The Arizona Riparian Council Newsletter

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WATER SOURCE DETERMINATION IN COTTONWOOD/WILLOW AND MESQUITE FORESTS ON THE SAN PEDRO RIVER IN ARIZONA

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*[**Editors' Note:** The San Pedro River ecosystem is one of the country's most significant riparian areas. Of particular interest in Arizona is the San Pedro National Riparian Conservation Area (SPNRCA). An international long-term research program termed Semi-Arid Land-Surface-Atmosphere (SALSA), was launched to understand, model, and predict the consequences of natural and human changes on the basin-wide water balance and ecological diversity at event to decadal time scales. The current research is focused on the San Pedro River basin, both in Mexico and the United States.*

Primary priorities of the research efforts during 1997 included basin-wide mesoscale meteorological modeling, upland estimation of variations in the surface energy and water balance and estimation of evapotransporation, and surface water and groundwater interactions in the riparian system.

The following article is 1 of 31 presented at a Special Symposium on Hydrology, Session on Integrated Observations of Semi-Arid Land-Surface-Atmosphere Interactions during the American Meteorological Society (AMS) Meeting held in Phoenix, Arizona, January 11-16, 1998. A SALSA web site has been established to provide additional information on research efforts by SALSA team members. The address is:
http://www.tucson.ars.ag.gov/salsa/salsahome.html
Please treat this article as provisional and use it only as a research aid. The AMS published preprints, available in January 1998, will be considered the final versions of these documents. The article here is from the web page and should be used as research information only.]

1. ABSTRACT

This research investigated physiological and environmental controls on plant water-use and transpiration loss at the species-level. We identified water sources (precipitation, stream, soil moisture and/or groundwater) utilized by cottonwood (*Populus fremontii*), willow (*Salix gooddingii*) and mesquite (*Prosopis velutina*) in relation to patterns of seasonal moisture stress, and consequences of plant water sources for stomatal regulation of transpiration. Results indicate that cottonwood, along perennial and intermittent stream reaches in Arizona did not utilize soil moisture derived from monsoon precipitation and were primarily dependent on ground-water, however, at an ephemeral site cottonwood utilized monsoon derived

Cont. page 3...SALSA

Inside This Issue

PRESIDENT'S MESSAGE

DESERT PRESERVATION PARTNERSHIP

On January 15, 1998, I represented the Arizona Riparian Council at a meeting at City Hall in Phoenix. The meeting was held by Mayor Skip Rimsza and his staff to discuss plans for acquisition of preserve lands in far north Phoenix. The area is referred to as the Sonoran Preserve Initiative and will include the acquisition of 15,000 acres of State Trust Lands. According to the Mayor, lands will be acquired using city revenues. No new taxes will be imposed.

The proposed preserve includes about 14 different areas north of Pinnacle Peak Road between 67th Avenue and Tatum Boulevard. It includes a broad corridor along Cave Creek, south of Carefree Highway. Biological values of the Cave Creek area were evaluated by a team of ecologists and biologists from the School of Planning and Landscape Architecture and the Life Sciences Department at Arizona State University, Northern Arizona University, Desert Botanical Gardens, and Arizona Game and Fish Department. A document, titled *Cave Creek Wash: Preservation Boundary Study*, contains their evaluation of and recommendations for the area.

Mayor Rimsza is in the process of building support for this project before asking the City Council to endorse the plan. He believes that if the area is not acquired now, the opportunity will be lost forever. Development is occurring rapidly at the northern boundaries of the city. The City Council will be asked to adopt the plan at an open meeting held at 2:30 p.m. on Wednesday, February 17. If adopted, the city will file an Arizona Preserve Initiative application asking the State Land Department for a conservation designation on these lands. Then, the city will have to bid on the lands at auction. If successful, this will be the first preserve to be purchased under the Desert Initiative Act.

After reviewing the results of the preservation boundary study, I believe the Arizona Riparian Council should endorse and support this effort to protect this important desert wash. I have reservations about the future impacts of adjacent development in the area. But it appears they intend to purchase substantial buffer lands adjacent to the wash.

For more information regarding this proposal, contact Eric Gorsegner, Assistant to the Mayor, City of Phoenix, at (602) 262-7111, or James P. Burke, Deputy Director, City of Phoenix Parks and Recreation Department at (602) 534-1870. Maps of the proposed area are available.

VOLUNTEER CORNER

The Arizona Riparian Council always needs people who will help at environmental education fairs with our booth. This can sometimes be with short notice and is often on weekends.

Our Treasurer has resigned. If anyone is interested in this position, please contact Jeff Inwood, Nominations Chair, to be put on a list of candidates for the office. You must be a current member of the Council. Duties include maintaining the Council's funds, arranging meeting facilities with vendors, etc. Elections take place at the spring meeting. The term of office for Treasurer is three years and there are two years remaining in the current term.

Ruth Valencia needs volunteers to help her seek donations for the spring meeting. Ruth may be reached at (602) 417-2400 X7012.

For further information, contact Cindy (602) 965-2490 or Jeff (602) 263-9522.

(Cont. from page 1 SALSA)
soil moisture. Mesquite shifted between groundwater and soil moisture in response to changing climatic and hydrologic conditions. Mesquite likewise had a greater ability to withstand increasingly negative midday water potentials. In contrast, cottonwood and willow appeared to regulate midday water potentials to -1.5 MPa, indicating that reliance on deep groundwater may be indicative of highly regulated stomatal control on transpiration.

2. Introduction

Of great concern is how human alterations of hydrology and climate influence terrestrial vegetation. One such example is the alteration of riparian ecosystems by groundwater pumping and surface water diversions. In semiarid and arid regions of the world, these impacts have produced dramatic structural and species composition changes in riparian systems (Stromberg and Patten 1990). Obligate riparian species, such as cottonwood and willow, will regulate water-use in a markedly different manner than the more drought resistant mesquite, which affects water-use efficiency and carbon acquisition, ultimately influencing competitive advantage and plant distribution. This research attempts to elucidate how different tree species found within riparian systems and adjacent uplands utilize available water and how these patterns of water-use affect species distribution and productivity.

Recent studies in arid environments have shown that plants may not be using water from all potential sources (Dawson and Ehleringer 1991), Lin et al. 1996). Depth of water extraction has been found to vary among species (Ehleringer and Dawson 1992, Flanagan et al. 1992) as well as within a species (Donovan and Ehleringer 1994, Williams and Ehleringer *in review*). We investigated seasonal patterns of water source utilization of semi-arid riparian tree species because it is likely that species-specific ability to utilize water from one or more hydrologic compartments has implications for plant and stand-level transpiration (Schaeffer and Williams, this volume) and plant hydraulic architecture.

Hydraulic architecture of dominant plants may have an important role in determining the structure and sustainability of plant communities and ecosystem processes. Xylem cavitation, the vaporization of water under negative pressure during drought, interrupts plant water transport. Cavitation occurs when xylem sap, which is under tension (Pockman et al. 1995), reaches critically low pressures and air bubbles are pulled into xylem conduits (Tyree and Sperry 1988). Xylem pressure is a result of transpiration, which is regulated by stomata, and soil water potential. Cavitation is injurious to plants, so stomata may operate to control transportation at a level below the critical xylem pressures that induce cavitation (Tyree and Sperry 1988). Previous research demonstrates that cavitation occurs in cottonwood and willow shoots at less negative xylem pressures (Pockman et al. 1995) than in mesquite (Pockman 1996). Plants adapted to using soil moisture will necessarily experience low soil water potentials favoring cavitation. Consequently, vulnerability to cavitation may correlate with water source acquisition strategies and stomatal behavior for these species.

In this research we related patterns of water source utilization with patterns of stomatal regulation, both of which may be operating to avoid cavitation. To examine these patterns we contrasted the obligate phreatophytes cottonwood (*Populus fremontii*) and willow (*Salix gooddingii*), with mesquite (*Prosopis velutina*) which is able to exist in both riparian and upland environments. Three principal research questions were posed. First, we asked if variations in groundwater or stream water availability influence the amount of rainfall derived soil moisture used by these species. We hypothesized that species with access to a stable water source, in this case groundwater or perennial streamwater, would be less likely to expend carbon to grow lateral surface roots to acquire sporadic precipitation. To examine this hypothesis, we studied stomatal and water acquisition behavior at sites characterized by different streamflow and groundwater characteristics. Although other studies have found that obligate phreatophytes did not utilize soil moisture (Busch et al. 1992), we speculated that, as conditions become less favorable for species existence and cavitation becomes more excessive, a species will utilize other water sources.

Second, we hypothesized that the water acquisition strategy and vulnerability to cavitation of a species would translate into definable patterns of stomatal regulation of transpiration. If this is the case, trees primarily dependent on groundwater should be relatively insensitive to seasonal soil moisture drought. Third, it is hypothesized that differences in these integrated patterns of water-use will explain differences in the species distribution of cottonwood, willow, and mesquite.

3. Methods

A pilot study was conducted in 1996 along an intermittent reach of Rincon Creek. In 1997 a more extensive study was conducted along the San Pedro River in south-eastern Arizona. Three San Pedro sites were selected to represent a gradient in surface water availability and depth to groundwater. The hydrologic regime varied from perennial to intermittent to ephemeral at Lewis Springs (LS), Boquillas Ranch (BQ) and Escapule Wash (EW), respectively. Sites along the San Pedro were selected in close proximity to encompass varying hydrologic regimes and with the target species (cottonwood, willow and mesquite) present. The ephemeral site appears to be the extreme hydrologic boundary of willow and cottonwood. At EW the stand of cottonwood and willow was sparse and graded into a mesquite community upstream.

At each site 7-10 individuals of each species were randomly selected as study plants. Each individual was repeatedly sampled at key times (spring, summer drought, and monsoon season) throughout the growing season to determine seasonal patterns of water source use. Stable isotopes of oxygen in xylem sap extracted from twig samples were used as a natural tracer for measuring plant fractional uptake from groundwater, soil moisture, streamwater and precipitation (Ehleringer and Dawson 1992, Brunel et al. 1995). During each sample period, soils for isotopic analysis were collected at each site from 5, 10, 25, 50 and 100-cm depths. At each sampling period and at all sites, streamwater was collected and groundwater was sampled containing a layer of mineral oil to minimize evaporation. Precipitation was collected monthly throughout 1997 and more frequently during the monsoon season (July-September). Using a pressure chamber, water stress was quantified with measurements of predawn leaf water potential (Ψ_{pd}) and midday leaf water potential (Ψ_{md}).

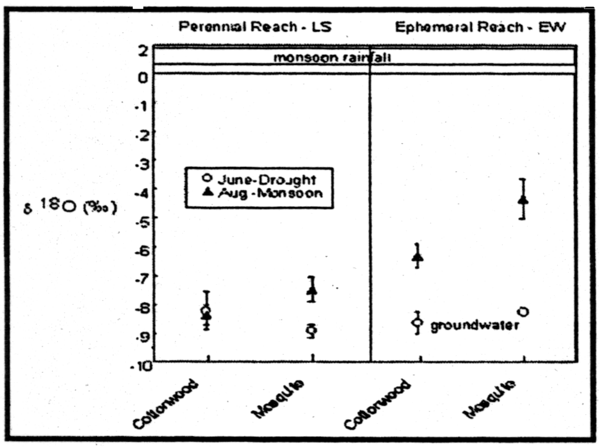

Figure 1. *Variations in the mean $\delta^{18}O$ value of xylem sap in cottonwood and mesquite during drought conditions in June and following a monsoon rain in August.*

4. Results and Discussion

Monsoon rains had $\delta^{18}O$ values ranging from 0.8 to 2.0 (‰), and groundwater had stable values throughout the year, averaging -8.6 (‰). We found little variation in the $\delta^{18}O$ values of cottonwood xylem sap sampled at LS during the June drought and in August after a significant input of monsoon precipitation (26.7 mm). This indicates that cottonwood did not utilize surface soil moisture at the perennial site (LS), and relied primarily on groundwater (Fig. 1), even after significant monsoon rain. However, at the ephemeral site $\delta^{18}O$ of cottonwood showed enrichment in August relative to xylem sap sampled in June, indicating a fraction of xylem sap was

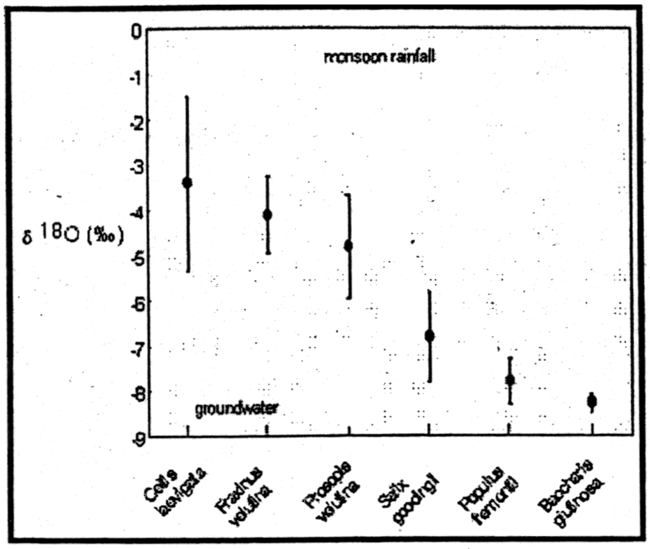

Figure 2. *Variations in the mean $\delta^{18}O$ signature of xylem sap for dominant woody plants at Rincon Creek, an intermittent stream in southeastern Arizona. Plant species are netleaf hackberry (*Celtis laevigata*), velvet ash (*Fraxinus velutina*), mesquite, Goodding willow, Fremont cottonwood, and seepwillow (*Baccharis glutinosa*).*

derived not from groundwater, but from soil moisture. This contrasts with previous research (Busch et al. 1992) which found cottonwood to utilize only deep groundwater at the Colorado River and the Bill Williams River in Arizona. Cottonwood trees at EW experienced greater water stress with mean Ψ_{md} declining to -2.5 MPa during the summer drought, while cottonwoods at LS maintained mean Ψ_{md} of -1.5 MPa. Whether cottonwood switches to water uptake by lateral surface roots is not known as the isotopic value may not represent a shift in the activity of roots used to take up water. However, the $\delta^{18}O$ value of the groundwater remained a consistent -8.7 (‰) throughout the summer, suggesting that roots higher in the sol profile were being used to uptake water. Regardless of the functional rooting depth for water uptake, these results indicate that summer rainfall is an important contribution to cottonwood water supply at a site marginal for the existence of this species.

Mesquite xylem water, sampled in August, showed $\delta^{18}O$ enrichment at both sites compared to xylem water sampled in June, indicating that mesquite utilized monsoon moisture at both the ephemeral and perennial sites (Fig.1). August mesquite xylem water was enriched relative to June xylem water by 3.9‰ at the ephemeral site and by 1.4‰ at the perennial site. Mesquite appeared to respond more dramatically to rainfall events at the ephemeral site compared to mesquite populations at the perennial site. Two processes may be responsible for the apparent difference in the magnitude of response of mesquite: 1) sites with less groundwater and surface water promote greater utilization of soil moisture, or 2) the magnitude of response is actually the same at both sites, but the clayey soil texture at LS has a dampening effect on the isotopic value of rainfall by mixing with older soil water. Construction of the isotopic profile of the soil will elucidate which explanation is more plausible.

Results at Rincon Creek indicate that willow experienced monsoon moisture ($\delta^{18}O$=6.8) (Fig. 2). Willow samples were collected after a rainfall event in July of 1996. This is in contrast to previous research (Busch et al. 1992) that found willow to utilize only deep groundwater. Further analysis of samples will need to be completed before specific conclusions can be reached about willow growing along the San Pedro.

Stomatal regulation patterns differed between the obligate phreatophytes and mesquite. The relationship between Ψ_{pd} and Ψ_{md} at LS (Fig. 3) indicates that regardless of Ψ_{pd}, Ψ_{md} are maintained at -1.5 MPa for both willow and cottonwood. In contrast, mesquite exhibited considerable variation in Ψ_{md}. Ψ_{pd} are a measure of soil moisture conditions with more negative values reflecting decreased soil moisture availability. The negligible slope of the relationship for cottonwood and willow indicates that these species maintain a critical level of Ψ_{md} as water availability declines. Maintenance of stable Ψ_{md} under conditions of decreased water availability may be accomplished either by 1) dynamic regulation of transpirational water loss by stomatal regulation, 2) increased soil-to-leaf hydraulic conductance, or 3) decreased leaf area. In contrast, mesquite tolerates a wide range of Ψ_{md}, indicating greater tolerance to low water potentials, and less stomatal regulation of transpiration.

Previous research found that cottonwood and willow stems may reach complete cavitation by xylem pressure of -2 to -3 MPa (Pockman et al. 1995). This indicates that cottonwood and willow at LS may be regulating Ψ_{md} to avoid cavitation. At the ephemeral site cottonwood utilized precipitation derived soil moisture, perhaps a result of the decrease in Ψ_{md} to -2.5 MPa, a level which is likely causing significant cavitation.

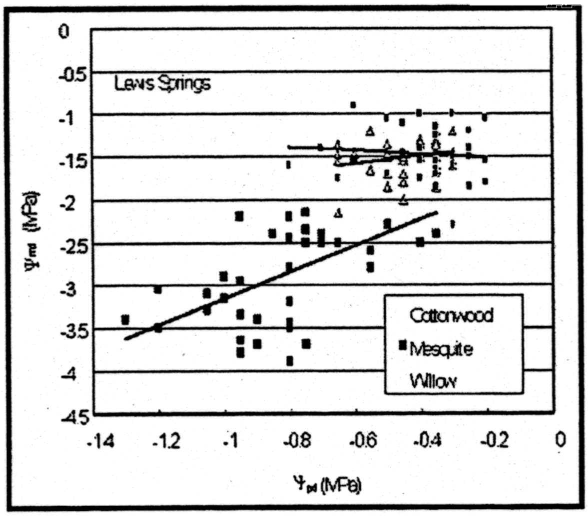

Figure 3. *Relationship between predawn (Ψ_{pd}) vs. midday (Ψ_{md}) water potential throughout the entire growing season of cottonwood, willow, and mesquite sampled at a perennial reach (Lewis Springs) of the San Pedro River.*

5. Conclusions

Site hydrology has an influence on the functional architecture of riparian tree root systems; not all sources of available water are used equally. Water usage depends on the species present and the hydrologic conditions. Stable isotopic analysis identifies plant water uptake from various hydrologic compartments. The complex and highly plastic behavior of mesquite must be considered in relation to water availability. Similarly, even obligate phreatophytes may exhibit flexibility in water sources at ecotones where the conditions for their survival are marginal. Our data indicate that obligate phreatophytes regulate critical water potentials in a different manner than the more drought tolerant mesquite. Patterns of stomatal regulation coupled with water source investigations could prove to be useful for determining plant functional types (Williams et al., this issue). Reliance on a single water source, while other sources of water are available may be indicative of plants that are extremely vulnerable to cavitation and exhibit more stomatal regulation of transpiration. If these water-use relationships are determined for a variety of functional types then it may be possible to scale up functional type relationships to characterize processes controlling transpiration at ecosystem or basin scales. One critical parameter may be the regulation of stomata to near critical cavitation levels.

Cottonwood and willow appear to rely on groundwater until irreversible cavitation levels are reached. Their tolerance of low water potentials is substantially less than that of mesquite, and they must maintain a high degree of transpiration regulation. These data provide further evidence that declining water tables will have a disproportionate effect on the sustainability of obligate riparian trees, such as cottonwood and willow, which are critically tied to groundwater levels.

6. Acknowledgments

Financial support from the USDA-ARS Global Change Research Program, NASA grant W-18,997 and USDA National Research Initiative Grant Program is gratefully acknowledged.

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Williams, D. G., J. P. Brunel, S. M. Schaeffer and K. S. Snyder, Biotic controls over the functioning of desert riparian ecosystems.

Arizona Water Protection Fund Launches Web Site!!!

The Arizona Water Protection Fund (AWPF) is in the final stages of constructing its Web site with the assistance of the Water Resources Research Center staff in Tucson. The Web site is designed to be a source of information for past and perspective grant applicants, other agencies, legislators, and the general public.

Established by the Legislature in 1994, the purpose of the AWPF is to provide monies "for the development and implementation of measures to protect water of sufficient quality and quantity to maintain, enhance and restore rivers and streams and associated riparian resources." The Legislature also created the AWPF Commission to administer the fund and is composed of 15 voting members and 4 non-voting ex-officio members.

The Web site will provide interested parties the opportunity to access the following information:

- common questions and answers (with links to the enabling legislation);
- past Commission meeting minutes;
- past AWPF newsletters;
- staff contacts;
- commissioner information; and
- a multi-media searchable database.

The searchable database allows viewers to access information on current and previous AWPF projects including: dollar amount awarded, project summary and contact person, map of project area, photos and status.

Interested parties will also be able to e-mail the Commission directly through the Web site to receive further information, or make comments.

This spring, the 1998 application forms will be available on the Web Site for use by potential applicants. For those interested, the AWPF address will be:

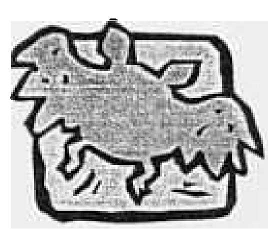
www.awpf.state.az.us

and the Web site should be accessible to the public around January 1, 1998. If you have any further questions, please contact Lisa Jackson at (602) 417-2448.

FALL CAMPOUT AND GET TOGETHER

The weekend campout for the Arizona Riparian Council this past October 18-19, 1997 was well attended and enjoyed by all. We camped at the Tonto National Forest, Cave Creek Ranger District, Ashdale Administrative Site.

Dr. Robert Smith and Jon Hokstra, graduate student, University of Arizona, gave us a presentation about crayfish and their distribution in the state. If anyone has information on locations of crayfish throughout the state please contact him at bobsmith@ag.arizona.edu. The boys from the Webelos Scouts who attended the campout had a great time catching specimens for them! After that informative talk, everyone went streamside to Cave Creek to see how riparian stream assessments were conducted. Janet Johnson and Lynn Mason from the Tonto National Forest showed how they assessed streams using the Tonto National Forest Riparian Area and Stream Channel Inventory and Assessment Methods which include Rosgen's Classification, Pfankuch Streambank Stability Rating, pebble counts, and the Bureau of Land Management's Proper Functioning Condition Assessment. Their assessment of Cave Creek was "impaired" or "functioning at risk." Dr. Robert Ohmart, Arizona State University, also talked to the group streamside and generally agreed with the assessment of the stream made by Janet and Lynn. He also told us about the Rapid Assessment of Riparian Systems (RARS) that is being worked on at ASU for the Arizona Game and Fish Department.



The rest of the afternoon was spent relaxing, bird watching, hiking, and overall just enjoying the surroundings. An excellent meal was produced by Buckaroo BBQ and it was enjoyed by all.

After dinner, Tim Snow, Bill Burger, and Marikay Ramsey from Arizona Game and Fish Department set up mist nets to catch bats over the stream. They had an echolocation device which could detect the bats and visually display their calls on a laptop computer screen. It was really quite fascinating and interesting. As the evening progressed they monitored bat activity for some time while some people gathered around the campfire and visited. Finally, around 9 PM they caught a juvenile female hoary bat, which Tim said was a rare find!

Saturday morning we split into two groups and enjoyed fields trips led by Janet Johnson and Lynn Mason to an exclosure along Camp Creek and by Scott Woods to the Sears Kay ruins.

year and shall be eligible for re-election.

Vice President. The Vice President shall assist the President in duties where needed. In the absence of the President, or in the event of the inability of the President to act, the President's duties shall be assumed by the Vice President. The Vice President shall serve in office for one year and shall be eligible for re-election.

Treasurer. The Treasurer shall serve as general business manager. The Treasurer shall be responsible for coordinating with the Secretary upon receipt of funds and shall disburse all funds of the Council. A report concerning all activities of the preceding year, and an auditing of accounts for that year shall be made by the Treasurer to the Council at its Annual Meeting, and at any time requested by the President. In the event neither the President, the Vice President, nor the Secretary can serve in their capacity, the Treasurer will serve pro-tempore. The Treasurer shall serve in office for three years and shall be eligible for re-election. (The individual elected for this position will complete Howard 's term of office with two years left.)

Member-at-Large. At-large members of the Council shall be elected to the Board of Directors by the majority vote of members at the Council's Annual Meeting. The at-large members shall assist the officers with their duties when necessary (completion of Pat's term of one remaining year).

If you are a current member and are interested in any of these offices, please contact Jeff Inwood at (602) 263-9522.

Howard Kopp was elected Treasurer last year, but resigned last fall due to other commitments. The Treasurer acts as the business manager for this organization. We desperately need to fill this vacancy with someone who is willing to oversee our finances. Another important responsibility of the position is arranging facilities, with the Secretary, for the spring and fall meetings. You do not need to be an accountant and it does not take a large commitment of time. It just takes a willingness to work with the group.

ARIZONA WATER PROTECTION FUND APPROVED GRANT APPLICATIONS - 1997 FUNDING CYCLE

Project Name	Applicant	Funding Amount
Bingham Cienega Riparian Restoration Project	Pima County Flood Control District	$83,179.00
Watershed Improvement to Restore Riparian and Aquatic Habitat on the Muleshoe Ranch	The Nature Conservancy	$126,315.00
Atturbury Wash Project	City of Tucson Water Dept.	$154,580.00
Altar Valley Watershed Resource Assessment	Altar Valley Conservation Alliance & Pima NRCD	$88,730.00
Ahakhav Tribal Preserve - Deer Island Revegetation	Colorado River Indian Tribes	$228,800.00
Walnut Creek Center for Education and Research-Biological Inventory	Yavapai Community College	$69,100.00
Demonstration Enhancement of Riparian Zone and Stream Channel along a Stretch of Pueblo Colorado Wash at Hubbell Trading Post National Historic Site	National Park Service	$91,110.00

APWF Table.....Cont. page 14

SPECIES PROFILE

THE USE OF XERORIPARIAN SYSTEMS BY DESERT MULE DEER

by Paul R. Krausman, The University of Arizona

Desert mule deer (*Odocoileus hemionus crooki*) inhabit the Sonoran and Chihuahuan deserts of North American; their range extends from southwest Texas to western Arizona and south into central Mexico. These desert mule deer are an important game animal with increasing popularity in Mexico. Although they are one of the dominant large mammals in southwestern deserts, they have not received much attention from the scientific community. Behavior, general ecology, diet, movements, and habitat have been examined in isolated areas and habitat studies have been general. Few studies have examined habitat of desert mule deer across their range and little is known of their dependence on riparian areas. However, biologists that have examined desert deer report that riparian areas are an important part of desert mule deer habitat.

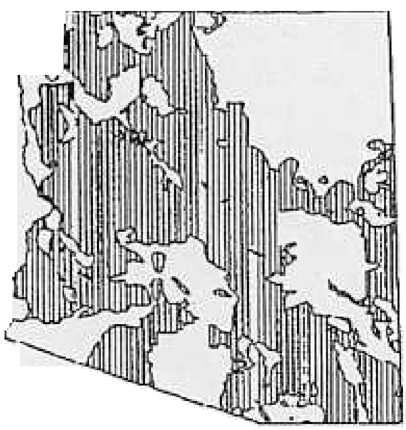


Fig. 1. Mule deer distribution in Arizona (Arizona Game and Fish Department Website, January 1998. http://www.gf.state.az.us/frames/fishwild/idx_game.htm)

Across their range from Big Bend National Park, Texas, in the east through Avra Valley near Tucson, Arizona, to the northwestern edge of their range in King Valley, Arizona, desert mule deer use riparian areas. In the King Valley most plant life is restricted to xeroriparian drainages. The areas between drainages are usually covered with wind-eroded desert pavement and have no vegetation or very sparse stands of creosote bush (*Larrea tridentata*), brittlebush (*Encelia farinosa*), and white bursage (*Ambrosia dumosa*). Dominant overstory species in the washes include plants that serve as forage and thermal cover, an important habitat component, especially during hot wet and hot dry seasons. The average width of washes in mule deer habitat ranges from 3.8 to 25.0 m, depending on the plant association and the type of wash. In general, wash systems in lower plant density associations are wider than those with high plant density associations. The largest washes used by desert mule deer are over 350 m wide.

At the eastern edge of their range the vegetation within wash systems is not similar to perennial species composition of adjacent areas and species overlap between the two areas is minimal. However, plant species diversity is greater in washes than in adjacent areas. Deer using plant associations with low plant densities probably find more forage in washes than in adjacent areas.

On the western edge of their range there is a marked difference between vegetation in washes and vegetation in areas adjacent to or between washes. There are less than two plants per 100 m^2 and these areas provide very little forage for deer and no shaded bedsites. Also, most preferred forage species are uncommon or not found outside of the washes.

These vegetation characteristics are important to deer. Where wash vegetation is more abundant (e.g., eastern part of range) deer use washes or are immediately adjacent to washes (i.e., within 30 m) 9% of the time. As temperatures increase and rainfall decreases moving westward, vegetation recedes to washes followed by desert deer. In central Arizona deer use washes 42% of the time in winter, increasing to 83% in the summer. In the arid and hot King Valley, desert mule deer used washes 99% of the time! Deer in these areas are using washes as they provide forage, cover, travel lanes, and birth sites.

Xeroriparian systems are an important part of desert mule deer habitat; in arid ranges that cannot be overlooked. Unfortunately, competition for deserts by mining companies, livestock operators, offroad vehicles, housing developers, and numerous other human activities often look at desert mule deer habitat as "unproductive" because animal abundance is not evident. Xeroriparian systems provide habitat for an array of wildlife of which desert mule deer are the largest (native). Conservation efforts have to ensure these important habitat components are not modified so they are no longer available to wildlife.

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deer use washes or are immediately adjacent to washes (i.e., within 30 m) 9% of the time. As temperatures increase and rainfall decreases moving westward, vegetation recedes to washes followed by desert deer. In central Arizona deer use washes 42% of the time in winter, increasing to 83% in the summer. In the arid and hot King Valley, desert mule deer used washes 99% of the time! Deer in these areas are using washes as they provide forage, cover, travel lanes, and birth sites.

Xeroriparian systems are an important part of desert mule deer habitat; in arid ranges that cannot be overlooked. Unfortunately, competition for deserts by mining companies, livestock operators, offroad vehicles, housing developers, and numerous other human activities often look at desert mule deer habitat as "unproductive" because animal abundance is not evident. Xeroriparian systems provide habitat for an array of wildlife of which desert mule deer are the largest (native). Conservation efforts have to ensure these important habitat components are not modified so they are no longer available to wildlife.

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LEGAL ISSUES OF CONCERN

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FLEXING THE MUSCLE OF CLEAN WATER ACT §401

The Clean Water Act (CWA) is 25 years old, but some of its muscle has not been flexed. Programs for controlling point source pollution are maturing, but water pollution is not yet a thing of the past. Naturally, attention is turning to nonpoint sources of pollution. Much like a circuit weight trainee moves from machine to machine to develop muscle mass, regulators and environmentalists are combing the Clean Water Act looking for ways to bulk up the measures that could reduce nonpoint pollution. The muscle mass of one provision, commonly known as §401, which requires states to certify that a permitted discharge will meet the surface water quality standards, is being flexed in new ways that may directly effect riparian areas.

Traditionally, states have issued certifications under CWA §401 for NPDES permits issued by EPA and Dredge and Fill (§404) permits issued by the U.S. Army Corps of Engineers. 33 U.S.C.A. §1341, 1342, 1344. The certification reflects the state's conclusion that the terms of the Federal permit, or any conditions the state attaches to the permit, will protect the quality of the water impacted by the permitted discharge. Through this authority the state can delay or even block the issuance of a permit until conditions are added to meet the state's concerns:

> *Any applicant for a Federal license or permit to conduct any activity..., which may result in any discharge into the navigable waters, shall provide...a certification from the State...that any such discharge will comply with applicable sections of [effluent limitations, water quality standards, performance standards and pretreatment standards].*

Federal Water Pollution Control Act §401, 33 U.S.C.A. §1341.

As state §401 certification processes have become more sophisticated over the years, so too have the controversies. For example, here in Arizona the Arizona Rock Products Association (ARPA) lobbied the 1996 Legislature to limit the role of the Arizona Department of Environmental Quality (ADEQ), the issuing agency for § 401. The new law defines the procedure for reviewing certification requests, sets strict time frames that must be followed until January 1, 1999 for processing the requests, and limits the state's authority to reviewing only those activities conducted within the navigable water. A.R.S.§ 49-202. ADEQ's failure to meet the time frame constitutes an automatic waiver of the state's right to issue the certification. A.R.S. §49-202.E. and F. After January 1, 1999, failure to act at all will trigger the waiver. *Id.* at F.

The ARPA legislation was a reaction to what it perceived as unnecessary delays and inefficiencies in the ADEQ process. But it was also in part a reaction to the first case that really tested the breadth of the §401 power. In 1994, the United States Supreme Court upheld the a state condition requiring minimum instream flows in a Federal Energy Regulatory Commission (FERC) license for a hydroelectric power plant near Olympic National Park in Washington. *PUD No.1 of Jefferson County v. Washington Department of Ecology,* 511 U.S. 700, 114 S. Ct. 1900, 128 L.Ed.2d 716 (1994). Although FERC argued that the CWA did not regulate water quantity, the Court held that minimum instream flows were required to meet "antidegradation" requirements which are a fundamental facet of water quality standards. Failing to maintain a viable salmon habitat in the Dosewallips River, the court ruled, would constitute a degradation of the water quality. *Id.*, citing FWPCA §303, 33 U.S.C.A. §1313(d)(4)(B) and 40 C.F.R. §131.12 (1992).

The second expansion of §401 also came out of the Pacific Northwest. Oregon environmental groups brought suit against the U.S. Forest Service for a declaratory judgment that issuing a grazing permit without a §401 certification was a CWA violation. The U.S. District Court in Oregon agreed and held that the definition of "discharge" was not limited to point sources, but could take in nonpoint sources as well. *Oregon Natural Desert Association v. Thomas* 940 F. Supp. 1534 (1996).

News travels fast and in Arizona the reaction to the Oregon decision was swift. The 1997 legislature added two new sections to the water quality statute which create an advisory committee charged with developing best management practices (BMP's) for grazing. ADEQ must adopt the committee's recommendations as a general permit in rule within 180 days of receiving them. Further, §401 certification for federally permitted grazing activities that meet the BMP's must be built right into the rule. A.R.S. §§49-202.01 and .02. In the meanwhile, ADEQ must grant §401 certification

> *for a grazing activity... conducted in accordance with any current voluntary state best management practices or any applicable best management practices established by the federal land management agency having jurisdiction over the land upon which the activity is occurring.*
> A.R.S. §49-202.01.F.

Somewhat like a personal trainer, the legislature is keeping a close eye on local exercise of these national §401 developments. The strength of Arizona's role in federal grazing permits could be akin to either a 180 pound weakling or a world record weightlifter, depending upon how the advisory committee recommendations come out. The evolution of the §401 certification program is definitely a program worth watching for those with concerns about the impact of grazing and other federally permitted activities on riparian areas.

AWPF Table.......Cont. from page 10

Project Name	Applicant	Funding Amount
Lyle Canyon Allotment Riparian Area Restoration Project	Steve Lindsey	$55,476.33
Talastima (Blue Canyon) Watershed Restoration Project	Hopi Tribe	$310,192.00
San Pedro River Preserve Riparian Habitat Restoration Project	The Nature Conservancy	$322,477.00
Santa Cruz Headwaters Project	Bobby Sharp	$100,445.00
Queen Creek Restoration & Management Plan	City of Superior	$209,004.00
Stable Isotopes as Tracers of Water Quality Constituents in the Upper Gila River	Arizona Geological Survey	$26,256.00
Tres Rios Wetlands Heavy-Metal Bioavailability and Denitrification Investigation	City of Phoenix	$117,728.00
Proctor Vegetation Modification	Coronado National Forest	$10,487.00
Creation of a Reference Riparian Area in the Gila Valley	Mt. Graham International Science and Culture Foundation, Inc.	$182,000.00
City of Surprise Pilot CAP Water Recharge Project	City of Surprise	$176,950.00
Oak Tree Gully Stabilization	Coronado National Forest	$35,265.00
Pasqua Yaqui Nation Nature Preserve	Pasqua Yaqui Nation	$95,383.80

The Arizona Riparian Council (ARC) was formed in 1986 as a result of the increasing concern over the alarming rate of loss of Arizona's riparian areas. It is estimated that < 10% of Arizona's original riparian acreage remains in its natural form. These habitats are considered Arizona's most rare natural communities.

The purpose of the Council is to provide for the exchange of information on the status protection, and management of riparian systems in Arizona. The term "riparian" is intended to include vegetation, habitats, or ecosystems that are associated with bodies of water (streams or lakes) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. Any person or organization interested in the management, protection, or scientific study of riparian systems, or some related phase of riparian conservation is eligible for membership. Annual dues (January-December) are $15. Additional contributions are gratefully accepted.

This newsletter is published three times a year to communicate current events, issues, problems, and progress involving riparian systems, to inform members about Council business, and to provide a forum for you to express your views or news about riparian topics. The next issue will be mailed in May with the deadline for submittal of articles April 15, 1998. Please call or write with suggestions, publications for review, announcements, articles, and/ or illustrations.

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CALENDAR

Sharing Our Precious Resources: Assuring an Adequate Supply of Clean Water for the Next 100 Years Through Conservation, Protection, & Use Planning, Environmental Concerns Coalition, on March 28, 1998 in at the Mesa Community and Conference Center, Mesa, Arizona. Contact the League of Women Voters at 520-282-4935 for more information.

Changes Around the Bend: The Lower Colorado River, Arizona Riparian Council Fall 12th Annual Meeting, April 17-18, 1998, Shilo Inn, Yuma, AZ. For further information, Contact Cindy Zisner at (602) 965-2490 or email Cindy.Zisner@asu.edu.

Challenge '98: A Working Symposium on Reducing the Impacts of Urbanization on Southwestern Wetland and Riparian Resources, New Mexico Riparian Council, April 16-18, 1998, University of New Mexico, Continuing Education Center. Contact Janelle Harden, Symposium Coordinator, 505-256-7607 or email jharden@nmia.com.

Invasive Exotic Species in Sonoran Desert Ecosystems, Arizona-Sonora Desert Museum, May 2-3, 1998 at the Museum in Tucson, Arizona. For information contact Barbara Yates at (520) 883-3220.

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