

## Guadalupe Bass Restoration Initiative

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*Abstract.*—The Texas Parks and Wildlife Department has initiated an innovative approach to fish and wildlife conservation in Texas. By working with alliances of landowners, we provide a holistic approach to technical guidance and help to secure funding for restoration and conservation actions throughout targeted watersheds. Although we have projects in many locations in the state, our most successful utilizes the state fish of Texas as an iconic symbol that provides a positive, high-profile image depicting the need for, and benefits of, watershed conservation. We chose the Llano River Watershed to begin implementation of the Guadalupe Bass Restoration Initiative and, to date, have 17 conservation and restoration initiatives in the watershed that encompass 21,370 ha and 56 km of rivers and streams. Projects focus on actions that restore riparian areas, reduce soil erosion and runoff, increase infiltration and aquifer recharge, improve water quality, and enhance habitat for both aquatic and terrestrial species. Through the initiative, we promote awareness and stewardship of fish and wildlife habitats, share best management practices, organize community involvement in local habitat conservation projects, provide technical guidance and planning assistance, and help leverage available resources. Additionally, in 2011 and 2012, we stocked more than 280,000 genetically pure Guadalupe Bass *Micropterus treculii* in the South Llano River to reverse the trend of hybridization with the nonnative Smallmouth Bass *M. dolomieu*. We also supported studies on fish community and habitat analysis in the Llano River Watershed and partnered with private landowners to develop a watershed conservation plan. We are now in the process of developing a habitat conservation demonstration area (CDA) that extends over a 7-km segment of the Llano River. The CDA will provide fishing, paddling and hiking opportunities, promote sustainable public use of the river, and highlight restoration actions through educational kiosks placed along paddling and upland hiking trails.

The Texas Parks and Wildlife Department (TPWD) has developed a holistic, community-based approach to protecting and improving habitat quality and quantity to provide environmentally and economically healthy watersheds. Effective watershed

conservation also helps to raise awareness of the resource value of watersheds and provides recreational benefits to our constituents. Our efforts focus on guiding development of watershed conservation projects throughout the state and coordinating these efforts among land owners, nongovernmental organizations, other state and federal agencies, and ap-

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propriate local governments. There are many tools that can help us reach our goals, including watershed conservation partnerships, conservation workshops, landowner incentive programs, and one-on-one work with private landowners.

Some of the projects we now have underway include

- Giant reed *Arundo donax* eradication in the Nueces basin. Working with the Nueces River Authority and landowners, a program is underway to eradicate this invasive plant before it becomes more fully established. It is estimated that giant reed now covers as much as 5% of the flood plain in the upper reach and around 1% in the lower sections. Giant reed creates problems by replacing native riparian plants, choking flows, consuming water, possibly interfering with stream meander, and reducing the ability of the river to dissipate energy.
- West Texas watershed projects. Working with the U.S. Fish and Wildlife Service (USFWS) and Desert Fish Habitat Partnership, projects are underway that restore grassland and enhance springs in the Alamito Creek and Terlingua Creek basins. They complement the work planned under the Big Bend Conservation Cooperative, which is a collaborative effort among agencies of the Department of Interior, TPWD, and Mexico that will help to coordinate conservation of more than 1,200,000 ha in the Big Bend region of Texas and Mexico.
- Statewide watershed conservation workshops. This series of workshops by TPWD staff is designed to provide guidance to landowners on proper watershed stewardship. Workshops include classroom and field components and focus on physical and biological functions of streams and riparian areas, floral and faunal species identification, conservation methods, and funding opportunities.
- Watershed conservation partnerships. We are currently involved as stakeholders or advisors in six watershed conservation partnerships around the state. The TPWD community-based aquatic habitat conservation program continues to aid in the creation of new partnerships at scales appropriate to meeting conservation challenges.
- Paddling trails. This program is highly popular and successfully promotes awareness of conservation efforts, recreational opportunities, and the value of a holistic watershed approach

to conservation with more than 400 km of inland trails. Creation of these paddling trails encourages a group of outdoor enthusiasts to spend more time on Texas rivers, increasing the number of stakeholders that have a vested interest in maintaining the quality of these streams. We will continue to develop trails in locations that compliment watershed conservation efforts.

Our most successful project utilizes the state fish of Texas, Guadalupe Bass *Micropterus treculii*, as an iconic symbol that provides a positive, high-profile image of the need and benefits of conservation and serves as an indicator of ecosystem health. Administered by TPWD, the Guadalupe Bass Restoration Initiative (GBRI) is the first project of the National Fish and Wildlife Foundation Keystone Initiative to conserve native species of black basses in the United States (Birdsong et al. 2010). The Guadalupe Bass is a central Texas endemic, naturally occurring only in streams draining the Edwards Plateau region (Brazos, Colorado, Guadalupe, and San Antonio River systems; see Birdsong et al. 2015, this volume, for range map). In recognition of the unique character of both the Guadalupe Bass and its habitat, this species was designated the state fish of Texas by the Texas Legislature in 1989. Abundance of genetically pure Guadalupe bass has decreased in recent decades (Koppelman and Garrett 2002), so the GBRI was initiated to help reverse this trend and ensure self-sustaining populations of this endemic black bass.

Factors contributing to the decline of Guadalupe Bass include decreased streamflow, habitat loss and degradation, and hybridization with nonnative Smallmouth Bass *M. dolomieu*. Habitat loss and genetic introgression are pervasive throughout the range of Guadalupe Bass. The GBRI addresses these factors by developing networks of willing private and public landowners interested in implementing coordinated landscape conservation actions at watershed scales. Conservation actions implemented by landowner networks and TPWD will also promote functional riparian and stream systems and emphasize the conservation of native fish communities and supporting habitats.

We chose the Llano River watershed to initiate the GBRI because of a high probability for genetic restoration and local interest in habitat conservation and restoration. Genetic restoration in this watershed began with stocking more than 280,000 genetically pure Guadalupe Bass in the South Llano River during 2011 and 2012 (Figure 1). Stocking has been an

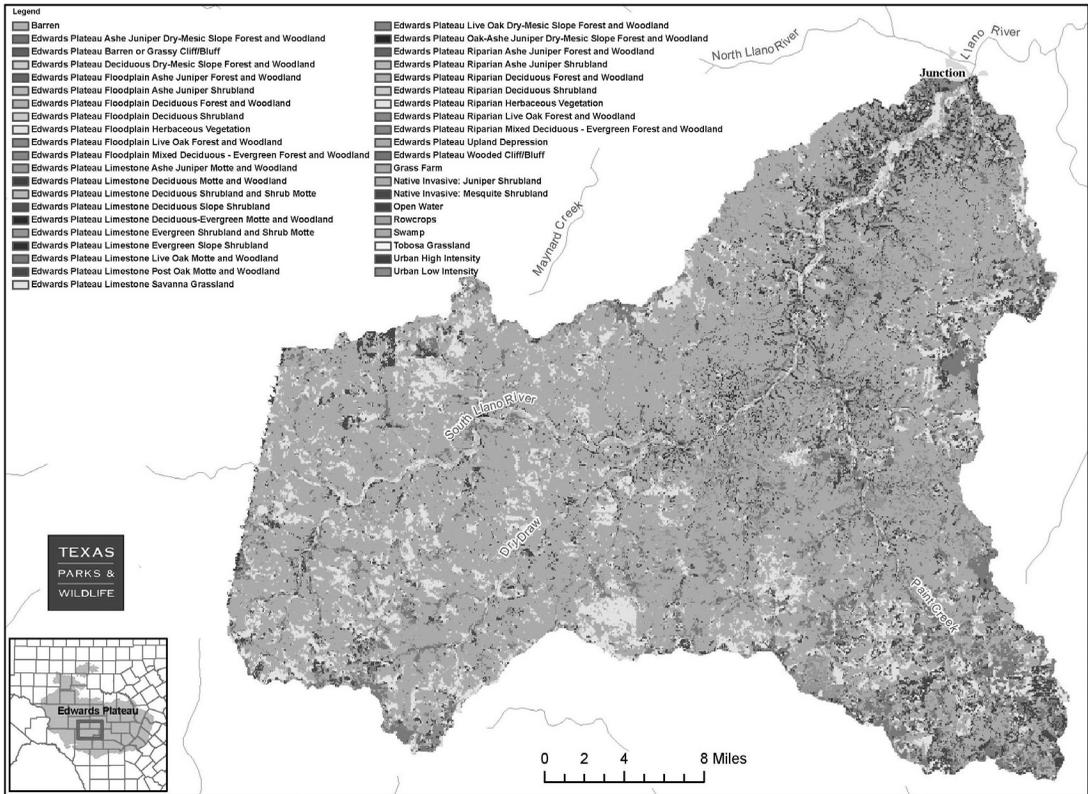


Figure 1. South Llano River Watershed.

effective method for genetic restoration in a similar system (upper Guadalupe River, Fleming et al. 2015, this volume) and should reverse the trend of hybridization with the nonnative Smallmouth Bass in the South Llano River. Hybridization was originally estimated to be approximately 3% (Bean et al. 2013), and genetic samples are collected on a yearly basis to monitor changes in the current level of hybridization.

Through the GBRI, we also promote awareness and stewardship of fish and wildlife habitats, share best management practices, organize community involvement in local habitat conservation projects, provide technical guidance and planning assistance, and help leverage available resources to fund conservation and restoration projects.

Current partnerships with private landowners include projects ranging in size from 14 to 2,100 ha and focus on actions that restore riparian areas, reduce soil erosion and runoff, increase infiltration and aquifer recharge, improve water quality, and enhance habitat for both aquatic and terrestrial species. We are also working with multiple partners in the lo-

cal community to develop a conservation demonstration area (CDA) that extends over a 7-km segment of the Llano River, beginning approximately 10 km upstream of the confluence of the North Llano and South Llano rivers (city of Junction) at the South Llano River State Park and extending downstream to the Texas Tech University Llano River Field Station (Figure 1). The CDA will provide fishing, paddling, and hiking opportunities; promote sustainable public use of the river; demonstrate best management practices; and highlight restoration actions through educational kiosks placed along paddling and upland hiking trails.

Several opportunities for habitat restoration exist within this CDA, including stabilization of eroding banks, riparian enhancement, invasive species management, instream habitat improvements, upland management and erosion control, and replacement of the existing highway bridge at the park entrance with one that accommodates natural fluvial processes and allows for improved passage of aquatic organisms. In addition to enhancing habitat for Guadalupe Bass, these activities will improve the

functional and esthetic value of the river, benefit fish and wildlife populations as a whole, and demonstrate the value of these actions to private landowners.

To assess the extent of erosion issues in the CDA, TPWD surveyed and mapped the magnitude and severity of eroding banks in this reach. The area of most immediate concern occurs within the park on the right bank of the river, approximately 300 m downstream of the Park Road 73 crossing. Over the course of 18 years, some parts of this bank have eroded as much as 37 m. Not only is the eroding bank contributing excessive sediments to the river, it also occurs in an area of the state park designated for recreation and will continue to impede access and pose a hazard to the public if not addressed. Additionally, the eroding area has already impacted parking facilities and drainage infrastructure located on top of the bank, forcing the relocation of the parking lot. The eroding bank is now gradually approaching the recently relocated parking lot and continues to cause damage to drainage infrastructure. The Texas Parks and Wildlife Department is developing plans in collaboration with stream restoration consultants to ameliorate this problem by stabilizing the bank using bioengineering methods. The finished product would replicate a natural streambank, provide protection against further erosion, improve the esthetic and recreational value of the area, eliminate the hazard posed to property and visitor safety, and enhance fish and wildlife habitat. The success of this objective depends upon replacement of a problematic bridge; therefore, these projects will be implemented in concert with one another.

The Park Road 73 bridge is a barrier to fish passage, has impacted aquatic habitat, and has altered river geomorphology. The movement of Guadalupe Bass and other aquatic organisms is inhibited due to the steep grade and increased current velocities associated with the box culvert, low-water crossing design. The bridge has also altered sediment transport by acting as a dam, lowering upstream current velocities, and reducing the ability of the river to carry sediment during bank-full flooding events. In addition, historical photos show that the bridge has caused the river to change direction from its historical path, cutting into the right bank just below the bridge. This has led to property loss at the state park and potential for ongoing erosion along this bank. The foundation of the bridge is believed to be actively undercutting on the downstream end as a result of the hydraulic forces generated as stream water pours off the concrete apron. This could create a po-

tential safety hazard (strong hydraulic current and/or eventual collapse of the bridge) to recreational users. Representatives from the Texas Department of Transportation, USFWS, and TPWD have held discussions regarding a possible project to replace or modify the existing bridge to improve fish passage and accommodate natural fluvial processes.

Biological studies in the CDA examining environmental factors such as availability and suitability of instream cover for Guadalupe Bass are also being supported by TPWD. Availability and quality of instream cover may have a strong influence on the distribution and abundance of Guadalupe Bass. Guadalupe Bass utilize woody debris (trees, logs, and root wads), undercut banks, and boulders for cover and as refuges from increased current velocity during high flows (Perkin et al. 2010). Adding instream cover in areas where it is currently lacking may increase abundance of Guadalupe Bass and other native fishes. Additional instream cover would also provide habitat for other aquatic organisms (e.g., aquatic macroinvertebrates), resulting in ecosystem-wide benefits. The addition of woody debris or combinations of wood and rock fish habitat structure in rivers and streams has been successfully used to improve fish habitat throughout the United States (Rosgen 1996). These structures provide additional cover and reduced current velocities. A survey of woody debris in the CDA conducted in summer 2011 indicated that the abundance of this type of cover was low compared to a reference reach. We plan to add woody debris or Rosgen type woody debris and rock structures (Rosgen 1996) into the restoration areas with the objective of increasing Guadalupe Bass abundance. Structures will be placed in areas where access to the river for heavy equipment is practical, woody debris is absent or low in abundance, potential for erosion to riverbanks is minimal, and they will not create an obstruction to other recreational uses (boating and tubing). A survey conducted on distribution and abundance of mesohabitat types within the CDA will be used to help guide the placement of these structures. All structures will be anchored or constructed to withstand high-flow events so that they will not move or be destroyed.

Several land-management opportunities exist within the CDA that could help support the long-term success of the proposed restoration projects. Modifying mowing locations or schedules (no-mow zones or seasonal mowing only) would support riparian enhancement activities and reduce erosion from runoff. Erosion from runoff could also be mitigated

with the establishment of bioswales and other best management practices. Additionally, by enhancing the current state park trail system in a manner that would discourage off-trail hiking and provide designated access points along the river, soil compaction and erosion could be reduced while also promoting the growth of native riparian plant species.

Healthy riparian corridors provide a number of benefits to people, water, fish, and wildlife, including improved water quality due to absorption and filtration of runoff; bank stabilization due to the dense root masses provided by riparian plants; increased forage and habitat for wildlife; improved aquatic habitat resulting from cooler shaded water, instream structure provided by woody debris, and nutrient contributions from leaf litter; reduced downstream flooding as a result of slower velocities and increased absorption; increased esthetic value; and improved aquifer recharge associated with slower velocities. Much of the riparian corridor along the South Llano River has been degraded due to mowing, overgrazing by livestock and wildlife, agricultural practices, and encroachment of nonnative invasive species. A survey completed by TPWD in the CDA documented the presence and extent of the two most prominent invasive plants in the area, chinaberry *Melia azedarach* and giant reed. We intend to enhance the riparian corridor and remove invasive species within the riparian areas of the CDA.

Several methodologies might be used to accomplish riparian enhancement. Areas with little riparian vegetation would be seeded with native grasses and forbs and plantings of saplings. Areas with incomplete riparian coverage by existing native species may only require the removal of invasive species. In instances where invasive species are removed, native species will be planted in the same location to prevent bank instability and loss of wildlife habitat. The use of mobile fencing enclosures may also be employed where wildlife browsing is preventing natural regeneration. All proposed restoration activities would be coordinated with park and university staff to ensure compatibility with existing priorities.

We have also undertaken eradication of invasive elephant ear *Colocasia esculenta* in a 12-km section of the South Llano River, upstream of the CDA. Elephant ear forms dense stands and chokes out native species, thus altering natural habitat and ecosystem processes and reducing biodiversity. We obtained landowner permission to access the plants along the banks of the river, and using hand sprayers, we applied the herbicides glyphosate (AquaNeat) and ima-

zomox (Clearcast). We performed the first treatment in June 2012 and followed with three more during the next 5 months. Initial response was barely noticeable, but subsequent treatments have proven extremely effective.

The initial US\$400,000 provided by the National Fish and Wildlife Foundation for the GBRI has been leveraged against more than \$2,000,000 in additional on-the-ground project funds. To date, we have initiated 17 conservation and restoration initiatives in the watershed that encompass 21,370 ha and 56 km of rivers and streams with the goal of restoring 780 ha of riparian, spring, and upland habitats (to reduce erosion and support aquifer recharge). In one tributary of the Llano River, Schep Creek, three ranches cover the entire subwatershed, and each of these ranches are now working with the Guadalupe Bass Restoration Initiative to improve habitat. Projects include grassland restoration, riparian vegetation protection, and spring flow enhancement. In 2012, the South Llano River Paddling Trail was established within the project area and will help to promote conservation efforts for Guadalupe Bass in the Llano River.

Through the GBRI, we partnered with the South Llano River Watershed Alliance to develop the North and South Llano River Watershed Conservation Plan. The plan is structured to help stakeholders become more familiar with the watershed and guide coordinated conservation and restoration efforts in the watersheds. The plan is designed to be a living document. As new information becomes available or conditions in the watershed change, beneficial activities will be identified, developed, or modified by stakeholders.

To further organize the community and initiate support for watershed conservation, the Upper Llano River Watershed Protection Plan has been established. This initiative is funded through the Healthy Watersheds program with the U.S. Environmental Protection Agency. The Texas Parks and Wildlife Department is assisting Texas Tech University, Texas AgriLife, the Texas State Soil and Water Conservation Board, and the local community with the development of this plan. The deliverables from this plan will benefit the North and South Llano River Watershed Conservation Plan by identifying desired conditions, prioritizing management practices, and developing specific recommendations that can be implemented in the watershed.

The GBRI also supports studies by Texas Tech University on fish communities and aquatic habitats

in the Llano River Watershed. The studies consist of four components representing a preliminary inventory of habitat availability and quality in the South Llano River Watershed and an evaluation of how habitat structuring at various spatial scales influences fish assemblage structure. The studies will also provide critical data on the habitat use patterns of Guadalupe Bass during various stages of its life history, as well as an initial assessment on the effects of habitat fragmentation on the species. Studies are also ongoing to provide one of the first estimates of the size, structure, and dynamics of a Guadalupe Bass population and to assess the overall effectiveness of stocking programs. An assessment of the potential for stocking programs to completely eradicate Guadalupe Bass  $\times$  Smallmouth Bass hybrids is also being addressed in laboratory trials by evaluating the performance and fitness of pure-strain Guadalupe Bass versus hybrids. These efforts will allow for a critical evaluation of degree to which the species is an indicator of the health and functionality of Edwards Plateau watersheds—one of the key tenets of the GBRI that is driving stream restoration efforts in this region.

The overall goals of the GBRI will benefit from components of these studies through creation of an integrated instream and riparian habitat map of the South Llano River from its confluence with Big Paint Creek to its confluence with the North Llano River near Junction, Texas; assessment of the habitat associations of species present in the study reach relative to habitat availability and the effects of habitat degradation on these associations; evaluation of the probability of species presence given variations in habitat area, edge ratio, isolation, and so forth; assessment of the habitat associations of Guadalupe Bass life history stages relative to habitat availability, degradation, and fragmentation; evaluation of the probability of Guadalupe Bass size-class presence given variations in habitat area, degree of fragmentation or degradation, isolation, and so forth; creation of Guadalupe Bass age-length key and growth model; and evaluation of the effects of fragmentation, habitat availability, and degradation on growth and age structure of local population subunits.

Recent trends of reduced precipitation in the region combined with already fragmented and degraded habitats have increased the level of threat for Guadalupe Bass. Climate change predictions suggest that this challenge will be ongoing. The University of Texas, in conjunction with TPWD, has developed niche models for Guadalupe Bass and other fresh-

water fishes by relating occurrence records with diverse, landscape-scale environmental data sets to predict occurrence probability throughout Texas. These models predict that, in the coming decades, assuring appropriate habitat for Guadalupe Bass will be even more challenging, and emphasize the need to strive for the greatest degree of habitat resiliency.

Toward that end, the value of a community-based approach and working with organized groups of landowners cannot be overstated. This approach provides an effective method for information exchange and, more importantly, enhances our ability to coordinate and focus grassroots efforts to protect, restore, and enhance aquatic, riparian, and upland habitats essential to the long-term health and sustainability of not only the Guadalupe Bass, but of all the natural resources of Texas. The resulting sense of pride and stewardship is the most effective way to achieve long-term, sustainable conservation.

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