LANDOWNER'S GUIDE

Stewarding the Pedernales River Basin

hill country alliance

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HOW TO USE THIS MANUAL

You are important to the Pedernales River Basin. If you are a resident, landowner, business owner or returning visitor in the Pedernales River Basin, there is a role for you in stewarding this Hill Country treasure.

This booklet is for those who want to protect and care for a landscape that provides clean water for millions of people, livelihoods for rural and urban communities, fish and wildlife habitat, aesthetic beauty, cultural heritage, and recreational activities. The Pedernales is a river that gives life.

Landowner's Guide: Stewarding the Pedernales River Basin is a manual on how to care for the river, the land around it, and the variety of life it supports. We can all start by caring for the small or large tracts of land we have responsibility for and control over.

Stewardship has become a buzzword in recent years, but too often the term is used without a clear understanding of what it really means. Stewardship can be defined as the inner-conviction that motivates landowners to care for and sustain the land entrusted to them. It is a voluntary obligation based on a love and appreciation of the land. This can be anyone from homeowner, to the rancher with thousands of acres. The reasons why land stewards want to care for the land may be threefold: for their own personal benefit (including economic reasons); for the benefit to future generations who will someday inherit or acquire the land; and for the benefits that society receives. When land stewards take responsibility to properly manage and conserve the natural resources under their care, everyone benefits.

It has been said that those who do not understand nature are destined to deplete it, and we see examples of this in the Hill Country. However, it is equally true that those who understand nature the best are compelled and inspired to take good care of it. When we better understand natural processes and work with nature, we become better stewards to the lands we rely on for our quality of life, clean water, economic resilience, recreation—and life itself.

This manual is intended to provide concise, accessible information that is relevant and useful to the residents and landowners of the Pedernales River Basin. Readers wishing to have more detail may refer to the references provided at the end of this booklet in Appendix A.

ACKNOWLEDGMENTS

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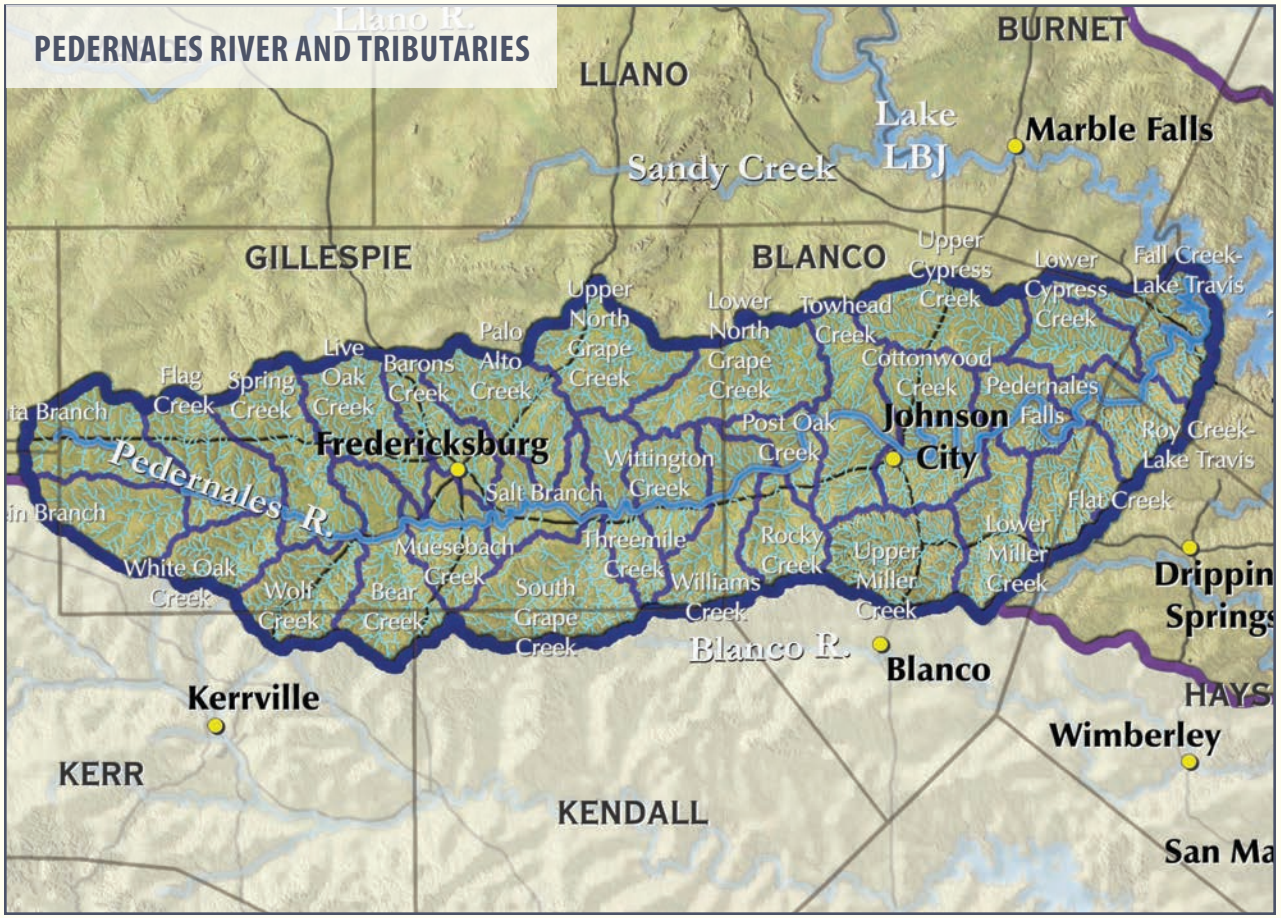
The Pedernales River Basin has a deep history in Central Texas. Archaeological evidence suggests human history in the basin stretches back nearly 10,000 years BC. Native American tribes such as the Lipan Apache, Comanche, and Tonkawa were drawn to the basin by its abundance of springs, water and stone.

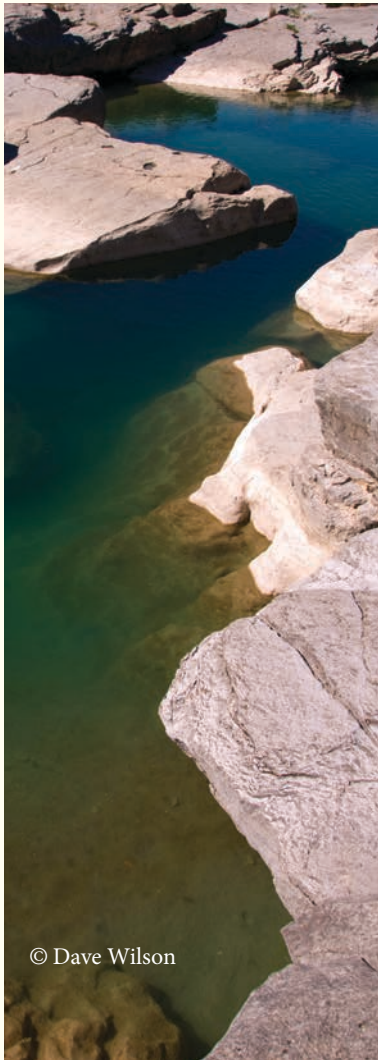
Edwards Chert, commonly known as flint, is abundant in the basin and Native Americans used it to make tools.[1] The first written accounts of the Pedernales River come from 17th century Spanish explorers, who coined the name 'Pedernales' from the Spanish term that was used to describe the flint rocks that characterize the riverbed.[2]

The Pedernales River emerges from a series of springs in western Gillespie County. From these headwater springs, the river flows more than one hundred miles to where it merges with the Colorado River at Lake Travis. Nearly 25 percent of the inflow to Lake Travis comes from the spring-fed Pedernales; the river is a major contributor to the drinking water supply for the Austin metroplex.[3] The entire watershed covers an area of nearly 1,300 square miles, across six Central Texas counties— Kimble, Kerr, Gillespie, Blanco, Hays, and Travis. The Pedernales River's tributary system comprises more than 3,000 miles of creeks and streams that support numerous watering holes and recreation areas, including nearly 9,000 acres of public parkland. Despite recent pressure from population growth and recreational activities, the river continues to foster a sensitive ecological system, including dozens of rare plants, fish, and salamander species.

PEDERNALES RIVER AND TRIBUTARIES



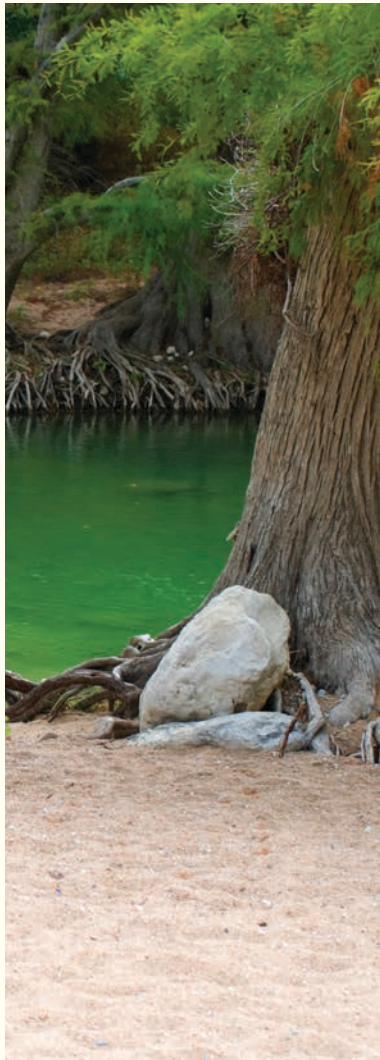
OVERVIEW OF THE PEDERNALES



© Dave Wilson

The Pedernales River Basin is characterized as having a subtropical climate, with dry winters and hot humid summers. The rainfall distribution in the watershed has two peaks. Spring is typically the wettest season, with a peak occurring in May. The second peak for rainfall is usually in September, coinciding with the tropical cyclone season in the late summer/ early fall.[4] The average rainfall totals across the Pedernales vary from 28 inches in western portions of the basin to 34 inches in the east.

The river can be one of extremes since it is prone to both flash flooding and extreme drought, with the highest peak flow rate of 452,000 cubic feet per second (3.4 million gallons per second) in 1952 and the river going completely dry in 2011. This was witnessed again in May 2015, when seven years of severe drought were interrupted by an extreme flood, during which intense rains overwhelmed the thin soils and steep slopes of the Pedernales and generated a peak flow rate near 150,000 cubic feet per second (cfs) when only days before the river flow was about 10 cfs.[5]



PEDERNALES RIVER BASIN QUICK FACTS

DRAINAGE AREA
1,280 square miles (819,200 acres)

MAJOR AQUIFERS
Edwards - Trinity and Trinity

MINOR AQUIFERS
Ellenburger - San Saba and the Hickory

HOME TO RARE SPECIES
19 plants, 34 fish, and 6 salamander species

SPRINGS
1,272 springs, with 75% located in Travis County

COMMUNITIES
Johnson City (pop. 1,785), Fredericksburg (pop. 10,829), Round Mountain (pop. 181), Stonewall (pop. 469), Hye (estimated pop. 105), Harper (pop. 1,006), Briarcliff (pop. 1,438)[6]

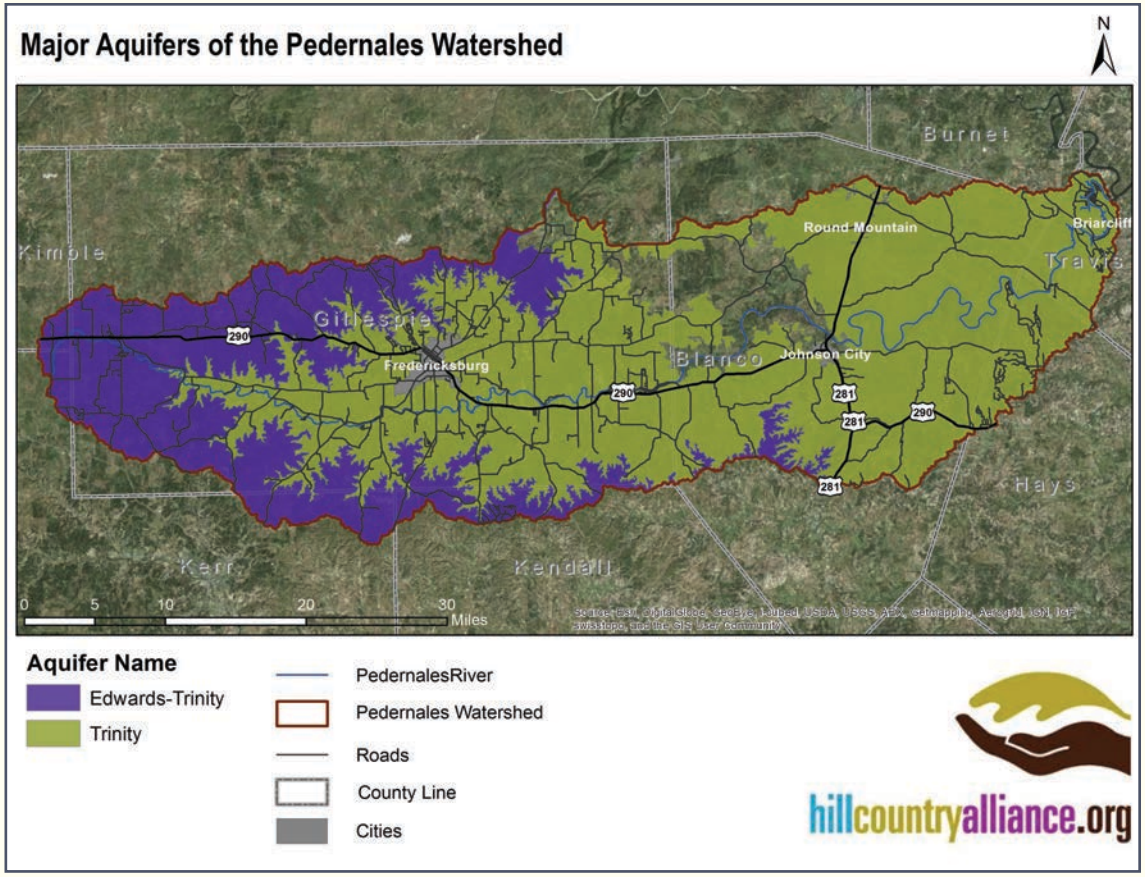
PARKS*
LBJ National Historical Park, LBJ State Park and Historic Site, Pedernales River Nature Park, Pedernales Falls State Park, Westcave Preserve, Hamilton Pool Park, Reimers Ranch Park, and Pace Bend Park

**These are only a few examples and do not include city parks located within the watershed.*

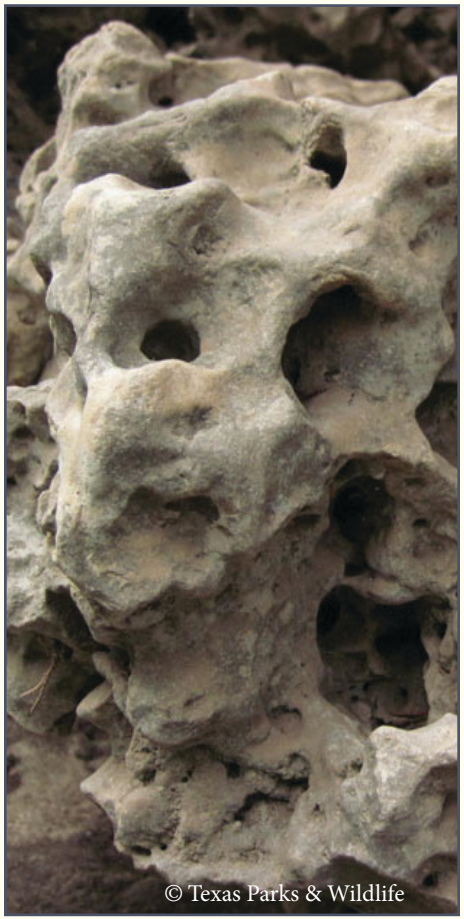
WATER

In the Texas Hill Country, water resources are subject to extremes and sometimes to misuse. How we choose to use this precious resource across the Pedernales River Basin can have profound effects on the quality and the quantity of the river as well as its springs and aquifers. Poor stewardship can result in an unsustainable future. What follows in this section is a primer of how the Pedernales water system works and recommended strategies to maintain healthy water quality and quantity.

In addition to the major aquifers in the watershed, the Trinity and Edwards-Trinity, minor aquifers that are more limited in geographic extent can be found throughout the watershed. These include the Ellenburger-San Saba and the Hickory.



Major Aquifers of the Pedernales River Basin


© Texas Parks & Wildlife

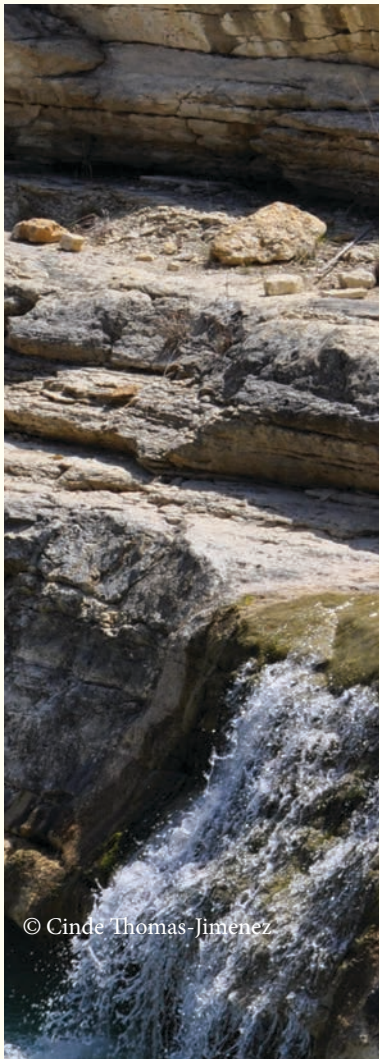
Surface Water and Groundwater Interaction

Rivers and aquifers provide most of the fresh water for Texas, and the interactions between surface water and groundwater are critical to maintaining the health of those resources. Understanding these interactions in the Pedernales River is particularly important for managing water quantity and quality within the entire drainage basin.

Understanding Karst Geology

Regions of the Pedernales River Basin and its underlying major aquifers are well-connected because of the limestone geology of the region. Developed over millions of years, some layers of this limestone bedrock have become porous, fractured, and perfect for moving water—down through recharge features, fissures, sinkholes, and karst rock—and up and out through freshwater springs. The word "karst" refers to these porous limestone aquifers and their exposed outcroppings on the land's surface.

In the karst environments that make up some of the Pedernales River Basin, aquifers may "leak out" into rivers and streams through springs, and this is referred to as a "gaining" segment of the river. When the surface water moves back underground through sinkholes and other recharge features, it is called a "losing" segment. It is the natural condition of the Pedernales to have springs and fractures within the karst riverbed that allow water to flow freely between the aquifer (groundwater) and the river (surface water)—providing an intricate and irrefutable interaction throughout the river's length.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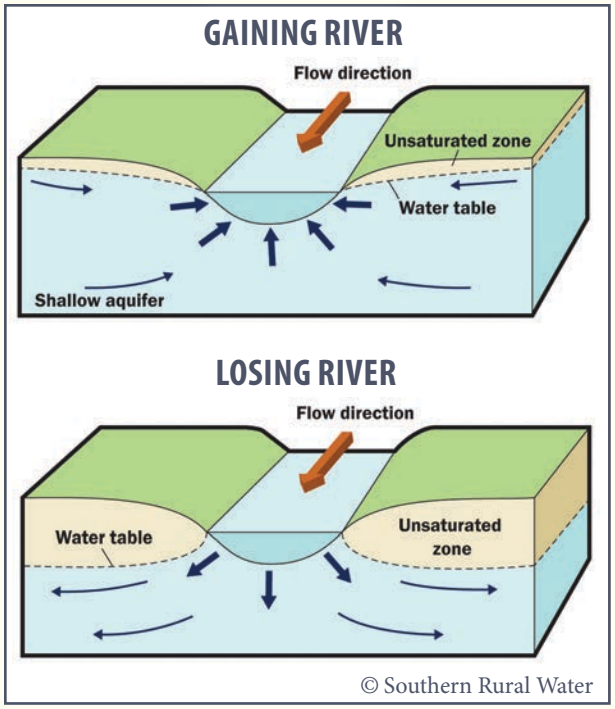
Land and Water Are Connected

In the Texas Hill Country, water is stored below in the Trinity Group of limestone aquifers. In the Pedernales River Basin, several aquifers supply both spring flow that keeps the river flowing and well water to residents:

- Springs and streams originating in the **Edwards and Glen Rose formations** provide the majority of main channel base flow in the western part of the Pedernales River Basin.
- The **Paleozoic and Trinity Aquifers** contribute to base flow in the eastern basin area.
- The **Hensel formation** directly underlies the central portion of the river basin. Due to the sandy nature of the Hensel as opposed to the carbonate characteristics of the majority of the other geologic units in the basin, areas underlain by Hensel are more buildable and amenable to agricultural and urban development.[7]



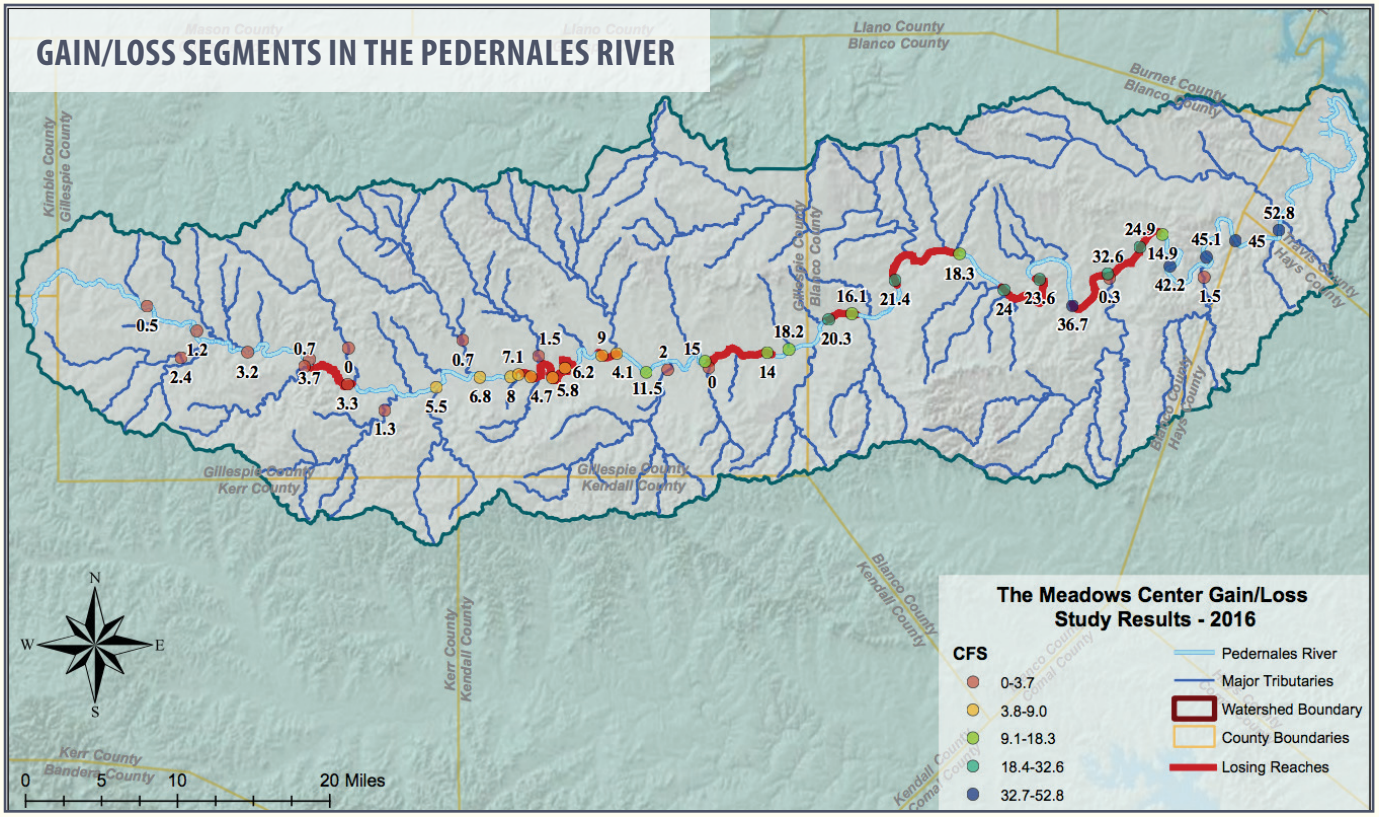
This diagram is a very general schematic of how groundwater contributes water into surface water (streams, rivers, and lakes). A "gaining stream" generally gains water from the ground, while "losing streams" lose water from the streambed out into the ground.

Flow in the Pedernales River

Flow in the Pedernales River is largely dependent on rain conditions in the river basin, with the highest average flow conditions coinciding with months that have the largest quantity of rain, typically in the spring and fall. In times of low rainfall, the river's base flow is sustained by spring flow. In addition, more than 20 major tributaries play a vital role in sustaining and adding to the river's flow, providing an estimated 60 percent of the overall flow in the Pedernales River.[8]

Groundwater enters the river from headwater springs originating from the Edwards and Middle Trinity aquifers. Other seeps and springs along the river's tributaries are the primary sources for increased flow downstream. Decreases in flow are generally the result of groundwater recharge, but evaporation and irrigation withdrawals for agricultural, manufacturing, mining, and municipal purposes are also factors.[9]

Segments of the river that are gaining, or showing an increase in the flow rate, indicate regions where spring flow, tributaries, and runoff are contributing to the river's base flow. Losing segments of the river, meaning a decrease in flow, indicate that surface water is seeping into the ground through recharge features in the riverbed— such as caves, holes, and fissures.



This map shows gaining and losing portions of the Pedernales River. Gaining segments are noted in blue and losing segments are noted in red. Overall, the Pedernales River is a gaining river, meaning flow generally increases moving downstream, though there are losing reaches where surface water recharges the underlying aquifers.

The Pedernales is generally a gaining river; in other words, as one moves downstream from the headwaters, the flow rate increases due to springs, seeps and inflows from its tributaries.[10] Significant gaining segments that are most vulnerable to groundwater pumping include downstream of Johnson City and approximately two miles upstream of Pedernales Falls State Park.[11]

There are also losing reaches in the river where surface waters recharge the underlying aquifers. Some losing reaches have a slow rate of recharge, and in others, water enters the aquifers very rapidly, sometimes taking only a few seconds to move from the surface to the aquifer. Water entering the aquifers through these areas undergoes little to no filtration or purification, so the health of these areas can significantly impact the quality of our groundwater. A significant losing segment in the Pedernales River that is most vulnerable to land use activity includes areas south of Fredericksburg and upstream of Pedernales Falls State Park.[12] A landowner with significant recharge features on his/her property has an added responsibility to carefully manage activity around the features to protect the aquifer.

STEWARDING OUR WATER RESOURCES

Without comprehensive knowledge of and intentional care for this river, its aquifers, springs, and streams are vulnerable to increasing pressures from human influence. The consequences for lack of care will affect landowners, businesses, neighbors, and downstream communities alike for years to come.

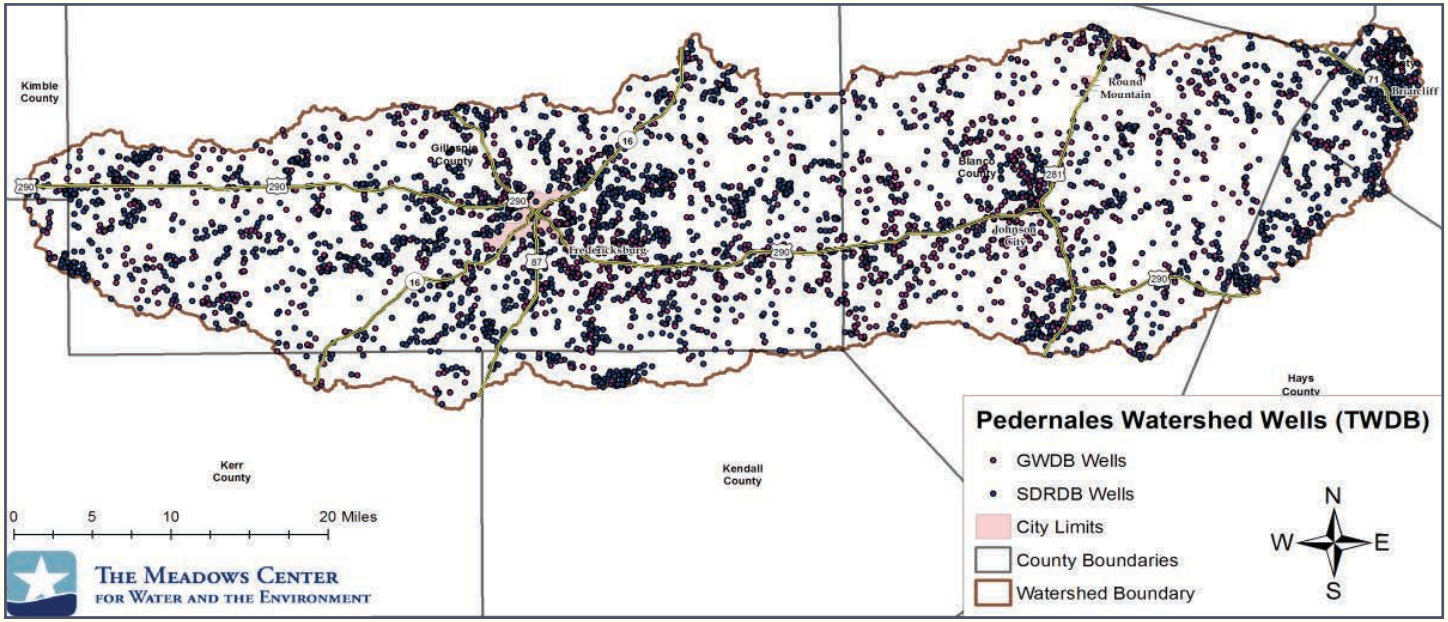
In order to take appropriate action to address these concerns, it is imperative to first understand how human behavior can endanger the river's health and ultimately the water supply.

Registered Wells in the Pedernales River Basin

The following map shows about 4,200 registered water wells located in the Pedernales River Basin.[13] These wells are widely distributed throughout the basin, but with noticeable concentrations in urbanized areas. Not shown are undocumented wells. By state statute, wells used solely for domestic purposes and that are capable

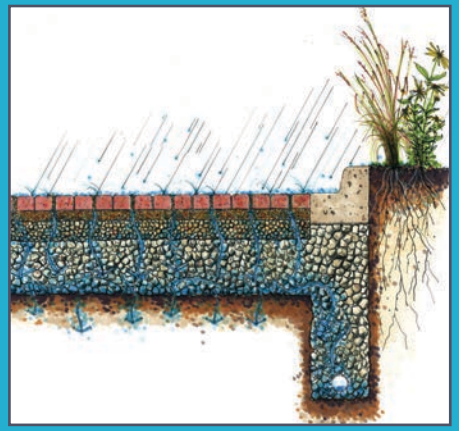
of producing no more than 10,000 to 25,000 gallons per day are exempt from Groundwater Conservation District permitting. As a result, many wells in the basin are exempt from permitting due to their size and purpose.[14]

Gillespie and Blanco Counties comprise the majority of the land area in the basin and while their populations are relatively small today, these counties are expected to nearly double in residents within the next 50 years.[15] With a growing population, the demand for water in the Pedernales River Basin will continue to increase. More wells will continue to drain the aquifer resources faster than they can recharge. A positive response to this situation is for citizens, landowners, community leaders, and lawmakers to shift focus toward smart water use, conservation, alternative sources of water, and efforts to balance demand with the long-term health of the river.



Impervious vs. Pervious Land Cover

While developed land in the Pedernales River Basin currently represents a small portion of the watershed, anticipated population growth will bring more impervious cover to the watershed that can have impacts on the water quality and overall health of the watershed if not managed properly.



Impervious cover in a watershed results in increased surface runoff. As little as 10% of impervious cover in a watershed can result in stream degradation. Permeable pavers allow stormwater to percolate into the soil to filter out pollutants and promote groundwater recharge.

Illustration provided by the USDA Natural Resources Conservation Service.

Impervious cover is any type of human-made surface that does not absorb rainfall. Impervious surfaces, such as concrete or asphalt, impede or alter the land's natural function of managing rainfall. Impervious cover increases the velocity and force of stormwater which results in greater erosion, storm damage, flash flooding, and larger amounts of pollutants and silt carried in to waterways. Unintentional impervious surfaces are created when land is overused and hard-compacted, making it perform just like concrete.

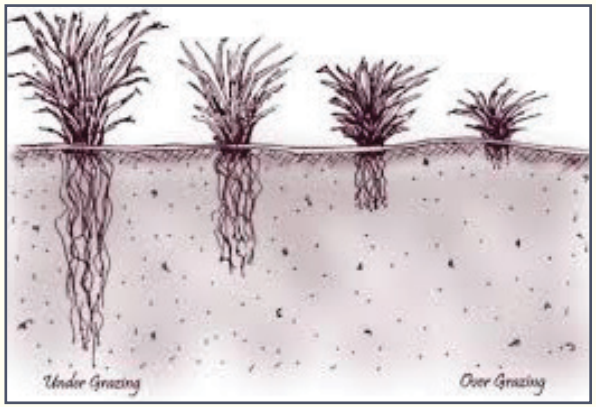
Pervious surfaces (also known as porous or permeable surfaces) allow water to pass through the surface material and sink back into the soil. As water seeps through to a rock base layer, pollutants are naturally removed and filtered through the underlying soil. Popular choices include turf block, pervious paver stones, permeable asphalts and pavements, gravel, mulch, decomposed granite, or wood chips for walkways.

Humans have choices in how to develop the areas where we work, recreate, and live. With anticipated population projections, it's increasingly important to look for opportunities to maintain landscapes that can absorb, filter, and even capture rainfall. A clean, flowing Pedernales River depends on it.

Soil for Water, a program of the National Center for Appropriate Technology, promotes land management principles and practices that optimize catching and storing water in the soil. Whether you have a small backyard or a large ranch, you can increase the water storing capacity of your soil (while reducing runoff and erosion) by incorporating the following practices:

1. Improve plant cover and minimize bare ground by increasing native, living plants.
2. Leave plant residue on the soil surface as mulch so this material can insulate soil from high temperatures, feed the soil biology, and promote nutrient cycling.
3. Reduce mechanical disturbances (e.g. tilling) that disrupt the soil biology and structure.
4. Promote plant and soil microbial diversity by both planting appropriate native seed mixes that grow in both cool and warm seasons and reducing your use of synthetic pesticides.
5. On portions of a property not used regularly for access, consider adopting management practices such as adaptive grazing management with sufficient recovery times, infrequent mowing, and management of wildlife populations to maintain healthy above-ground plant growth.
6. Keep in mind that woody cover is also good hydrologic cover with high porosity, high organic matter, and high infiltration rates. This includes cedar and mesquite in addition to oak, elm and other hardwoods.

To learn more, visit www.ncat.org/soilforwater/



Overgrazing happens when desirable vegetation in an area is exposed to levels of grazing that impede plant regrowth. When overgrazed, desirable plants become weaker and have shorter roots, reducing the quality and quantity of vegetation, increasing soil compaction and erosion, and creating opportunities for weedy species to establish.

Illustration provided courtesy of the Alberta Ministry of Agriculture and Forestry.

Pollution Can Foul Our Drinking Water

The water quality in the Pedernales River is generally good. However, with the growing population, communities across the watershed are grappling with what to do with their municipal wastewater. According to studies released by The Meadows Center for Water and the Environment between 2015-2017, the Pedernales River was found to have large increases in nutrient and sediment loading from Fredericksburg and upstream during stormwater events.[16] Nutrient and sediment loadings are often used as an indicator of man-made impact to water quality. Municipal wastewater effluent, animal waste, and fertilizers are common sources.[17] While these nutrients are natural parts of aquatic ecosystems, an excess amount of nitrogen or phosphorus entering a pristine river can cause algal blooms that seriously disrupt the ecosystem.

To maintain the good water quality, we need to continue to manage these two types of pollution: point source pollution and non-point source pollution. One is concentrated and direct; the other is diffused across the landscape. Individuals have everything to do with both.

Point source pollution comes from a single source such as a pipe or contamination source, and must be regulated by a discharge permit. Violations of discharge permits can cause severe environmental damage and can bring heavy fines to the perpetrator.

Non-point source pollution is common and can come from anywhere and everywhere. Individual activities are generally responsible for non-point source pollution, such as using too many lawn chemicals, washing cars in the street, applying excessive fertilizers (e.g. nitrogen and phosphorous) to agricultural lands, or failing to repair oil leaks.

Illustration provided courtesy of the University of Wisconsin-Extension and the Wisconsin Department of Natural Resources.

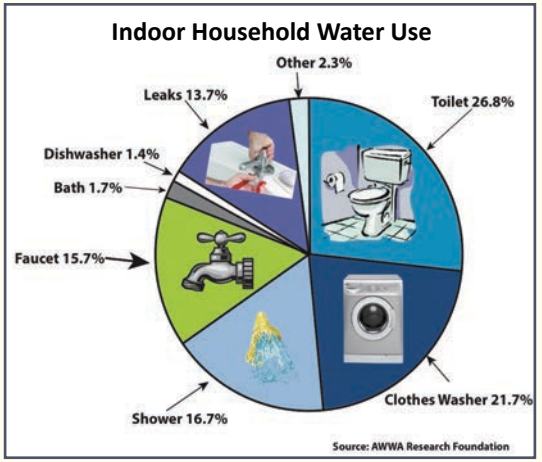
Non-point pollution is often cumulative in nature, i.e. not one thing, but many.

Conserving Water at Home

With a population expected to double over the next 50 years and a growing tourism industry, the municipal water demand in Blanco and Gillespie Counties is projected to increase by more than 25 percent.[18] As more people will be relying on the limited surface and groundwater in the Pedernales River Basin, the easiest and least expensive option to address these needs is water conservation.

Everyone who lives in the Pedernales River Basin has the ability to conserve water, whether you live down a dirt road or in downtown Fredericksburg. Reducing water use does not require tremendous sacrifice because most people generally use more water than is truly needed.

Plumbing Retrofit and Repair: Retrofit and repair begins with installing water-efficient fixtures and repairing old and leaking fixtures. Using high efficiency toilets, water-efficient washing machines, rainwater harvesting systems, and water-wise landscaping all help reduce water use.



Water-efficient showerheads and aerators for faucets can significantly reduce the amount of water used.

Insulation of hot water pipes can cut down on the time it takes for water to run hot from the faucet.

An easy way to test for toilet leaks is to place a dye tablet or food coloring in the tank. If the coloring appears in the bowl within a few minutes, the toilet has a leak and needs to be repaired.

Saving Water in the House: Take showers instead of baths. Keep your showers short and get in as soon as the water is warm enough. If you use the bathtub, reduce the water level by one or two inches. Turn off water while shaving or brushing teeth.

Conventional washing machines use 32 to 59 gallons of water per load. Wash only full loads and use the lowest water level setting needed for light or partial loads.

Wait for a full load to run the dishwasher and use a shorter wash cycle for dishes that are not heavily soiled. Instead of rinsing, scrape your dishes and let your dishwasher take care of the rest. When washing dishes by hand, do not allow the faucet to run while rinsing.

Reducing Outdoor Water Use

Most water is used on residential and business landscapes. A well-designed yard can be lush, colorful, carefree, durable, and beautiful while requiring little to no watering.

Local demonstration gardens abound. To name a few in Fredericksburg, the Post Office, Pioneer Museum, Gillespie County Courthouse, and USDA Service Center all showcase colorful gardens that utilize native species. Likewise, in Johnson City, you can check out the pollinator garden at the public library or the grass exhibit at the LBJ National Historical Park.

Water-conscious landscaping begins with proper planning and a native, drought-tolerant plant selection. It's important to consider how you will use your yard and strive for a balance of hardscape (impervious) and permeable surfaces. Hardscape refers to patios, outdoor kitchens, sitting areas, hot tubs or gazebos, walkways, driveways, and RV parking areas.

Non-native turf grass areas should be minimized — or excluded! Remember, turf grass is the automobile equivalent of a gas guzzler. An estimated 46 percent of municipal water use in Texas is spent irrigating urban landscapes and golf courses. However, a lovely grassy area can be achieved with native grasses that don't require supplemental watering or with a wildflower meadow.

By reducing the quantity of water that runs off your property, rain gardens help lower the risk of flooding and erosion.

Rain gardens have become popular for managing stormwater in dense urban settings, but these features have a place in a more rural environment as well. A rain garden is designed to capture and hold large amounts of rainwater before it enters the municipal stormwater system or a nearby creek. Rain garden plants effectively absorb pollutants and the garden's deep, porous substrate allows water to settle and infiltrate into the ground.

The City of Austin has a great guide for how to create a rain garden at your home or place of business in six easy steps. Use the URL below, or just search for rain gardens plus City of Austin. www.austintexas.gov/sites/default/files/files/Watershed/growgreen/raingarden_factsheet.pdf

Simple, Water-Conscious Landscaping

Water-conscious landscaping practices do not require a lot of extra time or money. Begin with a few simple changes in the yard care regime.

The Role of Mulch
Most people think about plants when they consider a water-saving landscape and overlook one of the most important water-conserving components — mulch. A thick layer of organic mulch spread around beds and trees keeps moisture in the soil and maintains plant health by providing habitat for beneficial mycorrhizal fungi.

This fungus forms a special relationship with plant roots and reduces long-term water needs. Mulch also inhibits weed growth and reduces soil temperature; however, mulch does decompose and may need to be re-applied.

Planting Tips
A Texas Hill Country landscape needs native, adapted, and drought tolerant plants, and there are many, beautiful, varied, and colorful choices. When possible, plant during cooler months, and plant in stages rather than all at one time.

Generally, grass needs four to six weeks to become established. Perennials and small shrubs take two to four months and large trees and shrubs may take one to two years.

Watering Tips for Establishing Plants and Grasses
Young plants typically need supplemental watering until they become established. Perennials, small shrubs, and groundcovers should be watered every two to three weeks. Large trees and shrubs typically do not need to be watered except in drought, a few times per year.

Fertilizers and Spraying
When it comes to fertilizers, it's best to use organic and natural products. Slow-release fertilizers feed slowly and don't leach away. These products pose less of a pollution threat to our rivers, streams, and groundwater. To control nuisance pests and plants, use best-management practices that safely and effectively control the target and be sure to minimize the use

For more help on native plants that will work well in your area, consider reaching out to the **Native Plant Society of Texas** (www.npsot.org/wp/), or your local chapter of the **Texas Master Gardeners** or **Texas Master Naturalists**.

of synthetic pesticides. Try natural products such as beneficial nematodes that won't pollute our water or poison birds, pollinators, and pets.

Non-traditional sources of water for landscaping

Non-traditional sources of water include air conditioner condensate, captured rainwater, and greywater from sinks, showers, and washing machines. Non-traditional sources of water are free and can produce high quality water. There may be restrictions on their use in some places, so be sure to check with your local agencies or neighborhood associations before installing an alternative system. As we continue to find ways to conserve every drop, these non-traditional water sources will prove to be invaluable resources for our families and communities.

Grasses

Rather than turf grass, consider planting native groundcover, shrubs, and flowers. These plants require less maintenance and water and can be much more attractive—to people and wildlife. Large, open spaces can be covered with wildflowers and native grasses such as buffalo grass and side oats grama.

Trees and shrubs

Trees are usually the most prominent feature in any landscape and should be chosen carefully. When

young, they are more susceptible to disease, less drought tolerant, and more easily damaged by deer or livestock. It may be necessary to protect trees and shrubs from hungry herbivores by placing a 12 or 14-gauge wire cage around them. Check with your local nursery for protective options best suited for your area and tree species.

Prior to planting trees, consider the location carefully, avoiding power lines, underground plumbing, or other factors that could create problems as the tree grows. When choosing native plants, consider size and light requirements and plant them appropriately. Drought tolerant plants will need regular watering when first planted in order to develop a healthy root system. Listed are trees that typically do well within the Pedernales River Basin and require low to moderate levels of watering. This is not meant to be a complete list of native species, but rather provide an idea of the variety of options from which to choose:

- Texas Ash
- Cedar Elm
- Chinquapin Oak
- Lacey Oak
- Texas Red Oak
- Mexican Buckeye
- Eve's Necklace
- Goldenball Leadtree
- Yaupon Holly
- Mexican Plum
- Texas Redbud
- Evergreen Sumac
- Flameleaf Sumac

© Robert O'Brien

This is one of several native bald cypress trees planted along Barons Creek in Fredericksburg at Frantzen Park that survived almost 10 feet of floods in October 2018.

Rainwater Harvesting

Rainwater harvesting is the collection and storage of rainfall from roofs or other impermeable surfaces for future use in either outdoor, non-potable use, or for interior, often potable water use. Rainwater may be collected in single rain barrels or in more complex systems with large cisterns or tanks. The many benefits of rainwater harvesting include:

1. Rainwater provides a water source when groundwater supplies are limited.
2. Rainwater harvesting reduces flow to stormwater drains and also reduces nonpoint source pollution.
3. The water itself is free; the only cost is to install systems for its collection and use.
4. The end use of harvested water is close to the source, localizing the distribution system.
5. Rainwater is superior for landscape irrigation—plants love it!
6. The zero hardness of rainwater prevents scale on appliances and eliminates the need for a water softener.
7. Rainwater tastes great!

Additional Resources:

- Texas Manual on Rainwater Harvesting: www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf
- Hill Country Rainwater Harvesting Information: www.hillcountryalliance.org/RainwaterHarvesting

LAND

The majority of land in the Pedernales River Basin is undeveloped and many large tracts (e.g. more than 100 acres) are still in place. The river and many tributary creeks flow through vast stretches of privately-owned ranches and generally remain free of development, making the Pedernales a top priority conservation area. Developed land is currently only 3.8% of the total basin acreage and is primarily residential, with most being low-density, single-family housing.[19] Future growth is expected to change land use in those areas from predominantly rural to substantially more suburban.

LAND COVER IN THE PEDERNALES*

DEVELOPED: 3.8%
Developed open space, low, medium and high-density development

FOREST: 24.4%
Deciduous, evergreen and mixed forest

SHRUB LAND: 54.4%
Shrub and scrub land

GRASSLANDS: 14%
Grasslands/herbaceous

PLANTED/CULTIVATED: 3.1%
Pasture, hay and cultivated crops

OTHER: 0.4%
Open water, bare rock, and woody wetlands

**Land cover indicates the physical land type.*

HOW TO MAINTAIN A HEALTHY RIVER BASIN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A simple definition of a watershed is "an area of land from which water drains to the lowest areas." However, good land stewardship strives not to shed or drain water out of the landscape but rather to slow the water down and captures and stores it both above and below the ground. When water is slowed down, flooding and erosion are reduced, habitat for wildlife and livestock is enhanced, and more water is available over a longer period of time. For these reasons, we prefer to use terms like "water catchment" or "river basin" instead of "watershed."


©Ryan Bass

Characteristics of a Healthy River Basin

A river basin is healthy when it captures and slowly releases water. For our river basins to act as catchments they must have dense, diverse vegetative cover, healthy soil, and substantial creek-side (riparian) buffers that catch and hold rainfall, sustain seeps and springs, and maintain steady-flowing streams even in times of drought. Permeable features such as sinkholes, karst substrate, and caves can recharge rainwater into the limestone aquifer, generating important seeps and spring flow to keep our creeks and rivers flowing. With good vegetation cover, the quality of recharge water is maintained.

The characteristics of a healthy Hill Country river basin are summarized below:

- **Vegetation and plant litter:** Healthy river basins have a diversity and abundance of native plant species (grasses, forbs, shrubs, and trees) of different age classes; the plant community will be vigorous (e.g. not overly grazed, browsed, or mowed). Dense vegetation slows down surface runoff and allows water to percolate into the ground. Deep, binding root systems also hold soil in place, reducing the movement of sediment and nutrients into water bodies. The soil surface should be nearly completely covered by living plants or plant litter such as fallen leaves, or dead grass from previous year's growth, which serves as protective mulch.
- **Soil:** Composed of mineral material (e.g. sand, silt or clay), organic matter (dead plant material), and living organisms (e.g. earthworms, fungi, and bacteria), soil provides the foundation for healthy land, water, and wildlife. Healthy soils consist of about 50% pore space which allows soil to remain aerated while also leaving storage space for water and nutrients. Healthy soil absorbs water like a sponge, and retains water and nutrients
- **Wildlife:** A healthy river basin provides habitat for a variety and abundance of native animals, including insects, birds, reptiles, rodents, bats, and large mammals. Some of these are yearlong residents while others are migratory. Non-native wildlife species that have been introduced (e.g. feral hogs and Axis deer) can outcompete native species and degrade habitat. In a truly healthy system, these invasive species will be absent or only present in small, controlled populations.
- **Fish:** A healthy river or stream provides different in-channel features (e.g. pools, runs, riffles, and large woody debris) that support a diversity of fish. The Texas state fish is the Guadalupe Bass, which lives in streams across the Pedernales River Basin and needs flowing water to spawn, feed, and meet other life-cycle needs.

NATIVE SPECIES PROFILE:
GUADALUPE BASS (MICROPTERUS TRECULII)

Named the official State Fish of Texas, the Guadalupe Bass is found primarily in rivers that drain in the northern and eastern portions of the Texas Hill Country. They are threatened throughout their native rivers by habitat loss and hybridization with the non-native, introduced Smallmouth Bass. A "stronghold" population of genetically-pure Guadalupe Bass occurs in the Pedernales River Basin.

Thanks to the work of Texas Parks and Wildlife Department's Inland Fisheries Division, a great deal of resources have been brought to bear to conserve Guadalupe Bass habitats in the Pedernales and other Hill Country river basins. Through the efforts of the Department, their local partners, and cooperating landowners, land and water resources are being conserved for the benefit of all aquatic species.

Importance of Riparian Areas

Clean, abundant water in the Texas Hill Country depends on a natural network of tributary creeks, rivers, and riparian areas that work to filter, store, and release water during and after runoff events. The riparian area is the narrow band of land adjacent to creeks and rivers where floodwaters spill out during high flows.

The dense natural vegetation in riparian area helps provide the following functions:

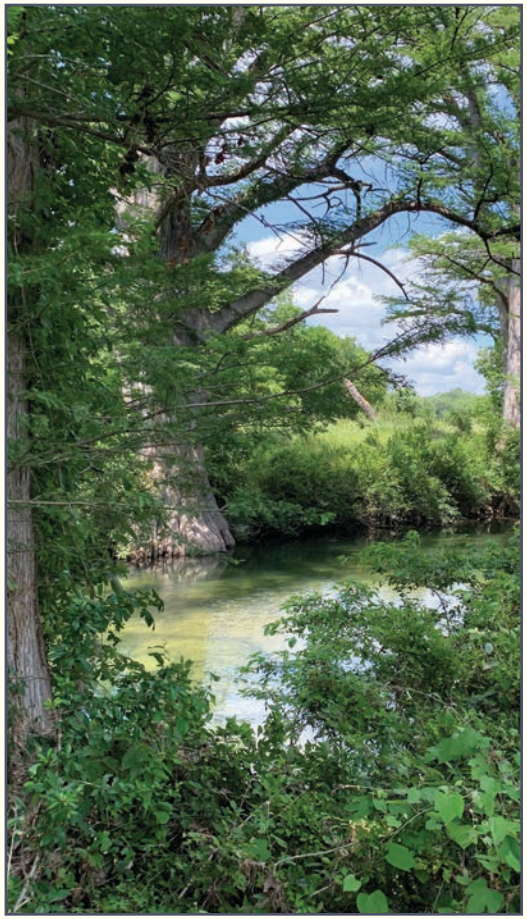
- Dissipate the energy of floodwater, which helps reduce erosion and stabilize banks
- Capture sediment in the floodplain
- Store water temporarily in the floodplain sediments
- Recharge shallow alluvial aquifers
- Sustain base flow

When these riparian functions are working properly under good stewardship, other values and benefits are provided:

- Improved water quality and more prolonged flows
- Improved fish and aquatic habitat
- Increase in livestock forage
- Improved wildlife habitat
- Aesthetic beauty and recreational value

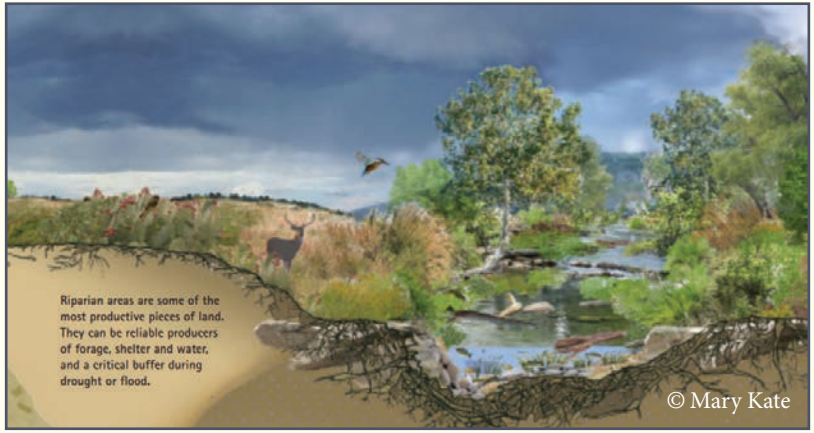
These functions and values of a riparian area can be damaged or hindered by any of the following types of mismanagement:

- Excessive or frequent mowing of large areas along the creek
- Brush and tree clearing or excessively manicured landscapes near the creek



- Removal of logs, dead trees, and woody debris from banks, channel, or floodplain
- Excessive populations of deer, exotics, or feral hogs
- Continuous or heavy livestock grazing
- Dense monoculture stands of invasive plants such as Arundo or Ligustrum
- Alteration of banks or channel by large equipment
- Low water dams and/or poorly designed crossings
- Removal of gravel or sediment
- Excessive pumping of alluvial water table

Riparian Area: the transitional band of vegetation that occurs between waterways large and small, and the upland regions that drain into them.



The first step in good riparian management involves identification of hindering factors. In many cases, all that is required is to stop doing those activities which impair riparian function. In other cases, more aggressive management is needed - such as reduction of deer and exotic populations. When proper management is applied, riparian areas normally recover rapidly.

Instead of mowing the entire riparian zone, consider creating and maintaining targeted access areas while allowing vegetation in between these access areas to grow. These strips of riparian vegetation are often referred to as "grow zones." Additionally, if logs or fallen tree limbs are not impeding access, consider leaving them by the creek; this woody material will help stabilize the banks and also provide habitat for wildlife.

INVASIVE SPECIES PROFILE: ARUNDO DONAX

The encroachment of non-native, invasive species such Arundo (Arundo donax, Giant Reed, or Carrizo Cane) and elephant ear (Colocasia esculenta) can influence a river's natural hydrology, affect flood flow conveyance, and crowd out native plants that support habitats for native wildlife.

Baron's Creek, which flows through Fredericksburg, has the highest infestation of Arundo in the Pedernales River Basin, with more than eight stands per mile.[20] Without effective management, this plant will rapidly colonize riparian areas, increase flooding, and limit river access for recreational and agricultural purposes.

If you think you have Arundo on your property, please call the Hill Country Alliance (512-894-2214) or visit Texas Parks and Wildlife Department's Healthy Creeks Initiative website (www.tpwd.texas.gov/landwater/water/aquatic-invasives/hill-country-giant-reed) to learn about resources available to help you control this non-native, invasive plant.

A variety of other non-native, invasive plant species have been found on the rangelands and throughout riparian areas in the Pedernales River Basin. Good intentions alone can exacerbate the infestation of these plants. Scientifically informed, safe management practices are needed to control these plants effectively and improve the health of the river basin. Learn more at: www.texasinvasives.org.

UPLAND MANAGEMENT IN A RURAL RIVER BASIN

The dense vegetation and abundant water that the first European settlers encountered in the Texas Hill Country fueled a ranching economy that flourished until the last half of the twentieth century. Over time, heavy grazing, significant soil erosion, brush encroachment, and periodic drought have altered the grasslands that once supported ranching. This section will discuss how holistic rangeland stewardship can help restore ecosystem health.

Rangeland Stewardship

Effective rangeland stewardship strives for ecological, economic, and social sustainability. Ecological sustainability means that species diversity and natural processes like the water cycle, nutrient cycle, and the flow of energy are maintained in the biological community. Economic sustainability requires that the

land produce enough income to cover the costs of ownership and hopefully generate revenue for land improvement. Social sustainability means that the land is passed down to succeeding generations intact, along with the conservation ethics that ensure that the land is taken care of.

Brush Management

Several species of native brush have increased to undesirable densities across the region; these include cedar (Ashe juniper), mesquite, prickly pear, persimmon, and several minor species. When brush gets too thick it interferes with livestock production, habitat for certain wildlife species, and recreational enjoyment. Controlling or managing brush has become a high priority for many landowners in the Pedernales basin and it is important that it be done properly, under the advice of natural resource professionals.

Cedar (Ashe juniper) is the most important (and most misunderstood) native brush species in the river basin and has the ability to dominate the landscape. However, cedar is also an ecologically important plant for wildlife and can help restore badly degraded soils. Instead of wholescale clearing, consider these alternative stewardship practices:

- Leave cedar on steeper slopes where it is needed to protect hillsides and canyons from erosion.
- Remove or thin cedar in numerous patches or strips, rather than large areas, in order to retain refuge habitat for wildlife.
- Remove the smaller cedar while leaving some or many of the large, mature cedar.
- Small cedar may be controlled with prescribed burning in winter or by cutting the trunk below the lowest branch.
- Leave a layer of dead cedar slash on the ground to provide protection and promote the growth of desirable grasses, forbs, and woody plants.

- If a chipper is used to reduce the volume of dead wood, cedar chip mulch should not be more than two or three inches thick; otherwise, this may impede germination of desirable species.
- Removing low branches from mature cedar trees can increase the amount of sunlight reaching the ground, potentially stimulating growth of native grasses stored in the seedbank.
- Small "wildlife piles" of cedar slash can provide habitat for small mammals and reptiles; woody material can also be stacked around desirable tree species to prevent browsing.
- If there is significant soil disturbance, native grass seed can be planted to hasten recovery.

A landowner used three rows of cedar logs to slow down erosion, trap sediment, and create conditions for grasses. The logs were placed carefully to follow the contour line along the hillside. In this same site, the landowner also broadcast native grass seed and covered the seed with a very thin layer of cedar mulch.

BRUSH MANAGEMENT CASE STUDY: BAMBERGER RANCH

One local success story is the Selah Bamberger Ranch Preserve in Blanco County. The 5,500-acre ranch has become one of the largest habitat restoration projects in the state, winning numerous awards from the State of Texas and The Nature Conservancy for its brush management practices implemented to benefit water supplies, wildlife habitat, and cattle grazing. For nearly 50 years, Bamberger Ranch has improved land health and wildlife habitat through several key stewardship practices. These practices include thoughtful cedar management (e.g. leaving cedar intact along steep hillsides and creek bottoms), seeding native grasses, and building a series of rock berms along the contours of the hills to trap and sink runoff into the ground. Today, the Bamberger Ranch is protected from future development through the Bamberger Ranch Preserve, a 501(c)(3) organization that hosts nearly 3,000 visitors per year to illustrate land management and conservation measure success to schools, tour groups, and other landowners.[21]

Controlling Ungulates

In many places across the Pedernales basin there is still an abundance and diversity of desirable native trees and shrubs; however most of these are older, mature trees with a notable lack of young trees. Historic overgrazing by sheep and goats as well as excessive populations of native white-tailed deer and non-native, exotic species (e.g. Axis deer) has greatly diminished reproduction of the next generation of trees. As older trees die of natural causes, there are few if any young trees to replace them. This leads to the gradual loss of tree and shrub diversity on many properties and the degradation of land and habitat value.

Deer, exotic animals, sheep, and goats also feed heavily on broadleaf flowering forbs. Many desirable species of flowering plants have been nearly eliminated on many tracts due to overgrazing by wildlife and livestock, sometimes exacerbated by the rooting and wallowing of feral hogs.

Management strategies for overabundant ungulate and other nuisance wildlife populations include:

- Stop or reduce supplemental feeding.
- Control white-tailed deer populations, especially females, through aggressive hunting, utilizing the Texas Parks & Wildlife Department's Managed Lands Deer Program for guidance and incentives.

- Control non-native, exotic deer species through aggressive hunting; exotic species such as Axis deer may be hunted year-round or commercially removed for the venison market.
- Trap and hunt feral hogs; some communities have created bounty programs for hogs; large corral traps are much more effective than small box traps; aerial gunning is effective in the winter where tree and brush canopy is not too dense.
- Install protective caging around saplings to prevent browsing and encourage regeneration of native trees and shrubs.

Grazing Management Strategies

Sustainable grazing management restores plant diversity, improves pasture productivity, enhances soil and plant health, protects water quality and quantity, increases groundwater recharge, and improves wildlife habitat. In order to maintain a sustainable grazing operation, ranchers must manage the stocking rate of livestock as well as the timing, frequency, and duration of grazing. Some basic management recommendations include:

- Stock conservatively, always keeping a surplus of grass; if conditions become dry, consider reducing livestock numbers instead of feeding hay. Implement rotational grazing that allows preferred grasses and forbs adequate time to recover.
- Add cross-fencing to increase the number of pastures in which livestock can be rotated.
- Prescribed burning, brush management, and control of non-native, invasive plants and animals can enhance land productivity for livestock.
- Monitor plant communities (fixed point photos or quantitative measurements) and soil health (e.g. amount of organic matter present) and adjust grazing management as needed.
- Install fencing to manage livestock grazing in riparian areas; short periods of grazing followed by long rest will help maintain healthy riparian vegetation.

Conservation Easements

Many Hill Country residents are choosing to preserve their land in perpetuity with the use of conservation easements.

A conservation easement permanently protects the natural resources of the property by placing restrictions on how the property can be developed. Each easement is tailored to the property and the landowner's specifications and is negotiated between the landowner and a land trust partner. A conservation easement requires current and future landowners to abide by the provisions of the easement.

Placing a conservation easement on a property does not make the land public nor is it a government program. To learn more about conservation easements and their benefits, contact area land trusts, speak with other landowners that have gone through the process, and speak with your legal or financial advisor. Here are a few local land trusts in the Pedernales River Basin:

The Hill Country Land Trust
www.hillcountrylandtrust.org - (830) 997-0027

Colorado River Land Trust
www.coloradoriverlandtrust.org - (512) 730-5160

The Hill Country Conservancy
www.hillcountryconservancy.org - (512) 328-2481

The Texas Land Conservancy
www.texaslandconservancy.org - (512) 301-6363

Cibolo Conservancy
www.ciboloconservancy.org – (210) 601-4599

Wildlife Management, Open Space Valuations

Since the 1960s, the Texas Constitution has supported the preservation of open spaces through its tax code. Properties that meet certain criteria may be taxed at a lower rate if appraised as Open Space Land or Designated for Agricultural Use. In 1995, the people of Texas approved Proposition 11, which amended the state constitution to add "wildlife management" as a qualifying agricultural practice.

A variety of management practices (e.g. improving habitat, controlling erosion, providing supplemental food, shelter, and water) can be implemented to sustain a wildlife management valuation. To learn more about whether your property qualifies, converting from an agricultural exemption to a wildlife exemption, or creating and implementing a wildlife management plan, visit the Texas Parks & Wildlife Department's website.

Green Infrastructure

The built environment and transportation systems we depend on for living and working inherently alter the environment. A basic challenge we face as the population increases in the Pedernales River Basin is to design such systems in innovative ways that harmonize with the cyclical nature of water, the regional climatic conditions, and the local geology.

Green Building and Low Impact Development (LID) aim to reduce impacts to the environment and may be engineered to either mimic the function of a healthy natural system or harmonize with the local hydrology and drainage patterns. Instead of using large centralized stormwater collection systems, LID uses decentralized stormwater controls to capture and process nonpoint source pollution. The benefits of LID include a decrease in erosion and flooding, improved water quality, and the aesthetic appeal of the decentralized stormwater controls, including rain gardens and other vegetated retention systems.

Green Infrastructure includes natural areas that are secured and maintained because they naturally capture, conserve and clean stormwater runoff. In urban environments, a combination of these approaches can be used to create a green tapestry that harmonizes with the water cycle. This also integrates natural areas with residential and work environments and offers numerous benefits including improved air quality, reduced noise and light pollution, and a more natural and peaceful place to live.

Bioswales are vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream.

Beneficial Microbes in Our Soil

It may be hard to believe, but some of the environment's best friends are things that cannot be seen without a microscope, things we call microbes. Words like bacteria and fungus often bring to mind infections and diseases, but in truth there are far more beneficial microbes than harmful ones.

Microbes purify our water as it moves through the soil, breaking down pollutants and destroying harmful pathogens. Microbes also protect plants from many harmful insects and diseases. Some even allow plants to thrive with less watering. However, many of the beneficial microbes can be destroyed by excessive or improper use of herbicides and pesticides. The effects of these products can be far-reaching when they wash downstream from lawns and agricultural fields.

The best plan is to minimize and responsibly use synthetic pesticides and fertilizers as well as dispose of household chemicals and pharmaceuticals properly to ensure these contaminants do not enter our streams and groundwater.

© Paul Barwick

NIGHT SKIES

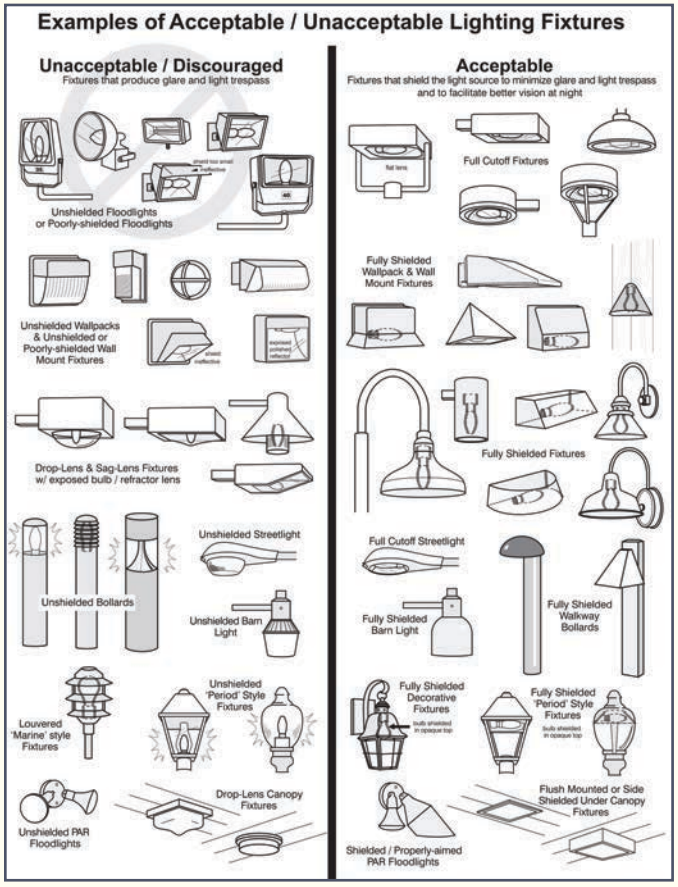
If we only pay attention to what we see during a morning or afternoon walk in the Pedernales River Basin, then we are missing half the picture. The fact is, natural darkness at night is an important consideration for the health of humans, plants, and wildlife.

Artificial light at night alters predator-prey dynamics, distracts nocturnal pollinators like moths from their important nightly work, and impedes navigation for migratory species that navigate by starlight, golden-cheeked warblers and painted buntings among them.

Population growth in the basin and the associated development occurring here now present both a challenge and an opportunity for our naturally dark nights and star-filled skies. If we take care to only use night-sky friendly outdoor lighting practices, we can preserve naturally dark, beautiful nights for the region's plants and wildlife, and for ourselves and future generations to enjoy.

Within the Pedernales River Basin, several local governments have adopted resolutions in support of night sky protection, including Blanco County, Burnet County, Gillespie County, Kerr County, Kimble County, and the City of Fredericksburg. Additionally, the City of Fredericksburg and the City of Johnson City have adopted Outdoor Lighting Ordinances to help ensure that good lighting practices are used in town.

Although the skies are beautiful from almost anywhere in the basin, star-viewing programs regularly offered at the open-air observatory in Reimers Ranch Park are well worth the trip. Regional astronomy



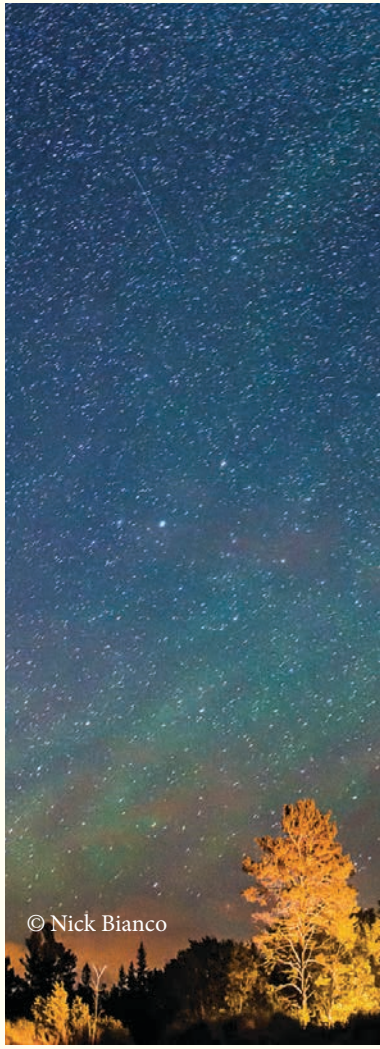
© International Dark-Sky Association

groups, like the Hill Country Astronomers, also hold periodic star parties in the basin, at the LBJ State and National Historical Parks and elsewhere, at which the public can observe celestial objects through telescopes.

Preserving Night Skies

How will we minimize light pollution and still have the light we need? By following the recommendations below you can reduce, if not eliminate, light pollution.

Turn Lights Off When You Do Not Need Them
Switches, motion detectors, and timers are all practical ways to make sure that lights are not left on when you do not need them. Although many people believe crime is deterred if there are lights on outside, this is not the case. Outdoor lighting actually can have the opposite effect, directing a criminal to a target and creating darker shadows where it is more difficult to see. The best bet for safety is to use a motion detector that turns the light on when someone approaches. Turning lights off when they are not needed will help protect our view of the stars, and provide our communities, wildlife, and plants the darkness they need at night to be healthy.



© Nick Bianco

Shield Lights to Direct the Illumination Down, to the Specific Place You Need It

Aiming lights "down" does not mean to just angle the light towards the ground. The light must be positioned so as to shine only where it is needed. It is especially important not to allow any light to be projected upward, above a horizontal line drawn through the lowest part of the bulb or lens. Use shielding to narrow the throw of the light, directing it away from neighboring properties and away from the eyes of passing drivers or pedestrians.

Many outdoor light fixtures on the market that are labeled as "dark sky" do not adequately shield the light-source from the view of passersby. Therefore, it is important to know where you will put the light and how much shielding is required for that location when you are selecting your fixture.

Lumens Matter–Use Only As Much Light As You Need

Because LEDs are much more efficient than older technologies, it is more useful to think about light in terms of "lumens"—the amount of light produced by a fixture or bulb—than in terms of Watts. If you have always used a 100W bulb for a specific purpose and are preparing to switch to LED, a 15W or 20W LED should produce the same amount of light (lumens) as a 100W bulb. The "Lighting Facts" label on the packaging will indicate the number of lumens that the bulb or fixture produces and it will often indicate the equivalent incandescent bulb type for your reference.

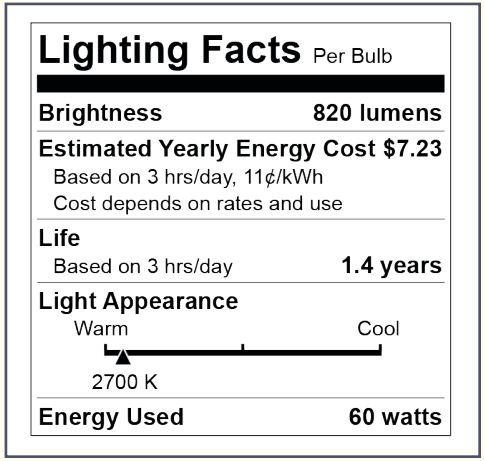
Also, keep in mind that applying more light can actually make it harder to see because light at night constricts our pupils, making it more difficult to see in the shadows.

In addition to challenging our vision, the use of too much light at night will cause light to bounce off of the surfaces we want to illuminate, reflecting up into the sky, into the eyes of neighbors and passersby, and into the habitat of nearby wildlife.

Finally, when we shield a light that has not been shielded, we are effectively focusing the light to where it is needed. As a result, we can use less powerful bulbs to achieve the same amount of light on our target, resulting in energy savings.

Select Lights with a Warm Color

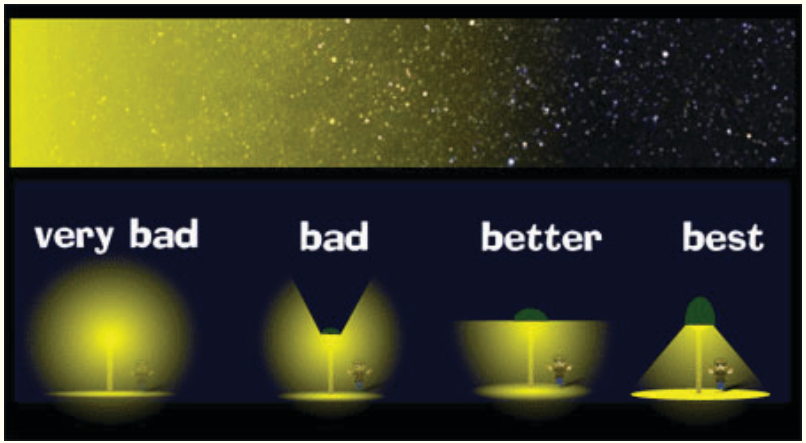
Hold up several white lights next to each other and you might find that there are actually subtle differences in the color of light that they produce. Some have a more amber or yellow tint, while others have a more blue

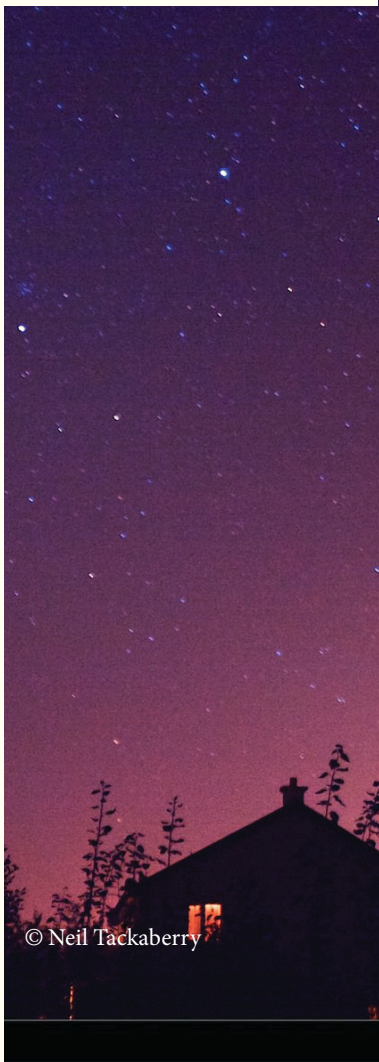


tint. Believe it or not, these subtle differences matter, not only for our view of the stars, but also for our health and the health of wildlife in our vicinity.

The blue light contained within bright white or blue white light scatters more in the sky, creating more sky glow, and it inhibits melatonin production in living organisms, including humans. Melatonin is an important chemical for several physiological processes that help us rest and regenerate at night.

When picking an LED bulb or fixture, be sure to check the "Lighting Facts" label and select a product that has a Correlated Color Temperature of 3000K or below. That will tell you that the light you are purchasing has lower levels of blue wavelength output and is preferred for nighttime use.

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PUBLIC PROCESSES

The river is ecologically sensitive and in many ways subject to the actions and interactions of the humans within its catchment. Because land, surface water and groundwater are so interconnected, it is vitally important that all landowners acknowledge their role in maintaining the overall health of the Pedernales River Basin. Fortunately, Texas offers many sources of assistance to landowners.

Groundwater Management

Groundwater Conservation Districts
The Pedernales River Basin includes portions of seven Groundwater Conservation Districts (GCDs) that generally follow county lines. The two districts with the most land area in the basin are the Blanco-Pedernales Groundwater Conservation District and the Hill Country Underground Water Conservation District, which have jurisdiction over Blanco and Gillespie Counties, respectively. These districts are responsible for managing a majority of the area's groundwater and are critical in ensuring groundwater is managed in a sustainable way.

Blanco-Pedernales Groundwater Conservation District
www.blancocountygroundwater.org/

Hill Country Underground Water Conservation District
www.www.hcuwcd.org

Groundwater Management Areas
Because GCDs in this region tend to follow county lines, rather than river basin or aquifer lines, in 2005 the State Legislature set up a process through which groundwater districts could work together to conduct joint planning to maintain shared aquifers. The resulting Groundwater Management Areas (GMAs) established groups of GCDs that more closely follow aquifer boundaries. The Pedernales River Basin is divided between two GMAs – GMA 9 and GMA 7. The GMAs are tasked with establishing Desired Future Conditions (DFCs) for the aquifers. The DFC establishes the parameters within which the aquifer will be managed for the next 50 years. This process provides an excellent opportunity for GCDs and the public to share their visions for sustainable groundwater management.
www.twdb.texas.gov/groundwater/management_areas/

Regional Water Planning Groups
In addition to the GMA planning process, there are also Regional Water Planning Groups (RWPGs) that guide the formation of a statewide water plan every five years. This regional water planning process was initiated in 1997 and there are 16 RWPGs in Texas. The majority of the Pedernales River Basin falls into region K, the Lower Colorado RWPG. In 2016, the RWPGs released their latest regional plans, which informed the 2017 update to the State Water Plan.
www.twdb.texas.gov/waterplanning/rwp/

Surface Water Management

Surface water within the Pedernales River is overseen by the Texas Commission on Environmental Quality (TCEQ) and is fully allocated to downstream users through senior, junior, or exempt domestic and livestock water rights. The Lower Colorado River Authority (LCRA) has water management authority in Blanco County, but its authority stops at the Blanco-Gillespie county line. LCRA takes an active interest in water quantity and quality in the Pedernales.

The cities of Fredericksburg and Johnson City are the only two municipalities with permits to release treated water in the river basin. Fredericksburg has a permit to discharge up to 2.5 million gallons per day of treated wastewater into Barons Creek, a tributary of the Pedernales. Johnson City has a permit for up to 0.303 million gallons per day into Town Creek.[22] The TCEQ permits for these treatment facilities have water quality requirements relating to total suspended solids, ammonia-nitrogen, dissolved oxygen levels, and CBOD. CBOD stands for carbonaceous biochemical oxygen demand and is considered to be an indication of wastewater pollutants.[23]

Texas Commission on Environmental Quality
www.tceq.texas.gov

Lower Colorado River Authority
www.lcra.org

Public Agencies

Texas State Soil and Water Conservation Board (TSSWCB)
Beginning in September 2002, the TSSWCB established a brush control program to remove brush in the Pedernales River Basin with the goal of increasing flow to Lake Travis. The Pedernales River Program has been allocated more than $4.4 million for this cost-share program. The TSSWCB has a goal of treating 140,000 acres of brush in the river basin. In 2012, the program's name was changed from Brush Control Program to Water Supply Enhancement Program, and the statewide annual funding dropped from roughly $4.5 million per year to $2.1 million per year.[24] As of 2010, just over 70,000 acres had been treated.[25] The TSSWCB also runs the Water Quality Management Plan Program, designed to assist large landowners, farm, and ranch operations to manage their property in a way that protects water quality. The Soil Board, as it's often called, also works with TCEQ to implement Watershed Protection Plans. www.tsswcb.texas.gov

Soil and Water Conservation Districts (Pedernales, Gillespie) and USDA NRCS
These agencies serve as an additional source of information and resources at the county level. Gillespie County Soil and Water Conservation District, for example, offers brush-clearing assistance through the NRCS Environmental Quality Incentives Program (EQIP). They also assist landowners in preparing conservation plans, developing prescribed burning plans, planning for pond construction, and controlling erosion. Local Soil and Water Conservation Districts also have access to the statewide resources offered by TSSWCB.

Texas A&M AgriLife Extension Service & Forest Service
Offices are funded and operated by Texas A&M University. Various ArgiLife specialists provide a wide range of public services and information related to farming, ranching, gardening, and land management. AgriLife hosts a variety of educational events for landowners throughout the year and is available to make site-specific stewardship recommendations. Likewise, the Texas A&M Forest Service helps property owners and communities conserve forest resources and prevent wildfires. www.agrilifeextension.tamu.edu

Texas Commission on Environmental Quality (TCEQ)
TCEQ is responsible for establishing surface water quality standards in Texas. In addition, TCEQ holds the public permits for surface water withdrawals from the Pedernales, as well as wastewater and stormwater discharge permitting. TCEQ periodically updates its surface water quality standards. Public involvement in this process is an important component to those updates, and engagement by local stakeholders will remain important in the future. www.tceq.texas.gov

Texas Parks & Wildlife Department (TPWD)
TPWD has extensive knowledge, expertise, and resources to

offer in the basin. Technical guidance is available from wildlife biologists assigned by county. TPWD biologists commonly assist with game counts, wildlife and land management strategies, and in providing assistance with writing wildlife management plans for 1-D-1 open space valuations. TPWD biologists are also hard at work on restoration initiatives and in conducting research.

The Landowner Incentive Program (LIP) is one of TPWD's programs that provides funding for sustainable land management practices. TPWD has received some funding for Guadalupe Bass conservation in the Pedernales River Basin from the National Fish and Wildlife Foundation and Southeast Aquatic Resources Partnership. Through these funding sources, TPWD has supported educational programming, habitat restoration, and stewardship projects on private lands that conserve Guadalupe Bass and other native fish and wildlife species.

TPWD also operates the Pedernales Falls State Park and the LBJ State Park and Historic Site within the basin. These parks provide outdoor opportunities for the general public to engage with the natural resources of the basin. www. tpwd.texas.gov

Texas Master Naturalists Program
The Master Naturalist Program is a statewide volunteer program coordinated by TPWD and AgriLife Extension. They have a strong presence in the Texas Hill Country and within the Pedernales River Basin through the Hays County, Hill Country, and Highland Lake Chapters. Volunteers working with the Master Naturalist Program provide education, outreach, and service for the beneficial management of natural resources. www. txmn.org

Lower Colorado River Authority (LCRA)
LCRA is responsible for maintaining the health of the lower Colorado River and the Highland Lakes System, and as such has a vested interest in the environmental sustainability and resilience of the Pedernales River - one of the Colorado's most important tributaries.

LCRA initiated its Creekside Conservation Program in 1990, with a goal of reducing sedimentation in the Highland Lakes. The program advances the use of best management practices to improve riparian health. LCRA partners with the Natural Resources Conservation Service, Soil and Water Conservation Districts, and willing landowners within the river basin. As of 2016, more than 285 landowners have participated in the program with more than 168,000 management acres complete in the Pedernales River Basin. More than 71,000 feet of cross fence were installed over the first 22 years and 33,900 brush management acres were completed.

LCRA is also an important resource for scientific data collection along the Pedernales. LCRA monitors water quality, quantity, rainfall and weather conditions, as well as biological information along the river. It also manages several parks and nature areas, including the Pedernales River Nature Park in Johnson City. www.lcra.org

Community Groups

Perhaps the greatest opportunities for protecting the long-term health of the river basin lie in the organizations, agencies, businesses, and individuals working for sustainable land management and conservation. By collaborating and sharing resources across groups we can easily achieve improved outreach and education results. This is not an exhaustive list, but a brief summary of organizations that are active in the Pedernales River Basin.

Fredericksburg - Native Plant Society
The Native Plant Society of Texas promotes the conservation, research and utilization of the native plants and plant habitats of Texas, through education, outreach, and example.

The Fredericksburg Chapter meets the fourth Tuesday of each month January - October in the Fellowship Hall of Memorial Presbyterian Church at 6:30 p.m. Meetings are open to the public and free of charge. https://npsot.org/wp/fredericksburg/

Fredericksburg Nature Center
One lesser-known natural treasure can be found in Lady Bird Johnson Municipal Park in Fredericksburg. A small 10-acre tract along Live Oak Creek was left undisturbed and somewhat forgotten for decades while the municipal park was developed. Through thousands of hours of volunteer labor since 2000, this tract is now the Fredericksburg Nature Center,

boasting more than 6,000 feet of hiking trails, with two loop trails and a 650-yard wheelchair-accessible trail. Visitors to the Nature Center will find seven distinct habitats with an amazing diversity of more than 650 species of birds, forbs, grasses, woody plants, amphibians, reptiles, and insects. www.fredericksburgnaturecenter.com

Friends of Pedernales Falls, Friends of LBJ National Historical Park and Friends of LBJ State Park
Many parks have organized groups of interested citizens that actively support their park. These nonprofit organizations work on behalf of park sites to assist with daily programs, special events, fundraising, and public education. These groups also serve as important links to local communities and park user groups. The Friends of Pedernales Falls, Friends of LBJ National Historical Park, and Friends of LBJ State Park are all located in the Pedernales River Basin. www.tpwd.texas.gov/state-parks/help-parks/park-friends-support

Hill Country Alliance (HCA)
HCA is a regional non-profit whose mission is to bring together an ever-expanding alliance of groups throughout a multi-county region of Central Texas with the long-term objective of preserving open spaces, water supply, water quality, and the unique character of the Texas Hill Country. HCA includes resources and expertise working in all Hill Country watersheds, and has acted as a convener for Pedernales-related groups in the past. The HCA-Pedernales group is comprised of stakeholders who are business owners, local government employees, nonprofit representatives, and landowners from across the watershed. HCA hosts educational events, creates educational materials, and facilitates discussion, research, and stewardship of our Hill Country natural and cultural resources. The Pedernales River Basin Program is the largest program of the organization and drives much of HCA's work. www.hillcountryalliance.org

Hill Country Land Trust (HCLT)
HCLT is a regional land trust that is very connected to local leaders and landowners in the Pedernales Basin. Formed in 1998, HCLT has the mission of conserving and protecting the agricultural lands, wildlife habitat and rivers of the Texas Hill Country for present and future generations. HCLT is responsible for monitoring and enforcing 17 easements in the Texas Hill Country, totaling 4,850 acres. The Pedernales River Basin is one of HCLT's priority conservation areas. www.hillcountrylandtrust.org

Hill Country Prescribed Burn Association
The Hill Country Prescribed Burn Association is an organization of volunteers which exists for the purpose of conducting safe and effective prescribed burns on private lands

within the geographical areas where its members reside. The goal of the membership is to use prescribed burning as a tool to enhance agricultural production and wildlife habitat by using fire. http://hillcountrypba.org/

Hill Country Science Mill
The Science Mill is a place for middle and high school students from around the region to come for hands-on learning experiences in the STEM fields (science, technology, engineering, and math). The Mill's focus is on careers in STEM and inspiring students to pursue science-related degrees. The Science Mill features an exhibit sponsored by the Hill Country Alliance that takes students inside an aquifer using state of the art video capabilities. The exhibit demonstrates why the sustainable management of our groundwater resources is so important. www.sciencemill.org

The Meadows Center for Water and the Environment
The Meadows Center for Water and the Environment at Texas State University began a program entitled "Pedernales River Project" in 2007 to study the current structure and function of the Pedernales River for the development of a conservation plan for the basin. The 2008 Integrated Assessment and 2013 Watershed Data Report are cited in the resources section.

In 2013, The Meadows Center began a further investigation in Hill Country rivers with the "How Much Water is in the Hill Country?" project. The goal for this project is to better understand the interaction of aquifers, springs, and rivers in the Hill Country and to help make critical decisions that will ensure there is enough water in the future for the environment and people alike. You can find a full list of resources and information focused on the Pedernales River and at: Pedernales.MeadowsWater.org.

Pedernales Neighbors Gathering
Landowners up and down the Pedernales meet biannually for social and educational purposes. Two river basin landowners lead the group: J. David Bamberger and Pam Reese. The Pedernales Neighbors Gathering is an excellent example of regular community meetings that routinely recruit more than 100 participants. Speakers are invited to provide short presentations about important ecological and policy-related issues facing the basin.

Pedernales, Doss, Harper Wildlife Management Associations
These groups are private citizens that have joined together to manage their land for the benefit of wildlife. They are recognized and supported by TPWD and hold regular meetings. www.tpwd.texas.gov/landwater/land/associations

Pedernales Wildlife Management Co-op Program
The co-op started more than 10 years ago by Harris Greenwood, who was interested in combatting the negative

Email info@hillcountryalliance.org if you would like information about The Pedernales Neighbors Gathering and invitations to bi-annual potlucks.

impacts of land fragmentation on wildlife habitat. The group holds annual meetings, with different speakers invited to present on wildlife management issues pertinent to the area. A planning committee meets more regularly. The two primary goals of the group are to increase residents' information about wildlife in the area, and to get neighbors together to meet each other. The group has grown from an initial meeting of 20 neighbors to an event that regularly exceeds 100 attendees.

Selah Bamberger Preserve

Selah, Bamberger Ranch Preserve is a 5,500-acre ranch in Blanco County that has been restored to its original habitat. Their mission is to teach ethical land stewardship — by example and outreach. They offer seminars for landowners and serve as a research lab for botanists, zoologists, and other scientists. They also provide hands-on science classes and nature camps for school children — 2,000 children in a typical year. Public tours and workshops are also available. www.bambergerranch.org

Soil for Water Program

Soil for Water is an outreach and demonstration program that focuses on the role soil health plays in catching and holding rainwater. Microorganisms build soil organic matter. When organic matter is increased, it functions like a sponge:

holding rainwater for long periods of time and releasing it slowly into plants, springs, creeks, rivers, and aquifers. Understanding and managing the health of the soil on your land can help you retain more water on-site and improve the condition of your ranch. www.ncat.org/soilforwater/

Texas Land Conservancy (TLC)
In 2012, TLC announced its Land for Water initiative. Using Geographic Information Systems (GIS), TLC identified six key river basins with irreplaceable natural resources that face imminent threats including land fragmentation and development. The six priority areas are the Lower Brazos, Lower Trinity, Neches, Llano, Pedernales, and Medina Rivers – an area of more than 27 million acres. The identification of these priority areas will guide TLC's outreach efforts going forward, which will have an increased focus on the Pedernales River Basin. www.texaslandconservancy.org

Texas Master Gardeners
Master Gardeners are members of the local community who take an active interest in their lawns, trees, shrubs, flowers, and gardens. They are enthusiastic, willing to learn and help others, and able to communicate with diverse groups of people.

What really sets Master Gardeners apart from other home gardeners is their special training in horticulture. In exchange for their training, persons who become Master Gardeners contribute time as volunteers, working through their Extension office to provide horticultural-related information to their communities. https://mastergardener.tamu.edu/

Texas Stream Team
Texas Stream Team (TST), as part of The Meadows Center for Water and the Environment, is dedicated to understanding and protecting the 191,000 miles of Texas waterways. They bring together community members, students, educators, academic researchers, environmental professionals, and both public and private sector partners to conduct scientific research and to promote environmental stewardship.

Anyone with a desire to monitor water quality or learn more about the natural resources in Texas can be involved. Volunteers monitor a wide variety of habitats from rivers, creeks, ponds, and lakes to bays, bayous, and estuaries. Citizen scientists are trained (free of charge) to collect water quality data using applied scientific techniques to monitor pH, dissolved oxygen, and other indicators of water quality at their favorite sites. The data supports academic research, informs policy, and serves as a de facto early warning system for water quality across Texas. www.JoinStreamTeam.org

Travis County Parks: Milton Reimers Ranch & Hamilton Pool

On the eastern edge of the river basin are two Hill Country parks that afford educational opportunities and outdoor recreation for visitors from around the state and around the country. Hamilton Pool, in particular, is a well-known attraction that draws large crowds of visitors. These Travis County Parks provide a critical connection for urban residents to be exposed to the importance of the land and water resources in the Hill Country. www.parks.traviscountytx.gov/find-a-park

Westcave Outdoor Discovery Center

A 75-acre preserve located just outside of Austin, Westcave Outdoor Discovery Center (formerly Westcave Preserve) is committed to inspiring people to develop a lifelong practice of enjoying and protecting nature. Westcave hosts 6,000 students annually for educational programming. The Lower Pedernales Stewardship Roundtable convenes regularly to explore topics in conservation along the Pedernales. www.westcave.org

APPENDIX A: HILL COUNTRY STEWARDSHIP RESOURCES

Books and Reports

Asher et al. 2016. *Blanco River Design Guidelines.* Lady Bird Johnson Wildflower Center.

Cow Creek Groundwater Conservation District. 2013. *Water: Yours, Mine & Ours.* Accessed from http://ccgcd.org/WaterBooklet/.

Gaskill, Mellissa. 2013. *Texas Land Conservancy's new Land for Water Initiative Aims to Protect Key Watersheds.* Culturemap Austin. Accessed from http://austin.culturemap.com/news/innovation/07-24-13-texas-land-conservancy-announces-land-for-water-initiative/.

Jaber et al. 2013. *Stormwater Management: Rain Gardens*. Texas A&M AgriLife Extension.

Jones-Lewey. 2014. *Your Remarkable Riparian: A Field Guide and Owners' Manual for Managing Riparian Areas*. Nueces River Authority.

Smyrl, Vivian Elizabeth. 2013. *Pedernales River.* Handbook of Texas Online. Published by the Texas State Historical Association. Accessed from *http://tshaonline.org/handbook/online/articles/rnp03*

Stanley. 2017. *Hill Country Ecology: Essays on Plants, Animals, Water, and Land Management*. Hugo House Publishers.

Stanley. 2014. *A Beginner's Handbook for Rural Texas Landowners.* Outskirts Press.

Stephens and Wrede. 2017. *Attracting Birds in the Texas Hill Country: A Guide to Land Stewardship*. Texas A&M University Press.

LCRA (Lower Colorado River Authority). 2012. *Pedernales River Watershed Brush Control Assessment and Feasibility Study*. Accessed from http://www.tsswcb.texas.gov/files/docs/brush/feasibilitystudies/FS_LCRA_2000.pdf

LCRA (Lower Colorado River Authority). 2013. *Pedernales Watershed Data Report.* Accessed from http://gato-docs.its.txstate.edu/jcr:0017f25d-be70-495b-81a1-822616f87ae1/Pedernales_River_Watershed_Data_Report.pdf.

Loflin and Shirley. 2006. *Grasses of the Texas Hill Country*. Texas A&M University Press.

TSSWCB (Texas State Soil and Water Conservation Board). 2012. *Texas Conservation Action Plan 2012 – 2016: Edwards Plateau Handbook.* Editor, Wendy Connally, Texas Conservation Action Plan Coordinator. Austin, Texas.

TSSWCB (Texas State Soil and Water Conservation Board). 2010. *Brush Control Program 2010 Annual Report*. Accessed from http://www.tsswcb.texas.gov/reports#wsep

Wrede. 2005. *Trees, Shrubs, and Vines of the Texas Hill Country: A Field Guide*. Texas A&M University Press.

Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf.

Wierman et al. 2017. *How much water is in the Pedernales? Occurrence of Flowing Water and Water Quality during Base Flow Conditions in the Pedernales River Basin.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:1de06744-9500-41ad-b2a0-6d7e669f4e7e/Pedernales_Report_FINAL_20170307.pdf

Wierman et al. 2017. *Determining the Source of Base Flow to the Pedernales River in Northern Blanco, Hays and Travis Counties.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:7b366652-9904-4c1d-9a87-ee885a5129fe/baseflow-report-final.pdf.

Websites

Preserving Dark Skies: See the International Darks Skies Association – Texas Chapter at http://idatexas.org/solutions/#solution1

Native Plants: See Lady Bird Johnson Wildflower Center Plant Database at www.wildflower.org/plants/

Non-native, invasive plants: See Texas Invasives at www.texasinvasives.org/

Sustainable grazing: See Soil for Water Program at www.ncat.org/soilforwater/

Other Resources

Hill Country View: radio features that highlight natural resource issues of the Texas Hill County at www.hillcountryalliance.org/resources/hill-country-view/

Hill Country Alliance Newsletter: sign-up for the newsletter at www.hillcountryalliance.org/ to learn about news, upcoming events, and programs designed to conserve the natural and cultural resources of the Texas Hill Country.

APPENDIX B

Sources

[1] Hill Country History. Published by the Texas Parks & Wildlife Department. Accessed from https://tpwd.texas.gov/kids/about_texas/regions/hill_country/big_kids/hill_country_history.phtml.

[2] Smyrl, Vivian Elizabeth. 2013. Pedernales River. Handbook of Texas Online. Published by the Texas State Historical Association. Accessed from http://tshaonline.org/handbook/online/articles/rnp03.

[3] Wierman et al. 2017. *How much water is in the Pedernales? Occurrence of Flowing Water and Water Quality during Base Flow Conditions in the Pedernales River Basin.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:1de06744-9500-41ad-b2a0-6d7e669f4e7e/Pedernales_Report_FINAL_20170307.pdf. Page 38.

[4] The Meadows Center for Water and the Environment, Texas State University. Pedernales River Watershed Data Report. 2013. Accessed from http://gato-docs.its.txstate.edu/jcr:0017f25d-be70-495b-81a1-822616f87ae1/Pedernales_River_Watershed_Data_Report.pdf. Page 13.

[5] Wierman et al. 2017. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 18.

[6] Wierman et al. 2017. *How much water is in the Pedernales? Occurrence of Flowing Water and Water Quality during Base Flow Conditions in the Pedernales River Basin.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:1de06744-9500-41ad-b2a0-6d7e669f4e7e/Pedernales_Report_FINAL_20170307.pdf. Page 12.

[7] Wierman et al. 2017. *How much water is in the Pedernales? Occurrence of Flowing Water and Water Quality during Base Flow Conditions in the Pedernales River Basin.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:1de06744-9500-41ad-b2a0-6d7e669f4e7e/Pedernales_Report_FINAL_20170307.pdf. Page 56.

[8] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.

edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 14.

[9] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 25.

[10] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 14.

[11] Wierman et al. 2017. *Determining the Source of Base Flow to the Pedernales River in Northern Blanco, Hays and Travis Counties.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:7b366652-9904-4c1d-9a87-ee885a5129fe/baseflow-report-final.pdf. Page 48.

[12] Wierman et al. 2017. *Pedernales Falls State Park Spring Dye Trace Project.* Meadows Center for Water and the Environment, Texas State University. Accessed from https://gato-docs.its.txstate.edu/jcr:1f05ed9d-ff98-499c-a969-a7390fb6717b/Pedernales%20Dye%20Trace%20Report_Reduced.pdf. Page 3.

[13] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 25.

[14] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 33.

[15] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 23.

[16] Wierman et al. 2018. *Pedernales River 2017 Storm Water Sampling*. Meadows Center for Water and the Environment,

APPENDIX B

Texas State University. Accessed from https://gato-docs.its.txstate.edu/jcr:f87fd5bf-30ea-46b4-add9-81b49452b6e3/Pedernales%20Stormwater%20Report%2004062018.pdf. Page 3.

[17] Wierman et al. 2017. *How much water is in the Pedernales? Occurrence of Flowing Water and Water Quality during Base Flow Conditions in the Pedernales River Basin.* Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/jcr:1de06744-9500-41ad-b2a0-6d7e669f4e7e/Pedernales_Report_FINAL_20170307.pdf. Page 54.

[18] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 23.

[19] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 28.

[20] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 30.

[21] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 32.

[22] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 28.

[23] Wierman et al. 2015. *How much water is in the Pedernales? Conservation Strategies, Management Approaches, and Action Plan*. Meadows Center for Water and the Environment, Texas State University. Accessed from http://gato-docs.its.txstate.edu/the-rivers-institute/MCWE_NEW_SITE/Projects/HowMuchWaterisinthePedernales.pdf. Page 28.

[24] TSSWCB (Texas State Soil and Water Conservation Board). 2012. *Texas Conservation Action Plan 2012 – 2016: Edwards Plateau Handbook*. Editor, Wendy Connally, Texas Conservation Action Plan Coordinator. Austin, Texas. Accessed from www.tsswcb.gov/reports#wsep.

[25] TSSWCB (Texas State Soil and Water Conservation Board). 2010. *Brush Control Program 2010 Annual Report*. Accessed from www.tsswcb.texas.gov/reports#wsep.

RESOURCE SPOTLIGHT

HCA Issue Papers

HCA's Issue Papers provide concise summaries of key topics related to the health of the Texas Hill Country. They highlight strategies for managing natural resources, explain the legal and policy context for conservation, and offer great summaries of a diversity of topics related to land, water, community, and night skies. www.hillcountryalliance.org/resources/hca-issue-papers/

Water: Yours, Mine & Ours

Water: Yours, Mine, and Ours was produced through an EPA Non-point Source Pollution project of the Cow Creek Groundwater Conservation District (CCGCD) known as the Water Stewardship Initiative. The purpose of this initiative is to heighten peoples' awareness about the importance of conserving, capturing, and keeping water clean. www.ccgcd.org/WaterBooklet/

Your Remarkable Riparian

The purpose of this beautifully illustrated guide is to cultivate awareness of native riparian vegetation and appreciation for its role in proper riparian function. It introduces the most commonly observed riparian vegetation in the Edwards Plateau and Rio Grande Plains. However, most of the plants presented in this guide occur in riparian areas all across Texas, including the Cross Timbers, Trans-Pecos and Rolling Plains. www.remarkableriparian.org/shop.php

This manual, first published in 2018, is a compilation from a variety of resources produced by the organizations listed below.

TEXAS PARKS & WILDLIFE

THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

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The Meadows Foundation
Serving the People of Texas

THE REESE FOUNDATION

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