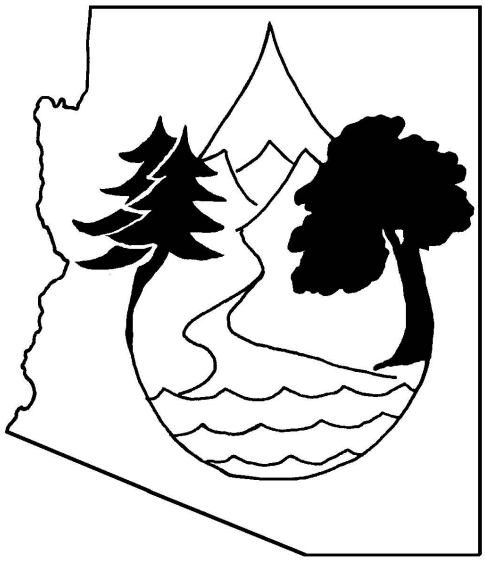
# TENTH MEETING OF THE ARIZONA RIPARIAN COUNCIL

Prescott Resort
Prescott, Arizona
April 12-13, 1996

# RESTORATION OF RIPARIAN AREAS



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1996

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# *ARIZONA RIPARIAN COUNCIL*
# *TENTH MEETING*
# *PRESCOTT RESORT AND CONFERENCE CENTER*
# *PRESCOTT, ARIZONA*
# *APRIL 12-13, 1996*

## Friday, April 12

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|---|---|
| 8:00-10:00 | Registration |
| 8:45-9:00 | **Kris Randall,** Arizona Riparian Council President. Welcome, silent auction, field trips. |
| 9:00-9:30 | **Robert D. Ohmart**, Center for Environmental Studies, Arizona State University. ***Arizona Risk Assessment: Major Threats to Riparian Habitats.*** |
| 9:30-10:00 | **William C. Hunter,** U.S. Fish and Wildlife Service, Atlanta, Georgia. ***Establishing Riparian Conservation Goals and Objectives Using the Partners in Flight Approach.*** |
| 10:00-10:15 | BREAK |
| 10:15-10:45 | **Michael L. Scott,** National Biological Service, Fort Collins, Colorado. ***Understanding Long-Term Channel Change Processes: Implications for Restoration.*** |
| 10:45-11:15 | **Julio Betancourt**, U.S. Geological Survey, Tucson, Arizona. ***Climatic Variability as a Constraint on Management and Restoration of Riparian Areas.*** |
| 11:15-11:45 | **PANEL DISCUSSION WITH INVITED SPEAKERS** |
| 11:45-1:00 | LUNCH |

## FRIDAY, APRIL 12, 1996
## AFTERNOON TECHNICAL SESSION

1:00 - 1:15 **Julia Fonseca[1], Marie Sullivan[2], Sherry Ruther[3], and Karen Novak[1].** [1]Pima County Flood Control District, [2]US. Fish and Wildlife Service, and [3]Arizona Game and Fish Department. ***Considerations for Revegetating Abandoned Farmland in the Cienega Creek Natural Preserve, Pima County.***

1:15 - 1:30 **Stephen C. Hart and Thomas E. Kolb.** School of Forestry, College of Ecosystem Science and Management, Northern Arizona University. ***Water-Use Patterns of Different-Sized Boxelder Trees Along Perennial and Ephemeral Streams.***

1:30 - 1:45 **Chris Vamos.** Kane Jorden von Oppenfeld Bischoff & Biskind, Phoenix. ***Mitigation Banking as an Incentive for Industrial and Commercial Participation in Riparian Restoration.***

1:45 - 2:00 **Barbara Raulston**. Bill Williams River National Wildlife Refuge, U.S. Fish and Wildlife Service. ***Restoration Efforts on the Bill Williams National Wildlife Refuge.***

2:00 - 2:15 **Jerry Stefferud[1] and John N. Rinne[2].** [1]Tonto National Forest, U.S. Forest Service and [2]Rocky Mountain Forest and Range Experiment Station, Flagstaff. ***Sustainability of Fishes in a Desert River: Observations on the Roles of Streamflow and Introduced Fishes.***

2:15 - 2:30 **John N. Rinne[1] and Jerry Stefferud[2].** [1]Rocky Mountain Forest and Range Experiment Station, Flagstaff, and [2]Tonto National Forest, U.S. Forest Service. ***Relationships of Native Fishes and Aquatic Macrohabitats in the Verde River, Arizona.***

2:30 - 2:45 **Curtis E. Deuser.** National Park Service. ***Desert Riparian Restoration Methods.***

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|---|---|
| 2:45 - 3:00 | BREAK |
| 3:00 - 3:15 | **Smith W. Covey.** Conservation Service, Flagstaff RC&D Office. ***Moccasin Wash Demonstration Project.*** |
| 3:15 - 3:30 | **Mark Briggs and Mary Schmid.** Rincon Institute, Tucson. ***Using Lessons Learned From the Past to Design an Effective Riparian Recovery Strategy: A Case Study Describing an Ongoing Effort Near Tucson, Arizona.*** |
| 3:30 - 3:45 | **Linnann Flora[1], Tina Ayers[1], and Lawrence Stevens[2].** [1]Department of Biological Sciences, Northern Arizona University and [2]Glen Canyon Environmental Studies/ATA, Inc. ***How Diverse are Riparian Plant Communities in Grand Canyon: Baseline Information for Riparian Habitat Protection and Restoration.*** |
| 3:45 - 4:00 | **Kris Randall.** Arizona Department of Environmental Quality. ***Rehabilitation of a Degraded Riparian Area Along a Portion of the Salt River in Central Arizona.*** |
| 4:00 - 4:15 | **Karen Novak**. Pima County Flood Control District, Tucson. ***Importance of Xeroriparian Habitat to Single-Family Residents in Unincorporated Pima County.*** |
| 4:15 - 4:30 | **Jamie Agyagos[1] and Teresa Shaffer[2].** [1]Coconino National Forest, U.S. Forest Service and [2]Arizona State Parks, Lake Havasu City. ***A Study of Breeding Bird Nesting Success in a Southwest Riparian Area.*** |
| 4:30 - 4:45 | **Mike Blanton.** Kingman Resource Area, Bureau of Land Management. ***Integrated Resource Management and Riparian Improvement on Grazing Allotments in the Kingman Resource Area.*** |
| 5:00 | Business Meeting and Elections |
| 6:00 | NO HOST CASH BAR, GRANITE MOUNTAIN ROOM |

6:30 Silent Auction Results. Items must be paid for and picked up by 8:30 PM from either Ruth Valencia or Marie Sullivan. Must be present to pickup items -- they will not be mailed.

7:00 DINNER, GRANITE MOUNTAIN ROOM

8:00 **Duncan T. Patten,** Center for Environmental Studies, Arizona State University. ***The Arizona Riparian Council: Evolution of Ideas and Encouragement of Alternative Restoration Approaches***.

8:30 Live music by Les Izmore.

**POSTERS** (Presenters please be at your posters at break times)

**M. G. Baker and D. M. Green.** College of Architecture and Environmental Resources, Arizona State University. ***Effects of Habitat Fragmentation by Urbanization upon Bird Diversity and Habitat in a Sonoran Desert Environment.***

**S. C. Brown, J. J. Donaldson, N. Kroska, and D. Cotter.** Jones & Stokes Associates, Sacramento, California. ***Habitat Restoration in an Urban Setting: Integrating Desert Riparian Habitat, Groundwater Recharge, and Community Participation.***

**A. J. Gavin[1], A. E. Springer[1], L. E. DeWald[2], E. Smith[3], and S. Silbert[3].** [1]Department of Geography, Northern Arizona University; [2]School of Forestry, Northern Arizona University; and [3]The Nature Conservancy. ***Restoration of a Rare, High-Elevation Riparian Community.***

**J. Hicks and S. Watada.** Design Workshop. ***Las Vegas Wash and Verde River Master Plans.***

## SATURDAY, APRIL 13

FIELD TRIPS

There are three (3) concurrent field trips. Everyone is responsible for their own transportation and we encourage carpooling. All trips are scheduled to end after lunch. **For all trips you need to provide your own lunch**.

8:00 AM We will be leaving **ON TIME** from the Resort parking lot for respective sites.

### WATSON WOODS - MARIE SULLIVAN AND JIM DONOVAN

In this field trip we will visit Watson Woods Preserve, a 125-acre riparian restoration site located along Granite Creek in Prescott. The Preserve was recently formed when a local nonprofit organization known as the Prescott Creeks Preservation Association (PCPA) established a long-term lease agreement with the City of Prescott to manage the area as a riparian preserve. This broad, alluvial system has a wide diversity of phreatophytic trees and is dominated by red willow (*Salix laevigata*) and hybrid cottonwoods (*Populus angustifolia* × *P. fremontii*). Subject to at least 140 years of use, including the first official settlement of the area by U.S. troops in the late 1800's, heavy historic grazing of sheep and cattle, placer gold mining, and gravel mining Watson Woods is far from pristine. PCPA has been informally conducting restoration tests on the area for 4 years, and is currently developing a comprehensive restoration plan for the site.

Despite the many urban pressures threatening the physical and biological integrity of this area, Watson Woods provides habitat for a wide diversity of bird species. During the field trip, past, present, and future land-use activities in the surrounding area will be discussed along the PCPA's plans for the area.

### PINE CREEK - ERIC GLOMSKI

**Due to parking this trip is limited to approximately 20 people. Please sign up at registration table**. Pine Creek, located in a private inholding in a pine clad valley of the Bradshaw Mountains, drains Brady Butte and a portion of the eastern range of these mountains. Pine Creek has been exclosed from livestock and recreational use for 1.5 years and had been

an active restoration site for 2 years. The project has been carried out by Prescott College classes during their last two winter semesters during which they have employed a variety of passive and active restoration techniques. Of particular interest are projects that aim at restoring the uplands on the site. They include seeding projects and the construction of earthen structures designed to increase groundwater percolation and storage.

### INSCRIPTION CANYON RANCH - SUE MORGENSEN

Currently the Arizona Game and Fish Commission is evaluating the potential purchase of the Inscription Canyon Ranch in Yavapai County. This ranch includes approximately 871 acres of private land and approximately 339 acres of state grazing lease in several parcels along the Verde River. Encompassed by the ranch are approximately 3.5 miles of the Verde River and associated riparian areas, from below Sullivan Lake to just east of the Prescott Forest Boundary, and over 1 mile of riparian land along lower Granite Creek to its confluence with the Verde River. Information will be given about this proposed acquisition.

**PLEASE, IN THE SPIRIT OF CONSERVATION AND RECYCLING, RECYCLE YOUR NAME TAG BY GIVING IT TO CINDY ZISNER, RATHER THAN DISCARDING IT.**

AGYAGOS, J.[1], and T. SHAFFER[2]. [1]Coconino National Forest, Sedona Ranger District, PO Box 300, Sedona AZ 86339-0300 and [2]Arizona State Parks, 1801 Highway 95, Lake Havasu City AZ 86406. ***A Study of Breeding Bird Nesting Success in a Southwest Riparian Area.***

In 1995, Coconino National Forest initiated a Breeding Bird Study following the protocol developed by Tom Martin (BBIRD). The purpose was to determine diversity and success of species nesting in the Forest's riparian lands, especially looking at neotropical migrants and potential habitat for endangered/threatened/sensitive species. This study was in place during June and July, manned by seasonal and volunteer help, as well as staff. While the thrills and challenges of conducting an intensive study in a riparian zone were exasperating, they could also be humorous, and rewarding. Limiting our data collection was a late start, heavy vegetation, and lack of funding for personnel. Presence of diverse species of fauna and flora made up for the trials. The presence of beaver in the study area produced conditions which nurtured a richness of riparian growth. Some of the areas studied are scheduled to be closed to grazing, for habitat protection. Future studies will reflect the effects of this closure.

BAKER, M. G., and D. M. GREEN. College of Architecture and Environmental Resources, Arizona State University, PO Box 872005, Tempe, AZ 85287-2005. ***Effects of Habitat Fragmentation by Urbanization Upon Bird Diversity and Habitat in a Sonoran Desert Environment.***

Urban expansion into wildlands has reduced and fragmented formerly contiguous wildlife habitats. Embedded within the urban matrix are newly formed habitat islands in a fragmented riparian ecosystem. Although these islands are riparian in floristic and physiognomic character, their function as wildlife habitat is not well understood. We assessed avian species use of riparian habitats along a gradient of increasing urbanization within the city limits of Phoenix, Arizona. We censused avian populations in riparian and adjacent nonriparian habitats representing the land use gradient. Plant composition was quantified by species, density, cover, and volume of canopy by woody perennial vegetation. We determined the spatial character of each riparian fragment by measures of land use adjacency and type, between and within respective riparian habitats. During the months of March through December, riparian fragments embedded in undeveloped and urbanized areas had species richness values of 70 and 74, respectively. Avian populations in urban habitats while abundant, had lower species diversity than wildland habitats. Urbanized habitats were dominated by introduced and generalist foraging species, while native birds accounted for greater species richness in wildland habitats. We feel the impacts of urbanization upon all riparian habitats can be reduced through proper urban planning and active habitat preservation management strategies, to preserve avian diversity.

BETANCOURT, J. U.S. Geological Survey, Desert Laboratory, 1675 W. Anklam Rd, Tucson, AZ 85745. ***Climatic Variability as a Constraint on Management and Restoration on Management and Restoration of Riparian Areas.***

Riparian areas in Arizona are dynamically linked to global-scale climatologies that modulate seasonal and annual streamflow, flood frequency, and magnitude, as well as key phenomena, such as upland fires that enhance overland flow and sediment transport. In Arizona, both interannual and interdecadal climate variability are linked to coupled ocean-atmosphere interactions involving shifts in the upper-air westerlies and what is now commonly called the ENSO (El Niño-Southern Oscillation) cycle. The Southern Oscillation involves interannual (and interdecadal) sea surface pressure and temperature anomalies in the equatorial Pacific, characterized by either a warm (El Niño) or cold (La Niña) ocean. In Arizona, the outcome of El Niño episodes (i.e., 1915, 1919, 1926, 1941, 1958, 1983, and 1993),. or decades of frequent El Niño events (1905-1930 and 1976-1995), is greater precipitation in fall, winter, and spring, with slightly reduced rainfall during summer. Drought occurs during La Niña events (i.e., 1904, 1917, 1925, 1943, 1950, 1955, 1974, and 1989) or decades when the Southern Oscillation oscillates at a lower, more irregular frequency (1930-1960). I will discuss several case studies of how the Southern Oscillation has affected 20th century streamflow, flood regimes, catastrophic drought, wildfires, and vegetation dynamics in the southwestern U.S. Dominant themes will be the challenge of discriminating climatic from land use effects, and management and restoration of riparian areas in a changing climate.

BLANTON, M. Kingman Resource Area, Bureau of Land Management, 2475 Beverly Ave, Kingman, AZ 86401. ***Integrated Resource Management and Riparian Improvement on Grazing Allotments in the Kingman Resource Area.***

The Bureau of Land Management (BLM) is mandated to manage the land it administers on the basis of multiple use and sustained yields. The BLM Manager must integrate the varied land uses with the resource goals developed through the land use planning process. The integrated resource management development on these grazing allotments illustrates some approaches to improving riparian habitat by reducing livestock impacts within the riparian zone. These allotment management plans (AMP) have been developed to allow light grazing use in the riparian areas during the nongrowing season, within increasing utilization levels above moderate use in the adjacent uplands which might adversely affect the watershed and wildlife habitat.

The impacts of livestock grazing on riparian ecosystems have been well documented, and various management prescriptions have been developed which reduce the adverse impacts and improve resource conditions. These range from complete exclusion of livestock to holistic resource management. The key is to find one of the prescriptions which integrates the needs of the resource base with the concerns of the public, and the ability of the livestock operator to accept ownership of the program.

BRIGGS, M., and M. SCHMID. Rincon Institute, 7290 E. Broadway Rd, #M, Tucson AZ 85710. ***Using Lessons Learned From the Past to Design an Effective Riparian Recovery Strategy: A Case Study Describing an Ongoing Effort Near Tucson, Arizona.***

The decline of the riparian ecosystem along lower Rincon Creek, near Tucson, Arizona, reflects the deterioration of riparian ecosystems in many other parts of the western United States. Prior to significant Anglo-American influences, the lower reach of Rincon Creek experienced intermittent to perennial flow and was dominated by a riparian forest (Arizona walnut, *Juglans major* -honey mesquite, *Prosopis velutina*) that extended to 0.5 km wide in some areas. Today, this once magnificent riparian forest no longer exists due to the combined effects of a variety of human activities, including groundwater pumping, stream channelization, agriculture, livestock grazing, and urbanization. Researchers and natural resource practitioners in Tucson are now evaluating the current conditions of lower Rincon Creek to develop a plan to bring this area back to health. Some of the issues and challenges that need to be overcome to improve the ecological condition of this damaged riparian area will be presented. In addition, some of the lessons learned from past riparian recovery efforts will be reviewed and how these lessons can be applied to Rincon Creek and other damaged riparian sites will be discussed.

BROWN, S. C., J. J. DONALDSON, N. KROSKA, and D. COTTER. Jones & Stokes Associates, 2600 V Street, Suite 100, Sacramento CA 95818-1914. ***Habitat Restoration in an Urban Setting: Integrating Desert Riparian Habitat, Groundwater Recharge, and Community Participation.***

Desert riparian habitat has been scarce and of great importance to wildlife in the southwest United States. Because the amount and quality of this habitat type has been greatly reduced from historic levels, restoring desert riparian habitat is a high priority in Arizona. This presentation describes a plan that is being implemented by the Town of Gilbert, Arizona, to establish riparian habitat and provide other wildlife and public use benefits at the town's 75-acre groundwater recharge pond complex. The facility is located in an urban area and uses treated water from the town's wastewater reclamation plant to help recharge the local groundwater. The project is funded primarily through two Arizona Department of Game and Fish Heritage Grants, and has already won two state environmental and planning awards. The project has been largely implemented by volunteers from the local community. Design features of the project include establishment of riparian vegetation along pond margins, marsh vegetation in a permanent pond, and upland vegetation on pond slopes; wildlife nesting structures; interpretive exhibits; and blinds for viewing wildlife. The environmental consulting firm of Jones & Stokes Associates, with assistance from Wild Seed of Tempe, Arizona, assisted the town with preparing the grant applications, developing the plan and details for implementation, collecting and installing cuttings and seeds, and implementing the project using community volunteers. The project successfully integrates enhancement of wildlife and public use values with the operation of a groundwater recharge facility and could serve as a model for other similar urban wildlife habitat restoration projects.

COVEY, S. Natural Resources Conservation Service, Flagstaff RC&D Office, 1633 South Plaza Way, Flagstaff AZ 86001. ***Moccasin Wash Demonstration Project.***

Moccasin Wash, located on the Kaibab-Paiute Indian Reservation just west of Fredonia, Arizona, has a long-standing history of streambed and streambank erosion. Prior to implementation of this riparian establishment project, the wash channel was degrading at a rate of about 2 feet per year. The Cocopai Resource Conservation and Development Area cooperated with the Kaibab-Paiute Tribe, the Arizona Department of Environmental Quality, and the Natural Resources Conservation Service to implement a restoration project on Moccasin Wash. Over 47,000 cottonwood and willow cuttings were planted in the winter of 1995-96 to protect the stream channel and streambanks from erosion. Secondary benefits of this planting is the establishment of a riparian plant community where no tree-form vegetation exists.

Other accomplishments associated with implementation of this project include construction of about 10 miles of fence to exclude livestock from the riparian area and to improve control of grazed animals, installation of four new watering facilities, and implementation of a planned grazing system to maintain upland vegetative cover.

DEUSER, C. E. Natural Park Service, 601 Nevada Highway, Boulder City NV 89005. ***Desert Riparian Restoration Methods.***

Riparian ecosystems in the southwestern United States are unique habitats that provide for greater biological diversity. The integrity of these habitats has been severely altered due to impacts from the exotic tamarisk (*Tamarix ramosissima*) tree and various land management uses. Although tamarisk is difficult to control there have been many successful spring restoration projects at Lake Mead National Recreation Area during several years of implementing an aggressive control program. Methods of tamarisk control including mechanical, chemical, prescribed fire, and maintenance will continue to be utilized. Site recovery of vegetation after tamarisk removal has been equally impressive. Natural plant recruitment processes and reintroduction by transplanting have proven to be successful revegetation methods. Fencing to decrease grazing impacts on riparian areas has also been used as an effective restoration tool at Lake Mead National Recreation Area. Monitoring of vegetation, tamarisk control, and water table levels are important elements of the riparian restoration program.

FLORA, L. M.[1], T. J. AYERS[1], and L. E. STEVENS[2]. [1]Department of Biological Sciences, Northern Arizona University, Flagstaff AZ 86011 and [2]Glen Canyon Environmental Studies/ATA, Inc., PO Box 22459, Flagstaff AZ 86002. ***How Diverse are Riparian Plant Communities in Grand Canyon: Baseline Information for Riparian Habitat Protection and Restoration.***

Restoration of southwestern riparian habitats requires accurate baseline information on plant species diversity and distribution. This is often difficult because human activities have so greatly altered riparian habitats that the pristine condition cannot be determined. We analyzed riparian plant species diversity and growth forms in relation to xeric, upland, and forested plateau habitats in the largely pristine Grand Canyon using Phillips et al. (1987) annotated Grand Canyon flora and Ayers et al. (1994) data. Analysis using GIS of Warren et al.'s (1982) Grand Canyon vegetation map revealed that riparian, wetland, and spring/seep habitats comprise 1,563 ha (0.3%) of the 486,878-ha park. More than 1,300 plant species occur in the park, of which more than 10% are riparian/wetland species. Seep/spring habitats are especially diverse, supporting approximately 5% of the total plant species in the Grand Canyon, but comprise a virtually insignificant area of the mapped region. Thus riparian habitats are disproportionately important as refugia for plant species. Growth form analyses demonstrates that riparian plant species are more likely to be clonal or rhizomatous than are upland plant species. Riparian habitats are more likely to support nonnative species: 12.5% of the lowland Colorado River species are nonnative, and nonnative taxa structurally dominate the river corridor. We discuss the negative correlation between species diversity and elevation in this system, and also the downstream shift in species composition from the Four Corners region to the Mohave Desert. We frame management considerations in this national park in terms of Pleistocene and Holocene climate changes and recent human activities on a regional scale.

FONSECA, J.[1], M. SULLIVAN[2], S. RUTHER[3], and K. NOVAK[1]. [1]Pima County Flood Control District, 200 N. Stone, Tucson AZ 85701, [2]U.S. Fish and Wildlife Service, 2321 W. Royal Palm Rd #103, Phoenix AZ 85021, and [3]Arizona Game and Fish Department, 555 N. Greasewood, Tucson AZ 85745. ***Considerations for Revegetating Abandoned Farmland in the Cienega Creek Natural Preserve, Pima County.***

Abandoned farmland located within the Cienega Creek Natural Preserve provides an opportunity to improve habitat for neotropical migratory birds and terrestrial mammals using this natural riparian corridor. The site is the type locality of *Sporobolus wrightii*, or Wright's sacaton, having been a sacaton bottomland in 1880. Prior to clearing in 1974, the site was a mesquite bosque, with only a small remnant grassland.

Goals of the revegetation project are to accelerate mesquite reestablishment, increase structural diversity and native plant species density, and to reestablish sacaton grass where feasible.

Adjacent, contemporaneous clearings provide locations where natural revegetation processes can be compared. Revegetation has proceeded more slowly in the farm field compared to other clearings. Grazing, soil ripping, exotic grasses, and generally inadequate soil moisture seem to be retarding the rate of recovery. The large size of the field (which reduces the efficiency of seed dispersal and increases evapotranspiration losses) compared to other clearings is probably another factor.

To overcome these obstacles, fencing, container plantings, and supplemental irrigation are proposed. Localized herbicide applications and weed mats will be used to reduce competition around container plants. Plantings will be clustered to reduce evaporation due to wind and to enhance irrigation benefits. Sacaton, mesquite, and several other species will be grown out from seed collected on site.

Trenches for archaeological clearance encountered pithouses and other buried cultural features in the south part of the field. The State Historic Preservation Office restricts the location of tree planting to areas where tree roots would not disrupt buried cultural horizons.

GAVIN, A. J.[1], A. E. SPRINGER[1], L. E. DeWALD[2], E. SMITH[3], and S. SILBERT[3]. [1]Department of Geography and [2]School of Forestry, Northern Arizona University, Flagstaff AZ 86001; and [3]The Nature Conservancy, 114 N. San Francisco St., Flagstaff AZ 86001.
***Restoration of a Rare, High-Elevation Riparian Community.***

An interdisciplinary team is collaborating to restore a rare, high-elevation riparian habitat that has supported one of the largest Bebb willow-mixed graminoid communities in the United States. This recently initiated, three-year riparian restoration project is supported by the Arizona Water Protection Fund and represents cooperative efforts of the Department of Geology and School of Forestry at Northern Arizona University, The Arizona Nature Conservancy, the U.S. Forest Service, and the U.S. Geological Survey. The restoration project will remove an early 1900 surface/subsurface water diversion in order to restore natural flow conditions downslope into the plant community below. The project involves characterization and monitoring of the surface/subsurface water quality and quantity, and vegetation in the plant communities above and below, and prior to and after, removal of the diversion. Monitoring will include measurement of precipitation, stream flow, water levels, spring and seep discharge, soil moisture, soil water pressure, Bebb willow water status, Bebb willow regeneration and early growth, and plant species diversity and distributions. In conjunction with the riparian restoration project, The Nature Conservancy is constructing fences in areas critical to the riparian restoration to mediate grazing effects on the ecosystem, and they are building a nature trail and developing an environmental education program focusing on riparian ecosystems and habitat restoration activities. If successful, the riparian restoration project will increase awareness of the importance of riparian ecosystems, and will restore and protect a unique, critical, high-elevation riparian habitat by providing greater quantities of water flow later in the summer for the riparian ecosystem.

HART, S. C., and T. E. KOLB. School of Forestry, College of Ecosystem Science and Management, Northern Arizona University, Flagstaff AZ 86011-5018. ***Water-Use Patterns of Different-Sized Boxelder Trees Along Perennial and Ephemeral Streams.***

Significant water stress can develop in riparian trees growing along waterways with highly variable flows, especially in semi-arid regions, such as the southwestern United States, where stream flows are often ephemeral. Over the last several decades, stream diversions and impoundments for supplying water and power to the rapidly growing urban centers of the western United States may also have significantly impacted the water relations of riparian vegetation. Because in semi-arid regions productivity, recruitment, and establishment of riparian trees are generally tightly coupled with water availability, natural or human-caused changes in water availability potentially can have significant ramifications for the sustainability of riparian forests. We compared water-use patterns of large (>20 cm diameter at breast height) and small (<10 cm diameter) boxelder (*Acer negundo* L.) trees growing along adjacent perennial and ephemeral streams in a montane riparian ecosystem in northern Arizona using a stable isotopic tracer approach. Specifically, we assess: (1) how the accessibility of stream water affected water source utilization by boxelder trees; (2) whether potential shifts in water source use during the growing season varies with tree size and the dependability of the water source; and (3) if seasonal shifts in water source use altered tree relations. Our results support the hypothesis that boxelder trees in these riparian ecosystems are phreatophytes, which avoid water stress by tapping groundwater. Nevertheless, monsoonal precipitation is an important source of water late in the growing season as stream flow and groundwater are reduced below spring levels. Stream water did not appear to be utilized by these trees based on similar water relations of box elder trees growing along perennial and ephemeral streams. Water stress was similar for large and small trees; this similarity in the water relations of large and small trees perhaps is due to the phreatophytic nature of these trees, and because small trees were vegetative sprouts from older stems with developed root systems and not true seedlings. Our results indicate that box elder trees have active roots in both the shallow and deep soil layers. We hypothesize that active shallow roots are predominantly used as conduits for nutrient acquisition, while the primary function of deep roots is for water uptake from reliable deep sources.

HICKS, J., and S. WATADA. Design Workshop, 310 S. Mill Ave., Suite 201, Tempe AZ 85281. ***Las Vegas Wash and Verde River Master Plans.***

We recently completed a riparian restoration master plan for Clark County, Nevada. The project is called Las Vegas Wash and is a restoration and recreation master plan that will restore wetlands that have been impacted by the growing Las Vegas area. We also would like to present the Verde River Master Plan prepared for Arizona State Parks, and Desert Spaces currently being prepared for Maricopa Association of Governments.

HUNTER, W. C. Partners in Flight, U.S. Fish and Wildlife Service, 1875 Century Boulevard, Suite 200, Atlanta GA 30345. ***Establishing Riparian Conservation Goals and Objectives Using the Partners in Flight Approach***.

The formation of the Arizona Riparian Council addressed an increasing need to exchange information and educate the public and managers alike about the status of riparian habitats and their importance to maintaining a high quality-of-life in the Southwest. Substantial knowledge on the present status and importance of riparian habitats now exists, in large part, due to the efforts of Council participants. With interest in restoring native riparian habitats continuing to grow, among the most important roles the Council serves is as a clearinghouse for restoration and revegetation information, including protocols and rates of success. Despite these notable achievements, plans for restoration and riparian systems still suffer from a lack of defined goals and objectives required to return vital and specific ecological functions and values to southwestern ecosystems.

I present a developing methodology employed by Partners in Flight to establish population and habitat objectives intended to support healthier populations of otherwise vulnerable birds. I use as an example, the efforts now underway along the Mississippi Alluvial Plain through a joint initiative restoring wetland habitats necessary for achieving waterfowl, shorebird, and landbird population objectives. The lower Mississippi River floodplain is the country's largest riparian system and is highly altered in ways that are familiar to those of us who have observed changes along major southwestern river systems. Although most priority birds and restoration protocols differ between these two regions, the process for setting specific acreages and desired habitat patch sizes for restoration within these systems should be remarkably similar. The West regional and Arizona state Partners in Flight working groups should make for dynamic partners with the Arizona Riparian Council by providing estimates on patch sizes and numbers of patches per system desired to support high priority riparian birds. The Arizona Riparian Council can then help to facilitate riparian habitat restoration and protection efforts needed to achieve these stated objectives, which in turn should lead to achieving at least one mutual goal of increasing the integrity of Arizona's precious riparian ecosystems.

NOVAK, K. Pima County Flood Control District, 201 N. Stone Avenue, Tucson AZ 85701. ***Importance of Xeroriparian Habitat to Single-Family Residents in Unincorporated Pima County.***

The development of riparian habitat maps, and subsequent adoption by the Pima County Board of Supervisors provided the basis for a survey of single-family residents' attitudes on the importance they place on xeroriparian habitat. This habitat is generally described as the vegetated area associated with smaller natural drainageways, found throughout undeveloped areas in the Sonoran Desert.

Single-family residents were selected for the survey based upon their proximity to regulated xeroriparian habitat. Three "zones of proximity" were defined and used for the survey. These zones are (1) the adjacent zone, residences with regulated habitat either within or immediately next to the property; (2) the vicinity zone, residences within a minimal distance from regulated habitat, but whose property did not contain or touch regulated habitat; and (3) the remote zone, residences that were far enough away from regulated habitat to have limited opportunity to experience the habitat.

A total of 45 phone interviews were conducted in February 1996. Participants were asked questions about their uses, attitudes, and concerns about the natural washes near their homes, their knowledge of the benefits of riparian areas and Pima County's Riparian Protection Ordinance, the impact of the removal of the vegetation associated with the natural wash on their attitude toward their homes, and the influence the presence of a natural wash would have on a home-buying decision.

Comparisons between the three different zones of proximity to the importance of xeroriparian habitat will be explored. Results of the surveys will be presented. This research is being undertaken as part of a Master's of Landscape Architecture thesis at the University of Arizona, College of Agriculture, School of Renewable Resources.

OHMART, R. D. Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211. ***Arizona Risk Assessment: Major Threats to Riparian Habitats.***

During the process of assessing the level of risks of anthropogenic stressors on riparian habitats in Arizona many human activities were considered. The three stressors deemed most detrimental were water management, groundwater pumping, and domestic livestock grazing. I will concentrate on the latter stressor because (1) the effects are insidious, (2) unmanaged grazing is ubiquitous within the state, and (3) it is a very difficult problem to solve through management. Proper functioning condition in streams, three phases of degradation with unmanaged grazing, and some information on the healing processes (with and without restoration) will be examined.

PATTEN, D. T. Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211. ***The Arizona Riparian Council: Evolution of Ideas and Encouragement of Alternative Restoration Approaches.***

The Arizona Riparian Council was spawned in 1985 at the First North American Riparian Conference in Tucson, Arizona. It hatched at a meeting that fall and has continued to grow and influence riparian management decisions throughout the state. Concerns that precipitated its origination in 1985 have not changed, but our understanding of Arizona's riparian systems has expanded, due to the activities and encouragement of the Council and its members. The Council's committees have played important roles in development of riparian management and enhancement. The Classification and Inventory Committee developed a digitized system that influenced federal and state classification systems and encouraged the U.S. Fish and Wildlife Service to test the Council's ideas on the National Wetlands Inventory classification system. The Water Resources Committee worked with the Arizona Department of Water Resources in establishing protocols for applications for instream flow rights for riparian systems. The Education Committee has influenced the public's perception of the importance of riparian systems through production of innumerable information publications. The Protection and Enhancement Committee produced an annotated bibliography of riparian publications. The Council has been recognized for its expertise, with representatives serving on statewide committees such as the Riparian Area Advisory Committee. All of these activities demonstrate a dynamic organization; however, the Council cannot rest on its laurels. The Council must adopt the new ideas developed from riparian research and resource management communities and encourage their application throughout the state. This means improving the dialog between the Council and resource users. Although much of the Council's early emphasis was on preserving and enhancing existing riparian ecosystems, it is imperative that the Council take an active role in restoration activities, even though this may be anathema to those who do not want to see expansion of "wetlands" in the state. Restoration of riparian ecosystems can take many forms. It may require active mechanistic approaches such as channel reconfiguration, or it may be an accidental consequence of some other activity that influences stream dynamics. Returning sufficient water to a stream with natural flow patterns may be all that is required. Releasing effluent into a stream may trigger restoration through inadvertent maintenance of a perennial flow. Many other approaches also exist and the Arizona Riparian Council with its expertise should play a significant role in Arizona and the Southwest in guiding resource managers and users toward improved riparian restoration activities.

RANDALL, K. Arizona Department of Environmental Quality, 3033 N. Central Avenue, Phoenix AZ 85012. ***Rehabilitation of a Degraded Riparian Area Along a Portion of the Salt River in Central Arizona.***

An ecologically based rehabilitation plan was developed to evaluate sites in a portion of the Salt River in Tempe, Arizona. Cottonwoods (*Populus fremontii*) growing in the river channel since 1988 were used as indicators of water availability. Temporal and spatial variation in biotic parameters of xylem water potential, foliage density, and shoot and radial growth indicated water availability at the three sites.

The storm drain site had high xylem water potentials, high foliage density, and the greatest radial growth. Using radial growth as the dependent variable and ten environmental parameters as independent variables, a multiple regression analysis showed that January, February, and March precipitation explained 54% of the variation in radial growth at this site. The channel site also had high xylem water potentials, but low foliage density, and the lowest radial growth. No environmental parameters significantly explained variability of radial growth at this site. Xylem water potentials were also high in the canal site while foliage density was low, and radial growth was slightly lower than the storm drain site. January, February, and March precipitation explained 69% of the variation in radial growth.

Environmental parameters of hydrology, geology, and fluvial geomorphology influenced water availability, establishment and maintenance of riparian vegetation, and overall channel geometry. A measurement of the influence of these parameters was the diversity in ages of trees observed at each site. All four age classes and the greatest number of class I trees (0 to 2 years) were present at the channel site where fluvial processes such as deposition and aggradation of alluvial sediments had a greater effect than at the other two sites.

Based on analysis of the biotic and environmental parameters, sites were ranked for probability of revegetation success. The storm drain site was ranked the highest. Early winter precipitation, which entered the site via a storm drain outfall, was the primary source of water for this site. The canal area was ranked second and early winter precipitation was also indicated as a source of water for this site. Neither precipitation, streamflow, nor depth to groundwater could explain the water source for the channel site. Dynamic fluvial processes operating in the channel were most apparent at this site, thus making maintenance of vegetation precarious. Therefore the channel site was ranked third.

This research developed a method whereby degraded riparian areas can be rehabilitated to a higher functional level by recognizing the processes that are occurring and enhancing them.

RAULSTON, B. U.S. Fish and Wildlife Service, Bill Williams River National Wildlife Refuge, 60911 Highway 95, Parker AZ 85344. ***Restoration Efforts on the Bill Williams River National Wildlife Refuge.***

Pole plantings have a good chance of success on the refuge because of a high water table and soils low in salinity. There have been three major pole planting projects on the refuge in the past 7 years, in 1990, 1991, and 1995. Approximately 71% of the poles planted in 1990 have survived. The 1991 planting effort was in a burned area. Due to thick saltcedar and cattail growth following the fire, access to the site is now almost impossible. Recent aerial photographs and visual inspections from high points around the site indicate that enough trees survived to at least provide a seed source. In 1995, 715 cottonwood and willow poles were planted on an alluvial bank formed after the 1993 flood. Of these, 190 were randomly selected for monitoring. Information on soil salinity, water table depths at the site, and growth and survival of these trees will be discussed. In addition, high water releases up to 6,800 cfs in 1993 and 1995 resulted in significant natural regeneration of riparian vegetation on the refuge.

RINNE, J. N.[1], and J. STEFFERUD[2]. [1]USDA Forest Service, The Southwest Forest Science Laboratory, 2500 S. Pineknoll Dr., Flagstaff AZ 86001 and [2]USDA Forest Service, Tonto National Forest, 2324 E. McDowell Rd., Phoenix AZ 85010. ***Relationships of Native Fishes and Aquatic Macrohabitats in the Verde River, Arizona.***

Limited information are available on the relative, quantitative, physical habitat utilization of a native fish community in large desert river systems in the Southwest. Ongoing studies on the upper Verde River, Arizona, are, in part, assessing velocity and depth of waters in this reach of undammed, free-flowing river and its habitation by respective species. Six native species are present and appear to occupy habitats based especially on velocity, and to a lesser extent, depth of water. Velocity and depths of a half dozen qualitatively defined aquatic macrohabitats will be delimited based on empirical data. Occupation of these habitats by the respective native fish species have to be partially defined. Three species (*Gila robusta, Catostoma insignis,* and *C. clarki*) are primarily glide to pool inhabitants, two (*Agosia chrysogaster* and *Meda fulgida*) occupy low gradient riffle-run habitat, and one (*Rhinichthys osculus*) predominates in high-gradient riffle habitat.

SCOTT, M. L., J. M. FRIEDMAN, and G. T. AUBLE. National Biological Survey, Midcontinent Ecological Science Center, 4512 McMurry Ave., Fort Collins CO 80525. ***Understanding Long-Term Channel Change Processes: Implications for Restoration.***

Members of the Salicaceae including cottonwood and willow are pioneer species that are dependent upon disturbance for establishment. Riparian sites suitable for establishment are typically created by flow-related processes of channel change. Different processes produce different patterns and extent of bottomland forest. Along perennial streams with moderate flow variability, most channel change is accomplished by relatively frequent flows; frequent establishment of small patches of trees is balanced by frequent removal of older patches. In this situation, channel width, forest area, and forest age structure remain relatively stable over time. In contrast, along ephemeral streams with high flow variability, channel change is dominated by the effects of extreme events; channel width is variable, tree establishment infrequent, and forest area and age structure are unstable. The latter situation best describes riparian ecosystems in the semi-arid Great Plains and desert Southwest. These processes have important implications for conservation and restoration of riparian cottonwoods: (1) maintaining a constant acreage of forest is unrealistic; (2) natural forest regeneration is possible only where channel change and flood disturbance are allowed; (3) defining presettlement condition is problematic (i.e., do we restore a cienega, an arroyo, or a cottonwood forest?); (4) understanding long-term geomorphic processes and system limitations assisted natural regeneration is sometimes possible along regulated streams.

STEFFERUD, J.[1], and J. N. RINNE[2]. [1]USDA Forest Service, Tonto National Forest, 2324 E. McDowell Rd., Phoenix AZ 85010 and [2]USDA Forest Service, The Southwest Forest Science Laboratory, 2500 S. Pineknoll Dr., Flagstaff AZ 86001. ***Sustainability of Fishes in a Desert River: Observations on the Roles of Streamflow and Introduced Fishes.***

Patterns of stream discharge and presence of introduced fishes appear to interact to influence community dynamics and sustainability of native fishes in streams of the arid Southwest. Few streams in Arizona retain a fish fauna that is predominantly native. The 60-km reach of the Verde River upstream from Sycamore Creek (near Tapco) is relatively unimpacted by water diversions, and still contains most of its native species. In 1994, we began a 10-year study to investigate the effects of streamflow and nonnative species on native fishes of the Verde River between Granite and Sycamore Creeks. Backpack electrofishers and seines were used to sample the fish community at seven sites in the spring, and two sites in the autumn during 1994 and 1995.

Native species (longfin dace, roundtail chub, spikedace, speckled dace, Sonora sucker, and desert sucker) comprised >80% of each sample. Relative abundance of red shiner was variable between samples, and occurrence of other nonnative species (fathead minnow, common carp, green sunfish, smallmouth bass, yellow bullhead, channel catfish, and flathead catfish) were modest (Table 1 next page).

Based on no evident difference in abundance of nonnative fishes, the differences in total number of fish captured between 1994 and 1995 samples could be due to substantial flooding in the reach during January-February 1995. Similar flooding occurred in 1993, and sampling that spring by Arizona Game and Fish Department indicated a notable reduction in total abundance of fish from previous years (Kirk Young pers. comm.). Our spring catch in 1994 contained a large proportion of Age 1 specimens of native species, whereas this age group was much less in spring 1995. Young-of-the-year fish were relatively more abundant during 1995 autumn sampling then in the autumn samples from 1994. This may indicate that flooding influences reproduction and survival of the native species.

Table 1. Relative abundance of fishes taken during spring (7 sites), and autumn (2 sites) sampling, 1994-1995, upper Verde River.

| Species | Spring 1994 | Spring 1995 | Autumn 1994 | Autumn 1995 |
|---|---|---|---|---|
| Longfin dace | 15.2% | 0.9% | 31.7% | 0.8% |
| Roundtail chub | 8.9% | 26.8% | 3.7% | 7.6% |
| Spikedace | 4.9% | 5.7% | 23.2% | 4.4% |
| Speckled dace | 2.0% | 2.0% | 1.0% | 23.3% |
| Sonora sucker | 20.8% | 25.3% | 16.0% | 20.9% |
| Desert sucker | 30.4% | 25.7% | 9.3% | 41.8% |
| Red shiner | 16.9% | 7.6% | 12.6% | 0.4% |
| Fathead minnow | 0.1% | -- | -- | -- |
| Common carp | 0.3% | 0.5% | 0.2% | -- |
| Smallmouth bass | 0.2% | 0.8% | 0.7% | -- |
| Green sunfish | <0.1% | 2.3% | 0.6% | -- |
| Yellow bullhead | 0.4% | 2.3% | 1.0% | 0.8% |
| Channel catfish | 0.1% | 0.2% | -- | -- |
| Flathead catfish | | 0.1% | -- | -- |
| *N* | 8,705 | 1,274 | 1,252 | 249 |

VAMOS, C. Kane Jorden von Oppenfeld Bischoff & Biskind, 4201 N. 24th St., Phoenix AZ 85016. ***Mitigation Banking as an Incentive for Industrial and Commercial Participation in Riparian Restoration.***

Wetland mitigation banking is a program designed to help achieve the goal of no net loss of our Nation's wetlands through advance restoration, creation, enhancement, or preservation of wetlands prior to unavoidable wetland degradation. In the past, compensatory mitigation of unavoidable impacts on wetlands has occurred in a fragmented fashion, creating uncertainty in the Section 404 permitting process. The new wetland mitigation banking program may provide a solution to this problem by establishing a credit system where large-scale wetland mitigation projects can be established and banked in advance and portions withdrawn over time to compensate for unavoidable wetland losses.

Section 404 of the Clean Water Act regulates discharges of dredged or fill materials into the waters of the United States. Under Section 404, the U.S. Army Corps of Engineers is primarily responsible for the issuance of permits to fill or degrade wetlands. Before the Corps will issue a permit, the applicant must meet the following criteria: (1) the applicant must either avoid adverse impacts to wetlands or demonstrate that such impacts are unavoidable. The applicant can show that an impact is unavoidable if no practicable alternative exists that would have a less adverse impact on the wetlands. (2) If impacts are unavoidable, the applicant must minimize such adverse impacts. (3) Last, the applicant must perform compensatory mitigation to offset adverse impacts that occur despite avoidance and minimization. Compensatory mitigation includes the restoration of previously degraded wetlands, creation of new wetlands, enhancement of existing wetlands, or preservations of existing wetlands. Wetland mitigation banking is a system whereby compensatory mitigation projects are performed in advance of development impacts, translated into credits, and then withdrawn and used to offset the losses caused by the wetlands development project.

Wetland mitigation banking can be used as an incentive for industrial and commercial participation in restoration of riparian areas. Industry can plan ahead for future development through "banking" in advance large parcels or contiguous riparian areas that have been restored, enhanced, created, or preserved. Larger, offsite wetland ecosystems may be more ecologically valuable than the smaller wetland areas being developed. Additionally, economies of scale make large-scale mitigation projects more cost effective than small-scale, project-specific mitigation.

These banked "credits" can then be withdrawn to offset eventual development. Wetlands degradation typically results from the cumulative impact of uncompensated, piecemeal fills. Some fills are too small to mitigate on a site-specific basis because of the impracticality and inefficiency of small-scale mitigation. Mitigation banking allows the developer to offset the cumulative impacts of fragmented fill projects by "withdrawing" from the large parcel bank a single, functionally equivalent parcel.

Wetland mitigation banking offers industry and commercial developers certainty in the permitting process by having established compensatory mitigation credit available to an applicant in advance of developing impacts. Additionally, the consolidation of compensatory mitigation projects may more effectively replace wetland functions in a watershed. Finally, economies of scale make large-scale mitigation an economically more attractive alternative than project-specific, piecemeal mitigation.

## NOTES