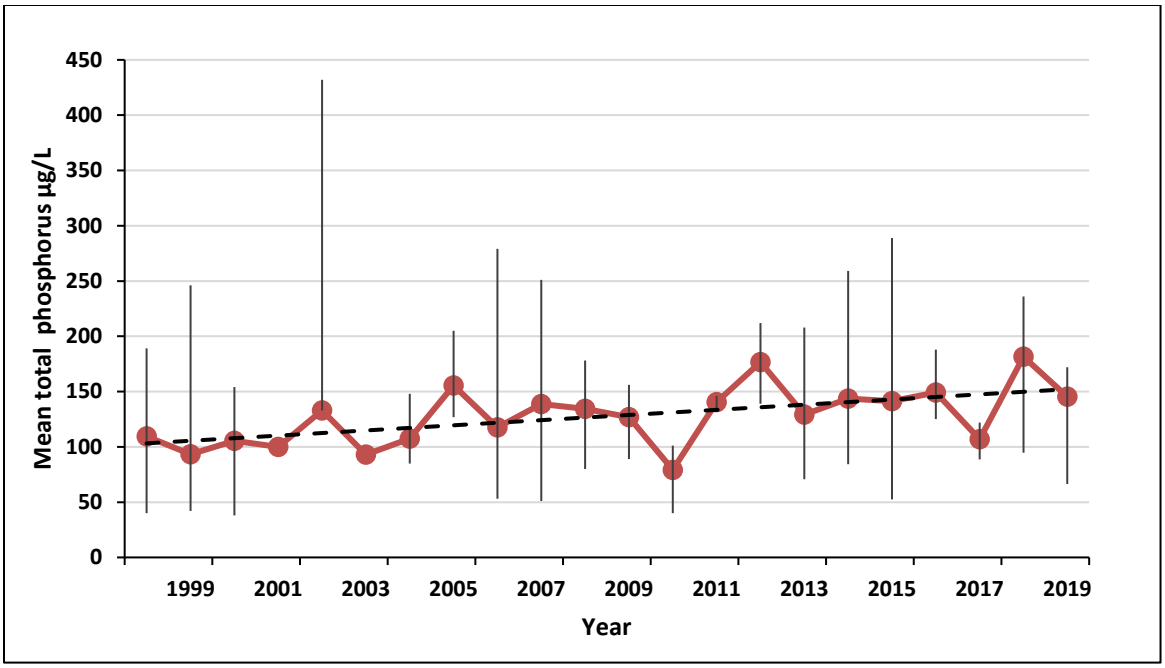


Figure 40. Mean total phosphorus (µg/l) from 1998 to 2019.

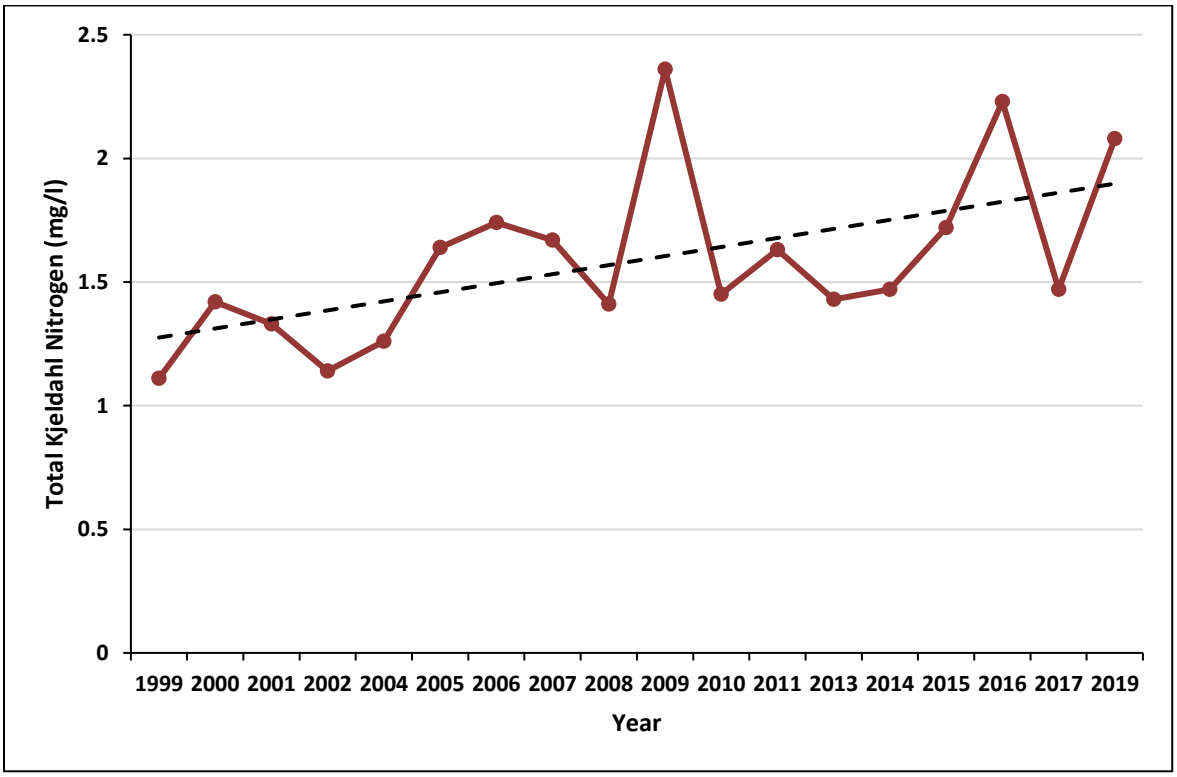


Figure 40. Mean total Kjeldahl nitrogen (mg/l) from 1999 to 2019.

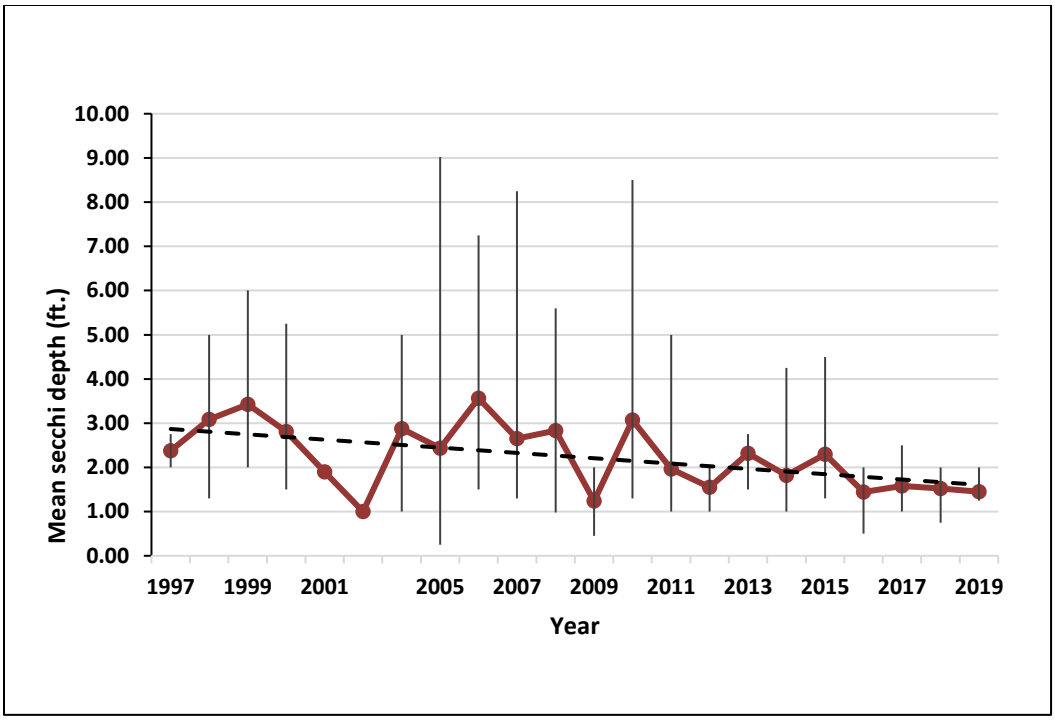


Figure 40. Mean secchi depths (feet) 1997 to 2019.

Table 1. Surface area, maximum depth, and miles of shoreline for Yellowstone Lake in 1965 and 2019.

	2019	1965
Surface Area (acres)	**450**	**455**
Maximum Depth (feet)	**14**	**16**
Miles of Shoreline	**6.34**	**6.34**

Table 2. Stocking history of Yellowstone Lake from 2009 thru 2019

Year	Species	Strain	Age Class	Number Stocked
2010	Muskellunge	Upper Wisconsin	Large fingerling	450
2010	Walleye	Fry	Unspecified	149,000
2011	Muskellunge	Upper Chippewa	Large fingerling	450
2011	Walleye	Lake Michigan	Small fingerling	7,735
2012	Muskellunge	Upper Wisconsin	Large fingerling	450
2012	Walleye	Rock-Fox	Small fingerling	7,735
2013	Muskellunge	Upper Wisconsin	Large fingerling	450
2013	Walleye	Rock-Fox	Small fingerling	7,735
2014	Muskellunge	Upper Wisconsin	Large fingerling	450
2015	Muskellunge	Upper Wisconsin	Large fingerling	450
2015	Walleye	Rock-Fox	Small fingerling	17,994
2016	Muskellunge	Upper-Wisconsin	Large fingerling	462
2017	Muskellunge	Upper-Wisconsin	Large fingerling	452
2017	Walleye	Rock-Fox	Small fingerling	15,856
2018	Muskellunge	Upper-Wisconsin	Large fingerling	227
2019	Muskellunge	Upper-Wisconsin	Large fingerling	227
2019	Walleye	Rock-Fox	Small fingerling	17,418

Table 3. Latitude and longitude coordinates of fyke nets during 2018 Yellowstone Lake muskellunge survey

Net number	Latitude	Longitude
1	42.76789	-89.97021
2	42.76467	-89.96830
3	42.76134	-89.96198
4	42.75714	-89.95766
5	42.75608	-89.96983
5A	42.75677	-89.96648
6	42.75794	-89.97038
7	42.76586	-89.97655
8	42.76645	-89.98052
8A	42.76631	-89.97923
9	42.76172	-89.97312
9A	42.76998	-89.97502
10	42.76295	-89.97346
11	42.76593	-89.97675
12	42.76593	-89.97675

Table 4. Latitude and longitude coordinates of fyke nets during 2019 Yellowstone Lake muskellunge survey

Net number	Latitude	Longitude
1	42.76997	-89.97501
2	42.76453	-89.96848
3	42.75617	-89.96980
4	42.75790	-89.97029
5	42.76177	-89.97292
6	42.76366	-89.97499
7	42.76643	-89.97912
8	42.75549	-89.96238
9	42.75994	89.97092
10	42.79712	-89.96947
11	42.76148	-89.97092
12	42.76928	-89.98393
13	42.76591	-89.98230

Table 5. Muskellunge proportional size distributions (PSD) from the 2018 and 2019 fyke net survey of Yellowstone Lake, Lafayette County.

	2018	**2019**
PSD_{38}	24.1	27.6
PSD_{42}	17.7	20.7
PSD_{50}	0	0

Table 6. Minimum, maximum, and mean length at age of muskellunge determined from PIT tag data from 2018 Yellowstone Lake, Lafayette County. No age 6 fish were collected.

Age	1	2	3	4	5	7	8	9	10	11	12
Minimum length	10.0	24.1	28.0	31.2	33.6	36.8	38.0	43.1	36.9	37.0	44.0
Maximum length	12.0	24.1	33.4	37.5	41.3	43.0	44.1	44.5	47.7	48.0	44.0
Mean length	11.0	24.1	31.4	34.4	36.9	38.5	42.3	43.6	42.86	44.2	44.0

Table 7. Walleye proportional size distributions (PSD) from the 2014 & 2018 fyke net surveys.

	2014	**2018**
PSD	84	45
PSD_{20}	9	24
PSD_{25}	1	6
PSD_{30}	0	0

Table 8. Minimum, maximum, and mean length of age of walleye determined from dorsal spine cross sections, 2018

Age	1	2	3	4	5	6	7	8	9	10
Minimum length	6.7		10.2		13.1	17.8	17.9	20.1	21.3	23.2
Maximum length	8.4		18.0		23.2	25.4	26.6	28.3	29.0	28.6
Mean length	7.4		13.1		17.8	21.0	22.4	24.5	24.4	25.5

Table 9. Largemouth mouth bass proportional size distributions (PSD) from 2014 & 2018 electrofishing survey.

	2014	**2018**
PSD	81	95
PSD_{15}	57	53
PSD_{18}	13	18

Table 10. Minimum, maximum, and mean length of age of largemouth bass determined from dorsal spine cross sections during the spring of 2018

Age	1	2	3	4	5	6	7	8	9	10	11	12
Minimum length	4.5	11.2	10.8	11.1	13.3	14.3	15.8	14.6	17.2	18.5	-	21.0
Maximum length	5.6	12.5	17.0	19.1	19.3	20.0	20.2	20.4	20.6	20.5	-	21.0
Mean length	5.0	11.8	13.8	14.8	16.4	17.7	18.2	18.6	18.4	19.4	-	21

Table 11. Minimum, maximum, and mean length of age of channel catfish determined from pectoral spine cross sections.

Age	3	4	5	6	7	8	9	10	11	12	13	14
Minimum length	12.1	11.4	12.1	18.4	26.0	25.8	22.6	22.0	22.2	21.4	21.0	24.4
Maximum length	14.2	22.2	22.2	20.5	26.0	25.8	24.8	26.9	28.7	29.5	28.4	28.1
Mean length	13.0	14.7	17.2	19.5	26.0	25.8	23.7	24.7	26.2	26.0	25.3	26.6

Table 12. Minimum, maximum, and mean length of age of bluegill determined from sagittal otolith cross sections.

Age	2	3	4	5	6	7
Minimum length	4.1	6.0	6.5	7.8	8.5	8.6
Maximum length	6.1	6.9	8.2	9.4	8.6	9.7
Mean length	5.0	6.6	7.4	8.1	8.6	9.2

Table 13. Minimum, maximum, and mean length of age of black crappie determined from sagittal otolith cross sections.

Age	2	3	4	5
Minimum length	6.8	8.4	8.3	10.8
Maximum length	8.3	9.9	12.4	11.8
Mean length	7.7	9.3	9.9	11.1

Table 14. Gamefish and panfish mean catch per unit effort and gear used.

Species	**Sampling period**	**Gear**	**Catch rate**	**Unit**
Muskellunge	Spring netting 1 & 2	Fyke net	0.54	Net night
Walleye	Spring netting 1	Fyke net	7.32	Net night
Channel catfish	Spring netting 1 & 2	Fyke net	4.88	Net night
Black Crappie	Spring netting 1 & 2	Fyke net	4.80	Net night
Largemouth bass	Spring electrofishing 2	Boom Electrofishing	22.75	Mile
Smallmouth bass	Fall electrofishing	Boom Electrofishing	3.40	Mile
Bluegill	Spring electrofishing 2	Boom Electrofishing	74.00	Mile

Table 15. Length categories by species used for proportional size distribution calculations.

Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Muskellunge	30	30	38	42	50
Walleye	10	15	20	25	30
Laregmouth bass	8	12	15	20	25
Channel catfish	11	16	24	28	36
Bluegill	3	6	8	10	
Black crappie	5	8	10	12	