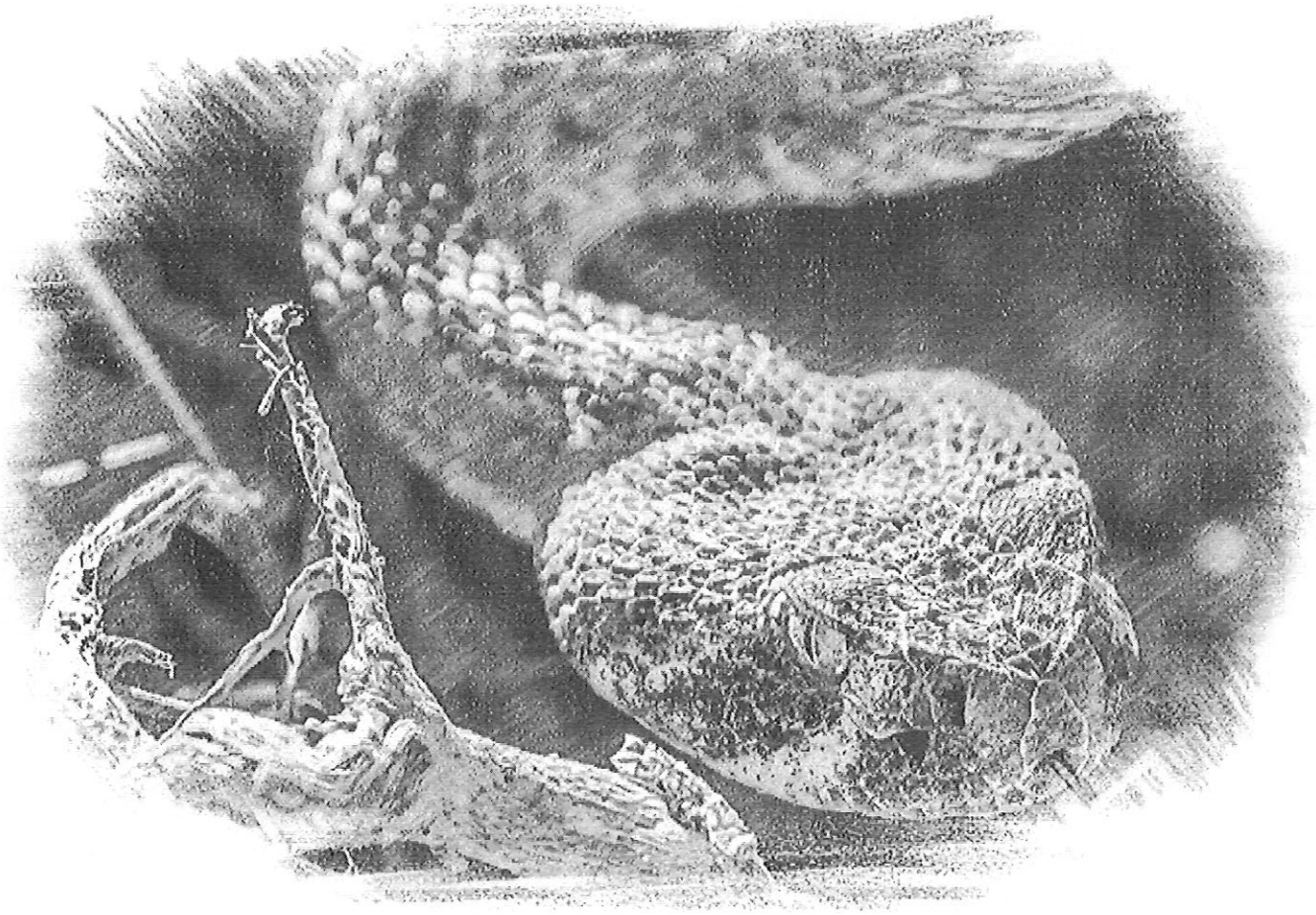
CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

2023



Terlingua Ranch Headquarters
Brewster County, Texas
May 22–24, 2023

CHRISTMAS MOUNTAINS
THE TEXAS STATE UNIVERSITY SYSTEM

Sponsored by the Texas State University System, the TSUS Foundation,
and the Texas State University Department of Biology

2022 CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

Terlingua Ranch Headquarters
Brewster County, Texas
May 22nd–24th, 2023

Monday, May 22nd

5:30 pm	Informal social for meeting participants on the patio by the café
6:30 pm	Dinner for meeting registrants at the Bad Rabbit Café (buffet available for attendees who did not preregister, $20.00)

Tuesday, May 23rd

8:00 am	Field trip to Christmas Mountains overlook (meet in the parking lot outside the bunkhouse)
8:00 am	Paleontology and Geology of the Cretaceous Upper Aguja Formation (meet on the patio outside the café)
1:00 pm	Paper session (in the bunkhouse beneath the Bad Rabbit Café)
6:30 pm	Dinner for meeting registrants at the Bad Rabbit Café (buffet available for attendees who did not preregister, $25.00)

Wednesday, May 24th

8:00 am	Field trip to Christmas Mountains overlook (meet in the parking lot outside the bunkhouse)
8:30 am	Geology stroll (meet on the patio outside the café)
1:00 pm	Afternoon paper session (in the bunkhouse beneath the Bad Rabbit Café)
6:30 pm	Dinner for meeting registrants at the Bad Rabbit Café (buffet available for attendees who did not preregister, $25.00)

FIELD TRIPS

Christmas Mountains Overlook
Trip leaders: Dave Lemke and Liz Measures
Tuesday morning at 8:00 – meet in the parking lot outside the bunkhouse

Participants will carpool up the Old Mine Road to a scenic overlook at the road's end. We will make several stops along the way to examine the geology and vegetation of the area and to take in views of the Rosillos Mountains and desert flats to the east and the Chisos Mountains to the southeast. The overlook, at an elevation of approximately 1640 m (5370 ft), provides stunning views of the region to the south and west, and participants will have the option of making the short but rugged hike to the summit at 1746 m (5728 ft).

Please note that the Old Mine Road requires short wheelbase, high-clearance vehicles and, consequently, the number of participants on this trip will, of necessity, be limited by the number of vehicles we have at our disposal.

Paleontology and Geology of the Cretaceous Upper Aguja Formation Exposed East of the Terlingua Ranch Lodge
Trip leaders: Thomas Shiller, Sue Mulroney and Adam Myers
Tuesday morning at 8:00 – meet on the patio outside the Bad Rabbit Café

In 1939, a team of paleontologists from the American Museum of Natural History traveled to the region now known as Terlingua Ranch. During their visit, Dr. Erich M. Schlaikjer and William O. Sweet collected vertebrate fossil remains from the Cretaceous Aguja Formation near Smallpox Well. These included the left mandible, limb bones (one later found to be the radius of a duck-billed dinosaur), and other fragments from a small horned dinosaur, and a *Deinosuchus* tooth (formerly referred to as *Phobosuchus*). The collection localities lie just to the east of the Terlingua Ranch lodge, adjacent to property owned by Adam Myers and Susan Mulroney. Broad exposures of the upper shale member of the Aguja Formation on the Myers/Mulroney property preserve a variety of vertebrate fossils (dinosaurs, turtles, and crocodilians) as well as fossil wood. A walk through the property will provide an opportunity to step back in time and observe rocks that formed when the landscape was strikingly different and discover the remains of plants and animals that lived over 65 million years ago.

Geology Stroll
Trip leader: Jim Chude
Wednesday morning at 8:30 – meet on the patio outside the Bad Rabbit Café

Join Jim Chude for a short hike to the overlook east of the headquarters area where he will provide an introduction to some of the major sedimentary rock formations and igneous intrusions that characterize the geology of the Christmas Mountains area. The hike will involve a short, mostly uphill trek over a gravel road and dirt path, as well as the possibility of some scrambling over open, rocky areas. This is a moderately easy hike, although since we are in the desert, plan to carry at least a liter of water with you.

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2023 CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

Tuesday, May 23

1:00 Introduction to the Christmas Mountains – A Site for Education and Research
David E. Lemke, Texas State University

1:15 Conservation Easements, Land Trusts, and the Christmas Mountains
Ashley Burke-Muraida, Texas Land Conservancy

1:30 We Got It There Then
Kelsey Wogan, Sul Ross State University

1:45 Quantifying the Impact of Extreme Drought on Gray Oaks (*Quercus grisea*) at Sul Ross' Hancock Hill, Brewster County, Texas
Benjamin Thomas* and Christopher Ritzi, Sul Ross State University

2:00 Montezuma Quail Habitat Preference as an Indicator for Invasive Exotic Feral Pig Presence in the Davis Mountains
Maya Ressler*, Justin T. French, Fidel Hernández and Ryan Luna, Sul Ross State University and Texas A&M University–Kingsville

2:15 Break

2:30 Arachnids of the Northern Chihuahuan Desert
Christopher M. Ritzi, Sul Ross State University

2:45 Use of Electric Fencing to Deter Bears in an Arid Landscape
Michael Janis, Rachael Connally*, Chase McCrory and Krysta Demere, Texas Parks and Wildlife Department

3:00 Elevation Grade Preferences of Whiptails at the Christmas Mountains
Derek Dacus*, Brandon Ramirez and Thornton Larson, Sul Ross State University

3:15 Progress Report on the Geologic Guide to the Christmas Mountains "Summit Road"
Elizabeth A. Measures, Sul Ross State University

3:30 The Geology of Parcels Owned by Sul Ross State University in Brewster County
Kevin Urbanczyk, Sul Ross State University

3:45 Break

4:00 A Sampling of Archeological Resources in Big Bend National Park, Texas
David W. Keller, William A. Cloud, Samuel S. Cason, Robert W. Gray, Richard W. Walter, Thomas C. Alex*, Roger D. Boren, Andrea J. Ohl, and Robert J. Mallouf, Office of the State Archeologist, National Park Service, and Sul Ross State University

4:15 Ecohydrology Improvements and an Evaluation of the Performance of Native Grasses in the Chihuahuan Desert
Aaron O. Ortega-Gonzalez*, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Sul Ross State University

4:30 Restoration of Native Vegetation in Areas Invaded by Lehmann Lovegrass
Andres Solorio Pulido*, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Sul Ross State University

4:45 Collaborative Restoration: The Rio Grande Joint Venture's Recent Endeavors in a Declining Ecosystem
Rebekah Rylander*, Jeff Bennett and Karen Chapman, American Bird Conservancy and Rio Grande Joint Venture

5:00 Looks Like a Good Place to do Research!
Martin K. Terry* and Dee Blinka, Sul Ross State University and EMDRIA.org

Wednesday, May 24

1:00 Hydrology and Geology as Structuring Mechanisms of Fish Communities in a Semi-arid Environment
Lauren E. Chappell* and Timothy H. Bonner, Texas State University

1:15 Winter Habitat Selection, Movement, and Survival of Scaled Quail in the Trans-Pecos, Texas
Caleb L. Hughes*, Ryan S. Luna, Carlos E. Gonzalez, Justin T. French, Louis A. Harveson, Sul Ross State University

1:30 Habitat and Hydrology Enhancement: Improving Ground Cover and Surface Water Retention Through the Use of Wattles
Jason R. Crosby*, Ty W. Goodwin, Eliana K. Dykehouse, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Sul Ross State University

1:45 Anti-Desertification and Water Conservation Planting on Private Land with the Groasis Waterboxx Plant Cocoon
Tom Jacobs, ReGreen Big Bend LLC and Desert Restore

2:00 The School of Constructive Arts - A Regenerative Approach to Building and Education
Robert Estrin* and Estella Dieci, School of Constructive Arts

2:15 Break

2:30 The Changing State of Light Pollution in the Greater Big Bend Region
Stephen Hummel, McDonald Observatory, The University of Texas at Austin

2:45 The Impact of Light Pollution on Wildlife
Amber Harrison, International Dark-Sky Association

3:00 A Cowboy's Observation of the Night Sky in the Dark
C. Jerry Lin*, Joel W. Walker, and Philip L. Cole, Lamar University and Sam Houston State University

3:15 Opportunities for Research Astronomy at the Christmas Mountains in the Greater Big Bend International Dark Sky Reserve
Joel W. Walker, Philip L. Cole and C. Jerry Lin, Sam Houston State University and Lamar University

3:30 The Science Behind the Merging of Neutron Stars
Philip L. Cole*, Joel W. Walker and C. Jerry Lin, Lamar University and Sam Houston State University

3:45 Break

4:00 Layer Cake Archeology: Preliminary Results of Geoarcheological Investigations along the Rio Grande at Big Bend Ranch State Park
Tim Gibbs, Texas Parks and Wildlife Department

4:15 A Preliminary Longitudinal Analysis of Changing Habitat Suitability in Cassin's Sparrow (*Peucaea cassinii*)
John L. Schnase* and Mark L. Carroll, NASA Goddard Space Flight Center

4:30 Ecology of Zone-tailed Hawks in Texas
Krysta Demere*, Brent Bibles, Ben Skipper and Clint Boal, Texas Parks and Wildlife Department, Unity College, Angelo State University, and Texas Tech University

4:45 Mystery Rocks of West Texas: Geyserite
David Rohr*, Kevin Urbanzcyk and Homer Mills, Sul Ross State University and O2 Ranch

5:00 A Study of Intra-fold Deformation in a Laramide Footwall Syncline Exposed in the Walls of Dog Canyon, Big Bend National Park
Jesse Moore Kelsch*, Zachariah Fleming and Kevin Urbanczyk, Sul Ross State University and Stephen F. Austin State University

5:15 A Brief Review of Sea Level Graphs presented in *National Geographic* Magazine
William Robinson, Consulting Geophysicist, Midland, Texas

ABSTRACTS

Tuesday Afternoon

An Introduction to the Christmas Mountains – A Site for Education and Research

David E. Lemke, Department of Biology, Texas State University

This presentation will provide a brief overview of the geology, ecology, and history of the Christmas Mountains property from its inclusion as part of the massive G4 Ranch in the nineteenth century to its recent transfer to the Texas State University System. Geologically, the approximately 4000-hectare property is characterized largely by marine sedimentary rocks of Cretaceous age that have been intruded by much younger (44–40 million-year-old) igneous rocks forming a complex caldera system. At present, the area supports several distinct habitat types. The potential for use of the property as an educational tool will also be discussed.

Conservation Easements, Land Trusts, and the Christmas Mountains

Ashley Burke-Muraida, Texas Land Conservancy

This presentation will provide a brief overview of conservation easements, land trusts, and how they work to preserve the natural landscapes of Texas. The Christmas Mountains have been conserved permanently through a conservation easement that is held by the Texas Land Conservancy. The presentation will explain how the legal agreements work for both the landowner and the land trust. I will walk through some of the history of land trusts and conservation law history, the history of the Christmas Mountains and how this partnership can make a difference in the future.

We Got It There Then

Kelsey Wogan, Department of Biology, Geology & Physical Science, Sul Ross State University

Trans-Pecos Texas is a large and complicated section of country that can be inaccessible for many reasons, not the least of which are the rugged and remote terrain and the fact that much of the land is privately owned. An enthusiastic, accommodating landowner with expansive geographical knowledge and an interest in purposeful adventuring can single-handedly facilitate surprising and significant discoveries in an area that has been largely unexplored. Over the course of several years, two botany students found separate populations of *Styrax platanifolius* var. *youngiae*, a beautiful plant collected only twice before in the area — once in 1914 and again in 2009. An oak tree with an astonishing resemblance to the "rediscovered" *Quercus tardifolia* of the Chisos Mountains was recognized and, growing underneath the remarkable tree, a grove of *Zanthoxylum parvum*, which was previously known from fewer than a dozen localities. In the thick underbrush lining a steep, rocky drainage, researchers encountered a small, scraggly shrub that resembles a *Crataegus* of some

sort, but specimens have not been keyed out to any known species. This list of interesting, rare, and potentially new plants (and even the caterpillars that feed on them) continues to grow as a small group of adventurers/researchers continues to explore. There is so much still waiting to be stumbled upon in this part of the world, especially by anyone willing to venture off the beaten path and keep their eyes open.

Quantifying the Impact of Extreme Drought on Gray Oaks (*Quercus grisea*) at Sul Ross' Hancock Hill, Brewster County, Texas

Benjamin Thomas* and Christopher Ritzi, Department of Biology, Geology & Physical Science, Sul Ross State University

Desert climates in the North American southwest are heavily influenced by the cyclic nature of Pacific Ocean trade winds. During La Niña, semi-permanent high-pressure systems settle over the southwest, often bringing prolonged drought and heat waves. Indigenous floras tend to be uniquely adapted to such weather events. However, anthropogenic climate change has exacerbated both the intensity and duration of extreme drought and heat waves during La Niña years. From 2020 to 2022, a three-year-long La Niña stretch, the Trans-Pecos region of far west Texas saw an equivalent three years of continuous drought at varying levels. The impacts were apparent, as many drought-tolerant species perished during this period. To evaluate the consequences of the drought, we compiled demographic data from a population of gray oaks (*Quercus grisea*) on public land adjacent to Sul Ross State University. Gray oak woodlands in the Trans-Pecos are largely confined to mountain habitats. Despite numerous xeromorphic adaptations, lower elevation (1200–1500 m) gray oak populations are particularly vulnerable to extreme weather events. The oaks are a group of well-documented keystone organisms in the southwest, functioning both as a food source and habitat for smaller organisms, making their inability to weather these extreme events of particular concern. Demographic data compiled from 240 gray oaks on Sul Ross' Hancock Hill revealed that nearly 7% of all oaks perished during this most recent drought. However, the age-class frequency ratio suggests that the oaks may be expanding their footprint on the hill. Here, we offer an interpretation of the data in context of other recent droughts, and what constitutes cause for concern.

Montezuma Quail Habitat Preference as an Indicator for Invasive Exotic Feral Pig Presence in the Davis Mountains

Maya Ressler[1]*, Justin French[1], Fidel Hernández[2] and Ryan Luna[1], [1]Borderlands Research Institute, Sul Ross State University and [2]Caesar Kleberg Wildlife Research Institute, Texas A&M University–Kingsville

Feral pigs (*Sus scrofa*) are highly intelligent, adaptive ecological generalists that affect many ecosystems through rooting. This foraging behavior disturbs the soil, which potentially reduces plant cover, alters soil composition, and ultimately causes nutrient loss and altered vegetation communities that other native species depend upon. Although scientists predict that feral pig densities are relatively low in west Texas, there is concern about the damage to sensitive ecosystems that occur predominantly in the sky islands of west Texas. Sky islands generate topographically diverse habitats that occur along an elevational-climatic gradient. There are organisms that thrive within specific spaces of this elevation gradient, one such example being the Montezuma quail (*Cyrtonyx montezumae*) in the Davis Mountains of Jeff Davis County. Montezuma quail are a cryptic quail species inhabiting the piñon-juniper woodlands of the southwestern United States and much of Mexico. Across their range, overgrazing has been identified as one of the biggest contributing factors to

population decline due to loss of ground cover and reduced forage availability. Increased feral pig densities may alter the plant communities in a similar way as overgrazing. This could reduce forage resources and ground cover that Montezuma quail utilize for nesting, temperature regulation, and predator avoidance. Though these birds are assumed to be relatively robust to regular droughts and changes to their environment, Montezuma quail might be vulnerable to more aggressive, generalist competitors, like feral pigs, that alter their environment and change, or reduce, choice resources. We fit a model, from collected presence data, to predict presence of feral pigs across the entire range of the Davis Mountains. Once we created a map of predicted feral pig presence, we were able to calculate a predicted overlap of 27% for predicted feral pig presence and predicted Montezuma quail habitat in the Davis Mountains. Feral pig presence does not completely overlap with predicted Montezuma quail habitat but occurs in areas that are considered critical for Montezuma quail when their populations are low and resources are scarce. This opens the door to question if feral pigs might have an effect on Montezuma quail resources and habitats.

Arachnids of the Northern Chihuahuan Desert

Christopher M. Ritzi, Department of Biology, Geology & Physical Science, Sul Ross State University

Arachnids tend to be an overlooked facet of animal biodiversity in the world around us. This is no different in the northern Chihuahuan Desert, where hot, dry conditions have shaped the various arachnid taxa into an amazingly diverse and unique group. In order to get a better appreciation of the diversity of the types of Arachnida present in the Chihuahuan Desert region, a summer field class has been conducted by Sul Ross State University every two years since 2018 to investigate and collect an assortment of the arachnids present in the region. From these collections, specimens were identified from the following orders: Araneae, Amblypygi, Uropygi, Acari, Opiliones, Scorpiones, Pseudoscorpiones, and Sulifugae, representing all but three of the known orders of the arachnids. Common methods for the collection and recovery of these arthropods included hand capture and kill jar collection, traps, Burlese funnels, ectoparasitic removals from hosts, blacklight flashlight surveys, and nighttime inspection of various habitats, including riparian areas and rock cuts. The variety of arachnids recovered will be discussed, including basic information about their natural history. In addition, the variety of families recovered from certain orders will be expanded upon, illustrating the need for more survey work to better document arachnid diversity in the region.

Use of Electric Fencing to Deter Bears in an Arid Landscape

Michael Janis, Rachael Connally*, Chase McCrory and Krysta Demere, Texas Parks and Wildlife Department

Black bears were extirpated from the Trans-Pecos region of Texas by the 1950s but began recolonizing the region from northern Mexico in the 1980s. This recolonization has led to increasing incidents of human-bear conflict. The prevalence of deer feeders on the Texas landscape creates a unique challenge because of the increased opportunity for human-bear conflict in remote and rural areas. Since 2018, Texas Parks and Wildlife staff have been testing the use of electricity to deter bears from attractants, using wildlife feeders in remote areas. Several types of electrified fence designs and different output energizers were tested. Systems that utilized an earthen ground return for the negative circuit were ineffective in the arid environment despite attempts to improve the grounding system. Using livestock panels to create a metal apron laid in front of an electric fence or underneath an electrified spincast feeder for the negative circuit have proven effective. A 7-wire all hot fence (±34 inches tall) with a metal grounding apron successfully deterred bears in 80% of

encounters (n=56) using energizers rated at 0.15–0.25 output joules. Likewise, electrified spincast feeders with a metal grounding apron successfully prevented feeder damage in 100% of encounters (n=43) using energizers rated at 0.08–0.20 output joules. A third design entailed adding a single hot wire positioned 2–3 inches above and 2–3 inches inside of an existing hog panel or netwire fence. Using 0.15–0.25 output joule energizers, this design successfully deterred bears in 95% of encounters (n=42). The current cost to construct a 32x32 foot electric fence around a deer feeder is approximately $580–$650, whereas energizing a spincast feeder costs approximately $340. Future plans include testing these three designs with smaller, 0.04 output joule, energizers.

Elevation Grade Preferences of Whiptails at the Christmas Mountains

Derek Dacus*, Brandon Ramirez and Thornton Larson, Department of Biology, Geology & Physical Science, Sul Ross State University

The Christmas Mountains of Brewster County, Texas, contain populations of *Aspidoscelis* species (whiptail lizards) that have been poorly surveyed due to a long history of private ownership and a strict easement. One factor that has been seemingly overlooked across *Aspidoscelis* species in general is the elevation grade preference of different species. Our objective was to determine if elevation grade is an important factor in habitat selection across the different *Aspidoscelis* species present. We expected that the bisexual species would favor the shallower elevation grades and would outcompete the parthenogenic species, leading to the parthenogenic species persisting at the steeper elevation grades. All our data was collected using observational studies and a clinometer to measure grade along transects. We calculated the diversity across all transects and between the high and low graded areas of our study site using the Shannon index. We also calculated the importance of grade in habitat selection for the three lizard species found using the $\chi 2$ test. We unexpectedly did not find any *A. tesselata*. We instead found six individuals of *A. inornata heptagramma*, which made up 15% of all whiptails found. The parthenogenic *A. inornata heptagramma* was observed using habitat it was not commonly documented to use and sharing habitat with bisexual lizards it is usually outcompeted by. The Shannon index and the $\chi 2$ test both suggest that grade is an important factor in habitat selection for the lizard species present. Furthermore, elevation grade was not observed as an important factor in determining habitat selection between parthenogenic and bisexual species.

Progress Report on the Geologic Guide to the Christmas Mountains "Summit Road"

Elizabeth A. Measures, Department of Biology, Geology & Physical Science, Sul Ross State University

Creation of a geologic guide to the Christmas Mountains "summit road" was proposed at the 2019 Christmas Mountains Research Symposium with a preliminary guide to be presented at the next symposium. There was no symposium for 2020 or 2021, and the 2022 symposium was not attended by the author. The preliminary guide will finally be available for use and critique at this symposium. Information in the guide was compiled from geologic maps, Google Earth, and information observed during hikes along the "summit road." The guide describes the geology along the segment of road from the gate (elevation ±4080 ft) to a point ±2.5 miles beyond, where the road begins to dip into Hidden Valley. The remainder of the "summit road," from the descent into Hidden Valley to the end of the road, will be added once feedback on the current guide has been evaluated.

The geologic guide to the road is intended to be used by people hiking the road, but portions of the guide can also be used while driving the road. However, many geologic features cannot be observed from a vehicle. In general, the lower part of the road cuts igneous sills and sedimentary rocks that have been uplifted and tilted by the emplacement of the Christmas Mountains laccolith. Thin-bedded, flaggy Boquillas Formation overlies the medium-bedded, nodular Buda Limestone. The road widens at a switchback (±0.8 miles, elevation ±4560 ft) and offers parking and a view to the north. Beyond this, the road is cut on upper beds of the massive, fossiliferous Santa Elena limestone, the oldest sedimentary unit present. No sills were emplaced in this massive unit. Farther on, the road transects more igneous sills and Del Rio Clay, a thin unit above the Santa Elena and below the Buda. The road widens into another parking area (±1.8 miles, elevation 5040 ft) and offers a view of Big Bend National Park. The road runs along more Sant Elena limestone until at ±2.5 miles (elevation ~5350 ft) the road starts to descend into Hidden Valley.

The Geology of Parcels Owned by Sul Ross State University in Brewster County

Kevin Urbanczyk, Department of Biology, Geology & Physical Science, Sul Ross State University

Sul Ross State University (SRSU) is located in Alpine, Brewster County, Texas, on more than 600 acres in the immediate Alpine vicinity. In addition to the parcels in Alpine that include the main campus, SRSU owns numerous small parcels varying in size from 5 to 80 acres making a total acreage of 317 acres outside of the main campus in Alpine. SRSU obtained these various parcels via donations from previous landowners. The parcels are located on or near many significant geologic features of the Big Bend region. Three of the parcels are located near the main road to the Terlingua Ranch lodge and are composed of Quaternary alluvium and/or Quaternary fan deposits. North of this area, two additional parcels are positioned west and northwest of Nine Point Mesa. These are also on Quaternary alluvium and/or Quaternary fan deposits. West of Highway 118, one parcel consists of Cretaceous age Pen and Aguja formations and is located on the eastern extension of the Tascotal Mesa transfer zone fault and is near the Agua Fria spring. Further west, one of the parcels is located on the northeast edge of the Solitario and is composed of Cretaceous Buda and Boquillas limestone. Another parcel is located near the southeastern edge of the Solitario and is also in the Buda and Boquillas limestone. Further southeast, a parcel just off of South County Road is located on Cretaceous Aguja formation and a Tertiary intrusion, and another parcel is south of Highway 170 (south of Terlingua) in the Long Draw drainage. The geology here is Cretaceous Pen Formation and Quaternary fan deposits. Much farther east, another parcel is located in the vicinity of Bullis Gap in Cretaceous Santa Elena limestone just north of the Lower Canyons. Lastly, the geology of the main Sul Ross campus includes the Tertiary Crossen trachyte lava flow, associated lacustrine limestone, Quaternary alluvium and alluvial fan deposits and Kokernot spring. All of the parcel ownership described here is from the Texas Natural Resources Information System Land Parcels 2022 dataset.

A Sampling of Archeological Resources in Big Bend National Park, Texas

David W. Keller, William A. Cloud, Samuel S. Cason, Robert W. Gray, Richard W. Walter, Thomas C. Alex*, Roger D. Boren, Andrea J. Ohl, and Robert J. Mallouf (with contributions by Betty L. Alex, Ashley Baker, J. Phil Dering, David V. Hill, Dawnella Petrey and Kathryn Puseman), Office of the State Archeologist, National Park Service, and Center for Big Bend Studies, Sul Ross State University

Big Bend National Park is proud to announce the release of the final report for a major archeological sampling survey of the park that literally spans the past four decades. The project was originally conceived in 1983 when

then Texas State Archeologist Robert Mallouf and Park Archeologist Thomas Alex first met and began discussing the possibility of conducting a predictive analysis sampling survey of park cultural resources. The park cannot manage cultural resources without knowing what those resources are. The project was intended to provide park management with the ability to predict the potential for cultural sites within the various environmental zones of the park's diverse landscape. Fieldwork was conducted in two phases dictated by the available funding. The first field season ran from 1995 through 1998 and the second phase of field work ran from 2005 through 2010. The highly technical geographic spatial analysis was developed during this time and final spatial analysis was done upon completion of fieldwork. The project was completed under a cooperative agreement with the National Park Service and the Center for Big Bend Studies at Sul Ross State University. The CBBS completed analysis and final report on this long-term project in 2022. After several months of professional review and approval, the report is now available for the public to digest. This presentation provides a description of the project and the impact upon park management. The full report can be downloaded from the National Park Service at https://pubs.nps.gov/Default.aspx?DocID=1883183

Ecohydrology Improvements and an Evaluation of the Performance of Native Grasses in the Chihuahuan Desert

Aaron O. Ortega-Gonzalez*, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Borderlands Research Institute, Sul Ross State University

The decline of scaled quail (*Callipepla squamata*) populations has been mainly attributed to habitat degradation. Increasing plant diversity and reducing soil erosion may help alleviate this problem. Therefore, we have employed a holistic strategy to restore riparian habitat within the Chihuahuan Desert based on building structures known as *trincheras* and reseeding native vegetation to improve hydrological processes to establish native plants. We expect restoration efforts to increase water harvest, reduce soil erosion, increase native vegetation, and positively affect scaled quail by increasing cover and food availability. Restoration efforts began in August of 2021, on a private ranch in southern Brewster County. To date, we have built 130 *trincheras*. Of those, 50 were assessed before and after the rainy season (May – October 2022) to measure how much soil the structures are trapping and changes in the vegetation structure and plant cover. Simultaneously we have been assessing the performance of different native grass species in a greenhouse with four different grass species: bristlegrass (*Setaria vulpiseta*), sideoats grama (*Bouteloua curtipendula*), whiplash pappusgrass (*Pappophorum vaginatum*, and blue grama (*Bouteloua gracilis*) as a first trial to identify the best native grasses to seed in *trincheras*. These four groups were divided into another four groups representing different rainfall rates: 2 inches, 4 inches, 6 inches, and 8 inches. This allowed us to assess the seed germination response for each grass species. Preliminary results indicate that *trincheras* increase soil retention and that *Bouteloua gracilis* and *Bouteloua curtipendula* have better outcomes than the other two species.

Restoration of Native Vegetation in Areas Invaded by Lehmann Lovegrass

Andres Solorio Pulido*, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Borderlands Research Institute, Sul Ross State University

Native and non-native grassland species can negatively interact and compete. Sometimes those negative interactions can affect native species by leading them to eradication and converting a diverse rangeland into

monocultures. This is due to non-native species having aggressive behavior and better response than natives towards drought and wildfires. Also, some non-native plant species are not preferred by wildlife. For example, scaled quail (*Callipepla squamata*) habitat is indirectly affected by negative interactions with invasive species such as Lehmann lovegrass (*Eragrostis lehmanniana*). Therefore, we initiated a restoration project for scaled quail habitat to mitigate Lehmann lovegrass monocultures and increase native plants for scaled quail. The project site was located in southern Brewster County and is part of the Chihuahuan Desert. Our study was designed to find and evaluate ways to decrease and control Lehmann lovegrass. We established 200 16m^2 plots with four different treatments. We used three line-intersections in each plot to compare if there were significant differences between treatments and to define which treatments had a better result to decrease and control Lehmann lovegrass. Treatments were soil disturbance, native plant seeding, soil disturbance and seeding, and a control. Data was taken before treatments were implemented during the summer of 2022 and post-rainy season in October 2022. Preliminary results indicate that seeding native grasses has the most significant amount of native vegetation within our treatments.

Collaborative Restoration: The Rio Grande Joint Venture's Recent Endeavors in a Declining Ecosystem

Rebekah Rylander*, Jeff Bennett and Karen Chapman, American Bird Conservancy and Rio Grande Joint Venture

The Rio Grande Joint Venture (RGJV) is a public-private habitat conservation partnership focusing on priority habitats of the Chihuahuan Desert, Tamaulipan Brushlands, and the Mexico portion of the of Gulf Coastal Prairie. The RGJV's primary focus is to restore critical and declining habitat for avifauna and other wildlife, while also coordinating and working with other entities to accomplish this goal. In recent years, the RGJV has been active in west Texas and Mexico by planning, assisting, and implementing riparian and grassland restoration projects, including using chemical treatments to reduce shrub encroachment in grasslands, and addressing stream incision and degradation by building brush weirs (aka beaver dam analogs) to increase residence time of annual flows and reconnect floodplains. This year, vegetation and bird monitoring efforts are underway to understand the impacts of these restoration efforts and determine appropriate adaptive management actions. Additionally, the RGJV has partnered with the Bird Conservancy of the Rockies and Pronatura Noreste A.C. to hold workshops throughout Mexico to garner expert opinions from landowners, ejidos, non-profit organizations, universities, and governmental agencies on the main threats to the grasslands in the Chihuahuan Desert. These workshops will develop conservation strategies and habitat restoration goals that all members of the community of practice can coordinate and collaborate on to bring about landscape-level improvements in Chihuahuan Desert habitats. The Rio Grande Joint Venture is committed to assisting with and providing a forum for landscape level conservation planning.

Looks Like a Good Place to do Research!

Martin K. Terry* and Dee Blinka, Department of Biology, Geology & Physical Science, Sul Ross State University (emeritus) and EMDRIA.org

More than six years ago, we started building (and are still building) an off-the-grid field station on over 2,000 acres of undeveloped land in Presidio County. The Blake Williams Biological Field Station, named for a visionary colleague who died prematurely in 2018, is a member of the Organization of Biological Field Stations, but it embraces more disciplines than the title suggests. Its domain name, desert research.org, encompasses

research in many areas, including archeology, astronomy, botany, vertebrate biology, geology, and history. In an age when the importance of field work is diminishing (check out the most prestigious journals in science and their top papers) the Chihuahuan Desert Preserve enhances the value of fieldwork and extends the experience to students in a wheelchair, providing easy access to the Chihuahuan Desert and the ability to stay overnight comfortably in an accessible space. The preserve, and its non-profit partner, the Chihuahuan Desert Preserve Association (CDPA), is not open to the general public, but does provide an off-the-grid haven for researchers and students, with overnight accommodations, spartan though they be. In Texas, where at least 95% of land is privately owned, accessibility to a relatively unexplored large tract of Chihuahuan Desert land, just over an hour from Alpine and only 15 miles from Presidio and half an hour from Marfa, opens opportunities to a wide range of researchers. Obviously, this is an ongoing project for many years, far past our lifetimes. This is our first opportunity to share what has been a long-time dream.

Wednesday Afternoon

Hydrology and Geology as Structuring Mechanisms of Fish Communities in a Semi-arid Environment

Lauren E. Chappell* and Timothy H. Bonner, Department of Biology, Texas State University

In semi-arid to arid karst terrains, such as the Edward Plateau region of Texas, groundwater outflows from Cretaceous-age strata provide permanent surface waters, which in turn provide critical habitat for a large number of endemic fishes. However, not all Cretaceous-age strata provide permanent surface water but instead can be areas of surface water loss (i.e., surface waters returning underground). The purpose of this study was to assess longitudinal fish community responses during wet and dry hydroperiods in three western Edwards Plateau streams with Cretaceous flow-gaining reaches in the headwaters, Cretaceous flow-losing reaches in the middle stretches, and Quaternary flow-losing reaches in the lower stretches as the rivers depart the Edwards Plateau and continue through the coastal plains of Texas. During the wet hydroperiod, endemic fishes typically associated with groundwater outflows were most abundant in the Cretaceous gaining reach and decreased in abundance longitudinally. During the dry hydroperiod, including extreme drought conditions, surface waters persisted in the Cretaceous gaining reaches and Cretaceous losing reaches. Endemic fishes were most abundant in the Cretaceous gaining reaches, less abundant in the Cretaceous losing reaches, but persisted in isolated pools of the Cretaceous losing reaches. Study results suggest that Cretaceous losing reaches can serve as ecological refuges for endemic species, despite previous interpretations of 1) Cretaceous losing reaches occurring because of anthropogenic alterations and 2) the Cretaceous losing reaches representing loss of critical habitat for endemic fishes.

Winter Habitat Selection, Movement, and Survival of Scaled Quail in the Trans-Pecos, Texas

Caleb L. Hughes*, Ryan S. Luna, Carlos E. Gonzalez, Justin T. French, Louis A. Harveson, Borderlands Research Institute, Sul Ross State University

Scaled quail (*Callipepla squamata*) are a native galliform bird of the Chihuahuan Desert that has experienced population declines in the last several decades. This population decline is partially attributed to habitat degradation, as habitat loss reduces scaled quail's usable resources for food, water, and shelter. This becomes critical during the winter season in the Trans-Pecos, when lower food availability and cold weather make habitat resources essential for withstanding winter weather events. In addition, juvenile recruitment and

available brood stock for the following nesting season are negatively affected by winter mortality, making winter a potentially influential period for scaled quail populations. Monitoring daily cycles in scaled quail habitat selection and movement allows us to observe how scaled quail respond to winter conditions, such as changes in movement patterns, selection of thermal refuges, and vulnerability to mortality. Our study seeks to describe these dynamics to supply knowledge on this understudied seasonal aspect of scaled quail ecology. We will trap scaled quail in southern Brewster County, Texas, during the winters of 2022–2023 and 2023–2024 using walk-in funnel traps and fit them with aluminum leg bands and Global Positioning System (GPS) backpacks to obtain location data and monitor survival across the winter season. During the winter of 2022–2023, we captured 335 individual scaled quail and deployed GPS backpacks on 40 scaled quail, 37 of which collected usable data. Since October 2022, these backpacks have collected 26,297 GPS locations for habitat selection and movement analyses. Survival monitoring since October 2022 has produced an overwinter survival estimate of 50.61% from 14 confirmed mortalities, most of which (43%) have been from mammalian predators. In the future, GPS data will be analyzed using an integrated Step Selection Analysis to identify scaled quail's selection and movement behaviors throughout the winter. Examining individual variation in these dynamics will help identify habitat attributes and movement behaviors conducive to greater individual fitness, thereby better informing future management efforts for scaled quail in the Trans-Pecos.

Habitat and Hydrology Enhancement: Improving Ground Cover and Surface Water Retention Through the Use of Wattles

Jason R. Crosby*, Ty W. Goodwin, Eliana K. Dykehouse, Carlos E. Gonzalez, Justin T. French and Louis A. Harveson, Borderlands Research Institute, Sul Ross State University

Habitat degradation is a primary cause of wildlife population decline. In the Trans-Pecos, livestock grazing regimes and prolonged drought have left a lasting impact on the region's fragile desert landscapes. The historic desert grassland climax plant community comprises 60% grasses such as Chino grama (*Bouteloua ramosa*) and other perennial grasses, 30% shrubs, and 10% forbs. Within the Trans-Pecos, there are currently degraded sites containing only 5% or less grass coverage, with 80% shrubs such as creosote bush (*Larrea tridentata*) or mesquite (*Prosopis glandulosa*), and 15% forbs. Bare ground percentages have increased significantly from the historic 2–5%, leading to considerable erosion. Human influence and management have caused the region's plant community shift and habitat degradation; active human management is necessary to enhance current landscapes to better support a host of interests such as wildlife, aquifer recharge, and carbon sequestration.

Intensive brush removal and native reseeding projects were undertaken on the Nine Point Mesa Ranch to better understand the challenges of habitat enhancement efforts in these desert landscapes. Over 60 hectares were grubbed in the spring of 2022 to reduce the creosote-dominated brush community and 3.25 hectares of the grubbed area were selected for treatment comparison and are the focus of hydrology improvements using wattles. Five treatments combining wattles and combinations of soil disturbance, brush cover, and reseeding were employed to help develop effective methods for enhancing severely degraded desert grassland habitats. Preliminary analysis suggests that brush-covered wattle treatments are most beneficial for vegetative production. An increase in soil moisture has resulted in an overall increase in plant ground cover across the test site. Soil moisture percentages ranged from 3% to 5% higher than in areas with no wattles. Soil temperatures averaged 1.7°C lower than exposed bare ground for wattles without brush cover, and approximately 3.9°C lower for wattles with brush cover.

Anti-Desertification and Water Conservation Planting on Private Land with the Groasis Waterboxx Plant Cocoon

Tom Jacobs, ReGreen Big Bend LLC and Desert Restore

Doug Tallamy's book *Nature's Best Hope* posits that climate change is so advanced that every property owner must restore and live in native species habitat, not go to nature elsewhere on public lands. The 190,000-acre Terlingua Ranch offers the 5,000 private landowners of 9,500 tracts a unique opportunity to make this happen. Some landowners, such as Carolyn Ohls, have led the way, but massive owner participation on arid acreage is needed to meet the challenge. There are two potential solutions to lack of water and property owner participation at Terlingua Ranch. The Groasis Waterboxx plant cocoon, a Dutch company's water conservation device, has been 90%-plus successful in desert water conservation planting in much harsher conditions worldwide. Each unit nurtures two plants for 9–12 months, is reusable up to 10 times, and requires 10–15 gallons of water at planting and never again (yes, you read right). At $38 per waterboxx, used 10 times, that's $3.80 a year and $1.90 (plus labor) per plant, with native seedlings available for less. Bulk purchases and seedlings reduce these costs even more. Once owners see highly visible waterboxxes with native plant and habitat restoration success throughout the Ranch, they will join in. So, why not a native oak, for example, on every tract? Why not 100? A gazillion milkweeds for monarch butterflies? Why not within 10 years? Why not right here, right now? *"Never doubt that a small group of thoughtful, committed citizens can change the world"* (Margaret Mead).

The School of Constructive Arts — A Regenerative Approach to Building and Education

Robert Estrin* and Estella Dieci, School of Constructive Arts

The School of Constructive Arts is advancing a holistic model of design, construction, and education. Our approach combines ancient knowledge of natural materials and energy with advancing technology to create living spaces in which human activity enriches the diversity, health, and vitality of the land. We call this regenerative building because it goes beyond sustaining humanity to repairing the damage done to the earth and re-centering human development within the interconnected whole of life. We are situated broadly within global permaculture and regenerative land use movements. In line with these movements, we are focusing our initial efforts on our main campus on the Terlingua Ranch. Since 2020, we have worked to convert a 20-acre lot littered with debris into a flourishing natural landscape. We have removed hazardous material and set up greywater irrigation and land-based water catchment, planted native trees, attracted new plants and wildlife, and constructed several environmentally-suitable, earthen buildings. In the process, we have hosted numerous related experiential programs teaching regenerative design, building, and agriculture to over one hundred community members, workshop attendees, and volunteers. In our next phase, we will construct a Proof-of-Concept building to exemplify our integrated, regenerative approach to building and education. It will utilize natural materials, natural energy, and whole-cycle waste and water systems while providing opportunities for hands-on programs. We call it the Garden House as it is adjacent to our vegetable garden, and will utilize recycled water, composting sanitation, and south-facing greenhouses to support our dry-lands agriculture and land restoration programs. The Chihuahuan Desert is an ideal setting for this exploration; as the Earth becomes more arid, the need for intelligent adaptations to living in dry environments is greater than ever and approaches taken here can be applied to dryland regions across the globe. To this end, we aim to position our efforts alongside regional conservation goals, and work in collaboration with community and

institutional partners on a shared vision of a regenerative future for the Big Bend and an example of what is possible.

The Changing State of Light Pollution in the Greater Big Bend Region

Stephen Hummel, McDonald Observatory, The University of Texas at Austin

Across North America, light pollution increased by an average of 10% per year from 2011–2022 or doubling in eight years. The night skies above the Big Bend region remain famously dark and full of stars, thanks in part to the rural nature of the region and long-term efforts to address poor outdoor lighting designs responsible for light pollution. A monitoring campaign by McDonald Observatory, the National Park Service, and numerous volunteers has documented both the increase and decrease of light pollution in the region since 2015. The results demonstrate the success of partnerships and outreach efforts in reducing overall light pollution, as well as emerging threats the region will face in the coming decade as technology changes.

The Impact of Light Pollution on Wildlife

Amber Harrison, International Dark-Sky Association

Light pollution, caused by excessive and misdirected artificial illumination of the night sky, is a global concern with detrimental impacts on both human health and the environment. This talk focuses on the impact of light pollution on wildlife, particularly nocturnal animals such as insects, birds, reptiles, and mammals. These animals rely on the natural darkness of their habitats for essential activities such as foraging, mating, and navigation. However, artificial light disrupts these behavioral patterns, leading to altered feeding habits, disrupted reproductive cycles, and reduced overall fitness. This presentation discusses the various impacts of light pollution on wildlife living in the Big Bend region and provides practical solutions to help reduce light pollution in your area.

A Cowboy's Observation of the Night Sky in the Dark

C. Jerry Lin*[1], Joel W. Walker[2], and Philip L. Cole[3], [1]Office of Research & Sponsored Programs Administration, Lamar University, [2]Department of Physics & Astronomy, Sam Houston State University, and [3]Department of Physics, Lamar University

This presentation proposes an education, research, and outreach vision in astronomy at the Texas State University System's (TSUS) Christmas Mountains (CM) Field Station located in Brewster County, Texas, and outlines the scientific plans of the proposed Christmas Mountains Observatory (CMO). Located next to Big Bend National Park, the field station represents one of the least light-polluted locations in North America. Coupled with the desert weather and elevation (peak height at 5,728 ft above sea level) that offer extended observational time and reduced atmospheric interferences, the observatory will serve as an ideal site for solar, planetary, and night sky observations. The CMO will house a meter-sized (1–2 m diameter) primary telescope, and smaller telescopes of dioptric (refracting), catoptrics (reflecting), and catadioptric (combining refraction and reflection) designs with associated mounts, sensors and signal processing instruments. The facilities will support the observational research of TSUS universities in astronomy, serve as a network site of the

international Pro-Am collaboration for astronomical data collection, perform solar dynamic studies, provide a field campaign platform for student projects in observational astronomy, facilitate star parties and summer camps, and offer opportunities for community engagement through astronomy education to the public. Through a proposed coordination with the International Dark-Sky Association in the search for kilonovas produced by neutron-star mergers, we anticipate making the CMO an observatory of global significance. Such opportunities will support the recruitment of TSUS students across the broad spectrum of STEM disciplines. In this presentation, we introduce our scientific plans of establishing a TSUS system-wide effort in acquiring high-end instrumentation to make the CMO a premier scientific research center in Observational Astronomy. Extramural funding, such as through the National Science Foundation's Major Research Instrumentation Program, will be sought to build the observatory's infrastructure. In addition to the Big Science Idea, we will discuss community outreach and engagement, including the potential for regional tourism. We will bring a portable telescope system allowing for on-site demonstration of night-sky observation during one of the evenings of the symposium. The participants will see what the dark sky of CM will afford in viewing of planets, galaxies, and nebulae.

Opportunities for Research Astronomy at the Christmas Mountains in the Greater Big Bend International Dark Sky Reserve

Joel W. Walker, Philip L. Cole[2], and C. Jerry Lin[3], [1]Department of Physics & Astronomy, Sam Houston State University, [2]Department of Physics, Lamar University, and [3]Office of Research & Sponsored Programs Administration, Lamar University

The Greater Big Bend International Dark Sky Reserve is a 15,000 square mile region that straddles the border between Mexico and the United States. This land is set aside in order to secure its pristine nighttime viewing conditions from the encroachment of light pollution. The Texas State University System owns the 9,270-acre Christmas Mountains tract within the Dark Sky Park region of the peripheral protection zone. The peak of this mountain range sits at 5,728 feet above sea level. These dark, elevated, arid conditions are ideal for doing significant scientific observing. In this presentation, we summarize science opportunities that are accessible with an affordable 1-meter class telescope, especially when it is operated as a component of a global telescope network.

The Science Behind the Merging of Neutron Stars

Philip L. Cole[1], Joel W. Walker[2], and C. Jerry Lin[3], [1]Department of Physics, Lamar University, [2]Department of Physics & Astronomy, Sam Houston State University, and [3]Office of Research & Sponsored Programs Administration, Lamar University

Multi-messenger astronomy marks a breakthrough in science. The seemingly simple thing of knowing where gold comes from was a profound scientific mystery until just a little over five years ago. On August 17, 2017, the LIGO and Virgo laboratories detected gravitational waves consistent with two neutron stars spiraling in, merging, and creating a black hole. Working in concert, these gravitational-wave laboratories could then approximately pinpoint the region in the sky where this neutron-star merger took place. A bright dense object is formed in the aftermath of this merger. The optical observations provided startling evidence that this fireball is formed solely of heavy elements, such as gold, platinum, and uranium. For the first time in history, we can now detect the merging of neutron stars. The two massive neutron stars spiral in at nearly the speed

of light and, upon merging, give rise to gravitation-wave undulations in space-time to spread across the universe. Neutron stars are about the size of a small city (12 miles in diameter) and are 600 million times the mass of the earth. Neutron stars are so dense that a teaspoon of neutron star material has a mass of about a billion tons, giving a surface gravitational acceleration of 100 billion times that of Earth. The structure of neutron stars is not yet fully understood. In the wake of the merger, the meter-thick iron-nuclei-lattice outer crust of the neutron star is blasted into space and these iron nuclei are then immersed within an incompressibly dense neutron soup thereby giving rise to the heavy-element fireball. A vast network of optical telescopes across the globe is needed and there can be no light pollution to obscure the optical signal. The Christmas Mountains is perfect! LIGO and Virgo will spot this gravitational-wave event and then we can search for the luminous object formed of gold/platinum/uranium with our meter-sized telescope. Such a TSUS facility will afford unique opportunities in the forefront of scientific research in coordination with the International Dark Sky Project. This work bears upon the intersection of optical astronomy, gravitational-wave astronomy, astrophysics, cosmology, particle physics, and nuclear physics.

Layer Cake Archeology: Preliminary Results of Geoarcheological Investigations along the Rio Grande at Big Bend Ranch State Park

Tim Gibbs, Big Bend Ranch State Park, Texas Parks and Wildlife Department

Past condition assessments of archeological sites along the Rio Grande Corridor of Big Bend Ranch State Park have documented widespread damage and overall poor surface preservation. Recent geoarcheological investigations, however, now suggest that there may be far more to these sites than we had ever expected. Four locations, in particular, appear to have retained cultural deposits that include well-preserved stratified buried surfaces separated by flood deposits. Once thought to be mostly absent from the region, these rare, well-stratified settings have the potential to make significant contributions to our understanding of the prehistoric archeology of the Big Bend.

A Preliminary, Longitudinal Analysis of Changing Habitat Suitability in Cassin's Sparrow (*Peucaea cassinii*)

John L. Schnase* and Mark L. Carroll, NASA Goddard Space Flight Center

Cassin's sparrow (*Peucaea cassinii* Woodhouse, 1852) is an elusive, ground-dwelling bird endemic to the arid grasslands of the Chihuahuan Desert. Like many grassland birds, there is evidence that Cassin's sparrow is experiencing loss of viable habitat and declining regional populations. To improve our understanding of the environmental factors affecting the range, population health, and overall ecology of Cassin's sparrow, we combined data from NASA's global climate modeling systems with field observations spanning the past 40 years to perform an exploratory, longitudinal analysis of the species' evolving environmental niche. First, we obtained annual, georeferenced occurrence records for the years 1980 through 2019 from the Global Biodiversity Information Facility (GBIF). We merged the observations into a time series comprising eight, five-year aggregated collections spanning the 40-year period of the study. We used environmental variables from NASA's Modern-Era Reanalysis for Research and Applications (MERRA) data product as our predictors. MERRA combines past satellite observations with numerical models to generate a consistent time series of hundreds of physical drivers of the Earth system, thereby providing a comprehensive simulation of Earth's observed climate as it has evolved over the past half century. We computed average values for MERRA's variables across the same time intervals as the observational data sets. These time-specific observations and variables were then used as input into a series of maximum entropy models that enabled a temporally-explicit view of

changing patterns of habitat suitability for the species. Preliminary results show a slow, declining trend in habitat quality and expected presence of Cassin's sparrow across the study area over the past 40 years. MERRA's variables point to drying soils and decreasing precipitation efficiency as important climatic drivers in these changes. The study also provides insights into the pace of change across the region that may help identify climate refugia for Cassin's sparrow and provide an indication of the relative difficulty the species may have colonizing new habitats, two indicators of increasing value to conservation science.

Ecology of Zone-tailed Hawks in Texas

Krysta Demere[1], Brent Bibles[2], Ben Skipper[3] and Clint Boal[4], [1]Texas Parks and Wildlife Department, Fort Davis, [2]Unity College, New Gloucester, Maine, [3]Department of Biology, Angelo State University, and [4]Texas Cooperative Fish and Wildlife Research Unit, Texas Tech University

Zone-tailed hawks (*Buteo albonotatus*) are an uncommon and wide-ranging raptor found throughout the Trans-Pecos region. The species is one of the least studied raptors found in North America and this has resulted in a poor understanding of its ecology, habitat requirements, and conservation needs. The information available was generally limited to knowledge that zone-tailed hawks are widespread but uncommon and diffuse across the Trans-Pecos, and that they primarily nest in woodlands associated with riparian systems but are also found nesting at high elevations in pine forests and on cliffs. This lack of information has resulted in the species being listed by Texas Parks and Wildlife Department as threatened within the state. In 2018, we initiated a research program in the Trans-Pecos to try to address the information needs that would improve our understanding and management of the species. We surveyed accessible riparian woodlands for nesting zone-tailed hawks, monitored their reproductive success, and quantified their nesting habitat. In 2021 we GPS tagged two male zone-tailed hawks and added a third in early 2023. We monitored 11 and 15 nests in 2018 and 2019, which experienced an observed nesting success rate of 55% and 60%, respectively. Successful nests fledged an average of 1.35 nestlings. In riparian areas, zone-tailed hawks nested in the largest trees available, but other variables were similar to what was randomly available. Our GPS tagged birds provided the first ever information on breeding home range and migration for the species. Initial data suggests the Trans-Pecos region home ranges exceed 500 km^2 (±200 square miles), with males making multiple daily round trip foraging bouts that can exceed 20 km (12 miles) away from the nest. Both hawks tagged in 2021 used similar migration routes that took them to Central America, where winter home ranges were in Guatemala for one and El Salvador for the other. Our ongoing study will provide data with which state wildlife management agencies can make informed status and management decisions.

Mystery Rocks of West Texas: Geyserite

David Rohr*[1], Kevin Urbanzcyk[1] and Homer Mills[2], [1]Department of Biology, Geology & Physical Science, Sul Ross State University and [2]O2 Ranch

An unusual silica rock specimen was discovered by Homer Mills on the O2 Ranch in Brewster County, Texas. The specimen occurred as float near the contact between the Oligocene-age Duff Tuff (consisting of volcaniclastic sedimentary rocks and possible lacustrine beds) and the Cottonwood Spring Basalt of the Buck Hill Group. The specimen is shaped like an inverted funnel, 15 cm across at the base and with sides sloping about 50 degrees. An opening is present at the apex, and spherical or oval grains or clasts 0.5–2 cm in diameter cover the sides. The clasts have spine-like fibers on the surfaces. We interpret the structure to be

geyserite, a dense variety of siliceous sinter, which is precipitated by the rapid cooling and evaporation of hot silica-rich water ejected from a vent during a geyser eruption. Silica precipitates as opal-A (noncrystalline hydrated silica) and alters through time to quartz.

A diverse biota inhabits hot spring systems, and water temperature exerts a primary control over biota. Above 75°C, most biota cannot live. Early studies of geyserite thought it formed by abiotic processes, because it formed around hot, sterile waters, but later studies noted that geyser eruptions are episodic and may be subaqueous. Modern geysers in New Zealand produce "geyser eggs" (1–2 cm) near the vents, some of which contain silicified filamentous microbes. Hot springs in Yellowstone National Park have spinose siliceous "shrubs" of bacterial origin. Studies in Iceland have shown filamentous bacteria undergo rapid silicification and encrustation. The Texas specimen is interpreted to have formed at a small hydrothermal vent with episodic eruptions, possibly in a subaqueous setting, although next to the vent, the water was cool enough for microorganisms, probably fibrous cyanobacteria similar to modern *Chloroflexa*, to grow. Like modern hot springs, the water was supersaturated with silica and the cyanobacteria fibers were quickly silicified.

A Study of Intra-fold Deformation in a Laramide Footwall Syncline Exposed in the Walls of Dog Canyon, Big Bend National Park

Jesse Moore Kelsch[1], Zachariah Fleming[2], and Kevin Urbanczyk[1], [1]Department of Biology, Geology & Physical Science, Sul Ross State University and [2]Department of Earth Sciences and Geologic Resources, Stephen F. Austin State University

The limestone beds comprising the cliff walls of Dog Canyon near the eastern boundary of Big Bend National Park were deformed into a large synclinal fold structure during the continent-scale Laramide mountain-building event between 75 and 40 million years ago. Dog Canyon incises this folded rock nearly parallel to the most informative plane of observation, making these exposures opportune for a structural analysis. The north-northwest-trending axis of the syncline reveals that the crust was horizontally shortened from west-southwest to east-northeast during the Laramide contractional deformation event, but mid-scale structures inside the syncline, like fractures, joints, and small faults, reflect locally different orientations of rock deformation. A theoretical spatial partitioning of deformation orientations within folded rock is tested here by mapping these smaller geologic structures exposed on the vertical cliff wall in the context of the larger fold. Because few of the small structures are accessible from the canyon floor, we created a dense point cloud of the southern wall of the canyon and used Cloud Compare to map the fractures and small faults. Structures mapped on the point cloud, plus near-canyon-floor hand measurements of lineated fracture planes, together speak to both intra-fold deformation partitioning and proposed obliquity of Laramide tectonics. Preliminary results are presented here. When completed, this digital mapping project may be used as an educational exercise; the results may also be displayed on the Dog Canyon trail for Park visitors seeking explanation of the tall, vertically tilted rock beds at the end of their hike.

A Brief Review of Sea Level Graphs presented in *National Geographic* Magazine

William Robinson, Consulting Geophysicist, Midland, Texas

During the late Pleistocene Epoch, near sea level ocean energy sculpted the limestone sea floor morphology of the Bahamas Banks in ways that guide understanding Bahamas geologic history. The graphs of ancient sea

level positions presented in this article hold a history no less amazing than the biological discoveries made by scuba divers entering blue holes within the interior of the enormous stratigraphic wonder—at times a string of small islands, sometimes a huge land area. Sea level positions over the past half million years are recorded in the geology. This review shows the dramatic ranges of ocean levels over Earth's most recent geology story, provides a sense of time for multiple sea level cycles to occur and predict the natural range of sea level for the "current" cycle that began only 18,000 years ago, including most of the history of human civilizations. Geologic morphologies of cliffs and terraces are created by near sea level wave energy at the platform margins but may be difficult to observe because they are complexly overprinted and are mostly submerged. Examples of concurrent geology include the emergent Florida peninsula, countless islands worldwide, and the presently submerged North Sea Dogger Bank Bering Strait land bridge. Throughout the geologic history of the Permian Basin of west Texas, sea level cycles are recognized for their importance in shaping the ancient seascape, to create traps for petroleum. Thus, are the universal applications of geology made to the present and the past, and to the future.

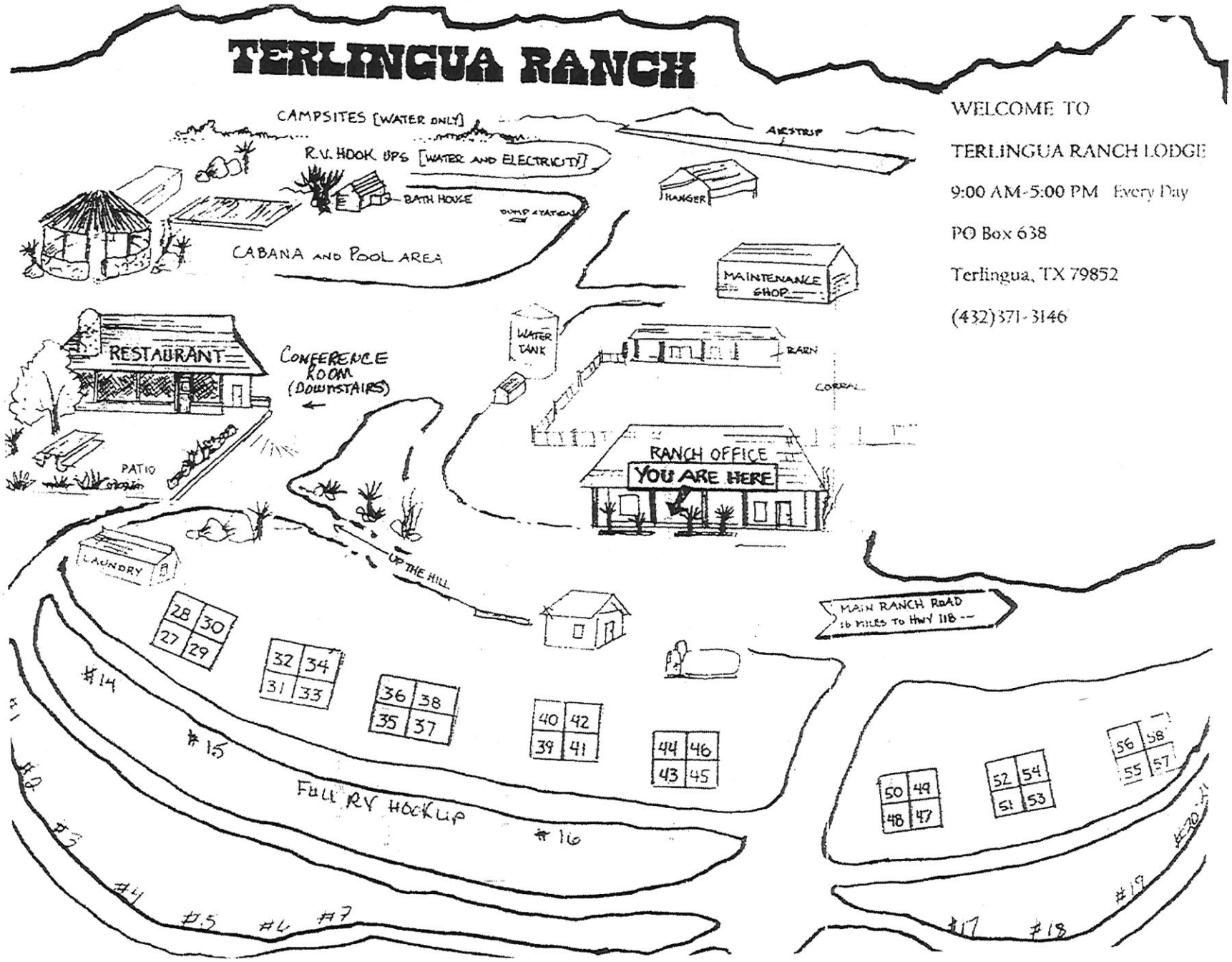
Welcome to Terlingua Ranch Lodge

16000 Terlingua Ranch Road
P.O. Box 638
Terlingua Ranch, TX 79852
(432) 371-3146

www.terlinguaranch.com

Office open 8:00 am to 3:00 pm

- **Room service.** If you need additional towels or linens, please come to the Front Desk.
- **Check-out** time is 11:00 am. If you wish to extend your stay, please notify the Front Desk prior to check - out.
- **The Bad Rabbit Café** is open from 7:00 am to 8:00 pm Wednesday through Saturday and 7:00 am to 2:00 pm on Sunday(hours may be extended for holidays, special occasions, and hunting season).
- **Security and Assistance** – for after-hours emergencies, a **911** phone is located on the patio next to the pool.
- **Pets** must be on a leash in common areas.
- **Pool hours** are 10:00 am to 10:00 pm. The bath house is open 24 hours, seven days a week.
- **Laundry** is open noon to 10:00 pm.
- **Water** is scarce – please conserve.
- **Burn ban** is currently in effect for Brewster County with warm temperatures and dry, windy conditions. Please confine outdoor cooking to the use of propane stoves. See the Front Desk for more information regarding burn bans.
- **Smoking** is allowed outdoors only. Please dispose of cigarettes in butt cans located throughout the Lodge.
- Please obey posted **speed limits.**
- Please respect **No Trespassing** and **No Hunting** signs throughout the ranch.



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2024

Terlingua Ranch Headquarters

May 20th–22nd, 2024

Front cover illustration: The western diamondback rattlesnake (*Crotalus atrox*) can be encountered across the southwestern U.S. and northern Mexico and is often found hiding under vegetation or other cover items, such as rocks, branches, and debris. The snakes are viviparous; about 165 days after mating, the female gives birth to 10–20 young, which head off on their own within a few hours to seek food and shelter; most do not survive their first year because they are heavily preyed upon by other species. Predators that feed on western diamondbacks (both juveniles and adults) include hawks, roadrunners, wild hogs, owls, king snakes, Texas indigo snakes, and coachwhips. Original photo taken by Susan Hanson at Terlingua Ranch.