tx H$_2$O

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URBAN WATER

A WaterSense home, on-campus conservation, graywater basics and more

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

As this issue's lead story asks, "What if one day you turn on your kitchen faucet and nothing comes out?"

According to the state water plan, demand for municipal water is expected to increase 71.4 percent by 2060. Can the state manage such an increase? Perhaps, but we need to conserve more now and develop new technologies and practices to save water in the future.

One of the biggest uses of municipal water, and the one with most potential for increased savings, is water for lawns and landscapes. The Texas Water Resources Institute's associate director, Dr. Kevin Wagner, along with Dr. Raul Cabrera and Dr. Ben Wherley of Texas A&M AgriLife Research recently published an excellent in-depth article in the *Texas Water Journal* examining urban landscape water use in Texas. The researchers found that water use by urban landscapes and golf courses represented roughly 46 percent of the urban/municipal water sector's total use during 2010.

To address these concerns, personnel within The Texas A&M University System and their collaborators are researching and demonstrating better ways to save urban water. Some of their innovative methods are spotlighted in this issue and include the following:

- AgriLife Research scientists are identifying turfgrass and landscape management practices in anticipation of two likely future trends: the spread of watering restrictions and increased or required use of nontraditional water sources for irrigation.
- The WaterSense home in Dallas is demonstrating how a homeowner might employ water-saving appliances, irrigation systems and best management practices for water conservation.
- The renovated campus golf course is making changes for drought tolerance, water reclamation and water efficiency.
- Six new campus buildings are using harvested rainwater and air conditioner condensate to water their landscapes.

I hope you enjoying reading this issue about a timely topic. As always, let's continue to make every drop count.

Roel Lopez
Interim Director

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The canopy and rainwater harvesting pillars at the Agriculture and Life Sciences Complex at Texas A&M University.
Photo by Leslie Lee, Texas Water Resources Institute.î

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Texas Water Resources Institute
make every drop count

Inside

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Rainwater falls into a collection cistern at the Agriculture and Life Sciences Complex at Texas A&M University. Photo by Leslie Lee, Texas Water Resources Institute.

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Story by Kathy Wythe

BEFORE THE TAP RUNS DRY

Municipal water users urged to conserve to help declining supplies

Photo from Crestock.com.

The future of water in Texas consists of "what ifs." What if Texas doesn't do anything to conserve water in the next 50 years? What if the drought continues? What if one day you turn on your kitchen faucet and nothing comes out? What then? Then it is too late.

The "what if" and "what then" scenarios don't have to happen. If there is anything positive about the state's continuing drought, it is that it has motivated legislators, state agencies and local municipalities to take action. Many agree that something has to be done. And, in the area of saving municipal water, the to-do list is long.

According to the Texas Water Development Board (TWDB) 2012 state water plan, Texas' population is expected to increase 82 percent from 2010 to 2060, mostly in urban areas. Reflecting that growth, demand for municipal water over the same time is expected to increase 71.4 percent. The plan also projects that municipal water demand will increase from 27 percent to 38 percent of the total demand, while water demand for agriculture — the state's biggest water user — will decline.

Regional water plans, which are part of the state plan, project that municipal water conservation strategies will provide 647,361 acre-feet — or 7.2 percent of the identified strategies — toward the additional water supplies needed in 2060.

Finding ways to save municipal water

Although building new reservoirs and developing "new" water, such as desalinated brackish water, may fulfill some of the additional demand, water conservation will play an essential part.

Water Conservation and Technology Center (WCTC) Director Dr. Calvin Finch was previously director of conservation for the San Antonio Water System and worked diligently to promote water conservation in the city. Finch said he remembers that while San Antonio organized and funded an extensive water conservation program, other cities did not, thinking they didn't need to.

"Now, all the cities have sobered up," he said. "And we have seen conservation programs increase available water supplies. Programs that use incentives and ordinances with education have the best results, but even cities that have just relied on water education are recording results that show their citizens are doing a better job of using water."

Finch said while the state water plan does recognize the importance of water conservation, he believes the examples of San Antonio and El Paso show that the state can do more. "The potential for water conservation is huge, and we have to treat water conservation as essential," he said. "It doesn't make any sense to spend billions of dollars on new water resources when we haven't eliminated water waste."

John Sutton, team leader of TWDB's municipal water conservation program, said conservation is typically the most economical water management strategy for providers to meet future needs.

"If you are able to lower overall demand, you may be able, if you are a growing system, to meet that growth without additional capacity," he said. For a water utility, it makes economic sense to put off capital construction of new treatment plants.

Conserving this water can come from many different strategies, according to experts.

It starts at home

Raising awareness and educating homeowners is foundational, experts say.

Sutton said many residents are not aware of exactly where their water comes from. "Past studies have shown that the more people are aware of their water source, the more likely and willing they are to participate in water conservation activities," he said.

Residents should be able to look at their water bill and understand how many gallons they used and for what activity. "Once people have that realization, they can better decide for themselves on what they may want to do to reduce use or at least be aware of their use," Sutton said.

In-home water conservation has traditionally centered on easy, practical steps such as installing low-flow toilets and showers, and on behavioral changes such as turning off the faucet when brushing teeth or running the washing machine or dishwasher only when full.

According to TWDB's projections provided for regional water planning, changes in efficiency standards for water-use appliances and fixtures will save an estimated 26 gallons per person per day over the 50-year planning period. ⇨

Lawn and landscape irrigation

A big portion of urban water is used for lawn and landscape irrigation.

A recent TWDB study analyzing metered water use in more than 250 Texas cities found that 31 percent of annual single-family residential water use in Texas is dedicated to outdoor purposes, such as car washing and pool, lawn and garden maintenance, with the rest used indoors.

Drs. Raul Cabrera, Kevin Wagner and Ben Wherley of Texas A&M AgriLife recently published a paper in the *Texas Water Journal* on urban landscape water use in Texas. The researchers found that water use by residential, municipal, business and educational landscapes and golf courses represented roughly 46 percent of total urban/municipal water use during 2010. Even without factoring in golf course water use, they estimate that the total annual water use for lawns and landscapes ranges from 1.9 million acre-feet to 4 million acre-feet.

"This effectively positions urban irrigation as the state's third largest water user, after agricultural irrigation and other urban uses, such as in-home and municipal use," Cabrera said.

Finch said some Texas cities still use 50 percent or more of their water for landscapes, a prime target for water conservation. "That has to be addressed," he said. "As a horticulturist, I can reasonably say that one half of that water use is unnecessary. In most of Texas, you can have attractive landscapes if your irrigation technology is good, you have no leaks and you are using the right amount of water and the right kind of plants."

According to Wagner, a number of strategies, tools and management practices can significantly reduce water usage in urban landscape irrigation.

"Using water-conserving landscape plants and suitable designs for each region in the state is foundational to landscape water conservation," he said. The Texas A&M AgriLife Extension Service has published and posted online listings of resource-efficient plants such as Earth-Kind® plants, native and adapted trees, and turfgrasses for specific parts of the state.

"Although there is limited information on actual water use or requirements by most of the recommended resource-efficient plants and grasses, the use of properly adapted species to each region should ensure their survival and ornamental performance within the limits of the expected average precipitation, with little to no supplemental irrigation," Wherley said.

"Ultimately, homeowners must be willing to adjust expectations and accept the occasional brown lawn during the summer months," Wherley said. "When established on good soil, most of our warm-season turfgrasses can persist under dormant conditions for prolonged periods in the absence of irrigation, bouncing back once rainfall returns in the fall."

The development of irrigation systems run by smart controllers based on evapotranspiration data or on soil moisture sensors can potentially save significant amounts of water.

Ongoing research by Dr. Guy Fipps and Charles Swanson of AgriLife Extension indicates that most smart controllers using weather data to apply the right amount of water are improving each year, but some still apply too much water.

Swanson said in their 2013 tests, all the controllers supplied adequate amounts of water. "However, we continue to see some controllers that have tendencies to over-irrigate or apply excessive amounts," he said.

Rainwater harvesting, another conservation measure for urban areas, has seen increased popularity and increased incentives from utilities and municipalities in recent years. Sutton said TWDB is receiving more inquires about rainwater harvesting from not just the Hill Country, where the movement started, but also increasingly from other areas of the state, including the Dallas-Fort Worth Metroplex. "Even East Texas, which is one of the wettest areas of the state, seems to be experiencing an increase in the number of rainwater harvesting systems being installed," he said.

Dotty Woodson, water resource program specialist at the Texas A&M AgriLife Research and Extension Center at Dallas, agreed, adding that the Metroplex has seen a large increase in businesses installing rainwater harvesting systems in the last two to three years. "Commercial businesses, office buildings, car dealerships — we are seeing a huge increase," she said.

"Many of the commercial businesses we are working with are putting in much larger systems than homeowners would, so the impact on municipal water irrigation is huge for a commercial location as compared to an average home," she said.

Woodson said that many cities in the Metroplex are looking at spending millions of dollars to build water and wastewater treatment plants because of population growth. "If many people would harvest rainwater and use that for irrigation, that would be a huge savings, so cities might be able to put off how they are going to spend those dollars," she said.

Some water conservation advocates are pushing graywater use for landscape irrigation as another way to save urban water.

"One of the 'low-hanging fruits' for saving water, but often overlooked, is using graywater from households," Finch said. Graywater is the untreated water from washing machines, bathroom sinks, and showers or bathtubs. Studies verify that it does not contain serious contaminants.

"With minimum precautions, water from our showers, bathroom sinks and clothes washers could be used to meet up to 10 percent to 25 percent of our overall landscape water needs," Finch said. ⇨

Urban/municipal use is the second largest category of water use in Texas, and landscape irrigation is its largest component. Photo from Crestock.com.

Cabrera is researching the potential use of graywater for home landscape irrigation in Uvalde. While it is difficult to estimate precisely the statewide potential for water savings from using graywater, he said the practice might reduce household landscape water use by up to 50 percent when coupled with water-conserving turfgrasses, plants and trees adapted to each region.

"Considering that the average family of four produces about 90 gallons of graywater per day, if this was used to irrigate a landscape, it could represent a significant water savings," he said.

Recognizing that retrofitting an entire house for graywater capture might be too expensive for homeowners, WCTC and the Texas Center for Applied Technology (TCAT) are demonstrating economical graywater use at the Mitchell Lake Audubon Center in San Antonio.

Mike Martin, interim director of TCAT's energy and environmental sustainability group and project director for the Mitchell Lake demonstration, said the project's goals are to show homeowners how to plan and construct an easy and affordable graywater system for irrigating native species garden plots. "We wanted to capture the graywater that was easily available to most homeowners," he said. "The most accessible graywater in many homes comes from the washing machine."

Martin said a simple graywater system can be relatively inexpensive, depending on factors such as the size of the landscape the homeowner wants to irrigate, the distance from the washing machine to the irrigated area and whether that area is uphill or downhill from the house. For the Audubon center, the cost of implementing graywater irrigation was about $285, which included a booster pump, a solar panel to power the pump, a surge tank and a drip irrigation system. He used mesh-stocking material as a simple filter to trap debris from the wash water. He estimates that a medium load from the washing machine generates 30 to 40 gallons of graywater, more than enough for a native plant garden.

AgriLife scientists such as Cabrera have conducted research on irrigating ornamental plants with graywater and, to date, have found no significant negative impact on any of the plants from graywater that contains either detergent or detergent and fabric softener.

For Martin, using graywater makes sense. "You have already paid for the water once to come into your house to wash your clothes," he said. "Why send it down the drain if you can use it to irrigate your plants?"

"I believe there will come a time when all newly constructed homes will be piped for graywater use. And then it gives homeowners the opportunity to irrigate their lawns and landscapes with graywater."

Better reporting, accountability from water providers

Recognizing that providers' accurate reporting of water use and conservation is paramount to planning for long-term water needs, the Texas Legislature has passed numerous bills through the years to direct state agencies, municipalities and water utilities in reporting.

TWDB's Sutton said water providers with 3,300 or more connections or those that receive more than $500,000 in financial assistance from TWDB must submit water conservation plans to the board. An entity with certain water rights must submit a water conservation plan to the Texas Commission on Environmental Quality.

These plans include five-year and 10-year targets for water savings in gallons per capita per day for total water use, residential water use and water loss. The plans also include best management practices needed to meet those targets, a utility profile, a leak detection program and a water conservation education program among other requirements. All entities that submit a water conservation plan must also submit annual progress reports on implementing these targets.

"There are about 600 entities in the state, out of about 3,500, that are required to have conservation plans," Sutton said. "That represents about 80 percent of the water use in the state."

Sutton said the annual reports show a downward trend in gallons of water used per person per day. "I think it is going to take at least another two or three years to really see where that trend is going and what we can determine."

Detecting and repairing leaky pipes

For municipalities and other water providers, preventing water loss from aging and leaking infrastructure or inaccurate meters could potentially save billions of gallons of water. A recent news article reported that Austin lost 3 billion gallons of water from leaky or broken pipes in 2012 and 4 billion gallons in 2011.

State law requires annual water loss audits for water providers with 3,300 or more connections or those receiving financial assistance from TWDB. All other retail providers must perform audits and file the report every five years. Recent legislation also requires that utilities filing annual water audits notify customers of any water loss.

Sutton said 2010 was the most recent year in which all water providers were required to submit a water loss audit, and the average water loss for the reporting utilities was 843,857 acre-feet, or 16.7 percent, of those utilities' total volume.

This water loss can happen in two different ways, real and apparent, Sutton said. "Real water loss is your leaks, your breaks, your storage overflows," he said. "Your apparent loss is on the metering side. It's not necessarily a true loss, but it's an area where you can't account for all the water loss."

He explained that old meters often under-register water use, resulting in lost revenue for the utility.

He said a water loss audit would identify potential problems and possible solutions. "Utilities should be able to use information from those audits to identify activities that should be included in their water conservation plans."

The TWDB is developing an online tool to consolidate and publish the annual water use surveys, water loss audits and water conservation reports.

If voters approve the constitutional amendment establishing funds to finance water projects in the state water plan, some of those funds must be used for water conservation projects and could be used for municipal infrastructure improvements.

Does it cost enough?

While all these measures will result in water savings for urban use, meeting water needs also requires matching the cost of water to its worth.

As part of utilities' water conservation plan requirements, they must have nonpromotional water rate structures, Sutton said, which means the rate structures must be cost-based and must not encourage excessive use of water. For example, the more water customers use, the more they are charged per unit.

An achievable goal?

"It's really important that all of us at the personal level and water-supply level take a good look at how we use water and how we can use it more efficiently," Sutton said. "Water is going to continue to get more expensive for its treatment and source development. I think we will see technology evolve and additional opportunities for savings.

"Are we going to run out of water?" he asked. "We may not always have the amount of water we wish we had, we may not always have the quality of water we wish we had, we may not always have a source of water that's as affordable as we wish it was."

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

Some information used for this story is from Texas A&M AgriLife Today news releases.

Who is doing what?

0 = percent increase between 1984 and today in the number of gallons the San Antonio Water System uses, despite a 67 percent increase in population

81 = number of water suppliers and organizations who are cooperating with the Water IQ statewide public awareness water conservation program

278 = number of rebate or incentive programs, such as clothes washer incentives, toilet replacements and water-wise landscaping, that water providers in Texas offered in 2012

200 million = gallons per day the North Texas Municipal Water District has saved during peak summer months, decreasing its annual use by 12-15 percent

637 million = additional gallons of water El Paso saved in 2012, compared to 2011

75.7 billion = gallons of water saved by conservation programs of 395 municipal water providers in 2011, amounting to 6.4 percent of the total volume of water the utilities provided

Column by Dr. Calvin Finch, Water Conservation and Technology Center director

GRAYWATER: AN UNDERUSED RESOURCE

WATER CONSERVATION & TECHNOLOGY CENTER

Securing Our Water Future

Graywater is a “new” water resource that could provide a relatively quick, inexpensive and easy way to extend Texas water supplies. It is ready to use at our homes, where it is produced.

Graywater is water captured from the clothes washing machine, bathroom sink, shower and bathtub. According to the Uniform Plumbing Code, a typical household produces 100 gallons of usable graywater per day. Dr. Raul Cabrera of the Texas A&M AgriLife Research and Extension Center at Uvalde, in research funded by the Rio Grande Basin Initiative, has said that amount of water could replace 10 percent to 25 percent of the potable water used on a typical Texas landscape.

My calculations show that a statewide push to retrofit 3.9 million homes to use 33 gallons of graywater a day would produce around 390,000 acre-feet of water per year. That is an impressive amount of water.

Another impressive number — an impressively low one — is the cost of retrofitting a home for graywater use as demonstrated at the Mitchell Lake Audubon Center in San Antonio. The common perception is that retrofitting a home for graywater is expensive. But at the center, Mike Martin of the Texas Center for Applied Technology in the Texas A&M Engineering Experiment Station (TEES) has shown that a homeowner could perform a retrofit for between $100 and $500. That is a small expense to supply 100 percent of the water needed for a low-water-use landscape or 15 percent of the water needed for a typical lawn.

Despite a body of scientific evidence that says graywater is safe for landscape use, regulatory officials and the public still have questions about its safety. The Water Conservation and Technology Center and a team of TEES engineers and researchers are working on a graywater initiative to address these questions. They are reviewing available research and identifying gaps in confirming the safety of graywater use. In addition to filling gaps in the science, this team is working to enhance adoption by delivering timely, easy-to-understand materials to the public, policy makers, city officials and others. The graywater initiative will need a major education component to be successful.

For example, water purveyors have questions about how a large-scale graywater program will affect sanitary sewer operations and existing recycled water (treated wastewater) programs. Homeowners and regulators also want more information on graywater retrofit and irrigation application options. Considerable research already exists on plant and soil responses to graywater, but it needs to be reviewed, organized and presented in an easy-to-use format for consumers. Finally, further research is needed on how graywater, air-conditioner condensate and harvested rainwater can be used together.

The lack of knowledge and the perceived issues that exist with graywater use are reflected in the attitudes of many local regulators and in the ordinances that govern graywater use in their cities.

In 2003, Robert Puente, then state representative from Bexar County, authored HB 2661. The bill was designed to liberalize the use of graywater and exploit its full potential. Unfortunately, the intent of HB 2661 was never communicated to homeowners who might consider using the resource. It is unclear whether communities’ regulations are much more limiting than needed or whether reasonable regulations are interpreted in ways that are not supportive of graywater use. The local ordinance and interpretation situation is an important factor that needs addressing if graywater use is to reach its full potential.

The average cost to build a reservoir is about $500 per acre-foot, not including the first year the reservoir is online, which costs $1,000 per acre-foot. If, as projected, a statewide graywater initiative could produce 390,000 acre-feet per year at an average of $300 per acre-foot, then it should be pursued.

Story by Kathy Wythe

WATER RULES

Photo by Leslie Lee, Texas Water Resources Institute.

In Texas, conservation increasingly the law of the land

Thanks to changes in Texas laws and city ordinances and rebates, state and local policies are catching up with water conservation practices, saving homeowners' water and money.

Today these laws, ordinances and rebates promote outdoor landscape conservation through activities such as encouraging xeriscaping, offering rainwater harvesting rebates and conducting free irrigation system audits.

Municipalities are also working to increase in-home conservation by offering free toilets and showerheads, plumbing repair programs and free water system check-ups.

Water-conserving landscapes

In its continued effort to promote landscape water conservation, the 83rd Texas Legislature passed Senate Bill 198 banning homeowner associations from prohibiting or restricting property owners from using drought-resistant landscaping or water-conserving natural turf. The association can still require the owners to submit a detailed description of their plans to ensure aesthetic compatibility with other landscaping in the subdivision.

This recent legislation follows a 2003 law that stated homeowner associations may not prohibit or restrict a homeowner from installing outdoor water-conservation measures such as rainwater harvesting systems, drip irrigation and composting. The associations can regulate the size, type, shielding and materials used and the location of the different systems. That law also allowed the associations to restrict the types of new turf property owners could plant, to encourage or require water- conserving turf.

Many water providers and municipalities in Texas offer rebates and incentives to promote water-efficient landscapes.

For example, the San Antonio Water System (SAWS) offers $100 coupons to local nurseries for residents who replace parts of their traditional lawns with certain drought-tolerant plants. Austin Water offers residential properties $25 for every 100 square feet of healthy turfgrass converted to native plant beds with a maximum rebate amount of $1,250. Dallas Water Utilities offers free irrigation system check-ups. El Paso, known for its aggressive promotion of water conservation, paid residents for years to replace their grass with gravel, cement or native plants. ⇨

Rainwater harvesting can provide water for drought-resistant landscapes. Photo by Leslie Lee, Texas Water Resources Institute.

As the drought lingers, more Texas cities and water providers are instituting stricter outdoor watering ordinances. El Paso Water Utilities' water conservation ordinance mandates year-round restrictions, including 3-day-a-week watering and certain times for watering. Austin allows only once-a-week watering with automatic irrigation systems and once-a-week watering with hoses.

To better enforce these ordinances, a new law gives municipalities the ability to bring civil actions against violators. Previously, they had to enforce these violations through criminal proceedings. Many cities turn off water to the irrigation system after repeated offenses.

Rainwater harvesting

In 2011, the Legislature passed several laws relating to rainwater harvesting systems that are connected to public water systems. For example, a rainwater harvesting system used for potable indoor purposes and connected to a public water system is required to have safeguards ensuring harvested rainwater does not contaminate the public water supply. The homeowner must also notify the water provider or municipality before installing the system, and the system has to be installed and maintained by a licensed plumber who is also a water supply protection specialist.

The Texas Commission on Environmental Quality (TCEQ), the state agency that sets drinking water standards, does not set minimum treatment requirements for rainwater except in situations where it will be used as a source for a public drinking water system. It does not regulate nonpotable uses of rainwater.

In 2013, the Texas Legislature added a few more regulations for rainwater harvesting. Now, any privately owned rainwater harvesting system that holds more than 500 gallons and has an additional water source, such as from the public water system, must have a mechanism for ensuring physical separation between the rainwater system and the auxiliary supply to prevent any possible contamination.

Rainwater harvesting and other water-efficient management practices are now mandated for certain state buildings. Any new state building with a roof area of at least 10,000 square feet must include on-site reclaimed technologies such as rainwater harvesting and air-conditioner condensate reuse systems. New state buildings with a roof area of at least 50,000 square feet in a region with an average rainfall of at least 20 inches must have rainwater harvesting systems.

On the local level, some municipalities and water providers offer rebates to encourage rainwater harvesting. For example, Austin Water offers rebates ranging from $0.50 to $1 per gallon of storage to customers who install rainwater harvesting systems. SAWS has custom rebates based on the amount of water anticipated to be saved, often suggesting that customers include other sources of water such as air-conditioner condensate to increase the amount of water saved.

Additionally, some cities require permits or registrations before or after installing rainwater systems. Richardson requires a permit for rainwater harvesting systems that collect 400 or more gallons of rainwater to ensure proper installation, as those systems typically require some sort of electrical and plumbing component. Smaller systems must be registered with the city by the homeowner but do not require a permit. Most cities have certain criteria for the systems' components.

In-home conservation

Besides incentives and rebates for outdoor conservation, many cities have incentives and rebates for in-home conservation. According to the Texas Water Development Board, 40 water providers offered incentives for installing water-efficient clothes washers in 2012; 53 providers offered toilet replacement.

For example, Austin Water provides free showerheads that use 1.5 gallons per minute, free bathroom sink aerators that use 1.0 gallon per minute and kitchen aerators that use 2.2 gallons per minute. Dallas Water Utilities offers free high-efficiency toilets to replace older, water-consuming toilets as well as minor plumbing repairs for low-to-moderate income customers. From 1994 to 2012, SAWS distributed more than 240,000 high-efficiency toilets, high-efficiency showerheads and faucet aerators.

Graywater use

Perhaps one of the last remaining frontiers in water conservation for landscapes is the use of graywater. Graywater is defined as the wastewater from clothes washers, showers, bathtubs and sinks that are not used to dispose hazardous or toxic materials.

Until 2003, graywater use was restricted under Texas law. That year the Texas Legislature passed a law allowing private homes to use up to 400 gallons a day of untreated graywater for landscape irrigation, gardening or composting, with some restrictions. The restrictions included not using graywater from washing machines that frequently washed diapers, not spraying the graywater into the air and not allowing the graywater onto neighbors' yards.

That same law mandated that TCEQ adopt rules for graywater use, which the commission did in 2005. According to TCEQ, residential graywater can only be used for foundation watering, gardening, composting and landscaping. There are criteria, standards and required components for various sources and uses of the graywater. For example, if graywater is used where the potential for human exposure may occur, the graywater must meet certain bacterial limits. If graywater systems are constructed and operated in accordance with TCEQ's rules, they do not require an authorization or permit from TCEQ.

Graywater-use ordinances vary from city to city. El Paso follows the International Plumbing Code, which allows for the installation of graywater systems with a permit. Dallas' plumbing ordinance requires approval for graywater systems used for landscape irrigation.

Austin recently adopted new residential graywater rules, some of which are outlined in a Frequently Asked Questions handout. Graywater may not be used for toilet flushing in single-family properties; for water features such as ponds, fountains, waterfalls and creeks; or in vegetable gardens with root crops or other plants whose edible portions touch the ground. Homeowners must obtain a permit for laundry-to-landscape systems and other gravity-flow systems using up to 250 gallons per day. In addition, they must get their system inspected upon installation. Larger gravity-flow systems and pressurized systems must be installed by a licensed plumber or professional engineer and require a permit. These systems must be periodically inspected.

For information on installing such water-efficient systems in accordance with laws and ordinances, contact your water provider.

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

Story by Leslie Lee

Photo by Leslie Lee, Texas Water Resources Institute.

Home sweet home

Texas A&M AgriLife opens the first WaterSense-labeled house in Dallas-Fort Worth

On any given evening in the 1980s, after a long day of working on the 240-acre property, the groundskeeper for the Texas A&M AgriLife Research and Extension Center at Dallas would have headed home to a small, red brick house behind the center's main buildings.

With an average-sized yard and a modest 1,500 square-foot floor plan, the 30-year-old home wouldn't have looked like much of an attraction. But today, after a water-minded renovation of the once-abandoned house, the thousands of visitors who have toured it this year would probably disagree.

The 2013 version of the home bears little resemblance to its former self. From the new water-efficient fixtures to the oasis-like backyard, the house stands as proof that conservation can be both practical and beautiful.

The first of its kind

The transformation began in summer 2012, when AgriLife staff started a major overhaul of the home. They replaced fixtures and appliances, installed efficient hot water and irrigation systems, and landscaped the yard to be water-efficient. Their goal was two-fold: to earn certification from WaterSense, a nationwide program established by

Patrick Dickinson of Texas A&M AgriLife Research gives a tour of the WaterSense home and its backyard, which includes crushed blue glass that is a water-permeable, safe and decorative landscaping material. Photos by Leslie Lee, Texas Water Resources Institute.

the U.S. Environmental Protection Agency (EPA), and to make the home an appealing and convincing demonstration site where consumers would visit and learn about water conservation.

"I've found over the years with Extension that if your demonstration doesn't look good, modern, contemporary and doable, then people aren't going to do it," said Dotty Woodson, Texas A&M AgriLife Extension Service program specialist for water resources.

"So, we updated as much in the house as possible — every light fixture, every door knob, every door hinge," said Patrick Dickinson, Texas A&M AgriLife Research program coordinator for urban water.

More than 1,000 people attended the house's grand opening in March 2013, when it was certified by EPA as a WaterSense home. Approximately 1,000 other homes in the United States are certified, but this WaterSense home is unique. Not only is it the first WaterSense-labeled home in the Dallas-Fort Worth Metroplex, it's also the first renovated home, as opposed to a brand new build, to achieve WaterSense-label certification in Texas. It's the country's only WaterSense-labeled home open for tours.

"We get busloads of people — realtors, builders, small groups of homeowners," Woodson said.

EPA's Region 6 office, located in Dallas, partners with the center to encourage the building of more WaterSense homes in the area. The AgriLife center promotes water-efficient homes to local homebuilders and municipalities.

"The WaterSense-labeled home on our campus is a great learning tool and demonstration site," said Clint Wolfe, AgriLife Research program manager for urban water. "Our hope is that local builders will embrace the WaterSense program and the benefits it can offer their clients. As water resources become more limited, building homes with the certification only makes sense." ⇨

To be WaterSense-certified, homes must meet standard criteria in three areas: indoor water use, including plumbing, plumbing fixtures and appliances; outdoor water use, including landscape design and any installed irrigation systems, which are optional; and homeowner education.

According to EPA, a WaterSense-labeled new home, compared to a traditional home, can save a family of four as much as 50,000 gallons of water annually. That's enough water to wash 2,000 loads of laundry. And, because heating less water and using less water also means using less energy, the combined water and energy savings could reduce the home's utility bills by up to $600 per year.

WaterSense program following EnergyStar's lead

"EPA modeled the WaterSense product program after the EnergyStar program," Woodson said. "The EnergyStar program changed the way manufacturers made electronic equipment, giving them incentives to get that EnergyStar label. WaterSense wants to do that same thing, with all water-using appliances, irrigation materials, all of it."

The WaterSense-labeling program currently is focused on products that provide a continuous flow of water, such as toilets, bathroom faucets and showerheads, said Karen Sanders, AgriLife Research program assistant for urban water.

"But eventually you will also see washing machines and dishwashers with the WaterSense label," Woodson said.

Because the team wanted the house to be 'green' and not just water-efficient, Dickinson said, the team made changes above and beyond EPA's criteria. "All of the light bulbs are LED bulbs, the countertops in the kitchen and bathrooms are made of recycled florescent bulbs and all of the house's appliances are also EnergyStar-rated," he said.

Another of the home's features is less obvious: the tankless, on-demand hot water system. Visitors might not even notice this particular efficiency if it wasn't for the education-minded home's wall cut-outs displaying the pipes and accompanying posters explaining how the system works. A circular hot water system is enclosed in the attic, and each drop location (for example, a bathroom) has an activation switch that is either hard-wired, such as a button by the sink, or wireless, such as a motion detector by the door. The guest bathroom's hot water is activated by a motion detector, which Dickinson said is a good option for a room often used by children.

"The tankless technology has been around for about a decade or so, but the on-demand aspect is newer," Sanders said. "There is a drop within 10–12 feet of each location, and the system gets hot water there within 10 seconds of activation. So, you get hot water pretty quick."

The system saves both water and energy, Sanders said, because it's only running when activated, and only to activated locations, instead of constantly running and heating water like traditional tank hot water heaters would.

Water conservation, DIY-style

A variety of partners worked with the center on the project, helping to make the high quality of the home possible. EPA and Dallas Water Utilities were the main partners, Woodson said, but many other companies provided materials and expertise. The staff also saved costs and made the project more

The WaterSense home's bathrooms are equipped with activation switches connected to the on-demand tankless hot water system. Photo by Leslie Lee, Texas Water Resources Institute.

relatable to consumers by doing the vast majority of the renovations themselves.

"We did 85–90 percent of the work on the house ourselves," Sanders said. "We only had help with the labor on the flooring, fencing and rock work."

"We know that for a project like this to succeed, it has to be relatable," Dickinson said. "So when we can tell homeowners that yes, we installed that toilet ourselves, they can relate to it better. We're not plumbers, we're not electricians, but we were still able to do so much of it ourselves, so it's doable for you as well."

The do-it-yourself (DIY) nature of the home doesn't stop there: Almost all its furniture was repurposed from discarded materials from the Center. For example, the base of the kitchen island came from an old drafting table.

The home's backyard was also completed almost entirely by the staff, and it is an array of textures and colors: shrubs, Hameln grass, river rocks, slate stones for the patio, decorative crushed blue glass, Blackfoot daisies and water-efficient Zoysia Palisades turfgrass.

Dickinson designed the landscape and plant selection for the home, and the yard will eventually include a rain garden. All of the plants are either native or adaptive, he said, which means they are appropriate and water-efficient for the region.

"We've selected plants for their scent, for their blooms, for their water-efficiency," Woodson said. "Blackfoot daisies will bloom all summer long."

"The plants we selected are so dependable and hardy — you never have to worry about them, unless you overwater them," Dickinson said.

The 1,000-gallon rainwater tank at the rear of the home provides all of the irrigation water for both the front and back yard. The system is equipped with a backup municipal water irrigation line, if needed. Once the landscape is established, the yards will use only rainwater, Woodson said.

"All of the landscaping is irrigated with drip, except the two lawn areas, where we are demonstrating efficient, multi-stream rotors," she said.

An affordable investment

"The return on investment is what I like to promote," Sanders said. "With the two shower-heads, two faucets and two toilets, that's approximately a $500 total investment for retrofitting two bathrooms, so you'll get your return on investment pretty quickly."

Dickinson noted that prices for water-efficient dual flush toilets, such as those used in the WaterSense home, range from $99 to $550.

"The WaterSense home's dual-flush toilets use either 1.1 or 1.6 gallons, whereas some older toilets use up to 2–5 gallons per flush," he said. "The bathroom sinks save 14 gallons per person, per day. So, 14 gallons, multiplied by 4 people, for 365 days — the water savings add up very quickly, and that gives you an idea of how much water you can save with these simple changes."

Some consumers might worry that changing to a water-efficient shower could reduce water pressure, but a spinning mechanism inside the WaterSense showerhead replicates water pressure while reducing the amount of water used, Dickinson said. "It literally projects the water, and you save water that way," he said.

Many cities offer rebates and incentives for replacing older toilets with water-efficient models, and some cities will give homeowners up to two efficient toilets, Woodson said. Often, rebates and incentives are also available for irrigation efficiency upgrades, rainwater collection systems and smart irrigation controllers.

According to the experts at the Dallas center, taking advantage of such incentives and using WaterSense products and standards is well worth the investment.

"Overall, making these small changes inside, plus changing the irrigation controller and converting to drip irrigation, made this home about 65 percent more water efficient than the average home," Dickinson said. "And that can add up to huge savings on a water bill."

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

The workings of the tankless hot water system are demonstrated throughout the WaterSense home in Dallas. Photo by Leslie Lee, Texas Water Resources Institute.

Story by Katie Heinrich

40 Gallon Challenge issues a call to reduce residential water use

The 40 Gallon Challenge, a nationwide residential water-conservation program, is helping Texans save water in ways new to them. The continuing drought, coupled with increasing water demands due to population growth, has elevated the importance of such conservation programs.

The program challenges participants to save 40 gallons of water a day by implementing water-conserving practices, said Dr. Diane Boellstorff, Texas' representative for the program and Texas A&M AgriLife Extension Service water resources specialist.

"These are simple, inexpensive behavioral changes that people can adopt, and it's amazing how much water can actually be conserved," she said.

Participants take either an online or hard-copy pledge. The pledge sheet is divided into indoor and outdoor categories and allows participants to check-off new practices or actions they will do to save water.

The indoor category includes practices such as running the dishwasher only when full, shortening showers by two minutes and installing aerators with flow restrictors on faucets. The outdoor category suggests using a broom instead of a hose to clean driveways and sidewalks, reducing irrigation station runtimes by two minutes and adding mulch around trees and plants.

The pledge lists the amount of water in gallons that each practice can save.

Taking the challenge

Those who want to take the challenge can visit 40gallonchallenge.org. Mousing over a state and selecting a county will reveal an ever-changing count of pledges signed and gallons saved, Boellstorff said. Once participants choose their state and county, they can fill out a pledge sheet.

Texas had 2,799 pledges as of September 2013, adding up to a potential savings of 516,308 gallons per day or more than 187 million gallons per year. Texas currently leads all other states in the number of pledges and gallons saved from the challenge.

Because the program is easy to administer and share, it is a great tool for AgriLife Extension agents, Boellstorff said. When Extension agents give a presentation on the 40 Gallon Challenge or another conservation topic, they give out pledge sheets to be filled out and later entered into the challenge's database.

"If you give people the pledge sheet, the learning occurs and the behavior change follows," she said.

Reducing water use

Boellstorff said the amount of water that participants pledge to save through the challenge amounts to about 62 percent of what they would have been projected to use annually. The result is that the water they would have used continues to be available for other purposes. She said a family of four uses about one-third of an acre-foot of water a year.

If everyone made a pledge and maintained it, big communities could easily avoid early-level drought restrictions, Boellstorff said.

Some participants are already good water savers and the pledge sheet may only offer them one or two new conservation techniques, Boellstorff said. Sometimes the challenge for water-conscious people is finding a 5-gallon challenge or other water-conserving practices they haven't already implemented, she said.

A look behind the challenge

The 40 Gallon Challenge National Project Director Ellen Bauske, of the University of Georgia, started the challenge through the Southern

Regional Water Program (SRWP). Supported by the U.S. Department of Agriculture National Institute of Food and Agriculture, SRWP encompasses research, extension and education water quality programs through land grant university systems in 13 Southern states. Participating states' water quality coordinators set aside funds for special projects. The 40 Gallon Challenge was one of the special projects they chose.

Boellstorff said Bauske invited other states' extension staff to join this initiative and encouraged them to promote the challenge in their states.

What's in store?

Boellstorff said the program has expanded in Texas because of the continuing drought since 2011. AgriLife Extension Regional Program Directors Susan Ballabina, Ron Woolley and Monty Dozier have made great efforts to promote the program, especially to county Extension agents delivering water educational programs to the public.

Boellstorff said with the drought's continued persistence, she foresees the program continuing, especially because of declining water supplies and growing populations.

The program also has room to grow. For example, people with private water wells are eager to participate to save their own water, reduce their energy bills and reduce the wear-and-tear on their pump, Boellstorff said.

"We need as many of the water conservation education programs as we can get," she said. "As they are each being developed, something new might be tried and discovered to be effective.

"So much water can be conserved through these voluntary programs that it's almost like finding new water without actually having any new water being produced, distributed or treated, just through water conservation," Boellstorff said.

For more information about the 40 Gallon Challenge or to make a pledge, visit 40gallonchallenge.org.

SIMPLE THINGS WE CAN ALL DO

Pledge sheet conservation techniques

INDOORS

Run the dishwasher only when full: saves **2 gallons daily**

Not leave water running while rinsing dishes: saves **5 gallons daily**

Fix a leaky toilet: saves **30 gallons daily**

Fill bathtub half full while bathing: (per person) saves **18 gallons daily**

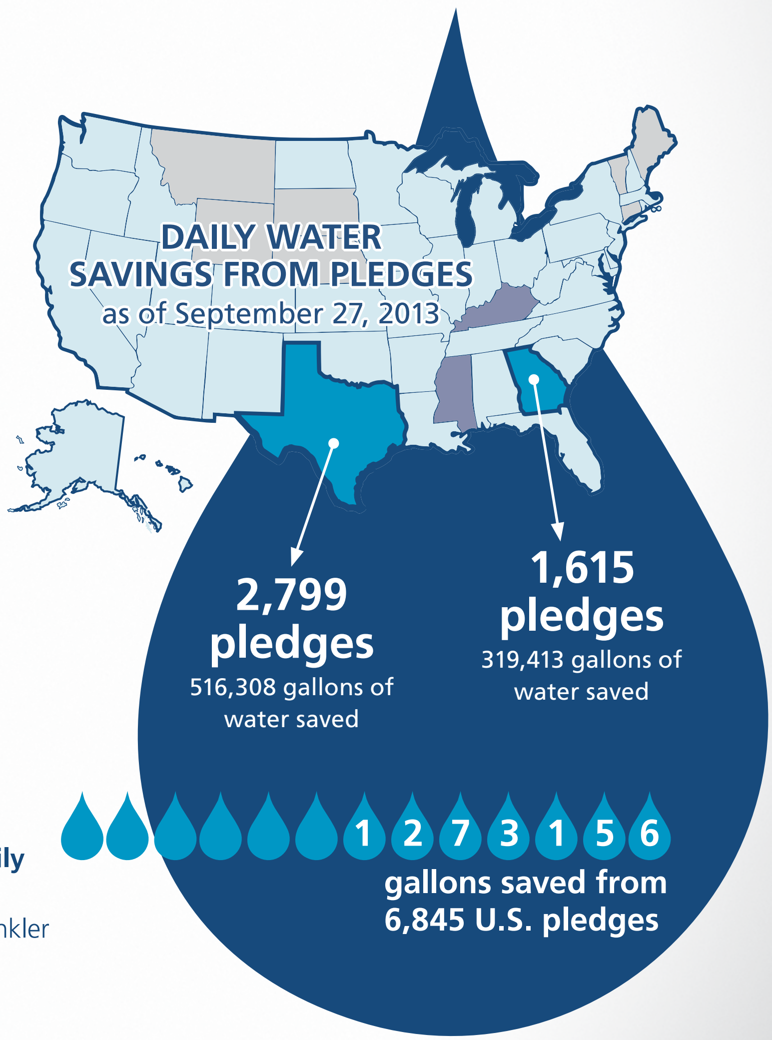
OUTDOORS

Reduce irrigation runtime by 2 minutes: saves **80 gallons daily**

Use a broom instead of a hose to clean driveways and sidewalks: **22 gallons daily**

Repair at least one pipe leak or broken sprinkler head: saves **20 gallons daily**

Replace 10,000 sq. feet of high water-use landscape with a low water-use landscape: saves **40 gallons daily**



Story by Katie Heinrich

MAROON & GREEN

New Texas A&M buildings conserve energy, water and money

The Agriculture and Life Sciences Complex at Texas A&M University features four 9,000-gallon rainwater harvesting cisterns. Photo by Leslie Lee, Texas Water Resources Institute.

Over the past three years, Texas A&M University has built six new buildings across campus that employ water harvesting and reuse systems. These new facilities are not only essential to the success of their colleges and departments, but are also playing a vital role in fulfilling one of the state's dire needs — water conservation.

By integrating rainwater harvesting (RWH) and air-conditioner (AC) condensate reuse methods into new campus buildings, along with implementing other resource-efficient initiatives, Texas A&M is continuing to improve conservation and sustainability on the College Station campus.

RWH involves the capture of rainwater. AC condensate reuse collects condensate that forms on air conditioning coils. These reuse technologies are used for landscape irrigation on campus, said Texas A&M Architect Lilia Gonzales.

Successes of campus conservation

Jim Riley, executive director of Texas A&M's Utilities & Energy Services Department, said the largest sector of Texas A&M's water consumption — more than 35 percent — comes from water evaporation at Texas A&M's four utility plants. The consumption occurs in the plant cooling towers and is a direct result of evaporative cooling used to absorb heat from most of the buildings on campus.

"When you have 19 million square feet of air-conditioned space to keep cool on a hot summer day, there will be more than 4 million gallons of water evaporated from all of the cooling towers in the four utility plants on campus," Riley said.

Landscape irrigation around campus makes up another 30 percent of Texas A&M's water use. All other domestic uses, such as water used in residence halls, for food preparation and in laboratories, account for another one-third of total consumption.

The university has its own water wells and manages its own water production, transmission, treatment, distribution and quality control and operates separately from the Bryan and College Station water systems. The university has seven water wells, which can produce up to 14 million gallons per day, he said.

A typical city does not have either the challenge or the reliability and efficiency that Texas A&M has with cooling and heating hundreds of buildings from central production facilities. A city's water consumption is driven by residential and commercial customers, with some industrial use, Riley said.

"Most cities have a higher percentage of residential use, which includes a lot of irrigation, but they do not have the large cooling towers, chillers, boilers and power generation equipment like we do here at Texas A&M," he said.

Although the university has grown significantly in square feet through the years, it has actually lowered its water consumption. Since 2000, Texas A&M has reduced its water consumption by more than 30 percent, Riley said.

Riley credits the reduction to four areas: correcting operation leaks and inefficiencies, improving thermal efficiency in the utility plants to reduce evaporative cooling, enhancing building design standards, and switching to automated irrigation systems.

"Over the last several years, instead of rejecting the heat to the atmosphere, we use the energy much more efficiently in the utility plants and buildings for heating hot water and in other uses," he said. "We have become more thermally efficient, so we don't have to evaporate as much water."

State regulations

Recent state regulations require the installation of water-efficient systems such as RWH and AC condensate reuse. Since September 2011, Texas Water Conservation Standards, administered by the State Energy Conservation Office, have been mandatory for all new state-funded buildings or state-funded major renovation projects, including those at state-supported institutions of higher education. These standards include requirements for RWH, reclaimed water, recycled water and AC condensate reuse.

Construction of any new state-funded building larger than 10,000 square feet requires approval from the State Energy Conservation Office, based on completion of a water compliance certification form documenting that an appropriate water recovery and storage system will be installed.

Campus landscape irrigation

Texas A&M's water wells are used to irrigate most of the campus landscape, but the six buildings built with RWH/AC condensate capture collect water in a cistern and use it to irrigate the surrounding landscape through a conventional sprinkler system.

"Rain and condensate water use makes good sense because it saves on groundwater consumption," Riley said. "Because rainwater and condensate are both pure, they do not have the salt and hardness that other water sources have. This makes them better than groundwater for watering the landscape as the water is almost like distilled water; it's that clean."

Logistics of AC condensate capture

While landscape irrigation conservation is a plus, AC condensate reuse provides a unique indoor conservation system that can collect more water than most may think.

Gonzales said facilities with large cooling demands can best take advantage of condensate reuse.

Condensate recovery systems work as follows: Air contains a certain amount of water vapor, or humidity. When warm air runs across chilled water coils in the air-conditioning system, the air cools and water condensation forms on the coils, much like water droplets on a glass of iced tea. This condensation is then collected and routed to a cistern either above or below ground, Riley said. In the new campus buildings, most air handlers in the air-conditioning system have a condensate drain that runs from the coils into a cistern, where the condensate is combined with collected rainwater. The condensate and rainwater are stored in the cistern and used during drier weather for landscaping and irrigation. ⇨

Designing a RWH system

Gonzales said RWH systems typically use gutters and downspouts to channel water from the roof to the cistern. Other components such as first-flush diverters and roof washers remove debris and other contaminants before the rainwater reaches the cisterns. Cisterns can be installed above or below ground and can be made of materials such as corrugated steel, concrete or fiberglass. The water can be gravity-fed or pumped for irrigation use.

When designing a RWH system, Gonzales said the first step is deciding on the intended use of the collected water. Estimating the amount of water needed for that use comes second. The next step is calculating whether enough water will be collected, based on rainfall totals and on the catchment surface area. The last step is determining whether an above- or below-ground cistern would be best, factoring in the available space, aesthetics, materials and costs.

Campus rain gardens also collect rainwater. The water percolates down through gravel or rocks, being filtered and cleaned in the process, and then is stored in the cistern.

Incorporating RWH/AC condensate reuse

Riley said RWH and AC condensate capture methods are easily implemented; once the cistern is designed and properly constructed, redirecting the roof drains into it is rather simple.

Gonzales said the earlier the capture methods are incorporated into a new building's design process, the more efficient and cost-effective the systems will be. It may also make sense to design these systems for existing buildings, depending on the complexity of the proposed design, she said. Although Texas A&M has no plans to adapt and install RWH technology into existing buildings, Gonzales said such a project would depend on cost and availability of funds.

Justifying the cost

"With a lot of things, economics tend to drive the decisions — if you are going to put in a cistern, roof drain and condensate recovery and harvesting system, there is going to be a cost to do it," Riley said. "You are going to have to justify that expense."

Riley said one challenge for Texas A&M in implementing water recovery systems is the very low rate the university charges its customers for water. The Texas A&M Utilities & Energy Services Department operates and maintains its own water system at less than $1.90 per thousand gallons of water use.

Riley said public utilities or city water municipalities typically charge between $2.50 and $5.00 per 1,000 gallons, so the university benefits from having lower rates.

But, Riley points out, "the higher the water rate that is paid, the better the economic payback is for installing water harvesting or reuse systems."

"The biggest consideration of these reuse methods is economically driven," Riley said. "Hopefully, the environment and conservation of resources is also considered. You want to make good use of water, but economics tend to be the driver. You have to be able to justify the expense of adding new water harvesting or reuse systems."

Although the payback for installing new water-saving systems at Texas A&M may take longer than average because university water rates are low, the university and Utilities & Energy Services are continually evaluating water harvesting and reuse opportunities, to create a more sustainable environment and reduce the use of groundwater.

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

Texas A&M University's buildings with RWH/AC condensate technology:

1. **The Agriculture and Life Sciences Complex**
   4 X 9,000-gallon cisterns
   40,000-gallon cistern
2. **Mitchell Physics Building**
   60,000-gallon cistern
3. **Arts and Humanities Building**
   20,000-gallon cistern
4. **Interdisciplinary Life Sciences Building**
   30,000-gallon cistern
5. **Memorial Student Center**
   26,000-gallon cistern
6. **Emerging Technologies and Economic Development Interdisciplinary Building**
   145,679-gallon cistern

Total water cistern storage:
over 350,000 gallons of water

Story by Leslie Lee

TURF IN TEXAS: still sustainable

Researchers test management practices and tout landscapes' benefits

A Texas A&M AgriLife Research turfgrass project examines root growth rates. Photo courtesy of AgriLife Research.

Turfgrass researchers at Texas A&M University are scientists, not fortune tellers.

But they say you don't need a crystal ball to spot two likely future challenges facing landscapes and turf in drought-prone Texas: more widespread watering restrictions for landscapes and mandated or incentivized use of alternative water sources for irrigation.

For researchers, preparing for these changes means finding the best turfgrass management practices for conditions involving lower-irrigation levels and lower quality water, said Dr. Ben Wherley, assistant professor in the Texas A&M University Department of Soil and Crop Sciences, and turfgrass physiology and ecology scientist for Texas A&M AgriLife Research.

"All of our projects relate to water. Whether it's a fertilizer study or a stress study, it always involves water — because of the nature of turfgrass, and because we know that we're going to have to cut back on the amount of water used on landscapes," Wherley said. "We recognize that municipal water restrictions and moving to alternative, lower-quality water sources are going to become the norm, so a lot of our irrigation research — well, all of it — is done with that in mind."

Dr. Richard White, professor in the same department and turfgrass management scientist for AgriLife Research, also focuses his research and teaching on practical problems facing landscapes. Both researchers study ways to keep turfgrass sustainable in Texas' urban areas. They research stress and drought resistance in grasses, turfgrass establishment, irrigation water management, and fertilizer and water interactions that affect plant growth.

Greenscapes benefit communities

Research on turfgrass management is worthwhile because landscapes provide innumerable benefits, Wherley said.

"Something that Dr. Chalmers always said is 'turf is a resource,'" Wherley said, of Dr. David Chalmers, professor emeritus in the soil and crop sciences department. "And just like any other resource, it's not simply there for people to look at and say 'wow, that looks beautiful;' it actually serves very important functions." ⇨

Turfgrass stabilizes soil and dust, acts as a biological filter, cools land and buildings, makes safe recreational spaces possible, and provides sociological benefits to communities.

"As we have such larger and larger urban sectors, landscapes have such enormous benefits for the urban environment," Wherley said. "Oftentimes people take green spaces for granted."

Preparing for the inevitable

In the future, maintaining such beneficial urban green spaces while also conserving water supplies will inevitably involve using nontraditional water supplies such as reclaimed and brackish water, White said. These alternative water sources are already used in many Texas cities but can pose challenges for turfgrass.

"We have to look at our management practices and turf varieties and find those that really work under those scenarios," Wherley said.

One of Wherley's research projects involves testing turfgrass varieties' drought and salinity tolerance in field and greenhouse trials. The four-year study began in 2011, is funded by the U.S. Department of Agriculture, and is co-led by Dr. Ambika Chandra, associate professor for AgriLife Research in Dallas. The project occupies about one-fourth of the turfgrass research facility in College Station and several plots at the AgriLife Research and Extension Center at Dallas, Wherley said. Five turf breeding programs at institutions around the country contribute their best materials to the collaborative project, he said.

Each year the project observes how various experimental species of grasses fare under normal to minimal irrigation, deprives the plants of irrigation through "field dry-downs," in which the irrigation water is completely turned off, and chooses five varieties that performed best and longest under those dry conditions. These "winners" are then put through salinity stress screenings to see if they can tolerate salty water, and mowing and traffic studies to test their real-world performance, Wherley said.

"Not only is drought tolerance key, but salinity tolerance is a major concern because most irrigated turf in the future will not be irrigated by high-quality drinking water; it'll be irrigated by recycled water, which tends to be higher in soluble salts," Wherley said.

Management makes a difference

Turfgrass management starts with variety selection, soil preparation and the plants' proper establishment, White said, followed by appropriate fertilization, irrigation and mowing practices.

One irrigation strategy White recommends is cycle-soak scheduling, which entails setting an irrigation controller to the following schedule: run for five minutes, turn off for an hour to let the water soak into the soil, run for another five minutes, then turn off to let the water soak in again.

This watering practice gives water time to enter the soil and be redistributed within the soil profile, and it also helps prevent runoff. In a typical 20-minute watering cycle on a home irrigation system, up to 40 percent of the water runs off the lawn, White said.

One station at the Texas A&M AgriLife Research turfgrass facility shows how water runs off after an irrigation system has run for less than 20 minutes. Photo by Kay Ledbetter, AgriLife Research.

"If homeowners would apply water using this method to their home landscapes, they would use water more efficiently, they would capture more water in the soil and they would produce better turf and landscape plants," he said.

White, Wherley and other AgriLife Research scientists test the effects of various management practices on runoff at their research facility on F&B Road near the Texas A&M campus. It includes 24 turf plots, each with separate irrigation systems, flow meters to measure the quantities of water applied and running off the plots, and automated samplers that collect runoff water.

Golf course research can help homeowners, too

The researchers' work isn't limited to home lawn studies, Wherley said. Turfgrass researchers in their department and AgriLife Research partner with industry groups and companies to test new products and technologies that may make more efficient use of irrigation water for golf courses and athletic field turf.

One current study, funded by the Golf Course Superintendents Association of America's Environmental Institute for Golf and the Lone Star (Texas) Chapter of Golf Course Superintendents, attempts to determine the minimal amounts of irrigation needed to sustain adequate quality and playability in Bermuda grass fairways across a growing season. In addition, the team is determining how these irrigation requirements are affected by mowing heights and golfer traffic, White said. The study is targeted to the golf industry, he said, but has applications for recreational managers and homeowners.

"Mowing is so important — doing it at the proper height and the proper frequency — and it does impact the health of the turf and water conservation," he said.

Mowing grass at the highest recommended height helps increase rooting depth, Wherley said. In another study, which examined establishment of St. Augustine grass sod during a 35-day period, root growth increased four-fold when mowing was withheld and turf was allowed to grow freely for the first few weeks after planting, he said.

"That plant is then going to be able to better withstand watering restrictions, such as only watering once every two weeks," he said. "If you let your lawn grow taller, you provide more leaf area for photosynthesis, so basically there's more energy capture, you're removing less of that energy-capture source, and extra energy spills into root growth."

"That's why we encourage people to mow their lawn taller. It may not look quite as nice and neat, but it will be able to withstand drought and lower watering levels much better than something that's cut too short."

Turf is tougher than you think

White said that they often test turf in extreme conditions, pushing it to its limits. Oftentimes, even zero irrigation can't kill warm-season turfgrasses. These grasses are bred for dry conditions.

"From a water perspective, it really takes an awful lot to kill warm-season grasses," White said.

A turfgrass system can look dormant and appear dead to the average observer, but with "just a little patience" and a little rain, it will return, White said.

"We've found, over the multiple years of drought that we've had here, even when things look like they're past the point of no return, by November, just with natural rainfall, we see these turf systems go from completely brown and dead — well, dead-appearing, when they are actually just dormant — to fully recovered, if they're planted on good soil," Wherley said.

He said that they've found this resilience of turf in multiple studies, including a major project with the San Antonio Water System in 2006 and 2007. The researchers tested turfgrass plots, all planted on native, nondisturbed soil, over 60 summer days with absolutely no rainfall or irrigation, Wherley said. All the tested warm-season turfgrass species recovered after irrigation resumed in the fall.

"If a turf system is planted on good soil, it can go dormant for months, and then recover," Wherley said. "So, people need to recognize that's what warm season grasses will do; that's just how they perform and behave."

"That's what makes these grasses a resource, a very functional resource, and we need to understand that sometimes our expectations of how it should look are skewed," he said. "People need to be willing to accept a brown lawn from time to time. As long as it's providing good, functional support and recreational support for its intended use, then it's all right."

"The expectations that a lot of folks have get in the way of the potential to conserve water," White said. "It doesn't always have to be jalapeño green."

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

Some information taken from a Texas A&M AgriLife Today story.

Story by Leslie Lee

CHARTING A NEW COURSE

Renovated campus golf course prioritizes water conservation

When visitors arrive on the Texas A&M University campus through New Main Drive, they are guided by the stoic administration building towering ahead and flanked by draping post oak trees. To their right stands Bonfire Memorial and to their left the campus golf course wraps green around Aggieland's southeast corner.

For a portion of 2013, the usually picturesque course was nothing but dirt, mud, creeks and trees, in the middle of a total overhaul. But it began taking shape this fall and re-opened Oct. 26.

Previously managed by the university, the course is now managed by Houston-based Sterling Golf in what Texas A&M officials called a "novel public-private partnership." Landscapes Unlimited planned the landscaping, and Jeffrey D. Blume, a 1989 Texas A&M graduate, developed the new course design. The numerous improvements include water-efficient practices and technologies.

Starting from scratch

According to Sterling Golf, its vision for the renovation was not only to develop the best on-campus course anywhere but also to represent the turfgrass expertise Texas A&M is known for among agronomists worldwide.

Another Aggie, Dave Elmendorf, class of 1971, will serve as the course general manager, and Carter Hindes, class of 2006, is Sterling Golf's director of agronomy.

Starting with a clean slate for the new course gave the developers a big advantage in improving it, Hindes said. "When you get to start a construction job from scratch, you get to put all the pieces in place," he said. This entailed removing the previous turfgrass and the old irrigation system and redesigning all 18 holes. Renovated in just 12 months, the new course now includes water-efficient turfgrass, a new reservoir and two new holes for turfgrass research and education.

Managing for profit and conservation

Water conservation is critical to the course because it is profitable as well as environmentally sound. In drought-prone states like Texas, many in the golf industry are preparing for future water restrictions by efficiently managing water and land, and using alternative water sources. The campus course management is following similar strategies and prioritizing water management and conservation, Hindes said.

Because the course is public and sells affordable rounds for students and staff, instead of running on memberships as a private course would, its business model includes both keeping the course attractive and saving money through water-efficient practices, Hindes said. There's a perception of golf courses as water-wasters, he said, but many superintendents work hard to conserve water.

"One big improvement we've made is that the turfgrass we selected for the fairways, Celebration Bermuda, is much more drought-tolerant than other varieties used on golf courses," Hindes said.

Because Celebration is an aggressive variety, it can handle drier conditions and recover from dry periods quickly, he said. To help the grass thrive over time, the landscapers capped the fairways' original, hard soil with sand before planting the turfgrass — improving soil aeration and allowing water to move better in the soil.

Another feature keeping the course both good-looking and efficient is the addition of native grasses in the roughs, which provide an attractive color contrast with the fairways and don't need irrigation once established.

"These will be taller grasses, in the out-of-play areas, where nobody will be hitting anything — well, they won't be trying to hit it there at least," he joked.

Another major improvement is the use of new water sources. "Before we renovated the golf course, it was relying on well water and, as a back-up, potable water," Hindes said.

"We've built a 2–3 acre reservoir in the creek that now collects the water that comes off the cooling tower on campus, as well as runoff from the course. So, we're able to use that water for irrigation. The goal is that once the golf course is grown-in, we will use only that water, and then the well water for back-up."

Using the latest technology

Those alternative sources of water will be used efficiently, thanks to the course's new irrigation system. Produced by Hunter Industries, it includes efficient rotor heads, uses evapotranspiration rate data and can be controlled from anywhere by Hindes, using computer software. The new system's pipes are all high-density polyethylene, or HDPE, he said.

"It's similar to gasline pipe, leaks are minimal, and 20 years from now those pipes will still be intact," Hindes said.

Exactly 1,183 irrigation heads cover the course, each individually controllable. In drier spots, the volume can be turned up, while wetter spots can be turned off or down. "It doesn't sound like much, but multiply that by 1,183 heads, and you make a big dent in water used," Hindes said.

An average person may not know, he said, that a course's irrigation is intrinsically linked with the way the course plays, which keeps superintendents busy.

"We're constantly out here checking the greens to see how the irrigation and fertilization levels are affecting how the course plays," Hindes said. "We have to make sure the course produces revenue, plays well and uses resources efficiently."

Sterling manages six courses and follows the same philosophy on each.

"Our owner and our CEO are good golfers and like courses to run fast and dry. Overwatering is just not acceptable. I'm the same way; I like the course to run fast. That's the way golf should be played. We think that drier is both better for the game and healthier for the turfgrass."

Over the summer, Hindes said, establishing the new turfgrass required extensive irrigation, and the intense heat was a challenge. "It's unfortunate, but when you grow Bermuda grass, you just have to establish it when it's hot and dry because it's a warm-season grass," he said.

The course also now features a fertigation system, which distributes liquid fertilizer products throughout the course and is just as precise as the irrigation system — allowing for each spot on the course to get just the right mix, amount and timing of nutrients, Hindes said. Sterling's chemists examine soil and water tests to determine exactly what is needed where, he added.

Staying ahead of the curve

As droughts and population growth strain water resources, the golf course industry is prioritizing water efficiency and turning to new water sources such as reclaimed water. The campus course is a microcosm of these trends, using new technologies and alternative water sources.

"It is the future, there's no doubt about that," Hindes said of reclaimed water use on courses.

Sterling Golf was founded four years ago, and the company has never been in business in Texas during a nondrought year.

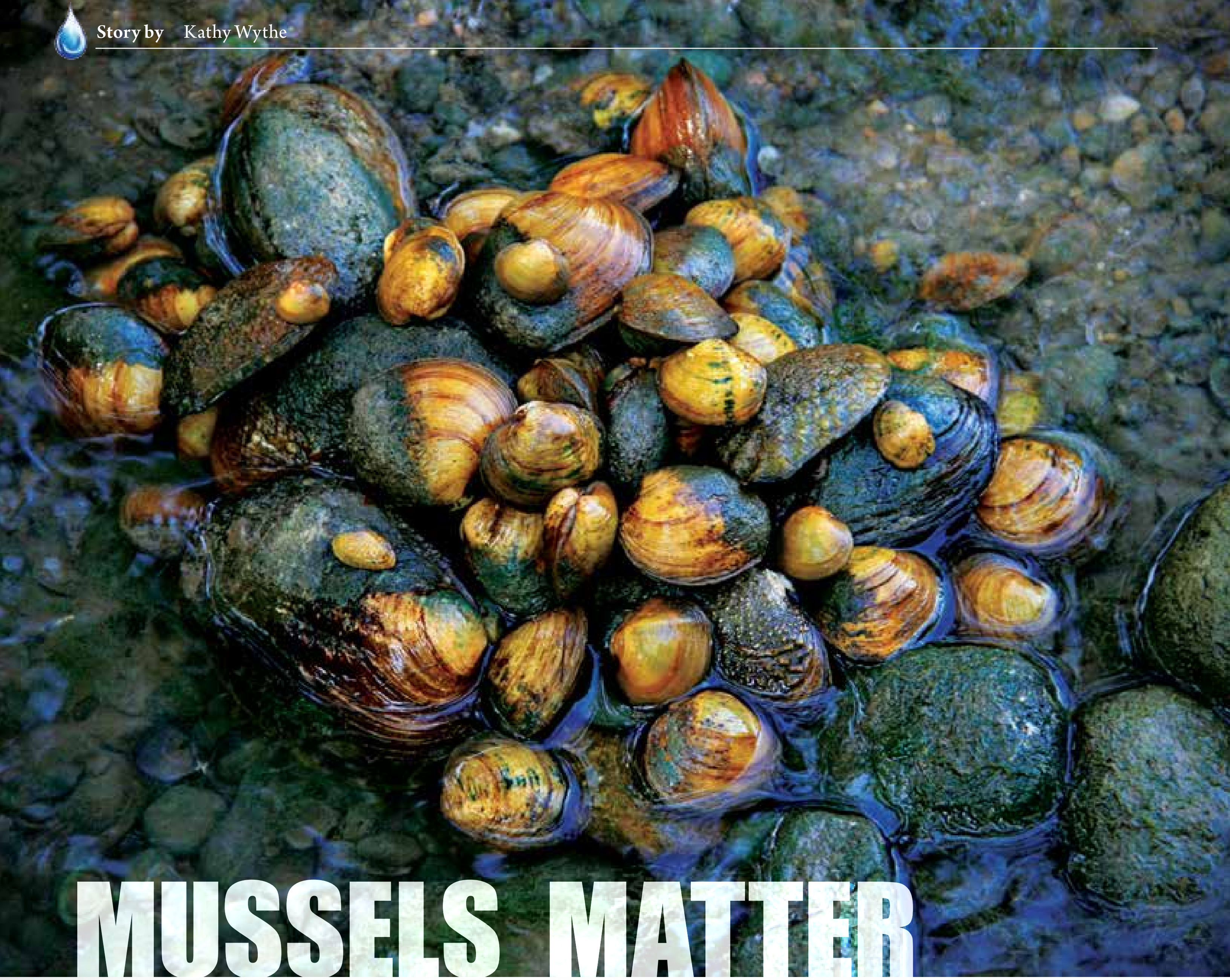
"If somebody calls us about buying or managing a course, the first question we ask is: Where's your water coming from?" he said. "If they pay for potable or well water, it's hard for us to justify that expense. Golf is a business, and we have to have affordable water to make it work."

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

Some information taken from TAMUtimes news releases.

Background: the Texas A&M University campus golf course mid-renovation. Right: Cater Hindes, Sterling Golf's director of agronomy. Photos by Leslie Lee, Texas Water Resources Institute.

Story by Kathy Wythe



MUSSELS MATTER

Research team increasing knowledge of mussels

The Texas A&M Institute of Renewable Natural Resources mussel research team conducts surveys of unionid mussels, such as those pictured, in several Texas rivers. Photo courtesy of IRNR.

Though zebra mussels in Texas give mussels a bad name, other freshwater mussels are welcomed and needed in Texas waters.

Invasive zebra mussels, first confirmed in Texas in 2009, are causing major economic and environmental damages to Texas reservoirs. But unionid mussels, a family of freshwater mussels, are important indicators of water quality and stream health and play an important role in freshwater ecosystems, according to Dr. Charles Randklev, research scientist for the Texas A&M Institute of Renewable Natural Resources (IRNR).

Because mussels are sensitive to changes in the environment, Randklev said, declining populations of mussels can mean that a stream's health is deteriorating. "In Texas, many streams and rivers are unable to support mussel populations at levels that existed in the past because of changes to the mussels' habitats and declining water quality," he said.

Randklev said that when these mussels start declining, it also affects freshwater ecosystems. Freshwater mussels mediate the transfer of nutrients between the water column and stream bottom, increase habitat diversity, and are a food source for some fishes, mammals and birds. "So when mussels start declining in a river or stream, it's going to impact other species that depend on them, whether it be for food or for habitat," he said.

Of the 52 mussel species known to occur in Texas, 15 were listed as state-threatened in 2009 because of declines in their distribution and abundance.

A state-threatened designation means that a species may become endangered in the state in the near future. Twelve of the 15 are being considered for federal protection under the Endangered Species Act (ESA).

"Unionid mussels are considered one of the most endangered groups of animals alive today," said Dr. Roel Lopez, IRNR director. "A listing under the ESA could potentially impact many aspects of the Texas economy related to water resources or environmental flows.

"Their long-term conservation requires understanding the mussels' distribution, life history and ecology, but unfortunately little is known about them," Lopez added.

Launching a new program

To remedy the lack of information about unionid mussels, IRNR launched a mussel research program in 2010.

"More fundamental knowledge of unionid mussels will allow resource managers to more effectively conserve populations of both rare and common mussel species," Lopez said.

Though the team lacked knowledge of rare mussels' current distributions and abundance, it had "a good idea of where these mussels species occurred historically," said Randklev, lead researcher for the mussel program.

The new program created a database of all mussel specimens collected in museums in Texas and other parts of the country in the last 150 years, said Julie Groce, IRNR senior research associate. From the database, the team produced a digitized map of where the mussels occurred historically.

"The map was used as a starting point to direct our future efforts," Groce said.

In the short time of the team's existence, different agencies have contracted with it for different purposes. The team currently consists of Randklev; Groce; Mark Cordova, research assistant; and Eric Tsakiris, graduate research assistant.

In 2010, the research team began conducting surveys of mussels in East and Central Texas river systems for the Texas Department of Transportation (TxDOT). TxDOT needs to know more about the current distribution, basic biology and habitat requirements of the 15 state-listed species, Groce said.

"Now that certain species are state-listed, TxDOT needs to take these species into consideration when it does any bridge or road construction or maintenance that might affect these species and their habitats," she said.

If any state-listed species live within planned construction or maintenance areas, the department must come up with a plan to avoid, minimize or compensate for any loss of the species or its habitat, she explained.

In addition to surveying mussel populations for TxDOT, the team has also developed preliminary distribution models for several state-listed mussel species. "Species distribution modeling allows us to predict where a certain species could occur in a given waterway and can provide a helpful starting point for conservation and management," Groce said.

"We successfully developed a species distribution model for the state-threatened smooth pimpleback for the Leon River, a tributary of the Brazos River," Randklev said. At the same time, researchers from the University of Texas at Tyler developed a model for the Texas pigtoe, which is also a state-threatened species.

An unexpected discovery

In the summer of 2011, while conducting studies in the San Saba River in Central Texas, the team made an unexpected discovery. It found the remains of a freshwater mussel species thought to be extinct: the false spike mussel or *Quadrula mitchelli*.

This single individual was the first hard evidence of the false spike in 30 years, Randklev said. The only other recent evidence was in 2000 when two specimens were collected in the San Marcos River. The IRNR team, as well as other scientists, has since found live false spike mussels in other Central Texas rivers. ⇨

Impacts of the mussel program

- Served as statewide project lead in freshwater mussel ecological work in Texas, particularly in Central Texas
- Rediscovered a mussel species thought to have been extinct: *Quadrula mitchelli* (false spike)
- Identified and confirmed a new host fish for *Lampsilis bracteata* (Texas fatmucket), a mussel species that is a candidate for protection under the ESA
- Successfully developed occupancy models for *Quadrula houstonensis* (smooth pimpleback), a mussel species that is a candidate for protection under the ESA
- Implemented a pilot Freshwater Mussel ID Workshop that trains participants in mussel ecology and identification

Relocating mussels as a potential drought strategy

Along with conducting surveys and developing models, the team has also done preliminary research showing that relocating mussels could be an effective strategy for saving populations affected by drought or bridge construction.

Randklev said the pilot study on drought relocation was conducted in response to a contingency plan developed during the 2011 drought by Texas Parks and Wildlife Department (TPWD) and U.S. Fish and Wildlife Service. The contingency plan aimed to alleviate droughts' potential impacts on mussels.

"The 2011 drought caused record-low flow levels in Texas streams, and many previously perennial streams went dry or became intermittent," he said. "A lot of mussels were stranded out of the water."

At the time, Randklev said, the team was studying the feasibility of temporarily relocating mussels to other locations while TxDOT works on bridges in areas with mussel populations, so they merged the two projects together.

Tsakiris and Randklev relocated three mussel species in the lower San Saba River to a site upstream with similar species and habitat. To date, all of the mussels recovered from the new site have survived and grown, Tsakiris said. "Short-term relocation is successful," he said, "but long-term, we still don't know." He will continue monitoring the mussels for two years as part of his dissertation research in Texas A&M University's Department of Wildlife and Fisheries Sciences.

Although the early results of this research are promising, the study was limited in scope, Randklev said. It needs to be replicated with different species and in different rivers in Texas to evaluate whether relocation is truly an effective management tool for other species and situations.

Tsakiris' future research will look at various life history traits such as reproduction cycles of these mussels in the San Saba. "If or when these species get listed, it is really important to have an understanding of how they reproduce and how their reproductive timing is associated with water temperatures and flow," Randklev said. "That will help to more effectively manage these populations."

Continuing the work

The team is now conducting projects in the lower Brazos River, the lower Sabine River, the middle Brazos River and the lower Guadalupe River.

Randklev said the team is doing surveys in the Brazos River near Houston and in Allen's Creek, a tributary of the Brazos, to examine riverwide patterns of mussel distribution and abundance for the Texas Water Development Board.

For TPWD, surveys in the lower Sabine will provide information about the distribution of mussels downstream from the Toledo Bend Reservoir, Randklev said. "This information could then be used later by TPWD and the Sabine River Authority to better manage mussel populations in this river," he said.

In another project for TPWD, the mussel team is surveying certain sites where TPWD is conducting instream flow analyses as part of the Texas Instream Flow Program. The program was created in 2001 by the Texas Legislature to determine the amount of water required to maintain a healthy river or sound ecological environment. Part of the mandate included scientific studies on how water flow affects aquatic life and habitat.

At three instream flow study sites on the middle portion of the Brazos River, the team is "examining the distribution and abundance of unionid mussels and collecting information on mussel-habitat associations," Randklev said. "This information will help inform instream flow recommendations by TPWD for this portion of the Brazos River."

The team will also gather more data on the false spike, the species the researchers discovered in 2011, on the lower Guadalupe River. "Understanding the distribution and abundance of this mussel is really important for the U.S. Fish and Wildlife Service when it is evaluating the species for listing," Randklev said.

Because the institute's scientists are experts on a variety of ecological and conservation questions related to unionid mussels, other agencies look to them for support, Lopez said. "In fact, the U.S. Fish and Wildlife Service will likely use information generated by the team to determine whether listing under the ESA is warranted for petitioned Texas mussel species," he said.

"Applied studies such as those conducted under this program could potentially shape conservation and management practices for rare and common mussel species throughout the state," he said. "That is saying a lot for such a young program."

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

Successful first year of Texas Well Owner Network trainings

Story by Danielle Kalisek

Photo from Crestock.com

In November, the Texas Well Owner Network (TWON) wrapped up its first full year of "Well Educated" trainings — with more than 600 participants successfully educated at 13 trainings throughout Texas.

Texas A&M AgriLife Extension Service specialists in soil and crop sciences and biological and agricultural engineering conducted the free, six-hour TWON trainings. Topics included household wells; improving and protecting water resources; groundwater resources; septic system maintenance; well maintenance and construction; water quality; and water treatment. Well owners could also bring water samples to the trainings to be analyzed for nitrate, total dissolved solids, arsenic and bacteria.

Private well owners are responsible for monitoring their own water well quality to ensure that their drinking water and all other aspects of their water system are safe. This training helps landowners better understand testing, inspection and maintenance of their wells.

Each attendee receives a TWON Well Owner's Handbook that details information presented in the training. Those who bring in water samples receive a well-water screening analysis report and information on fixing or treating any identified well problems.

In addition to the six-hour "Well Educated" training, TWON offers voluntary private water well screening events, known as "Well Informed screenings." A Well Informed session gives well owners the opportunity to have their well water samples screened for common contaminants including fecal coliform bacteria, nitrates and high salinity. The screening of the water sample is followed by a one-hour explanation of the screening results and water well protection practices. To date, 40 screenings have been held with more than 2,700 samples screened. As a result, participants have a better understanding of the relationships between practices in or near wells and the quality of water available for drinking and irrigation.

Though this year's trainings wrap-up in November, the project has received new funding to continue the Well Educated and Well Informed trainings through 2016. Interested well owners can check out twon.tamu.edu often for updated training dates and locations as well as for other water well information and resources.

Funding for the TWON is through a Clean Water Act nonpoint source grant provided by the Texas State Soil and Water Conservation Board and the U.S. Environmental Protection Agency. The project is managed by the Texas Water Resources Institute.

TWRI welcomes new staff

Photo by Leslie Lee, Texas Water Resources Institute.

Joel Andrus joined the Texas Water Resources Institute (TWRI) in September 2013 as a Texas A&M AgriLife Extension Service associate. Andrus is assisting in program planning and development in water resources. He is leading TWRI's ***Basin Approach to Address Bacterial Impairments in Basins 15, 16 and 17*** project, funded by the Texas Commission on Environmental Quality.

Through this project, TWRI will implement a new paradigm for addressing multiple bacterial impairments simultaneously within certain Texas river basins. The Colorado-Lavaca (15), Lavaca (16) and Lavaca-Guadalupe (17) basins are the focus for this effort. The project team will address four individual bacterial impairments on segments of Tres Palacious and Arenosa creeks and on two segments of the Lavaca River.

Before joining TWRI, Andrus spent eight years as a consulting engineer, helping various government agencies in Utah and Nevada address water-related issues. He earned a Bachelor of Science degree in applied physics and a Master of Science in civil engineering with a water resources emphasis, both from Brigham Young University. He is currently pursuing a doctorate in water management and hydrologic sciences from Texas A&M University.

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