



THE CHANGING SCIENCE OF MANAGING BRUSH FOR WATER YIELD

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Nature isn't static and neither is the science that strives to help us understand how ecological processes function.

"Science sometimes proves that we humans don't know what we think we do," said Dr. John Walker, Professor and Director of Research at Texas A&M AgriLife Research in San Angelo. "Science can turn up answers that are counterintuitive and may even fly in the face of things that people have witnessed on a local level."

Brush control as a means of large-scale water supply enhancement is a case in point, he said. Across the state, anecdotal evidence of landowners clearing brush and bringing back seeps and streams abounds. For years, the Natural Resources Conservation Service used Rocky Creek, located near San Angelo, as an example of the relationship between brush removal and water supply. In the late 1990s, policy makers and range managers made what seemed to be a logical leap: If removing brush in a small area would cause springs and streams to flow, then removing brush throughout a watershed should have the same impact on a much larger scale.

Dr. Georgianne Moore, Associate Professor of Ecosystem Science and Management at Texas A&M University, said, "When I came to Texas 11 years ago it was clear that Texas had a problem with brush encroachment and with water supply. Frankly, though, I was surprised that people were making a connection between brush encroachment and water supply -- and moving forward without

science to back up what they thought they knew."

She, along with other hydrologists and range scientists, was motivated to discover whether or not the underlying assumptions were true.

THE PILOT PROJECT

The first large-scale brush control project was implemented in the watershed of the North Concho River, northwest of San Angelo. Between 2000 and 2005, according to Upper Colorado River Authority reports, approximately 432 square miles of the 1,413 square mile watershed was cleared of mesquite and juniper in hopes of increasing stream flow in the river.

Dr. Bradford Wilcox, Professor of Ecosystem Science and Management at Texas A&M University, said, "The North Concho project was an important case study to determine if large-scale brush clearing would generate more water for cities."

Water planners projected that stream flow would increase three- to five-fold as a result of this \$14 million program; however, there has been no perceptible increase in the flow to the North Concho to date.

Scientists have identified several areas that help explain why clearing the brush didn't yield the anticipated water.

First, in the semi-arid environment of the Rolling Plains, brush control had to compensate for a high evaporation rate.

Walker, who currently serves as President of the Texas Section Society for Range Management, said, "San Angelo has a potential evaporation rate of six feet





Extensive government funded brush control on the North, Middle and South Concho River watersheds has not resulted in increased stream flow to these rivers.

annually. If, on January 1, you have an open stock tank that is 72 inches deep and you get no rain during the year, the stock tank will be dry on December 31. On an average year, we get 21 inches of rain annually. When it comes to water, we're clearly in a deficit situation."

Second, the water yield projections primarily were made using models with very little field research to support the numbers, Walker said. While modeling plays an important role in scientific research, models are only as good as the data they use and as the assumptions that they are built on.

In the case of the North Concho project, water planners assumed that after brush control the North Concho would become a perennial river. It was assumed that removing woody vegetation would free up soil moisture and thereby increase stream flow. Research showed, though, that stream flows in the western portion of the state, are actually enhanced by overland water during "big rain events." Groundwater makes up a very small percentage of stream flow.

Research also has shown that frequency and magnitude of floods has decreased over time. When floods do occur, the water is moving so swiftly over land that individual plants such as mesquite trees have very little impact on the overall quantity reaching the streams. Conversely, though, a diverse and healthy rangeland can slow water flow and increase infiltration, which improves water quality, but can limit stream flow.

Stream flows in western Texas reached their pinnacle between

1880 and 1970, Wilcox said. During this time, the land was recovering from a period of historic overgrazing that occurred in the late 1800s. It is estimated livestock numbers were 20 times to 60 times higher than now. The land was barren and degraded. Bare ground sheds more water, but the run-off carries valuable top soil with it silting in streams and reservoirs. From a watershed protection standpoint, a stand of mesquite, despite opinions to the contrary, is more valuable than bare ground, he said.

"The good news in all of this is that Texas rangelands are in better shape than they have been since the 1880s," Wilcox said.

Third, according to Moore, some of the early models that planners used oversimplified natural processes. For instance, the models assumed that plants use the same peak rate of water every day and did not account for changes because of season and weather conditions.

"Mesquite, juniper and saltcedar are not super plants," Moore said. "They react to environmental conditions just like every other plant, so their water use rate isn't constant. Despite popular belief to the contrary, they, too, are stressed by drought and limit their water use when it's dry." In addition, the plants' physiology limits the amount of water that they can use in any given day. Plus, their roots generally don't extend into the water table, preventing them from tapping directly into groundwater.

Water planners also assumed that water "saved" by removing woody vegetation remained available as "free" water that would enhance stream flow or immediately recharge aquifers, Moore



said. They didn't take into account the compensatory effect of other vegetation including grass or the evaporation that occurs when the canopy is removed. Research has shown that both factor heavily into water availability.

Fourth, water planners also overlooked the economic value of brush, Walker said. As more landowners have included wildlife as a source of income for their operations, the once-valueless brush is now considered prime habitat. In the case of the North Concho project, planners used 100 percent brush removal in their projections and landowners, on average, removed only 50 percent, Walker said.

Dr. Matt Wagner, Deputy Director of Wildlife at the Texas Parks and Wildlife Department, said, "It all comes down to what are the costs, what are the benefits and what are the landowners' goals? For most people, economic viability requires striking a balance between their wildlife and ranching enterprises, which means some brush will stay."

Maintaining an ecological balance is an important component to long-term water solutions, Moore said. It has been reported that private companies are proposing water schemes in the Hill Country that involve removing all brush on steep slopes to increase run-off into nearby streams and rivers.

"I value land stewardship," Moore said. "As the demand for water increases, I hope society doesn't ever allow 'salvaging water' to trump the best management practices that have helped return our rangelands to good condition."

ADDITIONAL RESEARCH FINDINGS

The research since the North Concho River Pilot Brush Control project was implemented in 2000 has provided a much more nuanced understanding of the relationship between the land, the

plants and the water cycle. Researchers have tackled the relationship between brush management and water supply at sites across the state. While the research doesn't support brush management as a large-scale water enhancement tool, it does demonstrate that brush control can have a positive impact on a smaller scale in areas with specific soil types and vegetative profiles.

"Improved range conditions across the state have also benefited spring flows," Wilcox said. "Spring flows, in areas that are protected from groundwater pumping, are higher than they've been since the late 1880s."

The connection between land management and spring flow is particularly evident in the Edwards Plateau. Here shallow soils over Karst limestone create a unique hydrologic situation where recharge is very direct and very fast, Wilcox said. As livestock numbers have declined and vegetation has re-established itself thereby protecting the thin soil and facilitating infiltration, spring flows have doubled in all the Karst river watersheds since 1965, Wilcox said.

Springs are more important in the Karst watersheds because they have a larger impact on stream flow, so intuition holds that brush clearing will allow better return. Although people like oaks and dislike juniper, the trees play the same role from a hydrological perspective, Wilcox said. And, although springs are highly responsive to brush clearing, there may be built-in limits to the response.

"The percentage of rainfall that becomes spring flow is already so high that I'm not sure that it will increase significantly with brush clearing," Wilcox said. For instance, in the Guadalupe and Frio watersheds, 25 percent of the rainfall becomes stream flow.

The eastern edge of the Carrizo-Wilcox Aquifer, which stretches from Mexico to Louisiana, may also yield stream flow in response



Contrary to popular thinking, the flow of creeks is not greatly affected by the density of brush in the watershed.



With fewer livestock and better overall stewardship, watershed conditions have improved in Texas in recent decades. Runoff has been reduced and infiltration has increased.

to brush management. The area receives 25 inches – 30 inches of rain per year, it has deep, easily penetrable soils, and the tree roots extend past the roots of grass and other plants, Wilcox said. These are general indications that stream flow can be influenced by manipulating vegetation.

“The greatest opportunity for water recapture occurs as you move east into higher rainfall areas over the Carrizo-Wilcox,” Wilcox said. “Ironically, though, brush management is not a priority here like it is in West Texas where it is less likely to have positive impact.”

In addition to having higher rainfall, the eastern part of the state is a forest ecosystem and not a savannah, Moore said. There is a big difference between the amount of biomass in a forest and grassland. The biomass difference between a savannah and grassland is not so sizable. By removing more biomass on a percentage basis, theoretically it is more likely to yield more water, Moore said.

IMPORTANCE OF NUANCES

The nuances in the relationships between land, plants and water are crucial, especially when public funds are sought to support

brush management efforts in the name of water quantity. The research findings have prompted some people to ask: is this the best use of public money if scientists can’t demonstrate a measurable return?

The state’s primary brush management program is the Texas Water Supply Enhancement Program operated by the Texas Soil and Water Conservation Board. The program, previously known as the Texas Brush Control Program, was revamped and renamed during the 2011 Legislative Session. It is based on the idea that large-scale brush clearing can yield enough water to increase water supplies for cities.

“Debate continues to surround the role of brush management in water supply enhancement, but that debate is largely taking place outside scientific circles,” said Wilcox. “Most range scientists have accepted the reality that brush control doesn’t yield water on a scale that directly benefits cities.”

The conversation gets complicated because the program is a significant source of funding that allows the Texas Soil and Water Conservation Board to operate a popular cost-share program for landowners.

People, at least those in agriculture and land management, don’t disagree that brush management has tangible benefits.

Wagner, former President of the Texas Section Society for Range Management, noted the importance of well-managed rangelands for water quality.

“There is no denying that healthy rangelands are vital to maintaining the quality of our groundwater and surface water supplies,” he said. In addition, brush management can enhance wildlife habitat for common and rare species.

“Wildlife is a public resource on private lands,” he said. “Good brush management can create habitat for all types of wildlife.” For instance, grassland birds are the species of greatest decline. Brush management is the best way to restore their habitat.

Then, there are aesthetics, oxygen production, carbon sequestration, increased forage productivity for livestock operations, support for rural economies and the list goes on. Perhaps the biggest benefit is that, as TWA Vice President Emeritus David K. Langford noted, brush management helps keeps people on the land.



Some of the most impressive water producing areas of Texas also have an abundance of brush. Scientists are now showing that dense shrubland and woodland often provides excellent hydrologic conditions for springs and sustained base flows.



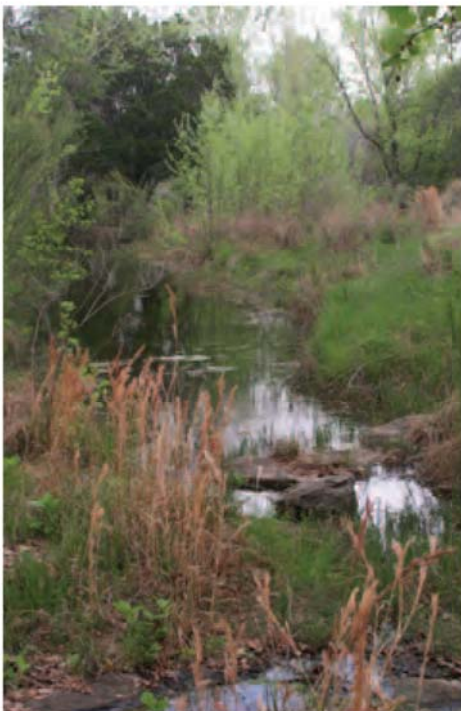
“When people stay on the land, they are able to keep it as productive open space,” Langford said. “As the demand for food, water, clothing and shelter continues to rise, the societal value of rangelands continues to rise, too.”

Unfortunately, though, many people don’t see the connection or the value. As a result, the conservation community must take care of the public trust.

“Public funding sought with the promise of public good, such as an increased water supply, needs to deliver on the promise,” Langford said. “If science tells us that we can’t deliver on the promise, then we need to reframe the request so it showcases the true benefits of land management practices such as brush control.”

Perhaps, the simplest fix is changing the program’s name back to the Texas Brush Control Program, Langford said. Of course, the original name change reflects another reality, a political one.

“In an urban-based legislature, it’s a whole lot easier to obtain funding for water supply enhancement than it is for brush control, despite its many benefits,” Langford said. 🐾



In some specific geologic settings, brush control may provide some localized increase in springs. While this is good for individual ranches, the increase is not a significant source of additional water for Texas.

MANAGING BRUSH AND WATER FOR AUSTIN

William Conrad works in the ever-sprawling shadow of Austin. As the Environmental Policy Program Manager for Austin Water Utility, he manages 42,000 acres of conservation land set aside by voters as part of the Balcones Canyonland Conservation Preserve (BCP) and Water Quality Protection Lands (WQPL).

“In 1992, the BCP got its start as a way to protect habitat for endangered species,” Conrad, who also serves as Second Vice President of the Texas Section Society for Range Management, said. “Then, in 1998, WQPL was enacted to protect water quality for Barton Springs, which is beloved by Austin’s citizens.”

By approving a series of bonds, residents provided funds allowing the land in the Barton Springs recharge zone, located in western Travis County and northern Hays County, to be purchased outright or through conservation easements. The land holdings are not contiguous, but intermingled with existing housing and business developments. The terrain ranges from stony hills to steep canyons and overlays the Karst limestone, characteristic of the Edward’s Plateau.

“For each land unit, we’ve created a landscape vision,” Conrad said. “The land can be at different successional stages, but we have a goal for each tract.” For instance, if the goal is endangered species habitat, the staff manages for a closed canopy, oak-juniper woodland. On the other hand, if the goal is ensuring water quality, the staff shoots for 15 percent canopy, he said. Generally, though they achieve a 20 percent to 25 percent canopy because of the demands of the Endangered Species Act, the expense of managing a heavy canopy and other factors, he said.

The management plan begins with mechanical clearing, where most, but not all, of the juniper is removed. Then, two years later, depending on growing conditions, the staff manages the hardwood species with fire.

“We’re one of the few places in the state that conducts urban prescribed burning,” Conrad said. “With the cost of mechanical

brush clearing running in the neighborhood of \$300/acre to \$350/acre, we can’t afford not to maintain our work.” In some instances, the range is re-seeded with native plants to enhance brush management efforts, diversify the vegetative cover and slow the advance of introduced grasses.

“We manage the surface to protect the quality of the water underneath,” Conrad said.

There is a direct connection, he said. Staff has conducted research where they have injected dye in caves on their properties and placed receptors in Barton Springs to see how quickly the water moves from one place to the other. It’s not unusual for the water in the Edward’s Aquifer to travel 15-20 miles in two to three days, which really limits the ability of underground systems to deal with contamination issues, he said.

“It’s hard to measure our impact on water quality in Barton Springs,” he said. “While we manage a good portion of the watershed, we don’t control all of it and the springs are still subject to the influence of development.”

Observation tells the staff that their efforts are making a difference. In the aftermath of a six-inch rain that fell within two hours, the staff watched crystal clear water pour from the rangelands into the caves.

“Again, we manage the surface for quality, but we feel that we are also having some effect on water quantity as well,” Conrad said. The staff’s models and estimates indicated that the brush management efforts yields about five percent more water than the land would without it, he said. The staff has seen seeps and springs begin to flow again.

“There is a big debate in the land management community on whether or not brush management can increase water supplies on a large scale basis,” Conrad said. “We’re confident that we’re positively influencing Barton Springs on the local level. But is that enough to fill a reservoir? Probably not.”

“For us, though, quantity matters less than quality,” he said. “Local voters passed bonds that set our management priorities. We’re doing exactly what the public asked us to do with their votes and their money.”