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PROCEEDINGS OF THE EIGHTH

Natural History of the Gila Symposium

February 27-29, 2020

Western New Mexico University

Silver City, New Mexico

EDITED BY

8th Natural History of the Gila Symposium Planning Committee

We dedicate these proceedings to Dr. Roland Shook (1945-2020, Professor Emeritus of Biology, Department of Natural Sciences, Western New Mexico University), a long-time member of the planning committee who spent hundreds of hours conducting ornithological research along the Gila River and loved everything about "the Gila."

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INTRODUCTION

The mission of the Natural History of the Gila Symposium (NHGS) series, little changed from that crafted by the organizers of the first offering of this event way back in 2006, "..is to provide a venue for researchers, land managers, conservationists, and educators to meet and share information and ideas gathered from the Gila Region including watersheds and neighboring areas extending into southwestern New Mexico, southeastern Arizona and Mexico."

The presentations at the 8th NHGS (February 2020), summarized in these proceedings, covered all these bases. Attendees at this event were treated to riveting keynote presentations on bear conservation (Karl Malcolm) and fish genetics (Tom Turner). Concurrent session presentations covered diverse topics ranging from agriculture, aquatic habitat monitoring, archaeology, astronomy, botany, climate change, forest management, hydrology, livestock grazing, military flyover impacts, outdoor recreation economy, paleontology, habitat restoration, wildlife biology, wildlife management, etc. A unique Creative Voice concurrent session featured readings of non-fiction perspectives centered on the "Gila Region" by regional writers, and a memorable Gila-inspired rap performance! Organizers of the 8th NHGS were pleased to bestow awards to four individuals who in their careers have made major contributions towards conservation, management and teaching others about the "Gila Region": Art Telles (Lifetime Achievement Award), Nick Smith (Conservation Award), Joe Saenz, (Conservation Award), and Ron Parry (Citizen Scientist Award).

The 8th NHGS was the result of two years of planning by dedicated members of the Planning Committee (Wen-chi Chen, Joneen ("Jony") Cockman, Gregor Hamilton, Beth Leuck, Dustin Myers, Nessa Rasmussen, Ted Presler, Roland Shook, Heather Steinmann, Kathy Whiteman) who brought unique skills to the planning process and mutual dedication to the ultimate success of this event. It was a privilege for me to work with each of these fine individuals and fellow committee members.

Let these Proceedings of the 8th Natural History of the Gila serve as a record of this memorable two-day event, and may they inform and inspire future offerings of the NHGS series.

William ("Bill") Norris, 8th Natural History of the Gila Symposium Planning Committee

LIFETIME ACHIEVEMENT AWARD: Art Telles, Jr.

The highest award given by the NHGS Planning Committee, the Lifetime Achievement Award, is intended to recognize exceptional and sustained activity demonstrated in Research, Education, Natural Resource Management and/or Policy centered in the Gila Region of southwest New Mexico and/or southeast Arizona.

Art Telles is a native of the Southwest, born and raised in El Paso, TX. He graduated from New Mexico State University as a double major, earning a B.S. in both Wildlife and Fisheries. While in school, he worked seasonally for the Lincoln National Forest, thinning trees and working on a spruce budworm spray crew. Art's official career in public service began when he landed a coveted fisheries internship (COOP) with the Siuslaw National Forest in Oregon.

He then traveled back to the Southwest, finishing out his internship on the Apache-Sitgreaves National Forests in Arizona, where he was converted to a full-time employee. His five years on the Apache-Sitgreaves involved working on developing partnerships, inventorying streams, and working on the first watershed restoration project for Apache trout on the West Fork Black River and several of its tributaries. Heading east to Texas, Art spent two years on the National Forests of Texas as a District Biologist (his first wildlife job), swimming with cottonmouths and re-establishing colonies of the elusive red-cockaded woodpecker.

Soon Art was back west in the Pecos Ranger District of the Santa Fe National Forest, where he spent three years as the District Biologist, helping to develop guidance criteria for grazing consultations across the Region, and working to re-establish Rio Grande cutthroat into historical habitat. Art then traveled south to the greatest gem of them all, the Gila National Forest. He served as the District Biologist on the Black Range District, spending much of his time helping to develop and implement the District's prescribed fire program. He moved on to the Gila's Forest Fish Biologist position, jumping all in to support the Gila trout and Chiricahua leopard frog recovery programs, including assisting in multiple stream renovations and working to establish leopard frog refugia habitats. Art devoted great energy and effort to protecting riparian habitats by securing funding for fencing and implementing exclusions. He played an important role in getting a fire ecologist hired on the Gila and in integrating the natural resource and fire programs on the Gila.

Art played a key role in the Southwest Region, serving with a team of fish biologists preparing consultations for Wildland Urban Interface projects, which subsequently helped to protect communities like Alpine, AZ during large wildfires. Art graduated to the Forest Biologist, and ultimately ended his 33-year career as the Forest Natural Resources and Planning Staff Officer. Throughout his tenure, he supported and championed large-scale projects, including the Luna Restoration Project, the Escudilla Landscape Watershed Restoration Action Plan, Travel Management Planning, and Forest Plan Revision. With his booming voice and presence, Art has always been an advocate for the resource, and for young natural resource specialists.

CITIZEN SCIENTIST AWARD: Ron Parry

The Citizen Science Award recognizes an individual or organization that shows a dedication to science in support of natural resource conservation by collecting and making available data that provide better understanding of the resource. The recipient is recognized for volunteer efforts.

Ron Parry was born and raised in Southern California. Exposure to the beauty and biodiversity of the California landscape in his youth converted him into a naturalist at a young age. Though he was fascinated by botany, the gift of a chemistry set from his parents one Christmas morning proved to be a turning point in his life, eventually leading him to a B.S in Chemistry from Occidental College and a Ph.D. in Organic Chemistry from Brandeis University. After

graduating from Brandeis, he carried out two years of postdoctoral research in plant biochemistry in the U. K., followed by a year of postdoctoral work at Stanford University.

Ron returned to Brandeis as an Assistant Professor of Chemistry in 1971 and moved to Rice University in 1978. Until his retirement in 2012, his research focused on the biochemistry and genetics associated with the formation of natural products: the complex toxins, antibiotics, and defense compounds produced by plants, microorganisms, and fungi. After retirement, Ron returned to his interests in natural history and began to study moths.

Moth Project

Moths and butterflies (Lepidoptera) are among the largest orders of insects. They are the biggest group of plant-feeding insects, and their activities have major ecological impacts. The order also includes many pest species. Southwestern New Mexico is an area rich in biodiversity, and is also a region that will be heavily impacted by the effects of climate change. The Lepidopteran fauna of Southwestern New Mexico has not been studied intensively, so there is much to be learned about this fauna before it is drastically altered by increased aridity and warmer temperatures.

Furthermore, less is generally known about moth biology than about the biology of butterflies. For these reasons, a detailed inventory of moth diversity in the Gila region has been undertaken. This project has two goals. The first is to expand the scientific knowledge base with respect to the moths of the Gila region through the collection, identification, and curation of local moth species. The second goal is to raise public awareness about the beauty and complexity of this group of insects in the face of their expected decline. This goal is furthered by the creation of a website entitled “Southwestern Moths” (https://southwesternmoths.com/) that displays voucher photographs of all the moth species identified by the project. Each photograph provides the name of the species, the date and place of collection, the wingspan of the specimen, the sex if it can be determined, and information about larval food plants, when known.

CONSERVATION AWARD: Joe Saenz

This award is given for outstanding efforts in species preservation, land management, or natural resource conservation within or across the greater Gila Region. The Conservation Award acknowledges an individual or group who demonstrates overwhelming positive conservation principles. The nominee must have shown long-term benefits for the natural environment in the Gila Region of southwest New Mexico and/or southeast Arizona.

Joe Saenz is a long-time resident of Grant County, New Mexico. He is a Native American from the Warm Springs Apache (Chiricahua/Huichol) and band of Red Paint people. Joe strives to practice his Native culture and ethics through his lifestyle, career, business relations, and outreach to the Apache people. He is an educator through and through with the goal of preserving the Apache culture while there are still Elders who can tell the stories.

The owner and operator of WolfHorse Outfitters, Joe is licensed to practice outfitting and guiding on the Gila National Forest. Through this venue he shares outdoor and wilderness ethics, horsemanship, and a low impact lifestyle with his clients at a personal level. He is also much sought after as a technical consultant of the Apache culture by the film and TV industry, as well as written media.

Joe is the co-founder of the Red Paint Pow Wow, now in its tenth season. This venue is instrumental in bringing Apache people together to share their dances and customs, to preserve the Apache culture, and to educate the public.

Joe is also Nantan (Chief) of the Chiricahua Apache Nation. As a member of Tribal Council, he has worked diligently for the last decade to bring recognition to this branch of the Apache people. His aims are to preserve a cultural history and lifestyle, to return the “lost” children to their land, and to build a nation.

CONSERVATION AWARD: Nick Smith

Nick Smith is a native New Mexican, born and raised in and around the greater Gila Region. From the beginning, he has been surrounded by the natural history of the Gila, as he was raised in the household of a career Game and Fish officer, dog man, and big cat expert. Nick became the same kind of man, but is also a competent outdoorsman and conservationist in his own right.

Nick began his career with the New Mexico Department of Game and Fish in 1980 as a seasonal technician. He became a permanent employee in 1983, working on desert bighorn reintroduction and depredation in southeast New Mexico. Moving back to western New Mexico, he lived and worked out of the NMDG&F Heart Bar property near the Gila Cliff Dwellings, working on depredation efforts and as a conservation officer assigned to the Gila Wilderness. He began working with Gila trout recovery efforts in 1985 and became an invaluable asset. Subsequently he moved to Quemado to work as a conservation officer and habitat specialist. For the last nine years of his career, Nick worked as a Mexican wolf recovery field biologist. In 2008, he retired from NMDG&F but continued working as a contractor with Mexican wolf and Gila trout recovery programs. Nick has also spent considerable time in Mexico, where he put his expertise to work on northern jaguar conservation. At present, he is working in southern coastal mountains of Mexico trapping jaguars and mountain lions for radio telemetry studies.

KEYNOTE PRESENTATIONS

Keynote Speaker Karl Malcolm

Five Lessons from the Naturalists, the Technophiles, and the Transcendent Translators

What it takes to be an effective conservationist has always been fluid through time. Put mildly, today's social and ecological issues are intertwined, urgent, and complex, making the work as difficult as ever. The large and widening gap between human experience and the deteriorating condition of natural systems that sustain our prosperity is the fundamental disconnect from which many of our current conservation failures stem. By seeking wisdom in the successes of our predecessors and peers we might be better equipped to scour the challenges of our time in search of impactful opportunities for action.

Karl Malcolm is a native of rural northern Michigan. Throughout high school and college, he funded his outdoor adventures working as the first mate on a salmon boat in the Great Lakes, a fly fishing, canoeing, and hunting outfitter and guide, and through a consultancy he founded to support the development and implementation of wildlife management, research, and educational programs. Karl's interest in nature, conservation, wildlife, and protected area management led him to study the role of nature reserves in harboring the unique biodiversity of southwestern China for his Ph.D. in Wildlife Ecology, which he completed in 2011 through a joint appointment with the University of Wisconsin – Madison and the Smithsonian Conservation Biology Institute. These experiences sparked an even deeper appreciation for America's unique wealth of public lands, particularly the National Wilderness Preservation System. Karl came to New Mexico in 2012 for his first job with the Forest Service. He has since served in roles at the district, forest, regional, and national levels, including assignments as the Southwestern regional wilderness and Wild and Scenic Rivers program manager, and regional wildlife ecologist. The allure and history of Gila Country in shaping a global legacy of wildlands management was a major draw for Karl to relocate to the American Southwest, and he takes every opportunity to play and explore where cell phones can take pictures but cannot receive calls.

Keynote Speaker Tom Turner

How and when do stream communities recover after wildfire?

Thomas F. Turner – Professor and Curator, Department of Biology and Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131

Over the last few decades, large and severe wildfires have burned millions of hectares of forested land including riparian zones. Recent wildfires in Australia brought the plight of terrestrial animals to a global audience, but comparatively little is known about how fires affect stream fishes and invertebrates. The Upper Gila River Basin is a hotspot for aquatic biodiversity in southwestern North America and has suffered four mega-wildfires since 2011. Massive fish kills were documented. This talk explores the causes of fish and aquatic invertebrate mortality and shows how and when recovery occurs, based on a collaborative research project that began in

2008. Native and non-native fish recovered at different rates, and differences in key traits partly explained differences in recovery rates. Refuges that harbored fish were patchy on the riverscape following wildfire, flooding, and ash and debris flows. Sites that were closest to the fire perimeter had longer recovery times. Overall, our results underscored the importance of a connected, free-flowing Gila River as essential to allow dispersal from refuges and foster recovery of stream communities. Damming will restrict fish movement and hamper or prevent recovery after future major wildfires.

Thomas (Tom) Turner is a Professor of Biology, Curator of Fishes in the Museum of Southwestern Biology, and Associate Dean for Research in the College of Arts and Sciences at the University of New Mexico (UNM). He began his career as a professional biologist after completing a Master of Science degree at Ohio University where he studied comparative genomics of fishes. He completed a doctorate in Biological Sciences in 1996 at Florida International University in Miami Florida where he fell in love with freshwater and marine environments and became seriously involved in conservation science and policy. After leaving Florida, he held a post-doctoral position in Wildlife and Fisheries Sciences at Texas A&M University for a little over one year, where he developed laboratory and numerical approaches to examine genetic and demographic effects of overfishing in the Gulf of Mexico.

Turner began at UNM in 1998 as an assistant professor and curator, and since then his research group has investigated questions about ecological and evolutionary processes in rivers, springs, and streams in arid regions of the American Southwest. A major research focus is the development of genetic and stable isotope methodology to uncover changes in biodiversity that accompany radical transformations of land, water, and climate. To do this, he uses resources held in natural history museums, especially the Museum of Southwestern Biology to establish baseline conditions and develop predictions about the future. Turner actively trains undergraduate, graduate, and post-doctoral scholars, and serves on science advisory boards for the Gila River, Rio Grande, and Columbia Basin Fish & Wildlife Programs. Turner's basic research and curatorial programs are supported by the National Science Foundation. His applied research program is supported by the US Department of the Interior, the State of New Mexico, and non-governmental organizations like Trout Unlimited and The Nature Conservancy. He regularly teaches Vertebrate Zoology, Ichthyology, Conservation Genetics, and Ecology and Evolution of Fishes courses, and participates in core Ecology and Evolution courses in the Department of Biology at UNM.

SESSION ABSTRACTS

*Names denoted with * indicate student presenters.*

Overview of Late 18th Century - 19th Century Apache Sites Located Along the Mimbres Valley, Gila National Forest

Adams, Christopher D., Gila National Forest Black Range and Wilderness Ranger Districts, chris.adams@usda.gov

This is an overview of Apache sites dating from the 1780s-1880s, located along Sapillo Creek and the Mimbres River of the Gila National Forest. This paper will highlight recent research on several Apache pictograph sites, a small Apache rancheria site, a unique Apache cache site, and a small Apache/Military skirmish site that has been unrecognized or poorly misunderstood on the Gila National Forest. Recent collaboration with Apache Tribes has resulted in new insights to the understanding of Apache use and site placement in and along the landscape of the Mimbres Valley. This paper is part of an ongoing Apache research project that the author has been conducting for the last 13 years on the Gila National Forest.

Native Gila Fish Tanks

Aldo Leopold Charter School Junior Class,* Aldo Leopold Charter School, Silver City, NM, madeline.alfero@aldostudents.org

The junior class of Aldo Leopold worked throughout the school year on maintaining native Gila fish in an artificial environment. These fish, the Sonora Sucker, Desert Sucker, Longfin Dace, and Speckled Dace, have not been successfully supported outside of the Gila River. For the presentation, the class will present their findings on their success in replicating their environment of the Gila in a tank and the progress that their actions will help to enable further research on the matter.

Archaeological Investigation at the Diamond Creek Locality in Gila National Forest

Arakawa, Fumi, PhD, New Mexico State University, farakawa@nmsu.edu
This presentation presents new archaeological field research at the Diamond Creek Locality in the northern Mimbres region. The locality lies in the Gila National Forest and Aldo Leopold Wilderness area in southwestern New Mexico, an area that has extensive pithouses and Classic Mimbres components. Our field studies focus on two sites—Twin Pines Village and South Diamond Creek Pueblo (SDCP)—as representing pithouse and Mimbres habitation sites in the region. From 2015 to 2019, we have carried out excavations and remapped these sites. In this presentation, I discuss new discoveries and how it relates to our research question: How did populations, who inhabited the Gila River headwaters and were surrounded by a forested environment, interact with people who lived in the semi-desert of Mimbres Valley and beyond?

Military Flight Training Over The Gila Region

Beck, Susan, Colonel, Retired, US Air Force, smbeck56@gmail.com

This presentation will increase your understanding of military flight training currently taking place in southwest New Mexico and especially the Gila region. There are several military operating areas and training routes in which these aircraft are allowed to train right now, including over the Gila National Forest and Gila Wilderness. Additionally, the presentation will include a brief update on the new Air Force proposal for adding F-16 fighter training into the Gila region from Holloman Air Force Base as a result of a recently-released National Environmental Policy Act (NEPA) Environmental Impact Statement. After this presentation, attendees will understand why military aircraft are flying over the Gila region and the potential impacts.

Efficacy of Mechanical Removal of Green Sunfish from Bonita Creek, a Closed System

Blasius, Heidi [1] and Jeff Conn [2]
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[2]Former BLM and current Chief of Resources NPS Saguaro

Bonita Creek is in southeastern Arizona and is unique in that it supports an intact native fish assemblage and exceptional riparian and aquatic values. Past native fish recovery actions, including construction of a fish barrier that prevents upstream incursions of nonnative fishes from downstream sources, have benefited the creek. However, the native fishery is still threatened by the presence of nonnative predatory and competitive fish species. To reduce the threat of nonnative fishes, the BLM Safford Field Office collaborated with federal, state, and other partners to begin mechanical removal of Green Sunfish (*Lepomis cyanellus*) in 2009. Green Sunfish were targeted due to their highly piscivorous nature. Nonnative fishes were removed from a 1.9-mile reach dominated by beaver dam pools and glides. Beaver dams effectively reduced the movement of green sunfish within the removal area. Baited Gee metal minnow traps, collapsible Promar traps, and hoop nets were the primary removal methods used. Occasionally seines, dip nets, and backpack electrofishers were used to augment and assess efforts.

Total effort using Gee metal minnow traps, collapsible Promar traps, hoop nets, and custom and crab traps was 46,677 overnight net sets from 2009-2017, which resulted in the removal of 22,709 Green Sunfish from Bonita Creek. In 2018, 1,146 overnight net sets at Bonita Creek resulted in zero Green Sunfish captured. No Green Sunfish have been seen or captured from Bonita Creek since October 2017. Results to date suggest Green Sunfish have been eliminated from Bonita Creek above the barrier.

Cause-specific Mortality and Survival of Elk in the Mexican Wolf Recovery Area in New Mexico and Arizona

Boyle, Scott Thomas*[1], James W. Cain III[2], Nicole M. Tatman[3], Steward G. Liley[3], James C. deVos[4], Josh Avey[4]
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[2]USGS New Mexico
[3]New Mexico Dept. Game and Fish
[4]Arizona Game and Fish Dept.

Since the reintroduction of Mexican wolves in 1998, there has been limited investigation into the potential influence of Mexican wolf recovery on vital rates of elk populations. Scat analysis studies have revealed that elk comprised greater than 70% of the Mexican wolf diet, but the population-level impact of wolf recovery on elk is unknown. Further, the Mexican wolf population has more than doubled from an estimated 42 individuals in 2009 to a minimum of 131 individuals in 2019. Given the recent increase in Mexican wolf population and the expectation of future growth in both size and distribution under the current recovery plan, it is important to understand if Mexican wolf predation is an additive, compensatory, or partially compensatory source of mortality for elk. Starting in February of 2019, 427 iridium GPS collars were placed on adult, female elk to monitor survival across western New Mexico and eastern Arizona in the Gila, Cibola, and Apache-Sitgreaves National Forests. In addition, we captured 229 elk neonates and fitted them with VHF ear tags during the 2019 calving season. Data collected from these collared individuals will be used to estimate survival rates and determine cause-specific mortality. Preliminary results will be presented.

Aquatic Habitat Assessment and Monitoring in Willow Creek with Citizen Science Support

Brooks, James E.[1], Jeff Arterburn[2], Chris Canavan[3] and Tyler Wallin[4]
[1]JEB Outfitters LLC
[2]Trout Unlimited Gila and Rio Grande
[3]New Mexico Environment Department Surface Water Quality Bureau
[4]New Mexico State University

Beginning April 2017, we initiated twice-annual (late spring, autumn) assessment and monitoring of aquatic habitats within the wetted perimeter of Willow Creek, a stream occupied by four native fish species, including Gila trout *Oncorhynchus gilae*. The Willow Creek watershed was severely impacted by the 2012 Whitewater-Baldy Wildfire. To assess and monitor post-wildfire impacts to aquatic habitats and to engage citizen scientists, “within wetted perimeter” sampling protocols were developed and implemented. Technical oversight, training, and simplified protocols ensured collection of dependable data designed to support development of stream restoration strategies. Initial 2017 assessment data demonstrated a compromised stream channel with incised and unstable banks, considerable sediment movement, and minimal pool development. Previously positioned stream habitat enhancement structures (primarily log cross vanes) were rendered ineffective by scouring. Monitoring data, August 2017 through November 2019, indicated that stream instability continued with reduction in depth, size, and frequency

of pool habitats, and straightening of the stream channel. Stream habitat improvement efforts should emphasize formation of channel meanders, reconnection to abandoned meanders, and increase in the depth and frequency of occurrence of pool habitats. Planned future work includes continued monitoring, incorporation of "bankfull" metrics, and provision of volunteer support to restoration activities.

Sharing Paleontology of the Gila at New Mexico Museum of Natural History and Science

Cantrell, Hannah*, Student at University New Mexico and Natural Heritage, hannahncantrell@gmail.com

New Mexico Museum of Natural History and Science is dedicated to preserving and interpreting the Paleontological record of New Mexico. For the first time, data about fossils collected in the Gila will be made widely available for the public to access in an online database called Arctos. Details and information uploaded into Arctos will include geologic information, taxonomy, related publications, and eventually images of specimens. Paleontological collecting occurred in the Gila for about 20 years (1995-2015) by New Mexico Museum of Natural History and Science staff. Specimens were then taken back to the museum and prepared for study, publication, public display, or storage within the collection. Vertebrate fossils from the Gila region range in age from late Miocene (about 6 million years old- Ma) to late Pleistocene (about 20 thousand years old). Some examples of fossil faunas from the Gila region include: Pleistocene one-toed horses, camels, and mammoths, and a late Miocene and early Pliocene (5-6 Ma) rhinoceros, several species of three-toed horses, and the earliest North American deer. By sharing Gila Conglomerate (=Group) data, the museum hopes to enhance public understanding of Gila natural history research and spark future exploration into Gila paleontology.

Raramuri Criollo Cattle and Climate Change in the Desert Southwest

Cibils, Andrés, PhD, New Mexico State University, acibils@nmsu.edu

The livelihood of rural populations along the US-Mexico border in the desert Southwest is tightly linked to cattle ranching. Changing climate is posing new challenges to ranchers across the region. At the Chihuahuan Desert Rangeland Research Center, we have found that in southern New Mexico, summers are becoming hotter, annual rainfall is increasingly variable, and the onset of summer rains is occurring later in the year. Over the past 50 years, desert grass production at our research site has declined by 38%. New strategies are needed to meet these unprecedented challenges. A growing number of ranchers on both sides of the border are beginning to raise desert-friendly cattle breeds that are able to cope with more variable forage conditions and hotter temperatures. One such breed is the Raramuri Criollo from the Copper Canyon in Chihuahua, Mexico. This cattle biotype – which descends from cattle introduced by Spanish settlers approximately 500 years ago – has been maintained with minimal crossbreeding by the Tarahumara people in the Sierras of the same name. It is believed that these cattle are better able to cope with a hotter and more variable environment while inflicting a lower environmental footprint on desert rangelands. A recent grant funded by the USDA National Institute of Food and Agriculture will allow us to build on past research to study the impact of Criollo cattle on desert vegetation and soils.

Hydrologic Restoration of Degraded Grassland in Arid and Semiarid Regions

Clothier, Van, Owner, Stream Dynamics, Silver City, NM, van@streamdynamics.us

We live in the Anthropocene. The entire surface of the earth has been impacted by human activity and land management decisions. In this context, most of the grasslands in arid and semi-arid regions have degradation processes. This work describes the changes caused by the anthropization of the landscape in grasslands of northern Mexico and the Southwest United States and how their hydrology behaves when faced with different rainfall intensities typical of these regions. It explains some main causes of the deterioration of grasslands in semi-arid zones, identifies systemic strategies to address these causes, and presents several concrete landscape intervention techniques that can help the restoration of these ecosystems. These include the restoration of historical flow paths, road drainage with rolling dips, post vanes to restore eroded stream banks and one rock dams for the restoration of small tributaries with erosive processes. The effects of these landscape interventions are documented photographically. The interventions and management guidelines presented in this paper can improve grassland hydrology and conserve soil.

The Gila Box Riparian National Conservation Area - A River in Transition

Cockman, Joneen, PhD, Lead Natural Resource Specialist, AZ BLM, jcockman@blm.gov

Intensive inventory and assessment data have been conducted for the 23 river miles within the Gila Box Riparian National Conservation Area from 2013 through 2019. Livestock were removed from the riparian ecosystem with the publication of the Management Plan in 1998. Plot data, Rapid Assessment Monitoring (RAM), water quality data and Rosgen classification have been employed in the monitoring protocol. After twenty years of rest from livestock, the river exhibits accelerated down cutting and entrenchment. This paper reviews the history of the river and the triggers that have led to substantial changes in the riparian ecology and function.

Spring Soils, Lotic Flow and WOTUS in Hard Rock Country

Cockman, Joneen, PhD, Lead Natural Resource Specialist, AZ BLM, jcockman@blm.gov

The recently proposed rule revision for Waters of the US (WOTUS) affects 90% of Arizona's waters. From 2013-2019 nearly 100 spring systems were examined in southeastern Arizona. Policy definitions of "riparian" frequently include the presence of hydric soil. Using field data, this presentation discusses the definition of riparian, whether or not the presence of soil is necessary, and if so, whether or not it must be hydric. It discusses the limitation of available inventory maps and challenges stream classification. Using examples from several tributaries to the Gila River, the research shows the impact that the proposed rule revision will have on many perennial spring resources which are examples of Arizona's dominant drinking water source.

Aldo Leopold and the Climate Crisis

Cole, A.T., Owner, Pitchfork Ranch, atandcinda@gmail.com

The evolution of conservation has gone through phases and crystalized in the revered land ethic of Aldo Leopold. When he and Estella purchased their abandoned, washed-out, 80-acre Wisconsin farm, where habitat restoration was born, global warming was little known. Now with the climate crisis, we're presented with a call to consider a post-Leopold environmental ethic based on survival in a post-industrial, hoped-for Environmental Civilization.

Building Collaborative Capacity for Forest Restoration on the Gila National Forest

Cooper, Martha S., The Nature Conservancy, mschumann@tnc.org

Improving forest health, reducing wildfire risk and increasing collaboration are shared goals among partners in Grant County. For the past three years, Grant Soil and Water Conservation District, Gila National Forest, The Nature Conservancy, and other partners have worked together to secure Collaborative Forest Restoration Program (CFRP) funding to 1) build the capacity for collaboration and 2) restore 237 acres of ponderosa pine, pinyon, and juniper on the Wilderness District of the Gila National Forest. The Gatton's Park wildland urban interface treatment (WUI) units were selected to reduce fire risk, enable landscape-scale fire restoration, improve wildlife habitat, and harvest small-diameter wood. One requirement of the CFRP program is multi-party and implementation monitoring. The Nature Conservancy and Aldo Leopold Charter School Eco-monitors collected pre- and post-treatment monitoring data within both WUI units; this data demonstrates that restoration goals are being met. Monitoring points and photos depict a more resilient forest stand structure. Other project indicators are measured to assess whether other project goals, for example, economic impacts and outcomes, are being met.

Gila River Floodplain Restoration Through Non-native Tree Removal

Cooper, Martha S.[1], Ellen Soles[2], Donna Stevens[3], Carol Ann Fugagli[3], Indigo Quinn Crockett[4]
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[3]Upper Gila Watershed Alliance
[4]Aldo Leopold Charter School

Riparian vegetation along the Gila River in New Mexico is dominated by multi-aged stands of cottonwoods, willows, sycamores, and other native species. However, the integrity and quality of riparian habitats can be diminished by a variety of stressors, including the presence and invasion of non-native woody species. Numerous agencies and organizations have worked over the last decade to reduce the presence of salt cedar and Russian olive within the Gila's riparian corridor. The Forest Service initiated this effort by removing salt cedars along the East Fork of the Gila River. The Upper Gila Watershed

Alliance surveyed, removed, and monitored salt cedars through the Wilderness Reach from the Forks to Mogollon Creek. The Grant Soil and Water District and The Nature Conservancy mapped, removed, and are monitoring salt cedar and Russian olive within the Cliff-Gila Valley on Freeport McMoRan and Nature Conservancy property. Maps and data tell the story of the distribution of non-natives, where the work happened, and the effectiveness of the projects. These stewardship projects help maintain our native riparian forest along the Gila River and contribute to sustaining viable and resilient populations of species of greatest conservation need, such as Southwest willow flycatcher.

Conserving Narrow-headed Gartersnakes by Keeping Common Fish Species Common

Christman, Bruce L.[1] and Randy D. Jennings[2]
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Thamnophis rufipunctatus is an obligately piscivorous snake of the Gila and San Francisco drainages in New Mexico and Arizona. Prey include Longfin Dace, Speckled Dace, Sonora Sucker, Desert Sucker, Loach Minnow, Spike Dace, Gila Chub, Gila Trout, and Apache Trout. Three fish species are federally listed.

Fishes of the Gila/San Francisco watersheds have evolved with recurring fire and subsequent high flows. Catastrophic wildfires and resulting ash flows pose threats to fish populations. Historically, fish population extinction from floods would be short-term followed by re-colonization from populations nearby. In managed aquatic ecosystems, fish populations have fragmented and often are restricted to headwater streams with little connectivity. *Thamnophis rufipunctatus* also has experienced genetic isolation and loss of connectivity.

After the Whitewater-Baldy Complex Fire, streams in southwestern New Mexico experienced ash flows resulting in near-total fish kills. Populations of *T. rufipunctatus* using streams subsequently declined or were lost. We propose a 'multi-species' approach to conserve *T. rufipinctatus* and native fish. Our approach aims to maintain *T. rufipunctatus* by keeping common native fish species (Longfin Dace, Speckled Dace, Sonora Sucker, and Desert Sucker) common. We propose to repatriate fish species within 6 months after heavy ash flows. Methods for repatriation may vary and will be determined after collaboration with regional fish biologists.

Pottery Analysis of Feature 2 at Berrenda Creek: An Introduction to an Orphaned Collection

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Berrenda Creek (LA 12992), located in Gila National Forest, is a Mimbres Classic Site excavated by New Mexico State University (NMSU) students in the summer of 1976. When archaeologists became aware of the site in 1975, the area was found to have undergone extensive vandalism by illegal pothunting

activities. The NMSU excavation of eleven features yielded hundreds of artifacts and ecofacts, including ceramics, lithics, groundstone tools, minerals, pollen samples, wood samples, and soil samples. The original analysis of artifacts recovered from the site was incomplete and currently remains incomplete, even over forty years later. "Orphaned" archaeological collections are a chronic issue for many institutions. Under-reporting and lacking analysis for these collections may be accidentally contributing to gaps in knowledge of prehistory. This paper focuses on the ceramic analysis of Feature 2, the southern-most roomblock of Berrenda Creek. The research conducted in this paper acts as an introduction to the information that can still be obtained from this forgotten assemblage. This "orphaned" collection is just one of many archaeological assemblages that need proper and updated analysis. Research on this collection is ongoing but has the potential to add information about life in the Gila region for Mimbres people.

A Potentially New Woodrat Endemic to the Gila

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Because numerous biomes converge in southwestern New Mexico, the Greater Gila Region hosts relatively high levels of biodiversity and many mammalian species reach their range limits in the region. Habitat heterogeneity, ranging from Chihuahuan Desert to alpine environments, makes the Gila a biodiversity hotspot for the United States. Careful characterization of species limits and insight into the dynamic history of species distributions are critical components of our understanding of mechanisms of diversification. We examine genetic variation in several species of woodrats (genus *Neotoma*) that have overlapping distributions in the Gila. Cryptic diversity (i.e., new species) and extensive hybridization between woodrat species have been recently documented elsewhere. We have identified a genetically distinct group within Stephen's woodrat (*Neotoma stephensi*) that is potentially endemic to southwestern New Mexico in the Greater Gila Region. We sequenced four genes from ten individual woodrats to characterize the extent of genetic divergence between these two lineages. These preliminary findings suggest the need for renewed investigation of other mammalian species potentially endemic to the region and further study of the geographic and historical factors that may have led to their divergence.

A Look Back at the Last 120 Years of Climate in SW New Mexico and Looking Forward

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This talk gives an overview of climatological monitoring across southwestern New Mexico. Starting with the first observations at Fort Bayard in 1867, we review what measurements have been collected and how they compare to current data. Today we have climate monitoring networks from National Oceanic and Atmospheric Administration, US Department of Agriculture Snow Telemetry, Remote Automated Weather System, from universities, and those privately owned. We review the past few decades of drought, compare it with the more distant past, and discuss the latest on climate indicators across the area, including temperatures, drought, rainfall, winds, growing season, and air quality. How has the monsoon

varied over the years? We also look toward the future and discuss the latest seasonal climate outlooks and what future climate could look like. The presentation concludes with a very popular citizen science effort called Community Collaborative Rain Hail and Snow network (CoCoRaHS) that anyone can join to help collect precipitation.

Abundance and Distribution of Sonora Mud Turtles Along the Upper Gila River In New Mexico

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Most studies of the Sonora mud turtle within the United States have been carried out in Arizona and extreme southwestern New Mexico. Infrequent records of the species along the upper Gila River in New Mexico prompted us to determine current abundance and distribution of the species in the region. During the summer of 2018, we surveyed locations that had historically supported *K. sonoriense*. We trapped turtles using small hoop traps as well as by hand. We weighed, sexed, measured, and photographed 19 individuals. Additionally, blood samples were taken from a small selection of captured turtles. Our results indicate that the abundance of mud turtles within the region varies dramatically, with 95% captured at one locality. Populations within the region seem to show significant sexual dimorphism, with females being larger and heavier than males. Many study sites show high abundance of invasive crayfish, *Orconectes virilis*, which have been found to prey on juvenile turtles. We suggest increased efforts to remove these and other exotic species from the Gila River drainage. Finally, long-term population studies should be carried out to determine basic life history parameters for the species in the region, as well as to clarify if conservation actions should be taken.

Assessing the Impact of a Recovering Predator Population on Prey Vigilance

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Predators change prey behavior, demographics, and movements. These changes can potentially decrease prey fitness through a reduction in foraging time, increased stress levels, and use of lower quality habitat. Although the magnitude of these indirect effects is still debated, if strong enough, they can reduce birth rates and decrease neonate survival. Prey have the ability to reduce the indirect effects of predators through behavioral changes, such as increased vigilance. This study aims to quantify the effects of the Mexican gray wolf (*Canis lupus baileyi*) reintroduction to Arizona and New Mexico on elk (*Cervus canadensis*) behavior. This ecosystem, in which the density of this recolonizing predator varies spatially, allows for a unique opportunity to better understand this relationship while simultaneously testing if elk behavioral responses to wolf risk are similar to that reported for other areas. We captured adult female elk across the wolf density gradient and fitted them with GPS collars. We captured and VHF ear-tagged a

portion of the collared females' calves to determine maternal status. Lastly, we are conducting behavioral observations on known individuals to investigate the effect wolves have on elk vigilance due to the risk of predation and its interaction with offspring presence/absence. Data collection and analysis are ongoing with an expected completion of May 2021.

Shifting Channels of the Gila: Historical Analysis of Land-cover Change along the Cliff-Gila Valley Floodplain from 1935 to 2016

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The Gila River in southwestern New Mexico provides a rare place to study and communicate how a dynamic river with a near-natural flow regime interacts with its floodplain over long time scales. This interconnected river-floodplain system contains a patchwork of land cover that supports a diversity of plants and animals, sustained in part by moving river channels that promote reworking of the floodplain and establishment of vegetation. The objective of our study was to describe how various types of land cover have changed in the Cliff-Gila Valley floodplain in response to interacting influences of people and natural events. We combined analysis of historical aerial imagery spanning 80 years, repeat photography, and contemporary time-lapse photography to characterize change in this connected river-floodplain system. Herein we show how the Gila River's channels have migrated across the floodplain since the 1930s and associated adjustments in the position and total area covered by riparian forests, herbaceous/scrub vegetation, bare ground, and agricultural land across time. We also share examples of multi-media content featuring the beauty, diversity, and vibrant nature of the Gila River. We invite you to see more about this and other creative collaborations related to watersheds at WitnessingWatersheds.com and PlatteBasinTimelapse.com.

Globemallows are Looking for a Little Understanding

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Globemallows, genus *Sphaeralcea*, exhibit a lot of variability within species and much overlap among species. In the US, New Mexico and Arizona are the states with the greatest species counts. The shared boundary between the two states has created some different ideas about where one species begins and another ends, both morphologically and geographically. It seems that somehow our political boundaries may have unintentionally erected some scientific boundaries as well. A brief look at the morphological variability and its geographic extent makes one wonder whether the term "species" even makes sense for a group like this, and such an examination may spur the need for a broader exchange of ideas.

On WNMU's Living Mascots: Our Southwestern Cliff Swallows (*Petrochelidon pyrrhonota tachina* and *P. p. swainsoni*)

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Professor and students at Western New Mexico University

During summer 2019, Dr. Scott Smith and student Chris Rose collected a conservative set of measurements on locations of WNMU's later-arriving Cliff Swallow (*Petrochelidon pyrrhonota*) populations in an effort to help the university identify likely future locations of nest sites, primarily for nuisance abatement, as Cliff Swallows have a homing tendency, attracting them to previous nesting sites. Dr. Smith was one of a team, consisting of himself, WNMU faculty members Dr. Corrie Neighbors and Dr. Kathy Whiteman, WNMU students Ken Sexton, Roxanne Snyder, and Scott Zager, and SW Audubon Society members Carol Ann Fugagli and Terry Timme, that conducted a separate spring 2019 pilot study featuring the WNMU Cliff Swallows.

In late 2019, Dr. Livingston took a cold, fresh look at Smith and Rose's summer 2019 dataset. While considering life requirements of colonial mud-nest dwellers, Dr. Livingston has discovered a common shading threshold, which avian colonists must elect to protect their habitat from damaging effects of the sun. Dr. Livingston used this dataset to support her hypotheses about the reasons Cliff Swallows choose their nest-site locations at WNMU. Using a variety of statistical and mathematical techniques, she also obtained formulae useful in determining locations likely to be colonized now and in the future in the Silver City solar climate.

She has uncovered some surprising and delightful facts about our living WNMU Cliff Swallow mascots, including a natural mathematical prowess! It was well-known that our campus has been the home of the Southwestern subspecies of Cliff Swallow (*P. p. tachina*), but Dr. Livingston has discovered that we are most likely the home of the little-known Mexican Cliff Swallow (*P. p. swainsoni*), too! Dr. Livingston and two of her students, supported by NM AMP grants, will describe their plans for conducting this year's 2020 Observational Cliff Swallow Population Study at WNMU on *all* of our Cliff Swallow colonies, including biodiversity identification, population densities, relation of sub-species differentiation and arrival times, nesting-site location and colony configuration metrics, photo essays and more, which will be housed at two of the largest repositories on biological data: the Global Biodiversity Information Facility and the National Biodiversity Network.

Weaving Resilient Agriculture with Microfarming in Silver City, New Mexico

Lundgren, Kristin and Shivani Ma, Wild Resilience Collective, klundgren2@gmail.com

The Wild Resilience Collective is a local crew of Earth stewards whose hope is to heal social and individual relationship to ecology by cultivating regionally appropriate, regenerative practices through entrepreneurship, education, and ceremony. One of the avenues for this practice is demonstrated through the growth of our collective micro-farming efforts throughout Silver City and surrounding areas. We believe the whole city can be seen as a farm ripe for harvesting and tending in new (and ancient) ways.

We have begun gleaning from the abundance of fruit trees and herbs already growing in our community. We have planted rainwater harvesting basins for future food sources working with Stream Dynamics. We are beginning to steward native food plants like prickly pear, mesquite, sacaton, and oaks in multiple plots. Many of our collective members have our own microfarm spaces that we tend with collective support, but our long-term goal is to collectively tend multiple plots throughout the community to provide regionally appropriate foods for each other and the community. Wild Resilience Collective envisions our community finding resilient ways of living with our environment that will allow us to thrive in harmony for years to come.

New Records of the Endangered Jumping Mice, *Zapus luteus*, Provide a Predictive Basis for Future Conservation Plans in the Gila

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We report on seven previously undocumented populations, two from the Gila, of a federally endangered species (New Mexico meadow jumping mice, *Zapus luteus*) that were first detected across three states in 2017 and 2018. These new records were combined with ensemble species distribution modeling of historical records curated by museums to evaluate persistence of this species over the next 50 years. Potential future distributions indicate complex changes on the horizon, where some areas increase in predicted distribution, while about half of the designated critical habitat areas are predicted to be unsuitable by 2070. Three of the newly discovered populations also occur outside future predicted climate conditions. When these results are combined with indexes of historical sampling efforts, the recognized and potential distribution of populations are severely mismatched highlighting vast areas that were never sufficiently sampled, especially in the Gila. Consequently, the current understanding of geographical limits of *Z. luteus* suggests that designated critical habitat areas may inadequately sustain some populations long-term and that proposing and implementing actions (i.e., translocations) may be premature. Without a comprehensive sampling strategy followed by fundamental natural history data and analyses that reveal patterns of geographic variation, proposed management activities for jumping mice are incomplete.

Ritual Landscapes of the Gila Region

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For thousands of years, people have marked the landscape with carvings or paintings. Rock art is found throughout the world, in almost every type of terrain. There have been many rock art sites identified on the Gila National Forest. Most locations are kept confidential, in accordance with federal law to better protect the resources. However, there are a few interpreted and accessible rock art sites on the Forest.

The term “rock art” is used throughout this presentation to indicate painted (pictograph) and carved, pecked, or incised (petroglyph) images, found in-situ on rock surfaces or cave walls. Despite the fascination popular culture has with rock art, relatively speaking, professional attention to the subject has been lacking. In North America, rock art studies have historically occupied a marginal position within the discipline of archaeology. Unlike other classes of material culture which may be displaced over time through site formation processes, rock art is found in primary context, providing a unique opportunity to examine not only the rock art but the landscape it sits in. When visiting a rock art site, one can almost feel transported back to the time and place when the landscape was transformed. This is the ability of a place to affect an experience.

The Power of the Outdoor Recreation Economy in New Mexico

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This presentation is an overview of the breadth of the outdoor economy in this state, with testimony from professionals who both benefit from it and help it grow.

A Floristic Inventory of the Gila Cliff Dwellings National Monument (Catron Co., NM, USA)

Norris, William R., PhD[1], Kelly Kindscher, PhD[2], Richard Felger, PhD[3], and Russ Kleinman, MD[1]
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The Gila Cliff Dwellings National Monument (Catron Co., NM, USA) was established in 1907 to protect Mogollon cliff dwellings on the headwaters of the Gila River. Within its boundaries (216 ha), the monument is cut by several creeks resulting in high topographic diversity (flat mesa, vertical cliff walls and steep slopes, narrow canyons, broad floodplain) resulting in the occurrence of numerous vegetation communities and high plant diversity.

We present the results of our long-term (since 2013) floristic inventory of the vascular flora of the Gila Cliff Dwellings National Monument. Our goal is to compile a comprehensive flora for the monument which characterizes the origin (native, introduced), habitat preference, abundance, and conservation status of each taxon. During our field work for this project, we have documented 478 vascular plant taxa in the monument to date, of which more than 90% are native to southwest NM. We have collected at least one voucher specimen for most of these taxa, which are deposited in the Dale A. Zimmerman Herbarium (SNM) at Western New Mexico University. Significant collections of vascular plants collected in the monument prior to our study, most deposited in the University of Arizona (ARIZ) and the University of Texas-El Paso (UTEP) herbaria, add another 91 taxa to the flora, bringing the grand total to 569 taxa.

In this presentation, we will discuss all aspects of this plant inventory, including challenges, and address the significance of thorough floristic work conducted in the 21st century.

A User-friendly Website to Aid the Identification of Moths Occurring in the Gila National Forest

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The planet is in the midst of a human-caused, mass extinction. In these circumstances, it is important to increase public awareness of the complex and beautiful biodiversity that is being threatened since "we will not fight to save what we do not love" (Stephen Jay Gould). While many people love butterflies, moths are relatively neglected by amateur naturalists. With this in mind, the presenter initiated a project in 2012 to document the diversity of moths that occur in the Gila National Forest and vicinity. The results are shown on a website entitled "Southwestern Moths." The website currently displays photographs of about 550 spread moth species. Each photograph is accompanied by data on the ID, family, sex, wingspan, collection location, and larval food plant for the illustrated moth. The presentation will describe the layout of the website, show some examples of documented moths, and include suggestions for how the website may be used most effectively in combination with other resources to identify local moths.

Four Years at The Elk Ridge Ruin: What We Have Learned and Where We Are Going

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Recently, four years of excavations conducted by the University of Nevada, Las Vegas in conjunction with the Gila National Forest were completed at the Elk Ridge Ruin, a large Classic period (AD 1000-1150) pueblo in the Mimbres River Valley, New Mexico. This project was done as part of mitigation efforts to protect the site from floodwaters in an arroyo that cut through the western portion of the site. The UNLV excavations uncovered 20 rooms (including habitation and storage), a ramada, and a midden. Analysis of architecture and floor assemblages have shed light on domestic and ritual activities, interaction, the pithouse to pueblo transition, and abandonment. This poster summarizes the results of the excavations and initial analyses and presents the various avenues of ongoing and future research utilizing the recovered material.

The Native Perspective

Scott, Jorden* and Fumi Arakawa, PhD, Student and Professor New Mexico State University, joscott@nmsu.edu

Ceramic vessels from the Classic Mimbres period, specifically the brilliant black on white vessels known for depicting fantastical geometric, realistic zoomorphic, and whimsical anthropomorphic designs have long been interpreted by many. These interpretations have offered extensive information concerning the

individuals who produced and designed the bold vessels. However, missing from these interpretive perspectives is the integration of a Native voice. I have focused on zoomorphic motifs, specifically swallow and swift depictions, and will introduce the current literature surrounding these species through ethnographic sources. In addition, this presentation will utilize the testimonials of two Zuni scholars in conjunction with ethnographic sources to begin making conclusions concerning the connections between these two avian species and the Mimbres culture, who painted them more often than other species. I conclude that these species are not omniscient to Native ways; however, they do hold strong connections with weather conditions and continue to be recognized as important beings.

Working Toward Sustainable Agriculture: Frisco Farm

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Frisco farm is a small, family-run, organic farm that produces vegetables for sale to local markets, as well as food for our family. Over ten years of operation, we have worked to find a balance between resource consumption and agricultural production. Variables adjusted to achieve this balance include fuels, fertilizers, water use, crop selection, market options, and scale of production. Considering these variables, could an economically and environmentally sustainable food system exist in the Gila region?

Preserving Ecosystem Services of the Gila River Watershed in the Face of Climate Uncertainties

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New Mexico's Gila River is the last major Southwestern river network with a largely unaltered hydrograph. Despite several layers of conservation policies bestowed upon the greater Gila region, this river system and the ecosystem services it provides are vulnerable to development that could exacerbate effects of a changing climate. The river network, however, is eligible for additional protections under the National Wild and Scenic Rivers Act (WSRA). If implemented, the WSRA would restrict future damming or diversions on designated river reaches and would seek to improve water quality and specific Outstandingly Remarkable Values, or ecosystem services, recognized within the management plan. Through triangulation of surveys, interviews, and literature analysis, this research seeks to identify the ecosystem services that are present in the river network, how climatic changes might impact these services, and how a tailored WSRA management plan can protect and enhance the services. An analysis of management plans for existing designated rivers in other watersheds reveals the potential of the WSRA to function as a climate adaptation policy for the Gila River Watershed. Results aim to inform river conservation decision-making across scales, from the watershed to the National Wild and Scenic Rivers System.

The New Mexico Night Sky and Why We Need To Protect It

Starkweather, Vandy and Gary Starkweather, Professional at Deming, NM, vandystar7@gmail.com

New Mexico has some of the darkest skies in the US. That darkness draws eco-tourism, promotes human and wildlife health, stimulates interest in astronomy, outer space and therefore science, and is thus beneficial to the general population. Lack of awareness of the benefits of our dark sky threatens to degrade it through light pollution. Once it is lost, it would be difficult to recover it, so raising public awareness is crucial to the dark sky's preservation.

New Mexico has a Night Sky Protection Act that delineates standards for business, private, and government lighting. I will give examples and show slides illustrating compliant fixtures. Lights that comply with the Night Sky Protection Act are beneficial to humans and wildlife. We will address issues of safety, circadian rhythm disruption and consequences, impact of glare on drivers, horizontal lighting on businesses, and the negative impact of sky glow. We also discuss the tourism benefits of dark skies, especially in the Gila Wilderness, and the economics of efficient lighting for homeowners and local governments.

Influence of Mexican Gray Wolf on Elk Resource Selection

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Predation is a primary limiting factor for prey and in addition to direct impacts (killing of prey), it establishes risk, which indirectly influences prey resource selection strategies. Our objective is to determine the influence Mexican gray wolves (*Canis lupus baileyi*) have on resource selection and spatio-temporal predator avoidance strategies of elk (*Cervus canadensis*). We captured 427 adult female elk and fitted them with Iridium-GPS collars in eastern Arizona and western New Mexico; > 70 Mexican wolves are also fitted with GPS collars. I will use step-selection functions to assess elk resource selection in relation to habitat attributes, climatic conditions, and diel activity patterns across areas of varying wolf densities to understand the extent to which the re-establishment of wolves influences elk populations. Multiple measures of predation risk will be examined in relation to elk resource selection. Risk indices will include an index of wolf presence—a function of wolf resource selection, utilization distributions, and pack size, density of wolf-killed elk, openness, and predicted risky areas, modeled from attributes of known wolf-killed elk sites. Seasonal resource selection of elk, including migratory behavior and areas, will also be determined. The collection of data is currently in progress, so preliminary results are pending.

Assessing Climate Vulnerability of the Gila National Forest

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Natural resources managers and their partners need information about the potential impacts of a changing climate on the ecosystem services of public lands. The USDA Forest Service and University of New Mexico have recently developed an all-lands climate assessment that resulted in a vulnerability map of the region that represents the disparity between late 21st-Century climate forecasts and the pre-1990 climate envelopes for all major upland ecosystem types. Uncertainty was determined by the level of agreement in results among multiple global climate models. We also tested the vulnerability map by considering vulnerability ratings in relation to ongoing ecological processes including wildfire, upward tree species recruitment, and the encroachment of desert scrub into semi-desert grasslands. The vulnerability map indicates that most lands are of high vulnerability and low uncertainty. Our testing of the map suggests that some effects of a changing climate are already evident and that the vulnerability map may be useful in supporting local managers and partners in planning and decisions. The Gila National Forest is used as a case study from which to report results and discuss carbon balance and opportunities for active and passive management.

Livestock Impacts to Protected Rivers in the Gila Watershed

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Riparian ecosystems in the greater Gila bioregion provide critical habitat for rare wildlife which are known to be harmed by livestock grazing. Since 2017, we've field surveyed ~400 miles of streams on five National Forests in Arizona and New Mexico for evidence of grazing impacts to streamside vegetation, soils, and streambanks. Surveys included portions of the Verde, East Verde, San Francisco, Gila, Blue, and Tularosa Rivers and major tributaries that contain critical habitat for federally protected wildlife. Virtually all of the surveyed areas have been closed to livestock grazing through past agency decisions. However, we documented widespread cattle grazing and occupancy in most surveyed reaches. Approximately 54% of stream miles were ranked with moderate to significant grazing impacts. Just 22% of stream miles were absent of any signs of cattle at all, and more than three-fourths of surveyed allotments had illegal grazing occurring. Successful recovery of rare wildlife dependent on riparian and aquatic ecosystems in the Southwest requires that livestock exclosure fencing is properly constructed, better monitored, diligently maintained, and properly enforced. We are using these data to support strategic litigation and land management advocacy with the desired result of improving U.S. Forest Service protection of ecologically irreplaceable river ecosystems.

Aquatic and Riparian Climate Change Vulnerability Assessment of the Southwestern United States

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In the arid southwestern region of the United States, functioning aquatic and riparian systems are critical habitat elements for a broad range of species. Furthermore, these same systems provide a spectrum of ecosystem services important for social and economic sustainability of the region. Many of these aquatic and riparian ecosystems are especially vulnerable, and land managers need tools to inform potential impacts due to the changing climate. To help identify and quantify potential vulnerabilities, the USDA Forest Service has developed an Aquatic and Riparian Climate Change Vulnerability Assessment. This assessment leverages diverse data sources to quantify vulnerabilities for all sub-watersheds in Arizona and New Mexico, as well as select sub-basins of Texas and Oklahoma. We have categorized vulnerability metrics into two broad categories: 1) intrinsic vulnerabilities—attributes that make an individual sub-watershed more susceptible to any potential shifts in climate, and 2) expressed vulnerabilities—attributes directly related to projected shifts in climate including temperature and timing of flow. Combined, these metrics provide a comparative tool to assess the relative magnitude of vulnerabilities across large and varied landscapes and multiple jurisdictions.