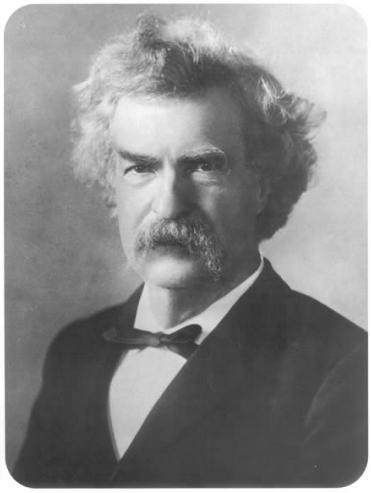
Brush Management--Increasing Usable Water Supplies

Words of Wisdom From Sages of Old Still Haunt Us



Mark Twain purportedly made the statement, *"Whiskey is for drinking; water is for fighting over".* Whether he actually said that or not isn't all that important. What is important is that the statement sums up the dilemma that water sources in Texas are at a crossroads. Sometimes the state has enough; sometimes it doesn't. It is a question of changing climatic conditions and increasing population versus a growing demand for water.

Marq de Villiers in his book, *Water: the Fate of Our Most Precious Resource*, first published in Canada in 1999, examines how water has been used to create and destroy civilizations throughout history and discusses the problems that could arise in the future if the world's water supply isn't protected. In his book Villiers says, "The trouble with water—and there is trouble with water—is that they're not making any more of it. They're not making any less, mind, but no more either. There is the same amount of water in the planet now as there was in prehistoric times. People, however, they're making more of—many more, far more than is ecologically sensible—and all those people are utterly dependent on water for their lives (humans consist mostly of water), for their livelihoods, their food, and increasingly, their industry. Humans can live for a month without food but will die in less than a week without water. Humans consume water, discard it, poison it, waste it, and restlessly change the hydrological cycles, indifferent to the consequences: too many people, too little water, water in the wrong places and in the wrong amounts".

Reflecting on Villiers' statement one cannot but help think about how water is displaced within our region, state, nation and around the globe. The irony is bitter as we think about the year 2011's sizzling heat and dry parched lands in our home state and then see on television a news reporter standing knee deep in water which is creating catastrophic flooding and destruction along a coastal region being battered by a hurricane.

As this publication is being developed, the year 2011 will be remembered as a drought in Texas unparalleled in its intensity. It was the most intense one-year drought in the state since 1895 when weather records began.

According to population and water demand projections reported by the Texas Water Development Board in a 2007 report titled, *"Water for Texas,"* the state's population is expected to more than double between the years 2000 and 2060. The projections are that the state will grow from its current 21 million inhabitants to 45.5 million inhabitants. In fact, 43 counties and 297 cities are projected to at least double their population, but another 45 counties and 137 cities are expected to lose population or remain the same. That means a lot of folks will be making a demand for water for domestic, municipal, industrial and agricultural uses, even though water demand is projected to increase by only 27 percent from almost 17 million acre-feet of water in 2000 to a projected demand of 21.6 million acre-feet in 2060.

Photo courtesy of TSSWCB

O.K. so much for philosophy and statistics, lets get to the point. Texas is home to 14 major rivers, and over 100 lakes. Twenty-three aquifers underlie about three-

fourths of the state. Collectively these sources provide usable freshwater for municipal, industrial and agricultural purposes. The focus of this publication will be on state efforts to enhance water supplies in specific areas of the Edwards Aquifer Watershed of the Texas Hill Country region through sound land and water management practices in select watersheds. It is recognized and admitted that this is not the only way to possibly increase water supplies for local communities; there are other strategies, but the work that is going on seems to hold promise. Let's take a look.

Texas Establishes a Water Supply Enhancement Program

In 1985 the Texas Legislature established a program known at the time as a brush control program. Later the legislature changed the name of the program to the Water Supply Enhancement Program because the purpose of the program is to plan and implement practices to remove certain water depleting brush species from a specific watershed for the purpose of increasing surface and groundwater. The benefits of managing and controlling brush is beginning to show the potential for additions to state water supplies, recharge of groundwater aquifers and increases in spring flow.

The United States Department of Agriculture's Natural Resource Conservation Service (NRCS) estimates that brush in Texas uses about 10 million acre feet of water annually, versus 15 million acre feet per year for human use. *(Texas State Soil & Water Conservation Board—State Brush Control Plan)* That's quite a contrast.

Looking to the Past

In order for one to understand the current physical features of the Hill Country's present landscape and water courses, we have to look to the past to see and understand how human activity played a significant role in its change and ultimately how their actions have impacted water sources.

Early European explorers were fairly specific in their description of the Texas hill country landscape as they passed through or settled in the area. They also knew very well the importance of water because its presence or absence meant life or death for them. Their routes

A Glimpse Into the Past

- *Country described as grassland or open savanna*
- *Patchy brush was seen along rivers and streams*

through the wilderness were usually dictated by the locations of water. The travel difficulties often described were frequently associated with getting to water or crossing streams.

In general, the countryside was described as grassland or open savanna. If one could go back in time to join an early exploration party or travel with a pioneering family, one's eyes might have beheld a vision of a countryside filled with short and tall grasses patterned by patchy brush and woody plants which would have been seen growing along upper ravines and adjacent to rivers and streams.

Bison herd grazing at the National Bison Range (U.S. Fish & Wildlife National Digital Library)

Prior to European settlement, the grazing pressure of migrating native animals such as bison tended to be light and periodic which allowed for hearty stands of grass to flourish. Most tree seeds deposited in a healthy grassland died

soon after germination because of their inability to compete with established grass for sunlight and water. What few tree seedlings did survive were often destroyed by natural wildfires.

Human Activities Accelerate Ecosystem Changes

It was around the mid-1800's when fundamental changes in much of the Texas flora and fauna in the hill country region had begun to take place. With the settlement of early Europeans came their domesticated animals such as cattle and horses resulting in more intensive competition with native wildlife for the existing forage, thus the ability of native grasses to suppress tree seedling establishment was destabilized.

Mid 1800's Began to See Changes in the Landscape

- *Fire, a tool of nature, was suppressed.*
- *Land was overstocked and overgrazed which favored dominance of shrubs and trees.*
- *Drought and climate change contributed to the problem.*

Another problem associated with the proliferation of brush species is that juniper and mesquite have noxious chemicals in their leaves resulting in livestock avoiding the browsing of seedlings. They are sort of like humans in that if given a choice between steak and bologna, they would naturally prefer to graze adjacent palatable grasses. One problem compounds another. European settlers tended to aggressively suppress fires and overstock the land with their livestock, so the removal of fire and over grazing pressure by their sheep, cattle, and horses created an environment that favored an increased dominance of shrubs and trees in what had previously been grasslands or savannas. Another factor that cannot be overlooked is that drought and climate changes have also helped woody plants to succeed.

Today, there is still rangeland being overgrazed as well as many ranch properties are increasingly being subdivided into smaller parcels as land is being sold for various uses or divided among heirs. Working to get these landowners to join in a cohesive effort to treat a watershed of excessive woody vegetation in order to bring the landscape back into its more historical natural state is a difficult task because of their varied reasons for owning, managing and using the properties.

We Don't Just Throw a Rock

Do we just throw a rock into a creek bed and say we will start at this point and then begin pulling up some trees along the banks to see if water will seep from the ground into the stream? Not hardly.

There are numerous studies and scientific reports available that goes deeply into the nuts and bolts of how to potentially increase ground water and stream flows through proper land management on select watersheds in which there is evidence that the acreage to be treated has the probability to recharge groundwater and streams.

To begin, here are some (not all inclusive) examples of key considerations for a water enhancement project to be successful. There needs to be knowledge of the size and location of the area considered for a management program including thought given to climatic factors. This means taking into the mix over a period of time precipitation intensity and rainfall distribution.

Soil factors is another example that must be considered because the texture and structure of soils is a primary determinant of how fast water can percolate through the ground. Data must reflect the water needs of a community or communities in the target watershed. Then there needs to be available sound data on the type, density and canopy cover of the brush species in the watershed to determine how much water is lost through transpiration followed by scien-

tific data on potential water yield that might be achieved through brush management and associated land treatment measures in the watershed.

Compound the above factors with the point that landowner cooperation is a key ingredient for success to a water enhancement program. Before a water enhancement program is started, an array of treatment measures including cost and benefits of the project must be considered along with wildlife considerations.

Here's What Got Folks Thinking

People in the San Angelo, Texas area were familiar with an interesting phenomenon that took place in the 1960's about 20 miles west of San Angel on West Rocky Creek, a tributary of the Middle Concho River.

West Rocky Creek is fed from a watershed that covers about 74,000 acres. Until the drought of 1918, the creek had flowed year round. Thereafter it flowed in the winter and was dry in the summer. Then in the 1930's the creek dried up completely.

The West Rocky Creek Story

- *Rangeland conservation practices led to phenomenal unplanned event in 1960's,*
- *Rocky Creek begins to flow after years of dormancy.*
- *Led to idea that rangeland restoration and maintenance programs can have an effect on local water quantity and quality.*

Now here enters an observable fact. In the 1960's five landowners whose combined holdings covered 33,000 acres, or about half of the watershed, started applying an accelerated range conservation program. They did not set out to prove anything— it just happened. Rocky Creek began to flow again. Thus was born the idea that a sound rangeland restoration program followed by maintenance and proper management can have a profound effect on the quality and quantity of the waters of Texas for future generations.

What followed next was the initiation of the North Concho River Pilot Brush Control Project conducted on the North Concho River Watershed near San Angelo. A research component of the project used a paired watershed approach with comparative analysis to measure differences in evapotranspiration between adjacent mesquite dominated tracts consisting of 200 acres each. The sites were located approximately five miles from the North Concho River in upland stands of mesquite where the depth to groundwater is at 50-60'.

Mesquite trees were treated with aerial application of herbicide on one site, while the other site was not treated. The study, conducted over a four-year period, included one year with nearly normal rainfall, two years with much lower than average precipitation, and one year with abundant precipitation.

The results of the study indicated that mesquite trees on the untreated site consumed .7 inches more water per year than did the treated site, where 70% of the trees had been killed by herbicide application. This equates to a water savings of 19,000 gallons per acre per year at the treated site. These findings validated not only the SWAT Model predictions of the feasibility study for this project, but also the efficacy of controlling mesquite on heavy soils in a non-karst environment as a water yield enhancement tool. The bottom line of the study suggests that a brush control approach on upland mesquites has great potential for increasing water yields in the Concho River Watershed and other watersheds with similar climatological conditions and hydrogeological settings.

Now let's turn to the Texas Hill Country.

Two More Success Stories

Streams originating in the Texas Hill Country that cross the Edwards Aquifer Watershed provides recharge to the aquifer. The totality of this watershed covers approximately 2,860 square miles and is part of the natural region known as the Edwards Plateau and the Balcones Escarpment. The Edwards Plateau is characterized by hilly, rocky terrain and thin soil supporting cedar covered hills (Edwards Aquifer Brush Control

Photo courtesy of Phillip Wright, USDA Natural Resources Conservation Service

Planning Assessment and Feasibility Study). According to the USDA Natural Resources Conservation Service, the Edwards Aquifer provides water for over 1.3 million Texans and 103,000 acres of irrigated land. It is the sole source aquifer providing municipal, industrial and recreational water for San Antonio and other cities and communities overlying the aquifer.

What makes this geographical region of the state attract people like a magnet from time past to the present is its aesthetic springs, crystal clear and cool waters, peacefully wandering creeks and clear swift flowing rivers.

The Seco Creek Demonstration Project

Because of the current demands of water usage in the aquifer, and because of future projections of water needs in the region, studies were conducted to determine if selective woody plant management would in fact increase water yields in select sub watersheds.

Seco Creek, a perennial seep spring, was the first demonstration project chosen. It is located in the upper Northwest part of the 45 square mile (176,000 acres) Seco Creek watershed. Researchers estimated that 35 percent of this area, or about 10,000 acres could be selectively treated for the removal of Ashe juniper in order

- *First demonstration project chosen*
- *Eight years of data collected*
- *Data indicates increased spring flow can be attributed to brush management*

to enhance spring flow with an end result of recharging the Edward's Underground Aquifer.

Obviously a study site had to be narrowed down. Consequently, an eight acre study site was chosen and Ashe juniper was selectively hand cut up slope from the spring site. Care was given to leave all mature Ashe juniper and all other woody species such as Texas oak, walnut and Live oak trees for wildlife habitat.

Researchers have eight years of data collected from the site, two years pre-treatment and six years of post treatment. Water quality data was collected on a monthly basis while water quantity data and cumulative rainfall totals were collected on a weekly basis.

In beginning this study the base flow of the spring was established by monitoring rainfall and spring flow for 14 months from February 1991 to April 1992. The average spring flow during this time was 3.11 gallons of flow per

minute. The site received nearly 60 inches of rainfall which was a monthly average of 4.28 inches during this time period

Then in April and May of 1992 eighty-five percent of the tree canopy of regrowth ashe juniper was removed by selective hand cutting on eight acres. Six years after the treatment, with 35 percent less rainfall, researchers recorded a 25 percent increase in spring flow. This amounted to about 44,000 gallons per acre per year after removal of the Ashe juniper.

The evaluation of data from this eight acre test project indicates that increased spring flow can be attributed to brush management, prescribed burning and grazing management. Looking at the numbers, the average increase of spring flow at the study site increased 0.67 gallons per minute which equal 964.8 gallons of water per day. If this increased spring flow were projected over one year it presents an image of producing approximately 352,000 gallons of water or approximately enough water to meet the average annual needs of six people.

It should be understood that continued success of a brush management program with the benefit of increased water yields requires continued maintenance practices such as proper grazing and related conservation practices in follow up to a brush management program.

The Honey Creek Demonstration Project

This is a second study which was structured on what was learned from the Seco Creek study.

To begin, let's establish the setting of the project. The study area consisted of two paired watersheds in and adjacent to the Honey Creek State Natural Area located about 30 miles north of San Antonio.

Geographically, the study site overlies the Trinity aquifer outcrop area which is also the catchment area for the Edwards Aquifer.

From November 2003 –July 2005, selective cutting removed about 70 percent of the ash juniper from the treatment watershed in the Honey Creek State Natural Areal.

Photo courtesy of Phillip Wright, USDA Natural Resources Conservation Service

To gain a better visual perspective of the issue, woody vegetation including ashe juniper had encroached upon areas that historically were oak grassland savannahs which crossed much of the Edwards aquifer catchment area near the study sites.

Overgrazing and fire control is generally attributed to the brush invasion. Compound that with the fact that ashe juniper is opportunistic meaning that it uses water from a shallow soil water source in the winter and a deeper water source in the summer. From reports from local ranchers and the scientific community, it is presumed that land use and vegetative land cover might have an effect on stream flow, spring discharge and/or groundwater recharge.

In initiating the demonstration project the assumption was that by removing ashe juniper and allowing native grasses to reestablish , the hydrology in the watershed might change to include changes to surface water runoff, evapotranspiration and groundwater recharge.

Let's look at the process

Two types of data were collected in the paired study areas. This included hydrologic data and water quality data during 2001 to 2010. The hydrologic budget data collected included rainfall,

Public Domain photo-Golden Cheeked Warbler

stream flow and evapotranspiration rates. The water quality component included analyzing major ions, nutrients and suspended sediments.

At the start of the study the percent coverage of ashe juniper in the reference and treatment watersheds were comparable.

From November 2003 through July 2005, selective cutting removed about 70 percent of the ashe juniper from the treatment watershed in the Honey Creek State Natural Area. Careful removal of ashe juniper was done to ensure that the habitat and nesting season of the Golden-cheeked Warbler was not harmfully affected.

Part of having the landscape appear historically comparable to what it was perceived to look like in the past, was avoiding Ashe juniper removal in the ravines along the stream channels and on steeper slopes.

In determining a time frame for the study, January 1, 2005 was set as the expressive date delineating “pre-treatment” and “post-treatment” time periods. The resulting hydrologic datasets were then examined for differences between the paired watersheds and between pre-treatment(2001-2004) and post-treatment (2005-2010) periods to assess the effects of brush management.

So, the process was in motion. Hydrologic data was collected which included rainfall, stream flow, evapotranspiration, and water quality. Groundwater recharge was not directly measured, but potential groundwater recharge was calculated.

The question then is, what was learned from the Honey Creek project? Over the period of the study there was no notable change in stream flow between the treated and non treated project area; however there was a noted difference in evapotranspiration (ET) rates in the treated watershed versus the reference watershed as a result of a change from woody to herbaceous vegetation . The study indicated an eight percent reduction in ET which means that there was less water leaving the watershed from evapotranspiration.

It must be understood that the environment is a complex system and not static which means that on a year to year basis evapotranspiration rates may vary depending upon climatic conditions of a given year. In short, one cannot expect to see a constant change of water being contributed to stream flow or groundwater recharge. But as noted, the study shows that over the long-term period dense woody vegetation in a watershed may lose more water to evapotranspiration than a watershed with a balance of herbaceous vegetation.

What was learned?

- *Study showed that controlling and managing dense brushy vegetation in watersheds can have a positive impact on ecosystems balance, water quality and quantity.*

The point is that if evapotranspiration can be changed by reducing brush plants, while still keeping them in a sense of balance with grassy vegetation to provide a stable ecosystem, there may be more water available for useable purposes providing annual climatic conditions are favorable.

What did the study reveal with respect to water

quality as a result of suspended sediment concentrations in the stream? During the pre-treatment phase of the study, no significant differences were found between the watersheds; however, a statistical difference was observed during the post treatment phase. There were less suspended sediments in the treated watershed compared to the reference watershed. This may be related to grassy vegetation acting as a filtering system to reduce sediment from entering waterways.

In summary, the studies point to the observation that controlling and managing dense brushy vegetation in watersheds can have a positive impact on ecosystem balance, water quality, and quantity.

Part of having the landscape appear historically comparable to what it was perceived to look like in the past, was avoiding Ashe juniper removal in the ravines along the stream channels and on steeper slopes.

Sink hole in Seco Creek Watershed showing recharge of Edwards Aquifer.
Photos on this page courtesy of Phillip Wright, USDA Natural Resources Conservation Service

Acknowledgements

Information in this publication was gratefully obtained from the following sources:

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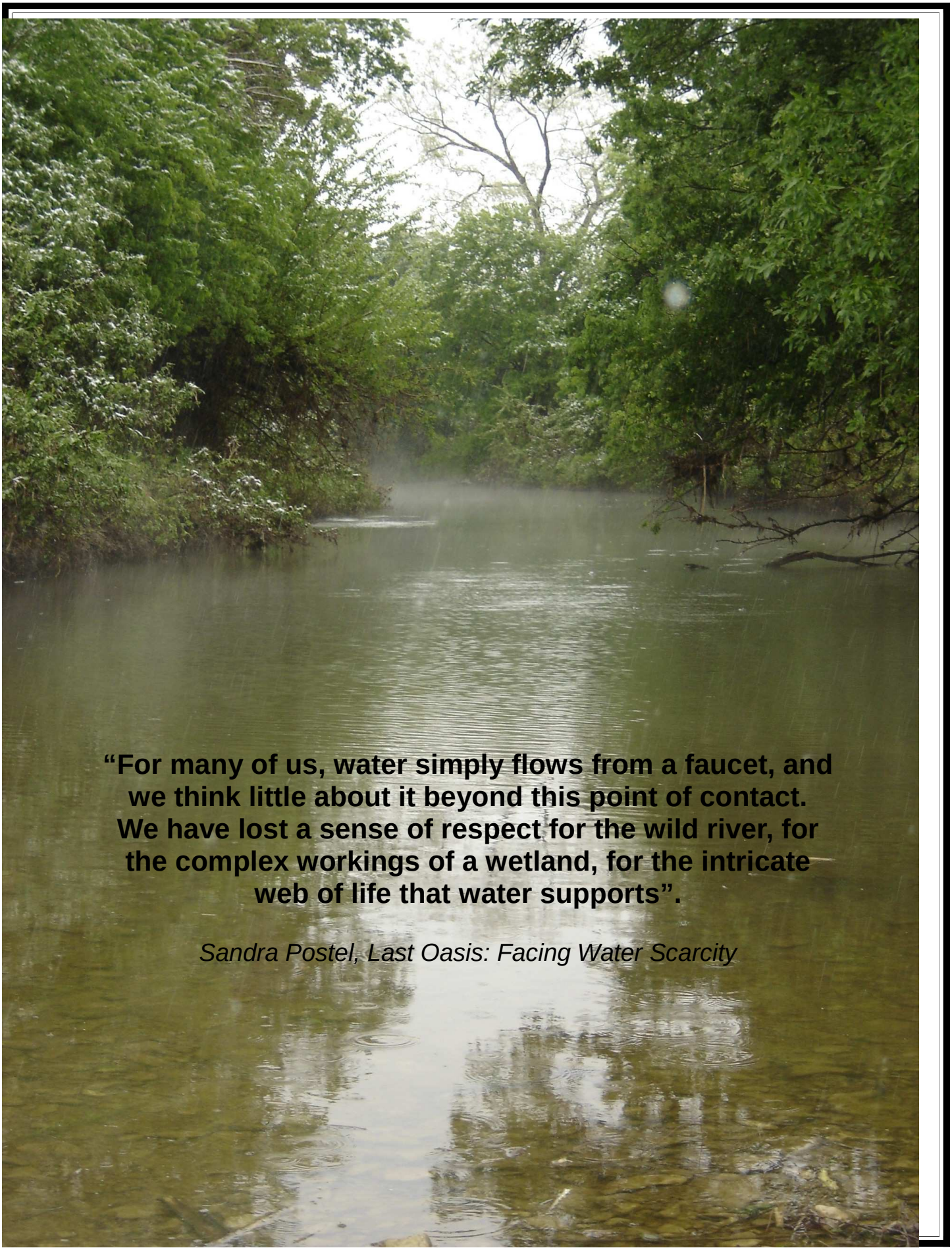
10. Personal interview with Phillip Wright, Range Management Specialist, USDA Natural Resources Conservation Service
11. Personal interview with Scott McWilliams, Staff Hydrogeologist, Upper Colorado River Authority



“For many of us, water simply flows from a faucet, and we think little about it beyond this point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports”.

Sandra Postel, Last Oasis: Facing Water Scarcity

"When you drink the water, remember the spring"

Chinese Proverb