



**Texas Water  
Resources  
Institute**

**December, 2001  
Volume 26  
No. 3**

---

***Introduction***

As Texas enters a new century, we are again reminded of just how precarious the State's water resources situation has become. The problem is simple. While water demands, spurred on by rapidly increasing population growth, will increase, it will be difficult to boost water supplies. Among the measures being considered is clearing mesquite, juniper and salt cedar to increase ground and surface water supplies.

Ironically, Texas has not always suffered from large infestations of brush species. Historians note that the native vegetation across much of Texas was originally grass prairies. They trace the infestations of mesquite in Texas to Anglo-American cattle grazing in the 1800s. Similarly, salt cedar was introduced to Texas in the 1880s to serve as a windbreak, to provide shade, and to prevent erosion along stream banks.



Studies of brush control show that mesquite, juniper, and salt cedar may be using, or wasting, as much as 10 million acre-feet (AF) of water in Texas each year.

Modeling efforts suggest that removing brush should create a water savings. Recent projects in the Seco Creek watershed, and Rocky Creek near San Angelo, suggest there may site-specific instances where brush control can increase water yields.

On the other hand, some studies suggest that there is not enough evidence for some specific sites, from data generated in the field, that replacing brush with grasses will increase water supplies.

One thing both sides agree on is that it would be very helpful to conduct additional field studies in watersheds throughout Texas, in order to learn more about the traits of sites where brush control has the best chance of succeeding.

Although people have been considering the conditions and situations under which brush control will save water for decades, this issue has now taken on new significance. As Texas looks for ways to stretch scarce water resources, clearing mesquite, juniper, and salt cedar is looked upon with greater interest.

Within the past decade, the Texas Legislature and other policy-making groups have stepped up efforts to determine the site-specific conditions under which brush management makes sense from a water resources point-of-view.

Throughout Texas, university researchers and professionals from a variety of federal, state and local agencies are engaged in studies pertaining to this subject. Studies include monitoring the water use of range plants, the hydrologic and ecological implications of brush clearing programs, and the economics and policies of such measures.

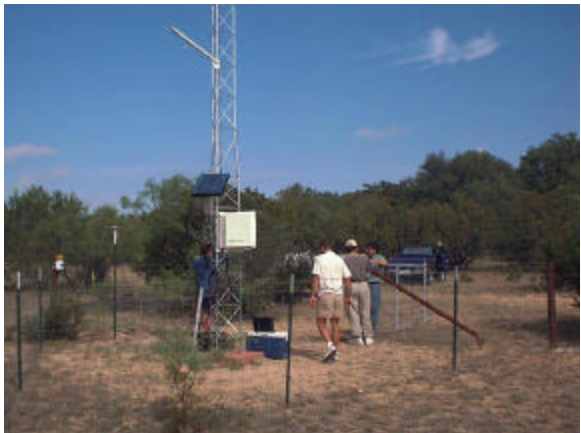
TWRI is playing a role in supporting brush control research. The Institute published a technical report that summarized feasibility studies in eight Texas watersheds, and helped TAMUS researchers obtain a grant from the U.S. Army Corps of Engineers to examine how brush clearing practices may affect terrestrial and aquatic ecosystems.

### ***Background Information***

Various governmental entities in Texas have developed incentives to facilitate the clearing of brush to boost water yields.

In 1985, the Texas Legislature enacted the Texas Brush Control Act, which authorized the Texas State Soil and Water Conservation Board (TSSWCB) to administer brush control projects on private lands to enhance off-site water yields.

In 1998, the Texas Water Development Board (TWDB) sponsored a study by a team of



researchers from the Texas A&M University System (TAMUS) Agricultural Program, the Texas Agricultural Experiment Station (TAES), the Upper Colorado River Authority (UCRA), the TSSWCB, and the U.S. Department of Agriculture Natural Resource Conservation Service (USDA/NRCS). This project conducted detailed studies to determine the feasibility of clearing brush in the North Concho River watershed in 1998.

In 1999, the Texas Legislature appropriated \$8 million to the TSSWCB to begin implementing a State cost-sharing program to implement brush control in the North Concho watershed. Working with five soil and water conservation districts (SWCDs), more than 130 landowners submitted plans to manage and implement brush control and conservation practices on 475,000 acres. To-date, brush control has been implemented on roughly 75,000 acres.

In 2001, a technical report that describes research to determine the feasibility of brush control in eight watersheds (the Frio River, the Nueces River, the Pedernales River, the Wichita River, the Canadian River, the Concho River, the Upper Colorado River, and the Edwards Aquifer) was published jointly by the Texas Water Resources Institute (TWRI) and the Blackland Research and Extension Center in Temple for the TSSWCB.

Currently, TWRI, the TSSWCB, the Brazos River Authority, the Lower Colorado River Authority (LCRA), and the Red River Authority are carrying out feasibility studies to learn how brush control may boost water yields in the Lake Brownwood, Lake Palo Pinto, Lake Fort Phantom Hill, and Lake Arrowhead watersheds.

In a separate project, TWRI and a team of TAMUS Agricultural Program and TAES scientists are now carrying out a project to assess the extent to which brush clearing may affect the ecology and aquatic biology of watersheds where these activities are carried out.

In the 2001 Legislative session, an additional \$8 million was appropriated for brush management in the North Concho. The TSSWCB directed \$15 million to fund brush control efforts in watersheds of the Upper Colorado, Concho, and Pedernales rivers, based on the recommendations from feasibility studies.

Recently, the TWDB recognized brush management as a “non-traditional” strategy to develop water supplies. Under Senate Bill 2, the omnibus water bill passed by the 2001 Texas Legislature, equipment, services, and supplies used for brush control in order to augment water supplies qualify for a tax exemption.

In some cases, the Texas Natural Resource Conservation Commission (TNRCC) has endorsed brush control as a means to achieve water quality objectives.

Brush control was identified as an approved management practice to support a Total Maximum Daily Load (TMDL) plan for Spence Reservoir. The idea is that strategically targeted control of salt cedar and mesquite could reduce salinity loading into the lake. Salt cedar store salt in their leaves and are thought to be a source of salinity runoff to the reservoir.

In a broad sense, the TNRCC has endorsed brush management and brush control as an approved best management practice (BMP) to limit non-point source pollution from farming and ranching operations, as well as a tool to stabilize soils by converting brush acreage to grasslands.

Recently, the Texas chapter of Environmental Defense began efforts to develop a set of principles that may serve as a guide to “responsible” brush control projects. Some of their core ideas are that the effect of brush control projects on water yields must be demonstrated; that brush management ought to be cost-effective, especially for publicly funded efforts; and that these activities should be compatible with natural soil and vegetation conditions.

### ***Studies Done Throughout the Texas A&M University System***

Several research and extension projects within the Texas A&M University (TAMU) System Agricultural Program have examined technical and policy aspects of brush control to boost water yields.

In 2000, a comprehensive study assessed the feasibility of brush control to free up water yields in eight Texas watersheds (the Canadian, Frio, Concho, Nueces, Pedernales, Upper Colorado and Wichita rivers, as well as basins that flow over the Edwards Aquifer recharge zone). These studies were funded by the TSSWCB. Lead TAES scientists in this study included J. Richard Conner of the Agricultural Economics Department; Joel Bach of the Rangeland Ecology and Management Department; and Ranjan Muttiah, William Dugas, and Wes Rosenthal of the Blackland Research and Extension Center in Temple. Other participants included Steven Bednarz and Tim Dybala of the USDA/ NRCS and Jeff Arnold of the USDA Agriculture Research Service (USDA/ARS).

The goal was to predict the hydrologic impact of brush control practices within each watershed, based on computer-based methods including digital elevation models, geographic information systems (GIS), and the use of the Soil Water Assessment Tool (SWAT) modeling software. This computer-generated information was verified and ground-truthed through the use of extensive physical surveys within each region. The project produced a comprehensive technical report that identifies the amount of water that can be expected to result from brush control efforts at specific sites, as well as the costs, benefits, and amount of government funding that will be needed to introduce brush control at given sites.

Studies by TAES researcher Bradford Wilcox reinforce the idea that it is critically important to incorporate the hydrologic



characteristics of specific sites into considerations of where brush control may result in the greatest water savings. Wilcox recommends that potential sites for brush control measures aimed at increasing runoff should receive at least 20 inches of rainfall annually, and that groundwaters or springs should flow into rivers and lakes. Soils should be shallow and underlain by fractured rock formations. Wilcox suggests that eradication of mesquite may not lead to increased soil moisture and groundwater recharge, unless water can move rapidly through the root zone.

TAES researchers Ben Wu and Eric Redeker recently cooperated with Thomas Thurow of the University of Wyoming to investigate the use of GIS, the SPUR-91 computer model, and data from field plots to assess the implications of brush clearing on water yields on the Cusenbary Draw watershed, which overlies the Edwards Plateau. Their study suggests that water yields would decrease by roughly a third if brush-infested sites were not treated, but that runoff and infiltration would likely increase by 43% if landowners removed 95% of all brush and kept those lands free from nuisance brush over a 10-year period.

Another project that examined the potential use of brush control along the Edwards Aquifer was the Seco Creek Project, which was a joint effort between the USDA/NRCS and the TAMUS Agriculture Program. Project leaders were Phillip Wright of USDA/NRCS and William Dugas of the TAES Blackland Research and Extension Center. One of the components of this effort involved determining whether removing juvenile, or regrowing, ashe juniper could increase springflows. The project demonstrated that prescribed burning, brush clearing, and improved grazing management on 8 acres near in the Little Seco Creek watershed near Uvalde could boost springflow by more than 352,000 gallons per year.

Studies of the economic and policy issues associated with brush control are concentrated in the Agricultural Economics Department. Former TAMU graduate student Beth Lemberg's Ph.D. dissertation dealt with the use of hydrologic and economic modeling tools to assess the viability of brush control in the Frio River basin. Her work was coordinated with TAES researchers J. Richard Conner and James Mjelde, and reinforces the idea that the costs and benefits vary greatly on a site-specific basis. For her studies, she received the Outstanding Dissertation Award by the Universities Council on Water Resources.

Studies that pertain to several issues associated with brush control are being carried out by TAMUS Agricultural Program scientists and Texas Cooperative Extension (TCE) professionals throughout Texas.

A team of TCE specialists is working on issues related to salt cedar and the hydrology of the Pecos River watershed. Goals are to determine the best mix of herbicides and application techniques to control salt cedar; to examine the amount of water salt cedars consume; to study the impacts of clearing salt cedar on water yields and water quality, and to assess how salt cedar populations may affect native vegetation. Participants include Larry White and Charles Hart, TCE range specialists from College Station and

Fort Stockton; and TCE Associate K. Brian Hays, and TCE Assistant Lindi Clayton (both from College Station). During the past two years, about 120 river miles of salt cedar have been treated in this watershed using aerially applied herbicides. Preliminary results from this project show that an acre of salt cedars use roughly 5 AF of water annually. White estimates that brush control on 2,774 acres in this region should save from 13,6000 to 34,000 AF of water annually.

Allan McGinty, a TCE Range Specialist at the TAMU Agricultural Research and Extension Center in San Angelo, has headed up a task force to examine how to eradicate salt cedar throughout the Upper Colorado River Basin. His studies have involved carrying out trials to evaluate the effectiveness of aerial applications of herbicides to treat nuisance brush near Lake Thomas and Lake Ivie. As part of this project, Hays and White are determining the potential water savings from control of salt cedar at Lake Thomas.

Similar efforts to determine the water use of salt cedar and to control this brush species are being conducted on the Canadian River by Hays, White, and TCE specialist J.F. Cadenhead. Results from studies along the Pecos, Canadian, and Colorado rivers show that removal of salt cedar may save considerably more water than clearing mesquite and juniper in these basins.

TAES Researchers Keith Owens and Robert Lyons (both with the TAMU Agricultural Research and Extension Center at Uvalde) have been studying the amount of rainfall intercepted by junipers throughout the Edwards Aquifer recharge zone. The project, which is being sponsored by the San Antonio Water System (SAWS), the Upper Guadalupe River Authority, the San Antonio River Authority, and the LCRA, is being conducted at 10 sites in seven counties. Preliminary results suggest that, during small rainfall events, junipers intercept nearly all the rain that falls. When more than 1 inch of rainfall occurs, most of the precipitation passes through the juniper canopy and may be available for runoff or groundwater recharge.

Researcher Bob Knight and TAMU graduate student Patrick Stewart are carrying out studies at the Welder Wildlife Foundation site at Sinton in South Texas. The goal is to examine how using herbicides and fire to clear brush influences the amount of runoff, sediment losses, and nutrients that result from brush control efforts.

A team of scientists at the Blackland Research and Extension Center in Temple is involved in a project to restore the vegetation in the Leon River watershed. Team leaders are TAES researchers Dennis Hoffman and William Dugas. This work involves clearing junipers and other nuisance brush species at selected sites and replacing them with native grasses. Candidate sites are selected using GIS systems and aerial photographs. The goal is to improve water quality and water supplies in the Leon River by removing brush, thus potentially increasing runoff. The project is sponsored by the Texas Department of Agriculture, the TWDB, the TSSWCB, the Texas Farm Bureau, and other organizations.

TCE specialists Larry White, Lindi Clayton, and Barron Rector are leading brush control efforts in a TCE program titled "Water for Texans." The effects of currently-used range

management practices are being compared to BMPs for clearing brush at 60 sites in watersheds throughout the Hill Country, South Texas, Central Texas, and the Blackland Prairie. BMPs are selected for each site following a year of calibration to show the benefits of brush clearing, grazing management, and the seeding of native grasses. The project involves monitoring runoff and sediment loads from sites where brush has been cleared to gather site-specific data on the effects of rangeland management on water yields. To explain the results of this program, field days are conducted at several of these test sites. The program is being expanded to include more watersheds in the near future.

White, TAMU graduate student Kurtiss Schmidt, and researcher Jim Kiniry of the USDA/ARS at Temple are now developing a model to examine the growth and water use of salt cedar and cottonwood. This study will provide insights into the amount of water that brush removal can free up in Texas river basins.

At Texas A&M University–Kingsville, researcher Timothy Fulbright of the Caesar Kleberg Wildlife Research Institute focuses his studies on the ecological implications of management practices of South Texas rangelands. Fulbright, who is the Director of the Wellhausen Experimental Station, suggests that we ought to consider the impacts of clearing large amounts of mesquite on the habitat of such birds as the scissor-tailed fly catcher, and the subsequent effect that would have on opportunities for ecotourism.

### ***How TWRI Is Involved***



Earlier this year, TWRI assembled a multidisciplinary team of researchers to examine the impact of brush clearing on water resources and wildlife habitat. The project, funded by the U.S. Army Corps of Engineers, began in April 2001. Lead TAES scientists include J. Richard Conner of the Agricultural Economics Department; Sallie Hejl and Kirk Winemiller and Neal Wilkins of

the Wildlife and Fisheries Department; Raghavan Srinivasan of the Spatial Sciences Laboratory; Ranjan Muttiah of the Blackland Research and Extension Center at Temple; and Keith Owens of the TAMU Agricultural Research and Extension Center in Uvalde. Steven Bednarz of the USDA/ NRCS Water Resources Assessment Team is a cooperator in this project.

The project focuses on two regions—the portions of the Medina, Hondo, Seco, Sabinal and Frio rivers above the Edwards Aquifer recharge zone, and sites in Middle and South Concho rivers and Spring and Dove creeks that flow into the Twin Buttes Reservoir. The study involves using digital elevation models and improved GIS tools for watersheds.

The SWAT computer model will be employed to simulate the effect of brush control strategies on the hydrology of these watersheds. Samples of aquatic organisms are being gathered from sites in these watersheds before and after brush control has been implemented, and the economic consequences of brush control measures are being assessed. The modeling efforts will involve estimating the amount of water that could be created if brush were only removed from sites that would not potentially harm wildlife habitat or water quality. The research team hopes to identify “wildlife friendly” strategies that remove brush species while benefiting the environment. Recently, TWRI awarded a number of grants to TCE personnel through the Subchapter G program, which is funded by the Texas Legislature. At least two of these projects will enhance efforts to manage rangelands to improve water yields.

### ***Other University Research***

Extensive research into various aspects of brush control are being conducted at universities throughout Texas.

At Texas Tech University (TTU), researchers in the Range, Wildlife, and Fisheries Management Department have studied the water use of range plants; methods to control salt cedar, mesquite, juniper, and other brush species; and the effect of brush control practices on runoff and sediment losses.

TTU researchers Ron Sosebee and Ernest Fish emphasize that mesquite is not necessarily an extravagant water user. Rather, they contend that mesquite is an “opportunistic” phreatophyte that will base its water use on the amount of water actually available at various soil depths. They point out that even though mesquite trees have a deep root system, they largely take water from shallow depths when rainfall levels are normal. Mesquite only use the deep roots (which can extend 75 feet) during droughts. They imply the prospects for increasing groundwater recharge by removing mesquite may be poor, since mesquite and grasses both utilize shallow root systems during normal hydrologic periods.



TTU Researcher Robert Mitchell and graduate student Brent Racher have studied the effectiveness of prescribed burns, as well as herbicides and mechanical methods, to remove salt cedar in the High Plains, and to treat mesquite at the Texas Tech Experimental Ranch near Justiceburg. Mitchell and graduate students Russell Fox and Mike Davin evaluated how the regrowth of salt cedar could best be controlled after a 1998 wildfire near Lake Meredith.



Sosebee suggests that we must carefully ponder the pros and cons of strategies to use brush clearing as a means to increase water yields. “The common perception is that noxious brush that has invaded rangelands and other wild lands is using all the soil water that otherwise would be available for filling reservoirs,” he says. “We need to examine if they use water more extravagantly than desirable species, and how much more water, if any, infiltrates into the soil when brush and grasses are present.”

Fish recommends that brush control be practiced throughout a watershed in a planned manner, and that areas in which mesquite and salt cedar are removed be replaced with native prairie grasses.

The Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University and the UCRA are now carrying out field experiments to evaluate the effect of brush control in the North Concho watershed. This project is led by TIAER researchers Ali Saleh and Abel Martinez. The study will determine the effect of brush canopies on the water balance by computing evapotranspiration, using the Bowen ratio and energy balances. The project will monitor sites with native juniper and mesquite trees, before and after brush has been cleared. This study is funded by the TSSWCB.

Researchers at the University of Texas at Austin are examining the likelihood that brush control may increase erosion. Paul Hudson of the Geography Department is assessing brush removal in the Honey Creek wildlife management area near Austin to determine how these measures may affect the ecosystem.

At the Freeman Ranch research site near Wimberley, Southwest Texas State University researcher Paul Barnes and graduate student Patty Ramirez are assessing the water use of juniper and live oaks. The goal is to better monitor the amount of transpiration generated from these plants, and to learn how brush removal affects the hydrologic relationships in the region. Barnes is working with TAMU Rangeland Ecology and Management Department researchers Steve Archer, Tom Boutton, and Chris Zhou of the TAMU Rangeland Ecology and Management Department to examine the water use of mesquite at the LaCopita watershed in South Texas.