Fisheries bulletin

KENTUCKY DEPARTMENT of FISH and WILDLIFE RESOURCES

Evaluation of Sauger Stockings in the Green, Barren and Salt Rivers

by: David Baker

Bulletin No. 117
June 2015

Evaluation of Sauger Stockings in the Green, Barren and Salt Rivers

By

David Baker, Fisheries Biologist

Kentucky Department of Fish and Wildlife Resources

June 2015

Partially funded by Sport Fish Restoration Funds

Sport Fish Restoration Project F-40 “Statewide Fisheries Research”

Abstract

Sauger were stocked in the Green, Barren and Salt Rivers from 2010-2014 in an effort to expand and supplement sauger populations in areas that were either isolated from the Ohio River (Green and Barren Rivers) or had a low density population (Salt River). Supplemental stockings were planned through 2016 with monitoring until 2020 to determine if these populations would be self-sustaining. Stocking and sampling efforts were terminated in 2014 due to factors such as poor spring and fall catch rates, poor relative weight values and lack of providing a recreational opportunity in each of these study areas. It was recommended that this stocking program be terminated and the fish be reallocated to the Kentucky River where a previous study showed that sauger do provide a substantial recreational fishery.

Introduction

In Kentucky, sauger (*Sander canadensis*) are found in the Ohio and Mississippi rivers and their major tributaries (Burr and Warren 1986). Sauger are a native top-level predator that inhabit the main channel areas of large turbid rivers (Hesse 1994; Maceina et. al 1996; Amadio et. al 2005; Jaeger et. al 2005; Bellgraph et. al 2008; Kuhn et. al 2008). During the spring, sauger tend to congregate below dams and near the mouth of creeks to spawn, creating an important seasonal fishery in many of Kentucky's rivers. While recreational fishing for sauger is extremely popular and expanding (LaJeone et. al 1992), it is important to evaluate the success of natural reproduction and determine the appropriate level of sustainable harvest.

Since sauger populations fluctuate naturally due to biotic and abiotic factors, year-class strength can be highly variable. Pitlo (1989) found that environmental factors before, during, and after spawning govern reproductive success of sauger, ultimately relating to year-class strength. While year class strength fluctuates, populations may exhibit long-term declines due to high exploitation (Hesse 1994; Pegg et. al 1997; Sullivan 2003), community changes (Bellgraph et. al 2008), or habitat loss (Hesse 1994; Macenia et. al 1996; Pegg et. al 1997; McMahon and Gardner 2001). Loss of spawning habitat due to channel alteration and barriers to migration are cited as some of the most commonly identified factors contributing to the decline of sauger populations (Graeb et. al 2009). While habitat preservation and improvements may benefit sauger populations, in systems where reproduction is highly variable and less than desirable, the population may be enhanced by supplemental fingerling stockings (LaJeone et. al 1992).

In 2010, the Kentucky Department of Fish and Wildlife Resources (KDFWR) began stocking sauger fingerlings into the Green, Barren and Salt rivers. The goal of this study was to evaluate the potential of establishing a self-sustaining sauger fishery through supplemental stockings in select pools of each system, most of which have been isolated from the Ohio River due to lock and dam infrastructure resulting in the loss of this fishery. The extent of angler use is unknown, but it's apparent that sauger can provide an important recreational fishery.

Study Area

Green River

Green River headwaters are located in Lincoln Country where it flows across central Kentucky to its confluence with the Ohio River upstream of Henderson, KY. Near Campbellsville, KY the Green River has been impounded to create Green River Lake, a flood control reservoir operated by the U.S. Army Corp of Engineers (USACE). Six lock and dams are located on the lower section of the river from Mammoth Cave National Park downstream to Spottsville, KY. Only Lock and Dams 1 and 2 are still in operation. Lock and Dams 3-6 have been placed into caretaker status by the USACE. Lock and Dam 4 was breached in 1965 and no longer impounds Pool 4. Due to this Lock and Dam system, fish migration from pool to pool has been limited to extreme high water events which do not occur on an annual basis.

For this study, only Pools 5 and 6 were stocked with sauger (Figure 1). Pool 6 extends from the tailwater of Green River Lake downstream to Lock and Dam 6 located about 1.8 miles downstream of the confluence with the Nolin River. This pool is approximately 125 miles in length offering a good diversity of riffle-run-pool habitat and a diversity of aquatic vegetation (*Justicia*, *Potamogeton* and *Podostemum*) and substrate (silt, sand, gravel, cobble, bolder and bedrock). Lock and Dam 6 impounds water upstream about 15 miles to Green River Ferry. Stream flow in this pool is heavily manipulated by releases from Green River Lake. Typically, lake releases attempt to mimic natural rain events and seasonal temperatures so not to negatively impact the aquatic communities in Pool 6.

Pool 5 is approximately 13.5 miles long and extends from Brownsville, KY downstream to Lock and Dam 5 located 0.25 miles downstream of Bear Creek. The entire reach of this pool is completely impounded and is dominated by muddy banks with woody debris and bank slips. There is very little in the way of habitat diversity; however, some back water areas are available in the three major tributaries in this pool (Beaverdam Creek, Alexander Creek and Bear Creek). Stream flow is this pool is heavily manipulated by releases from both Green River Lake and Nolin River Lake.

<u>Barren River</u>

East Fork Barren River and Line Creek converge west of Gamaliel, KY to form Barren River where it flows across south central Kentucky to its confluence with Green River directly upstream of Lock and Dam 4 near Woodbury, KY. Near Finney, KY, Barren River was impounded by the USACE in 1964 to form Barren River Lake, a 10,000 acre flood control reservoir. From the reservoir, Barren River flows to Bowling Green, KY, where the Bowling Green Municipal Utilities (BGMU) have constructed a low-head dam near their water intakes in an effort to store water and keep their intakes submerged. This dam is frequently inundated, therefore not creating an impassable fish barrier. Near the community of Greencastle, KY the USACE owns Lock and Dam 1 which is currently in caretaker status. Lock and Dam 1 creates a fish barrier that prevents fish from Green River and the lower section of Barren River from migrating upstream beyond this point. Extreme high water events are the only time Lock and Dam 1 historically has been inundated.

Sauger were stocked in the section of Barren River from the tailwater of Barren River Lake downstream to Lock and Dam 1 (Figure 2). From the Barren River Lake Tailwater downstream to Drakes Creek, the river has a complex of riffle-run-pool habitat. Aquatic vegetation is limited with substrate ranging from sand to small cobble. The low-head dam at the BGMU impounds water upstream to Drakes Creek. Throughout this impounded section, habitat complexity is poor and is comprised of muddy banks and woody debris. Below the BGMU dam, habitat again returns to riffle-run-pool habitat which continues downstream to Boat Landing Road Ramp. At that point, Barren River again becomes pooled due to the effects of Lock and Dam 1. Once again, habitat diversity becomes limited and is dominated by muddy banks and bank slips.

Water levels and flows in this study area are a direct function of the releases from Barren River Lake and the few major tributaries (Difficult Creek, Bays Fork, Drakes Creek, and Jennings Creek) located throughout this study area. Barren River Lake lacks the ability to manipulate the discharge temperature, like Green River Lake, which could negatively impact the aquatic communities in the upper reach of the study area.

Salt River

West of Danville, KY, the Salt River begins flowing downstream through a landscape dominated with agriculture and live stock. Near Taylorsville, KY, the USACE has dammed up the Salt River creating Taylorsville Lake, a 3,050 acre flood control reservoir constructed in 1983. From the reservoir downstream there is no other dam structures present allowing the Salt River to flow freely through the cities of Taylorsville, KY and Shepherdsville, KY before entering Fort Knox Army Base as it reaches its confluence with the Ohio River at West Point, KY.

The study area for stocking sauger extended from the tailwater of Taylorsville Lake downstream to Shepherdsville, KY (Figure 3). This section of the Salt River is low gradient, full of woody debris and muddy banks. The Salt River typically remains turbid and has issues with heavy siltation.

This section of the Salt River is heavily impacted by the outflows of Taylorsville Lake, Brashears Creek and Floyds Fork. A wide diversity of big river fish species are present throughout the study areas, with anecdotal information from anglers of periodic sauger spawning runs upstream to the Taylorsville Lake Tailwater when conditions are favorable. Migration of stocked fish into and out of the study is a strong possibility since no physical barriers are present in this section of river. This makes this study area unique when compared to the other study areas in the Green and Barren rivers.

Methods

Sauger broodstock were collected each winter from the Ohio and Kentucky rivers and hauled to the Peter W. Pfeiffer Fish Hatchery in Frankfort, KY to be spawned. Sauger offspring were held in ponds until the fry reached 1.5-2.0 in. This typically occurred around the first week of June at which time the sauger fingerlings were stocked into Pools 5 and 6 of the Green River, Barren River upstream of Lock and Dam 1 and the Salt River downstream of Taylorsville Lake. These stockings were as late in the spring as possible to reduce the potential negative impacts that certain abiotic variables, such as high spring flows, might have on the survival of the stocked fish (Gelwick 2001). Stocking success is contingent on many factors, most important of which may be water quality at time of stocking and food abundance (Paragamian 1992). Furthermore, stocking sites were selected when possible at tributary confluences and upper reaches of the study site in areas where sauger would be expected to naturally spawn. The stocking rate in each pool was 10 fish/acre, which was determined by calculating total river miles of each pool multiplied by average stream width. Sauger fingerlings were scheduled to be stocked from 2010-2016 with each stocked year class receiving oxytetracycline (OTC) marks to assist in detecting the presence of natural reproduction. Annual monitoring was planned to continue until the spring of 2020 to determine if the sauger stocking would produce a self-sustaining population.

During the spring, nocturnal DC electrofishing was conducted in the Green River at the Green River Lake Tailwater and the tailwaters of Lock and Dams 5 and 6. Barren River was sampled at Barren River Lake Tailwater, BGMU Dam and the tailwater of Lock and Dam 1, while sampling was conducted in the Salt River at Taylorsville Lake Tailwater.

Spring sampling was conducted when water temperatures ranged from 45-50^{0}F. Four 15-minute transects, two on each shoreline, were conducted in each tailwater. All sauger observed were collected, measured to the nearest 0.1 in and weighed to the nearest 0.01 lb. Otoliths were removed from a minimum of 5 fish per inch class to estimate contribution of stocked fish to each year class and determine age structure. CPUE data was used to index abundance of stocked and natural year classes.

In the fall, diurnal electrofishing surveys were completed in Green, Barren, and Salt rivers. Diurnal electrofishing surveys were warranted due to shallow water hazards that had to be navigated to effectively sample each system. Sampling was conducted when water temperatures ranged from 65-70^{0}F. A minimum of six- 15 minute transects were completed in the upper and lower reaches of each stocked pool. All sauger collected were measured to the nearest 0.1 in and weighted to the nearest 0.01 lb. Sampling sites were evenly distributed throughout the pool targeting areas with shallow bars, tributary confluences and shorelines with rock/rubble substrates.

At the completion of the study, data collected was analyzed using KDFWR's KFAS and KSLO software ran in SAS v. 9.2 (SAS 2007; Cary, NC). CPUE, size/age structure, relative weight, and year class strength data were used to determine if stockings had resulted in a self-sustaining sauger fishery in each river. Data was also analyzed using Fishery Analysis and Simulation Tools (FAST) modeling to determine if and what possible creel and size limits could be implemented to maximize the potential of each fishery.

Results

<u>Green River</u>

From 2010-2014, Pools 5 and 6 of the Green River were stocked with 365,093 sauger fingerling that ranged in size from 1.5-2.0 in (Table 1). Only the 2012 and 2014 year classes were OTC marked.

Spring sampling began in 2012 when only 14 sauger were collected from three tailwaters with an overall catch rate of 4.7 fish/hr (Table 2). Fish sampled ranged from 6.0-14.0 in and represented both stocked year classes. Catch rates improved during spring 2013 to 12.0 fish/hr as the size structure continued to show improvements with fish represented from the 5.0-17.0 in size classes. Catch rates fell during 2014 to 3.0 fish/hr which was to lowest collected during this project with no fish present <9.0 in indicating possible failure of the 2013 stocked year class. Overall, the tailwater of Lock and Dam 6 recorded the best catch rates of 7.7 fish/hr, followed by and Lock and Dam 5 (6.3 fish/hr) and Green River Lake (5.7 fish/hr) tailwaters (Table 3). Spring catch rates continued to remain lower than expected based on the number of year classes and fish stocked.

In spring 2012, otoliths removed from a subsample of sauger indicated that growth rates were good. Sauger on average reached 8.7 in at age-1 and 12.6 in at age-2 (Table 4). No additional age and growth data was collected during this project. During 2013, twelve age-1 sauger from the 5.0-9.0 in size classes were collected for OTC verification. One of the twelve fish collected was not OTC marked, indicating a possibility that low levels of reproductive success did occur (Table 5). This was the only year that fish were retained for OTC verification due the lack of marked year classes.

Fall catch rates were low across all years, 2012 recorded the best catch rate of 4.2 fish/hr with 2013 and 2014 being very comparable at 2.4 fish/hr and 2.9 fish/hr, respectively (Table 6). Young of the year (YOY) sauger were only present during the 2014 sample with a few fish collected below the 10.0 in class. Relative weight (Wr) on average was fair in the 8.0-11.9 in size group (88) but decreased with an increase in size (Table 7). The 12.0-14.9 in size group had an average Wr value of 77 and the ≥15.0 in size group averaged 75.

<u>Barren River</u>

Barren River was stocked with 101,612 sauger fingerlings that averaged 1.5- 2.0 in from 2010-2014 (Table 1). Additionally, 600,000 surplus sauger fry were stocked during April 2010. Only sauger fingerling stocked in 2012 and 2014 were marked with OTC.

Spring electrofishing surveys were conducted from 2012-2014. Catch rates during this period ranged from 0.3 fish/hr (2014) to 5.5 fish/hr (2013; Table 8). Overall, the average spring catch rate was 2.1 fish/hr with fish collected from the 6.0-17.0 in size classes (Table 9). Spring catch rates during the 5-year stocking period remained poor with little to no improvement in the size structure and abundance.

During spring 2013, otoliths were collected from six age-1 sauger ranging from the 7.0-11.0 in size class for OTC verification. All otoliths had a visible OTC mark indicating that all these fish were stocked and that no natural reproduction was detected from this sample (Table 5). This was the only time that age-1 fish were collected for this analysis due to the lack of marked year classes.

Fall electrofishing conducted from 2012-2014 yielded poor catch rates. Even with poor catch rates, CPUE data slightly improved each year. During 2012, sauger were collected at 0.6 fish/hr and improved to 0.8 fish/hr in 2013 and 1.6 fish/hr in 2014 (Table 10). Overall, fall catch rates averaged 1.1 fish/hr with fish collected from the 9.0-17.0 in size class. Relative weight values were the highest during 2012 at 84, followed by 77 in 2014 and 76 in 2013 (Table 11). Fish were only collected during 2012 in the 8.0-11.9 in size group with a Wr value of 91. The 12.0-14.9 in size group average Wr was poor at 76 and the ≥15.0 in size group average Wr was poor at 78.

Salt River

The Salt River received 67,610, 1.5-2.0 in fingerling sauger from 2010-2014 (Table 1). Additionally, 563,000 sauger fry were stocked during April 2010. Only sauger fingerling stocked in 2012 and 2014 were marked with OTC.

Spring sampling during 2012 recorded the highest catch rate of sauger at 29.0 fish/hr with fish collected from the 7.0-11.0 in classes (Table 12). Each subsequent year, spring catch rates dropped. In 2013, fish were collected at 11.0 fish/hr and 1.0 fish/hr in 2014.

Otoliths were collected from three age-1 sauger during 2013 that were in the 9.0-10.0 in size class for OTC verification. None of the otoliths were marked indicating that these were not stocked fish, but more than likely migrants from the Ohio River population (Table 5). This was the only time that age-1 fish were collected for this analysis due to the lack of marked year classes.

Fall electrofishing surveys conducted from 2012-2014 also resulted in poor catch rates. Catch rates were the lowest during 2014 at 0.3 fish/hr and the highest in 2013 at 5.7 fish/hr (Table 13). During this period the average catch rate was 2.7 fish/hr with fish collected from the 8.0-18.0 in size class. Overall, relative weight values were fairly consistent ranging from 81 (2014) to 84 (2012; Table 14).

Discussion

From 2010-2014 fingerling sauger were stocked from 1.5-2.0 in, averaging 1.7 in at a rate of 10.0 fish/acre. These stocking rates and size fish were unsuccessful at establishing populations in any of the study areas. In comparison, a five year stocking program in the Kentucky River, stocking 1.5-2.0 in fingerling at 10.0 fish/acre, was used to successfully created a put-grow-take fishery (Herrala 2014). Paragamian and Kingery (1992) recommended that fingerling sauger be stocked at 2.0 in noting survival seemed less dependent on the size of the fingerlings stocked and more dependent on environmental conditions such as water temperature and stream flow. However, Paragamian and Kingery (1992) did stock fingerlings from 1.8-5.5 in, averaging 3.3 in which resulted in increased densities in the study areas. Increasing average size of the sauger stocked may have potentially improved stocking success and negated some of the post-stocking mortality from handling and transportation.

Results from Paragamian and Kingery (1992) and LeJeone et. al (1992) indicated that fingerling survival was the highest when fish were stocked at water temperatures less than 70.0°F. Stocking temperatures in the Green, Barren and Salt rivers averaged 65.2°F during the five year stocking period, indicating stocking did occur at the appropriate temperature range, resulting in no additional stocking stress.

Stream flows at stocking also play a crucial role in post-stocking survival. High, muddy water conditions make it difficult for fingerlings to find food and migrate to areas with suitable habitat (Paragamian and Kingery 1992). There is a need for flexibility of stocking times so that stocking can occur when river conditions are appropriate in an effort to increase survival. Stockings in the Green, Barren and Salt rivers commonly occurred during periods of high flows due to releases from USACE lakes, creating conditions that were not conducive to survival. These conditions probably negatively impacted two year classes stocked into the Green River, three year classes in Barren River and one year class in Salt River (Table 15). LeJeone et. al (1992) reported success with establishing stocking sites in the upper portions of each study area so that stocked fish were in areas with habitat that are targeted for spawning activities. Stocking sites in the Green, Barren and Salt rivers were moved to tributaries in the upper sections of the study areas to avoid main river stockings when possible.

Kentucky River stockings resulted in catch rates of 0.0 fish/hr during year one of stocking and by the fourth year of stocking, overall spring catch rates improved to 54.3 fish/hr, ranging from 39.0-86.0 fish/hr (Herrala 2014). By the fourth year of stocking, the Green (12.0 fish/hr), Barren (5.5 fish/hr) and Salt (11.0 fish/hr) river catch rates were less than expected and at an undesirable level. Kentucky River stocking resulted in a good distribution and density of fish from the 5.0-19.0 in, with strong year classes resulting from stockings. Meanwhile, stockings in the Green, Barren and Salt rivers resulted in low densities with good distribution of fish from 5.0-17.0 in. The low densities may be due to poor year class survival based on river conditions at stocking. However, another concern was that Wr in the Green (80), Barren (77), and Salt (79) rivers were lower than observed on the Kentucky River (83). Since the densities in the Green, Barren, and Salt rivers were less than collected on the Kentucky River, it would have been expected to see higher Wr values of these fish if post stocking survival was the only issue. This is another indicator that the study areas did not adequately support this fishery at a comparable level as seen in the Kentucky River. Even though this stocking rate did produce a fishery in the Kentucky River, it may not have been an appropriate rate for the study rivers. LeJeone et. al looked at three fingerling stocking rates (4.4 fish/acre, 10.9 fish/acre, and 12.1 fish/acre) and determined that 10.9-12.1 fish/acre was the appropriate stocking rate to enhance a low density population. Additional research is needed to better evaluate appropriate stocking rates and the timing of stocking for reestablishing sauger populations in Kentucky's rivers.

Sauger typically inhabit large, turbid rivers in Kentucky (Etnier and Starnes 1993). Stockings in the Kentucky River were likely more successful based on the large average channel width, depth and turbidity. In comparison, the Green, Barren and Salt rivers have substantially narrower channels and shallower average depths. The study areas are mainly comprised of riffle-pool complex, compared to the long deep pools of the Kentucky River. Green and Barren rivers are fairly clear, while the Salt River is similarly turbid as the Kentucky River. Major tributaries are more readily available throughout the Kentucky River, providing fish refuge during high water, when compared to the Green, Barren and Salt rivers. Small gizzard shad are primary prey for sauger which are abundant in the Kentucky River, but present in significantly lower densities in the Green, Barren and Salt rivers.

Otoliths collected from age 1 sauger were examined for OTC marks during the spring 2013. The preliminary results were not a good indicator of the reproductive success of this population due to the small percentage of sexually mature fish present in the population in spring 2012. Spring 2013 would have been the earliest to expect natural reproduction since sauger reach sexually maturity between ages 2-5 (Jaeger 2004). Additional samples are needed to determine the presence of natural reproduction, however the lack of OTC marked year classes makes it difficult to determine. Now that stocking has been terminated, the presence of age 1 fish in the spring sampling could possibly indicate reproductive success from the 2010-2014 stocked year classes in the Green and Barren rivers since these study areas are isolated from Ohio River sauger populations, unlike the Salt River study area.

Management Recommendation

Sauger stocking in each of the three river systems have resulted in less than desirable catch rates, year class strength and relative weight values. Stocking has not resulted in creating an additional recreational fishery at any of the study areas. Therefore, it is recommended that sauger stocking in each of the Green, Barren and Salt rivers be concluded without further attempt to reestablish this species in all the study areas. At this point, there are not foreseeable alterations in habitat or water quality that would improve the likelihood of successfully establishing or enhancing sauger populations through supplemental stocking in these river reaches. Based on the presence of walleye in the Green and Barren river study areas, it may be more advantageous to evaluate establishing walleye fisheries in the Green and Barren river systems since the habitat and stream size appears to better suit walleye. In addition, native walleye stockings in the upper Barren River have been successful with adult fish being collected in the Barren River Lake Tailwaters.

Acknowledgements

I greatly appreciate all the hard work and dedication that was put into this project by all my colleagues at KDFWR. I would like to thank, Gerry Buynak, Jeff Ross, Sara Tripp and Jason Herrala for their guidance, leadership and reviews of this manuscript and supporting documents. Thank you to Jason Herrala, Sara Tripp, Nick Keeton, Ryan Kausing, Don Bunnell, Chris Bowers, Cory Woosley, Eric Cummins, John Zeigler, Phillip Matlock, Mike McCormack, Jeff Crosby, Paul Wilkes, Jason McDowell, Kenny Atha, and Jason Fitzgerald for their time spent conducting spring and fall electrofishing. Funding for this project was provided through a federal grant, F-40-R "Statewide Fisheries Research" under the Sport Fish Restoration Program.

References

Amadio CJ, Hubert WA, Johnson K, Oberlie D, Dufek D. 2005. Factors affecting the occurrence of saugers in small, high-elevation rivers near the western edge of the species' natural distribution. Transactions of the American Fisheries Society 143: 160–171.

Bellgraph BJ, Guy CS, Gardner WM, Leathe SA. 2008. Competition Potential between Saugers and Walleyes in Nonnative Sympatry, Transactions of the American Fisheries Society, 137:3, 790-800.

Burr BM and Warren, Jr. ML. 1986. A distributional atlas of Kentucky fishes. Kentucky Nature Preserves Commission. Scientific and Technical Series Number 4. 398p.

Etnier, DA and Starnes WC. The Fishes of Tennessee. Knoxville: University of Tennessee, 1993. Print.

Gelwick GT. 2001. Evaluation of fingerling walleye stockings among interior Iowa rivers. Completion Report Stream Fisheries Investigation. Project F-160 R. Iowa Department of Natural Resources. Fish and Wildlife Division. 54p.

Graeb BDS, Willis DW, Spindler BD. 2009. Shifts in sauger spawning locations after 40 years of reservoir aging: influence of a novel delta ecosystem in the Missouri River, USA. River Research and Applications 25:153–159.

Herrala, Jason. 2014. Evaluation of a Sauger Stocking Program on the Kentucky River. Sport Fish Restoration Project F-40 "Statewide Fisheries Research". Kentucky Department of Fish and Wildlife Resources. Fisheries Division. Bulletin 110.

Hesse LW. 1994. The status of Nebraska fishes in the Missouri River. 6. Sauger (Percidae: Stizostedion canadense). Transactions of the Nebraska Academy of Sciences 21: 109–121.

Jaeger, Matthew. 2004. Montana's Fish Species of Special Concern: Sauger. Montana Cooperative Fisheries Research Unit. Web. 12 March 2015. <http://www.fisheriessociety.org/AFSmontana/SSCpages/Sauger%20Status.htm>.

Jaeger ME, Zale AV, McMahon TE, Schmitz BJ. 2005. Seasonal movements, habitat use, aggregation, exploitation, and entrainment of saugers in the lower Yellowstone River: an empirical assessment of factors affecting population recovery. North American Journal of Fisheries Management 25: 1550–1568.

Kuhn KM, Hubert WA, Johnson K, Oberlie D, Dufek D. 2008. Habitat Use and Movement Patterns by Adult Saugers from Fall to Summer in an Unimpounded Small-River System, North American Journal of Fisheries Management, 28:2, 360-367.

LeJeone LJ, Bowzer TW, Bergerhouse DL. 1992. Supplemental stocking of fingerling walleyes in the upper Mississippi River. North American Journal of Fisheries Management 12:307-312.

Maceina MJ, Bettoli PW, Finely SD, DiCenzo VJ. 1996. Recruitment, movement, and exploitation of sauger in the Alabama waters of the Tennessee River. Alabama Department of Conservation and Natural Resources, Final Report 40, Montgomery.

McMahon TE, Gardner WM. 2001. Status of sauger in Montana. Intermountain Journal of Science 7: 1–21.

Paragamian VL and Kingery RW. 1992. A comparison of walleye fry and fingerling stockings in three rivers in Iowa. North American Journal of Fisheries Management 12:323-320.

Pegg MA, Bettoli PW, Layzer JB. 1997. Movement of saugers in the lower Tennessee River determined by radio telemetry, and implications for management. North American Journal of Fisheries Management 17: 763–768.

Pitlo J Jr. 1989. Walleye spawning habitat in pool 13 of the upper Mississippi River. North American Journal of Fisheries Management 9:303–308.

Sullivan MG. 2003. Active management of walleye fisheries in Alberta: dilemmas of managing recovering fisheries. North American Journal of Fisheries Management 23:1343–1358.

Table 1. Total number of fingerling sauger stocked in the Green, Barren and Salt rivers from 2010-2014.

Year	River			Total
	Green	Barren	Salt	
2010	107,198	27,122	14,760	149,080
2011	80,805	24,810	17,790	123,405
2012	51,390	29,880	17,860	99,130
2013	72,400	9,900	10,100	92,400
2014	44,300	9,900	7,100	61,300
Total	356,093	101,612	67,610	525,315

Table 2. Number of sauger collected and CPUE (fish/hr) of sauger collected in three tailwaters of the Green River during spring sampling from 2012-2014; standard error is in parentheses.

	Tailwater							
	Green River Lake		Lock and Dam 6		Lock and Dam 5		Total	
Year	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
2012	3	3.0 (1.0)	3	3.0 (1.9)	8	8.0 (2.8)	14	4.7 (3.1)
2013	13	13.0 (5.0)	15	15.0 (9.6)	8	8.0 (2.8)	36	12.0 (3.5)
2014	1	1.0 (1.0)	5	5.0 (2.5)	3	3.0 (1.0)	9	3.0 (1.0)
Total	17	5.7 (2.2)	23	7.7 (3.4)	19	6.3 (1.4)	59	6.6 (1.4)

Table 3. Relative abundance and CPUE (fish/hr) of sauger collected in three tailwaters of the Green River during spring electrofishing surveys from 2012-2014; standard error is in parentheses.

	Inch class														
Location	5	6	7	8	9	10	11	12	13	14	15	16	17	Total	CPUE
Green River Lake Tailwater						1	2	2	8	2			2	17	5.7 (2.2)
Lock and Dam 6	1	4		5	1	3	2	4	2	1				23	7.7 (3.4)
Lock and Dam 5		2	1		3	1	5	4		2	1			19	6.3 (1.4)
Total	1	6	1	5	4	5	9	10	10	5	1	0	2	59	6.6 (1.4)

Table 4. Mean back-calculated lengths (in) at each annulus for sauger collected from Green River on Febuary 21, 2012 and March 7, 2012, including 95% confidence interval for mean length per age class. Age determined from otoliths.

		Age	
Year	No.	1	2
2011	3	7.1	
2010	11	9.1	12.6
Mean		8.7	12.6
Number		14	11
Smallest		6.8	11.0
Largest		10.8	14.1
Std error		0.3	0.3
95% ±		0.7	0.7

Table 5: Percent contribution of age 1 sauger to the the 2012 year class in Green, Barren and Salt rivers.

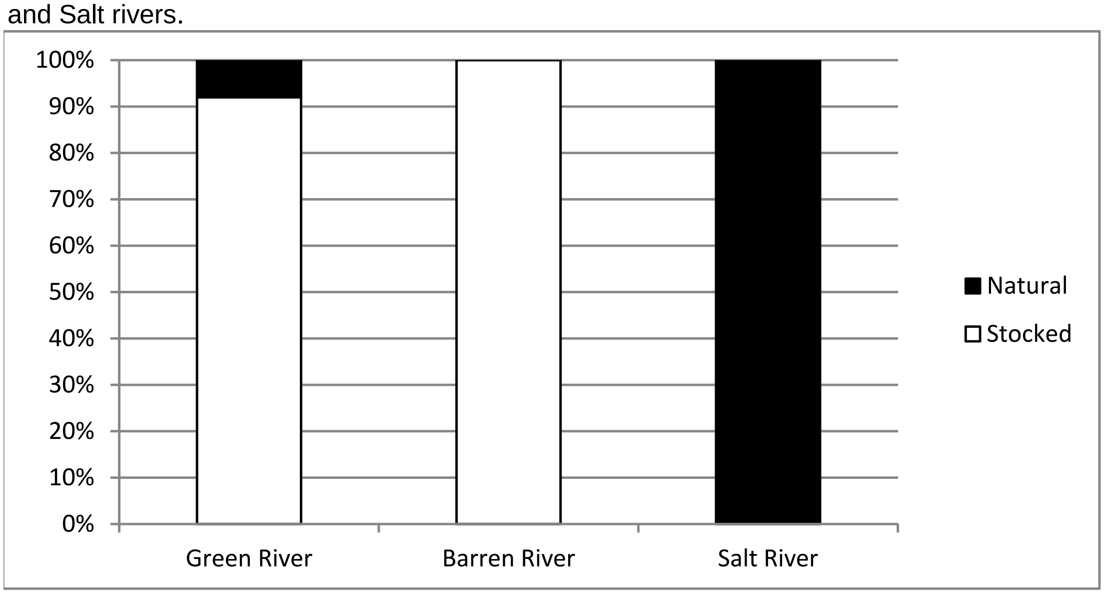

Table 6. Length-frequency and CPUE (fish/hr) of sauger collected during fall electrofishing surveys in Green River; standard error is in parentheses.

	Inch class														
Year	7	8	9	10	11	12	13	14	15	16	17	18	23	Total	CPUE
2012				2	5	7	4	1	3	1				23	4.2 (1.1)
2013					2	1	5	1	3	1				13	2.4 (0.8)
2014	2	2		1	1	2	1	2	3	1	3	1	1	20	2.9 (1.2)
Total	2	2		3	8	10	10	4	9	3	3	1	1	56	3.1 (0.6)

Table 7. Number of fish and relative weight (Wr) of sauger collected during fall electrofishing in the Green River from 2012-2014; standard error is in parentheses.

	Size group							
	8.0-11.9 in		12.0-14.9 in		≥15.0 in		Total	
Year	No.	Wr	No.	Wr	No.	Wr	No.	Wr
2012	7	75 (1)	12	76 (1)	4	76 (2)	23	76 (1)
2013	2	90 (5)	7	81 (2)	4	81 (2)	13	82 (2)
2014	4	109 (16)	5	75 (3)	9	72 (5)	18	84 (6)
Total	13	88 (6)	24	77 (1)	17	75 (3)	54	80 (2)

Table 8. Number of sauger collected and CPUE (fish/hr) of sauger collected in three tailwaters of Barren River during spring sampling from 2012-2014; standard error is in parentheses.

	Tailwater							
	Barren River Lake		BGMU Dam		Lock and dam 1		Total	
Year	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
2012	0	0.0	0	0.0	5	5.0 (3.0)	5	1.7 (1.2)
2013	No Sample		5	5.0 (3.8)	6	6.0 (3.5)	11	5.5 (2.4)
2014	1	1.0 (1.0	0	0.0	0	0.0	1	0.3 (0.3)
Total	1	0.5 (0.5)	5	1.7 (1.3)	11	3.7 (1.6)	17	2.1 (0.8)

Table 9. Relative abundance and CPUE (fish/hr) of sauger collected at three sites on Barren River during spring electrofishing surveys from 2012-2014; standard error is in parentheses.

	Inch class													
Location	6	7	8	9	10	11	12	13	14	15	16	17	Total	CPUE
Barren River Lake Tailwater												1	1	0.5 (0.5)
BGMU Dam Tailwater		1	1		1			1		1			5	1.7 (1.3)
Lock and Dam 1	1			3		3	1	2	1				11	3.7 (1.6)
Total	1	1	1	3	1	3	1	3	1	1	0	1	17	2.1 (0.8)

Table 10. Length-frequency and CPUE (fish/hr) of sauger collected during fall electrofishing surveys in Barren River; standard error is in parentheses.

	Inch class										
Year	9	10	11	12	13	14	15	16	17	Total	CPUE
2012	1				1		1			3	0.6 (0.4)
2013				3		1	1		1	6	0.8 (0.3)
2014				1	3	5	2	3		14	1.6 (0.7)
Total	1			4	4	6	4	3	1	23	1.1 (0.3)

Table 11. Number of fish and the relative weight (Wr) of sauger collected during fall electrofishing in Barren River from 2012-2014; standard error is in parentheses.

	Size group							
	8.0-11.9 in		12.0-14.9 in		≥15.0 in		Total	
Year	No.	Wr	No.	Wr	No.	Wr	No.	Wr
2012	1	91	1	78	1	82	3	84 (4)
2013	0		4	76 (1)	2	75 (1)	6	76 (1)
2014	0		9	75 (1)	5	79 (1)	14	77 (1)
Total	1	91	14	76 (1)	8	78 (1)	23	77 (1)

Table 12. Length-frequency and CPUE (fish/hr) of sauger collected during spring electrofishing surveys at one site in the Salt River; standard error is in parentheses.

	Inch class										
Year	7	8	9	10	11	12	13	14	15	Total	CPUE
2012	1	6	14	5	3					29	29.0 (9.9)
2013			1	3	1	2		2	2	11	11.0 (9.9)
2014				1						1	1.0 (1.0)
Total	1	6	15	9	4	2		2	2	41	13.7 (4.7)

Table 13. Length-frequency and CPUE (fish/hr) of sauger collected during fall electrofishing surveys in the Salt River; standard error is in parentheses.

	Inch class												
Year	8	9	10	11	12	13	14	15	16	17	18	Total	CPUE
2012		1			3			1			1	6	2.0 (0.9)
2013	2	1	2	8	1			3				17	5.7 (1.8)
2014			1									1	0.3 (0.3)
Total	2	2	3	8	4			4			1	24	2.7 (0.8)

Table 14. Number of fish and relative weight (Wr) of sauger collected during fall electrofishing in the Salt River from 2012-2014; standard error is in parentheses.

	Size group							
	8.0-11.9 in		12.0-14.9 in		≥15.0 in		Total	
Year	No.	Wr	No.	Wr	No.	Wr	No.	Wr
2012	1	88	3	87 (1)	2	84 (3)	6	84 (4)
2013	13	74 (2)	1	84	3	81 (2)	17	82 (2)
2014	1	81	0		0		1	81
Total	15	76 (2)	4	86 (1)	5	82 (1)	24	79 (1)

Table 15. Average discharge in cubic feet/sec (CFS) for the Green, Barren, and Salt Rivers during the week of sauger stocking.

	Rivers		
Year	Green	Barren	Salt
2010	3670	3510	285
2011	4126	3613	3491
2012	383	238	772
2013	665	3301	269
2014	711	730	418
Historical Average	2593	2299	1345

Figure 1. Green River sauger stocking area from Green River Lake to Lock & Dam 5 from 2010-2014.

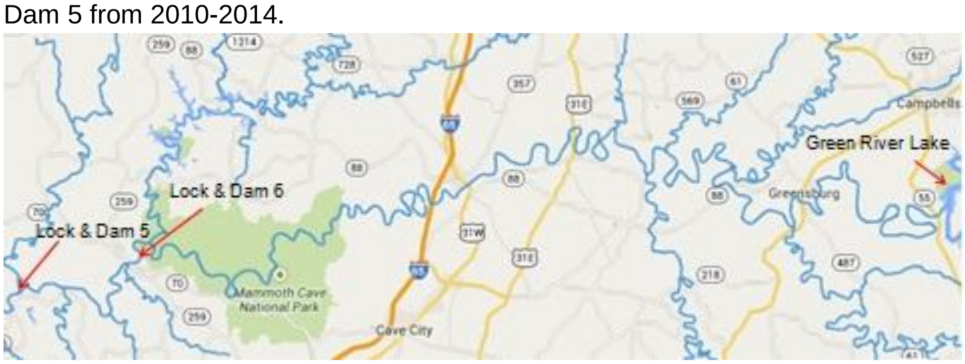

Figure 2. Barren River sauger stocking study area from Barren River Lake to Lock & Dam 1 from 2010-2014.

Figure 3. Salt River sauger stocking study area from Taylorsville Lake to Shepherdsville, KY from 2010-2014.