Fisheries bulletin

KENTUCKY DEPARTMENT *of* FISH *and* WILDLIFE RESOURCES

Assessment of Statewide Size and Creel Limits on Smallmouth Bass in Old Pool 6 of the Green River

By

Jason R. Herrala and David Baker

Bulletin No. 123

September 2019

ASSESSMENT OF STATEWIDE SIZE AND CREEL LIMITS ON SMALLMOUTH BASS IN OLD POOL 6 OF THE GREEN RIVER

By

Jason R. Herrala and David Baker

2019

Partially funded by the Sport Fish Restoration Program

ABSTRACT

Green River is a biologically diverse river that has many excellent sport fish populations including smallmouth bass. Old Pool 6, specifically, presents outdoor enthusiasts, boaters, and anglers with a large amount of public access. Green River has received a tremendous amount of publicity and so the recreational use of the system has steadily increased over the past 15 years. With this increase in pressure and publicity, additional monitoring and data collection was needed to ensure that the current statewide limits (12.0 in minimum size and 6 fish creel) are sufficient to prevent overexploitation of the smallmouth bass fishery. Based on otoliths collected in 2014, total annual mortality of smallmouth bass in Pool 6 of Green River was estimated to be 34.6%. An exploitation study was conducted from April 26, 2016 through April 25, 2017 to evaluate the contribution of fishing mortality on the smallmouth bass population. A total of 213 smallmouth bass ≥12.0 in were collected and tagged with Carlin dangler tags. Forty-seven tags were reported (20.6%) of which 34 smallmouth bass were released and 13 smallmouth bass were harvested. Corrections were made for tag loss and non-response to arrive at a corrected exploitation rate of 6.8% (natural mortality=27.8%). Predictive yield models indicated that at current levels of exploitation and natural mortality, regulation changes would have very little impact on the fishery. With KDFWR sampling showing consistent catch rates and excellent size distribution along with low exploitation, it is apparent that the current regulations on this waterbody are sufficient to sustain the smallmouth bass fishery.

INTRODUCTION

Warm water stream fisheries are a valued resource in the southeastern United States (Fisher et al. 1998). These streams provide excellent sport fishing opportunities for many species including smallmouth bass (*Micropterus dolomieu)*. Smallmouth bass are native to the interior eastern North America west of the Appalachians but have been widely introduced elsewhere (Etnier and Starnes 1993). In Kentucky, smallmouth bass are generally distributed in upland streams throughout the eastern two-thirds of the state along with having viable populations in several reservoirs across the state (Thomas 2011). *Micropterus spp*. are popular sport fish among anglers across the country, as millions of dollars are spent annually on equipment, boats and travel by anglers in pursuit of bass (Etnier and Starnes 1993). As a result of high angler interest, management agencies are beginning to implement stream specific strategies to improve and enhance stream smallmouth bass fisheries (Buynak and Mitchell 2002; Kruse and DeiSanti 2002). These strategies must be evaluated because management regulations are often not effective across large spatial scales (Martin and Fisher 2008).

The statewide regulation for smallmouth bass in Kentucky is a 12.0 in minimum size limit with a 6 fish daily creel limit. A limited amount of stream specific management strategies have been implemented on stream bass fisheries in Kentucky, but in only one instance has it been formally evaluated. The mainstem of Elkhorn Creek, located in Franklin County, Kentucky, was the first stream in the state where regulations were implemented deviating from the statewide size and creel limits on largemouth and smallmouth bass. A 12.0-16.0 in protective slot limit and a 6 fish daily creel limit not to include more than 2 fish above the protected slot limit was implemented in 1993 (Buynak and Mitchell 2002). The slot limit was chosen as the management option in Elkhorn Creek to encourage harvest of the high densities of <12.0 in smallmouth bass that had resulted in slow growth rates and low densities of quality sized smallmouth bass (≥12.0 in) in this stream. The regulation was effective when strong year-classes recruited to the protective slot. In 2013, a 12.0-16.0 in protective slot limit for largemouth and smallmouth bass was implemented in Otter Creek (Meade County, Kentucky) where only 1 fish of the daily creel limit (6) can be above the protective slot limit. In 2014, a high minimum length limit (15.0 in) and reduced daily creel limit (1 fish ≥15.0 in) was enacted on a 20.0 mile section of Floyds Fork (Jefferson County, Kentucky) due to expected increases in fishing pressure that could possibly result in the overharvest of the low density smallmouth and largemouth bass population. Neither regulation was formally evaluated.

Old Pool 6 of the Green River (125.0 miles in length) is part of the State of Kentucky Blue Water Trails Adventure Tourism Initiative and stretches from immediately below Green River Lake downstream to the former location of Lock and Dam 6 (removed in 2017) in Mammoth Cave National Park near Brownsville, KY (Figure 1). This reach provides appropriate habitat to support a quality smallmouth bass population and fishery as Lock and Dam 6 only impounded the lower twelve miles. Public boat ramps and canoe carry-down sites are located throughout this pool. According to Mammoth Cave National Park Public Use Counting and Reporting Report, recreational canoeing, kayaking, and boating had increased 18.8% from 2003 to 2012 in Pool 6 of the Green River (National Park Service) which may also reflect an increase in fishing pressure. Smallmouth bass in the Old Pool 6 of the Green River are managed under statewide size (12.0 in minimum) and creel limits (6 fish daily limit). Due to permitting requirements by the National Park Service and logistics of the study, tagging and sampling only occurred

from Green River Lake Tailwater River Mile (RM) 307 downriver to the Interstate-65 Bridge near Munfordville, KY at RM 224 (approximately two thirds of the total length of the pool).

The objectives of this study were:

1) Determine relative abundance (CPUE), size structure, and condition of smallmouth bass in Old Pool 6 of the Green River.
2) Quantify age/growth and mortality of smallmouth bass in Old Pool 6 of the Green River.
3) Determine if statewide size and creel limits are the best management option for smallmouth bass in Old Pool 6 of the Green River or if the population needs additional protection.

METHODS

Annual sampling—Smallmouth bass were sampled during the months of May and June from 2012 – 2017 using boat-mounted, pulsed DC electrofishing. Spring sampling was conducted at four sites that provided excellent spatial coverage of the river within the study area (Figure 1). All smallmouth bass collected were measured to the nearest 0.1 in and weighed to nearest 0.01 lb. Sampling was also conducted each fall to provide estimates of relative weight.

Age, growth, and mortality—Otoliths were removed from smallmouth bass in 2014 for determination of age and growth. Up to five fish per inch class (sizes 2.0 – 20.0 in) were sacrificed. All otoliths were aged under a dissecting microscope, and measurements taken to back calculate length at age estimates. Back-calculated lengths at ages were then used to fit a von Bertalanffy growth function (von Bertalanffy 1938). Age data from 2014 was paired with sampling data to form an age-length key which assigned ages to unaged fish. Age data for the entire sample was then input to Fisheries Analysis and Modeling Simulator software (FAMS; Slipke and Maciena 2014) to estimate total annual mortality using a weighted catch curve regression. A value of one was added to each age frequency to account for the absence of age-9 fish in the sample. Age-0 and age-1 fish were not fully recruited to electrofishing gear; therefore, they were not used to calculate total annual mortality. Natural mortality was calculated by subtracting annual fishing mortality from total annual mortality.

Exploitation— An exploitation study began on April 26, 2016 and concluded on April 25, 2017 to better evaluate the contribution fishing mortality has on this population. Prior to tagging, signs notifying anglers that the study was occurring and with instructions on reporting tags were posted at all public access sites from the Green River Lake tailwater downriver to Stovall Park in Munfordville, KY (Figure 2). Smallmouth bass ≥12.0 in were collected from the four standardized sampling sites and six supplementary tagging sites (Figure 1). Fish were held upright in a cradle while tagged with Carlan dangler tags attached under the anterior dorsal fin with stainless steel wire (Figure 3). Tags were labeled with reward amount, a sequential number and a random identifier number on one side. A telephone number to call and report the tag number was provided on the reverse side (Figure 4). These tagging methods are similar to those used by Missouri Department of Conservation in a recent smallmouth bass study (John Ackerson, personal communication). To account for non-response bias, a variable reward program similar to Pollock et al. (2001) was used. For our study, 25% of tags had a

reward of $75 (assumed 100% angler response rate on fish caught) and the remaining 75% of tags had a reward of $25. Upon reporting a tag, anglers were asked for the tag number, when the fish was caught, location of catch, if the fish was kept or released, and the estimated length of the fish. Return rate was calculated using the following equation (Pollock et al. 2001):

$$\text{Return rate} = \frac{\text{Number of \$25 tags returned}}{\text{Total number of \$25 tags}} \div \frac{\text{Number of \$75 tags returned}}{\text{Total number of \$75 tags}} \quad (1)$$

Nonreporting was calculated as:

$$\text{Nonreporting} = 1 - \text{return rate} \quad (2)$$

An additional adjustment required for a corrected exploitation value is estimated tag loss. Missouri Department of Conservation staff simulated annual tag loss of Carlan dangler tags on smallmouth bass in a natural environment by adding woody debris to a hatchery raceway. A second, unaltered raceway served as a control. Tag loss was higher in the control as a result of fish constantly swimming and rubbing the raceway walls. In woody raceways, smallmouth bass tended to take cover behind debris. They determined that tag loss after one year was 11.0% and that tagging mortality was 0% (John Ackerson personal communication). In lieu of performing additional tag loss studies, 11.0% was used as the tag loss estimate and 0% was used for the tagging mortality estimate for this study. Corrected exploitation was calculated as:

$$\text{Corrected exploitation} = \frac{\text{Total fish harvested}/(1 - \text{nonreporting estimate})}{(\text{Total fish tagged})(1 - \text{tag loss estimate})(1 - \text{tagging mortality estimate})} \quad (3)$$

Efficacy of regulations—Conditional fishing mortality and conditional natural mortality were computed from annual estimates of mortality, fishing mortality, and natural mortality. Yield-per recruit (YPR) models were fit using FAMS to model the current 12.0 inch minimum size limit versus the potential effects of a 15.0 inch minimum size limit and a 12.0 – 16.0 inch protective slot limit. The smallmouth bass populations were modeled with a theoretical cohort of 100 individuals and varying levels of exploitation at three levels of conditional natural mortality: the approximate value calculated in the current study and two additional values surrounding this estimate. Yield (kg), number of fish ≥12.0 in, number of fish ≥15.0 in, and number of fish ≥20.0 in were examined for each regulation.

RESULTS

Annual spring sampling—Smallmouth bass were sampled from 2.0 – 22.0 in classes during the study (Figure 5). Catch rates of smallmouth bass in spring electrofishing samples ranged from 25.0 fish/hr in 2014 to 39.8 fish/hr in 2012, and had a mean CPUE of 34.0 fish/hr (Table 1). With the exception of 2014, all spring samples resulted in overall catch rates greater than 30.0 fish/hr and indicate a generally stable population. Trophy smallmouth bass (≥20.0 in) were present in all samples ranging from 0.2 fish/hr in 2012 to 0.6 fish/hr in 2014.

Annual fall sampling—Relative weight (Wr) was calculated to index the condition of smallmouth bass. Mean Wr of smallmouth bass was variable during the study ranging from 77 in 2015 to 84 in 2014 with a mean of 81 (Table 2). In general, Wr decreased with increasing size.

Age, growth, and annual mortality—A total of 59 smallmouth bass were sacrificed in 2014. Fish ranged in size from 2.3 – 20.1 in and ages 1 – 11 (Table 3). Fish in the 2005 year class (age-9) were absent in the sample, and age-2 and 3 fish comprised 63.9% of the 2014 spring sample (Table 4). A von Bertalanffy growth function of back-calculated mean length at age indicated growth that is typical of other Kentucky streams (Table 5; Figure 6). Smallmouth bass reached the statewide 12.0 in minimum size limit at 3.6 years, 14 inches at 4.8 years, and 15 inches at 5.5 years. On average, trophy status was achieved at 10.9 years (near max age of 11 years). Using a weighted catch curve in FAMS, total annual mortality rate was estimated at 34.6% (Table 5; Figure 7).

Exploitation—A total of 213 smallmouth bass ≥12.0 in were tagged at eight locations (Table 6) throughout the study area of which 160 fish received $25 reward tags and 53 fish received $75 reward tags. Tagged fish were caught by anglers at all but two of the tagging locations, and only four fish reported were caught outside of tagging locations. In total, forty-seven tags were reported by anglers (22.1%) of which 34 smallmouth bass were released and 13 smallmouth bass were harvested (Table 6). Tags were reported from April – August during 2016 with the majority of fish being caught in June and no fish being caught and reported from September 2016 – April 2017 (Table 7). Of the 47 tagged fish reported by anglers, 36 fish had $25 reward tags and 11 fish had $75 reward tags. Utilizing equations (1) and (2), the reporting rate was estimated at 100%. From equations (3), corrected annual exploitation rate (annual fishing mortality) was 6.8%. The computed annual natural mortality rate of 27.8% (conditional natural mortality (cm) = 0.29).

Management implications—YPR models predicted that at the current level of natural mortality (used cm=0.30) a 12.0 in minimum size limit would provide the highest yield of the regulations examined (Figure 8). At low levels of natural mortality a 15.0 minimum size limit would increase yield when exploitation exceeded 27.1% (Figure 8). The 12.0 – 16.0 in slot limit failed to maximize yield regardless of natural mortality or exploitation levels.

At the current level of 6.8% exploitation and 27.8% annual natural mortality, YPR models predicted minimal to no differences in the number of 12.0 in fish, number of 15.0 in fish, and number of 20.0 in fish present in the fishery among regulations (Figure 9). A 15.0 minimum size limit would allow the most individuals to reach 12.0 in and 15.0 in, but with only a 1.0% increase over the current 12.0 in minimum size limit. The number of trophy, 20.0 in smallmouth bass present in the population was the same regardless of regulation.

DISCUSSION

CPUE of smallmouth bass in Old Pool 6 of Green River was above average when compared to other streams and rivers in Kentucky (Baker 2013; Baker 2014; Baker 2015; Baker 2016; Massure 2017;

Massure 2018). Catch rates of trophy smallmouth bass (≥20.0 in) were also above average in Old Pool 6 of Green River. CPUE of different size classes varied among years, but trends did not indicate the presence of a particularly weak or above average year class.

Smallmouth bass were aged up to 11 years which is in the upper range of maximum age for many smallmouth bass populations in the United States (Beamesderfer and North 1995). Smallmouth bass reached the statewide 12.0 in minimum size limit by age-4. This is consistent with many streams in Kentucky (Baker 2013; Baker 2014; Baker 2015) and slightly quicker growth than reported in other streams in the United States (Orth et al. 1983; Paragamian 1984; Beamesderfer and North 1995).

Tags were only reported for the first five months of the study (April – August). This is similar to a Missouri study in which the majority of tags were reported in the first three months after tagging (John Ackerson, personal communication). This could be an indication of a seasonal fishery. Tag returns on Old Pool 6 of Green River occurred during warmer months when water levels are typically low allowing for comfortable wading and easy paddling.

Total annual mortality was estimated at 34.6% (exploitation = 6.8%, natural mortality=27.8%). Angler attitudes toward harvest of black bass vary spatially (Champeau and Thomas 1993; Bonds et al. 2008; Isermann et al. 2012), often revolving around access and socio-economic factors (Wilson and Dicenzo 2002). Old Pool 6 of Green River has abundant access, and although it flows through rural areas, paddling tourism has increased considerably in recent years. Nonetheless, the annual exploitation estimate of 6.8% in the current study is much lower than exploitation observed in the Maquaketa River, IA (35%; Paragamian 1984), but similar to an exploitation estimate in the Columbia and Willamette rivers, OR (7.6%; Daily 1997). Angler attitude regarding black bass harvest has changed over time, and rates of voluntary catch and release have increased (Quinn 1996; Myers et al. 2008; Isermann et al. 2012). The natural mortality estimate of the smallmouth bass population in Green River was slightly below the national average provided by Beamesderfer and North (1995). Low natural mortality coupled with low exploitation results in increased longevity, and may be allowing more fish to reach trophy size in the absence of restrictive regulations.

Management implications—YPR models did not indicate that either of the length limits modeled would provide higher yield than the current 12.0 in minimum size limit, provided exploitation and natural mortality remain constant. A 15.0 minimum size limit predicted increased yield over the current regulation only when exploitation exceeded 27.1%; however, with catch-and-release fishing now the norm for black bass species, this scenario is unlikely in Old Pool 6 of Green River. Given the high rate of voluntary catch-and-release fishing by anglers, yield is likely not the best parameter to model and evaluate the effectiveness of regulations; rather, size structure of the smallmouth bass population is a better measure. Neither the 15.0 in minimum size limit or the 12.0 – 16.0 protective slot limit provided noticeably different numbers of fish that survived to 12.0 in, 15.0 in, or 20.0 in. Growth rate, although currently well within the range of smallmouth bass in Kentucky streams and rivers, would need to increase substantially to result in a larger number of fish reaching 20.0 in.
Because of low angler exploitation, the regulations modeled are unlikely to have any significant impact on the smallmouth bass population in Old Pool 6 of Green River, and no regulations changes for smallmouth bass are recommended.

Angler exploitation of black bass can vary spatially (Isermann et al. 2012; Bonvechio et al. 2014). While the exploitation rate from this study may be accurate for other streams and rivers in this region of Kentucky (i.e., Barren River, Drakes Creek) it may be considerably different throughout the state. Separate angler exploitation studies are recommended in other areas before recommending regulation changes. Additionally, the black bass restrictions placed on two central Kentucky streams, Floyds Fork (Jefferson County, Kentucky) and Otter Creek (Meade County, Kentucky), were done so without mortality or exploitation estimates. Future studies on smallmouth bass exploitation and regulation impacts would be well suited for these systems.

ACKNOWLEDGEMENTS

We would like to express our gratitude for the effort put into this project by our peers at KDFWR. We thank all of our coworkers for help with field work on this project: Wade Massure, Eric Cummins, Kayla Gerber, Dave Dreves, Joseph Zimmerman, Nick Keeton, Ryan Kausing, Brandon Sawyers, Chris Bowers, Jason McDowell, Bobby Widener, Mike McCormack, Phillip Matlock, and Derek Rogers. We also thank Dave Dreves for his reviews and input throughout this project. Funding for this project was provided through the Sport Fish Restoration Program.

REFERENCES

Baker, D.C. 2013. Warmwater stream sport fish surveys. Kentucky Department of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Baker, D.C. 2014. Warmwater stream sport fish surveys. Kentucky Department of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Baker, D.C. 2015. Warmwater stream sport fish surveys. Kentucky Department of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Baker, D.C. 2016. Warmwater stream sport fish surveys. Kentucky Department of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Beamesderfer, R.C.P., and J.A. North. 1995. Growth, natural mortality, and predicted response to fishing for largemouth bass and smallmouth bass populations in North America. North American Journal of Fisheries Management 15:688-704.

Bonvechio, T.F., B.R. Bowen, J.M. Wixson, and M.S. Allen. 2014. Exploitation and length limit evaluations of largemouth bass in three Georgia small impoundments. Journal of the Southeastern Association of Fish and Wildlife Agencies 1:33-41.

Bonds, C.C., J.B. Taylor, and J. Leitz. 2008. Practices and perceptions of Texas anglers regarding voluntary release of largemouth bass and slot length limits. Pages 219-230 in M.S. Allen, S. Sammons, M.J. Maceina, editors. Balancing fisheries management and water uses for impounded river systems. Amercian Fisheries Society, Symposium 62, Bethesda, Maryland.

Buynak, G.L. and B. Mitchell. 2002. Response of smallmouth bass to regulatory and environmental changes in Elkhorn Creek, KY. North American Journal of Fisheries Management 22:500-508.

Champeau, T.R. and P.W. Thomas. 1993. Voluntary release of largemouth bass by Florida anglers. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 45-317-322.

Daily, K. 1997. Exploitation, harvest, and population size of smallmouth bass in the Columbia and Willamette rivers in the vicinity of Portland, Oregon in 1996. Oregon Department of Fish and Wildlife. Information reports number 97-3, Portland, OR.

Etnier, D.A. and W.C. Starnes. 1993. The Fishes of Tennessee. The University of Tennessee Press/Knoxville, 2001.

Fisher, W.L., A.F. Surmont and C.D. Martin. 1998. Warmwater stream and river fisheries in the southeastern United States: are we managing them in proportion to their values? Fisheries 23(12):16-24.

Isermann, D.A., J.B. Maxwell, ad M.C. McInerny. 2012. Temporal and regional trends in black bass release rates in Minnesota. North American Journal of Fisheries Management 33:344-350.

Kruse, M. and K. Deisanti. 2002. Smallmouth bass in streams: strategies for high quality management. Sport Fish Restoration Project F-1-R-50, Study S-39, Job 3 and 4, Final Report. Missouri Department of Conservation. Jefferson City.

Martin, C.D. and W.L. Fisher. 2008. Recreational fishing for black bass in eastern Oklahoma streams. Procedings of the Annual Conference Southeastern Fish and Wildlife Agencies 62:168-176.

Massure, W.A. 2017. Warmwater stream sport fish surveys. Kentucky Deptartment of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Massure, W.A. 2018. Warmwater stream sport fish surveys. Kentucky Deptartment of Fish and Wildlife Resources. Stream fisheries investigations annual performance report. Frankfort, KY.

Myers, R., J. Taylor, M. Allen, and T.F. Bonvechio. 2008. Temporal trends in voluntary release of largemouth bass. North American Journal of Fisheries Management 28:428-433.

National Park Service. *National Park Service Visitor Use Statistics*. U.S. Department of the Interior. Web. 19 March 2018. https://irma.nps.gov/Stats/Reports/Park.

Orth, D.J., D.D. Oakley, and O.E. Maughan. 1983. Population characteristics of smallmouth bass in Glover Creek, Southeast Oklahoma. Proceeding of the Oklahoma Academy of Science 63:37-41.

Paragamian, V.L. 1984. Evaluation of a 12.0-inch minimum length limit on smallmouth bass in the Maqouketa River, Iowa. North American Journal of Fisheries Management 4:507-513.

Pollock, K. H., J. M. Hoenig, W. S. Hearn, and B. Calingaert. 2001. Tag reporting rate estimation: an evaluation of the high-reward tagging method. North American Journal of Fisheries Management 21:521-532.

Quinn, S. 1996. Trends in regulatory and voluntary catch-and-release fishing. Pages 152 – 162 *in* L.E. Miranda and D.R. Devries editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Socieity, Symposium 16, Bethesda, Maryland.

Slipke, J.W., and M.J. Maceina. 2014. Fisheries analysis and modeling simulator (FAMS), version 1.64.4. American Fisheries Society, Bethesda, Maryland.

Thomas, M.R. 2011. Kentucky Fishes. Kentucky Department of Fish and Wildlife Resources. Frankfort, KY.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Human Biology 10:181-213.

Wilson, D.M. and V.J. Dicenzo. 2002. Profile of a trophy largemouth bass fishery in Briery Creek Lake, Virginia. Pages 583-592 *in* D.P. Phillip and M.S. Ridgeway, editors. Black Bass Ecology, Conservation and Management. American Fisheries Society, Bethesda, Maryland.

Table 1. Smallmouth bass electrofishing catch per unit effort (fish/hr) from each length group collected during spring sampling from Old Pool 6 of the Green River from 2012 - 2017; standard errors are in parentheses.

	Length group (in)						
Year	<4.0	4.0-8.9	9.0-11.9	12.0-13.9	≥14.0	≥20.0	Total
2012	5.0 (1.0)	17.3 (2.7)	7.5 (1.7)	3.8 (0.9)	6.2 (1.2)	0.2 (0.2)	39.8 (5.0)
2014	0.6 (0.4)	11.7 (1.5)	4.4 (0.9)	2.6 (0.8)	5.6 (1.4)	0.6 (0.2)	25.0 (2.5)
2015	2.1 (0.6)	12.3 (2.0)	10.4 (2.0)	2.8 (0.6)	4.2 (1.1)	0.3 (0.1)	31.8 (4.4)
2016	1.0 (0.7)	7.8 (1.5)	12.2 (2.0)	8.7 (1.6)	8.3 (1.7)	0.3 (0.2)	38.0 (5.2)
2017	0.5 (0.3)	9.0 (1.8)	8.5 (1.9)	8.7 (1.5)	8.5 (1.6)	0.3 (0.2)	35.2 (3.9)
Mean	1.8 (0.8)	11.6 (1.6)	8.6 (1.3)	5.3 (1.4)	6.6 (1.1)	0.4 (0.2)	34.0 (2.7)

Table 2. Number of fish and the relative weight (Wr) for each length group of smallmouth bass collected in Old Pool 6 of the Green River during fall 2013 - 2017.

	Length group (in)							
Year	7.0-10.9		11.0-13.9		≥14.0		Total	
	No.	Wr	No.	Wr	No.	Wr	No.	Wr
2013	24	85	5	75	6	81	35	83
2014	44	87	23	79	11	81	78	84
2015	23	79	17	76	9	72	49	77
2016	19	86	27	76	21	77	67	79
2017	29	87	19	83	25	77	73	82
Mean		85		78		78		81

Table 3. Mean back-calculated length (in) at each annulus for smallmouth bass collected from Old Pool 6 of Green River in spring 2014, including the length range of fish at each age and the 95% confidence interval for each age group.

		Age										
Year class	No.	1	2	3	4	5	6	7	8	9	10	11
2013	5	3.1										
2012	14	5.9	6.3									
2011	16	7.2	8.6	9.4								
2010	11	7.2	9.2	11.0	12.0							
2009	3	7.8	10.3	12.1	13.8	14.9						
2008	4	8.4	10.4	11.8	13.1	14.1	15.3					
2007	3	8.1	10.2	11.6	13.2	14.1	14.9	15.8				
2006	1	8.1	10.1	12.3	13.1	13.7	14.1	15.3	16.5			
2005												
2004	1	8.2	10.5	12.5	15.1	16.4	17.8	19.4	19.9	20.3	20.8	
2003	1	7.9	10.0	11.1	12.5	13.8	15.5	16.8	17.8	18.4	19.1	19.7
Mean		6.7	8.6	10.6	12.7	14.4	15.3	16.5	18.1	19.4	19.9	19.7
No.	59	59	54	40	24	13	10	6	3	2	2	1
Smallest		2.3	5.2	6.0	9.6	12.9	13.6	15.3	16.5	18.4	19.1	19.7
Largest		9.8	11.8	13.2	15.2	16.4	17.8	19.4	19.9	20.3	20.8	19.7
Std. error		0.2	0.2	0.3	0.3	0.3	0.4	0.6	1.0	1.0	0.9	0.0
95%CI (±)		0.4	0.5	0.5	0.5	0.6	0.8	1.3	2.0	1.9	1.7	0.0

Table 4. Age frequency and CPUE (fish/hr) by age results for smallmouth bass collected from the Old Pool 6 of Green River in sping 2014. Standard errros are in parentheses.

	Inch class																					
Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	%	CPUE
1	3	1	1																	5	3.4%	0.8 (0.5)
2				26	15	9	4													54	36.7%	8.3 (1.3)
3					4	3	11	7	12	3										40	27.2%	6.1 (1.0)
4								1		5	10	4								20	13.6%	3.1(0.7)
5													5		1					6	4.1%	1.0 (0.4)
6												2		3		7				12	8.2%	1.9 (0.5)
7														3	1					4	2.7%	0.7 (0.2)
8															1					1	0.7%	0.2 (0.1)
9																				0	0.0%	0.0
10																			3	3	2.0%	0.5 (0.3)
11																		2		2	1.4%	0.3 (0.2)
Total	3	1	1	26	19	12	15	8	12	8	10	6	5	6	3	7	0	2	3	147	100.0%	25.0 (2.5)

Table 5. von Bertalanffy growth parameters used to model impacts of regulations on smallmouth bass in Old Pool 6 of the Green River where L_∞=theoretical maximum length, K=body growth coefficient, and t_0=time coefficient and population parameters obtained during a study of smallmouth bass in Old Pool 6 of Green River. Z=instantaneous rate of total mortality, A=total annual mortality, F=instantaneous rate of fishing mortality, u=annual exploitation, M=instantaneous rate of natural mortality, and v=annual natural mortality.

von Bertalanffy	
Parameter	Value
L_∞	610 mm (24.0 in)
K	0.151
t_0	-1.016
Max age	11 years

Population parameters	
Parameter	Value
Z	-0.424
A	0.346
F	0.083
u	0.068
M	0.341
v	0.278

Table 6. Number of smallmouth bass ≥12.0 in tagged by location and summary of tag returns for an exploitation study conducted in Old Pool 6 of Green River from April 26, 2016 - April 25, 2017.

Site	No. tagged	No. caught	No. released	No. harvested
Green River Lake tailwater	10	0	0	0
Above Roachville Ford*	78	19	16	3
Below Roachville Ford	0	3	3	0
Above Greensburg*	31	3	2	1
Below Greensburg	21	3	2	1
Above Glenview*	16	2	2	0
Below Glenview	8	2	1	1
Above Rio	37	14	7	7
Above Munfordville*	12	0	0	0
Below Munfordville	0	1	1	0
Total	213	47	34	13

*Standard spring sampling site

Table 7. Number of tagged smallmouth bass caught and reported by anglers by site and month from Old Pool 6 of Green River from April 26, 2016 - April 25, 2017.

	Month													
Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
Green River Lake tailwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Above Roachville Ford	2	0	12	2	3	0	0	0	0	0	0	0	0	19
Below Roachville Ford	0	0	2	0	1	0	0	0	0	0	0	0	0	3
Above Greensburg	1	0	3	0	0	0	0	0	0	0	0	0	0	3
Below Greensburg	0	0	2	0	0	0	0	0	0	0	0	0	0	3
Above Glenview	0	1	0	1	0	0	0	0	0	0	0	0	0	2
Below Glenview	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Above Rio	0	6	5	3	0	0	0	0	0	0	0	0	0	14
Above Munfordville	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Below Munfordville	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Total	3	7	26	7	4	0	0	0	0	0	0	0	0	47

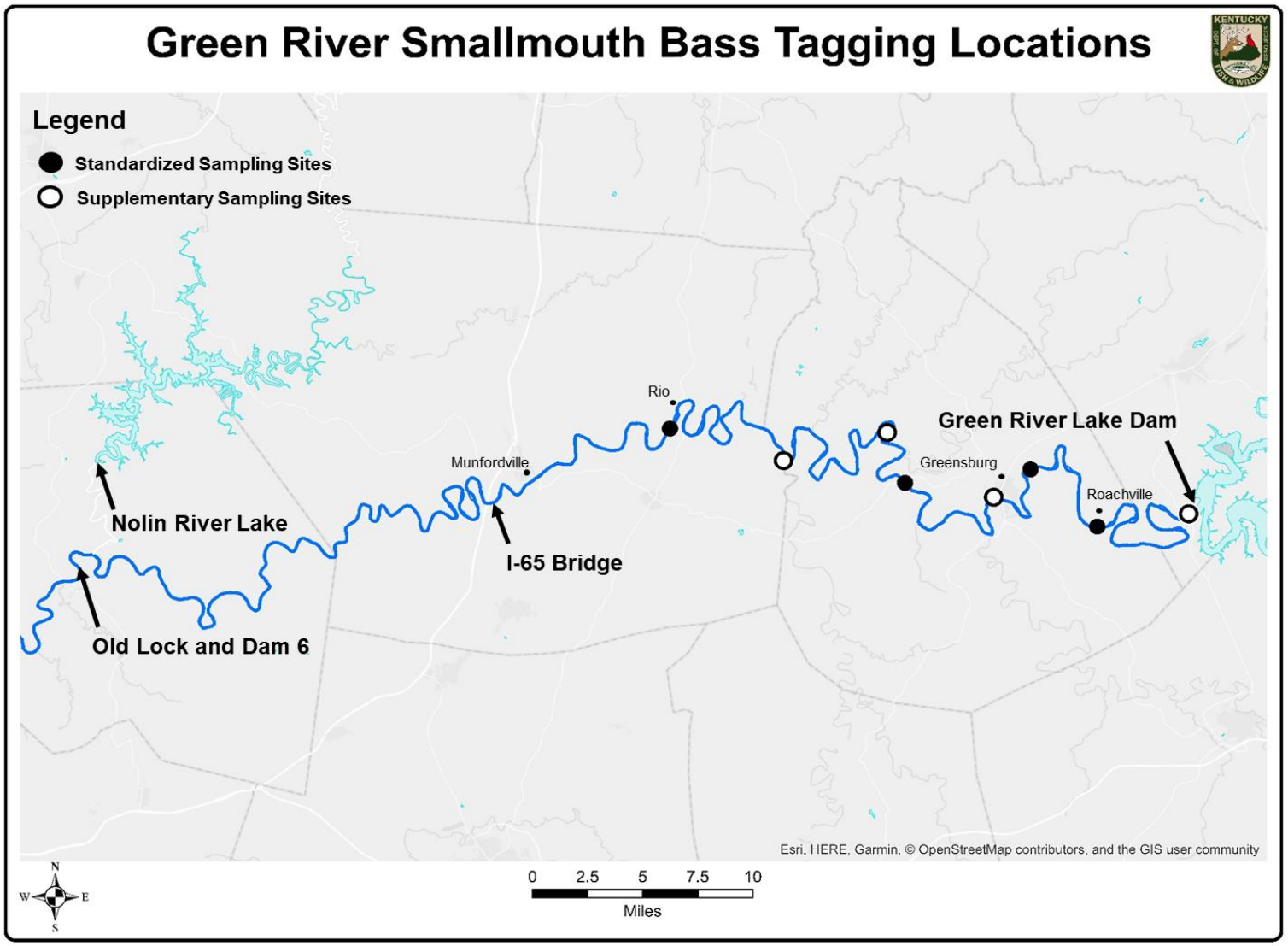
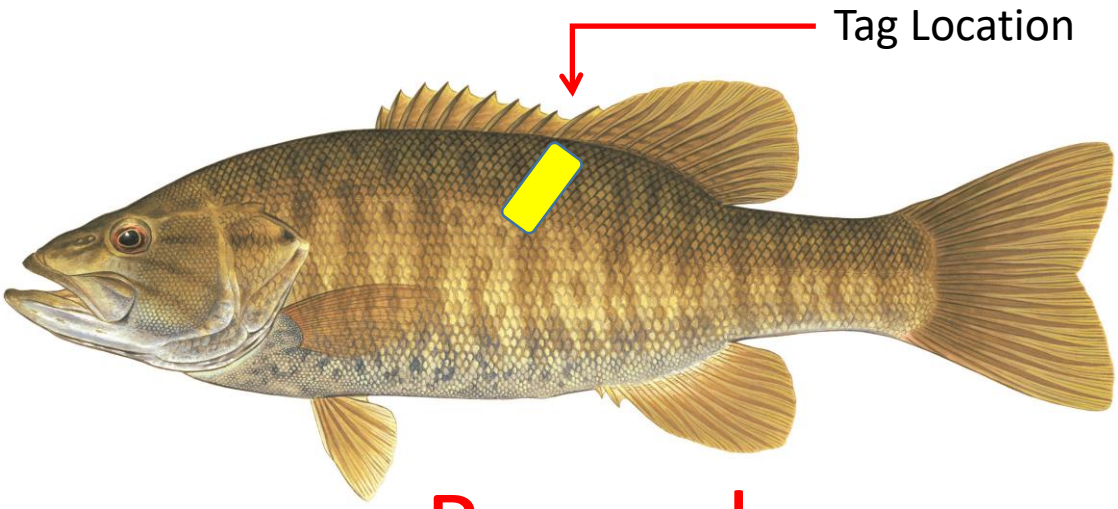


Figure 1. Map depicting the project study site which extends from Green River Lake Dam to the Interstate-65 Bridge on Old Pool 6 of Green River. Smallmouth bass were tagged at four standardized sampling sites (solid circles) and four supplementary tagging sites (open cirlcles).

Green River



Reward

FOR ALL REPORTED TAGS

Please remove tag from all tagged fish

Fish can be **released** or **harvested**

Tag Rewards are **$25** or **$75** for each tag reported prior to spring 2017

KENTUCKY DEPT. OF FISH & WILDLIFE RESOURCES

For more information or to report a tag call (800) 858-1549 x4451

SPORT FISH RESTORATION

Figure 2. Informational sign posted at access sites along Old Pool 6 of Green River to alert anglers about the tagged smallmouth bass exploitation study and instruction on how to report tags.

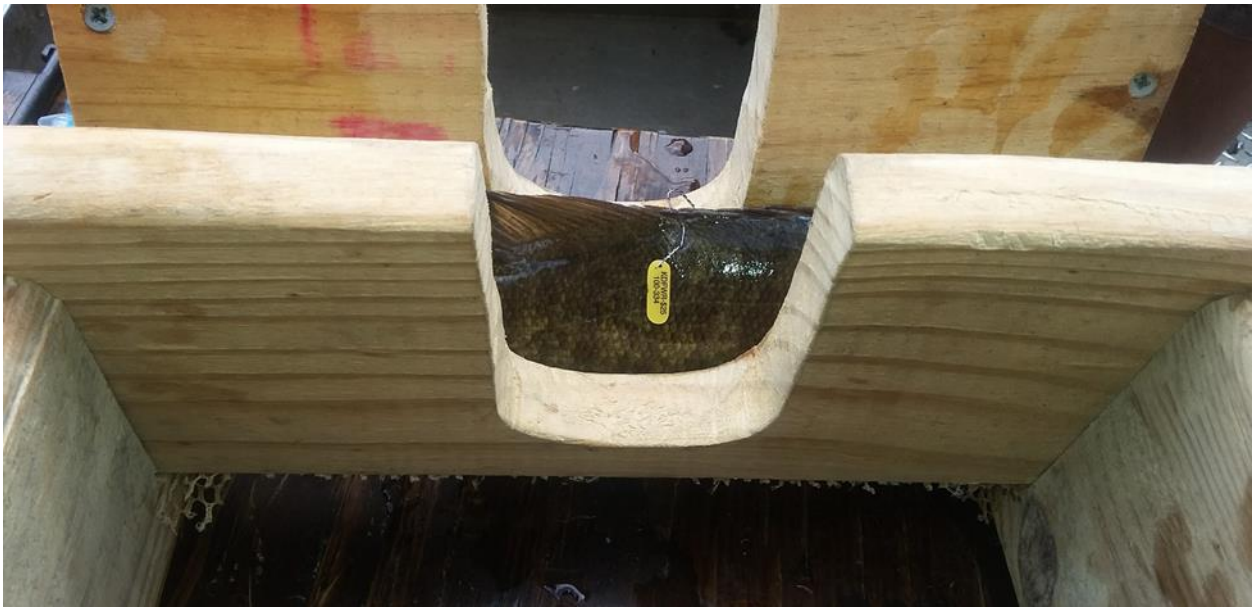


Figure 3. Smallmouth bass from Old Pool 6 of Green River with a Carlan dangler tag attached in the dorsal region of the fish. The fish were held in a cradle for tagging where they could be held securely in an upright position and allowed easy access to the dorsal region.

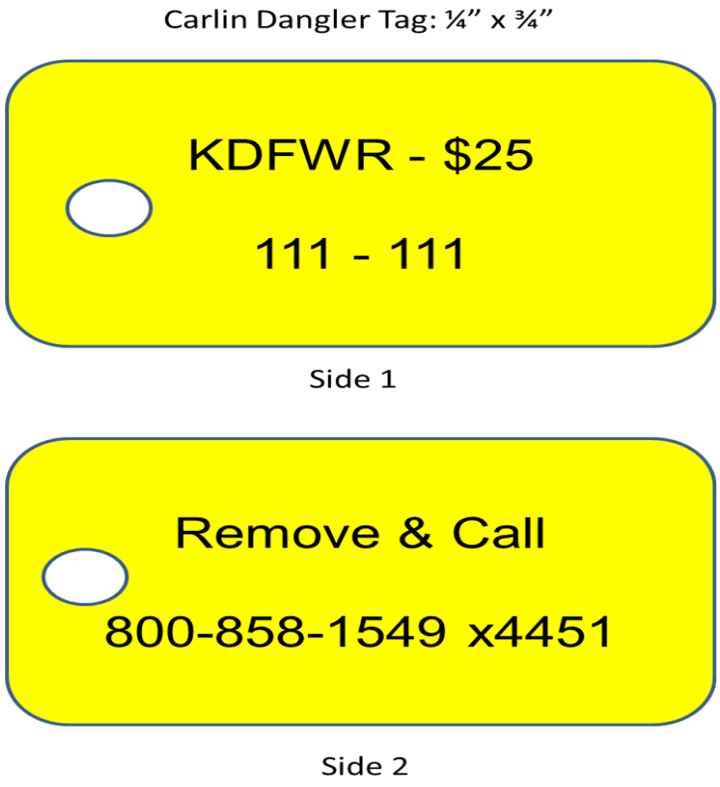


Figure 4. Carlan dangler tag design for smallmouth bass exploitation study on Old Pool 6 of Green River. The first digits of the number on side 1 were sequential tag numbers, and the second three digits were a random identifier.

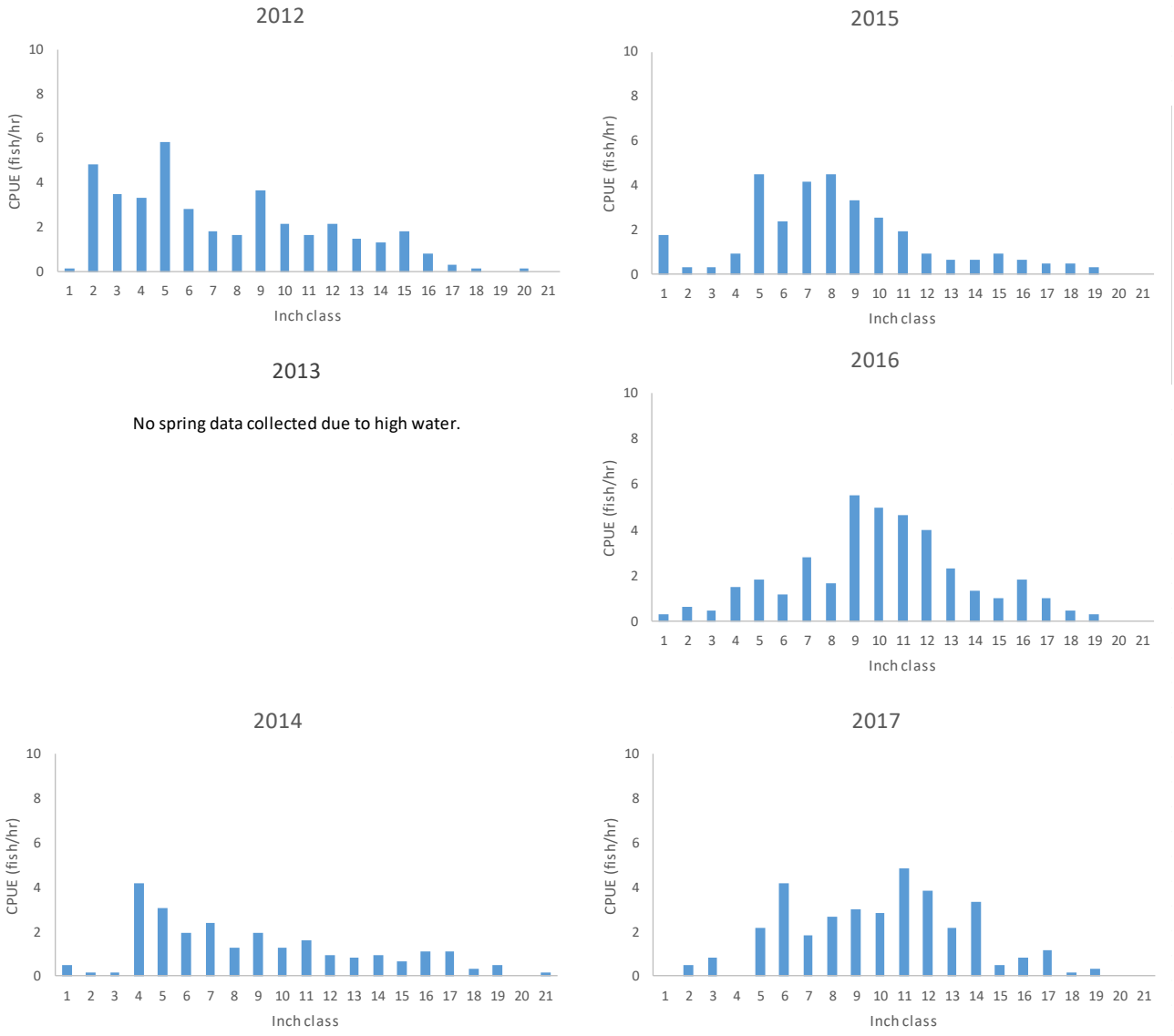


Figure 5. Smallmouth bass catch per unit effort (CPUE) by inch class from annual spring electrofishing sampling in Old Pool 6 of Green River from 2012 – 2017.

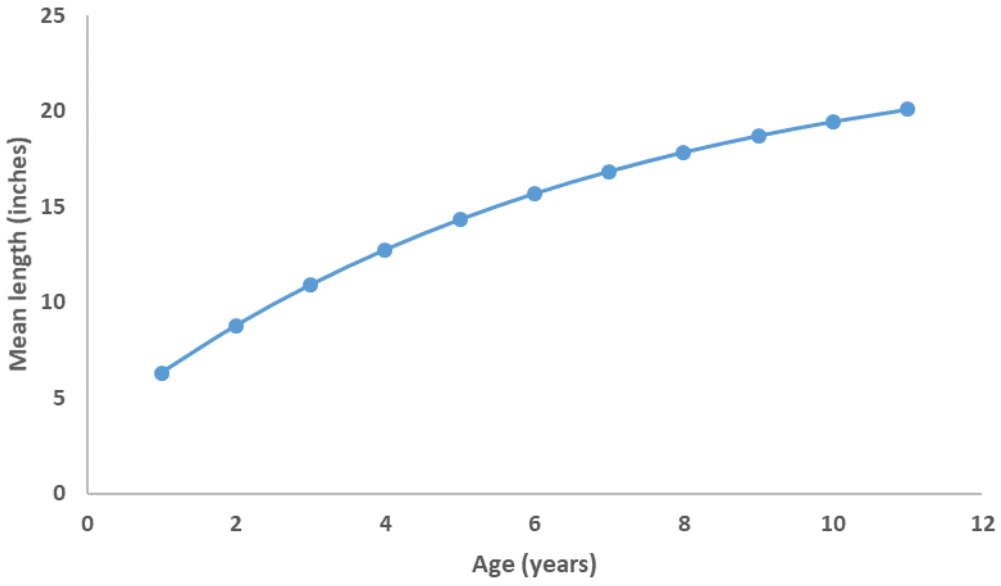


Figure 6. von Bertalanffy growth curve for smallmouth bass collected from Old Pool 6 of Green River in spring 2014.

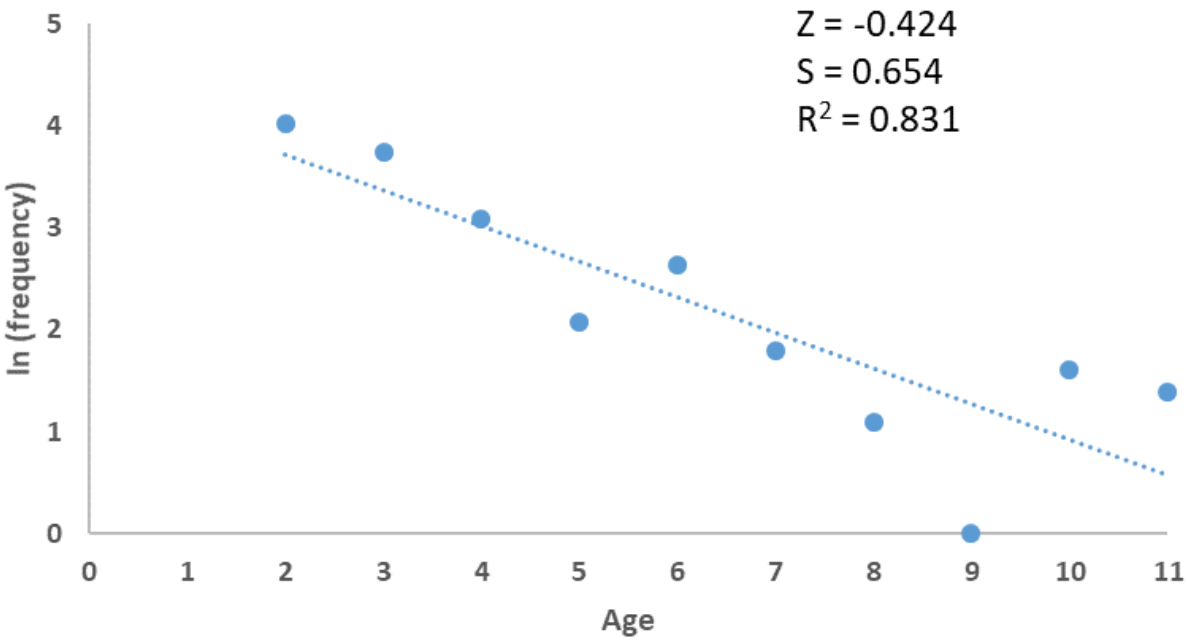


Figure 7. Weighted catch curve of the natural log (ln) frequency of fish at each age for smallmouth bass collected in Old Pool 6 of Green River in 2014. Age-0 and age-1 fish were not included in the catch curve, as they were not fully recruited to the gear.

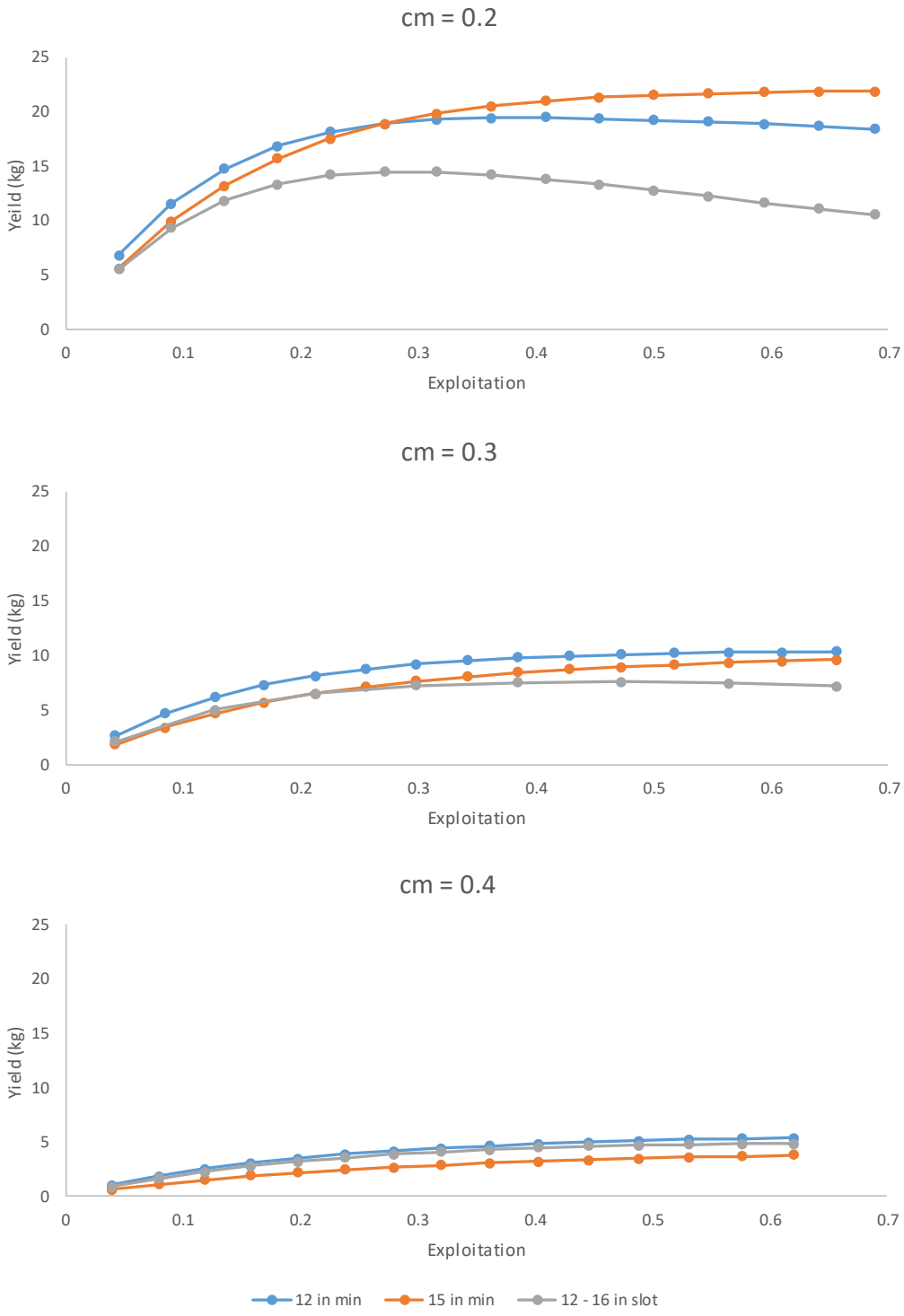


Figure 8. Yield-per-recruit models predicting yield of smallmouth bass in Old Pool 6 of Green River at increasing exploitation for three different regulations and at three levels of conditional natural mortality: low (cm=0.20), moderate (cm=0.30), and high (cm=0.40). The "moderate" level of natural mortality was set roughly equal to the natural mortality computed in the current study.

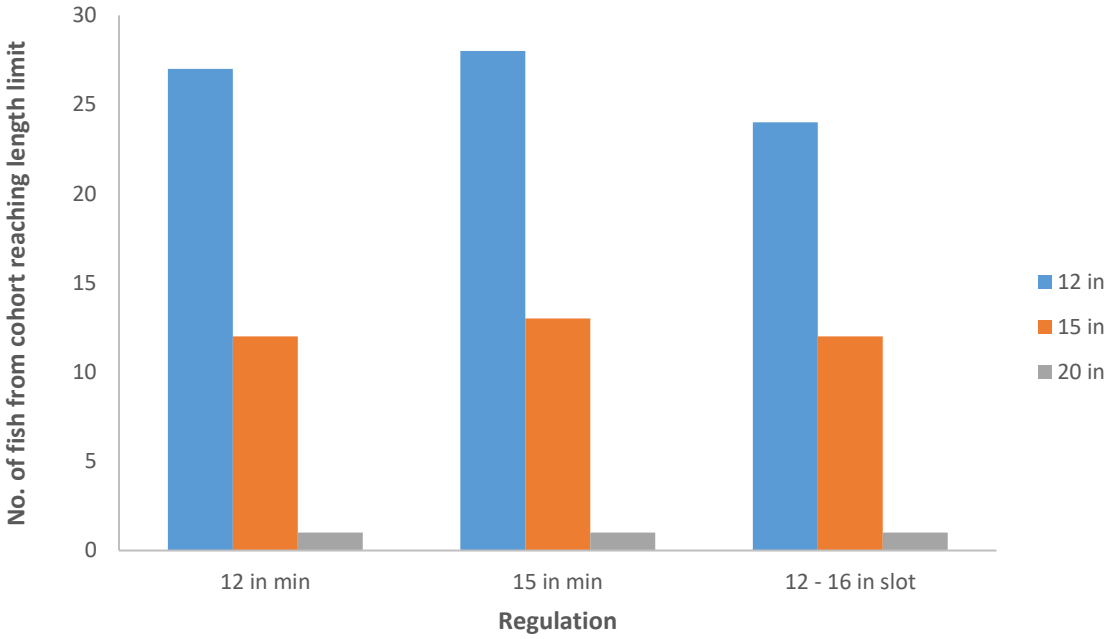


Figure 9. Number of smallmouth bass from a cohort of 100 individuals predicted to reach 12.0 in, 15.0 in, and 20.0 in Old Pool 6 of Green River at current levels of exploitation and natural mortality for three different regulations: 12.0 in minimum length limit, 15.0 in minimum length limit, and 12.0 – 16.0 in protective slot limit.