Arizona Riparian Council

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THE FALL AND RISE OF THE GREAT ECOSYSTEM ENGINEER

by Roger Joos, USDA Wildlife Services

Two species of beaver currently inhabit the world: the Eurasian beaver (*Castor fiber*) and the very similar North American beaver (*C. canadensis*). The Eurasian beaver ranges through much of Europe and Northern Asia. The North American beaver occurs from coast to coast and ranges from Alaska, Hudson Bay and northern Labrador south to the U.S.-Mexico border, Gulf coast, and northern Florida.

Oftentimes called "ecosystem engineers" or "wetland engineers," dam building beavers can dramatically alter stream community structure and ecosystem functioning. The stored water behind dams is important for many plants and animals, especially during droughts. Dams alter flow regimes which can reduce erosion and trap sediments, stabilize banks, raise water tables, trap phosphorus and nitrogen in sediments, and favor growth of willow and other riparian plants. As beavers open up the forests along streams, they create different habitats such as ponds, swamps, and meadows. The new habitat is inviting to numerous plants and animals and consequently increases species richness at a landscape scale (Wright et al. 2002).

Beavers first affect plants by flooding. Small plants will die and flooded trees usually die within a year. This action along with the cutting down of select trees around the pond will create favorable conditions for other species.

Aquatic insects and other invertebrates are greatly affected by beaver ponds. Species that typically dwell in gravel such as stonefly larvae, become less numerous and are replaced by silt-dwelling species such as mayfly and dragonfly larvae. A study in Canada showed that beaver lodges with their decaying wood added greatly to the animal abundance of otherwise mostly barren shoreline of sand and rock. Fourteen taxa occurred primarily within 8-10 m of beaver lodges compared to seven in areas without lodges (Muller-Schwarze and Sun 2003). But not all species benefit, some insects such as mosquitoes actually decline in numbers around beaver ponds.

Fish species usually benefit greatly from beaver activity but some are not so lucky. For example, beaver ponds in the Midwest can become too warm for trout, but when conditions are not favorable for them upstream, such as during droughts, many of them head for the ponds. Dams can also impede the upstream movement of anadromous fish when water flow is below normal.

Aquatic reptiles and amphibians are all attracted to beaver ponds for one reason or another. The red-spotted newt (*Notophthalmus viridescens viridescens*) of eastern North America have adapted to pond habitats that rapidly shift in space and time, likely because of beaver pond dynamics. Many species of frogs and turtles rely on ponds for reproduction and in many cases live their entire lives in ponds. In the desert Southwest toads typically rely on summer rain storms for reproduction but will certainly take advantage of available water before the rains come. Historically, beaver ponds may have been an important survival strategy for desert toads, especially in years of below average rainfall.

It also has been well documented that beaver ponds attract and support numerous species of

(Cont. pg. 3 .... Engineer)

Inside This Issue

PRESIDENT'S MESSAGE

Wow! What a great Spring Meeting! It's about a month since since our 20th Anniversary Celebration at the Museum of Northern Arizona in Flagstaff. It was three days of intense interaction, training, presentations on riparian science, reflection on our past and visioning for the future. Oh, and we had a good time too. Our Friday evening social at the Colton House was the highlight of the event for many, with the ambiance of historic upscale Flagstaff, and killer food! Not only did we leave Flagstaff with a pleasant extra pound or two under our belts, but most of us emerged re-energized to the enterprise of riparian protection, enhancement and advocacy.

Whoops, there's that word, advocacy. There was considerable discussion of that word at the meeting and the appropriate place for it in the role of the Arizona Riparian Council. The ARC board has had similar discussions of just what our role was with respect to "advocacy." While the ARC Constitution states that 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 point was made that we do not do this without having made a value judgment. The very existence of our organization owes to the judgment that we value riparian systems for all of the various benefits they provide. These range from hard economic considerations such as the benefits to water quality and availability, to the more esoteric benefits of beauty and peace for the soul.

Our visioning sessions during the Spring Meeting kept returning to a few key challenges: the connection between groundwater and surface water; the continued need to hold land management agencies to appropriate riparian grazing practices; and various aspects of increased human growth. While each challenge has it own unique type of impact, it seems to me that all of them inherently return to the theme of competition for a limited resource, free-flowing water. As we look forward to the next 20 years of the Arizona Riparian Council, this seems to me to be the critical fundamental challenge, to preserve free-flowing water in our watercourses. It will require us to use advocacy, at an appropriate and measured level, to share the values we hold dear with a public that sometimes just doesn't get it. Because the future depends on choices we make today, the Arizona Riparian Council must be an advocate for those choices that will help ensure the future of healthy vibrant riparian systems in Arizona. We don't need to be shrill, we don't need to be in-your-face, we must just clearly communicate that choices are being made, and that some choices lead to a sterile and decadent future for Southwest riparian systems, and others hold the promise of preserved and enhanced riparian systems and all that implies. Help us with this communications effort. Many of you attending the meeting indicated you would be willing. Let's hear from some of the rest of you also and move this process for preserving our riparian areas forward another notch! Thanks in advance…

I can't let this column go by without extending my thanks to our outgoing and incoming officers! Theresa Pinto is leaving our Board, vacating the Treasurer's position, but she has already indicated she will keep helping our efforts, just in a different capacity. Thanks so much Theresa for 6 (yes 6!) years of service as Treasurer.

Then there is Cindy… What more can be said about our continuing Secretary after her re-election? She's done it all for us and just keeps coming back for more. Cindy has even filled in as Vice President for most of the last year after Margie Latta moved out of state. Welcome back Cindy!

We also want to welcome three new members to our team. Roger Joos was elected Vice President, Cory Helton was elected the new Treasurer, and Ron Van Ommeren was elected to the vacant At-Large seat on the Board. Roger will serve a two-year term and Ron a one-year term, having been elected to fill the remaining time for terms vacated by others. Cory will serve a normal three-year term. Please welcome them to the Board as you have a chance!

Finally, just a word about what's coming up. Your Board has resolved to capture the momentum generated at our meeting in April. We will be planning field trips and activities, speakers and get togethers, and developing links with other organizations that have complementary interests. We are working with the Climatology workgroup of the Cooperative Extension unit at the University of Arizona to put together a Climate Change and Riparian Habitats workshop for next spring which will double as our 21st Annual Meeting. As always, we appreciate any suggestions for how we can make the Arizona Riparian Council more relevant and worthwhile. With these additional efforts comes an additional workload however, so please offer both your ideas and your help! Thanks to you all in the membership for your encouragement and continuing efforts.

Tom Hildebrandt, President

(Engineer . . . . Cont. from pg. 1)

birds. Researchers in south-central New York found that birds such as the Wood Duck (*Aix sponsa)*, Hooded Merganser (*Lophodytes cucullatus)*, Great Blue Herons (*Ardea herodias*), Pileated Woodpeckers *(Dryocopus pileatus*), Belted Kingfishers (*Ceryle alcyon*), accipiters, Ospreys (*Pandion haliaetus*), swallows, and Red-breasted Nuthatches *(Sitta canadensis*) all find beaver ponds more attractive than wetlands with no recent record of beaver activity.

The explosive evolution of rodents began about 55 million years ago, and has since produced a number of morphological variations of beavers or beaver like creatures. Enough fossils exist to paint a good picture of the modern beaver's ancestry. The smallest extinct beavers were about the size of a muskrat, and the largest was the size of a black bear (Muller-Schwarze and Sun 2003). Both species of modern beaver coexisted with the giant form until about 10,000 years ago. The giant beaver, along with many other large terrestrial mammals, went extinct in the late Pleistocene. The new environmental conditions created by the extinctions enabled modern beaver to increase their numbers and expand their geographical range.

It was in fact the beaver's large geographic range that helped pave the way for European settlement in North America. In the 1600s the European fur trade was established in North America due to severely depleted resources in Europe. From the mid 1600s to the late 1850s the fur trade essentially drew the maps of the North America.

The fur traders started trapping in the northeastern U.S. eventually expanding south and west as they depleted resources. The trapping expeditions did not reach the desert Southwest until the early 1820s. Earlier attempts to enter the region were thwarted by Apache and Spaniard opposition. Over the next few years many expeditions came through Arizona and New Mexico trapping all major rivers. It was not these trapping expeditions, however, that caused the decline of the southwestern beaver. By the 1860s, beaver numbers in the Southwest had nearly recovered back to the estimated tens of thousands that occurred before the trapping began.

Settlement of the Southwest began to accelerate in the 1870s. By 1912, Arizona had seen the construction of its first major dam on the Salt River, the importation of millions of cattle, and millions of hectares of desert land converted to agricultural use. These, along with the continued beaver trapping and additional river damming led to the current estimate of 5,000 beavers statewide.

The giant beaver in comparison to today's beaver.

By the end of the 19th century, beaver populations had been extirpated in many parts of the U.S. and Canada. Several states and some Canadian provinces took protective measures and prohibited any further trapping. In the early to mid-1900s many states including Massachusetts, South Carolina, and New York embarked on what would be successful reintroduction programs. Many of these reintroductions were simply meant to return beavers to their former range; range that had not been severely degraded. But the idea of using beavers as an agent of ecological restoration was not taken seriously until the 1970s.

If beavers could be returned to suitable stretches of degraded streams might they be able to help restore the area by impounding water and raising the water table? In 1977 exactly that happened. Beavers moved into a degraded area of Horse Creek in southwestern Wyoming and built dams of sagebrush (*Artemisia* spp.) and rabbitbrush (*Chrysothamnus nauseosus*) due to lack of woody material. Each spring the dams washed out. Bureau of Land Management personnel conceived the idea of supplying the beavers with aspen (*Populus tremuloides*) branches. The beavers immediately went to work and incorporated the aspen branches into their dams. The dams were not only strong enough to reduce the number of washouts, but helped to stabilize the stream banks.

This success led to a second phase of restoration which actually involved translocating beavers, along with a supply of aspen branches, to other degraded streams in the area. Three years later the water table on Currant Creek had been raised by 1 m and willows (*Salix* spp.) had begun to recolonize. Sediment load testing showed that the stretches of

Currant Creek with beaver dams carried 90% less sediment than areas without dams (Muller-Schwarze and Sun 2003).

Similar projects have been undertaken in Utah (Echo Creek), Montana (Howard Creek), Idaho (Cooper Creek), Arizona (San Pedro River), and New Mexico all with similar success. Between 1985 and 1999 folks on the Zuni Indian Reservation in New Mexico released beavers into seven degraded watersheds throughout the reservation. Within one to two weeks of releases, dams were completed which slowed the flow of water decreasing the sediment load and spreading water over a larger area raising the water table. Soon vegetation returned and wildlife from deer, elk, fish, amphibians, and the federally listed Southwestern Willow Flycatcher (*Empidonax traillii extimus*) began to use the recovering areas (Albert and Trimble 2000).

Not only does wildlife benefit, but municipalities and farmers also benefit from the increased water storage. Using beavers to help restore degraded stream is not only cost effective, but the systems can become self supporting after a few years. Wetlands are the cradles of life, where biological diversity can rival that of tropical rain forests. Half of North America's threatened and endangered species rely on wetlands or riparian systems. It is time we increase our partnership with nature's inexpensive engineers to bring back some of America's wetlands.

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NEW RULE SHOULD PROTECT STREAMS

Julia Fonseca, Pima County Regional Flood Control District

Arizona's streams are increasingly damaged by overuse of groundwater. Although state laws were created in 1919 to protect the interests of those who used flow from streams, state government has not prevented groundwater pumpers from diminishing the flows of rivers. In southern Arizona, excessive groundwater use has led to the elimination of perennial streams, wholesale destruction of communities dependent on streamflow, and a number of lawsuits.

In 1980, state statutes were passed (ARS 45-598A) requiring the Director of the state water agency, Arizona Department of Water Resources (ADWR) to adopt rules "governing the location of new wells and replacement wells in new locations in active management areas to prevent unreasonably increasing damage to ***surrounding land or other water users*** from the concentration of wells" (emphasis added).

In 1983, ADWR adopted temporary rules for the installation of new wells that in essence defined unreasonable damage as a well which causes greater than 25 feet of drawdown over a five-year period. This rule failed to protect surface water users because even an aquifer drawdown of a foot or two can result in a stream going dry. The rate-based criterion has also failed to protect existing wells from going dry. This temporary rule has been in place now for 23 years.

Now, ADWR is developing a permanent rule to govern the spacing and allowable impacts of new wells in active management areas. My agency, working with University of Arizona law professor Robert Glennon, has urged ADWR to adopt rules that protect users who hold surface water rights, and that consider damage to land caused by depletion of stream flow. We think that the rules should protect the benefits shallow water tables provide. This would include instream flow water rights as well as the rights of those who divert streamflow or pump groundwater under surface water law. In addition, we believe that ADWR should consider the damage done to the land when shallow water tables are depleted. These effects have included massive die-offs of riparian vegetation, fires, decreased property values, and sinkholes.

ADWR has responded that it lacks legal authority to address the concerns we have about surface water, and has ignored our concerns about land damage. Salt River Project has recently expressed their opinion about ADWR's continued unwillingness to deal with the issue of groundwater pumpers who are taking away water that has already been appropriated under surface water law. The time is long overdue for ADWR to live up to the state statutes and protect the land and other water users.

This issue will be considered by the Governor's Regulatory Review Council in June 2006.)

MEMBERSHIP SURVEY RESULTS

by Tim Flood

In recognition of the 20th ARC Anniversary, the Board authorized a survey of members to document past riparian successes and future challenges. First, the Board nominated many successful actions and riparian tools, and challenges and threats. From this list the Board then selected the top nine for the two categories. These lists were sent to the membership for ranking, with a "9" being the most important of the top nine and a "1" being least important. Participants were also asked to add additional items to the list of successes and challenges, although these would not be ranked. The survey was sent to the ARC listserve in spring 2006. Twenty-eight individuals completed the online survey and submitted valid responses. Responses were analyzed by calculating the mean rank scores.

PAST SUCCESSFUL ACTIONS OR TOOLS

ARC members identified "reduced riparian grazing" as the most important action or tool that has advanced the protection of riparian areas in Arizona. This item was followed closely by "endangered species listings" (Table 1).

Other successes added by participants included: In-stream flow appropriations rights; Heritage Fund, including acquisition and habitat evaluation and protection; Increased interactions of state, counties, stakeholders, and communities; Growing Smarter planning by local governments, including water element; establishment of riparian restoration and fluvial geomorphologists as a profession; and public awareness of restoration like Rio Salado.

Table 1. Actions or tools that advanced riparian protection.

Action or Tool	Mean score
Reduced riparian grazing	6.86
Endangered Species listing	6.57
Clean Water Act: Sec. 404 regulations	5.46
Water Protection Fund	5.04
Nonstructural approach to flood control	4.93
Funding riparian researchers	4.79
Restored Fossil Creek flows	3.86
Groundwater Management Act of 1980	3.93
ARC public education programs	3.32

CHALLENGES AND THREATS

Respondents were asked to "rank the challenges and threats we face in protecting riparian areas in Arizona." The leading challenges identified by respondents were urban sprawl, the ground/surface water connection, and demands of rural areas for water (Table 2).

Other threats suggested by participants were grazing, private wells, climate change (not drought), dam operations, fire and recreation, population growth, intergovernmental conflicts, and policymaker and legal issues.

Table 2. Challenges and threats we face in protecting riparian areas in Arizona.

Challenge or Threat	Mean Score
Urban sprawl	6.74
Ground/surface water connection	6.67
Rural area water demand	6.30
Weakening regulations	5.74
In-stream flow protection	5.63

COMMENT

Responders to the survey identified reduced riparian grazing and endangered species listings as the most important tools and actions over the past 20 years that have protected Arizona's riparian areas. This is helpful information because several federal agencies are developing land management plans that may impact riparian areas. The ARC can convey to the agencies that our members recognize the importance of reduced grazing in protecting riparian areas. Similarly, Congress is considering amending the Endangered Species Act. Our survey highlights the importance of this Act as a tool to protect riparian areas.

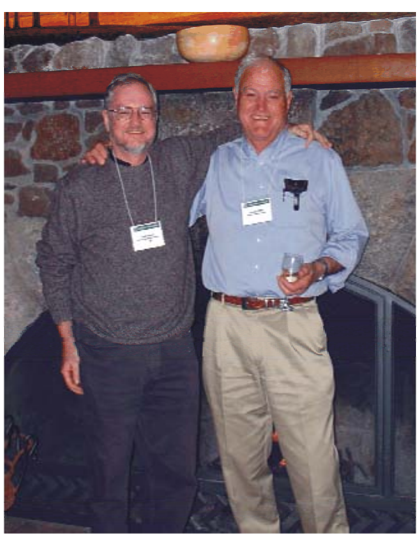
As we enter the ARC's 20th year, responders are most concerned about sprawl, the ground/surface water connection, and the water demands of rural areas. This information is helpful when speaking to urban planners and water managers. Responders also identified priorities and actions that ARC should take in the next three years. The Board is reviewing those suggestions and will ask our members for their help in addressing ther

2006 Spring Meeting, April 27-29

Cindy Zisner, Secretary

This year's annual meeting was a special one. The was the 20th time we have met to share our research and ideas about, not only Arizona's, but other riparian areas in the Southwest. The meeting was held at the Museum of Northern Arizona in Flagstaff. The meeting was held there because 20 years ago the first meeting was held at the Museum and we thought it appropriate to revisit. Not only did we hold the meeting at the Museum but we also invited our founding members, Duncan Patten and Chuck Hunter, to attend and address the membership. Duncan is currently Emeritus Professor from Arizona State University and a Research Professor at Montana State University. Chuck works with the Partners in Flight program of the U.S. Fish and Wildlife Service in Atlanta, Georgia. Kris Randall, former President of the Council, presented both Chuck and Duncan with plaques thanking them for their contributions and forming the Council.

Preceding the meeting we held a one-day classroom workshop on geomorphology that was conducted by Tom Moody, Natural Channel Design, Inc. Tom is an excellent teacher and made the course enjoyable and very understandable to those of us who were novices, as well as interesting to the professionals.



Chuck Hunter and Duncan Patten at the Colton House.

The plenary session on Friday started with Duncan and Chuck explaining why the Council was formed and they also offered challenges for our future. Tim Phillips from the Flood Control District of Maricopa County presented challenges that face an agency between conservation and society and reaching viable solutions. Andy Laurenzi from the Sonoran Institute talked about the nonprofit organization perspective of what has been done and what he foresees as future endeavors. Finally, Joe Feller, Professor of Law at Arizona State University, presented information on water law and how it's changed through the years. A panel discussion of these individuals provided a great discussion with the audience.

The afternoon session was technical papers and posters were presented at breaks. Afternoon presentations included: *Approaches to Address Riparian Issues in Arizona: The 1980s, 1990s, and the New Century* by William Werner; *History of Riparian Area Protection in Arizona* by Kris Randall; *The Southwestern Willow Flycatcher in Arizona: What We have Learned since the Early 1990s and the Outlook for the Future* by Susan Sferra; *Wild and Scenic Fossil Creek* by Jason Williams; *Using Wild and Scenic Rivers to Better Understand and Protect Riparian Areas in the American Southwest, a Case Study with Grand Canyon National Park* by Joel C. Barnes; *Bankfull Channel Dimensions and Watershed Size Influences on Potential Riparian Community Types in Arizona* by Dave Smith; *Projects to Enhance Arizona's Environment: An Examination of their Functions, Benefits and Water Requirements* by Kelly Mott Lacroix; *Genetic Diversity and Restoration Success* by Laura Hagenauer; *A New Design Mimicking Nature's Old Techniques* by Fred Phillips; *Riparian Restoration on Hopi Lands* by Sharon Masek Lopez; *A Point-Source Method of Estimating Evapotranspiration along the San Timoteo Riparian Corridor* by Chris Garrett, and *Where the Native Things are... Dead: Population Dynamics of Dominant Riparian Trees on the Colorado Plateau, Potential for Rapid Dominance Shifts during Drought, and the Effects of Exotic Species Removal on Native Cottonwoods* – Alicyn Gitlin. Abstracts can be read on the web site (http://azriparian.asu.edu/2006/Program20.pdf) and some of the presentations will be made available there as well.

Duncan Patten receiving plaque from Kris Randall.

Friday evening was spent at the beautiful Colton House where we had great food and conversations with one another. A docent from the Museum of Northern Arizona also gave us a presentation about the Colton House.

Saturday morning was field trips. Those who had attended the workshop went on a geomorphology trip and those who attended the meeting only visited the Flagstaff Arboretum to see their ongoing projects.

In conjunction with all of these events, Theresa Pinto stepped down as Treasurer and we presented her with a set of beautiful dragonfly candlesticks to remember us with. With that, I'd like to say thank you to all that were there. Duncan said some very kind words about me at the meeting and you all made it very special for me. Thank you all for attending and hope to see many of you throughout this and next year!

Tom Moody conducting workshop field trip exercise.

Back row, left to right: Tom Hildebrandt, President; Kris Randall, Protection and Enhancement Committee Cochair; Bill Werner, Protection and Enhancement Committee Cochair; and Diane Laush, Member-at-Large. Front row, left to right: Diana Stuart, Member-at-Large; Theresa Pinto, Outgoing Treasurer; Cindy Zisner, Secretary; and Tim Flood, Land Use Committee Chair.

SPECIES PROFILE

THE DRAGONFLY – ORDER ODONATA, GROUP ANISOPTERA

By Kathleen Tucker, AZTEC Engineering

Arizona Snaketail, Gray Sanddragon and Brimstone Clubtail all describe what we know as dragonflies. This subgroup of insect has distinct characteristics that distinguish it from other insect groups. Dragonflies have minute antennae, extremely large eyes, two pairs of transparent membranous veined wings, a long slender abdomen, an aquatic larval stage, and an extendible jaws underneath the head.

Dragonflies spend much of their life as an aquatic nymph. This phase of their life can be anywhere from 1 to 2 years up to 6 years. The nymph's abdomen contain gills which when expanded and contracted allows for short burst of underwater propulsion. They will molt from 6 to 15 times and have a voracious appetite during this phase. Emerging from the last molt is an adult that has functional wings. There is no intermediate pupal stage in the life cycle of a dragonfly.

A dragonfly's eyes cover most of their head and thus 80% of their brain is used for analyzing visual information. In addition to this feature, the extendible jaws and their strong wings for agile flight allow them to catch prey with one fatal bite. They are generalists and eat whatever suitable prey is abundant. This includes small insects such as flying ants, termites, gnats or mosquitoes. Their characteristics that allow them to catch prey also allow them to avoid being the preyed upon by birds, lizards, frogs, and spiders.

There is no courtship process with dragonflies. Copulation happens in flight with the male lifting the female in the air and while perched. It can take from a few seconds to 10 minutes. Their mating is at times violent with the male piercing the female in the eyes or abdomen and also biting the base of their wings. Interspe cific competition is so great that some male species will scoop out the sperm of the previous male before placing his own sperm. These species have a "scoop" at the tip of the abdomen for this purpose.

Brimstone clubtail. Used by permission of Dan Danforth.

Dragonflies will predominantly lay eggs in waters that lack pollutants. Thus it could be said that they are good indicators of good ecosystem quality. They are typically found at sites that have a variety of microhabitats. They are sensitive to pollution, acidity of water, amount and type of aquatic vegetation, temperature and whether the water is still or flowing. All of these affect the distribution of the larvae.

There are over 100 species that occur in the southwestern United States. They are very distinct and colorful creatures to be sought out.

Arizona snaketail. Used by permission of Dan Danforth.

REFERENCES

<http://www.azodes.com>. Accessed 4/30/06.

<http://www.ucmp.berkeley.edu/arthorpoda/uniramia/odonatoida.html>. Accessed 5/1/06.

NOTEWORTHY PUBLICATIONS

Elizabeth Ridgely, Tristar Engineering and Management, Inc.

Webb, R. H., and S. A. Leake. 2006. Ground-water surface-water interactions and long-term change in riverine riparian vegetation in the southwestern United States. *Journal of Hydrology* 320:302-323.

Riparian ecosystems function in stabilizing riverine environments, but riparian vegetation has changed throughout the Southwest, causing concern about losses of habitat and biodiversity. They are the ultimate expression of groundwater and surface-water interactions. The cause of reach-scale changes in riparian ecosystems is investigated.

Historically, few reaches in Arizona southern Utah, and eastern California below 1530 m had closed gallery forests of cottonwood (*Populus fremontii*) and willow (*Salix* spp.). Instead, many alluvial reaches that now have riparian gallery forests once had marshy grasslands and most bedrock canyons were barren. From the late 19th century to the present, repeat photography shows that all free-flowing river reaches in Utah and northern Arizona have had increases in riparian vegetation, especially the San Juan River. Types of riparian vegetation are discussed separately. However, when a reference to riparian vegetation is made, there is sometimes no distinction made between native vegetation and tamarisk (*Tamarix ramosissima*). The changes appear to be related to trapping of beavers (*Castor canadensis*) during the 19th century, downcutting of arroyos that drained alluvial aquifers between 1880 and 1910, frequent winter floods during the 20th century, an increased growing season requiring more use of water by agriculture, and stable groundwater levels. Reductions in riparian vegetation resulted from agricultural clearing, overuse of groundwater, flow diversion and impounding of water by reservoirs. Additionally, this occurs where high groundwater use lowers the water table below the rooting depth, where base flow is completely diverted, or both. The San Pedro and Santa Cruz Rivers are adjacent watersheds with documented water development and different changes in riparian vegetation.

The San Pedro River is effluent with a closed gallery forest of cottonwood flanked by mesquite (*Prosopis* spp.). Groundwater levels are high and fluctuate in response to recharge from floods. Colorado River pikeminnows (*Ptychocheilus lucius*) used to be abundant. Prolific beaver populations led to high water tables. Floodplains grew alkali sacaton (*Sporobolus airiodes*) with scattered woody vegetation.

In the 1870s floods began downcutting and a well-developed arroyo formed near the Gila River. The headcut was extended and widening ensued. In the 1930s there was a barren channel with no stable floodplains. After 1941 low floodplains developed. By the mid-1960s, flooding shifted to a fall and winter pattern. Woody vegetation increased in the canopy layer and dominated tamarisk as an understory.

Currently, groundwater levels remain high possibly attributable to agriculture. Groundwater development in and around Sierra Vista, Arizona, may pose a severe threat. In addition, mining operations in Mexico affect the overall aquifer system. However, a large increase in vegetation could, through evapotranspiration, reduce surface flows.

The Santa Cruz River was a discontinuous ephemeral stream in the 1830s with effluent-influent reaches of dense riparian vegetation. Historically, there was an open gallery forest of cottonwood trees with a mesquite bosque along the floodplain. In 1878 a downcut began into its floodplain near Tucson. Widening and substantial erosion happened between 1878 and 1891. In the 1930s a continuously incised channel formed from Tucson to the headwaters. Groundwater development in the 1950s resulted in a lowering of the water table, and the riparian vegetation and mesquite bosques were eliminated by the 1970s. Floods from 1977-1993 widened the channel to today's location.

The results are a change in seasonality of flooding, the flood history is nonstationary, and the flood frequency did not increase. Channel stabilization was attempted with "soil cement." The result was that the riparian vegetation died-off, and it was unable to reestablish itself. Since this re-engineering in 1993, deposits by floodplains within the banks have allowed some riparian vegetation to emerge.

In conclusion, total elimination of riparian vegetation as a result of groundwater development has only occurred in portions of three rivers. They are the Santa Cruz in Tucson, the Gila River in central Arizona, and the Mojave River in Barstow, California. Bank protection along the Salt River in Phoenix and the creation of reservoirs along the Colorado River has contributed to riparian vegetation loss.

Although flow regulation can favor the growth of riparian vegetation, future management should include periodic winter floods to introduce disturbance and initiate germination and recruitment of native species. Growth and potential life-span is a function of the stability of surface-water and groundwater systems.

Nagler, P. L., O. Hinojosa-Huerta, E. P. Glenn, J. Garcia-Hernandez, R. Romo, C. Curtis, A. R. Huete, and S. G. Nelson, Stephen. 2005. Regeneration of native trees in the presence of invasive saltcedar in the Colorado River Delta, Mexico. *Conservation Biology* 19(6):1842-1852.
Many riparian zones in the Sonoran Desert have been altered by elimination of the normal flood regime. Such changes have contributed to the spread of saltcedar (*Tamarix ramosisima* Ledeb.).

An investigation is made as to whether the restoration of a pulse-flow regime would permit native trees to regenerate in the presence of saltcedar. The issues were how frequently cohorts of cottonwood (*Populus fremontii* S. Wats.) and willow (*Salix gooddingii* C. Ball) establish, the establishment of cohorts in response to each large flood or to triggering threshold values, the factors that account to the mortality of trees (e.g., fire, depth to groundwater, salinity), a match between recruitment and mortality over multiple flood cycles, and a vegetation biomass change between years in response to differing annual flow conditions.

Although saltcedar is still the dominant plant, native cottonwood and willow trees have regenerated multiple times because of frequent flood releases from U.S. dams since 1981. Saltcedar is capable of producing seeds and germinating throughout spring and summer under a wide range of environmental conditions, but cottonwood and willow trees require spring floods timed to their shorter window of seed production and germination. However, after germination, cottonwood and willow seedlings must have access to moist soil or a water table within 2 m of the surface during the first season and a water table no deeper than 3-4 m for continued growth.

In the Colorado River Delta in Mexico the vegetation of the riparian corridor was mapped with ground and aerial surveys and satellite imagery from 1992 to 2002. Photographs were acquired with a multiband (blue, red, and near infrared) digital camera. These aided in the distribution of trees, shrubs, marsh, fire scars, and other land cover classes. Related vegetation changes to river flood flows and fire events were also used.

The main reason for tree mortality between floods is fire. From photographs, only fresh burns 1 to 2 years old were scored for the coverage of both live and dead trees collectively as a function of distance from the active channel. The photographs allowed an estimation of percent survivorship, percent recruitment of new trees, and percent attrition of trees. Saltcedar had the greatest mean cover and height. Whereas, open water had the least. A rapid turnover of tree populations was perhaps explained by 82% of the dead trees occurring in the fire scar areas. Native tree populations were dynamic with a turnover rate of approximately 5 years. The recruitment of new trees kept pace with attrition due to fire.

Biomass in the floodplain responds positively even to low-volume floods because native trees can withstand inundation longer than saltcedar. Summer biomass in the study area was correlated with the previous winter's river flow. On the groundcover classes were bare soil, water, or vegetation, and vegetation was further recorded by species. Dbh and height were also recorded. For open water, depth, electrical conductivity, and width were recorded by primary or secondary stream, drain, irrigation canal, and lagoon. Electrical conductivity was higher in agricultural drainage water.

The volume of flows was not as important as the number of years of flow in stimulating vegetation growth. Native hydromesic tress regenerated in response to pulse floods despite the presence of invasive dominant species. Establishment required spring floods and a water table within 2 m of the surface so that seedling roots could grow fast enough to remain within the capillary fringe of the water table as it declined over the first summer. The river receded to its channel by May of each flood year, but the vadose zone retained sufficient moisture to carry the seedlings through summer. Native trees dominated the banks forming an overstory that excluded saltcedar. Saltcedar and arrowweed (*Tessaria sericea*) dominated the floodplain away from the river.

The results support the hypothesis that restoration of a pulse flood regime will regenerate native riparian vegetation despite the presence of a dominant invasive species, but fire management will be necessary to allow mature tree stands to develop. Management practices that reduce the frequency of flood events would rapidly reduce the tree populations in the delta. Pulse floods and fire management will improve the habitat value of the riparian corridor, which could allow older trees to develop an increase the overall cover of trees compared to shrubs.

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 $20. 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 September, the deadline for submittal of articles is August 15, 2006. Please call or write with suggestions, publications for review, announcements, articles, and/or illustrations.

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CALENDAR

Arizona Riparian Council Board Meetings. The Board of Directors holds monthly meetings the third Wednesday of each month and all members are encouraged to participate. Please contact Cindy Zisner at (480) 965-2490 or Cindy.Zisner@asu.edu for time and location.

Arizona Hydrological Society 2006 Annual Symposium, Water & Water Science in the Southwest – Past Present and Future. September 13-15, 2006, Glendale Civic Center, Glendale AZ. http://www.azhydrosoc.org/symposia.html for more information.

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