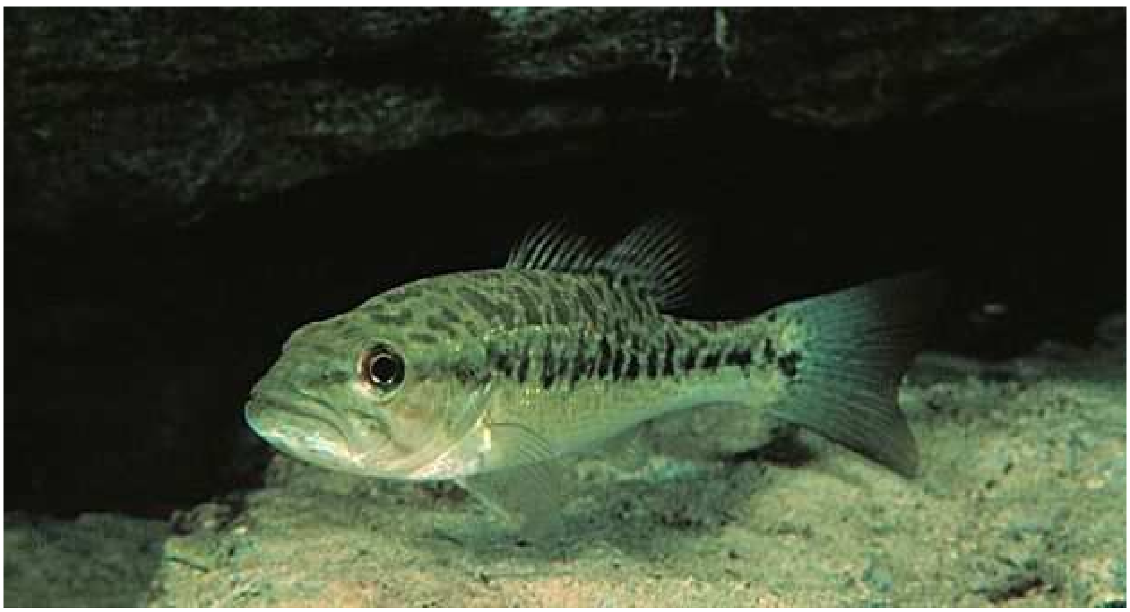
A Business Plan for the Conservation of Native Black Bass Species in the Southeastern US:

A Ten Year Plan



February 2010

Executive Summary

<u>Conservation need</u>: The southeastern US harbors a diversity of aquatic species and habitats unparalleled in North America. More than 1,800 species of fishes, mussels, snails, turtles and crayfish can be found in the more than 70 major river basins of the region; more than 500 of these species are endemic. However, with declines in the quality and quantity of aquatic resources in the region has come an increase in the rate of extinctions; nearly 100 species have become extinct across the region in the last century. At present, 34 percent of the fish species and 90 percent of the mussels in peril nationwide are found in the southeast. In addition, the southeast contains more invasive, exotic aquatic species than any other area of the US, many of which threaten native species.

The diversity of black bass species (genus *Micropterus*) mirrors the freshwater fish patterns in North America with most occurring in the southeast. Of the nine described species of black bass, six are endemic to the southeast: Guadalupe bass, shoal bass, redeye bass, Florida bass, Alabama bass, and Suwannee bass. However, many undescribed forms also exist and most of these are in need of conservation measures to prevent them from becoming imperiled. Furthermore, of the black bass species with the greatest conservation needs, all are endemic to the southeast and found in relatively small ranges (Figure 1). In an effort to focus and coordinate actions to conserve these species, local, state and federal agencies, universities, NGOs and businesses from across the region have come together in partnership with the National Fish and Wildlife Foundation to develop the Southeast Native Black Bass Keystone Initiative. Although the initiative plans to address all species of endemic black bass in the southeast, initial conservation actions will focus on three species with critical conservation needs: Guadalupe bass, redeye bass and shoal bass.

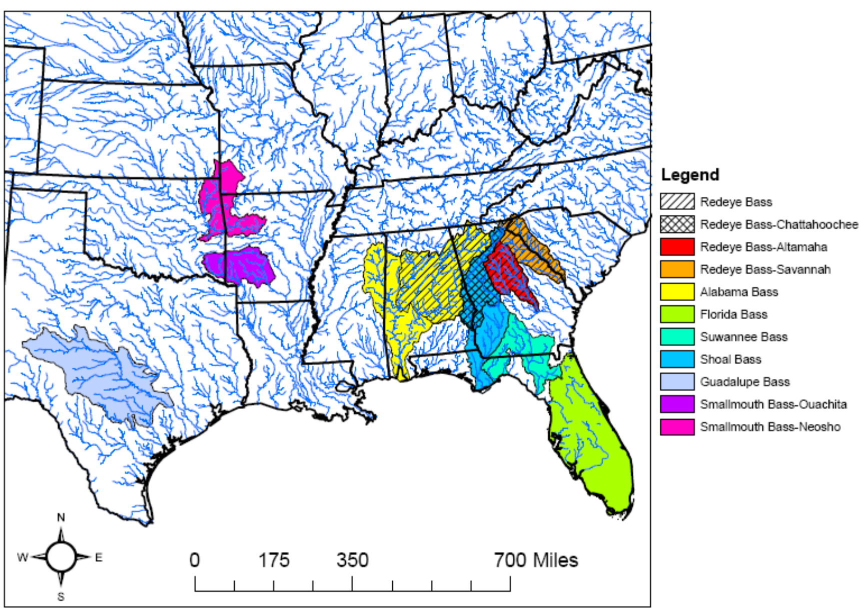


Figure 1. Map depicting ranges of native black bass species and unique populations in the southeastern United States. Ranges are based on occurrences at the cataloging unit (8 digit HUC) scale (http://water.usgs.gov/GIS/huc_name.htm).

Implementation Strategies:
Strategy 1: Ameliorate effects of invasive species
Strategy 2: Protect and maintain intact, healthy habitats
Strategy 3: Restore habitat
Strategy 4: Conduct research to fill critical information gaps
Strategy 5: Provide coordination and adaptive management

Conservation Targets:
Guadalupe bass: 7 to 10 self-sustaining, genetically pure populations.

Redeye bass (Savannah): Quantify and protect self-sustaining genetically pure populations in Savannah sub-basins.

Shoal bass: Quantify and protect self-sustaining, genetically pure populations in the Flint and Chipola rivers; restore/protect all historic shoal bass populations in tributaries of Chattahoochee River in middle Chattahoochee areas; establish or maintain 7 to 9 self-sustaining genetically pure populations below dams of the mainstem Chattahoochee River in Middle Chattahoochee area.

Key partners:
Guadalupe Bass: Texas Parks & Wildlife Department, Texas State University, U.S. Fish and Wildlife Service, Hill Country Fly Fishers, BASS/ESPN, North American Black Bass Coalition, Texas Bass Federation, Texas River Protection Association, Hill Country Alliance, local governments, Natural Resources Conservation Service, Texas Nature Conservancy, Lower Colorado River Authority, Guadalupe-Blanco River Authority, local conservation groups, private landowners, and regional water planning groups

Redeye Bass (Savannah): South Carolina and Georgia Department of Natural Resources, University of South Carolina, Clemson University, BASS/ESPN, North American Black Bass Coalition, Georgia Bass Federation, U.S. Fish and Wildlife Service, Upstate Forever, Southern Company, U.S. Forest Service, The Nature Conservancy, local angling groups, local governments, local conservation groups, private land owners, Natural Resources Defense Council, and Foothills Resource Conservation District Council

Shoal Bass: Georgia Department of Natural Resources, Alabama Department of Conservation and Natural Resources, BASS/ESPN, North American Black Bass Coalition, Georgia Bass Federation, Alabama Bass Federation, Florida Bass Federation, Southern Company, Florida Fish and Wildlife Conservation Commission, U.S. Fish and Wildlife Service, National Resource Conservation Service, National Park Service, Georgia Power Company, local governments, universities, The Nature Conservancy, Riverkeeper organizations (Upper Chattahoochee, Flint, and Apalachicola), local conservation groups, private landowners, and regional water planning groups

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Conservation Need

The southeastern US harbors a diversity of aquatic habitats and species unparalleled in the nation. Over 1,800 species of fishes, mussels, snails, turtles and crayfish can be found in the more than 70 major river basins of the region. More than 500 of these species are endemic to the southeastern states or to individual watersheds within them. The diversity of black bass species (genus *Micropterus*) mirrors the freshwater fish patterns in North America with most occurring in the southeast. Of the nine described species of black bass, six are endemic to the southeast: Guadalupe bass, shoal bass, redeye bass, Florida bass, Alabama bass, and Suwannee bass (Figure 1). However, many undescribed forms also exist and most of these are in need of conservation measures to prevent them from becoming imperiled (Table 1). Furthermore, of the black bass species with a conservation need, all occur in the south.

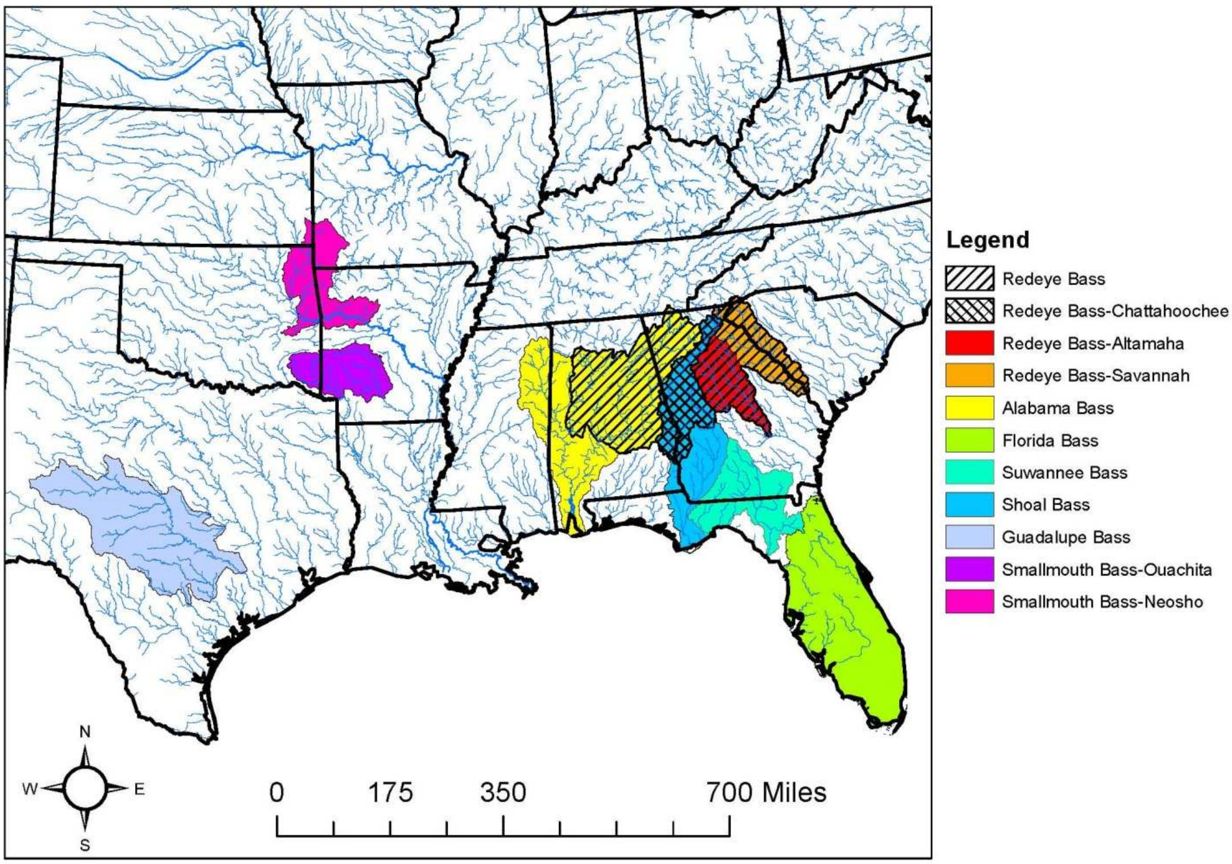


Figure 2. Map depicting ranges of native black bass species and unique populations in the southeastern United States. Ranges are based on occurrences at the cataloging unit (8 digit HUC) scale (http://water.usgs.gov/GIS/huc_name.htm).

Table 1. Native black bass species and unique populations in the southeastern United States in relation to conservation status, threat from invasive species, need for habitat restoration, need for habitat protection, need for coordination and adaptive management, and threats due to lack of scientific information.

Common name	Scientific name	Conservation status	Invasive Species Threats	Habitat Restoration	Habitat Protection	Integrated Planning	Lack of Information
Guadalupe bass	*Micropterus treculii*	Vulnerable[1, 2]	High	Medium	High	High	Medium
Shoal bass	*Micropterus cataractae*	Vulnerable[1, 2]	High	Medium	High	High	High
Suwannee bass	*Micropterus notius*	Vulnerable[1]	Medium	Medium	High	Medium	Medium
Redeye bass	*Micropterus coosae*	Secure[1]	NA	NA	NA	NA	NA
Redeye bass (Savannah)	*Micropterus sp. cf. M. coosae*[3]	NA	High	Medium	High	High	High
Redeye bass (Chattahoochee)	*Micropterus sp. cf. M. coosae*[3]	NA	Medium	Medium	High	High	High
Redeye bass (Altamaha)	*Micropterus sp. cf. M. coosae*[3]	NA	Medium	Medium	Medium	Medium	High
Alabama bass	*Micropterus henshalli*	NA	Low	Low	Medium	Medium	Medium
Florida bass	*Micropterus floridanus*	NA	High	Low	Medium	High	Medium
Smallmouth bass (Neosho)	*Micropterus dolomieu velox*[4]	NA	High	Medium	High	High	High
Smallmouth bass (Ouachita)	*Micropterus sp. cf. M. dolomieu velox*[4]	NA	High	Medium	High	High	High

NA=not assessed; High, medium, and low correspond to the level of threat or need.

[1] NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: October 23, 2009).

[2] *Jelks, H. L. and others. 2008. American Fisheries Society Imperiled Freshwater and Diadromous Fishes of North America. Retrieved August 3, 2009 from http://fisc.er.usgs.gov/afs/.*

[3] Straight, C.A., B. Albanese, and B.J. Freeman. [Internet]. [updated 2009 March 25]. Fishes of Georgia Website, Georgia Museum of Natural History; [cited October 23, 2009]. Available from: http://fishesofgeorgia.uga.edu

[4] The undescribed epithet is used here for the first time to differentiate between Ozark highlands (Neosho) and Ouachita highland forms and is based on information contained in Stark, W.J. and A.A. Echelle. 1998. Genetic structure and systematics of smallmouth bass, with emphasis on Interior Highlands populations. Transactions of the American Fisheries Society 127:393-416.

With declines in the quality and quantity of aquatic resources in the region has come an increase in the rate of extinctions; nearly 100 species have become extinct across the region in the last century. At present, 34 percent of the fish species and 90 percent of the mussels in peril nationwide are found in the southeast. Further, in a 1998 report titled Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity, The Nature Conservancy, looking at more than 2,000 small watersheds across the continental U.S., identified 87 sub-watersheds in the U.S. with 10 or more “at risk” species of freshwater fish and mussels. Seventy-five of these 87 “hot spots” are contained in the 14 southeastern states, and 18 of the top 19 are in four basins within their boundaries. These declines have many sources, including hydrologic alteration, habitat destruction, reduced water quality, loss of connectivity and the negative effects of nonindigenous species (e.g., predation, competition, and hybridization with native forms); roughly one half of the exotic fish species introduced into the southeast have become established, stressing or altering ecological systems. The southeastern US contains more nonindigenous aquatic species than any other part of the country (Benson et al. 2001). Some sources of habitat stress are direct such as stream piping, relocation, shoreline armoring, excessive siltation, and contaminants, and often associated with development, commerce, agriculture, forestry and mining. Less direct stressors, especially human population growth and climate change, cumulatively exert a persistent and growing landscape-level effect on fish and their habitats. As more people use increasingly limited natural resources, habitats are impacted. U.S. Census data from April 2000 indicate the human population of the 14 southeastern states exceeds 90 million (97,371,542) and, when compared to 1990 figures, points to an increase of over 14 million (14,656,552) people in 10 years. Significant continued population growth in the southeast is expected.

Climate models project that temperatures in the southeast will increase on average by 4°-10° F over the next 30 years, with increasingly hotter summers and higher heat indices. Based on recent precipitation trends in the region, increases and decreases in precipitation and temperature will be variably manifested geographically, potentially exacerbating existing droughts and developing water shortages in parts of the region. There is also an existing measurable trend in the southeast for precipitation to occur in more intense events. While uncertainties in precipitation projections make it difficult to predict effects on stream and river flows, areas experiencing drought may respond with greater pressure on groundwater for irrigation and water supply, exerting indirect consequential impacts on aquatic ecosystems. A study of possible effects from climate change on the world’s major river systems indicates that by 2050, every populated basin in the world will experience changes in river discharge and many will experience serious declines in water quality and quantity. It is reasonable to expect these climate trends to increasingly stress species that are near the upper ranges of their temperature tolerances in the southeast and those requiring specific habitats that may be affected by the associated hydrological changes.

These factors, combined with already fragmented and degraded habitats, will likely contribute to increased rates of imperilment of native species across the region, including several species of endemic black bass. The black bass species with the greatest conservation needs are endemic to the southeastern US and found in relatively small ranges. The distribution, biology, fisheries, threats and conservation needs of three species (forms) are described below although it is expected that this plan will ultimately be expanded to cover all the species and forms listed in Table 1.

[The above paragraphs consist of text modified from the Southeast Aquatic Resources Partnership's Southeast Aquatic Habitat Plan.]

Guadalupe Bass *Micropterus treculii*

The Guadalupe bass is a Central Texas endemic, occurring only in streams draining the Edwards Plateau region (Hubbs 1957). The native range includes streams of the San Antonio, Guadalupe, Colorado and Brazos river systems. It also has become established in the Nueces River system due to a 1973 introduction by Texas Parks and Wildlife Department (TPWD) of approximately 2,000 individuals from the Guadalupe River population. Species recognition came in 1953 when Clark Hubbs found numerous examples of sympatric occurrence with the closely related spotted bass *M. punctulatus* (Jurgens and Hubbs 1953; Hubbs 1954). In 1989, it was designated the State Fish of Texas by the Texas Legislature, in recognition of the unique character of both the Guadalupe bass and its habitat. Guadalupe bass has long provided a popular sport fishery in the Edwards Plateau region of Texas. The fishing experience is purported to be similar to that enjoyed by trout fishing enthusiasts; i.e., pounds of harvested fish are less important than the quality of a fishing trip for an agile, fast-water fish occurring in an attractive, natural setting. (average size = 0.5-1 kg; world record = 1.67 kg)

Edwards (1980) determined many of the critical components of Guadalupe bass life history. He noted their preference for flowing waters of streams, 2-10 m in width and association with large rocks, cypress roots, stumps and similar types of cover. They are usually found in waters with annual thermal fluctuations of 4-35 C, but not in thermally stable, headspring-influenced locations, where largemouth bass *M. salmoides* predominate. Guadalupe bass overwinter in deep pools with currents, spawn in quiet, shallow areas near a source of moving water and their young occupy gradually swifter and deeper waters as they grow. Each of these life history traits, and probably several others, contribute to the allotopic distribution of Guadalupe bass and largemouth bass within the streams of Central Texas.

Guadalupe bass numbers have decreased over recent decades and it was listed as "depleted" in Texas more than 30 years ago (Hubbs 1976). They were also on the Watch List of the Texas Organization for Endangered Species (TOES 1988). The species was also listed as "special concern" by Deacon et al. (1979), Williams et al. (1989) and Hubbs et al. (1991, 2008). The decline in abundance is due to a combination of factors, including decreased stream flow, reservoir construction, habitat degradation (Hurst et al. 1975; Edwards 1978) and hybridization with smallmouth bass *M. dolomieu* (Edwards 1979, 1980; Garrett 1991). Habitat loss and genetic contamination problems are pervasive throughout the range of Guadalupe bass. Stream flow declines and a decrease in habitat quality are due mainly to human cultural activities and population growth, and thus are likely to continue (Edwards et al. 1989). Guadalupe bass are adapted for small stream environments and do not flourish in typical Hill Country reservoirs (Hurst et al. 1975; Edwards 1980) or downstream of a dam with a hypolimnion release (Edwards 1978). Impounded rivers and streams reduce available habitat and confer an advantage on more lacustrine-adapted fish species.

Interspecific hybridization became a threat to Guadalupe bass survival when the ecologically similar smallmouth bass was introduced, beginning in 1974. TPWD initiated an intensive smallmouth bass stocking program in the Edwards Plateau region with the objective of increasing angler harvest in Central Texas streams and reservoirs (Garrett 1985). An unforeseen result of the stocking program was hybridization between these previously allopatric species (Edwards 1979, 1980; Whitmore and Butler 1982; Whitmore 1983). An electrophoretic examination of Guadalupe bass in 1989 showed extensive, introgressive hybridization with smallmouth bass in almost every Guadalupe bass stream system (Garrett 1991). The only remaining pure populations of Guadalupe bass were in Gorman Creek (Colorado River drainage) and the San Saba, Llano, Pedernales and Medina rivers (Garrett 1991). An assessment of the current status is now underway. Preliminary results show only the Pedernales River with a pure population of Guadalupe bass. The Nueces River population and a sanctuary population established at the Lost Maples State Park on the Sabinal River acts to further protect the species although these are both outside the native range. Although TPWD has a policy of no longer stocking smallmouth bass within the native range of Guadalupe bass, the hybrids are still problematic. Since 1992, TPWD has been evaluating the potential of a stocking program whereby pure Guadalupe bass are introduced into a genetically contaminated stream system (Johnson Creek) in order to numerically and reproductively overwhelm the hybrid swarm. Although total eradication of the smallmouth bass genome is improbable in some of the more contaminated stream systems, if the smallmouth bass genetic influence could be reduced to low levels (1%), genetic restoration would be considered successful (Allendorf and Leary 1988). Johnson Creek, a 25-km tributary of the Guadalupe River, has been stocked annually with an average of almost 50,000 pure Guadalupe bass fingerlings for the last 9 years. Electrophoretic results have shown a reduction in hybrids and a possible positive effect in the main stem as pure Guadalupe bass "leaked" out into the Guadalupe River. The stocking program was expanded in 2006 to include the mainstem Guadalupe River.

Redeye Bass *Micropterus coosae*

The redeye bass *Micropterus coosae* was described by Hubbs and Bailey (1940). The species native range includes upper portions of the Savannah and Altamaha river drainages on the Atlantic Slope, and the Mobile Bay and Apalachicola drainages on the Gulf Slope. A Santee drainage population is regarded as introduced (Oswald 2007; Rhode et al. 2009). Redeye bass prefer cool flowing Piedmont streams. Though reported to poorly tolerate impoundment, redeye bass have persisted and even thrived in several reservoirs in the upper reaches of the Savannah drainage (Koppelman and Garret 2002). These reservoir fish attain a much greater size than is seen in redeye in their native stream habitats. The world record redeye bass was caught from Lake Jocassee on the Savannah drainage, and weighed 2.34 kg.

Atlantic Slope populations of redeye bass differ morphologically from those of the Mobile Bay drainages, and are commonly referred to as ‘Bartram’s Bass’ (Freeman, unpublished data). Phylogenetic analysis supports this distinction, and further suggests significant divergence between Altamaha/Ogeechee redeye and those of the Savannah drainage. There is considerable variation within the Savannah drainage as well. The Tugaloo and Seneca watersheds in the upper drainage, and the middle Savannah River represent three distinct management units (Oswald 2007). South Carolina’s Comprehensive Wildlife Conservation Strategy lists the redeye bass of the Savannah drainage as a Species of Highest Priority due to its restricted native range and threats from introduced species (Kohlsaat et al. 2005).

Redeye bass comprise a portion of the black bass fisheries of the upper Savannah reservoirs, Lakes Keowee, Jocassee, Hartwell and Russell. Savannah stream populations also receive some notice as a sport fishing resource. The Augusta Shoals area of the Savannah River is popular for redeye and introduced smallmouth bass. Fly fishing for redeye on the Chattooga River has become popular among local trout anglers in the summer months.

Redeye bass have declined in the reservoirs of the upper Savannah drainage corresponding to the illegal introduction of Alabama bass *Micropterus henshalli*. This non-native species appeared first in Lakes Keowee and Russell in the early to mid 1980s. By 1990 biologists were having difficulty identifying some black bass collected, and hybridization was suspected. Barwick et al (2006) confirmed hybrids between redeye and Alabama bass from Lake Keowee. A 2004 comprehensive genetic survey shows that Alabama bass have spread throughout the upper Savannah system of reservoirs, as have hybrids, while redeye bass appear to have been nearly eliminated from both Lakes Keowee and Russell (Leitner 2007). In a survey of stream populations the same year Alabama bass and/ or hybrids were collected from 2 of 12 sites sampled. At one tributary site Alabama bass and hybrids were collected below a natural barrier to upstream movement from Lake Keowee, but only pure redeye bass were collected above it. In recent new collections above the same barrier 2 of 7 fish were field identified as Alabama bass, and 1 was identified as hybrid, indicating Alabama bass are moving further up this tributary population (SCDNR, unpublished data). The movement of these fish into tributary populations from the reservoirs is a threat to redeye bass in the Savannah drainage. Additionally, smallmouth bass were recently illegally introduced in the Augusta Shoals habitat. Both smallmouth bass and hybrids between smallmouth and redeye have since been collected from the shoals (Leitner 2008). Sampling is ongoing at all 12 tributary sites originally surveyed to assess any change in species composition.

Certainly, introduced species comprise the greatest threat currently to Savannah River redeye bass. The fish has already been displaced via hybridization from two reservoirs within its range. The expansion of Alabama bass and its hybrids indicate that redeye bass populations in two other reservoirs may experience similar displacements. Stream populations are at risk due to both upstream movement of introduced species and their hybrids, and the unauthorized stocking of non-native black bass species. The education of anglers and angling groups through multiple channels is an immediate conservation need.

Another threat to redeye bass in the Savannah drainage is urbanization and land use changes imminent throughout its range. Many of the Inner Piedmont streams that comprise redeye habitat are in private ownership and under considerable development pressure. Restoration of instream habitat and buffers in the upper, trout-water reaches of some streams is already underway. Expansion of this effort to target redeye bass habitat where it is degraded, and preservation of high quality intact stream habitats is needed.

In addition to the finfish and mussel species listed in the Ancillary Species Benefits section of this plan, two specifically identified crayfish species of special concern will receive direct benefits from habitat protections and improvements directed at redeye bass. They are the crayfish species Chauga crayfish *Cambarus chaugaensis* and longnose crayfish *C. longirostris* (Kohlsaat et al. 2005).

Shoal Bass *Micropterus cataractae*

Shoal bass (*Micropterus cataractae*) is a species endemic to the Apalachicola drainage, including the Chattahoochee and Flint river systems in Alabama, Florida, and Georgia. Additionally, the species was stocked into the Ocmulgee River, a tributary of the Altamaha River in the mid 1970s. Shoal bass are one of the most recently described black bass species (Williams and Burgess 1999), and very little information exists on the biology of this species. However, shoal bass are thought to be declining in abundance in many localities within its native range (Williams and Burgess 1999; Wheeler and Allen 2003; Boschung and Mayden 2004). Shoal bass are habitat specialists, occupying shallow, rocky riffles and shoals in medium- to large-sized streams and rivers and are intolerant of reservoir conditions (Wheeler and Allen 2003; Boschung and Mayden 2004). This species has been assigned a status of "Special Concern" by the Endangered Species Committee of the American Fisheries Society (Williams et al. 1989), mainly because of habitat loss and associated distributional declines. There is a possibility that the shoal bass may lose its protected status in Florida due to changes in the state's classification system.

In Georgia, significant fisheries have developed for shoal bass on the Flint, Ocmulgee, and upper Chattahoochee rivers, with a growing segment of the angler population seeking large, trophy ($\geq$ 2.25 kg) fish (J. Evans and C. Martin, Georgia Department of Natural Resources, personal communications). In terms of abundance and size structure, the highest quality shoal bass fisheries are found in Georgia, which also contains most of the remaining habitat for this species. The Flint River in Georgia flows over 320 km before being impacted by the first of three mainstem impoundments, making it one of only 42 rivers in the U.S. with > 200 km of unimpeded flow (Benke 1990). In contrast, numerous dams have been constructed on the Chattahoochee River, flooding shoal bass habitat and isolating shoal bass populations (Dakin et al. 2007). Thus, the Flint River in Georgia represents the largest remaining intact ecosystem for shoal bass in their native range. Shoal bass biology has been little studied in its natural range (Williams and Burgess 1999), and biologists lack the basic life history data that are vital for successful management of any fishery. The Florida Fish and Wildlife Conservation Commission (FWC) is currently studying shoal bass in the Chipola River to gain a better understanding of the population dynamics and genetic structure of this species. Additionally, Auburn University has been studying shoal bass population dynamics in Alabama streams since 2004 and in the Flint River, Georgia, since 2007.

Historically, shoal bass occurred in sympatry with native stocks of largemouth bass (*Micropterus salmoides*) throughout their native range. Largemouth bass and shoal bass are rarely found in the same habitat in streams. While shoal bass are commonly found in shallow riffle areas and fast current, largemouth bass more typically occur in pools and slower runs (Hurst 1969; Wheeler and Allen 2003). However, shoal bass have been commonly collected in run and even pool habitats (J. Evans, GDNR, and C. Paxton, FWC, personal communications). Shoal bass in the Ocumlgee and Flint River systems in Georgia appear to spawn in large shoal complexes, apparently moving often long distances to reach these habitats (S. Sammons, Auburn University, unpublished data). After spawning, some of these fish, particularly the larger individuals, leave the shoals and disperse throughout the river; however, many fish remain in shoal habitat for most of the year. In addition, Johnston and Kennon (2007) reported an ontogenetic shift in shoal bass habitat use in an Alabama stream, with larval, juveniles, and adults using distinct microhabitats within shoals. Furthermore, these habitat associations changed in response to droughts, which has been commonly reported for other lotic fishes (Matthews and Marsh-Matthews 2003). Working with the same Alabama shoal bass population, Stormer and Maceina (2009) found that shoal bass continued to be found in run and eddy habitat as water levels decreased, even when these mesohabitats constituted less than 20% of available habitat. Shoal bass only used pool habitats in late summer and fall, when shoal habitats were virtually dewatered. Also, the shoal bass population suffered high mortality during that drought event, resulting in an 80% decline in population size (Stormer and Maceina 2008), and had not recovered as of spring 2009. Thus, shoal bass in tributary systems appear to be highly vulnerable to droughts and the resulting loss of connectivity to mainstem systems (Matthews and Marsh-Matthews 2003), which may be exacerbated by the presence of mainstem dams and impounding of historic shoal bass habitats (Dakin et al. 2007).

Based on available knowledge, threats to shoal bass include the following:

1) Land Use Changes - Human population has shown a dramatic increase in the southeastern U.S. over the last half of the 20th century, and these rates appear to be increasing in the 21st century. Georgia's population has doubled over the last 50 years and increased more than 25% from 1990 to 2000, which was 20% faster than the rest of the nation (U.S. Census Bureau, http://www.census.gov/main/www/cen2000.html). This population growth has resulted in rapid rates of development and associated land use changes, including increases in impermeable surfaces, which has been shown to greatly affect hydrology of streams in surrounding watersheds. Johnston and Maceina (2009) documented a change in land use over a 30-year period in two Alabama watersheds where shoal bass have largely disappeared during that same time frame. In both cases, the natural pine-hardwood forest cover declined 32-51% while pine mono-culture increased more than three-fold. While this study showed little change in urban or residential uses, many new homes have been constructed along one of the streams since the last land-use survey in that study (2001), and land use continues to change rapidly in these watersheds. Associated with these land-use changes is a concomitant decrease in flows, which can be attributed to the 69% increase in the human population in the surrounding area over the same time frame (Johnston and Maceina 2009). Thus, changes in land use in watersheds containing shoal bass can potentially impact shoal bass populations by increasing runoff and siltation, as well as decreasing flows and increasing the deleterious effects of natural droughts.

2) Dams - Construction of dams was rampant across the southeastern U.S. during the first half of the 20th century (Miranda 1996). Dam construction leads to river fragmentation and isolation of fish populations, and can reduce genetic diversity and recruitment of river fishes (Martinez et al. 1994; Jager et al 2001; Jaeger et al. 2005). Beginning in the mid 1830s, shoal bass habitat began to be impacted by dams in the Apalachicola watershed. A series of mill dams were constructed on major tributaries of both the Flint and Chattahoochee Rivers in Alabama and Georgia (Dakin et al. 2007; Stormer and Maceina 2008) that restricted access to some shoal habitat. In the early 20th century, large mainstem dams were constructed on the Chattahoochee River near the cities

of Atlanta and Columbus, Georgia, further restricting fish movement and inundating shoal habitat (Dakin et al. 2007). More dams were constructed on the Chattahoochee River in the latter half of the 20th century, ultimately eliminating roughly half the shoal bass habitat found above the Fall Line of that river. Currently, shoal bass in much of the Chattahoochee Basin exist in small isolated populations found immediately downstream of dams and in shoals of large tributaries. Since shoal bass do not appear to tolerate impoundment (Williams and Burgess 1999), the tributary populations have been effectively cut off from mainstem shoal habitats by dams and are likewise isolated. The overall effect of dams in the Chattahoochee River has been to reduce a continuous population of shoal bass into a series of isolated populations of limited genetic diversity and low effective population size, with an increased likelihood of extinction (Dakin et al. 2007; Sammons and Maceina 2009). In contrast, the shoal bass population in the unimpounded section of the Flint River is largely intact, and recent data indicates that these fish frequently make long (> 60 km) migrations in the spring to reach large shoal complexes, where they presumably spawn (S. Sammons, unpublished data). Below the series of impoundments, shoal bass are found in and around limestone shoals and outcroppings, and also make long upstream migrations to spawn (T. Ingram, GDNR, personal communication). Because the mainstem impoundments on the Flint River were constructed below the Fall Line, they likely flooded less shoal bass habitat than the series of dams on the Chattahoochee River. However, altered flow regimes from these dams have been found to impact shoal bass recruitment, and GDNR has been stocking shoal bass in these areas for the last 20 years to mitigate the effects of these flows (R. Weller, GDNR, personal communication).

3) <u>Exotic Species Introductions</u> - Recently, anglers have been illegally introducing spotted bass into lotic systems in Georgia and Florida that formerly contained only largemouth bass and shoal bass. Unlike the native congeneric largemouth bass, spotted bass commonly use habitats similar to shoal bass. Spotted bass were first documented from the Flint River in 2005, and their population has grown substantially since. In Alabama, many streams in which shoal bass been collected historically now appear to be dominated by spotted bass (Stormer and Maceina 2008), which have been found to prefer the same type of habitat used by shoal bass (Vogele 1975; Hurst et al. 1975; Layher et al. 1987; Tillma et al. 1998). Spotted bass appear to be more of a habitat generalist than shoal bass (Vogele 1975; Sammons and Bettoli 1999), and may be able to outcompete shoal bass when the two are found sympatrically (Miller 1975; Smitherman 1975). Many river systems in the range of shoal bass are being degraded due to changes in land use and increased demand for water supplies (Williams and Burgess 1999), and degradation of habitat in systems where both species are found may favor spotted bass over shoal bass, due to their greater adaptability.

Smallmouth bass have recently been found in the Chattahoochee River below Morgan Falls Dam in Atlanta. This stretch was recently the site of a 5-year shoal bass restoration effort by the National Park Service and Georgia Department of Natural Resources. Like spotted bass, smallmouth bass also use similar habitats as shoal bass (Todd and Rabeni 1989; Dauwalter and Fisher 2008), and could become another competitor with shoal bass already dealing with the effects of altered thermal regimes from upstream dam releases and the presence of non-native spotted bass.

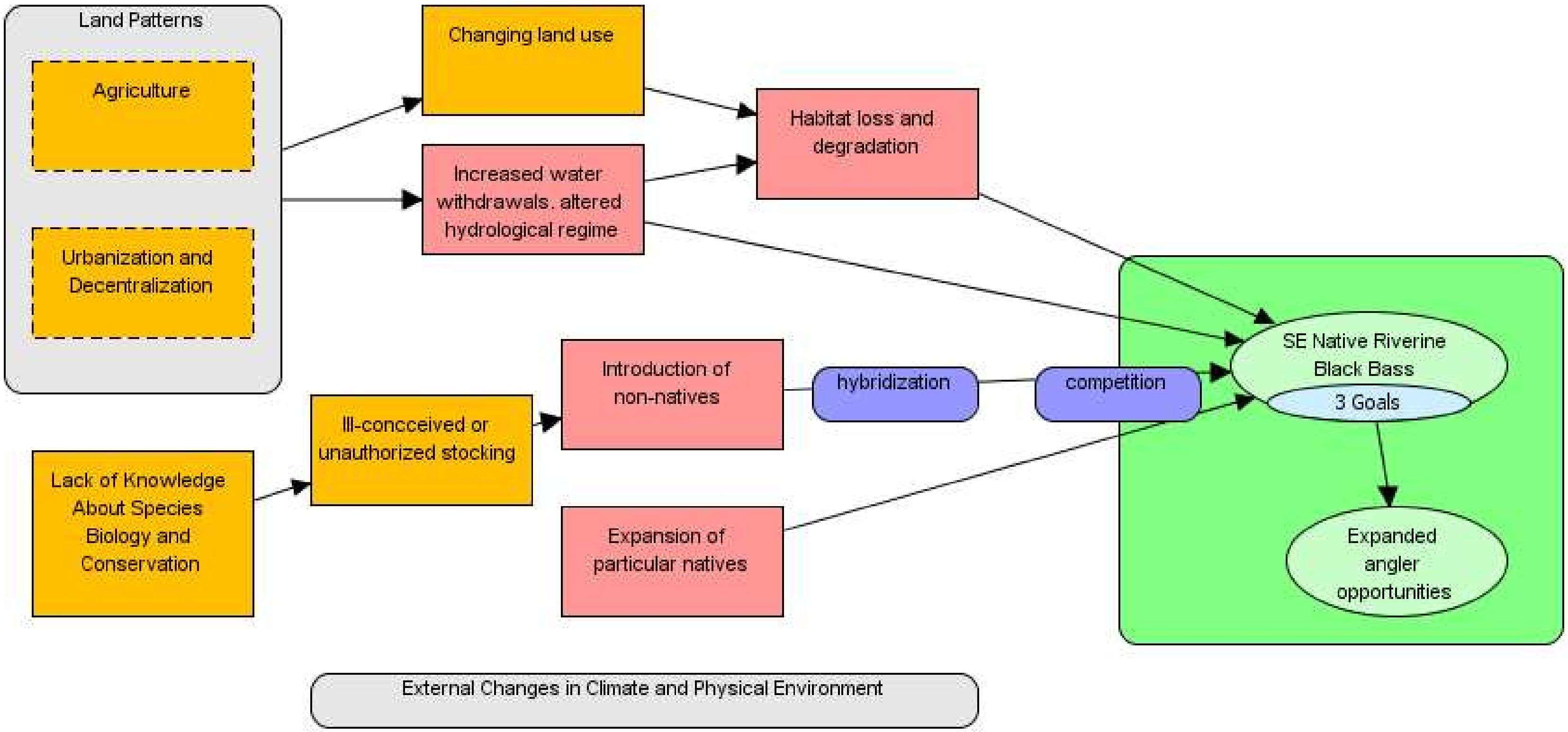
Diet of smallmouth bass, spotted bass, and shoal bass in rivers may be relatively similar, consisting of fish, aquatic insects, and crayfish (Vogele 1975; Austen and Orth 1987; Scott and Angermeier 1998; Wheeler and Allen 2003). Wheeler and Allen (2003) found that diet of shoal bass and largemouth bass was relatively similar in the Chipola River, Florida; however, they observed subtle differences between the species. Diets of age 0 shoal bass were dominated by mayflies; whereas, age-0 largemouth bass ate primarily grass shrimp *Palaemonetes* spp. Both species utilized fish and crayfish as they grew; however, largemouth bass switched to crayfish earlier than shoal bass. Hurst (1969) found little difference between diets of shoal bass and spotted bass in Halawakee Creek, Alabama, with both species feeding heavily on fishes and crayfishes. Thus, shoal bass may not only compete with other black bass species for space but also food, if supplies are limiting.

Regardless of the mechanism, spotted bass appear to be replacing shoal bass in many of the streams in Alabama. Lending further support for this hypothesis is the fact that the only viable shoal bass population found in the Auburn University 2005-06 survey was above a natural barrier, a vertical 3- to 5-m drop into a plunge pool on Little Uchee Creek, which may have impeded upstream migration of fishes in most years. Few spotted bass were collected by electrofishing in the areas with shoal bass above this plunge pool; however, the majority of black bass collected by angling below it were spotted bass. Furthermore, the section of Halawakee Creek above where Hurst (1969) sampled in 1968-69 is isolated from the downstream sections by a mill dam, and only largemouth bass were collected above the dam in 2005-06; whereas, spotted bass were commonly collected below the dam (Stormer and Maceina 2008).

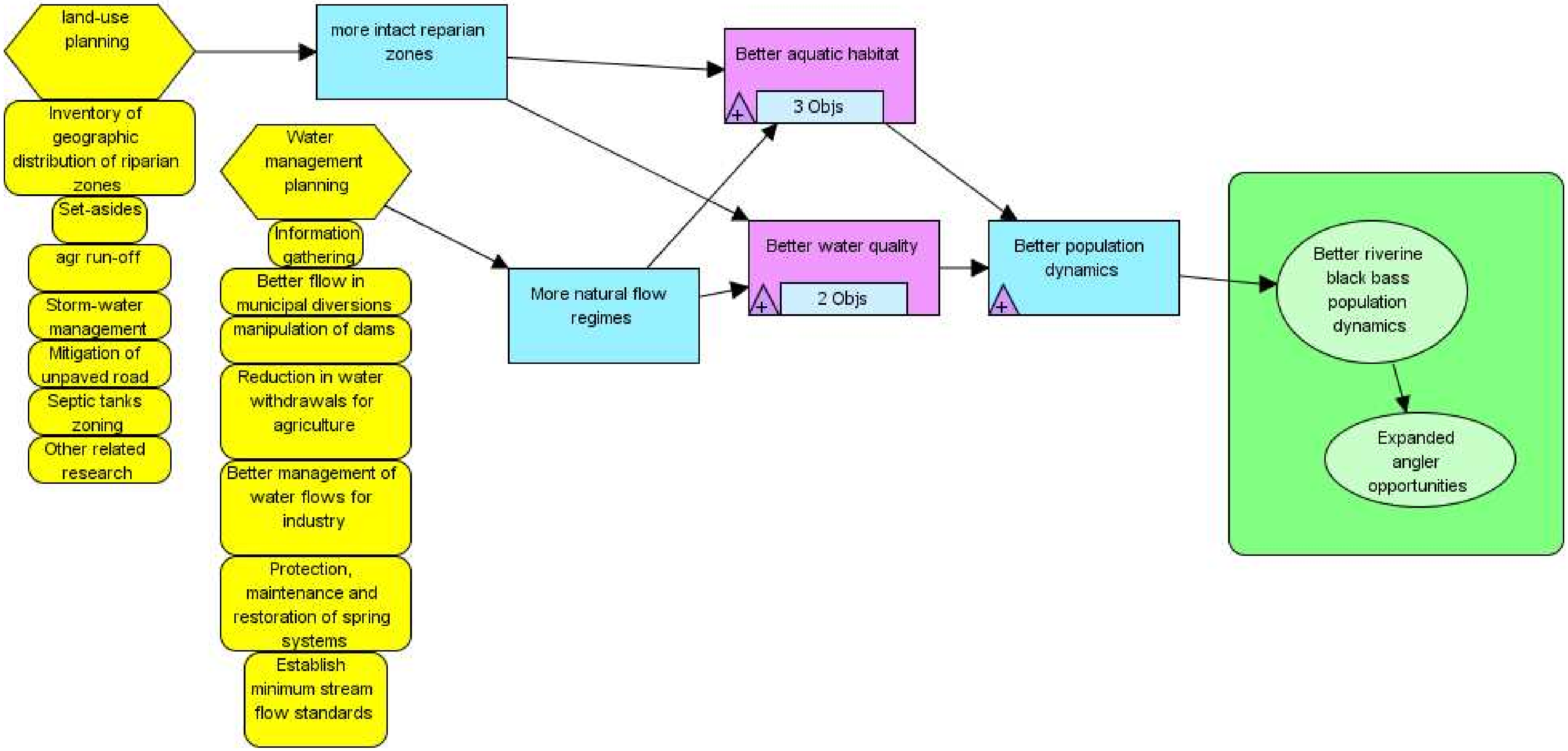
Black bass commonly hybridize with each other when one or more of the species is introduced (Whitmore 1983; Koppelman 1994; Pierce and Van Den Avyle 1997; Pipas and Bulow1998; Barwick et al. 2006), and therefore the likelihood of genetic introgression of introduced black bass species and native shoal bass appears to be high. Hybridization between shoal bass and spotted bass was recently documented in the Chipola River, Florida (Porak and Tringali 2009). Preliminary studies uncovered five hybrid individuals among the 45 presumptive Chipola River shoal bass genotyped to date. Estimates of effective population size (N_e) based on linkage disequilibrium and heterozygote-excess methods were 27.5 (95% CI = 20.7 to 38.3) and 20.4 (CI not available for this method), respectively. Should this estimate hold in the completed study, this low-N_e dynamic is likely to retard the ability of natural selection to purge the flux of non-indigenous alleles (some of which may be deleterious) into Chipola River shoal bass. Among individual shoal bass, high degrees of relatedness, especially full-sib and half-sib pairs, were observed. Accordingly, genetic dynamics within the Chipola River shoal bass population are not optimal for continued genetic viability.

Genetic analysis of suspected hybrid black bass in Halawakee and Osanippa creeks, Alabama, found two shoal bass-spotted bass hybrids in Osanippa Creek and one largemouth bass-spotted bass hybrid in Halawakee Creek (D. Philipp, Illinois Natural History Survey, unpublished data). Therefore, some hybridization has occurred on in these systems, which could jeopardize the future of shoal bass in Alabama, as has been observed for Guadalupe bass (*Micropterus treculi*) in Texas (Morizot et al. 1991). Two suspected black bass hybrids were collected by angling in the Chattahoochee River in Atlanta in spring 2009. These fish were field-identified as possible smallmouth bass-spotted bass hybrids; since then, numerous other reports of these odd-looking fish have been received by anglers fishing the same area (S. Sammons, Auburn University, personal communication). Thus, conservation of genetically-pure, native stocks of shoal bass should be a high priority of fisheries biologists.

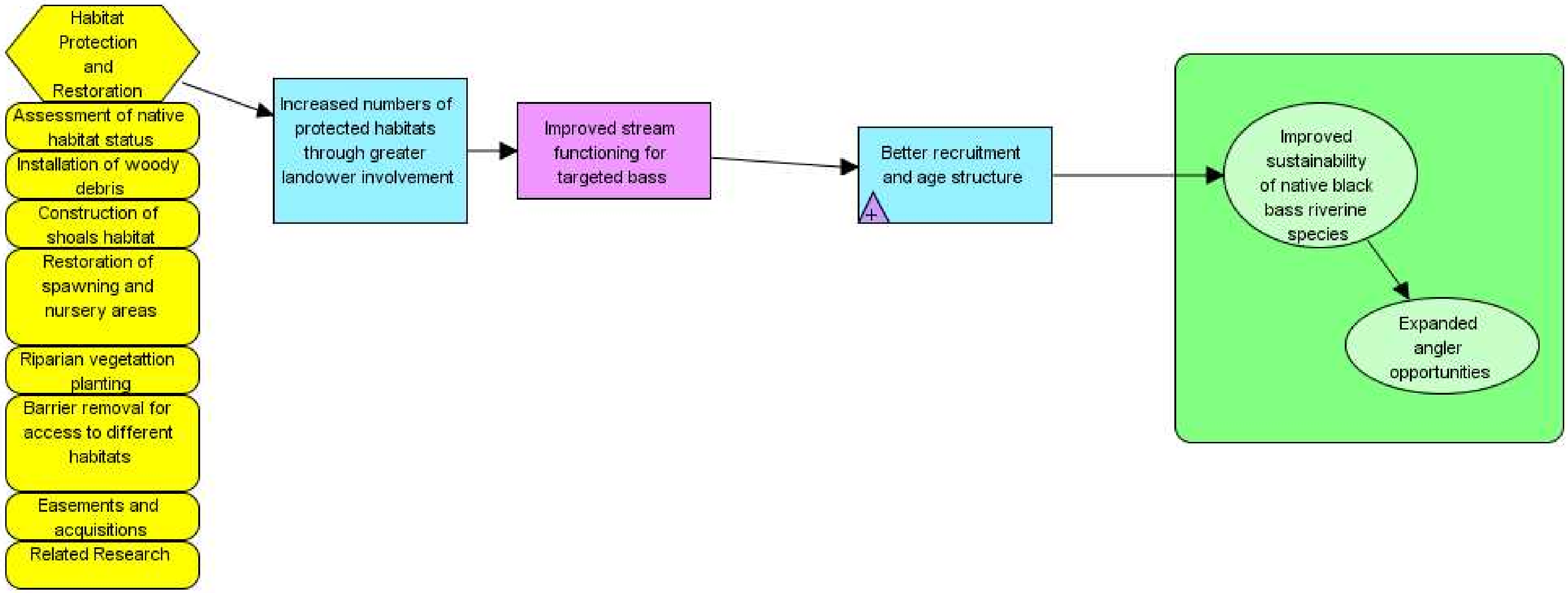
DRAFT Logic Framework. A logic framework is a diagram of a set of relationships between certain factors believed to impact or lead to a conservation target. Logic frameworks are typically composed of several chains of logic whose arrows are read as “if-then” statements to help better understand how threats contribute to conservation target declines. They are used to define the conservation problem, assess limiting factors, and prioritize key strategies.



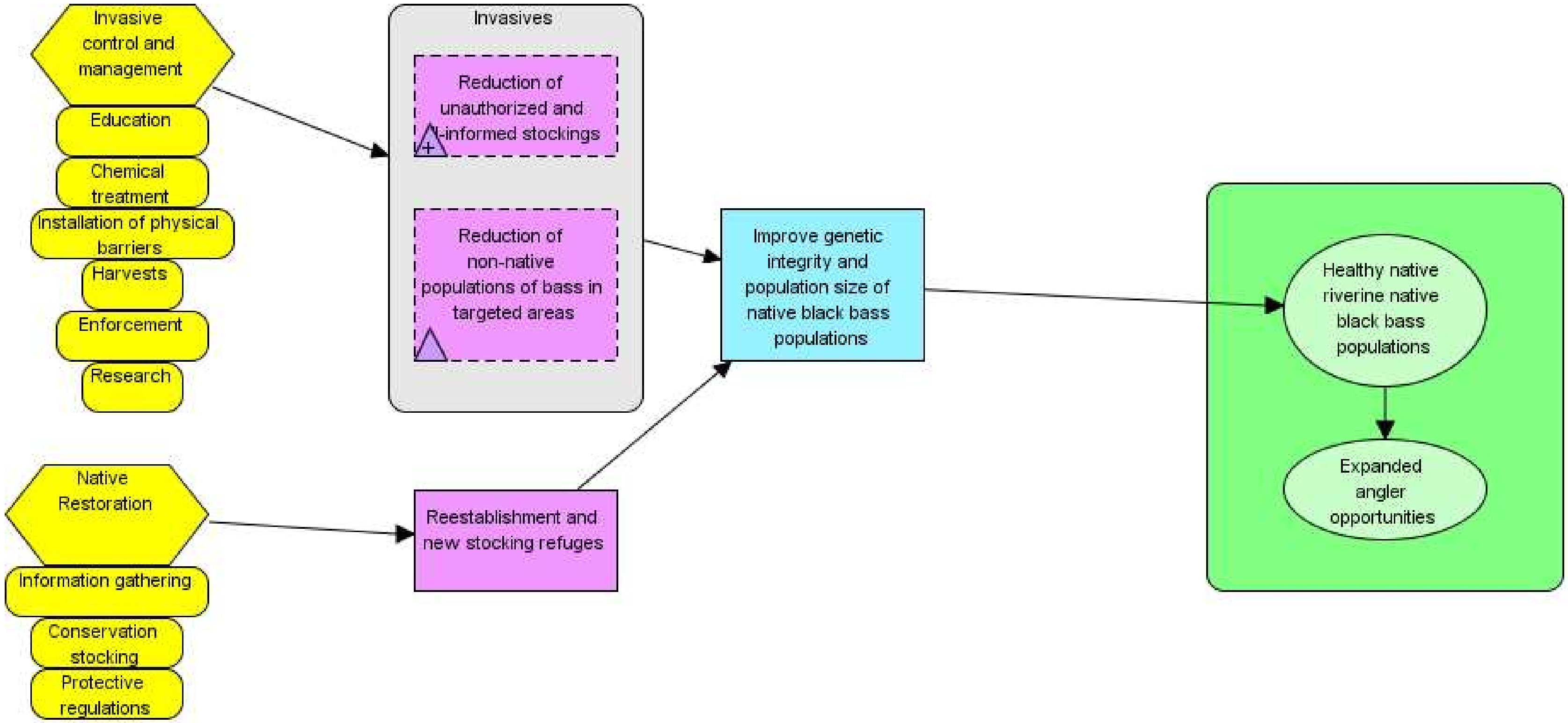
DRAFT Results Chain - Planning. A results chain identifies specific strategies to be implemented to restore native black bass.



DRAFT Results Chain – Habitat Protection and Restoration. A results chain identifies specific strategies to be implemented to restore native black bass.



DRAFT Results Chain – Ameliorate Effects of Invasives. A results chain identifies specific strategies to be implemented to restore native black bass.



Conservation Outcomes

In 2008, the Southeast Aquatic Resources Partnership (SARP) developed the Southeast Aquatic Habitat Plan (SAHP) to guide and facilitate the cooperative conservation of fish and aquatic resources in the southeastern US and fulfill the goals of the National Fish Habitat Action Plan within the region. The SAHP represents aquatic habitat conservation strategies developed by state fish and game agencies from the 14 southeastern states in collaboration with federal agencies, local organizations and community leaders in the region.

The following habitat objectives and targets were established by SARP in order to measure the long term success of conservation actions implemented under the SAHP. The objectives and targets also provide a framework for more specific conservation actions that will be taken to conserve endemic black bass and their habitats in the southeast through this NFWF Keystone Initiative. This initiative will contribute towards the goals and objectives of both SARP and the National Fish Habitat Action Plan in the southeast region.

Objective 1 - Establish, improve and maintain riparian zones:

Riparian zones buffer the impacts on adjacent waterbodies from human land use activities while supporting aquatic as well as terrestrial habitats. Wenger (1999) defines riparian zones as land areas located adjacent to waterbodies, often naturally vegetated with grasses, shrubs and trees. Effective riparian zones function as efficient traps, filtering out sediments and nutrients. They provide structure for ephemeral or intermittent channel flow. Vegetation closest to the waterbody provides cover and habitat for wildlife, helps maintain normal water temperatures, slows over-bank flows, and provides energy in aquatic systems. Vegetative roots, especially from woody plants and trees, decrease erosion of the banks and shorelines (Pollen and Simon 2005). During certain periods or under certain circumstances, riparian zones play significant roles in changing water quality as well as in the life stages and life-sustaining activities of many aquatic animals. Natural riparian areas also provide important habitat and travel corridors for terrestrial wildlife. Both grassed and forested buffers trap sediment. Forested buffers provide other benefits as well, such as better runoff control while also allowing input of large woody debris and other matter necessary for aquatic organisms (Wenger 1999). Urbanization, industrialization, agriculture and other types of development often degrade or reduce the size or health of riparian areas. Ideally, appropriately sized riparian zones in every watershed in the southeastern region should be permanently protected. In areas where vegetated riparian areas are already lost or loss is unavoidable, such as urban areas, methods to restore or provide the functions of healthy, natural riparian areas should be explored and utilized. The challenge is to maintain, conserve, permanently protect, construct or restore riparian zones that can support healthy aquatic habitats and populations of fish and other aquatic organisms while meeting public needs.

Targets

An ideal riparian zone would extend over all land adjacent to a waterbody to the extent necessary for effective buffer and support. Buffer slope and the presence of wetlands have been determined to be the most important and useful factors in determining ideal buffer width. Long-term studies suggest that a 30 m (100 foot) riparian buffer is sufficiently wide to trap sediments under most circumstances, although they can vary based on type of soil, hydrology, slope and vegetation.

Native forest vegetation should be maintained or restored to provide optimal benefit (Wenger 1999). Riparian buffers should extend along both sides of rivers and streams, including intermittent and ephemeral channels, and completely around natural lakes and impounded waters. The initial target for this objective is limited by available regional data on riparian areas.

Using data compiled and processed by the U.S. Environmental Protection Agency's (EPA) National Exposure Research Laboratory that used the U.S. Geological Survey's (USGS) National Hydrography Dataset, the Heinz Center (2002) determined that, nationally, 23% of the lands within 100 feet of the waters' edge along streams nationwide were either farmlands or urban development in the early 1990s.

Target 1A. Ensure that adequate non-urban/non-agricultural riparian buffer habitats exist on at least 85% of the lands within 100 feet of rivers and streams in the Southeast by 2022.

- By 2012 ensure that at least 78% of the lands within 100 feet of rivers and streams in the southeast have adequate riparian buffers.
- By 2017 ensure that at least 81% of the lands within 100 feet of rivers and streams in the southeast have adequate riparian buffers.
- By 2022 ensure that at least 85% of the lands within 100 feet of rivers and streams in the southeast have adequate riparian buffers.

Objective 2 - Improve or maintain water quality:

The quality of water includes physical, chemical, and biological characteristics that sustain plant and animal life and support a variety of human uses including drinking water, fishing and boating, agriculture and industry, and other types of recreation and transportation. Water quality characteristics can be altered by storms and seasonal changes; industrial, manufacturing or residential discharges and runoff; urbanization; agriculture; and other land uses, sometimes for many miles from the contamination site. Plants and animals in any aquatic community are sustained by the balance of temperature, nutrients, and organic material in the habitat. Maintaining good water quality and preventing, halting, or reversing alterations support these life-sustaining balances and reduce treatment costs for human use. The challenge is to maintain or adjust the balance of water quality characteristics in aquatic systems to meet the needs of fish, other aquatic and terrestrial organisms, and the public.

Targets

Ideally the magnitude of change for this objective will be measured by the maintenance of or increase in the percentage of, or the number of miles of, streams and rivers, or acres of estuaries, wetlands, lakes, reservoirs, and ponds with water quality characteristics that meet the designated use. An example of a designated use might be fishable/swimmable waters or waters supporting aquatic life and recreation, such as addressed in Section 303(d) of the federal Clean Water Act. A decrease in the percentage of waterbodies in the southeastern region with water quality unable to support healthy ecological systems is desirable.

The EPA maintains a database of waterbody segments/areas that are classified as impaired in accordance with Section 303(d). Although the data in that system are not consistently expressed quantitatively in terms of stream miles or area extent, the 303(d) list includes a total number of impaired waterbody segments/areas. That number (7,073 as of June 2007) is used as an interim basis for Target 2A for this objective. Note that states have different listing criteria for these data. Some criteria are primarily anthropogenic in focus, some don't consider emerging contaminants such as pharmaceuticals, and some may be less suitable for describing impairment in some of the Southeast's low gradient systems, such as some habitats of the lower Mississippi River floodplain. However, these are the best available data upon which to base many of the following targets. In addition, ongoing research has resulted in an increase in the number of 303(d) listings of impaired waterbodies every two years, presenting the challenge described on page 13. Data are available to meet this challenge in the target's assessment.

Several other targets were also developed for this objective focusing on specific water quality characteristics, as further described below, using data from The Heinz Center (2002). Although those data apply to the nation as a whole and not to the Southeast specifically, they were, nevertheless, used when developing targets pending future development of more specific targets when better data are available. Note that these targets are regional, and are not meant to apply at every individual site.

Target 2A. Restore at least 710 waterbody segments/areas in the Southeast (10% of impaired segments/areas as of June 2007) to nonimpaired status per the EPA 303(d) list.

- By 2012 restore at least 140 waterbody segments/areas in the Southeast to nonimpaired status per the EPA 303(d) list.
- By 2017 restore at least 350 waterbody segments/areas in the Southeast to nonimpaired status per the EPA 303(d) list.
- By 2022 restore at least 710 waterbody segments/areas in the Southeast to nonimpaired status per the EPA 303(d) list.

According to the Heinz Center (2002), the USGS National Water Quality Assessment (NAWQA) found that 77% of stream sites nationwide during the period 1992-1998 were exceeding at least one standard or guideline for contaminants that may affect aquatic life in water. This was used as a basis for Target 2B.

Target 2B. Reduce to 70% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants or emerging contaminants affecting aquatic life.

- By 2012 reduce to 76% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants or emerging contaminants in water affecting aquatic life.
- By 2017 reduce to 75% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants or emerging contaminants in water affecting aquatic life.
- By 2022 reduce to 70% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants or emerging contaminants in water affecting aquatic life.

The NAWQA (Heinz Center 2002) also found that 48% of stream sites nationwide during 1992-1998 were exceeding at least one standard or guideline for contaminants in sediments that affect aquatic life. This was used as a basis for Target 2C.

Target 2C. Reduce to 45% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants in sediments affecting aquatic life.

- By 2012 reduce to 47% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants in sediments affecting aquatic life.
- By 2017 reduce to 46% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants in sediments affecting aquatic life.
- By 2022 reduce to 45% the stream sites in the Southeast exceeding at least one standard or guideline for contaminants in sediments affecting aquatic life.

The NAWQA (Heinz Center 2002) also found that during 1992-1998 approximately 48% of farmland streams and 18% of urban/suburban streams nationwide had nitrate levels in excess of 2 parts per million (ppm). These data were used as bases for Targets 2D and 2E.

Target 2D. Reduce to 40% the farmland stream sites in the Southeast exceeding 2 ppm nitrate concentration.

- By 2012 reduce to 47% the farmland stream sites in the Southeast exceeding 2 ppm nitrate concentration.
- By 2017 reduce to 44% the farmland stream sites in the Southeast exceeding 2 ppm nitrate concentration.
- By 2022 reduce to 40% the farmland stream sites in the Southeast exceeding 2 ppm nitrate concentration.

Target 2E. Reduce to 10% the urban/suburban stream sites in the Southeast exceeding 2 ppm nitrate concentration.

- By 2012 reduce to 17% the urban/suburban stream sites in the Southeast exceeding 2 ppm nitrate concentration.
- By 2017 reduce to 15% the urban/suburban stream sites in the Southeast exceeding 2 ppm nitrate concentration.
- By 2022 reduce to 12% the urban/suburban stream sites in the Southeast exceeding 2 ppm nitrate concentration.

The NAWQA also found that during 1992-1998, approximately 73% of farmland streams, 68% of urban/suburban streams, and 54% of large river [defined as having average flows over 1,000 cubic feet per second (cfs)] sampling sites nationwide exceeded the EPA's recommended goal of 0.1 ppm concentration for phosphorus in order to prevent excess algal growth. These data were used as bases for Targets 2F, 2G, 2H.

Target 2F. Reduce to 65% the farmland stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.

- By 2012 reduce to 71% the farmland stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.
- By 2017 reduce to 68% the farmland stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.
- By 2022 reduce to 65% the farmland stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.

Target 2G. Reduce to 60% the urban/suburban stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.

- By 2012 reduce to 67% the urban/suburban stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.
- By 2017 reduce to 64% the urban/suburban stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.
- By 2022 reduce to 60% the urban/suburban stream sites in the Southeast exceeding 0.1 ppm phosphorus concentration.

Target 2H. Reduce to 45% the large river sampling sites in the Southeast exceeding 0.1 ppm phosphorous concentration.

- By 2012 reduce to 52% the large river sampling sites in the Southeast exceeding 0.1 ppm phosphorous concentration.
- By 2017 reduce to 49% the large river sampling sites in the Southeast exceeding 0.1 ppm phosphorous concentration.
- By 2022 reduce to 45% the large river sampling sites in the Southeast exceeding 0.1 ppm phosphorous concentration.

The NAWQA (Heinz Center 2002) found that 83% of farmland stream sites nationwide during 1992-1998 had at least one pesticide with concentrations exceeding aquatic life guidelines. This was used as a basis for Target 2J.

Target 2J. Reduce to 75% the farmland stream sites in the Southeast with at least one pesticide exceeding aquatic life guidelines.

- By 2012 reduce to 81% the farmland stream sites in the Southeast with at least one pesticide exceeding aquatic life guidelines.
- By 2017 reduce to 78% the farmland stream sites in the Southeast with at least one pesticide exceeding aquatic life guidelines.
- By 2022 reduce to 75% the farmland stream sites in the Southeast with at least one pesticide exceeding aquatic life guidelines.

Objective 3 - Improve or maintain watershed connectivity:

Watershed connectivity in a habitat context can be described as physical, chemical, and biological conditions that accommodate the movements of aquatic organisms, nutrients, water, or energy into various necessary habitats or habitat types. Waterbodies, whether flowing or static, require regular and, at times, unrestricted movements of these components to support their ecological systems. Watersheds need similar connectivity within and between rivers, streams, lakes and reservoirs, and between terrestrial and aquatic habitats. Some physical impediments to connectivity such as dams, levees, incised channels, armored shorelines, and culverts can block or change these movements. Impediments such as chemical, biological, and thermal barriers, invasive species, impervious areas, and reduction of the vegetated canopy can also affect connectivity. These impediments are more easily adjusted than the physical ones, although no adjustments are simple. Often barriers to connectivity have a positive use in one part of a watershed, but negatively affect the productivity of some ecosystems in other parts of the same watershed. Occasionally, the purpose for a barrier has disappeared altogether, but the barrier remains. The objective is to conserve or improve watershed connectivity in a manner that will maintain or improve the health of habitats, ecological systems, and populations of fish and other aquatic organisms and meet public needs within a watershed and the region.

Targets

For this objective the ideal targets would be measures of the maintenance of or increase in the number of watersheds in the Southeast with minimal (lowest number and degree of) impediments to connectivity. Since connectivity can be seen to support human needs as well as the life needs of aquatic plant and animal populations, an increase in the percentage or number of healthy aquatic habitats with minimal impediments to connectivity should demonstrate progress. Indicators of change might include chemical or physical changes in water quality, level or flow attributable to operations adjustments, number of dams removed, number of channels connected to floodplains, or alterations in land use patterns accompanied by increases in populations of certain species or functional guilds while continuing to meet human needs. While there are currently no compiled data on connectivity or aquatic habitat health as specific attributes per se, there are a few data sets that may be useful in assessing progress in meeting this objective. The FWS, in its Fish Passage Decision Support System database (FWS 2007), indicated as of June 2007 that there were at least 39,821 barriers to fish passage in the SARP states. Although the data in this database may not be complete, they have utility as a basis for identifying targets for this objective.

Target 3. Restore 1,000 miles of fish access to rivers and streams in the Southeast by effectively removing barriers to fish passage.

- By 2012 restore fish access to 500 miles of rivers and streams in the Southeast.
- By 2017 restore fish access to 750 miles of rivers and streams in the Southeast.
- By 2022 restore fish access to 1,000 miles of rivers and streams in the Southeast.

Objective 4 - Improve or maintain appropriate hydrologic conditions for the support of biota in aquatic systems:

The quantity and flow of freshwater in waterbodies varies naturally by season and precipitation, and unnaturally by human alteration and withdrawal of water from rivers and lakes as well as groundwater from aquifers. Both are important to aquatic communities. High flows and elevated water levels are part of the natural renewal of some habitats and coastal waters. In rivers, reservoirs or natural lakes, high flows during spring and summer greatly enhance reproductive success and survival of offspring for many species of fish and other animals. These same water levels support public needs for transportation, irrigation, drinking water and recreation. When people dredge rivers to enhance navigation, create reservoirs and build levees, they may change the hydrologic conditions of waterbodies and watersheds. (Sklar and Browder 1998). The objective is to maintain and/or adjust the quantity and flow of freshwater in rivers and streams in a manner that will enhance or sustain the habitats and populations of fish and other aquatic organisms while meeting public needs.

Targets

The magnitude of change for this objective should be measured as a percentage of increase in or increased number of miles of freshwater streams and rivers with instream flow protection plans; or acres of lakes, reservoirs, ponds, aquifers, and estuaries with hydrologic conditions that support sustainable populations of fish and other aquatic organisms compared to a referenced condition. The number of miles or acres of permanently protected freshwater bodies may be included in the measurement. However, data to assess these measures are currently either not available or have not been compiled and assimilated in a manner to allow such assessments to be made. Specific, quantifiable targets may be established for individual watersheds but would require further study to establish.

The Heinz Center (2002) analyzed changes in high and low flows and timing of those flows for 1930-1949 as a reference period and compared those data to the 10-year periods of the 1970s, 1980s and 1990s using USGS stream gauge data nationwide. The data showed in the 1970s that 55.1% of rivers had experienced a greater than 75% increase or decrease in flows or more than a 60-day change in timing of flows. For the 1980s and 1990s the data showed that 56.9% and 60.8%, respectively of rivers had experienced those changes from the reference period. Although these data are nationwide rather than specific to the Southeast, they were, nevertheless, used to formulate Target 4A pending future development of more specific targets after better data are available.

Target 4A. Reduce the percentage of rivers in the Southeast that have experienced more than a 75% change in high or low flows or more than a 60-day change in timing of flows since the 1940s to 58%.

- By 2012 reduce the percentage of rivers in the Southeast that have experienced more than 75% change in high or low flows or more than a 60-day change in timing of flows since the 1940s to 60%.
- By 2017 reduce the percentage of rivers in the Southeast that have experienced more than 75% change in high or low flows or more than a 60-day change in timing of flows since the 1940s to 59%.
- By 2022 reduce the percentage of rivers in the Southeast that have experienced more than 75% change in high or low flows or more than a 60-day change in timing of flows since the 1940s to 58%.

Using data from the USGS Circular Series *Estimated Use of Water in the United States*, which has been published every five years since 1950, The Heinz Center (2005) assessed freshwater withdrawals nationwide from all sources, for most purposes (such as public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric, not including freshwater diversions), using withdrawals in 1980 as an index. The year 1980 was chosen because it was the year of greatest water withdrawal (i.e., index value of 1.00) over the data series (1960-2000). Data showed that water withdrawals in the Southeast almost doubled between 1970 and 1980, declined to an index value of 0.77 in 1985, but then rose back to an index value of approximately 0.96 in 2000. Total freshwater withdrawals in the Southeast that year were 120.5 billion gallons per day (bgd). By contrast, human populations in the Southeast rose steadily in a nearly linear fashion from an index value of 0.72
in 1960 to 1.35 in 2000 (1.00 in 1980). These data were used as the basis for Target 4B.

Target 4B. Using freshwater withdrawal in 1980 as an index of 1.00 (125.56 bgd), reduce freshwater withdrawals in the Southeast from all sources to an index of 0.90 (113.0 bgd).

- By 2012 reduce freshwater withdrawals from all sources, using withdrawal in 1980 as an index of 1.00, to an index of 0.95 (119.2 bgd).
- By 2017 reduce freshwater withdrawals from all sources, using withdrawal in 1980 as an index of 1.00, to an index of 0.93 (116.7 bgd).
- By 2022 reduce freshwater withdrawals from all sources, using withdrawal in 1980 as an index of 1.00, to an index of 0.90 (113.0 bgd).

Areas of impervious surfaces (e.g., roads, parking lots, driveways, sidewalks, buildings) in urban and suburban areas can have major impacts on hydrology and water quality in these and downstream portions of watersheds. Although there are currently no data available to assess impervious surface area, The Heinz Center (2002), using data from the National Land Cover Dataset, a product of the Multi-Resolution Land Characterization Consortium [a partnership of USGS, U.S. Forest Service, the National Oceanic and Atmospheric Administration (NOAA) and EPA], determined the percentages of "natural" area patches in urban and suburban settings that fell into specified size groupings. Natural areas were defined as forest, grassland, shrubland or wetlands. They determined that in the Southeast 30% of urban/suburban natural areas in 1992 were patches of forest, grassland, shrubland or wetland, each 10-100 acres in size. Although not perfect, this approximate indicator for urban/suburban impervious area was used to formulate Target 4C.

Target 4C. Increase the percentage of urban/suburban natural area patches 10-100 acres in size in the Southeast to 35%.

- By 2012 increase the percentage of urban/suburban natural area patches 10-100 acres in size in the Southeast to 31%.
- By 2017 increase the percentage of urban/suburban natural area patches 10-100 acres in size in the Southeast to 32%.
- By 2022 increase the percentage of urban/suburban natural area patches 10-100 acres in size in the Southeast to 35%.

Objective 5 - Establish, improve or maintain appropriate sediment flows:

In a watershed, some sediment is carried in suspension by flowing water from inland to coastal waters, while some is deposited on banks and channel beds, supporting and sustaining aquatic habitats and their ecological systems. Sediment can positively and negatively affect the size and health of wetlands, rivers, streams, lakes, reservoirs, and coastal areas. Increased sediment can raise costs of water purification and navigation channel maintenance as well as damage fisheries and aquatic habitat. It can also build or renew wetlands, banks and benthic areas. Sediment transport varies because of factors such as soil particle type and local geology, precipitation and runoff as well as barriers to flow due to channelization, roadways, dams and land-use-induced erosion. The challenge is to maintain or improve the balance of sediment flow within aquatic systems in a manner that sustains water resources and maintains or improves the health of the habitats and their populations of fish and other aquatic organisms. This multifaceted challenge includes the need to a) maintain or improve the balance of sediment transfer to support the waterbody's structure, habitats and their associated communities, and b) ensure sufficient sediment supply to nurture adjacent wetlands and coastal marshes, and offset subsidence and sea level rise while sustaining water resources for human use.

Targets
The magnitude of change for this objective could be measured by maintenance of or increase in the number of watersheds in the Southeast with a balance of sediment flows supporting healthy habitats with populations of fish and other aquatic organisms while meeting human needs.

On a nationwide basis The Heinz Center (2002) found in general that croplands most prone to water erosion decreased significantly from 30.3% in 1982 to 21.6% in 1997, but this measure does not address non-agricultural erosion that occurs along large rivers and stream banks. Under section 303(b) of the Clean Water Act, the regional offices of the EPA work with state water regulatory agencies to list impaired waterbodies and develop total maximum daily loads (TMDLs) for the contaminants (U.S. EPA 2007). TMDLs describe the amounts of a pollutant that a waterbody can receive and still meet water quality standards, and allocate loadings among point and nonpoint pollutant sources. Excess sediment can impair waterbodies. To establish a baseline for Targets 5A and 5B, SARP could work with data managed by EPA Regions 3, 4, 6, and 7 to identify those waters currently listed as impaired by excess sedimentation and in need of a load allocation strategy. Future targets and timelines for load reduction could be set in cooperation with EPA and state programs charged with implementing the load allocations.

Initially, the relationship of this objective with those on water quality, connectivity, and hydrologic condition, for which measurable targets have been proposed, can be used for indirect, qualitative assessment until baseline data can be secured. Results from monitoring and assessing projects focusing on those objectives can, over time, provide some local and regional interim indicators that can be combined with emerging TMDL data. After 2010, development of additional data sources through the NFHI aquatic habitat assessment may provide other avenues to select targets. For this version of the Plan, Target 5A is qualitatively described without specific milestones.

Target 5A. Reduce the number of stream miles impaired by excess sediment.

Objective 6 - Maintain and restore physical habitat in freshwater systems:

Physical habitats are the structural elements that make streams, rivers, lakes, reservoirs and wetlands suitable for aquatic species. Examples of physical habitat in southeastern waters include stream channel morphology, substrate composition (gravel, rocks, sediment, etc.), benthic contours of lakes and reservoirs, aquatic vegetation, shoreline vegetation, overhead canopy cover, and woody debris. Physical habitat plays an important role in healthy ecosystems, providing shelter, spawning sites, nursery areas, and foraging areas for fish and other aquatic animals. It also affects water quality and energy production. When physical habitat is changed by natural storm or flood events, aging and decomposition, or anthropogenic activities, the health of the waterbody may change suddenly, slowly, or sometimes in stages following a ‘domino’ effect. Not all changes are bad, but some activities such as draining wetlands or rerouting streams through pipes or channels can result in destruction of physical habitat. Of major importance has been the large-scale loss of wetland habitats such as forested large-river floodplain, oxbow, and backwater areas, coastal marsh and seagrass beds. The structural elements of many streams and rivers, degraded by an assortment of land use practices or natural events, can be improved using stream restoration techniques. In reservoirs, managers add new structure to offset the loss of the original woody debris, but it is difficult to add enough to maintain optimum fisheries. Reservoirs also tend to develop problems related to the presence or absence of aquatic vegetation due to water level fluctuations. The challenge is to prevent the destruction of physical habitat and promote its restoration and improvement in a manner that meets both ecological and human needs.

Targets
Achievement of this objective will be measured as a reduction in alterations of aquatic habitats, and as the total amount (miles, acres and numbers) of protected, restored and enhanced habitat. Sources of data to help in establishing such baselines may include but are not limited to the AFS Reservoir Committee, U.S. EPA procedures for calculating stream habitat metrics, the U.S. Army Corps of Engineers (USACE) and the National Wetlands Inventory (NWI). Historical data may also be helpful. Note that only those habitat characteristics that can be attributed to maintenance, restoration or establishment of one or more identified structural elements will be used to determine the magnitude of change.

Target 6A. Reduction in acreage of freshwater wetlands drained or converted.

- By 2022 reduce the number of acres of altered freshwater wetlands drained or converted through development annually in the Southeast by 30%.

Target 6B. Reduction in number of stream miles destroyed or converted to unnatural or managed drainage systems.

- By 2022 decrease miles of streams destroyed or converted by permitted construction into unnatural drainage systems annually in the Southeast by 30%.

Target 6C. Increase in the number of miles of streams with improved instream physical habitat.

- By 2022 improve the physical habitat of reaches in streams and rivers containing structural improvements in the Southeast.

Objective 7 - Restore or improve the ecological balance in habitats negatively affected by Non-indigenous invasive or problem species:

Habitats and diverse populations of biota thrive in balanced, interdependent, natural and human-created systems. Occasionally, the addition of one or more non-native species to biotic communities within a habitat can alter systems and degrade habitats. These changes in the biotic communities of habitats have altered water quality characteristics, energy, nutrient, and sediment flow, and species composition. In addition to the damage to natural resources, such habitat degradation often negatively affects food and water resources, recreation, and economics for people (ISAC, 2006; Pimentel et al 2005). The absence or overabundance of a species or functional guild, especially invasive species, parasites or pathogens, can be major causes of such changes or imbalance (Sarakinos, 1999). Pathogens can weaken or destroy whole populations. Invasive species, not native to the habitat, may have no natural enemies present to limit rapid population expansion. Their fecundity, early and rapid development, ability to thrive on available nutrition and tolerance of a broad range of conditions help them to out-compete, and often destroy native populations and disrupt interdependent systems (Williams & Meffe, 2005).

Problem species can be introduced by natural occurrences such as storms and floods, and/or by human activities such as shipping, aquaculture, fishing, agriculture, horticulture, landscaping, exotic pet and aquarium trade, and stocking. Biota that improve the health of a system can be introduced in a similar manner. The objective is to encourage appropriate abundance of species or functional guilds within a watershed to establish or restore healthy ecological systems while supporting public use of resources. This will be achieved by controlling or preventing the introduction of new nonindigenous invasive or problem species.

Targets

Progress in meeting this objective will be assessed by using various state, regional, and national databases and management plans, as well as indices of population dynamics, aquatic community species composition, architecture function, and structure to identify problem species that threaten habitat health and establish baselines of habitat health in target watersheds. These changes may be expressed by an increase in the numbers of healthy essential species within a system, an increase in number or percentage of native animals or in acreage of native plants fitting unfilled niches, and/or a reduction in or eventual absence of populations of identified problem species within the target habitat. However, data on which to base such assessments are not yet available or compiled in a manner that can be readily analyzed, particularly for the SARP states as a whole. A suite of targets and strategies has been developed using available data. Development of additional data following initial results of the NFHI aquatic habitat assessment in 2010 may provide avenues for creation of more specific targets.

According to data from 1999 (Benson et al. 2001) for the FWS Southeast Region, the states in the FWS Southeast Region collectively reported, by individual state, a total of 564 nonindigenous aquatic species as having been introduced. However, some species are represented more than once in this total, as they have been introduced into more than one state. Based upon current (June 2007) data from the USGS Nonindigenous Aquatic Species (NAS) website (http://nas.er.usgs.gov/) for the 14 SARP states, comparable totals were 915 for the FWS Southeast Region states and 1,352 for the SARP states. Therefore, between 1999 and 2007 the numbers of introduced species increased in the FWS Southeast Region states by an average of 7.2% per year. However, not all NAS that are introduced into a state become established and survive year to year, develop reproducing populations or cause problems. Those that do are the most problematic and are the ones referred to in the objective. Using the same data sources as described above, a total of 349 NAS were collectively reported by the FWS Southeast Region states, by individual state, as having become established in 1999. The 2007 comparable totals are 499 for the FWS Southeast Region states and 736 for the SARP states. Thus, between 1999 and 2007 the numbers of introduced species that had become established increased in the FWS Southeast Region states by an average of 5.3% per year. This figure was used as a proxy for the whole region when developing Target 7A since, at present, there is no regional baseline.

Target 7A. Reduce the average annual rate of increase for established NAS in states in the FWS Southeast Region to 3%.

- By 2012 reduce the average annual rate of increase for established NAS in states in the FWS Southeast Region to 5%.
- By 2017 reduce the average annual rate of increase for established NAS in states in the FWS Southeast Region to 4.5%.

- By 2022 reduce the average annual rate of increase for established NAS in states in the FWS Southeast Region to 3%.

Because some non-native species can cause habitat degradation while others may fill an unfilled niche or cause no apparent change to habitat health, additional targets might be set on the basis of certain watersheds or habitat types. These additional targets may be possible at a later date, when all of the SARP states have completed Aquatic Invasive Species Management Plans.

Outcomes Specific to the NFWF Native Black Bass Keystone Initiative

Efforts by the Foundation under this NFWF Keystone Initiative will contribute to all seven of the SAHP objectives outlined above. Specifically, efforts under this NFWF Keystone Initiative are designed to reduce threats and ensure the survival of three relatively rare species of black bass by pursuing the following strategies:

Strategy 1: **Ameliorate effects of invasive species**

Guadalupe bass

The ongoing program of genetic restoration has proven successful in the headwaters of the Guadalupe River. In one of the major tributaries of the Guadalupe River, Johnson Creek, the Guadalupe bass population consisted of approximately 30% hybrids. This genetic contamination has now been reduced to 3%. The project was recently expanded to encompass the entire headwater region and what was a population made up of approximately 65% hybrids has now been reduced to less than 20%.

This program should be expanded to additional segments within the native range where genetic contamination exists. An assessment is currently underway to evaluate genetic status across all populations within the native range, and will be used to identify areas in need of conservation action. The most recent assessment of genetic status (1989) determined that the following systems were in need of conservation action:

- Guadalupe River, downstream to Canyon Reservoir
- Blanco River
- Colorado River
- San Gabriel River
- Lampasas River

The development of genetically-pure hatchery populations and annual stocking are ongoing initiatives funded by TPWD. However, rate of expansion and completion of the program are constrained by hatchery space needed to produce large numbers of pure Guadalupe bass. In addition, a plan to utilize the number and quality of brood fish that will allow for production of hatchery offspring that reflect the genetic diversity and condition of wild populations must be carefully developed and implemented.

Redeye bass (Savannah)

Surveys of 12 redeye bass stream populations in South Carolina have confirmed hybrids between redeye and introduced species in 2 streams, or about 17 % of sites surveyed. Alabama bass and their hybrids were collected in Little River near Lake Keowee. Smallmouth bass and their hybrids were collected in Savannah River at Augusta Shoals, near the Fall Line. Hybrids at both locations are the ultimate result of unauthorized stocking of non-native black bass in the drainage.

A comprehensive education and outreach campaign that explains the risk that transport and release of aquatic animals poses to the resource is needed. Education of the general public is needed, as well as targeted outreach to area angling groups. An effective campaign will utilize print, web-based, and on-air media, will reduce the risk of further black bass introductions, and will raise the profile of the redeye bass as a resource of natural and recreational value.

The original assessment of redeye bass stream populations in South Carolina was conducted in 2004, and included 12 stream sites representing significant populations. Repeat sampling of these populations is currently underway. There are still populations in the Savannah River drainage that have not been assessed. A more complete inventory of populations is needed, including genetic assessment and ongoing genetic monitoring.

Stocking of select streams with pure redeye is a viable tool in controlling the effects of introduced species. Targeted removal of non-natives may be as well. In producing genetically pure redeye bass, establishment of hatchery stocks that conserve the genetic diversity within and among individual watersheds of the Savannah will be carefully planned and coordinated.

The initial focus site for stocking will be the Augusta Shoals portion of the Savannah River. Smallmouth bass are present in the Augusta Shoals black bass population and hybrids between smallmouth and redeye have been confirmed there. Comprehensive pre and post stocking assessments of the population and its degree of genetic introgression will guide stocking decisions and evaluate success.

<u>Shoal bass</u>
The genetic status of shoal bass located in the ACF basin remains uncertain; however, hybrids between introduced spotted bass and shoal bass have been identified in Alabama streams and the Chipola River, Florida. Spotted bass have been found in the Chattahoochee and Apalachicola Rivers since the 1940s; however, they were believed to have been the northern subspecies (Williams and Burgess 1999). Introduction of the Alabama subspecies of spotted bass (now considered to be Alabama bass, *Micropterus henshalli*) to this system was more recent, first observed in the Chattahoochee River above the Fall Line in the 1970s. A recent analysis of the phylogenetic relationships among the black bass species has suggested that shoal bass are more closely related to Alabama bass than to the spotted bass (Kassler et al. 2002); thus, there may be a greater chance of hybridization between Alabama bass and shoal bass than between spotted bass and shoal bass.

Genetic threats to shoal bass are present throughout their native range, as anglers continue to stock non-native species of black bass all over the southeastern U.S. However, specific areas that are of special concern are:

- Chattahoochee River, Atlanta, Georgia area (smallmouth and Alabama bass)

- Chattahoochee River from West Point Dam downstream to headwaters of Eufaula Reservoir (spotted bass)
- Major tributaries to the Chattahoochee River from West Point Dam downstream to headwaters of Eufaula Reservoir (Alabama bass and spotted bass)
- Chipola River, Florida (Alabama bass and spotted bass)
- Flint River, Georgia (spotted bass)

Some genetic work has been conducted in several of these areas of concern by fisheries biologists in Georgia, Alabama, and Florida; however, a current assessment of genetic status across all populations is needed to allow for a baseline genetic structure to be determined, particularly in the Flint River, where spotted bass have only recently become established (2005).

***Strategy 2*: Protect and maintain intact, healthy habitats**

<u>Guadalupe bass</u>
Despite increases in human populations throughout the native range of Guadalupe bass, there are still many stretches of streams that are relatively pristine and intact. However, projections of population growth and water demands indicate that these locations will soon be at risk. The human population on the Edwards Plateau is predicted to increase by approximately 25% by 2020. Some subsets of this region are predicted to double in population size. The associated demands placed upon the ecosystem, particularly on water, will have direct effects on Guadalupe bass.

Watershed Management Plans will be developed for conservation of watersheds essential to Guadalupe bass. Each Plan will focus on a specific watershed or watershed segment to be undertaken. Plans will be developed by technical teams of TPWD and other experts working in coordination with a partnership of interested stakeholders (e.g., private land owners, local governments, state agencies, lake associations, conservation groups, etc.). Over the 10-year timeline of this Initiative, we expect to establish four watershed-specific conservation plans within the native range of Guadalupe bass.

The TPWD Watershed Policy and Management Program will coordinate the Plan development and focus on working through partnerships to conserve aquatic, riparian and upland habitats essential to the long-term health and sustainability of Guadalupe bass and associated natural resources. In this way we can improve our ability to protect our state fish as well as raise the public's awareness of the value of such resources.

<u>Redeye bass (Savannah)</u>
Portions of the middle and upper Savannah watershed are under considerable development pressure due to urbanization and land use changes. Many streams within the range of redeye bass are intact but in need of protection. The Chauga River sub-watershed will be an immediate area of focus. Work to identify the specific habitat requirements of redeye bass, and a comprehensive characterization of baseline habitat are needed. Identification of specific habitats where robust populations occur, as well as evaluation of threats from development, will be used to prioritize additional focus areas and individual stream sites for habitat protection.

Once identified, priority streams will be protected by any combination of land acquisition, conservation easements, and mitigation banking. Close coordination with stakeholders, including private and public landholders, state and local governments, and national and local NGO's, will take place. Participation and partnerships with groups already working in the area, including but not limited to Upstate Forever (conservation easements) and the Savannah Watershed Planning Stakeholders Group (water resource allocation) will insure success of our stream protection efforts.

Shoal bass

It appears that shoal bass have generally been able to maintain robust, self-sustaining populations throughout the portions of their range where habit has remained intact and healthy. However, the location and extent of these habitats have not been fully identified. Protection and maintenance of undisturbed springs, riparian zones, shoal areas, etc., is critical to the long term stability of shoal bass populations. Dam construction on the Chattahoochee River, particularly in the Atlanta and middle Chattahoocheee area (MCA) near Columbus, Georgia, has reduced abundance and recruitment of these fish through inundation of habitat and altered flow and temperature regimes. Also, dam construction has been found to isolate and reduce genetic diversity in shoal bass populations (Dakin et al. 2007). This species has been found to make long migrations to spawning areas in the spring (S.Sammons, Auburn University, unpublished data), which further illustrates the negative effects of dams on this species. Additionally, shoal bass have disappeared over the last 40 years in three of the four tributaries of the Chattahoochee River in Alabama that formerly had good populations of shoal bass. Causes of these declines are not known, but may be related to habitat degradation and negative interactions between shoal bass and introduced spotted bass. Shoal bass have been stocked in the Flint River below Lake Blackshear since 1972 by GDNR due to decreased recruitment after construction of Warwick Dam (T. Ingram, GDNR, unpublished data). Success of these stockings has been high, with average contribution of stocked shoal bass ranging from 10-40%. Similarly, a five-year stocking program below Morgan Falls Dam on the Chattahoochee River in Atlanta, Georgia resulted in a good fishery in an area where shoal bass were virtually eliminated due to altered flow and temperature regimes (Long and Martin 2008). Thus, shoal bass stockings appear to be a viable option to enhance or restore shoal bass populations. However, a recent effort by Alabama Department of Conservation and Natural Resources in the three Chattahoochee River tributaries where shoal bass had been extirpated was unsuccessful (Sammons and Maecina 2009).

_Str_ategy _3_: Restore habitat

Guadalupe bass

The streams that Guadalupe bass inhabit have experienced substantial changes within the last 50 years (Brune 1981). Urbanization of the Edwards Plateau region and the concomitant demands on surface and groundwater resources have resulted in fewer flowing streams and reduced flows in those that remain. Available habitat has also been reduced by reservoir construction (major reservoirs exist on all of the river systems inhabited by Guadalupe bass) and poor land management practices have degraded many of the remaining stream habitats.

More than 95% of Texas is privately owned, thus landowners are essential to successful restoration. The most effective approach to large-scale restoration is through community-based, cooperative actions (e.g., watershed protection plans, conservation easements, improved land management, etc.) coupled with professional expertise and guidance. The TPWD Watershed Policy and Management Program will coordinate these activities.

Restoration of habitats to an intact, naturally functioning state will enhance all life history stages of Guadalupe bass. Successful reproduction and recruitment will maintain populations at carrying capacity and naturally functioning environments ostensibly improve Guadalupe bass competitive advantage over congeners. Restoration of habitats in watersheds within the native range of Guadalupe bass will enable conditions that support increased distribution and abundance. Over the 10-year timeline of this Initiative, we expect to see a 30% increase in distribution of Guadalupe bass and a similar reduction in distribution and percentage of genetically contaminated populations.

Redeye bass (Savannah)

Degraded habitats within redeye bass streams in the Savannah result from a variety of anthropogenic factors, primarily non-point source runoff and riparian zone degradation. Habitat restoration work in the upper reaches of the watershed is already underway through partnerships between SCDNR, US Forest Service and Partners for Trout. The local NRCS has considerable expertise in the areas of riparian zone and in stream habitat restoration. These partnerships already in place will insure the success of habitat restoration work supported through this Initiative.

Initial areas of focus will be 12 Mile Creek, where recent dam removal has re-opened portions of the stream reach to redeye bass, and Cain Creek. As in strategy 3, a better understanding of the specific instream habitat needs of redeye bass, as well as baseline habitat status within the watershed is needed. This will be used to identify additional priority sub-watersheds, streams, or stream reaches for riparian zone and instream habitat restoration.

Shoal bass

Due to rampant development that has occurred in many of the drainages that contain shoal bass, this fish is vulnerable to the associated land-use changes, including increased water withdrawals to support the increased human population in these areas. Because shoal bass are habitat specialists, and appear to spawn in large rocky shoal areas with fast current, they can be negatively affected by increased siltation and runoff events caused by increased rates of development and land-use changes. In the Chipola River watershed in Florida, unpaved road crossings have been identified as significant contributors to sedimentation. Research in the Flint River, Georgia, has indicated that shoal bass can form large spawning aggregations in selected large shoal habitats, and GDNR biologists are currently engaged in identifying and measuring critical spawning habitat for shoal bass in the lower Flint River. Shoal bass spawning habitat has not been identified in smaller creeks and rivers, and much more of this work remains in the remainder of the shoal bass range. Once this habitat has been identified and measured, steps may be taken to preserve and/or restore such habitat in degraded systems.
Available habitat has also been reduced by reservoir construction. Dam construction on the Chattahoochee River, particularly in the Atlanta area and MCA, has reduced abundance and recruitment of these fish through inundation of habitat and altered flow and temperature regimes. Also, dam construction has been found to isolate and reduce genetic diversity in shoal bass

populations (Dakin et al. 2007). This species has been found to make long migrations to spawning areas in the spring (S.Sammons, Auburn University, unpublished data), which further illustrates the negative effects of dams on this species.

Strategy 4: Conduct research to fill critical information gaps

<u>Guadalupe bass</u>

Current collaborative research projects include assessment of introgressive status and gene flow in Guadalupe bass throughout its native range, quantification of habitat associations and movement within two stream reaches, and an assessment of individual specialization within populations relative to genetic diversity. Collectively, these studies address key questions related to restoration and recovery efforts. Additional research-based activities should involve: (1) identifying key knowledge gaps specific to restoration needs; and (2) research design and implementation of experimental activities.

Information on Guadalupe bass genetic diversity, habitat associations, and home range is available to begin a restoration program for recovery. Additional research is necessary to fill existing gaps in current understanding and to refine restoration activities. Potential research projects would address: (1) basic ecological and biological questions related to life history and reproductive requirements among native and introduced congeners; (2) influence of habitat on introgressive rates among congeners; (3) influence of local and regional factors on multiple scales, including Guadalupe bass populations and aquatic communities within the range of Guadalupe bass; and (4) efficacy and efficiency of restoration activities. Existing knowledge gaps and additional research needs will be clarified and prioritized by the process of Strategic Analysis and the implementation of activities under the primary strategies of 1) Reestablish and ensure genetic integrity of Guadalupe bass populations throughout the native range, 2) Restore habitat, and 3) Protect and maintain intact, healthy habitats.

<u>Redeye bass (Savannah)</u>

The basic genetic structure of redeye bass in Savannah drainage, and genetic variation among watersheds within the drainage, have been assessed. The identification of three individual management units comprised by populations of the Seneca, Tuguloo and Savannah main stem watersheds will be especially important to any future restoration efforts through stocking. Fish produced for stocking in the wild will need to reflect the genome and diversity of each receiving population. Through the same genetic survey work, 3 of 12 stream populations have been found to contain non-native congeners and hybrids. Perhaps most significantly, Redeye bass of the Savannah drainage are genetically divergent from other drainages within the range, to a degree that supports separate species status. Current research is assessing presence of non-native black bass species in select redeye bass streams, incidence of hybridization in those populations, and genetic change in those populations over time. These efforts will also assess relationships between habitat and incidence of hybridization.

While much has been learned about redeye in the Savannah, broad knowledge gaps with regard to the basic ecology and life history of this potential new species remain. Additional work is needed to most effectively implement conservation efforts. New studies will focus on the quantitative assessment of redeye populations throughout the Savannah River drainage, basic assessments of population structure, and an understanding of the habitat requirements of redeye bass at all life stages. New information gained through this strategy will guide conservation efforts undertaken in strategies 1,2 and 3.

Shoal bass

Despite being formally described in 1999, shoal bass have been little studied. Studies have recently been conducted on shoal bass across the ACF basin, including the Flint River above and below Lake Blackshear, the Chattahoochee River in the Atlanta area, Osanippa, Halawakee, Wachoochee, and Little Uchee creeks in Alabama, and the Chipola River in Florida. Much of this research in ongoing, but preliminary results have indicated that shoal bass biology and ecology is likely very different from most other black bass species. Much work remains to be done to adequately describe basic ecology of this fish, and the knowledge gaps are large. Specifically, knowledge related to the reproductive ecology and spawning habitat requirements of shoal bass is not only lacking, but it is critical information for proper management of this species. While the broad distribution of this species is known (i.e., the ACF Basin and the introduced population in the Ocmulgee River, Georgia), little is known about the specific distribution of this species within each drainage. Significant numbers of shoal bass are found in major tributaries on the Ocmulgee, Chattahoochee, Flint, and Apalachicola rivers; however, no data exists on the relative health of most of these populations. Likely tributary populations are more vulnerable to perturbations by land use changes and habitat elimination by dam construction than are populations in the mainstem of these river systems, thus baseline data is essential for future conservation and restoration efforts. Furthermore, smaller systems with potentially limited spawning habitat may increase the rate of hybridization with congenerics, thus genetic assessment of these populations should be a priority. Introgressive hybridization with other species is a significant problem for endemic shoal bass populations. Hybridization rates and extent of hybridization needs to be determined to set realistic goals for maintaining genetic integrity of shoal bass populations.

Strategy 5: **Provide coordination and adaptive management**

Guadalupe bass

This strategy will engage stakeholders in order to align philosophies and priorities with science and economics. Specific actions will occur within the first two years of the Initiative, to guide and refine all future NFWF and partners' investments. Existing scientific analyses provide a basic tier of guidance that allows partners to immediately tackle many important *actions* that are agreed upon as immediate priorities. However, there is an intense need for a higher tier process and plan that is informed by technical experts and cooperatively managed by local partners to identify and prioritize conservation and recovery *approaches* that are scientifically rigorous and socio-economically viable. This effort will result in a jointly developed strategic plan for habitat restoration that is founded in scientific and economic evaluations of previously existing habitat restoration projects and their respective impacts and benefits to Guadalupe bass. This process will refine physical and biological goals and priorities for river restoration to effectively guide future project implementation. It will also identify the most important private lands economic considerations, and likely paths to address them, that will ensure the ability to implement recommended conservation actions. Thus, the process will ultimately ensure the most efficient and effective use of time, funds, and resources for conservation and restoration of Guadalupe bass populations throughout the native range. The results of the integrated strategic planning and coordination will be a coordinated scientific process that integrates restoration and conservation project identification, evaluation, refinement, and prioritization.

Redeye bass (Savannah)

The hiring of a project coordinator will facilitate a cohesive approach across all strategies and activities outlined in this initiative. Stakeholders will be identified and contacted in the planning stages of all actions undertaken through this Initiative. This will work to garner support for the Initiative in general, to evaluate and prioritize conservation actions, and to identify partners for specific actions. In addition to the project coordinator, a Redeye Bass Technical Committee comprised of local and regional experts will be formed. This committee will serve to oversee sound scientific application in all actions undertaken through this Initiative.

Shoal bass

Shoal bass present a unique challenge among the species included in this initiative in that they are managed differently across their range by all three state fish and wildlife agencies with management authority over them. In Alabama, this species is listed as a species of special concern, protected by a complete harvest moratorium, and fishing in the last known Alabama population is discouraged. In Florida, shoal bass are also considered a species of special concern, but are also managed as a unique fishery in the Chipola River. Although Georgia has also designated shoal bass as a species of special concern, they are managed for recreational fisheries in the Chattahoochee, Flint, and Ocmulgee rivers, and a growing number of anglers have become interested in pursuing these fish. Furthermore, this fish has become an important component of the efforts by the NPS to manage the Chattahoochee River in Atlanta for native fishes. In addition, numerous stakeholder groups have been created that consider shoal bass as an important fish for both recreational fishing and conservation purposes, including the Upper Chattahoochee Riverkeeper, the Flint Riverkeeper, Shoal Bass Alliance, FloridaRiverFishing.com, and GeorgiaRiverFishing.com. These groups have become increasingly vocal over the last couple years in their interest in promoting shoal bass angling and protecting this fish for future generations to catch. In fact, the Shoal Bass Alliance and Flint Riverkeeper organizations have recently drafted a bill for the Georgia State Legislature consideration that will require that the “State of Georgia shall conserve existing populations of unique native sportfish and restore degraded populations of such sportfish to fishable populations throughout their native range in Georgia to ensure the right of present and future generations of anglers to fish for such sportfish and to protect and enhance Georgia’s fishing-related economy.” Although this bill would also include Suwannee and redeye bass, the impetus for this bill was the authors’ interest in shoal bass.

Native Black Bass Species	Baseline population Estimate	Current population trend (Strong decline, declining, stable, growing, strong growth)	Population/ watershed goal (healthy or viable pop)	Time to reach goal
Guadalupe bass	At risk throughout native range	Ranges from stable to declining	7 to 10 self-sustaining, genetically pure populations.	10 years
Redeye Bass (Savannah)	At risk throughout native range	Ranges from stable to declining	Quantify and protect self-sustaining genetically pure populations in Savannah sub-basins.	10 years
Shoal Bass	At risk in the Chattahoochee and Chipola rivers, stable in the Flint River	Ranges from stable to declining	Quantify and protect self-sustaining, genetically pure populations in the Flint and Chipola rivers; restore/protect all historic shoal bass populations in tributaries of Chattahoochee River in MCA, 7 to 9 self-sustaining, genetically pure populations below dams of mainstem Chattahoochee River in MCA.	10 years

Implementation Plan

Guadalupe bass

***Strategy 1:* Ameliorate effects of invasive species**

Actions:

- Assess current status of Guadalupe bass populations throughout the range
- Develop methods for reducing non-native bass populations in targeted areas
- Reestablish genetic integrity of hybridized populations in targeted areas
  - Prioritize stream segments to be stocked
  - Select streams that have high probability of success
  - Initiate remedial stocking program based on methodologies derived from the results of research from the upper Guadalupe River
- Monitor genetic status of Guadalupe bass populations and numbers of non-natives throughout the range

***Strategy 2:* Protect and maintain intact, healthy habitats.**

Actions:

- Assess locations and extent of healthy habitats using National Land Cover Database or similar approach
- Develop a priority list of watersheds/stream segments for protection actions
- Organize Technical Advisory Teams for individual watersheds/stream segments to analyze current data, define challenges, determine conservation methods and engage public support
- Develop action plans for addressing the objectives, select the best watershed management alternatives, list strategies for implementing alternatives and determine appropriate milestones for measuring progress
- Convene stakeholder groups to foster support of action plans
- Monitor conservation efforts and assess benefits to Guadalupe bass populations

***Strategy 3:* Restore habitat**

Actions:

- Assess locations, extent and type of impacted habitats using the National Land Cover Database or a similar approach
- Develop a priority list of watersheds/stream segments for restoration actions
- Organize Technical Advisory Teams for individual watersheds/stream segments to analyze data, define challenges, determine restoration methods and engage public support
- Develop action plans for addressing the objectives, select the best watershed management alternatives, list strategies for implementing alternatives and determine appropriate milestones for measuring progress
- Convene stakeholder groups to foster support of action plans
- Monitor restoration efforts and assess benefits to Guadalupe bass populations

***Strategy 4:* Conduct research to fill critical information gaps:**

Actions:

- Identify knowledge gaps critical to restoration of the species
- Design and conduct research as needed to enhance conservation efforts outlined in Strategies 1-3

***Strategy 5:* Provide coordination and adaptive management**

Actions:

- Fund Guadalupe bass conservation coordinator to oversee all restoration efforts
    - Coordinate implementation of Guadalupe bass conservation efforts under this NFWF Keystone Initiative
    - Monitor and evaluate timelines and performance
    - Coordinate project reporting and compliance
    - Conduct periodic reviews and assess potential modifications to enhance the initiative
    - Identify and solicit additional sources of funding and support for the initiative
    - Conduct public outreach

Implementation Partners:

Partners	**Contributions**
Texas Parks & Wildlife Department	Plan implementation and coordination
Texas State University	Research and technical guidance
U.S. Fish & Wildlife Service	Funding assistance and technical guidance
Hill Country Fly Fishers	Funding assistance
Local governments	Logistical support and outreach
NRCS	Technical guidance and support
The Nature Conservancy	Technical guidance and support
River authorities	Technical guidance and support
Local conservation groups	Technical guidance and support
Private landowners	Logistical support
Hill Country Alliance	Outreach and support
BASS/ESPN	Outreach and support
North American Black Bass Coalition	Outreach and support
Texas Bass Federation	Outreach and support
Texas River Protection Association	Outreach and support
Regional water planning groups	Technical guidance and support

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<u>Redeye bass (Savannah)</u>

***Strategy 1:* Ameliorate effects of invasive species**

Actions:

- Implement an education and outreach campaign
  - Develop local and national partnerships
  - Develop and implement print and on air media campaign
  - Pursue media coverage
  - Identify key groups to target
  - Develop printed and 'in person' outreach tools for presentation to key groups
- Monitor genetic change over time
  - Conduct complete inventory of streams to identify impacted populations
  - Identify priority populations for stocking or removal of non-natives
    - Augusta Shoals
  - Establish genetic stocks, by watershed, and supplement through stocking where appropriate
  - Establish routine genetic monitoring program to assess success

Strategy 2: **Protect and maintain healthy, intact habitats**

Actions:

- Identify priority sub watersheds and streams for protection based on in stream habitat conditions, assessed needs of redeye bass, and pressure from development.
  - Chauga River
- Work with stakeholders and partners (private and public landowners, state and local governments, and NGO's) to develop new partnerships and implement protections.

Strategy 3: **Restore habitat**

Actions:

- Identify degraded habitats based on in stream habitat conditions, and assessed needs of redeye bass.
  - 12 Mile Creek
  - Cain Creek
- Identify priority stream segments for habitat restoration and needed actions
  - Restoration of riparian areas
  - Restoration of in stream physical structure
  - Remediation of point and non-point source pollutants
  - Removal of barriers to fish movement and migration
- Work with stakeholders and partners (private and public landowners, state and local governments, and NGO's) to develop new partnerships in implementing restoration activities
- Implement restoration
- Evaluate success
  - Monitor response of redeye bass populations to habitat restoration.

Strategy 4: **Conduct research to fill critical information gaps:**

Actions:

- Identify knowledge gaps critical to protection of redeye bass in Savannah River drainage.
    - Basin wide habitat assessment
    - Basin wide population assessment
    - Redeye bass habitat requirements
    - Reproductive behavior
    - Movement
    - Age and growth
    - Food habits
- Design and conduct research to fill knowledge gaps.

Strategy 5: **Provide coordination and adaptive management**

Actions:

- Hire project coordinator
- Convene Redeye Bass Technical Committee
- Work with partners and stakeholders to elevate the profile of redeye bass, and its value as a unique and imperiled natural resource.
- Coordinate with partners and stakeholders for prioritization of conservation actions, and effective implementation.

Implementation Partners:

Partners	**Contributions**
SCDNR	Data collection, establishment of hatchery stocks, stocking
GADNR	Data collection, establishment of hatchery stocks, stocking
University of South Carolina Clemson University	Data collection Data collection
BASS/ESPN	Outreach and support
North American Black Bass Coalition	Outreach and support
Georgia Bass Federation	Outreach and support
US Fish and Wildlife Service	Funding Assistance
Harry Hampton Wildlife Fund	Funding Assistance
Upstate Forever	Outreach and easement implementation
The Nature Conservancy	Technical guidance and support
Local angling groups	Outreach
Local governments	Planning and outreach
River authorities	Technical guidance and support
Local utilities	Technical guidance and support
Southern Company	Funding Assistance
GA and SC water planning councils	Technical guidance and support

Partners	Contributions
Local conservation groups	Technical guidance and support
Private land owners	Logistical support
US Forest Service NRCS and Foothills RCD Council	Restoration technical assistance

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Shoal Bass

Strategy 1: **Ameliorate effects of invasive species**

Actions:

- Implement an education and outreach campaign
  - Develop local and national partnerships
  - Pursue media coverage
  - Identify key groups to target
  - Develop printed and 'in person' outreach tools for presentation to key groups

- Ensure genetic integrity of shoal bass populations throughout the native range.
  - Assess population genetics of shoal bass across the range
  - Assess current status of hybrid populations across the range
  - Prioritize stream segments to be stocked
  - Select streams that have high probability of success
  - Initiate remedial stocking program based on methodologies derived from those developed for Guadalupe bass on the upper Guadalupe River
- Monitor genetic changes over time

Strategy 2: **Protect and maintain intact, healthy habitats.**

Actions:

- Assess locations and extent of healthy habitats using National Land Cover Database or similar approach
- Develop priority list of watersheds/stream segments for conservation actions
- Analyze data, define challenges, determine protection methods and engage public support for individual rivers, watersheds, or areas
  - watershed protection plans
  - establish BMP's in upland areas
  - protect and enhance riparian zones
- Develop action plans for addressing the objectives, select the best watershed management alternatives, list strategies for implementing alternatives and determine appropriate milestones for measuring progress.
- Convene stakeholder groups composed of private landowners and other entities (cities, counties, industry and utility companies, river authorities, lake associations, conservation groups, etc.)

- Implement action plans.

***Strategy 3:* Restore habitat**

Actions:

- Identify critical spawning habitat used by shoal bass in large rivers and smaller tributary streams across the range
- Assess extent and type of impacted habitats using National Land Cover Database or similar approach
- Develop priority list of watersheds/stream segments for conservation actions
- Remove low-head dams where feasible to increase connectivity and habitat availability for shoal bass
- Reduce flow variation due to hydropower generation, particularly during the spawning season
- Restore native riparian vegetation and shoal habitat in impacted areas
- Develop action plans for addressing the objectives, select the best watershed management alternatives, list strategies for implementing alternatives and determine appropriate milestones for measuring progress.
  - establish BMPs in upland areas
  - restore riparian zones
- Convene stakeholder groups composed of private landowners and other entities (cities, counties, industry and utility companies, river authorities, lake associations, conservation groups, etc.)
  - Implement action plans

***Strategy 4:* Conduct research to fill critical information gaps:**

Actions:

- Identify knowledge gaps critical to restoration of the species
  - Survey tributaries of major rivers to identify population status of shoal bass throughout range
  - Conduct research to determine the reproductive ecology and spawning habitat requirements of shoal bass.
  - Determine hybridization rates and extent of hybridization with invasive species.
  - Design and conduct research and experiments as needed.

***Strategy 5:* Provide coordination and adaptive management**

Actions:

- Hire a coordinator to complete habitat restoration activities already proposed in the Chipola River and MCA watersheds.
- Coordinate recovery and habitat restoration efforts among all agencies that have shoal bass under their purview
- Engage stakeholders to prioritize the recovery needs of shoal bass across the range
- Clarify roles and coordinate resources for implementation.

Implementation Partners:

Partners	**Contributions**
Georgia Department of Natural Resources	Data collection and analysis, rearing and stocking fish, funding assistance
Alabama Department of Conservation and Natural Resources	Funding assistance
Florida Fish and Wildlife Conservation Commission	Data collection and analysis, rearing and stocking fish, funding assistance
U.S. Fish and Wildlife Service	Funding assistance, threats assessments, habitat restoration assistance
National Resource Conservation Service	Assist in identifying and/or developing BMP’s
BASS/ESPN	Outreach and support
North American Black Bass Coalition	Outreach and support
Georgia, Alabama and Florida Bass Federation Nation	Outreach and support
Southern Company	Funding Assistance
National Park Service	Funding assistance
Georgia Power Company	Funding assistance
Local governments	Political/legislative support, funding assistance
Universities	Data collection and analyses
The Nature Conservancy	Funding assistance, outreach and on-the-ground support
Riverkeeper organizations (Upper Chattahoochee, Flint, Apalachicola)	Outreach and on-the-ground support
Local conservation groups	Outreach and on-the-ground support
Private landowners	Landowner permission, outreach,implement BMP’s
Regional water planning groups	Outreach and policy support

Funding Needs

Success in achieving the goals of this business plan depends upon the Foundation raising and spending at least $23.6 million over 10 years on the strategies describe herein. It also depends upon government and non-government agencies and organization providing an additional $7.9 million over 10 years.

Budget estimates for the first 10 years of conservation efforts directed at the three species identified in this NFWF Keystone Initiative are provided below.

BUDGET CATEGORY	**YEARS 1-5**		**YEARS 6-10**	
	NFWF	**Cost-share**	**NFWF**	**Cost-share**
Strategy 1: Ameliorate effects of invasive species	$1,482,972	$494,324	$936,750	$312,250
Strategy 2: Protect and maintain intact, healthy habitats	$2,609,318	$873,939	$7,312,500	$2,437,500
Strategy 3: Restore habitat	$2,134,217	$711,406	$2,752,887	$917,629
Strategy 4: Conduct research to fill critical information gaps	$1,368,109	$456,036	$884,985	$294,995
Strategy 5: Provide Coordination and Adaptive Management	$2,107,890	$702,630	$2,107,890	$702,630
TOTAL KEYSTONE INITIATIVE	**$9,702,506**	**$3,238,335**	**$13,995,012**	**$4,665,004**

Evaluating Success

All conservation investments are made with a desire to have something change. Monitoring tells us whether that change is occurring. Evaluation tells us whether the combined set of investments being made are being designed and implemented to maximize that change.

The Foundation will work with outside experts to prioritize proposals based on how well they fit in with the results chains and priorities identified in this plan. Success of funded projects will be evaluated based upon success in implementing proposed activities and achieving anticipated outcomes. As part of each project's annual (for multi-year awards) and final reports, individual grantees will provide a summary of completed activities and key outcomes directly to NFWF. These would likely include outcome metrics identified at the initiative scale.

Periodic expert evaluation of all investments funded under this initiative will occur and will help grantees to monitor key indicators to ensure that data across individual projects can be scaled up to programmatic and initiative levels. Findings from monitoring and evaluation activities will be used to continuously learn from our grant-making and inform future decision-making to ensure initiative success.

Annual monitoring of genetic and population structure in selected streams will provide an empirical measure of progress on each of the strategies. Some streams may be chosen for simultaneous work on genetic restoration and habitat restoration or protection. This could preclude the ability to separately assess the impacts of the individual actions, but would be useful in assuring overall success of the initiative.

Long-Term Foundation Support

This business plan lays out a strategy to achieve clear outcomes that benefit endemic black bass and associated aquatic communities over a 10-year period. At that time, it is expected that the conservation actions partners have taken will have brought about new institutional and societal standards and environmental changes that will have set the population in a positive direction such that maintaining those successes or continuing them will be possible with reduced NFWF funding after ten years. To help ensure that the population and other gains made in 10 years won't be lost after the reduction of NFWF funding, the partnership must seek development of solutions that are long-lasting, cost-effective, and can be maintained at lower levels of funding in the future. Therefore, part of the evaluations of this initiative will address that staying power and the likelihood that successful strategies will remain successful at lower management intensity and financial investment.

The adaptive nature of this initiative will also allow NFWF and partners to regularly evaluate the strategies behind our objectives, make necessary course corrections or addition within the 10 year frame of this business plan. In some cases these corrections and additions may warrant increased investment by NFWF and other partners. However, it is also possible that NFWF would reduce or eliminate support for this initiative if periodic evaluation indicates that further investments are unlikely to be productive in the context of the intended outcomes.

Ancillary Benefits

This initiative will have a measurable benefit for a host of other imperiled species, all of which are to some degree dependent on clean, flowing water and healthy riparian habitat. We do not plan to monitor progress in achieving benefits for these species. However, the magnitude of benefits are described in the below table in terms of how much each of these species' ranges overlap with that of the southeast endemic black bass species that are the focus of this plan and, within that range, how much of a benefit the listed activities will have on each species. This table reflects fish species and not other high priority aquatic biota such as crayfish and freshwater mussels, which will also benefit from the result of implementation of this plan. Check marks indicate that these activities are likely to offer the greatest benefit to each species.

Fish

Imperiled fish species likely to benefit from activities directed toward endemic black bass species in the southeastern US. Data are arranged by drainage basin (range of individual endemic black bass species) and were modified (unless otherwise indicated) from Jelks, H. L. and others. 2008. American Fisheries Society Imperiled Freshwater and Diadromous Fishes of North America. Available online at http://fisc.er.usgs.gov/afs/. Retrieved [10/30/2009].

Scientific name	Common name
Apalachicola (range of shoal bass and redeye bass-Chattahoochee)	
Acipenser oxyrinchus desotoi	Gulf sturgeon
Alosa alabamae	Alabama shad
Ameiurus brunneus	Snail bullhead
Ameiurus serracanthus	Spotted bullhead
Cyprinella callitaenia	bluestripe shiner
Notropis chalybaeus	ironcolor shiner
Notropis hypsilepis	highscale shiner
Percina crypta	Halloween darter
Pteronotropis euryzonus	broadstripe shiner
Pteronotropis welaka	bluenose shiner
Ameiurus brunneus	snail bullhead
Ameiurus serracanthus	spotted bullhead
Morone saxatilis	striped bass (Gulf of Mexico populations)
Percina crypta	halloween darter
Florida (range of Florida bass and Suwannee bass)	
Acipenser brevirostrum	shortnose sturgeon
Acipenser oxyrinchus desotoi	Gulf sturgeon
Acipenser oxyrinchus oxyrinchus	Atlantic sturgeon
Menidia conchorum	key silverside
Enneacanthus chaetodon	blackbanded sunfish
Alosa alabamae	Alabama shad
Notropis chalybaeus	ironcolor shiner
Pteronotropis welaka	bluenose shiner

Pteronotropis sp. cf. metallicus	Alafia River sailfin shiner
Cyprinodon variegatus hubbsi	Lake Eustis pupfish
Ameiurus brunneus	snail bullhead
Ameiurus serracanthus	spotted bullhead
Morone saxatilis	striped bass (Gulf of Mexico populations)
Kryptolebias marmoratus	mangrove rivulus
Microphis brachyurus lineatus	opossum pipefish

Ouachita highlands (range of Ouachita smallmouth bass)

Acipenser fulvescens	lake sturgeon
Alosa alabamae	Alabama shad
Hybognathus placitus	plains minnow
Hybopsis amnis	pallid shiner
Lythrurus snelsoni	Ouachita shiner
Notropis chalybaeus	ironcolor shiner
Notropis girardi	Arkansas River shiner
Notropis ortenburgeri	Kiamichi shiner
Notropis perpallidus	peppered shiner
Notropis suttkusi	rocky shiner
Pimephales tenellus parviceps	eastern slim minnow
Pteronotropis hubbsi	bluehead shiner
Noturus lachneri	Ouachita madtom
Noturus taylori	Caddo madtom
Atractosteus spatula	alligator gar
Ammocrypta clara	western sand darter
Crystallaria asprella	crystal darter
Etheostoma pallididorsum	paleback darter
Etheostoma sp. cf. stigmaeum	beaded darter
Percina nasuta	longnose darter
Percina pantherina	leopard darter
Percina uranidea	stargazing darter
Polyodon spathula	paddlefish

Ozark highlands (range of Neosho smallmouth bass)

Acipenser fulvescens	lake sturgeon
Scaphirhynchus albus	pallid sturgeon
Amblyopsis rosae	Ozark cavefish
Cycleptus elongatus	blue sucker
Moxostoma lacerum	harelip sucker
Alosa alabamae	Alabama shad
Erimystax harryi	Ozark chub
Hybognathus placitus	plains minnow
Hybopsis amnis	pallid shiner
Notropis ortenburgeri	Kiamichi shiner
Notropis ozarcanus	Ozark shiner
Pimephales tenellus parviceps	eastern slim minnow
Noturus flavater	checkered madtom

Atractosteus spatula	alligator gar
Ammocrypta clara	western sand darter
Crystallaria asprella	crystal darter
Etheostoma moorei	yellowcheek darter
Percina nasuta	longnose darter
Percina uranidea	stargazing darter
Percina sp. cf. nasuta	Ouachita longnose darter
Polyodon spathula	paddlefish
Mobile Bay (range of Alabama bass and redeye bass)	
Acipenser fulvescens	lake sturgeon
Acipenser oxyrinchus desotoi	Gulf sturgeon
Scaphirhynchus suttkusi	Alabama sturgeon
Speoplatyrhinus poulsoni	Alabama cavefish
Typhlichthys subterraneus	southern cavefish
Cycleptus meridionalis	southeastern blue sucker
Alosa alabamae	Alabama shad
Cottus paulus	pygmy sculpin
Cyprinella caerulea	blue shiner
Hemitremia flammea	flame chub
Hybopsis lineapunctata	lined chub
Macrhybopsis sp. cf. aestivalis	Coosa chub
Notropis cahabae	Cahaba shiner
Notropis chalybaeus	ironcolor shiner
Notropis melanostomus	blackmouth shiner
Pteronotropis welaka	bluenose shiner
Fundulus bifax	stippled studfish
Ameiurus brunneus	snail bullhead
Noturus munitus	frecklebelly madtom
Atractosteus spatula	alligator gar
Morone saxatilis	striped bass (Gulf of Mexico populations)
Crystallaria asprella	crystal darter
Etheostoma bellator	Warrior darter
Etheostoma brevirostrum	Holiday darter
Etheostoma chermocki	Vermilion darter
Etheostoma chuckwachatte	lipstick darter
Etheostoma ditrema	coldwater darter
Etheostoma etowahae	Etowah darter
Etheostoma nuchale	watercress darter
Etheostoma phytophilum	rush darter
Etheostoma scotti	Cherokee darter
Etheostoma trisella	trispot darter
Etheostoma sp. cf. bellator	Locust Fork darter
Etheostoma sp. cf. bellator	Sipsey darter
Etheostoma sp. cf. zonistium	blueface darter
Percina antesella	amber darter

Percina aurolineata	goldline darter
Percina brevicauda	coal darter
Percina jenkinsi	Conasauga logperch
Percina kusha	bridled darter
Percina lenticula	freckled darter
Percina sipsi	bankhead darter
Percina smithvanizi	muscadine darter
Polyodon spathula	paddlefish
Microphis brachyurus lineatus	opossum pipefish

South Atlantic (range of redeye bass-Altamaha and redeye bass-Savannah)

Acipenser brevirostrum	shortnose sturgeon
Acipenser oxyrinchus oxyrinchus	Atlantic sturgeon
Moxostoma robustum	robust redhorse
Moxostoma sp. cf. erythrurum	Carolina redhorse
Thoburnia hamiltoni	rustyside sucker
Ambloplites cavifrons	Roanoke bass
Enneacanthus chaetodon	blackbanded sunfish
Clinostomus funduloides ssp.	smoky dace
Cyprinella xaenura	Altamaha shiner
Notropis bifrenatus	bridle shiner
Notropis chalybaeus	ironcolor shiner
Notropis hypsilepis	highscale shiner
Notropis mekistocholas	Cape Fear shiner
Notropis semperasper	roughhead shiner
Pteronotropis stonei	lowland shiner
Semotilus lumbee	sandhills chub
Elassoma boehlkei	Carolina pygmy sunfish
Elassoma okatie	bluebarred pygmy sunfish
Ameiurus brunneus	snail bullhead
Ameiurus platycephalus	flat bullhead
Noturus furiosus	Carolina madtom
Noturus gilberti	orangefin madtom
Noturus sp. cf. leptacanthus	broadtail madtom
Etheostoma collis	Carolina darter
Etheostoma mariae	pinewoods darter
Percina rex	Roanoke logperch
Microphis brachyurus lineatus	opossum pipefish
Ameirus catus	White catfish*
Campostoma anomalum	Central stoneroller*
Cotus bairdii complex	Smoky sculpin*
Etheostoma fricksium	Savannah darter*
Etheostoma hopkinsi	Christmas darter*
Etheostoma inscriptum	Turquoise darter*
Etheostoma zonale	Banded darter*
Hybopsis rubrifrons	Rosyface chub*

East and West Texas Gulf (range of Guadalupe bass)	
Anguilla rostrata	American eel**
Cycleptus elongatus	blue sucker
Dionda nigrotaeniata	Guadalupe roundnose minnow**
Etheostoma fonticola	fountain darter
Etheostoma lepidum	greenthroat darter
Gambusia heterochir	Clear Creek gambusia
Hybognathus placitus	plains minnow
Hybopsis amnis	pallid shiner
Macrhybopsis marconis	Burrhead chub**
Moxostoma congestum	gray redhorse
Notropis buccula	smalleye shiner
Notropis chalybaeus	ironcolor shiner
Notropis oxyrhynchus	sharpnose shiner
Percina apristis	Guadalupe darter**
Satan eurystomus	widemouth blindcat
Trogloglanis pattersoni	toothless blindcat

*For redeye bass in the Savannah Drainage: Adapted from South Carolina Comprehensive Wildlife Conservation Strategy, 2005. Available online at http://www.dnr.sc.gov/cwcs/.

**Adapted from the Texas Comprehensive Wildlife Conservation Strategy, 2005. Available online at http://www.tpwd.state.tx.us/twap.

Freshwater Mussels

Imperiled mussel species likely to benefit from activities directed toward endemic black bass species in the southeastern US. Available data are arranged by drainage basin (range of individual endemic black bass species). Data for Ouachita Highlands, Ozarks and Mobile Bay are being compiled and will be added to the plan in future revisions.

Scientific name	Common name
Apalachicola (range of shoal bass and redeye bass-Chattahoochee)	
Alasmidonta triangulata	Southern elktoe
Anodonta heardi	Apalachicola floater
Anodontoides radiatus	Rayed creekshell
Elliptio arctata	Delicate spike
Elliptio crassidens	Elephant-ear
Elliptio fraterna	Brother lance
Elliptoideus sloatianus	Purple bankclimber
Hamiota subangulata	Shinyrayed pocketbook
Medionidus penicillatus	Gulf moccasinshell
Pleurobema pyriforme	Oval pigtoe
Quadrula infucata	Sculptured pigtoe
Toxolasma paulum	Iridescent liliput

Villosa villosa	Downy rainbow
Florida (range of Florida bass and Suwannee bass)	
Alasmidonta wrightiana	Ochlockonee arc-mussel
Hamiota subangulata	Shinyrayed pocketbook
Medionidus simpsonianus	Ochlockonee moccasinshell
Medionidus walkeri	Suwannee moccasinshell
Pleurobema pyriforme	Oval pigtoe
South Atlantic (range of redeye bass-Altamaha and redeye bass-Savannah)	
Alasmidonta varicose	Brook floater
Lasmigona decorate	Carolina heelsplitter
East and West Texas Gulf (range of Guadalupe bass)	
Quadrula aurea	Golden orb
Quadrula houstonensis	Smooth pimpleback
Quadrula petrina	Texas pimpleback
Quincuncina mitchelli	False spike
Lampsilis bracteata	Texas fatmucket
Truncilla macrodon	Texas fawnsfoot

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