

STREAM SMALLMOUTH BASS MANAGEMENT PLAN

3rd Edition



Photo by: Mike Wintroath (edited by Paul Port)

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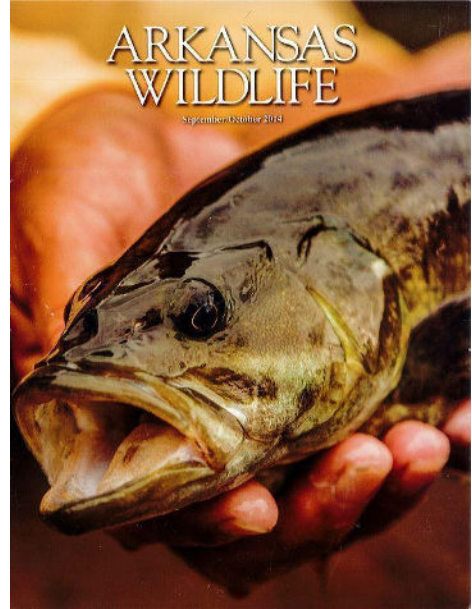
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INTRODUCTION

Smallmouth Bass (*Micropterus dolomieu*) are popular sportfish found in all major drainages of the Ozark and Ouachita highlands, and are commonly known as “smallies,” “brownies,” or “bronze backs.” Arkansas streams make up the southern border of the native distribution of the species within the United States. Smallmouth Bass are an excellent indicator of stream health, as they are intolerant of turbidity, high water temperatures, and environmental alterations.

Arkansas Game and Fish Commission (AGFC) staff created the Smallmouth Bass Management Plan to provide the best direction for the management of Arkansas’ Smallmouth Bass fisheries. The AGFC seeks to apply traditional management tools, as well as develop new and innovative tools and techniques, that will provide more efficient conservation and meet a variety of management goals tailored to diverse stakeholders. This plan focuses on stream dwelling Smallmouth Bass while the AGFC Reservoir Black Bass Management Plan (2017) considers Smallmouth Bass populations in lakes and reservoirs.



Goal

The goal of the Smallmouth Bass Management Plan is to wisely manage stream Smallmouth Bass populations and their associated habitats in order to provide high-quality fishing opportunities, to increase public satisfaction, and to conserve Arkansas’ unique resources.

Background

Smallmouth Bass are an important species in Arkansas streams and rivers from both ecological and recreation perspectives. In 2016, 368,183 licensed resident anglers spent about 13.4 million days angling in Arkansas (Hunt and Westlake 2018). Hunt and Westlake (2018) estimated that Arkansas resident anglers have \$3.26 billion invested in fishing equipment. Arkansas resident black bass anglers

spent an average of 4.9 days per year angling on small streams (Hunt and Westlake 2019). While less than the annual participation on reservoirs (13.6 days), it still underscores the importance that Arkansas black bass anglers place on stream fishing. In 2013 to 2014, anglers fished more than 321,000 hours on the Buffalo River, one of Arkansas' most visited Smallmouth Bass rivers (Todd and Hodges 2015). The majority (55%) of the fishing pressure targeted Smallmouth Bass.

Arkansas is the center for known Smallmouth Bass genetic diversity and is home to three distinct genetic lineages of Smallmouth Bass. Northern Smallmouth Bass are widely distributed around the United States and occur in the Ozark region in streams within the White River Basin. Neosho Smallmouth Bass only occur in the Ozark-Ouachita Interior Highlands in streams in the Arkansas River Drainage. Ouachita Smallmouth Bass occur in the Ouachita Mountain region of Arkansas and Oklahoma. Hybridized populations exist within these regions due to past stockings, movement of fish by anglers, and natural movements of fish. Because Smallmouth Bass prefer relatively cool water temperatures, Arkansas resides at the southernmost extent of their native range. Additionally, the Neosho and Ouachita lineages of Smallmouth Bass possess unique adaptations to the environmental conditions in this region. However, AGFC lacks information about how these lineages may differ from Northern Smallmouth Bass and if these genetic differences warrant distinct management strategies.

Biology

Habitat

Smallmouth Bass occur throughout the Ozark and Ouachita Highlands in the western and northern portions of Arkansas (Figure 1). They are typically most abundant in streams with permanent flow of clean water, low turbidity, and coarse rocky habitat. Within a stream, Smallmouth Bass prefer pool and run habitats (Brewer and Orth 2015). Smallmouth Bass often occur with other black bass species (i.e., Largemouth Bass and Spotted Bass) in streams. However, Smallmouth Bass rely on cooler water temperatures and cleaner water than Largemouth Bass and Spotted Bass and are often the most abundant black bass in streams that meet their habitat preferences. In general, Ozark streams have higher abundances of Smallmouth Bass than Ouachita Mountain streams (Filipek et al. 1995; Quinn et al. 2004; Dauwalter and Fisher 2008).

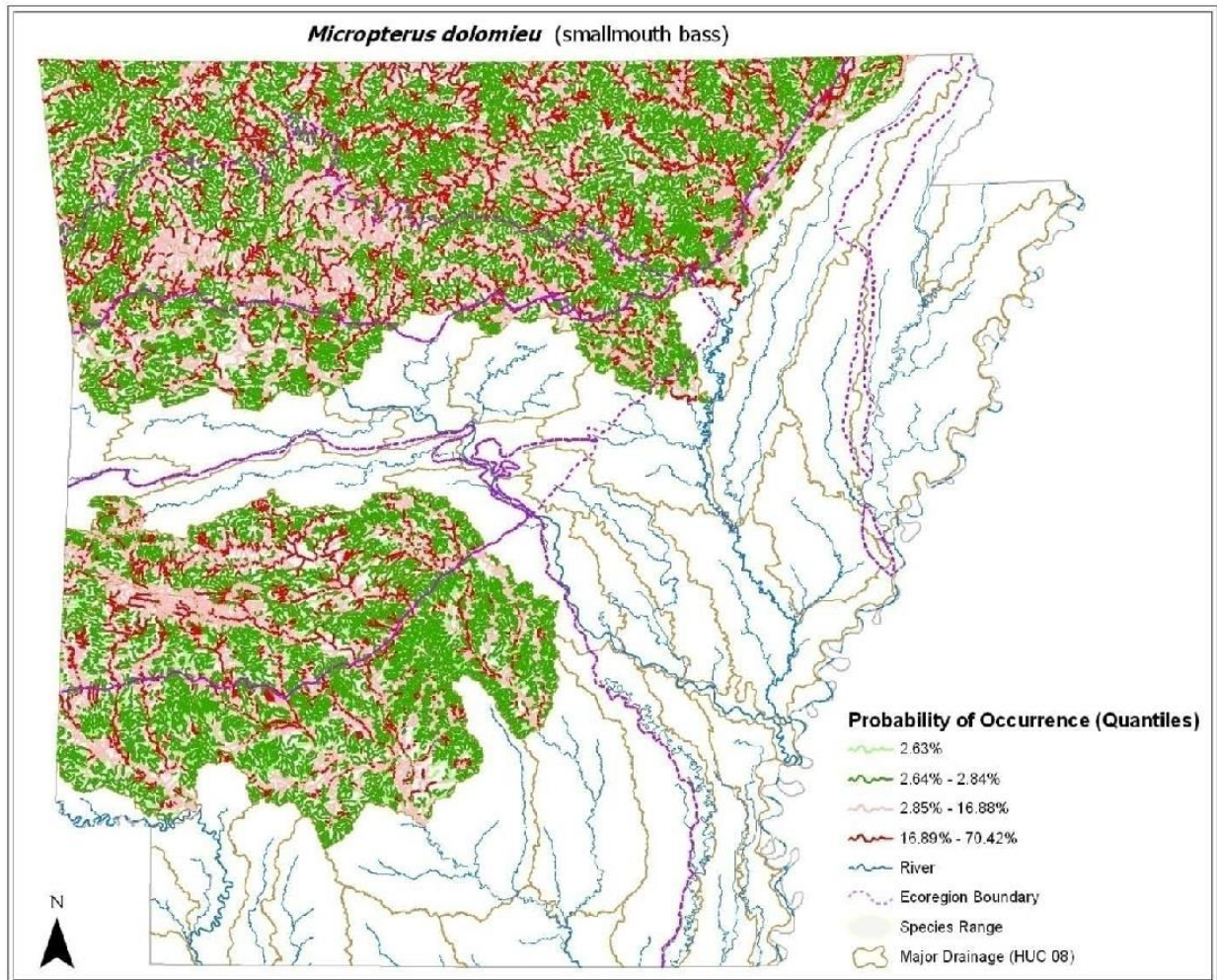


Figure 1. Arkansas Smallmouth Bass distribution (from Annis et al. 2011).

Reproduction

Smallmouth Bass spawn in Arkansas streams from April-June depending on water temperature and streamflow (Robison and Buchanan 1988). Graham and Orth (1986) observed Smallmouth Bass spawning between 54.5°F - 74.3°F in Virginia and West Virginia rivers. Smallmouth Bass will make multiple nesting attempts if there are brood failures due to an onset of cold temperatures or high flow conditions. Brewer and Long (2015)



noted that the spawning period was generally unknown for Neosho and Ouachita lineage Smallmouth

Bass. However, Martin (2017) found that Neosho Smallmouth Bass peak spawning extended from May 25 to June 10 in Illinois Bayou, Arkansas.

Prior to spawning, male Smallmouth Bass use their caudal fin to fan out a depression in the stream substrate where a female will subsequently lay eggs. Typically, larger male Smallmouth Bass will construct nests and spawn earlier with larger, more reproductively fit females (Wiegmann et al 1992). After spawning, males aggressively guard their nests from potential predators until fry swim freely. Males are relatively vulnerable to angling during the spawn due to their aggressive guarding behavior.

Growth and Mortality

Growth of Smallmouth Bass varies among stream systems, and is likely influenced by temperature, habitat, and prey availability (Brewer and Orth 2015). Smallmouth Bass in streams typically grow more slowly than those in reservoir systems. In Arkansas streams, (Table 1), Smallmouth Bass generally grow slower in Boston Mountain streams than other ecoregions (Brewer and Long 2015).

Mortality rates of Smallmouth Bass also vary among streams and are affected by angler harvest, streamflow conditions, and predation (Brewer and Orth 2015). Quinn et al. (2011) estimated the total annual mortality rate in Crooked Creek at 44-64%. The most recent estimate of natural mortality was 42% with angler harvest comprising 2% of annual mortality (Quinn et al. 2011). A study conducted in the Buffalo River estimated the total annual mortality rate of Smallmouth Bass as 42%, but the estimate ranged from 39%-53% depending on the location within the river (Whisenant and Maughan 1989). A more recent study (2008-2011) that focused on the lower half of the Buffalo River estimated the total annual mortality rate of Smallmouth Bass at 56% (Todd and Hodges 2015). Hafs et al. (2010) suggested that summer survival for Smallmouth Bass in Illinois Bayou was likely influenced by natural factors related to stream drying in two forks (Middle Fork, S = 79%; East Fork, S = 84%). The stream fork with the most angling access also had the lowest summer survival (North Fork, S = 67%). Bare (2005) estimated the annual survival of adult Smallmouth Bass to be ~84% in another Ozark stream. Rambo (1998) indicated low annual production for many small streams in the Boston Mountains, which may be related to low fertility of the water and stream drying in this ecoregion. There is a lack of data from Ouachita Mountain streams, but a study conducted on Glover Creek in the Oklahoma Ouachita region estimated total annual mortality to be 61% (Orth et al. 1983). Dauwalter and Fisher (2008) reported that high water temperatures decreased annual survival of Smallmouth Bass in an Ozark stream (Baron

Fork; age 1 range 0.07-0.24; age 2-3 range 0.18-0.26) compared to a Ouachita Mountain stream (Glover River; age 1-3 = 0.10).

Table 1. Mean lengths at age (total length, mm) of Smallmouth Bass from relevant studies (lengths in inches in parenthesis). Stream fish populations are subject to variable growth rates depending on environmental conditions (e.g., stream flow, temperature). In addition, methods and timing of capture vary among these studies. Therefore, these results are meant to provide a coarse comparison among streams.

Smallmouth Bass Age (Year)	Buffalo River (Todd and Hodges 2015)	Crooked Creek (Quinn et al. 2011)	Eleven Point River (Johnson et al. 2009)	Glover Creek, OK (Orth et al. 1983)	Kings River (Stein and Hopkins 2019)
1	190 (7.5")	158 (6.2")	149 (5.9")	130 (5.1")	149 (5.9")
2	255 (10.0")	236 (9.3")	219 (8.6")	183 (7.2")	217 (8.5")
3	295 (11.6")	289 (11.4")	292 (11.5")	242 (9.5")	270 (10.6")
4	347 (13.7")	347 (13.7")	346 (13.6")	263 (10.4")	329 (13.0")
5	391 (15.4")	368 (14.5")	384 (15.1")	299 (11.8")	362 (14.3")
6	447 (17.6")	403 (15.9")	422 (16.6")	346 (13.6")	412 (16.2")
7	456 (18.0")	393 (15.5")			425 (16.7")
8	463 (18.2")	426 (16.8")			
9	522 (20.6")				

Angler harvest for Smallmouth Bass can vary widely among streams (Filipek et al. 1995; Whisenant and Maughan 1989). However, recent creel surveys in Arkansas have found harvest to be very low. For example, a recent creel survey on the Buffalo River estimates < 1% of captured fish are harvested (Todd and Hodges 2015). In contrast, a tagging study conducted on several Missouri Ozark rivers estimated an annual mortality from harvest of about 20% (Williamson et al. 2015). Even if harvest is relatively low in Arkansas streams, angling effort can be very high (e.g., 1,603 hours/km annually on the Buffalo River (Todd and Hodges 2015); 1,387 hours/km annually on Crooked Creek (Quinn et al. 2011). Due to high angler effort, catch and release mortality, particularly in summer months when fish are already thermally stressed, may be significant but is currently unknown.

Diet

Several studies have documented the composition of stream Smallmouth Bass diets in the Ozark region. Middaugh and Magoulick (2019) noted that adult Smallmouth Bass diets in Ozark streams primarily fed on fish and crayfish, with crayfish more often making up the majority of the diets. Most studies document consumption of other macroinvertebrates (e.g., hellgrammites, stoneflies, etc.) but these insects seldom dominate the diet of adult Smallmouth Bass.



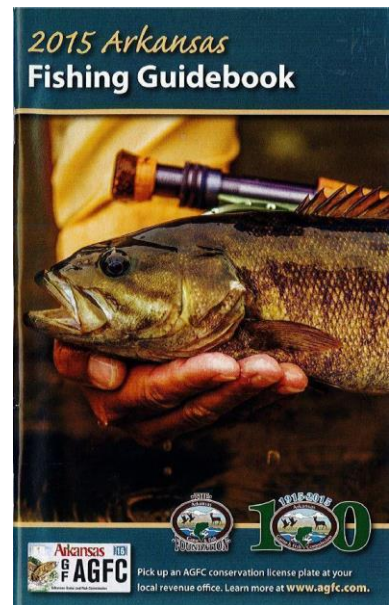
Conservation

Because Arkansas is at the southern limit for Smallmouth Bass, climate change could pose a threat in Arkansas streams that experience water temperatures near their tolerance level (Dauwalter and Fisher 2008). High temperatures during summer months lead to reductions in body condition in some streams (Middaugh and Magoulick 2019). Therefore, increasing summer temperatures could further reduce Smallmouth Bass growth and survival during summer months (Middaugh et al. 2018). Additionally, changes in duration and timing of floods and drought due to changing climate could reduce Smallmouth Bass abundances (Middaugh and Magoulick 2018). Destabilization of stream channels and increased sediment loading due to changes in hydrology may also reduce Smallmouth Bass abundance, especially through alteration of spawning habitat. It is possible that groundwater-dominated streams could provide refuge habitat to Smallmouth Bass from changing climate conditions.

Management Tools

Fishing Regulations

AGFC uses fishing regulations to equitably distribute the harvest among resource users, protect fish until after they spawn, and grow fish to larger size. Historically, AGFC regulated Largemouth Bass, Spotted Bass, and Smallmouth Bass harvest with a combined creel limit of 10 fish per day. This changed in the early 1980's to a six Smallmouth Bass per day creel limit and 10-inch minimum length limit. The first Smallmouth Bass Management Plan for Arkansas was finalized and approved by the Arkansas Game and Fish Commission during 1995 (Filipek et al. 1995), and its proposed harvest regulations were implemented during 1996. The plan established statewide harvest regulations for streams of relatively low productivity (Ouachita/Boston Mountain Zone in the code book), and a special Ozark Zone for streams with high productivity (Figure 2).



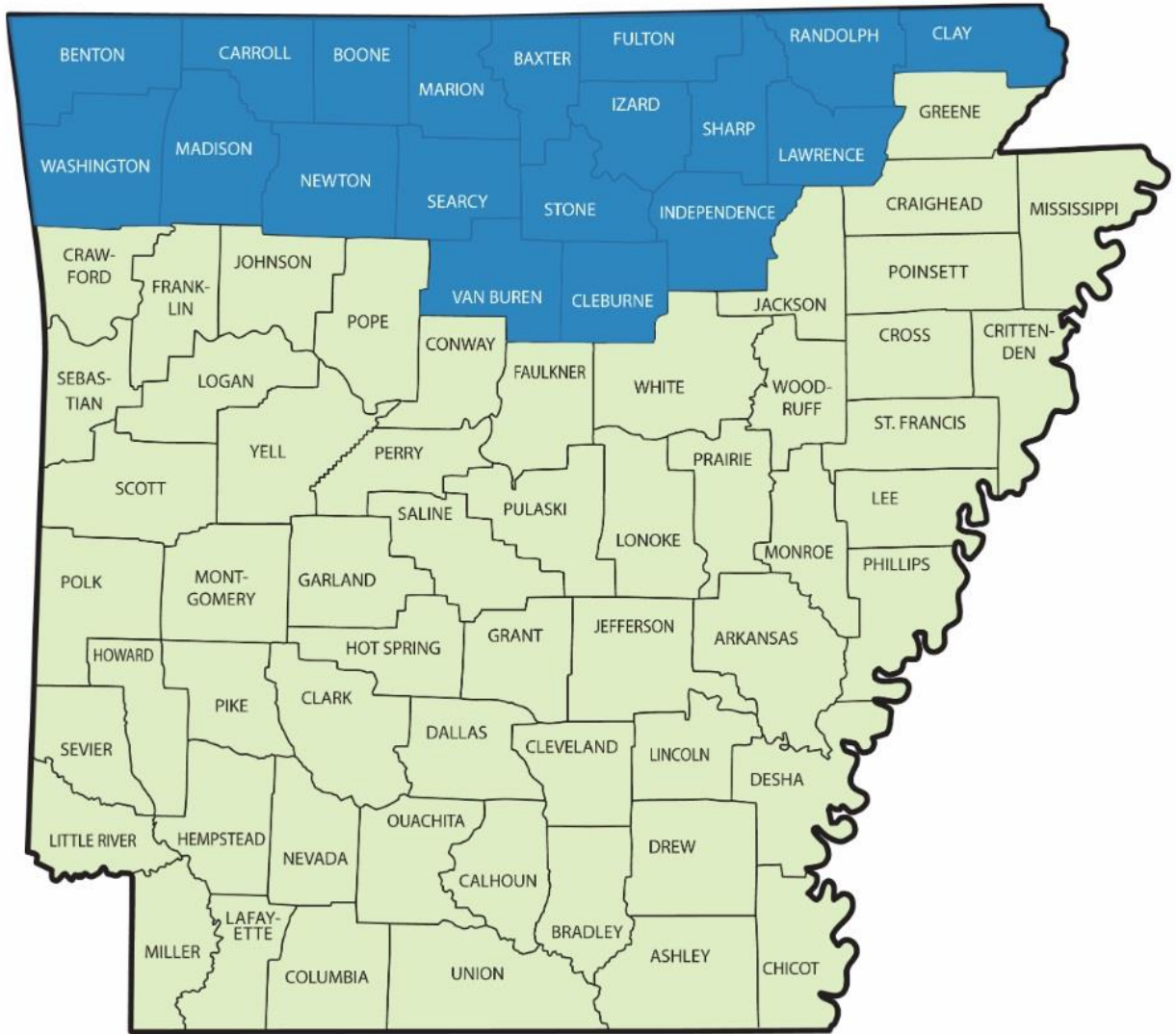


Figure 2. Smallmouth Bass map with Ozark Zone in blue. Smallmouth Bass in the Ozark Zone must be ≥ 12 inches in length to keep, whereas they must be ≥ 10 inches in the rest of the state. Special regulations apply on some water bodies.

AGFC uses biological criteria to establish Quality and Blue Ribbon stream designations (Table 2). Quality streams include the Mulberry River, Caddo River above Lake DeGray, Saline River and its four principal tributaries (Alum, Middle, North, and South Forks), the South Fork of the Ouachita River, and the upper Little Missouri River above Lake Greeson.

Table 2. Summary of stream Smallmouth Bass harvest regulations and minimum population criteria (density, biomass, growth) for establishing Blue Ribbon and Quality streams and special regulation areas (SRAs).

Zone	Length Limit	Creel Limit	Density (fish/mile)	Biomass (lbs/acre)	Length at age 4-5
Statewide	10	4			
Blue Ribbon	12	2	> 250	> 13	10 - 12
Quality	12	2	> 200	> 4	10 - 12
Ozark Zone	12	4			
Blue Ribbon	14	2	> 600	> 22	12 - 14
Quality	14	2	>320	> 13	12 - 14
SRAs ¹	18	1	-	-	-

AGFC recognizes Kings River, Spring River, South Fork Spring River, Eleven Point River, Illinois River, and War Eagle River as Ozark Zone Quality streams (Table 3). However, individuals should review AGFC fishing regulations for current regulations and greater detail on specific sections.

Table 3. Special fishing regulations for Smallmouth Bass in Arkansas rivers and streams. Additionally, Crooked Creek has a catch-and-release only zone.

14" Min Length Limit, 2 Fish Limit	12" Min Length Limit, 2 Fish Limit	18" Min Length Limit, 1 Fish Limit
Buffalo River	Caddo River	Crooked Creek (two sections)
Crooked Creek	Cossatot River	Kings River (one section)
Eleven Point River	Mulberry River	Buffalo River (one section)
Illinois River	Little Missouri River (above Lake Greeson)	Little Missouri River (below Lake Greeson)
Kings River	Saline River	
War Eagle Creek	White River	
	Ouachita River	

Habitat Management

Unfortunately, over the last 150 years, the quality of many waterways in Arkansas has degraded. Thousands of miles of streams have been impaired due to dam construction, industrial and agricultural pollution, poor forestry practices, and other activities. The 1995 Smallmouth Bass Species Management plan indicated that more than 25 percent of the state's Smallmouth Bass streams have been impaired (Filipek et al. 1995). Habitat management and restoration has become more common since passage of Amendment 75 and creation of the AGFC Stream Team Program.

Stream Team efforts revolve around three primary aspects of stream conservation: education, advocacy, and stewardship. The Stream Team has stabilized 23,120 feet of streambank on 23 Smallmouth Bass streams in just the most recent five years from 2014-2019 (Table 4).

Table 4. Stream Team Bank Stabilization Projects on Smallmouth Bass Streams between 2014 and 2019.

Waterbody	Length of Streambank Stabilized (feet)	Waterbody	Length of Streambank Stabilized (feet)
Spring River	3,300	Williams Creek	541
Eleven Point River	2,700	Mill Creek	540
Caddo River	2,625	Big Piney Creek	500
Ouachita River	2,532	South Fork Little Red River	387
South Fork Spring River	2,200	Caney Creek	305
Strawberry River	1,800	Big Creek	255
South Fork Caddo River	1,068	Prairie Bayou	240
Crooked Creek	900	Little Missouri River	200
Mulberry River	800	East Fork Horsehead Creek	113
Janes Creek	750	Little River	110
Kings River	600	Adds Creek	105
Left Fork Big Creek	549		

In 1993 the General Assembly enacted a law banning commercial gravel mining in 24 streams and some of their tributaries that were designated “extraordinary resources” in Arkansas water quality standards.



A. Before

B. Mid-Construction

C. Current

It also authorized the Pollution Control and Ecology Commission to draft regulations for permits to mine other waterways (Wilson 1998). Some conservationists encouraged removing obsolete low-head dams and slab crossings from streams. AGFC has partnered with 18 other government and non-government organizations to form the Arkansas Stream Heritage Partnership. This partnership develops strategies and protocols for removing obsolete barriers in Arkansas streams. Because most (> 90%) land in Arkansas is privately owned, stream habitat management presents many challenges. Successful stream management programs require partnerships with landowners to stabilize badly eroding stream banks and provide more natural habitat for Smallmouth Bass.

Stakeholders

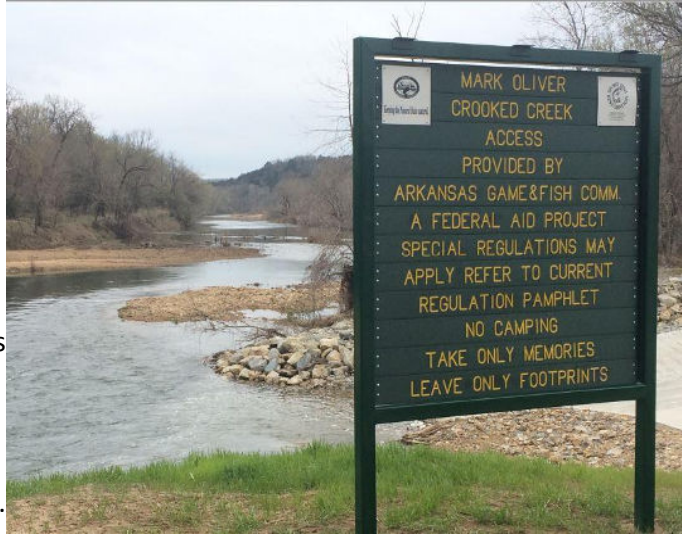
Successful management of the fish, habitat, and the stream watershed relies on effective communication with stakeholders. We define stakeholders as individuals or groups affected by management and includes those that think they will be affected and those who do not know they could be affected. In addition to gathering input from anglers during creel surveys, AGFC biologists also reach out to stakeholders through the AGFC.com website, social media, press releases, and public meetings. Stakeholder engagement gives AGFC staff the opportunity to provide



information on current projects, regulation changes, and overall updates on how the fish and stream are doing as a whole. Stakeholder values, preferences, and opinions inform fishery goals.

Stream Access

The Arkansas Game and Fish Commission is committed to providing the best access possible to the state's resources. However, there is a delicate balance to managing Smallmouth Bass stream access. Additional access increases fishing and floating opportunities. However, some stakeholders could realize decreased fishing success or overall satisfaction because of increased pressure. In general, increased access can help spread out users to different areas of the stream or break up long sections of stream to make it more accessible for shorter day trips.



Shoreline access areas can provide anglers that may not have a boat the opportunity to go fishing or a place to enjoy the stream for recreational purposes.

Recent Studies

Monitoring

The Arkansas Game and Fish Commission periodically monitors stream Smallmouth Bass fisheries. Recently, AGFC fisheries biologists have studied the Kings River (2015), Crooked Creek (2016-2019), Ouachita River (2017), and the Eleven Point River (ongoing). However, improved management of Smallmouth Bass fisheries requires not only more intensive study of popular streams but also additional streams where Smallmouth Bass are poorly understood.



University Research Studies

The Arkansas Game and Fish Commission has funded university research studies for Smallmouth Bass. Additionally, agency staff regularly assist and cooperate with universities conducting research on Smallmouth Bass. Recently, AGFC recently funded a study to better understand filamentous algae on the Buffalo River. Results of that study can help inform Smallmouth Bass management strategies. AGFC staff also collected genetic samples for university research projects at the University of Missouri, Oklahoma State University, and the University of Arkansas to help conserve the unique genetics of Arkansas Smallmouth Bass. Finally, AGFC staff collected Smallmouth Bass from the Cossatot River for researchers at Oklahoma State University to study temperature tolerances.

Creel Surveys and Tagging Exploitation Studies

Fisheries biologists use creel surveys to interview anglers about their fishing trips. These surveys provide biologists with information about the amount of time anglers spend fishing, how many fish they catch in that time, the number of fish they keep and release, the size of fish they have kept, and the anglers' opinion about the quality of a fishery. Creel surveys can also estimate non-reporting in tagging studies.



AGFC completed a creel survey on the Buffalo River during 2013-2014 (Todd and Hodges 2015). This survey documented 321,240 hours of angler use or approximately 80,657 fishing trips per year. Anglers spent about \$7 million in direct expenditures. Despite high fishing pressure, anglers harvested few fish overall and released nearly 100% of Smallmouth Bass.

Fisheries biologists use tagging studies to estimate the percentage of fish that are caught and harvested. Tagging studies also provide information on movement patterns, growth rates, and population abundance.

AGFC tagged Smallmouth Bass in Crooked Creek during spring 2019, and anglers have been asked to call in and return tags from fish they catch. AGFC also completed a creel survey on Crooked Creek and the Kings River during the 2019 floating season (Risley et al. 2020; Stein et al. 2020).

SMALLMOUTH BASS MANAGEMENT PLAN – GOALS, OBJECTIVES, AND ACTION ITEMS

GOAL 1 - FISHERY: MANAGE AND MAINTAIN HEALTHY COMMUNITIES OF SMALLMOUTH BASS AND OTHER AQUATIC SPECIES

OBJECTIVE 1.1: Assess population characteristics of Smallmouth Bass fisheries in 20 recreationally-important streams by 2031.

ACTION ITEMS:

a. Evaluate accuracy and precision of different types of electrofishing, angling, and snorkeling for collecting Smallmouth Bass

Although data on abundance, size structure, condition, recruitment, growth, and mortality are critical for assessing Smallmouth Bass populations, AGFC biologists lack standardized methods to collect Smallmouth Bass. Lack of access, as well as differences in stream width and depth also complicate standardized collections. Finally, seasonal and annual variations in flow further challenge AGFC biologists to select one gear that can effectively sample Smallmouth Bass across streams.

To better understand the effectiveness of gear types for sampling Smallmouth Bass in streams, AGFC should evaluate the accuracy and precision of estimating abundance and size structure of Smallmouth Bass using methods identified in the AGFC Stream Sampling Procedures (boat electrofishing, barge electrofishing, angling, and snorkeling) and make recommendations for standardized future collections.

b. Assess abundance, size structure, condition, recruitment, growth, and mortality of Smallmouth Bass

Effective management of Smallmouth Bass in streams requires data on population characteristics and population dynamics. AGFC biologists should collect information on abundance, size structure, and condition at least twice per stream. Additionally, AGFC biologists should collect information on age, growth, recruitment, and mortality at least once. These data will inform data-driven decisions that will allow AGFC to manage Smallmouth Bass fisheries to meet stakeholder goals.

c. Develop an index of year class strength for Smallmouth Bass and identify factors related to annual variation

Numerous studies across the U.S. have determined that Smallmouth Bass populations suffer from highly variable reproductive success. These variations challenge biologists to manage fisheries. Understanding Smallmouth Bass year class strength would allow AGFC biologists to reduce variation in abundance and size structure and manage for quality, sustainable fisheries.

d. Develop an online computer database/information system to store and analyze stream fisheries sampling data

An online and centralized database has several advantages. First, a centralized database improves our ability to make comparisons across Arkansas. This type of database also ensures that all staff collect the appropriate data that can inform management decisions. Finally, this system would reduce errors and improve efficiencies in analysis and reporting.

OBJECTIVE 1.2: Assess genetic status of Arkansas Smallmouth Bass Populations by 2024.

ACTION ITEMS:

- a. Continue to evaluate potential introgression of Tennessee-lake strain alleles into the upper Ouachita River from 2021-2025.***

AGFC stocked Tennessee lake-strain Smallmouth Bass into the lower reaches of Lake Ouachita. Similar stocking programs in Broken Bow and Tenkiller lakes in Oklahoma led to introgression of non-native alleles into native lineages (Taylor et al. 2018). Successful conservation and management requires a long-term evaluation in the upper Ouachita River to evaluate whether introgression of non-native alleles has occurred. At Broken Bow Lake, introgression was slow and required over a decade of study to document. Because hatcheries often utilize Smallmouth Bass from the Upper Ouachita River, conservation requires understanding the genetics of brood fish.

- b. To conserve the genetic integrity of Arkansas' three strains of Smallmouth Bass, develop a stocking protocol that utilizes brood fish from the recipient stream's basin.***

Three strains of Smallmouth Bass exist in Arkansas, but past stockings have intermixed strains in select streams. As the center of diversity for the species (Stark and Echelle 1998), successful conservation requires a plan to maintain the genetic diversity of Smallmouth Bass in Arkansas. This genetic diversity is important for tolerance to disease, climate change, and local adaptation.

- c. Perform a statewide genetic evaluation to determine the degree of introgression of non-native alleles into native Neosho and Ouachita lineages.***

A recent study by Oklahoma State University (Taylor et al. 2018) indicated that pure Neosho Strain may no longer exist in Oklahoma due to effects of stocking non-native strains. This study suggests that AGFC needs to closely examine potential introgression of both Neosho and Ouachita genetic lineages in Arkansas. An Arkansas study should include evidence from morphology, mitochondrial DNA, and nuclear DNA and should include fin clips from Smallmouth Bass from all major basins and hatchery sources. This study will provide the basis for development of a genetic diversity management plan for the species.

OBJECTIVE 1.3: Utilize harvest restrictions (length and creel limits) that are biologically and sociologically appropriate to manage Smallmouth Bass populations by January 1, 2027.

ACTION ITEMS:

- a. Evaluate current Smallmouth Bass harvest regulations to ensure that length and creel limits can achieve fishery management goals.***

Fisheries biologists utilize harvest regulations to manage fish populations to meet fishery goals. The selection of specific regulations relies on a thorough understanding of the reproductive success, growth, and survival of a population (see Objective 1 above, strategies 2 and 3). Biologists also select regulations that can attain the goals of the stakeholders who use those resources. Finally, AGFC should seek to minimize regulation complexity by utilizing no more than six length and creel limit combinations.

b. Evaluate mortality rates of released fish caught by different lures or methods.

Catch-and-release of black bass has become commonplace. Harvest of Smallmouth Bass occurs in some streams while catch-and-release is nearly 100% in others. However, hooking mortality may be a significant factor negating catch-and-release angling. Successful use of fishing regulations (harvest and gear restrictions) requires understanding the effect of hooking mortality on the size and age structure of Smallmouth Bass populations. The AGFC Smallmouth Bass committee will complete a literature review of Smallmouth Bass hooking mortality by December 31, 2022.

GOAL 2 - HABITAT: CONSERVE, RESTORE, AND ENHANCE AQUATIC HABITAT

OBJECTIVE 2.1: Evaluate Smallmouth Bass temperature tolerances and impacts of land use and climate change on stream habitat by 2026.

ACTION ITEMS:

a. Document temperatures of Smallmouth Bass streams by contracting with the U.S.G.S. to collect temperature data at existing streamflow gages.

Temperature is a master variable that regulates distribution, growth, mortality, and recruitment of fish. Arkansas streams are on the southern edge of the species range, and temperatures may limit southern populations of Smallmouth Bass. Unfortunately, continuous water temperature data are only collected by USGS at ~50 sites statewide, and most of the sites are not relevant to Smallmouth Bass fisheries. During 2021, USGS was collecting relevant continuous temperature data at the War Eagle River, the upper White River, the South Fork of the Little Red River, and the upper Buffalo River at three sites. Additionally, AGFC has funded collection of temperature data at the Cossatot River, the Middle Fork of the Little Red River, and Strawberry River. Temperature data should be collected for at least 5 years at a gage site before the temperature thermistor is rotated to a different gage. Temperature gage data are needed for several streams, including the Caddo River, the upper Ouachita River, the Little Missouri River, Illinois River, and Crooked Creek.

b. Collect water temperature data using inexpensive deployable loggers at multiple sites within the watersheds of USGS-gaged streams to determine holistic thermal conditions in the watershed.

A thorough understanding of water temperatures within a watershed requires data from smaller streams as well. Onset Hobo TidbiT loggers (~\$115 each) should be deployed at 15-25 sites per watershed for two years within watersheds that have an active temperature gage. These data will be

valuable baseline data for understanding any changes in the thermal conditions of streams due to climate changes.

c. Determine temperature tolerances of the three genetic lineages of Smallmouth Bass occurring in Arkansas streams at multiple sizes or life stages.

The number of very warm nights >75°F has increased over time in Arkansas (<https://statesummaries.ncics.org/downloads/AR-print.pdf>). Warm nights prevent cooling off of streams and may lead to higher maximum daily temperatures. Temperature tolerances of native genetic lineages are largely unknown, and the ability of Smallmouth Bass to tolerate higher temperatures is not understood. AGFC biologists are working with researchers at Oklahoma State University and the University of Central Arkansas to determine critical thermal maximums for our native lineages and subspecies.

d. Assess the impacts of nuisance filamentous algae blooms on Smallmouth Bass fisheries.

Nuisance filamentous algae blooms were documented in the Buffalo National River during 2016 and 2017, and these blooms extensively covered 20-70 stream miles. Nuisance algae blooms have also been observed in the Cossatot River, and this bloom was followed by a fish kill in Gillham Lake. Algae blooms may be associated with low dissolved oxygen and high temperature conditions that can have sublethal or lethal effects. These blooms are thought to be related to extended periods of low flows and nutrient enrichment. As animal production continues to expand, elevated nutrient problems can be expected to increase. AGFC staff and the public need to be aware that ADEQ recently developed a harmful algal bloom management plan (<https://www.adeg.state.ar.us/water/pdfs/HAB-ResponsePlan-Manual-bookmarks-2019-12-12-Final.pdf>) and ADEQ has developed a public complaint form (https://www.adeg.state.ar.us/complaints/forms/algae_complaint.aspx). There is a need to integrate AGFC responses to filamentous algae blooms with the planning efforts of multiple agencies and associated stakeholders towards filamentous algae blooms.

OBJECTIVE 2.2: Protect environmental flows for major Smallmouth Bass fisheries.

ACTION ITEMS:

a. The Fisheries Division should work with the Arkansas Natural Resources Commission and local landowner and fishing groups to protect environmental flows using methods outlined in the 2014 Arkansas Water Plan.

The Arkansas Water Plan brings data, science, and public input together to define water demands, water supplies, issues, and potential solutions to meet the future needs of Arkansas. (<https://arwaterplan.arkansas.gov/plan/ArkansasWaterPlan/Default.htm>). Arkansas is a riparian water law state, and landowners adjacent to waterways may reasonably use water as a property right, but riparian owners' withdrawals may be limited if use unreasonably harms another riparian's use. The Arkansas Natural Resource Commission is only able to regulate riparian use during a shortage declared by the Director, which initiates a lengthy data-driven allocation process (ANRC Title 3, Rules for the Utilization of Surface Water 2016). ANRC uses a modified Tennant method (10% of mean seasonal flows) for allocation during a declared shortage.

Non-riparian use of water is permitted by ARNC if "excess surface water" is available, which is 25% of the water available annually above the amount required to satisfy current and future needs including:

riparian rights, needs of federal projects and reservoirs, flows for fish and wildlife, water quality, aquifer recharge, navigation, and future needs of the basin in the state water plan. Fish and wildlife flows are determined by the Arkansas Method and is generally based on the percentage of mean monthly flows in three seasons.

ANRC wrote in the 2014 water plan, “ANRC will evaluate and assess alternative methods for estimating fish and wildlife flows, or other instream needs and uses, as more accurate, scientifically reviewed, and defensible methods become available. Section 7 (Appendix C) of the Arkansas Water Plan, Water Availability Report outlines the framework of using a risk-based approach in a stakeholder driven process to determine fish and wildlife flow needs in different stream classes. This risk-based framework would use flow-ecological relationships. Therefore, it is important for AGFC to determine these flow-ecological relationships for Smallmouth Bass fisheries.

b. Determine biological responses of Smallmouth Bass to flow alteration in Arkansas streams.

AGFC has contracted a series of studies concerning environmental flow needs for fisheries to the Arkansas Fish and Wildlife Cooperative Fish and Wildlife Research Unit at the University of Arkansas. A recent project examines flow-ecology relationships for fishes, including Smallmouth Bass, in the Ozark and Ouachita Interior Highlands. We will work with the researchers to integrate their results into future water plan revisions.

c. Determine flow conditions when summer water temperatures are likely to exceed critical thermal maximums and likely to exceed ecoregion criteria for impairment for Smallmouth Bass fisheries.

Because temperature is a master variable, temperature-flow relationships and their relationship to biological impairment reference points may be useful as a risk-based assessment for environmental flow assessments.

OBJECTIVE 2.3: Complete two miles of streambank restoration projects while promoting habitat stewardship through landowner assistance and coordination with nongovernmental organizations and state and federal agencies.

ACTION ITEMS:

a. Help landowners apply stream bank stabilization techniques such as cedar tree revetments, stream bank grading, replanting of riparian vegetation, fencing off cattle, and addition of log cribs through the Stream Team program.

AGFC Stream Team Coordinators will work with the Natural Resources Conservation Service (NRCS) to help interested landowners acquire federal assistance through the Environmental Quality Incentives Program (EQIP), the Wildlife Habitat Incentives Program (WHIP), the Conservation Reserve Program (CRP), and the Wetland Reserve Program (WRP). AGFC Stream Team Coordinators will work with the U.S. Fish and Wildlife Service (USFWS) and landowners to conduct their Partner’s for Wildlife Program. AGFC Stream Team will work with the Arkansas Natural Resources Commission to implement Clean

Water Act 319 Programs on priority watersheds (funded through EPA) as part of non-point source pollution abatement programs.

- b. Cooperate with state and federal agencies to develop habitat conservation and restoration projects on priority streams. In addition, assist non-profit conservation groups such as the Nature Conservancy and fishing groups with their efforts to restore, protect, and conserve stream habitat.***

The AGFC Stream Team conducts high-quality work around the state, but habitat needs are larger than what this group can accomplish alone. Partnerships with other agencies and with conservation groups are critical for accomplishing needed work and can greatly increase the amount of stream habitat work accomplished. AGFC staff should partner with these groups as appropriate to creatively promote and increase work conducted around the state. For example, AGFC biologists currently provide biological monitoring and assessment for a restoration project being conducted on the West Fork White River.

- c. Increase public outreach through registering additional Stream Teams.***

The AGFC Stream Team program enables citizens to actively participate in conservation of local streams and watersheds. AGFC provides participants education and training in water-quality monitoring, stream bank maintenance, and restoration techniques. AGFC then guides participants through project planning and implementation for projects such as litter control, stream-side tree plantings, water-quality monitoring, and more. Increased participation in the program will serve to increase public appreciation of streams and utilize volunteers to perform important conservation work. AGFC should increase promotion of this program through the agency website, social media, and other educational materials.

- d. Continue to review permit applications and provide impact-reducing recommendations to other state and federal agencies.***

The AGFC Environmental Coordination Division will continue to perform environmental reviews for projects such as dam construction, gravel mining, pollution discharges, bridge construction, and stream channelization. These reviews are critical to ensure projects consider ecological effects on stream systems.

- e. Support the Arkansas Stream Heritage Partnership in locating, documenting, and removing barriers to stream fish migration.***

Many dams exist around that state that no longer provide the intended function or that are no longer needed. These structures can present a human safety hazard as well as restrict ecological connectivity between the upstream and downstream side, for example by preventing stream fish migration. The AGFC leads the Arkansas Stream Heritage Partnership which is a partnership of multiple government and non-profit agencies that works to remove these barriers. The Arkansas Stream Heritage Partnership should seek to conduct barrier removal projects where appropriate.

GOAL 3 - PEOPLE: PROVIDE RECREATIONAL FISHING OPPORTUNITIES FOR OUR STAKEHOLDERS

OBJECTIVE 3.1: Each year, connect with stakeholders to gather opinions, build relationships, and educate the public on Smallmouth Bass management.

ACTION ITEMS:

a. Identify and contact stakeholders.

District biologists will identify potential stakeholders and invite them to be involved in the waterbody management plan process. Stakeholder input is important and comments from stakeholders can identify resource issues and inform fishery goals.

b. Work with the AGFC Human Dimensions Specialist to conduct a statewide survey of Smallmouth Bass anglers to understand angler values, motivations, and preferences.

This survey would allow AGFC to tailor management to meet changing angler preferences, increase stakeholder satisfaction, and improve support for fisheries management activities. AGFC staff can obtain Smallmouth Bass angler contact information from creel surveys, public meetings, previous surveys, etc.

c. Perform a creel survey simultaneously with angler exploitation studies on several Smallmouth Bass streams.

Creel surveys allow AGFC to measure fishing effort and catch (and harvest) rates. Additionally, creel surveys provide direct measures of angler success and satisfaction.

d. Develop management plans on major SMB waters utilizing stakeholder input.

Successful management of Smallmouth Bass fisheries requires long-term planning. Each major Smallmouth Bass fishery should have a management plan that describes the resource, clarifies fishery goals set by stakeholders, and outlines the objectives and strategies to meet those goals.

e. Utilize a variety of communication tools to inform stakeholders of management goals, research projects, sampling updates, and habitat improvements.

AGFC staff should utilize social media, AGFC.com, YouTube, constant contact emails, Wild Science webinars, online forums, and press releases to provide the public with information on Smallmouth Bass management news and activities. Stakeholders should also have a variety of ways to engage with AGFC staff regarding Smallmouth Bass management.

OBJECTIVE 3.2: Develop a plan to provide adequate access to Smallmouth Bass streams by 2022.

ACTION ITEMS:

a. ***Improve and maintain current access sites.***

Partner with, cities, counties, non-governmental organizations, state and federal agencies to improve and maintain current public access. Access to Smallmouth Bass streams will continue to decline as landowners close off historical private access areas on non-navigable waters (e.g. War Eagle, Illinois Rivers).

b. ***Work with landowners and NGOS to improve access to streams while still accommodating those wanting a wilderness experience as well as mobility impaired anglers.***

Improve and maintaining current access to non-navigable waters while accommodating all types of users ranging from those wanting a wilderness experience to other areas that are easily accessible for the mobility impaired.

OBJECTIVE 3.3: Develop educational programs that promote stream habitat, conservation, and fishing for Smallmouth Bass by 2024.

ACTION ITEMS:

a. ***Work with the AGFC Fisheries R-3 team to develop programs to increase participation in Smallmouth Bass fishing in streams.***

R3 stands for recruitment, retention, and reactivation and the R-3 initiative seeks to increase participation in fishing and hunting. AGFC Fisheries and Education Division staff should seek ways to promote fishing for Smallmouth Bass in Arkansas streams to individuals who canoe and kayak but currently do not own a fishing license. Additionally, staff should engage with the public in a variety of education and outreach programs that market Smallmouth Bass fishing.

b. ***Increase awareness of the unique genetic strains of Smallmouth Bass in Arkansas through social media, news releases, and public presentations.***

Anglers are unaware of the unique strains of Smallmouth Bass in Arkansas or that Arkansas is the center of diversity for the species. Anglers may not value this diversity if they are not educated about the issues.

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