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# TEXAS

PARKS & WILDLIFE

The OUTDOOR MAGAZINE of TEXAS

# EVERY DROP COUNTS

THE STATE OF WATER: A DECADE LATER

## GULF

LARRY MCKINNEY

## SPRINGS

JOE NICK PATOSKI

## RIVERS

ANDREW SANSOM

## LAKES

LARRY D. HODGE

## WETLANDS

WENDEE HOLT CAMP

## BAYS

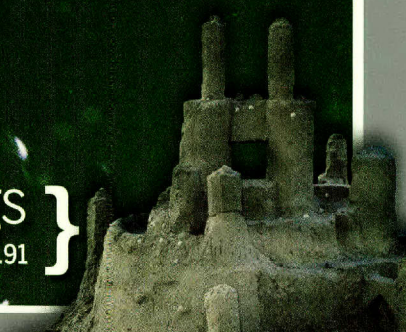
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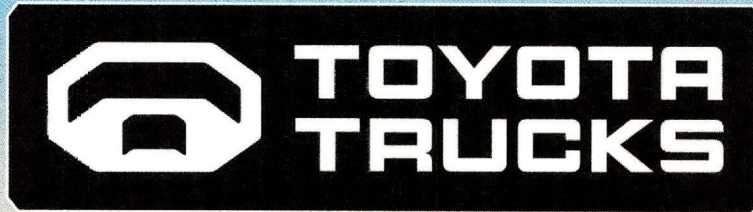
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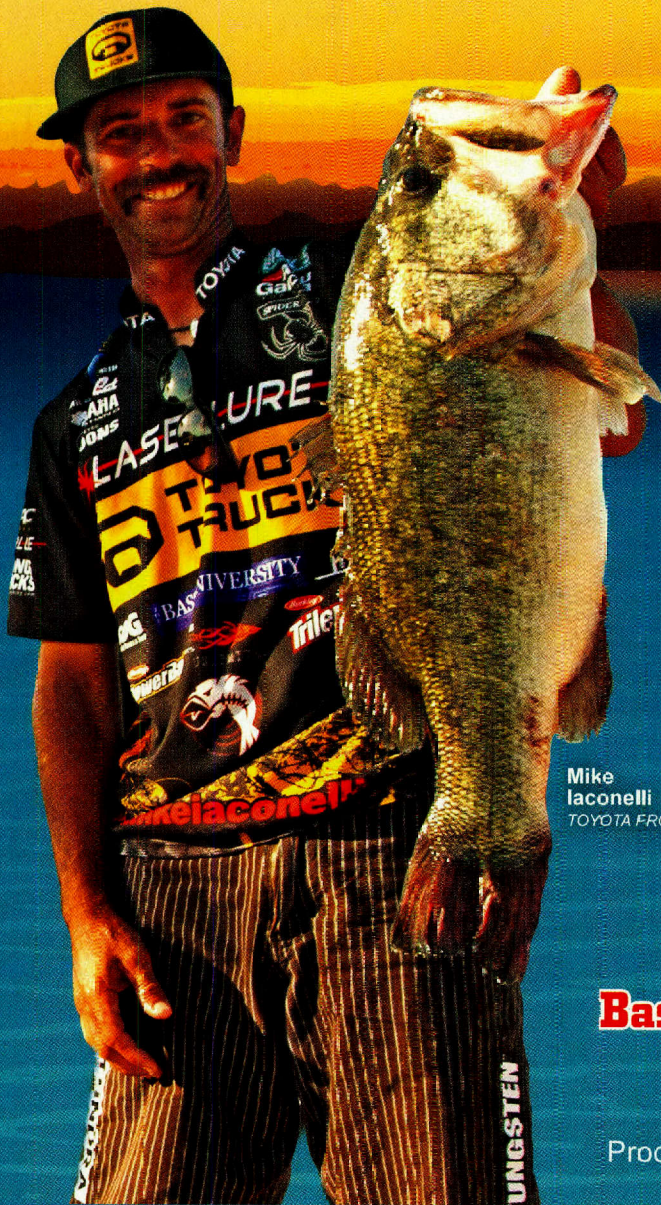




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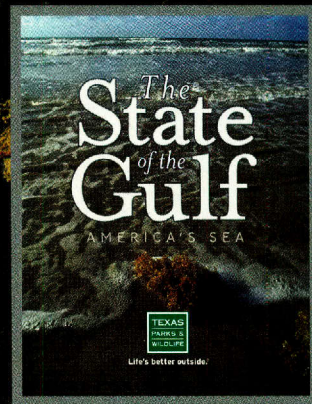
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The state of Texas water is complicated, with challenges around every bend.



### The State of Water

Visit [www.texasstateofwater.org](http://www.texasstateofwater.org) to watch 2011's *The State of the Gulf: America's Sea*, the latest in the series of TPWD documentaries on water, and to watch the TPWD-sponsored water symposium held in January. On the website you'll also find other parts of our decade-long water initiative, including videos and magazine articles, plus links to other water resources.

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THIS PAGE: A foggy morning at the Rockport-Fulton harbor. Photo © Larry Ditto

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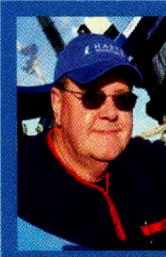
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# In the Field

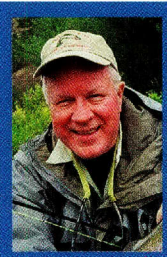
## LARRY MCKINNEY

is the executive director of the Harte Research Institute for Gulf of Mexico Studies, where he leads an interdisciplinary team that integrates science, policy and socio-economic expertise to help assure an economically and environmentally sustainable Gulf. Before that, he directed environmental and marine fisheries programs at the Texas Parks and Wildlife Department. He wrote the lead article in the first seven water issues.



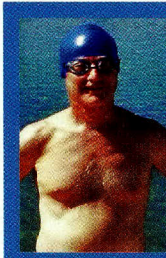
## ANDREW SANSOM

serves as executive director of the River Systems Institute and is a professor of geography at Texas State University. He is a former executive director of the Texas Parks and Wildlife Department and former executive director of the Nature Conservancy of Texas, and he is founder of the Parks and Wildlife Foundation of Texas. He is the author of four books, including *Water in Texas*, and his fifth book is due to be published in the fall.



## JOE NICK PATOSKI

has been an avid swimmer, paddler and student of Texas springs since his first dip in the chilly waters of Burger's Lake in Fort Worth as a child. He is the author of biographies on Willie Nelson, Selena and Stevie Ray Vaughan, and his latest book is *Generations on the Land: A Conservation Legacy*. He lives and plays near the Blanco River outside the Hill Country village of Wimberley.



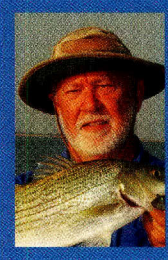
## CAROL FLAKE CHAPMAN

grew up on the Texas Gulf Coast, never far from a bay. She has traveled around the world to write about outdoor adventure and the natural world for magazines and newspapers, but her greatest satisfaction comes from writing about places in Texas that touch the soul. Those places usually involve water. She edits a newsletter on the subject of fresh water for the River Systems Institute.



## WENDEE HOLT CAMP

has written for every TP&W water issue since 2004 on topics such as constructed wetlands, river creatures and freshwater springs conservation. She has won three International Regional Magazine Association awards for her work in the magazine, most recently for her feature on the Gulf "dead zone" in the 2008 water issue. Wendee writes primarily about science, the environment and outdoor travel for magazines such as *Scientific American*, *National Wildlife*, *Nature* and *Miller-McCune*.



## LARRY D. HODGE

grew up on a Central Texas farm during the drought of the 1950s, and his appreciation for water is rooted in childhood experiences of carrying water from a barrel into the house for use, and scanning the sky for rain clouds as crops withered. A member of the Texas Outdoor Writers Association and the Outdoor Writers Association of America, Larry regards changing people's attitudes toward water as one of the biggest challenges facing Texas today.

# MAIL CALL

PICKS, PANS AND PROBES FROM OUR READERS

## LETTERS

### IN SUPPORT OF OUR OFFICERS

I recently read the letter from Barry Wood of Willis ("Missing the Mission," May 2011) and the response written by Lt. Col. Craig Hunter of TPWD's law enforcement field operations.

The case featured in your April edition ("Buried Evidence") was close to home. I live three miles from Lampasas, where the three victims of the accident lived.

If Mr. Wood is considering canceling his subscription based on his dislike of one story, he must think that each article must interest him or else the editor has "missed the mission." When I read the article, the first thing that came to mind was that it might encourage people who have knowledge of crimes to come forward and ease the pain of crime victims.

If Mr. Wood enjoys being outdoors as much as he does reading about it, I hope he finds his time outdoors safer because of officers like Jim Lindeman. As I watched the news coverage of the boat being uncovered, and the emotions of officer Lindeman, I can tell you that he has not "missed the mission" that he swore to as a law enforcement officer of the State of Texas.

In anticipation that Mr. Wood is canceling his subscription, please find enclosed my personal check for a one-year subscription to the magazine, to be presented to a person or organization selected by officer Lindeman.

Please thank officer Lindeman for his dedication to duty and Lt. Col. Hunter for standing up for the officers who risk their lives safeguarding our precious wildlife resources and the citizens who enjoy them.

JIMMY SUNVISON  
Lampasas

**TP&W MAGAZINE RESPONDS:** Lt. Col. Craig Hunter reports that he has received many calls, letters and emails from across the state supporting the work that game wardens do and specifically their work on the Lake Buchanan case.

### WHEN WERE THE BIGHORNS GONE?

I hate to spoil the statistics on when the desert bighorns disappeared from West Texas ("Regal Return," April 2011), but during the mule deer season right after Thanksgiving in 1964, my partner and I saw a bighorn with a three-fourths curl on three different occasions while hunting. He had been injured or previously shot, because one of his forelegs was crippled. His horns were not quite as long as the picture on the back cover of your April issue, but we watched him through binoculars, and I have no doubt on the identification.

P.J. MOCK JR.  
La Porte

**TPWD'S DESERT BIGHORN SHEEP PROGRAM LEADER FROYLÁN HERNÁNDEZ RESPONDS:** Regarding bighorn extirpation dates, the last documented native Texas desert bighorn sighting occurred in October 1958 on the Sierra Diablo Wildlife Management Area. However, some literature, including "A Historical Review of Reports, Field Notes, and Correspondence on the Desert Bighorn Sheep in Texas," notes that the "last native Texas bighorns were gone by the early 1960s." It is possible that there were a few bighorns left in 1964. However, we consider 1958 the last documented sighting.

### NATURAL OR NOT?

You have stated that Caddo is the only natural lake in Texas ("The Best of Texas, Naturally," March 2011). Why would Eagle Lake not be considered natural?

RICK MILLINOR  
Wimberley

**TP&W MAGAZINE RESPONDS:** Eagle Lake, in Southeast Texas, was indeed a natural lake until about 1900 when an earthen dam was constructed and water diverted from the Colorado River to enlarge the lake. Caddo Lake, also a natural lake, has likewise been modified by a dam. Many other natural lakes exist in Texas, such as East Texas oxbow lakes and Panhandle playas. Caddo Lake is the only natural lake of significant size in Texas.

### CONCERNS ABOUT RIFLE AD

I have been a subscriber for several years and truly enjoy your magazine. You address all ages and especially children, which is great. But when I turned to Page 16 of the June issue I just about dropped my teeth! You have an ad by LaRue Tactical showing a weapon that looks like something used in the military. Do people actually hunt wild animals with these? Is this something you want the children you're trying to teach about wildlife in Texas to see? I was thinking about getting a subscription for my 8-year-old grandson but not if you continue to have this type of ad in your magazine. I was shocked, appalled and disappointed. I know times are hard, but did you really need to resort to this type of advertisement?

PENNY LAIRD  
Houston

**TP&W MAGAZINE RESPONDS:** We realize that the firearm in the ad does not look like a conventional hunting rifle, and we appreciate your perspective. We carefully considered many issues in accepting the ad. Our Law Enforcement Division signed off on the ad, saying it shows a legal firearm. Our agency leadership also approved it with the idea that it is not our agency's place to dictate what type of firearm a person should use, as long as it is legal. And, we believe this company has the right to advertise a legal product. The firearm, while appearing to be a military-style weapon, is used in recreational settings such as target shooting and some types of hunting.

### Sound off for "Mail Call"!

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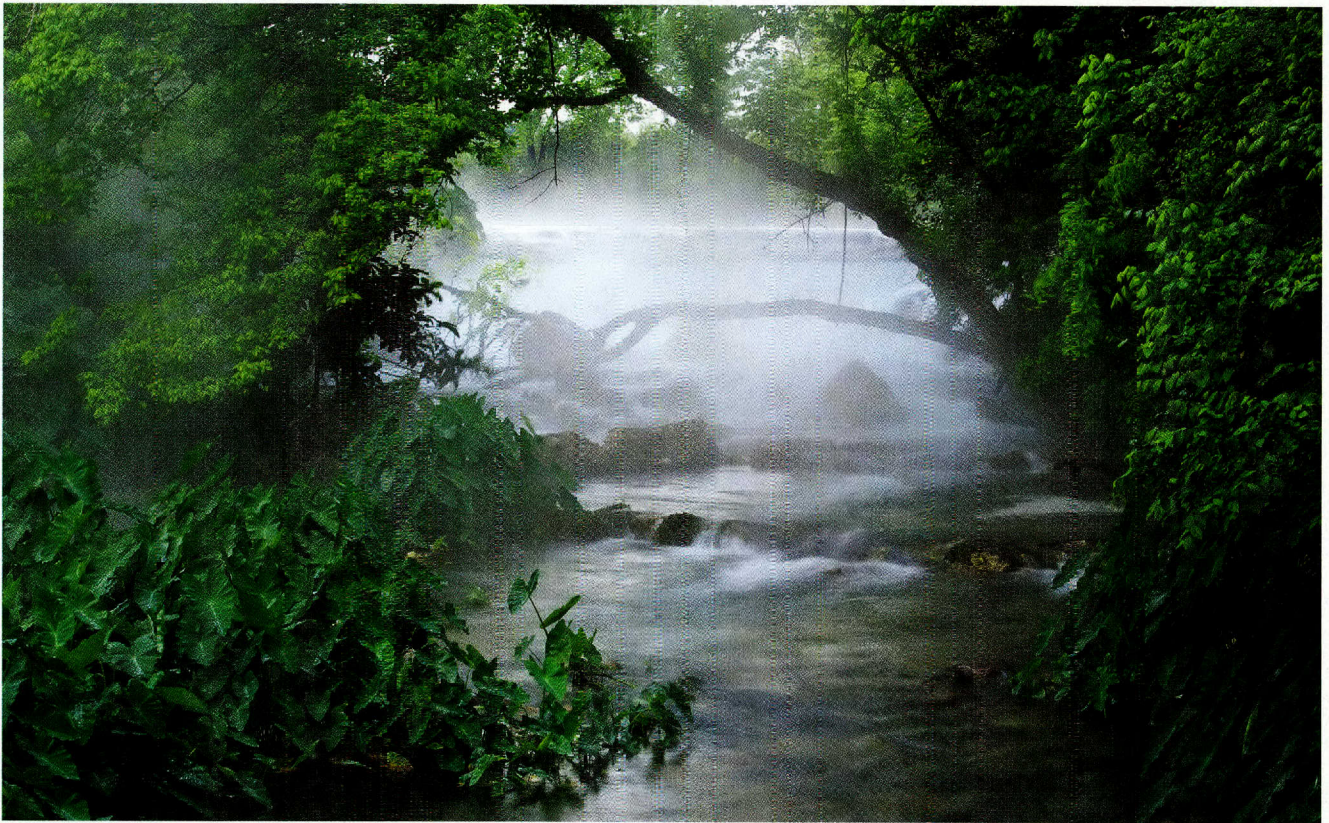
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# SCOUT

NEWS AND VIEWS IN THE TEXAS OUTDOORS

## SAVING THE SPRINGS

*After decades-long battles, stakeholders have created the Edwards Aquifer Recovery Implementation Program.*



**Water.** For centuries, Texans have searched for, used, wasted, stored, manipulated and fought over it. It seems unlikely, then, that 26 disparate groups could agree on anything having to do with this precious resource, much less come up with a way to preserve two iconic springs. Yet it might actually happen.

Seven major and dozens of smaller outflows along a cliff in New Braunfels form Comal Springs, source of the 2-mile-long eponymous river and home to endangered riffle and dryopid beetles. San Marcos Springs includes more than 200 outflows into Spring Lake, centerpiece of Texas State University's Aquarena Center and a world-class biodiversity site. The springs and the San Marcos River are designated critical habitat for endangered Texas blind salamanders, San Marcos gambusias, fountain darters and Texas wild rice.

Both of these springs flow from the Edwards Aquifer, a vast

reservoir within the nooks and crannies of underground rock stretching nearly 200 miles along the Balcones Fault from Brackettville to Austin. The main source of water for San Antonio, this aquifer also supplies between 30 and 70 percent of the water in the Guacalupe River, which feeds San Antonio Bay home of the whooping crane and many a fisherman's honey hole. In fact, an enormous swath of Texas depends on the health of the Edwards Aquifer and its springs. If water represents a thorny issue, this aquifer is a veritable bramble patch.

Without going into the long and complex history, things came to a head in 1991, when increasing demand threatened to leave the springs literally high and dry. The Endangered Species Act provided the basis for a lawsuit seeking minimum flows to protect denizens of the springs, and, therefore, the springs themselves.

When the lawsuit failed to resolve all the issues, says Cindy

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The San Marcos River, opposite, and the Texas blind salamander, above, could benefit from the aquifer recovery plan.

Loeffler, TPWD water resources branch chief, the U.S. Fish and Wildlife Service initiated the Edwards Aquifer Recovery Implementation Program. The Legislature subsequently specified stakeholders, including San Antonio, other area municipalities, state agencies, environmentalists, farmers, businesses and outdoor enthusiasts. Stakeholders had until 2012 to develop and have approved a Habitat Conservation Plan.

While many hurdles remain, the group has, according to Robert Gulley, Edwards Aquifer Recovery Implementation Program manager, produced a plan that it believes will meet all the requirements. And it did it by consensus.

“We have between 60 and 90 people at meetings, and openness is the hallmark of what we’ve done,” Gulley says. “There is a huge difference between the way individuals interact with each other now versus when we started. When we reach an impasse, someone always steps back and says, ‘Let’s look at it from a different perspective.’”

The plan includes two basic approaches — restoration and mitigation measures to enhance viability of the endangered species, and flow protection measures to ensure the survival of both springs. The latter include voluntary irrigation suspension in certain drought conditions, water conservation incentives and assistance for smaller municipalities, emergency pumping reductions and an innovative aquifer storage and recovery unit that will store water San Antonio doesn’t need in wet periods for use in dry periods.

Loeffler says that the recovery plan represents phased, adaptive management. “There are still many unknowns, primarily because we don’t know how severe future droughts will be or how bad the ecosystem impacts will be. To help address this uncertainty, we have adopted an incremental, phased approach that allows us to adjust if we need to,” she says.

Three TPWD staff members serve on the program’s science subcommittee: Jackie Poole, Wildlife Division; Doyle Mosier, Inland Fisheries; and Norman

Boyd, Coastal Fisheries. Loeffler, with assistance from TPWD water attorney Colette Barron-Bradsby, represents TPWD on the steering committee.

Tough issues remain, including funding — to the tune of some \$30 million per year — and federal approval of the 300-page plan. Should the funding issue fail to be resolved, a federal judge or the Legislature could end up calling the shots, Gulley says.

“Our way has stakeholder buy-in,” he says. “And when you take this many stakeholders who couldn’t get along and they find a way to get along and come up with a good plan, then we ought to find a way to pay for it.”

Loeffler adds: “We’ve made a lot of progress. I hope we can take this collaborative model and apply it to other natural resource conservation efforts.”

No matter what the plan’s ultimate fate, its participants have shown that, sometimes, Texans can cooperate over water. ★

—Melissa Gaskill

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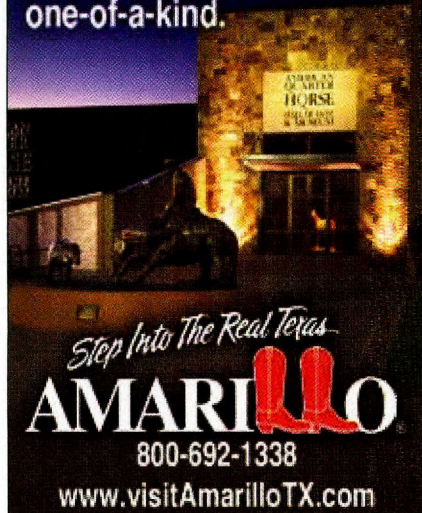
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# Stocking the South Llano

River gets Guadalupe bass, sees new watershed protection effort.

**The Texas Parks and Wildlife** Department completed the first stocking of Guadalupe bass in the South Llano River in May, marking a new chapter in a decades-long effort to save the state fish of Texas. The release is part of a prototype effort of a new watershed-scale approach to water resource conservation in Texas.

Since 1992, TPWD has been stocking Guadalupe bass in the Guadalupe River system, trying to restore a balance that was upset when native Guadalupe bass started interbreeding with imported smallmouth bass. Interbreeding creates a hybridization problem by causing native fish to lose their genetic identity. In the South Llano, biologists have a chance to make a big difference.

"When we started in the Guadalupe River system almost 20 years ago, Guadalupe bass hybridization there was already at 30 percent and worsening," says Gary Garrett, TPWD Inland Fisheries biologist and a leader of the



TPWD released Guadalupe bass fingerlings into the South Llano River in May.

agency's new watershed program. "But in the South Llano, samples show only 3 percent hybridization. We're starting this one early, and that's why we have such a great chance to nip the problem in the bud."

Four fish releases were performed, with about 175,000 Guadalupe bass fingerlings released into the South Llano River this year.

The restoration effort is broader than just the bass releases. Led by TPWD, a diverse coalition is also planning to fight erosion and protect river water quality through tactics like improving riverbank stabilization, planting native plants, creating log complexes and building boulder installations. An important goal is to remodel poorly designed road crossings that alter the riverscape and are often barriers to fish passage.

The restoration coalition will empower landowners by assembling and communicating best management practices showcasing river protection tactics. The TPWD Landowner Incentive Program is offering grants to landowners to manage not only the river corridor but also uplands that drain into the river and affect water quality. A key partner is the South Llano Watershed Alliance, composed of riverside landowners and other stakeholders.

TPWD is even working with locals and applying for grants to create a new Texas paddling trail for kayakers and canoeists along the South Llano.

To help pay for these South Llano River projects, TPWD has assembled close to \$1.4 million in funding. ★

— Tom Harvey

## SIGHTS & SOUNDS

### TEXAS PARKS & WILDLIFE TV AND RADIO



#### TELEVISION

LOOK FOR THESE STORIES IN THE COMING WEEKS:

**June 26–July 3:** Bald eagles back in Texas; hunting dogs; biking Cleburne State Park; Mott Creek Ranch nature tourism; Palo Duro Canyon.

**July 3–10:** The frog listeners; managing habitat with fire; Lake Bob Sandlin State Park; bait and lure basics; deep-woods Atlanta.

**July 10–17:** Carp fishing catches on; Bonham State Park; prescribed burns on the Edwards Plateau;

birding basics; Neches River scenics.

**July 17–24:** Habitat help for lesser prairie-chickens; living in a state park; Lake Arrowhead State Park; timbers and turkeys at Ewing Mound; Lake Brownwood moenrise.

**July 24–31:** Panhandle wildlife recovery; trapping and tracking pintails; Palo Duro Canyon State Park; sar chills wildlife on Running R Ranch; South Texas butterflies.



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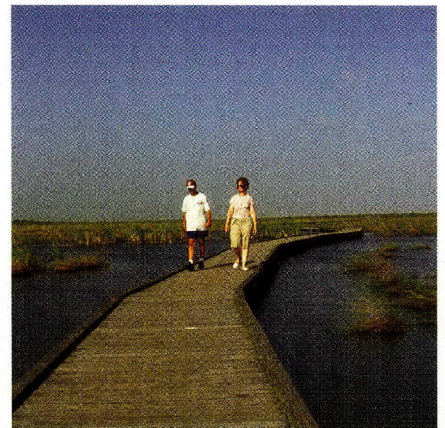
# Sea Rim Returns

*Coastal park finds new life after hurricane devastation.*

Last February, Texas master naturalists hosted a beach cleanup at Sea Rim State Park. But they didn't stop there. Since March, members of the Sabine–Neches chapter have worked to rebuild more than a mile of beach dunes destroyed by Hurricane Ike along the park's coastal boundary.

Part of the dune restoration project calls for installing 4,000 feet of sand fencing in a critical area that's quickly eroding close to park facilities. Along the remaining frontage, volunteers will place square hay bales to stabilize sand.

In September 2008, Sea Rim State Park — ravaged by Hurricane Rita in '05 — was two weeks away from reopening when Hurricane Ike pounded the region. After massive cleanups, the park opened to visitors on a limited basis. In the meantime, reconstruction of facilities — funded by \$2 million allocated by the 81st Legislature — started this summer.



Dunes and boardwalks have been undergoing restoration at Sea Rim State Park, which suffered damage from Hurricane Rita and Hurricane Ike.

“A new maintenance building and residence will be built first,” says park manager Tracy Ferguson. “Also, new elevated walkways over the dunes have been better designed to protect our dunes from future storm surges. One walkover will

have 10 tent pads so people can tent camp over the dunes.”

Other planned improvements include beach unit road repairs, parking area improvements, a day-use area (with picnic tables and grills), potable water, restroom facilities and rinse showers.

Though popular tours by airboat have ceased, you can still swim, fish, paddle, hike and go bird watching at Sea Rim State Park, which is split by Texas Highway 87 into the D. Roy Harrington Beach Unit and the Marshland Unit. To access the beach, you can either park your vehicle and walk, or drive right onto the beach. Camping is self-contained or primitive only. Bring everything you need; no drinking water or restrooms are currently available.

Be sure to stroll the Gambusia Boardwalk, just recently rebuilt. Named for the park's resident mosquito fish, the ¾-mile-long elevated nature trail winds across wetlands in the beach unit. During spring and fall migrations, birds galore stop over at Sea Rim. Heads up: Keep an eye out for American alligators, which inhabit the park's marshes (never provoke or get too close to an alligator).

Sea Rim State Park is located 20 miles south of Port Arthur on Texas Highway 87. For more information, visit [www.tpwd.state.tx.us/searim](http://www.tpwd.state.tx.us/searim) or call 409-971-2559. ★

— Sheryl Smith-Rodgers

PHOTOS BY TPWD

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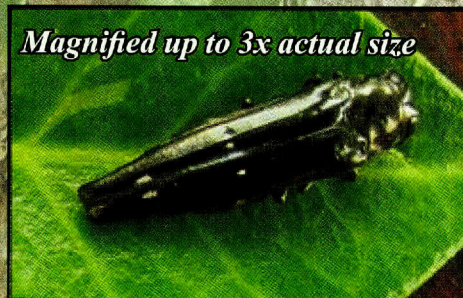
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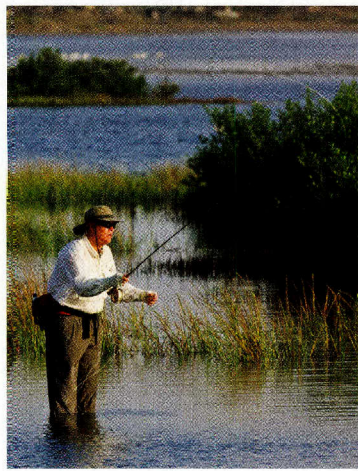
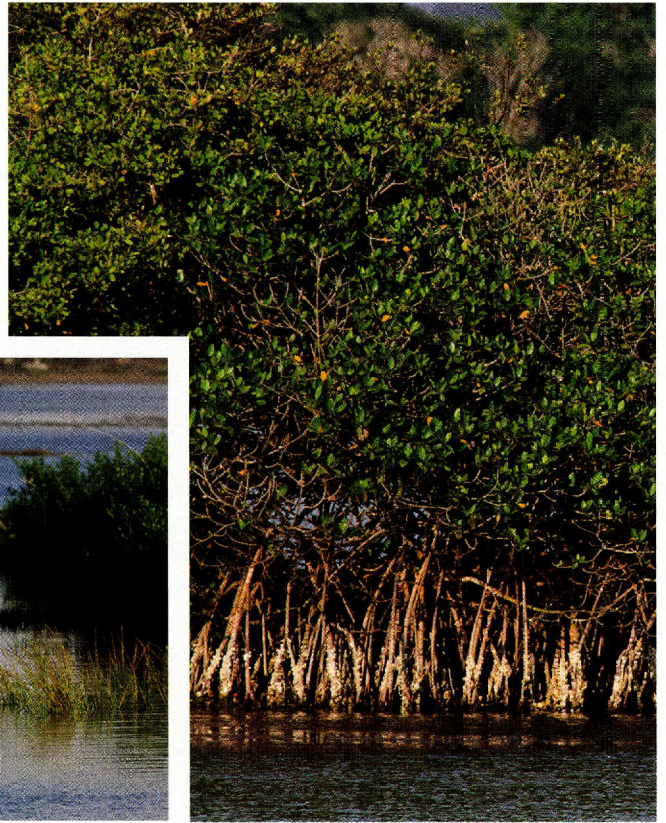
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# Multiplying Mangroves

*Rising warmth and salinity increase black mangrove numbers.*



Whenever he's out collecting data, Eric Madrid often hears old-timers describe how favorite fishing spots along the Texas Gulf Coast have changed.

"They tell me that black mangrove are everywhere now, and they didn't used to be nearly as common," says Madrid, a botanist with Texas A&M University who's studied the species since 2009.

What's up? "Warmer temperatures are a primary reason," he explains. "We hypothesize that changes in water salinity brought about by the construction of the Intracoastal Waterway in the '40s have also played a role in the expansion of black mangrove populations in Texas.

Black mangroves, found in coastal areas, are havens for birds, fish and other animals. The plants send up structures called pneumatophores, seen in left photo, to absorb oxygen.

Today, our state's largest population of these shrubby trees grows in northern Corpus Christi Bay near Aransas Pass."

Madrid, who's part of an international team monitoring the species in the Gulf of Mexico, can't yet predict how larger populations of mangroves will affect Texas coastal ecosystems. But they are important.

"Mangroves are part of the base of the food chain in Texas wetlands, and they also help to create habitat for fish, crabs, insects, small invertebrates and birds," Madrid says.

Black mangroves — named for the flaky, black bark — occur in wet soils dampened by high tides. To survive occasional submersions, mangrove roots send up hordes of pencil-like structures (called pneumatophores) that emerge from the ground and absorb oxygen. Another survival trick: Seeds sprout into seedlings (propagules) while still on the tree! After falling off, they can float up to a year before rooting. ★

— Sheryl Smith-Rodgers

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## TEXAS READER

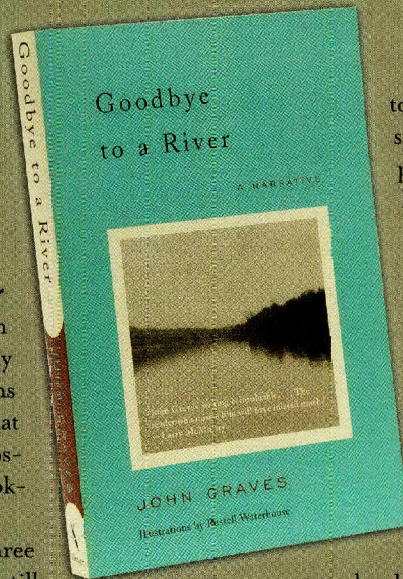
### Goodbye to a River

*History and landscape intertwine in classic river narrative.*

**A canoe trip down the Brazos River** with John Graves recalls a stolen afternoon in a graying shed, rubbing small, grimy hands over careworn tools as Grandpa spins tales of Indian summers and the big one that got away. Perhaps it is this deep-rooted nostalgia that compels us to reach to our bookshelves for *Goodbye to a River* again and again.

Fifty years after the book's release, and three decades after my first read, Graves' odyssey still resonates. As the book falls open to a random passage, the author's simple words evoke summer afternoons so still and slow that your heart seeks and finds a harmony with the pulse of nature that envelops you. Graves' hand-gathered and hair-raising historical recollections begin to weave into that captivating narrative, and his underlying message appears.

"We will be nearly finished, I think, when we stop understanding the old pull toward green things and living things,



toward dirt and rain and heat and what they spawn," he writes as he and his dachshund pup navigate a stretch of the Brazos from Possum Kingdom to Glen Rose for nearly a month in the fall of 1957. Graves worried about the impact of dams planned along the route, and his fear of the river's demise inspired him to make the river itself the main character of his first (and ultimately most respected) book.

We are privileged to sit a spell with Graves, silent companions like that dachshund pup, and we see through his eyes the "tawny, weather-stained gash" of canyons and the "ingrained gray of great sandstone boulders tumbled along the shore." With him, we skin the squirrel and hungrily sample the stew as we listen to him pine for those wild creatures he thinks may vanish.

"We don't deserve the eagles," he writes. "They will go."

A simple feat, really, paddling that lonely swath of the Rio de los Brazos de Dios ("the arms of God"). It's in the telling of the tale that Graves performs the herculean feat of reminding us who we are, why we're here and why it all matters.

—Louie Bond

## Understated Elegance

# Understated Elegance



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# Winged Jewels

*Beautiful, colorful damselflies have superior vision.*

**When you're out splashing in a Texas river or creek this summer, hold your arms still above the water and see who shows up. More than likely, you'll attract a few damselflies, those winged jewels of turquoise blue, orange red, metallic green and other colors that seem to dart everywhere.**

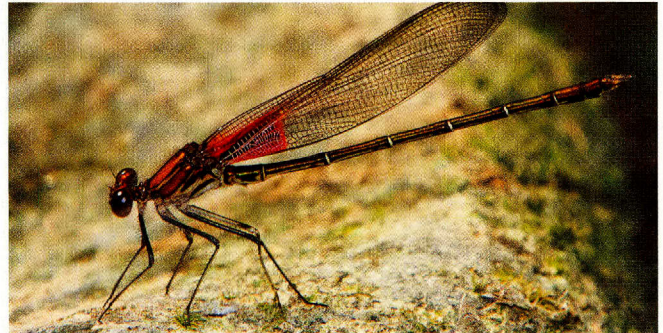
"Damselflies will perch on just about anything, even you," says John Abbott, an entomologist and author of *Damselflies of Texas: A Field Guide*. "Don't worry — they're harmless!"

Though lacking shyness, damselflies rank first in another area. "In the insect world, damselflies have the best vision," Abbott says. "That's because they have a pair of compound eyes that each has more than 10,000 lenses."

Damselflies are in the same order as dragonflies, but damselflies are generally smaller and more slender-bodied. At rest, dragonflies hold their wings open, while damselflies keep theirs closed.

In Texas, Abbott has identified 79 damselfly species with the help of professionals and enthusiasts reporting records through his website ([www.odonatacentral.net](http://www.odonatacentral.net)). Many have blue bodies, but not the American rubyspot (*Hetaerina americana*), a widespread species. It has a green-brown abdomen, and, as its name implies, it has a deep red spot marking the base of its four wings.

"They're usually seen along stream sides, where males and females perch on vegetation," Abbott says. "Males often chase one another in spirals, competing for perches and mates."



**Damselflies, such as this American rubyspot, are generally smaller than dragonflies. Another difference: They close their wings at rest.**

Adult damselflies feed on small flying insects, such as flies, leafhoppers and beetles. After mating, the female rubyspot deposits her eggs within plant stems or leaves at or just below the water line. Nymphs hatch out in the water and feed on aquatic insects. After molting a dozen times, mature damselflies climb out of the water and — like a cicada — slowly emerge from their nymphal shells. Most adults live about a month and may mate several times. ★

— Sheryl Smith-Rodgers

## THE FUTURE OF TEXAS IS WATER



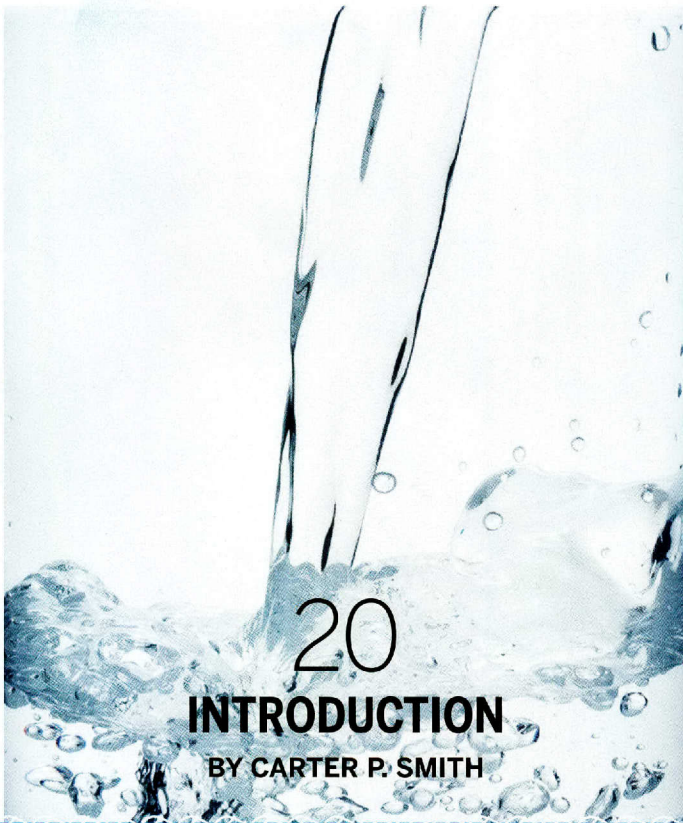
**Brazos River Authority**  
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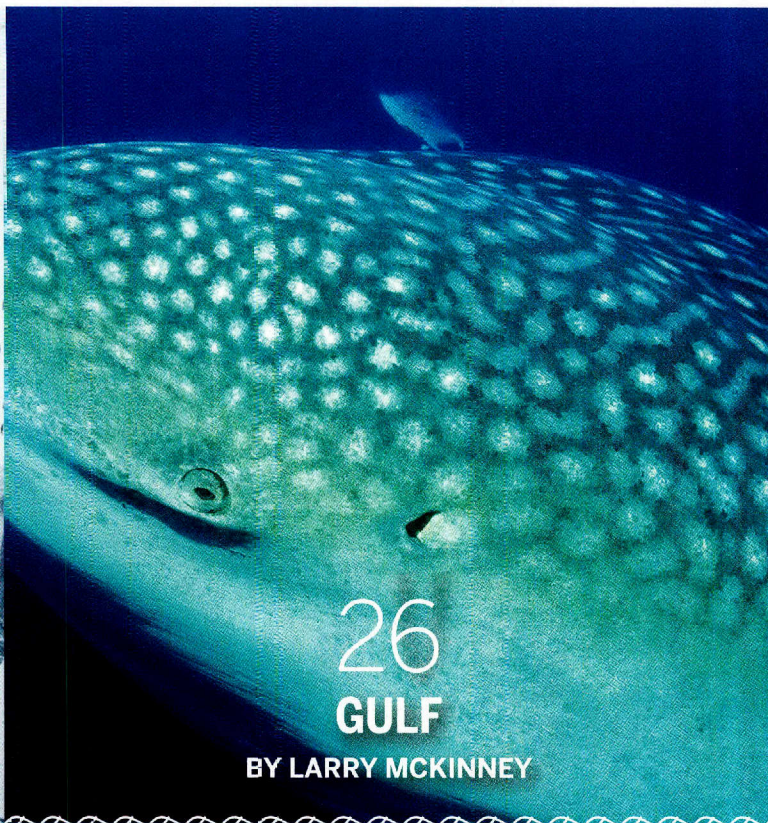
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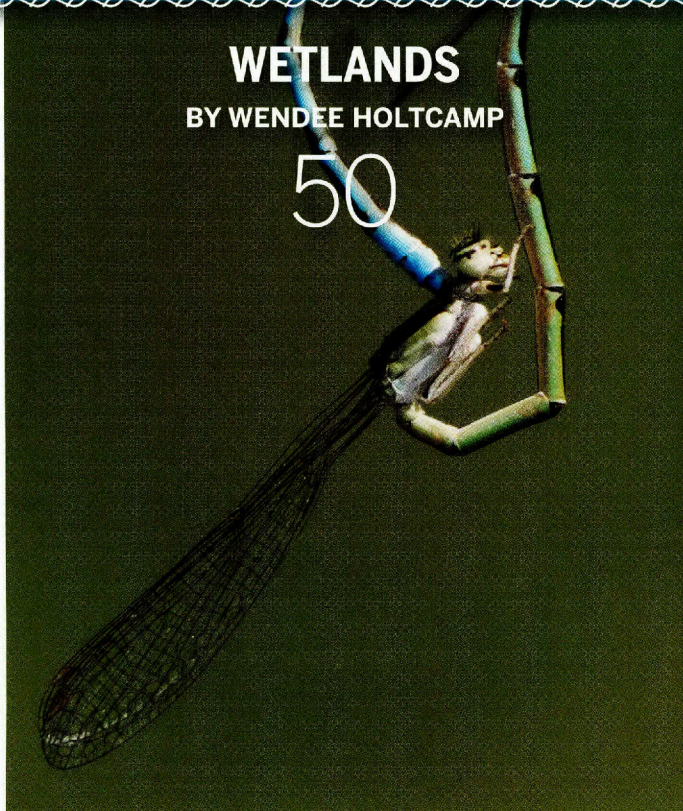


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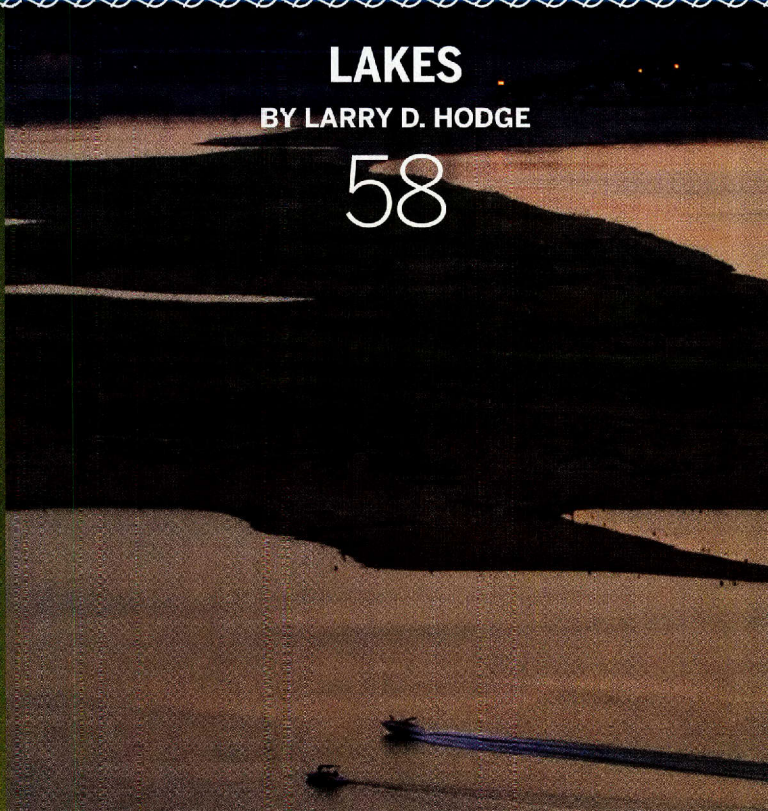
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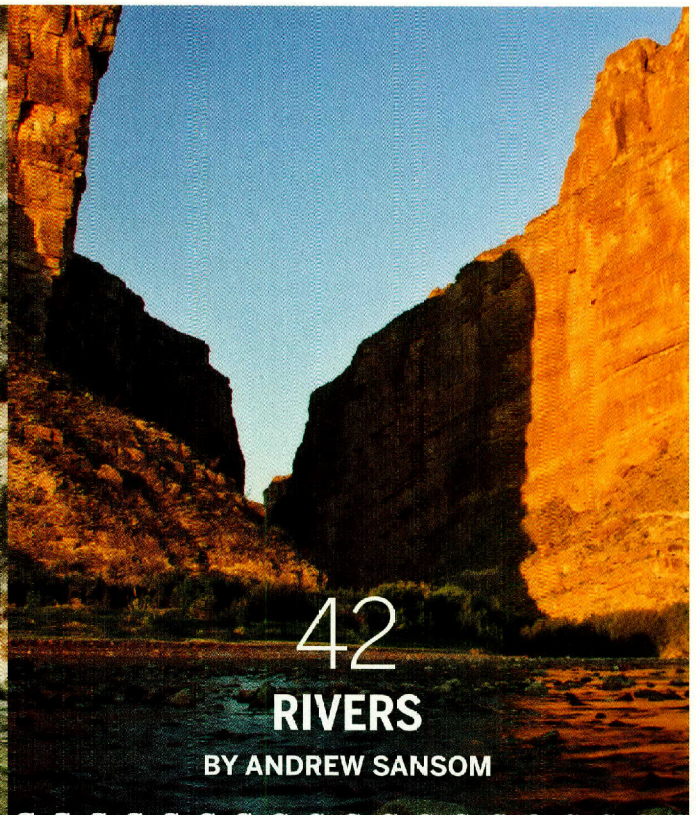
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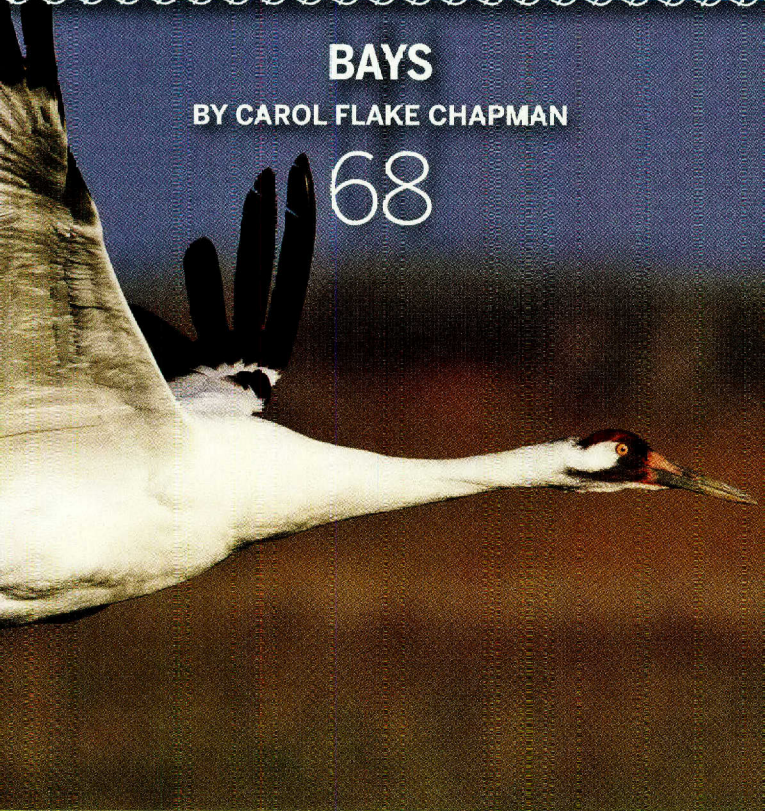


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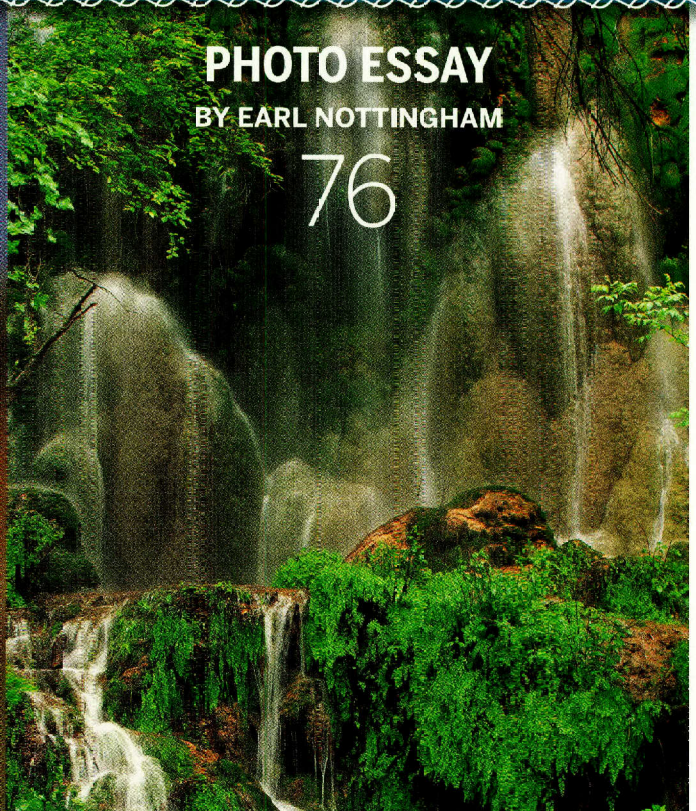
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# A DECADE OF WATER

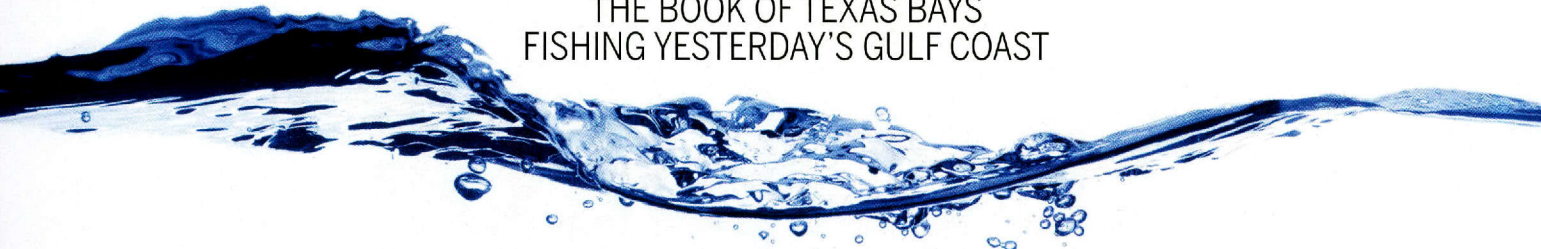


**The state of Texas water is complicated,  
with challenges around every bend.**

BY CARTER P. SMITH

TPWD Executive Director

THE SPRINGS OF TEXAS  
 WATER IN TEXAS  
 THE TIME IT NEVER RAINED  
 GOODBYE TO A RIVER  
 PADDLING THE WILD NECHES  
 TEXAS RIVERS  
 THE WATER HUSTLERS  
 THE BOOK OF TEXAS BAYS  
 FISHING YESTERDAY'S GULF COAST



My bookshelf is chock-full of writings relating to Texas water — shallow and deep, salty and fresh, inshore and offshore, surface and ground, flowing and dammed, droughts and downpours. As a collector of such things, I suspect I am not alone.

In a state where most of us are seemingly always one day closer to the next drought, water and weather are top of mind for Texans.

Protecting the source of our drinking water and investing in the quality of water in rivers, streams, creeks, aquifers, estuaries and reservoirs are values that Texans identify as major statewide priorities. These sentiments are shared by all sectors of the Texas populace, irrespective of social, political, economic or geographic considerations.

A number of years ago, I was involved in a San Antonio ballot initiative for a one-eighth-cent sales tax to support purchasing land and conservation easements over critical recharge zones above the Edwards Aquifer. This would help protect water quality in the aquifer, the city's sole source of drinking water. In doing so, other valued conservation goals would be accomplished, such as protecting open space, wildlife habitat and Hill Country farmland and ranchland.

But it was the fate of the water that clearly sealed the deal. As I stood in front of polling places, voters almost invariably had the same response: "Oh, you are working on the water proposition. Of course, I'll vote for that. We have to protect our water." It was that straightforward.

The state of water is and has been the defining natural resource issue for this state, and will be for centuries to come. There's an old saying: "*Agua es vida.*" Water is life. No words could be truer when

contemplating the health and vitality of our present and future economies, our environment, our human and natural communities and our quality of life.

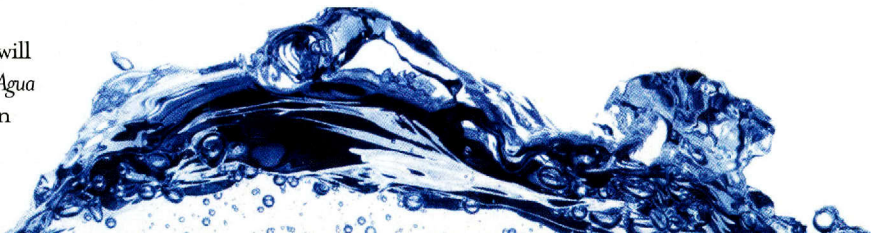
For the past 10 years, the Texas Parks and Wildlife Department has proudly heralded the value of our water resources in this magazine's annual State of Water series, published each July. These features — written by authors who know their way around a raindrop, a watershed, an aquifer, a meandering river, a seagrass nursery and an ocean floor — have highlighted the state's diverse array of aquatic resources, from the aquifers to the bays and from the springs to the Gulf. Their thoughtful prose has captured the beauty, richness, variability, fragility and utility of our water bodies, as well as the contention that surrounds this precious resource. These writers have tackled the hard questions confronted by policy-makers grappling with how to meet the state's competing water demands for a growing population and a healthy environment.

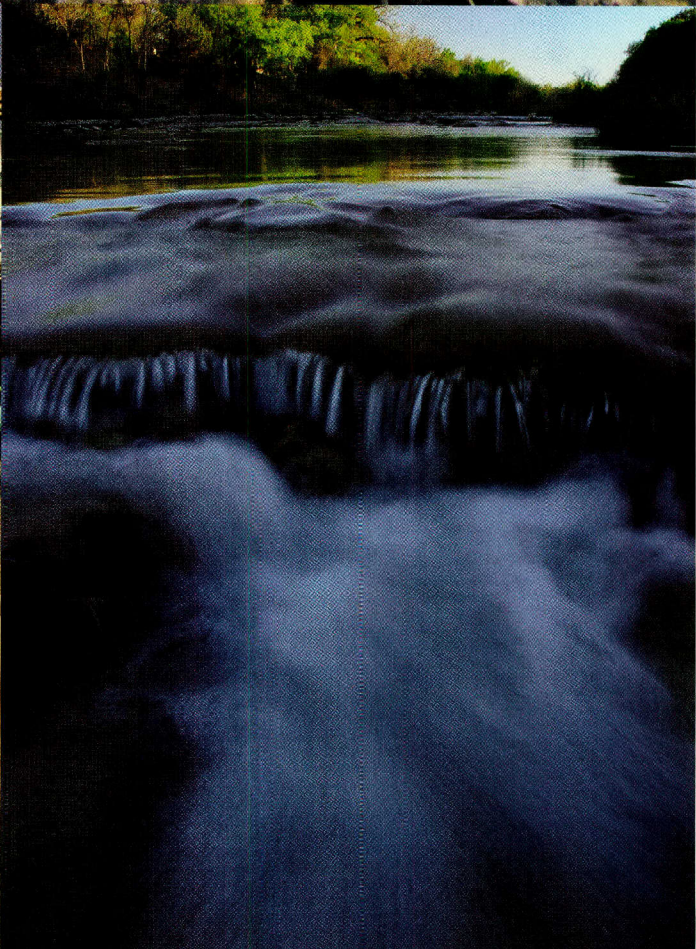
Where will the water come from? Who is going to get it? How much will they get? These questions have been part and parcel of every serious writing and



Texas water is broad and varied: ocean, lake and stream, drought and flood.

**The state of water is and has been the defining natural resource issue for this state, and will be for centuries to come. There's an old saying: "*Agua es vida.*" Water is life. No words could be truer when contemplating the health and vitality of our present and future economies, our environment, our human and natural communities and our quality of life.**

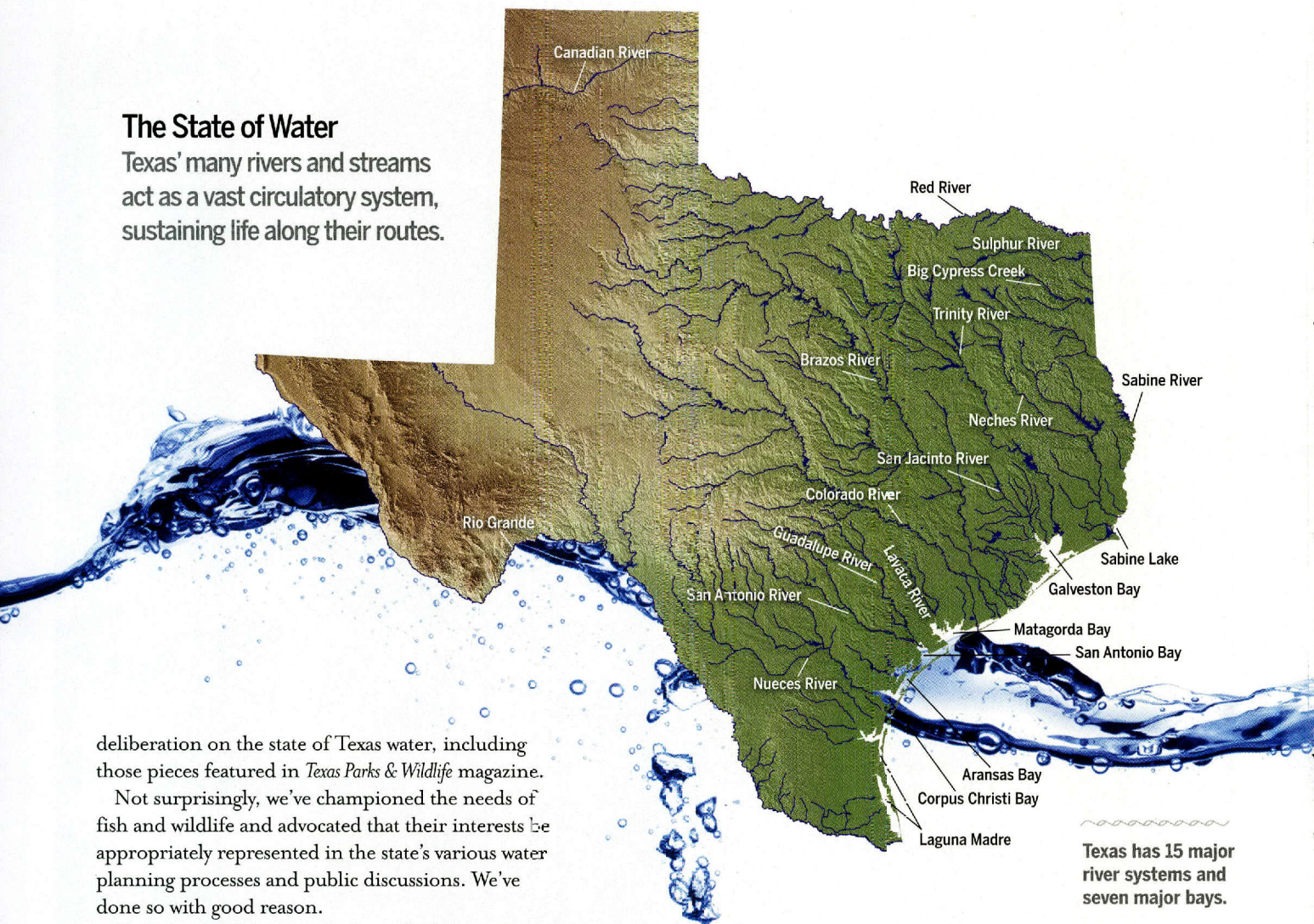




PHOTOS, CLOCKWISE FROM TOP LEFT: © LARRY DITTO, © JIM OLIVE, © LANCE VARNELL, © GRADY ALLEN

## The State of Water

Texas' many rivers and streams act as a vast circulatory system, sustaining life along their routes.



Texas has 15 major river systems and seven major bays.

deliberation on the state of Texas water, including those pieces featured in *Texas Parks & Wildlife* magazine.

Not surprisingly, we've championed the needs of fish and wildlife and advocated that their interests be appropriately represented in the state's various water planning processes and public discussions. We've done so with good reason.

Texas is one of the most biologically diverse places in the Western Hemisphere. We harbor more birds and reptiles than any other state, and we enjoy comparatively high levels of species richness and rates of endemic species. That diversity is made possible by well-stewarded watersheds, robust aquifers, flowing springs, clean rivers, healthy bays and estuaries and Gulf waters.

Those aquatic habitats not only serve the vital needs of our diverse plant and animal communities, but they are essential in meeting the growing and evolving outdoor recreational demands of our population. Fish- and wildlife-associated recreation is big business in Texas. The most recent studies from Southwick Associates found that hunting, fishing and other forms of nature-related activities contribute \$16 billion a year to our state's economy.

Water sports such as kayaking and canoeing are some of the fastest-growing leisure activities in the country. Communities big and small, from Houston and Arlington to Luling and Lufkin, have embraced their bays, lakes and rivers as important natural economic generators, designating and promoting paddling trails for residents and tourists alike.

So as we roll out this 10th edition of the State

of Water, let's examine where we stand on water-related issues that affect our state's exceptional natural heritage.

IN 2002'S WATER ISSUE, Larry McKinney laid the groundwork for subsequent discourse with "Water for the Future," his reflective piece on balancing water needs for humans and the environment. He eloquently articulated the critical basis for maintaining sufficient "environmental flows" in our rivers and ultimately into our bays and estuaries, where they provide life-giving nutrients, sediment and pulses of freshwater for the shrimp, crab, redfish, trout, flounder and other bay-based fish and wildlife that depend upon them.

Other pieces covered the waterfront, both literally and figuratively. Jan Reid wrote about the future of our remaining big springs such as Comal Springs in the Hill Country, and Elmer Keeton penned his thoughts about the fate of the mighty Ogallala, the mother of all groundwater resources in the Texas Panhandle. Jim Anderson described the biological richness of our estuaries, such as Matagorda Bay, and

Joe Nick Patoski took us down the undammed and unforgiving Devils River, perhaps the wildest Texas river. My predecessor, Bob Cook, effectively characterized the importance of good land stewardship and the crucial role private landowners play in protecting our surface and groundwater.

Not surprisingly, these conservation issues remain relevant today. McKinney projected that our state's population would double by 2050, increasing the need to emphasize water conservation as a measure that each of us can positively affect with individual choices.

The future of our aquatic resources is being contemplated and debated by our citizens and state leaders in forums across the state. Extensive science and stakeholder processes (mandated by the passage of Senate Bill 3 in 2007) are under way to identify appropriate environmental flows in each of the state's major river basins. Deliberations about high and low river flows, the needs of fisheries dependent upon those flows, and the degree and timing of freshwater pulses into our bays are all part of the state-directed, bottom-up efforts originally envisioned in SB3.

The process, a necessarily messy one by design and democracy, has had its challenges. The debate among stakeholders in some basins about environmental flows has been, to borrow a phrase from Robert Penn Warren, "not exactly like Easter week in a nunnery." In others, the deliberations are proceeding amicably. Ultimately, however, it will be up to the Texas Commission on Environmental Quality to delineate and defend the specific set of flow conditions required to maintain sound ecological environments in our rivers.

In South and Central Texas, representatives from regional river and water authorities, agricultural interests and conservation agencies have spent the last several years working earnestly on the Edwards Aquifer Recovery Implementation Program. The voluntary, stakeholder-based process is designed to help protect the vitality of the region's life-giving spring flows and the conservation needs of imperiled species.

The city of San Antonio and its partners have been busy on another aquifer-related project that protects more than 90,000 acres of critical Edwards Aquifer recharge land. The relatively inexpensive process of acquiring voluntary conservation

easements from willing private landowner partners made this possible.

Thanks to more than \$10 million in private donations, TPWD recently acquired 19,000 acres along the Devils River — including 10 miles of pristine river frontage — to add to its existing state natural area complex. Many public paddling trails have opened, including seven in May in the Dallas–Fort Worth area. These and other investments ensure that we have special places on and around our waters to use and enjoy for generations to come.

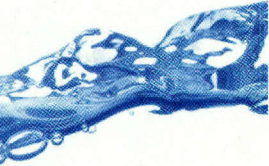
Conversely, other new and imposing challenges have also descended upon us. The Deepwater Horizon incident in the Gulf of Mexico in 2010 was the largest oil spill in the Gulf's history. Thankfully, the Texas coast was not as obviously and immediately affected as other Gulf coastlines. Nonetheless, many species that spend part of their lives in our waters were affected directly and indirectly — such as juvenile sport fish and Kemp's ridley sea turtles — so we share a large stake in the Gulf's ultimate restoration and recovery.

Moving inland, our lakes continue to suffer from a proliferation of exotic and invasive plants that clog the water's surface. Noxious species such as giant salvinia and water hyacinth threaten large freshwater bodies such as Toledo Bend, Caddo Lake and Lake Conroe. Their rampant expansion threatens our native aquatic species, interferes with boating, fishing and other recreational access, affects property values and compromises the integrity of our aquatic habitats.

A new and invasive interloper, the zebra mussel, has made its way into Lake Texoma on the Texas/Oklahoma border. This exotic mussel, which originally hails from western Russia, reproduces most prodigiously and affixes itself to any available hard substrate, whether boats, trailers, pipes or pilings. Zebra mussels pose serious challenges for area water managers. Efforts to arrest their spread may affect portions of the water supply system for more than 4 million people in North Texas alone.

The state of water is a complicated one, replete with challenges around every bend. Add in plans for new surface reservoirs, legal challenges about groundwater ownership, proposed federal endangered species listings of certain native freshwater mussel species and the effects from the recent drought, and discussions about water are anything but dull.

As we look ahead, we should remember that water resources are precious and precarious, and most assuredly finite. Conservation is neither a luxury nor a privilege, but rather a promise that we cannot afford to ignore. We all play roles, big and small, in this undertaking. Ultimately, our actions will forever define us as stewards of the springs, creeks, rivers, lakes, bays and Gulf waters that sustain us all. ★



**As we look ahead, we should remember that water resources are precious and precarious, and most assuredly finite. Conservation is neither a luxury nor a privilege, but rather a promise that we cannot afford to ignore.**



INTRO

GULF

SPRINGS

RIVERS

WETLANDS

LAKES

BAYS

PHOTO ESSAY

~~~~~  
Whale sharks, the world's biggest fish, are one of more than 15,000 species found in the Gulf of Mexico.



# AMERICA'S SEA

**We all have a stake in the future of the Gulf of Mexico.**

BY LARRY MCKINNEY

PHOTO © WOLFGANG POLZERAKKI IMAGES

It's our nation's gas station, seafood market, water filter and, sometimes, our trash can. It has been called America's Sea, the American Mediterranean, the Energy Coast and the Industrial Coast. It has also been called the Lost Coast and the Forgotten Coast. What is the Gulf of Mexico? It is probably some of all of those things, but for me, living on its margins and studying it for nearly 50 years, it is home.

Not everyone sees what I see in the Gulf. I was filled with dismay and frustration upon hearing a senior federal agency administrator — charged with managing our nation's ocean waters — write off the Gulf before an audience of agency staffers. I have stood silently seething as a leader of a major conservation group stated that there was nothing worth saving in the Gulf, that it was a lost cause. I doubt any of them have ever visited the Gulf. If they had seen what I have seen, or been where I have been, they would certainly eat those words.

In the Gulf, I have swum within a 90-member school of the largest fish in the world, whale sharks. Ten-foot-long juveniles and 30-foot-long adults glided through milky clouds of bonito eggs in the cobalt-clear waters above Ewing Bank, in the north-central Gulf, 63 miles off the Louisiana coast. It was a feast that would sustain these giants of the deep on their endless ocean voyage circling the Gulf.

I have seen morning come to the Laguna Madre from my kayak. With silence as my only companion, I watched a school of redfish break the surface. Tails waving purposefully and flashing iridescent blue, they fed urgently along the shallow bottom, preparing for their fall migration offshore to spawn. Roseate spoonbills, invisible just minutes before, glowed pink in the early light as they methodically raked their specialized bills back and forth, back and forth, filtering out their breakfast. Fish, shrimp and crabs rippled, jumped and

streaked about — some chasing breakfast and some being chased. As the sun rose higher, a green carpet of seagrass meadow expanded out from around my boat until it reached the far shore and rippled back in the early morning breeze.

I have been assaulted by a silver cloud submerged beneath the waters of the open Gulf off northern Florida. Initially stunned as a wall of panicked eyes raced at, and then around, me, I became disoriented and dazzled by a flashing mosaic of silver fish. It was a school of menhaden, so numerous they could not avoid me but for some reason determined to get past me. Lost within a swirling disco ball of fish, I fought to tell up from down. They passed suddenly, and I tried to regain my composure. The reason for their panic became clear as the last of them raced by and left me suspended in the ocean. Long, silver torpedoes were harrying the school like wolves — tarpon! They paid no attention to me as they pursued dinner, and within seconds they, too, passed out of sight. I drifted, bemused, back to the surface.

These are just a few impressions of a lifetime of memories about my Gulf of Mexico. Who could experience such and think the Gulf not worth any and all efforts to protect it? I wish the naysayers and ignorant could experience a tiny fraction of what I have experienced. Were that possible, the future would not be so unsure. We face significant challenges to the Gulf's future, but it is not lost, not even close to being lost. What we have is worth all our best efforts to save.

**We face significant challenges to the Gulf's future, but it is not lost, not even close to being lost. What we have is worth all our best efforts to save.**

**Five sea turtle species are found in the Gulf, such as this loggerhead under an oil rig, and each species is classified as either threatened or endangered.**





PHOTO © JESSE CANCELMO

## Economic Engine

The Gulf of Mexico is a sea of contrasts where the nation's economy and the environment both coexist and contend. It is home to one of the most diverse ecosystems in the world and one of the most productive.

The Gulf is a key to our nation's energy security. More than 3,300 oil and gas platforms and structures dot the waters of the Gulf, and connecting them together is an unimaginable maze of pipelines, funneling their output into the heart of the United States. More than 45 percent of the refining capacity, 30 percent of oil production and 20 percent of the natural gas produced in the U.S. comes from here. The Gulf contains major energy reserves — 60 percent of the oil and 40 percent of the natural gas.

If you drive a car, use anything made of plastic, heat or cool your home, eat bread, pork, beef or poultry — you have a stake in the future of the Gulf of Mexico. If you eat seafood, hunt, fish, go bird watching or enjoy the beach — you have a stake in the future of the Gulf of Mexico.

## Environmental Infrastructure

The Gulf is not only a key to the energy security of our country, it is equally important to our environmental security. More than 38 percent of the nation's continental wetlands, some 39.8 million acres, can be found here. Some 50 percent of all seagrass, historically around 1.25 million acres, flank the near-shore waters of the northern Gulf. All mangrove habitat in the U.S. (647,000-plus acres) is found in the Gulf, primarily occurring in Florida, but some in Texas. The healthiest and most productive oyster reefs in the world sit intermingled with other Gulf habitats.

Most of this environmental infrastructure is encompassed within estuaries. Like a string of pearls, estuaries dot the margins of the northern Gulf and are the engines that drive the region's incredible productivity. An estuary is where the sea and a river meet — where sediment and nutrient-laden fresh water mix with seawater. This dynamic mixing often produces a rich brown soup that fuels the entire coastal ecosystem. The 39 major



PHOTO BY TPWD, OPPOSITE © LARRY DITTO

Gulf estuaries account for nearly 42 percent of such areas in the U.S., so it should be no surprise that the Gulf is as productive as it is — one of the most productive bodies of water in the world.

Between 70 and 90 percent of all commercially and recreationally important finfish and shellfish depend on habitats found in estuaries for some part of their life cycle. The Gulf accounts for 80 percent of all shrimp harvested (241 million pounds), 62 percent of all oysters harvested (22.1 million pounds) and more than 1.4 billion pounds of annual seafood production.

Recreational fishing is a significant economic engine. More than 40 percent of all saltwater anglers fish in Gulf waters, spending \$16.2 billion annually. Texas and Florida dominate all statistical categories of saltwater fishing, and each year anglers generate billions of dollars in economic benefits for their states. Louisiana license plates proudly proclaim the state as a "sportsman's paradise" — a great part of the Gulf's amazing productivity comes from the seemingly endless miles of Louisiana wetlands. The estuaries and wetlands of Mississippi, Alabama, Texas and Florida do not pale in comparison.

**The Gulf of Mexico is a sea of contrasts where the nation's economy and the environment both coexist and contend. It is home to one of the most diverse ecosystems in the world and one of the most productive.**

The Gulf provides 1.4 billion pounds of seafood each year and is a major producer of shrimp and oysters. The output is fueled by a series of amazingly productive estuaries.



## A Diverse Gulf

The Harte Research Institute recently published *The Gulf of Mexico: Origin, Waters and Biota, Volume 1 Biodiversity*. It was a stunning revelation of the rich diversity of life that calls the Gulf home. It took the largest book that modern printing technology could handle to list the 15,419 species found in the Gulf. We joked that we did not publish the book so much as we birthed it. The book weighed 7.6 pounds!

As one might expect there are a lot of seashells (mollusks) in the Gulf: 2,455 species. Crabs and shrimp are even more numerous: 2,638 species. It may surprise you to know there are also 782 species of corals and anemones, 522 species of starfish and urchins, 71 species of sharks and rays, 28 species of whales and dolphins and five species of sea turtles.

## Challenging Future

Some 41 percent of the continental U.S. drains into the Gulf by way of the Mississippi River system. Basically anything that happens in the heartland of the U.S. eventually flows to the Gulf. One much-publicized result of this has been the regular formation of a hypoxic zone, or dead zone, at the mouth of the Mississippi River. It is no small phenomenon and can reach as much as 8,500 square miles, about the size of New Jersey. Within the dead zone, fish, shrimp and shellfish cannot survive and must either move or die. The cause is nutrient overenrichment, and much of that comes from agricultural fertilization runoff. Any expansion of the zone threatens the entire upper coast of Texas from Sabine Lake to Matagorda Bay.

The Gulf has lost as much as one-half of its wetlands and far more of its seagrass meadows, mangroves and oyster reefs. The losses have come from coastal development, subsidence and channelization. The full meaning of that loss came home to the Gulf as a series of devastating hurricanes pounded the region in the past decade. Wetlands, oyster reefs and seagrass can be natural barriers to reduce storm surge; where they were lost we paid the price in lives and property.

The Gulf of Mexico is basically a shallow subtropical sea, and as such is this

country's most vulnerable body of water to the effects of climate change. Rising sea levels, expected to be as much as three feet in this century, will flood thousands of acres. Coastal communities will become islands or disappear beneath the waves of the next hurricane. Warming water temperatures will drive fish like the southern flounder out of much of the Gulf and bring new species and a stampede of invasive species.

Ocean acidification will make it far more difficult for the thousands of marine species that transform calcium carbonate into shells and skeletons. These include oysters, shrimp and crabs, the mainstay of commercial fisheries in the Gulf. Coral reefs, as we know them, could disappear in our lifetimes or those of our children because they can no longer build the massive skeletons that define them.

## Framework for Action

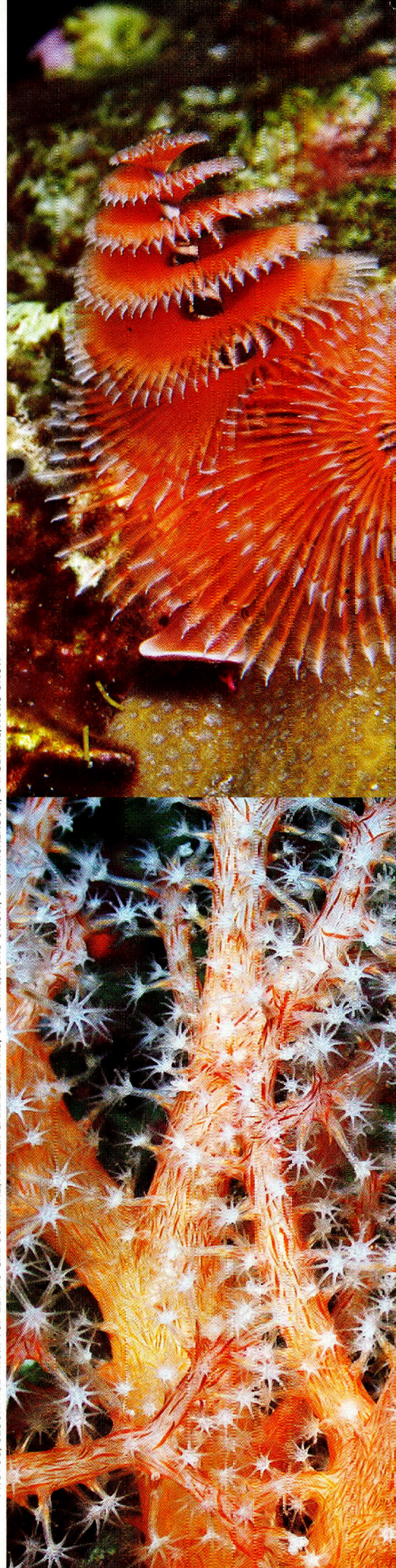
The challenges we face can seem overwhelming and too complex to solve, but that is not the case. Examples of positive actions are happening around the Gulf, from wetlands restoration to beach cleanups to turtle rescues.

For the first time ever, our country has a national ocean policy. One directive of that policy was the establishment of a National Ocean Council to coordinate the ocean-related activities of various federal agencies.

The Gulf of Mexico Alliance is a state-driven partnership with federal agencies, businesses and nongovernmental organizations. It is a regional model of ocean governance that has been emulated in other coastal regions, the ideal means both to craft national policies into regionally effective ones and then to implement those policies.

Positive actions by individuals and organizations, regardless of scale, can together make a difference and a positive one. We really have no choice. We all have a stake in the future of America's Sea. ★

The deep-water ecosystems of the Gulf may have suffered damage from last year's Deepwater Horizon oil spill. Studies will give us insight into the spill's effects.



PHOTOS, CLOCKWISE FROM TOP LEFT: © G.R. SCHMAHL/FLOWER GARDEN BANKS; © IFGIMS/NURC-UNCW; © I.E. HICKERSON; © IFGIMS/NURC-UNCW



PHOTO © JIM OLIVE

## GAUGING THE EFFECTS OF THE OIL SPILL

The Deepwater Horizon oil spill (also known as the BP spill or Macondo blowout) began with an explosion and fire that killed 11 workers on April 20, 2010. Oil flowed into the Gulf of Mexico until relief wells stopped the spill three months later. An estimated 4.9 million barrels of crude oil escaped, making it the largest accidental marine oil spill in history.

It was not the first spill to have large-scale impacts on the Gulf of Mexico. Ixtoc I, off Mexico's Yucatán Peninsula, spilled 3.3 million barrels of crude oil from June 3, 1979, to March 23, 1980. Much of the lower Texas coast beachfront, from Port Isabel to near Matagorda Bay, was coated in oil. One significant difference between these two incidents was the great depth of the Macondo blowout (approximately 5,000 feet) compared with Ixtoc (160 feet). The full impact of the spill remains unknown, but the coastal wetlands, so important to commercial fisheries of the Gulf, may have escaped the level of damage initially feared.

Long-term effects on ecosystem health remain a concern. The open-ocean and deep-water ecosystems of the northern Gulf may not have been so lucky, and we await the results of new studies. Our general lack of knowledge about ecosystem dynamics and function — and linkages between these communities and the shallower continental shelf ecosystem — is a serious impediment to assessing such damage. The Gulf's remarkable resilience is certainly being tested, and we hope it will rebound. Only time and comprehensive study will tell us for sure.



INTRO

GULF

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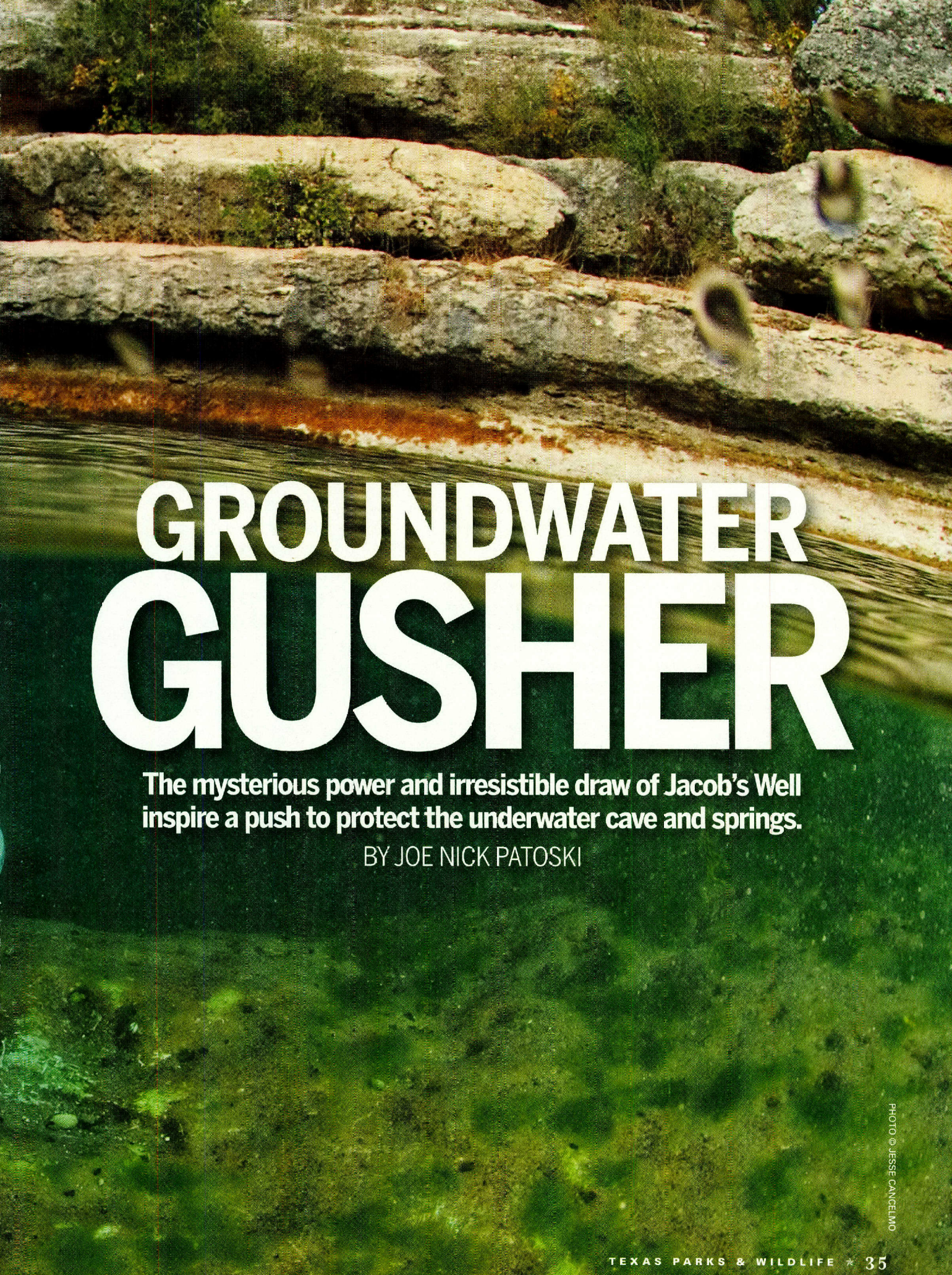
WETLANDS

LAKES

BAYS

PHOTO ESSAY

Divers have mapped the depths of Jacob's Well, finding it to be either the longest or second-longest underwater cave in Texas.

A photograph of a natural rock pool. The water is clear and greenish, reflecting the surrounding environment. The pool is bordered by large, light-colored rocks. In the background, there are more rocks and some green vegetation. The overall scene is a natural, outdoor setting.

# GROUNDWATER GUSHER

The mysterious power and irresistible draw of Jacob's Well inspire a push to protect the underwater cave and springs.

BY JOE NICK PATOSKI

At first sight, Jacob's Well appears to be a deep, dark hole at the bottom of a pool of creek water — nothing more. Pay attention to how the hole, about 15 feet in diameter, has perpetually gushed pure artesian water out of the ground since before humans first wandered around this part of what is now known as the Hill Country, and it takes on deeper meaning. Listen to stories about it, and it becomes something much more than just a special natural place.

Spanish explorers described a head of water 4 to 6 feet high being pushed to the surface from far below. American Indians living in the area considered the place sacred. The name Jacob's Well was supposedly inspired by a survivor of the Battle of San Jacinto, the decisive battle for Texas' independence from Mexico, who first saw it while looking for a place to build a mill along the Blanco River and declared it "like unto a well in biblical times."

Local elders speak of leaping in as kids and being thrust back to the surface by the force of the flow. The location in the eastern Hill Country — the dry, rocky rise above the coastal prairie — makes it all the more remarkable. That a place like this exists in the 21st century, when half the springs documented in Texas in 1900 have gone dry and disappeared, is a miracle.

At least that's how it seems whenever I'm gazing into the blue and green hues tinting the water and the limestone walls of what is the beginning of a giant underwater cave. Everything sparkles like magic, a phantasmagorical welcome to another world below.

Peer into its depths and it pulls you in.

That pretty much sums up David Baker's life since May 1988. He had been in Austin working as a designer and carpenter on a theatrical production when he took a drive with his wife to the village of Wimberley, got direc-

tions, walked down a trail to the end of a limestone bluff and saw Jacob's Well for the first time.

"The hair on my arm just stood up," he says as he relates his first impression of the bubbling spring surrounded by elegant cypresses with a rough, rocky bluff rising above it. "I couldn't get it out of my mind. I was so confident we were going to move here that I rented a storage locker."

In a matter of months, Baker left a mountaintop home near Santa Cruz,

Local elders speak of leaping in as kids and being thrust back to the surface by the force of the flow. The location in the eastern Hill Country — the dry, rocky rise above the coastal prairie — makes it all the more remarkable.

The allure of Jacob's Well lies below the surface in a 5,550-foot-long underwater cave.

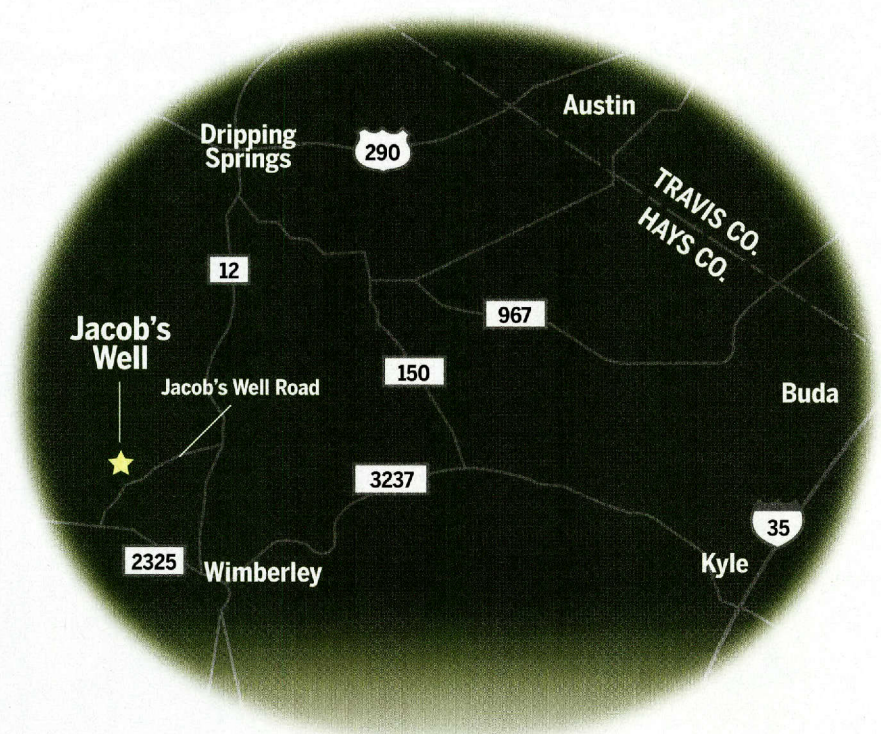






PHOTO COURTESY OF DAVID BAKER



PHOTO © JESSE CANCELMO; HISTORICAL PHOTOS COURTESY OF DAVID BAKER

Calif., in the redwoods, where on a clear day you could see the Pacific and the town of Monterey. He packed up his pregnant wife and his 9-month-old son, Jacob, and moved into a rock cottage a few short steps away from Jacob's Well.

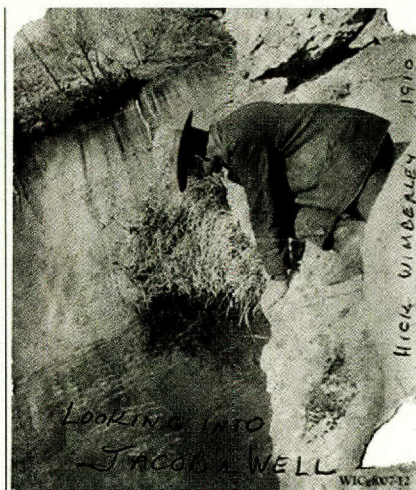
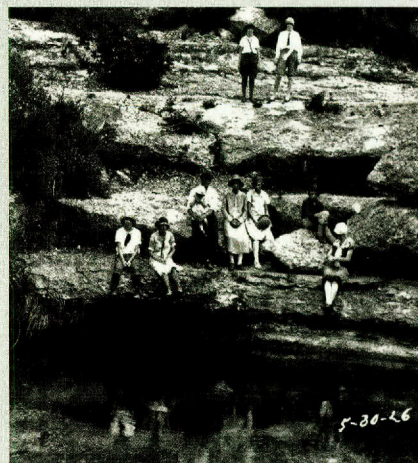
Fast-forward 23 years.

The sign in front of a former RV park reads "Welcome to Jacob's Well Natural Area, the Jewel of the Hill Country." A couple hundred yards past the sign, David Baker sits at a desk, typing at a computer, preparing a paper to protect the well he fell in love with. Baker's office is neither bucolic nor picturesque, but rather chaotic. Baker fields calls, refers to charts and converses in geologist/hydrologist acronyms, citing DFCs (desired future conditions), ADRs, MAGs and GAMs as he talks about the Well's past, present and future.

Baker toils in the trenches these days, working his way through a very thorny political process, having been schooled in contrarian water laws. Texas treats surface water such as lakes and streams as a common resource owned by all Texans, while groundwater such as Jacob's Well is considered private property. The "rule of capture" states that the owner of surface property owns the water underground as long as it is not part of a subterranean stream.

Baker was in the minority voting bloc when the board of directors of the Hays Trinity Groundwater Conservation District, an entity he was instrumental in establishing, voted earlier this year to issue new pumping permits for a development and a golf course that Baker fears will hasten the Well's demise. There is already an annual decline of two feet under current conditions, Baker pointed out during discussions before the vote.

Board President Jimmy Skipton, a developer and property rights advocate from Henly, responded, "That's David's opinion." As an individual, Skipton has filed a lawsuit against Hays County for establishing development rules that require lot sizes to be at least six acres for homes dependent on individual water wells. Skipton wants to sell 1.5-



Jacob's Well, a prominent spring near Wimberley, has held a fascination for generations of people, from early settlers to modern scuba divers.

acre lots on the 165 acres he would like to develop.

David Baker wants Jacob's Well to continue being Jacob's Well.

For natural places to remain natural, stewards like David Baker are required. Special places lack lobbyists, money to contribute to politicians and the legal tools to fend off forces that compromise their integrity and threaten their existence. The best hopes are advocates willing to devote time, money and research in order to preserve, protect and conserve places such as Jacob's Well.

In the big picture of earth science, karst aquifers are rare and unique — spongy-looking hard limestone reservoirs hundreds of feet below the surface that filter water, hold water and produce water, pushing it above ground, as is the case of Jacob's Well.

The Well feeds Cypress Creek and Blue Hole, the town park and swimming hole in Wimberley, before the water flows into the Blanco River about five miles downstream. The creek courses through scenic landscapes of twisted oak and gnarly scrub woodlands and abun-

**For natural places to remain natural, stewards like David Baker are required. Special places lack lobbyists, money to contribute to politicians and the legal tools to fend off forces that compromise their integrity and threaten their existence.**

Blue-green water and limestone walls mark the entrance to the giant underwater cave of Jacob's Well. David Baker has led the effort to protect the spring and the surrounding land.

PHOTO BY  
CHASE A.  
FOUNTAIN/  
TPWD

**When I finally saw it, I got it. Of the proverbial 1,100 springs that define the Texas Hill Country, this one was indeed special, exceptional and worth fighting for.**

dant grasslands, bordered by high bluffs and hills beyond the drainage. The beauty is both surreal and exceptional. Endangered golden-cheeked warblers thrive in abundance here.

My introduction to Jacob's Well came through Stephen Harrigan's 1980 article for *Texas Monthly* magazine and his 1984 novel, *Jacob's Well*, in which he tells the story of the Well and its attraction to scuba divers, and how several cave divers died in its chambers. I came away wondering what kind of place exerted that sort of fatal attraction.

Between 1960 and 1985, eight divers died in the Well, primarily because of the tight passageway between the third and fourth chamber, the quicksand-like sediment at the bottom of the third chamber that is easily stirred up and narcosis, a condition of confusion that can affect divers at depths greater than 100 feet. Don Dibble, a master scuba instructor and the owner of the Dive Shop in nearby San Marcos who almost lost his own life on a recovery dive on behalf of the San Marcos Area Recovery Team, wrote his own account of the Well's allure for divers for *Reader's Digest*.

I didn't actually see the Well until

the early 1990s after I moved into the Wimberley community and was invited to a festival at Baker's Dancing Waters Inn.

When I finally saw it, I got it. Of the proverbial 1,100 springs that define the Texas Hill Country, this one was indeed special, exceptional and worth fighting for.

In 1996, Baker got serious about protecting Jacob's Well when Wimberley residents began meeting to discuss formally incorporating the village. Baker was on the water and sewer committee. One consensus recommendation from the committee was the need to form a non-profit land trust and water trust in the Wimberley Valley to ensure water quality and quantity, a critical element of Wimberley's tourist economy. Working with Jack Hollon, whose family had donated ranchland to create Rancho El Cima for the Boy Scouts of Houston and who had seen the Blanco River go dry in the 1950s, landowner Johanna Smith, University of Texas history professor Patrick Cox and physician-nutritionist Dr. Philip Zyblot, Baker helped form the Wimberley Valley Watershed Association in December 1996.

Listen to a podcast of this story  
at [passporttexas.org/category/  
podcasts/web-exclusive/](http://passporttexas.org/category/podcasts/web-exclusive/)

The nonprofit organization began writing small grants and engaging in water quality monitoring, participating in the Texas Watch program. It also focused on ownership of Jacob's Well, which had been divided into four major pieces, with more than 120 parcels in the 100-acre area around it.

"It was extremely fragmented," Baker says. "We debated whether to buy land around the Well to get it under one owner or work on the surrounding watershed to protect the recharge. We decided we needed to get land around it for an educational center."

In 2005, with financial help from the Save Our Springs Alliance in Austin, the group got a loan for \$2 million to purchase 46 acres, including 100 percent of the well. The selling price was about \$1.1 million less than the appraised price. The SOS Alliance put a conservation easement on most of the property to prohibit future development and to limit impervious cover such as asphalt and concrete to 6 percent. The Wimberley group had two years to pay back the loan.

In 2007, 69 percent of Hays County voters approved \$30 million in bonds for open space. The Wimberley Valley Watershed Association hired the Lady Bird Johnson Wildflower Center and architects Lake/Flato to create a master plan with input from 30 residents. The group determined that environmental education, aquifer research and recreation were the top priorities.

The patchwork of acquisitions was completed in late December 2010 when developers of the mobile home park canceled plans to build a "green" development with 65 condominiums and a hotel on 15 acres adjacent to the Well and dropped a lawsuit against the Wimberley Valley Watershed Association over access issues and the perceived right to build a road through the property. Instead, the developers agreed to sell the land for \$1.7 million. Hays County ponied up half the price and the Texas Nature Conservancy loaned the other half, citing the unique attributes and ecological significance of Jacob's Well.

Humpty-Dumpty has been put back together again. Today, Hays County owns Jacob's Well and 96 acres around it. The Wimberley Valley

Watershed Association has a three-year contract with the county to manage the property and oversee education and public outreach.

Slowly but surely, the surrounding landscape is returning to its natural state. Through better understanding of how the land and water are interconnected deep underground, people are beginning to appreciate the critical role we play in this system and how easily we can disrupt the balance that has made nature's abundance such a critical key to human growth and progress.

But that is not enough.

The "rule of capture" property right accepts the Texas Supreme Court's judgment made in 1908 that groundwater is too "mysterious and occult" to regulate like a river, lake or stream. Looking down into Jacob's Well, I can understand the judges making that sort of determination.

But our understanding of groundwater has improved considerably over the past century. We know how it works, how it moves, where it starts and where it stops.

Through Baker's initiatives, scuba divers and dye tests, we know that Jacob's Well is connected to the Edwards Aquifer near San Antonio and to Barton Springs in Austin, that the actual well is at least 5,550 feet long as mapped by divers for the United States Geological Survey (the first- or second-longest underwater cave in Texas, depending on the latest measurements of Phantom Cave near San Solomon Springs in West Texas), that the water emerges from the Cow Creek Limestone formation and that pumping from some of the larger of the 6,600 wells in western Hays County reduces the flow of Jacob's Well.

The Well stopped flowing twice — in the summer of 2000 for the first time ever and during the drought of 2008 when 42 wells in the county and nearby Onion Creek went dry. The Well survived the historic drought of the 1950s but may not be able to endure the population boom in Hays County and the surrounding Hill Country.

Education is the best hope.

"It's so neat to watch people react to it," Baker said. "It's the mystery. This hole in the ground. Nobody knew how deep it was. It was intriguing watching people relate to it. Some would be afraid. 'That's where the divers drowned.'

"Some look at it as sacred. I feel that way about it: Here's the earth, giving water, the one thing besides air we need to live, it's doing it every day, it's done it for millions of years, it's a miracle. It was also chaotic. Nobody really was responsible. I kind of started to become somewhat of a policeman, which wasn't a pretty job. But someone needed to take responsibility for managing this resource."

Receiving the Texas Commission on Environmental Quality's Texas Environmental Excellence Award for 2011 has helped validate his work. Baker prefers another standard of measure: "If the well's flowing, the water's still clean so we can drink it and our kids can still swim in it, we get an 'A.' If the water's polluted or quits flowing, we've failed."

He acknowledges he's in a race against competing interests and that the deck may be stacked against him.

"Sometimes I do feel it's not going to work out, that it's too late. But then I see all these people who get it. That's when I realize that we can do it."

As if on cue, a women's hiking club from Canyon Lake arrives and Baker delivers an informal talk about the Well and shows hydrological charts, historical photographs and underwater video before sending the group on the path down to Jacob's Well. (Free public tours of the Well are conducted at 10 a.m. on Saturdays.)

I'm not sure who walked away happier from the visit — the hikers or Baker.

"I found something bigger than myself," he told me. "It gave me a purpose for my life the past 22 years to create something that would be here after I'm gone that I could share with the community."

And now they come — to see, to study, to experience and even to jump in. If Baker gets enough people to do that, they just might save Jacob's Well for this century and even beyond. ★



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PHOTO ESSAY

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The majestic walls of Santa Elena Canyon in Big Bend National Park give testament to the power of the Rio Grande.



# KEEPING RIVERS FLOWING

Texas streams are under stress as the state struggles to balance environmental and economic water needs.

BY ANDREW SANSOM

We camped on a sandbar in Santa Elena Canyon. The sheer 1,500-foot walls of the spectacular gorge on both sides of the river we Americans call the Rio Grande rendered our view of the sky a narrow, winding ribbon of blue far above. At twilight a peregrine falcon swooped down between the ramparts and snatched a Mexican free-tailed bat right out of the air. After the dinner dishes were washed and put away, the ribbon over our heads deepened to a richer hue, now spangled with countless stars.

Pleasantly tired, we savored the afternoon's run. The river flowing through the canyon was challenging enough but presented no serious danger to us in our canoes. In the campfire's glow, we savored our anticipation of the day to come. The strong currents of this great river would take us through the challenging formation known as the Rockslide and ultimately out of Santa Elena into the Chihuahuan Desert sun.

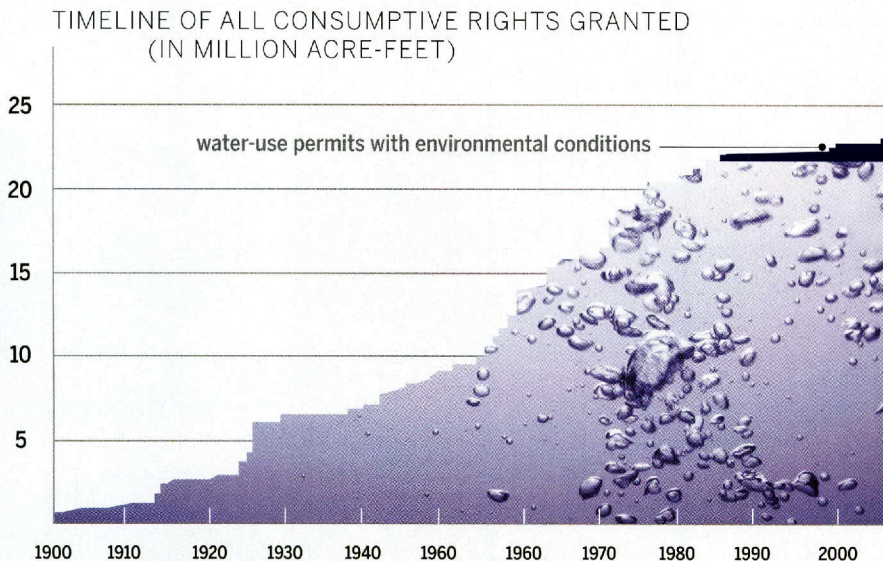
We never dreamed that the day would come when there would not be sufficient water in the river for such an adventure to be possible.

Our run was but a small stretch of one of 3,700 named streams and 15 major rivers that wind through nearly 200,000 miles of Texas countryside. Along the way, this vast circulatory system of our state provides water for almost 200 major reservoirs and ultimately flows into seven coastal estuaries to nourish one of the most prolific coastal ecosystems in the world.

Unfortunately, that system is threatened today as never before. According to the Texas water plan, the population of Texas is expected to more than double between 2000 and 2060, growing from

**According to the Texas water plan, the population of Texas is expected to more than double between 2000 and 2060, growing from 21 million to 46 million. Although we are faced with the enormous task of providing life-giving water to all these new Texans, we have already given permission for more water to be withdrawn from many of our rivers than is actually in them.**

## Texas Water Rights



By the time Texas began putting environmental conditions on water rights permits, most of the water in our rivers had already been spoken for.

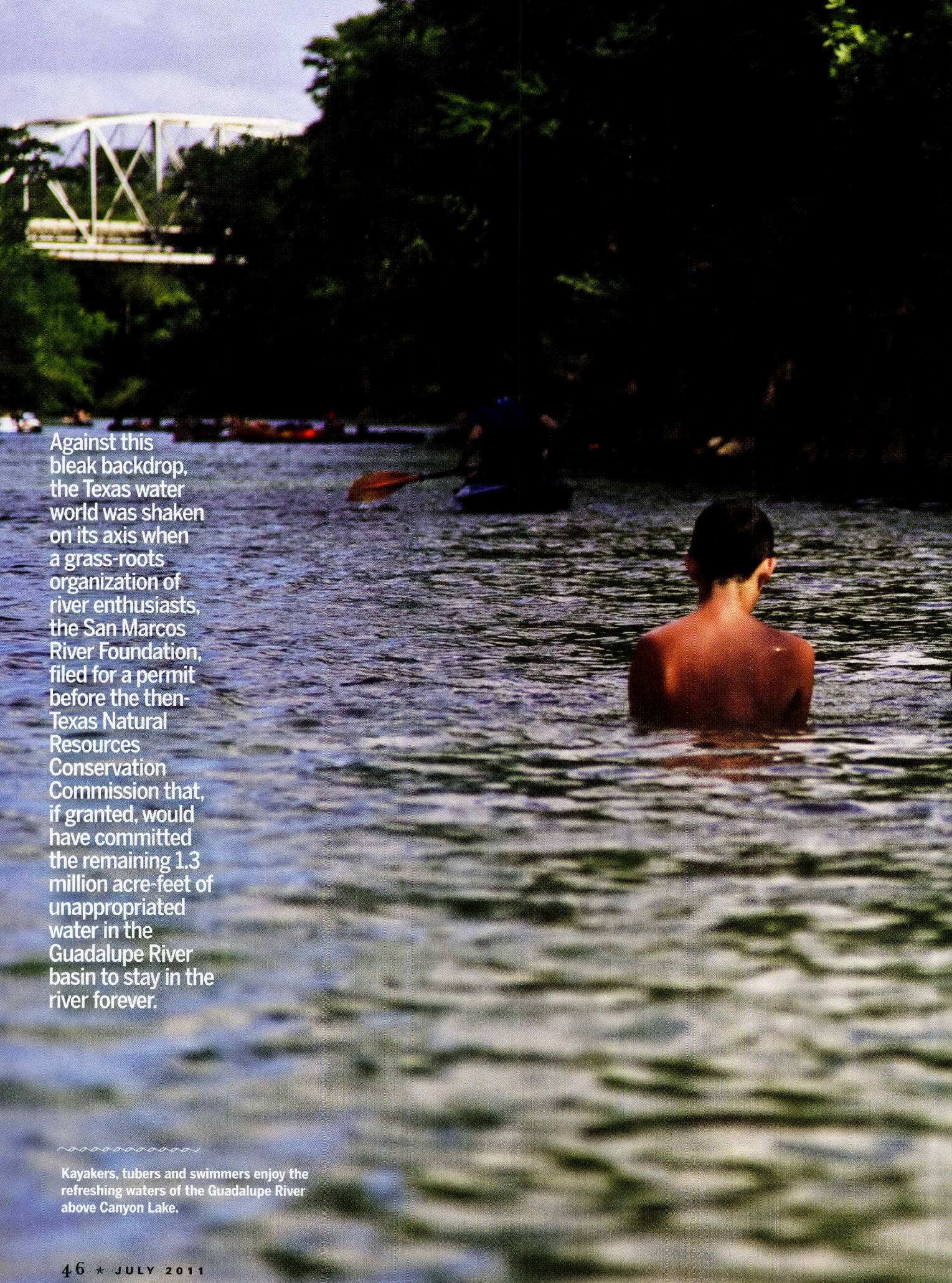
Source: National Wildlife Federation





PHOTO © LARRY DITTO

Population growth, groundwater pumping and other factors threaten to strain Texas rivers as never before.

A photograph of a river scene. In the foreground, a person is swimming, seen from the back, with their head and shoulders above water. In the middle ground, a person is kayaking, also seen from the back, with a blue kayak and a brown paddle. In the background, a white metal truss bridge spans across the river. The river is surrounded by lush green trees and vegetation. The lighting suggests it might be late afternoon or early morning, with a soft glow on the water and the bridge.

Against this bleak backdrop, the Texas water world was shaken on its axis when a grass-roots organization of river enthusiasts, the San Marcos River Foundation, filed for a permit before the then-Texas Natural Resources Conservation Commission that, if granted, would have committed the remaining 1.3 million acre-feet of unappropriated water in the Guadalupe River basin to stay in the river forever.

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Kayakers, tubers and swimmers enjoy the refreshing waters of the Guadalupe River above Canyon Lake.



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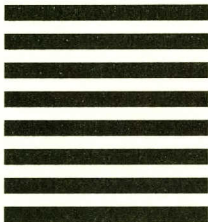
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PHOTO BY BRANDON JAKOBET/TPWD

21 million to 46 million. Although we are faced with the enormous task of providing life-giving water to all these new Texans, we have already given permission for more water to be withdrawn from many of our rivers than is actually in them. To put it another way, if all the water rights permits currently issued were fully used, some of our most beautiful and important Texas rivers would actually be dry today. Now consider that we will have twice as many people who need water in the next generation.

These rivers are important to us. We've used them for navigation, to generate electricity, to carry away our waste, to irrigate our farmlands, to provide us with recreation and much more. Although we have relied on rivers for many ecological and economic services, we have done little to ensure that water will remain for fish and other aquatic creatures, for beauty and serenity, for recreation and the environment.

Population growth and other factors — including the increased groundwater pumping that threatens to dry up the springs that nourish Texas rivers — promise to strain rivers as never before and potentially even dry them up. As inconceivable as this frightening specter may be, we have witnessed the mighty Rio Grande with so little flow that it no longer reached the Gulf of Mexico.

It was not until the mid-1980s that the State of Texas began putting environmental conditions on consumptive water rights permits, and by that time, most of the water in our rivers had already been spoken for, says Cindy Loeffler, water resources branch chief for the Texas Parks and Wildlife Department.

Against this bleak backdrop, the Texas water world was shaken on its axis when a grass-roots organization of river enthusiasts, the San Marcos River Foundation, filed for a permit before the then-Texas Natural Resources Conservation Commission that, if granted, would have committed the remaining 1.3 million acre-feet of unappropriated water in the Guadalupe River basin to stay in the river forever. Reaction was swift and harsh. Critics

called the application a thinly veiled effort to limit growth in the region. Something akin to panic spread among those with interest in that water. Quickly, legislation was filed in the Texas Senate to make such permit applications by nonprofit conservation organizations illegal.

Cooler heads prevailed and Lt. Gov. David Dewhurst called for a study involving legislative leaders from both houses (as well as stakeholders, including environmentalists and economic interests), with a mandate to return to the Legislature with an agreed-upon plan to address what was suddenly, thanks to the San Marcos River Foundation, a rather urgent issue. The heart of the issue was how to maintain the economic uses of Texas rivers while protecting the "environmental flows" that nourish the life within them.

The San Marcos River Foundation's permit application was denied by the Texas Commission on Environmental Quality in 2003, but that same year, the Legislature formally created a 15-member study commission that, after years of meetings and negotiations, came to a consensus on a plan to protect environmental flows in our rivers and streams.

The results of the environmental flows negotiations, which were affirmed by a second panel, were subsequently embodied in Article 1 of Senate Bill 3, passed by the Legislature in the spring of 2007. The act, among other things, established an aggressive sequential schedule that called for setting environmental flow standards two river basins at a time. Starting with the Sabine/Neches basin and the Trinity/San Jacinto basin, the process was designed to establish criteria for both instream flows, the amount of water needed in a stream to protect habitat, water quality and recreation, and freshwater inflows, the amount of water flowing into a bay or estuary necessary to maintain its ecological health.

A key reason for the expedited process was the realization that a number of pending water rights applications awaited decision by the Texas Commission on Environmental Quality. What little water remained would likely be designated for other uses in the absence of any environ-

**The expert science teams are to consider only science in determining the amount of environmental flows needed to maintain a sound ecological environment in Texas rivers and streams. The science team report, which forms the basis for stakeholder recommendations, is submitted directly to the commission without edits or amendments from stakeholders.**

mental flow requirements.

A unique feature of the Texas environmental flows process (as laid out in Senate Bill 3 and now part of the Texas Water Code) is that it is scientifically informed. A statewide Environmental Flows Advisory Group has been established to oversee the process. Texas Parks and Wildlife Commissioner Karen Hixon is a member of this group. The Environmental Flows Advisory Group has appointed a statewide Science Advisory Committee and also appoints stakeholder committees for each river basin. These groups of stakeholders, called Basin and Bay Area Stakeholder Committees, represent both environmental interests and economic interests, including agriculture, industry and municipal interests. Once constituted, the stakeholder committees select an expert science team for the basin to advise them.

Through a process that mandates input from the public and technical support from each of the state agencies concerned with water — the Texas Commission on Environmental Quality, the Texas Water Development Board and the Texas Parks and Wildlife Department — environmental flow recommendations are submitted to the commission for adoption as legal rules. The stakeholder committees are charged with reviewing recommendations from the expert science teams and considering them in the context of other factors, primarily pres-



TOP PHOTO © LAURENCE PARENT; BOTTOM © RUSSELL A. GRAVES

**In a process now under way, stakeholders and science teams are determining standards to protect "environmental flows" in rivers and streams.**

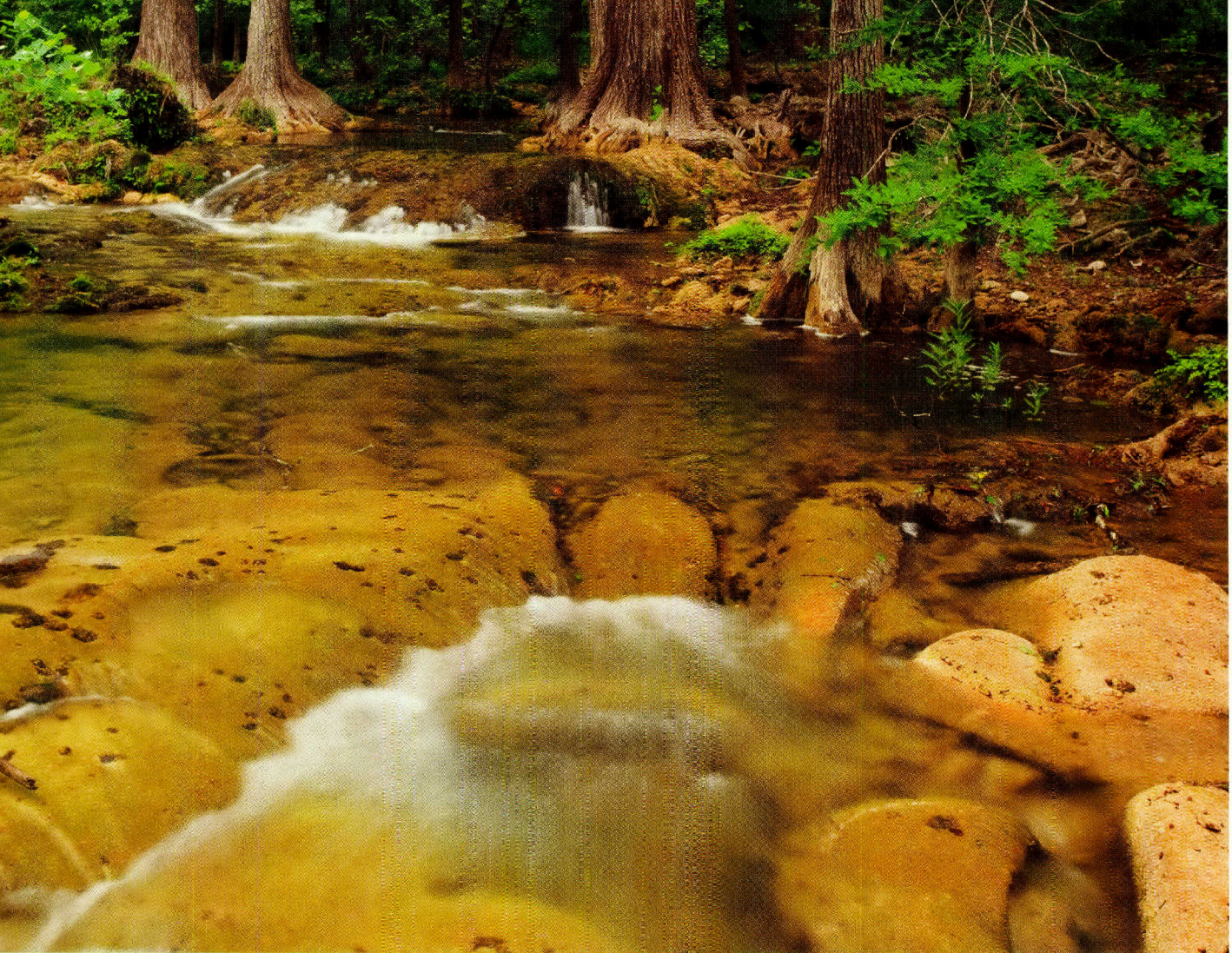
ent and future water needs for purposes other than the environment.

The expert science teams are to consider only science in determining the amount of environmental flows needed to maintain a sound ecological environment in Texas rivers and streams. The science team report, which forms the basis for stakeholder recommendations, is submitted directly to the commission without edits or amendments from stakeholders. Based on the two reports and on input from the public, the commission is charged with rulemaking to establish legally binding environmental flow standards for each bay and basin.

Another unique feature of the process is that it incorporates a concept known as adaptive management, which assumes that new knowledge may come forth concerning the needs of our rivers and allows for the standards set by the commission to be reviewed at least every 10 years and revised as necessary.

To date, following the sequential schedule laid out in Senate Bill 3, rec-





ommendations have been submitted to the commission for the Sabine/Neches/Sabine Lake system and the Trinity/San Jacinto/Galveston Bay system.

According to Myron Hess, an expert in water law and Texas water program manager for the National Wildlife Federation, results so far are mixed, but he is cautiously optimistic. The process is "struggling," Hess says. The expert science team for the Trinity Basin could not find a way to work together and split down the middle on its report, with consultants representing water users and river authorities on one side and biologists on the other. As a result, the commission staff did not receive a unified recommendation from the science team, and, perhaps for this reason, proposed environmental flow standards are, in Hess' view, "very low."

In the Sabine/Neches basin, according to Hess, stakeholders concluded that more study was needed before they could recommend environmental flow regimes. Though a report was filed late

from the stakeholder group, the commission staff had substantially reduced the science team's recommendations in its proposed rules.

After considering staff recommendations and input from interested parties (including Commissioner Hixon, who expressed concern that the proposed rules were "not consistent with the legislative intent of SB 3"), TCEQ commissioners voted 2-1 to add only 10 percent to the staff base flow recommendations for the Sabine, Neches and San Jacinto rivers. Responding to this action, Hess declared: "TCEQ's position paints a very troubling picture for the future of our estuaries. It must serve as a wake-up call for everyone who cares about Texas rivers and the Texas coast."

The good news is that things look much better in the next two rivers in the Senate Bill 3 process, the Guadalupe and the Colorado/Lavaca. The expert science teams have completed their work, and both reached consensus, coming forth with a unified set of rec-

ommended standards. Additionally, the stakeholder groups in both basins are working together well, and the prevailing attitude seems to be that a strong positive outcome will result. At the same time, TPWD scientists under Loeffler's direction are fully engaged in the process, and the department's efforts on behalf of both the ecological health and the recreational use of Texas rivers have greatly increased.

These are positive signs and come none too soon. The rivers of Texas deserve no less.

Recently, I returned to Santa Elena Canyon, where there was so little water flowing that we had to put in at the mouth, normally the end of the trip, and paddle upstream to the Rockslide in the still pool of water that is all that remains of the river there. The canyon is still magnificent, and though we were again humbled to be back beneath the lovely ribbon of sky, the flowing Rio Grande is gone, and somehow the great canyon has lost its soul. ★



INTRO  
GULF  
SPRINGS  
RIVERS  
WETLANDS  
~~~~~  
LAKES  
BAYS  
PHOTO ESSAY

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Familiar bluets, a common species of damselfly, share Texas wetlands with numerous other species.





# WILD, WILD WETLANDS

**Texas marshes, home to a stunning array of wildlife,  
have been drained, dredged and carved up,  
but now an unlikely team is working to reverse the decline.**

BY WENDEE HOLTCAMP

The moon is full, the night is warm, and I'm sitting in the high seat of an airboat, like a queen on a wetland wildlife safari. I feel like a firsthand witness to the springtime creation of new life. The deep glunk-glunk of a bronze frog, like a banjo, creates the song of the night, and baby marsh birds are everywhere. Two black-necked stilts guide their chicks, beige fuzzballs on stick legs, across a mudflat. A 6-foot gator slithers perilously near as a downy moorhen chick submerges itself, and I gaze in awe at the glowing orange eyes of what seems like a hundred of the reptilian beasts down the watery slough.

It is so beautiful and wild that this could be Africa's Okavanga Delta, only we're a mere hundred miles east of Houston.

I've joined Texas Parks and Wildlife Department biologists at the 24,250-acre J.D. Murphree Wildlife Management Area to find and catch alligators and mottled ducks in the marshes on the upper Texas coast. Duck hunters converge on these marshes every fall and winter, but populations of mottled ducks have taken a nosedive in Texas over the past 45 years. Some blame the increase in alligator populations, but it's more likely that mottled duck declines may merely be symptomatic of landscape modification writ large on this low-lying coastal plain formed from the Sabine and Neches rivers.

Since European settlers first arrived, this marshy landscape has been carved, dredged, polluted and sucked dry. Many different types of wetlands exist in Texas and around the world — from coastal marsh to prairie potholes to bottomland hardwood forests along creeks and rivers — and this is by no means the only place that wetlands have been disregarded in the pursuit of human enterprise before recognition of their intrinsic worth. For decades after European colonization, wetlands were maligned, feared and cursed, and according to the U.S. Fish

and Wildlife Service, more than half of the lower 48's original 221 million acres of wetlands have, in fact, disappeared. The U.S. Swamp Lands Act of 1849 gave away 65 million acres of federal wetlands with the caveat that the new owners would drain them.

Over time, attitudes changed. Science revealed the myriad ways wetlands help us — they provide critical habitat for the fish

**Science revealed the myriad ways wetlands help us — they provide critical habitat for the fish we harvest and the birds we delightedly watch, not to mention amphibians, reptiles, insects and other invertebrates.**

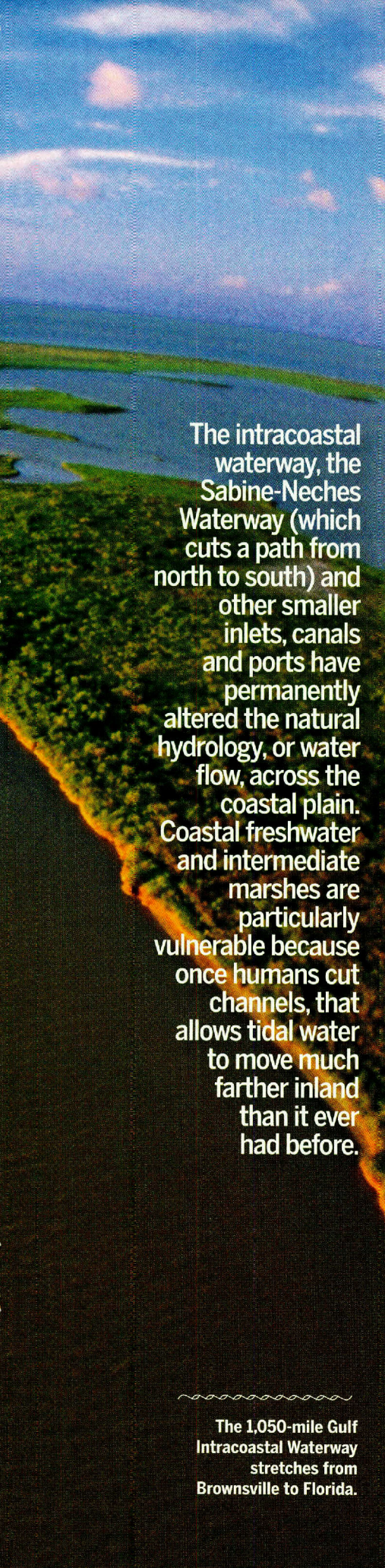


The J.D. Murphree Wildlife Management Area, between Port Arthur and Sea Rim State Park, is a land of alligators, ducks, frogs and fish.



PHOTO © MITCH VILLEREA





The intracoastal waterway, the Sabine-Neches Waterway (which cuts a path from north to south) and other smaller inlets, canals and ports have permanently altered the natural hydrology, or water flow, across the coastal plain. Coastal freshwater and intermediate marshes are particularly vulnerable because once humans cut channels, that allows tidal water to move much farther inland than it ever had before.

The 1,050-mile Gulf Intracoastal Waterway stretches from Brownsville to Florida.

we harvest and the birds we delightedly watch, not to mention amphibians, reptiles, insects and other invertebrates. Coastal wetlands offer a measure of flood control by absorbing excess rainfall and protecting inland homes from greater destruction during hurricanes.

In the natural state of affairs, coastal wetlands exist in a gradient of saltiness. Farthest inland are freshwater wetlands, followed by intermediate, then brackish and, finally, salt marsh nearest to the ocean. Each type has its own unique plants and animals. Roseate spoonbills, pelicans, sandpipers, terns and other shorebirds feed on the abundant fish and shellfish in the estuaries, which include brackish, intermediate and salt marsh.

“[Almost] all the fish in the Gulf have their nursery habitat in the estuary,” says Tom Tremblay with the Bureau of Economic Geology, who has documented the loss of Texas coastal wetlands over the past 50 years. “If you lose the estuary, you lose the fish. That’s the bottom of the food chain for a lot of things.”

Freshwater marshes have the highest plant species biodiversity, and many shorebirds and waterfowl nest here.

“Freshwater coastal marsh is extremely important due to the diversity and production dynamics of fish, wildlife and plants found there,” explains Jim Sutherlin, TPWD’s upper Texas coast wetland ecosystem project leader, based at Murphree. “Here is where a tremendous amount of insect production occurs — dragonflies, mayflies and a host of others. This really cranks the food web.”

As the airboat picks up speed, bugs whiz by my face with surprising rapidity: *whack-whack-whack*. Above the water’s surface, cordgrass intermingles with black-rush and bulrush, sedges and common reed, creating a soft, windswept look. The bright spotlight illuminates wigeon-grass beds growing under the water’s surface. Mottled and other “dabbling ducks” tip their bottoms in the air while feeding on wigeongrass and other underwater plants, along with the occasional crayfish and invertebrate.

From the water, the marsh looks vigorously healthy and abounding with new life. In the cover of night, hens take their brood out to feed and

explore, and seeing these wild animals in their natural element is breathtaking. Yet, from a bird’s-eye view, it becomes apparent how much the intricate labyrinth of marshy land has been carved up and dredged.

Starting in the late 1800s, engineers began building the 1,050-mile Gulf Intracoastal Waterway parallel to the coastline, and it now stretches from Brownsville to Florida. The intracoastal waterway, the Sabine-Neches Waterway (which cuts a path from north to south) and other smaller inlets, canals and ports have permanently altered the natural hydrology, or water flow, across the coastal plain. Coastal freshwater and intermediate marshes are particularly vulnerable because once channels are cut, that allows tidal water to move much farther inland than it ever had before.

“Too much salt water will kill freshwater plants that hold the fragile organic soils together,” says TPWD biologist Mike Rezsutek. “Once the plants are dead, the soil is easily eroded, turning marsh into open water. More-salt-tolerant plants can’t colonize before the soil is lost.”

Most baby marsh birds do not like salty water, either. Ducklings of mottled ducks, for example, will die in water with salinity over 8 parts per thousand.

Much of Texas’ coastal wetlands have disappeared or been negatively affected since human settlement, and nowhere is that loss more pronounced than on the upper Texas coast. This region nearest Louisiana loses more than 40 feet of land per year — the highest rate of coastal erosion in Texas and some of the highest in the nation — compared to a statewide average of two feet per year. Sea level is rising around the world, but the “relative sea level rise” varies on different coastlines. On the upper Texas coast, not only is the ocean level rising, but the ground is also sinking because of the extraction of groundwater and oil. All this contributes to the decline of coastal marsh.

We glide through the watery labyrinth as the full moon ascends, a giant orb over the landscape owned by the gators and ducks, frogs and fish. As we approach a family of mottled ducks, Rezsutek lies on his stomach at the airboat’s bow, ready to catch each and every



**In these modern times, wild nature overlaps human enterprise. On the Texas coast, they are intertwined, interspersed and, to some extent, interdependent.**

**Above: Marsh-dwelling mottled ducks have been on the decline in Texas. Right: Dredged mud is being used to build up marshland on the upper coast.**

one as they scurry for cover.

He hands them to another biologist, who counts each one out loud before placing it into a sack. After the entire brood is captured, each duckling gets a leg band and is released. The data collected helps provide information on movements, survival, harvest rates and population estimates. Another team is out catching alligators to document their abundance and diet.

The shimmering lights of the Beaumont-Port Arthur petrochemical complex, one of the nation's largest, illuminate the horizon. In these modern times, wild nature overlaps human enterprise. On the Texas coast, they are intertwined, interspersed and, to some extent, interdependent. And after decades of conflicting interests and demands on the landscape, in a few shining examples, they have begun to work together not just to make up for damage done, but as partners in the creation of new life.

SIX YEARS LATER, I'm on an airboat in the same coastal marsh but in broad daylight, when ducklings, baby birds and most gators are hiding. Sutherlin takes me out to a cracked, drying moonscape of brown mud in the middle of the Murphree's Salt Bayou Unit. The vastness of the mud field is astounding. It stretches on as far as the eye can see.

Did all those hurricanes wash the marsh away? Did it die from salty water? Did it erode or sink from rising seas? What happened here? The mud, it turns out, is part of a project to reverse the decline of the marsh.

With so much coastal marsh eroding and degrading for various reasons, biologist Jamie Schubert in TPWD's Coastal Fisheries Division submitted a post-Ike recovery grant application to the National Oceanic and Atmospheric Administration, and was awarded \$1 million to restore 37.5 acres of marsh.

"We were able to bring Golden Pass Liquid Natural Gas on board and use



their dredged material to leverage the funds and increase the project size to about 1,500 acres,” says Rezsutek. In the Sabine-Neches Waterway, Golden Pass ships unload in a terminal that is equivalent to a driveway off a street. Mud constantly fills in and settles on the bottom of the terminal, requiring constant dredging. Instead of dumping it at a Corps of Engineers dredge placement site, Golden Pass opted to work with TPWD to create a beneficial use for the dredge spoil.

The airboat pilot kills the engine, and we carefully step out and onto a giant expanse of cracked mud. “It’s like the surface of the moon,” says Sutherlin. It’s barren, all right. I have to walk carefully on the solid surfaces, which are separated like pillars with masses of goopy muck in between and underneath — after all, they deposited 3.2 million cubic yards of mud here.

Building up the elevation of the marsh buffers it against erosion and sea level rise, which has contributed to marsh decline here for decades.

“Settlement will occur across the entire area,” explains Rezsutek, “so the end product will have similar contours — ponds, channels, high marsh — as

the degrading marsh, just at a slightly higher elevation.”

All the mud gets tested to make sure it does not have any chemicals that could be toxic to wildlife or plants. When it’s ready, the mud is transported from the terminal to the marsh through a giant pipe, and then workers allow the mud to settle before planting three different marsh grass species. Sutherlin points out the rows of newly planted salt grass, marsh hay and seashore paspalum.

“We have to re-establish vegetation on the landscape to get the habitat to function,” he says.

Within a few months, this entire area will be covered in verdant marsh grasses — along with feeding shorebirds.

“Historically, this was fresh to intermediate marsh. Changes to the hydrology cut off freshwater flows, and the Sabine-Neches Waterway allowed salt to come in a big way,” says Sutherlin.

Right now the restored mud marsh is brackish, but as a mosaic of emergent plants gets re-established over time, it should become less salty. TPWD has plans to reduce the volume of salt water that reaches the marsh here, and then over time, the region’s notoriously heavy rainfalls will help keep fresh water in the marsh.

“Our intent is to restore the hydrology to a point where we simulate the historic functions of that landscape,” Sutherlin says.

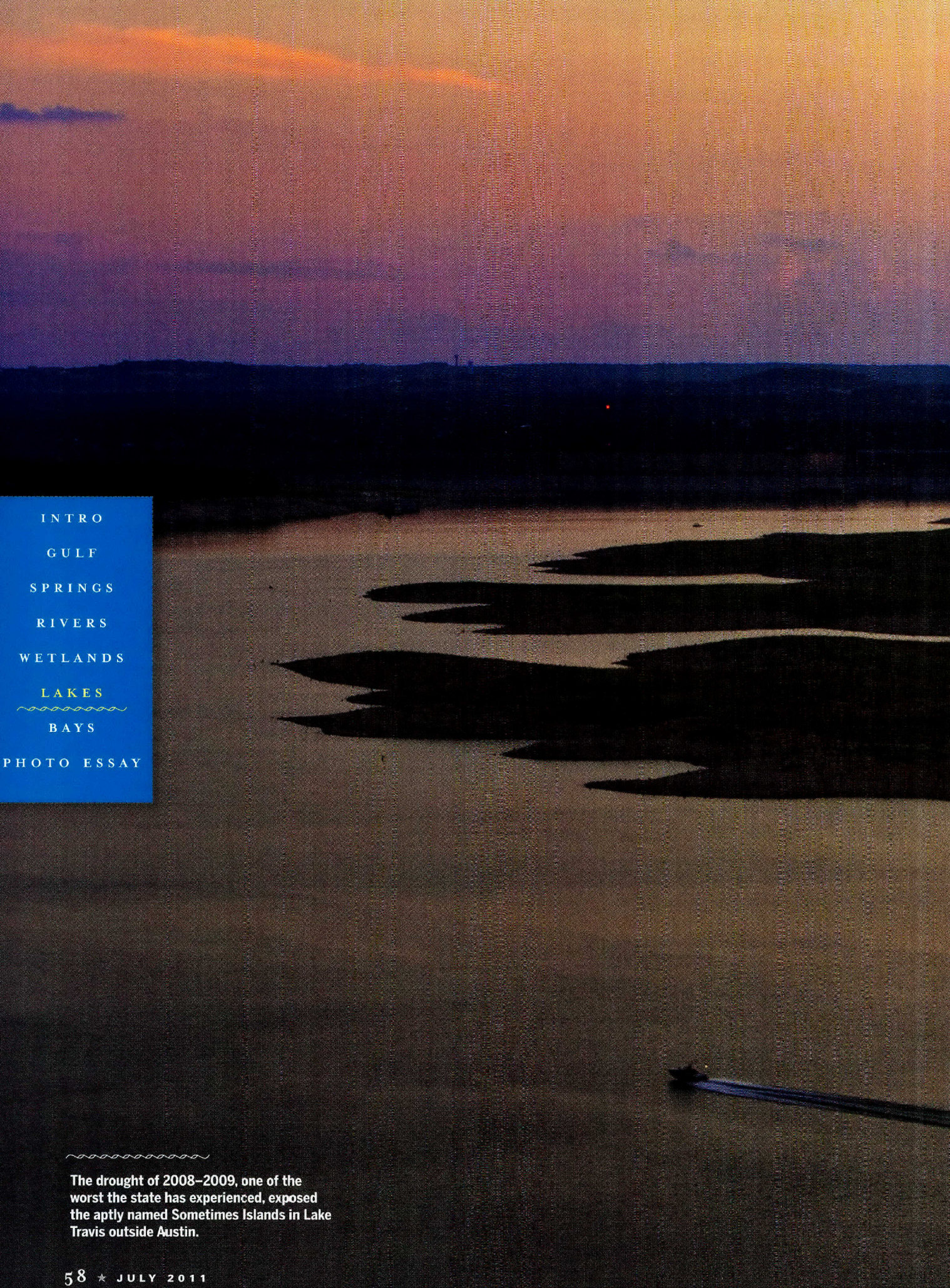
The project exemplifies how TPWD can work with industry to create win-win situations. Besides Golden Pass’ terminal, there are billions of cubic yards of dredge spoil that comes out of these channels every year, some of which is now used in various “beneficial use” projects around Texas bays and estuaries.

“We can complain about the navigation folks all we want to, but when we start to solve this is when we start working with them to use every ounce, every cubic foot of this material that comes out of the ship channel,” says Sutherlin.

“I think that we are growing as professionals as a result of things like Hurricane Ike that just devastate the whole system,” Sutherlin adds. “It allows us to really begin to build our vision for how the Texas coast might be maintained.” ☆



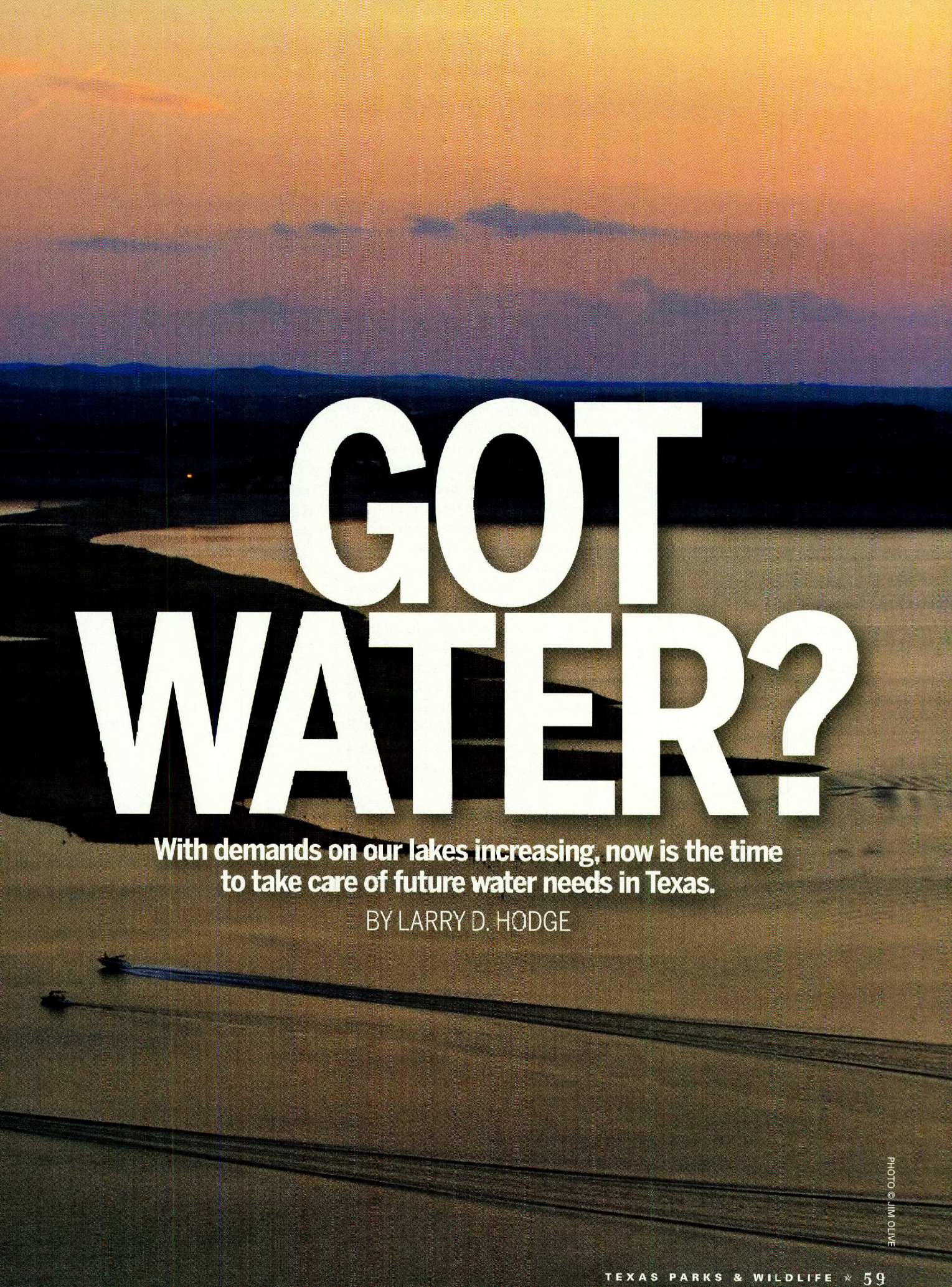
TOP PHOTO © ROLF NUSSBAUMER/HOLFNP.COM; BOTTOM © WENDEE HOLT CAMP



INTRO  
GULF  
SPRINGS  
RIVERS  
WETLANDS  
LAKES  
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BAYS  
PHOTO ESSAY

~~~~~  
The drought of 2008–2009, one of the worst the state has experienced, exposed the aptly named Sometimes Islands in Lake Travis outside Austin.





# GOT WATER?

**With demands on our lakes increasing, now is the time to take care of future water needs in Texas.**

BY LARRY D. HODGE

PHOTO © JIM OLIVE

Texans love their lakes, whether they are fishing for the lunker of a lifetime, speeding across the surface propelled by the wind or a herd of gas-fed horses or simply luxuriating in the view of the setting sun from a lakeside campsite, restaurant or home.

“At the lake” is where many Texans live on weekends. We boat, swim, camp, paddle, fish, sail, party, bond, laze. We make memories that will last a lifetime. Lakes surprise us with 10-pound bass like the one I caught on Cooper Lake in March, or the serenity of a morning kayak paddle on Caddo Lake like the one my wife and I enjoyed last year.

Few living Texans can remember the time when the state was not blessed with a multitude of sparkling lakes. Yet it was not always so, and not so long ago.

Responding to the drought of record that bled Texas dry in the 1950s, Texas built reservoirs — to date 196 of them with a surface area of 5,000 acres or more, 175 of which are used for water supply. In ensuing years we have built a great urban civilization that depends on lakes.

Yet perhaps because they are so central to the fun parts of our lives, we sometimes take the serious side of lakes for granted. Lakes are water. Water is life.

“Reservoirs are our water supply,” says David Wheelock, manager of water supply and conservation for the Lower Colorado River Authority. “We have no near-term concerns about the reservoirs and their ability to meet our current needs. However, as competing demands for water increase, we have to more carefully manage all our water resources.”

Texas reservoirs and all other sources of water — groundwater, reuse of water, conservation, desalination — already fall short of providing all our water needs during droughts. Right now, if a drought equal to that of the 1950s were to occur, demand for water would far outstrip the supply. And that supply is decreasing.

According to *Water for Texas: Summary of the 2011 Regional Water Plans*, the basis for the

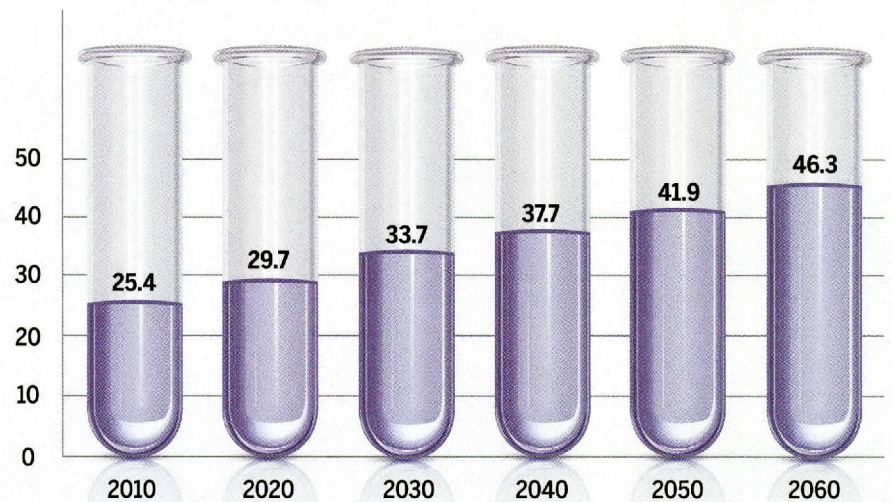
2012 state water plan developed and revised every five years by regional water planning groups and the Texas Water Development Board, existing water supplies are projected to decrease about 10 percent between 2010 and 2060. During the same time period, demand is expected to increase by 22 percent, primarily because of an expected population increase to 46 million people.

Failure to plan for and meet the demand for water would have dire consequences. By 2060, “If no water management strategies could be implemented to meet these needs, Texas businesses and workers could lose \$115.7 billion in income, 1.1 million jobs would not be created, and 1.4 million in population growth would not be achieved,” says the 2012 state water plan, now in draft form. “Forgone state and local business taxes

**Right now, if a drought equal to that of the 1950s were to occur, demand for water would far outstrip the supply. And that supply is decreasing.**

## Texas Projected Population Growth

MILLIONS OF TEXANS



**The population in Texas is expected to nearly double between the years 2010 and 2060. The growth rates, however, will vary considerably across the state.**

Source: Texas Water Development Board



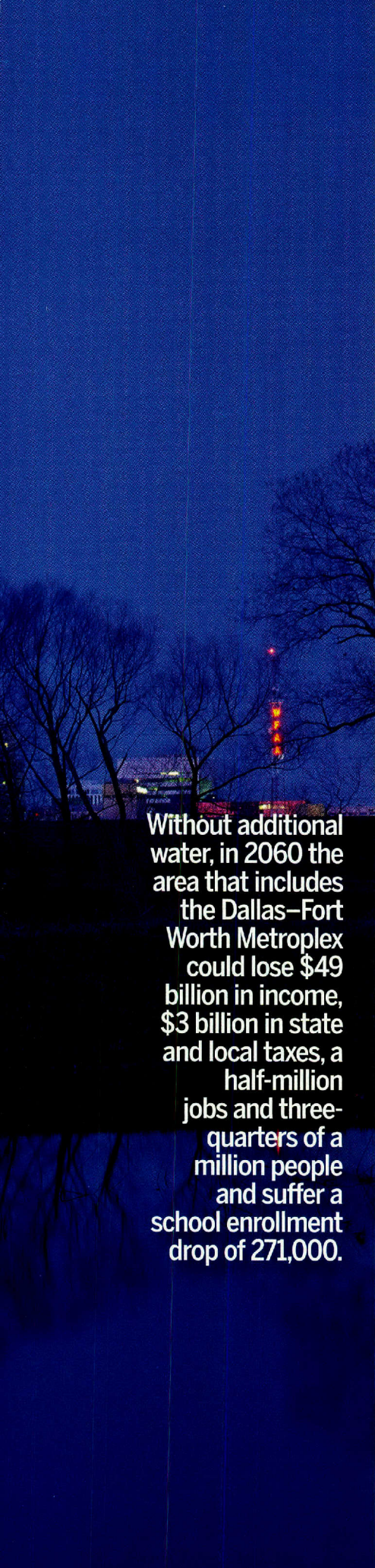
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Researchers are studying playa lakes to try to determine groundwater infiltration rates and the effects on aquifer recharge. The results may guide aquifer-boosting land management practices.

PHOTO BY EARL NOTTINGHAM/TPWD



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Dallas, where the Trinity River runs near downtown, obtains its water from area reservoirs. It has plans to tap into more reservoirs as its population expands.



Without additional water, in 2060 the area that includes the Dallas–Fort Worth Metroplex could lose \$49 billion in income, \$3 billion in state and local taxes, a half-million jobs and three-quarters of a million people and suffer a school enrollment drop of 271,000.

PHOTO © LAURENCE PARENT

associated with lost commerce could amount to \$9.8 billion in 2060.”

Reservoir management strategies would have the greatest economic impact on urban areas, except those in the Texas Panhandle, which depend primarily on groundwater from the Ogallala Aquifer. Without additional water, in 2060 the area that includes the Dallas–Fort Worth Metroplex could lose \$49 billion in income, \$3 billion in state and local taxes, a half-million jobs and three-quarters of a million people and suffer a school enrollment drop of 271,000.

Those figures are just for the year 2060 and assume a drought of record. Impacts in previous years would also be severe; estimates are in the 2012 plan.

There is no intention among those responsible for planning for Texas water needs and supplying water to allow a statewide version of the disaster that struck the Great Plains late in the 19th century when drought stymied efforts to settle and farm the region, leaving behind what one writer called “a mass of human wreckage in the shape of broken fortunes, deserted farms and ruined homes.” Yet this will happen again unless we act, and act now.

Regional water planning groups have been busy seeking to identify their water

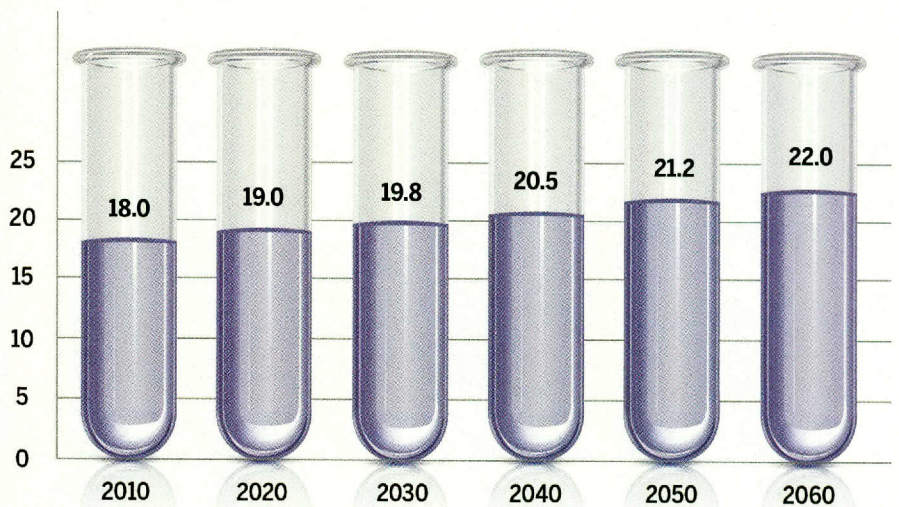
needs each decade through 2060, ways to meet those needs and the price tag for doing so. The 2007 state water plan estimated the cost at \$31 billion; the 2012 version hikes that to \$53 billion. Of that \$53 billion, half needs to come from local sources and half from the state, and nearly \$32 billion of the total needs to be spent in the next 10 years. TPWD serves as a nonvoting member on each of the 16 groups, providing input on impacts to fish and wildlife resources.

Regional water plans identify a wide range of strategies to meet the demand for water, including 26 new reservoirs (up from 16 in the 2007 plan) to supplement those already existing. Some are “traditional” reservoirs, those that impound a flowing stream. Others are off-channel reservoirs that can be used to hold and store water pumped from a stream in times of high flow, then used when needed.

Groundwater has special appeal to reservoir operators, because it can be used in conjunction with surface water. The groundwater can be left in the ground until needed to supplement reservoirs in time of drought. “If managed conjunctively with surface water, groundwater can lessen the impact of a drought,” says John Hofmann, central

## Texas Water Demand Projections

MILLIONS OF ACRE-FEET



Although the population is projected to nearly double, water demand is projected to increase by only 22 percent. This smaller increase is primarily due to declining demand for agricultural irrigation water and increased emphasis on municipal water conservation.

Source: Texas Water Development Board

and lower basin manager for the Brazos River Authority. "There are concerns about the long-term impact on ground-water supply, and conjunctive use is a really long-term approach, but it may be 10 to 15 years before we need to access that source."

Another option is to increase the conservation capacity of existing reservoirs. Many reservoirs, especially those built by the U.S. Army Corps of Engineers, were built primarily for flood control, and much of their capacity is unused most of the time. The Corps of Engineers and the Brazos River Authority are studying reservoirs in the Brazos River basin to determine if some flood control capacity can be reallocated to conservation, in effect making the lake bigger. While it sounds simple, raising the conservation pool level could mean having to build new boat ramps, raise bridges, move utility lines and possibly modify dams or spillways.

"The costs will be large for the amount of water generated, but there may be no other options in some cases," says Brad Brunett, water services manager for the Brazos River Authority. "We will look at all the factors and decide on a case-by-case basis if reallocation will be worth the cost."

Existing reservoirs will continue to be

the source of the majority of water, but only if they are maintained. "The long-term issue in reservoir management is sedimentation," says LCRA's Wheelock. Sediment washed into reservoirs will eventually harm them.

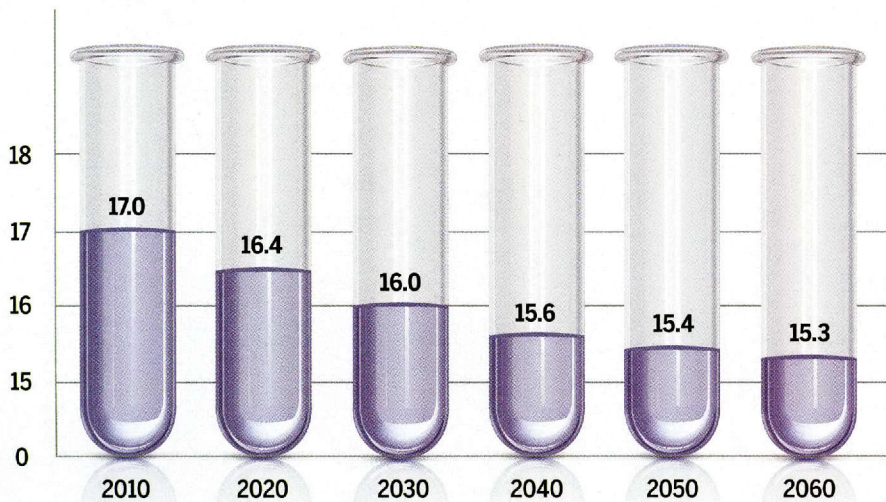
"We estimated in the 2007 state water plan that Texas' major reservoirs could be losing up to 90,000 acre-feet of storage per year due to sedimentation," says Carolyn Brittin, deputy administrator for water resources planning and information for the Texas Water Development Board. "Existing water supplies in the state are projected to decrease about 10 percent by 2060, primarily due to accumulation of sediment in reservoirs, the depletion of the Ogallala Aquifer and decreased ground-water availability."

Brunett says that sedimentation happens in all reservoirs. "Possum Kingdom Reservoir, [BRA's] oldest, has collected roughly 184,000 acre-feet of sediment — 25 million dump-truck loads — in the last 65 years," he says. "That is larger than Lake Granbury in its entirety. Dredging on that magnitude is not feasible. Another 50 years in the future, the economics of water will be different, and who can say if dredging will be feasible or not. Ultimately, we will have three choices:

One option is to increase the conservation capacity of existing reservoirs. Many reservoirs, especially those built by the U.S. Army Corps of Engineers, were built primarily for flood control, and much of their capacity is unused most of the time.

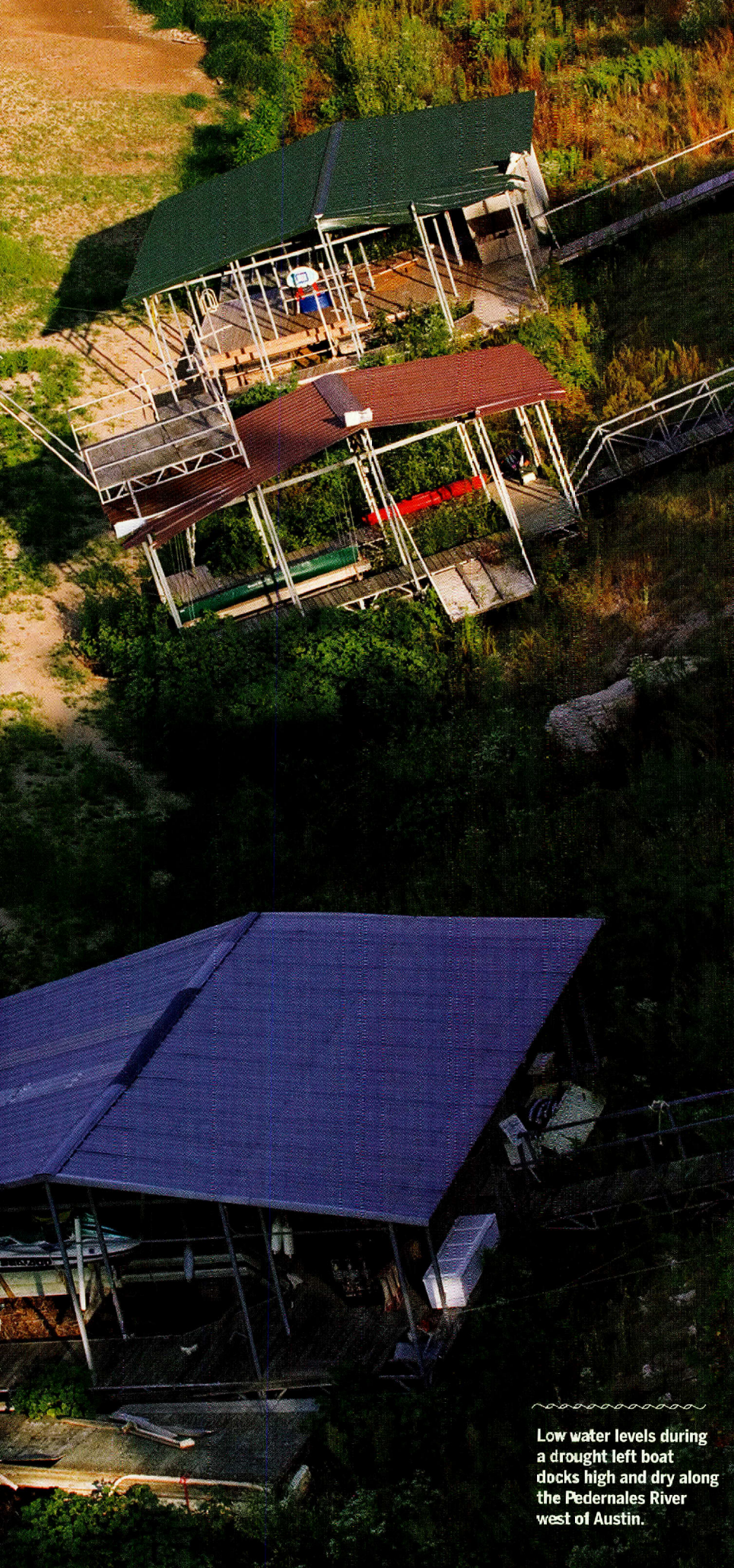
## Texas Existing Water Supplies

MILLIONS OF ACRE-FEET



Existing water supplies are projected to decrease — primarily because of accumulation of sediment in reservoirs, depletion of the Ogallala Aquifer and decreased groundwater availability, such as mandatory reductions associated with Gulf Coast Aquifer subsidence.

Source: Texas Water Development Board



Low water levels during a drought left boat docks high and dry along the Pedernales River west of Austin.

dredging, building new reservoirs or developing other sources of water.”

River authorities are helping to fund sediment-reducing land use practices on private lands within watersheds feeding reservoirs. LCRA’s Creekside Conservation Program resulted from a study on how to reduce sedimentation from the Sandy Creek watershed in Gillespie and Llano counties.

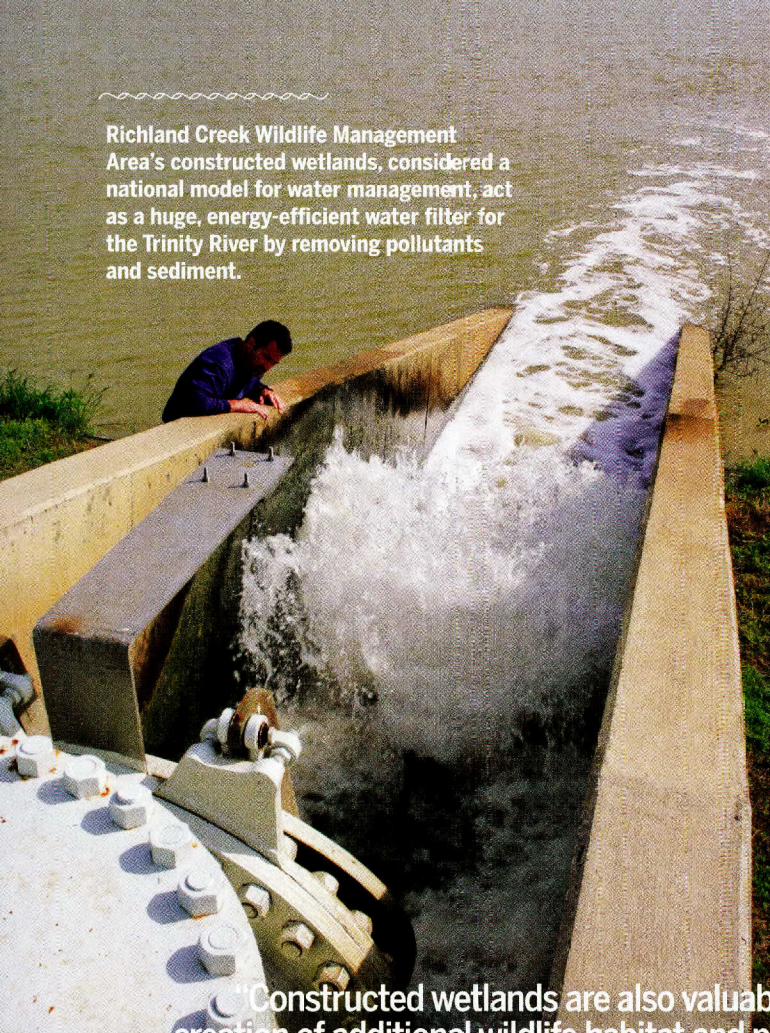
“Plan A was to install check dams and let the sediment drop out, then mine it and get rid of it,” says Rusty Ray, supervisor of land conservation services for LCRA. “The cost was sky-high. Plan B was working with private landowners to stabilize their soils so it doesn’t wash into the reservoirs. We now do as many as 25 projects a year in 10 counties.”

Our aquifers are still the largest freshwater reservoirs we have, but the science is still developing to measure just how changes in land management practices might affect infiltration of water into the soil and subsequent seepage into aquifers for eventual discharge through springs into streams. Texas Tech University’s Ken Rainwater and his colleagues have been working on a project that may someday be able to help answer that question. Rainwater’s team uses instruments to record changes in water stored in and evaporated from playa lakes and temperature probes at different depths in the soil to measure infiltration rates around playa lakes. They are also working with the Texas State Soil and Water Conservation Board’s water supply enhancement program to study how local applications of brush control can increase stream flow and groundwater storage.

“What we are hoping to establish with this research is a way to gauge the impact of changes in land-use practices on groundwater infiltration and aquifer recharge,” he says. “There is more than one direction water can go — infiltration, evaporation, transpiration, runoff — and we hope someday to be able to give land managers guidance as to what portions of a watershed might be best suited for brush control or other management practices. The only way to really see changes in the flow is to measure them, but observing the impact may take years. If we remove brush, some of the rainfall

PHOTO © JIM OLIVE

Richland Creek Wildlife Management Area's constructed wetlands, considered a national model for water management, act as a huge, energy-efficient water filter for the Trinity River by removing pollutants and sediment.



“Constructed wetlands are also valuable because of their educational value, creation of additional wildlife habitat and public acceptance of the reused product — people see them more positively than they do a wastewater treatment plant.”



PHOTOS BY EARL NOTTINGHAM/TPWD; BOTTOM RIGHT BY TPWD



may run off, but some may raise the water table. It took years for the water table and stream flows to go down; it will likely take years for them to recover.”

The quality of water entering reservoirs is also important and serves as the focus of work by Larry Hauck of Tarleton State University. As water flows across the land or through aquifers, it picks up minerals, nutrients, bacteria and chemicals and carries them with it. Like Rainwater, Hauck is interested in being able to measure what’s happening as a way of evaluating the effectiveness of management practices.

“I think we can do a better job of measuring what is going on in watersheds,” he says. “As our nation undertakes restoration of impaired water bodies and protection of threatened water bodies, watershed management will be a crucial part of the process.”

In recognition of the importance of managing watersheds, TPWD has set up the Watershed Policy and Management Program within its Inland Fisheries Division. The program’s goals have a direct impact on reservoirs, says Gary Garrett, the senior scientist and program director.

“Land management practices reduce erosion and sedimentation, help percolation to feed higher-quality water into streams and reservoirs and keep riparian areas healthy,” he says. “It’s easy to think about reservoirs as not being connected to anything else, but they are. The water quality and quantity of reservoirs as well as sediments are all directly affected by their watersheds.”

Constructed wetlands along the Trinity River — the George W. Shannon Wetlands Water Reuse Project on TPWD’s Richland Creek Wildlife Management Area near Corsicana and the East Fork Raw Water Supply Project at the John Bunker Sands Wetland Center near Crandall — are emerging as national models for reusing water and dealing with sedimentation and pollution. Water pumped from the Trinity River — which consists largely of return flows from wastewater treatment plants in the Metroplex — circulates through wetlands, which let sediment settle out while aquatic plants gobble up phosphorus and nitrogen, and bacteria on the

plants remove harmful chemicals. The polished water is then piped to water supply reservoirs, where it begins the cycle anew.

“Wetlands are very energy-efficient, because they primarily use the sun’s energy to clean the water,” says Ellen McDonald, a water resources engineer with Alan Plummer Associates, the company that designed the wetlands.

“Constructed wetlands are also valuable because of their educational value, creation of additional wildlife habitat and public acceptance of the reused product — people see them more positively than they do a wastewater treatment plant.” Another benefit of water reuse projects is that the footprint on the landscape is minuscule compared to that required for new reservoirs.

Supply is one variable in the water equation; conservation is another. All regional water plans depend on conservation to some degree, because saved water is cheap water. In 2009, LCRA estimated that conservation programs cost about \$400 an acre-foot for water yielded, while new reservoirs and pipelines cost about \$2,000 an acre-foot. The amount of water that regional water plans estimate could be saved through agricultural and municipal conservation is more than the supply that would be generated by construction of the 26 new reservoirs proposed in the 2012 state water plan. Regional water plans are increasingly relying on conservation as a strategy for meeting future water needs, and voluntary conservation in urban areas could play a major role in avoiding the need for expensive new reservoirs.

Another challenge facing reservoir operators across the state is the desire of lakeside property owners and recreational users to have lakes maintained at stable levels rather than using the water for the purposes intended when the lakes were constructed.

“More and more people are opposing the use of reservoirs for water supply needs and wanting to keep lakes full for recreation and property interests,” says BRA’s Brunett. “Ultimately, we can’t have both during dry times, and people are going to have to understand that. Otherwise, we are facing much greater shortages of water than we realize.”

“We all benefit from decisions that were made 50 to 60 years ago about water,” says Ruben Solis, director of the water development board’s surface water resources division. “Now we need to make similar decisions for the benefit of future populations. It won’t be cheap, but it’s necessary. It’s part of recognizing what your vision for the future is and that there is a cost for that. What do we want to pass on to future generations? That’s what water planning is all about.”

“We have to be visionaries,” adds LCRA’s Wheelock. In the final analysis, that is the challenge facing those charged with supplying Texans with water: envisioning ways to work within legal, environmental, climatic, political and social restraints to keep the water coming.

It will keep coming — but only if we make it so, and water will come only in quantities that nature, politics and economics allow.

Making the best use of that water is up to each of us. ★

## FOR FURTHER READING

Anyone who drinks water will want to read *The Big Thirst: The Secret Life and Turbulent Future of Water* by Charles Fishman, which takes a global look at water and water issues. There is a tremendous amount of information available via the Internet about Texas reservoirs and water issues. The links below were used as sources for this article and are a start:

Texas Water Development Board: [www.twdb.state.tx.us](http://www.twdb.state.tx.us)

Lower Colorado River Authority: [www.lcra.org](http://www.lcra.org)

Brazos River Authority: [www.brazos.org](http://www.brazos.org)

Texas Commission on Environmental Quality: [www.tceq.state.tx.us](http://www.tceq.state.tx.us)

Texas Water Matters: [www.texaswatermatters.org](http://www.texaswatermatters.org)

North Texas Municipal Water District: [www.ntmwd.com](http://www.ntmwd.com)

Tarrant Regional Water District: [www.trwd.com](http://www.trwd.com)



INTRO

GULF

SPRINGS

RIVERS

WETLANDS

LAKES

BAYS

PHOTO ESSAY

~~~~~  
Whooping cranes return to Texas each fall  
to spend the winter along the coast.

A whooping crane is shown in profile, flying from left to right. Its long neck is extended forward, and its wings are partially visible on the left side. The background is a gradient of dark blue and purple, with a subtle texture.

**BIRD BY BIRD, FIN BY FIN,  
DROP BY  
DROP**

**For whooping cranes and other species,  
life depends on the health of Texas bays.**

BY CAROL FLAKE CHAPMAN

PHOTO © LARRY DITTO

Two distant white blobs stand out against the grayish horizon on an overcast day as the 75-foot Wharf Cat chugs slowly across Aransas Bay on its way to the Aransas National Wildlife Refuge. Bracing myself on the boat's observation deck, I focus my binoculars on the marshy southwest edge of the refuge and then nearly drop them in excitement as the blobs resolve themselves into a pair of huge birds feeding in a shallow pond.

One of the birds lifts its head in our direction, and there is no mistaking the distinctive reddish-capped head, the prominent beak, the long, curving neck, the stilty blue-black legs.

There's a collective gasp from my fellow passengers, who have come to Port Aransas on this cool, breezy late-February weekend for the Whooping Crane Festival. Because the endangered cranes have had such a precarious hold on the earth over the past decades, this is like getting a glimpse of a fabled relic from a mythical age. It feels as though we have spied a unicorn in the mist.

"That's old Lobstick," says George Archibald, founder of the International Crane Foundation, whose voice crackles with emotion over the boat's loudspeaker. He has spotted an old friend.

Named for his nesting area in Canada — in wetlands along Lobstick Creek, in the Northwest Territories — the 32-year-old patriarch is the oldest-known bird in the flock, says Archibald. Along with his younger mate, the elderly crane has staked out this part of the refuge, and he is usually the first whooper that visitors to the refuge can spot from the water. Sadly, he and his mate had no chick accompanying them this past fall when they arrived at the refuge after their long migration from Canada.

The number of surviving whooping cranes has been encouraging this past winter, however, according to Tom Stehn, who directs the crane program for the Aransas reserve. The total count for

the cranes as of mid-February, he says, was a record 281, which suggests a rebound from the disastrous winter of 2008, when the flock saw a significant die-off. It appeared that many of the birds had starved to death.

Because Texas bays are inextricably connected to inland watersheds, the cranes, like all the creatures that draw sustenance from the bay ecosystem, are affected by what happens upriver. Freshwater inflows from rivers provide the renewal water that flows through the estuary, diluting seawater and delivering nutrients.

**Because the endangered cranes have had such a precarious hold on the earth over the past decades, this is like getting a glimpse of a fabled relic from a mythical age.**



The Aransas National Wildlife Refuge on the Texas coast is home to whooping cranes each winter.



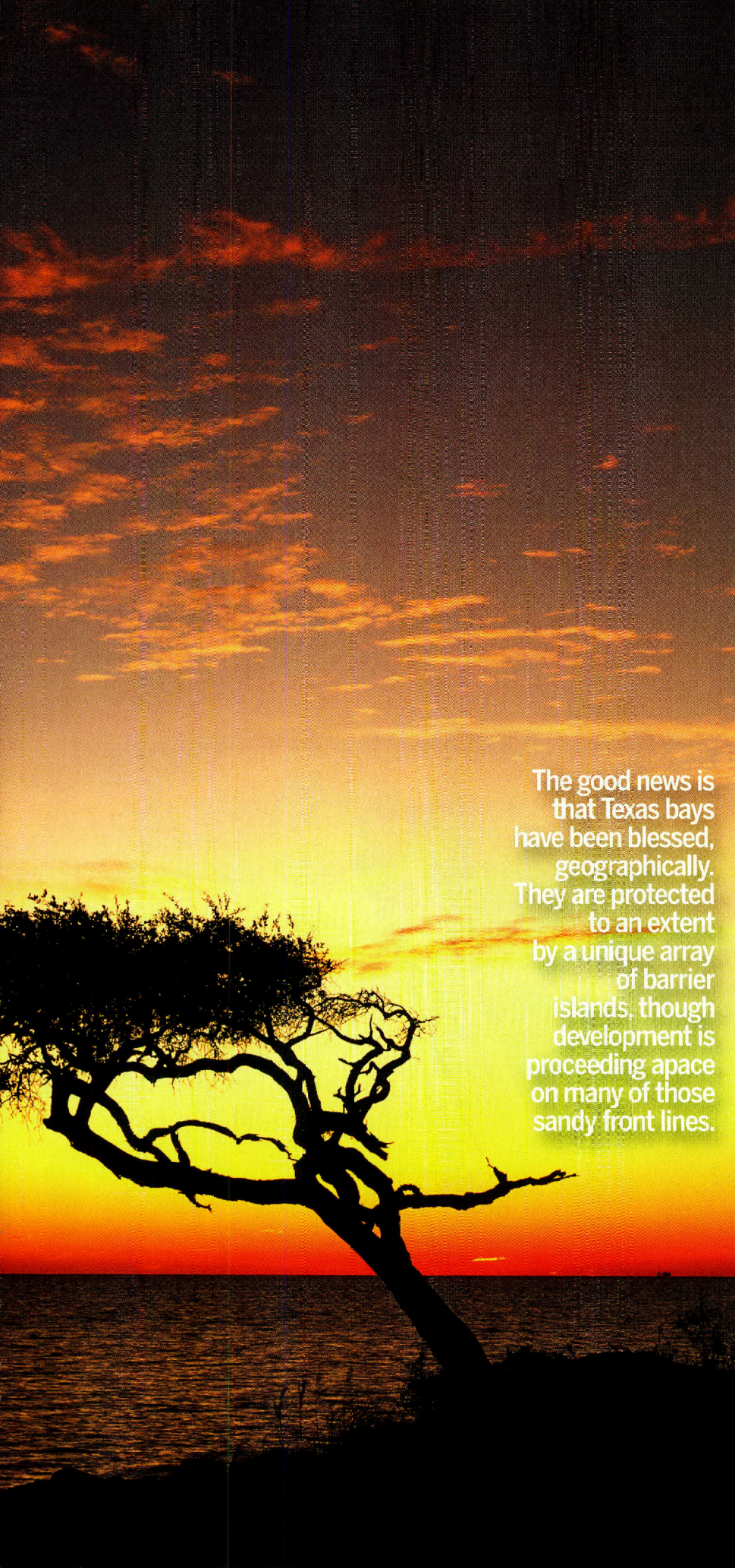
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American oystercatchers make their nests along Aransas Bay and share their tidal habitat with other shorebirds.

PHOTO © ROLF NUSSBAUMER/ROLFNPCOM



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Besides whooping cranes, the Aransas National Wildlife Refuge along Aransas and San Antonio bays provides habitat for alligators, javelinas, pelicans and more.



The good news is that Texas bays have been blessed, geographically. They are protected to an extent by a unique array of barrier islands, though development is proceeding apace on many of those sandy front lines.

The winter of 2008 was marked by the severe drought that affected Texas rivers and therefore the bays into which they empty. As freshwater flows from the Guadalupe River into San Antonio Bay decreased, salinity in San Antonio and Aransas bays increased, and the blue crabs, on which the cranes depend, declined in size and numbers.

Inflows, then, are a key factor in survival for life in and around the bays.

“We have to maintain habitat quality through environmental flow management in the watersheds,” emphasized Liz Smith, a researcher at the Center for Coastal Studies at Texas A&M–Corpus Christi, who has begun working for the International Crane Foundation.

The species may appear to be slowly recovering, Stehn notes, “but to me they are walking toward the cliff and in danger of falling off.” The fate of the cranes is entwined with the state of the bays that surround their winter habitat. “The bays must remain highly productive,” he says.

THERE IS PLENTY OF POTENTIALLY bad news to consider about Texas bays and the complex, interconnected chain of life that they sustain. Texas is not only subject to recurrent drought and floods, which affect the freshwater flows into its seven major bay systems, but the Texas Gulf Coast is largely flat and therefore vulnerable to subsidence, erosion, tropical storms and hurricanes.

Large swaths of the coast and the inland watershed systems that affect the flow of Texas rivers and thus the bays are being rapidly developed. Wetlands are diminishing, and the demand for fresh water is increasing quickly.

The good news is that Texas bays have been blessed, geographically. They are protected to an extent by a unique array of barrier islands, though development is proceeding apace on many of those sandy front lines.

What’s more, the bays have proved surprisingly resilient, at least so far. By some measures, the bay systems, and particularly Aransas Bay, are in relatively good health, given the human pressures and climatic extremes that they are subject to. Water quality has remained fairly stable, and some fish populations are

PHOTO © LAURENCE PARENT



“The bay is maintaining itself. It’s doing what an estuary is supposed to do, and it’s doing it pretty well. I keep getting surprised by the resilience of the bay system and the species that live here.”



PHOTOS: CLOCKWISE FROM TOP LEFT:  
© GRADY ALLEN, © TODD STEELE,  
© GRADY ALLEN,  
© JOE RICHARD/SEAFAVORITES



actually rebounding.

Perhaps the best news for Texas bays is all the measuring and monitoring going on, from counting such creatures as cranes and seatrout and shrimp to the almost constant probing of such water-quality variables as salinity, turbidity and dissolved oxygen capacity. As I journeyed around Aransas Bay, meeting with folks whose business or whose passion it is to assess how our bays are doing, I felt a sense of confidence that we won't be caught unaware should the delicate balance at work in the bays begin to tip.

**THE BIG PICTURE OF THE BAYS** actually begins with some of the smallest of the life forms that ply their waters. Karen Meador, who works as Aransas Bay ecosystem leader at the Rockport station of Texas Parks and Wildlife Department's Coastal Fisheries Division, describes the importance of the bag seine technique she and her colleagues use to collect samples of the assorted small fry that have spawned on the edge of the bay. The samples are particularly crucial each spring, she says, because they are an indicator of how the reproductive phase of several species fared during the winter.

We walk out to the edge of Little Bay, buffered from Aransas Bay by the sandy sliver of Rockport Beach Park. Meador points out the noisy black skimmers and American oystercatchers that are nesting in a protected area of the park. Two of Meador's colleagues don waders and drag a 60-foot seine along the bottom of the bay, just offshore, pulling up an astonishing bounty of tiny fish and baby crabs.

Hiding in the murk at the bottom are several Southern flounder babies, and flopping around vigorously are wee little spotted seatrout and red drum, the tiny redfish already sporting the distinctive black dot on their tails. There are dozens of juvenile pinfish, croakers and bay whiffs, too, along with the tiny crabs in pursuit of anything that moves. It's an encouraging catch after a cold winter.

Meador and her team use bay trawls, gill nets and oyster dredges to monitor

**TPWD scientists track the health of Texas bays by monitoring crabs and key fish species and checking water quality and habitat.**

**Listen to a podcast of this story at [passporttotexas.org/category/podcasts/web-exclusive/](http://passporttotexas.org/category/podcasts/web-exclusive/)**

the key bay species sought by anglers and commercial fishermen.

"We monitor the populations of those key species," she says, "but we're now using a more ecosystem-based philosophy. We're looking at the quality of water and habitat and trying to correlate that with the abundance of the species we're monitoring."

Despite all the perky little seatrout shimmering in the seine net, says Meador, "we've seen some decline of this species along the midcoast."

Other indicators, however, have been positive. Despite all the recent stresses, including a 50-year record drought followed by the wettest summer on record and a cold snap, some fisheries are at or near record numbers, including red drum. Gill nets have brought up seven to 10 species per haul, indicating an increase in diversity in the bay. Moreover, the seatrout seem to be on an upswing.

One of the difficulties for scientists, observes Meador, is that fish populations have normal up and down cycles, irrespective of extremes of weather and human intrusion, and nature can always harbor surprises, both good and bad.

"The bay is maintaining itself," says Meador. "It's doing what an estuary is supposed to do, and it's doing it pretty well. I keep getting surprised by the resilience of the bay system and the species that live here."

**ARANSAS BAY IS IN SUCH** general good health that it was chosen as one of 28 sites in the National Estuarine Research Reserve System, known as NERRS, whose goal is to conduct long-term research in relatively natural settings.

"In order to be chosen as part of the project, a site has to be fairly pristine," says Sally Morehead, manager for the Mission-Aransas Bay NERR project, which is based at the University of Texas Marine Research Institute in Port Aransas. The Mission-Aransas Bay NERR, which encompasses 185,000 acres, has remained healthy, she says, in part because the land sur-

rounding the reserve includes undeveloped ranchland as well as land protected as part of the Aransas National Wildlife Refuge.

Each NERR around the country is using standard procedures to conduct system-wide water monitoring, says research scientist Kiersten Madden. We are heading by boat to the Aransas Bay monitoring station, one of five stations located around the reserve. We arrive at a platform in the bay, where a cylindrical device suspended inside an underwater pipe is transmitting data every 15 minutes for salinity, dissolved oxygen levels and turbidity.

We visit the Education Center in Rockport, where visitors can view the real-time data on weather and water quality being transmitted by the reserve monitors. The data, says Madden, is useful to commercial fishermen as well as scientists. But just as important as the real-time data are the charts from previous years that indicate the effects of drought and flood on salinity.

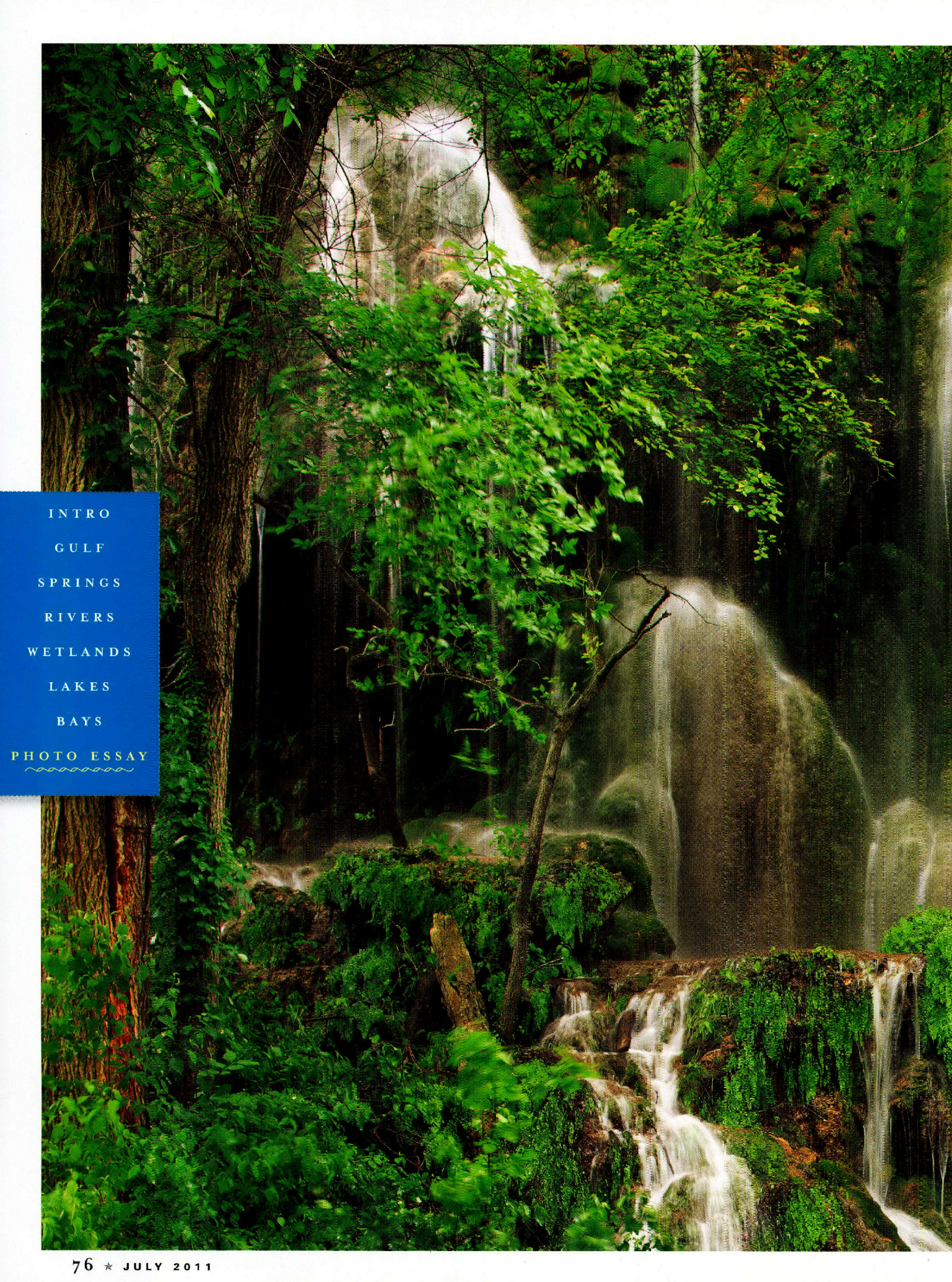
As I peruse those charts, a group of visitors punches a button in a whooping crane exhibit across the room, launching a recording of a crane's eerie mating call, and I feel a chill as I look at the spike in salinity from 2008 that coincided with all those crane deaths.

When you can see the cause-and-effect fluctuation in water conditions so clearly, you can't help but wonder what might happen if things got a lot worse, weather-wise, or if we take out too much water from the Guadalupe River before it gets to San Antonio Bay.


Though it may seem a stretch to compare such large birds requiring so much space to caged canaries in a coal mine, there is a way in which this iconic species carries a special message about the health of our bays.

Because they are the rarest of the species in that ecosystem, Liz Smith explains, they are the most vulnerable to sudden changes.

"There is the possibility that reductions in freshwater inflows could push the balance past the point where different organisms could tolerate those conditions," she says. "So let's not find out what would happen if that balance is tipped." ★



INTRO  
GULF  
SPRINGS  
RIVERS  
WETLANDS  
LAKES  
BAYS  
PHOTO ESSAY  
*~~~~~*

A vibrant photograph of a waterfall cascading down a rocky, moss-covered slope in a dense, green forest. The water is captured in motion, creating a misty spray at the bottom. The surrounding vegetation is thick and lush, with various shades of green foliage and tree branches framing the scene.

# WATER PARKS

Water is something to celebrate as it flows  
through Texas' national and state parks.

PHOTOGRAPHY BY EARL NOTTINGHAM

COLORADO  
BEND STATE  
PARK

Spring-fed waters from Gorman Creek cascade 60 feet down multiple tiers of fern-covered travertine slopes to form Gorman Falls.

Waters born from above and below, from desert downpours to crystalline springs, carve their way across the vast Texas map, shaped and colored by their geography and geology. They gradually unite and mix as tributaries become creeks, creeks become rivers and rivers become gulf. Along their transformative journeys, many will flow through tranquil places, away from the noise and trappings of civilization, each bringing beauty to the landscape and inspiring those who seek its restorative power.

**GUADALUPE  
MOUNTAINS  
NATIONAL PARK**

Shallow-water salt flats and gypsum flats are all that remain of an ancient lake, once fed by surrounding streams and by the runoff from the Guadalupe Mountains.



**CADDO LAKE  
STATE PARK**

Thick bald cypress trees and lush vegetation in tannin-colored water create a maze in the sloughs, bayous and ponds of Caddo Lake.



**BIG BEND  
NATIONAL PARK**

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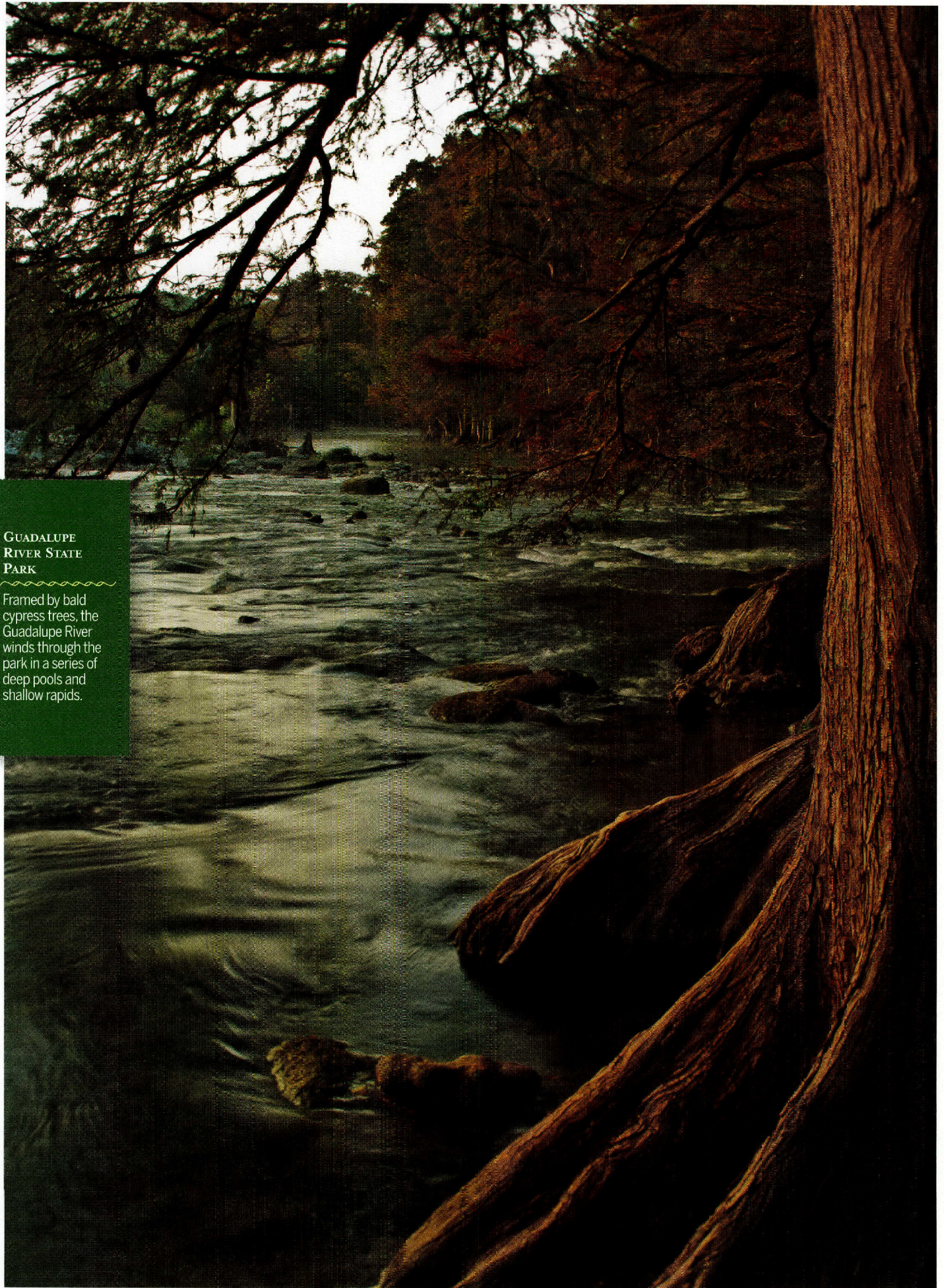
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GUADALUPE  
RIVER STATE  
PARK

Framed by bald cypress trees, the Guadalupe River winds through the park in a series of deep pools and shallow rapids.



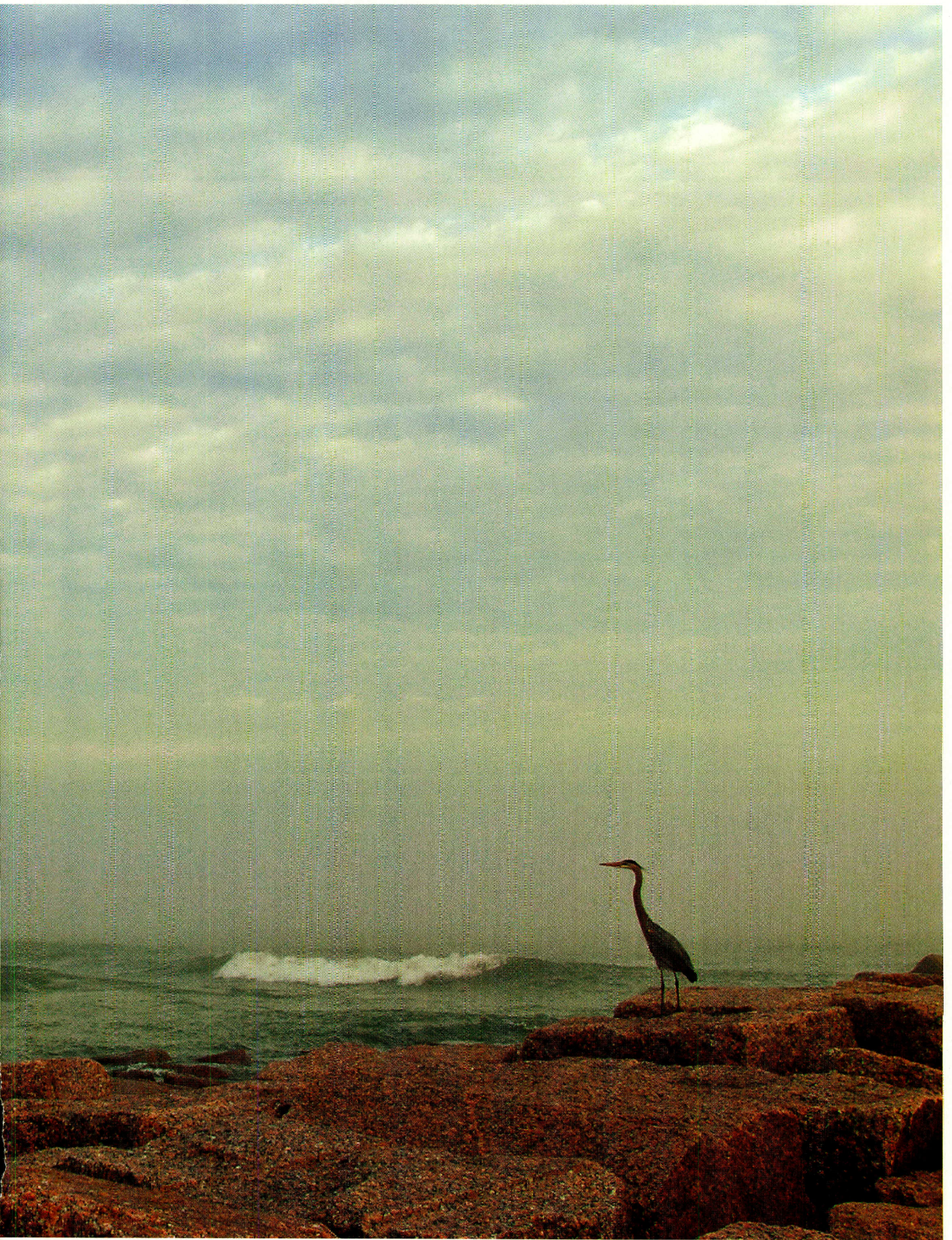
**FALO DURO  
CANYON STATE  
PARK**

A red tributary of  
silted claystone and  
sandstone flows after  
a rainstorm on its  
path to the Red River.



**MUSTANG  
ISLAND STATE  
PARK**

Tides flow  
through the jetties  
of Mustang Island,  
merging waters of  
Corpus Christi  
Bay with the  
Gulf of Mexico.



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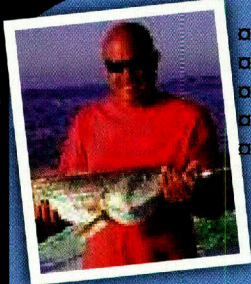
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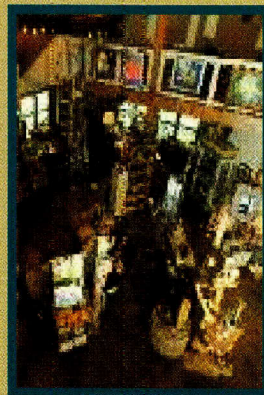
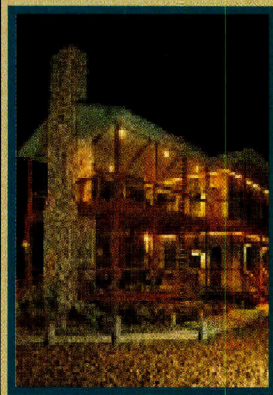
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# A Decade of Water



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# Texas Wild

## BEACH TIDINGS

Texas' shores are home to plenty of living things, even though saltwater comes and goes.

### » OCEANS ON THE MOVE

**SPLAT!!** You just finished your super sandcastle and the ocean washed it away. What's the big idea!? The water wasn't that close an hour ago. "Tides" are the big idea. Oceans all over the world have tides because of the moon and gravity. About every 12 hours, water from the beach travels its farthest toward land for "high" tide. Your sandcastle washed away because high tide came in. "Low" tide happens about every 12 hours, too. That's when the shoreline will be its farthest out at sea. Here in Texas, our beach water comes from the Gulf of Mexico, a special part of the Atlantic Ocean. Because of its bowl shape, the Gulf of Mexico seems a lot like its own ocean.

PHOTO BY CHASE A. FOUNTAIN/TPWD

## » Sandy Lands

Walk along the shores of the Gulf of Mexico and you might find cool stuff washed up from far away, carried in by the waves and tides. But Texas has plenty of its own cool stuff living right here!

» Sea oats handle harsh beach conditions like constant saltwater spray and little fresh water really well!



» Beach morning-glory climbs all over the sand dunes; it's nicknamed "goat's foot."

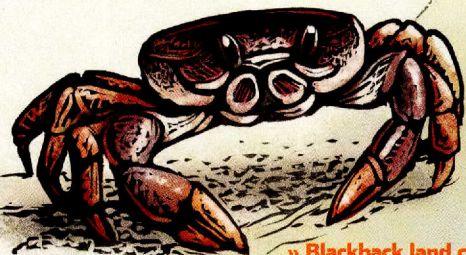
» Spotted ground squirrels skitter among the dunes in search of seeds, roots and treats that wash up on shore.

» Snowy plovers line their nests with pieces of shells gathered from the seashore.



» Gulf Coast kangaroo rats get most of their drinking water from the seeds they eat.

» Keeled earless lizards have no outside ears, so no sand gets stuck in them.



» Blackback land crabs have to get in the saltwater to get their gills wet every now and then.

## » Beach Houses

Sand dunes might just look like lumps of sand, but for our beach animals they serve as important homes. So as fun as it looks, please don't climb on the dunes, Dude! Instead, let the plants do all the climbing. It's their job to stick their roots down and keep the wind from blowing the sand away!

» Laughing gulls really do sound as though they're laughing when they call out to one another.

» Gulf Coast ribbon snakes don't have venom, but they do have stripes down their backs, which look cool as they zip through the sand!

» Beach evening primrose has bright yellow flowers.

» Ghost crabs got this name because they run and camouflage so quickly into the sand, you wonder, "Did I really see something?"

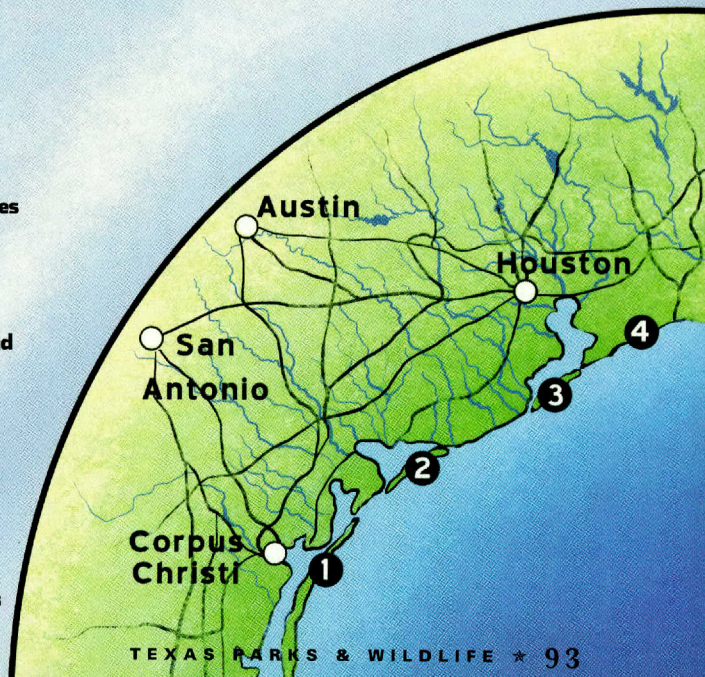
» Willets walk along the surf poking their long bills in and out of the wet sand in search of food.

» Sanderlings like to chase one another as they bop in and out of the water's edge.

» Sargassum or "seaweed" grows in the ocean, but tides and waves wash it ashore, where tiny beach critters snuggle in to hide. Shorebirds often search for supper in the sargassum.

## Wiggle in the Waves

- 1 Mustang Island State Park got its name from wild horses that used to roam here. Today the horses and the Karankawa Indians, the first people to live here, are all gone, but it's a very cool place to camp!
- 2 Matagorda Island Wildlife Management Area is an island that has more than 19 endangered species and an awesome lighthouse built in 1852.
- 3 Galveston Island State Park marks the spot where Cabeza de Vaca and his crew shipwrecked in 1528. And did you know that pirates once used this island as a hideaway?
- 4 Sea Rim State Park was once home to prehistoric Indians. How do we know? From the clamshell mounds (called "middens") discovered here.





# Spike's Activity Page



## >> WILD SOCIAL STUDIES

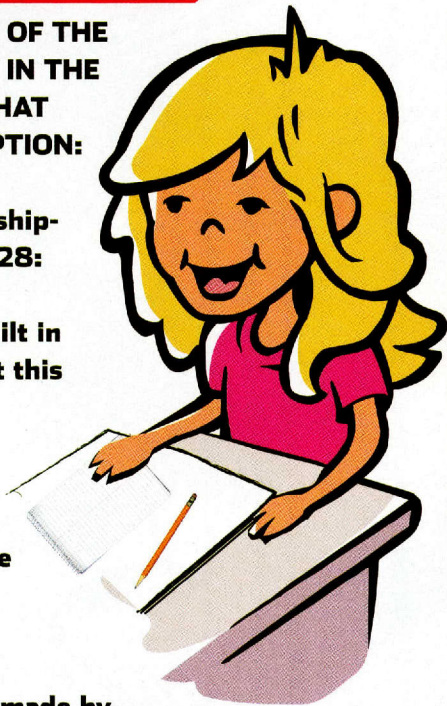
WRITE THE NAME OF THE SPECIAL "WIGGLE IN THE WAVES" PLACE THAT FITS THE DESCRIPTION:

1) Cabeza de Vaca ship-wrecked here in 1528:

2) A lighthouse built in 1852 still stands at this special spot:

3) Karankawa Indians were the first people to have lived here:

4) Here you'll find clamshell mounds made by prehistoric Indians:



## >> WILD SCIENCE

Plants and animals that live on sandy beaches must have special adaptations. List one adaptation for each sand-dweller below:



Keeled earless lizard

\_\_\_\_\_

\_\_\_\_\_



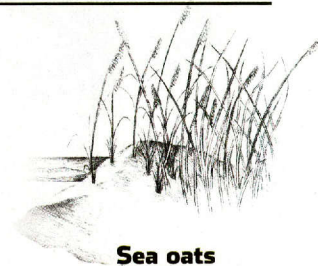
Gulf Coast kangaroo rat

\_\_\_\_\_

\_\_\_\_\_



Ghost crab



Sea oats

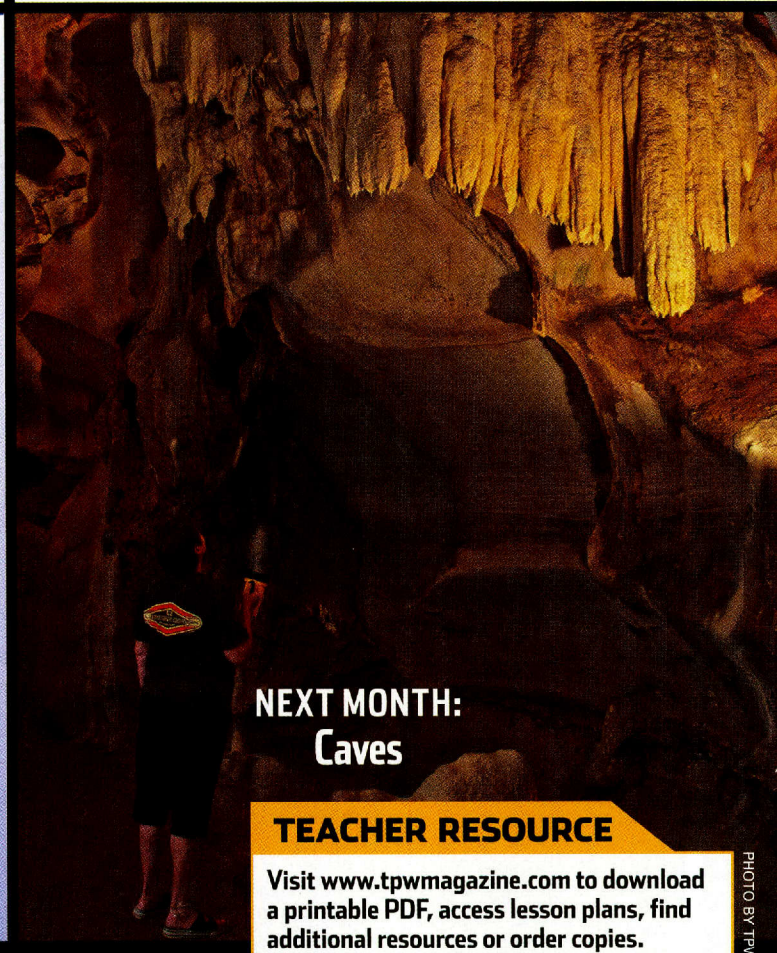
## >> KEEPING IT WILD

DO YOU LIKE TREASURE HUNTING ALONG THE SHORE TO DISCOVER WHAT THE WAVES WASHED IN?

Beachcombing can be a blast! The next time you go beachcombing for cool stuff, bring along a reusable bag and keep an eye out for bummer stuff, too, like



trash. Not only will you help keep our Texas beaches beautiful, but the critters that call the sand and dunes home will thank you!



NEXT MONTH:  
Caves

### TEACHER RESOURCE

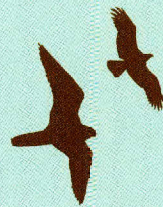
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## IMAGE SPECS:

Pentax 645 AFD camera with Pentax 35mm lens, Fujichrome Velvia, f/22 at 1/4 second

Photographing Texas beaches is especially rewarding at sunset or sunrise. The fine, smooth sand, once doused with a wave, glistens and reflects in varying ways as the water soaks in and seeps back to the sea. Photographer Tim Fitzharris captured this sunset scene at Padre Island National Seashore, with the dramatic effect enhanced by rich colors in the sky and sand ripples in the foreground.

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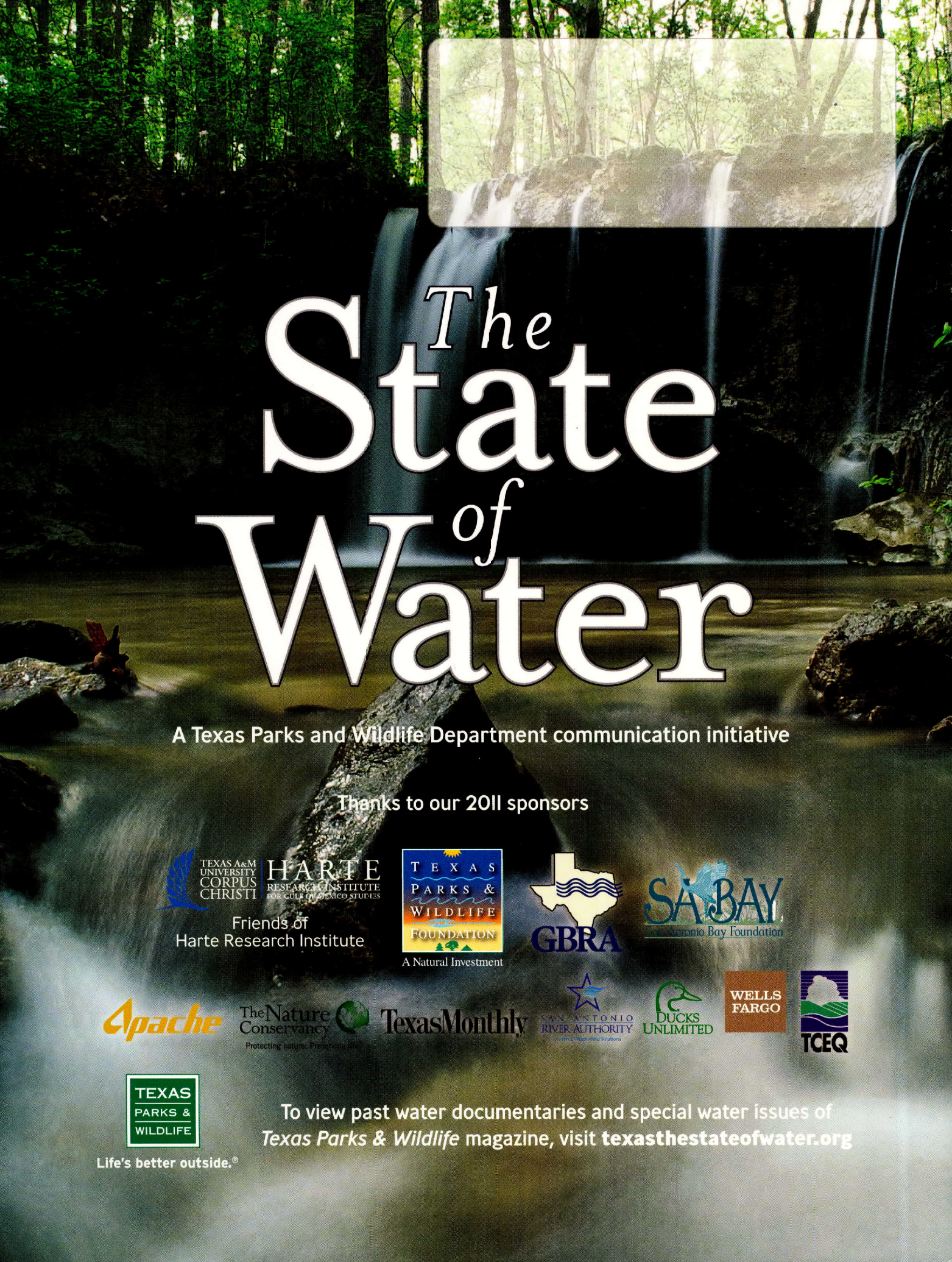
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