Arizona Riparian Council

Volume 17, Number 3 September 2004

Characterizing Southwestern Willow Flycatcher Habitat along the Lower San Pedro and Gila Rivers, Arizona: Vegetation and Hydrogeomorphic Considerations

by Chuck Paradzick, Arizona Game and Fish Department, Phoenix, and School of Life Sciences, Arizona State University, Tempe

Conservation of wildlife populations hinges on making informed habitat management decisions. Wildlife habitat-use patterns need to be studied over long time frames and multiple spatial scales to capture responses to environmental changes. This is especially crucial to species that occupy ephemeral habitats having high temporal variability in habitat conditions and species distributions (e.g., Southwestern floodplain forests). However, few research projects are designed or funded with such intentions, rather habitat associations are pieced together from several projects, each one building upon the last.

The Arizona Game and Fish Department (AGFD) has been conducting and compiling distribution and abundance data on the federally endangered Southwestern willow flycatcher (*Empidonax traillii extimus*) since 1993 (Fig. 1). The flycatcher is a riparian-obligate songbird that nests in streamside thickets and reservoir-delta forests in the Southwest (core of its range includes Arizona, California, New Mexico, and Nevada). Due primarily to habitat loss and alteration, flycatchers declined precipitously over the last century. Its listing as endangered in 1995, and a 1996 U.S. Bureau of Reclamation (USBR) Biological Opinion for the raising of Roosevelt Dam, prompted an increase in research and monitoring efforts, among other conservation actions, in central Arizona. AGFD, USBR, and the U.S. Geological Survey (USGS) partnered to conduct a long-term demographic monitoring project at Roosevelt and along the Gila and lower San Pedro Rivers. In 1998, AGFD began collecting data on nest-site selection by the flycatcher and in 2003 that analysis was published (Allison et al. 2003). Similarly, in 2003, AGFD analyzed flycatcher habitat selection using GIS, and remote sensing (satellite imagery, digital elevation models) at multiple spatial scales (Hatten and

(*Cont. pg. 3 . . . . Flycatcher*)

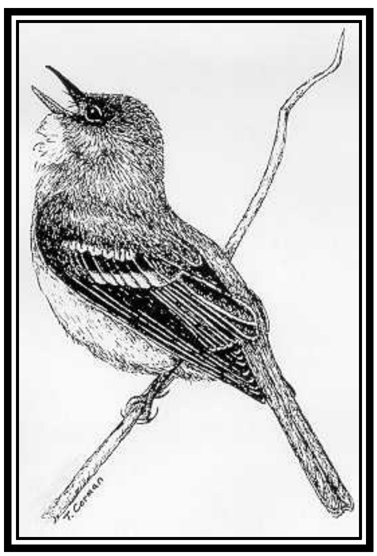

Figure 1. Southwestern willow flycatcher.

Inside This Issue

ARC October 16-17, 2004 Fall Campout and Get-Together Gray Hawk Ranch Nature Center along the San Pedro River

Join us at the Arizona Riparian Council Fall Campout and Get-Together on Saturday-Sunday, October 16-17, 2004. We will be camping at the Gray Hawk Ranch Nature Center, along the San Pedro River, 3918 Gray Hawk Lane, PO Box 807, Sierra Vista, AZ 85636-0807. We encourage everyone to arrive by 1 pm on Saturday. A map can be found on the ARC website at <*http://azriparian.asu.edu/2004/fallmtg.pdf*> and will be emailed to those who register.

The San Pedro River is an internationally recognized treasure. It is the last major free-flowing river remaining in the southwestern United States. Its location makes it a critical corridor for bird migration as well as the movement of animals and plants across this border region. The Upper San Pedro has been protected as the Nation's first Riparian National Conservation Area.

The Saturday afternoon program will focus on the San Pedro and our invited speakers are Holly Richter, Upper San Pedro Program Manager, The Nature Conservancy; Bill Civish, Bureau of Land Management; and Russell Scott, USDA Agricultural Research Service. We will have a field trip along the San Pedro on Sunday morning.

Gray Hawk Nature Center
Sierra Vista, Arizona

Dinner will be prepared for us by Gray Hawk Ranch on Saturday evening and coffee for breakfast for Sunday morning with your own breakfast. Let us know if you prefer a vegetarian meal. Portable restroom facilities will be provided. This year a small fee is being charged to offset a portion of the costs associated with dinner and restroom facilities. Please copy and fill out the form below and return it along with your check to the Arizona Riparian Council by October 7th.

The Gray Hawk Nature Center, located on the beautiful San Pedro River, seeks to promote understanding, appreciation, and conservation of the natural environment through education and hands-on learning experiences. The Center is a non-profit, 501c3, environmental education facility located among the "sky islands" of southeast Arizona. There are a few rules: no pets, no fires, and please use the restroom facilities provided and not the forest.

Jeff Inwood, President

✂---

Registration Form
Please submit by October 7

Name ____
Address ____
____
Email address:_________________________________ Phone: ______________________
Check here ____ for vegetarian meal. If so, how many? _____
No. of people (include yourself): Adults ($15) __ Children 10-18 ($10) __ Children 1-9 ($0) __
Total ____
Return to: Cindy D. Zisner, Arizona Riparian Council, Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe, AZ 85287-3211

(*Flycatcher cont. from pg. 1*)

Paradzick 2003). Both manuscripts noted a missing piece to the habitat puzzle – analysis of patch-level selection that could link selection scales.

In addition to understanding habitat affinities for sensitive species, defining the ecological processes that create and maintain such habitats provides the foundation for making informed land and water management decisions. These associations are especially important for the conservation and recovery of endangered species, like the flycatcher, that occur in high disturbance habitats, such as along arid-land rivers, where available habitat can fluctuate both spatially and temporally.

In 2001, to determine patch-level selection with an eye toward linking scales and to address the pattern-process connection, I approached Dr. Julie Stromberg at Arizona State University for guidance to develop a Master's thesis.

This study had two overall goals and each goal had multiple objectives:

1. Describe patch-scale flycatcher habitat selection patterns for the population located near the Gila River and San Pedro River confluence, and integrate the findings of the two previous studies completed by AGFD.
   a. Develop and test a model of habitat selection using patch-level presence-absence data and a suite of vegetation and environmental variables based on literature.
   b. Compare structural traits of tamarisk (*Tamarix ramosissima*)-dominated occupied patches to occupied cottonwood (*Populus fremontii)*-willow (*Salix gooddingii*)-dominated patches to aid in the determination of tamarisk influence on flycatcher persistence and recovery (an ongoing objective of the AGFD and USGS).
2. Define the geomorphic and hydrologic conditions that create and sustain these habitat components.
   a. Contrast hydrology, geomorphology, and vegetation between the regulated Gila River and unregulated San Pedro River.
   b. For each river, quantify differences in hydrology, geomorphology, and vegetation patch structure between willow flycatcher occupied and unoccupied patches.
   c. Relate environmental differences to the occurrence of vegetation required by flycatchers.

The thesis is still "under construction," with the first goal more developed than the second. Below, is a summary of my research to date on goal 1 (Habitat Selection) and some thoughts on potential management implications.

STUDY AREA AND METHODS

Habitat Selection

To characterize flycatcher habitat selection, I measured vegetation components at 10 occupied and 10 unoccupied (but potentially suitable for nesting based on literature) patches on each river reach: lower San Pedro River (Mammoth to Gila River confluence) and middle Gila River (Dripping Springs Wash to just below Kelvin Bridge), for a total of 40 patches (Fig. 2).

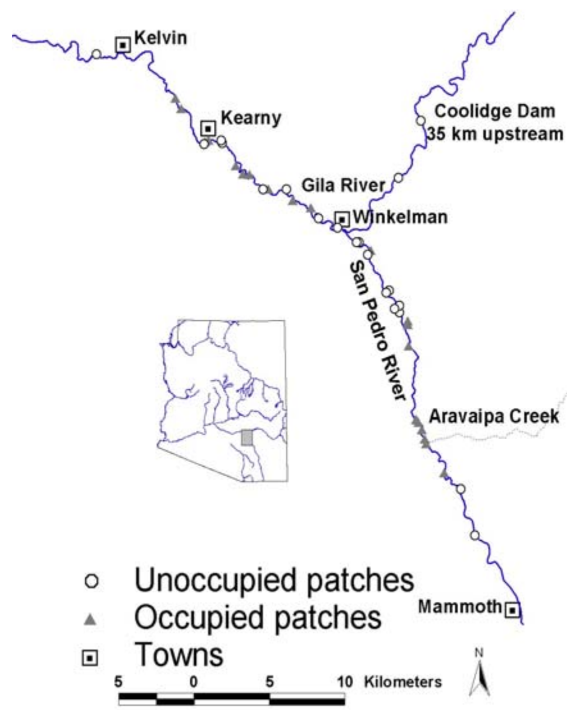

Figure 2. Confluence of the lower San Pedro River and Gila River and locations of study sites.

Table 1. Final variables included in the logistic regression model explaining willow flycatcher habitat patch selection on the Gila and lower San Pedro Rivers, Arizona.

Variable	Coefficient	SE	Wald	P	Odds Ratio	Odds ratio 95% CI Lower	Odds ratio 95% CI Upper
Basal Area 5.5 – 15 cm[a]	0.863	0.354	5.939	0.015	2.37	1.18	4.75
Water[b]	1.911	1.195	2.558	0.110	6.76	0.65	70.27
% Forest in 4.5 ha neighborhood[c]	0.691	0.356	3.780	0.052	2.00	0.99	4.01
Constant	-7.634	2.437	9.812	0.002			

[a] Odds ratio calculated in 20-cm increments: $(cm^2/100m^2)/20$

[b] Modeled as a binary variable: 1 = water <1 m from patch, 0 = water >1 m from patch

[c] Odds ratio calculated in 10% increments

Within each patch, I sampled approximately 10% of the total patch area using randomly placed 100-m^2 plots. In each plot, I counted all woody stems, estimated vertical foliage volume and diversity, canopy cover, maximum canopy height, and distance to water. I also estimated ground cover within the patch and delineated patch types, based on dominant plant species, cover, and size class, in the surrounding 4.5-ha neighborhood. The sampling area was based on results of Hatten and Paradzick (2003) – this area was linked to site selection but information on floristics and vegetation structure was lacking. Patch types within the 4.5-ha area included forest (>60% cover), woodland (25-60% cover), shrubland (multi-stemmed shrubs or trees <5m tall) (>25% cover), grass-forb land (>25 % cover), channel/water, and open/bare (<25% cover). I used a cluster analysis to group patches by floristic composition, correlations to reduce variables, and multiple logistic regression to determine selection patterns.

RESULTS

Preliminary Findings

- Cluster analysis suggested two main floristic groupings of patches: cottonwood-willow (Pofr-Sago) dominated (>58% total basal area) and tamarisk (Tara) dominated (>51% total basal area).
- Occupied patches were dominated by dense stands of young (5.5-15 cm diameter at breast height [DBH]) tamarisk and/or willow.
- Occupied patches had consistently high (>70%) and homogeneous canopy cover.
- Vertical foliage density was high in all strata, and greatest between 7-9 m (above mean nest height), but foliage diversity did not differ between unoccupied and occupied patches.
- Occupied patches were close to water or saturated soil.
- Occupied patches had greater forest (of any type) in the surrounding 4.5-ha neighborhood.
- Tamarisk-occupied patches also had greater woodland in the 4.5-ha neighborhood.
- Tamarisk and cottonwood-willow occupied patches had similar structural characteristics.
- Multivariate logistic regression model suggested that basal area of trees 5.5-15 cm DBH, amount of forest in the 4.5-ha neighborhood, and presence of water were the best predictors of occupied habitat (Table 1).

MANAGEMENT IMPLICATIONS

Nesting Southwestern willow flycatchers along the Gila and lower San Pedro Rivers selected dense patches dominated by young (5.5-15 cm DBH) tamarisk and willow trees located near moist soils or standing water, and within a larger complex of riparian forest. Stands of young trees had dense canopy cover and high foliage density, which supports the qualitative descriptions of flycatcher habitat requirements in the literature, and is similar to results of other studies of flycatcher habitat use in Arizona and in other parts of its range.

High stem densities of young tamarisk and willow provide the needed within-patch structure during the breeding season. Dense vegetation can benefit offspring production through nest concealment from predators, and may also provide a cooler microclimate that could be especially important in the desert Southwest. Similarly, the presence of water could not only influence microclimate through evaporative cooling, but might also increase insect abundance, and the vigor and growth of riparian trees used during the breeding season.

Avian survival and reproductive rates are linked to habitat choice and habitat selection does not necessarily re reproductive viability if the habitat is a sink for the species. There is a current resurgence of tamarisk removal projects throughout the West and some researchers have hypothesized that tamarisk has negative effects on flycatcher fitness; however, little empirical data has been presented to substantiate this assertion. Research by AGFD and USGS suggests that reproductive rates, nest success, juvenile and adult survivorship, and breeding-season physiological conditions at flycatcher sites at the Gila and lower San Pedro Rivers and Roosevelt Lake are similar between habitats, and the populations are stable or expanding at both areas. These data highlight the need to collect quantitative data through empirical studies to make informed flycatcher management, conservation, and river restoration decisions.

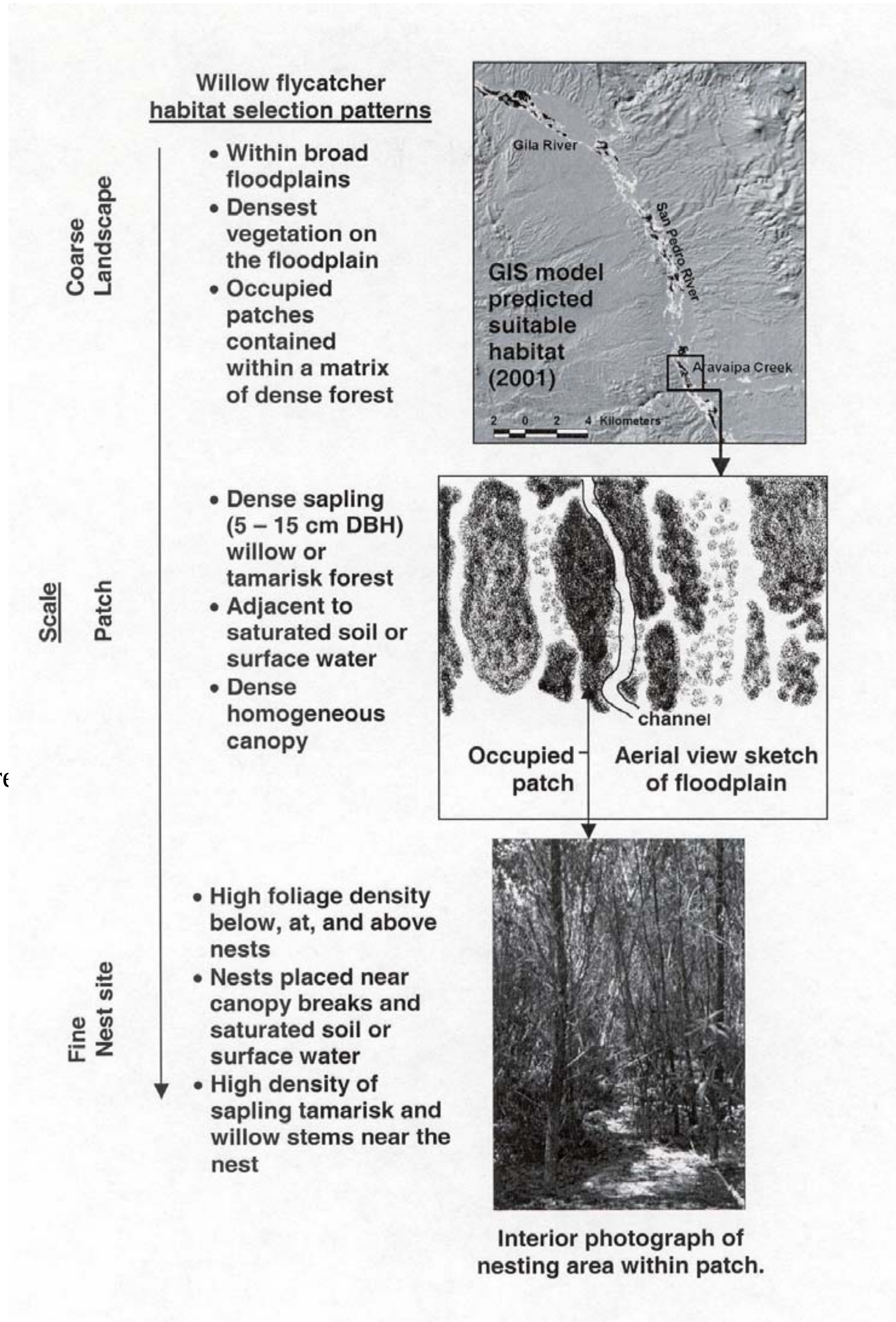

Figure 3. Southwestern willow flycatcher habitat preferences at multiple spatial scales: landscape scale shows GIS-model results (black polygons) overlaid on digital elevation model of lower San Pedro River floodplain (modified from Hatten and Paradzick [2003] and Paradzick and Hatten [2004]). Patch scale shows sketch of occupied flycatcher patch and local surrounding habitat (Paradzick unpubl. data). Nest scale shows photograph of nesting trees and within patch structure (photo by A. Smith).

A synthesis of habitat-selection results of the three studies completed along the Gila and lower San Pedro Rivers is shown in Figure 3. Together, and with results from other flycatcher habitat studies, a more complete picture of habitat needs can be described. The preference for young dense forest stands (<9 year cottonwood-willow, <20 yr tamarisk) presents a management challenge both in protecting extant sites and sustaining available habitat through time. This preference highlights the importance of periodic disturbance in the riparian ecosystem to produce new cohorts of trees suitable for flycatcher nesting over the long-term. Management actions should not only consider direct effects to forest communities, but alterations to the underlying ecosystem processes could influence the abundance and distribution of suitable habitat.

In the second part of my research, preliminary analysis suggests that vegetation communities, and fluvial and hydrological conditions on the Gila River differ considerably from the lower San Pedro River. Tamarisk patches dominate the Gila, whereas cottonwood-willow is more abundant on the San Pedro. Also, recent survey data from AGFD suggest that habitat on the Gila River is becoming decadent with little recruitment of new trees, and some occupied patches have been desiccated by the combination drought and reduction of water releases from Coolidge Dam, which have defoliated nesting areas causing flycatchers to abandon habitat. While on the San Pedro River, USBR, The Nature Conservancy, and Salt River Project have been acquiring property, decreasing groundwater withdrawals, and reducing livestock impacts on the floodplain. New, young habitat is developing and flycatchers have been recorded colonizing these areas. Thus, an ecosystem approach is needed to assess how historic and recent flow regimes, groundwater pumping, and livestock grazing, influences the current conditions of flycatcher nesting habitat and its future potential on Southwestern rivers.

LITERATURE CITED

Allison, L. J., C. E. Paradzick, J. W. Rourke, and T. D. McCarthey. 2003. A characterization of nesting and non-nesting plots for Southwestern willow flycatchers in central Arizona. *Studies in Avian Biology* 26:81-89.

Dockens, P. E. T., C. E. Paradzick, and J. R. Hatten. 2004. Application of a Southwestern willow flycatcher GIS-based habitat model: An estimate of breeding habitat in Arizona, 2001. Pp. 28-59 *in* P.E.T. Dockens and C.E. Paradzick, eds., *Mapping and monitoring Southwestern willow flycatcher habitat in Arizona: A remote sensing approach.* Nongame and Endangered Wildlife Program Technical Report 223. Arizona Game and Fish Department, Phoenix, AZ.

Hatten, J. R., and C. E. Paradzick. 2003. A multiscaled model of Southwestern willow flycatcher breeding habitat. *Journal of Wildlife Management* 67:774-788.

LAND USE COMMITTEE UPDATE *by Tim Flood*

Last month, Arizona Public Service (APS) updated their plans for decommissioning the Childs-Irving facilities. Since 1909 a flume had diverted most of the 43 cfs flow of Fossil Springs into turbines to generate hydropower. In 1999, APS decided that the environmental benefits of closing the facilities outweighed the business impact, and now is proceeding with surrendering its license. APS recognizes this unique opportunity to return 14 miles of the diverted Fossil Creek to its original channel and reestablish a rare, travertine-dominated, riparian area.

APS expects the Federal Energy Regulatory Commission to approve its surrender application within a few months, and to return flows to Fossil Creek around December 21, 2004. Costs for decommissioning are estimated at $13 million.

The process requires consultation with numerous federal and state agencies. The APS Project Team is paying much attention to document the cultural, historic, and engineering aspects of the facilities, including the perspectives from past and current employees. Similarly, the Team expressed their commitment to dismantle the facilities in an environmentally sensitive manner. A temporary bridge to Irving will be constructed this month. Prior to restoring flows, a native fish renovation project will occur. The Bureau of Reclamation will build a fish barrier near the Verde River. Native fish will be

Land Use Update Cont. . . . 14

MARTINEZ CANYON UPDATE

Tom and Tomas Taylor, Mesa, AZ

In the fall of 2001 the Arizona Riparian Council selected Martinez Canyon for its annual Fall Campout. Some significant events have occurred since then, and some critical decisions for this riparian canyon are "coming around the corner."

At the campout we presented our Martinez Canyon Native Fish Project. We began this project in 2000. With perennial, spring-fed pools we proposed they could be utilized for the conservation of native fish species. We sent the proposal to the Bureau of Land Management (BLM), and also to the Arizona Game and Fish Department (AGFD). BLM completed the Environmental Assessment (EA) authorizing three species. We volunteered our efforts with AGFD and so far we have two dace species in the water. The longfin and the speckled dace *(Rhinichthys chrysogaster* and *R. osculus*, respectively). The third species authorized is the Gila chub (*Gila intermedia*). Two attempts to locate a population in Mineral Creek came up empty-handed. Incidentally, it was a phone conversation we had with the late Dr. W.L. Minckley that inspired proposing Gila chub from Mineral Creek. Before we could capture Gila chub at the alternate sight the species became a candidate for listing. This delayed the capture due to a Section 7 review with the U.S. Fish and Wildlife Service (USFWS). Just recently, this review has been completed and soon with cooler weather and a habitat check the Gila chub should be part of the native fish assemblage.

At the time of the Fall 2001 Campout some photopoints were established by Tim Flood and other ARC participants. This crucial procedure initiated by the ARC will ensure close monitoring of this rare desert riparian habitat.

Another significant event occurred this past Veteran's Day, 2003. The AGFD released 30 head of desert bighorn sheep (*Ovis canadensis mexicanus*) into the Mineral Mountains, the range where Martinez Canyon is situated. This is a reintroduction effort as the desert bighorn sheep have historically inhabited these mountains. The sheep are monitored by aerial flights and ground radio telemetry. There is has been at least one lamb birth since the release of the sheep! Needless to say some of the sheep migrated to the environs of Martinez Canyon, finding great habitat in the towering peaks.

Recently while participating in a "Watershed Survey" with some BLM staff we encountered what may be a "message." While hiking in lower Martinez Canyon we came upon a pair of nesting Zone-tailed Hawks (*Buteo albonotatus*) with their young fledging still in the nest. A few months ago the BLM began prohibiting motorized vehicle traffic in this ephemeral section of Martinez Canyon, where the raptor nest already existed. The "message" we ponder is the possibility these Zone-Tailed Hawks regained their nest without the motorized vehicle disruptions.

Since the Fall 2001 ARC Campout in Martinez Canyon, workshops have begun on a "route inventory" for the Mineral Mountains and surrounding landscape. The objective of the workshops is to review existing routes from maps recently produced. Three alternatives are recommended for each route. A (1) "green" alternative leans toward closures, (2) a pro motorized leans toward leaving them open, and (3) the "tweener" alternative may leave a route open, but with limitations. Since the original topographic maps of the area, and even since 1992 aerial photographs, you can see a proliferation of roads. Mining activity ended more than two decades ago, so the majority of these "wildcat" roads may have been created by off-highway-vehicles.

If you would like information on participating in these workshops, would like to visit Martinez Canyon for a possible bighorn sheep sighting, or to see reintroduced native fish, please feel free to contact Tomas or Tom Taylor. Also, when the critical time comes for public review of BLM's proposed route designations we will let the ARC be aware so we can get your valuable comments!

We thank the ARC for accessibility and replies we have received. Please contact us by email: Tom at *arizonadeserttom@aol.com* or Tomas at *whiptaillizard@aol.com* .

NOTEWORTHY PUBLICATIONS

Elizabeth Ridgely
Gila River Indian Community, Pima-Maricopa Irrigation Project

Barnosky, A. D., E. A. Hadly, and C. J. Bell. 2003. Mammalian response to global warming on varied temporal scales. *Journal of Mammalogy* 84(2):354-368.

Paleontological information was used to evaluate and compare how Rocky Mountain mammalian communities changed during past global warming events characterized by different durations (350, 10,000–20,000, and 4 million years) and different per-100-year warming rates (1.08°C, 0.18°C, 0.06-0.088°C, 0.0002-0.00038°C). The goals were to determine whether biotic changes observed today are characteristic of or accelerated relative to what took place during past global warming events and to clarify the possible trajectory of mammalian faunal change that climate change may initiate. The determination is complicated because actual warming rates scale inversely with the time during which temperature is measured, and species with different life-history strategies respond, or do not respond in different ways.

Nevertheless, examination of past global warming episodes suggested that approximately concurrent with warming, a predictable sequence of biotic events occurs at the regional scale of the central and northern U.S. Rocky Mountains. First, phenotypic and density changes in populations are detectable within 100 years. Extinction of some species, noticeable changes in taxonomic composition of communities, and possibly reduction in species richness follow as warming extends to a few thousand years. Faunal turnover nears 100% and species diversity may increase when warm temperatures last hundreds of thousands to millions of years, because speciation takes place and faunal changes initiated by a variety of shorter-term processes accumulate. Climate-induced faunal changes reported for the current global warming episode probably do not yet exceed the normal rate, but continued warming during the next few decades, especially combined with the many other pressures of humans on natural ecosystems, has a high probability of producing effects that have not been experienced often, if ever, in mammalian history.

Predictions about how terrestrial vertebrates will respond to current global warming, projected to occur at rates of 1.4–5.88°C per 100 years, have been based primarily on modern ecological studies or on analysis of data from the Pleistocene-Holocene transition. Such studies suggest that mammalian communities in a given geographic region will respond to climatic change by altering 1) relative abundance of individuals within species; 2) taxonomic composition as species locally (extirpation) or globally (extinction) disappear or colonize; and 3) species richness as rates of extinction, extirpation, and immigration are affected. Other possible effects of environmental change are expression of different phenotypes such as nutritional quality or environmental factors, genetic change through population processes, and evolution of new species when environmental change induces new selective pressures, fragments species ranges, and encourages dispersal. Changes in speciation rates, like the other factors listed in point 3, would contribute to changing species richness.

Two uncertainties remain. First, what is the sequence of events and expected extent of change as the duration of a warming event continues over time spans that are long by ecological standards (i.e., hundreds, thousands, and millions of years)? Second, are ecosystems already experiencing such a fast rate of global warming that the resulting biotic changes are fundamentally different from those that characterized past warming episodes?

The object was to more reliably understand the trajectory of biotic change that mammals will experience as a result of the current global warming episode. The background rate of temperature change was established for the past 60 million years and, within that context, assessed how mammalian species and communities changed during four previous warming events: Medieval Warm Period (MWP), two different glacialinterglacial transitions (GIGT), and the Mid-Miocene Climatic Optimum (MMCO). The resulting information provided a useful baseline for recognizing what is ''normal'' for rates of climate change and accompanying faunal dynamics and whether currently observed faunal changes reflect a unique response to global warming or fall within the range of background noise in the context of the last 60 million years. As with most paleontological data, it was not possible to prove that observed biotic changes that coincided with climatic change were caused by the climatic change. However, observed faunal responses were consistent with expectations.

The observations led to a generalized model of how global warming may affect the mammalian component of communities over spans of time that are long by ecological standards and establish which faunal responses are normal given the background rate of climate change that characterized the Cenozoic. As a global warming episode begins, morphologic changes become evident in populations as nutritional and other ecophenotypically important aspects of their environment affect individuals. Concurrently, relative abundance of individuals within species changes, leading to slight changes in species ranges as populations expand and contract. Population-level genetic changes may occur from the resulting effects on gene flow and population size. These responses are evident by the time global temperature is elevated 18°C within 100 years and remains elevated for 400 years (MWP). If global temperature rises 58°C within a few millennia (e.g., the first 5,000 years of an interglacial period), extinctions, extirpations, and immigrations lead to clear changes in taxonomic composition of local communities and possibly some reduction in species richness. When warming persists over a million years or so, with global temperature increasing at least 28°C (possibly in some interval of time less than a million years), relative abundance of species within higher taxa changes dramatically, and speciation may become important in augmenting species richness of local communities. Concurrently, extinction, immigration, and emigration on this million-year time scale are widespread, leading to a nearly completely new set of species relative to the prewarming time (MMCO). How much such dramatic changes result from the long duration of the warming episode itself, and how much from the accumulation of other biotic influences over such long time periods, remains unclear.

Implications emerged as follows: first, past warming episodes seem to have been characterized by an initially fast rate of change and then stabilization of rates as global temperatures remained elevated through the duration of the episode. This holds true for all 4 past events discussed. In terms of biotic response, the length of time during which temperature increased and the total duration of the warm episode seem to be important. Elevating global mean temperature at least 18°C in 100 years seems to elicit local biotic response, and the greater the magnitude of initial warming and the longer the warming episode persists, the more biotic change accumulates.

The 1st-order response is change in populations and geographic ranges, and the 2nd-order response is extinction of species. The 3rd-order response of rebuilding species diversity through speciation takes much longer than the 1st- and 2nd-order responses. Neither the faunal responses that currently are being reported nor the rate of warming so far measured has yet exceeded what was normal for most of mammalian history. That means that there are still some more or less naturally operating mammalian communities within earth's ecosystems. Mammalian response to the current global warming episode probably is now within the 1st-order response: that is adjusting phenotypes and minor adjustments in geographic ranges. Concerns arise with the very high probability of continued rapid warming rates through the rest of this century and beyond.

Within a few decades, the rate of global temperature change will have exceeded the norm for mammalian history. When the threshold is crossed, the authors predict that the 2nd-order response to climate change – extinction and dramatic geographic range changes leading to very different taxonomic compositions relative to what now exists in given localities - will accelerate rapidly. Extinction may well be elevated relative to past warming events, such as the MWP and GIGTs, especially in view of the other human-induced changes that have the net effect of habitat fragmentation on the one hand and homogenization of global biota on the other (introduction of exotic species). Speciation, the 3rd-order response, will not act to maintain diversity because it operates on a much longer time scale than the 1st- and 2nd-order responses.

Biotic systems are resilient within a certain range of rates in global temperature change over periods that are long relative to a human lifetime. This range of normal rates has not been exceeded yet. Thus, there is still hope of conserving natural landscapes that exhibit most of the climate-equilibrated ecosystem dynamics to which mammalian communities have adapted during their long evolutionary history. However, it also is clear that we are on the verge of exceeding the natural variation in rates of global temperature change as global warming continues into the next century. In this light, worldwide efforts to curb duration and acceleration of global warming are critical to conserving natural biotic systems, if ‘‘natural’’ is taken to mean conditions within the bounds of typical faunal response and climatic-change rates through the past 60 million years.

Willot, E. 2004. Restoring nature, without mosquitoes? *Restoration Ecology* 12(2):147-153.

Historically many wetlands were drained to help control malaria and other deadly diseases. However, increased populations of pathogen-transmitting mosquitoes occur when wetlands and riparian habitats are built or restored. This article illustrates the pros and cons about restoration or creation of wetlands with respect to mosquitoes. Abundant mosquitoes should not be regarded as an after-the-fact surprising side effect but rather, abundant mosquitoes should be viewed as a direct result of providing habitat suitable for them. Funding mechanisms and educational institutions often fail to address the reality that restoring or creating wetlands has a downside.

The association between disease and wetlands was known long ago. The swampy area south of Toledo, Ohio, was considered almost uninhabitable due to disease, presumably malaria, until most of the swamp was drained between 1870 and 1920. The desert Southwest was not exempt: several U.S. Army camps, in what is now southern Arizona, were closed due to malaria. Dramatic decreases in mortality are attributable to decreases in malaria, cholera, typhoid, and diphtheria. One author attributes the decline in malaria in the United States during the late 1800s to removal of mosquito habitat (by drainage of potential crop land and swamps and removal of mill ponds), better rural housing, rapid transportation, and other components of modern civilization. Another author concludes that widespread draining enabled that reduction, by exposing rich agricultural land that permitted people to increase their standard of living, resulting in better-built houses, better diets, and isolation of the sick.

Louisiana was too difficult for France to defend largely due to mosquitoes. In 1802 Napoleon sent 33,000 men to conquer Haiti and the Mississippi; 29,000 died of yellow fever. As a result, France sold Louisiana to the United States in 1803.

Western and Eastern equine encephalitis, St. Louis encephalitis, and LaCrosse encephalitis viruses are present in the United States.West Nile virus, introduced into the U.S. in New York in the late 1990s, is spreading westward. The virus causes either a mild illness or much more serious meningitis or encephalitis. In 2003, 230 deaths were reported according to the Centers for Disease Control.

The introduction of either an exotic species of mosquito or an exotic pathogen could have serious consequences: an endemic pathogen in an exotic mosquito host or an exotic pathogen in an endemic host might result in greater disease transmission. When we restore or create riparian and wetland habitat, we typically create excellent mosquito habitat.

In California, between 1974 and 1988, at least five of nine pilot water treatment plants using aquatic macrophytes closed because of mosquito problems. At Sweetwater Wetlands in Tucson, Arizona, a surface-flow, wastewater treatment-constructed wetland, mosquitoes increased 100-fold after starting operation . Weekly monitoring and several abatement methods, allowed significant control of mosquitoes; now Sweetwater is an instructive example for others building wetlands.

Mosquitoes are highly mobile. *Aedes albopictus* arrived in the mid-1980s, most likely in used tires shipped to

Texas from southeast Asia. As desiccation-resistant eggs in used tires, *A. albopictus* rapidly spread throughout the eastern U.S., although in Florida transport of graveyard floral arrangements fostered their spread. As people receive shipments of living bamboo and banana plants bought on-line or from stores stocked via trucks moving across the country, they provide excellent opportunities for *A. albopictus* to spread.

Some people distinguish between human-inhabited space (culture) and wild space (nature). However, for mobile species this is sometimes merely a conceptual boundary, not an ecological one. For example, in southern Arizona, the mosquito *Culex uinquefasciatus* (a possible vector for West Nile virus in the Southwest; see Goddard et al. 2002), breeds readily in either wetland areas or human-made containers, such as empty watering jugs or discarded cups.

When we say we desire to experience nature, what most of us mean is that we want to experience selected aspects of nature. This is consistent with our preferences in other areas: we find some risk, even deadly risk, tolerable. For example, we prefer that our children not be killed in traffic, but that preference does not lead us to refuse to have roads near schools. The idea of "untouched nature" is important to many people. Wilderness sometimes is better preserved when abundant mosquitoes and black flies serve as deterrents to keep most humans away and thereby allowing the ecosystem to flourish with minimal human influence. More of us now can want wetlands if the associated risks are not too great.

The *Society for Restoration Ecology's Primer* opens with an extended definition of “'ecological restoration,” which includes the idea that we aim to restore underlying capacities that permit elements of the ecosystem to interact in ways promoting flourishing of species suitable for that region. The idea is to restore function, not to make the ecosystem resemble that of some earlier time. This interest in function constrains what can or cannot be considered suitable species. The interest in restoring function is often to restore a kind and level of function suitable not only for wildlife but also for humans. We need to admit mosquito-posed problems and explore what we can do to limit those problems. Perhaps we need the equivalent of “school zones'” where mosquitoes are more aggressively monitored and managed at wetlands near significant human populations.

Mosquito-transmitted viruses also threaten nonhuman species. West Nile virus primarily affects birds. Humans and horses are sometimes called “dead-end hosts'”; they can acquire the virus from a mosquito, but they do not transmit it. In North America, birds of over 100 species can be killed by West Nile. In certain situations, to protect particular bird species, it may be beneficial for us to manage mosquito populations. The dilemma is that mosquitoes transmitting a virus may threaten bird populations that are desirable inhabitants of that ecosystem. Adding fish such as *Gambusia* that eat mosquito larvae may help control mosquitoes and hence reduce risk to birds, but *Gambusia* may threaten other fish species or other aquatic organisms.

Restoring mosquito habitat has both advantages and disadvantages; we want wetlands, but we do not want to increase current or potential health risks. As a society, we do a reasonable job managing risks posed by things like cars traveling near schools. We can manage, also imperfectly, risks associated with wetlands. One of the prices of restoring wetlands will be continuous monitoring. By integrating mosquito awareness and control into an entire project, it seems reasonable that some people will volunteer to monitor mosquito species and numbers. After mosquitoes were under control at Rumney Marsh, Park Avenue Restorations Project in Massachusetts, support for the project increased. The author closes by stating that, “When we create or restore wetlands, we not only restore or create wildlife habitat for humans to enjoy; we also create human social environments. What type of human social environments do we promote, if we write, fund, encourage, or implement proposals or books that ignore or minimize known problems?”

LEGAL ISSUES OF CONCERN

*Richard Tiburcio Campbell, U.S. Environmental Protection Agency**

THE CONTINUING STRUGGLE OVER THE VALIDITY OF INSTREAM FLOW RIGHTS IN ARIZONA

*(*After six years practicing environmental and water rights law in Arizona, Richard is now an Associate Regional Counsel with EPA Region 9, which includes Arizona within its jurisdiction. The viewpoints expressed in this article do not necessarily represent the viewpoints of the EPA.)*

"[I]f nature accomplishes a result which is recognized and utilized, a change of process by man would seem unnecessary".[1]

Phelps Dodge continues to challenge the State of Arizona's legal authority to issue instream flow permits for the benefit of recreation, and fish and wildlife. As discussed in previous issues of the *Arizona Riparian Council Newsletter* (16[1]:13 and 16[2]:7]) Phelps Dodge is steadily moving its legal claim through Arizona's administrative and lower courts to an expected resolution by the Arizona Supreme Court. The stakes are high. Dozens of instream flow permits have been approved by the Arizona Department of Water Resources (ADWR) over the last two decades. In addition, important instream flow permit applications, such as one filed by the U.S. Forest Service (USFS) for Fossil Creek, are currently before ADWR.

An instream flow right is a surface water right recognized under Arizona's surface water code that remains *in-situ* or "instream," for purposes of maintaining flows for wildlife, including fish and/or recreation. At present, any person, including the federal government, may apply to ADWR for an instream flow permit. ADWR is required to approve a complete application unless the instream use conflicts with vested rights, is a menace to public safety, or is against the interests and welfare of the public.

The instream flow application that Phelps Dodge is challenging involves one filed in 1999 by USFS, Tonto National Forest for a segment of Cherry Creek, a tributary of the Salt River, located east of Roosevelt Lake. Phelps Dodge filed a timely protest to the application, arguing that the Arizona Legislature never expressly authorized ADWR to issue instream flow permits. Phelps Dodge also argued that the appropriation of water in Arizona necessarily requires a diversion of water out of the stream, which in effect prevents the use of water for instream purposes. In its responsive pleadings, ADWR argued that because the Legislature had expressly included "recreation" and "wildlife, including fish" as permissible purposes for obtaining a right to appropriate water, and these purposes necessarily involve maintenance of instream flows, the Legislature had indeed granted ADWR legal authority to issue instream flow permits. ADWR also pointed out that the Arizona Court of Appeals had expressly embraced this logic in a previous decision involving water rights:

> [I]n 1941 when 'wildlife, including fish' and in 1962 when 'recreation' were added to the purposes for appropriation, the concept of *in situ* appropriation of water was introduced – it appearing to us that these purposes could be enjoyed without a diversion ... We therefore find that by these amendments the legislature intended to grant a vested right to the State of Arizona to subject unappropriated waters exclusively to the use of recreation and fishing.

McClellan v. Jantzen, 26 Ariz. App. 223, 225; 547 P.2d 494, 496 (1976), *review denied*. In spite of this legal precedent, Phelps Dodge continued to press its administrative appeal. Salt River Project (SRP) subsequently joined the fray on the side of ADWR, obviously concerned about retaining upstream flows in several stream systems for downstream use by its customers.

Leading up to the administrative hearing of this matter

---

[1] *Empire Water & Power Co. v. Cascade Town Co.*, 205 F. 123, 129 (8th Cir. 1913).

in 2002 the administrative law judge got the parties to agree that the legal questions regarding ADWR's authority to issue instream permits should be resolved prior to tackling the issue of whether the permit application was sufficient. After a public hearing involving oral arguments was held on December 13, 2002, the judge decided in favor of ADWR and SRP. (*See* the *Arizona Riparian Council Newsletter* 16[2]:7 for a further discussion of this administrative decision.)

Phelps Dodge appealed the administrative decision to the Maricopa County Superior Court in 2003. In March 2004, the Honorable Michael D. Jones found the administrative decision to be "well-reasoned" and ruled in favor of ADWR and SRP. *See Phelps Dodge v. ADWR*, Case No. LC2003-000343-001 DT (March 8, 2004).

The Superior Court found the reasoning of the Arizona Court of Appeals in *McClellan v. Jantzen* to be persuasive. The Superior Court also cited in support of its ruling the Montana Supreme Court's decision regarding instream flow rights in its *Adjudication of Existing Rights to the Use of all Water***,** 311 Mont. 327; 55 P.3d 396 (2002). The Superior Court did not discuss or quote the Montana decision, but one line of reasoning in the Montana Court's decision deserves special attention: "Ample case law depicting the evolution of the prior appropriation doctrine, and emerging from throughout the West, supports a conclusion that the doctrine should not rigidly demand a diversion where unnecessary to achieve the intended beneficial use." (311 Mont. at 341; 55 P.3d at 404). The Montana Court specifically held that Montana law had never required a diversion for a valid appropriation of water "[b]ecause beneficial use rather than diversion is the touchstone of the prior appropriation doctrine, because Montana has long recognized as beneficial the use of water for fish, wildlife and recreation; and because Montana has validated non-diversionary appropriations [i.e., stock watering]...." (311 Mont. at 345; 55 P.3d at 407). The Montana Court's reasoning is particularly persuasive because like Montana, Arizona's surface water right code is also based on the doctrine of prior appropriation.

It is worth noting that several other state courts have dispensed with the diversion requirement. Though not discussed by the Maricopa Superior Court, Oregon has long recognized that "when no 'ditch, canal, or other structure' is necessary to divert the water from its natural channel, the law does not vainly require such works, prior to an appropriation." *In re Water Rights in Silvies River* (Or. 1925), 115 Ore. 27, 237 P. 322, 336. Similarly, the Colorado Supreme Court found that "It is not necessary in every case for an appropriator of water to construct ditches or artificial ways through which the water might be taken from the stream in order that a valid appropriation be made. The only indispensable requirements are that the appropriator intends to use the waters for a beneficial purpose and actually applies them to that use." *Town of Genoa v. Westfall*, 141 Colo. 533, 349 P.2d 370, 378 (Colo. 1960). Moreover, the Idaho Supreme Court persuasively noted that "where an appropriative water right does not require a diversion to make it effective and beneficial, in the absence of a statute requiring a diversion there appears to be no practical reason why a diversion should be required." *State, Dept. of Parks v. Idaho Dept. of Water Admin*., 96 Idaho 440, 530 P.2d 924, 933 (Idaho 1974)(Bakes, J., concurring). More recently, in *State v. Morros*, 104 Nev. 709, 766 P.2d 263, 265 (Nev. 1988), the Nevada Supreme Court validated an inlake appropriation for recreation purposes and recognized that just as the common law "conformed to the practical demands of stockwatering," so should it reflect the fact that "diversions are not needed for and are incompatible with many recreational uses." *Morros*, 766 P.2d at 267.

The Nevada case raises an important practical issue. The position held by Phelps Dodge could charitably be characterized as anachronistic except that the position held by Phelps Dodge also brings into question the validity of long-standing stock-watering rights since diversion is unnecessary to secure this type of water right. It remains a mystery why the Arizona Cattlemen's Association decided not to weigh in on the side of ADWR and SRP.

In sum, what the Maricopa Superior Court, and several other state courts, have recognized is that the notion that a physical diversion of water is necessary to create a surface water right is an anachronism. At Arizona's statehood, and some years later, the requirement that surface water be diverted in order to trigger its appropriation was sensible because it was a practical necessity. Much as an 1800's miner was required to "stake a claim" by physically erecting corner posts at the very spot they intended to mine, a physical demonstration of the diversion of surface water was the only sure way a would-be water appropriator could provide notice to the public at large of the appropriator's intent to advantage oneself of the prior appropriation law, and to establish the volume of water the appropriator intended to put to beneficial use. In contrast, present-day advances in geohydrology, computer modeling, and water measurement devices, render the diversion requirement unnecessary. (The mining industry may be forgiven their preoccupation with the physical diversion aspects of the prior appropriation doctrine. After all, even the 21st century miner must still "stake a claim" by erecting corner posts and posting notice.)

It is important to note that the Maricopa Superior Court decision is not the end of the matter. Phelps Dodge appealed the Superior Court decision to the Arizona Court of Appeals on June 25, 2004. As of the date of this article, no briefs have been exchanged or oral arguments scheduled.

NEW MEXICO, TEXAS GOVERNORS PLEDGE TO RESOLVE CONFLICTS OVER COMPACTS

At a meeting of governors from U.S. and Mexican border states held in late August, New Mexico Gov. Bill Richardson and Texas Gov. Rick Perry announced that they will try to negotiate a solution to a long-standing conflict between their states over water deliveries. For decades, tensions between the two neighboring states have escalated as New Mexico has struggled to meet its water delivery obligations under compacts governing the Pecos River and Rio Grande. The Rio Grande Compact, signed by Colorado, New Mexico, and Texas in 1938, and the Pecos River Compact, adopted 10 years later by New Mexico and Texas, divvied up the water from the two rivers among the states. As an upstream state, New Mexico is required to ensure that enough water flows to Texas to meet compact requirements. Under the agreements, New Mexico essentially can use no more water from the rivers than it did at the time the compacts were negotiated, with Texas getting what is left over. The problem, water experts say, is that New Mexico and Texas have undergone tremendous growth and change since the compacts were adopted. While both New Mexico and west Texas were largely agricultural during the early to mid-20th century, increasing demand from growing cities along the rivers, including Albuquerque and Carlsbad in New Mexico and El Paso and Juarez in Texas, put new strains on the compacts. At the same time, drought has cut flows in both rivers. Furthermore, pueblo water rights were not factored in when water was allocated under the compacts. Another issue complicating the matter involves providing water habitat for endangered species.

SERC www.serconline.org State Environmental Resource Center

Editor's note: *This article was adapted from the email newsletter* WILDLINES *III, Number 34, produced by SERC (State Environmental Resource Center). More information can be obtained about them at their website.*

Land Use Update . . from pg. 6

captured, and piscicide applied to remove non native fish by late November 2004.

Four APS five-worker crews will deconstruct 18 segments. Estimated timeframes for various removals are: wood and metal flume starting in 2005; Childs facilities by 2006; and Irving power plant in 2007-20008. The fish and frog habitat will be reassessed in 2007 with current plans to remove 14 feet from the crest of the Fossil Springs diversion dam pending "Adaptive Management." Sediment behind the dam is expected to wash out naturally. Handoff to USFS will occur in 2009.

APS deserves much praise for their plans to restore full flows to Fossil Creek.

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

The purpose of the Council is to provide for the exchange of information on the status, protection, and management of riparian systems in Arizona. The term "riparian" is intended to include vegetation, habitats, or ecosystems that are associated with bodies of water (streams or lakes) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. Any person or organization interested in the management, protection, or scientific study of riparian systems, or some related phase of riparian conservation is eligible for membership. Annual dues (January-December) are $20. Additional contributions are gratefully accepted.

This newsletter is published three times a year to communicate current events, issues, problems, and progress involving riparian systems, to inform members about Council business, and to provide a forum for you to express your views or news about riparian topics. The next issue will be mailed in January, the deadline for submittal of articles is December 15, 2004. Please call or write with suggestions, publications for review, announcements, articles, and/or illustrations.

Cindy D. Zisner
Center for Environmental Studies
Arizona State University
PO Box 873211
Tempe AZ 85287-3211
(480) 965-2490; FAX (480) 965-8087
Cindy.Zisner@asu.edu

web site: http://azriparian.asu.edu

CALENDAR

Arizona Native Plant Society Annual Conference, October 1-3, 2004. Desert Outdoor Center, Lake Pleasant, AZ. For more information, contact Doug Green, Board Member at (480) 998-5638 or azbotman@yahoo.com for added details and/or registration.

Arizona Riparian Council Fall Meeting, October 16-17, 2004. Gray Hawk Ranch Learning Center, Sierra Vista, AZ, along the San Pedro River. Deadline for registration is October 7. More information will be available on the website http://azriparian.asu.edu and list serve http://lists.asu.edu/archives/riparian.html as it becomes available.

Arid Regions 10th Biennial Conference: Restoration and Management of Arid Watercourses, November 16-19, 2004, Hilton Phoenix East/Mesa, Mesa, Arizona. For more information on the conference, including the Call for Abstracts, please see web site at www.azfma.org and click on the Arid Regions Conf tab.

BT5 1005
Center for Environmental Studies
Arizona Riparian Council
Arizona State University
PO Box 873211
Tempe, AZ 85287-3211

Printed on recycled paper

APOLOGIES FOR THE LATENESS OF THE NEWSLETTER!!