8th Annual
Science on the Sonoita Plain Symposium
June 4, 2016

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, the primary thematic focus was on invasive species, and included a series of presentations, a panel discussion, "grab-bag" discussions, and an afternoon field visit. We hope you enjoy this recap of the 8th annual Science on the Sonoita Plain Symposium.

Proceedings compiled by Suzanne Wilcox (Audubon)

Planning Committee: Gita Bodner (The Nature Conservancy), Larry Fisher (Cienega Watershed Partnership, University of Arizona), Linda Kennedy (Audubon), Shela McFarlin (Cienega Watershed Partnership), Thomas Meixner (Cienega Watershed Partnership, University of Arizona), and Mead Mier (Pima Association of Governments)

Special thanks to:
Shela McFarlin, Tahnee Robertson, Mead Mier and Audubon Volunteers

Photos courtesy of
Linda Kennedy (Audubon) & Tahnee Robertson (CWP)

Funding was provided by Audubon Research Ranch, The Nature Conservancy, the Bureau of Land Management, and the Cienega Watershed Partnership.

For previous proceedings and video recordings, go to YouTube
https://www.youtube.com/results?search_query=science+on+the+sonoita+plain
And to the Audubon Research Ranch Library:
http://researchranch.audubon.org/landing/library/science-sonoita-plain

Agenda & Table of Contents

12:10 Lunch/Poster Session

Exotic Species in the Sonoita Plain – Part I: Linda Kennedy, Moderator

1:05 The Ecology of African Lovegrasses (*Eragrostis* spp.) in the Southwestern United States: Carl Bock & Jane Bock (University of Colorado, (Ret.)) ...p. 17-20

1:50 Arizona's Non-native Pest Plant Problems: Francis E. (Ed) Northam … p. 21 & 22

2:30 – 2:50 Break/poster session – Cookies provided by Tony Leonardini

Exotic Species in the Sonoita Plain – Part II: Linda Kennedy, Moderator

2:50 Effects of Nonnative Grasses on Density and Nest Success of Birds in Desert Grasslands: Erik Andersen, Robert Steidl (University of Arizona)… p. 23

3:20 Life and Death After Bullfrogs, Patterns of a Fungal Amphibian Disease and its Effects on Chiricahua Leopard Frog Conservation within the LCNCA and Surrounding Areas: David Hall, Phil Rosen (University of Arizona) … p. 24

3:50 – 4:15 Panel Discussion: D. Hall, C. Bock, J. Bock, E. Andersen, & E. Northam

4:15 – 4:30 WOW! Moments: Tahnee Robertson, Facilitator

4:30 – 6:30 Field Trips on AWRR (optional) Sign up in lobby

- South Post Canyon (Green Sunfish, Bullfrogs) Roger Cogan (Audubon)
- Treatment of Exotic Plants (Lehmann, Whitetop) Linda Kennedy (Audubon)

Posters

- Using Watershed Health Indicators to Improve Management Strategies and Community Engagement: **Amanda Smith**, Mead Mier, Melanie Alvarez (Pima Association of Governments) … p. 25
- Tamarisk: **Doug Siegel** (Pima County), Presented by Mead Mier (Pima Association of Governments) … p. 26
- Breeding habitat selection of the western distinct population of the yellow-billed cuckoo (*Coccyzus americanus*) within Audubon Arizona Important Bird Areas: **Steven S. Prager** (Arizona Audubon) … p. 27
- Avian Survey at the Research Ranch: **Tony Leonardini** (Volunteer, Appleton-Whittell Research Ranch) … p. 28
- Fooled by Nature, Again? Contrasting GIS-based Predictive Models of Habitat Connectivity with Genetic Relatedness among Mountain Lions: **Ashwin Naidu**, et al., (University of Arizona) … p. 29
- Canelo Hills Cienega Preserve Herbarium and Flora: **Kathryn Miller** (Student, Patagonia Union High School & Volunteer, Appleton-Whittell Research Ranch) … p. 30
- Protecting the Prairies One Squirt at a Time: **L. J. Kennedy**, R.C. Cogan, S.L. Wilcox (Appleton-Whittell Research Ranch) … p. 31
- Whitetop – What to call this species is a challenge and management of this species is even worse!: L.J. Kennedy, **R.C. Cogan**, S.L. Wilcox (Appleton-Whittell Research Ranch) … p. 32

Welcome!

LARRY FISHER, *Cienega Watershed Partnership/University of Arizona*

Welcome to all, and thanks for coming to the Science on the Sonoita Plain Symposium for 2016.

This is our eighth symposium, and it seems like interest has just seemed to grow steadily over the past several years, as once again, we are completely sold out, and it's just great to see this room filled with people eager to learn about developments on the Sonoita Plain.

For a bit of background: This symposium was initially convened as a support group for researchers working across this diverse landscape on a wide array of topics of interest – in short, scientists who were looking for connections and synergies in their work.

More recently, the symposium has transformed into a broad-based forum of exchange among all interested stakeholders – not only scientists, but also land managers, local landowners, conservation and community activists, and just concerned local citizens – and it has become one of the signature annual events sponsored by the Cienega Watershed Partnership.

The emerging tradition for the Symposium is to hold it on the first Saturday of June, and to use the event to continue sharing results of scientific investigations as well as experience and insights gained from a range of land management activities occurring within the upper watersheds of the Cienega Creek, Sonoita Creek, and the Babocomari River.

The Symposium's format has changed over the years. We now try to identify a key topic of interest each year for deeper analysis and discussion. In the past three years we've focused on climate change, mesquite encroachment, and water management; this year our primary thematic focus will be on invasive species. We've also retained sessions that showcase the diverse research and program work that is happening in the area – our miscellaneous, "grab bag" sessions this year include presentations on conservation of seeps and springs, response of ornate tree lizards to climate change, natural tracers of source waters to critical wetland habitats, grassland sparrows and exotic grasses, the Cienega Watershed Partnership's watershed health indicators project, a report from BLM on the Las Cienegas National Conservation Area, and of course, the always popular endangered fish update from Fish and Wildlife Service. We also have an excellent array of poster sessions, and we have set aside time for our presenters to provide a summary of their posters, and for you all to interact with them to discuss their findings. So, thanks again to everyone for making the trek out here to join us, and for your interest and contributions to sustainable land management efforts on the Sonoita Plain.

Some of our Presenters

Anthony Gilbert
Gita Bodner
Sami Hammer
Larry Fisher
Trevor Hare
Ron Pulliam
Jennifer McIntosh

Erik Andersen
Francis E. (Ed) Northam
Amy Markstein
David Hall

Ashwin Naidu
Amanda Smith
Shela McFarlin
Mead Mier

Presentations

CWP's "Indicators Project": Assessing the Health of the Cienega

LARRY FISHER, Kelly Mott Lacroix, and Thomas Meixner, Adriana Zuniga Teran, *Cienega Watershed Partnership/University of Arizona*

How healthy is our watershed? To answer this question the Cienega Watershed Partnership (CWP) is working with partners to identify indicators that can provide an annual snapshot of watershed health for natural and socio-cultural resources. The State of the Cienega Watershed process allows the CWP to capitalize on our partners' existing data and provides a mechanism for regularly evaluating watershed health and adapting CWP program priorities and actions. It will also offer a range of opportunities to engage with the public on watershed issues. Over the past two years, CWP has convened a series of workshops, conducted an electronic survey, and held several smaller working group sessions. This extensive input from partners has helped identify the basic criteria for selecting priority indicators, and trim a very long list of possible indicators to a core set of indicators that can help us gain a strong real-time assessment of watershed health.

CWP partners identified an initial set of 47 indicators that were divided into four categories: 1) upland, 2) water and riparian, 3) social-cultural, and 4) landscape. In our most recent workshop (February, 2016), participants prioritized and consolidated these into a proposed set of core indicators, identifying the source of the data, and how the information will be collected and presented. Our goal this year is to field-test this approach using these selected indicators and methods, and present our initial attempt at defining the state of the watershed during our winter 2016 CWP meeting. The annual State of the Watershed report will be made available in an online format, as well as a shorter, brochure type hard copy report that can be shared with the public during community presentations.

Inventorying Spring Ecosystems in the Sky Island Region

SAMI HAMMER,
Sky Islands Alliance

Over the past four years Sky Island Alliance has been working to develop new information on the biological and management status of springs in the Sky Island Region. We employed a combination of expert and citizen science inventories and ecological assessments to collect data on spatial location, ecological threats, restoration potential, and the biological, hydrological and geomorphological status of springs. Data collected is now available online regionally and internationally through the Springs Inventory Database (springsdata.org) and is being used to inform restoration and protection of spring sites. This database provides a landscape level context for making management decisions and is a tool to identify high priority restoration sites.

Ecological and Evolutionary Responses to Temperature: How Ornate Tree Lizards will Respond to Climate Change

A. GILBERT, *Ph.D. Candidate, Department of Biological Sciences, Ohio University*

Anthropogenic climate change is a pervasive threat to the planet's biodiversity. Rising temperatures caused by human activity will impact ecosystem functioning to the point of global mass extinction. Ectothermic vertebrates are at risk to rapid changes in environmental temperatures, because of their thermal dependence of physiological traits. Previous studies have assessed extinction risk of populations that display mismatches between environmental and thermal physiological traits by combining environmental temperature (such as air temperature [Tair] and mean environmental temperature [Te]) with thermal physiological data. Populations will be more susceptible in habitats that have warmer Tair or Te's than thermal physiological traits. Linking thermal preference, thermal performance, body temperature, and thermoregulatory behavior, to environmental temperature has become critical to evaluate the responses of ectotherms to changes in climate, because body temperature in ectotherms determines their physiological capacity to perform important behaviors within their environment, but ultimately to grow, reproduce, and survive.

My research attempts to disseminate how ornate tree lizards (*Urosaurus ornatus*) are likely to respond to climate change by characterizing their thermal biology and physiology. I use this organism as a model in my research because it is broadly distributed, has a fast life cycle, but is also specialized for extremely warm thermal environments. Few studies to date have focused on understanding the thermal biology of a high-temperature specialist. Therefore, I try to understand how lizards specialized for extreme thermal environments cope with temperature, and attempt to explain patterns beneficial for other lizards inhabiting more tropical or temperate environments to respond to changes in global climate. I will summarize the work I have done on the research ranch to date, including characterizing the relationship between food availability and individual locomotor performance, and the relationship between survival and thermoregulatory behavior.

The Cienega Watershed Timeline Project: A Work In Progress

SHELA MCFARLIN,
Cienega Watershed Partnership

The Cienega Watershed Timeline Project has moved significantly from its 2012 beginnings as a shared history exercise to become an interactive web-based timeline with researched and verified entries of almost 700 events in Cienega Watershed history. A climate timeline is provided as well for those years in which temperature and other climate records are available. The Project remains a work in progress and may be accessed at: http://apps.tucson.ars.ag.gov/cienegatimeline/ or simply Google "Cienega Timeline".

The Project is managed by a volunteer work group whose members include: Shela McFarlin with the Cienega Watershed Partnership, Alison Bunting, Empire Ranch Foundation; JJ Lamb, Vail Preservation Society; Martie Maierhauser, formerly with Colossal Cave Mountain Park; Gerardo Armendariz and Dr. Haiyan Wei, Agricultural Research Services (ARS); Dr. Gita Bodner, The Nature Conservancy; Doug Duncan, US Fish and Wildlife Services, Kathy Donahue (Volunteer), and Dr. Robin Pinto (University of Arizona). ARS's partnership has permitted the simple initial spreadsheet to become a web-based timeline using a TimeGLIDER JavaScript Library application, researchable on titles, categories and key words by varying time scales.

Why is this project worthwhile? The Timeline covers over 145 million years of Cienega Watershed history. Paleontology, archaeology, Native American history, land use history, historical events from legislation to individuals, major climatic or landscape events, and other topics are now available to users ranging from researchers to students. The work group members are in the process of sourcing and verifying each event and linking events to resources, oral histories, maps or images that provide more information. Although a number of entries already pertain to plants and animals, a separate team is working on adding and verifying natural history events for the Timeline. These events will permit a user to trace not only the disappearance or appearance of species, but the context of larger watershed history.

Volunteers to work on the natural history or ecological components are needed. Please contact the work group at: timeline@cienega.org

Natural Tracers of Source Waters to Critical Wetland Habitats for Endangered Species

JENNIFER MCINTOSH & Rachel Tucci *University of Arizona, Department of Hydrology and Atmospheric Sciences*, Ron Tiller & Andrew Salywon, *Desert Botanical Gardens* and Jeanmarie Haney, *The Nature Conservancy*

The Cienega Creek Watershed (CCW) contains some of the highest quality riparian woodland, riverine, and cienega wetland habitats in Arizona that are critical for threatened and endangered species. In fact, 28 miles of Cienega Creek, downstream from its confluence of Gardner Canyon are designated as "Outstanding Arizona Waters." These riverine and wetland habits, and underlying groundwater in the alluvial basin, are under pressure from threats of increased groundwater pumping, land use, climate change, and mining. Limited baseline data on water quality and hydrologic conditions have been obtained, but remain insufficient to assess potential and/or future environmental impacts. Additional information is needed to support land managers in selecting priority actions for management and protection.

Our study uses natural chemical and isotopic tracers to evaluate groundwater and surface water flow regimes in the CCW. Specifically, we are investigating the timing and location of groundwater recharge, hydrologic connections and transit times between mountain block recharge and wetlands in the center of the basin, and the seasonal source of baseflow to upper and lower Cienega Creek and its tributaries. Initial water stable isotope values and SO_4/Cl ratios show that the cienegas, springs, riparian groundwater and streams in the upper CCW are dominantly sourced from basin groundwater recharged by winter precipitation at mid-elevations. Many of the surface waters were subsequently evaporated. Further analysis is being done to evaluate the influence of summer monsoon floodwater recharge to riparian groundwater and discharge to surface waters. Interestingly, several groundwater samples, including Questa Springs and the Airport Strip well had relatively low oxygen isotope values suggestive of high-elevation, winter recharge. The tritium concentration in Questa Springs was only slightly above the detection limit, indicating a mixture of young (<60 years old) and older (>60 years old) water, consistent with other groundwater samples analyzed from Davidson Canyon. On-going sampling and analysis of precipitation, surface water, and groundwater across the CCW will help to provide important baseline data on the quality, source, and age of water that can be used to model, manage and protect the region's natural resources.

The Spread of Exotic Grasses and Decline in Grassland Sparrows: What can we do about it?

H. RONALD PULLIAM,
Borderlands Restoration

We have documented changes in plant species composition and bird populations in the Sonoita grasslands by comparing plant survey and bird census data on sites established by various researchers over a 45-year period (1971-2015). Sparrow populations, seed production and changes in food availability were assessed by repeating protocols on same sites originally established by Pulliam in the early 1970s. More recent changes in vegetation were determined by comparing Bock et al 2003-4 data with 'ReBock" (2013-14) data from the same study sites and using same sampling methods. The most consistent change observed in plant species composition was a large decline in native grasses (especially *Bouteloua gracilis*) and a large increase in Lehmann' lovegrass (*Eragrostis lehmanniana*).

Many grassland birds have shown steep population declines over the past 45 years, especially open country sparrows that overwinter in the Sonoita Plains. The data strongly suggest a causal relationship between sparrow population declines and changes in plant species composition. I will discuss the magnitude and spatial extent of the population declines, speculate on future trends, and discuss what, if anything can be done to reverse the increase in invasive lovegrass and declines in bird populations.

Restoration Prioritization, Implementation and Training Workshops in the Sonoita Plains and Huachuca Grasslands

TREVOR HARE,
Watershed Management Group

Watershed Management Group is working the Ciénega Watershed Partnership on a comprehensive riparian and upland restoration prioritization process to better inform where and how to expend limited resources to restore degraded sites of the Las Ciénegas National Conservation Area and surrounding areas. This iterative process is informed by existing data and expert opinion and will provide managers and others with a prioritization of known problem areas and suggested approaches and methods.

Data collection from existing sources is underway and the expert knowledge work will begin shortly. Data being collected includes existing maps of erosional areas in sacaton grasslands, DEMs (Digital Elevation Models), previous restoration work areas and goals/methods/outcomes, riparian and upland condition, infrastructure locations, watershed condition ratings (if available), and proximity to critical resources such as wetlands and Ciénega Creek. Expert knowledge will be consulted and captured through a series of workshops with subject experts, stakeholders, land and wildlife managers, landowners, and user groups.

Next steps in the process with funding from the BLM to CWP is to identify one arroyo and one sacaton site to begin restoration work, and if appropriate use those sites to conduct half day training workshops on low-tech approaches to arroyo restoration and erosion control with area landowners and managers. In addition we will be developing and producing guide books on using the prioritization process and approaches and methods for erosion control and restoration in the Sonoita Plains and Huachuca Grasslands.

Another phase of the grant will involve engagement of those living and working the land in the watershed to engage their expertise and provide educational opportunities. The goal is to increase understanding of shallow groundwater dependent ecosystems with the opportunity to tying CWP's goals and PAG's shallow groundwater studies and outreach to WMG's 50 year vision to restore creeks throughout the Tucson Basin, with Ciénega Creek being an example of what used to exist along the Santa Cruz and Rillito.

Implementation of the Topminnow and Pupfish Safe Harbor Agreement at the Appleton-Whittell Research Ranch of Audubon

DOUG DUNCAN, *U.S. Fish and Wildlife Service*
and Ross Timmons*, Arizona Game and Fish Department*

The Arizona Game and Fish Department has a Safe Harbor Agreement that can help conserve and recover four endangered native fishes, the Gila topminnow *Poeciliopsis o. occidentalis*, Yaqui topminnow *P. o. sonoriensis*, desert pupfish *Cyprinodon macularius*, and Sonoyta pupfish *C. eremus*. Currently, 20 ponds have been enrolled, supporting 24 fish populations. Landowners are interested in native species for several reasons, foremost being their desire to assist with the conservation of native species. The Safe Harbor has assisted recovery by creating duplicate populations of remaining topminnow and pupfish lineages, establishing and fostering partnerships between nontraditional groups and individuals for the conservation of the species, reducing the use of mosquitofish as a vector control agent, and educating interested people on the plight of native fishes and their conservation.

The Audubon Research Ranch signed on to the Safe Harbor in 2010, with the first release of desert pupfish occurring at the third annual Science on the Sonoita Plain. A total of 229 pupfish were released by meeting participants on June 4, 2011. Ever since, monitoring of the pupfish population in the pond has been done during Science on the Sonoita Plain, with 2016 continuing that tradition. The Safe Harbor and desert pupfish in the Audubon Research Ranch Pond are yet another example of cooperative conservation in the area, and an outstanding example of how such sites contribute to the education of the public regarding native fishes.

Purpose: desert pupfish monitoring @ Science on the Sonoita Plain

Location: Appleton-Whittell Research Ranch
Personnel: Doug Duncan

This was the fifth year of monitoring desert pupfish *Cyprinodon macularius* at this Safe Harbor site. We set four baited Gee metal minnow traps in the pond at ~1000 hrs. Traps were set for about two hours each: checked at ~1230 hrs. Size class break for adult and juvenile was 15mm. Most fish captured were greater than 15mm. Just before pulling traps, an estimated minimum of 75 pupfish, mostly adults, were still swimming free outside the traps. There were probably another 75 fish in vegetation; there was more emergent vegetation this year than in some preceding years. There were 193 fish captured in the traps; 161 adults and 32 juveniles. This is the second highest number of fish captured, less only than the year after stocking, when many juveniles were present. Many adult males were in breeding color, though no very young fish (YOY) were captured or seen in the pond. Temperatures in May were fairly cool, making reproduction unlikely before the monitoring. All fish appeared healthy and no nonnative fish were found. The catch per unit effort (fish/trap hour) was 18 (21 last year). Minimum number in traps and swimming free was 344. About 50% of the water is covered by *Eleocharis*. Flat rocks placed in the pond by Audubon staff were observed being heavily used by juvenile pupfish, but need to be adjusted. Plants are beginning to grow on some of the rocks. This pupfish population should be augmented with pupfish from other sources this year.

Desert pupfish *Cyprinodon macularius* monitoring history at Audubon Appleton-Whittell Research Ranch, Arizona.

Date	Event	Adults trapped[2]	Juveniles trapped[2]	Catch per unit effort (fish/trap hour)	Number pupfish observed outside of traps	Minimum number pupfish present
4 June 2011	fish released	-	-	-	-	229
9 June 2012	Monitoring[1]	146	148	37	48	342
8 June 2013	monitoring	13	0	2	17	30
7 June 2014	monitoring	55	27	11	40	122
6 June 2015	Monitoring	143	23	21	50	216
4 June 2016	Monitoring	161	32	18	75	268

[1] Four baited Gee metal minnow traps deployed two hours each.
[2] Number of fish.

The Ecology and Possible Control of Lehmann Lovegrass (*Eragrostis lehmanniana*) in the American Southwest

CARL E. BOCK and **JANE H. BOCK**
Ecology and Evolutionary Biology
University of Colorado

Lehmann lovegrass is a warm-season perennial bunchgrass, native to southern Africa, that was purposefully introduced into Arizona beginning in the 1930s as a means of restoring degraded native rangelands. Through continued seeding and subsequent spread, this invasive exotic species now occurs widely across the Southwest from southeastern California to west Texas, and well down into Mexico. Its potential distribution has been estimated to encompass up to 70,000 km2, where it frequently forms dense, almost monotypic stands.

There have been a number of studies comparing the flora and fauna of areas invaded by Lehmann's lovegrass versus comparable sites still dominated by native vegetation. A small number of animal species dependent upon tall, dense grass cover apparently thrive in its presence. Known examples include the Botteri Sparrow (*Peucaea botterii*), cotton rats (*Sigmodon sp.),* harvest mice (*Reithrodontomys sp.*), and at least one grasshopper (Phoetaliotes nebrascensis). However, the great majority of native species are significantly diminished in areas invaded by the African exotics, including various grassland birds, insects, and rodents, along with grasses, forbs, and succulents, including agave. Therefore, continued spread of Lehmann lovegrass represents a significant threat to the biodiversity and ecological integrity of many southwestern grasslands and savannas.

We have surveyed literature about the ecology of Lehmann lovegrass, in both the New and Old Worlds, with the goal of elucidating and exploring management practices that might be used to reverse or at least restrain its continuing spread across the Southwest.

In both its native and introduced ranges, Lehmann lovegrass grows primarily on mid-elevation sites with moderate temperatures and abundant warm-season precipitation. It is unlikely to spread into higher elevation sites with prolonged periods of sub-zero temperatures, or into low deserts with insufficient precipitation, or into areas with predominantly cool as opposed to warm-season rainfall. It usually grows on relatively level sites with sandy soils, but these preferences are not absolute, and there is no reason to expect the ultimate southwestern distribution of Lehmann lovegrass will be limited by either topography or soils.

Lehmann lovegrass reproduction occurs primarily by means of copious but very small seeds, most of which are produced asexually. Seeds germinate and seedlings survive best in relatively open sites with minimal cover of either vegetation or litter, such as in areas that have experienced disturbances including fire, drought, and livestock grazing. There are two reasons why Lehmann lovegrass produces large seedbanks ready to germinate following any sort of disturbance that happens to open the vegetative canopy. First, harvesting the small seeds is energetically unprofitable for many seed predators, including birds, rodents, and ants. Second, only a portion of any season's seed crop germinates after the first rain, with other portions remaining for future opportunities. Another advantage Lehmann lovegrass has over many other grasses, in both its native and introduced ranges, is that it is relatively unpalatable to livestock.

In Africa, Lehmann lovegrass has been described as an early to mid-successional species that eventually gives way to other native grasses in areas with little or no disturbance, such as lightly-grazed or ungrazed sites. This is in decided contrast to the situation in North America, where (as least so far) there is no evidence that established stands of Lehmann lovegrass will be outcompeted by native species, even in the absence of disturbance.

A particular puzzle in the Southwest is whether disturbances such as drought, fire, and livestock grazing are either necessary or sufficient to cause incursions of Lehmann lovegrass into previously unoccupied or sparsely occupied areas. For example, some studies suggest that dense ungrazed stands of native grasses can at least slow if not absolutely prevent growth of lovegrass populations, while other studied have found no relationship between grazing history and establishment and spread of the exotics. Similarly, Lehmann lovegrass has been reported to increase dramatically following certain wildfires, while other apparently similar burns had no such effect. Finally, Lehmann lovegrass appears more drought tolerant than some native species, but less so than others, so that drought-related mortality may favor the African exotic in some situations but not in others.

We propose a model (clearly in need of further careful testing) whereby the likelihood of Lehmann lovegrass establishment following disturbance depends on the impacts of that same disturbance on native grasses already at the site. It is a competition-based model, wherein a dense canopy of native grasses can prevent or at least retard the germination and growth of Lehman lovegrass seeds and seedlings. Alternatively, if disturbance causes mortality of the native plant canopy, lovegrasses will quickly colonize the area as long as a seed source is present. Once a lovegrass population has become established, any future disturbance-related mortality is unlikely to provide opportunities for re-colonization by native plants, at least over the long term. This is because the large lovegrass seedbank facilitates such a rapid recovery.

There are no established protocols for removing Lehmann lovegrass from an area, or for preventing further colonization and spread. Given its ongoing and expanding threats to regional biodiversity, there is an urgent need for research into possible methods of control. We offer the following points for consideration:

I. The standard array of herbicides (such as glyphosate) will kill Lehmann lovegrass, but no species-specific treatments are known, and there is increasing concern about the hazards of applying such chemicals in the quantities and scale required to have any sort of regional effects. Given its large seedbanks and positive germination response to increased light, initial control in established stands is unlikely to result in anything except a new crop of the same species. Some research suggests that repeated spraying can be effective, especially if coupled with disturbances such as fire that would trigger germination and exhaustion of much of the seedbank, and if followed by seeding with native species.

Spot-kill of individual plants in mixed stands can be a useful approach in the initial stages of an invasion, especially if litter and native grass canopy are sufficient to retard Lehmann seed germination. However, this approach is labor-intensive and likely would be prohibitively expensive except on a local scale, to say nothing of the risks to native species from careless herbicide application.

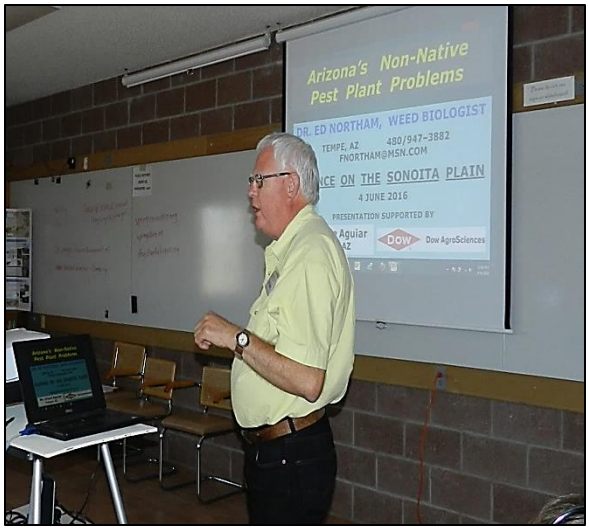
II. Prevention or minimization of disturbances to native grasses almost certainly will retard if not absolutely prevent the spread of Lehmann lovegrass into new areas. Given the inevitability of drought in southwestern grasslands, the only major disturbances to be managed are fire and livestock grazing. There is no evidence that livestock exclusion or fire prevention by themselves will facilitate the return of native vegetation to areas where Lehmann lovegrass already dominates. However, these actions could well serve to protect established native grasslands from future invasion by the African exotic.

III. Given the importance of seed production to Lehmann lovegrass, a key method of control might be to reduce the size of its seedbank. Then, when the inevitable die-off of adults plants occurs (native or exotic), Lehmann lovegrass would be less prepared to take over by seedling establishment. Possible approaches would include repeated mowing or even grazing, timed just prior to the period when seed heads are produced. Given the fact that native grasses frequently are more dependent upon vegetative growth rather than seed reproduction, reducing or eliminating flowering likely would handicap Lehmann lovegrass more than many of its native competitors. We recommend field-based research to examine this possibility.

IV. Finally, there would be great value in determining just why Lehmann lovegrass apparently gives way to other native grasses in the absence of disturbance in its native range in Africa, but not in its invasive range in the Southwest. One approach would be to determine just what attributes these competitively superior African grasses possess over Lehmann's, so that we might look for those same traits in southwestern native species to be used in re-seeding efforts. Another research possibility involves the well-known enemy release hypothesis – namely, that there are species such seed predators or soil pathogens reducing a species' competitive ability in its native range that are missing from the introduced range. In fact, a specific soil fungus has been identified that negatively impacts Lehmann lovegrass in southern Africa. There are dangers associated with importing one exotic in the hopes of controlling another – namely, that it might prove more toxic to native grasses than to the desired target species. Nevertheless, we recommend careful laboratory-based research into the possible use of soil pathogens to handicap Lehmann lovegrass in the Southwest, just as appears to be the case in Africa.

Arizona's Non-Native Pest Plant Problems

FRANCIS E. NORTHAM,
Weed Biologist



Pests happen, and their infestations, infections, interference or invasions disrupt human affairs and ecological processes. According to Environmental Protection Agency (EPA) documents, a pest can be any insect, rodent, nematode, fungus, weed or other forms of terrestrial or aquatic plant or animal life that is injurious to health or the environment.

Note: EPA's definition does not limit pests to foreign biota. Thus, northeastern Arizona's Black Plague complex [which includes native prairie dogs, fleas, non-native Black Plague bacteria and human disease] is an example of a three organism mediated pest system. Pets (dogs / cats / rabbits / ferrets) can disperse infections by bringing plague-infected fleas from rodents into human living spaces.

Kudzu is an example of an invasive plant that can destroy electric transmission lines, full-grown Pine trees, pasture vegetation, croplands, fences and native vegetation on a vacant Arizona urban lot.

Bermuda grass is an aggressive colonizer of American crop production fields and third world subsistence farming plots, but some farmers grow this African grass for hay markets and harvest seed or sod for turf markets.

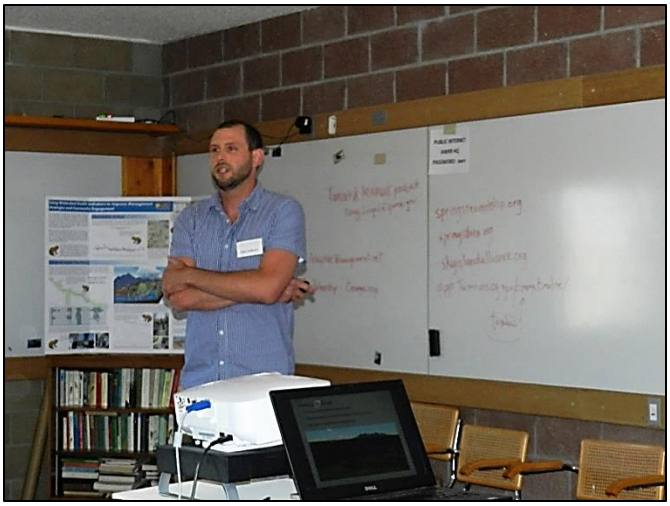
Giant Salvinia demonstrates that a seemingly innocuous, introduced ornamental, aquatic fern can interfere with delivering irrigation water from the lower Colorado River into the All American Canal, plus it blocks sunlight to submerged plant communities along 40+ Arizona/California river miles. Currently, this weed are being controlled by a biocontrol agent (beetle) to keep Salvinia mats at less than 10% of their peak coverage in 2002-2003.

Camelthorn is another widespread, shrub that is a direct threat to Sonoita Plains' grass-lands and conservation areas. Attributes of these invasive weeds will be reviewed to show how various aspects of plant biology exploit human activities which then cause economic misfortunes, ecological distresses or health debilities.

Other Arizona invasive plants which are potential hazards in Sonoita Plain landscapes: (1) Annual Grasses – Bromes and Wild Oats, (2) Bull and Canada Thistles, (3) Musk & Scotch Thistles, (4) Old World Bluestems, (5) Perennial Lovegrasses, (6) Quackgrass, (7) Trees (Russian Olive, Chinese and Siberian Elms), (8) Whitetop Mustard.

Several vegetation management practices decrease the likelihood of pest plant invasion including: (1) learn how to identify your land's natural plant community species and existing weeds so that (2) you recognize when new plants begin appearing in your area; (3) watch areas of your land where soil surfaces are periodically disturbed (roadsides!!!); (4) check recently burned areas for new weed species, especially (5) monitor where fire-fighting vehicles were operated and parked; (6) check weed species listed as contaminants on planting seed-lot tags before spreading that batch of seed on your land.

Effects of Non-Native Grasses on Density and Nest Success of Birds in the Desert Grasslands



ERIK M. ANDERSEN and Robert J. Steidl, *School of Natural Resources and the Environment, University of Arizona*

Desert grasslands are among the most threatened ecosystems in North America due in part to changes in vegetation structure and composition from invasions by nonnative grasses and encroachment by woody plants. These invasions have reduced the quantity and quality of habitat for many wildlife species, including birds that breed in grasslands, which have declined more rapidly than any other group during the last 30 years. Although evidence for declines in grassland species is strong, linkages between breeding birds and vegetation composition, structure, and floristics in grasslands are not well established. From 2013-2015, we surveyed populations of breeding birds and vegetation on 140 plots that spanned a gradient of nonnative-grass cover at three locations in southeast Arizona. We used distance-sampling methods to estimate density of breeding birds and estimated daily survival rates for 577 nests of 27 species. After identifying habitat features important to density and nest success, we evaluated the effects of percent composition of three nonnative grasses that have invaded desert grasslands: Lehmann lovegrass, Boer lovegrass, and yellow bluestem. Of the 15 most common species of birds, density of five varied in response to percent composition of at least one species of nonnative grass. Density of Botteri's sparrows increased and density of grasshopper sparrows and ash-throated flycatchers decreased as percent composition of Lehmann lovegrass increased. Density of mourning doves and blue grosbeaks increased as percent composition of Boer lovegrass increased, and density of Botteri's sparrow increased as percent composition of yellow bluestem increased. For the four bird species where we monitored >50 nests, nesting success of two species varied with percent composition of nonnative grasses. Nesting success of Botteri's sparrows decreased and grasshopper sparrows increased as percent composition of Lehmann lovegrass increased. For these two species, effects of increased percent composition of Lehmann lovegrass are directionally opposite for density and nest success, which suggests the possibility that nonnative grasses can decouple habitat selection cues from the resources that have been linked to those cues over evolutionary time.

Life and Death After Bullfrogs, Patterns of a Fungal Amphibian Disease and its Effects on Chiricahua Leopard Frog Conservation Within the LCNCA and Surrounding Areas

DAVID H. HALL and
Phillip C. Rosen,
University of Arizona

By 2013 large-scale efforts were successful in eradicating and controlling bullfrog populations within the upper Cienega creek watershed. This allowed for the successful re-establishment of a Chiricahua leopard frog metapopulation within the Las Cienegas Natural Conservation Area by 2014. By 2015 the amphibian fungal disease chytridiomycosis swept through the region with every known population becoming infected. Disease die-offs are now common in the region with 100% fall/winter frog mortality occurring in the majority of populations. These populations survive as "annuals" as disease mortality affects only frogs and not larval stages (tadpoles). As a result tadpoles metamorphose and frogs race to reproduction within a year before the disease strikes them down and their offspring survive the winter in the tadpole stage. Curiously three populations have not demonstrated disease die-offs and frog fall/winter survivorship is high in these three populations. We are investigating the reasons these populations withstand the infection without evident effects. In addition, we address how land managers and scientists use what they have discovered and apply them to management practices and further research to insure the Chiricahua leopard frog persists in the region in the face of the disease.

Posters

Using Watershed Health Indicators to Improve management Strategies and Community Engagement

AMANDA SMITH, *Pima Association of Governments*, asmith@pagregion.com

Co-Authors: Mead Mier, *Cienega Watershed Partnership, Pima Association of Governments*, mmier@pagregion.com; Melanie Alvarez, *Pima Association of Governments*, malvarez@pagregion.com

Riparian habitat and well owners, alike, rely on shallow groundwater resources. Pima Association of Governments' (PAG) Watershed Planning Program has been monitoring watershed health indicators for riparian areas of Tucson since 1989. Our research shows long term trends depicting the localized drought and groundwater pumping impacts on a shallow groundwater dependent system.

This poster will include a comprehensive look at PAG's watershed planning studies, in collaboration with data from regional partners, and regional recommendations for management strategies that are being considered by the local governments in the PAG Council.

PAG's long term and consistent Cienega data reveal both seasonal and long term trends. As a result, the data for lower Cienega Creek is useful for underrepresented lowland creeks in Arizona for State drought planning and may serve as a proxy for health status of the l watershed. These research reports and inventories are being applied to aid effective decision making, restoration practices, policy and regional outreach.

PAG is working in coordination with Cienega Watershed Partnership (CWP), and jurisdictions to assess important health indicators watershed-wide. We are working with Watershed Management Group and CWP to engage residents with community stewardship events. These partnerships build upon and document the rich cultural heritage of water, including oral history records, youth engagement and art experiences to share human connections with the watershed. This poster includes some our partner's work to show the status of the watershed as a whole.

Treating Tamarisk (Tamarix species)

Doug Siegel, *Pima County*
Presented by **MEAD MIER**, *Pima Association of Governments*

Treating Tamarisk trees has become an issue of increasing concern within Pima County properties to protect biodiversity. Personal observations, coupled with an abundance of literature on Tamarisk impacts, indicate that reductions in flora and fauna diversity are typical when Tamarisk invades riparian habitats. By participating in quarterly walk throughs within Cienega Creek Natural Preserve (CCNP), we have been able to observe treatment results over time and witness Tamarisk expansion.
A grant project to address these Tamarisk invasions within CCNP and other county managed properties at Pima County Natural Resources Parks and Recreation (NRPR) has created the pathway for trying a few modified techniques that have shown promising results. Cut stump treatment with drilling shows great promise, while a stem injection treatment provides a reduced cost alternative, though it hasn't proven itself as favorable as cut stump treatment thus far.

Benefits for cut stump treatment with combined drilling show there is an above average observational success rates, cut stump applications can be made any time of the year, likelihood of a spill is significantly minimized due to the small amount of herbicide used, opens up canopy to increase flora and fauna biodiversity and treatment requires minimal equipment.
Drawbacks include labor intensive if cut trees need to be removed from site, depending on the impact to rare and endangered species, tree removal will require the appropriate permits and potential translocation of chemical to a non-target species due to intertwining roots.

Benefits for stem injection treatment are that treatment requires minimal equipment, Dead, standing trees are left behind for bird habitat, treatment causes less disturbance on the environment than most, over time, the canopy opens to increase flora and fauna biodiversity, reduced labor and equipment costs. The Drawbacks are that treatment should take place only in late summer to fall when carbohydrates are translocating to the below ground tissues and temperature fluctuations can influence success rates.

Ultimately, our goal is to protect biodiversity on NRPR managed lands. Both of these treatment options have merit depending upon location and restrictions that may be in place, but for overall success, I would encourage cut stump treatments for immediate impacts that open up the canopy. If cut stump treatments aren't available, stem injection has good potential if treatment timing and procedures are closely adhered to.

Breeding Habitat Selection of the Western Distinct Population of the Yellow-billed Cuckoo (*Coccyzus Americanus*) within Audubon Arizona Important Bird Areas

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Understanding breeding habitat preferences of the western distinct population of the yellow-billed cuckoo (*Coccyzus americanus*), a species listed by the United States Fish and Wildlife Service (USFWS) as Threatened, is key to its conservation. Natural history accounts of the bird note that, in its breeding range, it nests in cottonwood/willow riparian gallery forests and relies on adjacent mesquite bosque for foraging.

In the summer of 2015, Audubon Arizona staff and permittees surveyed five Audubon Important Bird Areas (IBAs) to determine cuckoo presence/absence and to assess breeding status. Using the protocol published by the USFWS, surveyors detected cuckoos 154 times, in four of the five IBAs. Of these sites, three supported birds that were likely breeding. One site contained habitat consistent with cuckoo natural history accounts – extensive cottonwood/willow riparian gallery forest with adjacent mesquite upland scrub and Madrean pinyon-juniper woodland. The second site was less consistent with cuckoo habitat descriptions with most detections occurring in extensive mesquite bosque along dry, ephemeral portions of the San Pedro River. The third site was the least consistent with previous cuckoo breeding habitat descriptions. Detections at this site were made in ephemeral drainages dominated by encinal oak woodlands and adjacent semi-desert grasslands. This use of what was thought to be atypical cuckoo habitat was also observed by Tucson Audubon biologists during their 2015 surveys of several oak-dominated drainages within southeastern Arizona sky island IBAs. Studies looking to determine presence/absence of cuckoos and eventual designation of critical habitat should consider these and potentially other habitat types.

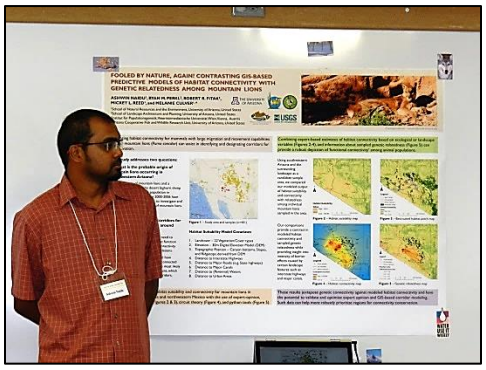
Avian Survey at the Research Ranch

TONY LEONARDINI, Ph.D., Volunteer,
Appleton-Whittell Research Ranch of the National Audubon Society

Despite being an Audubon facility since 1980, the Appleton-Whittell Research Ranch had huge data gaps regarding birds that relied on the 8000-acre sanctuary and ecological research station. Many scientists conduct research projects on individual species or assemblages and staff track sightings on an ad hoc basis, but until the Research Ranch was nominated as an Important Bird Area in 2004 there had been no effort to establish long-term avian surveys. The 2006 Christmas Bird Count was the first time a CBC had included the Research Ranch. Although each research project and annual IBA and CBC efforts added to the knowledge base, huge spatial and temporal gaps hindered understanding of how birds used semi-arid grasslands and associated ecosystems. These knowledge gaps were especially glaring as the Research Ranch can serve as a reference area by which land uses, such as grazing by domestic livestock, exurbanization, military use, and conversion to vineyards, can be compared and evaluated.

To rectify these deficiencies, in 2013 the Research Ranch was divided into 13 areas which are surveyed on a weekly basis, using a combination of transect routes with timed stops, stationary timed stops and "just plain wandering around looking for birds." Approximately 800 hrs. and 1150 miles (car and foot) have been spent in the field per year. In 2014, locations of 158 species were documented; 157 were documented in 2015. Several species have been added to the Research Ranch checklist which now stands at 261. Data are housed locally in spreadsheet format and periodically entered into E-bird.

Linking GIS-Based Models of Habitat Connectivity with Genetic Relatedness among Mountain Lions



A. NAIDU, R. M. Perkl, C. Wissler, R. R. Fitak, M. L. Reed, and M. Culver1

Estimating habitat connectivity for mammals with large migration and movement capabilities such as mountain lions (Puma concolor) can assist in identifying and designating connectivity areas for conservation. Several studies have indicated the need to protect critical habitat linkages that function toward maintenance of genetic connectivity among potentially subdivided populations. Combining expert-based estimates of habitat connectivity based on ecological or landscape variables with information about sampled genetic relatedness can assist in the identification of high priority areas for connectivity conservation. In this study, we modeled habitat suitability and connectivity for mountain lions in the southwestern United States and northwestern Mexico with the use of expert opinion, GIS, and circuit theory. In so doing, we tested the model's output of landscape resistance against estimates of genetic relatedness and genetic distance among individual mountain lions throughout the study area. We then mapped estimates of pairwise relatedness among individual mountain lions sampled in the area to display functional connectivity. We juxtapose this result with models of habitat suitability and landscape connectivity. Our analyses reveal that sampled genetic relatedness supports modeled habitat connectivity and provide insights into potential habitat connectivity that can enhance gene flow. Our findings identified that landscape resistance is negatively correlated with genetic relatedness, and positively correlated with genetic distance among individual mountain lions. This leads us to infer support for our model of habitat suitability among mountain lions in this region. We also surmise that landscape resistance can be used to predict genetic relatedness and genetic distance in support of previous studies that used GIS-based modeling approaches. These results also have the potential to optimize expert opinion and GIS-based corridor modeling for strengthening prioritization of regions for connectivity conservation.

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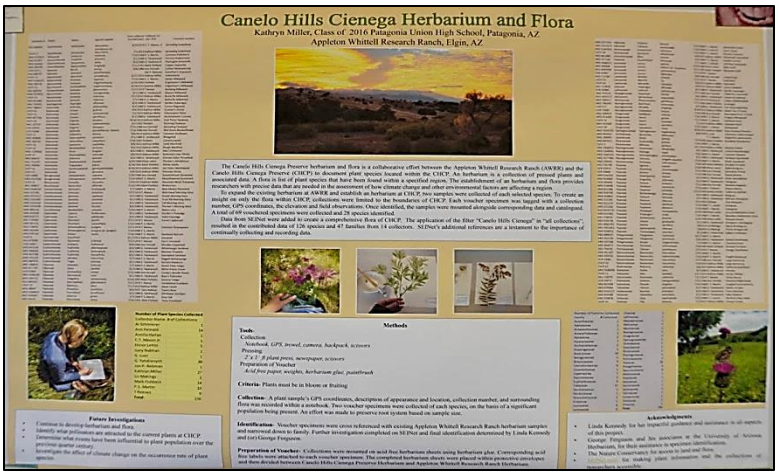
Canelo Hills Cienega Preserve Herbarium and Flora



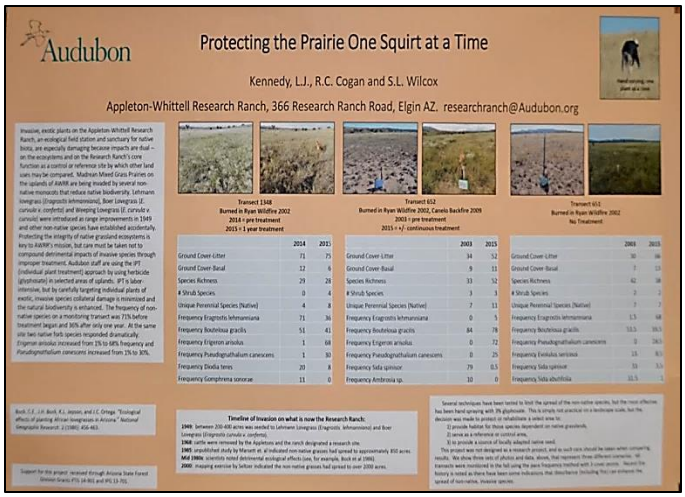
KATHERYN MILLER,
Patagonia Union High School, Patagonia AZ and Appleton-Whittell Research Ranch, Elgin AZ

The Canelo Hills Cienega Preserve herbarium and flora is a collaborative effort between the Appleton Whittell Research Ranch (AWRR) and the Canelo Hills Cienega Preserve (CHCP) to document plant species located within the CHCP. An herbarium is a collection of pressed plants and associated data. A flora is a list of plant species that have been found within a specified region. The establishment of an herbarium and flora provides researchers with precise data that are needed in the assessment of how climate change and other environmental factors are affecting a region.

To expand the existing herbarium at AWRR and establish a herbarium at CHCP, two samples were collected of each selected species. To create an insight on only the flora within CHCP, collections were limited to the boundaries of CHCP. Each voucher specimen was tagged with a collection number, GPS coordinates, the elevation and field observations. Once identified, the samples were mounted alongside corresponding data and catalogued. A total of 69 vouchered specimens were collected and 28 species identified.

Data from SEINet were added to create a comprehensive flora of CHCP. The application of the filter "Canelo Hills Cienega" in "all collections", resulted in the contributed data of 126 species and 47 families from 14 collectors. SEINet's additional references are a testament to the importance of continually collecting and recording data.

Protecting the prairies one squirt at a time



KENNEDY, L.J., R.C. Cogan, S.L. Wilcox. *Appleton-Whittell Research Ranch of the National Audubon Society*. Elgin, AZ

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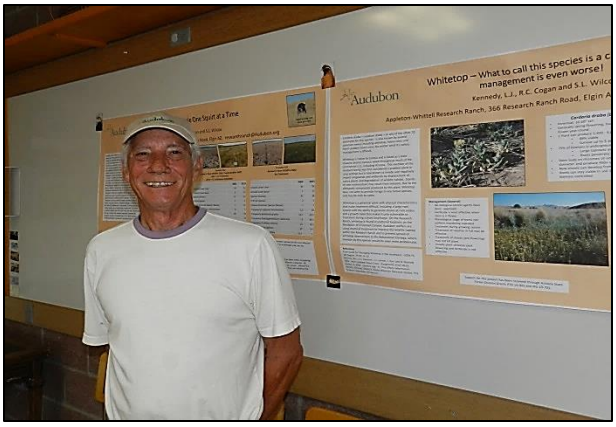
Invasive, exotic plants on the Appleton-Whittell Research Ranch, an ecological field station and sanctuary for native biota, are especially damaging because impacts are dual – on the ecosystems and on the Research Ranch's core function as a control or reference site by which other land uses may be compared. Madrean Mixed Grass Prairies on the uplands of AWRR are being invaded by several non-native monocots that reduce native biodiversity. Lehmann lovegrass (*Eragrostis lehmanniana*), Boer Lovegrass (*E. curvula v. conferta*) and Weeping Lovegrass (*E. curvula v. curvula*) were introduced as range improvements in 1949 and other non-native species have established accidentally.

Protecting the integrity of native grassland ecosystems is key to AWRR's mission, but care must be taken not to compound detrimental impacts of invasive species through improper treatment. With support from grants through Arizona State Forest Division (PTG 14-901 and IPG 13-701), Audubon staff are using the IPT (individual plant treatment) approach by using herbicide (glyphosate) in selected areas of uplands. IPT is labor-intensive, but by carefully targeting individual plants of exotic, invasive species collateral damage is minimized and the natural biodiversity is enhanced. The frequency of non-native species on a monitoring transect was 71% before treatment began and 36% after only one year. At the same site two native forb species responded dramatically to the treatment: *Erigeron arisolus* increased from 1% to 68% frequency and *Pseudognathalium canescens* increased from 1% to 30%.

Whitetop – What to Call this Species is a Challenge and Management of this Species is Even Worse!



Kennedy, L.J., **R.C. COGAN**, S.L. Wilcox. Appleton-Whittell Research Ranch of the National Audubon Society. Elgin, AZ

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Cardaria draba – Lepidium draba – or any of the other 20 synonyms for this species - is also known by several common names including whitetop, hoary cress and heart-podded hoary cress. No matter what it's called, management is difficult.

Whitetop is native to Eurasia and is listed as a state invasive and/or noxious weed throughout much of the continental U.S., including Arizona. This member of the mustard family was first considered a problem plant in crop settings but is now known to invade and negatively impact rangelands and wildlands by displacement of native plants and degradation of wildlife habitat. Stands of near monoculture may result from invasion, due to the allelopatic compounds produced by this plant. Whitetop does not seem to provide forage to any native species, and may be toxic to cattle.

Whitetop is a perennial plant with physical characteristics that make treatment difficult, including a large root system with the ability to generate clones at root nodes and a growth habit that makes it only vulnerable to treatment during a short timeframe. On the Research Ranch, whitetop is found in scattered locations on the floodplain of O'Donnell Canyon. With support from grants through Arizona State Forest Division (PTG 14-901 and IPG 13-701), Audubon staffers are using chemical treatment to improve the wildlife habitat within the Research Ranch and to prevent spread of whitetop downstream to the Babocomari Cienega, where invasion by this species would be even more problematic.