Preliminary Black Bass Population Dynamics in Spavinaw Creek, Oklahoma

Oklahoma Department of Wildlife Conservation, Streams Program

Black Bass Report No. 11
Federal Aid Project F24AF00402
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Objective(s):

I. Establish contemporary baseline black bass population dynamics data in Oklahoma streams using standardized sampling techniques.

II. Use historical black bass population dynamics data, when available, to analyze potential changes in black bass population growth rates, size structure, and mortality.

III. Evaluate the effectiveness of current stream black bass fishing regulations.

Executive Summary:

Beginning in 2016, the Oklahoma Department of Wildlife Streams Program instituted a black bass monitoring program for Largemouth Bass, Smallmouth Bass, and Spotted Bass. Sampling will occur on a rotational basis. In October of 2025, six sites on Spavinaw Creek were sampled for black basses using tow-barge electrofishing, boat electrofishing, and angling. Among the five sites sampled, 71 Neosho Bass and 16 Spotted Bass were collected. This resulted in L_{∞} of 616 mm and 417 mm respectively. Neosho/Smallmouth Bass max age and size were 7 and 380 mm. Spotted Bass max age and size were 9 and 406 mm. These surveys yielded estimates of population dynamics for two of the three species present in the system that will be useful for evaluation of both statewide and special area regulations.

Introduction

Stream fishing represents an important fisheries resource for freshwater anglers (Fisher et al. 1998). In Oklahoma, it is estimated that between 24-31% of anglers fish in rivers or streams each year (Fisher et al. 1998; Fisher et al. 2002; U.S. Department of the Interior et al. 2011). Consequently, recreational fishing in Oklahoma streams provides a substantial boost to the economy of the region (Fisher et al. 2002; Boyer and Fisher 2007). Black bass are the most sought-after sport fish in eastern Oklahoma streams despite survey results indicating most anglers (>75%) rated black bass fishing as fair or poor (Fisher et al. 2002). Black bass catch rates, harvest rates, angling pressure and yield have been observed to differ substantially between northeastern and southeastern streams in Oklahoma (Martin and Fisher 2008). Additionally, black bass densities, lifespans, recruitment, and growth rates have been reported to differ between ecoregions in Oklahoma (Stark and Zale 1991; Brewer and Long 2015). Therefore, management recommendations that benefit stream black bass populations in northern Oklahoma may not be adequate for black bass populations in southern Oklahoma. Ultimately, this may require different regions or waterbodies to be managed independently to improve black bass fisheries in these systems (Fisher et al. 2002; Williamson et al. 2019).

Largemouth Bass (*Micropterus nigricans*) and Spotted Bass (*Micropterus punctulatus*) are both native to Oklahoma streams. Historically, there were two taxonomically recognized subspecies of Smallmouth Bass, *Micropterus dolomieu*: the northern, wide-ranging subspecies *M. d. dolomieu* and the Neosho subspecies *M. d. velox* (Hubbs and Bailey 1940), which is native to the Arkansas River basin. Additionally, a genetically distinct lineage of Smallmouth Bass (Ouachita Smallmouth Bass), occurs in southeastern Oklahoma in the Ouachita Mountains ecoregion (Stark and Echelle 1998; Brewer and Long 2015). However, recent work has since elevated both lineages to species; the Neosho Bass (*Micropterus velox*) in Arkansas River tributaries and the Little River Bass (*Micropterus* cf. *dolomieu*) in Red River tributaries (Kim et al. 2022).

Historical stockings of non-native Smallmouth Bass have led to the introduction and establishment of several populations in streams and reservoirs throughout Oklahoma (ODWC, unpublished data). Smallmouth stockings were halted by the Oklahoma Department of Wildlife (ODWC) after genetic results confirmed the taxonomic status of Neosho and Ouachita Smallmouth Bass (Little River Bass). Nevertheless, introgressive hybridization between

Smallmouth Bass and both Neosho Bass and Little River bass has been documented (Malloy et al. 2000; Taylor et al. 2016; Taylor et al. 2018). In this report, when discussing statewide regulations and populations, "Smallmouth Bass complex" will refer to each of these three species as they are sister taxa (Kim et al. 2022). Individual populations for which genetic work has confirmed species identity will be referred to as such throughout the methods and results.

Historical sampling of stream black bass occurred sporadically in Oklahoma, but, like elsewhere across their range, study of basic population dynamics has historically lagged studies conducted in reservoirs (Fajen 1975). Consequently, the ODWC has never incorporated a standardized monitoring program to monitor black bass population dynamics in streams. Therefore, historical data related to recruitment, growth, and mortality of stream black bass populations is sparse (but see Leonard and Jenkins 1952; Orth et al. 1983; Stark and Zale 1991). Based on a survey of stream black bass in eastern Oklahoma, Stark and Zale (1991) recommended a 229 to 305-mm (9.0-12.0 in) protected-slot length-regulation on Smallmouth Bass in northeastern streams; however, in southeastern streams a high minimum length regulation (>381 mm or 15 in) for Smallmouth Bass and liberal harvest regulations for Largemouth Bass and Spotted Bass were recommended. Prior to 2014, the statewide daily limit was six combined Largemouth Bass and Smallmouth Bass (no daily limit for Spotted Bass) with no length restrictions, but Smallmouth Bass in the upper Illinois River and its tributaries were subjected to a 229 to 305-mm protected slot limit. Additionally, within a daily bag of 6 combined black bass, only one Smallmouth Bass over the slot limit was allowed. Currently, size regulations for Largemouth and Smallmouth Bass in streams are set at a 356 mm (14 in) minimum length limit. Statewide harvest regulations limit anglers to six combined black bass; however, anglers fishing in rivers and streams are only allowed to harvest one Smallmouth Bass as part of their daily limit. Spotted Bass harvest is limited within the combined daily limit of six black bass with no size restriction except on the Blue River Public Fishing and Hunting Area (PFHA), which has a 356 mm minimum size limit.

Due to the popularity of black bass with stream anglers in Oklahoma, and the paucity of population dynamics data for informing management decisions, the ODWC Stream Program instituted a black bass monitoring program in 2016. As part of the monitoring program, streams will be sampled on a rotational basis. Data collected within the black bass monitoring program will document contemporary black bass population dynamics data and serve as the foundation for a long-term black bass population dynamics dataset for evaluating temporal trends. The data collected will be instrumental in evaluating the effectiveness of current stream black bass regulations in place to maximize fishing opportunities valued by constituents.

Methods

Study Area

The headwaters of Spavinaw Creek begin near Bentonville, Arkansas. The stream enters Oklahoma South of Maysville, it flows approximately 37 rkm (river kilometers) and is separated from Lake Hudson by Spavinaw Lake and Lake Eucha (Figure 1). Lake Eucha was opened in 1952 and has 2,860 surface acres of water. It is also a water source for the city of Tulsa, Oklahoma. Spavinaw Lake was completed in 1924 and offers 1,548 surface acres of water. Lake Hudson is the end point of Spavinaw Creek and was completed in 1964 and contains 12,000 surface acres of water.

Field surveys

While present in all the rivers sampled by the Stream Program to date, low sample sizes of Largemouth Bass preclude calculation of population dynamics needed to manage populations. Additionally, there are a myriad of self-sustaining, actively managed Largemouth Bass populations in reservoirs around the state of Oklahoma. For these reasons, the Stream Program ceased collection of Largemouth Bass in black bass surveys in 2021. Sampling sites are typically delineated at the reach scale. A reach was defined as whichever is greater: 40x wetted width, or a length of the stream containing three of each primary channel unit types (i.e., run, riffle, pool).

Surveys were conducted from October 8 to October 21, 2025. One wadeable site was sampled with an electrofishing canoe outfitted with Infinity Electrofishing Control Box (Midwest Lake Management, Polo, Missouri). One Site was sampled with an electrofishing boat with the same electrofishing gear as the canoe. Six of the sites were angled to increase sample size with the focus on larger individuals. Shock canoe and boat electrofishing were conducted using pulsed direct current (DC), 60 Hz, and 25% duty cycle. Water conductivity was measured on site and voltage was adjusted to maintain adequate target power as outlined in Miranda (2009). Electrofishing was conducted upstream in a zigzag pattern and care was taken to sample all available habitat types, excluding shallow riffles due to the depth limitation of the shock canoe and boat.

With the recent separation of Neosho Bass, it has become important to determine population variance of Neosho, Smallmouth, and intergrade. Due to this, 52 fin clips were collected to be sent in for genetics.

Laboratory methods

Black bass were collected, identified to species, marked with an identifier tag, measured for total length (TL, mm) and put on ice for transportation to the laboratory. Laboratory processing included measurements of weight (g), removal of sagittal otoliths, and sexing mature (> young-of-year, YOY) individuals. Otoliths were extracted from all specimens that did not have bi or tri-colored tails indicative of Spotted and Smallmouth Bass complex YOY. Individuals ≤ 100 mm were recorded as YOY. Otoliths are known to provide accurate age estimates for black bass and have been shown to be superior age estimators when compared to scales and pectoral fin rays, especially when aging older specimens (Long and Fisher 2001; Phelps et al. 2017; Starks and Rodger 2020). Sagittal otoliths were read whole while under a microscope (Nikon SMZ25, Nikon Co., Tokyo, Japan) with the aid of an external light source. To prevent any potential underestimating bias, any whole otolith that was determined to be ≥ 4 years was sectioned and re-aged. The sagittal otolith was fixed to the support arm of a low-speed saw (Buehler, Lake Bluff, Illinois) and sectioned. If growth rings were not visible, the cross section was sanded using 1500-grit sandpaper. Annual growth rings were counted independently by two experienced readers. In instances where the age estimate varied between the two readers, an additional reader was brought in to verify the age estimate. Reader agreement was 100% and all otoliths were retained for growth analysis. All otoliths were photographed using Nikon SMZ25 camera mounted on the microscope to facilitate ease of reading and long-term data storage.

Analyses

Using published black bass length values for stock, quality, preferred, memorable, and trophy calculations, proportional size distribution (PSD) indices were calculated for each species in each stream (Gabelhouse 1984). It should be noted that in general, lotic Smallmouth and Spotted Bass populations grow slower than their reservoir counterparts and observed PSD values can be skewed towards smaller classes in riverine systems (Carlander 1977; Fiss et al 2001; Meneau 2010; T. Starks, ODWC, unpublished data).

Black bass were pooled together by species to estimate growth rates. Comparison of black bass growth rates was accomplished by fitting a nonlinear estimation of a von Bertalanffy (VB) growth equation (von Bertalanffy 1938) to age/length data from each stream. The VB growth equation formula is as follows:

$$L_t = L_\infty\left[1 - e^{-K(t-t_0)}\right]$$

where t is time units (y), L_t is the length of the fish at age t, L_∞ is the maximum mean (asymptotic) length, K is the Brody growth coefficient, and t_0 is the theoretical age at which a fish would have a length of zero. The VB growth model has become the standard analysis among fisheries scientists for modeling growth (Isely and Grabowski 2007). Upper and lower 95% confidence intervals (CI) were calculated using 10,000 iteration bootstrapping methods. Predicted length at ages and associated 95% CIs were calculated from the VB growth model. VB growth equation calculations were conducted using the FSA package (Ogle 2016) in R (R version 3.5.2; R Core Team, 2022) and compared with the Oklahoma Fisheries Analysis Tool (OFAT).

Black bass mortality rates were calculated using a weighted linearized catch curve. Catch curve methods estimate mortality rates by regressing counts of fish in each age class as a function of age. Age classes on the ascending limb of catch curve plots were removed as they are underrepresented in the sample and heavily influence mortality rate estimation. The gears used in this study have been found to select against age-0 fish, which necessitates their removal from analysis (Balkenbush and Fisher 1999). The descending limb of the catch-curve is linear when the natural logarithm of catch is plotted against age, and the negative slope of the linear regression model fit to the data is an estimate of instantaneous mortality (Z; Ogle 2016). Because old age classes are typically represented by fewer individuals, weighted regression methods were used to decrease their impact on estimates of Z and in turn total annual mortality (A; Maceina and Bettoli 1998). One assumption not commonly met when estimating mortality rates using catch curves is constant recruitment in the population. Black bass exhibit annual variation in recruitment (Lukas and Orth 1995; Maceina and Bettoli 1998; Smith et al. 2005). However, nominal, random fluctuations in recruitment (as is the case in most black bass populations due to varying environmental conditions during the spawning season) are acceptable. Directional change in recruitment, either constantly increasing or decreasing over time confounds catch curve analyses (Miranda and Bettoli 2007), but this is not suspected to be the case for stream black bass populations in eastern Oklahoma based on examination of trends in fall young of year (YOY) black bass densities (ODWC, unpublished data). Upper and lower 95% CI were estimated for Z and A. All mortality calculations were conducted using the FSA package (Ogle 2016) in R (R version 4.2.2; R Core Team, 2022) and compared with OFAT.

Length-weight regression models were performed to find any outliers to later compare with genetic analysis. This model can also be used to have a perceived notion of health and performance, which in a system like Spavinaw Creek can be very useful with the lack of water connectivity due to the lakes present.

Results

Data analysis conducted must be used with discretion as we do not have the genetics data to go along with statistics to ensure the proper Neosho Bass and Smallmouth Bass relationship within the Spavinaw creek drainage.

Surveys in Spavinaw yielded 71 Neosho/Smallmouth Bass and 16 Spotted Bass. Sex ratios for Neosho/Smallmouth Bass were 42% male, 46% female, and 12% YOY/juvenile. Spotted Bass sex ratios were 38% male, 56% female, and 6% YOY/juvenile.

Neosho/Smallmouth Bass ranged in size from 149-380 mm (mean 236 mm) with mean predicted length at ages 1,2,3,4,5, and 7 reported (Table 1). Spotted Bass ranged in size from 161-406 mm (mean 293 mm) with mean predicted length at ages 1,2,3, and 9 reported (Table 2). Proportional size distributions (PSD) were calculated for Neosho Bass/Smallmouth Bass and Spotted Bass; they share the same length requirements for each category (Table 3). Five Spotted Bass and three Neosho Bass/Smallmouth Bass exceeded preferred size. No memorable or trophy sized individuals were collected for either species.

Both Spotted Bass and Neosho/Smallmouth Bass had sample sizes to facilitate VB growth equations and predicted mean length-at-age plots. The VB growth equation for Neosho/Smallmouth Bass resulted in an L_∞ of 616 mm (24 in), K=0.09, and t_0=-3.4. The oldest Neosho/Smallmouth Bass was 7 years old. The VB growth equation for Spotted Bass resulted in an L_∞ of 417 mm (16 in), K=0.56, and t_0=-0.009. The oldest Spotted Bass collected was nine years old. Figure 6 and Figure 7 contain length and age frequency histograms for Neosho/ Smallmouth Bass and Spotted Bass respectively. Proportional Size Distribuions (PSD) for Neosho/Smallmouth Bass were 23% Quality, 5% Preferred with the rest being the Stock length. PSD for Spotted Bass was 50% Stock, 25% Quality, and 25% Preferred. Annual mortality for

Neosho/Smallmouth and Spotted Bass is reported to be 46% and 17% respectively, percentages should be viewed with descretion because of limited sample size.

Discussion

Further data analysis will be conducted once genetic testing results are received. Genetic analysis should be received in early 2026. The current results show that there is more than likely Smallmouth Bass and Neosho Bass in the von Bertalanffy growth estimates, depicted by a large, unreasonable L_{∞}. Spavinaw Creek is an interesting system due to its reletively small size and its connection to three resevoirs. The lack of continuous stream connectivity in the system will have likely affected the Neosho Bass population negatively by reducing water area, however there is a chance the dams present could have also kept these Neosho Bass away from the Smallmouth Bass population and reducing hybridization above Lake Eucha. In an attempt to make the von Bertalanffy growth curve more resemble a Neosho Bass population pre-genetic testing, statistical analysis were ran again with two outliers removed, a seven and a four year old fish either due to age or size that seem more relatable to a Smallmouth Bass. This resulted in an L_{∞} of 349 mm (14 inches) which does in fact follow more closely to a mostly pure Neosho Bass population. The statistics with the completed genetic testing done will allow for a better outlook on the population in Spavinaw Creek.

Spotted Bass data was able to be used to calculated a growth curve and predicted mean lengths at age, however the low sample size of sixteen should make use of these results questionable untill more samples can be done. The lack of individuals sampled in the age classes four through eight affected the smoothness of of the growth curve significantly. When comparing Spotted Bass of Spavinaw Creek to the rest of the systems sampled by the streams program, it ranks as the third highest $L_{\infty,}$ tied for second highest max size, and a tied max age. Spavinaw Creek also seems to house the fastest growing population of Spotted Bass, with the exception of the year one age class in the Blue River and Illinois River, in systems samples by the streams program, but would really benefit with more indivuals being collected in the future.

Management Reccomendations

It is recommended that Spavinaw Creek remain in future stream black bass monitoring surveys. Because of an increasing population in the Ozarks, agriculture, water consumption, and runoff are also significantly increasing. All these changes negatively impact cool, spring fed streams in this ecoregion. It is likely that Neosho Bass will decline in the future due to these changes. Therefore, it is essential that population densities are focused on when we have a clear understanding of Neosho Bass and Smallmouth Bass identifiable characteristics without the use of genetics.

Evaluation of regulations will be conducted after all streams in the black bass monitoring rotation have been conducted. Region specific population models (i.e., pooled northeast and southeast data) will be used to increase sample sizes and evaluate differences between regions and species (i.e. Little River Bass, Neosho Bass, and Smallmouth Bass). Evaluation of the current size and harvest regulations will be facilitated by the data collected within the black bass monitoring program, as well as ancillary data collected for other concurrent projects.

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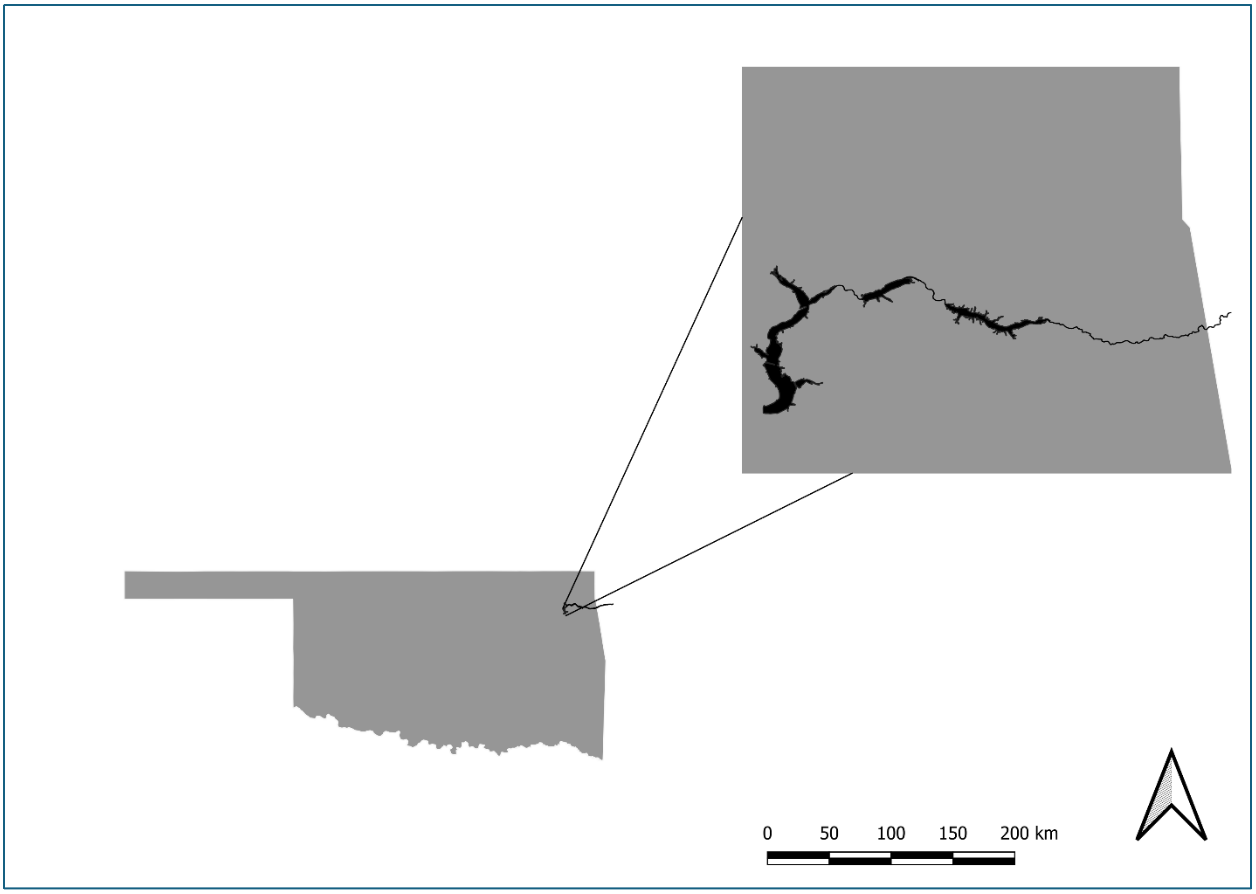

Figure 1. Spavinaw Creek including reservoirs in system.

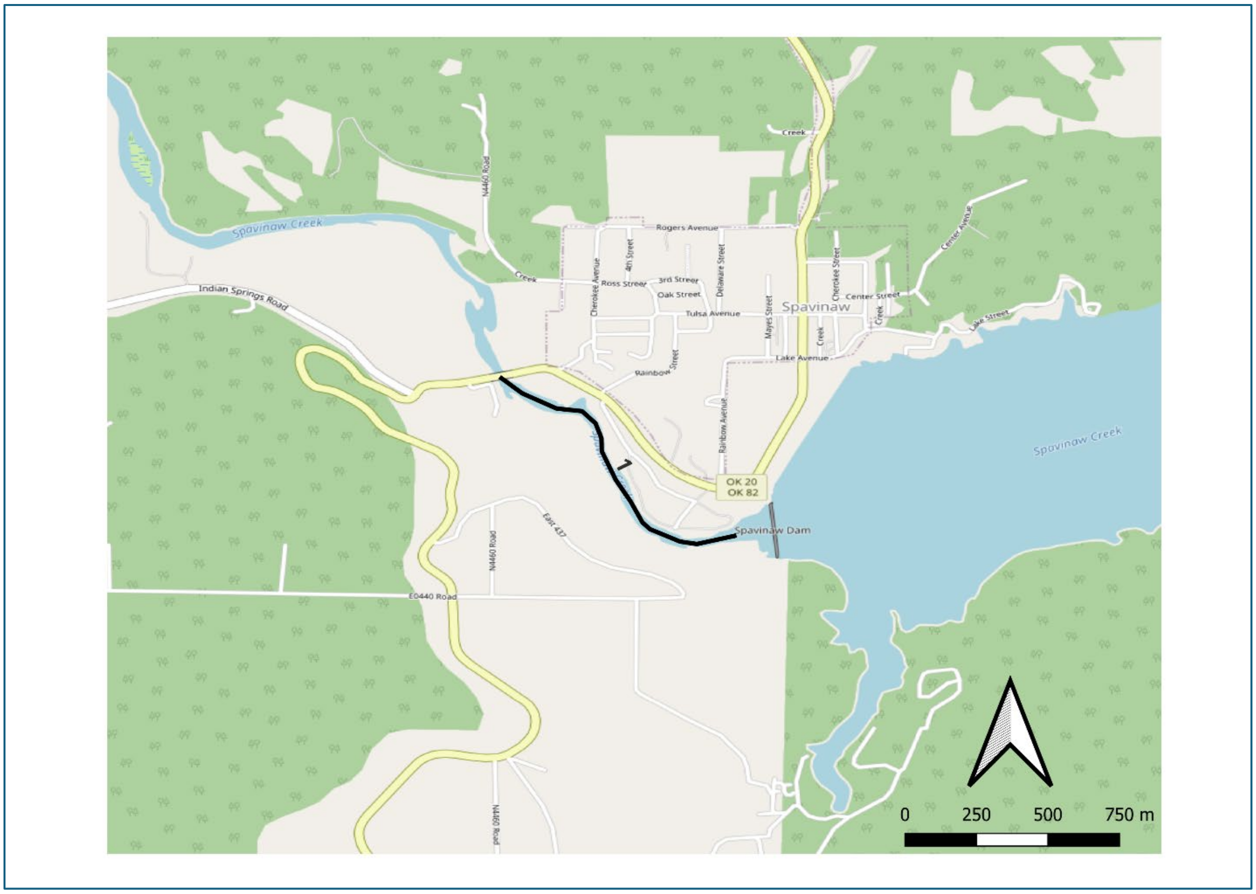

Figure 2. Site 1 below Spavinaw Dam.

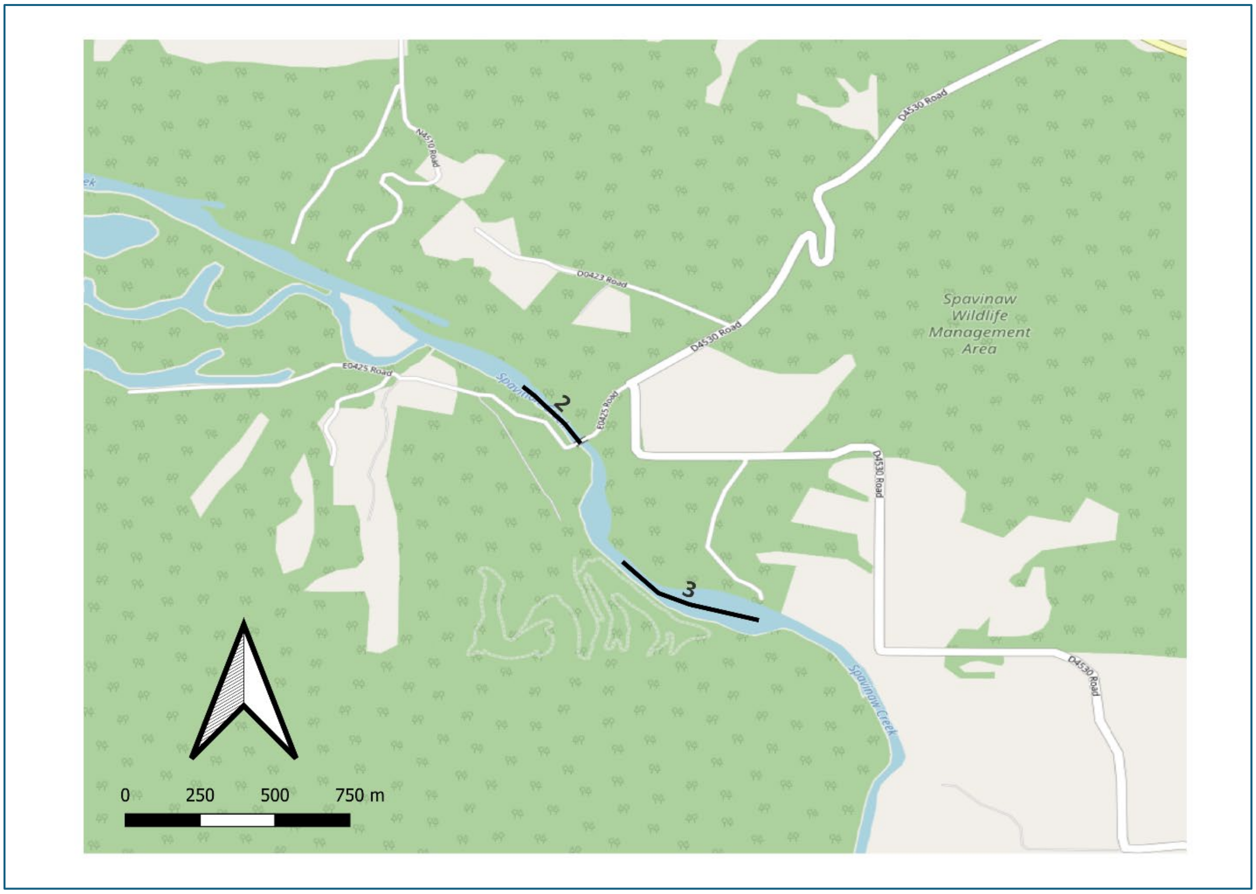

Figure 3. Sites 2 and 3 on Spavinaw Creek near Spavinaw WMA.

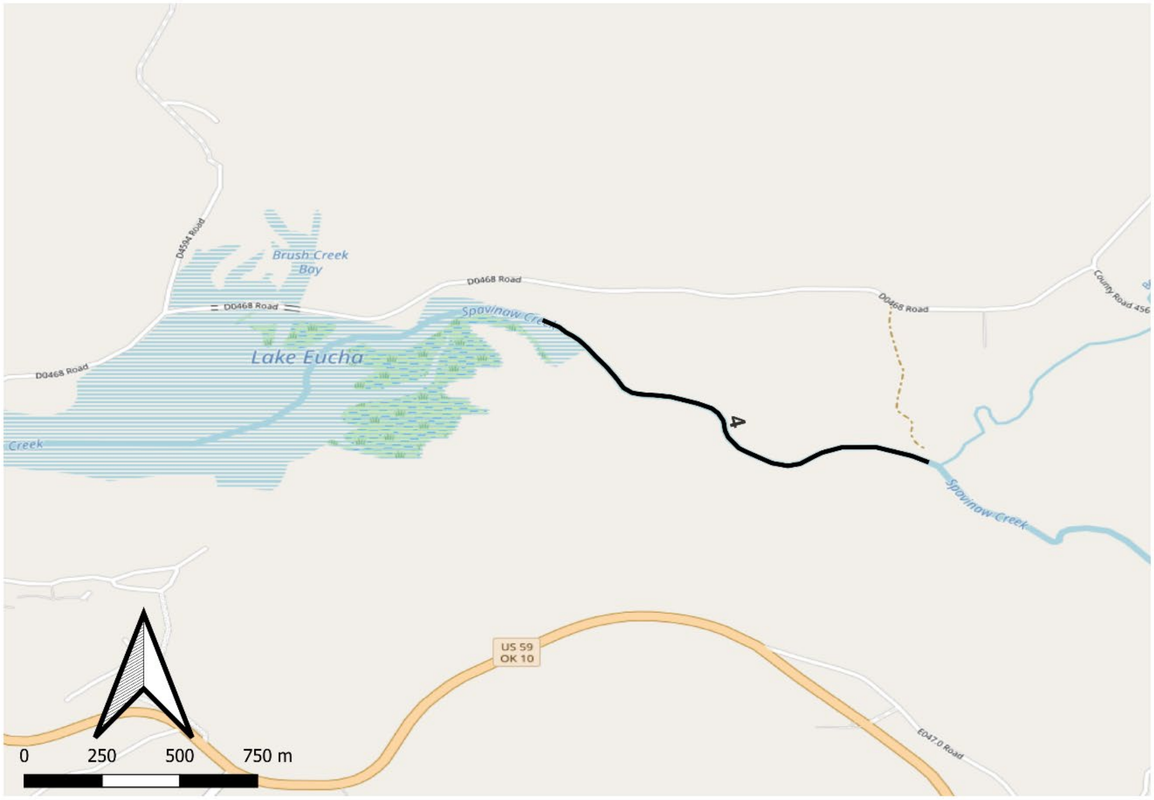

Figure 4. Site 4 on Spavinaw Creek above Lake Eucha.

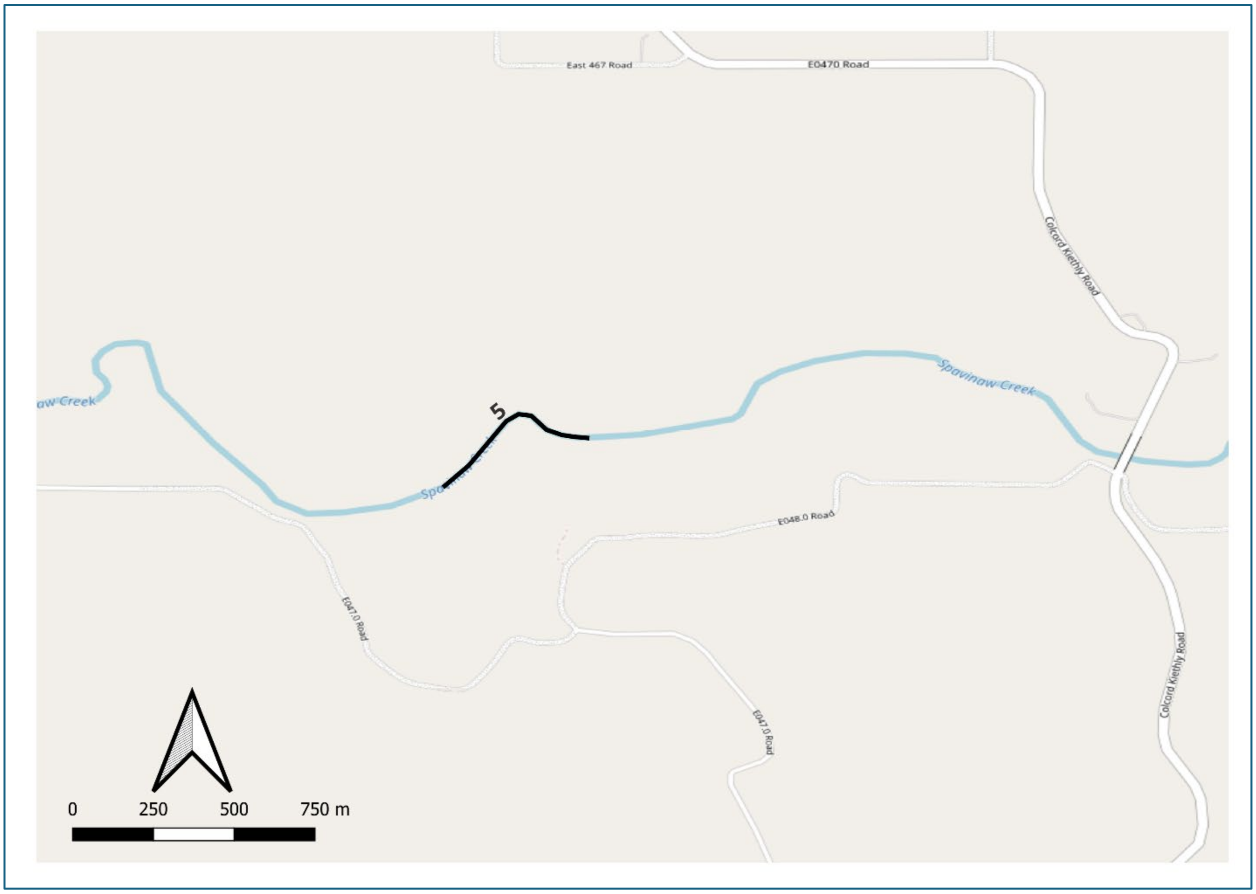

Figure 5. Site 5 on Spavinaw Creek near Beartoter Hollow.

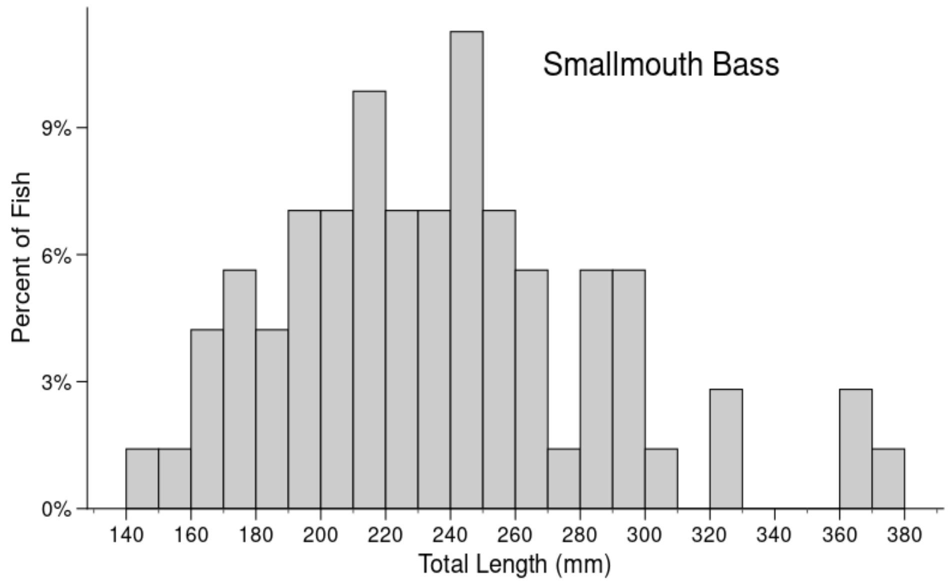

Figure 6. Length and age frequency histograms for Neosho Bass/Smallmouth collected in Spavinaw Creek.

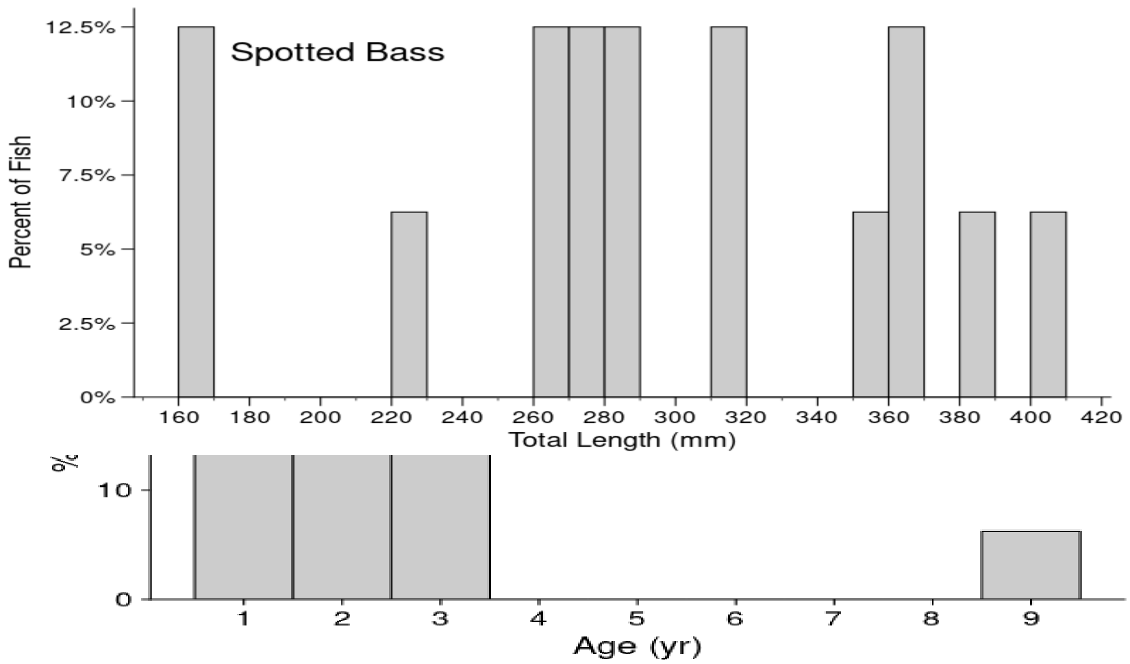

Figure 7. Length and age frequency histograms for Spotted Bass collected in Spavinaw Creek.

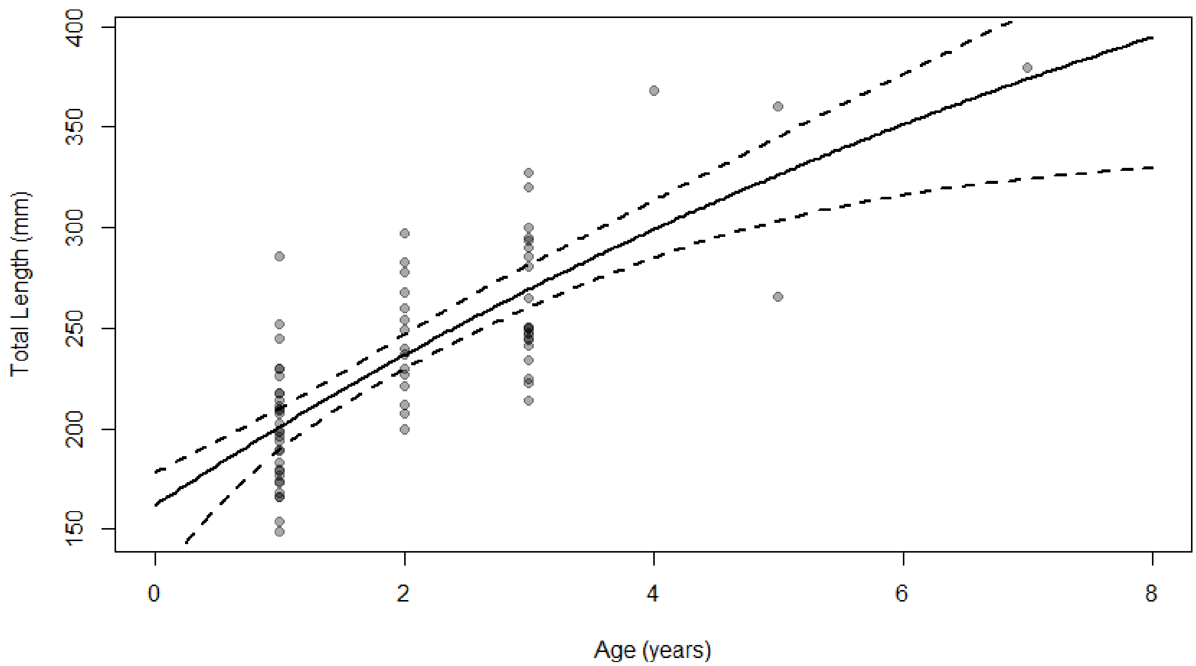

Figure 8. von Bertalanffy growth curve for Neosho/Smallmouth Bass in Spavinaw Creek.

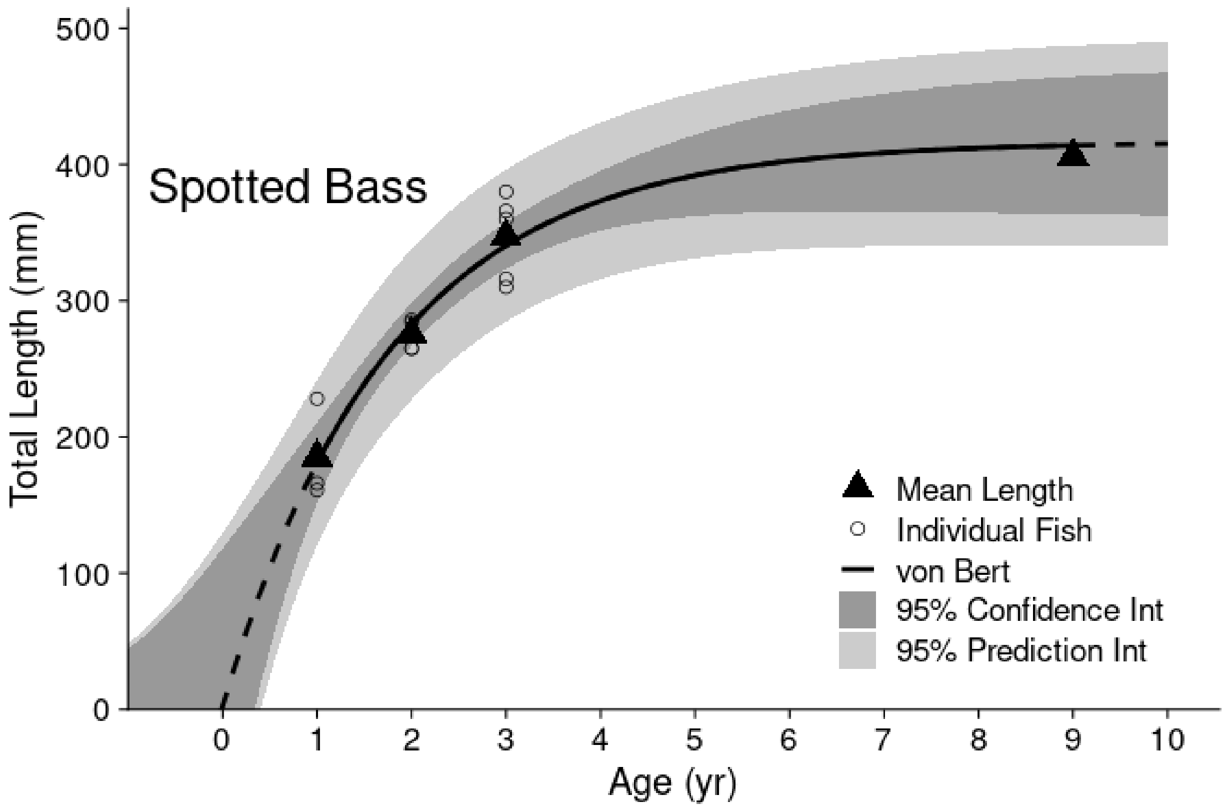

Figure 9. von Bertalanffy growth curve for Spotted Bass in Spavinaw Creek.

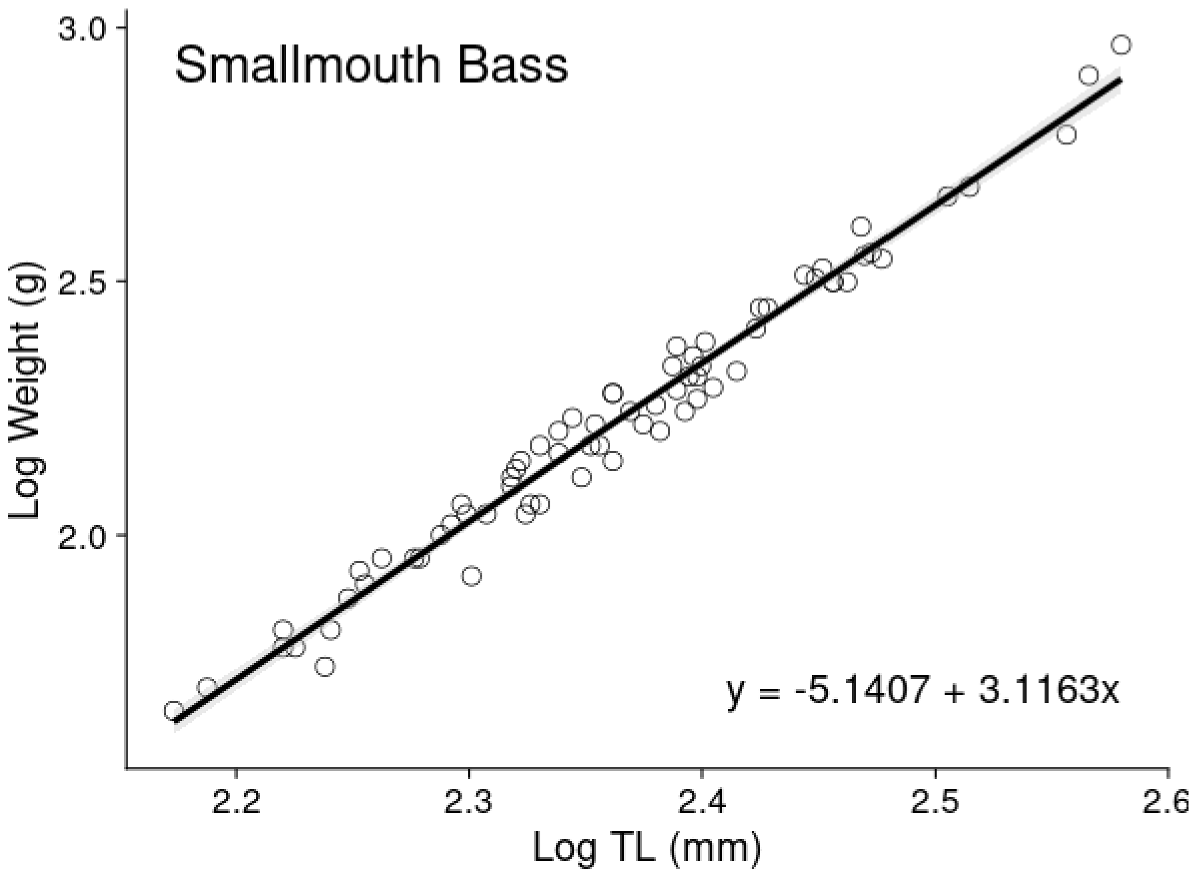

Figure 10. Log transformed Length-Weight Regression for Neosho/Smallmouth Bass in Spavinaw Creek.

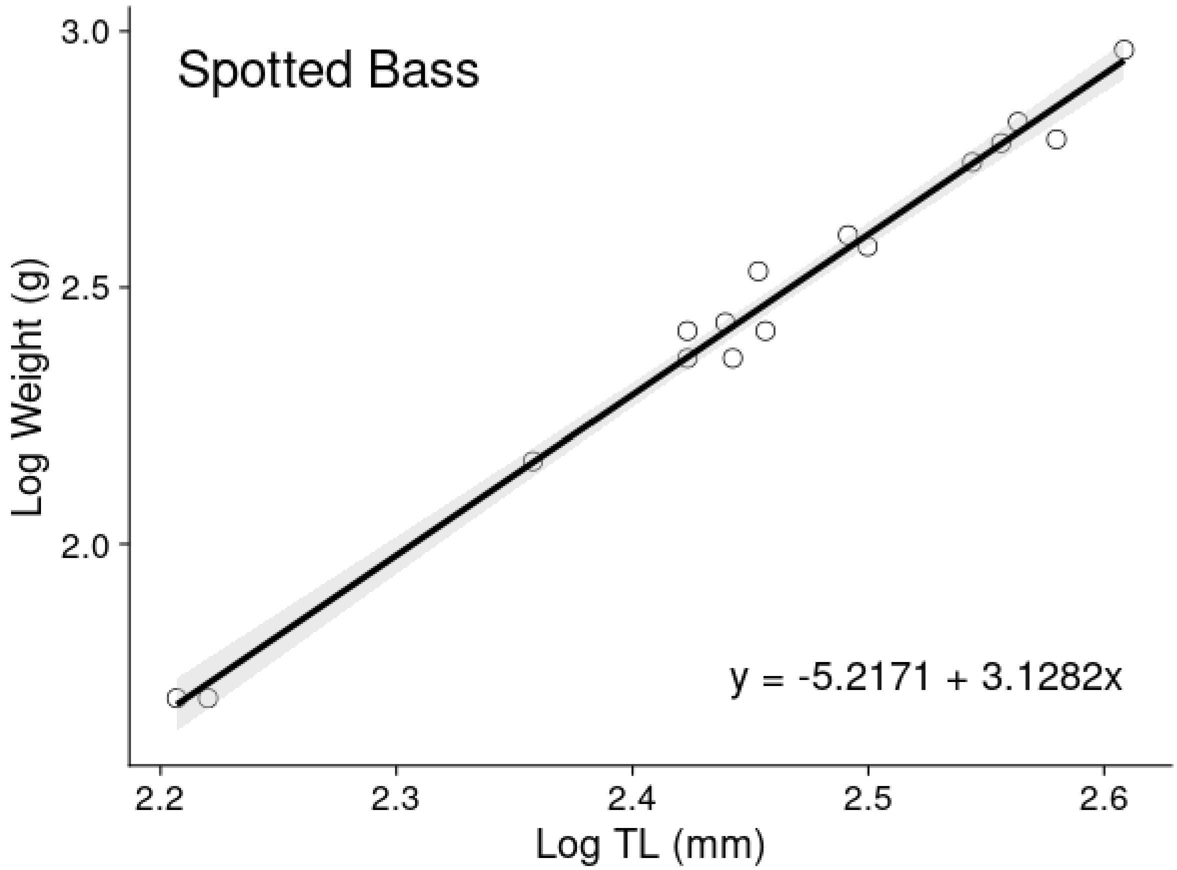

Figure 11. Log transformed Length-Weight Regression for Spotted Bass in Spavinaw Creek.

Age	Mean TL	L 95% CI	U 95% CI
1	199.8387	189.2361	210.4413
2	244.2667	229.5888	258.9445
3	263.3333	249.5732	277.0935
4	368	NA	NA
5	313	220.88	405.12
7	380	NA	NA

Table 1. Neosho/Smallmouth Bass predicted mean length (mm) at age with 95% confidence intervals for Spavinaw Creek.

Age	Mean TL	L 95% CI	U 95% CI
1	185	142.7651	227.2349
2	275.3333	268.1289	282.5378
3	347	324.487	369.513
9	406	NA	NA

Table 2. Spotted Bass predicted mean length (mm) at age with 95% confidence intervals for Spavinaw Creek.

	PSD-S	PSD-Q	PSD-P	PSD-M	PSD-T
Length (mm)	180	280	350	430	510

Table 3. Spotted Bass and Smallmouth Bass Proportional Size Distribution including categories Stock, Quality, Preferred, Memorable, and Trophy.