ANDERSON, B. W., and P. E. RUSSELL. Revegetation and Wildlife Management Center, 201 S. Palm Drive, Blythe, CA 92225. ***Riparian revegetation on the 'Ahakhav Tribal Preserve, 1996-98.***

In spring 1996, a 20-acre revegetation project was initiated on the Colorado River Indian Reservation. Since then, approximately 75 more acres have been added to the revegetation effort between the 'Ahakhav Tribal Preserve and the Revegetation and Wildlife Management Center in 1997, and another 100 acres in 1998. The nine-step revegetation method has been or is being employed in the implementation of these projects. Preliminary soil analysis of the sites determined potential problems that could adversely affect growth, while it also assisted in determining the proportions of the sites that could support each of several candidate riparian species. Intensive soil analysis of the sites allowed for planting each individual plant where it had a high probability of surviving, given the range of conditions on the sites. Trees and shrubs on each site were irrigated at a rate of 10 gallons/day, 6 to 7 days/week using a drip irrigation system during the first growing season. The growth and development of the trees were monitored weekly throughout the first growing season and three times during the following growing season.

ARROYAVE, P. Resource Management Office, Lower Colorado Region, Bureau of Reclamation, PO Box 61470, Boulder City, NV 89006-1470. ***Biological and Conference Opinion on the lower Colorado River operations and maintenance: Reasonable and Prudent Alternative Provisions 5, 7, and 8 pertaining to the endangered Southwestern Willow Flycatcher.***

The Reasonable and Prudent Alternative (RPA) Provisions 5, 7, and 8 involve the protection of Southwestern Willow Flycatcher breeding pairs and habitat along the lower Colorado River. RPA Provision 5 requires the immediate habitat protection/restoration of 1,400 riparian areas by January 1, 2001, with a priority on Willow Flycatcher-occupied habitat. RPA Provision 7 directs the Bureau of Reclamation (Reclamation) to implement protective management for existing flycatcher breeding groups and suitable habitat, while RPA Provision 8 directs Reclamation to fund a 5-year survey and monitoring effort for the Southwestern Willow Flycatcher along the lower Colorado and confleunt drainages. The presentation will summarize Reclamation's strategy and progress in meeting the requirements of these RPA Provisions.

BRIGGS, M. K., and S. CORNELIUS. Sonoran Institute, 7650 E. Broadway, Suite 203, Tucson, AZ 85710. ***Opportunities for ecological improvement along the lower Colorado River and Delta.***

The lower Colorado River mainstem and Delta have been significantly altered by a variety of human-related activities, including river impoundment, agriculture, water diversions, introduction of exotic plants, and groundwater pumping. In some areas the native wetland habitat that formerly dominated this region has disappeared completely. Nevertheless, there are areas where significant wetland habitat persists as a result of incidental circumstances or purposeful restoration actions. These areas provide important conservation and restoration opportunities. In this investigation, 10 restoration efforts along the lower Colorado River from Parker Dam to the Delta region were evaluated to learn how lessons from these experiences can benefit future rehabilitation efforts. In addition, investigators assessed the general ecological condition of this reach to identify critical native wetland plant communities and recommend strategies for protecting these areas in the future.

It is apparent that wetland ecosystems in both the Delta and the mainstem would benefit if effluent waters were allocated to support wetlands, rather than allocated to evaporative basins. Other important strategies for improving the ecological condition of the river should include altering reservoir releases, improving the effectiveness of revegetation efforts, and developing bi-national, collaborative approaches involving local communities and landowners to identify and carry out projects that benefit both them and the ecological condition of the river.

BRIGGS, M. K., and J. S. MURRIETA. Sonoran Institute, 7650 E. Broadway, Suite 203, Tucson, AZ 85710. ***A community-based effort to repair damaged riparian ecosystems along the Santa Cruz River in Sonora, México.***

Natural resource practitioners in Sonora, México, and Arizona, have embarked on a community-based effort to repair damaged riparian ecosystems along the Santa Cruz River in Sonora. In comparison to most other major rivers that cross the U.S.-México border, the reach of the Santa Cruz River in Sonora has received little attention. Although portions of this reach are in good ecological condition, other parts have been heavily damaged by a variety of human-related activities including agriculture, gravel pit operations, and livestock grazing. In addition, this region has suffered from a drought that has lasted over 15 years. Ecological decline along this reach includes loss of riparian plant communities, deterioration of water quality, increased channel instability, and a decline in groundwater levels. These changes impair the well-being of many species of wildlife as well as undermine the economic vitality and overall community health of riverside communities. In close cooperation with universities, federal and state agencies, and conservation organizations from both sides of the Arizona-Sonora border, the Sonoran Institute is working at the community level to design and implement practical, hands-on recovery protects that focus on improving the overall ecological condition of the river and its focus on improving the overall ecological condition of the river and its riparian ecosystems, as well as enhancing the overall health and economic vitality of towns along the Santa Cruz River. Specifically, three activities are being carried out: (1) a series of livestock management workshops that will provide local ranchers with a variety of strategies for improving the management of livestock along the river; (2) the development of a river park that will reduce damage from recreation activities as well as enhance the protection of intact riparian communities; and (3) the continuation of a water-quality monitoring program.

BRYANT, G., and P. ROSE. U.S. Bureau of Reclamation, Yuma Area Office, PO Box D, Yuma, AZ 85366. ***Restoring Imperial Division wetlands and other environmentally friendly river operations.***

For almost 100 years, the U.S. Bureau of Reclamation (Reclamation) has harnessed the Colorado River to irrigate crops and generate power. Water from the lower Colorado River has also quenched the thirst of millions in Arizona, California, Nevada, and the Republic of México. Only comparatively recently have federal and state water administrators recognized that recreational and environmental uses are crucial elements in river operations. In 1997, Reclamation released a Biological Assessment of its Colorado River operations; the U.S. Fish and Wildlife Service responded to the Biological Assessment with a Biological Opinion. The result of these two documents is a new direction for Reclamation's operations of the lower Colorado River.

One example of Reclamation's new direction is its wetlands restoration project in the Imperial Wildlife Refuge. The pilot project is a 12-step environmental enhancement and restoration program, the activity will occur on about 4 miles of wetlands on the Arizona side of the river. Project goals include restoring the aquatic habitat in that area to a state similar to the way it was prior to the 1983 Colorado River flood by restoring historical connections between the main river channel and the various backwaters. This work will create corridors that will be used by native fishes and recreational water users.

The presentation will discuss the Imperial Division project and relate it to the larger changes taking place within Reclamation's river operations.

CLEVERLY, J. R., and S. D. SMITH. Department of Biological Sciences, 4505 Maryland Parkway, University of Nevada-Las Vegas, Las Vegas, NV 89154-4004.
Physiology and ecology of woody species in a* Tamarix ramosissima*-impacted floodplain of the Mojave Desert.

Many hectares of southwestern U.S. riparian corridors have been altered by the invasion of the facultative phreatophyte *Tamarix ramosissima* (saltcedar) from Asia. There are a suite of characteristics of both *T. ramosissima* and invaded riparian corridors that promote the success of *T. ramosissima*.. For example, *T. ramosissima* alters flood and fire patterns, forming an ecosystem better suited to the growth and reproduction of itself at the expense of native species. One important property of *T. ramosissima*, as contrasted to the native species, is its tolerance to both heat and drought stresses. The gas exchange, growth, and carbon storage responses of *T. ramosissima*, *Salix exigua* (coyote willow), *Pluchea sericea* (arrowweed), and *Prosopis pubescens* (screwbean mesquite) were measured under natural and glasshouse manipulations of temperature, drought, and competition stresses. Growth in *T. ramosissima* seedlings, both above and below ground, was consistently lower than in other seedlings, suggesting that *T. ramosissima* is an inferior competitor. However, *T. ramosissima* allocates two orders of magnitude more starch in taproot storage than co-occurring species, further suggesting that *T. ramosissima* is well-adapted to the risks of potential stress than native species. While the stomata of *P. sericea* responded to the interaction of heat, drought, and competition stresses, *T. ramosissima* stomatal conductance was impacted primarily by temperature and competition stresses. Because root elongation was not different between the three species, the tolerance of *T. ramosissima* to drought stress is thought to be related to starch storage in organs that are capable of adventitious sprouting. In a variable environment, *T. ramosissima* is expected to perform more poorly, relative to native species, when mesic conditions predominate.

ELLIS, M. Imperial National Wildlife Refuge, PO Box 72217, Yuma, AZ 85365. ***The effect of the Biological Opinion and Multi-Species Conservation Program on national wildlife refuges on the lower Colorado River.***

I plan to discuss how the Biological Opinion and Multi-Species Conservation Program are affecting national wildlife refuges on the lower Colorado River. I plan to highlight recent coordination between the refuges and U.S. Bureau of Reclamation to illustrate how we are working together to conduct habitat restoration projects related to endangered species conservation. I will also cover past, current, and potential roles the refuge managers play in the development of these planning efforts.

EWAN, R. F., and J. EWAN, School of Planning and Landscape Architecture, College of Architecture and Environmental Design, Arizona State University, PO Box 872005, Tempe, AZ 85287-2005. ***Wash preservation boundary studies and their application to urban desert preserve planning in Phoenix, Arizona.***

This presentation outlines the findings and application of the North Phoenix Wash Preservation Boundary Studies (1996-98) being conducted by faculty from Arizona State University (ASU) Main Campus College of Architecture and Environmental Design; faculty from ASU West campus Department of Life Sciences; specialists from the Desert Botanical Gardens and Arizona Game and Fish Department; and a landscape architect and planning and development manager from the City of Phoenix Parks, Recreation, and Library Department (PRLD). The intent of the study is to recommend preservation boundaries that are consistent with the existing ecology of the Cave Creek, Apache, Skunk Creek and its tributaries, and Deadman Washes and adjacent land within Phoenix. The recommendations are being applied to the planning and the PRLD Sonoran Preserve System in Phoenix.

The study areas span approximately 0.25 to 0.5 mile on both sides of the centerline of each wash and are bounded on the north by the Phoenix city limit, and on the south by the Central Arizona Project canal. Vegetation sampling has been done for 60-100 quadrats within each study area. Vegetation is then categorized on the basis of this sampling, aerial photographs and field observations, and mapped using GIS. The vegetation was classified into six types. Damaged areas were also mapped. In addition, wildlife observations were noted during the field visits. Identified wildlife include: desert tortoise, Gila monster, coyote, javelina, Red-tailed Hawk, Great Horned Owl, and Cactus Wren. Using this information, a group of ecologists, landscape architects, planners, and park managers developed three boundary options for each wash: maximum, moderate, and minimum preservation.

A report has been published on Cave Creek Wash for the PRLD and was presernted to the Phoenix City Council and the Phoenix Parks Board. The Board supported the maximum preservation boundary that includes 4,500 acres of land. A significant contribution of this study and report is in its application to urban wild land planning in Phoenix. As the PRLD noted after reviewing the report, they learned that "the process of establishing preserve boundaries should be based on scientific understanding of the natural systems instead of property ownership and topography, as was commonly done in the past" (PRLD 1997). The report for the remaining washes will be published in July 1998. These studies have helped in the development of the *City of Phoenix Sonoran Preserve Master Plan* (Draft, 1998) which was approved by the Phoenix City Council in February 1998.

Ewan, J., R. Fish Ewan, et al. 1996. *Cave Creek Wash Preservation Boundary Study*. Herberger Center for Design Excellence, College of Architecture and Environmental Design, Arizona State University, Tempe, AZ.

City Phoenix PRLD. Winter 1996/97. *Phoenix Sonoran Preserve Update* 1(2).

City Phoenix PRLD. January 1998. *The City Phoenix Sonoran Preserve Master Plan,* Draft.

FONSECA, J. E.[1], and R. WAHL[2]. [1]Pima County Flood Control District, 201 N. Stone, Tucson, AZ 85701 and [2]ENTRANCO, 2400 W. Dunlap Avenue, Suite 100, Phoenix, AZ 85021-2813. *Hydrology and vegetation of an effluent-dominated ephemeral stream, Pima County, Arizona.*

Riparian vegetation along a 9-mile long reach of the lower Santa Cruz River (Avra sub-basin) is influenced by variation in effluent flows and periodic scouring by floods. Other important factors influencing the extent and maturity of vegetation are the river's lack of direct connection to an aquifer, grazing, and variations in soil texture. Under present conditions, the riparian communities in the study area will remain in a relatively early successional stage, and be dominated by relatively xeric species.

The lower Santa Cruz River receives approximately 50,000 acre-feet of secondary per year from treatment facilities located near Tucson, Arizona. Wide fluctuation in diurnal, seasonal, and interannual flows selects for plant communities that tolerate a wide range range of soil moisture conditions.

Storm flows periodically remove riparian vegetation, while providing germination conditions for some species. Flows less than the 25-year recurrence interval are confined to the channel in most locations, a feature which increases the erosiveness of flows. Flows exceeding the estimated 25-year discharge have occurred as recently as 1993. Within the active channel, a narrow (roughly 10 to 50 feet wide), but prominent subchannel supports perennial surface flow of treated sewage effluent.

The regional water table is generally 250 feet below surface, precluding the establishment of phreatophytes at locations distant from the main channel. Riparian vegetation is restricted to a narrow band of streamside vegetation bordering the existing effluent flow path. When the position of streamflow shifts within the channel or flows cease due to channel scouring increases infiltration upstream, streamside vegetation can die from desiccation. Soils are generally loamy sands and gravelly sands, which have little cpacity to retain moisture.

Parallel to the channel, a series of narrow bands of riparian vegetation are formed along the steep soil moisture gradients. Cattail, seepwillow, and various non-native grasses occur in the channel. Strand and mixed xeroriparian scrubland vegetation of desert broom, burrobrush, saltcedar, Goodding willow, mesquite, desert willow, and blue and Mexican palo verde are common within and immediately adjacent to the channel. Both *Tamarix pentandra* and *T. aphylla* are present. The transition to uplands is abrupt, as evidenced by creosote occurring alongside the seepwillow stands.

Overall, riparian canopy cover and vegetation volumes are low (0-0.4 m^3/m^2), with occasional patches where volumes are in excess of 0.6 m^3/m^2 (SWCA 1996). The highest vegetation volumes (>1.8 m^3/m^2) are found within a secondary channel isolated from the erosive forces along the main channel. A rancher periodically diverts effluent for paster irrigation purposes into this secondary channel, allowing some tree species to grow to maturity. Grazing of the area influences stand composition, selecting against certain species.

GOULD, G. Resource Management Office, Lower Colorado Region, Bureau of Reclamation, PO Box 61470, Boulder City, NV 89006-1470. ***Biological and Conference Opinion on lower Colorado River operations and maintenance. Alternative Provision Number*** 3 ***and 10 — protected habitat for native fishes and Lake Mead razorback sucker study.***

This discussion includes the approaches to accomplishing the Provisions 3 and 10 of the Biological and Conference Opinion on lower Colorado River operations and maintenance. Provision 3 includes providing from 300 to 600 acres of protected habitats for native lower Colorado River fishes, including bonytail and razorback sucker. This will involve using 200+ acres of existing open water and construction of other facilities to complete the requirement. Provision 10 includes a study of Lake Mead conditions to gather background information relating to the occurrence of small numbers of juvenile razorback suckers in the lake.

HOGAN, D. Southwest Center for Biological Diversity, PO Box 710, Tucson, AZ 85702-0710. ***A conservation perspective on the Lower Colorado River Multi-Species Conservation Program.***

Born appropriately in a Las Vegas meeting of water and power agencies, the Lower Colorado River Multi-Species Conservation Program (MSCP) has today evolved into an elaborate gamble with the survival of endangered species and the health of the Colorado River ecosystem. Representatives from the Arizona Department of Water Resources, California's Colorado River Board, and the Southern Nevada Water Authority, as well as federal wildlife and reclamation representatives speak grandly of this "ecosystem management" plan. Yet a glance behind the curtain of rhetoric reveals a water and power junta ultimately unwilling to budge for the benefit of wildlife.

It was the prospect of critical habitat designation for the razorback sucker and other "big river" fish which in the early 90s moved water and power agencies to suddenly embrace a heretofore foreign language of conservation for Colorado River management. Reluctant to yield their history of maximum use, these agencies initiated development of their own Multi-Species Conservation Program alternative to the perceived restrictions of federal Endangered Species Act (ESA) oversight. Yet though the MSCP is far from finalization, water and power agencies have already been promised 50-year ESA "take" permits from the U.S. Fish and Wildlife Service (Service) applicable to impacts to listed species resulting from operation of all dams and diversions between the Grand Canyon and International Boundary with México.

The MSCP's absolute and conscious failure to consider the effects of U.S. water and power operations and facilities on the Colorado River vegetation, wildlife, and people south of the border in México is perhaps the most glaring example of problems with the Program. Today the river reaches the Gulf of California only after a series of wet years forced the Bureau of Reclamation (Reclamation) to release water from Hoover Dam in anticipation of flooding. Even these infrequent flows are likely to become a thing of the past when Reclamation adopts its proposed rule to allow off-stream storage of Colorado River water later this year. Despite significant international interests, MSCP participants have emphatically stated that no water will be formally allocated for river conservation in México.

Another significant problem involves delegation of Reclamation and Service ESA responsibilities to the MSCP Steering Committee under the Service's Lower Colorado River Biological Opinion. Under the Opinion, federal agencies must now essentially rely on the water and power-dominated Committee to dictate what can and cannot be accomplished for endangered wildlife along the lower river. The MSCP Steering Committee's opposition to draw down of Lake Mead in an effort to protect Arizona's largest willow riparian forest is a strong indication of water and power's unwillingness to proceed with substantive changes in Colorado River management for the benefit of wildlife.

Despite the obvious shortcomings of the MSCP, the concept of ecosystem management where the needs of wildlife are treated at least as seriously as the needs of agribusiness and other uses remains sound. But given its current direction, the Lower Colorado River MSCP is not likely to result in anything more than maintenance of the water and power status quo.

KESLER, D. Colorado River Indian Tribes, Fish and Game Department, PO Box 777, Parker, AZ 85344. ***Colorado River Indian Tribes 1997 mesquite resource assessment.***

The Colorado River Indian Reservation contains over 25,000 acres of remnant mesquite habitats, representing the largest contiguous mesquite stands on the lower Colorado River. The Poston and South Management Units (7,050 and 6,768 acres, respectively) probably host the largest contiguous breeding populations of Lucy's Warblers (*Vermivora luciae*) and Abert's Towhees (*Pipilo aberti*); and the largest wintering population of Phainopepla (*Phainopepla nitens*) (Bureau of Indian Affairs 1982) on the lower Colorado River — exemplifying these stands' importance to wildlife. Additionally these areas are valued by members of the Colorado River Indian Tribes because they provide cultural and fuel resources.

Gary P. Nabhan, Peter L. Warren, and Michael Parton (1985) of the University of Arizona were commissioned by the Tribes to assess the two largest stands in 1985. In 1997 concerns about mesquite resources arose again and the following study was conducted by the Colorado River Indian Tribes Department of Fish and Game to assess several factors relating to mesquite abundance, wildlife use, regeneration, and changes since 1985. Using a combination of field and Global Information System (GIS) analyses we found that:

A. Mesqute is the dominant vegetative type on 25,077 Reservation acres.
B. Cords (27,365) of mesquite wood are available in the size needed for cultural ceremonies.
C. Since 1985, usable wood resources have declined by 25%.
D. Saltcedar (*Tamarix* sp.) is only prevalent in areas with medium mesquite densities.
E. Large portions of the mesquite stands are dead or dying from unknown causes.
F. Mesquites were regenerating naturally in selected portions of the stands.

Our observations suggest that the primary cause for mesquite declines between 1985 and 1997 is overharvest and poor cutting practices. This study resulted in the development of a mesquite management plan (Kesler 1998) for the Colorado River Indian Tribes and several successive studies are underway to determine the wildlife use of the stands, impacts of harvest, and the cause of dying trees.

USDI, Bureau of Indian Affairs. 1982. Final Environmental Assessment report: agricultural and recreational leasing and development on the Colorado River Indian Reservation. Phoenix, AZ.

Nabhan, G. P., P. L. Warren, and M. Parton. 1985. Mesquite resources of the Colorado River Indian Tribes. University of Arizona, Tucson, AZ.

Kesler, D. C. 1998. 1998-2007 integrated mesquite harvest management plan. Colorado River Indian Tribes Department of Fish and Game, Parker, AZ. 48 pp.

MARLER, R. J., and D. T. PATTEN. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe, AZ 85287-1601. ***Response of riverine ecosystems to wastewater inputs.***

Three river systems in Arizona (Salt-Verde-Gila Rivers, Santa Cruz River, and Agua Fria River) were studied to determine the interaction of wastewater input with the riverine ecosystem. The riverine ecosystem components addressed on the Salt River complex included: water chemistry, hyporheic invertebrate and diatom communities, riparian vegetation, and the associated terrestrial invertebrate and avian communities utilizing the riparian vegetation. Only riparian vegetation was studied on the Santa Cruz and Agua Fria Rivers. Water chemistry was significantly different between the effluent and control sites on the Salt River complex in regards to ammonium, nitrate, nitrite, SRP, DOC, and chloride. The riparian vegetation showed a positive response to the elevated nutrient concentrations in wastewater with increased growth rates, cover and density, and there was an increase in piscivorous bird abundance near the effluent release site. Diatoms and hyporheic invertebrates showed a decrease in species richness. Terrestrial invertebrates showed a change in community structure, with the control reach having more species with aquatic life stages and the effluent reach having more homopterids (aphids).

MILLER, R. K.,[1] and F. O. PHILLIPS[2]. [1]USDI Bureau of Indian Affairs, Branch of Forestry, PO Box 10, Phoenix, AZ 85001 and [2]Colorado River Indian Tribes, ‘Ahakhav Tribal Preserve, Route 1, Box 23B, Parker, AZ 85344. ***Cultural inderpinnings of riparian restoration on Tribal lands along the lower Colorado River.***

Five Indian reservations occupying 384,000 acres le along the lower Colorado River between Laughlin, Nevada, and the U.S.-México border. The riparian vegetation along this stretch of river, both on and off the reservations, has been highly altered due to a number of factors. Factors include early fuelwood use by steamboats, the building of dams and resulting flood control, channelization projects, saltcedar introduction, agricultural clearing, and urban development. Extensive changes resulting from these activities are causing concern and spurring action.

Active riparian restoration is currently taking place on Tribal lands of the Chemehuevi, Quechan, and Colorado River Indian Tribes (CRIT). Special emphasis is being placed on reestablishing the indigenous tree species: honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*P. pubescens*), Fremont cottonwood (*Populus fremontii*), and willow (*Salix* spp.). Mesquite is especially valued as it supplies wood for cradleboards, beans for food, and is used in combination with arrowweed (*Tessaria sericia*) in funeral pyres for traditional Mojave and Chemehuevi cremations. Cottonwood provides the preferred material for Quechan cremations; however, lack of this species on the Fort Yuma Reservation has caused the Tribe to use alternative woody species, including athel tamarisk (*Tamarix aphylla*) — a practice some elders now question. Willows continue to be used for basketweaving.

Historical documentation, oral tradition, and legends all point to the many ties these tribes have with the Colorado River and those plant and animal species which constitute this riparian ecosystem. A partial explanation of the cultural links these tribes share with the Colorado is found on a brass plaque on the Fort Mojave Indian Reservation:

> *For the Aha Macave (Mojaves) the river was the center of existence. They practiced a dry farming method, relying on the regular overflow of the Colorado River to irrigate crops planted along the banks. They supplemented this with wild seeds and roots, especially mesquite beans, and game and fish taken from the river with traps and nets.*

Many of these cultural connections remain and provide a a foundation for the desire to once again have functioning riparian ecosystems on tribal lands. The Chemehuevi Tribe’s reforestation and beach restoration project, Quechan’s cottonwood bosque reestablishment efforts, and CRIT’s 1,042-acre ‘Ahakhav Preserve and Recreational Area provide graphic examples of these tribes’ commitments to riparian restoration and cultural preservation.

MURPHY, T. Resource Management Office, Lower Colorado Region, Bureau of Reclamation, PO Box 61470, Boulder City, NV 89006-1470. ***Biological and Conference Opinion on lower Colorado River operations and maintenance. Reasonable and PRUDENT Alternative Provision Number 14 — ecological restoration on the lower Colorado River.***

This paper discusses the approach and results to date of restoring natural functions of portions of the channelized and stabilized lower Colorado River. This project has to consider facets such as geomorphology, flows, successional results, and the “Law of the River.” Several pilot projects are underway or proposed. A feasibility report for restoring large areas, approximately 500 hectares, will be completed by January 1999.

PHILLIPS, F. O.[1], R. HENRY[1], T. SHAFFER[1], B. ANDERSON[2], and D. L. WEGNER[3].
[1]'Ahakhav Tribal Preserve, Colorado River Indian Tribes, Route 1, Box 23B, Parker, AZ 85344, [2]Revegetation and Wildlife Management Center, 201 S. Palm, Blythe, CA 92225, and [3]Ecosystem Management International, PO Box 23369, Flagstaff, AZ 86002-3369. ***Restoration and monitoring of riparian habitat on the lower Colorado River.***

In 1996, the Colorado River Indian Tribes established the 'Ahakhav Tribal Preserve. This 1,042-acre aquatic, wetland, riparian ecosystem has historically been drastically altered due to river channelization, dams, and the introduction of exotic plant species. Preserve goals include native plant revegetation, aquatic/wetland restoration, pre- and post-restoration ecological monitoring with an objective of utilizing the area for environmental education and low impact recreation. By 1997, the Preserve plan was approved and all environmental consultation and construction permits secured. In 1996, the Bureau of Indian Affairs, Woodlands Forestry provided the Preserve first "seed" grant of $22,000 for a native plant nursery and a 2-acre revegetation project. Two years later the program has secured over $3 million in grants and donations from over seven state, federal, and private organizations. Secured funding will restore over 225 acres of revegetation, 350 acres of wetland/aquatic restoration, and before and after ecological monitoring of restoration operations. Grants also fund habitat protection, interpretive trails, environmental education, and outdoor recreational programs. These programs have served over 2,500 people ranging from tribal and community members to school groups, colleges, nonprofit organizations, Boy Scouts, and elderly groups. At the newly established Preserve Office and Visitors' Center, we continue to materialize future plans and projects for the long-term self-sustainability and monitoring of the project and its restored habitats.

The efforts being developed at the 'Ahakhav Tribal Preserve will serve as a template for cultural preservation and ecosystem restorating in the lower Colorado River region.

SCOTT, M. L.[1], G. C. LINES[2], and G. T. AUBLE[1]. [1]U.S. Geological Survey, Biological Resources Division, Fort Collins, CO 80525 and [2]U.S. Geological Survey, Water Resources Division, San Diego, CA 92123. ***Response of riparian cottonwoods to channel incision and associated water table declines along the Mojave River, California.***

Rivers draining alluvial basins throughout the southwestern United States are typically unstable and prone to catastrophic channel adjustments in response to high magnitude floods. In this region, floods, and a number of other factors including land- and water-use practices, are thought to have initiated a widespread pattern of channel incision and associated changes in the distribution, abundance, and composition of riparian vegetation. However, because of flow variability, changes in the fluvial landscape are discontinuous and typically involve spatial and temporal lags in geomorphic and biological responses to changes in physical conditions. Thus, clear cause-and-effect relationships between channel change processes like incision and riparian vegetation response are often obscure. In 1995, mapping and classification of riparian vegetation along the Mojave River in southern California revealed an 8 km reach in which severe stress and widespread mortality of riparian cottonwoods (*Populus fremontii*) were observed. Pre-existing information on surface flows, water table depths, and channel geometry within this portion of the Mojave, offered an opportunity to examine possible relationships between flow-related channel change and observed declines in riparian vegetation. Using channel and floodplain topographic surveys, water table depths, soil characteristics, and tree-rooting depths, we document a process of channel incision and quantify its effects on riparian cottonwoods as measured by stand mortality, tree live crown volume, and patterns of radial stem growth. Comparisons of topographic cross-sections from 1963 and 1997, indicated a net change in channel elevation between -0.71 and -3.6 m within the stressed zone. Analysis of radial stem growth suggested that two episodes of channel incision followed large floods in 1983 and 1993, with the effects of the 1993 flood being more pronounced. Channel incision following the 1993 flood produced net water table declines $\geq$1.4 m on the adjacent floodplain where cottonwood stand mortality ranged between 60-95%. Where water table declines were between 0 and 1.4 m, stand mortality was 7-13%; however, trees exhibited reduced radial stem growth and loss of leaf area, based on measurements of live crown volume. Our results suggest that riparian cottonwoods are sensitive to changes in shallow groundwater environments and measurements of stem growth and other structural responses may be used to elucidate spatial and temporal patterns of water table declines associated with channel incision.

SHAFFER, T., and F. PHILLIPS. ‘Ahakhav Tribal Preserve, Colorado River Indian Tribes, Route 1, Box 23B, Parker, AZ 85344. ***Developing an educational program for students in the lower Colorado River Valley.***

The ‘Ahakhav Tribal Preserve began as a result of the Colorado River Indian Tribes taking a step to restore their culture, and the environment on which that culture depended. Their traditional land, the lower Colorado River Valley, in the last 150 years has seen significant effects of human actions, as has the tribal social structure. As people acculturated to western society, much information about the animals and plants was lost. The environmental education program at the Preserve was established not to replace what has been lost, but to provide information about the environment, appreciation of the diverse ecosystem that exists here, and teach methods of observation, critical thinking, and synthesis to the future leaders of the lower Colorado River Valley.

An effective restoration project requires preliminary assessment of habitat, selection of species to reintroduce, and a plan for expansion, maintenance, and longtime care to succeed. So it is with educational programs.

In setting up programs along the Colorado River, it was first necessary to talk with youths, parents, and educators to assess the needs of the local youth. The area is primarily rural. Needs assessment began by working with youth and adults preparing summer camp activities, canoe adventures, outreach work in classrooms, and youth groups/classes coming to the Preserve.

Second was the development of the curriculum to be used. Project Wild, Project Wet, and others were included in the programming. The bulk of the original programs are centered around exploration of the habitat with knowledge acquired through all the senses. The most requested program is the introduction to animals and their habitat. Many a student has fondled the animal skins, skulls, and feet from the Preserve’s donated collection. The sandy substrate of the Preserve yields a dependable wealth of tracks, burrows, and scat found while hiking. Plants of the Preserve is another popular theme. Within a 1 mi hike of the bus drop-off, the students can visit and compare five vegetation types: park, freshwater marsh, saltcedar thicket, revegetated riparian, and agricultural field. Birds, insects, art, drama, and physical activities are part of the curriculum plan. Several activities can be simplified or made more complex to suit the needs of the group. After a few years of a thematic-based environmental education program, emphasizing observation and thinking skills, it will be necessary to expand the programs to match the higher level thinking. At this time, therefore, programs are set up as a foundation on which teachers and students can build.

There are unique opportunities for students at the Preserve. First is to see habitat restoration firsthand, in the making. Another is interaction with visiting scientists working on various projects that the Preserve entertains. Staff and students have the opportunity to interact with these professionals and participate in research in their own backyard. The educational programs at the ‘Ahakhav Tribal Preserve are growing hand-in-hand with the trees to provide improved habitat for wildlife and humans alike.

SHAFROTH, P. J.[1,2], J. C. STROMBERG[1], and D. T. PATTEN[1]. [1]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe, AZ 85287-1601 and [2]U.S. Geological Survey, Biological Resources Division, 4512 McMurry Ave, Fort Collins, CO 80525-3400. ***Woody riparian vegetation along the dammed Bill Williams River and the undammed Santa Maria River, Arizona.***

Altered streamflow regimes resulting from river damming have contributed to downstream changes in riparian vegetation. Present knowledge of dam impacts on the interactions between streamflow regimes, fluvial processes, and riparian vegetation comes largely from a synthesis of information from studies in different disciplines and/or geographic regions. Few studies have examined these relationships simultaneously on dammed and undammed portions of a given river system. From 1995-1997, we collected data on a suite of vegetation and physical environmental variables at 16 cross-floodplain transects, 8 on the Bill Williams River downstream of Alamo Dam, and 8 on the Santa Maria River upstream of Alamo Dam in western Arizona. Physical variables included surface and groundwater hydrology, floodplain topography, and soil particle size and electrical conductivity. Vegetation variables included the distribution, species composition, stem density, and basal area of various woody riparian patch types, age class distributions, and seedling establishment. Operation of Alamo Dam has resulted in more than an order of magnitude decrease in peak flows along the Bill Williams River, and increased low flows. The unregulated Santa Maria has much larger peak flows and periods of low or zero flow, depending on the reach. Largely because of the low flow difference, more sites along the Santa Maria had large annual water table fluctuations (>1 m) than along the Bill Williams. Sites along the Santa Maria with relatively small fluctuations (<1 m) in annual groundwater levels supported more *Populus fremontii* and *Salix gooddingii*-dominated patches than simlar sites along the Bill Williams. Overall, woody vegetation density and basal area were higher on the Bill Williams than on the Santa Maria. *Tamarix ramosissima* was the most frequently occurring woody species in sample quadrats on both rivers; however, patch types characterized by the exotic *Tamarix ramosissima* were more abundant along the Bill Williams. *Tamarix* basal area tended to be higher along the Bill Williams than the Santa Maria, both in quadrats where it was dominant and subdominant. During our study period, seedling establishment was generally more successful along the Bill Williams River, likely due to higher and less variable water table levels. Very few stands along either river pre-date the completion of Alamo Dam in 1968. On both rivers, many stands apparently established following periods of high flow in the late 1970s, early 1980s, and early 1990s. The results of this study add to the growing body of knowledge on the impacts of dam operations on vegetation, and thereby provide managers of downstream resources with additional information upon which reasonable management objectives and actions can be developed.

SNYDER, K. A., D. G. WILLIAMS, and V. L. GEMPKO. School of Renewable Natural Resources, BSE 325, University of Arizona, Tucson, AZ 85721. ***Water source determination in cottonwood/willow and mesquite forests on the San Pedro River in Arizona.***

In semi-arid and arid regions the extreme spatial and temporal variations in plant-available moisture play a critical role in determining patterns of dominant species distribution and function, and consequently have important implications for ecosystem water balance. 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*) to determine if spatial and temporal water availability influenced root water uptake behavior of key riparian species along the San Pedro River in Arizona.

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, stream water, and precipitation. We hypothesized that populations with access to a stable source of water, in this case shallow groundwater or perennial stream flow, would be less likely to expend carbon to grow lateral surface roots to acquire sporadic precipitation. To examine this hypothesis, we studied water acquisition behavior at sites characterized by different stream flow regimes and groundwater characteristics. Results indicated that cottonwood and mesquite trees, along a perennial reach of this river did not utilize soil moisture derived from monsoon precipitation and primarily used groundwater. However, at an ephemeral site both of these species utilized monsoon-derived soil moisture. Mesquite at the ephemeral site used a greater proportion of surface soil moisture relative to cottonwood. Willow did not appear to use appreciable amounts of surface soil moisture along perennial or ephemeral stream reaches. Mesquite also exhibited more negative midday water potentials than did cottonwood and willow. In contrast, cottonwood and willow at the perennial site maintained midday water potentials around -1.5 MPa. However, at the ephemeral site, cottonwood utilized precipitation-derived soil moisture, perhaps because of the decrease in midday water potentials to -2.0 MPa. 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 tided to groundwater levels.

SPRINGER, A.[1], L. DEWALD[2], and T. GODWIN[1]. [1]Department of Geology and [2]School of Forestry, Northern Arizona University, Flagstaff, AZ 86011. ***Hoxworth Springs: restoration of a unique high-elevation riparian area.***

Restoration of a perennial spring-fed stream is in progress in the Lake Mary drainage basin near Flagstaff, Arizona. Hoxworth Springs occurs at the contact of volcanic rocks and the Kaibab Formation at an elevation of about 7,020 feet above sea level. The springs support a perennial reach of stream approximately 2,500 feet long. The morphology of the channel below the springs has been altered through different multiple uses. Ongoing work is designed to restore the structure and function of this unique riparian area. The Coconino National Forest has closed a road to the spring and has built different fence structures to manage the grazing of cattle and elk. In 1997, through an Arizona Water Protection Fund grant, a “carbon copy” technique was applied to the modified channel below the perennial spring to return some of its pre-modification morphology. These areas were seeded with a grass seed mix. Accurate surveys have been conducted to document pre- and post-restoration topography. Vegetation monitoring is in progress in each different level of grazing management and each channel restoration area. Significant differences in species and composition occur in each different grazing management area.

Groundwater and surface water quantity and quality monitoring are in progress from above the perennial springs to below the grazing management areas. Shallow wells have been placed in the thin alluvial material below the springs to document any changes in groundwater level induced by the restoration.

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VON OPPENFELD, R., R. T. CAMPBELL, and A. M. ARBOLDEA. The TEST Law Practice Group, Kane Jorden von Oppenfeld Bischoff & Biskind P.L.C., 4201 N 24th Street, Suite 300, Phoenix, AZ 85016. ***The Endangered Species Act along the U.S. -Mexican border: desalinization of the lower Colorado River as a case study.***

The United States and Mexico share a border region containing an extensive expanse of forested islands and riparian areas, some of the most significant situated along Arizona's border with Mexico, that serve as habitat for endangered species. Due to increasing industrialization and trade between the U.S. and Mexico, more attention is being paid to the border ecosystem and species habitat by U.S. and Mexican policymakers. Bi-national cooperation regarding the border environment is increasing. Environmentalists are also viewing the border ecosystems with interest. The result is that application of the Endangered Species Act (ESA) to border environmental issues could emerge as a major issue in the near future. Private landowners, industry, states, and the federal government may run an increasing risk of being sued or prosecuted for ESA violations due to their water use and resource management practices along the border.

This paper will illustrate these ESA issues by examining the possible effects of a federal government decision to bring the Wellton-Mohawk desalting facility in Yuma completely online in light of the fact that such a decision might adversely impact endangered species in Mexico's Colorado River Delta. The Delta is primarily fed by agricultural drainage water from the Yuma desalting plant. The side effect of the continuous rerouting of irrigation water has been to revive the Delta's largest estuary. If the Yuma desalting plant were to come off "standby ready reserve" then its drainage would be treated for release into the mainstream of the lower Colorado River and the Delta could be deprived of its principal water source. It is possible that various endangered species in the Delta and Upper Gulf Region would be impacted. This paper will examine how the ESA would work in such a scenario.

Because the Delta lies in Mexico this paper will address the issue of whether the ESA should apply south of the U.S. border. Although a 1992 Supreme Court decision denied standing to environmentalists seeking application of the ESA to species outside the U.S., Colorado River agency action in the U.S. could be subject to challenge. It is possible that environmental advocates protesting action in Mexico might get standing. This paper will discuss the potential extraterritorial use of the ESA in Mexico.

Finally, application of the ESA in the border region must be studied in light of the presence of increasing cooperation between U.S. and Mexican environmental authorities, including a recent agreement between the U.S. Secretary of the Interior and his Mexican counterpart to preserve the environment along the border. This paper will discuss these bi-national issues as well.

The case of the Colorado River Delta provides an example of the type of ESA issue becoming ripe for discussion as interest in the U.S.-Mexican border environment rises. This paper will use the Delta issue to address the ESA's potential impact on those doing business or exploiting resources along the U.S.-Mexican border. This paper will also consider the increasing bi-national cooperation on border environmental issues taking place between the U.S. and Mexico. Those interested or concerned about the

possible applicability of the ESA to environment issues along the U.S.-Mexican border will find this paper useful.

WALKER, M. Resource Management Office, Lower Colorado Region, Bureau of Reclamation, PO Box 61470, Boulder City, NV 89006-1470. ***Biological and Conference Opinion on the lower Colorado River operations and maintenance: Reasonable and Prudent Alternative Provisions and Incidential Take terms and conditions.***

The results of formal consultation with the U.S. Fish and Wildlife Service concerning ongoing lower Colorado River operations and maintenance activities was the issuance (to Reclamation) of a final Biological and Conference Opinion on April 30, 1997. This document outlined approximately 33 separate Reasonable and Prudent Alternative Provisions and Incidental Take terms and conditions. The requirements are associated with three jeopardy opinions (razorback sucker, bonytail chub, and Southwestern Willow Flycatcher), two likely to destroy or adversely modify critical habitat opinions (razorback sucker and bonytail chub), and two “take” but not likely to jeopardize opinions (Yuma Clapper Rail and the flat-tailed horned lizard).

The presentation will briefly describe each of the major requirements along with short summaries of implementation status.

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Science and habitat restoration in the lower Colorado River: the 'Ahakhav Tribal Preserve project.

Historically, the lower Colorado River provided unique and environmentally important habitats for native fish, birds, insects, and plants. In 1928, with the passage of the Boulder Canyon Project Act and building of Boulder Dam, the dynamic nature of the lower Colorado River was changed. Upstream control and diversion of water has significantly changed the dynamic nature of the lower river ecosystem resulting in a biologically compromised ecosystem. The river today, for all intent and purpose, is a managed conduit to move water from Lake Mead to the southern International Boundary as quickly and efficiently as possible. Bank stabilization, levees, and channel control have taken the place of backwaters, marshes, and a meandering river. The Colorado River Indian Tribe, with support from the State of Arizona, embarked on an innovative approach to restoring important riverine habitats in 1996 with the initiation of the 'Ahakhav Tribal Preserve. Restoring backwaters and riparian areas are the primary focus of this initial venture. Determining the biological response to the re-opening of backwaters and increasing flow levels is important in the development of a management template for the future. Specific areas of evaluation include determining the utilization of habitats before and after habitat improvement and stability of habitats once they are restored. Determination of the aquatic biological integrity is based on the evaluation of insects, fish, algae, and aquatic plant production with changes in water quality. Comparison of backwater responses in the Tribal Preserve will be made to similar studies being conducted in backwaters in the upper Colorado River basin. The studies being coordinated by the Colorado River Indian Tribes will provide a sound scientific evaluation of the procedures and processes that can be used for habitat restoration in similar areas in the lower Colorado River system.

WIESENBORN, W. D. Lower Colorado Regional Office, U.S. Bureau of Reclamation, PO Box 61470, Boulder City, NV 89006. ***MacNeill's sootywing, an endemic riparian butterfly of the lower Colorado River.***

MacNeill's sootywing, *Hesperopsis gracielae* (MacNeill), is a small (wingspan ≈23 mm) dark-brown skipper found along the lower Colorado River and its tributaries in southeastern California, western Arizona, southern Nevada, and southern Utah. The species was first described in 1970. Flights of *H. gracielae* occur from April to October in two or three generations. Although larvae of *H. gracielae* feed only on *Atriplex lentiformis*, a halophytic riparian shrub found in dense clumps along lower Colorado River drainages, the insect is only sporadically encountered compared with the distribution of its larval host. The rarity of this butterfly, and concern over habitat destruction due to urban and agricultural development, has afforded *H. gracielae* the global rank of "G3?", indicating its conservation status is rare or uncommon but not imperiled.

The rarity of *H. gracielae* compared with that of *A. lentiformis* suggests that factors other than larval-host availability influence its occurrence. One such factor may be the availability of a food source for *H. gracielae* adults. *Hesperopsis gracielae* adults must forage on other plant species, because *A. lentiformis* is wind-pollinated and does not produce nectar. Foraging flights between host and non-host plant species therefore would be expected.

To examine the interplant movement of *H. gracielae* adults, the frequency and sequence of flights between patches of *A. lentiformis* and nonflowering honey mesquite, *Prosopis glandulosa*, were examined on 17, 20, and 24 September 1996 adjacent to the Bill Williams River in western Arizona. Flights occurred across a 4-m wide, dirt and gravel road separating the two plant species. A total of 267 flights by *H. gracielae* was observed during 10.5 hrs, and the number of flights to *A. lentiformis* compared with those to *P. glandulosa* did not significantly differ within each date. Although random sequences of *H. gracielae* flight direction, to *A. lentiformis* or to *P. glandulosa*, were observed on each of the dates sampled, alternating sequences were detected after observed times of flight to *A. lentiformis* were shifted earlier by 2 min, 4 min, and 1-2 min on the three dates. Observed flights to *A. lentiformis* therefore were delayed behind observed flights to *P. glandulosa* by a constant interval on each date. A maximum of 6, 5, and 4 flights cosecutively in the same direction was observed on the three dates, estimating minimum population size. Repetitive flights by *H. gracielae* between *A. lentiformis* and *P. glandulosa* may have been associated with shade seeking, mate finding and reproduction, searching for additional hosts, or foraging. Presence of leaf nectar on the *P. glandulosa*, and rarity of floral nectar during the study, suggests the skippers were foraging at leaf nectaries. Adult Lepidoptera will feed on extrafloral nectar, and extrafloral nectar may provide nectar-feeding insects an alternative food source when floral nectar is rare.

WERNER, W. E. Arizona Game and Fish Department, 2221 W. Greenway Rd., Phoenix, AZ 85023. ***Lower Colorado River Multi-Species Conservation Program***.

Agencies involved in management of lower Colorado River resources, including federal and state water, power, and fish and wildlife agencies, have joined forces with private entities to develop a 50-year plan for the conservation of 102 species of fish and wildlife from Glen Canyon Dam to the boundary with Mexico. Although mainstream Colorado River dams and reservoirs have provided benefits to resource users, construction of those features and introduction of non-indigenous flora and fauna, have resulted in major impacts to biological diversity with resultant listing of several species under the federal Endangered Species Act. The primary purpose of the Lower Colorado River Multi-Species Conservation Program is to develop and implement conservation measures to offset effects of ongoing water and power diversions and to conserve species to avoid additional listings.