tx H2O

Special Edition

A Publication of the Texas Water Resources Institute

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

Working to make every drop count

Welcome to this special edition of *txH$_2$O*. This issue highlights many Texas Water Resources Institute (TWRI) projects, presenting an overview of their efforts, objectives, and accomplishments.

TWRI currently manages about 90 projects, ranging from a multi-year, multi-state initiative implementing strategies for meeting the water demand in the Rio Grande Basin to annual competitive grants for graduate students at universities throughout Texas. The institute partners with more than 250 faculty and other personnel within The Texas A&M University System and at 17 other universities and research agencies to carry out these projects. These outcome-based efforts are making a difference in the areas of water quantity and quality. TWRI focuses on developing projects that link university faculty and their expertise into research and educational programs that provide solutions to complex water issues.

We diligently work to transfer the information derived from research projects to agencies, municipalities, homeowners, agricultural producers, youth, individuals, industries, decision makers, and other citizens. Bridging the gap between scientific research results and those needing the information is at the heart of our purpose as an institute. In addition to *txH$_2$O*, the institute produces four print and web publications, news releases, technical reports, fact sheets, and other informational materials. Our webmaster supports 27 websites, many project-specific. To find out more about any of these projects, visit the project websites or go to TWRI's home page at *twri.tamu.edu*.

What is accomplished through these projects are examples of dedicated teamwork and stellar research and education with one goal in mind: making every drop count.

B. L. Harris

B.L. Harris

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For more information and to subscribe to *txH$_2$O*, visit our website at

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TEXAS A&M UNIVERSITY

AgriLIFE RESEARCH & EXTENSION
Texas A&M System

Texas Water Resources Institute
make every drop count

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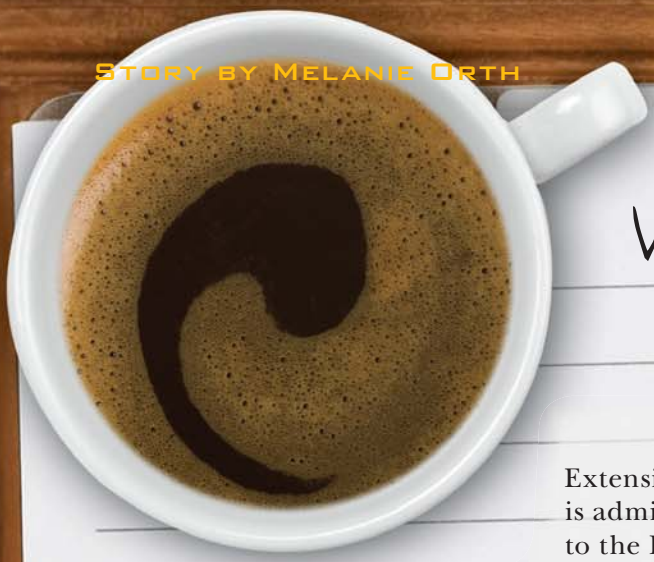
Story by Melanie Orth



Working with partners

Institute is making every drop count

As water issues continue to be critical around the globe, the Texas Water Resources Institute (TWRI) maintains its focus on fostering, facilitating, and communicating priority water resources research and outreach programs throughout the world.

The institute was established as the Water Research and Information Center by Texas A&M University System Chancellor Gibb Gilchrist in September 1952. The center was renamed the Water Resources Institute in 1963.

The Water Resources Research Act of 1964 established water resources institutes in each state and provided funds for research on solving water issues. The Texas Legislature and Governor John Connally designated Texas A&M University as the land-grant institution for the home of Texas' water resources research institute. The institute became the Texas Water Resources Institute in 1971.

Today, TWRI is one of 54 institutes in the National Institute for Water Resources (NIWR), which serves as the contact between individual institutes and the federal funding sponsor, U.S. Geological Survey (USGS). Partial funding and administrative leadership is provided by Texas AgriLife Research and the Texas AgriLife Extension Service. The institute is administratively linked to the Dwight Look College of Engineering through the institute's associate director of engineering and also to the College of Agriculture and Life Sciences at Texas A&M.

TWRI addresses the state's priority water issues by working with more than 250 water-related faculty and associates to obtain grants from state and federal agencies and other entities.

"Our projects focus on developing alternative sources of water, making agricultural and urban irrigation more efficient, improving water quality, conserving water resources, maintaining aquatic and riparian habitats, managing watersheds, and shaping water resources policy," said Dr. B.L. Harris, TWRI's acting director. Joining Harris on the leadership team is Kevin Wagner, associate director, and Dr. Ralph Wurbs, associate director of engineering.

The institute currently manages about 90 active projects with more than $24 million in funding. TWRI's project managers are responsible for planning, developing, and implementing water-related research and educational projects. Current TWRI staff managing projects are Allen Berthold, Lucas Gregory, and Danielle Supercinski; Dr. Bill Fox, assistant professor at the Texas AgriLife Blackland Research and Extension Center at Temple; Richard Hoffpauir, research engineering associate; and Aaron Hoff, student technician. Jaime Flores, watershed coordinator, and Gary Bryant, watershed coordinator and Extension program specialist, coordinate specific projects in the Lower Rio Grande Valley and the Pecos River Basin, respectively.

The institute has established many partnerships that, in addition to the colleges, units, and agencies at Texas A&M, include 12 other Texas universities, three out-of-state universities, more than 40 federal, state, and local governmental organizations, and numerous engineering firms, commodity groups, and environmental organizations.

TWRI's communications team informs the public of innovative water research and education programs through its websites, newsletters, expert directories, technical reports, fact sheets, educational materials, and other publications. Most can be viewed or downloaded by visiting the website at *twri.tamu.edu*. The institute recently started publishing a digital journal and participating in a digital water library (see story on page 28). The communications team is Kathy Wythe, communications manager; Leslie Lee, program assistant; Jaclyn Tech, software applications manager; Courtney Swyden, training program coordinator; and Supercinski.

TWRI's Water Resources Training Program offers training

Employees of the Texas Water Resources Institute include (back row, left to right) Richard Hoffpauir, Lucas Gregory, Dr. Bill Fox, Jaclyn Tech, Kevin Wagner, Dr. Ralph Wurbs, Rosemary Payton, Dr. B.L. Harris, and Kathy Woodard; (front row, left to right) Aaron Hoff, Danielle Supercinski, Allen Berthold, Kathy Wythe, Leslie Lee, Courtney Swyden, and Sarah Seidel.

courses on the latest computer technologies and products of university research to water resource professionals. Swyden heads up this program (see related story on page 24).

TWRI awards research funds to graduate students from Texas universities through grants funded by the USGS Water Resources Research Program and the W.G. Mills Scholarship Program (see related story on page 26).

The institute staff also includes Rosemary Payton, assistant to the institute director; Sarah Seidel, business coordinator; Kathy Woodward, office associate; and Michael Foggit, systems administrator. "These valuable employees work hard to keep the institute on track and running smoothly," Harris said.

"Our vision for the institute is to remain one of the top water resources institutes of NIWR, respected by faculty and administrators across the state and nation as a valuable partner for research and outreach programs," Harris said. "We plan to be successful in obtaining and managing water project funding and highly valued as a source of scientifically valid information by those seeking or needing information. We also plan to continue facilitating scholarships, internships, and undergraduate and graduate programs involving water."

TWRI Directors

Ernest Smerdon	1964–1968
Jack Runkles	1968–1983
Wayne Jordan	1983–2000
Allan Jones	2000–2008
B.L. Harris (acting)	2009–present

TWRI Fast Facts

- Employs 16 full-time, one part-time, and three student employees
- Manages some 90 active projects with more than $24 million in funds
- Partners with more than 120 Texas A&M University System associates to obtain funding for research and/or education projects
- Works with 56 county AgriLife Extension agents
- Collaborates with more than 120 associates at 17 other universities and research agencies

Story by Kathy Wythe

Synergistic eradication

Center's First Project Tackles Invasive Plant at Treasured Lake

Caddo Lake, straddling the state line between Texas and Louisiana, is a treasure for many people. Known for its signature bald cypress trees draped with Spanish moss, this treasured lake is also a home to vast diversity of wildlife. In recent years, giant salvinia, a fast-growing fern native to South America, has invaded the lake, threatening to steal the treasure away.

With leadership from Sen. Kay Bailey Hutchison and funding from Congress, a new center is finding ways to control and eradicate this invasive plant in Caddo Lake.

The Center for Invasive Species Eradication (CISE), under the direction of the Texas Water Resources Institute (TWRI), was recently established by Texas AgriLife Research and the Texas AgriLife Extension Service. The center is directing research, demonstrations, educational programs, and treatment activities that initially focus on eradicating giant salvinia in Caddo Lake. Next it will contend with other noxious non-native plant species in Texas. Congress provided the funds through the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Non-native invasive plants are unwanted species that have usually been introduced unintentionally from other countries and have the ability to spread out of control, ultimately displacing native species. The Texas Department of Agriculture currently lists 32 noxious weeds growing in Texas, including giant salvinia, giant cane, and saltcedar (tamarisk).

"This center is a collaborative effort to complement and connect with ongoing endeavors by others dealing with invasive plant problems," said Dr. B.L. Harris, acting director of TWRI. "We look forward to working with not only AgriLife Research scientists and AgriLife Extension specialists but also other universities; local, state, and federal agencies; and other groups and individuals to provide practical solutions to controlling invasive species and preventing future infestations."

The center's first undertaking is the *Caddo Lake Giant Salvinia Eradication Project*, which seeks integrated, multi-agency management options for giant salvinia (*Salvinia molesta*). The free-floating aquatic fern was introduced to the United States by the water garden industry. Since its appearance in this country, giant salvinia has been an aggressive invader that can double in size in four to 10 days under favorable growing conditions.

"Caddo Lake in East Texas was first infested with giant salvinia in 2006, and within two years the plant's coverage expanded from less than 2 acres to more than 1,000 acres," said Dr. Michael Masser, AgriLife Extension fisheries specialist. "The plant can form thick mats over the lake, choking off sunlight to the fish, plants, and animals below, and greatly hinders boating, fishing, and other recreational uses of the water.

"So far, efforts to control giant salvinia such as chemical spraying and mechanically removing the invasive plant have yielded moderate success but have not completely eliminated the species from the lake," he said.

Harris said AgriLife Extension and AgriLife Research project members are collaborating with other agencies on this effort, including the Caddo Lake Institute, Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service,

Caddo Lake is the focus of the first project for the Center for Invasive Species Eradication. Scientists will demonstrate and evaluate different methods for controlling and preventing the growth of giant salvinia. *Photo by Lucas Gregory*

U.S. Army Corps of Engineers, NRCS, Cypress Valley Navigation District, Louisiana Department of Wildlife and Fisheries, and Louisiana State University.

TWRI project manager Lucas Gregory said project members are evaluating and demonstrating control methods—primarily chemical and biological—and assessing their effectiveness in killing giant salvinia.

Masser and Dr. Paul Baumann, AgriLife Extension weed specialist, are establishing chemical treatment demonstration sites.

"We are testing and evaluating different chemical treatment practices using a variety of chemicals, surfactants, and combinations at various concentrations, rates, and timings to determine the most effective chemical control methods," Baumann said.

Dr. Allen Knutson, AgriLife Extension entomologist, is leading the biological control efforts of the center using weevils proven to eat only giant salvinia. He is working with TPWD, U.S. Army Corps of Engineers' Lewisville Aquatic Ecosystem Research Facility andthe USDA Agricultural Research Service in Weslaco to improve methods of rearing weevils for release in Caddo Lake and tactics for monitoring their impact on giant salvinia.

Knutson, who is located at Texas AgriLife Research and Extension Urban Solutions Center at Dallas, said the nature of Caddo Lake presents a perfect setting for giant salvinia to establish and thrive. "A vast majority of the lake is actually a swamp that is largely inaccessible by boat or canoe and provides giant salvinia a great place to hide," he said. "These areas are ideal candidates for establishing biological control and will hopefully provide a continual line of defense against the further spread of giant salvinia in the lake."

Baumann said the combination of chemical and biological control should prove to be effective. "This project offers a unique opportunity and solution where integrated pest management practices will need to be employed," he said. "The use of herbicides along with the weevils that feed on giant salvinia will be a synergistic combination that will provide for giant salvinia control at levels not achievable with either practice used alone."

Along with the research, education is essential to getting the word out about this noxious weed and ways to prevent its spread to other lakes, Gregory said. AgriLife Extension and TWRI are collaborating with TPWD and other agencies to educate boaters, landowners, and the public about the invasive plant.

The project's long-term goal is to identify the most effective control methods and incorporate them into agency guides, such as the NRCS *Field Office Technical Guide* and Extension educational program materials, so public and private organizations will have proven approaches to eradicate giant salvinia, Gregory said.

"We anticipate that results from the Caddo Lake project will result in well-documented 'state of the science' management practices that can be applied on private and public water bodies statewide," he said.

TPWD has an interactive education website about invasive species found in Texas: *TexasInvasives.org*. Project materials are available on CISE's website at *cise.tamu.edu*.

Story by Danielle Supercinski

Don't let the river run dry

Efficiency and conservation efforts in the Rio Grande Basin

An unknown fact to most is that high water demands by agriculture along with the ever-increasing urban population in the Rio Grande Basin and a lack of available water supplies sometimes cause the river to stop flowing before it reaches the Gulf of Mexico. The Rio Grande Basin Initiative (RGBI) came into existence to promote efficient use of available water supplies and to implement water conservation practices to meet present and future demands.

Rio Grande Basin agriculture is highly productive, with irrigation claiming more than 85 percent of the river's water. In addition, population growth and urban water demands in the basin have already increased and are expected to double in the next 50 years. Persistent drought in the region also limits the amount of water available for agriculture and urban uses.

Formed in 2001 with funding from the U.S. Department of Agriculture's National Institute of Food and Agriculture, the RGBI project, formally titled *Efficient Irrigation for Water Conservation in the Rio Grande Basin*, involves about 150 researchers, specialists, and county Extension agents from Texas AgriLife Research, the Texas AgriLife Extension Service, and New Mexico State University's Agricultural Experiment Station and Cooperative Extension Service, with the Texas Water Resources Institute (TWRI) managing the project. This team works with local irrigation districts, agricultural producers, homeowners, and other state and federal agencies to address the various water issues in the basin.

"The Rio Grande Basin Initiative is a model outcome-based program focused on conducting scientific research to develop new innovative water conservation practices and then conducting educational programs and demonstrating new technologies for producers and homeowners to make them aware of water issues and encourage them to adopt new practices that are more efficient and conserve water," said B.L. Harris, acting director at TWRI.

To help organize these efforts, the project is divided into nine task groups; each focuses on different areas of water conservation and efficient irrigation. The task groups are (1) irrigation district studies; (2) irrigation education and training; (3) institutional incentives for efficient water use; (4) on-farm irrigation system management; (5) urban water conservation; (6) environment, ecology, and water quality protection; (7) saline and wastewater management and reuse; (8) basinwide hydrology, salinity modeling, and technology; and (9) communications and accountability.

"A major strength of the Rio Grande Basin Initiative is the dynamic nature whereby the focus is continually shifting to the highest priorities and opportunities for conserving the maximum amount of water throughout the basin," said Dr. Ronald Lacewell, assistant vice chancellor for federal relations, and member of the RGBI economics team.

The RGBI project also has a heavy focus on accountability and outcomes to verify benefits of the project. The personnel not only conduct demonstrations, studies, and educational programs, but also keep track of their results—water savings,

Researchers transplant abscisic acid–treated watermelon and pepper seedlings to evaluate their stress tolerance under a center pivot system. *Photo by Daniel Leskovar*

dollar savings, number of participants, knowledge gained, practices and technologies implemented—and report them on an annual basis, Harris said.

"In this age of accountability, the RGBI is at the forefront, documenting the accomplishments of each activity in terms of water conserved and providing high-quality resources to the communities along the Rio Grande, ensuring a sound and profitable investment of federal resources," Lacewell said. "Productivity is guaranteed through the process adopted for each year's work; each participant must document plans and expected results, then sign a contract with the Texas Water Resources Institute before proceeding. At the completion of the year, it is required that each participant document accomplishments."

Since the inception of the project, more than 4 million acre-feet of water savings have been reported as a result of the various ongoing project efforts. Hundreds of publications, articles, fact sheets, and presentations have also resulted from these efforts.

AgriLife Extension engineers and economists work closely with irrigation district managers to prioritize the need for canal infrastructure improvements, analyze the economic cost-benefit ratio of the needed improvements, and determine which practices should be implemented to receive the most efficiency in the canal systems.

Sonny Hinojosa, irrigation district manager at Hidalgo County Irrigation District No. 2, said, "Our region is faced with increased water demands, drought, salinity, and invasive aquatic plants—issues that impact agricultural, municipal, and industrial users. We rely on the RGBI for assistance with these issues."

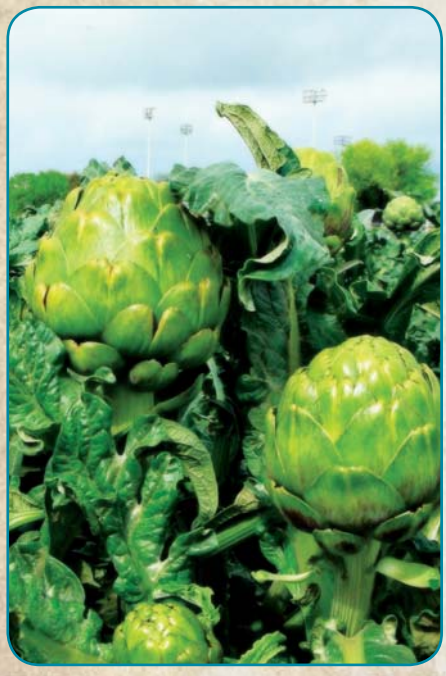
Hinojosa said that RGBI efforts have been of tremendous value to his irrigation district: "During our region's water supply shortage period, the RGBI assessed the situation, developed strategies to conserve water, assisted in implementing these strategies, and monitored the effectiveness of the water conservation projects."

In addition to the Texas AgriLife Research and Extension and New Mexico components of this project, Texas A&M University-Kingsville is also involved in the area of on-farm irrigation system management. Shad Nelson, associate professor of soil and plant science at Texas A&M-Kingsville, said his work in on-farm irrigation management is funded largely by RGBI and has created a synergistic relationship between faculty and scientists at the Texas A&M-Kingsville Citrus Center and the Texas AgriLife Research and Extension Center at Weslaco.

"Our collaborative efforts on water conservation projects are providing South Texas growers with measurable water-saving methods for the preservation of irrigated crop production in the Lower Rio Grande Valley as urban growth increases," he said.

Those are just a few of many examples of how the efforts of RGBI are benefiting the Rio Grande Basin and its citizens. These and many other accomplishments of the project are documented in the annual progress reports. Previous reports as well as the 2010 report can be found at *riogrande-conference.tamu.edu.*

The diversion intake for the original Rio Grande pumping plant for Hidalgo County Irrigation District No. 2.
Photo by Zhuping Sheng



An integrated production system was developed for the Wintergarden area using Globe artichokes.
Photo by Daniel Leskovar

"As the associate vice chancellor for federal relations, I find programs such as the RGBI a delight to carry to the people in the region and to provide updates and briefings to members of Congress due to the dramatic advances in water saved attributable to the project, the high level of accountability of each participant, the partnership with New Mexico adding synergism and multi-state cooperation, and the contribution to the communities, both urban and agricultural, located in the basin," Lacewell said.

And for Hinojosa and the rest of the Valley, the benefits are long-term.

"The effort and commitment put forth by the RGBI will not only help sustain agriculture in our region, but also provide for its future development," Hinojosa said. "It is a pleasure to work with a group that possesses such vast knowledge of conservation and efficient use of limited resources. The education and training that the RGBI has brought forth is a tremendous tool that will be utilized for years to come."

The RGBI has just received its continued funding for the 2010–2011 project year, which signifies the 10th year of the project. As population in the area increases and water supplies become even more constrained, projects like RGBI will be needed well into the future to help ensure availability and quality of water for this region. For further information, materials, and articles about RGBI, visit *riogrande.tamu.edu*.

Story by Melanie Orth

Saving the soil

AgriLife units work to improve training terrain

Heavy tanks and armored vehicles that have continually rolled over the 67,000-acre West Range at Fort Hood for the past 60 years have accelerated soil erosion. Fort Hood, the largest active duty armored post in the U.S. Armed Services and located near Killeen in central Texas, uses the range as the primary training and maneuver area for two armored divisions.

The Texas Water Resources Institute and Texas AgriLife Blackland Research and Extension Center are working to improve the training terrain. The units are collaborating with the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and Fort Hood's Integrated Training Management and Directorate of Public Works on two projects: the *Fort Hood Range Revegetation Pilot Project* and the *Fort Hood Training Lands Restoration and Maintenance Project.*

Dr. Bill Fox, assistant professor at Blackland, said the main objectives of these projects are to help maintain quality training lands for soldiers and other military personnel, maintain and improve the natural resource base, protect the surrounding watersheds, and improve the water quality of supply reservoirs.

The revegetation project began in 2003, and project members started evaluating the addition of composted dairy manure to primary training areas as a management practice. Compost enhances soil quality and promotes vegetative growth, Fox said. Thus far, about 25,000 tons of composted dairy manure from the impaired North Bosque River Watershed have been applied to more than 2,000 acres of training lands at Fort Hood.

Taking compost out of the Bosque River watershed helps relieve that watershed of excess phosphorus found in the manure, Fox said. "Excessive nutrients in one watershed are being used to fertilize nutrient-starved soil in another," he said. "We have also determined that nutrients in dairy compost under recommended rates do not pose a threat to the water quality of protected watersheds within Fort Hood."

The project also uses compost in coordination with contour ripping practices. Placing compost and grass seeds over the contour rips helps establish vegetation buffers and reduces runoff and erosion, Fox said. Both the contour ripping and revegetation have reduced stormwater discharge by about 50 percent compared to untreated areas.

Fort Hood armored vehicles used in critical training maneuvers can leave ruts that cause soil erosion and damage the landscape.

The restoration and maintenance project was federally funded in 2007 and works on developing best management practices that effectively control compaction, runoff, erosion, woody species management, tank trail management, and sedimentation. Applying these practices on a representative watershed has reduced erosion by up to 90 percent and stormwater runoff by more than 60 percent, Fox said.

Through both projects, Fort Hood is integrating sound environmental stewardship and improving training conditions for soldiers.

"The U.S. Department of the Army and the U.S. Department of Defense have placed special importance on improving environmental factors that affect these training facilities," he said. Visit *twri.tamu.edu/txH2O* to read more about these projects.

Story by Kathy Wythe

Toxic and deadly

Working to manage algae in Lake Granbury

Lake Granbury, located about 33 miles southwest of Fort Worth, is a recreation haven for water enthusiasts. In recent years, however, bacteria and golden algae have threatened the lake's water quality.

Educating citizens about water quality issues affecting Lake Granbury and determining ways to manage the deadly algae are the focus of two Texas Water Resources Institute (TWRI) projects.

Lake Granbury, a critical water supply in North Central Texas, provides water for more than 250,000 people in about 15 cities. It also supplies water for industrial use, including cooling water for a natural gas–fired steam electric power plant and the Comanche Peak nuclear power plant.

Brazos River Authority (BRA) studies have detected contamination of *E. coli* in several areas of the lake, primarily in coves with poor water circulation. *E. coli* is an indicator bacteria used to detect fecal contamination of water and the presence of pathogens. These *E. coli* sources can be from sewage overflows, polluted stormwater runoff, or malfunctioning septic systems.

Toxic golden algae blooms have killed fish in Lake Granbury and Lake Whitney, downstream of Lake Granbury, and in more than 21 lakes in five Texas river basins. These fish kills have caused substantial economic loss in these areas.

Through the project *Improve Water Quality in Hood County*, managed by TWRI and funded by the U.S. Department of Agriculture's Natural Resources Conservation Service, Texas AgriLife Extension Service staff members have developed education programs to help landowners, homeowners, businesses, and the city of Granbury reduce nonpoint source pollution.

Dr. Bruce Lesikar, AgriLife Extension agricultural engineer, and a team of AgriLife specialists and county Extension agents have educated residents about watershed planning, land management for small acreages, on-site wastewater treatment systems, graywater systems, rainwater harvesting, pet and wildlife waste management, and bacterial sources in water. The group has also produced six publications and a series of more than 20 fact sheets about specific water quality issues, including nutrient and sediment loadings, bacteria, urban and agricultural nonpoint sources, and landscape chemicals.

"The education programs provided through this project increase participants' knowledge of the connection between their activities and the lake and how specific management practices can limit the impact on lake water quality," Lesikar said. "This information will lead to a change in behavior and create a sense of ownership of Lake Granbury and ultimately lead to improved water quality."

In the project *Testing Approaches to Golden Algae Control: In-Lake Mesocosm Experiments*, funded by the U.S. Army Corps of Engineers, and previous projects funded by the U.S. Department of Energy and the Texas Parks and Wildlife Department (TPWD), scientists from three universities are investigating golden algae's

Lake Granbury and the city of Granbury with its historic buildings, including the Hood County Courthouse, have grown into a popular tourist destination. Texas Water Resources Institute manages two projects helping to improve the lake's water quality.

explosive growth and deadly toxins. In research started at Lake Possum Kingdom and continuing at Lakes Whitney, Granbury, and Waco, the scientists have identified environmental and chemical factors—including low temperatures, low nutrients, and brackish salinities—that stress the organism, causing it to become more toxic and enabling blooms, said Dr. Daniel Roelke of Texas AgriLife Research.

Roelke said 10 years of monitoring data collected by Texas AgriLife Research, TPWD, and the BRA show that the incidence and magnitude of golden algae blooms are linked to river inflows, with systemwide, fish-killing blooms occurring at lower inflows and higher salinities. In addition, termination of blooms is linked to high river inflows that typically occur in the spring.

"The linkage between incidence of golden algae blooms, inflows, and salinity is of concern because combined effects from human population increase and climate change could lead to periods of decreased inflow and increased salinity, which may then increase the frequency and magnitude of blooms," he said.

Roelke, Dr. Bryan Brooks of Baylor University, and Dr. James Grover of the University of Texas at Arlington have also discovered an apparent competition between golden algae and blue green algae in certain Texas lakes. "There appears to be a chemical warfare between golden algae and blue green algae. Only when golden algae wins this chemical warfare is it able to bloom," Roelke said.

The research team is exploring potential management strategeties to mitigate blooms. "It may be that through the manipulation of water chemistry in the coves of these lakes, systemwide blooms can be avoided," Roelke said. "It may also be possible to create areas of refuge for fish, accelerating the recovery of fish populations."

The control strategies involve the manipulation of hydrology, pH, or ammonia. The team is also investigating the influence of blue green algae on golden algae and the influence of aquatic plants on golden algae blooms.

Recent research from this team was published in a dedicated volume (46, 2010) of the *Journal of American Water Resources Association* and will be further showcased in a special collection of papers to be published by the *Journal of Plankton Research.*

Dr. B.L. Harris, TWRI's acting director, said these two projects not only benefit Lake Granbury residents but will also help "protect the tourist industry around lakes around the state, encourage more widespread lake usage by fishermen, and generally protect the economic base of the impacted areas."

Much of the information gained through TWRI's two projects is being used by the BRA as it develops a watershed protection plan for the lake. The plan's development is funded through the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency.

Find links to AgriLife Extension Bookstore publications, fact sheets, and scientific publications at *twri.tamu.edu/txH2O.*

Story by Leslie Lee

Talking sustainability

Federal initiatives target major water resources concerns

Federal initiatives are large-scale projects, often encompassing multiple counties, regions, or states, made possible by congressional funding. The following Texas Water Resources Institute (TWRI) projects have impacted major water resource problems in Texas and beyond.

Ogallala Aquifer Project

The Ogallala Aquifer, stretching from South Dakota to Texas, covers 174,000 square miles, including 36,080 square miles in the Texas High Plains. In western Kansas and the Texas High Plains, the aquifer is declining at an unacceptable rate. Aquifer depletion rates of 1 to 3 feet per year are common in that region, and recharges are very small. Water availability, cost, and policy, together with technology development and adoption rates, are reshaping the rural landscape.

In 2003 a multi-state group of researchers tackled the problems associated with aquifer decline, and since then the *Ogallala Aquifer Project* has addressed the complex issues related to sustaining the Ogallala Aquifer and maintaining a stable rural economy. The U.S. Department of Agriculture's Agricultural Research Service (ARS), with identified project funds provided by Congress, funds the project.

The collaborative *Ogallala Aquifer Project* involves the ARS's laboratories at Bushland and Lubbock, and four other partners: Kansas State University, The Texas A&M University System, Texas Tech University, and West Texas A&M University; about 85 engineers and scientists are on the research team.

The researchers have been tasked with—among numerous other objectives—improving water management for crops to decrease dependence on groundwater resources; assessing the interrelationships with future climate forecasts, cropping patterns, and water-use policies and regulations; developing and evaluating water-saving technologies for agricultural industries; and estimating the economic impacts of water management activities.

As the project progresses, researchers make significant water discoveries. A research team determined that irrigation demand on the Texas High Plains could outpace the capacity to pump water from the aquifer if rainfall decreases during severe droughts due to global climate change. Other researchers developed marker and electrophoresis technologies that will aid in screening peanut germplasm for drought and heat tolerance and will help develop water-saving cultivars.

Another research team's database of current water-use practices and technologies will be used for a more extensive agricultural and economic database for counties in Texas and Kansas that access the aquifer. Researchers also determined that using water-efficient crop varieties that increase yield by 30 percent, coupled with some water use restrictions, would increase the amount of water left in the Ogallala Aquifer in 2060 and increase agricultural economic activity over the baseline.

With results such as these, the *Ogallala Aquifer Project* can help preserve the sustainability of the aquifer.

Participants take stream cross-sectional measurements as part of stream restoration training.

U.S.-Mexico Transboundary Aquifer Assessment

In the desert region of the U.S.-Mexico border, where the population is growing and the surface water is unreliable, groundwater is an essential drinking water source. Declining aquifers and water quality, coupled with increasing water demand, are raising concerns about long-term availability of these supplies.

The *U.S.-Mexico Transboundary Aquifer Assessment Projec*t is conducting scientific research to assess binational aquifers, important water sources for the U.S.-Mexico border region.

Providing a scientific foundation for state and local officials to address water resources challenges in this region, this project is developing binational groundwater information for water resources agencies, managers, and water users that depend on these border aquifers. The new information will be applied to analyze strategies to protect water quality and enhance supplies.

"Groundwater is used for all the drinking water in southern New Mexico; for all of Juarez, Mexico; and for half of the El Paso area," said Dr. Ari Michelsen, director of the Texas AgriLife Research and Extension Center at El Paso and principal investigator for Texas on this project. "In many areas it is the only water source for much of the U.S.-Mexico border region."

Four aquifers in the project's scope are Mesilla Basin and Hueco Bolson aquifers in New Mexico, Texas, and Mexico, and the Upper Santa Cruz and Upper San Pedro aquifers in Arizona and Mexico.

TWRI and the Water Resources Research Institutes in New Mexico and Arizona, in cooperation with the U.S. Geological Survey (USGS), administer this project. Scientists from New Mexico State University, Texas AgriLife Research, University of Arizona, USGS, and state agencies and their Mexican counterparts are collecting and evaluating new and existing data to develop comprehensive groundwater quantity, quality, and flow models for binational aquifers.

Researchers currently are analyzing geographic information system data for the Mesilla Basin. Project personnel also coordinate meetings with Mexico at national, state, and local levels.

North Central Texas Water Quality

Five of the major reservoirs in the Trinity River Basin managed by Tarrant Regional Water District (TRWD) serve 1.6 million people in 11 counties and are expected to serve 2.66 million by 2050. Water quality in these north central Texas reservoirs is a growing concern.

Since 2004, TWRI and Texas A&M AgriLife have worked with TRWD to study sediment and nutrient loading and potential improvements in these reservoirs. Sediment loading affects reservoir capacity and water clarity; nutrient loading causes algae growth that impacts water treatment and recreational use.

This project has assembled information for specific TRWD-managed reservoirs and associated streams: Benbrook, Bridgeport, Cedar Creek, Eagle Mountain, and ⇨

One of the tasks of the Ogallala Aquifer Project is to improve the design, performance, and management of irrigation practices and systems. *Photo by Texas Tech University*

Richland Chambers reservoirs. Researchers are using computer models to analyze the biological, physical, and economic feasibility of alternative management practices and facilities.

"This project is helping to improve and maintain the water quality within the five reservoirs through education, outreach, and the watershed protection planning process," said Allen Berthold, TWRI project manager. "The project's ultimate goal is to accommodate growing populations and increased urbanization with sufficient high-quality water."

Congressional funding for this project is provided through the U.S. Department of Agriculture's Natural Resources Conservation Service. The numerous collaborators involved with TWRI on this project include TRWD, Texas AgriLife Research, the Texas AgriLife Extension Service, Texas A&M University's Spatial Sciences Laboratory, Alan Plummer Associates Inc., and Espey Consultants Inc. AgriLife Research scientists, AgriLife Extension specialists and agents, and selected private consultants are assisting TRWD in developing and implementing watershed protection plans (WPPs) for Cedar Creek and Eagle Mountain reservoirs, while modeling and economic studies are being conducted on Richland Chambers, Bridgeport, and Benbrook reservoirs.

Public stakeholder meetings are providing educational programs about water quality protection. These meetings directly affect the content and implementation of WPPs, Berthold said. "The watershed protection planning process and its stakeholder involvement are important because it takes not only a reactive approach to address certain parameters of impairment, but also a proactive approach to other concerns within the watershed," he said.

In 2008 project personnel created an AgriLife Extension curriculum guide to demonstrate the effects of soil erosion and sediment transport in the region. This guide is used with demonstration trailers to illustrate the importance of watershed management. Project members have conducted more than 120 educational programs dealing with watershed management and water quality for about 6,000 school-age children and 900 adults. The project has also conducted watershed management training sessions in north central Texas for city and county officials, state and federal agency personnel, and community members.

Links to these initiatives can be found in the web version of this story at *twri.tamu.edu/txH2O.*

Story by Margaret Foust

Power of the people

Restoring impaired water bodies with stakeholder-driven WPPs

Watershed protection plans (WPPs) are one of the approaches stakeholders are using to protect and restore water bodies and watersheds in Texas. WPPs are voluntary and actively involve local landowners as opposed to regulatory approaches that require compliance with specific regulations.

Texas Water Resources Institute (TWRI) is involved in several projects implementing WPPs. In particular, two of these plans are the Buck Creek WPP and the Pecos River Basin WPP.

TWRI is currently managing two projects to improve the water quality of Buck Creek, a small creek in the Texas Panhandle's Red River Basin. Both of these projects are funded by the Texas State Soil and Water Conservation Board (TSSWCB) through a Clean Water Act Nonpoint Source Grant from the U.S. Environmental Protection Agency (EPA). Through the *Watershed Protection Plan Development for Buck Creek*, the project team has identified specific sources of *E. coli* in the creek using bacterial source tracking. These bacteria may indicate the presence of pathogens that can cause disease and make the creek unsafe for recreation. Project members are also evaluating potential management alternatives for restoring the water body and educating landowners on the benefits and usefulness of certain best management practices.

"Developing landowner- and stakeholder-driven plans to restore water quality is a great approach to addressing water quality impairments," said Lucas Gregory, TWRI project manager. "Not only do landowners and stakeholders know what key sources of water quality impairments are, they also have excellent ideas about how to correct the impairments and are more likely to participate in implementing WPPs that they helped develop."

A supplemental project, *Modeling Support for Buck Creek Watershed Protection Plan Development*, is providing additional information on the magnitude and distribution of bacteria levels in the watershed. Stakeholders will use this information to determine which best management practices to include in the Buck Creek WPP, Gregory said.

To date, Buck Creek project members have completed three years of intensive monitoring that better describes potential concerns in the watershed, submitted water quality data to the Texas Commission for Environmental Quality (TCEQ) for use in its biannual water quality assessment in 2010, and completed the draft of the Buck Creek WPP.

Phyllis Dyer, Buck Creek watershed coordinator, said the TSSWCB is currently reviewing and commenting on the WPP. "We will address those comments and present the edited version to Buck Creek Watershed stakeholders and allow them to provide comments on the plan," she said. "Once final stakeholder comments have been received and addressed, we will resubmit the plan to TSSWCB and EPA."

Gregory estimated that the projects related to Buck Creek will continue for five or six more years, with the stakeholder effort to restore water quality continuing much longer.

TWRI is also involved in a WPP for the Texas portion of the Pecos River. Winding more than 900 miles through eastern New Mexico and West Texas, the river ⇨

Phyllis Dyer isolates colonies of *E. coli* Bacteria from a water sample.
Photo by Kay Ledbetter

is crucial to many communities for irrigation, recreation, and environmental uses as well as recharging underlying aquifers. It provides about 9.5 percent of the annual inflows to the international Amistad Reservoir while contributing 26 percent of its salt loading. The reservoir provides a major source of drinking and irrigation waters for the Lower Rio Grande Valley and its millions of residents.

"Today, the river has dwindled to a trickle in some areas," said Gary Bryant, Pecos River Watershed coordinator and AgriLife Extension program specialist. "The expansion of water demand throughout the watershed coupled with the spread of non-native saltcedar, inefficient irrigation systems, and recurring droughts have depleted the water supply and led to deteriorating water quality in portions of the river."

In Texas, the river's salinity is so high in some locations that the water can be harmful for irrigation and livestock watering and is not used for human consumption, Bryant said. This salinity stems from natural saline deposits—remnants of the shallow Permian Sea that once covered the area—in soils and rocks.

Dissolved oxygen (DO) levels in portions of the river do not meet Texas' water quality standards. As a result, several portions of the river are listed as impaired on the *2006 Texas Water Quality Inventory and 303(d) List*. "The reduced quality and quantity of the river, paired with other watershed influences, has reduced the river basin's biodiversity," he said.

In 2004, TWRI began working with Texas AgriLife Research and Extension on the *Watershed Protection Plan Development for the Pecos River* project. The WPP, published in October 2008, addresses watershed concerns, impairments, and resource management issues. The WPP was developed using scientific data gathered throughout the course of the project, along with information and guidance from watershed landowners, Bryant said.

TWRI is now working on two projects to implement portions of the Pecos WPP that are funded by TSSWCB through a Clean Water Act Section 319 grant from EPA. The first project, *Implementing the Pecos River Watershed Protection Plan through Invasive Species Control (Saltcedar) and by Providing Technical and*

Gary Bryant works with landowners and others to implement the elements within the plan.
Photo by Danielle Supercinski

The U.S. Highway 90 Pecos River Bridge spans the Pecos river a few miles north of its confluence with the Rio Grande.
Photo by Lucas Gregory

Financial Assistance to Reduce Agricultural Nonpoint Source Pollution, is implementing some of the highest-priority practices recommended in the WPP.

Major objectives of this project are to treat saltcedar chemically along the riparian corridor in areas not previously treated, to promote the use of biological control mechanisms in areas near and away from the river channel, and to assist landowners in removing saltcedar debris from earlier treatments using controlled burns, Bryant said.

Working with landowners, soil and water conservation district staff members are developing at least 20 water quality management plans. The site-specific plans are designed to improve watershed management, enhance watershed health, and restore water quality by providing technical and financial assistance to landowners so they can carry out management practices, Bryant said.

Project members are also providing educational programs for watershed landowners and residents to increase awareness about watershed management and stewardship.

"We are continuing to develop working relationships with watershed landowners and to establish long-term restoration efforts that lead to the sustainability of the WPP implementation effort," he said.

Through *Implementing the Pecos River Watershed Protection Plan through Continuous Water Quality Monitoring and Dissolved Oxygen Modeling,* project members are installing a new real-time water quality monitoring station near Girvin that will be incorporated into TCEQ's continuous water quality monitoring network. Project members are also developing a computer-based watershed model to evaluate DO levels in the river. This will help identify potential sources of pollutants contributing to the limited DO levels and potential management measures that will decrease pollutant loadings and restore DO levels in the river, Bryant said.

"These two projects should go a long way in improving the quality of the Pecos River," Bryant said.

The institute is involved in other WPP projects, including the Attoyac Bayou, Lake Granbury (see related story on page 10), and the Arroyo Colorado (see related story on page 18). For more information, visit *twri.tamu.edu/txH2O.*

Story by Kathy Wythe

A watershed blueprint

Partners work together to restore Arroyo Colorado's health

In 2002 the Texas Commission on Environmental Quality (TCEQ) set a target of 90 percent reduction of nutrients and biochemical oxygen demand for the Arroyo Colorado to regain its healthy condition.

Eight years later, the Arroyo Colorado, an ancient channel of the Rio Grande in the Lower Rio Grande Valley, has been the focus of multiple projects; educational and outreach efforts; and collaborations between local, state, and federal governmental agencies to help restore the watershed.

To guide these efforts, the Arroyo Colorado Watershed Partnership (ACWP) was established in 2003. The partnership is made up of more than 700 people, representing federal, state, and private organizations, who work to improve watershed health, integrate watershed management, and seek out watershed project funding. The Texas Water Resources Institute (TWRI) administers the partnership in cooperation with TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB). In 2007 the partnership published one of the first watershed protection plans (WPPs) in the state. The plan is a blueprint for restoring the health of the Arroyo Colorado.

"There has been much progress toward protecting the Arroyo Colorado Watershed," said Jaime Flores, the watershed coordinator. "And we have been successful in garnering local support from volunteers as well as through collaborative events and projects."

Although winding just 90 miles from Mission to the Lower Laguna Madre, the Arroyo Colorado is essential to the Valley, Flores said. It helps control flooding and drainage, carries commercial barges from the Port of Harlingen to the Laguna Madre, and provides recreation. And it is a sanctuary for rare and endangered birds. Water flow in the Arroyo Colorado comes from treated wastewater, urban stormwater runoff, irrigation return flows, and base flows from shallow groundwater.

In 2007 TWRI began managing the WPP implementation project, along with other Arroyo Colorado projects. To date, TWRI has submitted or helped with 34 grant proposals involved in protecting the arroyo. TWRI is currently coordinating six projects directed toward carrying out the WPP and restoring the arroyo. In addition to the implementation project, other projects monitor agricultural runoff to evaluate effects of implementing best management practices; educate farmers on integrated farm management systems and turf producers on nutrient, pesticide, and irrigation management; and construct a wetland to remove nutrients from the Port of Harlingen. TWRI is also producing public service announcements that educate farmers and urban residents on local water quality issues. Funding for these projects is from TCEQ, TSSWCB, the Texas General Land Office, and the U.S. Environmental Protection Agency (EPA).

"All these projects play an integral part of the implementation of the watershed protection plan and are working together for the benefit of the Arroyo Colorado, its environment, and the surrounding communities," Flores said.

Education and outreach are important components of the WPP. Flores has given more

More than 23,700 individuals have viewed the physical Arroyo Colorado watershed demonstration model, which educates people about the watershed; the geography of Cameron, Hidalgo, and Willacy counties; and nonpoint source pollution and how it occurs.

Jaime Flores works with the Arroyo Colorado Watershed Partnership to implement the watershed protection plan.

than 100 presentations to youth and other organizations. More than 23,700 individuals have viewed the physical watershed demonstration model, which educates people about the watershed; the geography of Cameron, Hidalgo, and Willacy counties; and nonpoint source pollution and how it occurs. The Nueces River Authority funded the construction of the model through the Clean Rivers Program.

The ACWP and member cities of the Lower Rio Grande Valley Texas Pollutant Discharge Elimination System Storm Water Task Force have installed more than 1,000 storm drain markers throughout the Valley.

"The storm drain markers, reading 'No Dumping, Drains to Laguna Madre,' remind citizens not to dump their waste or trash directly into a storm drain or anywhere that the waste will end up in the storm drains," Flores said.

"The partnership and local cities have also installed some 40 road signs marking Arroyo Colorado crossings or the boundary of the Arroyo Colorado Watershed," he said. "The storm drain markers and road signs are part of the partnership's ongoing efforts to restore and protect the watershed."

A recently finished project, *Education of Best Management Practices in the Arroyo Colorado Watershed*, was successful in promoting programs associated with the WPP, including nutrient management, cost-share programs, and a soil-testing campaign, Flores said. More than 6,200 individuals were educated through this project, and more than 3,310 soil samples, representing more than 100,000 acres, were collected during the annual soil-testing campaigns. Projected fertilizer savings based on soil tests were an estimated 3.3 million pounds of nitrogen and 3.8 million pounds of phosphorus, compared to rates planned before testing. The soil-testing project won a Texas Environmental Excellence Award in Agriculture for its success.

One of the plan's top recommendations is to construct wetlands for treatment of point source and nonpoint source pollution. Wetlands serve as a habitat for fish and other aquatic animals, stabilize streambeds and banks, and filter and process wastewater contaminants in the water.

TCEQ and EPA fund a three-city wetland project as part of a Clean Water Act grant. "The city of San Juan opened its 7.5-acre wetland this year on Earth Day, the city of La Feria opened its wetland in December 2009, and San Benito should break ground later this year on a 20-acre wetland, all part of the actions recommended by the watershed protection plan," Flores said.

For more information, visit the website at *arroyocolorado.org*.

Story by Margaret Foust

The battle of bacteria

Agencies, stakeholders focusing on restoring water quality

Bacteria is the No. 1 pollutant of water in Texas, causing many of the state's water bodies to be placed on the *Texas Water Quality Inventory and 303(d) List* for failing to meet contact recreation use standards.

Across the state, agencies and local stakeholders are identifying the sources of pollution in bacteria-impaired water bodies and are developing management strategies to restore water quality and remove these water bodies from the impaired-water list.

In 2006 the Texas Commission on Environmental Quality (TCEQ) and the Texas State Soil and Water Conservation Board (TSSWCB) established the joint task force on Total Maximum Daily Loads (TMDLs). Chaired by then director of Texas Water Resources Institute (TWRI) Dr. Allan Jones, its goal was to identify the best and most cost-effective and time-efficient tools for developing bacteria TMDLs and TMDL implementation plans (I-Plans). The task force recommended a three-tier approach for stakeholders to use in implementing TMDLs. This step-by-step tiered approach is incorporated into numerous TWRI bacteria-related projects.

The *Improving Water Quality in Carters and Burton Creeks Project*, funded by TCEQ, is developing a TMDL and TMDL I-Plan, using Tier 1 objectives, to reduce *E. coli* loading. The Texas Institute for Applied Environmental Research is providing technical support for the TMDL development for these creeks, located in central Brazos County, and TWRI is working with local watershed stakeholders to develop the TMDL I-Plan.

Projects in Attoyac Bayou, Lampass and Leon rivers, and Big Cypress Creek watersheds are following the Tier 1 and Tier 2 steps.

Project members of the *Development of a Watershed Protection Plan for Attoyac Bayou* are collecting water quality and stream-flow data, conducting a watershed source survey and developing a comprehensive GIS inventory, and analyzing water quality data using load duration curves and spatially explicit modeling. They are also conducting bacterial source tracking (BST) and evaluating the sources of *E. coli* that are contributing to the bayou's bacterial load. In addition, members are conducting a Recreational Use Attainability Analysis to determine the most appropriate water quality standard for the bayou, a subwatershed within the Upper Neches River Watershed.

Lucas Gregory, TWRI project manager, said local stakeholders are giving their input on possible sources contributing *E. coli*; collecting that information is a critical step in developing an effective watershed protection plan (WPP). TSSWCB funds the project through a Clean Water Act Nonpoint Source Grant from the U.S. Environmental Protection Agency (EPA).

In addition to the typical water quality data collection, *Lampasas and Leon River Bacterial Source Tracking Assessment Project*

Augie De La Cruz with Water Monitoring Solutions installs a staff plate as part of the water quality monitoring for the Big Cypress Creek bacteria assessment project.

members are collecting bacteria from known animal feces to include in the Texas *E. coli* BST library, Gregory said. TSSWCB funds this project through its State General Nonpoint Source Grant Program.

The goal of *Modeling Support and Bacterial Source Tracking for Big Cypress Creek Bacteria Assessment* is to remove Big Cypress Creek, located in northeast Texas, and its tributaries, Tankersley and Hart creeks, from the state's impaired water list. TSSWCB funds this project from its TMDL general revenue fund.

A group of Big Cypress Creek Watershed stakeholders has learned about water quality rules and approaches to watershed planning and has expressed interest in addressing the bacterial impairments in the watershed, Berthold said. Through information gained from this project, they will decide to develop either a WPP or a TMDL and TMDL I-Plan, he said.

The institute recently finished three projects using Tier 2 steps that examined bacterial pollution in tributaries of the Little Brazos River in Robertson County. Findings will be presented to watershed stakeholders, who will determine the next steps in managing water quality in the tributaries.

The TMDL task force was also charged with developing a roadmap for scientific research on how bacteria behave under different conditions. Tailored to address some of the specific issues identified in the report, the project *Fate and Transport of* E. coli *in Rural Texas Landscapes and Streams* was initiated to better understand *E. coli* in the environment and evaluate better bacteria management strategies, Berthold said. TSSWCB is funding the project through a Clean Water Act Nonpoint Source Grant from EPA.

Through this project, team members are identifying, characterizing, and quantifying *E. coli* loading from various sources in an impaired watershed. Members are also monitoring bacteria survival, growth, regrowth, and die-off under different environmental conditions and monitoring re-suspension of *E. coli* in streams to test current assumptions regarding the fate and transport of bacteria in an environment and outside of the host animal.

"These areas being investigated are relative unknowns as far as understanding bacteria goes," Berthold said. "Information gleaned from this project will provide much needed information and will help improve modeling applications that are used to illustrate the transport of bacteria throughout a watershed and are dependent upon assumptions made regarding bacteria life cycles, their ability to survive and regenerate, and their impacts on water quality."

For more information, visit *twri.tamu.edu/txH2O.*

Story by Leslie Lee

Lone Star Healthy Streams

Teaching best management practices statewide

The Lone Star Healthy Streams (LSHS) Program uses education to reduce the amount of bacteria entering Texas water bodies from livestock operations and feral hogs. This program, originally developed in 2007, has been expanded through a new project, *Development of a Synergistic, Comprehensive Statewide Lone Star Healthy Streams Program*.

The LSHS Program initially developed and tested educational opportunities for cattlemen focusing on bacterial contamination of watersheds by grazing animals and how that bacterial contamination can be reduced. The program also encouraged adoption of best management practices designed to reduce bacterial loading to Texas streams and waterways.

The expanded LSHS Program, to be delivered by the Texas AgriLife Extension Service, will integrate programs for grazing cattle, horses, poultry, dairy cattle operations, and feral hogs into an industry-endorsed, statewide program for reducing bacterial loading from livestock operations and feral hogs.

Building upon the initial program, LSHS is incorporating efforts from other projects such as the *Guide to Good Horsekeeping*. This guide, targeting practices that horse owners can implement to reduce bacterial loading, was developed through the project *Copano Bay Water Quality Education*. That program was developed and implemented in response to bacterial water quality issues in Copano Bay that impaired oyster harvest in the bay and contact recreation in the Aransas and Mission rivers. Bacterial source tracking in the Copano Bay Watershed by Texas A&M University-Corpus Christi identified cattle, horses, and other animals as sources of the bacteria.

The expanded LSHS Program is integrating this horse owners' education program and others to produce standardized resource manuals, presentations, and an interactive website for bacterial runoff management for each of the major classes of livestock and for feral hogs.

"This program will be a tremendous tool for use throughout the state to reduce bacterial loading from livestock operations and feral hogs," said Kevin Wagner, associate director of the Texas Water Resources

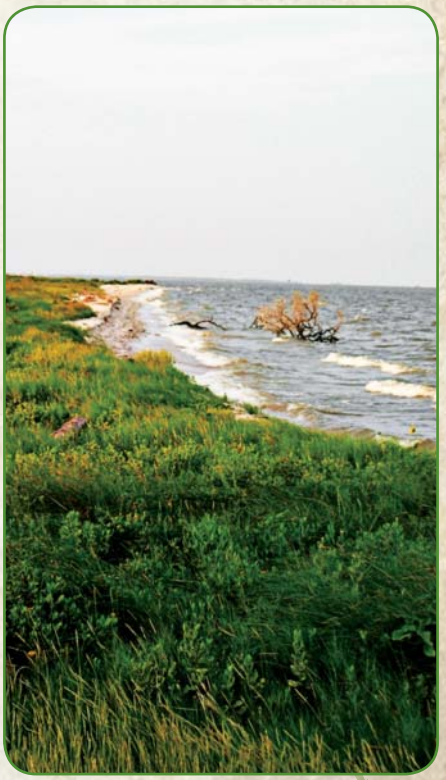
The Lone Star Healthy Streams Program teaches owners of cattle operations and other livestock operations how to reduce bacterial loading in Texas waterways.

Institute (TWRI). "It will provide a one-stop shop for the livestock industry and natural resource agencies to access information regarding bacterial water quality issues related to livestock, as well as measures that can be implemented in response to development of Total Maximum Daily Loads, TMDL implementation plans, and watershed protection plans throughout Texas."

All of these programs have been funded by the Texas State Soil and Water Conservation Board (TSSWCB) using Clean Water Act Nonpoint Source Grant funding from the U.S. Environmental Protection Agency.

Since its inception, LSHS has involved numerous collaborators, including TSSWCB, U.S. Department of Agriculture (USDA) Natural Resources Conservation Service, USDA Agricultural Research Service, TWRI, Texas AgriLife Research, the Texas AgriLife Extension Service, Texas Department of Agriculture, Grazing Lands Conservation Initiative, and organizations such as the Texas Farm Bureau, Texas and Southwestern Cattle Raisers Association, Independent Cattlemen's Association of Texas, Texas Cattle Feeders Association, Victoria Soil and Water Conservation District (SWCD), Hall-Childress SWCD, Little Wichita SWCD, Welder Wildlife Foundation, and private ranchers.

To learn more, visit *twri.tamu.edu/txH2O*.



Texas A&M University-Corpus Christi conducted bacterial source tracking research in the Copano Bay Watershed.

Story by Courtney Swyden

Water Resources Training Program

Assisting water professionals one workshop at a time

The Texas Water Resources Institute (TWRI), in cooperation with other agencies and experts, began the Water Resources Training Program in 2008 with one goal in mind: to help water professionals by developing and providing training courses that offer intensive hands-on instruction and answer questions about the latest technologies, computer modeling, and water management strategies.

Training courses are coordinated by TWRI in collaboration with Texas A&M University's Spatial Sciences Laboratory (SSL) and Zachry Department of Civil Engineering, the Texas AgriLife Blackland Research and Extension Center at Temple, and the Texas AgriLife Research and Extension Urban Solutions Center at Dallas.

TWRI leads the marketing and administration of these courses on water-related geographic information systems, remote sensing technology, and computer simulation models. During the training program's introductory year, TWRI, collaborators, and more than 20 instructors within The Texas A&M University System offered 10 training courses across the state to more than 300 participants.

"The training program offers courses at competitive prices so that water professionals and students alike are able to participate in the various courses," said Dr. B.L. Harris, acting TWRI director.

Models such as the Water Rights Analysis Package (WRAP), Soil and Water Assessment Tool (SWAT), and the Agricultural Policy/Environmental eXtender (APEX) are taught in introductory and/or advanced training courses. Participants receive hands-on instruction and on completion are able to apply what they learned to their situations.

"For example, after the SWAT workshop, participants can apply the learned principles and methods to a watershed of their choice with readily available data or their own data," said Dr. Raghavan Srinivasan, Texas A&M professor and SWAT workshop instructor.

"Dr. Srinivasan was very good with answering questions, very patient, and very knowledgeable," said an advanced SWAT workshop attendee. "Thank you again for this great training. We are very excited about the opportunities to use the [SWAT] model, and there is no better way to learn than from this workshop." The training program has grown rapidly, and in 2009, 27 training courses were offered, working with 41 instructors within the Texas

Dr. Dave Rosgen of Wildland Hydrology conducts field exercises in West Verde Creek, located in the Hill Country State Natural Area, during the Applied Fluvial Geomorphology Short Course, one of the first courses offered by the training program. *Photo by Megan Meier*

A&M System to teach more than 800 water professionals about various water resources technologies. As the program expands, current courses are updated based on the needs and feedback of participants.

Dr. Ralph Wurbs, Texas A&M professor and WRAP workshop instructor, emphasized the importance of having each participant discuss what he or she hopes to learn from the training. "During the trainings, I like to learn who the participants are and where they are in their knowledge with the model," he said. "This helps me to cater the workshop to them based on their needs."

In other training programs, TWRI works with Texas AgriLife Research, the Texas AgriLife Extension Service, state and federal agencies, and other universities to conduct training programs in watershed protection planning. The Texas Watershed Planning Short Course, funded by the U.S. Environmental Protection Agency (EPA) through the Texas Commission on Environmental Quality, provides training and promotes sustainable approaches to managing water quality throughout the state.

This course provides guidance on stakeholder coordination and education and outreach. It meets the EPA's nine key elements of a watershed protection plan, data collection and analysis, and tools available for plan development.

A Texas Watershed Planning Short Course attendee said, "Great job, AgriLife folks! Thank you for all your hard work putting this course together in a condensed version while retaining essential pieces."

After completing the short course, participants are invited to attend the biannual Texas Watershed Coordinator Roundtables to discuss current issues and updates on watershed protection plans and strategies for successful implementation, as well as answer questions and address concerns.

Additional workshops, including Getting In Step and the Key EPA Internet Tools Course, are offered free to watershed coordinators with outreach campaigns to stakeholders.

TWRI develops curriculum materials, handles logistics, and administers continuing education credits. Faculty and staff can focus on model development and training as TWRI assumes a greater role in administering these courses.

For more information about the Water Resources Training Program or to see a list of upcoming courses, visit *watereducation.tamu.edu.*

Story by Leslie Lee

Getting their feet wet

Young water researchers learn the ropes, thanks to grants

Writing a proposal for a competitive grant program can be complicated, but add in calculating indirect costs and securing a cost-share agreement, and the process of applying for a research grant could seem daunting for graduate students early in their careers.

Through the Texas Water Resources Institute's (TWRI's) Graduate Research Grant Program, partially funded by the U.S. Geological Survey (USGS), Texas university graduate students in water resources–related fields can learn how to apply for a competitive research grant and thereby learn vital practical skills, such as developing and following a budget.

In 2010, TWRI provided to 10 students a total of $50,000 in grants; since 2001, TWRI has provided $498,796 to support 104 students in water resources fields.

Helping student researchers acquire start-up funding for projects and training them in proposal writing are major goals of this USGS-funded program.

Fan-Wei Zeng, a Rice University graduate student in earth science, received a research grant in 2007 for her project *Carbon Isotopic Measurements of Dissolved Inorganic Carbon: A New Tool to Assess Groundwater-River Exchange in the Brazos River Basin*.

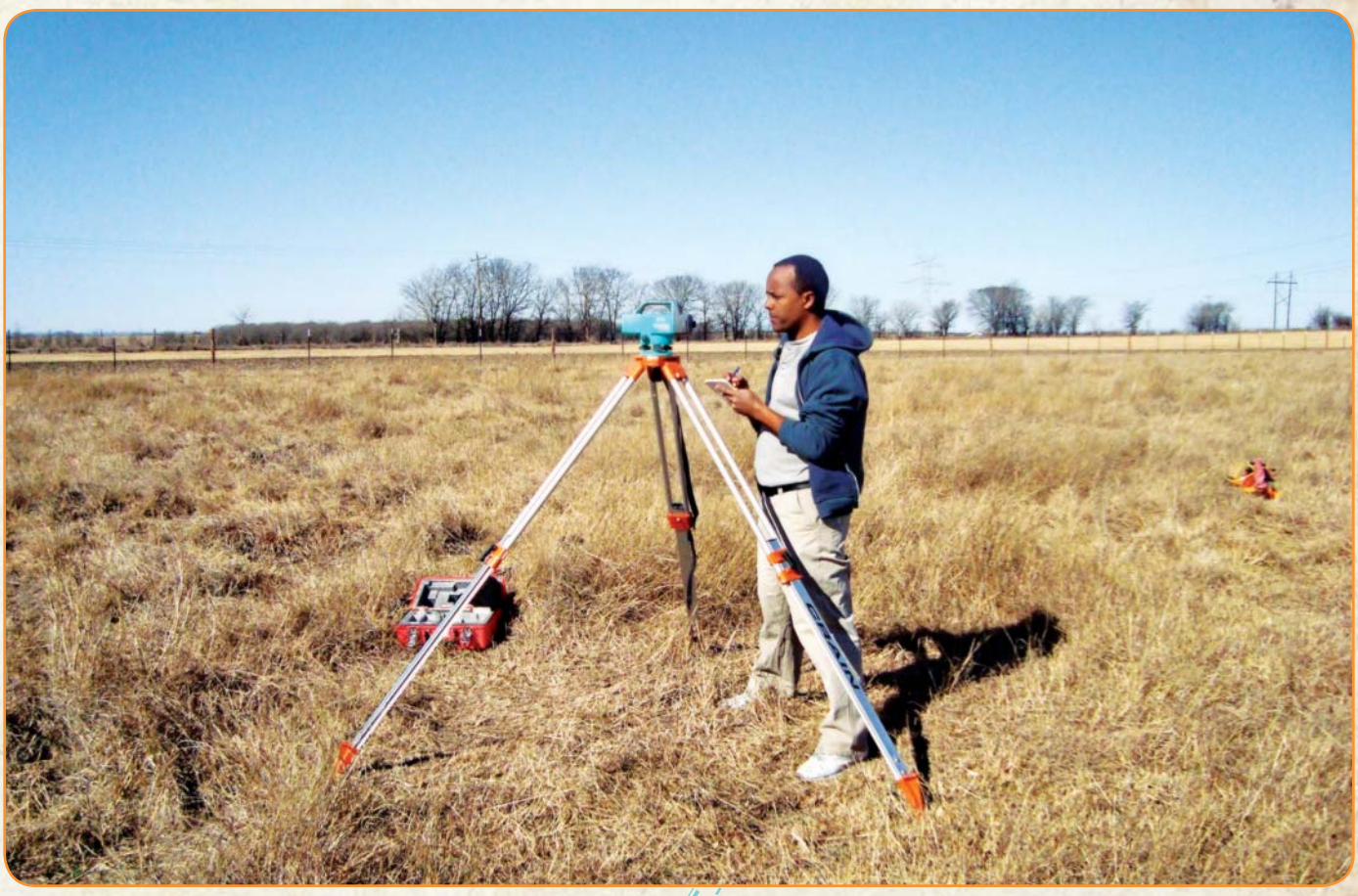
"Writing the proposal for the TWRI funds and then managing them herself were important experiences for Fan-Wei," said Dr. Caroline Masiello, assistant professor of earth science and Zeng's adviser. "This built her confidence in her ability to fundraise and to write about her work, and it has helped her really excel."

TWRI recently surveyed all advising professors of TWRI-USGS grant recipients from 2003 to 2007, and of the 41 responses received, 23 reported that their students' projects received additional funding from another source after receiving the TWRI grant. The total amount of follow-on funding was $2,800,331—averaging about $121,753 for each project. Several researchers said the grant was important seed money and assisted their students in further funding the research projects.

After receiving her TWRI-USGS grant, Zeng received four more awards and fellowships, in 2008. "Fan-Wei was able to leverage a number of other awards based on data generated through her TWRI funding," Masiello said. "This was an important seed grant for her."

Many USGS-funded students continue their water-related work in academia or in research fields. Jon Goodall was a civil engineering graduate student at The University of Texas at Austin when he received a TWRI-USGS research grant in 2003 for his project *Coupling Modular Hydrologic Models with Geographic Information Systems (GIS)*. He is now an assistant professor of civil engineering at the University of South Carolina.

In 2009 Goodall received a National Science Foundation CAREER award for the project *Integrated Modeling for Watershed Management*.



Takela Dinka, a 2009–2010 grant recipient, conducts research at Riesel, studying shrink-swell soil hydrology.

The 2010–2011 grant recipients are examining such topics as the biological treatment of wastewater contaminated with estrogenic compounds and the effect of photovoltaic nanomaterial roofing on harvested rainwater quality. To learn more about their work, visit *twri.tamu.edu/funding/usgs.*

Mills Scholarships

Throughout the past three decades, the Texas Water Resources Institute (TWRI) has awarded Mills Scholarships with funds endowed by Mills Cox, former chair of the Texas Water Development Board. The scholarship program is open to graduate students at Texas A&M University, Texas A&M University at Galveston, and Texas A&M University at Qatar who are pursuing research in water-related studies.

In 2010, TWRI will provide to 16 students a total of $24,000 in scholarships. Since 2001, 139 students have received funding from the Mills Scholarship program.

To learn more about the program and the funded students, visit *twri.tamu.edu/funding/mills.*

TWRI *Briefs*

TWRI goes digital with journal, water library

While some news industry experts predict paperless newspapers and magazines in the future, the Texas Water Resources Institute (TWRI) is already publishing a digital journal and participating in a water digital library.

TWRI and the nonprofit organization The Texas Water Journal publish the online journal by the same name, which is devoted to Texas water resources management and policy issues from a multi-disciplinary perspective that integrates science, engineering, law, planning, and other disciplines. It also provides updates on key state legislation and policy changes by Texas administrative agencies.

Editorial board members are Dr. Todd Votteler, executive manager of intergovernmental relations and policy for the Guadalupe-Blanco River Authority; Dr. Ralph Wurbs, TWRI's associate director for engineering and professor in Texas A&M University's Zachry Department of Civil Engineering; and Kathy Alexander-Martin. Votteler is the editor in chief. TWRI staffers Kathy Wythe, Leslie Lee, and Jaclyn Tech serve as the editorial/support team.

The Texas Water Journal can be viewed at *journals.tdl.org/twj*. Authors can submit papers through the website.

TWRI is also involved with the Texas Water Digital Library (TWDL), an online repository for the research and works of Texas university water resources entities. TWDL creates a single place for researchers to find water data from every part of the state.

Dr. John Leggett of the Texas A&M University Libraries and Mark McFarland of the University of Texas Libraries, both co-directors of the Texas Digital Library, formed a group to create the TWDL.

Dr. David Maidment, director of the Center for Research in Water Resources at The University of Texas at Austin; Dr. B.L. Harris, acting director of TWRI; and Dr. Ken Rainwater, director of the Texas Tech University Water Resources Center, are working with Leggett, McFarland, and digital library professionals from those universities to build the repository. Still in the development stage, the digital library can viewed at *repositories.tdl.org/twdl-ir*.

Much of the TWRI information that will be in the TWDL already resides in the Texas AgriLife Research section of the Texas A&M University Libraries Digital Repository at *repository.tamu.edu/handle/1969.1/6061*.

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TWRI on Twitter

Timely information and links from the Texas Water Resources Institute (TWRI) are now available on Twitter. Visit *twitter.com/TxWRI* to stay current on water research and outreach news in Texas, including training course announcements, research outcomes, meeting announcements, and news articles.

If you're on Twitter, join in the conversation. Twitter is a great place to ask TWRI questions about funding opportunities, research and outreach projects, and Texas water facts.

TWRI offers free publications!

Enjoyed reading this issue of *txH$_2$O*? You can receive *txH$_2$O* and Texas Water Resources Institute (TWRI) publications by subscribing online at *twri.tamu.edu/txH2O*. Also tell us what you think of the magazine by taking the online survey found on that page.

txH$_2$O is published three times a year and spotlights not only TWRI projects and results but also other university research and educational projects dealing with water resources. It also features in-depth articles on major water resources issues in Texas, ranging from agricultural nonpoint source pollution to landscaping for water conservation.

New Waves, an email newsletter, publishes timely information about water resources news, results of projects and programs, and new water-related research projects, publications, and faculty at Texas universities.

RGBI Outcomes is an eight-page newsletter spotlighting research and education programs of the Rio Grande Basin Initiative, a federally funded project focused on increasing available water through efficient irrigation and water conservation.

Periodically, the institute publishes project-specific newsletters, fact sheets, and other publications. Read those at the specific project's website.

In cooperation with Texas AgriLife Research scientists, Texas AgriLife Extension Service professionals, and others, the institute publishes technical reports and educational publications that provide details of water resources issues from various locations within the state. Visit *twri.tamu.edu/publications* for the complete list.

TWRI facilitates USGS grants to faculty

In addition to administering an annual grant program for graduate students in water resources–related fields, the Texas Water Resources Institute also facilitates Texas researchers' participation in the National Competitive Grants Program. This program provides research grants of up to $250,000 for faculty in water resources. The grants support research on water supply and water availability, including investigations of possible new sources of supply, improvement of impaired waters, conservation of existing sources, and limits on growth in demand. The program is funded by the U.S. Geological Survey (USGS), in cooperation with the National Institutes for Water Resources.

Of the researchers from Texas who have applied to the program, an average of one in three has received funding. To learn more about this program, visit *water.usgs.gov/wrri/news.html* or email Leslie Lee at lhjordan@tamu.edu.

For information about other Texas Water Resources Institute projects, visit *twri.tamu.edu*.

Texas AgriLife Extension Service

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