Arizona Riparian Council

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PART 3: RESTORATION OF RIPARIAN VEGETATION IN THE ARID SOUTHWEST: CHALLENGES AND OPPORTUNITIES

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Editors' Note: This is Part 3 of a paper by Julie Stromberg that was presented at the "Restoring and Maintaining Riparian Vegetation in the US Southwest" a U.S. Fish and Wildlife Service/Bureau of Reclamation workshop on Restoring Natural Function to the Lower Colorado River held in Las Vegas, Nevada, on July 8-9, 1998.

HOW DO WE RESTORE DEGRADED ECOSYSTEMS? (*CONT.*)

3) Restoration of Plants and Fungi

Restoration Plantings. A decade or so ago in the U.S. Southwest, "riparian restoration" was synonymous with "cottonwood pole planting." We have learned, however, that planting is a successful restoration tool only if accompanied by other actions, i.e., only if the root causes of the absence or scarcity of the native species are addressed (Briggs 1996). Pole plantings of cottonwoods and willows often die, because water tables fluctuate too much or because the soils at the restoration site are too salty (Anderson 1998). If the plants do survive, but we do not alter river management, the net effect often is the restoration of a single age class rather than restoration of a dynamic, multi-aged population. Nonetheless, such measures can constitute an important stop-gap measure to restore forest structure as we also work towards longer-term and more sustainable solutions.

There are times and places where it is necessary to plant native plant species to achieve restoration success or at least hasten recovery. For example, planting or seeding are essential if local seed sources have been depleted in number or in genetic diversity. On the Owens River in California, physical integrity was restored when stream flows were released back into the river (Hill and Platts 1998). Few seed-trees had survived the long-term dewatering, however. So, cottonwood seeds were collected from other river sites and released into the Owens River gorge, at an appropriate time in spring. On some reaches of the St. Mary's River, as well, long-term river regulation and dewatering have depleted the cottonwood patches (Rood, personal communication). Planting or seeding may be essential to allow these riparian ecosystem to recover (within our lifetime) in response to the newly naturalized river hydrograph.

We need to remind ourselves, periodically, of the biological complexity of riparian corridors. The cottonwood-

Cont. pg. 3...Restoration

Inside This Issue

PRESIDENT'S MESSAGE

Many of you are aware of the Arizona Riparian Council's (ARC) involvement with Arizona Public Service (APS) in restoring the flow to Fossil Creek. During the week of September 11, 2000, ARC along with The Nature Conservancy of Arizona, Northern Arizona Audubon Society, the Yavapai-Apache Nation, American Rivers, and the Center for Biological Diversity signed an agreement with APS to make this restoration a reality. In the agreement, APS agrees to "...restoring full flow back to Fossil Creek no later than December 31, 2004." All signatories of this agreement concur with the jointly developed restoration plan.

Sam Coppersmith worked with the environmental groups to develop the agreement with APS. I want to thank him for all his hard work and doing such a terrific job.

Turning to other issues, water quantity and water quality are "hot topics" of discussion these days. Recently, the Governor's Water Management Commission was created through Executive Order 2000-7 and signed by Governor Hull on May 2, 2000. There are approximately 50 members representing agricultural interests, municipalities, development community, environmental interests, local governments, state agencies and other representatives interested in the enhancement of Arizona's water management system. The Arizona Riparian Council was given a seat on the Commission on August 3, 2000, and Ruth Valencia will represent the Council. In addition, Charles Redman, Director of the Center for Environmental Studies, was also given a seat on the Commission. The Governor also announced creation of a Native American Advisory Council on Groundwater.

The objectives of the Commission are:

- to evaluate the goals outlined in the 1980 Groundwater Management Act for the five Active Management Areas (AMAs) to assure they remain appropriate and achievable;
- evaluate mechanisms to reduce the use of mined groundwater and increase the use of renewable water supplies and most efficiently meet the water needs of the AMAs; and
- evaluate whether changes are needed in statutes, rules or policies to improve the effectiveness of water management in the AMAs at the state and local levels of government.

The Commission was given 18 months to accomplish these objectives. They will be assisted by a large Technical Advisory Committee. An interim report is due to the Governor on June 1, 2001 and a final report on or before December 1, 2001.

As with any large group, the interests at the table will be varied. ARC as well as other environmental organizations will need to be very focused on protecting rivers and riparian areas. Ruth will provide status reports on the Commission in future newsletters. If you have specific issues you would like represented please contact a member of the ARC Board or contact Ruth Valencia at Ruth.Valencia@nau.edu or call her at (520) 523-6613.

ARC's Fall meeting will be held at the Kessler's ranch located near Cordes Junction. Information on the meeting is provided in this newsletter. This meeting is an informal campout. Please plan to attend.

Kris Randall, President

(Restoration...Cont. from pg 1)

willow streams I have studied in central and southern Arizona support several hundred plant species, the relative abundance of which changes from year to year depending, in part, on rainfall and flooding patterns (Wolden and Stromberg 1997). Although there have been many efforts to plant the woody dominants of Sonoran riparian forests – including Fremont cottonwood, Goodding willow, mesquite, and quailbush (*Atriplex lentiformis*), as well as some efforts to plant herbaceous species – it is a daunting task to attempt to restore hundreds of species through direct plantings.

Use of donor seed banks is a promising technique to restore some of this biodiversity to degraded sites. A soil seed bank is defined as a soil's reserve of viable, ungerminated seeds. Donor soils have been obtained from high-integrity reference ecosystems to restore biodiversity to various types of degraded or newly created wetlands (Brown and Bedford 1997; Burke 1997). Seeds of the woody riparian dominants generally are not present in the seed bank, but many of the annual plants and herbaceous perennials do form persistent or at least transient seed banks. Before adopting this donor soil approach, one should conduct studies to find out which species, and how many species, are present in the seed bank of possible donor sites. Some seed banks can contain large numbers of less desirable species, such as exotic herbs.

Seed banks also can constitute a source of "hidden biodiversity," wherein the seeds at a degraded site are "waiting" below-ground for the return of suitable conditions. We are currently investigating the seed bank dynamics of the dewatered Agua Fria River below New Waddell Dam in central Arizona. Our preliminary data suggests to us that remnants of the past riparian community do indeed reside in the seed bank of the Agua Fria riparian corridor (Boudell, unpubl. data). Thus, little planting or seeding may be required to restore the site, should flows of water be restored to the below-dam ecosystem (Springer et al.

Goodding willow

1999).

Soil fungi are another important, but often overlooked, component of riparian ecosystems. Many human actions that affect soils, such as various agricultural practices, can deplete populations of mycorrhizal fungi. Re-introduction of mycorrhizal inoculum can improve the chances of restoration success on the many abandoned agricultural fields that line our arid-region rivers. Preliminary data by Brantlee and others (unpub. data), for example, suggests that growth and/or survival of giant sacaton, a plant that once dominated floodplains of many southwestern rivers, is improved by the addition of mycorrhizal inoculum.

Exotic Species. Exotic species – those that have been introduced accidentally or intentionally by humans to a region in which they did not evolve – pose a definite challenge to riparian restorationists. There are hundreds of exotic plant species that have become naturalized in riparian corridors. A small percentage of these have become management issues due to their prevalence, negative influences on the ecosystem, or inability to totally mimic the functions of displaced natives.

Generally, removal of exotics is an effective restoration strategy only if part of larger plan than includes restoration of processes and conditions (but see Barrows 1998). We need to ask, is the exotic the cause of degradation or a symptom? Often, the abundance of riparian exotics is one symptom or facet of a complex, systemic resource allocation problem. Without addressing the root causes of degradation that have led to the loss of the native species, there is a risk that traditional control measures – such as herbicides and biocontrol insects – will serve only to worsen the situation. In other words, some plants may be better than none (Anderson 1998).

Restoring natural processes and removing stressors, and then stepping back, can be an effective strategy for restoring native riparian species to some exotic-dominated sites. By restoring more natural stream flows and herbivory patterns, for example, we can tip the ecological balance in favor of the native species (Poff et al. 1997). The middle San Pedro River provides an interesting case study of natural recovery (Stromberg 1998). Stream flows in the San Pedro vary from perennial to ephemeral depending on local geology, tributary inputs, and the extent of local and regional groundwater pumping. Tamarisks dominate in the reaches with ephemeral flow and deep water tables, but grow intermixed with cottonwoods in the wetter reaches. In these perennial reaches, cottonwoods have been increasing in abundance relative to tamarisk in the past decade. During this time period, livestock have been removed from the sites, upstream groundwater pumping had been reduced, and spring flows have been high. Under these conditions, cottonwoods apparently can outcompete tamarisks. Also necessary to the recovery were several winter/spring floods that created opportunities for species replacement. Without suitable control sites, however, it is difficult to determine the relative influence of weather and management actions on the vegetation change.

Through a phenomenon that can be termed biological inertia, populations of some exotics persist for a long time after removal of the disturbance factor(s) that facilitated their invasion. They may produce self-favoring conditions (e.g., tamarisk and fire cycles), may simply have a long life span, or may be very fecund. In such cases, there is a need to manually remove the exotics before, coincidental with, or even long after the implementation of other restoration measures. Once a firm commitment has been made to naturalize processes, we may be able to expedite recovery of the natives by mechanically removing the exotics.

A success story using this approach can be found on a reach of the Rio Grande River in New Mexico. On the Bosque del Apache Wildlife Refuge, as on much of the highly regulated Rio Grande, tamarisk has become the dominant plant species. Lowered water tables, increased river salinity, and lack of winter/spring recruitment-types floods for several decades have all contributed to a declining cottonwood forest, while past floodplain clearing and at least one appropriately timed summer flood allowed for the influx of tamarisk (Everitt 1998). To restore the site, managers of the Refuge have mimicked the effects of large floods by using bulldozers, herbicides, and fire to clear the extensive stands of tamarisk at a cost of from $750 to $1,300 per hectare (Taylor and McDaniel 1998). They then released water onto the bare flood plains in spring, with a seasonal timing that mimicked the natural flood hydrograph of the Rio Grande. This allowed for the establishment of a diverse assemblage of native and exotic plants. The multi-level canopy, diversity of vegetation structure, and diversity of insect life provided by this riparian assemblage is expected to provide superior wildlife habitat to the tamarisk thickets that came before. Tamarisk clearing was essential, but it is the appropriate timing and quantity of water flows that will drive the system toward an increasingly native composition. Similar restoration efforts are being made at sites along the lower Colorado River.

Closing Words. There are many other examples of restoration successes (and failures) that could be brought to light. I close with a plea to all those involved in restoration attempts to document, publish, and share their results. Only from an extensive and shared knowledge base can we stop repeating the mistakes of the past and move towards a more desirable future. We are fortunate in that riparian ecosystems are inherently resilient: given the Southwest's high temperatures and long growing seasons, an adequately watered site can rapidly vegetate, allowing us to rapidly see the fruits of our labors.

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AFMA Task Force Formation

The Arizona Riparian Council for the past year has been working closely with the Arizona Floodplain Managers Association (AFMA). As many of you are aware we helped sponsor a meeting this past April with them. The *Southwest River Management & Restoration: Nonstructural Approaches* was well attended, with over 200 participants from various disciplines all working with floodplain issues. A survey was conducted at the meeting, which resulted in the formation of an Ad Hoc Committee to determine how to meet the goal of "promoting river management and restoration using nonstructural approaches appropriate to the arid Southwest." I have been representing the Council on this Committee and we have recommended that an interdisciplinary Task Force be formed to achieve the following objectives:

- ♦ Encourage the development of technology for managing the Southwest riverine environment.
- ♦ Training and cross training between disciplines.
- ♦ Influence the literature to include southwestern river restoration and management research.
- ♦ Promote an exchange of information and encourage interdisciplinary communication.
- ♦ Influence riverine management policy.

The AFMA Board of Directors River Management and Restoration Ad Hoc Committee is requesting input and help from professionals in the water resources, planning or environmental disciplines to accomplish these following objectives to meet our goal. If you read our purpose statement at the back of this newsletter, some of these objectives are the same as ours and, hopefully, by working together we can meet them.

The initial Task Force organization meeting is scheduled for October 27, 2000 at the Flood Control District of Maricopa County. More detailed information is available on the AFMA web site at http://www.azfma.org.

If you are interested in attending, please contact Valerie Swick at (602) 506-4872.

Hope to see you there!

Cindy D. Zisner

SPECIES PROFILE

YELLOW WARBLER (*DENDROICA PETECHIA*)

by Kathleen Groschupf, Tempe, Arizona

Sweet, sweet, sweet, I'm so sweet, proclaims the small, bright yellow bird from his perch high up in the willow tree. Listening carefully, you wait for another song to help identify this species that is singing so steadily early in the morning. Just a minute! The next song is different, and so is the next one! "What is going on here?," you start to wonder, "the book states the Yellow Warbler sings such a song, but what is with these other renditions? Why is it singing different songs? Is it a Yellow Warbler?"

If you could see the bird, you would have no difficulty in identifying the Yellow Warbler (*Dendroica petechia*), observing its bright yellow body and yellow head interrupted by a prominent, black, beady eye. Chestnut colored vertical streaks upon its breast, and yellowish tail spots clinch the identity of this singing male (Kaufman 1991).

Widely distributed in the mid- and northern latitudes of North America, the Yellow Warbler has been studied extensively. The 43 recognized subspecies of Yellow Warbler are separated into three groups, formerly distinguished as separate species, based primarily on migratory status and head coloration. Birds in the migratory *aestiva* group [formerly known as Yellow Warbler (*Motacilla aestiva*)] have an all-yellow head. The breeding distribution is from "northwestern and north-central Alaska, northern Yukon, northwestern and central Mackenzie, northern Saskatchewan, Newfoundland south to southern Alaska (west to the Alaska Peninsula and Unimak Island), northern Baja California, through Mexico to northern Guerrero, Puebla, and southeastern San Luis Potosi, and to central and northeastern Texas, central Oklahoma, northern Arkansas, northern Mississippi, central Alabama, central Georgia and central South Carolina" (American Ornithologists' Union 1998). In winter, Yellow Warbler is widespread in Mexico, found beside the two sedentary groups, *petechia* and *erithachorides* [formerly known as Golden Warbler (*Motacilla petechia*) and Mangrove Warbler (*Dendroica erithachorides*), respectively]. Golden Warbler males are characterized by a well-defined chestnut crown, whereas, Mangrove Warbler males are characterized by having the entire head chestnut, or sometimes having just a chestnut hood. Golden Warblers, limited in distribution, are fair to common residents on Isla Cozumel. Mangrove Warblers are fair to common residents in the mangroves along both coasts (Howell and Webb 1995).

In Arizona, Yellow Warblers can be heard singing in mid-March as the first migrants pass through, while others stay. They are common residents, staking out multipurpose territories where they will attract Yellow Warbler females, breed, and raise young, in habitat dominated by willows (*Salix* spp.), cottonwood (*Populus fremontii*), and sycamore (*Platanus wrightii*) along the riparian corridors of the Sonoran and Transition Zones (Monson and Phillips 1981). As with most riparian species in Arizona, the number of populations of Yellow Warblers has declined due to destruction of the willow habitat, either directly by man or by over-grazing of cattle (Ohmart 1994).

Females, which are yellow like males but lack or have faint chestnut streaks on the breast, arrive soon after males, courtship chases ensue, and pairing occurs. The pairing is primarily monogamous, but polygyny sometimes occurs, where a male mates with another female and nests in the same territory, or rarely, maintains two territories with two females. Extra-pair copulations are not uncommon (Yezerinac et al. 1996), and males with more chestnut streaking on their breasts have a higher probability that they will sire extra-pair young than males with less streaking (Yezerinac and Weatherhead 1997).

Shortly after her arrival, the female starts to build a deep cup nest usually 1- 2 meters off the ground in a shrub or tree. Construction materials for the outer part consist of grasses and bark strips covered with plant down and fine fibers. Spider webs are on the outside of the nest and are also attached to the branches that support the nest. The nest is built usually in two to three layers consisting of a base of nettles, a frame of grass fibers, and a liner usually of deer hair, feathers, and airborne seeds (Mico 1998).

Yellow Warblers are frequent victims of cowbird nest parasitism, in part because Yellow Warblers are abundantly distributed and their distribution range coincides with that of the cowbird. Yellow Warblers have a fascinating way of dealing with cowbird parasitism. If a female Brown-headed Cowbird (*Molothrus ater*) lays an egg in the nest before the warbler has laid one of her own or shortly after, the warbler buries it by placing layers of nest material over it. If the nest is parasitized again, the warbler will build another layer. One parasitized nest consisted of six tiers containing a total of 11 cowbird eggs and was 14.6 cm in height (Berger 1955).

"Sweet-sweet-sweet-I'm-so sweet," interrupts your earlier thoughts of extra-pair matings and streaked breasts. The male is still singing his songs from the willow tree. Yellow Warbler males have variable song repertoires based on their singing behavior, or song delivery, not on the structure of the song. Songs, about 1 second in duration, usually consist of 6-10 syllables, some of which are repeated. So, the song you just heard consists of three repeated syllables, ("sweet-sweet- sweet"), then another two repeated syllables ("I'm-so"), and an ending syllable ("sweet") (Fig 1A; You can see that bird song mnemonics don't necessarily match human word for bird word). Defining different song types by types of syllables used within the song, males may have 10-17 different song types (Spector 1992). Figure 1B illustrates another song type, one that does not follow the previous mnemonic. How the males pattern the delivery of these and other different song types is what gives them the variable song repertoires.

The song repertoires are grouped into two categories of singing — Type I and Type II (Spector 1991). In Type I, a male sings one song type over and over, at a slow rate, about 5.2 songs per minute. It takes about a week on territory for a male to develop this normal, after sunrise, or daytime singing behavior. Type I singing is rarely used in a bout

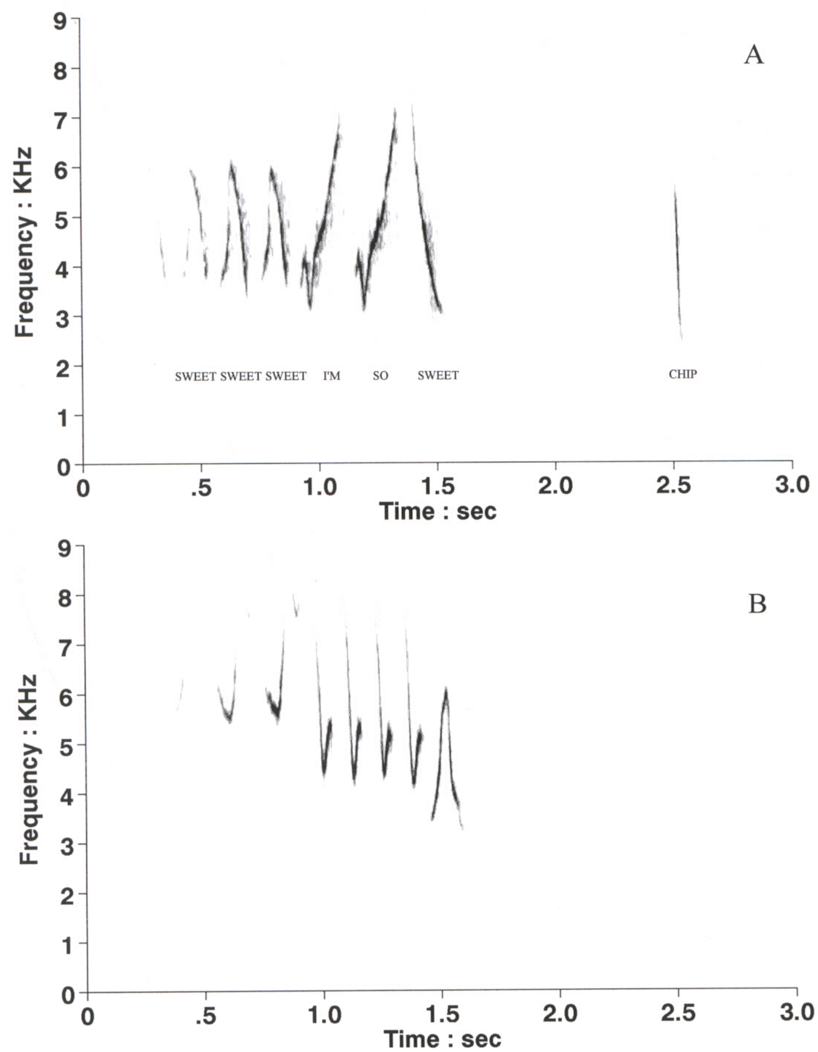

Figure 1. A. Sonogram of one Yellow Warbler song type consisting of six syllables illustrating the familiar mnemonic, "sweet-sweet-sweet-I'm-so-sweet." The song is followed by a call note, that sounds like "chip." B. Sonogram of another Yellow Warbler song with different types and numbers of syllables, so to the human ear it would not sound the same as the first song.

before dawn. Type I singing appears to be used in context with intersexual, or male-female, interactions. After pairing with a female, males tend to be silent as they accompany their female around the territory, but if the female disappears from his sight, he will engage in Type I singing. He also sings one song type over and over as he approaches the nest to feed nestlings, and sometimes sings right at the nest.

In Type II singing, a male uses several different song types (5-16) from his repertoire, sung at a much faster rate of 10.6 songs per minute before dawn, and 6.6 songs/minute after sunrise. Call notes, which sound like "chip" are often interspersed between songs (Fig. 1A). Pre-sunrise, or dawn singing takes more time to develop, being short or omitted the first two weeks, but during incubation and nestling periods, dawn singing can last 30-45 minutes. Almost all of the dawn bout consists of Type II singing, but it is also used in the daytime. Spontaneous daytime singing, especially after pairing, is Type II singing. Apparently, Type II singing is used in intrasexual, or male-male, interactions. In a dawn bout, neighboring males will perform matched counter-singing, in which they temporally alternate singing, with the following male singing a song that is the same or similar to the one the leading male just sang. Type II singing is also used when males approach each other at their territory boundaries. In fact, Type II singing occurs most often away from the nest area, near territorial boundaries, whereas, Type I singing occurs near the nest site.

Of course, unmated males sing differently from mated males. Because they have yet to attract a female, they continue to perform Type I singing.

So, by listening attentively to a singing bird, you can obtain a host of information about it. In addition to identifying which species it is, you can learn its mating status, how long it has been on territory, the breeding stage it is in, and you can use it to locate a nest. This not only works with Yellow Warblers, but with many other bird species. The next time you observe a bird singing, take a minute, don't just hear it, listen to it.

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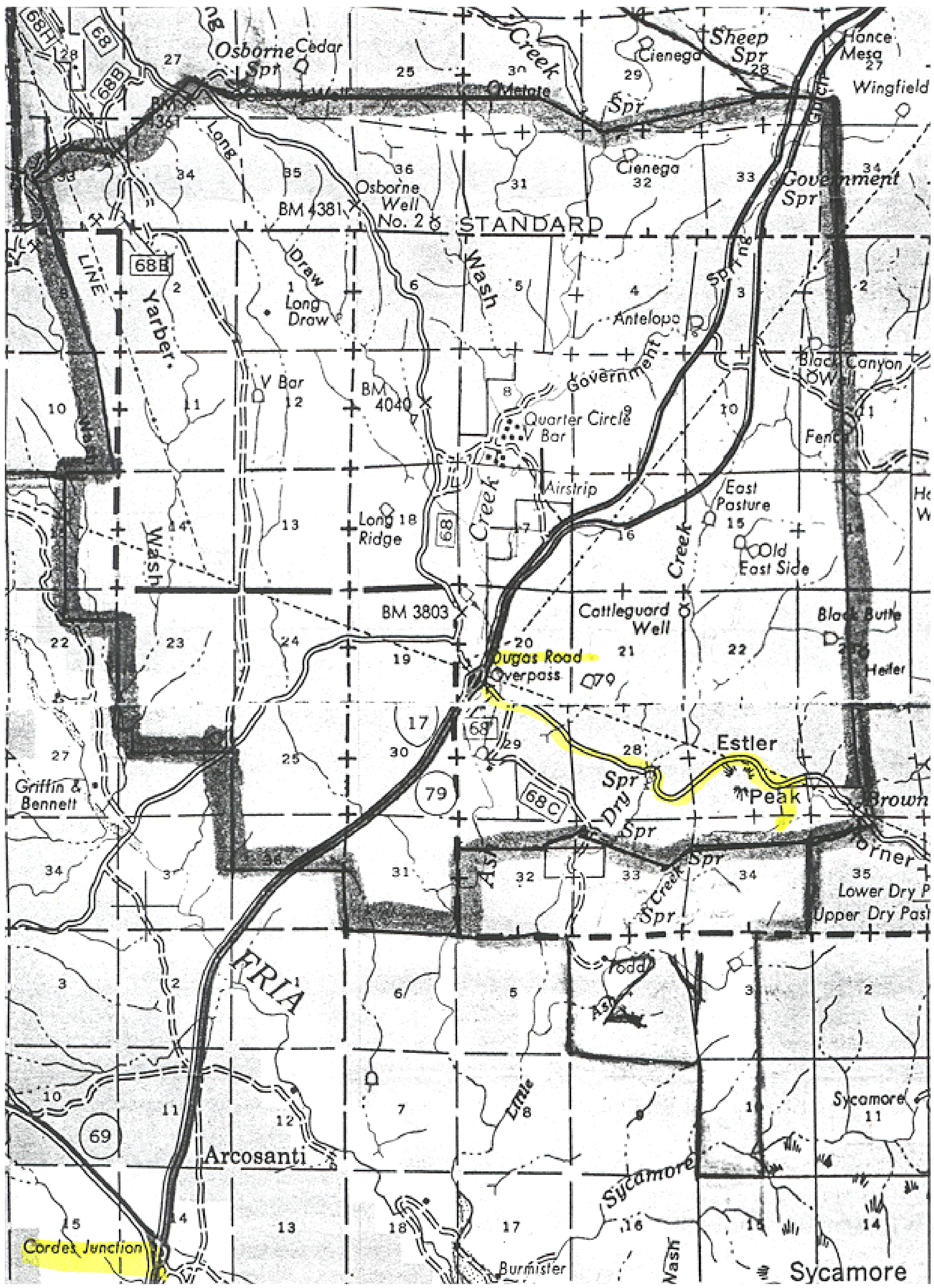
FALL CAMPOUT GET-TOGETHER OCTOBER 14-15

Our Fall Meeting is planned for October 14-15, 2000 at Orme Ranch, Mayer, AZ, hosted by ranchers, Alan and Diane Kessler. We will camp on their ranch and will be given a tour of some sites on the ranch (time permitting). Other topics include mitigation banking and a hike along the Agua Fria River at Arcosanti on Sunday.

On Saturday, October 14, we will meet at 1 PM at the ranch and have a welcome, followed by the tour of the ranch, free time to explore on your own, and dinner on us of hamburgers or veggie burgers with the fixin's. Lunches and breakfast on Sunday are on your own so please bring your own goodies.

Please let Cindy Zisner (Cindy.Zisner@asu.edu or 480-965-2490) know by Sept 30 if you will be able to attend. She needs to know how many will be attending (family members are welcome) and whether you want a hamburger or veggie burger. There is a map and instructions below.

To get to the campsite, exit 268 off of I-17, approximately 70 miles north of Phoenix and 75 miles south of Flagstaff. Take Dugas Road east approximately 3 miles past Estler Peak, then take the second 2-wheel track road to the right and down to Little Ash Creek.



NOTEWORTHY PUBLICATIONS

Jere Boudell, Department of Plant Biology, Arizona State University

Editors' Note: *Please welcome Jere Boudell, a third-year doctoral student in the Department of Plant Biology, Arizona State University, as our new Noteworthy Publications Editor.*

Ehrenfeld, J. G. 2000. Defining the limits of restoration: The need for realistic goals. *Restoration Ecology* 8(1):2-9.

Setting goals for ecological restoration has been a difficult task for both scientists and practitioners alike. It is this task that allows us to measure the degree of project success or failure. Ehrenfeld attempts to explain the variety of philosophies that guide restoration project design and goals. She then brings together these philosophies in an attempt to produce coherence for ecological restoration goals.

The diverse philosophies at work within restoration ecology emerged from a range of specialties within applied science, whose practioners all sought to restore damaged ecosystems. Conservation biologists worked to restore degraded systems in order to save rare and endangered species. Specialists from geography increased the scale of project goals and viewed restoration from a landscape perspective. Wetland managers focused on restoring ecological functions to degraded systems. Finally, Ehrenfeld discusses the need for realism in setting restoration goals.

Conservation biologists working to restore degraded systems often focus on duplicating conditions that favor the species of concern. However, focusing on restoring conditions for one or a few species neglects the surrounding members of the community and fails to address the interactions of the species at the ecosystem and landscape level.

In geography, the processes that drive the existence of species and community formations are the focus of restoration. This is a crucial step in restoring degraded systems. However, determining which processes drive the system that perform which functions can be quite difficult. We don't know all of the variables involved in ecosystem functioning. Focusing on one or two processes alone can work to the detriment of other processes and even interfere with important ecosystem functions.

Out of wetland management came the focus on restoring ecosystem services. Again, Ehrenfeld discusses the inherent danger of focusing on one service to the neglect or detriment of other valuable services.

Finally, Ehrenfeld discusses the importance of having and stating realistic goals for restoration projects. We cannot create exact duplicates of previously pristine ecosystems. Leading the public and hence policy makers to believe that we can create functioning ecosystems, may bring about the acceptance of destroying natural systems if they believe ecosystem replacement can occur.

Ehrenfeld states that we can set realistic restoration goals if we:

1) realize that to set realistic restoration goals one approach will not suffice
2) be realistic: We cannot reproduce pristine functioning ecosystems within a few years if at all.

Identifying the varying aspects of the project system, and using the varying approaches to restoring those components, should produce realistic and perhaps obtainable restoration goals. A healthy dose of realism will hopefully alert our policy makers to the reality that we cannot simply replace functioning ecosystems.

Keddy, P. 1999. Wetland restoration: the potential for assembly rules in the service of conservation. *Wetlands* 19(4):716-732.

Restoration is often called the "ultimate test of ecology." It is through restoration projects, when ecosystems are repaired or created, that theoretical ecology meets application ecology. The success or failure of restored and created ecosystems illustrates our understanding of ecosystem structure and function. In order to meet project goals successfully, restoration ecologists need to accurately predict the response of community composition to ecosystem manipulations. Keddy proposes "assembly rules" as a method of predicting community composition in restored and created wetland ecosystems. He also promotes the use of ecological indicators in project monitoring.

Assembly rules refers to the process of "how restricted communities of organisms are assembled from larger species pools." To use this predictive method, one needs a list of available species that are able to colonize the project site, a list of abiotic and biotic factors that limit the species ability to thrive on the project site (filters), and a list of life history traits of the species that allow them to tolerate the varying filters. Armed with this information, assembly rules allows the ecologist to predict which species possess the life history traits that will allow them to survive the varying filters present on the project site.

Keddy uses three examples to illustrate the potential of assembly rules in restoration ecology. Of the three examples, the prairie pothole ecosystems example stands out. Water regime, salinity, and disturbance are the main filters that affect community composition in prairie potholes. Many species in these systems possess similar life-history characteristics. This complicates the process of predicting community composition, as the more complex and intricate interactions between species and environmental factors are difficult to include in assembly rules methodology.

An experimental wetland is used to further illustrate assembly rules methodology. Species in containers were subjected to a variety of abiotic and biotic factors. Water level and fertility were the two main filters that affected the species used in the experiment. A list of species was generated based on their response to the filters tested.

Keddy then stresses the importance of monitoring to restoration project success. As many ecologists have pointed out before, monitoring is essential in determining if project goals were achieved. In monitoring systems, Keddy has pointed out the value of using indicators to assist in determining the status of the project site. Ecological indicator is a vague term, but Keddy lists several criteria, such as making the indicator ecologically meaningful, simple, and pragmatic. He also suggests several procedures such as, using the filters selected in the assembly rules methodology, to further assist in selecting the most appropriate indicators. Keddy finally suggests setting critical limits for each indicator in order to determine if the project site has recovered, is improving, or has failed to meet project goals.

Restoration ecology is the ultimate indicator of our understanding ecosystem structure and function. The use of predictive methodologies is essential if restoration ecologists are to successfully meet project goals.

Shafroth, P. B., J. C. Stromberg, and D. T. Patten. 2000. Woody riparian vegetation response to different alluvial water table regimes. *Western North American Naturalis*t 60(1): 66-76.

In the semi-arid and arid Southwest riparian ecosystems, alluvial groundwater is very important to many riparian plants. The decline in ground water, whether due to natural fluctuations, groundwater pumping, or impoundment, often has deleterious effects on riparian vegetation. Shafroth et al. examine the responses of *Populus fremontii*, *Salix gooddingii*, and *Tamarix ramosissima* to naturally occurring groundwater fluctuations along the Bill Williams River in western Arizona.

In April 1995, the authors selected three sites that contained seedlings and saplings of the three test species that established between 1993 and 1995. At each site, one *Populus fremontii* individual was excavated and its root distribution sketched. Several variables were measured such as depth to groundwater, soil texture, stem density, and basal area. Regression was used to determine the relationship between stem density and basal area and groundwater depth.

The most important conclusion of this investigation was that change in depth to ground water relative to the previous depth to groundwater was more critical than the absolute depth to groundwater. At one site (BW1), saplings survived and their basal area increased when the depth to groundwater was –2.91 m. However, at another site (BW5) almost no saplings survived when depth to groundwater reached –1.55 to –1.97 m. One of the main differences at each of the sites, was the degree of change in depth to groundwater. BW5 experienced a change in depth to groundwater of 1.11 m in 1996 and 2.38 m in 1997. However, BW1 experienced a change of only 0.48 in 1996 and 0.8 in 1997.

Shafroth et al. suggest that the historical depth to groundwater influenced the plants root development or architecture and this root architecture is what is affected by the change in depth to groundwater. Otherfactors also affect the outcome of the plants response to changes in depth to groundwater. Soil texture, temperature, humidity, and the plants own physiology all influence a plants response to changes in depth to groundwater. *Tamarix ramosissima* at site BW5, for example, survived the greater change in depth to groundwater.

Based on these results, Shafroth et al. suggest that the outcome of investigations such as theirs, have strong implications for stream flow management. In impounded systems such as the Bill Williams, management could vary flow releases to affect and promote the establishment of desirable species.

MARC REISNER, ENVIRONMENT WRITER, DIES

Excerpted and adapted from The Times, by Myrna Oliver, Staff Writer

Marc Reisner, who alerted authorities and environmentalists to the problems inherent in irrigating the American West in his landmark 1986 book *Cadillac Desert*, has died at age 51. He died in July of colon cancer in his Marin County [CA] home.

His seminal book on misuse of water resources – *Cadillac Desert: The American West and Its Disappearing Water* – sparked ongoing water policy reform to curb and reverse depletion of water supplies caused by dam building and other policies of the federal Bureau of Reclamation and state and local water management agencies. "This is well-written history and analysis, thoroughly researched, and abundantly clear in its message," Dean E. Mann wrote in *The Times* when *Cadillac Desert* was published. With Reisner's help, the book was turned into a documentary miniseries for PBS in 1997, earning a Columbia University Peabody Award.

A 1979 Alicia Patterson Journalism Fellowship funded Reisner while he meticulously researched once-secret files of the Bureau of Reclamation and talked to its former employees. Future generations would suffer, Reisner asserted in the book, because of flagrant waste of water for both cities and farming and from salt deposited in the soil by excessive fertilization.

Reisner wrote another important and entertaining book in 1991, *Game Wars: The Undercover Pursuit of Wildlife Poachers*. The book detailed the harrowing life of about 200 agents of the U.S. Fish and Wildlife Service.

Reisner, with Sarah Bates, also wrote the book *Overtapped Oasis: Reform or Revolution for Western Water* in 1990 and wrote op-ed articles on the environment for *The Times*, the *Washington Post*, the *New York Times* and several magazines.

At the time of his death, he was working on a book about the influence of natural disasters on California's history and politics. Reisner earned a bachelor's degree at Earlham College in Richmond, IN. He worked a couple of years in Washington, D.C., on the national staffs of Environmental Action and the Population Institute as a lobbyist and scriptwriter for an environmental telethon. From 1972 to 1979, he was a staff writer and communications director for the New York-based Natural Resources Defense Council. Reisner was named an honorary trustee of the Tuolumne River Preservation Trust after serving for many years on its board, and earned a Rene Dubos fellowship, a Bay Education Award from the San Francisco Bay Institute, and a commendation from the American Whitewater Affiliation. He was planning to use funds from a Pew Fellowship in marine conservation, which he received earlier this year, to restore native salmon habitats in California. Reisner was a distinguished visiting professor at University of California-Davis, lecturing on the interaction of civilization and the environment.

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

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

This newsletter is published three times a year to communicate current events, issues, problems, and progress involving riparian systems, to inform members about Council business, and to provide a forum for you to express your views or news about riparian topics. The next issue will be mailed in January, the deadline for submittal of articles December 15, 2000. Please call or write with suggestions, publications for review, announcements, articles, and/or illustrations.

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CALENDAR

The Ecology and Conservation of the Willow Flycatcher Conference, 24-26 October 2000, Arizona State University, Tempe, AZ. The conference will focus on research relating to Willow Flycatcher biology, management, and conservation. For more information, contact Mark Sogge (520-556-7311 X232 or Mark.Sogge@nau.edu).

Desert Fishes Council, November 16-19, 2000. Furnace Creek Ranch (Death Valley National Park, CA). For more information go to the website http://www.utexas.edu/depts/tnhc/.www/fish/dfc/meetings/2000/call.html or contact Dean Hendrickson at deanhend@mail.utexas.edu.

4th National Mitigation Banking Conference, 18-20 April, 2001, Ft. Lauderdale, FL, Radisson Bahia Mar. The conference will be the 2001 update on mitigation and conservation banking, and offer targeted sessions for both experienced and beginning bankers. Call for Papers deadline is October 27th! For more information, visit http://www.terrene.org or phone 800-726-5253.

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