

PROCEEDINGS OF THE NINTH
Natural History
of the Gila
Symposium

February 23-24, 2022

Western New Mexico University

Silver City, New Mexico

EDITED BY
9th Natural History of the Gila Symposium Planning Committee

Mission Statement

The Natural History of the Gila Symposium's mission 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.

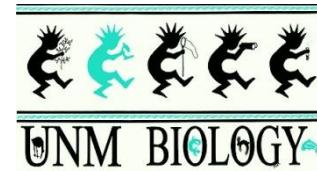
Partners for this symposium include Western New Mexico University, Native Plant Society of New Mexico—Gila Chapter, United States Forest Service, Bureau of Land Management, Southwest Word Fiesta, The Black Range Naturalist, and University of New Mexico Department of Biology.



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THE BLACK RANGE NATURALIST

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2022 Planning Committee Members

Bob Barnes—The Black Range Naturalist

Joneen (“Jony”) Cockman—AZ BLM Safford

Gregor Hamilton—University of New Mexico

Beth Leuck—Professor Emerita

Dustin Myers—USFS Gila National Forest

William (“Bill”) Norris—Western New Mexico University

Ted Presler—Creative Voices Organizer; Southwest Word Fiesta

Jenny (“Nessa”) Rasmussen—USFS Gila National Forest

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Special thanks to Stephen Fox for helping to organize "Creative Voices."

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INTRODUCTION

The mission of the Natural History of the Gila Symposium series has changed little over the 18 years since it was first crafted, but our world certainly has. Only weeks after the hugely successful 8th symposium was held in February of 2020, COVID-19 was declared a pandemic. The next two years proved to be transformative across the globe, our nation, and our beloved Gila region in ways horrific, humbling, and hopeful. Fear, loss, isolation, anger, and depression permeated our collective experiences. And yet, emerging from this dark place, we reaffirmed our profound connection to each other and the natural world around us. The Gila National Forest experienced unprecedented usership during this time, evidence of the need for human connection to nature and the remarkable value of our wild places.

It was uncertain what the 9th symposium would look like when the committee began planning in earnest. Would we be able to meet in-person? Should we meet in-person? What level of risk would the committee, presenters, and attendees be willing to assume? Did we have the skillsets to pull off a virtual symposium? What would that look like? The committee settled on offering the event in a hybrid in-person and virtual setting so that each person could decide for themselves the level of risk they were willing to accept. There were also secondary and perhaps cascading benefits to providing a virtual option. Specifically, the event could expand its reach and attract keynote speakers, presenters, and attendees from further away who did not have the time or the resources to travel. This could mean we would be able to highlight research being done within the Gila region by universities and researchers across the country, as well as bring additional and new information and ideas into our dialogue that are relevant, but not necessarily specific to it. The committee saw this as advantageous far beyond the 9th symposium given the broad context of climate change.

The presentations at the 9th symposium summarized in these proceedings covered aquatic ecology, habitat restoration and conservation tools, mammals, plants, fungi, archaeology, education, astronomy, and forestry. Whether it was the new format or a thirst to return to normalcy, the symposium saw its largest turn-out for student presenters, which gave us hope and reassurance for a very bright future. University President Dr. Joseph Shepard and Forest

Supervisor Adam Mendonca both highlighted this in their opening remarks. Attendees had the opportunity to hear a passionate and inspiring keynote address on the history and importance of Wilderness preservation, delivered by the esteemed Ed Zahniser, retired senior writer and editor for the National Park Service Publication's Group and son of the late Howard Zahniser, primary author of the Wilderness Act of 1964. Another keynote address by Silver City's own Stephanie Garcia Richard, New Mexico's Commissioner of Public Lands, illuminated listeners regarding the many aggressive actions being taken to conserve natural resources on public trust lands while raising revenue to support education. The committee was pleased to bestow awards to six individuals who have made significant contributions towards conservation, management, and education in the Gila Region: Dave Henson (Lifetime Achievement), Johnny Zapata (Lifetime Achievement), Marilyn Markel (Education), Allyson Siwik (Friend of the Gila), Bob Barnes (Citizen Science), and the late Sonnie Sussillo (Citizen Science).

The Creative Voices session was offered in-person only. It honored Aldo Leopold and Dutch Salmon, including readings of their works and delightful, original skits and monologues from students at Aldo Leopold Charter School. The event was brought to a close by two local poets who wove words into a rich tapestry of immersion in the Gila's earth, water, wind and sky. A special thank you goes out from the Committee to Stephen Fox for stepping up at the last minute to host the Creative Voices session and for doing a spectacular job.

The 9th Natural History of the Gila Symposium was the result of two years of planning by dedicated members of the committee. Wen-Chi Chen and Yen Chu, without whom the website would not be. William "Bill" Norris, our fearless and patient leader. Joneen "Jony" Cockman and Ted Presler, neither of whom ever run out of great ideas. Gregor Hamilton, who keeps us on our toes, especially Dustin. Beth Leuck, our rock. Kathy Whiteman, who keeps things moving forward and never lets us down. Elizabeth "Liz" Sorrells, master of ceremonies and bravery. All the planning would have been for naught without the excellent support provided by Western New Mexico University's Media Technology Services (Michael Acosta, Joe Chavez, Jason Roland) and Video Communications (April Hanson, Cody Ahlm, Tuan Tran) support staff, who saved us from ourselves on more than one occasion. It was our privilege and honor to work with you.

We also appreciate Donna Stevens' generous donation of skill and time to assemble and copy-edit the Proceedings of the 9th Natural History of the Gila. Let them serve as a record of the memorable two-day event and an inspiration to future offerings.

Dustin Myers and Nessa Rasmussen, 9th Natural History of the Gila Symposium Planning Committee

LIFETIME ACHIEVEMENT AWARD: David Henson



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.

David Henson is currently the Biology Department Head and Science Division Chair at Eastern Arizona College in Thatcher, a two-year community college. As of 2022, he has committed 42 years to teaching at the high school and college levels. He received a BS in Microbiology, and MS in Educational Leadership from Northern Arizona University. He also attended University of Arizona for a MS in Biology.

Along with a passion for biological sciences, Henson is known for his own athleticism and coaching in basketball. He was an Academic All-American in Division 1 NCAA during his time playing basketball. The game supported him with full-ride scholarships to Northern Arizona University. He is better known for his skills coaching both boys' and girls' basketball. He took his boys and girls high school teams to eight Arizona State championship games, winning one boys state championship and two state runner-ups. When his daughters reached high school age, he took up coaching girls' basketball and took them to four state championships, winning two. When his daughters Jenny, Lindsey, and Taylor played under his coaching, they were 123 and 6 in four years and still hold an Arizona record with 58 consecutive wins.

The largeness, discipline, bravado, and expertise he brought to basketball he brings to teaching outdoor biology and natural resources. He began his tenure at Eastern Arizona College in 2002 and has developed outdoor curricula for Freshman and Sophomore students. Students are given the opportunity to explore the great outdoors by joining the Bureau of Land Management, US Forest Service, Arizona Game and Fish Department, and Arizona Department of Water Resources in real projects working alongside federal and state employees, collecting real data, and taking ownership in understanding experimental design, data capture and analyses and reporting. Most of these projects are oriented toward water quality studies and habitat restoration.

Water quality studies span 75 miles of the Gila River starting at Red Rock, New Mexico and extending through the BLM Gila Box Riparian National Conservation Area (RNCA). In the RNCA several study sites inform water quality for several US Fish and Wildlife Service Biological Opinions for rare and sensitive fish species. In 2006 Secretary of Interior Gayle Norton appointed Henson to the Advisory for the Gila Box Riparian National Conservation Area. His classes also monitor water quality at several BLM wildlife/wetland habitats and assist BLM with rare plant studies.

The gem of his undergraduate research programs is a ranarium complex at Discovery Park, an outdoor branch campus facilitated by Eastern Arizona College. The ranarium for the Chiricahua leopard frog (*Lithobates chiricahuensis*) is considered Arizona's most successful ranarium in

out-planting frog egg masses. More than 13,000 egg masses have been planted in CLF Management Unit 4 in the Galiuro Mountains and Aravaipa watershed. A second ranarium is under construction for hosting CLF from the Turner Ranch in New Mexico. A third ranarium is in the dream phase, where phenotypic studies will be conducted between the Arizona and New Mexico populations.

Henson was an integral part of acquiring the Discovery Park Campus for the College in 2006. The design and development of the ranariums and partnerships with state and federal agencies led him to develop the Ecology and Undergraduate Biological Research course offerings at Eastern Arizona College.

His undergraduate research curriculum has captured the attention of the University of Arizona and has steered Eastern Arizona College toward developing a four-year degree in partnership with UA. From 2013 through 2020, he partnered with the Safford BLM STEM program. During this time, 32 students were provided paid positions with BLM, some of which were year-round.

When have you seen Freshman and Sophomore college students getting to take part in research that is normally reserved for MS and PhD students? Almost never. His students have gone on to capture good jobs and great career paths. For his enthusiasm and expertise in education leadership, the Steering Committee for the Ninth Natural History of the Gila Symposium awards the Lifetime Achievement Award to David J. Henson.

LIFETIME ACHIEVEMENT AWARD: Johnny Zapata



Johnny Zapata: The Man, The Myth, the Legend! ***USFS (Retired) 1974-2021***

Johnny Zapata was born and raised in San Lorenzo, NM. He joined the US Forest Service, Gila National Forest, in April 1974 at the ripe age of 17 as a firefighter based out of Me-Own Fire Base. Since then, Johnny has served most of his career on what is now the Wilderness District of the Gila National Forest in various positions and roles, including range, wildlife, fisheries, wilderness management and patrol, recreation and trails, wildland firefighter, animal packer, consultant to multiple recovery teams, safety officer, air quality coordinator, and countless others. Johnny has worn many hats during his 47 years with the USFS, but most often it was a cowboy hat. Throughout much of his storied career, Johnny managed a herd of more than 60

head of riding and pack stock that became the shining example for the Forest Service of what a successful stock program could be and what it could accomplish.

Johnny, dependable and humble, epitomizes what it means to be a USFS employee and a steward of this land he has always called home. Johnny was the constant (and quiet) driving force behind on-the-ground recovery activities for Threatened and Endangered Species such as Gila trout and Chiricahua Leopard Frogs, as well as wildfire response for the nearly 770,000 acres of the Aldo and Gila Wilderness Areas. His contribution to the recovery of these federally listed species, as well as contributions to wildfire, range management, wilderness management, and to the USFS, is immeasurable and cannot be overstated. Johnny has been nationally recognized by both the US Fish and Wildlife Service and the US Forest Service for his efforts, receiving the Recovery Champion Award (USFWS) the prestigious Chief's Award (USFS).

His impact on the nation's first Wilderness through maintaining and restoring wilderness character is matched only by those founding fathers who helped to establish it. If there was a Mt. Rushmore of the Gila Wilderness, Johnny would be front and center!

CITIZEN SCIENCE AWARD: Bob Barnes



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.

Robert (Bob) Barnes grew up in a military family and experienced the wild areas of the Americas from an early age: Alaska, Puerto Rico, California, New Mexico, and Tennessee, for starters. He received his Bachelors from California at San Bernadino (English). His Masters work focused on methodology and systems, with work at Boston University (MA, International Relations) and Public Administration at the University of Tennessee. Following his “military obligation,” he entered the public service, working first for USDA and the Department of Energy. At DoE he managed a multi-disciplined team working on issues related to complex systems. All of that, however, was about eating and raising kids. His passion has always been natural history. Bob produced natural history (mostly avian) videos to sustain that passion. His material has appeared in productions aired on national networks. In 2007, he retired and moved

to New Mexico. When he and Rebecca first visited Hillsboro, he exclaimed, “I don’t know anything about this stuff. That is cool – way cool!” Shortly thereafter, he produced the Black Range website (www.blackrange.org), dedicated to both the natural and cultural history of the Black Range. In 2018, he developed and started the production of *The Black Range Naturalist*, a quarterly focused on the natural history of the Black Range. Now in its fifth year, *The Black Range Naturalist* supplements and is supported by the website.

Conceptually, both the website and the quarterly push the boundaries of open access as far as possible, and from the beginning they have been focused on community-based science. Luckily, the community that they have been able to draw on has ranged from those who make occasional observations to those who have dedicated their lives to research and/or the management of the natural resources of the region. Both the website and *The Black Range Naturalist* have benefited from a variety of perspectives, expertise in varied disciplines, and the willingness of contributors to share their experiences and knowledge with others. This mix has been the key to the success that the website and quarterly have enjoyed. It is to this community, both the contributors and the readers, that Barnes looks to as he considers future “experiments.”

CITIZEN SCIENCE AWARD: Sonnie Sussillo



Sonnie spent her working life involved in professional activities not directly related to natural resources. After moving to Silver City in 2008 and retiring in 2012 from working for the Federal Communications Commission, Sonnie devoted her time to familiarizing herself with the Gila region and volunteering her time, expertise, and organizational skills to numerous nonprofits in the Silver City area. She became active in several organizations that promoted conservation of the Gila River and its environs, including Gila Resources Information Project (GRIP) and the Gila Conservation Coalition.

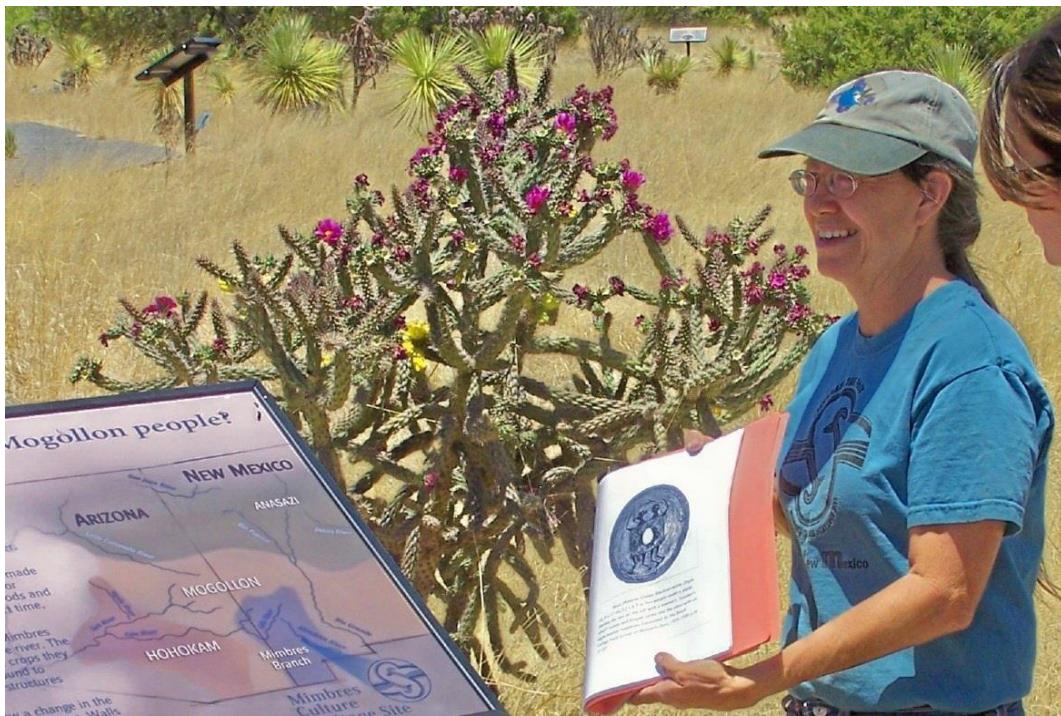
Sonnie evolved into a passionate advocate for the public lands of the Gila region. She was happiest outdoors hiking, birding, tracking, and just simply enjoying the beauty of the region she had come to call home. She recorded the splendor of the land through her photographs and

writings about the nature and landscapes of the Southwest. One of her most important contributions to the science of the Gila region occurred in 2013 when she joined the Gila National Forest Inventory Team and joyfully worked for four years with the team inventorying over 600,000 acres of land surrounding the Gila River. The report from the team helped shape the 2019 Gila National Forest Revised Forest Plan, and it also contained data used to support the legislation now in front of Congress to designate about 450 miles of the Gila and San Francisco Rivers as Wild and Scenic.

Sonnie was a member of the Gila River Festival Planning Committee, and she led field trips, moderated presentation sessions, and secured presenters for the Gila River Festival. Her tracking work for Sky Island Alliance contributed data to the organization's work on the migration of animals in the Sky Island Region of New Mexico, Arizona, and Mexico.

Sonnie was still engaged in conservation issues of the Gila region in 2021 when, during a hike, she died suddenly in the arms of her beloved forest. But her contributions to our knowledge and appreciation of the Gila region will live on, as will our memory of the woman who made them.

EDUCATION AWARD: Marilyn Markel



The recipient of this award educates, engages and motivates students, colleagues, and the community beyond the classroom, providing a model of excellence for conservation education, stewardship, and leadership in the Gila Region of southwest New Mexico and/or southeast Arizona.

Marilyn Markel, a native New Mexican, has long had an interest in the history and archaeology of the Southwest. Marilyn is a graduate of the University of New Mexico and has 30 plus graduate hours at Western New Mexico University in history and archaeology, with a focus on southwest New Mexico. Ms. Markel, now retired, had a career as an educator and taught archaeology at Aldo Leopold Charter School in Silver City for ten years as part of the Youth Conservation Corps program.

Ms. Markel is the recipient of the 2020 prestigious Society for American Archaeology Crabtree award for spearheading efforts in the Mimbres Valley of New Mexico to preserve archaeological sites and educate young people of all ages on the value of the archaeological past. She has made significant contributions to the understanding and preservation of Mimbres sites in New Mexico, through over 25 years of volunteer work on university field school excavations, promotion of site

protection through stewardship, transforming the local artifact-collecting community into an avocational/professional archaeological society, and educating schoolchildren about the value of archaeological heritage. Ms. Markel has assisted archaeological field schools, preserved sites, published children's books on archaeology, and helped create a center, the Mimbres Culture Heritage Site, devoted to the preservation and interpretation of Mimbres archaeology through educational outreach.

FRIEND OF THE GILA AWARD: Allyson Siwik



This award is given to an individual or organization whose efforts inspire appreciation and elevate protection of the Greater Gila Region of Southwest New Mexico, Southeast Arizona, And Mexico. The award recognizes efforts across a range of activities (e.g. advocacy and policy, creative arts, journalism, stewardship and restoration).

Allyson Siwik is the Executive Director of the Gila Resources Information Project (GRIP), a nonprofit environmental organization that works to promote community health by protecting our environment and natural resources in southwest New Mexico. She is also director of the Gila Conservation Coalition (GCC), a partnership of three conservation organizations – GRIP, Upper Gila Watershed Alliance, and Center for Biological Diversity – that works to protect the free-flow of the Gila River and the wilderness characteristics of the Gila and Aldo Leopold Wilderness Areas.

Allyson has a BA in biology from Colby College (Waterville, ME) and a Master of Environmental Management in Resource Economics and Policy from the Duke University School of the Environment (Durham, NC). Allyson's work with the U.S. Environmental Protection Agency brought her to the U.S.-Mexico Border region where she has lived in Silver City since 1996. She has served as director of GRIP since 2003 and GCC since 2004.

Allyson coordinated the successful, 15+-year campaign to defeat the Gila River diversion project that would have harmed the ecology of New Mexico's last wild river and wasted hundreds of millions of dollars. She has worked alongside GCC's co-founder and chairman, the late M.H. Dutch Salmon, and GCC partners Donna Stevens of the Upper Gila Watershed Alliance and Todd Schulke of the Center for Biological Diversity. Over the years, Allyson has participated in hundreds of public meetings, legislative hearings, rallies, and protests and worked with community members, business people, elected officials, conservationists, scientists, and sportsmen in advocating for protection of the Gila River and use of Arizona Water Settlements Act (AWSA) funding for cost-effective water projects that will bring water supply resilience to southwest New Mexico without harming the Gila. The Gila diversion planning process came to an end in 2020 when the state of New Mexico pulled the plug on the environmental compliance process, since the costs of a diversion project significantly outweighed the benefits. In 2021, the state legislature passed House Bill 200 that prohibits funding of a Gila diversion and took away the consultative role of the pro-diversion NM CAP Entity in future AWSA expenditure decisions.

Allyson is a co-founder and one of the coordinators of the Gila River Festival. Established in 2005, the Gila River Festival is an annual event that celebrates New Mexico's last free-flowing river and its important role as the centerpiece in our region's natural and cultural heritage. The festival provides a diversity of opportunities for participants to experience and learn about the natural and cultural history of the area through the arts, humanities, and natural sciences. The event is designed to foster a deeper understanding of the Gila River through expert-led field trips and workshops, lectures by scientists, authors, historians, and conservationists, and programming in the visual and performing arts, film, music, and dance.

Allyson helped lead the Peaceful Gila Skies coalition and its successful campaign to stop the Holloman Air Force Base proposal for F-16 pilot training over the Gila that would have put the Gila National Forest, Gila and Aldo Leopold Wilderness Areas, and nearby communities like Silver City at risk from wildfire, extreme noise, and environmental contamination.

KEYNOTE PRESENTATION



Keynote Speaker Stephanie Garcia Richard

30x30: Centering public lands in the conservation effort

Commissioner Garcia Richard will explore the ways that the State Land Office has been transformed from its historic reliance on extraction, including efforts to create new, sustainable energy sources and protect freshwater from use in fracking. She will also report on the efforts the office has underway with their partners, including research universities, conservation advocates, and landowners, to develop new methods for regenerative agriculture and soil health.

Commissioner Stephanie Garcia Richard is the first woman, the first Latina, and the first educator to serve as New Mexico's Commissioner of Public Lands.

Born in Tucumcari and raised in Silver City, Stephanie learned at a young age the importance of serving others. Her father, a WWII veteran, was a teacher; her mother was active in their church and community. Stephanie grew up in a family that operated ranches on the eastern plains and northern mountains of New Mexico, sparking the strong connection to our land that she holds today. After graduating from Silver High School, Stephanie went on to receive her undergraduate degree from Barnard College at Columbia University in New York.

Stephanie was elected to the New Mexico House of Representatives in 2012. During her six years as a State Representative, she championed laws to increase access to a quality education, transparency, and investments in renewable energy, job training, and economic development. She served as Chair of the House Education Committee for two years before being elected Land Commissioner in 2018.

As Land Commissioner, Stephanie is focused on raising as much money as possible while always keeping an eye toward stewardship and preserving the land for generations to come. We can diversify the revenue that comes into the Land Office by tripling the number of renewable energy projects, promoting outdoor recreation, and encouraging new and innovative commercial development on state trust land. With the largest continuous oil and gas resources potential ever assessed in the world sitting in southeast New Mexico, and land that is prime for wind and solar development, Commissioner Garcia Richard is committed to working to make more money for New Mexico while protecting the health of our land.

KEYNOTE PRESENTATION



Keynote Speaker Ed Zahniser

The American wilderness imagination

Edward Zahniser, eddzahniser@comcast.net

This talk traces aspects of the language and impulse of the landmark 1964 "National Wilderness Preservation System Act" back to the writings of Vermonter George Perkins Marsh in his 19th-century book, *Man and Nature: The Earth as Modified by Human Action*, and to the "Forever Wild" clause in the New York State Constitution. The latter now protects 16 wilderness areas, mostly on New York State Forest Preserve lands, particularly in the Adirondack and Catskill Mountain regions. New York State's constitutional protection for wilderness helped inspire the impulse to create federal wilderness protection by law, and not by administrative whim, which had never given so-designated wilderness an enduring preservation traction.

For the full text of Edward Zahniser's keynote presentation, please see p. 40.

SESSION ABSTRACTS

*Names denoted with * indicate student presenters.*

Restoring Willow Creek: An opportunity

Brooks, James, Biologist/Packer, JEB Outfitters LLC, arroyodejaime@gmail.com

Jeffrey Arterburn, Trout Unlimited-Gila/Rio Grande Chapter

Chris Canavan, Blue Heron Environmental

Allen Haden, Natural Channel Design

Amanda Gehrt, U.S. Forest Service - Reserve

Carolyn Koury, U.S. Forest Service - Silver City

Susan Styer, New Mexico Environment Department

Jill Wick, NM Department of Game and Fish

High elevation cold water streams of the Mogollon Mountains in southwestern New Mexico are becoming increasingly compromised by post-wildfire impacts. Willow Creek in the upper Middle Fork Gila River drainage is a prime example. Stream habitat conditions assessed and monitored since 2017 by a Trout Unlimited-led effort of citizen scientists found degraded stream channel conditions including: 1) channel incision and straightening, 2) stream bank erosion, 3) low abundance and shallow depths of pool habitats, and 4) sparse riparian canopy cover. After listing Willow Creek as impaired (Clean Water Act: aluminum, temperature), a watershed-based survey and restoration plan was commissioned by the New Mexico Environment Department (NMED) and accepted by the Environmental Protection Agency in 2021. Implementation of proposed restoration strategies to reduce erosion and stabilize the stream channel beginning in 2022 will include willow planting, constructing one rock dams and Zuni bowls, selective placement of rock clusters and large woody debris, toe rock placement, log vane placement, and channel realignment. Four funding sources have been identified to support Willow Creek restoration efforts: State of New Mexico-funded programs for River Stewardship (NMED), Habitat Stamp (Department of Game and Fish), and Water Trust Board (San Francisco Soil and Water Conservation District); and U.S. Forest Service with National Fish and Wildlife Foundation. The resident fish community, including the federally protected Gila trout (*Oncorhynchus gilae*), other wildlife species, and humans will all benefit from restoration of the Willow Creek watershed.

Conservation genomics of spikedace (*Meda fulgida*)

Cameron, Alex*, PhD Candidate, University of New Mexico, alcameron@unm.edu

Megan J. Osborne, PhD, University of New Mexico

Thomas F. Turner, PhD, University of New Mexico

Spikedace (*Meda fulgida*) is an endangered minnow that is an important member of the native fish community of the Gila River Basin throughout Arizona and New Mexico. Like other endemic fishes, it has experienced dramatic declines due to habitat alteration and the introduction

of nonnative species. Understanding how much genetic diversity remains, and where, is crucial to its conservation and management. Here we used a new genomic technology to generate single nucleotide polymorphisms (SNPs) to characterize population structure, genetic diversity, and effective population size (N_e) for all remaining populations of spikedace. We found two distinct genetic lineages of spikedace in Aravaipa Creek (AZ) and the Upper Gila River (NM). Patterns of genetic diversity among lineages indicate that Aravaipa Creek fish retain the most genetic variation among spikedace and suggest long-term stability within this population relative to others. Each lineage of spikedace still retains a population stronghold, but we found considerable variation in genetic diversity and effective size among reintroduced populations. Reintroduced populations within the Verde River exhibited $N_e < 100$ while one in the Blue River had a $N_e > 500$. These results suggest some streams within the historically occupied range of spikedace may not offer suitable habitat, underscoring the importance of habitat quality and restoration for successful reintroduction.

The trifecta crisis and natural climate solutions

Cole, A.T., atandcinda@gmail.com

“We live in the most important moment in human history.” The Sixth Assessment Report by the United Nations International Panel on Climate Change (IPCC) is said to be a “code red for humanity” because the crisis is “inevitable, unprecedented, irreversible.” Average atmospheric carbon reading for 2021 was 414ppm, and the science world is unanimous that the safe limit is 350ppm. Climate scientists tell us to thwart this crisis we must stop polluting the atmosphere with greenhouse gases, end fossil fuel use, consume less meat and dairy, limit air traffic and transport, and weatherize homes and businesses, to name a few. Yet, if we stopped emitting greenhouse gases today and carbon didn’t take forty years to do its mischief, we could arrest further increases in the 414ppm number, but would do nothing to draw down the 64ppm to the safe level of 350ppm. The solution to the draw-down question is addressed in the Paris Climate Agreement (“The most mature carbon dioxide removal method is improved land stewardship” and “better stewardship of land is needed”), the recent IPCC reports, and a variety of peer reviewed science papers (“natural climate solutions can provide 37% of cost-effective CO₂ mitigation needed through 2030 for a > 66% chance of holding warming below 2°C”). Habitat restoration is one of 21 recognized natural climate solutions and we have been restoring the Pitchfork Ranch for almost 18 years. We have same-location photographs to demonstrate changes due to restoration. Everyone can do this.

Diet of a riverine specialist, *Thamnophis rufipunctatus*, in SW New Mexico

Christman, Bruce L., Conservation Herpetologist, Private Consultant, nattybrew@hotmail.com
Dr. Randy D. Jennings, Western New Mexico University

The narrow-headed gartersnake, *Thamnophis rufipunctatus*, is a riverine aquatic specialist, listed federally as Threatened, preying almost exclusively on fish. During 13 seasons of field work studying this snake we have collected data on its preferred prey, from 61 individual snakes we

have 84 identifiable prey items consisting primarily of native fish species. *Thamnophis rufipunctatus* is intricately linked to native fish communities and their continued health and persistence in the Gila and San Francisco River drainages. Loss of *T. rufipunctatus* populations across its range are attributable to introductions of non-native spiny-rayed sport fish and other non-native predators (bullfrog and crayfish).

Springs conservation - patterns and processes

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

More than 100 springs have been inventoried and assessed to date on southeastern Arizona lands administered by the Bureau of Land Management. Needed improvements in springs resource condition and management are frequently the same at each spring system. Type of spring system, recognition of the total springs resource, fencing parameters, fences crossing drainages, providing water for livestock, and location of livestock infrastructure are components of springs conservation. This paper will provide a case study of several spring systems and the conservation plans being developed to promote conservation of the entire springs resource.

Setting the stage for forest conservation

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The left wing and the right wing are attached to the same bird: both want good watershed management and the resulting products like clean air and clean water. The timber industry of the past was about big trees and bringing lumber products to market. In the past 30 years the market has waned, the loggers and skilled artisans of the forest industry have been extirpated, and forestry management has turned to fire as a tool. However, large-scale fires that turn into wildfires often do more damage than good. How did we get here? This paper provides a brief history of forestry and public perception in the western states and sets the stage for a panel of speakers. The forestry session brings together forest industry champions, forest personnel and boots-on-the-ground to discuss what a forestry future could look like for the Gila National Forest and surrounding region. This session will share insights and challenges unique to the Gila. It will also share insight and innovation from other regions, best management practices and discussion on federal authorities and contract mechanisms that could be utilized to overcome challenges. The session will foster an open dialogue to discuss what a future forest industry could look like to conserve watersheds and produce clean air, clean water, healthy wildlife habitat, and vibrant fisheries, along with outdoor recreation.

Long-nosed bat (*Leptonycteris yerbabuenae*) diet and movement in southwestern New Mexico

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Kathryn E. Stoner, Colorado State University

Does long-nosed bat (*Leptonycteris yerbabuenae*) diet vary within seasons, across years, and across sites in relation to local flowering agave density, and if so, what effect does this have on their movement patterns in southwestern New Mexico? To test this question, we will collect bat fecal samples from multiple distinct sites and molecularly assess plant and insects in the bats' diet, as well as mark individuals with PIT tags to track their movement patterns. We suspect that diet will differ between times of high and low agave nectar availability such that bats may be supplementing their diet with insects and possibly other nectar sources (i.e., artificial nectar from hummingbird feeders) during periods of low flowering agave availability. This ongoing project has a significant citizen science component and is currently looking for new hummingbird feeder sites in areas within or close to Silver City, Rodeo, Animas, NM, and Portal, AZ, to monitor long-nosed bat activity.

Habitat suitability and predictive analytics for informing a repatriation of an endangered desert fish

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Dr. Colleen A. Caldwell, New Mexico State University

Repatriation is a critical element in the recovery strategy for the endangered, endemic desert fish, Gila chub (*Gila intermedia*). Replications of populations are critical to ensure resiliency to environmental pressures. However, the lack of suitable habitat at the repatriation site is understood to be a contributing factor for failed repatriation attempts. Our goal will be to provide suitable repatriation recommendations based on a systematic habitat assessment of extant populations in Arizona and New Mexico, as well as extirpated populations in New Mexico. We collected habitat data on three Arizona streams with extant Gila chub populations. We characterized the habitat at each stream reach by collecting information on stream morphology, macroinvertebrates, substrate, flow, habitat types, cover, water quality, and fish abundance. We then related each habitat variable to our metric of suitability, Gila chub abundance, using a random forest model. Though preliminary, the top random forest model demonstrated that six habitat variables (percentage of pool habitat, speckled dace (*Rhinichthys osculus*) abundance, elevation, substrate embeddedness, stream surveyed, and the percentage of fine substrate) contributed principally to Gila chub abundance. Future efforts for this investigation will include stream reaches from two additional extant Gila chub populations. We will use predictive analytic tools to predict Gila chub abundance at each of the potential repatriation sites in the San Francisco River, New Mexico, based on highly ranked habitat variables in the top random forest model. From the top model, we will rank New Mexico streams for future repatriation efforts.

30x30: Centering public lands in the conservation effort

Garcia Richard, Stephanie, Keynote Speaker, NM Commissioner of Public Lands,
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Commissioner Garcia Richard will explore the ways that the state land office has been transformed from its historic reliance on extraction, including efforts to create new, sustainable energy sources and protect freshwater from use in fracking. She will also report on the efforts the office has underway with their partners, including research universities, conservation advocates, and landowners, to develop new methods for regenerative agriculture and soil health.

Immediate effects of a wildfire on bats in a ponderosa pine (*Pinus ponderosa*) forest

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Suppression of wildfires during the last century caused increases in trees and understory debris throughout forests of western North America that have enabled wildfires to ascend into canopies, causing high intensity, stand-replacing fires. Bats are common inhabitants of western forests, including some that roost in trees. I report on immediate impacts of a wildfire on relative abundance and species richness of bats in a ponderosa pine forest of southwestern New Mexico. Of seven netting sites with similar paired netting efforts in summer 2006, the greatest decrease (54%) in bat captures occurred at the single site that experienced a canopy, stand-replacing wildfire around most of the site. Most other sites yielded increases in bat captures, whereas a few sites had minimal decreases during a summer with little precipitation. At the site with the wildfire, captures of Arizona myotis (*Myotis occultus*) decreased the most, with a 94% decline in females. Captures of male *M. occultus* were similar pre- and post-fire. Silver-haired bats (*Lasionycteris noctivagans*) had a 59% reduction in captures. For all species combined, females declined 84% whereas males declined 35%. Number of species detected on both sampling sessions were generally similar. Species that commonly roost in ponderosa pines appeared most affected by this intense fire. These opportunistic data help understand the immediate effects of stand-replacing fires on bats in ponderosa pine forests of the southwestern United States.

Freeport-McMoRan's bat conservation initiative: collaborations for management and outreach

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Several Freeport-McMoRan (Freeport) mining operations have key biodiversity initiatives centered on bat conservation and management. The company recognizes that subterranean mine features and natural caves at both active and discontinued operations serve as important roosting and breeding sites for many species of bats. In addition, native agaves that grow on/around company property provide an essential food source for nectar-feeding bat species. These agaves are in decline across their historic range due to various natural and anthropogenic factors.

In accordance with our commitment to biodiversity conservation, Freeport has developed collaborative relationships with experts in the private, public, and non-governmental organizational (NGO) sectors to assist in advancing the company's bat conservation initiatives. Efforts include developing and deploying bat monitoring protocols, as well as implementing management actions to enhance bat roosting and foraging resources. In addition, Freeport has leveraged these conservation actions to promote environmental education for learners of all ages. We have worked with students from underserved communities, Native American partners, and retirees across the state to raise awareness about the ecological services and economic benefits that bats provide.

This presentation will highlight the company's bat conservation initiatives across New Mexico and Arizona, using specific case studies to illustrate how diverse partnerships have helped us strengthen and promote the sustainability of our programs over the long-term.

The natural night sky of the Gila Region

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Patricia A. Grauer, Cosmic Campground International Dark Sky Sanctuary, NM

This research began as a project to certify the Cosmic Campground as the first International Dark Sky Sanctuary in the northern hemisphere. The first night's data show that, far from being a dark vault, the natural night sky is an animated light display. Data from the Cosmic Campground International Dark Sky Sanctuary, published in refereed scientific journals, demonstrate that even during a deep solar minimum the brightness of the natural night sky varies in brightness by more than 50%. Changes in natural night sky airglow brightness are produced as the solar extreme ultraviolet radiation and charged particles in the solar wind interact with the Earth's upper atmosphere. Awareness is growing that the study of natural terrestrial airglow may offer clues to researchers in fields as diverse as geomagnetic activity, climate change, high energy cosmic rays, planetary atmospheres, gravity waves, severe weather, light pollution, nocturnal plants and animals, recreation in parks, radio communications, and more. Even in the era of the James Webb Space Telescope, the natural night skies of the Gila region continue to be a source of new scientific information.

Crayfish effects on aquatic communities in the upper Gila River watershed differ among sites, seasons, and taxa

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David Propst, PhD, University of New Mexico
Alesia Hallmark, PhD, University of New Mexico
Thomas F. Turner, PhD, University of New Mexico

There is an urgent need to understand the role of invasive crayfish in southwestern stream communities. Crayfish are explosive breeders, occur at high densities, and are omnivorous,

feeding on organisms that they simultaneously compete with for food. Yet, there is relatively little research on their role and impact in the region. Here we evaluated landscape-wide effects of crayfish on aquatic invertebrate and fish communities, leveraging a ten-year dataset comprised of invertebrate and fish abundance from 12 sites in the upper Gila River drainage. To understand whether there was any relationship between crayfish and community structure, we compared invertebrate and fish richness, evenness, and diversity with crayfish abundance through time and among sites. We then investigated the relationship between crayfish and four key invertebrate taxa (Ephemeroptera, Trichoptera, Nematocera, and all other Diptera). Lastly, we used community ordination techniques and multivariate analyses to examine the effects of crayfish and abiotic factors on invertebrate and fish assemblages. Crayfish abundance was consistently highest at the lowest elevation sites and varied greatly within sites from year to year. We found inconsistent overall effects of crayfish on community structure. However, we also found that crayfish sometimes were positively associated with richness and diversity at lowland sites, particularly in warmer months. Secondly, we found that invertebrate abundance often correlated positively with crayfish abundance and these relationships were sometimes non-linear. Lastly, we found that invertebrate community assemblages varied little among sites. However, fish communities appeared most impacted by elevation and the compounded effects of non-native fish and crayfish.

Topographic and climatic controls on post-fire seedling establishment in the Jemez Mountains

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Chris Marsh, University New Mexico
Joseph Crockett, University New Mexico

Changing climatic conditions are exacerbating a legacy of fire exclusion that has increased high-severity wildfire risk in southwestern US forests. Evidence from large high-severity patches shows low rates of post-fire conifer establishment. Post-fire planting can overcome dispersal limitations, but warmer and drier conditions are causing low rates of survival. We established an experiment in the footprint of the 2011 Las Conchas fire in the Jemez Mountains of northern New Mexico to quantify the effects of aspect and vegetation cover type on seedling survival for four common southwestern tree species. We planted seedlings stratified by aspect (north, south) and cover (under shrubs, no cover) and calculated indices of landscape position as predictor variables for survival. We found differences in survival by species and, for three of the species, significant positive effects of landscape positions that buffer incoming solar radiation and concentrate water on survival. We found no effect of shrub cover on survival. We used these data to inform a model to predict the probability of ponderosa pine (*Pinus ponderosa*) seedling survival using boosted regression trees. Our model of models, which included models with different combinations of topographic indices and incoming solar radiation, could predict the probability of survival with approximately 90% accuracy. Our results demonstrate the ability of small-scale topographic variability to buffer the microclimate of a site from the regional climate in an ecologically meaningful manner.

Progress on locating temper sources in the Sapillo Valley for the analysis of Lake Roberts Vista site painted sherds

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The purpose of this project is to identify the valley source(s) of temper to reveal trade and production patterns. Alluvial sand samples were taken from side drainages in the upper and middle Sapillo Valley during the summer of 2021. They will be compared to the temper materials from a sample of painted ceramics from the Lake Roberts Vista site, a Mimbres pithouse and pueblo site in the Sapillo Valley on Gila National Forest property. The site was excavated in the early 1990s for a series of field schools. The ceramics used for the study come from floor contexts of structures ranging from the Georgetown phase pithouses to Classic period pueblo rooms, and all are Mimbres pottery types. Previous INAA cluster analyses of clay identified a cluster belonging to the Sapillo/Upper Mimbres area (Gottschall et al. 2002), indicating that pottery production likely occurred in the Sapillo Valley. Using an optical microscope and X-ray diffraction, petrographic characterization will focus on both the side drainage sands and temper material used in the pottery sample from the site. From these analyses, specific side drainages may be linked to temper material used in the sampled ceramic assemblage to see if pottery was made at the Lake Roberts Vista site or if it imported pottery from other larger sites in the valley, and if these patterns changed over time.

Environmental niche modelling and mapping of invasive virile crayfish in the Lower Colorado River Basin

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The Lower Colorado River Basin of Arizona (LCRB) is invaluable to freshwater biodiversity, harboring numerous endemic species. Over the last forty years, non-native virile crayfish (*Faxonius virilis*) have become established in waterbodies of the LCRB, outcompeting and preying upon native species. However, their invasion potential and potential distribution remain poorly understood. This study addresses two questions: (1) what is the environmental niche of virile crayfish, and (2) what is the geographic distribution of virile crayfish in the LCRB? We conducted a geographically comprehensive field survey across 108 wadable stream sites in the LCRB in the summer of 2021 to assess site occupancy of virile crayfish, developed environmental niche models to characterize habitat suitability, and projected habitat suitability to all 100,237 interconfluence stream reaches in the LCRB. We fit Environmental Niche Models (ENMs) via multiple statistical algorithms using nine GIS-derived natural and anthropogenic landscape predictor variables. We used Area Under the Curve (AUC) to evaluate model performance and Gini index to evaluate variable importance. AUCs ranged from 0.84 to 0.85, indicating good model fit. Wetness index, percent forest, and human population density within watershed were the strongest predictors, whereas dam density and percent agriculture were relatively weak predictors. ENMs predicted crayfish presence in 50.5% of perennial streams and

8.4% of intermittent streams. Habitat suitability was greatest in perennial streams in high elevation forests. GIS layers from this ENM will aid conservation efforts by providing occurrence estimates at the fine spatial resolution needed to prioritize eradication.

An overview of the mammals of the Gila region

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A study of the mammals of the Gila region of New Mexico was conducted from 2012 through 2020, with 2,919 voucher specimens collected through fieldwork and collaborations with commercial trappers, in addition to data from camera traps, review of major holdings at 46 museums ($n = 12,505$ georeferenced specimens), and literature review. Specimens cover a 170-year span dating back to 1850, and were unevenly distributed spatially and temporally across the Gila region. Most areas were very poorly represented, and, when summed across all mammal species, ranged from 0.02 to 3.7 specimens per km^2 . The survey documented 108 species (104 extant) for the region. High species richness, greater than that reported for 38 states in the United States, is likely due to the juxtaposition of multiple biomes in the Gila, including the Sonoran, Chihuahuan, and Great Basin Deserts, the Rocky Mountains and Sierra Madre Occidental, and nearby “sky islands” of the Southwest. Two species, *Leptonycteris yerbabuena* and *Zapus luteus*, are documented for the first time from the study area. Expansions of the known range of these species, and *Sciurus arizonensis* are described from specimen and camera data. Preliminary phylogeographic studies of four species (*Notiosorex crawfordi*, *Neotoma albicula*, *Perognathus flavus*, and *Thomomys bottae*) using the mitochondrial cytochrome-b gene reveal the dynamic biogeographic history of the region and reinforce how landscape complexity and climate change have jointly contributed to diversification and thus high mammalian diversity in the region.

A brief history of bryology in the Gila National Forest

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Kelly Allred, New Mexico State University
Karen Blisard

Bryology is the study of mosses, liverworts, and hornworts. E.O. Wooton and O.B. Metcalfe were the first to collect bryophytes in what would become the Gila National Forest around the beginning of the 20th century. John Holzinger, who taught botany in Minnesota, made more than 100 bryophyte collections in the Mimbres Valley and Black Range in 1911. Work on these three plant lineages has markedly accelerated in the Gila National Forest in the past decade. We will discuss historical trends and highlight the contributions of Wooton, Metcalfe, and Holzinger.

CCAST, Collaborative Conservation and Adaptation Strategy Toolbox

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Natural resource managers and restoration practitioners have voiced the need for increased coordination around key conservation challenges, and more effective sharing of lessons learned from on-the-ground projects and applied research. The Collaborative Conservation and Adaptation Strategy Toolbox (CCAST) responds to these needs by providing a platform that supports peer-to-peer knowledge exchange. Sponsored by the US Fish and Wildlife Service and the Bureau of Reclamation, CCAST supports the development and dissemination of Case Studies while coordinating issue-based networks to collaboratively address shared challenges. CCAST case studies help overcome common barriers to communication, including the lack of time, capacity, and technology to share project information. Building on the foundation of these case studies, CCAST supports Communities of Practice (CoPs) on non-native aquatic species, drought adaptation, grassland restoration, and pollinator conservation. CoP participants guide the focus of case studies based on their own needs and challenges. Furthermore, CoP partners help CCAST identify critical challenges and research priorities, develop decision-support tools, and participate in webinars and workshops to showcase project experience. CCAST also supports emerging conservation professionals by mentoring student interns in partnership with the University of Arizona. Interns develop writing skills, build professional networks, and learn from practitioners' experience. This model has enabled CCAST to grow into an expanding partnership that supports hundreds of participants from federal, state, and local governments, non-governmental organizations (NGOs), research institutions, and private land managers. CCAST's modular and scalable model allows us to offer the CCAST platform as a tool for emerging partnerships to overcome critical conservation challenges.

Genomic variation of endangered New Mexico meadow jumping mice: Implications for conservation and management

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Riparian-associated species in the arid Southwest often face a series of threats. Persistently low population sizes can impede the long-term viability through the loss of genetic variability in a fragmented landscape via drift. The ability to adapt to local conditions is also essential for

viability. Conservation genomics provide powerful windows into these processes, and we applied this approach to study the federally endangered New Mexico meadow jumping mouse (*Zapus luteus luteus*). We used ddRADseq and obtained over 8,000 single nucleotide polymorphisms (SNPs) from across the subspecies range. We evaluated genomic variation within and among US Fish & Wildlife Service Critical Habitat Areas (CHAs) from eight geographic regions (i.e., mountain ranges) to determine how drift and selection have structured populations using neutral and outlier loci. In our preliminary results, we found that geographic areas are significantly differentiated from one another, have persistently low genetic variability, and effective population sizes are concerningly low. Additionally, geographic areas maintain genomic signatures consistent with adaptation to local conditions. Combined, these results suggest that both drift and adaptation have complementary roles in structuring divergence but there may be insufficient genetic variation to sustain viable populations without active management efforts. Assessments of demographic history combined with other forms of geographic variation will provide a powerful management framework to help identify optimal source populations for restoration activities, including captive breeding, genetic augmentation, and/or repatriation of some populations of the New Mexico meadow jumping mouse. These new insights enable informed decisions to ensure neutral and adaptive variation is preserved.

Bigleaf sedge (*Carex amplifolia*): A rare plant with a personality

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All rare plants have personalities. One such plant is the bigleaf sedge (*Carex amplifolia*). The bigleaf sedge is known in NM only from the Black Range. However, this sedge is a dominant species in the wetlands of Oregon and Washington some 1000 miles from the Black Range. Yet no other disjunct populations have been found between the Pacific Northwest populations and the Black Range. The aberrant occurrence in the Black Range is part of this sedge's personality. This sedge is tall with abnormally wide leaves and pistillate spikes with brown to brownish green perigynia with subspherical bodies that are connected to a sometimes-bent beak 0.7-1.1 mm long. We now know of seven populations of the sedge in the Black Range. The first population was found by E. H. Roalson along Diamond Creek in 1994. Since then, six other populations have been reported from the Black Range. The unusual disjunct population, its characteristic identifying features, rhizomatous habit, obligate wetland habitat preference, and those seven populations give the bigleaf sedge its NM personality.

The impact of forest disturbance on stream flow dynamics

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There have been many studies worldwide demonstrating that changes in forest cover result in change in water yield. In the late 1970s, the U.S. Forest Service developed a handbook titled Water Resource Evaluation of Non-point Silvicultural Sources (WRENSS) funded by the Environmental Protection Agency to simulate changes in stream flow following reductions in forest cover, primarily from timber harvest in the seven hydro-physiographic regions in the

continental United States. In the 1990s, Troendle and Nankervis updated the Rocky Mountain Region component of the model to reflect the most current state of the science on interception and evapotranspiration modifier coefficients. Subsequent studies have validated the model output over a broad range in watershed scale and disturbance regimes (e.g., timber harvest, fire, insect mortality, etc.). Wildland Hydrology incorporated the WRENSS technology in developing their Watershed Assessment and River Stability and Sediment Supply (WARSSS) methodology in 2006. The WARSSS methodology evaluates introduced sediment (e.g., Hillslope and Channel) relative to flow-related sediment (Hydrology) to determine whether a stream is aggrading (increase in sediment storage) or degrading (scour) and uses the WRENSS model as the hydrology component driver. In the case of the Waldo Canyon fire in 2012, WARSSS was implemented to help prioritize the recovery and mitigation efforts on a fire that burned more than 18,000 acres. Whether evaluating the effects of disturbance or simply determining the current condition of the watershed, the WRENSS and WARSSS technologies provide excellent tools to assist watershed managers in making informed decisions.

Gila trout (*Oncorhynchus gilae*) recovery in Whitewater Creek

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Jill M. Wick, New Mexico Department of Game and Fish

The 2012 Whitewater Baldy Fire negatively affected many Gila trout (*Oncorhynchus gilae*) populations in New Mexico and significantly hampered recovery of the species. However, it did provide restoration opportunities for several Gila trout streams, including Whitewater Creek. For the last seven years, the New Mexico Department of Game and Fish has been working with the U. S. Forest Service, U.S. Fish and Wildlife Service, and local communities to restore Gila trout to the Whitewater Creek drainage. The project required three piscicide treatments of rotenone to remove all nonnative trout. Removal success was then verified with over 200 environmental DNA samples and thousands of seconds of electrofishing. Over 40 helicopter flights and 150 mule loads were required to deliver gear and personnel to the project area. Currently, over 25,000 Gila trout have been repatriated to the drainage with a third stocking planned for August 2022. Whitewater Creek is expected to be one of the most robust populations of Gila trout, providing significant contributions to recovery and a great angling opportunity for local communities.

Wild School

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Nothing has the same impact as experiential education. For twenty-five years I have had the privilege of teaching students the complexities of ecology, the practice of conservation, and the skills necessary to conduct research in the field. I have taught them backcountry ethics and wilderness skills that turn a fear of the wild into a love of the wild and that has turned timidity into self-confidence and self-reliance. The centerpiece of my teaching career has been the Wild Semester, taught since 2005 at Hermosa, New Mexico, on the eastern edge of the Aldo Leopold

Wilderness in the Gila National Forest. I have been given the opportunity to acquire this property for continued and expanded use as a conservation research and education facility. I have created a non-profit organization, Natural Curiosity, for that purpose. It is our intention to partner with like-minded individuals, organizations, and agencies in the Gila region to host and/or facilitate research projects, educational programs, and conservation work from trail maintenance to biodiversity surveys, as well as to conduct our own activities in this vein.

Restoration economies -- considerations, challenges, and opportunities

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Successful landscape scale restoration requires collaborative planning and partnerships dedicated to a shared vision. It also requires industry capable of utilizing restoration byproducts at a pace and scale equal to the in-wood capacity.

My presentation will touch on considerations, challenges and opportunities for landscape scale restoration.

An amateur lichenologist's introduction to field identification of lichens

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Lichens are one of the least understood and most overlooked components of virtually all natural ecosystems. Drawing on my experiences as a Western New Mexico University graduate student, I will relate a layman's introduction to the basics of lichen biology, evolution, and identification challenges in the field. While my research was done in the Sandia Mountains (Cibola NF), all species that will be discussed can also be found in the Gila. Far from being a "background character," I hope to show that lichens are worth our respect, wonder, and much more research!

Production of an outside ranarium for Chiricahua leopard frogs

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Nathan Cline, Eastern Arizona College

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Chytrid (chytridiomycosis) threatens Chiricahua leopard frogs (*Rana chiricahuensis*). Ranariums have been established with the goal to increase frog numbers. Ranariums are typically constructed in interior climate-controlled conditions. While an exterior ranarium may increase the likelihood of chytrid contamination, Eastern Arizona College's Discovery Park ranarium has successfully provided frogs and egg masses for repopulation at multiple sites in the southwestern United States. This case study may provide introductory evidence of how an uncontrolled environment may lead to more environmentally resilient frogs compared to climate-controlled ranariums.

Long-term monitoring at the Iron Bridge tract of the Gila River Preserve

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The Gila River's highly variable flow regime shapes and sustains riparian and aquatic habitat. The Iron Bridge Conservation Area, one tract of The Nature Conservancy's Gila River Preserve, was acquired in 2006 with the NM Department of Game & Fish. During the past 15 years, three additional contiguous properties have expanded this part of the Preserve to over 200 acres. The predominantly native vegetation has rebounded from decades of year-round grazing, showing dramatic increases in canopy cover. Data from long-term monitoring of groundwater dynamics, fishes, and birds will be shared, demonstrating the conservation values of this site in supporting the high biodiversity characteristic of the Cliff-Gila Valley.

Preliminary survey of aquatic hyphomycete species in four streams within the Gila region, New Mexico

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Aquatic hyphomycetes are a polyphyletic group of fungi within the Deuteromycota that live in well aerated, fast-flowing streams. Aquatic hyphomycetes are key decomposers of plant litter in streams. The purpose of this study was to identify the common aquatic hyphomycete species found within the Gila Region, New Mexico. Decomposing leaves from four streams were examined to identify conidia of aquatic hyphomycetes. The four streams sampled for this study were: a) the Mimbres River below the Mimbres Culture Heritage Site on property owned by the New Mexico Game and Fish Department, b) the Gila River at the Box Canyon, c) Sapillo Creek in the Sapillo drainage, and d) Mangas Creek at Mangas Springs. This study makes comparisons and discusses the differences in species and species abundance found among the four designated survey sample locations. Results of the preliminary study found that *Tetracladium marchalianum* was a species seen at every sample location. *Lunulospora curvula* was another species that had great abundance and was located at two of the four sample sites. This preliminary survey is thought to be the first of its kind for the Gila region.

Recent changes in climate for the range of the Chiricahua leopard frog

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Dr. Nathan Cline, Eastern Arizona College

An analysis of recent climate fluctuations throughout the ecological range of the Chiricahua leopard frog (*Rana chiricahuensis*) may provide insight into the potential recovery of species that have been significantly impacted by chytrid (chytridiomycosis). Fluctuating monthly temperatures have been suggested to affect the resilience in some amphibians to chytrid. In this

study, we compared monthly temperature frequency as well as monthly maximums and minimums from the year 2000 to 2020.

Abiotic factors and high severity burn patch shape and size influence ponderosa pine dispersal distance

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Matthew Hurteau, Ph.D. University New Mexico

The area burned by high-severity fire and individual patch size have increased across the southwestern US in recent decades. Large high-severity patches tend to have limited seedling establishment because they are too far from intact forest to be reseeded. However, dispersal distance is not constant and factors such as topography and patch shape could influence the proportion of a high severity burn patch that is within the dispersal distance of intact forest. We sought to quantify the effects of a range of abiotic factors on dispersal distance to better predict post-fire regeneration. We sampled ponderosa pine regeneration on 51 transects 160 m from intact forest into severely burned forest in 10 patches across five fires that occurred on the Gila National Forest from 1989 to 1995. We stratified our sampling by aspect, slope, and relative position of the intact forest. We found that regeneration density was greatest when nearer to and downslope from intact forest and that the decrease in density with distance was influenced by slope and relative position. We used our model to estimate spatially explicit seedling densities across all five fires to quantify interactions between patch shape and abiotic attributes. We found that the shape of larger patches interacted with these factors to influence the proportion of each patch that was accessible to dispersal and the predicted density of seedlings across space. Our results show that patch shape and size interact with abiotic attributes to influence regeneration patterns.

The American wilderness imagination

Zahniser, Edward, Keynote Speaker, eddzahniser@comcast.net

This talk traces aspects of the language and impulse of the landmark 1964 "National Wilderness Preservation System Act" back to the writings of Vermonter George Perkins Marsh in his 19th-century book, *Man and Nature: The Earth as Modified by Human Action*, and to the "Forever Wild" clause in the New York State Constitution. The latter now protects 16 wilderness areas, most on New York State Forest Preserve lands, particularly in the Adirondack and Catskill Mountain regions. New York State's constitutional protection for wilderness helped inspire the impulse to create federal wilderness protection by law, and not by administrative whim, which had never given so-designated wilderness an enduring preservation traction.

For the full text of Edward Zahniser's keynote presentation, please see the next page.

The American Wilderness Imagination

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The history of achieving the 1964 Wilderness Act in the U.S. Congress is commonly seen as an eight-year legislative struggle. The first Wilderness Bills were introduced in Congress in 1956—in the House of Representatives by John P. Saylor of Pennsylvania and in the Senate by Hubert H. Humphrey of Minnesota. The Wilderness Act was signed into law by President Lyndon B. Johnson on September 3, 1964. My father, Howard Zahniser, primary author of the Act, had died in May 1964. My mother, Alice, attended the White House signing, and President Johnson gave her a pen he used. Three years later President Johnson sent me a letter telling me I was being drafted for two years of U.S. Army service!

I offer you not an eight-year legislative history, but a deeper glimpse of Wilderness Act history, the history of the American wilderness imagination. We are projected into the wilderness struggle today by the imagination of a great cloud of witnesses who not only *came* before us, but also *go* before us as we allow wilderness to accept us into itself.

We can frame the history of winning the U.S. “National Wilderness Preservation System Act” as a 100-year struggle, from 1864 to 1964. Two 1864 events launch such a history of the Wilderness Act. The first event is President Abraham Lincoln’s taking time during the Civil War to sign an act ceding certain federal public domain lands of Yosemite Valley and the Mariposa Grove of Big Trees—Giant Sequoia trees—to the state of California for public parklands.

Also in 1864, George Perkins Marsh published his book *Man and Nature*. Historian and planner Lewis Mumford, in the mid-20th century, deemed Marsh’s book the fountainhead of American conservation. Marsh’s book is subtitled: “The Earth as Modified by Human Action.” The verb form of that word, *to modify*, occurs in the opening paragraphs of the Wilderness Act. This was no accident. My father, Howard Zahniser, chief architect of the 1964 Wilderness Act, closely studied the beginnings of American concern for wilderness. Zahnie, as friends and associates called my father, knew to begin at the beginning.

What George Perkins Marsh achieved in *Man and Nature* was a historical synthesis of global assaults on forests by humankind. The book is still in print. It has never been out of print. It went through some seven printings by 1873. Marsh wrote the book in Italy, where U.S. President Abraham Lincoln had posted him as a diplomat. Marsh had witnessed the destruction of Vermont's forests in his own lifetime. But it was Marsh's travels in the Mediterranean Basin that enabled him, gradually, to see the potential disaster in our wanton destruction of forests. But Marsh's awakening was not instant insight. It was gradual.

In 1856, Marsh and his wife had traveled in North Africa, in the southern Mediterranean Basin. Marsh had been sent to North Africa by Jefferson Davis, who was U.S. Secretary of War then. Ironically, as Marsh wrote *Man and Nature*, Jefferson Davis was president of the Confederate States of America.

Jefferson Davis had asked Marsh to study the camel, which the U.S. Army was interested in using to fight indigenous American Indians in the Southwest. In North Africa, Marsh realized that many desert areas he and his wife traversed were former sites of great civilizations founded on great forests that had harbored elephants, not camels.

But it did not hit Marsh full-face just then. Marsh's 1856 book, *The Camel*, opens with the then prevailing notion that humans were not capable of significant impacts on God's creation. But then Marsh was posted to Italy by Abraham Lincoln. His travels there convinced him that formerly great civilizations of the northern Mediterranean Basin, such as Greece, also declined as their forests were cut down—just as Marsh witnessed forests of his home state of Vermont devastated. So, the subtitle of Marsh's 1864 book *Man and Nature*: "The Earth as Modified by Human Action," was both actually and metaphorically a watershed event for Marsh's thinking. Forests were keepers of watersheds, and watersheds were keepers of civilizations.

The text of the Wilderness Act begins: "An Act / To establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled." The text quickly moves to the policy statement, Section 2 (a), "In order to assure

that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness."

Hear those phrases "does not occupy and modify all areas . . . leaving no lands designated for preservation and protection in their natural condition"

In its broadest sweep, the U.S. Wilderness Act is a statement of social ethics. It is about restraint and humility. It is about heeding this warning about forest values that George Perkins Marsh articulated 100 years earlier, in 1864. The Wilderness Act is about restraint and humility for what we do *not* know about the land organism, about which ecologist Aldo Leopold wrote.

In recent memory, acid rain, acidic deposition, forced us to understand soil relationships. What we discovered in soils was the same spiraling downward of complexity that the Hubble space telescope found spiraling outward as the complexity of the universe, or multiverse. Tachyons, which may be the same as neutrinos, for example, have a mass that is imaginary. Isn't that luscious science? The mass of tachyons is imaginary.

And what about these opening lines of the Wilderness Act? "An Act To establish a National Wilderness Preservation System for the permanent good of the whole people . . ." For the permanent good of the whole people. I commend to your repeated close reading the text of the Wilderness Act. Find it at *wilderness.net*. The Act makes its own best case for wilderness stewardship and wilderness education.

I belabor this conservation history and George Perkins Marsh's work—this 100-year history of realizing a Wilderness Act—to show that wilderness preservation was not a new idea in the 1950s. Wilderness preservation as a vision for the future of federal public lands has been around a long time.

Directly across Lake Champlain from George Perkins Marsh's home state of Vermont, the Adirondack Mountains region of New York State testifies to Americans' long-standing concern for wildlands. In 1872, the people of New York State began to move to create an Adirondack State Park. Their motivation is not difficult to understand. In 1871, New Yorkers suddenly found themselves net importers of wood fiber for the first time ever. Heeding Marsh's warnings in *Man and Nature*, New Yorkers, in 1872, moved to protect their remaining forests and the Adirondack Mountains watershed, which supplies the water for the Erie Canal and New York City.

In 1885, New Yorkers created, on the state-owned lands of the Adirondack and Catskill State Parks, their State Forest Preserve lands. Then, in 1894, New Yorkers inserted into their state Constitution the so-called "forever wild" clause. The clause stipulates that those forest preserve lands will be kept "forever as wild forest lands."

A voting member of that 1894 Constitutional Convention was the lawyer and judge Louis Marshall. Louis Marshall was a great champion of Jewish civil liberties, immigrant rights, and the rights of all minorities. Louis Marshall led the floor fight at the 1915 New York State Constitutional Convention that stopped a move to gut the "forever wild" clause. In American wilderness preservation history, Louis Marshall is also known as the father of Robert Marshall, the indefatigable Bob Marshall who labored within the U.S. Forest Service and what became the Bureau of Indian Affairs to protect wilderness and whose estate gifted crucial early support for The Wilderness Society. Bob Marshall died at age 39. His brother George Marshall, a member of The Wilderness Society Governing Council, was the first person to whom my father Howard Zahniser sent the very first draft of a Wilderness Bill.

The Adirondacks and Catskills still preserve—in their "forever wild" state forest preserve lands—the wildlands-protection impetus that led to creation of Forest Reserves on federal public domain lands. However, the Forest Reserves, originally true reserves, in which logging, mining, livestock grazing, and homesteading were prohibited, were subsequently redesignated as national forests open to logging, mining, and grazing.

New York State citizens were able to make stick, in their own backyard, a wildlands preservation

impulse that conservationists such as John Muir and Robert Underwood Johnson were not able to make stick on U.S. federal public domain lands. Addressing members of New York's State legislature in 1953, my father had called the Adirondack and Catskill forest preserve "Where Wilderness Preservation Began." I hope you will tuck this bit of U.S. Wilderness Act pre-history into your mental backpack for your all-important wilderness preservation work in Europe.

The U.S. Wilderness Act is an ethical statement about human relations with what Aldo Leopold called the land organism. In fact, in Judeo-Christian thought, wilderness has a long, long tradition, of being prophetic of human culture. By "prophetic," I don't mean predicting the future. Prophetic here means a calling back to fundamental, right relationships. Wilderness has been the location for calling people back to right relationship with the land, the human community, and God. The wilderness sojourn of the Hebrew people fleeing 400 years of slavery in Egypt under the Pharaoh is reported in the Hebrew Scriptures' Book of Exodus.

Biblical scholar Walter Brueggemann says the wilderness experience of the Hebrew people, as codified in their scriptures, furnished the building blocks of their national identity. The wilderness experience gave them their laws. The wilderness experience gave them the name of God. Other scholars echo Brueggemann's assessment. As scholar Ulrich Mauser reads the New Testament Gospel of Mark, the ministry of Jesus embodies a new Exodus wilderness experience. In Mauser's reading of Mark's Gospel, Jesus of Nazareth works out highlights of his ministry in the wilderness, atop mountains, or near the sea.

In the language of modern psychology, Jesus works out highlights of his ministry in these natural settings known to produce the diminutive effect. These are wild settings that, like Gothic cathedrals, put us in spatial perspectives that impress on us our proper scale in the universal scheme of things.

Wilderness experience calls us back to what my father described as a sense of *dependence* and *interdependence* as well as *independence*. Wilderness experience calls us back to a right relationship with the whole community of life on Earth that derives its existence from the Sun. Wilderness experience calls us back to the realization that, as my father wrote, we prosper only

as the whole community of life prospers.

Novelist Andrew Lytle writes that prophets do not come from the city promising riches and wearing store-bought clothes. No, prophets have always come from the wilderness, stinking of goats . . . and telling of a different sort of treasure. Wendell Berry writes that, “If change is to come, it will come from the margins. . . . It was the desert, not the temple, that gave us the prophets.” In much original Hebrew scripture, the words for *desert* and *wilderness* are the same word.

This prophetic role of wilderness experience — how wilderness calls us back to right relationship, to right living, to social justice —also figures strongly in the history of the U.S. Wilderness Act. To see this, we must step back before George Perkins Marsh and 1864, back to the 1830s, to the Transcendentalist reformers’ era, the era of Margaret Sarah Fuller, Ralph Waldo Emerson, and Henry David Thoreau.

My father was a lifelong student of Emerson and Thoreau. He served a one-year term as honorary president of the Thoreau Society from 1956 to 1957. One of my father’s public-school teachers had her students memorize an Emerson quotation each week. My father’s interest eventually shifted more to Thoreau. It was Thoreau who, in his 1862 essay “Walking,” inscribed the koan-like rallying cry of conservation that “. . . in Wildness is the preservation of the World.”

In his book of American scripture, *Walden*; in his posthumous books *Cape Cod* and *The Maine Woods*; and in his millionous well-polished words of Journals, Thoreau meditates on the utter necessity of wildness. Thoreau’s essay “Walking” combines two 1850s lectures drawn from his journals: “The Wild,” and “Walking.”

It’s intriguing how Thoreau does not say we preserve wildness. He says wildness preserves the world. And for Thoreau, who read French, German, Latin, and Greek, this word *world* is the Greek word *kosmos*, meaning not only world but also beauty, pattern, and order . . . in Wildness is the preservation of the World, Beauty, Pattern, Order. Isn’t that an amazing intuition?

Until the recent resurgence in women's studies, Margaret Sarah Fuller was less well known than Emerson and Thoreau. But many scholars now credit Fuller as the greatest of Transcendentalist thinkers. Many consider Margaret Fuller's book *Woman in the Nineteenth Century* to be, still, the best statement on that subject. Fuller edited the Transcendentalist magazine *The Dial*.

Margaret Fuller is important to Wilderness Act history because her reformist agenda in the 1840s has an uncanny, almost one-to-one correspondence with the legislative agenda of U.S. Senator Hubert H. Humphrey in the 1950s. Fuller advocated American Indian rights, ending slavery, women's suffrage, women's rights, education reform, rehabilitation of women prisoners, and more. Her Transcendentalist reform agenda and Senator Humphrey's legislative agenda, of which the Wilderness Act was one important element, show that wilderness is not at the periphery of society. Wilderness is a core concern of a truly whole society, holistically seen.

Fuller's and Humphrey's similar agendas round out the truth of Thoreau's assertion that "in wilderness is the preservation of the World." The Wilderness Act was part of a large legislative package backed by Senator Humphrey that included the National Defense Education Loan Act, Voting Rights Act, and the Civil Rights Act. Wilderness and wildness are not at the periphery of a truly great society. They are at its core. Here you see the truth declared as the Wilderness Act opens—Congress construes the Wilderness Act to be "for the permanent good of the whole people. . ." by a House of Representatives vote of 373 to 1. Isn't that amazing?

In fact, Howard Zahniser was propelled from a secure job with the federal government—and a pension!—into full-time work for wilderness in part by his grave disillusionment over the use of atomic bombs on Japan. If atomic bombs were the culmination of industrial technology, surely we must find a way to relearn the great lesson of our kinship with all life.

Wilderness and wildness are integral to what farmer, author, and poet Wendell Berry calls "the circumference of mystery." Wilderness and wildness are integral to what Poet Denise Levertov calls "the Great Web." Wilderness and wildness are integral to what the Reverend Dr. Martin Luther King Jr. calls "our inescapable network of mutuality." Poet Gary Snyder describes wildness—which Howard Zahniser described as the fundamental character of wilderness—the

ordering of impermanence. Wilderness and wildness are integral to what God describes to Job as the “circle on the face of the deep,” to the biosphere, to that circle of life, our circle of life. Life.

The prophetic call of wilderness is not to escape the world. The prophetic call of wilderness is to encounter the world’s essence, the Earth’s immortal genius, the planetary intelligence.

Wilderness calls us to renewed kinship with all of life. We humans will extend ethical regard to the whole community of life on Earth only as we feel that we are a part of that community.

In Aldo Leopold’s words, we will enlarge the boundaries of the community, we will enfold the land in our system of ethics, we will live out a land ethic, only as we feel that we are part of that community. By securing a national policy of restraint and humility toward natural conditions and wilderness character, the Wilderness Act has taken us one hugely significant sociopolitical step toward enlarging, in humility, our boundaries of the community to embrace ethically, the land.

Go forth for the wilderness. Do good. Tell the stories. And bring back a different sort of treasure . . . for the permanent good of the whole people.

Ed Zahniser has been a frequent speaker on Wilderness Act history and wilderness issues throughout the United States and virtually in Europe and the U.S. His father, Howard Zahniser, was the architect and chief proponent of the Act with the U.S. Congress. Ed is the author of the book of Adirondack poems, *The Way to Heron Mountain*, and the forthcoming *Adirondack Cabin and Mountain Poems*. He edited and wrote portions of the prose book *Where Wilderness Preservation Began: Adirondack Writings of Howard Zahniser*. Ed retired as Senior Editor and Writer with the National Park Service Publications Group. He worked closely with historian Mark Harvey on *Wilderness Forever: Howard Zahniser and the Path to the Wilderness Act* and the anthology *The Wilderness Writings of Howard Zahniser*.