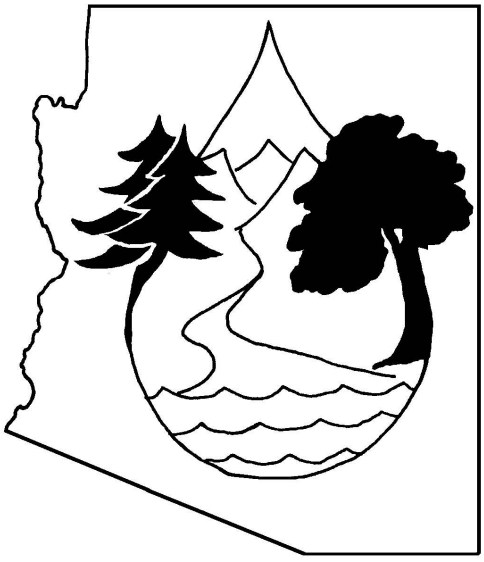
SEVENTEENTH MEETING OF THE ARIZONA RIPARIAN COUNCIL

Hon-Dah Resort
Pinetop, Arizona
April 4-5, 2003

Fire on the Watershed: Are we Burned Out or Ready to Fan the Flames?



PROGRAM AND ABSTRACTS
2003

Seventeenth Annual Meeting
Arizona Riparian Council
Hon-Dah Resort
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FIRE ON THE WATERSHED:
ARE WE BURNED OUT OR READY TO FAN THE FLAMES?

FRIDAY, April 4

8:00-10:00	**Registration**
8:30-8:45	**Welcome** – Jeff Inwood, President
8:45-9:15	**Fire Regimes in Arizona Ecosystems: Desert to Subalpine** – Paul Sheppard, Laboratory of Tree-Ring Research, University of Arizona
9:15-9:45	**Impacts of a Historical Wildfire on a Watershed Scale** – Peter Ffolliott, University of Arizona
9:45-10:00	**Water-Related Impacts of Wildfires in the White Mountains - A Few Lessons Learned –** Laurel Lacher, Lacher Hydrological Consulting
10:00-10:30	**BREAK** - View Posters
10:30-11:00	**Burned Area Emergency Rehabilitation (BAER): Assessment and Treatment –** Grant Loomis, Tonto National Forest
11:00-11:30	**Fire Effects to Riparian Areas, Recent Experience from the Rodeo/chedeski Fire** – Tom Subirge, Apache-Sitgreaves National Forest
11:30-12:00	**Panel Discussion**
12:00-1:15	**LUNCH**
1:15-2:00	**Business Meeting**
2:00-2:20	**Arizona's Forest-Riparian-Community-Rangeland Restoration – Or Let it Burn.** Brad Vandermark, Arizona Country Environmental Consultants

2:20-2:40 **New Solutions for Long-Term Riparian Restoration and Maintenance.** Jim Crosswhite, EC Bar Ranch.

2:40-3:00 **Plant Species Diversity and Richness Patterns Across Water Availability and Flood Intensity Gradients along the San Pedro River, Arizona.** Sharon Lite, Juliet C. Stromberg, and Ken Bagstad, Arizona State University.

3:00-3:20 **BREAK** - View Posters

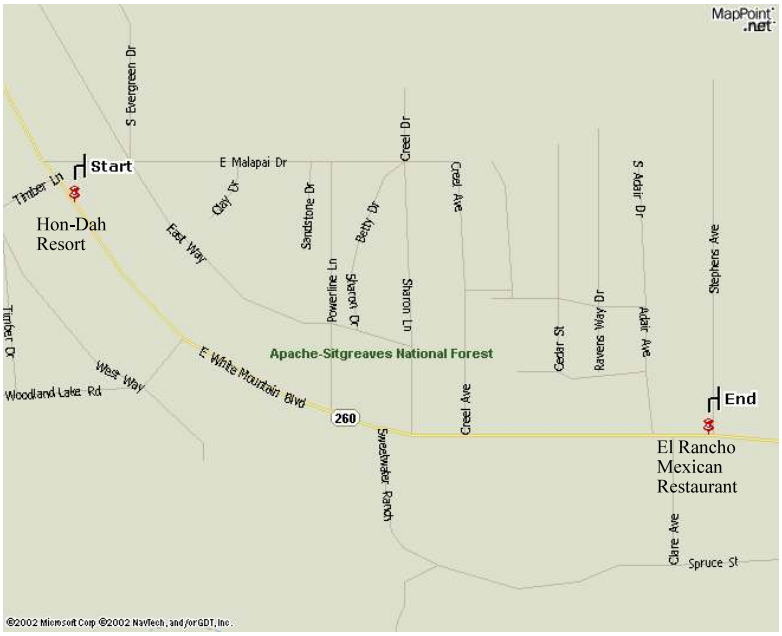
3:20-3:40 **Water Resources and Land Use Planning at Empirita Ranch.** Julia Fonseca, Pima County Flood Control.

3:40-4:00 **Observations of Resource Use by Bats along a Sonoran Desert Riparian Corridor.** Debbie Buecher, University of Arizona.

4:00-4:20 **Change in Riparian Vegetation Structure Following Fire along the Upper San Pedro River.** Tyler J. Rychener and Juliet C. Stromberg, Arizona State University.

4:20-4:40 **Relationships Between Hydrology, Exotic Plants, and Woody Fuel Loads in the Middle Rio Grande of New Mexico**. Roy Jemison and Deborah Finch, U.S. Forest Service, Albuquerque, NM, and Charlie Wickland, Energy, Minerals, and Natural Resources Department, NM.

7:00 Dinner at El Rancho Mexican Restaurant (on your own)
1523 E White Mountain Blvd
Pinetop, AZ 85935
(928) 367-4557



POSTERS (view at breaks)

Wildfires in Arizona: Soil Physical Changes and Their Effect on the Spatial Distribution of Infiltration, Recharge, and Runoff Generation. Karletta Daane' Chief, Brenda Ekwurze, Paul A. Ferré, Bart Nijssen, and Abe Springer. University of Arizona and Northern Arizona University.

Land Imprinting Specifications for Ecological Weed Suppression and Ecosystem Restoration in Arid Wetlands. Robert M. Dixon and Ann B. Carr, Imprinting Foundation, Tucson.

Restoration of Wet Meadows: Two Years of Monitoring the Influence of Burning Herbaceous Communities on Groundwater Recharge. Abe Springer, Gina Mullen, and Tom Kolb, Northern Arizona University, and Melissa Amentt, Sequoia National Forest. Presented by Jeremy Kober, Northern Arizona University.

FIELD TRIP - SATURDAY, APRIL 5

We encourage car pooling on field trips. Please properly prepare for hiking, don't forget water to drink, hat, sun screen, etc, and a sack lunch. Meet in the Hon-Dah Resort hotel lobby at 8:30 AM. Dr. Ffolliott will be leading us on a trip to his research site on Stermer Ridge, which is south of Pinedale.

ABSTRACTS

(Abstracts are ordered alphabetically by first author.)

BUECHER, D. C. Wildlife Ecology Program, School of Renewable Natural Resources, University of Arizona, Tucson, AZ 85721. ***Observations of resource use by bats along a Sonoran Desert riparian corridor.***

Current knowledge suggests that fire can decrease the density and appropriate condition of tree snags useable by wildlife. For some species this can be a loss of critical habitat and can impact populations. Fires that occur after years of fire suppression may initially do more damage to snags due to the buildup of fine fuels at their base. This fuel accumulation can cause hotter fires and an opportunity for a surface fire to reach the tree crown. Although little has been done to specifically evaluate the impact of fire on forest bats, there are a number of bat species that are known to roost in trees. Tree bats roost in foliage, in cavities in snags and under exfoliating bark of mature trees. Recent research has shown that the density of tree snags is an important element in habitat selection by many tree-roosting bats.

This preliminary report of resource use by bats along a Sonoran Desert riparian corridor near Tucson, Arizona, is an evaluation of chiropteran community structure in Sabino Canyon Recreational Area, Coronado National Forest (USDA). For this study, bats are netted on a monthly basis over semi-permanent pools in a mixed riparian and Sonoran Desert environment. Reproductive assessment and standard measurements of captive bats are recorded. Bats are held in individual cloth bags before release to collect guano for later analysis. Guano analysis will provide important information regarding diet choice by different bat species in a Sonoran Desert setting. I am also recording echolocation calls from released bats for development of a call library and conducting an acoustic assessment of free-flying bats along the riparian corridor. To date, 16 bat species have been captured and this study will continue throughout the year to evaluate both winter and summer use of water holes by bats in a Sonoran Desert habitat. This research will provide resource managers with information on how bats use a riparian environment and will be useful when making fire management decisions.

CROSSWHITE, J. EC Bar Ranch, PO Box 44, Nutrioso, AZ 85932. Email: jim@ecbarranch.com. Website: www.ECBarRanch.com. ***New solutions for long term riparian restoration and maintenance.***

New solutions are needed for long-term restoration and maintenance of riparian areas. A combination of groundwater pumping through new water wells and periodic droughts has caused the water table to drop in many riparian zones, such as Nutrioso Creek. As water levels fall, turbidity rises making it harder to remove the creek from the 303d list as an impaired water. Habitat is lost making it harder for wildlife to survive. As the water table declines, ranching economics suffer.

One objective of the Forest Health initiatives to thin trees is to increase the amount of water flowing into streams and rivers. Logging, controlled burns, and wildfires have the effect of thinning trees. Less than 30% of riparian zones on public lands are in Proper Functioning Condition due in part to large ungulate grazing (livestock and elk). When riparian zones are in poor condition, increased flows lead to erosion, increased turbidity, flooding, and other water quality problems downstream. Therefore, forest improvements must include riparian restoration to be sustainable. However, the plant materials needed for restoration are not readily available.

To satisfy the need for plant materials, private landowners should have incentives through long-term contracts to grow willows and cottonwoods. If such "crops" were grown in riparian zones on private property, they could provide annual cuttings on a sustained basis, improve water quality, and wildlife habitat. If landowners sold plant materials they would pay the costs of planting, fencing, and livestock management. Less public funding would be required for riparian restoration.

Private landowners should have incentives to maintain riparian zones in PFC for the long term. Generally, state and federal grant programs do not address the long-term maintenance issues. A successful program to use as a model is the National Conservation Buffer Initiative. Where is the incentive program to restore, preserve, and protect the riparian corridors the Buffer Initiative program is designed to support?

Landowner incentive programs would increase riparian land values making them equal or greater than adjoining upland pastures suitable for real estate development. Higher appraised values make conservation easements more attractive. When use restrictions are placed on riparian zones, they are more likely to reach PFC and transport a sustainable water supply from the upper end of a watershed to other parts where it is needed.

I have become aware of problems and solutions to preserving riparian zones while implementing water quality, habitat, and economic practices along 2½ miles of Nutrioso Creek on the EC Bar Ranch. A more comprehensive discussion relating to national riparian zone issues can be found in the new book entitled *Riparian Areas: Functions & Strategies for Management* by the National Research Council available through the National Academy Press (**www.nap.edu).**

DAANE' CHIEF[1], K., B. EKWURZEL, P. A. FERRÉ, B. NIJSSEN, AND A. SPRINGER[2]. Department of Hydrology and Water Resources, University of Arizona, Box 210011, Tucson, AZ 85721-0011 and [2]Department of Geology, Northern Arizona University, Flagstaff, AZ 86011. ***Wildfires in Arizona: Soil physical changes and their effect on the spatial distribution of infiltration, recharge, and runoff generation***. (POSTER)

Investigators at the University of Arizona and Northern Arizona University have formed a group to study the hydrologic effects of wildfires. The focus of our research will be to determine the extent to which fire-induced changes in physical soil properties can lead to changes in infiltration, recharge and runoff generation. Although we know that soils can become hydrophobic following a burn, little is known about the impacts of fire on the soil properties that control the movement of water and air through the root zone. In addition, there is an urgent need to understand how these local changes in soil physical properties affect infiltration, recharge, and runoff generation over a larger area. Our research will lead to the development of pedotransfer functions that will predict the change in soil hydraulic properties as a function of soil type and burn conditions. Our modeling efforts will determine how, and to what extent, these changes in local soil properties effect changes at larger spatial scales. In turn, this information can be used in developing guidelines for low-impact, prescribed burns and in predicting the hydrologic impacts of natural wildfires. Given the importance of fire as a landscaping agent in Arizona, an improved understanding of its effect on catchment hydrological processes, will allow land and natural resource managers to develop strategies to cope with or benefit from such changes.

DIXON, R. M., AND A. B. CARR. Imprinting Foundation, 1231 E. Big Rock Road, Tucson, AZ 85718. ***Land imprinting specifications for ecological weed suppression and ecosystem restoration in arid wetlands.*** (POSTER)

The no-till method for seeding called land imprinting has been under development in Tucson, Arizona, since 1976. Through ecological weed control, land imprinting has restored perennial grasses to 20,000 hectares of degraded rangeland in southern Arizona since 1980. Imprinting accelerates the secondary succession of plant types past the weed stage through superior control of rainwater at the soil surface. Early imprinters were massive machines with large diameter rollers that were designed to operate on the rocky, brushy terrain of southwestern deserts. Newly designed imprinters have smaller diameter rollers and are easier to transport. Some can work on 2:1 slopes and even steeper. Simple seeders, directly driven from the imprinting roller, deliver complex mixes of native seeds to the roller top where they are carried forward, dropped on the soil surface and then imbedded in the imprint surfaces. V-shaped imprints funnel resources downward where they can work in concert to germinate seeds and establish seedlings. Based on more than two decades of field experience, land imprinting specifications have been developed for ecological restoration and sustainable agriculture. These include general imprinter and seeder design specifications that will help to insure success of revegetation projects. Also, experienced fabricators can use these specifications as a guide for constructing state-of-the-art seeding imprinters. Finally land imprinting excels in holding soil and water resources in place to germinate seeds, establish seedlings and accelerate plant succession. Thus imprinting is very effective in ecosystem restoration in arid wetlands and elsewhere.

FFOLLIOTT, P. F.[1], AND D. G. NEARY.[2] [1]School of Renewable Natural Resources, University of Arizona, Tucson, AZ 85721 and [2]Rocky Mountain Research Station, USDA Forest Service, Flagstaff, Arizona 86001. ***Impacts of a historical wildfire on a watershed-scale.***

An opportunity to study the impacts of a watershed-scale wildfire on hydrologic and ecological characteristics of a ponderosa pine forest ecosystem in the Southwest presented itself following the devastating Rodeo-Chediski wildfire of late June-early July 2002, which burned 475,000 acres in north-central Arizona. Hydrologic characteristics (streamflow regimes, erosion-sedimentation processes, etc.) and ecological characteristics (tree mortality, forage and habitat loss, etc.) are being evaluated on the Stermer Ridge watersheds, located in the headwaters of the Little Colorado River, to assess the short- and long-term impacts of this historical fire. One of the two watersheds was severely burned while the other watershed suffered a low to moderate burning severity. These watersheds had been moth-balled after the completion of earlier watershed research studies. However, the control sections were re-instrumented, a weather station on the site was re-established, and a sampling grid was re-located immediately following the suppression of the wildfire to provide a basis to study the relative impacts of varying fire severities on the hydrologic and ecological characteristics of the burned watersheds. Findings to date with respect to changes in hydrologic processes, soil resources, and vegetation will be reported upon in this presentation. Information of this kind is needed to plan and manage for on-site post-fire watershed rehabilitation and to understand the impacts of fire on downstream riparian habitats and anthropological infrastructures.

FONSECA, J. Pima County Flood Control District, 201 N. Stone Ave., 4th floor, Tucson, AZ 85721. ***Water resources and land use planning at Empirita Ranch.***

The lower Cienega Creek groundwater basin is an example of an area with significant groundwater-dependent riparian resources. While existing groundwater use is low, scientific investigations provide a basis for concerns that increased groundwater pumping in the vicinity of Cienega Creek at Empirita Ranch would reduce the extent and duration of surface flows and lower the water table along the stream.

Unlike the Santa Cruz and San Pedro River basins, steps have been taken in advance of development to reduce the threat to groundwater-dependent riparian areas along Cienega Creek. These steps have included land acquisitions, negotiation of limits to groundwater pumping with developers, comprehensive land use planning and scientific investigations to inform decision-making. These actions have occurred at the local level, through County government functions.

Retiring irrigated pasture lowered water use at Empirita Ranch by 225 acre-feet per year. A contract and additional land acquisition limited future groundwater pumping associated with the Empirita Ranch development to1,600 acre-feet per year. Land use planning reduced the potential water use associated with build-out of Empirita Ranch, and would likely change the location of groundwater pumping in a way that would reduce impacts to riparian resources. Monitoring of stream flows and groundwater began in 1986 and continues today.

The human population in the lower Cienega Creek basin will continue to grow, regardless of whether Empirita Ranch is developed. Groundwater will continue to supply human needs in this area. How much additional groundwater is needed to meet future needs in the area and what impacts occur as a result will be greatly influenced by past and future land use planning decisions.

JEMISON[1], R., D. FINCH[1] AND C. WICKLAND[2]. [1]USDA Forest Service, Rocky Mountain Research Station, 333 Broadway Blvd. SE, Suite 115, Albuquerque, NM 87102. E-mail: rljemison@fs.fed.us; **dfinch@fs.fed.us;** and [2]Energy, Minerals and Natural Resources Department, 408 Galisteo, Santa Fe, NM 87504-1948. Email: cwicklund@state.nm.us.
Relationships between hydrology, exotic plants, and woody fuel loads in the Middle Rio Grande of New Mexico.

We are investigating management options to reduce the risk of wild fires in the Bosque (riparian zone) of the Middle Rio Grande in New Mexico. The Bosque, one of the longest and contiguous riparian zones in the western US, developed under a much different river flow regime and land uses than exist today. River regulation and flood control, with diversion dams, levees, and fire suppression, have decoupled the self-perpetuating and self-sustaining terrestrial biotic community from the water on which it depends. Elimination of flooding, lowered water tables, and lack of naturally occurring cool fires have allowed exotic plants to establish and thrive in monotypic vegetation types as well as beneath Cottonwood overstories. Salt cedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) have formed thickets that are almost impassable without the use of mechanized equipment. The presence of exotic woody plants increase the risk of fire near the river communities of Albuquerque, Socorro, Bernalillo and several Pueblos, reduce opportunities for recreational use of river woodlands, and contribute to the loss of native plants. For example, woodlands dominated by a cottonwood overstory and exotic understory, when burned, typically return as exotics only. In collaboration with landowners and managers, Forest Service scientists are testing methods to reduce and control the build up of exotic fuels in the understory. In this presentation, we will describe the relationships between water management, exotic plant distributions, and fuel loads on the Middle Rio Grande, and describe current management and research practices in use that address the identified problems.

LITE[1], S., J. STROMBERG[2], AND K. BAGSTAD[3]. [1]Department of Geography, Arizona State University, PO Box 870104, Tempe, AZ 85287-0104; [2]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe, AZ 85287-1601; and [3]MWH (Montgomery Watson Harza Consultants), Chicago IL 60606. ***Plant species diversity and richness patterns across water availability and flood intensity gradients along the San Pedro River, Arizona***.

Woody and herbaceous species diversity patterns were examined along the San Pedro River at 18 sites spanning gradients of moisture availability (mean depth to groundwater and surface flow permanency) and flood intensity (total stream power). For woody species, wetter sites had higher wetland species richness and more vegetation patch types. Total and wetland species richness within cottonwood-willow patches and total vegetation patch types increased with increasing site moisture and flood intensity. The number of species within particular functional groups was also related to site moisture and flood intensity. Pioneer upland species increased at sites with higher total stream power, with *Isocoma tenuisecta, Opuntia engelmanii,* and *Gutierrezia microcephala* occurring at sites with higher disturbance levels, while *Hymenoclea monogyra* and *Ericameria nauseosus* were more evenly distributed. Increases in pioneer wetland species were related to higher flow permanency and total stream power. *Salix exigua, Baccharis emoryi, Pluchea sericea,* and *Platanus wrightii,* were present primarily at wet and high disturbance sites while *Populus fremontii, Salix gooddingii, Tamarix ramosissima, Baccharis salicifolia,* and *Baccharis sarothroides* were prevalent across moisture and disturbance gradients. Total pioneer species richness decreased at higher elevations, likely due to lower disturbance levels in the upper reaches. Site hydrology variables were related to overall herbaceous species diversity only during dry seasons. Among functional groups, however, richness of perennial wetland plants (which comprised a small percentage of the flora) was strongly linked with site hydrology, with seasonally-averaged richness values declining at dry sites. Richness of wetland and upland ruderals (the most abundant functional groups) increased at sites with high flood intensities and showed strong seasonal response to rainfall levels and recent flooding. Overall herbaceous richness declined along an elevational gradient, associated with declining rainfall levels.

LOOMIS, G. Tonto National Forest, 2324 E. McDowell Rd, Phoenix, AZ 85004. ***Burned area emergency rehabitation (BAER): Assessment and treatment***.

The presentation will address water quality and hydrologic effects to areas after a burn. The Forest Service's Burned Areas Emergency Rehabilitation (BAER) process will be discussed. Included will be the affects of fire on watersheds, how the Forest Service assesses values at risk, and the various types of BAER treatments. Photos of recovery of burned areas will show the effectiveness of these treatments over time.

RYCHENER, T. J., AND J. C. STROMBERG. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601. ***Change in riparian vegetation structure following fire along the Upper San Pedro River.***

Compared to other forested areas in the southwestern USA, little is known about the influence of fire on vegetation structure and composition in riparian communities. Following the 1988 acquisition of the San Pedro Riparian National Conservation Area (SPRNCA) in southeast Arizona, land use changes, including the removal of livestock, together with increased human presence, may have allowed for increased frequency of fire disturbance in the riparian zone and surrounding desert grasslands. This study focuses on effects of four riparian fires within the SPRNCA (1994, 1998, 2 in 1999). Structure and composition of woody plant communities were compared between burned sites and paired unburned sites with similar hydro-geomorphology and elevation. Stem mortality percentages within burned sites ranged from 26% to 31% for mesquite (*Prosopis velutina*), 13% to 43% for cottonwood (*Populus fremontii*), and 6% to 16% for willow (*Salix gooddingii*). Older mesquite had greater rates of stem mortality (63%) than older cottonwood (23%) or older willow (16%). Higher densities of young mesquite stems and willow saplings were observed at some burned sites compared to the unburned pairs, suggesting post fire re-sprouting by these species. These results suggest that within the SPRNCA, fire will influence riparian vegetation by shifting forest composition from cottonwood to willow, and mesquite structure from older woodlands, or bosques, to younger shrublands.

ABE SPRINGER[1],GINA MULLEN[2],TOM KOLB[3], and MELISSA AMENTT[4], [1]Department of Geology, Northern Arizona University, Flagstaff, AZ 86011; ph. 928-523-7198; fax 928-523-9220; e-mail: abe.springer@nau.edu; [2]Environmental Science and Policy Program, Northern Arizona University, Flagstaff, AZ 86011; e-mail: gina.mullen@nau.edu; [3]School of Forestry, Northern Arizona University, Flagstaff, AZ 86011; ph. 928-523-7491; e-mail: tom.kolb@nau.edu; [4]Sequoia National Forest, e-mail: **maamentt@fs.fed.us.** ***Restoration of wet meadows: Two Years of Monitoring the Influence of Burning Herbaceous Communities on Groundwater Recharge***. (POSTER presented by Jeremy Kober.)

While some research has addressed the hydrologic impacts of tree thinning in ponderosa pine-dominated ecosystems, impacts of prescribed burning in these ecosystems have received little attention. Prescribed burning is increasing in Southwestern ponderosa pine ecosystems, and has the potential to impact groundwater recharge. We are addressing this issue by studying the impacts of prescribed burning on evapotranspiration of the herbaceous understory in an upland wet meadow at Hart Prairie, Arizona. Four treatments were randomly applied to replicated circular plots (2 m radius) in herbaceous communities dominated by bracken fern or grasses (1 unaltered control), 2) repeatedly clipped to remove all vegetation, 3) burned during the pre-monsoon season, and 4) burned during the late-summer monsoon season. Treatment effects on herbaceous evapotranspiration were assessed by soil-water budgets based on repeated soil-moisture measurements. Comparisons between control and clipped plots in 2000, 2001, and 2002 showed that both herbaceous communities used substantial amounts of water that otherwise might be available for groundwater recharge and down gradient seep and spring ecosystems. Results for the summer of 2001 suggest that fire during the pre-monsoon period decreased herbaceous water use in the fern-dominated community, and to a lesser degree in the grass-dominated community. Results for the 2002 growing season show that there was significantly more soil water in the burned plots 2 years after the prescribed burn than in the unburned plots. We are doing additional monitoring to determine whether or not this increased soil moisture is available to recharge the underlying shallow aquifer and support the down-gradient riparian communities. Also, we anticipate doing larger prescribed burn in the spring of 2003.

SUBIRGE, T., Apache-Sitgreaves National Forest, Springerville Ranger District, P.O. Box 760, Springerville, AZ 85938. ***Fire effects to riparian areas, recent experience from the Rodeo/Chedeski fire***.

The Rodeo/Chedeski fire of June 2002 has not had extensive impact on riparian areas yet (3/28/2003). Riparian vegetation has for the most part withstood all flows off of the burned area, and none appears to be uprooted or washed out. Elk have greater effect on vegetation from herbivory, than do flood flows at this point. Most channel morphology alteration to date has been in the form of subtle signs of widening, while channel incision is less prominent. Most channel deepening seems related to man-caused influences, such as culvert locations, culvert removals, road crossings, and stock tanks. Some channel incision is related to natural causes, and may result in de-watering small wet meadows or taking immediately adjacent floodplains out of reach of normal bankfull flow events. The immediate effects of flood events have been limited which is likely due to a limited watershed size. Flood flows cannot acquire sufficient power to do massive damage in a short time. Evidence of channel alterations from the past century indicate that damage will likely sustain for many decades, before trends reverse.

VANDERMARK, B. Arizona Country Environmental Consultants, 4702 E. Ahwatukee Dr., Phoenix, AZ 85044. ***Arizona's forest-riparian-community-rangeland restoration – or let it Burn.***

Arizona's natural vegetation has developed over eons with riparian, rangeland and forest plant species that are based on limited natural rainfall and periodic natural wildfires. The relatively recent settlement of Arizona and the western United States by Native Americans, Spanish conquistadors, and western Europeans has attempted to impose humanity's desire to control and direct nature. Unfortunately, the cumulative impacts of these human activities has caused nature's balance to be skewed with severe consequences as witnessed by the recent Rodeo-Chediski fires in eastern Arizona and other large western United States wildfires during the spring, summer and fall of 2002.

The Arizona forest-riparian-community-rangeland interface mix gets us into the realm of "ecological restoration." Ecological restoration raises four major questions to be asked, and answered, before an Arizona consensus can effectively be formulated. If an Arizona consensus, inclusive of all its citizens and interest groups, cannot be forged, then ultimately nature will enact its consensus – irrespective of Arizona's humanity! Ideally, future natural (or prescribed) fires would "rarely exceed 3,000 acres" as was the case in "presettlement times."[1]

Four major questions raised by Thomas M. Bonnicksen[2] that must be asked and answered are:

- First and most serious question is philosophical — Should we attempt to restore ecosystems?
- Second question is Social — What do we want to restore?
- Third question is Scientific — What can we restore?
- Fourth question is Political — Who decides what we will restore?

This policy paper begins answering these critical questions.

The State of Arizona and its citizens need to come to grips with its forest-riparian-community-rangeland fuel-load situation. Our past inaction, and unwillingness to pay the cost of maintaining our environmental heritage, is coming due now. It is time for all Arizonans to address and resolve this forest-riparian-community-rangeland interface challenge. The spirit of Arizona lives on, and it will rise from the ashes of this catastrophe. Let's begin our cooperative forest-riparian-community-rangeland restoration consensus efforts!

[1]Pyne, Stephen J. 1995. Nouvelle Southwest. Presented at *Conference on Adaptive Ecosystem Restoration and Management: Restoration of Cordilleran Conifer Landscapes of North America*, June 6-8, Flagstaff, Arizona, p. 10-16.

[2]Bonnicksen, Thomas M. 1993. Social and Political Issues in Ecological Restoration. Pp. 108-114 in *Sustainable Ecological Systems: Implementing an Ecological Approach to Land Management*. Proceedings, June 12-15, 1993, Flagstaff, Arizona, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-247.

NOTES