SPRINGS OF TEXAS

SPRING OWNER'S GUIDE

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Gods and heroes were born out of springs, and ever afterward came and went
between the above and below worlds through their pools. Every pueblo had sacred springs
somewhere near-by. There was every reason to sanctify them—physical, as life depended upon
water; spiritual, as they had natural mystery which suggested
supernatural qualities; for how could it be that when water fell as rain, or as snow, and ran away,
or dried up, there should be other water which came and came,
secretly and sweetly, out of the ground and never failed.

Paul Horgan
Great River: The Rio Grande in North American History

Cover photograph: Spring in Hamilton County

Springs of Texas

SPRING OWNER'S GUIDE

Table of Contents

Springs have played a major cultural, historical, ecological, and spiritual role in shaping Texas. Springs in the state are as varied and unique as the landscape, and are an important resource for all Texans. Many springs have disappeared and the quality, integrity, and existence of many more are threatened. Threats come from natural and human sources. Natural changes occur from shifts in climatic patterns, erosion, and faulting. Other changes can happen through urbanization and the fragmentation of large ranches, poor range management, and pumping of groundwater.

While the certainty of decreasing springs can be attributed primarily to human activity, we can take responsibility for their continued care and existence. Through these efforts, we can protect of one of our state's most fragile resources.

Dry Spring
(Photo Courtesy of Texas Parks and Wildlife Department (TPWD))

The intent of this guide is to increase awareness of the importance of springs and to assist spring owners in taking steps to care for their springs. We've recommended resources by topic throughout the guide in order to encourage further education and exploration. Additional resources are listed at the end of the guide. If you cannot find what you are looking for, please contact the Springs of Texas Project (512) 327-6915 or the Rivers Systems Institute (512) 245-9200 for assistance.

GETTING TO KNOW YOUR SPRING

The Importance of your Spring

Most Texans do not realize that many of our streams and rivers are fed by waters from springs, rather than directly from rainfall and subsequent surface run-off. In many instances, these **base-flows** account for a large volume of water in a river or stream. Through the natural filtration of sand and gravel, springs usually provide flows of better quality than from the other sources of water flowing into our streams and rivers.

In its immediate vicinity, your spring probably creates habitat for aquatic and terrestrial animals and supports diverse vegetation for a healthy ecosystem. It may provide drinking water for you or your livestock, or may serve as a recreational area. The presence of 'healthy' springs and the wildlife they support may substantially contribute to some owners' incomes through hunting leases and nature tourism.

In many areas of Texas, springs are the focal points for local communities through recreation, tourism, historical interest, and as a water supply source.

Spring feeding the Colorado River
Travis County

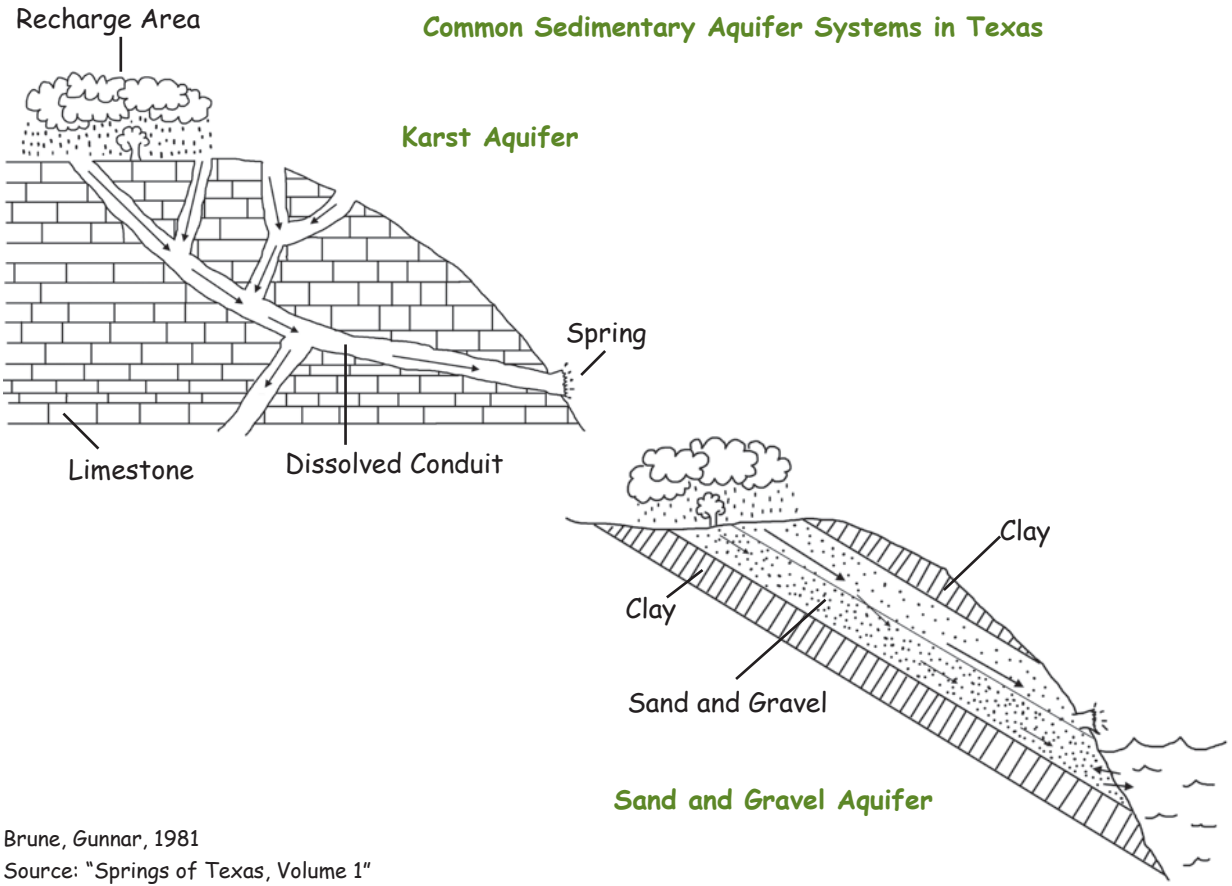
The Source of your Spring

Although images of springs sometimes evoke mystery, the water flowing from your spring is part of the **hydrologic cycle**. Rain or snowmelt percolates (**recharges**) into the ground and flows as groundwater through pores and fractures. Geologic formations that store and transmit this water are **aquifers**. The amount of time it takes for water to move through an aquifer can vary widely, from less than a day to thousands of years. The natural discharges from aquifers to the ground surface are springs. They can manifest as either a visible outlet in the landscape or as one or more hidden openings along the sides or bottom of a water body.

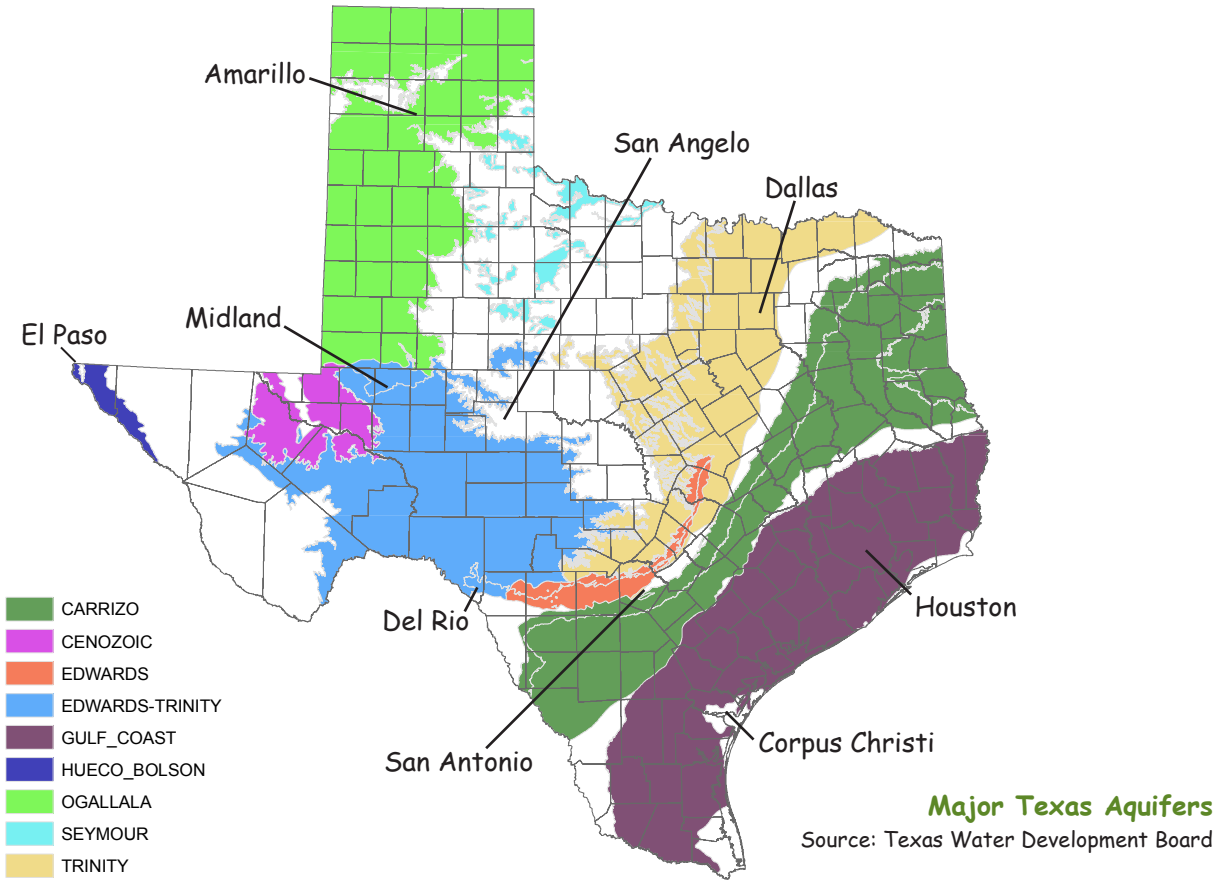
Nine major aquifers and 21 minor aquifers are found in Texas, underlying about 81 percent of the state. Most of the aquifers in Texas are **sedimentary**, ie., water that is contained in the spaces between sand and gravel particles. The larger sedimentary aquifers are the Ogallala aquifer in northwest Texas, the Gulf Coast aquifer along the Texas coast, and the Carrizo-Wilcox aquifer which parallels the Gulf Coast Aquifer approximately 100 miles inland. Other sedimentary aquifers are the limestone or **karst** aquifers of the Edwards (Balcones Fault Zone) in central Texas and the Edwards-Trinity (Plateau) in central West Texas. Far West Texas has **igneous** rock (volcanic rock) aquifers, as well as sand and gravel aquifers along stream courses and in valleys between the mountains.

Contact your local or neighboring groundwater conservation district for more information regarding the aquifer in your area. Contact information is available through the Texas Water Development Board at www.twdb.state.tx.us or by calling (512) 463-7847. Detailed aquifer information is available in "Major and Minor Aquifers of Texas," Report 345, Texas Water Development Board, available at www.twdb.state.tx.us, or by calling (512) 463-8337.

Common Sedimentary Aquifer Systems in Texas

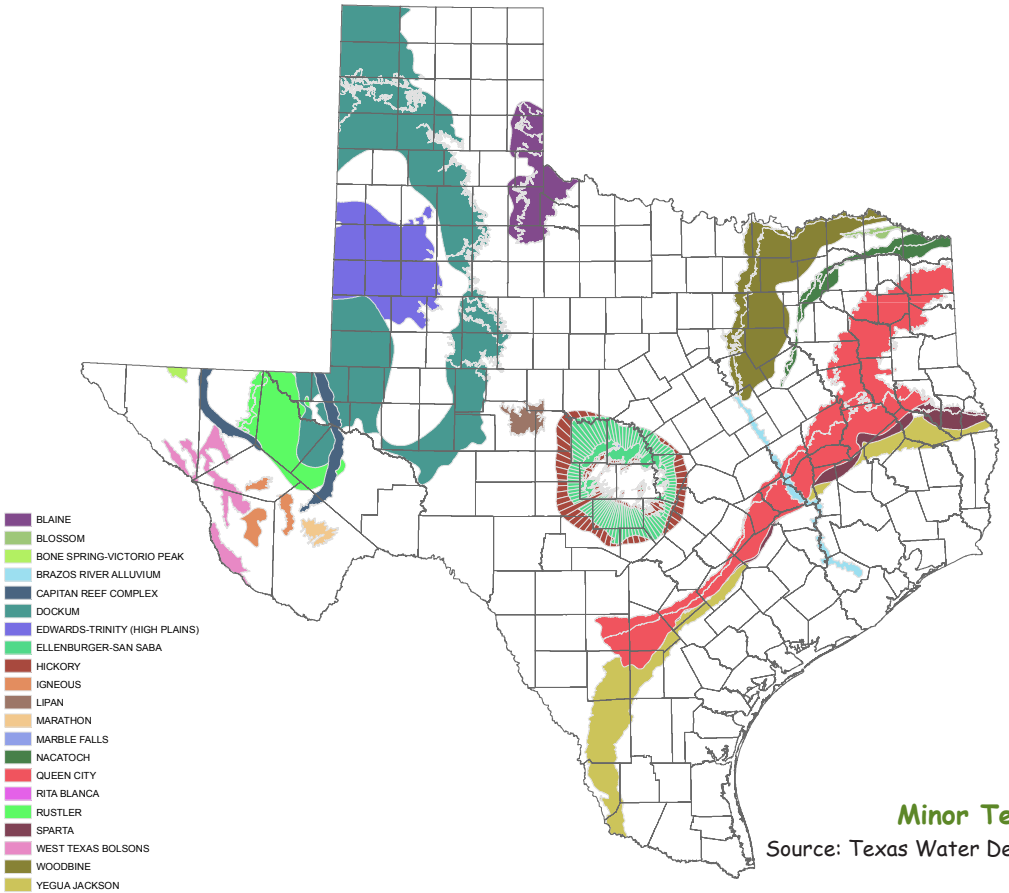


Brune, Gunnar, 1981
Source: "Springs of Texas, Volume 1"



Major Texas Aquifers

Source: Texas Water Development Board



Minor Texas Aquifers

Source: Texas Water Development Board

How your Spring Works

The flow and quality of springs can vary greatly. These properties are often complicated by the surrounding soil and vegetation at the ground surface, as well as by topographic, geologic, and aquifer characteristics. Weather conditions add a further complicating factor.

Springs can occur under **artesian** or **gravity-fed** conditions. Artesian springs happen where impermeable rocks overlie most of the aquifer, and thus confine the aquifer under pressure. A fracture in the confining layer allows the pressurized water in the aquifer to rise to the surface and flow somewhat like a fountain. Gravity springs occur under water-table conditions; that is, the groundwater is under atmospheric pressure. The discharge will rise or fall in response to the volume of the water stored. These springs often emerge from low points in the landscape, for example, from the sides of hills or in valleys.

Some springs have remarkably constant flow (**perennial**). Others fluctuate widely, perhaps flowing only after rains (**ephemeral**) or during a certain season (**seasonal**). Flow from springs can range from tens of thousands of gallons per minute to flow that is barely measurable. An extremely low-flowing spring or a temporary outflow from a hillside resulting from a recent precipitation event is called a **seep**. All types of springs and seeps are important.

One of the distinguishing characteristics of springs is the more/less constant temperature of the water at the spring outlet. Whether hot or cold, water emerging from springs has a relatively consistent temperature because of its groundwater origin. The consistency of the groundwater source of springs provides highly stable ecological systems at the ground surface, despite their vulnerability to external influences. Conductivity, pH, and other water quality parameters are influenced more/less by the stable chemical composition of the issuing aquifer.

Information on basic spring characteristics in Texas can be found in "Springs of Texas," Volume I, by Gunnar Brune, available through the Texas A&M University Press or your local library, and "Major and Historical Springs of Texas," Report 189, Texas Water Development Board, available at www.twdb.state.tx.us or by calling their publication department at (512) 463-8337.

Additional general information about the physiology of springs is available through the USGS website at ga.water.usgs.gov/edu/watercyclesprings.

The Plants and Animals that Live in or near your Spring

Certain plant, macroinvertebrate, and fish species require the stable temperature and water chemistry of spring outlets. Texas wild rice, for example, requires clear, cool, fast-flowing spring water and is only found in the springfed San Marcos River.

Generally speaking, most springs support more common plant and animal species found in aquatic environments. This does not negate the importance of a healthy spring. Many springs are found in the drier areas of the state. As these springs and their downstream flows are often the only perennial source of available water, they help support numerous species of wildlife, such as deer, small mammals, amphibians, reptiles, and birds. Springs support the wildlife that many ranchers depend upon for part of their income. Although your spring may be a seep or only flow seasonally, it ensures a healthier landscape in a sometimes otherwise limited setting. Even in the wetter climate of east Texas, springs provide habitat for less mobile organisms and enhance the natural landscape through species diversity.

You can often find a spring source in a flowing stream by feeling the temperature change in the water.

In their larval stages, the dragonfly and damselfly are two of several macroinvertebrate predators in the spring ecosystem. Their main diet consists of other insects but they are known to consume fish and amphibians.

Animals

While spring inhabitants often include both macroinvertebrates (e.g., aquatic insects, crustaceans, flatworms) and vertebrate species such as fish and amphibians, macroinvertebrates are more common. As primary consumers, they play an important role in the processing of organic matter. They are also important as a food source for vertebrate species: fish, amphibians, and reptiles. Some macroinvertebrates commonly found in Texas spring habitats include damselflies and dragonflies, case-maker caddisflies, riffle beetles, snails, water striders, predaceous diving beetles, crayfish, and flatworms.

Crayfish
(Photo courtesy of Nueces River Authority (NRA))

The fish communities found only in springs and their downstream reaches are generally quite limited. **Endemic species** (known only to a specific area) or **native species** (found only in Texas) that are restricted to spring habitats include the greenthroat darter, the Nueces roundnose minnow, and Devils River minnow. Habitat for these fishes is confined to larger spring runs and spring-fed river segments where the ambient temperature and water quality is very close to that in the spring outlet. These species all require dependable flow.

Damselfly Larva
(Photo courtesy of TPWD)

Fish species commonly found in spring habitats and in other bodies of water include the western mosquitofish, green sunfish, yellow bullhead, Mexican tetra, and the central stoneroller. Sunfish and bass species are generally restricted to larger spring systems with deep-water habitats (i.e., pools and downstream habitats) that contain cover.

Other common vertebrates found in spring habitats are salamanders, frogs, snakes, and turtles. Spring salamanders belonging to the genus Eurycea are one of the more unique and interesting organisms found in Texas springs. Frogs (both tadpoles and adults) are often abundant in Texas springs, especially those devoid of fish. Commonly occurring frogs are leopard frogs and cricket frogs, although other species such as the pickerel frog can be found as well.

The greenthroat darter inhabits Edwards Plateau streams, especially spring-influenced headwaters. (Photo courtesy of TPWD)

Reptiles are fairly well represented in Texas springs, although their presence often goes undetected. These include poisonous snake species, such as the cottonmouth (water moccasin) and copperhead, and non-poisonous snake species, such as the diamondback and blotched water snakes. Water snakes can be abundant in springs that feed perennial pools or tanks and are commonly confused for the water moccasin.

Unlike snakes, turtles are often limited to larger springs that support pool habitats. Common turtle species include sliders, stinkpots, common snapping turtles, and soft shell turtles.

Spring environments may also result in the presence of an unusual, endemic or **relict** (survivors from different prior environmental conditions) species adapted to and dependent upon the thermal and hydrologic stability of the spring.

Native water pennywort with spikerush

Plants

Various types of ferns, sedges, grasses, and other plants can be indicative of a spring even if water is not always visible. Typical spring flora is primarily comprised of perennial species including both native and invasive plants. While water-loving plants growing in and around springs are not usually found in the surrounding landscape, these plants are rarely exclusive to spring water. Species commonly observed include pennywort, water clover, seedbox, spikerush, flatsedge, watercress, mint, arrowhead, cattails, waterwillow, smartweed, and chara.

Native Southern Shield Fern and Maidenhair Fern
(Photo courtesy of TPWD)

Many types of ferns are often found emerging from moist rock fissures adjacent to spring discharge areas, most commonly maidenhair fern and southern shield fern. These two ferns may be found under other moist habitats. Maidenhair fern is often associated with seeps and may be found growing on fractured limestone bluffs and along stream banks.

Not all species observed are natives. Plants often seen around springs include elephant's ear (wild taro) and Eurasian water milfoil. Some non-native species are benign, but others are invasive and outcompete the natives. These invasive species interrupt the natural ecosystem and degrade the health of the whole system.

The floating non-native, invasive water lettuce easily spreads to aquatic habitats.

Non-native taro (elephant ear) invading spring habitat. (Photo courtesy of TPWD)

For assistance and additional information about spring habitats and the plants and animals that depend on them, contact a regional biologist. Contact information can be found at www.tpwd.state.tx.us/landwater/land/private/ or by calling (800) 792-1112.

A list of field guides and online plant and animal identification resources is included at the end of this guide.

A word of caution: if you bring a native aquatic plant from another source of water to your spring, undesirable plant or animal matter may come along for the ride.

The composition of the macroinvertebrate community is commonly used as an assessment tool for water quality in streams and can be quite telling about the overall health of a spring system. A diverse, healthy population of macroinvertebrates means a greater food source supply for larger animal species.

The Biological Health of your Spring

Springs are the "canaries in the coal mine." Changes in spring flora and fauna can indicate compromised groundwater quality. While spring flow volumes can fluctuate naturally, viewed over time, alterations in springflow patterns are reflective of general aquifer health and local and regional water table changes.

Adult Damselfly
(Photo courtesy of TPWD)

Aquatic organisms can act as natural monitors of water quality, responding to a combination of stressors to which they are subjected. By responding to their total environment, organisms often provide a better-integrated assessment of environmental conditions than do chemical or physical measurements. In degraded aquatic ecosystems, the diversity of organisms is decreased and there are typically fewer kinds of organisms, with more sensitive species disappearing altogether. The aquatic organisms present at a particular spring can offer insight into the health and quality of that spring.

As stated earlier, the diversity and abundance of organisms present at a spring is greatly affected by the flow, temperature, and the amount and type of habitat available. The constant flow and temperature of many springs allows colonization by certain species that are unable to maintain populations in streams with highly variable discharge.

For a description of biological indicators of watershed health, the importance of aquatic diversity, and photographs, visit www.epa.gov/bioiweb1.

The Historical Significance of your Spring

Your spring, whether large or just a trickle, probably played a role in the early habitation of Texas. Many spring owners report finding artifacts near their springs, and archaeologists generally surmise that the earliest Texans drank from, camped at, or lived by most Texas springs.

Springs all over the state were important sources of water for Native Americans, as well as the guideposts for many of their trails. These same springs determined many early European explorer routes. In the 18th and 19th centuries, locations of transportation routes, including supply and stage coach lines, and military outposts and ranches were largely determined by the presence of the dependable water supply provided by springs. They also provided watering holes for later cattle drives.

Utilized first by prehistoric peoples, Spanish explorers reportedly camped at Grierson Springs in 1684. These were the first consideration in the siting of a Fort Concho outpost in 1878. Grierson Springs, Reagan County

The importance of springs to Native Indians is exemplified by the Davis Hackberry Spring in Sterling County. This small oasis in an otherwise dry setting of mesquite, prickly pear, yucca, and grasses contains artifacts from the Late Archaic period (ca. 1000-300 B.C.), the Late Prehistoric period (ca. A.D. 700-1600), and the Historic period (after A.D. 1600). The spring was probably used as a seasonal bison-hunting camp, as evidenced by the numerous artifacts, and perhaps as a trading center for several nomadic tribes.

Cattle herds gathered at a spring site in Gonzales County to begin the Texas to Kansas Chisholm Trail ride.

In the 1800s, Rock Spring in Karnes County provided water for soldiers and travelers along the San Patricio Trail. Gravel pits dug for construction of IH 37 and other roadways stopped the flow of this historic spring.

In the 1800s, the large spring-fed cistern in the background provided water to a steam locomotive hauling granite to the State Capitol. Llano County

Early European settlements were often centered around spring waters (Big Spring, Dripping Springs, Carrizo Springs, Richland Springs, Hughes Springs, Sulphur Springs, etc.). Many health spas flourished around springs in the 1800s. Historically, homes were often built near a spring; sometimes the ruins of old homes, barns, and equipment offer poignant evidence of a former way of life. As springs failed, communities and homesteads were often abandoned.

Your local county historical commission (ask your county clerk for members' names) and/or your county museum may be useful for historical information. Gunnar Brune's book, 'Springs of Texas,' Volume I, also contains historical information about the springs he visited. This is available through Texas A&M University Press or your local library.

CARING FOR YOUR SPRING

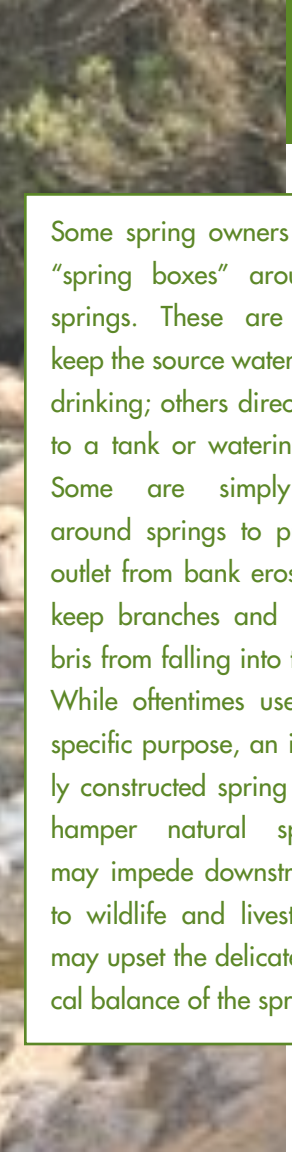
Your spring is an essential part of the larger natural system. As a spring owner, your role as steward is invaluable to the overall health of the hydrology and ecology of Texas' diverse landscape. Successful caring for a spring need not be extensive or expensive but careful planning is essential. We offer brief suggestions on how to care for your spring. We encourage you to seek expert advice, when necessary, to acquire more comprehensive information on your area's surrounding environmental systems and on specific spring management techniques.

You have probably observed your spring over time and already have some idea of its overall health and/or flow patterns. Does it require maintenance or is it just responding to natural conditions such as a dry weather pattern and resultant lowered aquifer conditions?

To maintain your spring

In terms of spring maintenance, we suggest that "if it ain't broke, don't fix it." Unfortunately, many springs do need our help as their natural systems have been hampered by improper range management, and urban, agricultural, and industrial development. Erosion may be causing excessive siltation of the spring. Outlets might be clogged with branches, leaves, or other matter.

The overall rule of thumb for spring maintenance is that overzealous actions may interrupt the natural micro-ecosystem that serves the larger ecological balance. Caution is the best action. Observe your spring, its plants, and its animals over time before performing any maintenance. If maintenance is needed, proceed with care, as your spring, its structure, and its habitat are very fragile. Be mindful that any alteration of rock or soil around the spring could interfere with flow and that the use of shovels and mechanical equipment could destroy a spring.



Some spring owners construct "spring boxes" around their springs. These are used to keep the source water clean for drinking; others direct the flow to a tank or watering trough. Some are simply placed around springs to protect the outlet from bank erosion or to keep branches and other debris from falling into the outlet. While oftentimes useful for a specific purpose, an improperly constructed spring box may hamper natural springflow, may impede downstream flow to wildlife and livestock, and may upset the delicate ecological balance of the spring.

If you are considering basic maintenance, please keep in mind these points:

- If the outlet is restricted, note if the vegetative matter contains any small snails, worms, or aquatic species, and then remove obstructions carefully. Replace inhabited matter back directly where it was found. Place uninhabited plant matter back into the stream or pool away from the outlet so that it may become food or cover. (Recently fallen branches are not usually considered habitat).

- If erosive and unstable soils are around the spring outlet, please consult a specialist before undertaking stabilization or planting activities. The improper use of fill and stabilizing techniques may damage the spring outlet. The planting of appropriate native vegetation will help to stabilize soils, promote clean flow, and enhance bio-diversity.

The dilemma of cedar, mesquite, and exotic plant removal

Much has been said about the negative impacts of Ashe juniper (cedar) and mesquite on springflows, and the impacts of salt cedar on flow and quality of streams in the west. Juniper, mesquite, and salt cedar are important habitat and food sources for several species of wildlife in times of drought. This guide is not intended to address wide -scale brush removal; we only suggest that you consider every spring independently.

Within your spring's immediate vicinity, exotic or non-native plant species such as elephant ear (taro), water hyacinth, or water lettuce could diminish the overall health of your spring system. Nonetheless, without other vegetation, these species stabilize banks and provide some cover for wildlife. Please do not arbitrarily remove these species or other nearby non-endemic or exotic shrubs/trees without speaking to knowledgeable persons/land stewards in your area.

For information regarding technical assistance with spring maintenance activities, contact the Springs of Texas Project at (512) 327-6915 or springsoftexas@sbcglobal.net.

To protect your spring

While you may seemingly have little control over the source of your spring, you can take certain measures to protect your spring outlet and its surroundings. The primary protection is to control or prevent livestock - and destructive wildlife such as feral hogs - access to the spring outlet.

Livestock, just by their numbers and size, often negatively impact springflow, quality, and overall spring habitat. Livestock and wildlife, like humans, prefer fresh sources of drinking water and often will go straight to the spring outlet in an otherwise large pond or flowing stream. They trample down or eat the spring vegetation, they clog the outlet or break down the soils/rock, and they degrade the water with excrement.

Some owners rotate livestock through pastures with springs but this is not really protecting the spring outlet and downstream habitat. A preferable alternative would be to place a wildlife-friendly fence around the fragile spring source and give your livestock access to water further downstream or adjacent to the spring source. If your spring fills a pond or stock tank, consider fencing part of the tank area where the spring flows into the containment. Be careful to avoid any alteration of the slope or surrounding vegetation.

Cows drinking cool, clean water directly from spring outlet
(Photo courtesy of TPWD)

Make sure that toxic elements (fertilizers, pesticides, etc.) are not kept or used upslope of your spring. Likewise, try to keep livestock holding pens away from spring outlets or where surface water runoff could introduce contamination. These and other simple management techniques could have substantial impacts on a spring's overall health.

If your spring is used for recreation, remember that human footsteps crush vegetation and paths promote erosion. Thoughtful management techniques can have substantial impacts on a spring's health:

- Locate the recreation area, and any roadways or trails, away from the springhead.
- Clear vegetation sparingly to avoid erosion and to minimize habitat destruction.
- Stay as natural as possible.

The following agents may also be able to provide assistance with spring protection efforts: your local Soil and Water Conservation District (www.tsswcb.state.tx.us) at (254) 773-2250, local county extension agent (county-tx.tamu.edu) at (979) 845-7808, or the local Natural Resource Conservation Service center (www.tx.nrcs.usda.gov/) at (254) 742-9819. Small grants may be available through the National Fish and Wildlife Foundation (www.nfwf.org).

Protection around spring outlet
with downstream watering trough for livestock
Gillespie County (Photo courtesy of TPWD)

To monitor your spring

Monitoring your spring is important for your own knowledge and for the health of the local ecosystem. On a broader scale, the information could be used to show the significance of your spring as part of the regional hydrology, and perhaps be incorporated into future water planning/protection efforts. You can conduct basic water quality tests such as temperature, pH, clarity, and conductivity with inexpensive equipment. Water flow can sometimes be measured with a bucket and a stop watch. An aquatic biota assessment can be used to establish a background of expected conditions applied to your spring. With continued observation, this then becomes the standard for discerning the relative health of your spring.

Measuring springflow with a bucket and stopwatch

- Decide what you want or are willing to monitor, and then make a monitoring plan. Your monitoring plan could include biota, flow, and quality measurements, as well as noting conditions that could affect your springflow: i.e., plant growth and dormant seasons, area brush removal activities, and extreme weather conditions,

- Monitor your spring on a regular basis. Take photographs.

- Be consistent with sampling protocols and locations for meaningful tracking.

Your local river authority or groundwater conservation district should be able to help you develop a monitoring plan and provide advice on conducting water quality and flow measurements. Contact information for Texas River Authorities is available through the Texas Clean Rivers program at www.tceq.state.tx.us or by calling (521) 239-1000.

Find contact information for your local or neighboring groundwater district at www.twdb.state.tx.us or by calling (512) 463-7847. Your regional Master Naturalist program may also be able to provide you with advice and on-site assistance at masternaturalist.tamu.edu. Click on "Find a Chapter." A monitoring checklist is available from the Springs of Texas Project (springsoftexas@sbcglobal.net or (512) 327-6915).

To keep your spring flowing

Protecting the quality of your spring's water and its flow from activities outside of your control can seem like a difficult task, yet there are a number of things you can do. First and foremost, become an advocate for your spring.

- Work with your neighbors whose activities can help or hamper your spring. Agree on adhering to land management/use practices that will not contaminate or otherwise obstruct springflows.
- Work with your local groundwater conservation district to implement rules to protect aquifer water levels and springflows.
- Encourage local and state entities to actively promote education on the importance, care, and protection of springs.

You can find contact information for your local or neighboring groundwater district at www.twdb.state.tx.us or by calling (512) 463-7847.

To find your spring's history

Springs often played a major role in the lives of early Native Americans, as well as Spanish explorers and the first European settlers. Your spring might have its own story, including when and how it acquired its name.

You might have a personal story associated with your spring. The story need not be exciting or relevant to Texas history but could be interesting or fun for you and your family. One such story involves a family whose spring was the source of their drinking water. The story goes that one of the sons often went to the spring for a drink in the middle of the night. One dark night he accidentally swallowed a minnow, much to his brother's delight.

You, your children, or child's class could conduct interviews of long-time local residents, family, and former owners to develop a written, video, or oral history of your spring. Be sure to collect old photographs and take new ones.

Archival information on your spring and its history may be available at your county museum, local library, or from your County Historical Commission. Gunnar Brune's book, "Springs of Texas, Volume I," contains historical information about the springs he visited. This is available through Texas A&M University Press or your local library.

For documenting history yourself, the Texas Historical Commission has guidelines on how to collect oral histories. Call (512) 463-6100 and ask for "Fundamentals of Oral History, Texas Preservation Guidelines."

During the latter years of the 19th century in Gillespie County, a woman went to the family's spring to collect drinking water. While she was there, a band of Indians surrounded the cabin but did not disturb anything. Anxious, the woman crawled into the spring cave and stayed there until nightfall when she could safely return home, very wet and very cold.

To use your spring for education

Your spring might be a multi-faceted outdoor classroom project. Some spring owners offer their springs to local middle or high school science/social studies classes. Perhaps a class would adopt your spring to monitor for you.

Possible independent student and class projects include:

- Researching written and oral history
- Measuring water quality and water flow
- Identifying the spring's flora and fauna
- Learning about springs and their roles in the natural and human communities
- Studying the importance of abundant and clean water resources to the community, and how they might be changing
- Researching the inter-relationship between surface water and groundwater
- Correlating the relationships among biodiversity and ecosystems, springs and stream systems, and aquifers and geology

All these activities help children gain a greater appreciation of the natural world. Whatever you study, remember that a class of students can trample and destroy spring habitat almost as effectively as livestock; please plan accordingly.

Your school, local nature center (see list at end of this guide), or local or neighboring groundwater conservation district can help you with this activity. The Texas Master Naturalist program, sponsored by Texas Parks and Wildlife Department and the Texas Cooperative Extension has corps of well-informed volunteers who provide education and outreach, and who are dedicated to the beneficial management of natural resources within their communities. Contact your regional program at masternaturalist.tamu.edu.

ADDITIONAL RESOURCES

For additional advice on where and how to begin, contact the Springs of Texas Project or the Texas Rivers System Institute at Texas State University.

Springs of Texas Project
2525 Wallingwood, Suite 705 P
Austin, Texas 78746
(512) 327-6915
springsoftexas@sbcglobal.net

River Systems Institute
Texas State University
(512) 245-9200
MA01@txstate.edu

Field Guides

These are general guides, mostly specific to Texas. No guides are available just for springs and spring habitats.

A Field Guide to Freshwater Fishes of Texas by Chad Thomas, Timothy H. Bonner, and Bobby G. Whiteside, published in 2007, is available through Texas A&M University Press, www.tamu.edu/upress, (800) 826-8911.

Amphibians and Reptiles of Texas by J.R. Dixon, published in 2000, is available through Texas A&M University Press, www.tamu.edu/upress, (800) 826-8911.

Dragonflies and Damselflies of Texas and the South-Central United States: Texas, Louisiana, Arkansas, Oklahoma, and New Mexico by John C. Abbott, published in 2005 by Princeton University Press. This guide may be ordered through odonatacentral.bfl.utexas.edu.

A Field Guide to Common Texas Insects by Bastiaan M. Drees, Ph.D. and John A. Jackman, PhD, published in 1998, is available from Gulf Publishing Company.

Aquatic Vegetation Identification Cards, publication number B-6095, are available through the Texas A&M Extension Bookstore at tcebookstore.org, or call (979) 845-6573. Cards include both native and non-native aquatic plants.

On-Line Guides, Photographs, and General Information

For photographs of various macroinvertebrates: www.odonatacentral.com and www.mayflycentral.com.

For photographs and descriptions of common Texas insects including aquatic species: insects.tamu.edu/fieldguide/#odonata.

For photos, range maps and voice recordings for nearly all of the frogs and toads in Texas, as well as information on other amphibians and reptiles: www.zo.utexas.edu/research/txherps.

Texas Nature Centers are available to assist you

Armand Bayou Nature Center
8500 Bay Area Blvd.
Pasadena, Texas
(866) 417-3818 toll free
(281) 474-2551 x 14
abnc@abnc.org
www.abnc.org

Austin Nature and Science Center
301 Nature Center Drive
Austin, Texas 78746
(512) 327-8181
www.ci.austin.tx.us/ansc

Chihuahuan Desert Research Institute
PO Box 905
Fort Davis, Texas 79734
(432) 364-2499
www.cdri.org

Cibolo Nature Center
140 City Park Road
Boerne, Texas 78006
(830) 249-4616
www.cibolo.org

Ft. Worth Nature Center and Refuge
9601 Fossil Ridge Rd
Fort Worth, TX 76135
(817) 237-1111
www.fwnaturecenter.org

Hana and Arthur Ginzbarg Nature Discovery Center
7112 Newcastle
Bellaire, Texas 77401
(713) 667-6550
mail@naturediscoverycenter.org
www.naturediscoverycenter.org

Houston Arboretum and Nature Center
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arbor@airmail.net

San Marcos Nature Center
430 Riverside Drive
Mail: 630 E. Hopkins
San Marcos, Texas 78666
(512) 393-8448
www.smgreenbelt.org

Sibley Nature Center
1307 E. Wadley
Midland, Texas 79705
(432) 684-6827
www.sibleynaturecenter.org

Valley Nature Center
301 South Border Ave.
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Weslaco, Texas 78599-8125
(956) 969-2475
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info@valleynaturecenter.org

Wildcat Bluff Nature Center
2301 N. Soncy Road
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Amarillo, Texas 79159
(806) 352-6007

Please provide us with feedback on this guide, and tell us your success stories, challenges and thoughts. Also, please get in touch with us if you would like to share information about your spring. Send comments to:

Springs of Texas Project
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Karst spring. Kerr County

A Special Thanks

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Springs of Texas is a nonprofit organization dedicated to the education of both the public and private sector on the importance and fragility of our water resources. Our current Springs of Texas Project is to complete the classic work begun by the late Gunnar Brune. His "Springs of Texas, Volume I," documents the geology, hydrology, ecology, history, and archaeology of springs in 183 of Texas' 254 counties. The Springs of Texas Project will complete his work in the remaining 71 counties.

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