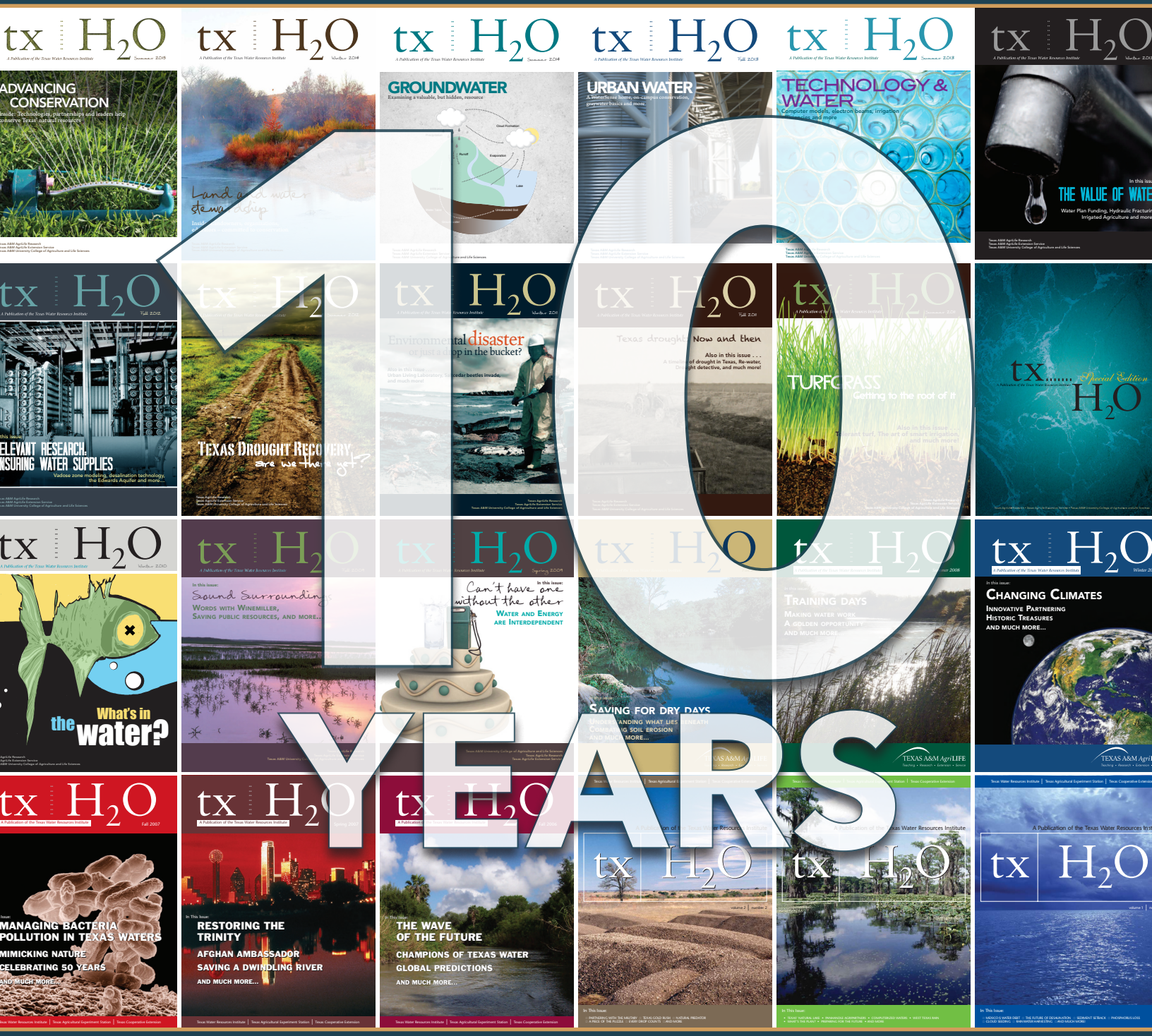
tx H$_2$O

A Publication of the Texas Water Resources Institute

Fall 2015



Texas A&M AgriLife Research | Texas A&M AgriLife Extension Service | Texas A&M University College of Agriculture and Life Sciences

Working to make every drop count

In this Fall issue of *txH2O*, we look at a variety of topics, including the management of floods in Texas, the institute's award-winning bacterial source tracking program and water education programs for kids around the state. State Climatologist Dr. John Nielsen-Gammon is profiled and quail researchers talk about the relationship between drought recovery and quail recovery. A story on the Texas Water Resources Institute (TWRI) and Texas A&M Institute of Renewable Natural Resources (IRNR) training program rounds out this issue.

It is with a bit of sadness that this is the final "From the Director" I will write in *txH2O*. As you may know, I have been director of both TWRI and IRNR for the past three years. I want to thank TWRI's dedicated employees for all their hard work. It's been a privilege to lead these folks. Each one is a professional committed to "making every drop count" in Texas and beyond. They take their responsibilities working for the state's official water institute seriously and go above and beyond their duties to make sure the research, education and outreach mission of the institute is accomplished. In particular, I would like to thank and acknowledge the leadership and friendship of Dr. Kevin Wagner, TWRI associate director. He made "pulling the wagon" much easier.

As of December 2015, Dr. John Tracy will become TWRI's director. Dr. Tracy comes to Texas from Idaho, where he served as the director of the Idaho Water Resources Research Institute for the past 11 years. He brings a wealth of knowledge and more than 30 years of experience in water resources engineering, watershed management and other water resources research. Dr. Tracy is well-known nationally as a leader in water resources research and pressing water resources issues. I will continue serving as IRNR's director, and I will be working with Dr. Tracy and Dr. Wagner to ensure a smooth transition as I hand over the leadership.

As always, let's do what we can to make every drop count.

Roel Lopez
Director

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The institute has published *txH2O* for 10 years.

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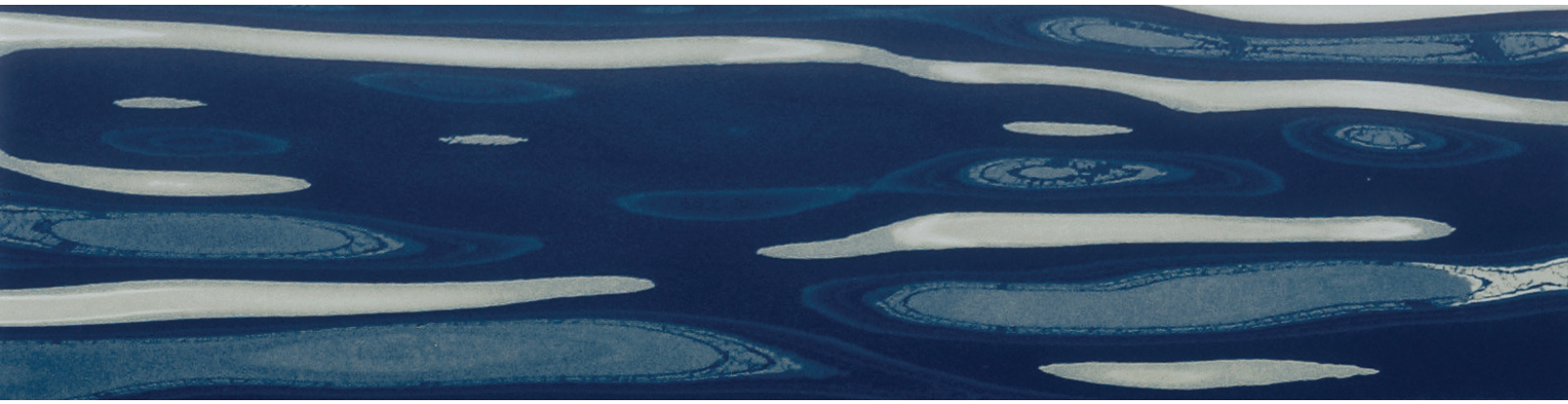
Texas Water Resources Institute
make every drop count

Volume 10, number 2, Fall 2015



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Story by Kathy Wythe

Tracy named institute director

Dr. Mark Hussey, vice chancellor and dean for Agriculture and Life Sciences, Texas A&M University System, recently named Dr. John C. Tracy as the new director of the Texas Water Resources Institute (TWRI). He will assume his position in December 2015.

"We are excited to have someone like Dr. Tracy join our team to lead our water programs at TWRI that support our core missions of teaching, research, extension and service," Hussey said. "He brings a wealth of experience and talents that will serve us well."

Tracy said he is eager to begin as TWRI's director.

"Texas has one of the most diverse water resource landscapes in the country," he said, "and the state must be able to address and manage a wide range of water resources challenges at almost a moment's notice. TWRI has the necessary capabilities to connect resources of the Texas A&M System to water resources communities across Texas."

Tracy comes to TWRI after serving as director of the Idaho Water Resources Research Institute at the University of Idaho for 11 years. While at Idaho, Tracy also served as associate vice president for research since 2009 and was a faculty member in the university's Department of Civil Engineering.

As director, Tracy said he believes he can serve as a catalyst to bring together faculty at Texas A&M University with Texas A&M AgriLife Research scientists and Texas A&M AgriLife Extension Service outreach specialists to address the water resource issues Texas faces.

"I see the Texas Water Resources Institute enhancing its current role in addressing Texas' water resource challenges, and I believe that Texas A&M is poised to further its role in leading the development of both technological and policy solutions to many of Texas', the nation's and the world's most pressing water resource problems."

Tracy currently serves as president for the American Water Resources Association and as secretary/treasurer for the Executive Management Board of the National Institutes for Water Resources. In addition, he served on the governing board of the University Council on Water Resources and was its president in 2008–2009.

Prior to his work at the University of Idaho, Tracy held academic positions at Kansas State University, South Dakota State University and the Desert Research Institute, where he also was the director of the Center for Watersheds and Environmental Sustainability for four years.

Tracy received his doctorate in engineering and master's in civil engineering from the University of California at Davis and his bachelor's in civil engineering from Colorado State University.

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

Dr. John Tracy named the Texas Water Resources Institute's director.

Story by Leslie Lee

250,000 words later

txH2O celebrates 10 years of publishing Texas water research and news

When *txH2O*'s first issue landed in mailboxes in the summer of 2005, it showcased rainwater harvesting as a practice beginning to gain traction around the state, the Rio Grande Basin Initiative in its early stages and hosting its fourth conference and the U.S. Geological Survey and National Institutes for Water Resources recognizing the Texas Water Resources Institute (TWRI) as one of the nation's top five water institutes.

Much has changed in Texas water research and education over the past decade, but some things haven't. TWRI is still the official water institute for the state, and *txH2O* remains one of the few regularly printed magazines covering all things Texas water.

TWRI has published 25 issues of this flagship publication since Vol. 1, No. 1. The magazine has covered most every region and water issue in Texas, from desalination in El Paso to environmental flows into coastal bays, and from erosion and compost issues at Fort Hood to technology developed in Temple helping Ethiopian herdsmen.

Known for its in-depth science reporting, *txH2O* has continually sought to help Texans understand complicated Texas water issues. The magazine's content has tackled the state's evolving water quality standards, important computer models in Texas water management, hydraulic fracturing water use and groundwater administration.

"We take pride in taking on complex Texas water research and translating it into stories that the public can understand and enjoy," said Kathy Wythe, TWRI communications manager and *txH2O* managing editor. Wythe has served as an editor of the magazine since 2006. TWRI staffers Danielle Kalisek and Leslie Lee have written for the magazine since 2005 and 2009, respectively.

txH2O has also taught readers how to maintain efficient landscape irrigation systems, calculate water footprints, protect private well-water quality and conserve water at home. Big names in Texas water have filled the pages of the magazine, including rainwater harvesting expert Billy Kniffen and former Texas Water Development Board Chairman Carlos Rubinstein.

"The magazine is just one way TWRI fulfills our mission of providing Texas water education and outreach," said Dr. Kevin Wagner, TWRI associate director. "We look forward to publishing *txH2O* for many years to come and covering all of the exciting strides sure to be made in Texas water research in the future."

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

txH2O BY THE NUMBERS

250,000+ words published

3,500+ print and email subscribers

250+ articles published

25 issues published

10 years of publishing

6 staff members from TWRI and AgriLife Communications write and produce the magazine

Story by Kathy Wythe

(Top photo) Downton Houston, looking south after Tropical Storm Allison in 2001. Allison left behind 22 fatalities, 95,000 damaged automobiles and trucks, 73,000 damaged residences and more than $5 billion in property damage. Photo courtesy of the Harris County Flood Control District.

(Bottom photo) The 1935 flood in Austin was one of the worst in that city's history. Photo by Charles C. Raines. Photo by Charles C. Raines, courtesy of Austin History Center.

Planning for the next **BIG** one

Federal, local management plus early warnings keys for controlling inevitable flooding in Texas

In May 2011, Texas was in the midst of the worst one-year drought in its recorded history. At many lakes, boat ramps stood isolated far from the water's edge, and on many ranches, owners sold their cattle because their land couldn't support the livestock. Four years later — May 2015 — Texas recorded its wettest month ever, and much of the state was experiencing major flooding. On Memorial Day weekend, roadways flowed like rivers in Houston, Austin and Dallas-Fort Worth, and in the worst areas, homes and people were swept away.

Figures from the Office of the State Climatologist at Texas A&M University show that May averaged 7.54 inches of rainfall across Texas, surpassing the previous record of 6.66 inches in June 2004. In the Dallas-Fort Worth Metroplex, it was the single wettest month since April 1942, with just under 17 inches.

This 180-degree change in weather conditions is not uncommon for the state. For instance, the drought of record of the 1950s ended in the spring of 1957 with massive rains. Every major river and tributary in the state flooded, causing damages estimated at $120 million, according to the 2012 state water plan.

Flooding is normal for Texas

Although flooding is an expected natural occurrence, most years Texas leads the country in flood-related causalities and damages. With increased population, urbanization and changing climate, the problem, experts said, is growing.

"There is nothing unnatural about flooding," said Dr. Ralph Wurbs of Texas A&M's Zachry Department of Civil Engineering. "Most streams are going to get out of their banks every few years. It's when people are there (in the flood's path) that it becomes noticeable because of the damages."

Flooding in Texas is typically caused by either bursts of heavy rainfall or saltwater surges from tropical storms and hurricanes, sometimes both.

"Houston in particular is very vulnerable to both of those (heavy rain and saltwater surges) because of where it is located," said Dr. Sam Brody of Texas A&M Galveston's Department of Marine Sciences and Texas A&M's Department of Landscape Architecture and Urban Planning.

He said flooding along the Texas coast is a chronic problem, punctuated every 15 to 20 years by tropical storms and hurricanes. In 2008, Hurricane Ike caused about $27 billion in damages. "Galveston is still recovering from that storm," he said.

Dr. Philip Bedient of Rice University's Department of Civil and Environmental Engineering agreed that flooding in Texas is increasing, along with losses from floods. "The state is getting more frequent floods, more devastating floods, and it will continue, especially in the coastal areas where we had huge growth and expansion of population," he said.

The Dallas-Fort Worth Metroplex is not necessarily experiencing more rainfall events, but when it does rain, it tends to rain more, according to Dr. Dong-Jun Seo of the University of Texas at Arlington's (UT-Arlington) Department of Civil Engineering.

"In North Texas, over the last 50 years or so, the rainfall amounts from heavy precipitation events have increased by 15 to 20 percent," he said.

"If we hypothesize that the same trends will occur in the next 50 years, then we expect to see more extreme rainfall," Seo said. "So far what we are seeing in North Texas is very much in line with what the climate scientists have been predicting."

For Brody, the issue is not so much the climate, which he agreed is changing, as it is humans. Increased population growth and urban development and the corresponding increase in impervious structures, such as commercial buildings, homes and parking lots, are exacerbating the flooding problem.

"Think about two gears. One small gear is moving very slowly; that's climate," he said. "One big gear, which is moving very quickly, is the people moving into vulnerable locations. And those things work to amplify the problem. ⇨

Flood waters on Shoal Creek in Austin during a September 1915 flood. Photo by Ellison Photo Company, courtesy of University of North Texas Libraries, The Portal to Texas History and Austin History Center, Austin Public Library.

"Because of the proliferation of impervious surfaces across the landscape in Houston and other metro areas, there is nowhere for the water to run except into people's homes."

A brief history of flood management

Efforts to reduce and manage flooding range from building dams and levees to passing local ordinances that prohibit building in flood-prone areas. Since Texas doesn't have a statewide flood control plan, most efforts fall on the federal government and local communities.

Wurbs said the federal government, by way of the U.S. Army Corps of Engineers, got into the flood control business in the 1930s after a series of disastrous floods, especially those along the Mississippi River. The 1936 Flood Control Act gave the Corps the authority to control flooding by building and operating flood control reservoirs. Throughout the United States, the Corps built more than 500 dams with about 30 in Texas.

The Corps also builds levees and channels to manage flooding, including the Dallas Floodway along the Trinity River and the San Antonio River Walk, which is part of the San Antonio Channel Improvement Project.

Along with the Corps, the U.S. Department of Agriculture's Soil Conservation Service, now the Natural Resources Conservation Service, assisted local entities in building nearly 2,000 earthen dams on private property to prevent and control flooding.

In addition to structural flood control efforts, Congress established the National Flood Insurance Program in 1968 to encourage wise development in floodplains, or the areas around lakes, rivers and streams prone to flooding. The Federal Emergency Management Agency (FEMA) manages the flood insurance program. For citizens to obtain flood insurance, their cities have to participate in the flood insurance program, which requires cities to adopt and enforce 100-year floodplain management regulations to reduce future flood risks for new construction.

On a local level, communities manage potential flooding through their stormwater management programs and development regulations. Structural defenses include drainage and detention basins that capture excess water and slowly release it to nearby streams.

Researchers study flood control solutions

The experts said better flood management involves short-term and long-term, structural and nonstructural solutions. Some of the long-term answers, such as flood control dams, are becoming too expensive, so communities are turning to other answers.

Brody and other researchers have conducted a number of national studies on what can be done to control flooding. They looked at a range of structural and non-structural mitigation techniques; two stood out.

The first technique, a type of vertical avoidance, was building structures above the expected 100-year flood water level, which is called freeboard. "We have found that communities that have freeboard requirements are saving on average $960,000 in avoided flood losses per year," said Brody, who is also director of the Institute for Sustainable Coastal Communities at Galveston.

The second major mitigation strategy was protecting open spaces around bayous, streams and floodplains. He said communities that move structures back from these areas save about $500,000 a year.

Visualization tools that help individuals and community leaders see the consequences of building in or near the floodplain can help, Brody said. The Center for Texas Beaches and Shores and the Hazard Reduction and Recovery Center at Texas A&M developed a web-based Texas coastal atlas (www.tamug.edu/CTBS) that allows users to visualize the consequences of living in these vulnerable areas. The atlas covers 29 coastal counties.

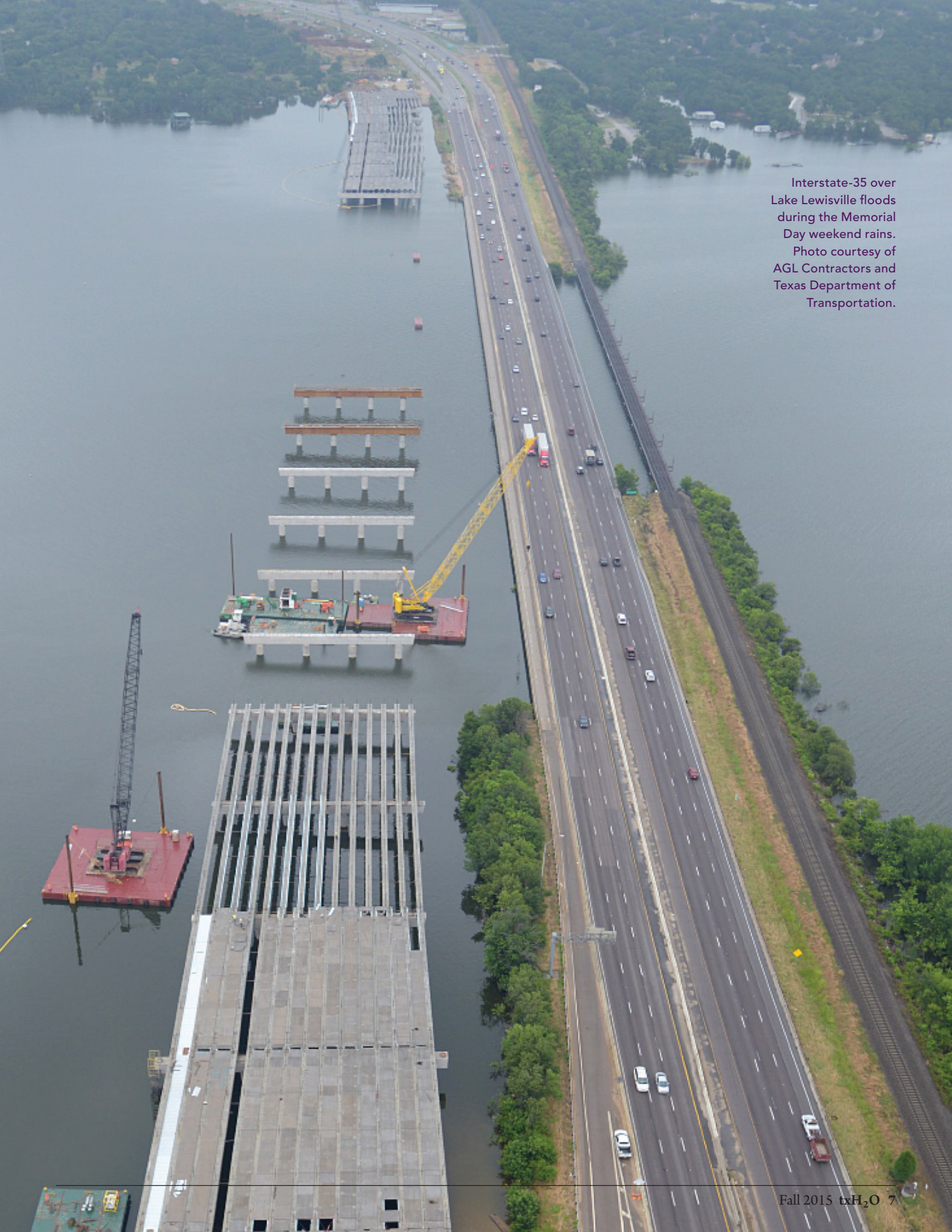
"If you are a resident, you can see where you are in relation to the floodplain," he said. "If you are a decision-maker, you can see here are my risk zones; here is where my population is; here is where it is growing."

Then, Brody said, decision-makers could ask the question: 'What can I do to create incentives or regulations to help my community grow in the future in a more resilient fashion?'

"I really think putting this information in the hands of the residents and decision-makers is going to create more effective actions at the community and household level," he said.

Seo said improving flood control infrastructure is a long-term solution but one that will be very expensive, maybe too expensive, especially with uncertainty in rainfall amounts and extreme swings in the climate predicted.

"Due to climate change and urbanization, it has become much more difficult to model, assess and predict what these flooding risks are like," he said. "In the past, we assumed the climate on average stayed the same. Then we could extrapolate what may happen in the future based on what has happened in the past. But because of these changes, we can't assume that anymore." ⇨



Interstate-35 over Lake Lewisville floods during the Memorial Day weekend rains. Photo courtesy of AGL Contractors and Texas Department of Transportation.

Flood waters surround a building between the Trinity River and what today is Montgomery Plaza during the 1949 flood in Fort Worth. The flood is considered by many to be the worst in Fort Worth's history. Photo courtesy of Fort Worth Library.

Aerial photograph of the July 26, 1938 flood in Austin, looking northeast from Congress Avenue, south of the Colorado River.
Photo by Neal Douglass. Photo by Neal Douglass, courtesy of of University of North Texas Libraries, The Portal to Texas History and Austin History Center, Austin Public Library.

Brody said a multiuniversity group recently received a $3.6 million grant from the National Science Foundation (NSF) to conduct research and education on flood risk reduction. One of the questions the scientists will be answering is which flood mitigation techniques, both structural and nonstructural, are most effective in reducing the adverse impacts of floods?

Warning system aids in flood-response decisions

Since flooding is inevitable, the most viable solution may come down to warning systems to make a difference in decreasing the damage and loss of life from flooding, the experts said.

In the late 1990s, Rice's Bedient, who is also director of the Severe Storm Prediction, Education and Evacuation from Disasters Center, developed a radar-based flood warning system for the highly urbanized, flood-prone area around the Texas Medical Center in Houston, which is in the Brays Bayou Watershed. The Flood Alert System (*FAS3.flood-alert.org*) is an integrated system using radar, rain gauge information, bayou stage data and hydrologic modeling to predict the overall threat of out-of-bank flooding of the bayou near the medical center. National Weather Service (NWS) radar data gives the system rainfall information every five minutes for a 1-square-kilometer area. "It's like having hundreds of rain gauges, so it's very accurate," Bedient said.

Before the alert system, Bedient said, "We would watch bayous rise, and we would use the rising rate of the bayou to indicate flooding potential. The problem with that is it doesn't say anything about what is going to happen next."

After Tropical Storm Allison dropped around 20 inches of rain on the medical center over five days in 2001 and caused $2 billion in damages, Bedient was funded to expand and enhance the system.

The current system gives the Texas Medical Center two to three hours of notice that a flood is going to occur.

"So now with this system in place and with all the improvements — flood gates and doors and other things — in the med center, they can lock it down and protect against even the 500-year flood in less than an hour," Bedient said.

Through the years, the Flood Alert System has a successful track record, providing sufficient warning times before more than 50 major storms, including Hurricane Ike in 2008 and the 2015 Memorial Day weekend, when 7.6 inches of rain fell in 12 hours over Brays Bayou Watershed.

Partnership developing integrated, Metroplex-wide warning system

The 2015 Memorial Day weekend also brought massive flooding to the Dallas-Fort Worth Metroplex. Cars were stranded on major highways, and a mobile home park was partly submerged by high waters. A Grand Prairie apartment building was evacuated — twice.

It is that type of flooding and other severe weather in the Metroplex that has propelled a partnership of universities, governmental agencies and private businesses to work on developing a warning system for the region, Seo said.

"There is a very strong need to have an integrated flood warning system for densely populated urban centers to provide early, accurate and location- and time-specific warnings for millions of people," Seo said. "What we need is much improved observing systems for these flood-causing atmospheric conditions and on-the-ground flooding conditions as well as communications systems that can gather data and transmit information to everyone fast, just like traffic information systems."

Through the Collaborative Adaptive Sensing of the Atmosphere, or CASA WX, Seo said the group has deployed five low-cost weather radar systems that provide very high-resolution rainfall information along with severe weather information, such as damaging winds, tornadoes and hail. Unlike NWS radars, CASA WX uses smaller, faster-scanning radars that cover the lower atmosphere where a majority of severe weather takes place. Plans call for eventually deploying 16-20 CASA WX radars in North Central Texas.

The CASA WX radar system is part of a five-year, $10 million NSF project with the North Central Texas Council of Governments to create an urban test bed in the Metroplex to demonstrate improved hazardous weather forecasts, warnings and responses in a densely populated urban environment.

Seo said this warning system will give users very detailed flooding information based on high-resolution observations and hydrologic and hydraulic modeling.

Currently the early warning model is subscription-based supported by annual fees collected from participating cities, he said, but the goal is to make the system available to residents in the future.

Also part of the effort to develop an early warning system is a four-year, $1.2 million NSF-funded UT-Arlington project on urban water sustainability. The partnership of universities, governmental agencies and private businesses is developing a regional cyber infrastructure for observing and modeling urban water and generating products for decision-makers to address water challenges such as flooding, stormwater management and climate change adaptation in the Metroplex.

"Flooding is a multiscale phenomena, and it is very difficult to do an assessment at the local scale only, so you need large-scale modeling capabilities and high-performance computing, data processing and analysis capability," Seo said. "This is what we are building (with this grant)."

Seo plans to use the public's water observations gathered on social media and develop cell phone applications for crowdsourcing to help improve the early warning system. People will be able to enter observations such as high water levels in their backyards or ponding on their streets.

"If we can harvest in real time various flooding and related water information from citizens, then that information can be used along with model results to warn people with more lead time and additional accuracy," he said.

A changing world calls for innovative flood solutions

Although progress has been made, flood management will always be a concern.

"It's not a one solution problem," said Texas A&M's Wurbs. "We have to continue all the different solutions in combination. It's much more difficult now than it was 30 years ago to construct more projects. We are probably not going to be constructing more flood control projects, so we will have to do more regulatory type things like regulating development."

Brody agreed that communities need to implement a combination of techniques specific to their community and across ecological systems. "Realistically there are no standardized magic solutions," he said. "We have to think about being proactive, not reactive. We need to not try to recover from the flood but prevent the impact from the start."

Brody believes the state could significantly contribute by providing technical assistance and guidance, creating visualization tools and warning systems, working with local communities and having resources for studies.

He said the Harris County Flood Control District's Tropical Storm Allison Recovery Project, which was created after the 2001 storm and comprehensively assessed the flood risks associated with the major flooding sources within Harris County, has been very successful. Brody said it is a good model and poster child for flood impacts for the nation.

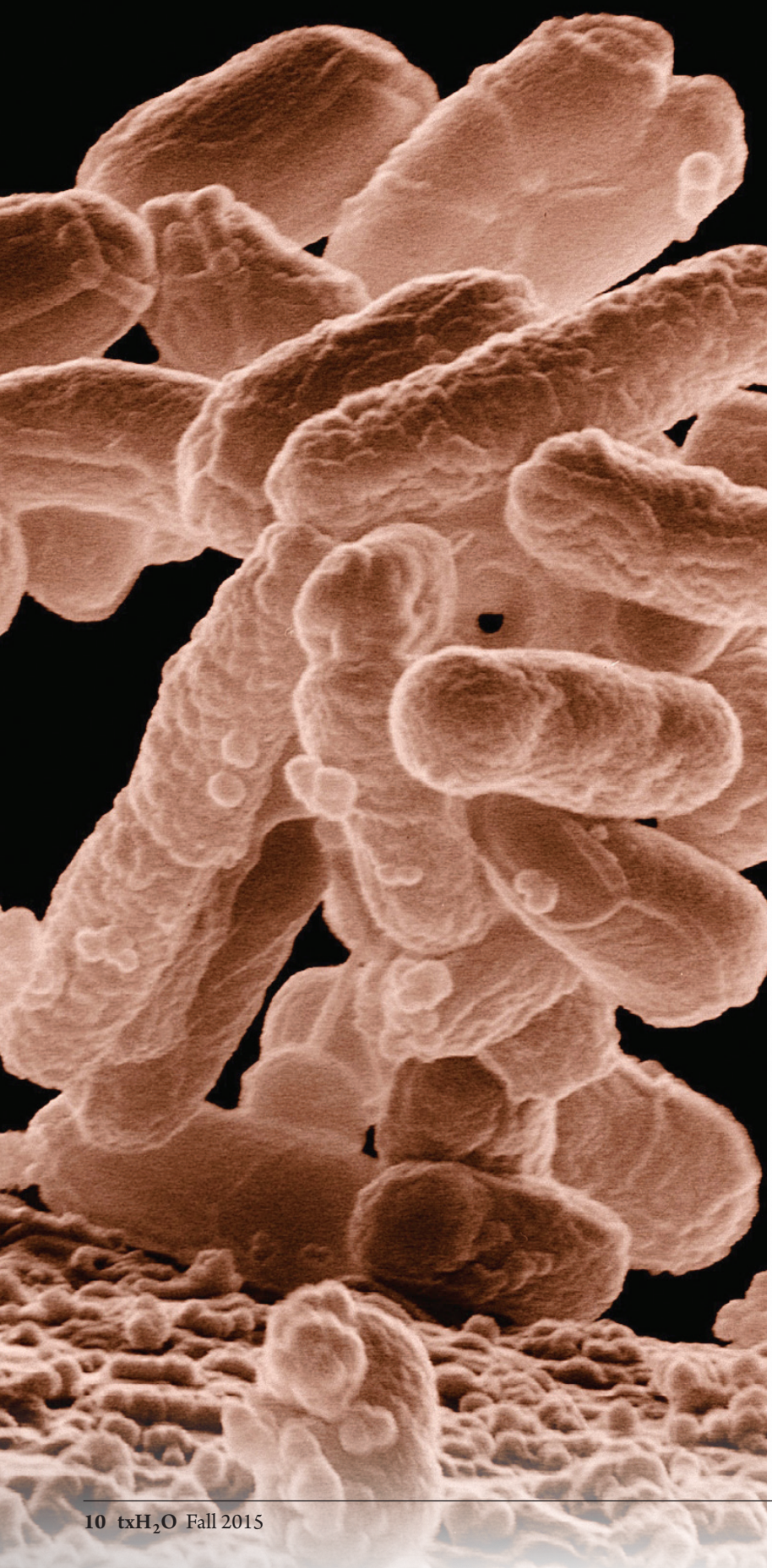
Bedient said new building practices and new subdivisions are following rules that tend to limit their impact. "But there is so much legacy development that resides in floodplains that causes damages to keep going up," he said. "There are too many people, too much impervious cover and too many channels eating into these urbanized watersheds."

While it is difficult to fix existing structures, communities can be proactive with new development.

"Texas has the biggest stretch of undeveloped coast in the country," Brody said. "From Houston to Corpus Christi, it is virtually undeveloped and is slated to be developed in the future, so we have a great opportunity to think about solutions and put them into place before we add new people and structures, which we are doing real rapidly."

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

Story by Leslie Lee



Electron micrograph of *E. coli*. Photo by Eric Erbe, digital colorization by Christopher Pooley, USDA Agricultural Research Service.

A decade of solving water quality mysteries

Reflecting on the success of the Texas BST Program

More than 10 years ago, the Texas Bacterial Source Tracking (BST) Program (*texasbst.tamu.edu*) began filling a need in the state's water quality efforts that no other program was pursuing: in-stream measurements of the specific human and animal sources of bacterial nonpoint source pollution in local watersheds.

Before BST technology, water quality restoration projects relied on source surveys and computer models to identify bacterial pollution sources, and these methods oftentimes told an inaccurate or incomplete story.

Source surveys estimated the numbers and distributions of livestock and humans in a watershed, but they could not assess most wildlife species or how bacteria move within waters. Computer modeling addressed bacteria transport issues, but because wildlife populations are rarely known, models were unable to adequately assess wildlife contributions.

However, thanks to a group of researchers from Texas A&M AgriLife Research, the Texas Water Resources Institute (TWRI) and the University of Texas School of Public Health (UTSPH), bacterial pollution sources in watersheds can now be characterized more precisely, and therefore restoration efforts can take more targeted and effective approaches.

"BST is able to evaluate wildlife contributions, along with other major sources, and the impacts of transport because BST uses in-stream water samples for its assessment," said Dr. Kevin Wagner, TWRI associate director. "It has been incredibly helpful in every watershed where we've used it."

How BST science informs restoration projects

When a local water body doesn't meet water quality standards, the most common methods the state of Texas uses for developing plans to restore water quality are either a total maximum daily load (TMDL) paired with an implementation plan or a watershed protection plan (WPP).

TMDLs study and describe the point and nonpoint sources of pollutants affecting a water body; the maximum amount of pollutants the water body can receive daily and still meet standards for its uses; and the reductions needed, if any, from each pollutant source. WPPs are locally developed, comprehensive plans that implement water quality protection and restoration strategies. WPP stakeholders holistically address the causes of impairments and threats to the watershed.

Both routes begin with gaining local stakeholders' involvement and input on potential pollution sources, local water quality problems and possible strategies for restoration.

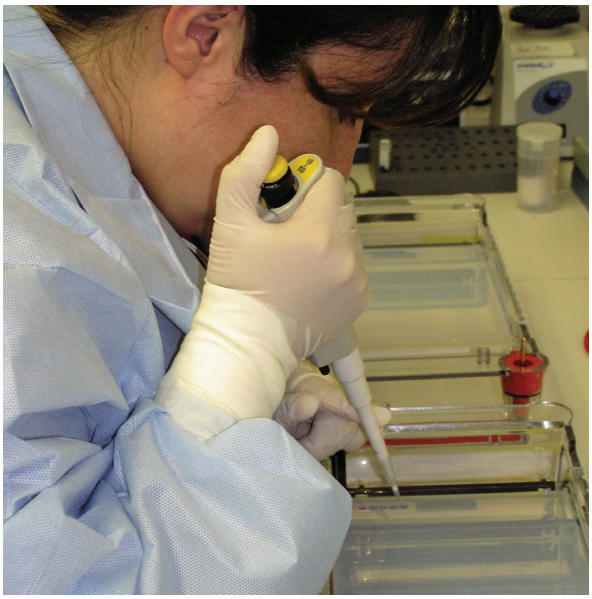
"It's very important to have stakeholder involvement from the beginning," said Dr. George Di Giovanni, professor at the UTSPH El Paso Regional Campus. "That not only helps with community support for the project, but also with sample collection, because accessing many water bodies requires permission to be on private property."

Source tracking field work then begins with frequent monitoring of *E. coli* levels at water monitoring stations throughout the watershed, Di Giovanni said. *E. coli* is the state's indicator bacteria of choice for evaluating the suitability of freshwater water bodies for swimming and other recreation. Samples are usually collected monthly for one to two years to gain a better understanding of the water quality and how it may change seasonally and with a variety of flows, Wagner said.

At the same time, project personnel conduct a survey of the watershed for potential pollutant sources and collect known-source fecal samples in the watershed from wildlife, livestock operations, wastewater treatment plants, septic systems and other sources.

The premise behind BST is that DNA fingerprinting can identify species-specific bacterial strains since each species has different diets and digestive systems with distinct bacterial strains. This distinction allows the original source of the fecal contamination to be identified.

"Landowners are sometimes concerned about source tracking and ask, 'Are you going to tell me that all this *E. coli* bacteria is coming from my cattle and not so-and-so's?'" Di Giovanni said. "But that's not what we're doing; we're looking at general source classifications — cattle, avian wildlife, nonavian wildlife, human, etc."



(left photo) A lab technician works in Dr. George Di Giovanni's lab. Photo courtesy of Dr. George Di Giovanni.

(right photo) Lucas Gregory, TWRI project specialist, and a student collect water samples to analyze for *E. coli* and other water quality data. Photo courtesy of Texas Water Resources Institute.

E. coli bacteria found in water samples from the local water bodies are then cultured in a lab and analyzed using DNA fingerprinting. *E. coli* bacteria from the known-source fecal samples collected in the watershed are also DNA fingerprinted. Then, by comparing those two results, the sources of *E. coli* in that watershed are identified.

"The BST methods that we employ are similar to those used by industry and public health officials to identify microbial sources following process contamination or disease outbreaks," said Dr. Terry Gentry, associate professor in Texas A&M University's Department of Soil and Crop Sciences. "Many BST methods have been developed over the past two ⇨

decades, but we focus on methods that have been both published in the peer-reviewed literature and validated using samples from Texas watersheds."

Pilot project led to trust of BST methods

In 2002, scientists from TWRI and AgriLife Research were tasked with helping address water quality impairments in the Lake Belton and Lake Waco watersheds to support TMDLs being developed there. After getting input from local and regional stakeholders, the researchers began using the BST approach there and collected *E. coli* samples throughout the watershed in 2003.

The research team included Di Giovanni, Dr. Suresh Pillai, AgriLife Research faculty fellow, and Dr. Joanna Mott, now chair of the Department of Life Sciences at Texas A&M University – Corpus Christi. The project was coordinated by the Texas Farm Bureau and funded by the Texas State Soil and Water Conservation Board (TSSWCB), through a U.S. Environmental Protection Agency Clean Water Act grant.

"We used a BST approach to identify the human and animal sources impacting the lakes," Di Giovanni said. "Then we began to build analytical equipment infrastructure, and we started to build a watershed-specific *E. coli* library for that project.

"At the time, one of the weaknesses in most other TMDL approaches was that nonpoint sources of pollution were a significant but uncharacterized component of fecal pollution loading into water bodies," he said.

Nonpoint source pollution is all water pollution that does not come from point sources. Point sources are regulated, end-of-pipe outlets for wastewater or stormwater.

BST technology allowed the researchers to further identify sources within the nonpoint source category. These specific sources include birds, other wildlife, cattle, other livestock, leaking septic systems, wastewater treatment plants and other issues.

"Before BST, many computer models attributed much of the bacterial contributions to cattle, because that was one of the few sources there was good data on," Wagner said. "But BST helped us confirm what many landowners suspected, that cattle were only part of the contributions; on average, cattle contribute about 13 percent of *E. coli* in the rural watersheds studied to date."

One surprising finding of that initial project was that wildlife were a significant contributor of pollution, Di Giovanni said. Their research showed that 40 to 49 percent of the *E. coli* bacteria came from wildlife sources in lakes Belton and Waco watersheds, followed by cattle and then humans.

"And those high wildlife levels have been a finding in almost every study we've done," he said. "Wildlife contributions are much higher than previously thought."

"Having this more complete data helps us increase trust with stakeholders and really helps us with communications during implementation efforts," Wagner said.

Following the success of the Lake Belton and Lake Waco project, in 2006 the Texas Commission on Environmental Quality (TCEQ) and TSSWCB established a joint task force to identify the best, most cost-effective and time-efficient tools for developing bacteria TMDLs. The task force examined BST methods and recommended BST best practices to the state, and TSSWCB began funding the Texas BST Program, led by Di Giovanni, Gentry and Wagner.

BST Library helps improve waters across Texas

Following that initial funding, the *E. coli* bacteria collected and catalogued during the pilot project formed what would become the statewide Texas E. *coli* BST Library, Wagner said.

"The library has grown through subsequent studies," Di Giovanni said. "We've completed 18 studies in 14 different watersheds across the state, and we've certainly expanded and refined the library quite a bit."

The Texas BST Library now contains more than 1,500 *E. coli* isolates obtained from more than 1,300 different domestic sewage, wildlife and livestock fecal samples. These isolates, which represent more than 50 animal subclasses, were selected after screening several thousand isolates from the studies conducted throughout Texas over the past decade.

Di Giovanni's and Gentry's labs oversee and maintain the Texas *E. coli* BST Library data and bacterial culture collections.

In early projects, the BST team could only identify sources through comparisons with known-source fecal samples from that project, but now the library makes the source tracking process more efficient and accurate.

The research team won a 2007 Texas Environmental Excellence Award in Agriculture for its work, as well as the 2014 Texas A&M College of Agriculture and Life Sciences Dean's Outstanding Achievement Award for Interdisciplinary Research.

"One of the reasons the BST Program has been so successful is that it represents a true collaboration between multiple researchers, universities and agencies across Texas," Gentry said. "The extent of this collaboration gives stakeholders greater confidence that the BST results will be helpful for identifying and ameliorating issues in their watersheds."

Watershed restoration projects for Buck Creek, Attoyac Bayou, Leon River, Lampasas River, Bosque River and the Arroyo Colorado have all benefited from source studies conducted by the BST Program, Wagner said.

Moving forward, the program is looking to help with water quality efforts in urban watersheds, he said.

"We're really turning our attention to try to do more of this work in more urbanized settings," he said. "In predominately rural watersheds, wildlife contributes about half of the bacteria. We'll see if that differs in urban settings or not."

"Water quality is a challenge in urban watersheds, and there is much more of a potential impact from human-derived sources," Di Giovanni said. "We need to take a close look at that and see if we can identify controllable sources."

"As we continue to address water quality issues in Texas, the BST Program is always available to provide local entities with guidance and assistance in performing BST for watersheds," Wagner said. "BST has been tremendously helpful in identifying significant bacterial sources throughout Texas."

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

Story by Danielle Kalisek

Texas State Climatologist Dr. John Nielsen-Gammon. Photo by Danielle Kalisek, Texas Water Resources Institute.

Getting to know State Climatologist John Nielsen-Gammon

Professor tirelessly serves as resource for the Texas' weather and climate

On the top floor of Texas A&M University's Oceanography and Meteorology Building, overlooking the east entrance to campus, sits the Office of the Texas State Climatologist. Prior to the 2011 drought, its occupant, Dr. John Nielsen-Gammon, was a man very few people had heard of.

Since then, he has become a well-known resource for journalists, researchers, industry leaders and the public for information on the state's weather and climatic conditions. Once people know they can rely on his office for a comprehensive perspective of what's going on, they keep coming back.

About the Office

Nielsen-Gammon is one of 48 state climatologists in the United States, most of them located at land-grant universities. Appointed in 2000 by then Gov. George W. Bush, he is the second state-appointed Texas state climatologist at Texas A&M; Professor John Griffiths held the position for the 25 years prior.

The state climatologist's job description is to help Texans make the best possible use of weather and climate information. Nielsen-Gammon monitors climate and weather, produces regular reports on the state of the climate in Texas, conducts research and serves as a liaison to federal government agencies for meteorological issues that affect Texas.

Base funding for the office is from the university, but Nielsen-Gammon also receives project-specific funding from state and federal agencies.

A lifetime of weather expertise

Nielsen-Gammon's early expertise was in weather and air pollution. He received a bachelor's in earth and planetary sciences and his master's and doctorate in meteorology, all from the Massachusetts Institute of Technology.

He said his interest in meteorology dates back to long before college.

"It seemed like a fascinating topic, trying to understand things that happen," Nielsen-Gammon said. "Weather is always happening to people, and it's always changing, so there's always something new to learn.

"Being the state climatologist allows me to directly apply my knowledge to help people, and I get the benefit of always having something different to do."

A day in the life of the state climatologist

There's no such thing as a typical day as state climatologist, Nielsen-Gammon said. Much of his work is outreach; he is invited to give about 40 talks a year throughout the state and is often interviewed by media personnel who contact him for climate and weather information.

In May 2014 he started keeping track of his interviews, which totaled 184 by August 2015 with 56 interviews between May 12 and June 17 of 2015 alone.

Various professional groups also come to him for his expertise.

Nielsen-Gammon sometimes is asked his opinion on climate legislation proposed in the Texas Legislature. He also testifies two or three times per session in front of various committees on climate-related issues such as drought updates or climate change, he said.

He noted the most interesting group recently seeking his knowledge was professional engineers designing infrastructure that had to withstand the elements. They needed to know the expected frequency of floods, temperature ranges and other weather-related information to be sure their design could withstand the possible range of conditions, and they were interested in how to do that when the climate is undergoing long-term changes. ⇨

Participating in interviews and offering his expert advice account for only about half of his time.

As a regents professor in the Department of Atmospheric Sciences, the rest of his time is spent on typical university faculty duties — research, teaching, university service and other activities.

Overall, Nielsen-Gammon's main research focus is Texas climate impacts. Because of his relatively broad background in atmospheric sciences, he believes he's well positioned to understand different aspects of climate and climate change.

"I try to be sort of a generalist and talk about what we know about climate in general and what we don't know and do general outreach through blogging."

For several years Nielsen-Gammon maintained a Houston Chronicle blog titled the "Climate Abyss;" however, for the past couple of years, he has posted on the Climate Change National Forum (climatechangenationalforum.org).

The forum has 25 to 30 contributors who offer a "cross-section of perspectives from the scientific community both on science and possible policy options," he said. "We can be a resource to people who want to hear what's going on from different perspectives and not just have a single point of view put forward. We do require whatever people put forward be legitimate and founded on science."

Figuring out the guessing game

From droughts to floods, hot to cold and all in between, Texas weather is constantly changing. Texas experienced the worst one-year drought in 2011. As of July 16, 2015, Texas was officially 100-percent drought free after record rainfall during May 2015. The state remained drought-free for two weeks, according to the U.S. Drought Monitor. Throughout the summer, drought popped back up and spread rapidly throughout the state.

A lot of his work as a state climatologist involves putting data into a historical context.

For example, in May he set out to estimate the statistical likelihood of the record May rainfall, which is probably much greater than one in 1,000 year likelihood, Nielsen-Gammon said. To do this, he took data from May, June, September and October of previous years, which are the climatologically wettest months in Texas, and plotted the number of months with particular amounts of statewide average rainfall in inches through 2014. He then added May 2015 onto the plot, and, in comparison, it topped the chart for record rainfall.

As the state resource for this type of information, he was contacted during the record May rainfall event and asked for more specific rainfall information.

"Halfway through the (May rainfall) event, I got a request from state officials to give them daily precipitation totals for a statewide average, and those numbers didn't exist, so I had to figure out a way to calculate them."

To determine this information, he put the state inside a grid with 100 squares and picked a weather station within or close to each square to make sure he had a representative average. There are several hundred weather stations that report regularly in Texas.

He said he waited until the end of the month to see if his predicted averaged numbers agreed with what the official averages were, and they came out pretty close.

The previous record for the highest amount of monthly rainfall events was in 1957, the year that ended the state's worst drought of record.

"The next thing that happened in 1957 is we had a dry summer, then a wet fall, so history seems to be repeating itself," Nielsen-Gammon said. "It takes more than two events to actually have a pattern, but so far it's happening."

These wet and dry events impact the historical frequency of dry spells in various cities in Texas. With this type of information, he can look at a city and see how often the city has gone at least 50 days in the summer without a half-inch of total rainfall.

Nielsen-Gammon is also responsible for determining the appropriate level of drought in Texas to submit to the U.S. Drought Monitor, a weekly map of drought conditions produced jointly by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture (USDA) and the National Drought Mitigation Center at the University of Nebraska-Lincoln. Every week that passes with a particular area in the same dry conditions bumps that area into a more severe drought category.

Looking toward this winter, most climate forecasts are predicting a strong and strengthening El Niño, which favors a wet winter in many parts of the country because of the way the weather interacts with the jet stream, Nielsen-Gammon said. Using his historical rainfall data for November through March, he can choose a particular El Niño strength and see how much rain has fallen historically under similar conditions.

"With this event, we're talking about something that will be out near the extremes of historical El Niños, so the chances of it being dry… Well, it's never happened. It's been above normal and close to normal, but it's never been dry since 1950, which is as far back as we have good El Niño condition data," he said. "It's not a guarantee that we'll have adequate rain, but it's about as sure of a bet that you'll get six months in advance."

On the other hand, Texas only received near-normal precipitation during the two strongest El Niño events

From the top floor of Texas A&M University's Oceanography and Meteorology Building (left photo), State Climatologist Dr. John Nielsen-Gammon uses charts, maps, spreadsheets, graphs and more to compare current weather data with historical data and to determine weather statistics. (right photo). Photo by Danielle Kalisek, Texas Water Resources Institute.

in recent history, 1982–1983 and 1997–1998. "While this winter should be wet, it may not be all that wet," Nielsen-Gammon said.

While a lot of his work is focused on statewide average precipitation, most people are more interested in their local precipitation. Nielsen-Gammon maintains data to show folks in specific cities how the odds of rainfall change when narrowed down from a statewide average to a specific location.

"There's a lot more variability in smaller areas, so some places will be unlucky even if the state gets above average rainfall."

Conducting research and other activities

When Nielsen-Gammon is not looking at the climate and weather patterns, he is researching it. His main funded research is focused on drought, the state's biggest climate issue.

Through work formerly supported by USDA and currently supported by NOAA, he estimates drought severity at a fine-scale resolution, which serves as input to the U.S. Drought Monitor. This county-level data is especially important because USDA has certain drought relief funding available depending on the Drought Monitor's record of drought length and severity in the county, he said.

"We need to make sure (the U.S. Drought Monitor is) getting every county right," Nielsen-Gammon said. "We are taking recent data analysis from the National Weather Service and putting it into a historical context using long-term climate observations and converting that into different indices that measure drought severity at different time scales."

He also works on many other research projects. Changes in runoff into Texas reservoirs, impacts of weather station location and land use changes on temperature records, and the roles of natural variability versus climate in changes in extreme weather events are just a few of the other issues he researches.

Aside from traveling around the state, researching and running the latest computer models, when Nielsen-Gammon is not at work, he likes being outdoors. Golfing and hiking are among his favorites. While there's not that much opportunity for hiking in College Station, he manages to get out occasionally, he said. He also enjoys both listening to and playing music. "I like to go to Houston occasionally for the symphony or opera. I also play the piano for a folk group at weekly mass in Bryan," he said. "I'm interested in everything."

Looking ahead

Nielsen-Gammon said he'd like to eventually get back to full-time teaching and research; however, for now he plans to stay in the state climatologist role.

"Right now with everything going on, I find there's a lot I need to do, and I think I'm a good person to do it," he said.

"I'm working mainly at the local level. The things you can do to change the climate require global-scale action, but everyone has to adapt to whatever happens to the climate. Whatever I can tell people about what's going to happen a year from now or 10 years from now is useful information."

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

Story by Eva Vigh

Looking to the future

Youth education programs promote Texas water conservation

Texans in drought-susceptible areas face an arid future without knowledge of water management and planning. According to environmental experts, the best place to begin teaching these strategies is schools. Introducing water education to children is critical to ensuring adequate clean water for future generations.

Various Texas water education programs such as Water4Otter, International Junior Master Gardener (JMG) and the Texas Water Development Board (TWDB) Kids have designed educational tools and curricula specifically for young students in an attempt to increase knowledge of water-related issues and conservation.

Water4Otter campaign

"We know that across the North Texas region, water conservation is going to account for one-fourth of our future water supply," said Denise Hickey, public relations and water conservation manager at North Texas Municipal Water District (NTMWD).

"We need to start teaching our youth the value of water and that it's a limited source."

In 2014, NTMWD launched Water4Otter, a water awareness campaign funded by TWDB and intended to serve as a statewide model.

The campaign uses mascots Otis the Otter and his friends Bob the Bobcat and Farah the Fox to help remind children that Lavon Lake, the primary natural water source in North Texas, is a resource shared by humans as well as animals.

Research from NTMWD's regional Water IQ campaign in 2014 suggested that students were more likely to be concerned about water efficiency if they related water consumption to the needs of animals that rely on the same source of water, Hickey said.

"If you relate water use to the needs of the otter, then students will go home and start talking to their parents," she said. "The whole aim of the program is to increase the conservation of water and efficiency in the home."

Children explore a garden as part of the JMG program. Photo courtesy of International Junior Master Gardener program.

The Water4Otter program delivers in-school presentations and provides removable stickers with water-saving tips to students. Children can place these stickers around their home as a friendly reminder to parents to maintain eco-friendly habits, such as fixing leaks or only washing full loads of dishes. The water district also designed the Water4Otter app, a free interactive game that encourages children to learn water conservation strategies while helping Otis and his friends.

JMG curriculum

Engaging children in educational, hands-on water conservation activities is a mission shared by JMG as well.

"Water conservation in Texas is vitally important," said Lisa Whittlesey, national coordinator of the kids gardening program. "It is so important our children understand that because they are our future consumers of water and decision-makers on how water resources are allocated."

JMG is composed of seven different curricula that focus on teaching children to give back to their communities. The *Operation Water* curriculum is designed exclusively for water education, and each of the other programs also emphasizes the importance of water as a natural resource that must be preserved, said Whittlesey, a Texas A&M AgriLife Extension Service specialist.

She said the curriculum encourages students to be active learners by participating in experiments and community conservation projects. "Kids really learn by doing," she said. "Our program is taught in a very hands-on, engaging way so the kids actually experience it and are not just reading about it."

Some of the skills the students learn include the appropriate selection and use of landscape plants and mulch and irrigation techniques that minimize water loss in gardens.

"They do experiments to show, for instance, that watering deeply really encourages the root system to grow deeply," Whittlesey said. "During a drought it's better to water deeply and infrequently versus small, frequent amounts of water."

The JMG curriculum is aligned with the Texas Essential Knowledge and Skills (TEKS), which are the state's academic standards, and the Standardized Testing and Reporting (STAR) test. It also strongly supports project-based learning — a teaching method that encourages hands-on involvement to help master concepts, she said.

TWDB Kids

In view of the JMG curriculum, TWDB developed a similar approach to youth water conservation awareness by offering classroom-based curricula in four programs:

- *Water for Texas*: a 16-page coloring and activity book for kindergartners through third graders designed to engage them in water conservation techniques at home
- *Major Rivers*: a multidisciplinary set of educational materials for fourth and fifth grade classrooms
- *Raising Water IQ*: a curricula for students in sixth through eighth grade, in which water resources are covered in greater depth
- *Water Exploration*: a high school, web-based curriculum where students and teachers work together to conduct research, build a stronger understanding of water science and explore solutions to critical water issues. ⇨

Some of the interactive activities developed by TWDB include constructing a bean bag or water balloon toss to symbolize water usage. Older students have opportunities to identify where their school could increase water-use efficiency by measuring water fountains or calculating water usage every time the football field is irrigated.

"We really hope to have educated and more aware water users," said John Sutton, municipal water conservation team lead at TWDB. "As they grow, they are our future water users and decision-makers."

Program impacts

As these programs continue to engage students across the state, evaluation data shows that they are making a measurable difference.

Hickey said Water4Otter post-campaign studies revealed approximately 78 percent of the 3,000 students who returned the surveys participated in water-related conservation activities with their families and used the removable stickers around their home.

Research on the junior gardening program's impacts indicated that children became more actively involved in their community and environment as related to water conservation after successful course completion, Whittlesey said.

The program reaches one million children a year nationally, and approximately 200,000 a year in Texas.

Sutton said pre- and post-tests distributed to classrooms enrolled in TWDB Kids revealed a significant increase in student awareness of water conservation issues. The Major Rivers program reached about 33,000 students last year alone.

As water concerns continue to increase and evolve in Texas, the success of these programs will play a vital role in educating youth on the management, preservation and conservation of the state's water supply.

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

(left photo) A student participates in a wetland demonstration as part of the JMG program's classroom education courses. (right photo) Students unearth sweet potatoes during their trip to a garden through the JMG program. Photos courtesy of International Junior Master Gardener program.

MAJOR RIVERS
Texas Water Education

TEXAS WATER DEVELOPMENT BOARD K-12 EDUCATIONAL RESOURCES
TWDB KIDS
www.twdb.texas.gov/kids

Junior Master Gardener
growing good kids

Water Exploration

Story by Leslie Lee

Does drought recovery equal quail recovery?

Experts study weather, habitat and populations amidst quail decline, advise landowners on management

In the Rolling Plains, bobwhite quail numbers took a nosedive in 1994 and have never fully recovered. Photo courtesy of Texas A&M AgriLife Extension Service.

Megabrood: that's a term most Texas quail enthusiasts haven't used in about a decade. But this year, it made a comeback.

Rains that soothed and flooded landscapes across the state in May and June 2015 resulted in near-optimum conditions for quail in many regions. Good rainfall, habitat conditions and survival rates resulted in many ranchers spotting large coveys of quail, or megabroods. Some hens hatched nests of up to 20 chicks and many hens "double-clutched," or hatched more than one brood, experts said.

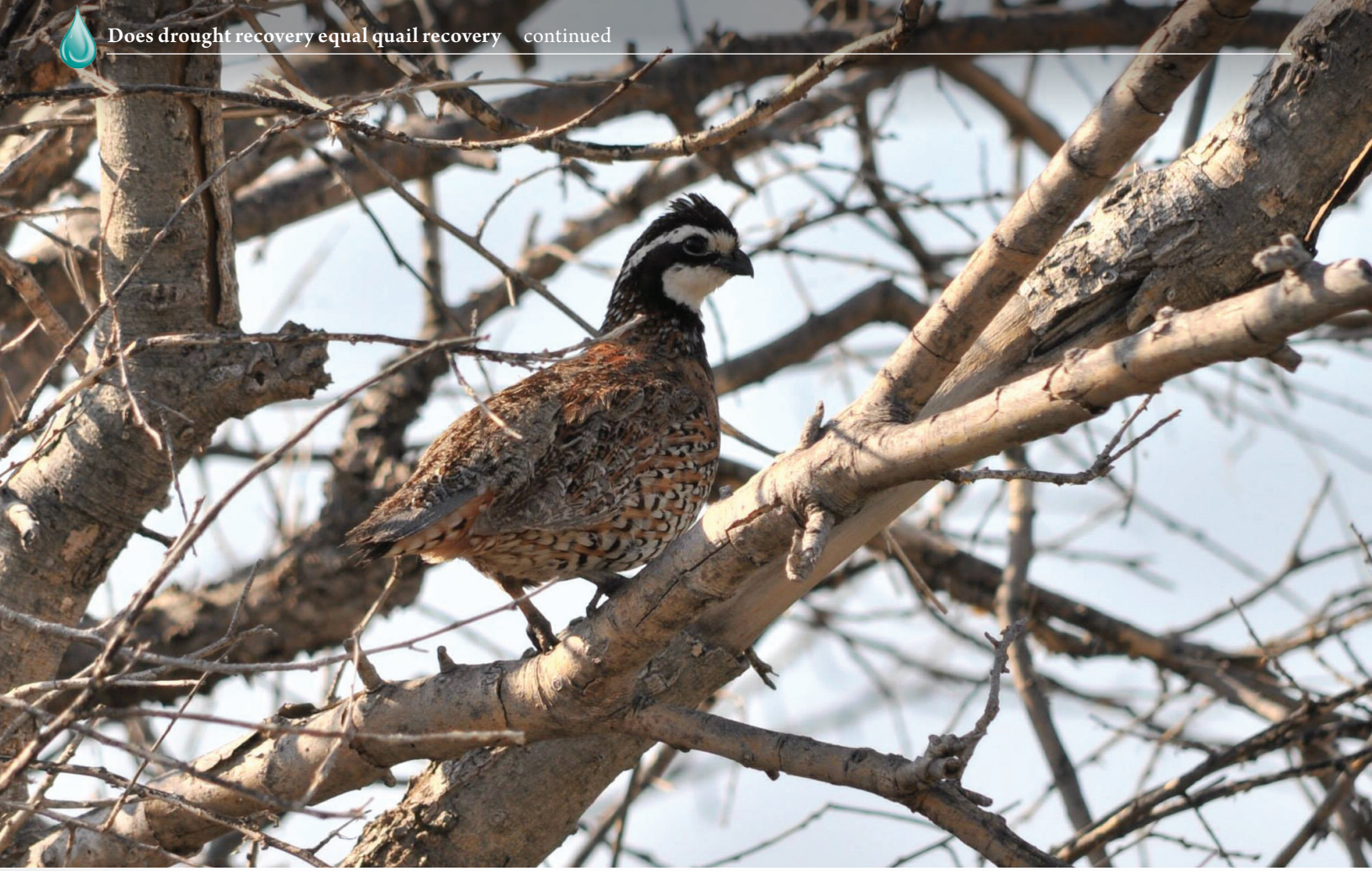
"If we have rain, we'll have quail, and if we don't, we won't," is an oft-repeated adage among West Texas ranchers, said Dr. Dale Rollins, executive director of the Rolling Plains Quail Research Ranch (RPQRR). The Texas Parks and Wildlife Department's (TPWD) annual roadside quail counts were published in September and mostly agreed, showing increased populations from last year in most ecoregions. The "boom" was most pronounced in West Texas, Rollins said.

Four species of quail are historically found in Texas: bobwhite, which are the most popular and are abundant throughout much of the state; scaled or blue, usually found in the western half of the state; Gambel's, much less abundant and found only in the western parts of the Trans-Pecos region; and also less abundant, Montezuma, which range in the Trans-Pecos and the western Edwards Plateau.

Despite decent roadside counts and ranchers' optimistic reports in 2015, quail are still in the midst of a long-term decline that won't be fixed by one wet spring, experts said.

The North American Breeding Bird Survey, a U.S. Geological Survey project, has shown a decline in Texas bobwhite breeding numbers at a rate of 3.9 percent per year from 1970 to 2009, according to TPWD.

"In Aldo Leopold's day, experts were saying quail had been declining for 50 years," said wildlife biologist Brian Pierce, an associate director of the Texas A&M Institute of Renewable Natural Resources (IRNR). "So that means this decline has been happening for more than 100 years; this is nothing new." ⇨



Male bobwhite quail on a calling perch in Stonewall County. Photo by Becky Ruzicka. Texas A&M AgriLife Extension Service.

As drought conditions inevitably rise and ebb in Texas, quail hunters and enthusiasts continue to hope for and work toward conservation of the species, and wildlife researchers study all the factors involved in the storied birds' survival.

When the rains come

Rain's positive effects on quail are multifaceted.

First, grassland prairies that are healthy and tall enough to provide the 6-inch-tall bird with sufficient cover from both terrestrial and aerial predators are essential to quail. Second, the birds require habitats with numerous clumps of native grasses to nest in because the shelter provides effective cover from predators and the climate needed to brood a nest. Third, quail chicks need a healthy crop of insects to eat to get the protein they need for rapid development.

Additionally, because rain benefits the entire grassland ecosystem, other species, such as rodents, also abound following rains. This provides alternative prey for quail predators, taking some pressure off quail. Lastly, when all these factors are present, the numbers of nests per hen, chicks hatched per nest, and surviving chicks are all higher, resulting in an increased base population leading into winter.

"Quail reproduce in the summer, and if conditions are favorable, then they can have multiple clutches of chicks in a year, and that's when you see the population renewing itself," said Dr. Brad Dabbert, the Burnett Foundation Endowed Professor of Quail Ecology at Texas Tech University and a leader of the Quail-Tech Alliance.

Quail-Tech is a partnership between Texas Tech University and privately owned ranches in a 38-county, 22-million acre area in west central and northwest Texas. The alliance began in 2010 and currently works with 27 partner ranches, conducting both research and outreach on the properties.

"This (alliance) has given us a great Rolling Plains-wide picture of what's happening, to a certain extent, with quail populations," Dabbert said.

According to the alliance's research, rainfall and bobwhite population numbers in the Rolling Plains share a significant positive correlation. They also found that rainfall is a limiting factor for bobwhites, meaning that their populations can only grow so much during drought, regardless of other factors. Research on their ranches found that lack of food and cover during drought reduces the number of

nesting attempts by as much as 80 percent while also decreasing the survival of chicks produced by the few nests that are attempted, he said.

Rollins said that sufficient rain is at least half of the piece of the puzzle for quail population growth, but management is also important. "Rain is definitely the ace in the deck," he said. After the wet spring of 2015, he estimated that 40 percent of the coveys seen on the research ranch in the summer were megabroods.

He and his staff study the ranch's quail populations as well as the effects of various land management practices. The nonprofit ranch is a 4,700-acre property in Fisher County that works in partnership with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research.

The $2 million question

Although the population had already been declining for decades, both bobwhite and blue (or scaled) quail populations substantially decreased in Texas in the mid-1990s. In most of the state's ecoregions, the birds have followed a "boom and bust" pattern over the years, with lower counts mostly coming in drier years. But, since the 1990s, counts in the "boom" years have mostly been below the long-term averages, Rollins said.

In the Rolling Plains, bobwhite quail numbers took a nosedive in 1994 and have never fully recovered, he said. Even during wetter years, veteran West Texas quail hunters forecast the season cautiously and predict a good quail year only "if the wheels don't fall off," Rollins said.

So, what's causing the decline? Explanations range from obvious ecological explanations, such as habitat loss, urban and suburban development and degradation of native grasslands, to fire ants or disease.

To help solve the mystery, the Texas Legislature passed a biennial exceptional item for fiscal years 2014-2015 to support integrated approaches by AgriLife Extension, with AgriLife Research, to use the Texas A&M University System's resources to address the decline. The state-designated $2 million fund established the Reversing the Quail Decline Initiative, for which Rollins serves as the state coordinator. The funding was also renewed for the 2016-2017 biennium.

In September the initiative hosted a Statewide Quail Symposium, the first event of its kind since 1999, bringing together researchers, educators and experts from across the state, to discuss relevant topics, including quail decline.

The decline, however, may not be easily fixed, Pierce said. ⇨

(left photo) Hatched nest of blue quail underneath prickly pear cactus.

(right photo) The Rolling Plains Quail Research Ranch is used as a research and demonstration facility to foster understanding and management of bobwhite and scaled quail in West Texas. Photos courtesy of Rolling Plains Quail Research Ranch.

"There are boom and bust cycles in weather, but quail populations keep declining steadily over the decades — so we know the cause isn't the weather," Pierce said. "The cause of the decline is the one thing we don't want to admit: it's us."

Pierce helped conduct a recent study funded by the initiative that found habitat loss due to land use change to be the greatest indicator of future quail population declines. Increases in land values and human population density most closely correlated with decreases in quail counts. The research was conducted by Pierce, IRNR Director Dr. Roel Lopez, IRNR Research Scientist Israel Parker and Texas A&M Department of Wildlife and Fisheries Sciences Regent's Professor Dr. Nova Silvy, and compared economic, agricultural and land use metrics among ecoregions in Texas from 1993 to 2012.

As human population density in Texas continues to increase, quail population densities will continue to decrease, Pierce said.

Landowners can help birds fight back

Although the quail decline is indisputable, there are management practices that landowners can adopt to help quail survive, the experts said.

"We can't control the weather or the climate, but we can control how we manage our land," Pierce said.

Pierce said an IRNR research study conducted from 2011 to 2013 found that ranches in the Rolling Plains, all experiencing the same drought conditions, saw drastically different quail numbers depending on how they managed the land. Cattle ranchers that managed grazing conservatively saw success in their quail numbers, while ranchers who made decisions unfavorable to quail habitat saw low quail numbers.

"Conservative grazing and moderate stocking rates are key," Rollins said. "A rancher with bird dogs is a quail's best friend. We think that good stewards have the advantage if they maintain nesting cover. Quail like to nest in last year's grass, what's called residual grass cover. So, if you've grazed it all to the ground, your quail are at a disadvantage."

"Managing land for both cattle and quail can be very compatible, and grazing management and quail habitat can go hand in hand," Dabbert said.

He said that proper management during drought or low-rain years will also result in landscapes and quail populations that bounce back quicker when rains do eventually come.

"You hear folks say 'if we have rain, we'll have quail, and if we don't have rain, we won't have quail,' and to a certain extent that's true," he said. "But if you don't manage your populations and land properly in the meantime, you're going to have to wait a lot longer after these tremendous rain events to see the benefits to your quail."

Quail-Tech recommends supplemental feeding as one way to help quail populations during dry years. Broadcasting supplemental feed, which involves distributing it not onto roads or short grass but out into the tall grasslands where quail can safely find it without leaving cover, is a technique that they have found to be effective in sustaining base quail populations in the Rolling Plains, Dabbert said.

"So even though we have to work within the context of rainfall, there are management factors that we can do that will keep our higher populations higher and our lower populations not as low during those drought years," he said.

RPQRR research has shown that maintaining clumpgrass nest-sites throughout a landscape increases quail survival rates, Rollins said.

"Quail like to nest in grass, and they don't care if it's little bluestem, or silver bluestem, or tobosagrass — there are several species that will fit the bill," he said. "But you've got to have nesting cover across the landscape. We recommend landowners have at least 300 suitable bunchgrasses per acre. You don't want the clump to stick out among the landscape. Nesting cover across the landscape diffuses predators' search-efficiency.

"Here in the Rolling Plains, we also get a lot of broomweed in wet years, which is one of my favorite plants for quail," Rollins said. "Nothing insulates a quail crop better than a canopy of broomweed. To a quail it's like a covered shopping mall."

Land management benefits water and quail

What's good for quail is often good for both the water and land, the experts said. Many of the same land conservation practices that benefit watersheds' water quality, other wildlife species and soil conservation also benefit quail.

"You don't have to be carrying a shotgun and following bird dogs to appreciate quail and the systems that produce them," Rollins said.

Managing grazing, building spreader dams along ranch roads to reduce runoff and create plant and wildlife oases, maintaining native grasses and conducting prescribed burns are some of the recommended techniques that help quail and also provide ecosystem-wide benefits.

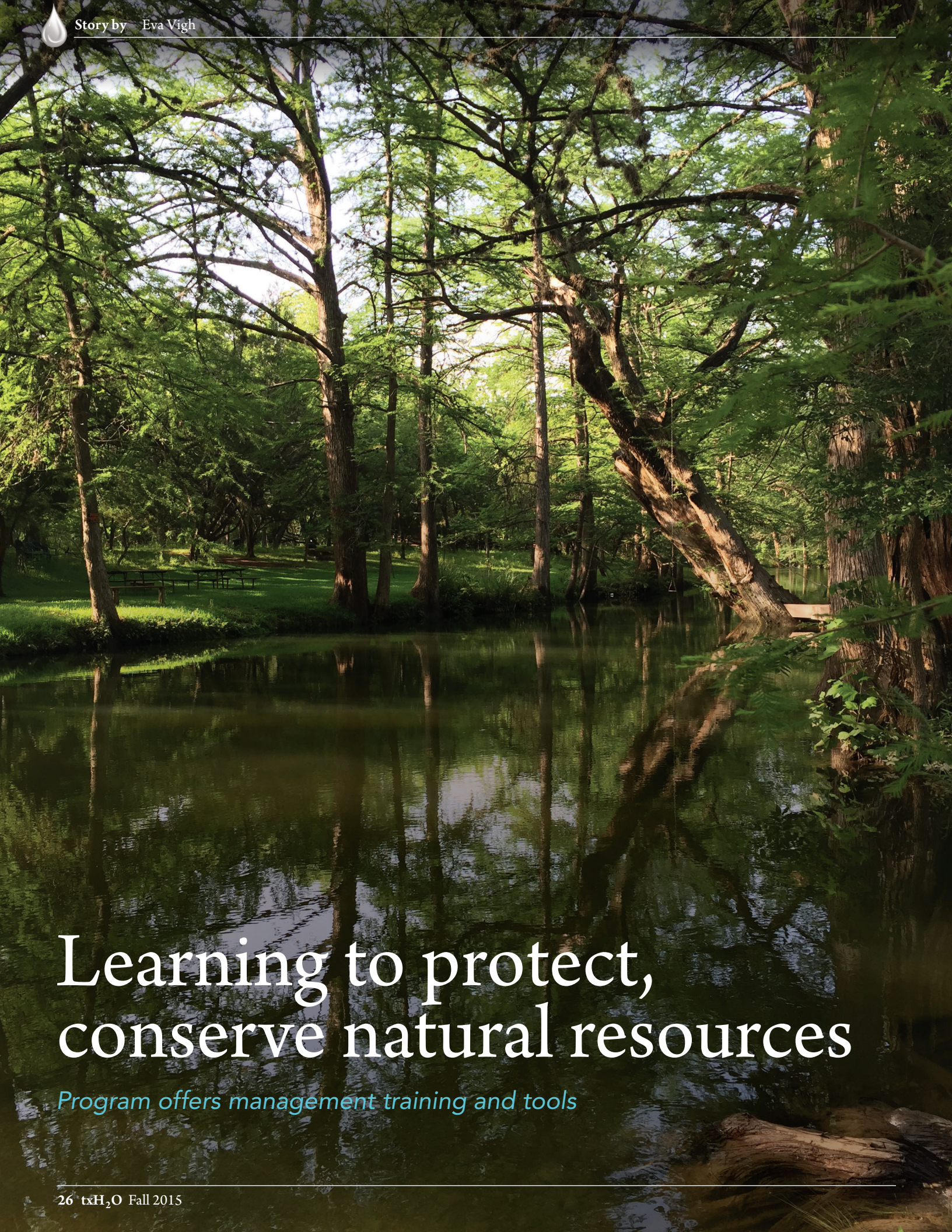
"When the grassland is healthy, quail are healthy," Pierce said.

"Healthy landscapes benefit wildlife, landowners and the public. Because approximately 97 percent of all land in Texas is privately owned, we should focus more of our efforts toward helping landowners understand and execute good land management practices."

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

The Reversing the Quail Decline Initiative seeks explanations for the decline of quail throughout the state. Photo courtesy of Texas A&M AgriLife Extension Service.

Story by Eva Vigh



Learning to protect, conserve natural resources

Program offers management training and tools

The more Texans know about their water and other natural resources, the more likely they are to participate in conserving and protecting these resources. Additionally, professionals must understand emerging management tools to address critical natural resource issues.

The Natural Resources Training Program of the Texas Water Resources Institute (TWRI) and Texas A&M Institute of Renewable Natural Resources (IRNR) serves interested landowners and citizens as well as water and natural resource professionals and offers intensive, educational courses across the state.

The two main goals of the program are to provide landowners with appropriate practices to address natural resource issues and to offer training for professionals on natural resource management tools, innovative technologies, geographic information systems (GIS) and computer models.

Watershed Short Course

TWRI initiated its first training course — the Texas Watershed Planning Short Course — in 2008 in an effort to teach the necessary strategies for developing a watershed protection plan.

Implementation of such strategies has a significant impact on water resources in terms of quality and supply, said Dr. Kevin Wagner, TWRI associate director.

"Education is imperative to achieving long-term improvements in both water conservation and water quality," he said. "This is a well-established fact that has been demonstrated in study after study."

The short course was developed as a weeklong training in response to the U.S. Environmental Protection Agency's nine-element watershed planning guidelines to help watershed coordinators practice sustainable procedures and implementation strategies in managing water quality. Watershed restoration and protection topics such as data collection and analysis, stakeholder coordination and tools for plan development are covered in this course.

Watersheds and riparian areas are important ecosystems and a critical focus of the Natural Resources Training Program. Photo by Nikki Dictson, Texas Water Resources Institute.

Watershed Coordinators Roundtable

According to Nikki Dictson, Texas A&M AgriLife Extension Service program specialist for TWRI and coordinator of the training program, watershed coordinators from around the state also meet at the biannual Texas Watershed Coordinator Roundtable to discuss program updates, funding and any concerns or innovations to improve watershed planning and implementation efforts. As a result of the roundtable meetings, the Fundamentals of Developing a Water Quality Monitoring Plan and Introduction to Modeling trainings were introduced to provide further support for professionals in implementing monitoring strategies for characterizing and evaluating watersheds. Other trainings include Getting in Step, Stakeholder Facilitation and Implementation workshops.

Meeting training needs

TWRI continues to create new trainings to meet the needs of interested stakeholders as well as water and natural resource professionals, Dictson said.

In 2012 TWRI began the Texas Riparian and Stream Ecosystem Program. Dictson said the program's goal is to promote healthy riparian zones by educating stakeholders on riparian principles, watershed processes, hydrology, erosion/deposition principles and vegetation and to provide the tools to prevent degradation and improve water quality.

Landowners, agency staff, city officials and the public are encouraged to attend the riparian workshops held in different watersheds around the state. At the workshops, they learn about the important benefits of healthy riparian areas, which act as buffers to stabilize banks, prevent erosion and filter out sediments and pollutants.

Dictson said the riparian program has been very successful since its start, with 1,030 attendees impacting a combined acreage of more than 187,000 acres. More than 99 percent of post-workshop evaluations showed that participants were mostly or completely satisfied with the program and course materials and all would recommend this course to others. Additionally, 94 percent said they would adopt management practices discussed in the course to improve riparian management and water quality.

"I loved the workshop and learned so very much about this fascinating and integral part of our ecosystems," wrote an attendee of the riparian workshop in Hamilton. "The tragic news reports of Wimberley and the Blanco River are horrific," she said, referring to the Memorial Day flash floods. "Your workshop's messages are more important now than ever, as the streams and rivers heal...as well as the people who live by and love them."

Dictson said this attendee was very instrumental in bringing the riparian workshop to Georgetown in September, where more than 100 attendees gathered to learn about the riparian areas in the San Gabriel River Watershed. ⇨

"We've done more than 25 riparian landowner workshops across the state," Dictson said. "These are geared toward priority watersheds addressing water quality issues."

Additional trainings offered through the riparian program include the Introduction to Proper Functioning Conditioning (PFC) Training — an overview of the riparian assessment method used to rate functional processes of riparian zones. Multiple conferences co-sponsored by the program included the 2015 Urban Riparian Symposium in Austin, which presented timely information regarding a variety of stream and riparian issues to participating professionals through workshops, keynote speakers and presentations.

The Natural Resources Training Program continues to engage landowners, water coordinators and professionals, expanding the different trainings and workshops throughout Texas.

If professionals express a need for a previously held course, Dictson said she tries to accommodate that. The program recently offered the Water Rights Analysis Package (WRAP) Fundamentals Short Course in response to such requests.

Led by Dr. Richard Hoffpauir of Hoffpauir Consulting in College Station, the WRAP course offered the opportunity to obtain hands-on experience with the modeling system and gain an understanding of basic water rights analyses. The Texas Commission on Environmental Quality's Water Availability Modeling system uses WRAP along with input datasets for all the river basins of Texas.

ArcGIS training

Partnering with TWRI, IRNR offers an Introduction to ArcGIS 10 course. Professionals in nearly every field can take advantage of the course, which provides participants with a solid foundation of understanding ArcGIS software and basic GIS tasks, said Amy Snelgrove, a program coordinator for TWRI and IRNR.

"GIS is a tool that allows you to study relationships between various geographic features, based on both their physical attributes as well as their location on the surface of earth," Snelgrove said. "Through GIS analysis, you can see spatial patterns in data, giving a better understanding of how the location of features influences traits or locations of other features."

Users can not only analyze the location of features, but look at characteristics of those features as well. GIS analysis can be particularly useful for watershed analysis in determining the flow of water, municipal water usage and possible sources of contamination, Snelgrove said.

"Our training courses and workshops have evolved and improved over the years, continually serving Texans and meeting education needs," Wagner said. "We will continue to provide the best in water and natural resources training."

For more information about the Natural Resources Training Program, visit nrt.tamu.edu.

(left photo) Dr. Daren Harmel with USDA Agricultural Research Service talks about automated stream sampling to the Texas Watershed Planning Short Course attendees.

(right photo) Kyle Wright with the Natural Resources Conservation Service discusses agricultural programs during a riparian workshop in Wimberley. Photos by Nikki Dictson, Texas Water Resources Institute.

Story by Kathy Wythe

TWRI offers watershed monitoring, planning to stakeholders

With more than 440 water bodies impaired in Texas, understanding the potential causes and sources of those impairments is critical. After these issues are understood comes the work of restoring the water bodies.

The Texas Water Resources Institute (TWRI) has the staff and expertise to help with both. It includes a seven-member water team and graduate students, who are involved in watershed monitoring and watershed protection planning in a dozen watersheds throughout Texas.

"With a half century of combined watershed-based planning experience, TWRI has the experience, expertise, organizational skills and knowledge to gather, collect and analyze water quality data and then guide stakeholders in developing science-based and stakeholder-supported plans necessary for restoring local water bodies," said Dr. Kevin Wagner, TWRI associate director.

Lucas Gregory, TWRI project specialist, said the team collects water quality data, including stream flow, turbidity, dissolved oxygen, pH, conductivity, temperature, transparency and total depth, and then analyzes the data to develop a complete understanding of the water quality in the watershed. The team also incorporates the data into geographic information system (GIS)-based models of the watershed as well as sample water for *E. coli* or any other water quality constituent. (See *A decade of solving water quality mysteries*, page 10.)

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

Wagner agreed.

"Effective monitoring and watershed assessment provides communities and organizations with information needed to identify and better understand potential causes of local water quality impairments," he said. "Having that information allows them to proceed with developing watershed-based plans to begin restoring the watershed."

Wagner said the team is a statewide leader in coordinating and implementing locally driven watershed programs. The team has the capability to raise awareness through water quality education and outreach, assist in selecting appropriate management measures, draft restoration plans for local communities using feedback from local stakeholders, coordinate implementation of completed plans and help secure funding for planning and implementation.

For more information and resources, visit *txH2O* online at twri.tamu.edu/txH2O.

Members of the Texas Water Resources Institute's water team take water quality samples in Carters Creek. Photo by Lucas Gregory, Texas Water Resources Institute.

Texas A&M AgriLife Extension Service

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