Twenty-Eighth Meeting of the Arizona Riparian Council

1899 Ballroom
High Country Conference Center
Flagstaff, Arizona
October 15-16, 2015

Tools and Techniques for Assessing and Restoring Riparian Habitat

Cosponsored by:

School of Forestry
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Soil and Water Conservation Society

Program and Abstracts
2015

TWENTY-EIGHTH ANNUAL MEETING
ARIZONA RIPARIAN COUNCIL

Co-sponsored by:
School of Forestry, Northern Arizona University
Soil and Water Conservation Society

TOOLS AND TECHNIQUES FOR ASSESSING AND RESTORING RIPARIAN HABITAT

1899 Ballroom, High Country Conference Center
201 W Butler Ave, Flagstaff, AZ 86001
October 15-16, 2015

Thursday, October 15, 2015

7:45-8:30 a.m. — ***Registration***

8:30-9:00 a.m. — ***Welcome and Goals and Objectives of Meeting***
Kris Randall, President, Arizona Riparian Council; Kevin Grady, Assistant Research Professor, School of Forestry, Northern Arizona University; Gary Wendt, Treasurer, Soil and Water Conservation Society, Arizona Chapter

9:00-9:45 a.m. — ***Wet/Dry Mapping, ER Sensors, and SWAT Models: Hydrological Tools to Better Understand River Drying Patterns at Different Temporal and Spatial Scales*** - Daniel Allen, Assistant Professor, College of Letters and Sciences, Arizona State University, Polytechnic campus

9:45-10:30 a.m. — ***Soil Moisture Monitoring to Inform Riparian Restoration, Monitoring, and Research Projects*** - Matthew Grabau, Restoration Scientist, Sonoran Institute and Geosystems Analysis, Inc., Tucson

10:30-10:45 a.m.	***BREAK (Posters)***
10:45-11:30 a.m.	***A Restoration Framework for the Upper Gila River, Arizona*** - Bruce Orr, Senior Scientist, Stillwater Sciences, Portland, OR
11:30 -12:15 p.m.	***The Reality of Climate Change and the Need for Genetics Approaches in Riparian Restoration*** - Tom Whitman, Regents' Professor, Biological Sciences & Merriam Powell Center for Environmental Research, Northern Arizona University
12:15 - 1:30 p.m.	***LUNCH (Posters)***
1:30-1:50 p.m.	***The Use of Tablet Computers for Field Data Collection in the Verde River Watershed*** - Anna V. Shrenk and Calvin Rogers
1:50-2:10 p.m.	***Direct Seeding and Seedling Production as a Tool for Restoring Riparian Habitats*** - Lindsey Bunting, Matt Grabau, Mike Milczarek, Barbara Raulston, Bill De Vor, and Fransisco Zamora
2:10-2:30 p.m.	***Zonal Planting Methodologies for Restoration on the Upper Gila River*** - Shawn Stone, J. Johnson, G. Leverich, and R. More Hla
2:30-2:50 p.m.	***Use of the "Bank Assessment for Non-point Source Consequences of Sediment" (BANCS) Model for Predicting Stream Bank Stability and Sediment Influx to Streams*** - Allen Haden
2:50-3:10 p.m.	***Break (Posters)***
3:10-3:30 p.m.	***Estimating Springs Density in Death Valley National Park*** - Katie Junghans, Abe Springer, Larry Stevens, and James Allen
3:30-3:50 p.m.	***Springs Online: A Secure, Collaborative Tool to Enter, Analyze, and Retrieve Springs Inventory Data*** - Jeri Ledbetter, Larry Stevens, and Abe Springer
3:50-4:10 p.m.	***Improving Understanding Through Synthesizing Environmental Flow Needs Data in Water Scarce Regions*** - Kelly Mott Lacroix, Elia Tapia, and Sharon B. Megdal

4:10-4:30 pm. *Critical Riparian Vegetation for the* **Danaus plexippus** *Population Migration and Breeding in Arizona* - Gail Morris, C. Kline, and S. Morris

4:30-4:45 p.m. *Wrapup and What's Next*

6:30 p.m. ***Dinner (optional)***, Weatherford Hotel (directions below)

Posters

How Do Quantitative Traits of Colorado River Flora Vary with USDA Database Categorical Indicators of Stress Tolerance? - Miles McCoy, Thomas Kolb, David Merritt, Emily Palmquist, Barbara Raulston, Daniel Sarr, and Patrick Shafroth

VWRC: A Collaborative Watershed Approach to Improving Riparian Areas in the Verde Watershed - Anna V. Schrenk, Calvin Rogers, and Jamie Nelson

Directions to the Weatherford Hotel from the Drury Inn

1. Drury Inn & Suites - Flagstaff, 300 S Milton Road, Flagstaff, AZ 86001
2. Head east toward W Butler Ave
3. Turn right onto W Butler Ave
4. Turn left onto S Beaver St
5. Turn right onto W Aspen Ave
6. Weatherford Hotel, 23 N Leroux Street, Flagstaff, AZ 86001

Friday, October 16, 2015
Site Visit to Picture Canyon/Rio de Flag

8:30 a.m. Leave Drury. People staying at hotels other than the Drury should plan to arrive at the Picture Canyon/Rio de Flag site by 8:45.

8:45 a.m. Arrive at Picture Canyon/Rio de Flag (RDF). Group will gather. David McKee of the City of Flagstaff will lead a tour of the Phase II portion of RDF and describe the work has been done in this reach and some of the cultural history of the area.

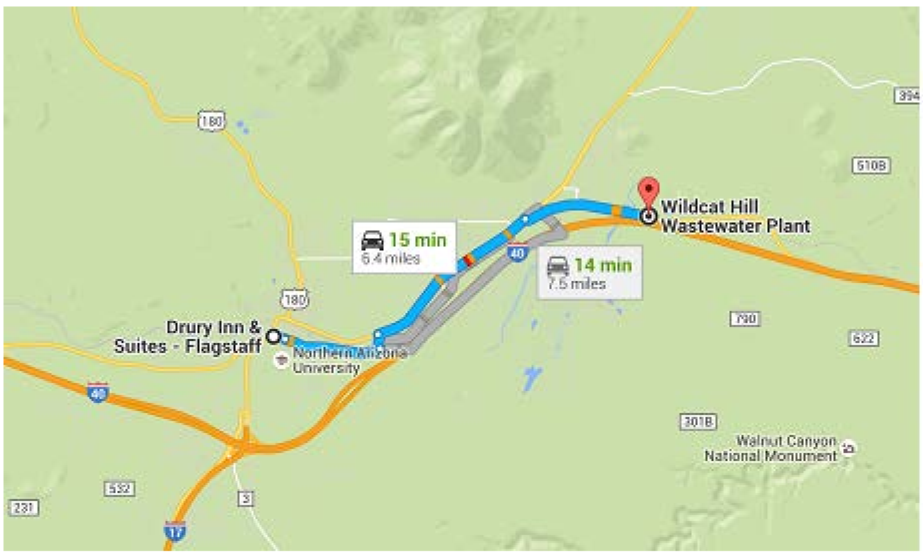
10:00 a.m. Return to the parking area, at upper portion of RDF Phase I. Allen Haden and Stephanie Yard of Natural Channel Design will lead the group on a hike along the Picture Canyon trail to see the features that were constructed as part of the Phase I project. At the upper portion there is a wetland which plays a role for the RDF. Stations will be set up to demonstrate tools and techniques for assessing the riparian area. You will be able to go from station to station.

- Measure channel cross-sections
- Laser level
- Survey grade GPS
- Vegetation monitoring
- Sample grid
- Computer tablets
- Photo monitoring

Around 11:00 if we are done with the demonstrations, everyone can hike to the lower portion of the RDF and see the additional restoration work that was done on that section of the creek.

Directions to Picture Canyon/Rio de Flag

1. From the Drury Inn, head east toward W Butler Ave
2. Turn right onto W Butler Ave
3. Continue straight to stay on W Butler Ave
4. Turn left onto Ponderosa Pkwy
5. Turn right onto Historic Rte 66
6. Turn right to stay on Historic Rte 66
7. Turn left onto N El Paso Flagstaff Rd
8. You will see the Wildcat Hill Wastewater Plant
9. Park on the shoulder of N El Paso Flagstaff Rd



Background of Area

The area that we will look at is the Picture Canyon Meander Restoration Project Phase I & Phase II along the Rio de Flag. In 2009, this area received funding to restore the fluvial processes of the Rio de Flag and to enhance the riparian corridor for habitat, recreation, and aesthetics in the Picture Canyon area. Objectives included restoring channel meander and floodplain function, eliminating noxious weeds, restoring riparian and wetland plant communities, increasing plant species diversity, creating additional wetland habitats, improving water quality, increasing wildlife habitat, and providing recreational benefits.

The Rio de Flag (RDF) is the primary watercourse winding through Flagstaff, Arizona. The stream channel is ephemeral or intermittent depending on the season or local geology. Picture Canyon is located on the east side of Flagstaff along the RDF.

Sometime in the past, the stream channel above and below Picture Canyon was dredged and straightened, removing a number of natural meanders. This channelization was likely done to rapidly remove effluent released from the Wildcat Hills Waste Water Treatment Plant. The dredged and straightened section had no access to its floodplain and supported a very limited riparian plant community. Noxious weeds invaded the site due to the soil disturbance from the trenching activities. The result was a significant narrowing of the riparian area and a rapid transit of the perennial stream flow, effectively reducing riparian and wetland habitat.

Water quality of releases from the wastewater treatment plant were vastley improved due to technology upgrades and there is no longer a need to rapidly remove the released water from the site. The goal of the project was to restore the fluvial processes of the stream and enhance the riparian corridor for habitat, recreation, and aesthetics. Specific objectives included: eliminate noxious weeds, restore channel meander and floodplain function, restore native riparian and wetland plant communities, increase plant species diversity, create additional wetland habitats, improve water quality, increase wildlife habitat, provide recreation and aesthetic benefits, and demonstrate and educate the general public of the restoration methods. The riparian and wetland area have roughly doubled in size from 2 to 5 acres.

The improved riparian, aesthetic and recreational values of the property in addition to the significant cultural resources associated with the site have led the City of Flagstaff to purchase the property and manage it as a natural and cultural resource preserve.

Before and After Photos of the Rio de Flag Restoration Project (courtesy of Allen Haden, Natural Channel Design)

Upper reach before

Upper reach after

Arizona Trail area, before

Arizona Trail area, after

Lower reach before

Lower reach after

Invited Speaker Bios and Abstracts
(Listed alphabetically)

Daniel Allen, Assistant Professor, College of Letters and Science, Arizona State University, Polytechnic campus

Daniel Allen received his Ph.D. from the University of Oklahoma in 2011, advised by Dr. Caryn Vaughn. He conducted his post-doctoral research training at Arizona State University from 2011-2012 with Dr. John Sabo, and at the University of Michigan from 2012-2014 with Dr. Brad Cardinale. In 2014, he became an assistant professor at Arizona State University. He is an ecologist who studies interactions between ecological processes (biodiversity and food webs) and physical processes (hydrology and geomorphology), and studies stream and riparian ecosystems.

Wet/dry Mapping, ER Sensors, and SWAT Models: Hydrological Tools to Better Understand River Drying Patterns at Different Temporal and Spatial Scales

Although the study of intermittent rivers has been neglected in the past relative to perennial systems, we are in the midst of burgeoning interest in intermittent river ecology and hydrology. New hydrological tools are being developed to quantify and better understand patterns of river drying. In arid systems like the southwestern US, understanding river-drying patterns is crucial for protecting and managing riparian ecosystems, as the function and structure of riparian ecosystems is largely tied to local hydrology. He will present a brief overview of three different hydrological tools that are being used to study river-drying patterns at different temporal and spatial scales: wet/dry mapping, electrical resistance (ER) sensors, and soil-water-air-temperature (SWAT) models. Each approach can be used to describe river-drying patterns, but are better suited for different temporal and spatial scales of interest. Mapping of wet and dry reaches of a river ("wet/dry mapping") is labor intensive and typically conducted once or a few times per year, and provides extremely accurate spatial drying patterns for a given river but only at a single point in time. ER sensors measure the presence/absence of water at a single point in space, but log water/presence absence data continuously, providing extremely accurate temporal drying patterns but only at a single point in space. SWAT models use geospatial and climate data to model surface flows and can estimate river drying dynamics under future climate conditions, but are most accurate at larger spatial scales. He will briefly present results of research studies using each approach to demonstrate how they can be used. Allen will close the talk by discussing how he thinks these different techniques may be able to be integrated to be able to accurately model how riparian ecosystems may change as a result of altered river drying patterns due to climate change.

Matthew R. Grabau, Ph.D., Restoration Scientist, Sonoran Institute and Geosystems Analysis, Inc.

Matthew Grabau is a restoration scientist with the Sonoran Institute in Tucson, Arizona. He has a M.S. and Ph.D. in agricultural and biosystems engineering from the University of Arizona, where he worked on developing cottonwood and willow seeding techniques. In a previous lifetime, Matt earned his B.S. in Wildlife Science from the University of Arizona. He has been working on riparian restoration projects, primarily on the lower Colorado River in the US and Mexico, for the past ten years. His focus is integrating hydrology, soil science, and biology, and developing applied research and monitoring programs to inform conservation and restoration of riparian areas.

Soil Moisture Monitoring to Inform Riparian Restoration, Monitoring, and Research Projects

Riparian vegetation depends on high plant-available soil moisture from shallow groundwater and/or capillary rise. Additionally, wet surface soils enhance habitat quality for riparian obligate species such as the Southwestern willow flycatcher. While groundwater depth is often examined on some level for riparian restoration and monitoring projects, soil moisture dynamics typically are not. Numerous options are available for both manual and automated soil moisture monitoring that can provide a more complete assessment of plant water availability. This talk will provide examples of soil moisture monitoring programs for various riparian research projects along the Colorado River in the US and Mexico over the past nine years.

In 2007, we installed soil moisture monitoring equipment to observe irrigation frequency and water availability in experimental cottonwood and willow seeding plots in Cibola, Arizona. The first year of data documented that irrigation was applied less frequently than requested, potentially explaining a lack of willow establishment. For the following three years, the monitoring system was used to determine the effects of prescribed irrigation frequencies on soil moisture availability for established cottonwoods and also to estimate water budgets. Instrument data indicated that a decreased irrigation frequency (once per month versus once per week) reduced labor needs without adversely impacting soil moisture availability due to shallow groundwater and fine-textured soils.

In 2012 and 2013, irrigation distribution and soil moisture was monitored at an 80-acre restoration site near Blythe, California. Irrigation distribution results indicated that irrigation efficiency was limited by large field sizes, coarse soils, and low irrigation flow rates. A water budget generated from instrument readings and remote sensing data showed that much of the site received irrigation far in excess of evapotranspirative demand, while portions of the site were likely supported to some extent by groundwater.

Several locations in the Laguna Grande Restoration Area of the Colorado River floodplain in Mexico also were instrumented to monitor the response of soil moisture and groundwater to delivery of Minute 319 environmental flows. We observed that at this restoration site – 80 river km removed from the pulse flow delivery point at Morelos Dam – soil moisture increased due to rising groundwater as opposed to infiltration of surface flows, especially in monitoring locations farther removed from the main river channel. Repeated soil moisture increases and decreases also explain observed soil salinity reductions. These projects demonstrate the usefulness of soil moisture monitoring technology. For irrigated restoration sites, monitoring data can be used to develop alternate restoration and irrigation designs and then monitor their effectiveness. Ultimately, monitoring results also could be used to decrease irrigation demand and Colorado River water diversions. For unirrigated sites, soil moisture monitoring data can improve understanding of soil moisture dynamics in the unsaturated zone and capillary fringe. Potential constraints for use of monitoring equipment include the need for soil-specific sensor calibrations, soil salinity, soil heterogeneity, and protection from human and animal disturbance.

Bruce K. Orr, Senior Ecologist/Vice President, Stillwater Sciences

Bruce Orr (Ph.D., Entomology/Ecology, University of California-Berkeley; B.A. Biological Sciences/ Environmental Studies, University of California-Santa Barbara) has over 25 years of experience leading complex projects involving natural resource inventories, integrated natural resource management plan development, and federal and state regulatory processes in rivers and watersheds throughout the western United States. In recent years his focus has been on large-scale ecosystem restoration planning and implementation in rivers and wetlands, and continuing his research on riparian ecosystem dynamics. He has led numerous multi-disciplinary, large-scale river corridor restoration studies in major watersheds throughout California (San Joaquin, Sacramento, Tuolumne, Merced, and Santa Clara rivers), and other parts of the Southwest (Virgin River [Utah, Arizona, Nevada] and the Gila River [Arizona]). Dr. Orr provides senior strategic support on many of Stillwater's large-scale regulatory, watershed management, and restoration projects, including ongoing work on river-floodplain restoration to promote recovery of salmon and steelhead, and tidal wetland restoration in the Sacramento-San Joaquin Delta for the California Department of Water Resources.

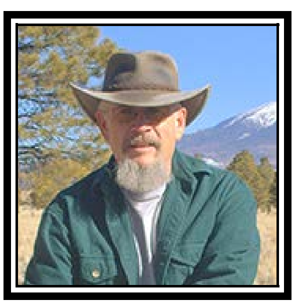
A Restoration Framework for the Upper Gila River, Arizona

Like so many ecologically important riverine systems in the Southwest, the upper Gila River in Arizona is sensitive to natural and anthropogenic stressors, including flooding, invasion by non-native plants, wildfire, urban encroachment, and various land- and water-use practices. The river also supports critical habitat for southwestern willow flycatcher (SWFL), as it is known to be occupied by flycatchers and provides attributes essential to the species' long-term conservation, despite much of it being densely infested with non-native tamarisk. A key concern in the watershed, therefore, is the eventual arrival of the tamarisk leaf beetle introduced elsewhere in the Southwest. While there are numerous potential benefits to tamarisk suppression via biocontrol (e.g., groundwater conservation, riparian habitat recovery, fire-risk reduction), short-term negative consequences are also possible, such as defoliation during the flycatcher nesting season.

In preparation for anticipated impacts following beetle colonization, we developed a restoration framework in coordination with a collaborative science team and the Gila Watershed Partnership of Arizona. The framework is intended to promote recovery of native riparian habitat and subsequent local increases in flycatcher population, as well as supporting other species of concern, such as the yellow-billed cuckoo. Central to this effort, we are conducting an Ecohydrological Assessment to identify sustainable restoration sites based on consideration of natural and anthropogenic factors that, together, influence restoration opportunities-flood-scour disturbance, vegetation community structure and resilience, surface- and groundwater availability, soils conditions, SWFL habitat suitability and potential, wildfire potential, and land-use activities. Data collected specifically for the project include high-resolution remote-sensing products, GIS-based delineation of geomorphic activity, and vegetation field mapping. These data along with other information generated by the science team, including pre-biocontrol vegetation monitoring and flycatcher-habitat modeling, were synthesized to produce a comprehensive restoration plan that highlights those areas of the river best suited for active restoration and, ultimately, assists the Gila Watershed Partnership (GWP) and others in development and prioritization of appropriate, cost-effective restoration strategies.

Developing monitoring and adaptive management plans is an important part of planning and implementing successful and sustainable restoration projects, particularly given the uncertainties associated with anticipated climate change effects on riverine and riparian ecosystems. We have continued to work with the GWP in the subsequent permitting and site-specific restoration design and implementation phases. Shawn Stone of the GWP will discuss more of these aspects in his companion talk.

Bruce Orr[1], Glen Leverich[1], Zooey Diggory[1], Tom Dudley[2], Jim Hatten[3], Kevin Hultine[4], Matt Johnson[5], and Shawn Stone[6]. [1]Stillwater Sciences, Berkeley, California, glen@stillwatersci.com, bruce@stillwatersci.com, zooey@stillwatersci.com; [2]Marine Science Institute, University of California, Santa Barbara, California, tdudley@msi.ucsb.edu; [3]Columbia River Research Laboratory, U.S. Geological Survey, Cook, Washington, jhatten@usgs.gov; [4]Desert Botanical Garden, Phoenix, Arizona, khultine@dbg.org; [5]Colorado Plateau Research Station, Northern Arizona University, Flagstaff, Arizona, Matthew.Johnson@nau.edu; [6]Gila Watershed Partnership, Safford, Arizona, shawn@gwpaz.org



Tom Whitham, Regents' Professor and Executive Director of the Merriam-Powell Center for Environmental Research & Department of Biological Sciences, Northern Arizona University

Tom Whitham grew up in a wholesale nursery that developed new varieties of trees and shrubs that were derived from clones of somatic mutants found in the field. Observations of clonal variation in trees and a fascination with insects greatly influenced his education and research interests. He received his Ph.D. from the University of Utah, where he discovered that the distribution of insects in the wild was highly sensitive to tree genotype. Throughout his career, he has explored how other species ranging from soil microbes to beavers and elk, climate change, and invasive species interact with tree genotype to affect community structure and ecosystem processes. To explore these interactions, large-scale experiments were required. This led to collaborations with other researchers and conservation agencies such as Arizona Game and Fish Department in which replicated experimental forests spanning 1,500 km were planted as part of habitat restoration. The findings from these forests have played an important role in the development of genetics approaches for mitigating the impacts of climate change, invasive species and other global challenges. These approaches are highlighted in the award winning PBS documentary film "A Thousand Invisible Cords: Connecting Genes to Ecosystems." For this research he was recently awarded the Eminent Ecologist Award from the Ecological Society of America.

The Reality of Climate Change and the Need for Genetics Approaches in Riparian Restoration

The role of genetics in restoration has largely revolved around the mantra of restoring with local genotypes. Other than this largely accepted policy, the use of genetics in restoration has been minimal. However, anthropogenic impacts on the planet have largely rendered this policy as inadequate at best and damaging at worst. Climate change and other global challenges represent grave risks for all ecosystems of the world. Because of rapid environmental change, plants that are locally adapted today are likely to be locally maladapted to tomorrow's environments. Thus, in regions of especially rapid change such as the American Southwest, local populations are likely to lack sufficient genetic variation to adapt to these new environments. Similarly, with rapid change and a fragmented landscape, many species cannot migrate fast enough to reach favorable environments. Ignoring this "climate change reality" will likely result in restoration failure, high biodiversity loss, and the loss of restoration funding. With foundation species that support 1,000s of other species (e.g., Fremont cottonwood, coyote willow), it is crucial to identify the individual plant genotypes and populations that can survive future environmental conditions. By focusing on these foundation species that are community and ecosystem drivers, we can save many of the species that are dependent upon them for their survival. To achieve this goal, new experimental approaches are required that identify the genetic components of local adaptation to future conditions, biodiversity, community stability, and ecosystem processes. Key to this approach is the use of field trials embedded in lands to be restored such as the Southwest Experimental Garden Array (http://www.sega.nau.edu). Based on the findings in these trials, restoration biologists can then deploy superior genotypes and populations that are most likely to survive future environmental conditions.

Technical Papers and Poster Abstracts

Listed alphabetically by first author.

Bunting, L.[1], M. Grabau[1,2], M. Milczarek[1], B. Raulston[3], B. De Vor[4], and F. Zamora[2].
Direct Seeding and Seedling Production as a Tool for Restoring Riparian Habitats.

Cottonwood (*Populus* spp.) and willow (*Salix* spp.) species are an integral part of riparian habitat restoration in the southwestern United States. Vegetative propagation is typically used to generate planting stock since these genera are easily established from cuttings. However, if source plants are not carefully selected, vegetative propagation can negatively impact genetic diversity and sex ratios. These effects may decrease passive seedling recruitment potential and resilience against environmental stressors. For these reasons, sexual propagation (e.g., direct seeding, seedling propagation, passive establishment from on-site seed dispersal) is recommended to improve diversity. Direct seeding can also dramatically reduce restoration costs. Depending on direct seeding rates, resultant high tree densities provide competitive advantages over invasive species (e.g., tamarisk). Selective harvesting of seeded areas can also be used for collection of genetically diverse material for cuttings and poles. It had been speculated that a short window of viability for cottonwood and willow seed would make large-scale seeding or seedling production impractical, and seeding attempts prior to 2006 were largely unsuccessful.

To address perceived limitations to seeding and seedling production, we completed a feasibility study to develop reliable seed collection, treatment, storage, and direct seeding practices. We found that seed viability can be extended to several years by freezing, which allows for seed banking, long-term revegetation coordination, and flexibility in seeding dates. Successful direct seeding demonstration projects have been completed along the lower Colorado River in the United States and Mexico. In some cases, resulting tree density has been excessive and seeded areas are being used for collection of genetically diverse poles. Additionally, new seed collection and processing techniques have been adopted by restoration plant material providers, who use automated seeding to propagate seedlings and provide planting stock. This method has become the principle production practice for this grower and the primary source of plant material for Bureau of Reclamation Multi-Species Conservation Program riparian restoration sites. Finally, by clearing vegetation and irrigating to mimic natural germination conditions, low cost restoration can be achieved by taking advantage of seedfall from adjacent planted or remnant vegetation.

The primary limitation for direct seeding is that clearing and irrigating to promote native vegetation recruitment also recruits weed seedlings which might require treatment during the first growing season. The primary limitation for seedling production is the additional time required to grow seedlings to the desired outplanting size compared to propagation of rooted cuttings.

[1]GeoSystems Analysis, Inc., Tucson, AZ: [2]Sonoran Institute, Tucson, AZ: [3]US Department of the Interior, Bureau of Reclamation, Boulder City, NV: and [4]Greenheart Farms, Arroyo Grande, CA

Haden, A. ***Use of the "Bank Assessment for Non-point Source Consequences of Sediment" (BANCS) Model for Predicting Stream Bank Stability and Sediment Influx to Stream.***

The BANCS model is described in the Watershed Assessment of River Stability & Sediment Supply (WARSSS) developed by Dave Rosgen P.H., Ph.D. This method is approved by the US Environmental Protection Agency for predicting sediment supply from eroding stream banks to streams. It utilizes the Bank Erosion Hazard Index (BEHI) and estimates of near bank stress (NBS) to provide estimates of tons of sediment per foot of stream bank per year that is sourced from stream banks and subsequently carried by the stream. It has not been widely applied throughout the arid Southwest, however studies and multiple applications by Natural Channel Design, Inc. and others indicate that it is a reliable tool for estimating bank erosion, lateral movement and sediment influx to both ephemeral and perennial stream systems. We will provide a review of the methods and supporting data collected for Arizona streams as well as examples of how the model has been utilized in assessment and monitoring for past projects. Continued use of the BANCS model in our region combined with additional verification and refinement will lead to a more accurate and useful tool for sediment and stability estimation.

Natural Channel Design, Inc., 2900 N. West St., Ste.#5, Flagstaff, AZ 86004

Junghans, K.[1], A. Springer[1], L. Stevens[2], and J. Allen[3]. ***Estimating Springs Density in Death Valley National Park*.**

Fundamental to stewardship of springs is an understanding of their location and distribution. The largely incomplete inventory of springs in the United States has been detrimental to the protection of these important ecosystems. In most cases, it is unrealistic to locate every spring in a landscape due to limited resource availability for surveying, rarity of springs across landscapes, and physical remoteness of springs.

Accumulation curves use a subject's rate of discovery and statistical extrapolation methods to estimate the total number of subjects within a population. This study uses the rate of spring discovery in Death Valley National Park to evaluate the applicability of using accumulation curves to estimate a landscape's total spring density. It is proposed that accumulation curve analyses are a robust statistical procedure that can be used to produce accurate estimates of a landscape's spring density. Establishing a non-resource intensive method to estimate a landscape's total spring density will improve global springs stewardship by providing valuable information for planning and implementing effective springs surveying, monitoring, and restoration programs.

[1]School of Earth Sciences and Environmental Sustainability, Northern Arizona University, PO Box 5694, Flagstaff AZ 86001; [2]Springs Stewardship Institute, Museum of Northern Arizona, 3100 N. Fort Valley Rd., Flagstaff AZ 86001; and [3]School of Forestry, Northern Arizona University, PO Box 15018, Flagstaff AZ 86011

Ledbetter, J.[1], L. Stevens[1], and A. Springer[2]. ***Springs Online: A Secure, Collaborative Tool to Enter, Analyze, and Retrieve Springs Inventory Data.***

Although they are among the most biologically and culturally important and highly threatened ecosystems in Arizona, springs are poorly studied, inaccurately mapped, and inadequately protected. Research and conservation efforts focused on streams often overlook springs that provide the baseflow for these systems. What little information exists is often fragmented, and largely unavailable to those who need it most - land managers, Tribes, conservation organizations, and researchers. Springs Online, a database hosted by the Springs Stewardship Institute, was launched in January 2014, offering a user-friendly interface that provides access to springs data. Comprehensive inventory is a fundamental element of ecosystem stewardship. It provides essential information on the distribution and status of resources and processes within an ecosystem. We have developed a systematic method for collecting inventory data that leads to assessment, planning, management action, and monitoring. A comprehensive evaluation requires a survey of geomorphology, soils, geology, solar radiation, flora, fauna, water quality, flow, georeferencing, and cultural resources, as well as a thorough assessment of the site's condition and risks to the ecosystem. The information we collect in each category is complex, and many of the data are interrelated. We designed this relational database to provide a framework for information compilation and analysis of biological, physical, and cultural relationships, many of which are poorly understood. The database, at springsdata.org, currently includes location information for 10,224 springs of Arizona and some level of survey data for 2,081 sites. Location information for sites not already published requires permission, as does any access to survey data. This online database offers a user-friendly interface to enter, retrieve, and analyze inventory data, making it accessible for landowners and managing agencies as well as researchers to improve the quality and integration of information about springs.

[1]Springs Stewardship Institute, Museum of Northern Arizona, 3101 N. Fort Valley Road, Flagstaff AZ 86001; and [2]School of Earth Sciences and Environmental Sustainability, Northern Arizona University, 523 PO Box 5694, Flagstaff AZ 86011, Geology (Bldg #12), room 206.

McCoy-Sulentic, M.[1], T. Kolb[1], D. Merritt[3], E. Palmquist[2], B. Ralston[2], D. Sarr[2], anf P. Shafroth[4]. ***How Do Quantitative Traits of Colorado River Flora Vary with USDA Database Categorical Indicators of Stress Tolerance?*** (POSTER)

Categorical rankings of habitat and stress tolerance of plant species, such as the USDA Wetland Indicator Status, are often used to classify plant species into functional groups and infer environmental preference. Yet, such categorical data often are best guesses about species characteristics and thus need to be informed by quantitative measurements of traits associated with habitat and stress tolerance. Consequently, we investigated the relationship between categorical classifications and four traits indicative of plant strategy and stress tolerance. We compared stem specific gravity, specific leaf area (SLA), seed mass, and plant maximum height among categorical rankings of USDA Wetland Indicator Status, and drought tolerance rankings based on USDA Fire Effects Information System and other literature. Traits of 98 plant species found along the Colorado River in Grand Canyon were measured empirically or obtained from flora and online databases. Height differed among both drought tolerance and wetland indicator status categories for woody species, but not herbaceous species. Stem specific gravity and seed mass differed across categories for both woody and herbaceous species. Species found in more mesic areas had lower stem specific gravity and lighter seed mass. Species found in xeric uplands had higher stem specific gravity and greater seed mass. For herbaceous species, SLA was lowest in the obligate wetland (OBL) category and highest in the facultative wetland (FACW) category. Overall, drought tolerance and wetland indicator categories of species were more strongly associated with differences in stem specific gravity and seed mass than SLA or height.

[1]School of Forestry, Northern Arizona University, 200 East Pine Knoll Drive, AZ 86011; [2]US Geological Survey, Southwest Biological Science Center, 2255 N Gemini Rd, Flagstaff, AZ 86001; [3]USDA Forest Service, National Stream and Aquatic Ecology Center, 2150 Center Ave, Bldg A, Ste 368, Fort Collins, CO 80526; [4]US Geological Survey, Fort Collins Science Center, 2150 Centre Ave, Bldg C, Fort Collins, CO 80526

Mott Lacroix, K E. , E, Tapia, and S, B. Megdal. ***Improving Understanding Through Synthesizing Environmental Flow Needs Data in Water Scarce Regions.***

Water rights for environmental flows are not universal, and oftentimes, legal tools used to incorporate the environment into water management only require new users to consider their impact. It can be difficult to include the needs of riparian and aquatic ecosystems in new plans when relevant information is not always available, especially when other existing uses already outstrip available supplies. There is a need for easily accessible and understandable science on the water requirements for riparian and aquatic species, so managers can make informed decisions about whether or not to include riparian and aquatic species in their community's water management future. This presentation will describe a geospatial database created to synthesize available data on environmental flow needs and responses across the Chihuahuan, Mohave, and Sonoran deserts in the U.S. and Mexico. The presentation will also summarize results from a 2015 study of the current understanding of the link between hydrology and riparian and aquatic ecosystems across the deserts of the U.S. and Mexico. The environmental flows database created for this synthesis can be used to identify critical geographic and topical knowledge gaps where further research is needed, as well as serve as a single place for water and land managers to assess and use the most currently available information to make more informed management decisions and recommendations.

Water Resources Research Center, College of Agriculture, University of Arizona

Morris, G., C. Kline, and S. Morris. ***Critical Riparian Vegetation for the* Danaus plexippus *Population Migration and Breeding in Arizona.***

Asclepias spp. and nectar plants for breeding and migration are key to the *Danaus plexippus* population recovery across North America. A recently published paper, "Status of *Danaus plexippus* in Arizona" established the importance of riparian areas as crucial monarch migration and breeding corridors in Arizona. Monitoring data collected by the Southwest Monarch Study (tagging 12,088 monarchs by 384 individuals in 276 unique locations and 134 unique sighting locations of monarch adults and/or immatures) led to the identification of key breeding *Asclepias* spp and nectar flora resources preferred by *D. plexippus* by elevation. Monarch butterflies were also reported puddling in slow-moving streams and seeps especially when temperatures are high and humidity is low, an uncommon behavior in monarch butterflies. Nearby riparian trees, especially cottonwoods and Goodding willows, were utilized for night roosts. This study also identified small overwintering monarch aggregations in Phoenix, Yuma, Parker, Lake Havasu, and Tucson.

Arizona was divided into three climate zones: mountainous regions, high desert and cool plateau highlands, and the low- to mid-altitude deserts. *Asclepias subverticillata* was the most favored breeding milkweed in the mid- and high-elevation regions especially in cienegas, seeps, and river floodplains. Meanwhile *A. subulata* was most utilized by monarchs in the lower desert elevation ephemeral washes followed closely by *A. angustifolia* in its range. Other *Asclepias* observed for monarch breeding included *A. asperula, A. engelmanniana, A. erosa, A. linaria, A. nyctaginifolia, A speciosa*, and *A. tuberosa*. To a limited extent *A. albicans* and *A. funastrum cynanchoide* were also used for ovaposition although less frequently.

Monarch butterflies will favor *Asclepias* for nectar but will lay eggs on milkweeds before it is in bloom. In those cases they will utilize the following flora in their range: *Apocynum cannabinum, Baccharis salicifolia, Cirsium* spp., *Helianthus annuus, Medicago sativa, Senecio flaccidus* var. *flaccidus, Trifolium pinetorum*, and *Verbena macdougalii*.

During their fall migration, monarch butterflies are not breeding, so instead they require strong nectar sources to store lipids to fuel their long-range flight and winter torpor. They will utilize *Asclepias* spp. in bloom for nectar when available. The following nectar in their range were favored by *D. plexippus* during the fall migration: *Baccharis salicifolia, Baccharis sarothroides, Bebbia juncea, Bidens laevis, Ericameria* (*Chrysothamnus*) spp., *Cirsium* spp., *Helianthus annuus, Senecio flaccidus* var. *flaccidus, Verbesina encelioides*, and *Vitex agnus-castus*.

The Southwest Monarch Study is a partner with Monarch Joint Venture and is supporting the development of Monarch SOS by Nature Digger, a new smart phone application currently only available for education purposes. When it is complete next season, it will be instrumental in reporting monarch adults and immatures, tagging information and in identifying *Asclepias* spp. Currently available for iPhones and iPad, it will be available for Android users as well.

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Schrenk, A. V., and C. Rogers. ***The Use of Tablet Computers for Field Data Collection in the Verde River Watershed.***

The Verde Watershed Restoration Coalition (VWRC) is a multi-stakeholder coalition working collaboratively in the Verde watershed of central Arizona to implement a watershed-scale restoration plan. VWRC originated in 2010 in order to increase collaboration and communication between stakeholders. Friends of Verde River Greenway (FVRG) is the leading non-profit organization within VWRC which provides staff support to the project.

The Verde River Cooperative Invasive Plant Management Plan (CIPMP) is VWRC's five-year management plan with the primary ecological goal of removing of woody invasive plant species throughout the watershed. VWRC is currently going into its fourth treatment season, and has implemented the use of Android tablets for field data collection. Data collected for the project includes; baseline inventory of invasive species, treatment data, and post-treatment monitoring. Previously, enormous amounts of data had been collected on paper data sheets, and then manually entered into the VWRC database. The results of using this old school method as we know are many tedious hours of data entry, costliness and sometimes poor data quality.

The use of tablets has recently been discussed as a possible method of field data collection among many watersheds partnerships within the Colorado River Basin; VWRC has opted to be the pilot in testing this process. We will present the applications being field tested as well as the new procedures and protocols that have been developed and implemented for field data collection in the Verde. We will also share our success and challenges using this new school technology. The introduction of the tablets has greatly streamlined our ability to process data quickly and evaluate data being collected by field crews in real time. The tablets have resulted in better communication between field crews, more accurate data collection, and more efficient data entry at lower costs.

Some of this year's improvements include new rapid pre- and post-monitoring techniques, and more in-depth data collection for site recovery and native species recruitment.

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Schrenk, A. V.[1], C. Rogers[2], and J. Nielsen[3]. ***VWRC: A Collaborative Watershed Approach to Improving Riparian Areas in the Verde Watershed***. (POSTER)

The Verde Watershed Restoration Coalition (VWRC) is a multi-stakeholder group of representatives from federal and state agencies, private landowners, corporations and non-profit organizations working on a watershed scale initiative to manage invasive plants. The Verde River Cooperative Invasive Plant Management Plan, a five-year plan, was competed by VWRC in 2010. The plan includes not only ecological goals but also equally important social, economic and management goals.

In 2011, with a major effort led by Friends of Verde River Greenway, the plan came to life through a collaborative effort between VWRC partners. Support staff was hired, private landowners engagement was initiated, mapping was completed on three demonstration projects, VWRC's Steering Committee was formed and a mapping workshop was held.

In 2012, partnerships with Arizona Conservation Corps (AZCC) and The Vetraplex were formed. VWRC started implementation of the plan in earnest by putting young adults and returning war veterans to work removing invasive non-native plants from riparian areas within the Verde Watershed. During the first three fieldwork seasons, treatment crews and VWRC partners removed over 3,500 acres of invasive plants on over 40 miles of streamside habitat on both public and private lands. The plan focuses on four primary woody invasive species: saltcedar (*Tamarix* spp.), giant reed (*Arundo donax*), tree of heaven (*Ailanthus altissima*), and Russian olive (*Elaeagnus angustifolia*) as well as secondary weed infestations. VWRC is using "lessons learned" from each season to inform the adaptive management process. Come visit our poster and we'll share our accomplishments and lessons learned with you.

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Stone, S.[1], J. Johnson[1], G. Leverich[2], R. More-Hla[1]. ***Zonal Planting Methodologies for Restoration on the Upper Gila River.***

The Upper Gila Riparian Restoration project is a proactive effort to re-establish native habitat for threatened and endangered species prior to colonization by the tamarisk leaf beetle (*Diorhabda* spp.). While the responsibility of restoring critical habitat for the southwestern willow flycatcher in one of its most productive breeding grounds may prevail in prioritizing goals, a broad, ecosystem-based approach to restoration must be maintained. Due to limited time before the arrival of the tamarisk leaf beetle, active restoration techniques have been employed. We utilize an excavator and masticating head to mechanically remove tamarisk from the riparian corridor and apply an herbicide to the freshly cut stumps. Native plant container stock is then introduced for greater establishment potential and to suppress secondary weed invasions. Provisional seed zones are used to direct seed collections to ensure plant materials are locally adapted. Seeds are then cataloged with accession numbers and given propagation numbers prior to germination. When these plant materials are introduced onto our restoration sites, their success can then be tracked and attributed to variances in source materials, propagation techniques, etc. Local geomorphic diversity across our sites necessitates greater biologic diversity, as varying depths to groundwater support varying vegetative communities. We have classified planting zones for vegetative communities according to groundwater depths. These zones are based on an examination of relative elevation data at each of our restoration sites, which was then re-validated with our groundwater monitoring results. Re-establishing riparian obligate to xeric native plant species in the appropriate locations can help support a greater variety of faunal species, minimize erosion after the initial treatment, and re-establish ecosystem processes negated by tamarisk monocultures. We assess our progress with the aid of a mobile cloud data-logging software for GIS systems. This software streamlines our process in tracking everything from plant population and phenology to the extent of an area treated with herbicide. We hope that this careful approach will ensure cost effectiveness by capitalizing on evolutionary adaptations and minimizing re-treatment efforts.

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