

10th Annual
Science on the Sonoita Plain Symposium
June 2nd, 2018



Annual Meeting of the Sonoita Valley Planning Partnership

Sponsored by:
Cienega Watershed Partnership
National Audubon Society

With Support from Partnering Organizations:
The Nature Conservancy
Bureau of Land Management

At the
Appleton-Whittell Research Ranch of the National Audubon Society
Elgin, Arizona

The Science on the Sonoita Plain symposium was established to bring together and share the results of scientific investigations that are occurring within and informing us about the unique and diverse resources of the Sonoita Plain in the upper watersheds of Cienega Creek, Sonoita Creek, and the Babocomari River.

These symposia grew out of an important effort that began in 1995, the Sonoita Valley Planning Partnership (SVPP), a voluntary ad hoc association of agencies, user groups, conservation organizations, and individuals working together to achieve community-oriented solutions to local and national issues affecting public lands within the Sonoita Valley. The Cienega Watershed Partnership, a 501c(3) non-profit organization that was founded in 2007, administered the SVPP until 2015 when regular meetings ceased. The CWP mission is to facilitate cooperative actions that steward the natural and cultural resources of the Sonoita Valley while enabling sustainable human use.

This year, our 10th Anniversary of the Symposium, we offered a 10 year retrospective on research and program developments in the area, and this included a series of presentations and panel discussions with a range of scientists, land managers and practitioners.

Proceedings compiled by Suzanne Wilcox (Audubon)

Planning Committee: Gita Bodner (The Nature Conservancy), Larry Fisher (Cienega Watershed Partnership, University of Arizona), Cristina Francois (Audubon), Shela McFarlin (Cienega Watershed Partnership), Thomas Meixner (University of Arizona and Cienega Watershed Partnership), Dave Murray (Bureau of Land Management), Amanda Smith (Sonoran Institute), and Suzanne Wilcox (Audubon)

Thanks also to:

Shela McFarlin for organizing the Cienega Watershed Partnership breakfast & Cristina Francois, Benjamin Beal & Suzanne Wilcox (Audubon) for the cake.

Tahnee Robertson (CWP) for technical support.

Photos courtesy of
Suzanne Wilcox & Benjamin Beal (Audubon)
Tahnee Robertson (CWP)

AGENDA
SCIENCE ON THE SONOITA PLAIN
TENTH ANNUAL SYMPOSIUM
June 2, 2018

- 8:30 Welcome and introduction: Tom Meixner (CWP), Christina Francois (AWRR)
- 8:40 Ten Year retrospective, Part I
- 8:40 – Introduction to session and speakers (Linda Kennedy, moderator)
 - 8:50 – State of the Cienega Watershed (Adriana Zuniga-Teran)
 - 9:10 – Weather and Climate (Mike Crimmins)
 - 9:30 – Chiricahua Leopard Frogs (David Hall, Philip Rosen)
 - 9:50 – Pronghorn Recovery on the Sonoita Plain (John Millican, Glen Dickens)
- 10:10 COFFEE BREAK/POSTER SESSION
- Poster presentations – brief introductions
 - Opportunities to visit and discuss posters
- 10:30 Ten Year Retrospective, Part II
- 10:30 – Ecological monitoring (Gita Bodner)
 - 10:50 – Water (Mead Mier, Tom Meixner, Julia Fonseca)
 - 11:10 – Cultural heritage (Chris Schrager, Alison Bunting)
 - 11:30 – Trends in stakeholder engagement (Shela McFarlin, Karen Simms)
- 11:50 Update on the Endangered Desert Pupfish, Doug Duncan
- 12:00 LUNCH BREAK (bring your own)
- Also - further opportunities to visit poster presentations



- 12:45 Panel discussion, Q and A on the Ten Year Retrospective
- Interactive discussion with audience
- 1:45 Miscellaneous topics (Gita Bodner, moderator)
- 1:45 – BLM Leadership update (Margie Guzman)
 - 2:00 – Pima County update (Karen Simms)
 - 2:15 – Update, Madrean Archipelago Conference IV (Tahnee Robertson)
 - 2:30 – Response of grassland rodents to fire, livestock grazing, exurban development, and the spread of exotic lovegrasses in the Sonoita Valley (Zach Jones)
 - 2:50 – Aquatic and Riparian Connectivity in Arid Landscapes (Akanksha Sharma)
 - 3:10 – Photographic Archaeology at Empire Ranch (R. Pinto, A. Bunting, S. McFarlin, and D. Tuggle)
- 3:30 Evaluation; WOW! Moments (Tahnee Robertson, facilitator)
- 3:50 Wall of Honor awards – Tom Meixner, CWP
- 4:05 Closing remarks - Shela McFarlin, Linda Kennedy
- 4:15 Adjourn for 10 year anniversary celebration and refreshments



Posters:

1. Erin Gray and Jennifer McIntosh – Using water isotopes and solute chemistry to investigate the hydrology of surface water in the Cienega Creek Watershed
2. Nicole Weber, Erin Gray, Jennifer McIntosh – Natural tracer study to constrain transit times and flowpaths of groundwater from Davidson Canyon to Lower Cienega Creek
3. Roy Petrakis et al. - Using an Experimental Landscape to Develop a Regional Ecosystem Services Approach to Watershed Restoration
4. Scott Jones – Mesquite encroachment in the Las Cienegas National Conservation Area
5. Doug Duncan – Pupfish Don't Like the Cold

KEY

CWP – Cienega Watershed Project

AWRR – Appleton-Whittell Research Ranch of the National Audubon Society

WRRC – University of Arizona Water Resources Research Center

US FWS – US Fish and Wildlife Service

BLM – Bureau of Land Management

CNF – Coronado National Forest

All presenters' names are **boldened**



Welcome to the 10th Symposium



Tom Meixner, Cienega Watershed Partnership and Cristina Francois, Audubon

Adaptive management for the Cienega Watershed

Adriana Zuniga-Teran

The Cienega Creek is one of the last running streamlets of Southern Arizona and its surrounding watershed contains some of the rarest habitats in the American Southwest. It is also the home of several threatened and endangered species, contains many active cattle ranches, and is an attractive visitor destination. Unfortunately, the watershed is



threatened by population growth, human development, and climate change. In addition, plans have been approved to open a copper mine within the watershed, which would alter the hydrological systems. Stakeholders are concerned about the state of the health of this watershed and have founded the Cienega Watershed Partnership, who funds this project. The purpose of this project is to assess the state of the Cienega Watershed with the use of transdisciplinary research methods. Stakeholders have been involved in this project since its conception and have identified a list of indicators that can measure the state of the watershed. In this presentation, we will share the second annual assessment of the state of the watershed that includes a preliminary analysis of the data. By getting together to examine the trends of the data over time, stakeholders can guide management actions that can result in a better health of the watershed.

Adriana Zuniga-Teran works as a Staff Scientist at the Udall Center for Studies in Public Policy and a Senior Lecturer at the School of Landscape Architecture and Planning at the University of Arizona. She works on several research projects related to resilience, wellbeing, and environmental justice. Adriana has worked in the State of the Cienega Watershed project funded by the Cienega Watershed Partnership for three consecutive years.

Dr. Zuniga is a trained architect with 15 years of experience, with a Master's in Design and Energy Conservation and a PhD in Arid Lands Resource Sciences with a minor in Global Change.

She has published her research in multiple venues including peer-reviewed journals, book chapters, and blogs directed to the general public.

Pronghorn Recovery on the Sonoita Plains

John Millican, AAF Field Project Manager, and Glen Dickens, AAF Vice-President

In 2011, 2013 and 2014 the Arizona Antelope Foundation (AAF) was awarded 3 different Sky Islands Initiative-National Fish and Wildlife Foundation (NFWF) grants totaling \$510,000 to support the AAF's 10-year Southeastern Arizona Grasslands Pronghorn Initiative initiated in April 2010. Matching non-federal contributions valued at \$800,000 include: AAF and private land owner project labor and materials; Pima County Sonoran Conservation Plan land acquisition funds and Arizona Game and Fish Big Game Tag Habitat Partnership Funds. The "Southeast Arizona Collaborative Grassland Workgroup", created in February 2010, collaboratively drafted a southeastern Arizona Regional Pronghorn Strategy to: Increase Pronghorn population numbers, distribution and connectiveness. Partners in this working group include: AAF, AZGFD, BLM, USFS, SLD, USDA, USFWS, NRCS, and Pima County, Arizona Wildlife Federation, AZ Land Trust, Audubon Society, Tombstone High school and local ranchers/landowners. Long-term goals for this 9-year grant period 2011-19 are to; 1) establish a region-wide dynamic geodatabase with integrated multi-species layers to prioritize grasslands restoration/maintenance activities for pronghorn and other sensitive grassland species, 2) permanently record pronghorn travel corridors and remove or modify barriers, including fences, shrubs and trees, 3) target/plan grassland treatments/burns in priority habitat locations on an annual and long-term basis to benefit the highest number of keystone grassland species, 4) supplement at least one pronghorn population and increase numbers in two subpopulations and 5) improve grassland habitat in five pronghorn subpopulation zones. We discuss the projects measurable progress to date focusing on the Sonoita Plains regarding acres of grassland restoration, connectivity acres through fence modifications, predator removal and population supplements and increases.



John Millican holds a BS degree from UofA in Wildlife Ecology and retired from the AZGFD with 30 years as a District Wildlife Manager. John is currently the chairman of the SV/Douglas Habitat Partnership Committee, President of the Huachuca Gould's Chapter of NWF, and has been the AAF Field Project Manager since 2012. John was instrumental in the transplant of Chihuahuan Pronghorn into the San Bernardino Valley, and has been at the forefront of Gould's turkey management and translocation efforts in the Huachuca Mountains and SE AZ

Ten years of Chiricahua Leopard Frog Conservation on the Las Cienega National Conservation Area: A Blueprint for Success

David H. Hall and Phillip C. Rosen

Since 2009 a large-scale conservation program began to recover the threatened Chiricahua leopard frog populations in and around the Las Cienega National Conservation Area. Working with partners in the Bureau of Land Management, Cienega Watershed Project, Arizona Game and Fish Department, U.S. Forest Service and Department of Fish and Wildlife we have had considerable

success. This success is largely due to our focusing on the addressing the major threats to the frog: habitat loss, nonnative predation and fungal disease. This program may be a model for the frog's recovery throughout Southern Arizona.



David Hall (MSc, University of Arizona) has been working with Arizona aquatic reptiles and amphibians for over 35 years. His interest in habitat restoration for Arizona leopard frogs and bullfrog removal began in 1997. Since this time he has been involved in several successful bullfrog eradication efforts throughout southern Arizona. He currently is working on bullfrog removal efforts to recover over 150,000 acres of land for Chiricahua leopard frogs in the areas around the towns of Arivaca and Portal Arizona.

Decade of extremes: A look back at the weather and climate of southeastern Arizona

Michael A. Crimmins,

Southeastern Arizona's seasonal-transitional climate puts it at the crossroads of weather systems from the north in winter and monsoonal moisture from the south in summer. This leads to a dramatically varying climate over weeks to months to years. This presentation will take a retrospective look at the major weather and climate events that occurred across the region over the past ten years including a recap

of winter and summer temperature and precipitation patterns, variations in the El Niño-Southern Oscillation, and changes in drought conditions. The events will be placed in a longer-term historical, climatic context and a discussion of regional climate projections will also be offered as a look into potential changes that may be in store for the region due to climate change.



Mike Crimmins is on the faculty of the Department of Soil, Water, and Environmental Science at the University of Arizona and is an Extension Specialist in Climate Science for Arizona Cooperative Extension. He has been in this role for 13 years working with ranchers, farmers and natural resource managers across Arizona to integrate climate information in their planning and decision making and assisting them in developing strategies to adapt to a changing climate.

A window into time: ecological monitoring from near and far

Gita Bodner, The Nature Conservancy

The Sonoita Plains form the stage for many different efforts to track and understand changing ecological conditions, from grassland monitoring across the valleys, to wet-dry mapping along the length of Cienega Creek. Many season-to-season and year-to-year changes are so dramatic that it is hard to notice longer-term shifts.

Other changes happen so slowly that we fail to notice them entirely. Looking at vegetation, water, and processes such as fire, this presentation will string together snapshots of conditions across time to try to give context for what we see today. From grassland responses to drought, to riparian forest interactions with streamflow, today's shifting conditions are tomorrow's baseline.

Gita's role with The Nature Conservancy is to help land managers figure out how to fill their most important information needs. In the Sonoita Plains, that role has included squeezing drought insights from a decade of grassland data, guiding a scenario planning effort to prepare for changes that are outside of local managers' control, contracting for sub-surface geology surveys around wetlands, and more.



Water and Science on the Sonoita Plain

Mead Mier, Thomas Meixner, and Julia Fonseca

Over the last ten years many oral and poster presentations have been given on water within the Cienega Creek watershed. These presentations illustrate the importance of water throughout this landscape. This



Symposium started with a focus on the Sonoita Plans and opened to include the lower parts of the Cienega Watershed in the County Preserves and other lands. The topics covered vary from discussions of range management approaches to increase infiltration, to the links to aquatic species, to the status of flows in the Cienega Creek and the underlying groundwater that supports the perennial surface waters of the basin. These talks have included investigations of how private wells influence the hydrology of the system, how restoration might influence watershed hydrology across all the aquatic systems of the Sonoita Plain, and how the fundamental hydrology of the Sonoita plain perennial waters actually works. To provide models of inspiring new approaches, the symposium has additionally featured presentations that focus on the water of other watersheds in southern Arizona and across the Southwest, such as Sonoran Institute Santa Cruz River efforts, rancher advice on restoration from New Mexico, and Watershed Management Group's water accounting budgets for Sabino Creek. The story of the last ten years includes the proposed Rosemont mine and the development of improved hydrologic understanding from the efforts to understand the environmental impacts of the mine. These various efforts directly related to the mine have led to the development of more robust understanding of the hydrology of the system. Critically in the last several years the use of isotopic and geochemical investigations has opened up a clearer picture of the perennial waters in this landscape and has resulted in an understanding of the regional hydrology and source water that supplies the perennial systems and the long time scales over which the system responds to changes. The drought over the last 20 years displays this long time scale nature as the perennial waters appear to be continuing to respond to the drying out of the system that has occurred.

The Rich Cienega Watershed Cultural Heritage: Update on Cultural Resource Management and other Heritage Programs.

Chris Schrager (Bureau of Land Management)
Alison Bunting (Empire Ranch Foundation)

The Cienega Watershed contains thousands of archaeological and historic sites ranging from isolated projectile points and campsites to large Hohokam village sites and historic complexes like Kentucky Camp and the Empire Ranch Headquarters. More than just sites, within the watershed are active projects and programs populated by professional and interested

individuals who describe, interpret, protect, study and engage in active management of this rich resource. This paper addresses how heritage programs and specific projects have developed or changed in the last decade or so by looking at:



1. Major protective and interpretive efforts: the Kentucky Camp and Empire Ranch Headquarters
2. New discoveries and interpretations of prehistoric use of the area
3. Heritage efforts developed in the last decade: the Oral History and Back Then work; the Cienega Timeline Project; the Empire Ranch Archives and Docent program; the Cienega History Project
4. Future challenges: resource shortages and increased costs of preservation; connecting preservation values; climate change?

Chris Schrager is a preservation archaeologist for the Bureau of Land Management Tucson and for Coronado National Forest with years of experience in federal cultural resources management. Alison Bunting brings her professional experience as a retired librarian (USLA) and archival knowledge to heritage work groups and projects in the watershed. She is a member of the Empire Ranch Foundation, the Cienega Oral History, Timeline and History Work Groups.

Trends and Changes in Stakeholder Engagement and Collaboration in the Cienega Watershed

Karen Simms (Pima County) karen.simms@pima.gov

Shela McFarlin (Cienega Watershed Partnership)

shela_mcfarlin@yahoo.com



The Cienega Watershed (and adjacent Sonoita Plain) is known as a place where

engagement and collaboration produce adaptive management for public lands. Since 1995, the public has been involved in land management planning; scientists have been partners in adding the science

component. In 2009, the Science on the Sonoita Plain (SOSP) symposium formalized the presentation of science and applied management in a public setting which continues today. Public engagement and collaboration, however, commenced years before when planning began for the Las Cienegas National Conservation Area (then called the Empire-Cienega Resource Conservation Area). One important product was the Bureau of Land Management approval of the Resource Management Plan in 2003 after six years of intensive collaborative work with the Sonoita Valley Planning Partnership (SVPP).



This presentation addresses the who? What? and Future? Of engagement and collaboration in the watershed by looking at these questions:

- 1) Who has participated in the last ten to twenty years. What institutions, organizations, agencies and individuals. What changed and why?
- 2) What types of participation occurred and what settings? Planning meetings, implementation like the biological planning field sessions, docents and youth in hands-on programs, and workgroups.
- 3) What topics have been addressed and have these changed over time? Was it all about planning? Or other topics like water use or mining, or applied science.
- 4) Are there serious issues that threaten engagement and collaboration? What supports continuing collaboration? How are changes in agency resources, new demographic factors, new attitudes on partnerships, and specific development proposals affecting public participation?

We will discuss these questions from the standpoint of trends and the context of both agency and non-profit roles.

Both presenters were previous Bureau of Land Management managers with experience in the watershed although Karen gets the 30-year pin for her deep engagement; Shela only 20 years off and on. Karen is current manages resources for Pima County; Shela is immediate past chair for the Cienega Watershed Partnership.

Update on the Endangered Desert Pupfish

Doug Duncan



Panel Discussion, Q and A of the Ten Year Retrospective



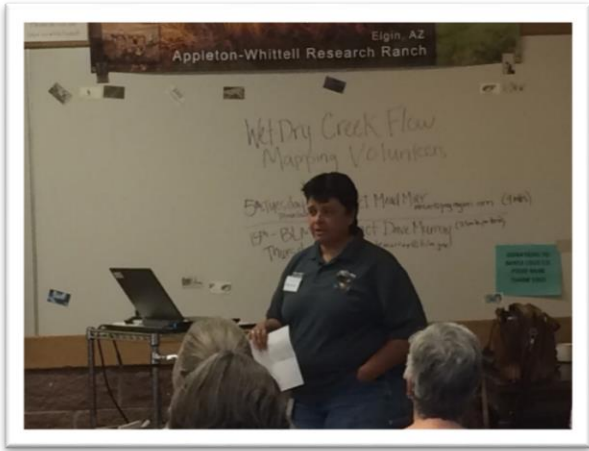
Left to right: John Millican, Chris Schrager, Alison Bunting, Karen Simms, Gita Bodner, Mike Crimmins, David Hall, Tom Meixner, Adriana Zuniga-Teran and Shela McFarlin



Left to right: Alison Bunting, Karen Simms, Gita Bodner, Mike Crimmins and David Hall

BLM Leadership - Update

Margie Guzman



Pima County - Update

Karen Simms



Madrean Archipelago Conference IV - Update

Tahnee Robertson



Response of grassland rodents to fire, livestock grazing, exurban development, and the spread of exotic lovegrasses in the Sonoita Valley

Zach Jones,

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Rodents are the most abundant vertebrates in the grasslands and savannahs of the Sonoita Valley, and they play a critical role in the dynamics of these ecosystems. Our research, conducted in the valley since the mid-1970s, has shown that the composition of grassland rodent assemblages is strongly driven by habitat structure. The rodent fauna can be divided into three groups. The first group, strongly dependent upon relatively tall and dense grass cover, includes harvest mice (*Reithrodontomys*), pygmy mice (*Baiomys*), and cottonrats (*Sigmodon*). These species are most abundant in areas with light to no livestock grazing, and the absence of recent fire. They likely depend on cover as a way of avoiding detection by predators. Second is a group of species associated with relatively open ground, including pocket mice (*Chaetodipus* and *Perognathus*), and kangaroo rats (*Dipodomys*). These species usually are more abundant on grazed than ungrazed sites, and in areas that have recently burned. In contrast to the first group, these species likely depend on early visual detection and maneuverability to avoid predation. The third group includes habitat generalists whose distribution seems largely independent of cover, including grasshopper mice (*Onychomys*) and, especially, deer mice (*Peromyscus*). In our studies, grassland rodents as a whole usually were more abundant in unburned and ungrazed or lightly grazed landscapes than in areas that were more heavily grazed or recently burned.

Landscapes in the Sonoita Valley invaded by exotic lovegrasses (*Eragrostis* spp.) are rodent-poor compared to native grasslands. An exception are the cottonrats (*Sigmodon*). These robust rodents primarily are grazers rather than seed or insect eaters, which may explain their abundance in the densely foliated but species poor grasslands dominated by the African exotics.

Finally, we have found that rodents can be abundant in grasslands that are part of exurban neighborhoods of moderate to low housing density, but that ground cover is an important determinant of community composition, just as it is in undeveloped landscapes. Some landowners in exurban neighborhoods mow their properties farther from their homes than is recommended for fire protection. This likely has the unintended consequence of disfavoring rodents dependent on tall grass cover, and thereby reducing total rodent diversity and abundance.

Zach Jones received a B.S. in Biology from Colorado College in 1995, and a PhD in Ecology and Evolutionary Biology from the University of Colorado, Boulder, in 2003. He has collaborated extensively with the Bocks in their studies in southeastern Arizona. Zach presently is Associate Professor and Chair, Department of Biological Sciences at Southwestern Oklahoma State University.

Aquatic and Riparian Connectivity in Arid Landscapes

Akanksha Sharma, Larry Fisher, Donald Falk, Michael Bogan

School of Natural Resources and the Environment (SNRE),
The University of Arizona, Tucson

Aquatic and riparian ecosystems are valuable and critical in arid environments, supporting a diverse suite of resident and migratory species over different life stages. Ecological connectivity is an important property in the functioning of these

ecosystems, and a significant subject of interest for researchers, managers, practitioners and other stakeholders. Furthermore, a variety of perceptions exists on aquatic and riparian connectivity among stakeholders, and connectivity of aquatic and riparian ecosystems in arid landscapes is a relatively unexplored subject. We focused on these questions in the US portion of the Madrean archipelago, using a combination of quantitative spatial analysis and qualitative methods, to capture the diversity of perspectives on aquatic and riparian connectivity among experts. We synthesized these perspectives into a connectivity framework that deconstructs aquatic and riparian connectivity in arid landscapes into connectivity components and their dimensions. We applied this framework to a case study of the threatened Chiricahua leopard frog (*Rana chiricahuensis*) in the Cienega Creek basin in Arizona. Using GIS and regression analysis, we created connectivity indices for the focal species. This connectivity framework and the related indices provide customizable options for stakeholders to assess aquatic and riparian connectivity multidimensionally using readily available data. These tools can be used by stakeholders for exploratory analysis, assessment and visualization of aquatic and riparian connectivity, especially in arid landscapes.

Akanksha Sharma is an MS student in the Natural Resources and Environment program. Interested in almost all aspects of ecosystems, since moving to the US from India, she has worked with the Desert Landscape Conservation Cooperative on human dimensions of conservation, and focused on connectivity in the Madrean Archipelago for her MS thesis. Dr. Larry Fisher is a Research Professor at the SNRE and a member of the Cienega Watershed Partnership Board of Directors, with work ranging from climate policy and adaptation to international conservation. Prof. Don Falk is a Professor at the SNRE focusing predominantly on fire ecology and restoration, with joint appointments in the Laboratory of Tree-Ring Research and the Institute of the Environment. Dr. Michael Bogan is an Assistant Professor at the SNRE and an aquatic ecologist and entomologist who has studied varied aspects of aquatic ecosystems and their ecology in the Madrean Sky Islands and beyond.



Photographic Archaeology at Empire Ranch

By **Robin Pinto**, Alison Bunting, Shela McFarlin and Dave Tuggle

Members of the Cienega History Project are continuing to research the development of the Empire Ranch using the extensive photographic collection from the Empire Ranch Foundation Archives. From over 7000 images during the past 130 years, we are investigating the sequence of construction, evolving spatial organization, and use of different materials in the buildings, structures and fences around the main headquarters. In

a letter written in 1876, Herbert Hislop described the arrangement of the original 4-room building, its zaguan opening, and the enclosed adobe-block corral within. Even though no piece of that adobe corral is extant today, its form can still be felt and visualized in the layout, circulation patterns, and purposes of the modern structures today around the historic ranch.



Robin Pinto studies the evolution of cultural landscapes in Southeast Arizona and focuses on four topics of historic change: early settlement and homesteading, the New Deal and federal work programs, ranching on public lands, and the arrival and development of national parks. She has an MLA and PhD from the University of Arizona. She has written historical landscape assessments for NPS on a number of southeast Arizona parks and works with the BLM Heritage and History Teams to study landscape change at the Empire Ranch and in Cienega Creek watershed.

Wall of Honor awards



Previous recipients for the Wall of Honor at Cienega Watershed Partnership:

Left to right: Tom Meixner *moderator*, Doug Duncan, Dennis Caldwell, Gita Bodner, Karen Simms and Alison Bunting

New Wall of Honor Recipients for 2018

Linda Kennedy and Dan Robinett



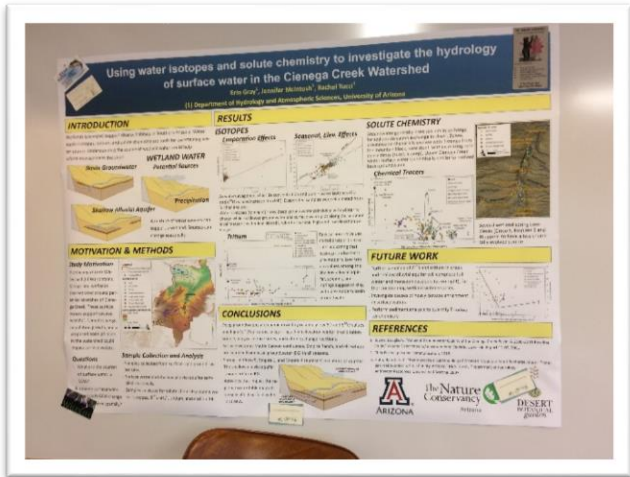
Posters

Using water isotopes and solute chemistry to investigate the hydrology of surface water in the Cienega Creek Watershed

Erin Gray¹ and Jennifer McIntosh¹

¹Department of Hydrology and Atmospheric Sciences
The University of Arizona

Analysis of water stable isotopes and solute chemistry can reveal the source of water in surface water systems, and the nature of the hydrologic connection between surface water and local and regional groundwater. This research uses water stable isotopes (^{18}O , 2H , ^{34}S , ^{13}C), solute chemistry, and tritium to investigate the seasonal sources of water in wetlands (cienegas), Cienega Creek, and the riparian aquifer within the Las Cienegas National Conservation Area (LCNCA) in the upper Cienega Creek Watershed, an area of unique biodiversity in Southern Arizona. Seasonal samples of streams, springs, and shallow groundwater from piezometers along the length of Cienega Creek were analyzed. Wells tapping into basin groundwater were also sampled. Preliminary results suggest that surface water and water in the shallow alluvial aquifer is a mixture of primarily basin groundwater recharged prior to the 1950's with a smaller component of more recent recharge. The apparent reliance on basin groundwater implies that surface water in LCNCA could be impacted by changes in the regional water table. This insight, as well as baseline hydrologic data that this research provides, will aid research efforts and help inform groups interested in the preservation of surface water within LCNCA regarding future management decisions.



Erin Gray is a master's student in Hydrology at the University of Arizona. Over the past two years, she has worked with Dr. Jen McIntosh on research that uses isotopes and solute chemistry to identify the source of surface waters in the Las Cienegas National Conservation Area. As a hydrology intern at Tucson Water, Erin applies skills gained from her master's research to characterize recharged Colorado River Water at Tucson's managed recharge sites. Following graduation in December 2018, Erin plans to apply her knowledge of isotopes and water chemistry in a career that works towards the goal of keeping water in the environment.

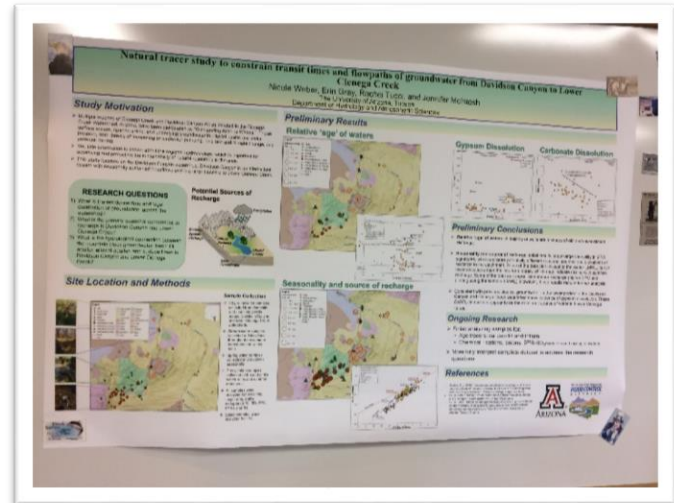
Natural tracer study to constrain transit times and flowpaths of groundwater from Davidson Canyon to Lower Cienega Creek

Nicole C. Weber, Erin Gray, Jennifer McIntosh

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

Multiple reaches of Cienega Creek and Davidson Canyon Wash, located in the Cienega Creek Watershed, Arizona, have been designated as “Outstanding Arizona Waters.” These surface waters, riparian areas, and underlying

groundwater in alluvial basins are under pressure from threats of increasing groundwater pumping, land use and climate change, and potential mining. Yet, little information is known about the regional hydrogeology, which is important for accessing and protecting the sustainability of natural resources in the area. This study investigates the hydrologic connection between the Santa Rita Mountains and lower Cienega Creek, along the Davidson Canyon subwatershed. Davidson Canyon is an intermittent stream with seasonally sustained baseflows and is a large tributary to Lower Cienega Creek.



This research aims to: (1) identify areas of recent recharge; (2) determine the relative age and transit time of groundwater; (3) better constrain the Local Meteoric Water Line; and (4) use hydrochemistry and isotopes to evaluate the flowpaths and mixing of groundwater and interaction with surface waters. To address these aims, groundwater and surface water samples were collected seasonally in 2017-2018 and analyzed for major ion chemistry, stable isotopes ($\delta^{18}\text{O}$, δD , $\delta^{13}\text{C}$, $\delta^{34}\text{S}$) and radioactive isotopes (^3H and ^{14}C).

Nicole Weber is a Masters Student at the University of Arizona who is working on graduating from the Hydrology and Atmospheric Sciences department in December of 2018. Her main research focus is on the use of water chemistry of surface waters and groundwaters to constrain the sources flow paths and residence times. As an undergraduate, Nicole worked specifically with stable water isotopes as tracers to analyze the effect of wildfires on the flowpaths of groundwaters and surface waters in semi-arid regions. Fascinated with this work, Nicole now works with the Pima County Flood Control District and University of Arizona to constrain the transit times and flowpaths of groundwater using natural tracers in the Lower Cienega Creek Watershed, AZ.

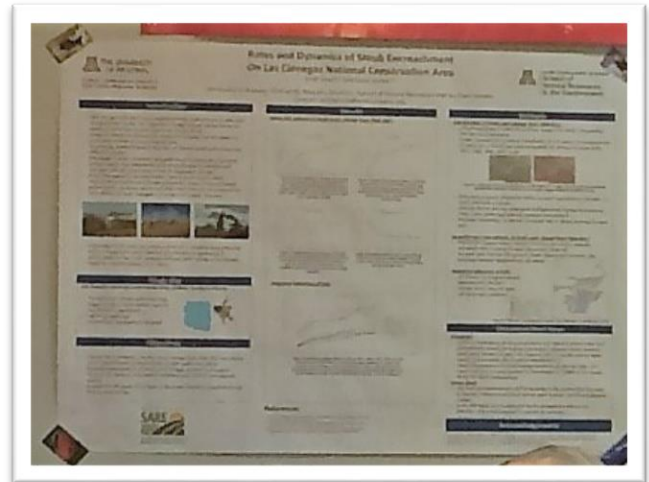
Assessing the Conservation Effects on Cienega Creek Watershed

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³ Biophilia Foundation, 1201 Parson Island Road, Chester, MD 21619



Keywords: watershed restoration; erosion control; ecosystem services; environmental flows; experimental landscape; hydrological modeling

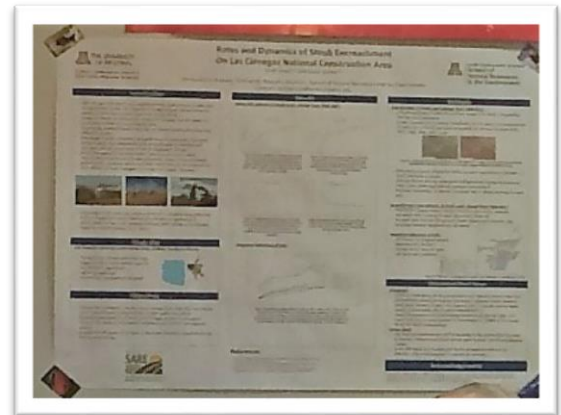
Arid and semi-arid watersheds have been severely degraded by a combination of both anthropogenic and natural processes including unsustainable grazing and timber harvests, long-term droughts, and acute flooding events. We are investigating the effectiveness of various holistic watershed restoration techniques, used by land managers to combat the negative effects of these processes, using an experimental landscape located in southeastern Arizona. Our study site, Smith Canyon, located in the Nogales Ranger District of the Coronado National Forest, consists of numerous (~125) structurally-similar sub-canyons, each covering approximately 5 to 10 acres. This unique and fairly uniform landscape presents an opportunity for rigorous large-scale experimentation since each sub-canyon can be treated as a replicate unit. Restoration treatments will focus on the use of check dams and other erosion control methods, varying by both location and size, designed to reduce erosion impacts from single rainfall event runoffs. To assess the effectiveness of the treatments and consider the ecosystem services provided, we will develop a spatial database and hydrological modeling process. We plan to use these research results to provide a protocol for the development of a large-scale, localized spatial database and hydrological modeling network, with the overarching goal of catalyzing a viable payment for ecosystem services in the region. Shifts in the way restoration is approached on the landscape can have major benefits for the quality of watersheds within our region, including improving environmental flows and buffering from changes in natural systems, as well as the value of water itself.

Roy Petrakis received a MA in Geography from the University of Arizona in 2015. His thesis was centered on understanding the implications of historic management practices and fluctuating climate on riparian vegetation along the Rio Grande in central New Mexico. His main research interests are focused on the use of remote sensing and GIS sciences to better understand issues regarding land use/land cover change, climate, management, and ecology within areas of the arid southwestern US.

Mesquite Encroachment in the Las Cienegas National Conservation Area

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Rangelands provide a myriad of ecosystem services (ESs) giving them substantial value to socioecological systems. Over the past 150 years, many rangelands have experienced an increase of shrubs at the expense of perennial grasses. This state change, termed woody plant encroachment (WPE) or shrub proliferation, can result in alterations to ecosystem structure and functions with recent revelations suggesting that provisions of ESs can both increase or decrease under WPE.



While the proliferation process and its drivers are varied and complex (e.g. excessive livestock grazing, increases in atmospheric CO₂, altered fire regimes, and climate change) consensus is emerging that interactions among multiple factors are key. The strength of these interactions varies with local constraints imposed by landforms, soils, and topography. Thus, long-term spatial/temporal dynamics of the proliferation process or responses to brush management are a challenge to predict. Furthermore, the long-term efficacy of brush management actions is largely unknown.

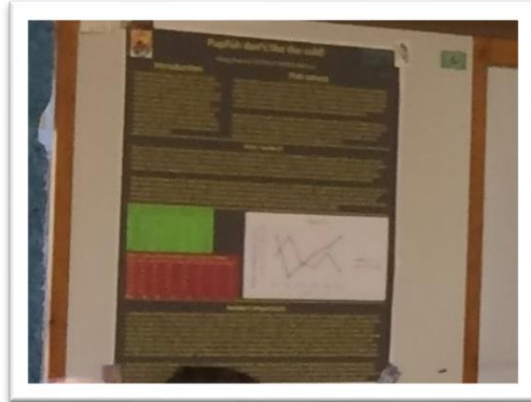
The proposed poster will provide results from my dissertation research in which I'm quantifying long-term rates and patterns of shrub cover (velvet mesquite) across Las Cienegas National Conservation Area (LCNCA) on sites with contrasting soils, topography, and management histories (e.g. brush management). I am utilizing historical time-series aerial photography and modern satellite imagery spanning from 1936-2017 and land use records to achieve this task. My poster will present findings on how mesquite have spread across LCNCA over an 80+ year timeframe as well as how shrubs have re-encroach areas that have undergone brush management in relation to topo-edaphic variables which may be dictating these rates. I believe these results will be valuable to the BLM who is currently planning future brush management actions on the LCNCA to help target when and where to treat to achieve the most desired results.

My name is Scott Jones and I am a PhD candidate in the Arid Lands Resource Science program at the University of Arizona. The focus of my dissertation research is looking at the long-term rates and dynamics of the shrub encroachment process and how landscape changes (such as grassland-to-shrubland shift resulting from the proliferation process) can affect the provision of ecosystem services. I am also interested in trade-offs and synergies to ecosystem services that might be present following restoration actions. My research is focused on Las Cienegas National Conservation Area located in southern Arizona which is currently undergoing woody plant encroachment from velvet mesquite and also has a long history of brush management actions to control this phenomenon. This unique landscape is not only a working ranch but also provides numerous recreational activities as well as critical wildlife habitat truly defining what a mixed-use landscape is.

Pupfish Don't Like the Cold

Duncan, Doug <doug_duncan@fws.gov>

Desert Pupfish (*Cyprinodon macularius*) were released into the Appleton-Whittell Audubon Research Ranch's headquarters pond in 2011. The release was made under the Arizona Game and Fish Departments Safe Harbor Agreement. Desert Pupfish are native to the lower Colorado River basin generally, and the San Pedro basin specifically, with the type specimen being collected on the San Pedro during one of the U.S.-Mexico boundary surveys. Every year during the Science on the Sonoita Plain, I have monitored the Desert Pupfish population. The number of pupfish captured has varied from a low of 13 individuals, to almost 300 fish in two different years. There is a correlation between low winter ambient temperatures recorded at the Research Ranch and the number of Desert Pupfish captured. The elevation at the Research Ranch Headquarters is about 1,450m and is close to what we consider the elevational limit for Desert pupfish (1,650m). This poster will present the Desert Pupfish monitoring results from 2012 to 2017 and illustrate which winter temperatures seem to have the greatest impact on the fish in the Headquarters pond.



Doug Duncan is a fish biologist working to preserve native aquatic diversity in the Madrean Biogeographic province. He is employed by the US Fish and Wildlife Service, and his dogs names are Porter and Mingus.