6th Annual

Science on the Sonoita Plain

June 7, 2014

Sponsored by:
Cienega Watershed Partnership
Sonoita Valley Planning Partnership
National Audubon Society

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

The Sonoita Valley Planning Partnership (SVPP) is 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 SVPP was created in 1995 in response to BLM's initiation of a collaborative planning process for Las Cienegas National Conservation Area. The SVPP provides a forum for participants to share information and work together to perpetuate naturally functioning ecosystems while perpetuate naturally functioning ecosystems while preserving the rural, grassland character of the Sonoita Valley for future generations. The SVPP is now administered and supported by the Cienega Watershed Partnership, a 501c(3) non-profit organization that was founded in 2007 to facilitate cooperative actions that steward the natural and cultural resources of the Sonoita Valley while enabling sustainable human use.

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.

This year, the focus was on mesquite management and ecology with updates on new and continuing scientific efforts on other topics. We hope you enjoy this recap of the 6th annual Science on the Sonoita Plain Symposium.

Proceedings compiled by Amanda D. Webb

Planning committee: Gita Bodner (The Nature Conservancy), Larry Fisher (CWP, University of Arizona), Julia Fonseca (Pima County Office of Sustainability and Conservation), Linda Kennedy (Audubon), Shela McFarlin (CWP), Annamarie Schaecher (CWP), Amanda Webb (University of Arizona)

Thanks also to:
David Murray provided technical support.

The 2014 Science on the Sonoita Plain Breakfast was provided in Honor of Grant Drennen, organized by the Cienega Watershed Partnership and funded from contributions through the Grant Drennen Funds and by the Appleton-Whittell Research Ranch.

The Board of Directors for the Cienega Watershed Partnership wishes to thank those donors who honored Grant Drennen through contributions to CWP following his passing in 2013. Grant (1953-2013), as range conservationist for the Bureau of Land Management Tucson, worked with many to develop a lasting collaborative and adaptive range management approach.


Grant Drennen, photo by Diane Drobka

Funding to compile these proceedings was provided by The Nature Conservancy and the Bureau of Land Management augmented by the Cienega Watershed Partnership through the Grant Drennen Funds.

Cover photo of Research Ranch and conference photos were provided by Tahnee Robertson.

A Certified Professional in Rangeland Management
Continuing Education Workshop, 6 CEU

Agenda and Table of Contents

8:00 Registration & light breakfast (courtesy of Cienega Watershed Partnership and Audubon)

8:30 Welcome and introductions – Linda Kennedy (Audubon) & Shela McFarlin (Cienega Watershed Partnership)

8:45 – 12:00 Mesquite management session (with break, midmorning)–moderated by Phil Heilman (USDA – Agriculture Research Service)

- General overview of brush management issues: Phil Heilman (USDA-ARS)
- Hydrologic aspects of mesquite encroachment: Russ Scott (USDA-ARS)….. p.4
- Upland versus bottomland mesquite communities: Julia Fonseca (Pima County)….. p.5
- Historic control methods and results: Dan Robinett (Robinett Rangeland Resources)….. p.6
- Current management considerations and recent efforts: Dan Quintana (BLM)
- Panel discussion, Q and A – all speakers

12:15 Lunch

1:15 – 4:00 Presentations (with break, midafternoon) – moderated by Gita Bodner (The Nature Conservancy)

- Delineation and Screening of Recharge Sites for Installation of Rock Detention Structures in the Babocomari River, a Tributary of the San Pedro River: Laura M. Norman, Laurel Lacher, David Seibert, H. Ron Pulliam, Trevor Hare, Valer Austin, Miguel Villarreal, Floyd Gray, and James Callegary..... p.8
- Land Management Practices Under Climate Extremes: Implications for Soil Loss and Dust Production: Jason Field….. p.10
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- The Cienega Timeline Project: An Update: Shela McFarlin and Annamarie Schaecher….. p.18
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4:00-4:15 Wrap-up: Shela McFarlin & Linda Kennedy

Scientific Posters (displayed all day)

- Could Repeated Fires be used to Manage Mesquite?: Linda Kennedy, Carl Bock, Jane Bock, and Zach Jones….. p.20
- Temporal Study of Cienegas at Cienega Creek using Multispectral Satellite Imagery and Aerial Photography: Natalie R. Wilson, Laura M. Norman, Ron Tiller, Andrew Salywon, Leila Gass, and Miguel Villarreal
- Black-tailed Prairie Dog Release Efforts on the Empire Ranch: Sarah Hale….. p.22
- Response of Ornate Tree Lizards to Disturbance: Matthew Lattanzio….. p.23

Evapotranspiration in Southern Arizona Rangelands

Russell L. Scott

Southwest Watershed Research Center, USDA-ARS, Tucson, AZ 85719

In dryland regions like southern Arizona the vast majority of the precipitation returns to the atmosphere via local evaporation. Evaporation can occur directly from water evaporating from water stored in the soil and other surfaces or through plant root water uptake and transpiration at the leaf surface. These combined fluxes are called evapotranspiration or, more simply, ET. Traditionally, ET was determined indirectly from the water balance equation: ET = P – R – S where P is precipitation, R is runoff, and S is storage (e.g. soil water) change. New technology has also made direct measurements of ET available.

In this talk, I will review what watershed water balances and direct measurements reveal about the ET in southern Arizona rangelands. I will also examine whether measurements in grassland, shrubland, and mesquite savanna rangeland ecosystems reveal any differences or changes in ET that might have been brought about by “brush” (woody plants such as creosote or mesquite) expansion.

Russ Scott presents to a full house. The National Audubon Society’s Appleton-Whittell Research Ranch provided facilities for the symposium. Over 100 people attended including local residents, land managers, scientists, and conservationists.

Mesquite Bosques—Loss and Renewal

Julia Fonseca

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There are approximately 26,000 acres of mesquite woodlands mapped in Pima County outside of tribal lands, and 32% of these are in reserve status (Fonseca and Jones 2009). Under Pima County's Sonoran Desert Conservation Plan, over 3000 acres of bosque have been acquired and ~200 acres restored since 2000 (Fonseca and Jones 2009).

In the Cienega Creek Natural Preserve near Tucson, there has been net decline in the canopy height of bosques (Swetnam et al. 2013). In addition, bosques outside the channel have been lost due to soil piping, clearing by utilities, and meander development.

At the same time, new mesquite bosques are still forming or being maintained through flooding. Where flooding still occurs, bosques are characterized by a diverse tree, grass, herb and vine community. Mesquite-dominated vegetation growth is also slowly reclaiming areas of former clearings inside and outside the arroyo, in areas where access to the water table is sufficient.

With continued drought and aquifer decline in the Cienega Creek watershed, I would expect to see further loss of the structural and vegetative diversity that these plant communities provide, especially in bosques located on old terraces high above the water table and isolated from overbank flood processes.

Fonseca, J. and Jones C. 2009. Progress Report: Measuring effectiveness of open space land acquisitions in Pima County, Arizona, in relation to the Sonoran Desert Conservation Plan. Accessed at http://www.pima.gov/cmo/sdcp/reports/d52/Acquisition_Analysis.pdf

Swetnam, T., Guertin, D.P., Kimoto, A., and Canfield, E. 2013. Riparian vegetation characterization of the Lower Santa Cruz River and Cienega Creek through remotely sensed multi-sensor data fusion. Addendum to Historical Conditions of the Effluent-Dependent Lower Santa Cruz River. Pima County Regional Flood Control District.


Julia Fonseca


Dan Robinett


Laura Norman

A History of Mesquite Management in Southern Arizona

Dan Robinett

Robinett Rangeland Resources LLC, dgrobinett@gmail.com

Photographic evidence from the turn of the century shows the nature, extent and magnitude of mesquite expansion in semi-desert grasslands across the southwest. Three species of mesquite occur naturally in Arizona. Velvet mesquite, *Prosopis velutina*, the Sonoran desert species and western honey mesquite, *P. glandulosa var torreyana*, the Chihuahuan desert variety are responsible for encroachment into grasslands in southern Arizona.

Mesquite on semi-desert grasslands provides habitat and forage for both livestock (including honey bees) and wildlife species. Food, fuel, shade and wood products are among the many amenities mesquite provides humans in the area. At some level of cover and density mesquite dominance of the plant community can lead to serious problems like accelerated soil erosion, loss of forage production, difficulty in handling livestock and negative impacts on groundwater and grassland species of plants and wildlife.

Mesquite was recognized as a problem in the region as early as the late 1890s. By the 1940s and 50s research was active at locations like the Santa Rita and Jornada Experimental Ranges. Studies looked at mesquite biology, hand control methods, prescribed fire, chemical control and economics of control.

Mechanical control of mesquite using various machines and implements were largely developed in Texas and studied throughout the region.

The pros and cons of mechanical and chemical control are discussed in detail. Techniques like aerial broadcast and hand applied herbicides, prescribed burning, chaining, root-plowing, bulldozing and the need for maintenance practices are presented.

The articles and other publications used to develop this information are displayed.

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Delineation and Screening of recharge sites for installation of rock detention structures in the Babocomari River, a tributary of the San Pedro River

Laura M. Norman[1], Laurel Lacher[2], David Seibert[3], H. Ron Pulliam[3], Trevor Hare[3], Valer Austin[3,4], Miguel Villarreal[1], Floyd Gray[1], and James Callegary[1]

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We developed and implemented a methodology to identify favorable artificial recharge sites for augmenting groundwater and surface water resources in the rich savanna rangelands of Southeast Arizona using integrated remote sensing (RS), geographical information systems (GIS) and hydrological models. We accessed and/or developed topographic, soils, geology, hydrology, and vegetation richness data covering the entire Babocomari watershed to look for seepage and springs, modeled surface runoff and sediment yield (Fig. 1) and then simulated recharge using a groundwater model to screen potential recharge areas for potential to impact baseflow (Fig. 2) in the Upper Babocomari River. We then coupled the surface water and groundwater model findings with expert opinion to identify sites favorable for earthen and rock detention structures designed to enhance natural recharge (Fig. 3).

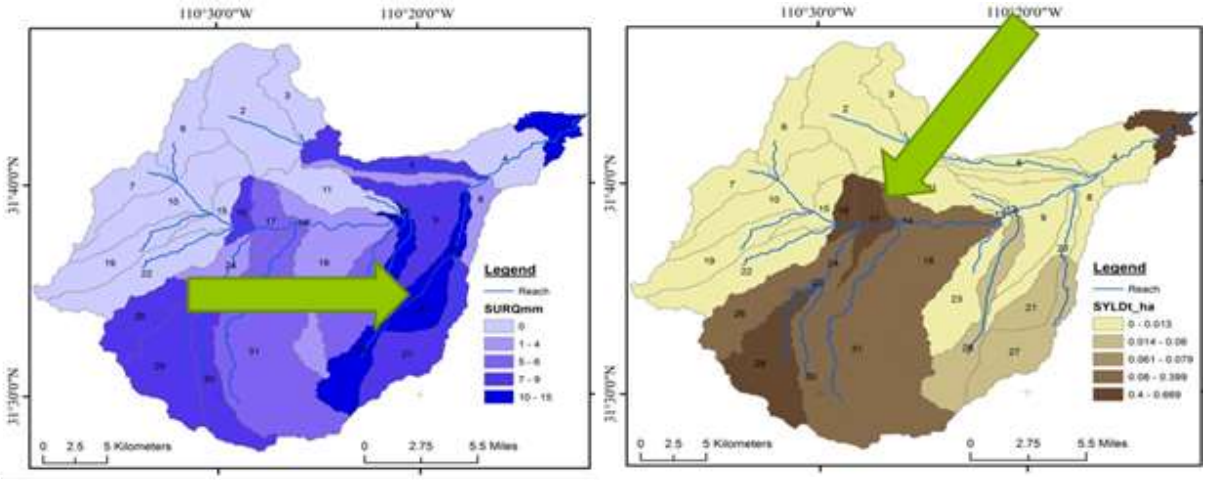

Figure 1. Maps describing preliminary SWAT model results for the watershed (Norman 2013).

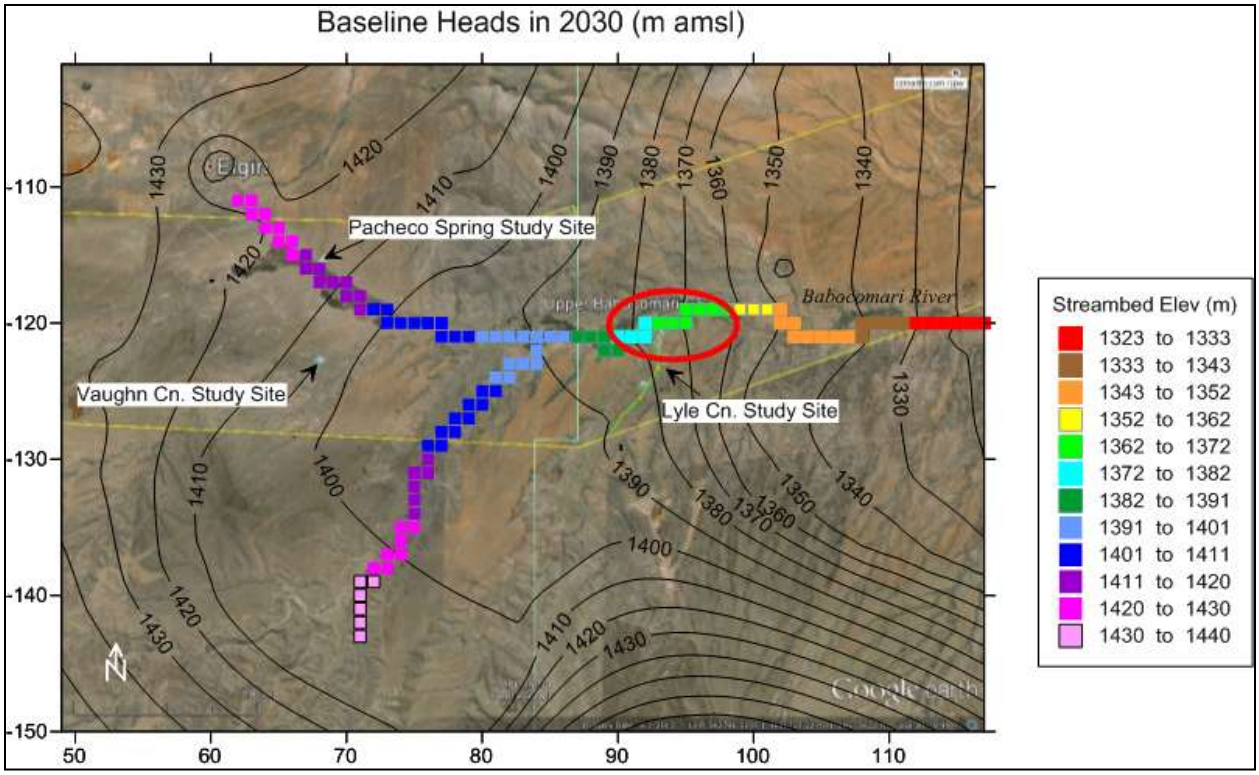

Figure 2: Groundwater-level contours marked in 10-meter (33-ft) intervals. Colored boxes represent the elevation of the top of the streambed in 1-meter (3.3-ft) intervals. Red circle indicates the area where groundwater levels are very close to the elevation of the top of the streambed, suggesting a good target site for groundwater recharge.

Figure 3. LEFT: Photograph of Trevor Hare laying one-rock dams at Lyle Canyon with Dan Robinett in background; RIGHT: Pankaj Jamwal, Laura Norman, Miguel Villarreal, Michelle Coe, & Jakeb Prickett surveying Vaughn Canyon using Global Positioning System.

Visit our websites to learn more:
http://geography.wr.usgs.gov/science/aridlands/Babocomari.html
http://borderlandsrestoration.org/projects/the-babocomari-river-restoration-project/

Land management practices under climate extremes: Implications for soil loss and dust production

Jason P. Field

School of Natural Resources and the Environment
University of Arizona

Wind erosion operates over a large range of spatial and temporal scales and can have important implications for ecological and hydrological processes, especially in drylands where soil moisture is limited and ground cover is inherently sparse. Drylands are globally pervasive and many are undergoing accelerated land degradation due to increased land management activities, as well as increased climate variability, both of which can have substantial effects on soil loss and dust production. Despite the fundamental importance of aeolian processes within these systems, there are few direct measurements of aeolian sediment transport that span multiple wind events following land management practices or climate extremes.

To evaluate the effects of land use and climate variability on the potential for accelerated soil loss, rates of wind- and water-driven sediment transport were estimated under different land management practices (grazed, burned, and burned+grazed) during a three-year study period, which included a year with wet/dry extremes. Rates of wind-driven sediment transport were also estimated at the vegetation-patch scale to assess the potential for sediment loss and/or deposition within bare-, herbaceous-, and shrub-dominated patch types. To place these results in a broader context, our site-specific estimates from the Santa Rita Experimental Range and preliminary results from Las Cienegas National Conservation Area are compared to other recently published measurements of wind-driven sediment transport in disturbed and undisturbed dryland ecosystems.

Results indicate that land management activities under wet/dry climate extremes can substantially increase the amount of wind-driven sediment transport, which can cause accelerated soil loss and increased dust production (Figure 1).

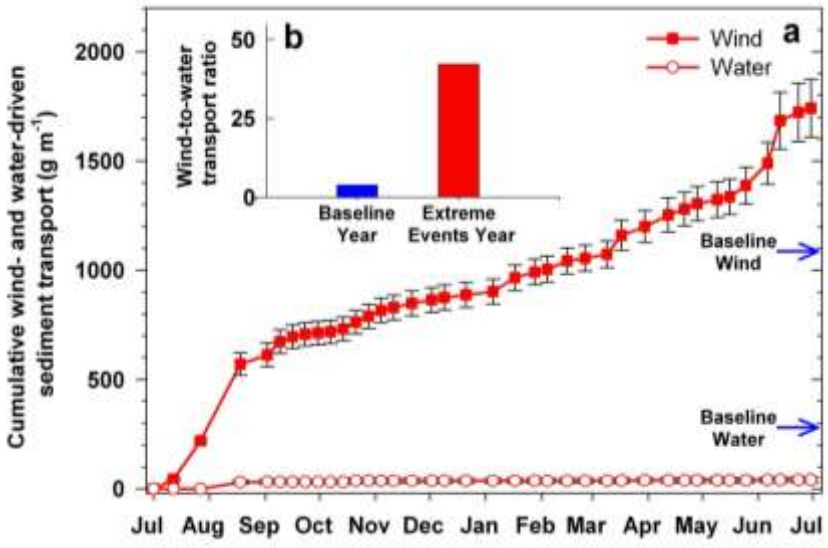

Figure 1. (a) Cumulative wind- and water-driven sediment transport in a semiarid grassland for a period including a 25-year precipitation event (August) followed by the driest 9-month period (September to May) on the more than 100-year instrumental record; (b) wind-to-water transport ratio for baseline conditions and global-change-type extreme events (reference totals indicated by blue arrows in [a]).

Results also indicate that at the vegetation-patch scale shrubs are significantly more efficient at capturing wind-blown sediment and other ecological resources than grasses and that this difference is amplified following disturbance (Figure 2).

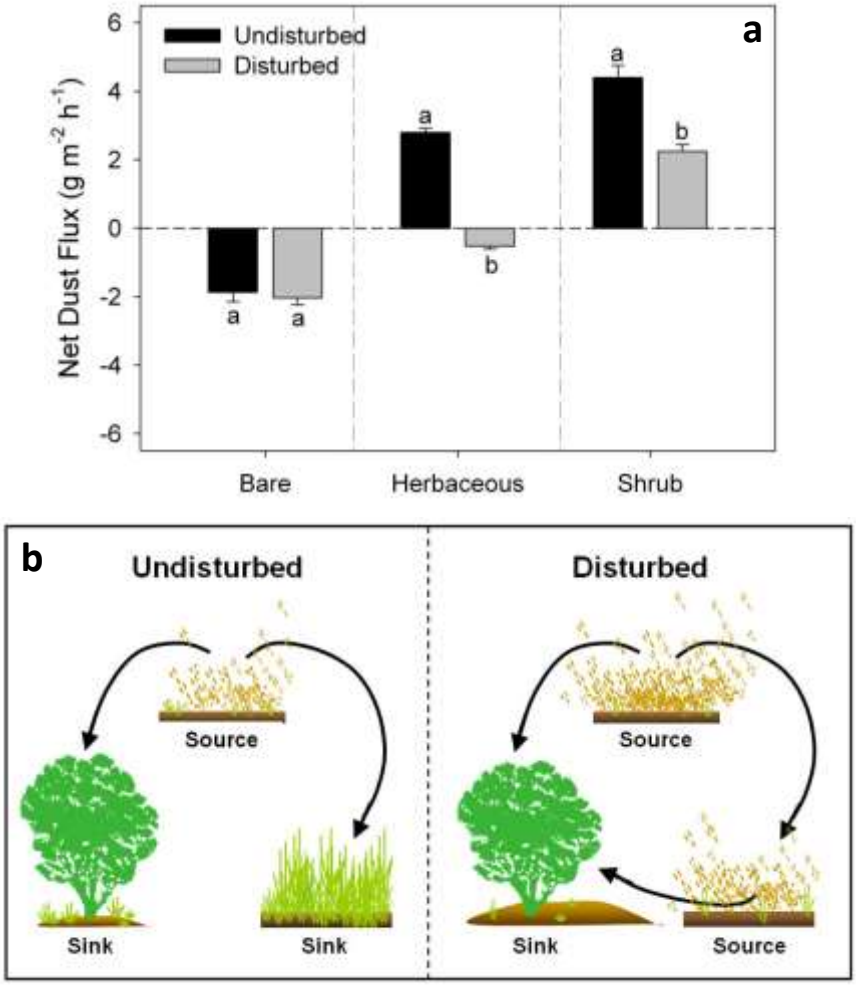

Figure 2. (a) Net dust flux (height integrated values from 0 to 1 m above the soil surface) for bare-, herbaceous-, and shrub-dominated patches for four simulated dust events under relatively undisturbed conditions and for four simulated dust events following moderate disturbance. Error bars represent the standard error of the mean; means within each patch type that have the same letter do not differ significantly ($p < 0.05$); (b) conceptual framework for wind-driven sediment capture and deposition following moderate disturbance.

Comparing results across ecosystem types suggests that for relatively undisturbed systems, shrublands have inherently greater rates of wind-driven sediment transport than grasslands, woodlands and forests. More generally, results indicate that 1) rates of wind-driven sediment transport will likely increase under projected climate extremes, 2) disturbance can particularly amplify these rates and 3) changes in vegetation patches have important implications for desertification and accelerated soil loss.

The Cienegas at Las Cienegas National Conservation Area – It's all about the Water

Andrew Salywon*, Ronald Tiller, Veronica Nixon, Matt King, Dustin Wolkis, David McCarroll, and Kevin Hultine

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Although cienegas are one of the rarest and most endangered habitats in southern Arizona, they have received little scientific attention towards explicit description of exact locations, area, water sources and quality and their importance to wildlife. The total acreage of cienegas today is fraction of what it was in pre-Columbian times. It is well known that historic anthropogenic activities, coupled with climatic conditions, especially those leading to groundwater decline, have had significant negative effects on cienegas in the region. In order to monitor, restore and protect cienegas, essential baseline information must be gathered to provide quantifiable data for either positive or negative change in these habitats. It is towards this goal that we have initiated a study to map and characterize the basic hydrology and ecology of cienegas at Las Cienegas National Conservation Area (LCNCA).

Our first objective was to provide a geo-referenced GIS layer with the outlines of the cienegas generated with sub-foot accurate GPS units by walking the perimeters of these areas. Our completed mapping project has outlined roughly 38 acres of cienegas habitat at LCNCA. Given that LCNCA has ca. 45,000 acres, then cienegas comprise only 0.08% of the landscape and are indeed very rare habitats. This layer provides a baseline foundation for informed monitoring and studies of the cienegas and wetlands and will benefit many diverse parties, including hydrologists and ecologists, working from the species level to the landscape level.

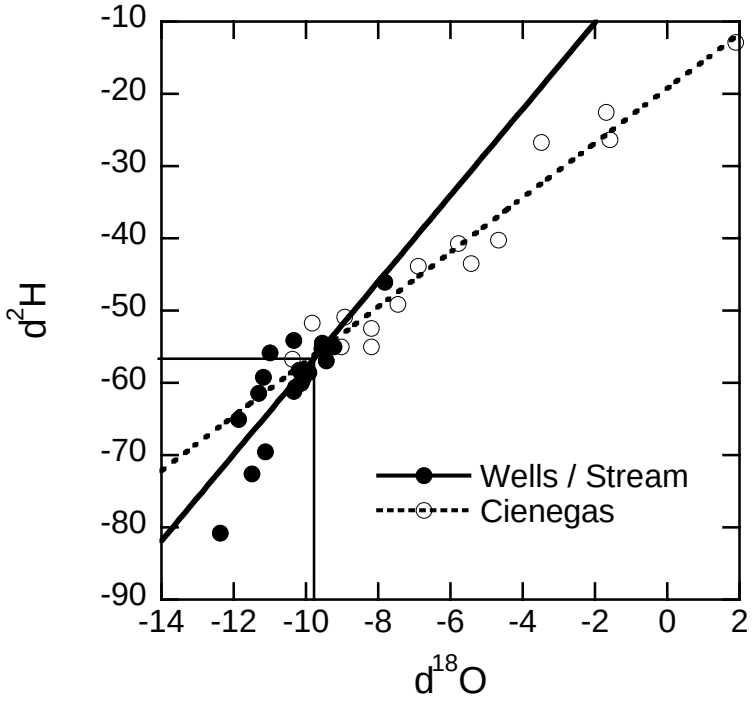
Our second objective is it to deliver a sub-foot accurate geo-referenced GIS layer of the pre-existing wells and piezometers on LCNCA in order to provide essential data for a new highly accurate countoured groundwater map for LCNCA. A new groundwater map will provide a better understanding of the hydrology of the watershed in order to make more informed decisions about how long-term climate and/or groundwater withdrawal in adjacent areas may affect the water resources of the NCA. The groundwater map currently being used is based on an analysis done nearly 40 years ago (Harshbarger and Associates, 1975) where wells were mapped using 1958 USGs 15' quad topographical maps with 40 ft. contours and a small scale. Our near-survey grade data has revealed that some of the old data points are in error by up to 177 ft. with significant implications for groundwater modeling.

The third objective is to provide stable isotopic concentrations (d^2H, $d^{18}O$) and water quality analyses of groundwater, surface waters and on-site precipitation. Preliminary isotopic analysis indicates that the source of cienega water is the same as groundwater/baseflow stream water and is comprised primarily of winter moisture with water from the cienegas in the spring are evaporatively enriched (Fig. 1). Water quality analysis has revealed similar values for cation, anions, pH, and electrical conductivity of most surface waters and springs. A comparison of the nutrient ion (NO_3-N, PO_4) concentration of a grazed versus ungrazed section of Cinco Ponds cienega revealed that, as expected, grazing increased both nitrate-nitrgen and

phosphorous concentrations. However, the water quality index was still very good (grazed- 91 for NO_3-N & 92 for PO_4 vs. ungrazed- 96 for both NO_3-N & PO_4).

Our fourth objective was to gather data on the use of cienegas by wildlife (mammals and birds). Not surprisingly, we found that cienegas are important habitat to waterfowl and wading birds. Open water is essential for these species. If open water is to be maintained in cienegas, some form of disturbance (grazing and/or fire) must be considered in a revision to the Resource Management Plan.

Fig. 1. Preliminary analysis of water stable isotopic concentrations (d^2H, $d^{18}O$) for cienegas, stream, piezometers and wells at Las Cienegas National Conservation Area. The solid-line represent the meteoric water line and the dashed-line represent the local evaporation line.




Laurel Lacher


Jason Field


Andrew Salywon

Cretaceous Paleontological Resources of the Sonoita Valley, Revisited

Robert McCord

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In 2010, near the beginning of a new grant funded project to explore the Cretaceous paleontological resources of the Sonoita Valley, I made a presentation at this symposium on what had been previously discovered in the Valley, and my expectations for the future. Here, near the end of that project, I felt it important to present what we have learned in the past four years. An excellent synopsis of the then known fossil record may be found in my abstract for the 2010 symposium. Due to a better understanding of the local geology, one notable change is that we no longer believe that there is a record of ankylosaur nor ornithopod in the Turney Ranch Formation. Of the three Cretaceous formations known to be productive in the past (Shellenberger Canyon, Turney Ranch and Fort Crittenden) only one, the Fort Crittenden Formation, provided us with new discoveries in this study, although all three were prospected. This until recently unrecognized exposure of the Fort Crittenden Formation has provided us with two broad areas of productivity with about 120 meters of measured section mapped in one of the areas with localities tied to it.

Besides new field discoveries, this project has afforded us the opportunity to reexamine the previous paleontological finds in the collections from the Fort Crittenden Formation in the area, and those records have afforded us some new discoveries as well. Newly recognized dinosaur taxa include: an ?allosauroid; both large and small dromaeosaurs; an advanced ankylosaur (an Arizona first); a saurolophine; a chasmosaur; and, a centrosaur, cf. Nasutoceratops. The previous reported titanosaur in the fauna has been questioned in the literature. While raising legitimate questions, we do not believe that its presence has been definitively refuted, and (pending additional analysis) we might have more material. Excitingly, dinosaur eggshell was discovered. While it is still undergoing analysis, we believe it is Dinosauroid Spherulitic, specifically Tubospherulitic, employing the Hirsch eggshell nomenclature. Although no new invertebrate body fossils were discovered or identified, we have recognized a rich record of invertebrate trace fossils of several different types, all currently in the preliminary stages of analysis.

Palynomorphs have been recovered in the past but these mainly reflected the aquatic and near aquatic areas of deposition with little representation of the surrounding forest or woodland. This did not help refine dating, correlation, nor comparison to the relatively well understood floristic provinces in the Cretaceous of the Western Interior. For this reason we have conducted additional sampling and are awaiting the results of that analysis.

Our re-inspection of previous collections has resulted in many modifications to our understanding of the fauna as well. Identifications of Basilemys , Gyrodus, Pterosauria and Pycnodont are in error. Reports of, or specimens label in, collections as Cimolomys, Protalphadon, Cimolestes, Myledaphus, cf. Paralbula, cf. Opisthotriton, and cf. Scapherpeton are likely correct, but we doubt their provenance being the Fort Crittenden Formation, or indeed, Arizona.

Recently PAH and reflectance of fusinite studies in the Fort Crittenden Formation have suggested frequent wildfires. These compliment other studies of frequent wildfires in the Cretaceous of the Western Interior and prompt us to examine our bones for recently developed evidence of burning. On gross examination, possible evidence of both fleshed and non-fleshed burnt bone was recognized. This bone is now undergoing more thorough analysis to confirm (or dispute) these conclusions.

In summary, our work in the Cretaceous Fort Crittenden Formation has resulted in a dramatic increase in the known dinosaur fauna. We have also established the area as a dinosaur nesting area. Our review of the previous collections has given us a more accurate notion of the actual content of the fauna. Ongoing analysis has high potential for reveling additional insights about the Cretaceous ecology.

Robert McCord

Roger Crogan

Shela McFarlin and Annamarie Schaecher

Identifying cienega plants at Las Cienegas NCA, photo by Shela McFarlin

Crotalid Assessment at the Appleton-Whittell Research Ranch: Use of Coverboards and Nail Polish to Study Rattlesnake Populations

Roger C. Cogan, Conservation Coordinator

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Abstract - A rich diversity of amphibian and reptile species occurs at the Appleton-Whittell Research Ranch. The Research Ranch is an 8000 acre sanctuary for native biota and research facility in the semi-arid grasslands of southeastern Arizona, managed by the National Audubon Society. Since cattle were removed from the sanctuary in the late 1960s, four species of crotalids/rattlesnakes have been identified by staff and researchers within the preserve.

INTRODUCTION: Four rattlesnake species have been identified within the boundaries of the Research Ranch: Western Diamondback (Crotalus atrox), Black-tailed (Crotalus molossus), Mohave (Crotalus scutulatus) and Banded Rock (Crotalus lepidus). Due to natural behaviors and relatively large body size, rattlesnakes are possibly the most often encountered snake species at the Ranch. Efforts are ongoing to document preferred habitat utilization and important over-wintering sites. In 2013, individual rattlesnakes have been opportunistically marked, in an effort to estimate population numbers.

METHODS: The Research Ranch management area covers eight thousand acres of primarily semi-arid grassland. Searches for amphibians and reptiles are conducted when conditions are appropriate for herpetological surface activity. However, most encounters occur during times when staff and researchers are traveling on roadways and trails or working in the field. When sightings occur they are documented with photographs whenever possible and recorded. GPS locations of unique and rare sightings are recorded for future reference.

We have begun marking individuals with fingernail polish as a non-invasive method to identify individual rattlesnakes. The snakes are marked using different colored polish and different location combinations on the rattle (see photo at right). Although not permanent, this method should assist identification for at least two years. Over-wintering sites are discovered by investigating likely locations during the fall and spring, when the snakes are often found basking.

Our most recent effort to document herpetofauna includes the use of “coverboards,” wooden or corrugated metal rectangles placed in likely sites early in the spring. Snakes, especially, are known to take refuge

in protected sites such as these. Periodic examination, i.e. “flipping” may reveal species that have not yet been recorded on the Research Ranch.

RESULTS:
2013
Western Diamondbacks: 35 sighted, 15 marked
Black-tails: 40 sighted, 15 marked
Mohaves: 18 sighted 3 marked

January – May 1, 2014
Western Diamondbacks: 12 sighted, 7 marked
Mohaves: 2 sighted, none marked

Over-winter sites 2011 - 2014
Eight sites have been identified

CONCLUSIONS: During the history of the Research Ranch there have been several surveys for herps and individual species have been investigated. This is the first attempt to document precise locations utilized by crotalids, assess population numbers and identify preferred, possibly crucial overwintering sites within the Research Ranch boundaries.

For more information about the reptiles and amphibians of the Research Ranch, visit http://researchranch.audubon.org/Library.html and scroll down to “Taxon” or contact the author directly at 366 Research Ranch Road, Elgin, AZ 85611 or rcogan@audubon.org.

Black-tail rattlesnake being marked with nail polish at a den site

The Cienega Watershed Timeline Project: An Update

Shela McFarlin, Annamarie Schaecher

Cienega Watershed Partnership

From humble beginnings to a web-based timeline. Cienega Watershed partners began the Cienega Watershed Timeline Project at the November 2012 State of the Watershed Workshop, with 30 individuals identifying events they experienced or knew about from the Cretaceous to 2013. We collected additional information from a variety of timelines ranging from drought chronologies to oral histories to expand the timeline--now almost 400 entries. A separate work group headed by Doug Duncan will add significant conservation events (plants and animals).

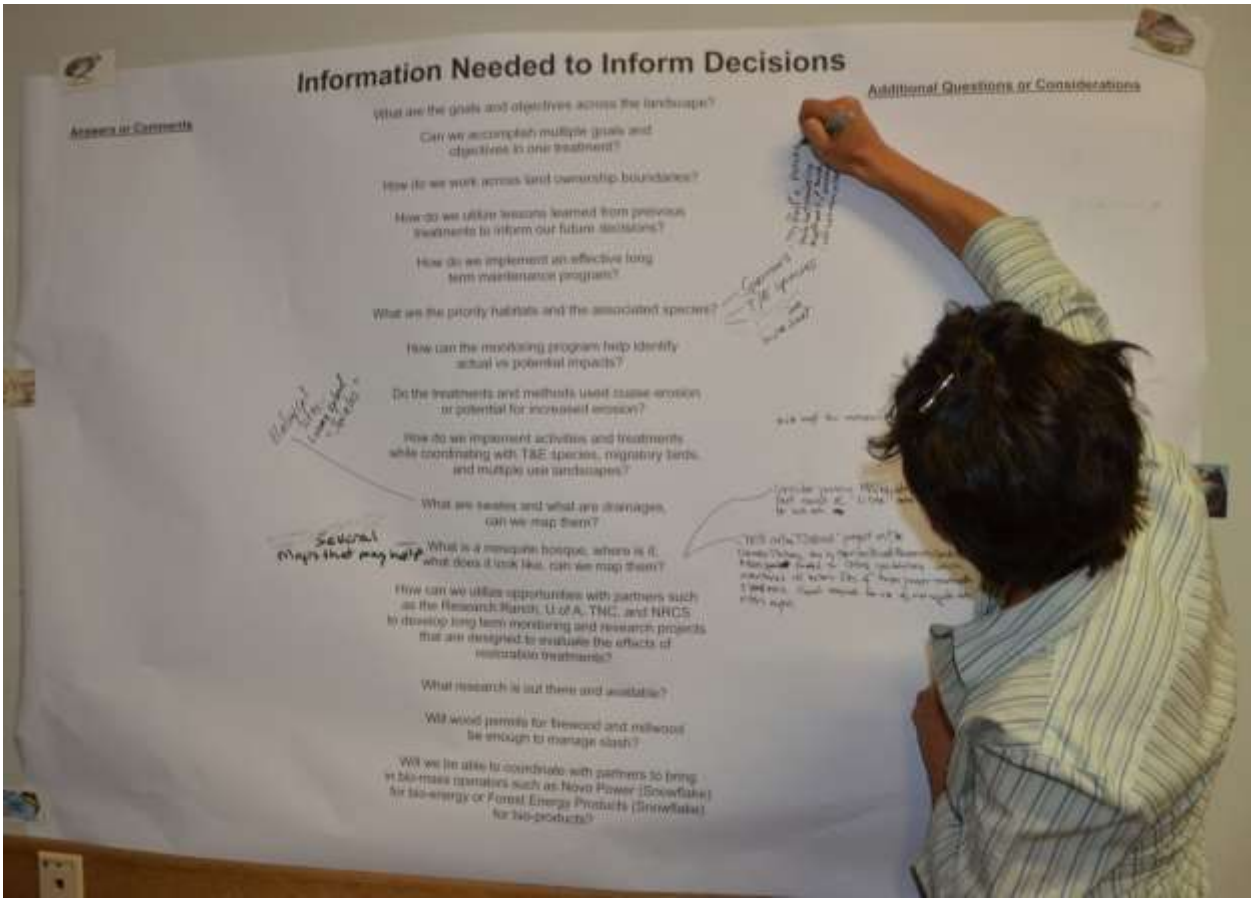
Current efforts include data verification, adding sources, and beginning to determine significance of events in the watershed.

Project has three components:

- gathering information so that the timeline represents natural and cultural events in the area;
- providing this information in a story to the general public, stakeholders, youth and others through appropriate media; and,
- addressing what the events and lessons learned through the timeline events mean for understanding and sustaining the watershed.

ARS's partnership has permitted the simple initial spreadsheet to become a web-based timeline using a TimeGLIDER Javacript Library application, researchable on titles, categories and key words by varying time scales. Climatic data for the watershed appear below the time scales selected. The public will have access from at least two links: the Cienega Watershed Partnership (CWP) www.cienega.org and the Agricultural Research Services host site.
The categories and tags for pulling information were set up by the Timeline Work Group: Members include: Shela McFarlin and Annamarie Schaecher with CWP; Alison Bunting, Empire Ranch Foundation; JJ Lamb, Vail Preservation Society; Martie Maierhauser, Colossal Cave Mountain Park; Drs. Gerardo Armendariz and Haiyan Wei, Agricultural Research Services; Dr. Gita Bodner, The Nature Conservancy; and Doug Duncan, US Fish and Wildlife Service. This group provides both information for the project (links to maps, histories, etc) and oversight for its completion.

Screenshot of the timeline (below) at: http://apps.tucson.ars.ag.gov/cienegatimeline/



Gita Bodner of The Nature Conservancy adds comments to a poster of management questions brought by Dan Quintana of the Bureau of Land Management to gather input from other participants.

Could Repeated Fires be Used to Manage Mesquite?

Linda Kennedy[1], Carl E. Bock[2,] Jane H. Bock[2], and Zach F. Jones[3]

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Encroachment of velvet mesquite (Prosopis velutina Woot.) into grasslands in the Southwest may have been facilitated by reduction in number and scope of wildfires. However, efforts to use fire to control further invasion have not usually been considered successful (see, for example McClaran, 2003 and Geiger & McPherson, 2005). Trees that are smaller than 1 cm diameter may be killed, but larger trees usually survive a fire. Study plots established in the 1980s on the ungrazed Appleton-Whittell Research Ranch and on adjacent cattle ranches yielded some unexpected results after wildfires.

In 1968, Frank and Ariel Appleton sold their cattle and transformed their Elgin Hereford Cattle Ranch into The Research Ranch to serve as an ungrazed reference area for ecological research. In the 1980s, 75 sampling plots were established:

- 25 on sites dominated by native grasses on the Research Ranch (Ungrazed-Native),
- 25 on sites dominated by exotic grasses on the Research Ranch (Ungrazed-Exotic),
- 25 on sites with a mixture of native and exotic grasses on adjacent cattle ranches (Grazed-Mixed).

Wildfires in 1987 and 2002 presented the opportunity to study the effects of fire on mesquite in each of the above habitats, and we were able to compare the impacts on sites that burned once against sites that burned in both fires. For a full description of the field methods and statistical analyses, please see Bock et al., 2007. In brief, the percent ground vegetation burned was determined in each habitat: Ungrazed-Exotic, Ungrazed-Native, Grazed-Mixed. The three mesquite trees (> 1m height) closest to the center point of each sampling plot (75 in each habitat for a total of 225 trees) were examined for 5 growing seasons after the 2002 wildfire. Mortality of mesquite and post-fire regrowth (foliage recovery) were determined. In this study:

- 100% of mesquite trees in Exotic-Ungrazed plots were top-killed, whereas 79% of trees in Native-Ungrazed and 28% of trees in Mixed-Grazed were top-killed.
- By 2006, foliage volume of burned mesquite (excluding ground sprouts [see photo, at right]) averaged 58% of the pre-burn level in Mixed-Grazed grasslands, but only22% in Ungrazed-Native and 1.3% in Ungrazed-Exotic habitats.
- If ground sprouts (see photo, at right) were included in the foliage volume calculation, Grazed-Mixed grasslands had recovered nearly 80%, Ungrazed-Exotic grassland foliage volume of mesquite was

approximately 65%, and Ungrazed-Native was the lowest at 56%.

- After five growing seasons, maximum ground sprout height was greater among 155 top-killed trees than among the 70 trees that were not top-killed.
- Trees that burned once (2002) produced more foliar regrowth than trees that had burned twice (1987 & 2002).
- Thirteen of 225 trees died (i.e. no re-sprouts after five growing seasons). All were in Ungrazed plots (eight in Native and five in Exotic).
- Of 84 trees that burned only in 2002 – one died. Of 66 trees that burned in 1987 AND 2002 – twelve died. Mortality was not related to the size of the tree.

Results from this study indicate that fire may, in fact, be a tool in reduction of mesquite density of mature trees, but only if repeated fires occur when dry fine fuels are abundant. Mature mesquite in native grasslands may be more vulnerable to repeated fires than mesquite in grasslands dominated by exotic grasses. Much more research is necessary to determine if the results from this study can be replicated and at a level that is significant from a management perspective.

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Photo of Ryan Wildfire (above) by John Hoffman.

Black-tailed Prairie Dogs at Las Cienegas National Conservation Area: Initial Community Impacts

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Many tests of the keystone species concept have only assessed areas occupied by these species or the effects of their removal on the ecosystem. We have had the opportunity to assess effects of the addition of a potential keystone species to an ecosystem from which they have been extirpated for at least 50 years. The black-tailed prairie dog (BTPD; *Cynomys ludovicianus*) has been commonly described as a keystone species, meaning that its influence on the ecosystem is disproportionately large compared to its abundance. BTPDs physically alter their environment by burrowing, foraging, and maintaining short vegetation on their colonies, which provides habitat and shelter for other species, creates macropores for water percolation, turns over soil, provides young nutritious plant shoots for grazers, creates fire breaks in grasslands, and prevents woody plant encroachment. BTPDs also serve as an important food source for many terrestrial carnivores and birds of prey. Despite their many services, BTPDs have been considered pests range wide, and many eradication programs, some state and federally sponsored, were carried out beginning in the early 1900s. Because of these eradication programs, the BTPD was extirpated from Arizona by 1960. Over the past 6 years the Arizona Game and Fish Department and the Bureau of Land Management have re-established the BTPD at Las Cienegas National Conservation Area in southeastern Arizona. We assessed small mammal species diversity on, off, and on edges of colonies through live-trapping, and determined if prairie dogs suppress woody plant growth (i.e. mesquite and acacia) by use of experimental exclosures. We found that small mammal species diversity and richness increased between 2012 and 2013, and the greatest diversity was on edges of colonies (compared to on and off colonies). We also found that woody plants placed in exclosures on prairie dog colonies grew at a greater rate than those left exposed to prairie dogs. Our results suggest that these re-established prairie dogs may not have fully resumed their keystone role yet, but they are beginning to change the environment in ways that suggest resumption of this role in the future.

Behavioral Asymmetries, Social Networks, and Environmental Variation: Divergence among Male Tree Lizard Morphs in Disturbed Habitats

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Male-male competition is a key component of sexual selection that drives variation in resource holding potential, social behavior, and ultimately reproductive success among males. This phenomenon is particularly common among males in color polymorphic species where morphs differ in their degree of aggression and territoriality. Interactions between dominant morphs in these species tend to escalate more than interactions between different morphs, resulting in a greater likelihood of injury. Given that variation in morph behavior is associated with variation in their ability to secure preferred resources, resource-limited environments should pose a significant challenge to existing morph relationships. Here we investigate the consequences of habitat variation for male tree lizard (Urosaurus ornatus, Fig. 1) social networks at three sites within the Appleton-Whittell Research Ranch differing in resource (tree and shrub) availability linked with differences in disturbance (burn) history.

Fig. 1: An adult male *U. ornatus* and the three male color morphs (based on color, inset). The morphs differ in aggression and thus their ability to exploit preferred resources (e.g.,

Burned (resource-limited) environments should promote greater competition for habitats and prey and a greater risk of injury from contest escalation. We consider two hypotheses: either male strategies (behaviors) will remain fixed and social network structure shifts, or, conversely, male behavioral differences may be modulated in order to maintain morph spatial relationships among the study sites. We demonstrate that male U. ornatus in burned sites are larger (Fig. 2), have fewer parasites, and escalate to chasing and biting behaviors during male-male encounters more frequently than males from a non-burned site.

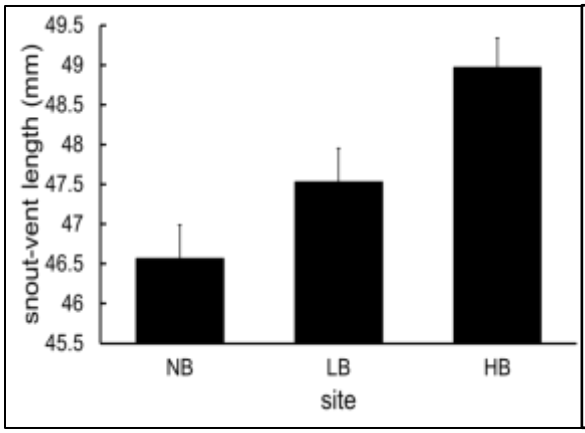

Fig. 2: Body size (snout-vent length, mm) of *U. ornatus* lizards at three sites differing in prescribed burn history. The sites include: a non-burned control (NB), low-frequency burn (LB), and high-frequency

We find support for our first hypothesis: male social networks differed among the sites. Specifically, in the more-limited habitat, the spatial dispersion of morphs reflected their behavioral differences. That is, only aggressive males usurped living trees and consumed higher quality (higher trophic level) prey types (Fig. 3).

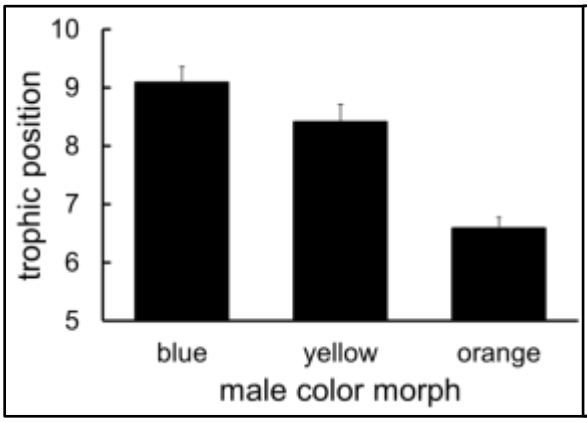

Fig. 3: Trophic position of the three male *U. ornatus* color morphs at the High-frequency Burn site, based on carbon and nitrogen isotopic data. Lizards at higher trophic position consume

We conclude that environmental variation may influence animal social network structure. Moreover, behavioral and environmental variation may promote despotic social dynamics and ecological divergence in resource-limited habitats.

Pronghorn, photo by Liz Webb