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Texas Master Naturalist Program

The Enigmatic Eel – A Metamorphic Journey

KEVIN MAYES, TPWD – AQUATIC BIOLOGIST

DEAN HENDRICKSON, UT-AUSTIN – CURATOR OF ICHTHYOLOGY

“Get off my hook!” is one of the nicer things shouted when a surprised angler finds an American eel wriggling its best to get off that hook. Slimy, slippery, snaky, writhing, crazy beasts. And fish biologists love it.

The American eel, *Anguilla rostrata*, is an amazing catadromous (living in fresh water and spawning in the ocean) fish with a remarkable life history involving huge migrations. Immature adults, a.k.a. “yellow eel,” live in freshwater rivers, lakes, and estuaries, feeding on fishes and invertebrates for 5 to 20 years before making a remarkable, long-distance journey to the Atlantic Ocean to spawn in the depths of the Sargasso Sea (by the Bermuda Triangle).

To make this seaward journey, yellow eel undergo a striking transformation, maturing into silver eel adapted to life in the deep salty sea. Their skin turns silver and bellies white, their fins and eyes enlarge, and their bodies elongate and fatten. Once mature eel reach the Sargasso, they broadcast spawn—scattering eggs and sperm in the water column—and presumably die. Fertilized eggs drift and hatch

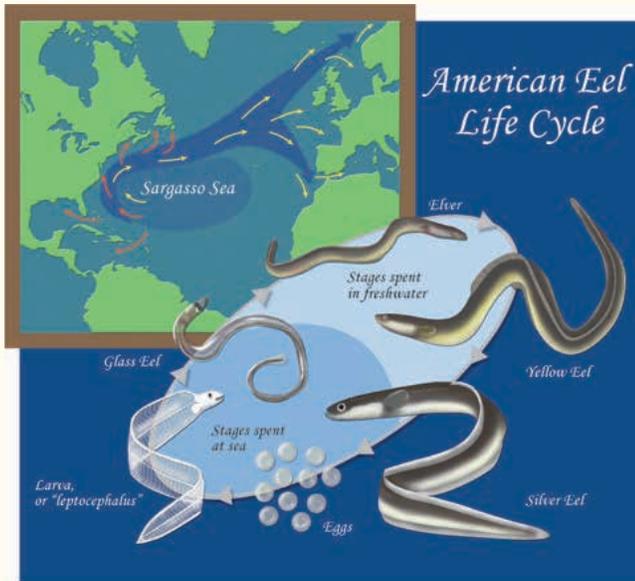
An American Eel in the “yellow eel” life stage caught by TPWD biologists sampling the Sabine River. Photo courtesy of Clint Robertson, TPWD.

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The Enigmatic Eel – A Metamorphic Journey



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into larvae, called “leptocephalus,” which look like a transparent willow leaf and continue to drift around in the ocean’s mix of plankton.

Captured by the Gulf Stream many are transported to the eastern seaboard of the U.S., but some, we don’t know how many, enter the Gulf of Mexico. On their way into coastal estuaries another transformation takes place. The leptocephali shift into a more eel-like shape but remain transparent: a stage called the “glass eel.” Along the eastern seaboard it’s fairly predictable when glass eels make runs into estuaries and up rivers. As glass eels work their way upstream they elongate and become brown or gray. In this stage they are called “elvers,” and they are on a mission to move upstream. Elver runs support huge commercial fisheries and aquaculture operations (e.g., for unagi in Japanese restaurants),

spinning off reality TV shows. Elvers have uncanny abilities to navigate around most obstacles, even leaving the water to make headway, at least for short distances. Elvers are the last stage before the transformation to yellow eels.

Although global populations are in decline, American Eel is widely distributed across most major river drainages of the Atlantic coast of the U.S. and Canada, where it’s well studied. However, relatively little is known about the species in the Gulf of Mexico, including Texas. What time of year or how many glass eels, for example, arrive in Texas rivers and estuaries is a complete mystery, and we have very little sample data because they are rarely encountered with typical fish sampling gear (eel tend to be nocturnal as well). The most commonly encountered stage is the yellow eel because they end up on trotlines and fishing poles, and become the subject of notable fishing tales.

There are American eel records from each of the major river basins in Texas, but most observations are now concentrated downstream of large dams. As reservoirs were built on Texas rivers in the ’50s and ’60s, these massive structures became effective migration barriers, even for the little elvers and yellow eels driven by their innate desire to move upstream. This mysterious fish continues to surprise scientists as well as anglers as new information comes in.

As fish biologists we need more data on eels in Texas and across the Gulf of Mexico and its tributaries to make sound management decisions to protect and conserve these remarkable, enigmatic, yet lovable creatures. To get that data, we have launched a campaign to encourage fisherman and scientists alike to report observations and provide specimens of all stages of the species. If you’d like to learn more about this effort or download the wanted poster, check out the American Eel webpage at <https://sites.cns.utexas.edu/hendricksonlab/american-eel>.

If you took and possess a photograph of an American Eel and know where and when it was seen, please submit that observation to the iNaturalist project:

www.inaturalist.org/projects/fishes-of-texas
or send it to fishesoftexas@gmail.com.

More reading on American Eel

www.fishesoftexas.org/taxon/anguilla-rostrata

https://en.wikipedia.org/wiki/Eel_as_food

www.newyorker.com/tech/elements/the-poetic-life-of-the-lowly-eel

The Link Between Alligator Gar and Floodplains

CLINT ROBERTSON, TPWD – AQUATIC BIOLOGIST

Fishes in the gar family (Lepisosteidae) come from an ancient lineage, which is evident from their appearance. Their armor-like scales, called ganoid scales, form an impenetrable barrier over their long, torpedo-shaped bodies.

In addition to their suit of armor, their mouths are full of long sharp teeth that give them a menacing, prehistoric appearance. Another interesting feature of gars that is attributed to their ancient lineage is a highly vascularized swim bladder that allows them to utilize atmospheric oxygen by gulping air. This specialized swim bladder essentially functions as a lung. There are currently seven extant species of gar, with four occurring in Texas: longnose gar, spotted gar, shortnose gar, and alligator gar.

Alligator gar (*Atractosteus spatula*) are the largest of all the gar species and one of the largest freshwater fish in North America, second only to white sturgeon that occur in rivers along the Pacific Coast. Historically, alligator gar ranged from the upper Mississippi River as far north as Illinois, east to Florida, and south into central Mexico. However, over the past half century their range has been significantly reduced to the lower Mississippi River drainages of Louisiana and Mississippi, and the Gulf Coast drainages of Alabama, Florida, Mexico, and Texas. The reasons for decline throughout their historical range are many, but some of the main contributing factors include misinformed eradication programs (people think they wipe out game fish populations), unrestricted harvest regulations, and river flow alterations from dams and levees. The latter of these is critically important given that successful alligator gar reproduction is directly tied to their access to floodplain habitats during their spawning season.

Alligator gar grow to impressive sizes. It's amazing to think that a baby alligator gar on the left will grow to be the size of the alligator gar on the right. Photo courtesy of Clint Robertson, TPWD.

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Texas rivers, such as the Trinity River, still maintain naturally sustaining populations of alligator gar. Given that successful alligator gar reproduction is dependent on access to floodplain habitats, growing water demands and expanding populations in the Dallas–Ft. Worth (DFW) Metroplex could potentially impact river-floodplain connectivity in the Trinity River. Due to these potential impacts, research efforts by Texas Parks and Wildlife Department (TPWD) biologists are currently underway to ensure that these ancient fish persist in this river basin. Biologists are currently trying to quantify the amount of river-floodplain connectivity in the middle Trinity River basin (from DFW to Lake Livingston) that will support successful alligator gar reproduction. To do this, researchers hope to pinpoint various aspects of flooding events that lead to successful alligator gar reproduction, such as timing, magnitude, and duration of floods.

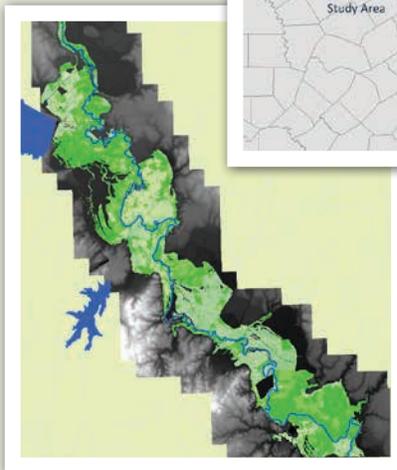
To begin this process, researchers utilized an existing 1-dimensional hydraulic model (a model that can predict water surface elevations along the river at various river flow levels) developed by Tarrant Regional Water District and high resolution (1-meter) topography data to create floodplain inundation maps for various modeled river flow levels. Creating these floodplain inundation maps at various river flow levels (e.g. 5,000, 10,000, 20,000, ..., 80,000 cubic-feet-per-second) allows for the development of a river discharge (flow)–floodplain inundation relationship that can be used to predict the inundation extent of past and future flooding events. With the knowledge that alligator gar prefer to spawn on herbaceous and/or shrub vegetation types this relationship can then be further refined using TPWD’s Ecological Mapping Systems database of mapped vegetation types to estimate the inundation extent of suitable alligator gar spawning habitat.

Once the relationship between river discharge and alligator gar spawning habitat availability is established, the next step for the researchers will be to determine the hydrologic variables (flooding characteristics) needed for a successful spawning year by looking into the past. To do this, researchers will link historical spawning habitat availability (e.g. river discharge) with known years of successful alligator gar reproduction in the middle Trinity River. To determine which years were successful for reproduction, researchers must determine the known year of birth (age) of alligator gar that have been collected (i.e., if you collect the fish as an adult, reproduction was successful). To determine this, researchers utilize the largest otolith (ear bone, which

there are three) in the fish’s skull and count the growth rings, or years of age similar to counting rings on a tree. Although the fish have to be sacrificed in order to obtain the otoliths, the otoliths have been shown to be the most reliable way to estimate the age of alligator gar.

Utilizing statistical methods, hydrologic variables such as timing (months of the year), duration (how many days of inundation), and magnitude (amount of spawning habitat available) can then be correlated with successful reproduction events to determine the conditions that are most conducive for successful alligator gar reproduction. These conditions can then be recommended for inclusion in future water management decisions in the basin to ensure healthy alligator gar populations remain in the middle Trinity River Basin.

Alligator gar are an integral part of the river and reservoir ecosystems in which they are found. They are analogous to lions on the Serengeti, the apex predators that provide important “top-down” control of the food web. But beyond their important ecological role, alligator gar are providing an ever-growing role as a targeted recreational species for hook and line anglers worldwide. These anglers are flocking to the Trinity River in Texas for a chance to battle with 7-foot-long, 300-pound river monsters. Understanding the important link between Alligator Gar and floodplains is critical to maintain adequate numbers of these species for people to be able to enjoy recreationally, but more importantly, to ensure that this species persists for generations to come.



Alligator gar spawning habitat floodplain inundation study area in the Middle Trinity River encompassing about 200 river miles. Map produced by TPWD River Studies Program.

Floodplain inundation map for an 80,000 cfs flood showing the total area of inundation and the vegetation classes (different colors of green), as well as the high resolution topographic data utilized (dark background areas). Map produced by TPWD River Studies Program.

River Restoration Guidelines Now Available

RYAN MCGILLICUDDY, TPWD – CONSERVATION ECOLOGIST

JOHN HART ASHER, LADY BIRD JOHNSON WILDFLOWER CENTER – ENVIRONMENTAL DESIGNER

MICHELLE BERTELSEN, LADY BIRD JOHNSON WILDFLOWER CENTER – ECOLOGIST

The flood events in May and October of 2015 severely impacted the communities along the course of the Blanco and San Marcos rivers. Alongside tragic personal and economic losses were significant impacts to ecological resources. Majestic old growth bald cypress trees and other streamside vegetation were uprooted and damaged at a devastating scale, leaving the river banks completely bare in some areas and exacerbating the risk of future erosion.

Following the floods, the Texas Parks and Wildlife Department and a number of partners, including the Ecosystem Design Group at the Lady Bird Johnson Wildflower Center, set out to inform landowners as to how flood affected landscapes can be restored to a more resilient state that allows for both ecological functions and recreational access. The long term goal of many residents is to reestablish the tree canopy that was completely lost in places; however, that process will take many years. In the meantime it is very important that streamside landowners take steps to allow strong native riparian grasses and sedges to thrive and to establish the proper conditions for ecological succession. Such species have deep and dense root systems that hold the banks together and resist erosive forces, while much of the woody debris that was deposited by the flooding can provide fish and wildlife habitat, help to reinforce the riverbanks, and act as a nursery for new tree growth.

To help guide residents on the path to establishing more resilient landscapes, the Wildflower Center and TPWD developed a Blanco River Restoration Design Guidelines booklet. In this document there is a general discussion regarding riparian function, historical site conditions, and active methods for preserving or enhancing private landscapes, with a case study demonstrating how landowners can manage storm water and riparian restoration on their properties. While the guidelines were developed for the Blanco River, many of the concepts in the booklet are broadly applicable to the streams of the Hill Country and beyond.

The guidelines are now available for download from the TPWD website at:

http://tpwd.texas.gov/publications/nonpwdpubs/media/blanco_river_design_guidelines_2016.pdf

More information on the Ecosystem Design Group at the Lady Bird Johnson Wildflower Center can be found at:

www.wildflower.org/consulting/



A rendering from the booklet of a restored riparian landscape that is usable and ecologically functional.

Hidden Treasures of Texas

LARRY LARRALDE, SAN ANTONIO RIVER AUTHORITY – AQUATIC BIOLOGIST

Divers search for mussels in the San Antonio River Basin.

Mussels gathered during a SARA sampling event.



If you've ever walked along the edge of a creek or stream and noticed what appears to be a rock but isn't, there's a chance you have located a freshwater mussel. These hidden aquatic treasures require good water quality and habitat with flowing water to survive and flourish.

At first glance they are solid as a rock, with no arms, legs, eyes, or ears; however, they possess a keen sense of their immediate surroundings. Mussels are one of the first organisms to sense any type of environmental stressor, and their absence in a stream may indicate something wrong within a body of water.

Freshwater mussels are a critical component of healthy aquatic ecosystems, acting as bio-monitors and playing vital roles in nutrient cycling and water quality maintenance. Most mussel species are sensitive to disturbance due to their sedentary lifestyle and dependence upon good water quality, and populations of these invertebrates have recently declined across most of North America. Nationwide, mussels are the most imperiled group of organisms.

Currently, 15 mussel species in Texas are listed as threatened at the state level, and of those 15, six are now candidates for federal listing by the United States Fish and Wildlife Service under the U. S. Endangered Species

Act. Three Central Texas species are among those listed as threatened by the State; the Golden orb (*Quadrula aurea*), Texas fatmucket (*Lampsilis bracteata*), and Texas pimpleback (*Quadrula petrina*), all of which are historically found within the San Antonio River Basin. In 2011, the San Antonio River Authority (SARA) became proactive regarding mussel conservation efforts and initiated baseline mussel sampling. These baseline sampling efforts evolved into more intensive mussel surveys which had not been completed in the basin for over 20 years.

In the fall of 2014, SARA biologists completed sampling events along the Westside Creeks and lower Cibolo Creek just east of San Antonio. Future sampling plans in the basin include sampling of the San Antonio and Medina rivers and several of their tributaries. Our goals with this sampling effort are to obtain as much data and information as possible in order to protect and sustain these hidden treasures of Texas for future generations to enjoy.

Wallowing: Wild Pigs Get Down and Dirty in Texas Waters

MARK TYSON, TEXAS A&M AGRILIFE EXTENSION – EXTENSION ASSOCIATE

Wild pig wallowing seems like a fairly straightforward and simple behavior; purely defined, wallowing is coating the body surface with mud. Yet, according to a recent literature review there could actually be more going on below the surface.

In addition to temperature regulation, wild pigs may also wallow for skin care, health reasons, and reproductive behaviors. While wallowing is a natural behavior, it can have severe implications to watershed health and function. With exotic, invasive wild pigs occupying at least 134 million acres in the state this has led to a Texas size problem for our watersheds.

Temperature Regulation

The primary and most understood reason for wallowing behavior in wild pigs is regulating their body temperature, known as thermoregulation. Wild pigs lack sweat glands and will root in moist soil associated with water to create

wallows. Ideally, the wallow will be filled with a loose, muddy substance. Outside temperatures are thought to influence the level of wallowing exhibited by pigs; on hot days, pigs will cover 50% to 75% of their bodies in mud. Although we commonly associate wallowing behavior with hot days, multiple researchers suggest that adult wallowing behavior can be observed at temperatures of 60°F and above.

Skin Care and Health Reasons

Mud is an important component of wallows primarily because it serves as a cooling agent. Research has reported that the water in the mud on the skin of a pig took two hours to evaporate, compared to 15 minutes when clean water

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Trapped wild pigs laying in a wallow (center). Photo courtesy of Mark Tyson





*Wild pig wallow located near a riparian corridor.
Photo courtesy of Mark Tyson*



*Wild pig wallow along a creek bank.
Photo courtesy of
Texas A&M AgriLife Extension*

alone was used as a cooling agent. Pigs are unable to reach large parts of their body surface on their own, so this makes a coating of dried mud very useful. Pigs will scratch and rub their bodies on a fixed object to remove undesired objects and ectoparasites. This rubbing behavior can have negative implications to trees, since excessive rubbing can cause girdling and ultimately mortality of the tree.

Wallowing may also serve as a means to promote healing. A researcher in Spain described wallowing in male wild pigs who were injured in male-to-male combat, and reported that the behavior occurred as a means of wound care. He suggested that the bacterial properties of mud may function to assist in reducing infections.

Reproductive Behaviors

During a time period where wallowing is not typically associated with temperature regulation (October – February), the same researcher observed more frequent signs of wallowing in large-bodied, mature males compared to females or other smaller males. In his study, it was estimated that the peak of reproductive activities took place between October and November. Based on the association of predominantly mature male wallowing behavior and peak female receptivity, it is thought that wallowing could be an important component of wild pig reproductive behaviors.

Implications of Wallowing to Water Bodies

While wallowing is a natural behavior, its implications to the waters of Texas are extensive. Researchers have attributed bacterial contamination, increased soil erosion, increased turbidity, and decreased riparian plant cover to wild pig wallowing behaviors. Many waters in Texas are already impaired by high levels of bacteria. Wild pigs only serve to further this problem. The manipulation of soil and the creation of wallows destabilizes stream banks and leads to increased levels of erosion. This in turn leads to more soil particles in the water, which increases turbidity. These factors lead to the degradation of water quality and disturb aquatic ecosystems, thus creating a trickling effect on many native Texas flora and fauna.

The big question being asked is: what can we do about the wild pig problem in Texas? You can begin by learning more about wild pig behaviors and damage abatement strategies that are available in Texas. We have a wide variety of resources available on our website: www.feralhogs.tamu.edu

Although the wild pig predicament can seem overwhelming, there is no need to wallow in your sorrows. Understanding the problem, formulating a plan, and taking action are the best ways to stop wild pigs from getting down and dirty in our Texas waters.

Project-Based Learning for Feral Hog Control

DEBBIE MAGIN

The students in two of Mr. Zach Brown's Seguin High School classes are learning how feral hogs can impact water quality in nearby Geronimo Creek. To teach the students about this real-world problem, the SHS Ag Teacher is using Project-Based Learning, or PBL, which links hands-on learning with creative problem solving. Mr. Brown is a recipient of a grant from the Seguin Education Foundation. The grant not only provides for field trips for his classes but also provides funds for materials that his Ag Mechanics class will turn into several types of feral hog traps.

PBL provides opportunities for local businesses to partner with schools to solve local problems and give input on community projects. Mr. Brown's proposal is a great example of that collaborative process. Karen Taylor, Seguin Area Chamber of Commerce board member and co-owner of Seguin Fabricators, a family-owned, steel fabrication company, welcomed Mr. Brown's Ag Mechanics class to tour their facility, seeing first-hand how a set of drawings becomes a structure in a wastewater or water treatment plant. Ms. Taylor and Seguin Fabricators staff demonstrated how the materials and methods that the students themselves will be using in class are used to produce high quality steel, aluminum, and stainless steel fabrication.

Also partnering in this PBL collaboration are Texas AgriLife Extension and the Guadalupe-Blanco River Authority (GBRA). Ward Ling (with Extension) facilitates the Geronimo Creek Watershed Partnership, a group of local stakeholders working to improve the water quality in Geronimo and Alligator creeks. Mr. Ling gave a presentation on nonpoint source pollution to Mr. Brown's Wildlife class and, along with Josh Helcel, Extension's feral hog specialist, explained why the Geronimo and Alligator Creeks Watershed Protection Plan identified feral hogs as one of the sources of high levels of bacteria and nutrients in Geronimo Creek. Cinde Thomas-Jimenez,

with GBRA's Public Communication and Education Department, and Lee Gudgell, GBRA Water Quality Technician, will be working with both classes at the Irma Lewis Seguin Outdoor Learning Center. GBRA staff will give the students hands-on training, covering water quality and the elements of a healthy aquatic habitat.

Zach Brown's students will do their own research into feral hogs and different types and uses of feral hog traps. They will be able to use the funds provided by the Seguin Education Foundation to build traps that can be used to catch hogs and remove them from the Geronimo Creek watershed. Coming full circle, one of these traps will be donated to the auction held at Seguin Education Foundation's annual fund-raiser, Denim and Diamonds.

The Seguin Chamber's Education Partnership Committee identified PBL as an opportunity for local businesses and chamber members to share their expertise and resources with area schools while gaining insight into the youth's perspective on problem-solving and changes in their communities. Several other PBL projects are being planned. If you have an idea for a PBL project and would like to be involved please contact Kendy Gravett at the Chamber office.

Feral hog damage.



How's Your Waterway? Find Out Online with H-GAC

BECKI BEGLEY AND ANDREA TANTILLO,
HOUSTON-GALVESTON AREA COUNCIL WATER – RESOURCES PROGRAM

Do water quality and computer technology make a good team? For the Houston-Galveston Area Council (H-GAC), the answer is “yes.”

H-GAC offers three interactive tools to help the region's residents take a closer look at the waterways around them. Each of these tools can be used on a desktop, laptop, tablet, or smart phone. No need to download or install an app.

WRIM

The Water Resources Information Map (WRIM) is an interactive mapping tool displaying water quality data from professional (Texas Clean Rivers Program) and volunteer (Texas Stream Team) monitoring stations across the region.

The WRIM is available to anyone, from water quality project managers looking for detailed information to residents trying to get an idea of the water quality in their favorite swimming or fishing spot.

Explore maps based on multiple monitoring parameters – including bacteria, dissolved oxygen, nutrients, chlorophyll a, and PCBs and dioxins. Maps include water quality information, photos and overviews of waterways, locations and extensive details about monitoring stations, and information about different water quality issues.

Data on the WRIM isn't real time, but is updated quarterly with new data and trends.

Visit www.h-gac.com/go/WRIM

Basin Summary Report

H-GAC produces the Basin Summary Report as a snapshot of water quality in the region every five years. Data in the report is based on technical analysis of historical, current, and projected water quality trends, with public and stakeholder input and review.

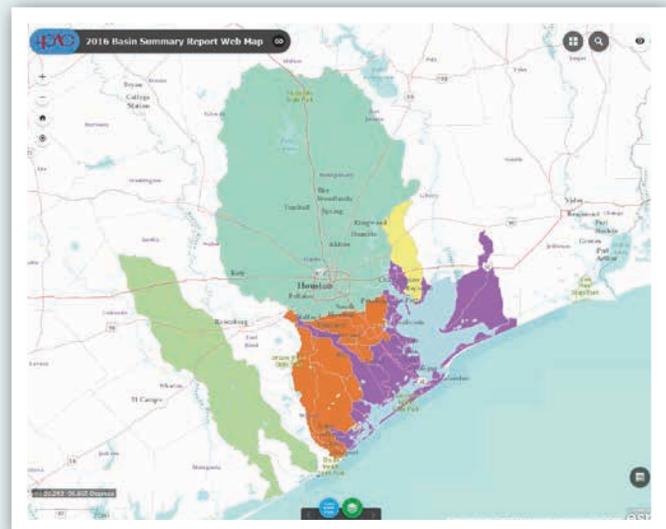
The report offers a comprehensive assessment of regional water quality and is developed for a technical audience

looking for in-depth detail and analyses. Instead of producing a lengthy printed publication, H-GAC delivers this report via an interactive website. Scroll through each section of the report with user-friendly tabs, or use an interactive map to access water quality summaries, including an overview of watershed issues, potential pollution causes, water quality trends, recommendations, and more.

The Basin Summary Report will be available online in summer 2016. Visit www.h-gac.com and search for “Basin Summary Report.”

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The Basin Summary Report Web Map is one of three useful interactive tools now available on the H-GAC website.



TWRI Offers Watershed Monitoring, Planning to Stakeholders

KATHY WYTHE, TEXAS WATER RESOURCES INSTITUTE – COMMUNICATIONS MANAGER



Lucas Gregory, TWRI Project Specialist, collects water quality data for the watershed planning process.

With more than 440 water bodies impaired in Texas and others in danger of becoming impaired, understanding the potential causes and sources of impairments is critical. After understanding comes the work of restoring and protecting the water bodies, requiring effective planning backed by sound science and public input and support.

The Texas Water Resources Institute's (TWRI) eight-member expert water team, with assistance from Texas A&M University Water Management and Hydrological Science Program graduate students, works with local stakeholders, Texas A&M AgriLife Research and Texas A&M AgriLife Extension Service faculty and staff, other universities, and state and federal agencies to restore impaired water bodies and proactively protect unimpaired watersheds in a dozen watersheds across Texas.

"With a half century of combined watershed-based planning experience, TWRI has the experience, expertise, organizational skills, and knowledge needed to gather, collect, and analyze water quality data and guide stakeholders in developing and implementing science-based and stakeholder-supported plans

to restore and protect local water bodies," says Dr. Kevin Wagner, TWRI's deputy director.

Wagner says effective monitoring and watershed assessment provides communities and organizations with information needed to identify and better understand potential causes of local water quality impairments and guide restoration efforts.

Understanding pollutant fate, transport, and management is essential to restoring a water body, says Lucas Gregory, TWRI project specialist. The team, along with its partners, addresses this need through demonstration projects that evaluate

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How's Your Waterway? CONTINUED

Riparian Buffer Tool

Landowners can create riparian buffers (vegetated areas) along waterways to help naturally slow stormwater runoff and protect water quality by filtering pollutants. State and federal incentives and programs are available to help landowners implement these buffers. Unfortunately, resources and information is widely dispersed and often challenging to obtain.

To help landowners navigate through the resources and learn more about riparian buffers, H-GAC, with feedback from Texas Parks and Wildlife, Texas A&M AgriLife Extension

Service, Harris County Flood Control District, the U.S. Army Corps of Engineers, and the U.S. Department of Agriculture, developed an online Riparian Buffer Tool to help simplify the process.

Visualize what a riparian buffer would look like using an interactive mapping tool, calculate cost estimates, compare watersheds across the region, find agency contacts, and learn more about incentive programs and tax reduction opportunities.

Visit www.h-gac.com/go/riparian

These tools were designed specifically to address the watersheds in the Houston-Galveston region, but the applications can be translated to any geographic region. H-GAC staff can share GIS methodology to help agencies replicate any of the interactive mapping tools.

For more information, contact Todd Running at (713) 993-4549.

TWRI Offers Watershed Monitoring, Planning to Stakeholders

CONTINUED

management practice efficiency and provide hands-on teaching to stakeholders. Because bacteria is the leading cause of impairment, bacteria fate and transport research is critical. This research has furthered the understanding of bacteria's life cycle in soil and aquatic environments, and has greatly enhanced the accuracy of planning efforts to manage these pollutants in a variety of watershed types.

The institute's Bacterial Source Tracking Program provides further information by characterizing fecal pollution sources in watersheds, enabling more targeted water quality improvement efforts.

Gregory says the team measures stream flow, turbidity, dissolved oxygen, pH, conductivity, temperature, and transparency, and collects water samples for lab analysis of E. coli and other constituents of concern. Once collected, data are analyzed to develop a better understanding of water

quality in the watershed. The team also incorporates the data into geographic information system (GIS)-based models to help with watershed planning and management prioritization.

"By collecting and analyzing water quality data and conducting watershed surveys, we can provide the science and data needed to begin restoration work in local water bodies," Gregory says.

Once the watershed assessment is completed, TWRI's water team can assist with the planning and implementation process. Through coordinated efforts, TWRI raises the awareness of local stakeholders through water quality education and outreach, assists in selecting appropriate management measures, drafts restoration plans using local feedback, coordinates implementation of completed plans, and helps secure funding for planning and implementation.

For more information, visit TWRI's website: <http://twri.tamu.edu/publications/reports/2016/tr-484/>

Landowner Incentive Program 2016 Updates

ARLENE KALMBACH, TPWD – LANDOWNER INCENTIVE PROGRAM COORDINATOR

The Texas Landowner Incentive Program (LIP) is a collaborative effort between the TPWD Wildlife and Inland Fisheries divisions and the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program. It is designed to meet the needs of private, non-federal landowners wishing to enact good conservation practices on their lands for the benefit of healthy terrestrial and aquatic ecosystems.

At this time the LIP program has 18 active LIP projects underway and is in the process of contracting with private landowners to begin nine more projects with treatments involving invasive brush management, native prairie establishment, riparian restoration, pollinator and monarch habitat restoration, and much more for the benefit of Texas wildlife and watersheds.

Think your property might be a good fit for the LIP program? Contact your local TPWD or USFWS biologist to learn more! Go to www.tpwd.texas.gov/lip to learn more about the program and to find your local biologists. A deadline for new project pre-proposals will be set for mid-summer, so be sure to check the website for updates and to see what's new with the program!

Partners Program: http://www.fws.gov/southwest/es/arlintontexas/pdf/FY16_Texas_Trifold_11092015-1049A.pdf

TPWD biologist info: http://tpwd.texas.gov/landwater/land/technical_guidance/biologists/

USFWS biologist info: http://www.fws.gov/southwest/es/arlintontexas/pdf/TX_PFW_AOR.pdf

Landscape conservation through the Guadalupe bass restoration is just one example of a collaborative initiative between state, federal, and local partners. Photo by Preston Bean, TPWD.



Pastures for Upland Birds 2016 Updates

ARLENE KALMBACH, TPWD – LANDOWNER INCENTIVE PROGRAM COORDINATOR

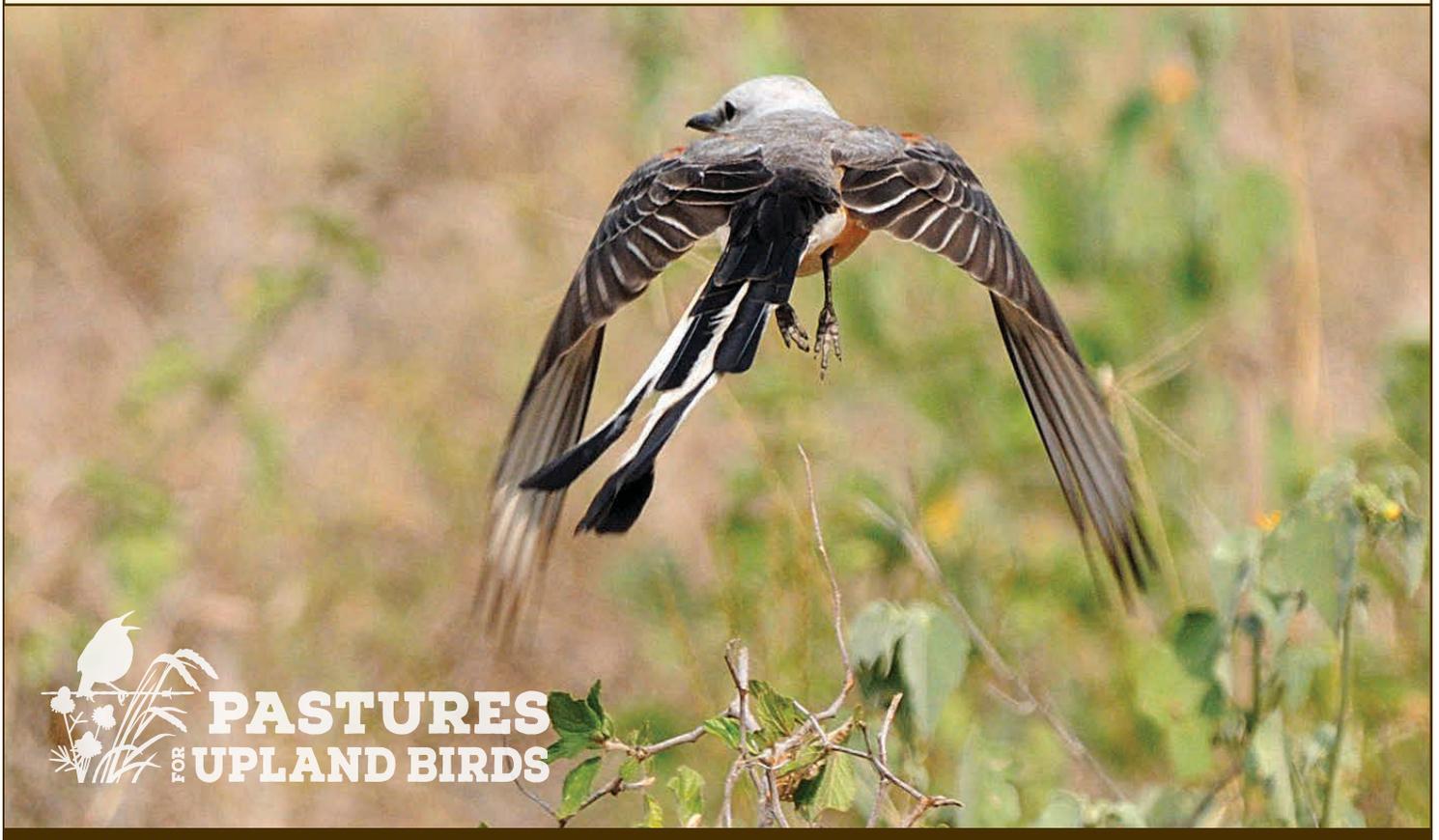
Historically, native tallgrass prairies and prairie-oak savannahs dominated over 24 million acres in east-central Texas. These ecosystems provided essential habitats for many forms of wildlife, including for grassland birds. Grassland birds that were part of the native prairie ecosystem included: eastern meadowlark, northern harrier, Le Conte's sparrow, short-eared owl, dickcissel, scissor-tailed flycatcher, mourning dove, northern bobwhite, eastern wild turkey, and others.

Over the last century and a half, the region's native prairies and savannah grasslands were converted to agricultural land uses and have virtually disappeared. One of the obvious consequences of this massive prairie conversion was the loss of millions of acres of natural biological diversity and wildlife habitat.

In partnership with the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program, the Pastures for Upland Birds program (PUB) provides cost-share incentives and technical guidance to private landowners to restore native grass and forb vegetation on pastures and hayfields dominated by exotic grasses such as bermudagrass, bahiagrass, and old world bluestems.

At this time the PUB program has 18 active PUB projects underway restoring nearly 1,000 acres in east-central Texas coinciding with portions of Blackland Prairie and Post Oak Savannah. Want to learn more about the PUB program? Go to www.tpwd.texas.gov/pub.

Scissor-tailed flycatcher. Photo by Chase A. Fountain, TPWD.



Texas Master Naturalist Program

MARY PEARL MEUTH, TEXAS MASTER NATURALIST PROGRAM – EXTENSION ASSOCIATE

Evening primrose is one of several wildflowers drivers often seen along Texas roadsides during early spring. Photo courtesy of Robert Burns, Texas A&M AgrilLife Extension Service.



Holy spring! This year our spring bloomed earlier, bigger, and wetter than ever. As you drive down those highways and backroads watch for new blooms, pollinators, and birds visiting the state. But as you drive by, can you call out the names to those flowers or feathered animals? If you are curious to learn more about the blooming of wildflowers and the general science to the environment around you in Texas, the Texas Master Naturalist program might be just right for you.

The Texas Master Naturalist program is a statewide program whose mission is to develop a corps of well-informed volunteers to provide education, outreach, and service dedicated to the beneficial management of natural resources and natural areas within their communities for the state of Texas. Through this program, over 10,000+ volunteers have been trained to date with a curriculum focusing on topics like weather and geology, wetlands and forests, stewardship and laws, and the basic study of mammals, birds, fishes, insects, amphibians, and reptiles. Many communities and organizations rely on such citizen volunteers for implementing youth education programs; for operating parks, nature centers, and natural areas; and for providing leadership in local natural resource conservation efforts. In fact, a short supply of dedicated and well-informed volunteers is often cited as a limiting factor for community-based conservation efforts.

An individual gains the designation of Texas Master Naturalist after participating in an approved chapter training program with a minimum of 40 hours of combined field and classroom

instruction, obtaining 8 hours of approved advanced training, and completing 40 hours of volunteer service. Following the initial training program, trainees have one year in which to complete their 40 hours of volunteer service and 8 hours of advanced training. To retain the Texas Master Naturalist title during each subsequent year, volunteers must complete 8 additional hours of advanced training and provide an additional 40 hours of volunteer service coordinated through their local chapter.

The Texas Master Naturalist program offers trainings throughout the year in the 46 chapters that are established across the state. Many chapters will be holding fall trainings this year and will be looking for new members to join their ranks. To find your local chapter, check the Texas Master Naturalist state website: <http://txmn.org/chapters/>. And to learn more information about the Texas Master Naturalist program and the great things these volunteers are doing in Texas, contact the State Program Coordinator, Michelle Haggerty (mmhaggerty@tamu.edu) or the Assistant State Program Coordinator, Mary Pearl Meuth (mpmeuth@tamu.edu) for more information.

ETCETERA

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THE MAILING LIST?**

Send your name and email address to beth.bendik@tpwd.texas.gov to be notified via email when a new edition is posted online.

**HAVE AN ARTICLE
YOU'D LIKE TO SUBMIT?**

If you would like to submit an article or announcement concerning watershed-related activities, initiatives, or workshops* for the next issue, please email the editor at: ryan.mcgillicuddy@tpwd.texas.gov

* Please note that the newsletter cannot include announcements of for-fee seminars or workshops for which Texas Parks and Wildlife Department is not a sponsor.

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Already a Texas Master Naturalist?

The Texas Master Naturalist Program would like to invite you to our 17th Annual Meeting this year on October 21-23, 2016 at La Torretta Lake Resort on the shores of Lake Conroe.

The Texas Master Naturalist Annual Meeting is geared toward Texas Master Naturalist volunteers, agency advisors, representatives of partner organizations, and supporters of the statewide TMN program. The meeting provides an opportunity for our volunteers and affiliates to receive all of their Advanced Training requirements for the year within one weekend. It's also an opportunity for program participants and supporters to network, share new ideas and projects, and to learn from one another.

Proposals for presentations are now being accepted and registration details will be available this summer. To learn more about this year's meeting, visit our 17th Annual Meeting website: <http://txmn.org/2016-annual-meeting/>.



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