CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

2016

Terlingua Ranch Headquarters
Brewster County, Texas
May 23rd–25th, 2016

THE TEXAS STATE UNIVERSITY SYSTEM™

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CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

Terlingua Ranch Headquarters
Brewster County, Texas
May 23rd–25th, 2016

Monday, May 23rd

6:00 pm Informal social for meeting participants by the swimming pool

7:00 pm Dinner available (on your own) at the Bad Rabbit Café

Tuesday, May 24th

9:00 am Field trip to Christmas Mountains overlook (meet in the parking lot next to the swimming pool)

9:00 am Arroyo hike (meet on the patio outside the café)

1:30 pm Paper session (in the bunkhouse beneath the Bad Rabbit Café)

6:30 pm Dinner for meeting registrants at the Bad Rabbit Café (regular dinner menu will be available for others at the café)

Wednesday, May 25th

7:00 am Morning Bird Walk (meet on the patio outside the café)

10:00 am Morning paper session (in the bunkhouse beneath the Bad Rabbit Café)

1:30 pm Afternoon paper session (in the bunkhouse beneath the Bad Rabbit Café)

6:30 pm Dinner for meeting registrants at the Bad Rabbit Café (regular dinner menu will be available for others at the café)

FIELD TRIPS

Christmas Mountains Overlook
Trip leader: David Lemke
Tuesday morning at 9:00 – meet in the parking lot next to the swimming pool

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 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.

Arroyo Hike
Trip leader: Michael Huston
Tuesday morning at 9:00 – meet on the patio outside the Bad Rabbit Café

We will carpool to an area near the base of the Christmas Mountains and spend the morning hiking up (and back down) one or more of the numerous arroyos that dissect this area. These drainages support a plant community that is distinctly different from that which occupies the dry slopes of the Christmas Mountains. The presence of greater amounts of soil moisture supports an abundance of shrubs and small trees such as persimmon (*Diospyros texana*), evergreen sumac (*Rhus virens*), Mexican buckeye (*Ungnadia speciosa*) and even a few oaks (*Quercus* spp.). The trip will focus on the natural history of the area, especially the vegetation and avifauna. This is a moderately easy hike, although there will be a few rough spots. Since we are in the desert, plan to carry at least a liter of water with you.

Morning Bird Walk
Trip leader: Rebekah Rylander
Wednesday morning at 7:00 – meet on the patio outside the Bad Rabbit Café

Bring your binoculars and join us for a casual walk around the Terlingua Ranch Headquarters area and an introduction to the avifauna of the area. Graduate student Rebekah Rylander will help you learn to identify species common to this dry desert habitat through their physical features and characteristic calls. A small amount of hiking over the rocky terrain will be necessary.

CHRISTMAS MOUNTAINS RESEARCH SYMPOSIUM

Tuesday, May 24

1:30 Welcome and Introductions

1:45 An introduction to the Christmas Mountains – a site for education and research
David E. Lemke, Texas State University

2:00 Get Involved with Citizen Science
Stacey Britton and Kate Seideman-Barclay, Texas State University

2:15 Community collaborative rain, hail and snow network (CoCoRaHS)
Jim DeBerry, National Weather Service

2:30 The Botanical Research Institute of Texas: a scientific resource for all
Barney Lipscomb, Sula Vanderplank and Edward Schneider, Botanical Research Institute of Texas

2:45 Break

3:00 Lost in the labyrinth — non-Mexican depictions of the largely Mexican geographic distribution of *Lophophora* spp. (Cactaceae)
Martin Terry and Keeper Trout, Sul Ross State University and Cactus Conservation Institute

3:15 A preliminary report of 3,4,5-trimethoxyphenethylamine concentrations in over-the-counter topical products purported to contain *Lophophora williamsii* (Cactaceae)
Robert LeBlanc and Martin Terry, Sul Ross State University

3:30 Family first: the social black-crested titmouse
Rebekah Rylander and M. Clay Green, Texas State University

3:45 Environmental assessment of the Rio Grande in the Big Bend region of Texas
Kevin Urbanczyk, Jeffery Bennett, Lydia Smith, Kenny Saunders, Pete Diaz, Diego Araujo, Christopher Chapa and Michael Montagne, Sul Ross State University, National Park Service, Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service

4:00 Long-term monitoring of biological control of saltcedar (*Tamarix*) along the Rio Grande, with notes on interactions with athel (*Tamarix aphylla*) and a new locality record of a saltcedar associate
Christopher M. Ritzi, Alexandra Hassenflu and Anne Marie Hilscher, Sul Ross State University

4:15 Break

4:30 Insect diversities in areas impacted by the biological control of saltcedar (*Tamarix* spp.) in west Texas
Jaimie Michelle Lawhorn and Christopher Ritzi, Sul Ross State University

4:45 Building resilience in Rio Grande tributaries through reforestation
Jeffery Bennett and Joe Sirotnak, National Park Service

5:00 Bee diversity along an elevation gradient in the Christmas Mountains
Kate Seideman-Barclay and Michael Huston, Texas State University

Wednesday, May 25

Morning Session

10:00 Development of a geology field course in the Christmas Mountains and Big Bend region
Mark T. Ford and Thomas L. McGehee, Texas A&M University–Kingsville

10:15 The southern extent of the Tascotal-Mesa fault at the Christmas Mountains
Veronica Sanchez, Texas A&M University–Kingsville

10:30 Paleostress fields of the Christmas Mountains
Alexander Johnston, Texas A&M University–Kingsville

10:45 Break

11:00 Photogrammetry and geomorphic change detection
Bryan Roberts and Kevin Urbanczyk, Sul Ross State University

11:15 Archaeological applications of photogrammetry in the Big Bend
Samuel Cason, Sul Ross State University

11:30 Apollo astronaut training in the Big Bend
Pat Dasch, Sul Ross State University

Afternoon Session

1:30 Monitoring protocols for spring inventory and assessment, Big Bend Ranch State Park, Texas
Zach Weathers and Kevin Urbanczyk, Sul Ross State University

1:45 Recent collections and observations of the rare milkweed vine, *Matelea atrostellata* (Apocynaceae)
David E. Lemke, Texas State University

2:00 Post-drought mortality and recovery of desert willow in Ben's Hole Canyon
Kelsey Dannen, Collin Tubbs, Jackson Johnson, Matthew Harrison and Michael Huston, Texas State University

2:15 Mammal species richness of the Christmas Mountains research area
Allison Scott and Michael Huston, Texas State University

2:30 Co-occurrence and habitat selection of mesocarnivores in Big Bend National Park
Skyler Stevens, Patricia M. Harveson, Catherine C. Dennison, Michael Stangl and Raymond Skiles, Sul Ross State University and National Park Service

2:45 Roadkill ecology – spatial and temporal scales of recently deceased terrestrial vertebrates along the I-10 corridor from Comfort to Fort Stockton
Jeremy Luther and Michael Huston, Texas State University

3:00 Break

3:15 Terrestrial snails and life in the desert
Francis Horne, Texas State University

3:30 Dietary analysis of the microwhip scorpion (Palpigradi: Eukoeneniidae) from Val Verde County in southwestern Texas
Mary Jones, Ned Strenth and Loren Ammerman, Angelo State University

3:45 Changes in insect biomass in the Christmas Mountains due to abiotic factors
Allison Bordini and Michael Huston, Texas State University

4:00 Preliminary analysis of *Chrysina woodii* (Coleoptera: Scarabaeidae) populations in the Davis Mountains of west Texas
Timothy Maddox and Ned E. Strenth, Angelo State University

4:15 A preliminary survey of the crayfishes (Crustacea: Decapoda) of west Texas and eastern New Mexico
Michael Lucero, Angelo State University

4:30 Break

4:45 A sedimentary survey of the Tornillo Creek drainage basin, an ephemeral stream system in Big Bend National Park – preliminary findings
Thomas G. Stoddard, Sul Ross State University

5:00 Cretaceous karst deposits of Shafter, Texas
Casey Mitchell and David Rohr, Sul Ross State University

5:15 Stratigraphic and depositional analysis of the Leonardian Cibolo formation in the Marfa Basin in the vicinity of the Chinati Mountains, Texas
Christopher Pate, Sul Ross State University

ABSTRACTS

Tuesday Afternoon

Introduction to the Christmas Mountains – a site for education and research

David E. Lemke, Department of Biology, Texas State University, San Marcos, TX

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 a well-developed desert grassland ecosystem comprising several distinct plant community types and may represent one of the best-preserved examples of Chihuahuan Desert grassland in the State. The potential for use of the property as an educational tool will also be discussed.

Get involved with citizen science

Stacey Britton and Kate Seideman-Barclay, Department of Biology, Texas State University, San Marcos, TX

Citizen scientists are volunteers from diverse backgrounds with an interest in supporting scientific research. Working with research organizations, educational entities and government, citizen scientists act to further scientific understanding and appreciation in their communities and beyond. Examples of successful efforts to recruit citizen scientists of all ages in the state of Texas include the Texas Nature Trackers and iNaturalist programs, among many other opportunities. A wide variety of projects are available to meet the interests of individual volunteers as well as the needs of the organizations. Citizen scientists perform a wide variety of research, data collection, and data entry tasks that reduce the cost of research, increase the scope of possible research, and can result in significant impacts on public policy. Citizen scientists are an underutilized resource in monitoring changing conditions and wildlife activity; however, strengthening efforts to provide information widely to the public about citizen scientist opportunities is likely to result in increased participation by volunteers who have interest but lack the guidance to get started.

Community collaborative rain, hail and snow network (CoCoRaHS)

Jim DeBerry, National Weather Service, Midland, TX

West Texas is one of the most sparsely populated areas of the state. As result, meteorological observations here are similarly sparse. Even automated observing platforms are not as abundant out here as in more populated areas of the state, for funding for such systems logically tends to be concentrated where benefits will be maximized, i.e., population centers. As a result, west Texas rainfall climatology is poor. In 1998, the CoCoRaHS (Community Collaborative Rain, Hail and Snow) network was established. CoCoRaHS is a unique, non-profit, community-based network of volunteers of all ages and backgrounds working together to measure and map precipitation (rain, hail and snow). With a simple rain gauge and an internet connection, landowners can establish a climatology of rainfall on their land. The denser the observing network, the better, especially in

mountainous terrain such as the Christmas Mountains, for rainfall can vary considerably in areas of dissimilar topography. CoCoRaHS is the cheapest, easiest-to-use network devised so far for measuring precipitation.

The Botanical Research Institute of Texas: a scientific resource for all

Barney Lipscomb, Sula Vanderplank, and Edward Schneider, Botanical Research Institute of Texas, Fort Worth, TX

The Botanical Research Institute of Texas (BRIT) is a global scientific institute and learning center focused on conservation and knowledge sharing. The BRIT mission is to conserve our natural heritage by deepening our knowledge of the plant world and achieving public understanding of the value plants bring to life. BRIT shares knowledge about the plant world to enhance life for people and all living things through research, education, and publishing. Two research collections at BRIT, the Herbarium and the Library, are the cornerstones of our mission. What are these foundational resources and how are they used? Our herbarium comprises an international collection of around 1 million dried plant specimens, the earliest from 1791, whilst our library is a worldwide collection of botanical and horticultural literature, with over 125,000 books, journals, collections of original artworks, manuscripts, photographs, and other archival materials, dating back to the 16th century. BRIT researchers are studying the floras of north-central Texas, east Texas, Enchanted Rock, the LBJ National Grasslands, and the flora of the southeastern United States. BRIT also has floristic and conservation projects in Baja California and the Mexican borderlands. The BRIT Press furthers the Institute's conservation mission through innovation and excellence in preparation, manufacture, and distribution of scholarly botanical research and scientific discoveries for the twenty-first century. BRIT publishes the Journal of the Botanical Research Institute of Texas (JBRIT) and a botanical miscellany book series of monographs, floras, field guides, biographies, and more. In the area of education, BRIT is looking to build graduate programs in botany with local universities. Bella's Preschool Programs and Camp BRIT offer a means for introducing children to the wonders of nature. The BRIT SEED (Science-based Experiential Education Design) School inspires and supports educators in connecting learners to nature through the use of outdoor classrooms, nature and urban environments. Green Revolution is a year-round environmental leadership platform focused on increasing environmental stewardship and E-STEM skills of students in the 6–12th grades. Students, or Agents of Change, investigate their world to identify, design, and implement creative solutions to improve human health and sustainability of the environment.

Lost in the labyrinth — non-Mexican depictions of the largely Mexican geographic distribution of *Lophophora* spp. (Cactaceae)

Martin Terry[1,2] and Keeper Trout[2], [1]Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX and [2]Cactus Conservation Institute, Alpine, TX

The genus *Lophophora* consists of a handful of specific and subspecific taxa; the phylogenetic relationships among them are currently under intensive investigation, as is their biogeography. Most of these small cacti occur in calcareous soils of the Chihuahuan Desert and Tamaulipan thornscrub in the central plateau of northern Mexico between the Sierra Madres, as well as in a much smaller contiguous region with similar habitats along the Rio Grande in the adjacent U.S. state of Texas. Here we offer a brief critical review of the current state of knowledge of the biogeography of *Lophophora*, based largely on published maps that have been created over the past century as approximate representations of the geographic distribution of the genus as a whole and/or of one or more of the major infrageneric taxa, such *as L. williamsii* (peyote).

A preliminary report of 3,4,5-trimethoxyphenethylamine concentrations in over-the-counter topical products purported to contain *Lophophora williamsii* (Cactaceae).

Robert LeBlanc and Martin Terry, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

Samples from a collection of commercial over-the-counter products that were claimed explicitly or by implication to contain *Lophophora williamsii* (Cactaceae), an over-harvested species of cactus, have been collected. The purpose of this investigation is to determine the presence or absence of *L. williamsii* metabolites in the products. The samples will be extracted with organic solvents with acid-base washes and analyzed by high pressure liquid chromatography (HPLC). This will indicate the presence of the stable and abundant alkaloid mescaline (3, 4, 5-trimethoxyphenethylamine) in samples of ostensibly L*. williamsii*-infused oils and ointments that were distributed as topical remedies. If detectable levels of mescaline are found in a given extract, then we can infer that *L. williamsii* is present in the corresponding topical products.

Family first: the social black-crested titmouse

Rebekah Rylander and M. Clay Green, Department of Biology, Texas State University, San Marcos, TX

The black-crested titmouse (*Baeolophus atricristatus*, hereafter BCTI) is a small, non-migratory passerine that has a tendency to form family flocking groups due to delayed juvenile dispersal. A recently elevated species, separated from its sister-taxon, the tufted titmouse (*Baeolophus bicolor*), the BCTI is an ideal model species for studying family-flocking dynamics. Between 2013 and 2015, 263 individual BCTI were captured and color-banded at the Freeman Center in San Marcos, Texas, where family flocks were resighted and monitored. Using a generalized linear mixed effects model and Fisher's exact test, the weight ($p < 0.01$) and sex ($p < 0.01$) of juvenile BCTI appeared to influence which individuals in a brood delay their dispersal. The Julian date was found to be a significant predictor for annual flock size ($p < 0.001$), with territory size increasing an average 3.4 ha ($p < 0.01$) between the breeding and non-breeding season. Juvenile BCTI that delayed their dispersal often establish territories adjacent to their parents the following year, thus creating kin-structured neighborhoods. Social interactions between these related individuals were almost always passive as opposed to aggressive ($p < 0.05$), potentially leading to an increase in inclusive fitness for both individuals involved. Family flocking dynamics of the BCTI are more complicated than previously thought, and future research may yield insight into how this species evolved its current social structure. With the ever-growing threat of habitat fragmentation, the importance of the family unit to the survival of the BCTI may be key for management of this species.

Environmental assessment of the Rio Grande in the Big Bend Region of Texas

Kevin Urbanczyk[1], Jeffery Bennett[2], Lydia Smith[2], Kenny Saunders[3], Pete Diaz[4], Diego Araujo[4], Christopher Chapa[4] and Michael Montagne[4], [1]Department of Biology, Geology, and Physical Sciences and Rio Grande Research Center, Sul Ross State University, [2]National Park Service, [3]Texas Parks and Wildlife Department and [4]U.S. Fish and Wildlife Service

The Rio Grande Wild and Scenic (RIGR) reach, located in the Big Bend region of far west Texas, is one of the most significant groundwater-dependent aquatic ecosystems in North America. However, diminishing flows and altered sediment dynamics have resulted in decreased conveyance capacity, increased flooding, decreased aquatic habitat and decreased water quality. These trends are especially evident in the upper

portion of the reach. A particularly important aspect of the aquatic habitat of the RIGR is its ability to support the reintroduction of the Rio Grande silvery minnow (RGSM). The RGSM was extirpated from the region in the 1960s, and has recently been reintroduced at several locations in the RIGR. The recent Upper Rio Grande Basin to Bay Expert Science team noted the lack of biological data related to flow and other habitat conditions in the RIGR. With a multi-institutional and multi-disciplinary team, we have assessed various aspects of the river in the RIGR reach, including the interactions between flow, water quality, geomorphology and sediment mobility, and aquatic habitat. Results include the quantification of the gaining reach between the stream gages at Johnson Ranch and Foster Ranch (~6 cms/212 cfs) concomitant with an improvement in water quality. These results come from numerous synoptic gain/loss studies, water quality studies, and from analysis of stream gage data. These improvements to the overall condition of the river (more flow and less salinity) are the result of base flow contributions to the river from the Edwards Trinity Plateau aquifer and a related aquifer in adjacent Mexico. The aquatic habitat of the RIGR has been assessed through numerous down-river trips to sample for fish and invertebrates and associated parameters (water depth and velocity and basic field water quality parameters). Results include the recent discovery of the RGSM 57 river miles downstream from a reintroduction site near Dryden and its affinity for silt and sand substrate and backwater conditions. The invertebrate sampling confirms the general observation of downstream improvement of water quality indicated by an increase in the Index of Biological Integrity median scores.

Long-term monitoring of biological control of saltcedar (*Tamarix*) along the Rio Grande, with notes on interactions with athel (*Tamarix aphylla*) and a new locality record of a salt cedar associate

Christopher M. Ritzi, Alexandra Hassenflu and Anne Marie Hilscher Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

Saltcedar (*Tamarix* spp.) is a deciduous shrub or small tree that was introduced into the United States from Eurasia in the early 1800s to stabilize riverbank erosion and to serve as a windbreak and ornamental. However, due to a high reproductive potential, saltcedar has become invasive on many river systems in the western United States. Some of the worst tamarisk infestations have occurred in the southern areas of the Rio Grande, and in an attempt to control this plant by biological means, a consortium consisting of the USDA, NRCS, and Sul Ross State University released several species of tamarisk leaf beetle (*Diorhabda* spp.) in southern Brewster and Presidio counties in Texas. The suitability of the species was evaluated, and data suggested that the Tunisian subtropical species (*D. sublineata*) was best suited to this region. Observations have indicated that the tamarisk leaf beetles were capable of establishing on a close relative non-target species, the athel tree *(T. aphylla*). Six sites along the Rio Grande River, from Lajitas to Candelaria, Texas, have been routinely monitored to determine the long-term impact of leaf beetle defoliation on saltcedar and the non-target athel trees in the region. Although defoliation had remained steady during previous years, significant defoliation events were not observed until September and October of 2014 and only patchy activity observed during 2015. Additionally, a newly discovered biological control agent for salt cedar was collected in the region, providing the opportunity to examine interactions and potential competition between beetles in the future.

Insect diversities in areas impacted by the biological control of saltcedar (*Tamarix* spp.) in west Texas

Jaimie Michelle Lawhorn and Christopher Ritzi, Department of Biology, Geology, and Physical Science, Sul Ross State University, Alpine, TX

Saltcedar (*Tamarix* spp.) is an invasive species of tree in North America, native to Asia and the Mediterranean. First introduced in the early 19th century for erosion control, saltcedar has spread to dominate over 2 million acres in the United States and Mexico. Biocontrol began in 2001 with the introduction of the saltcedar leaf beetle in Utah, Colorado, Nevada, and Wyoming; this has led to the control of over 200,000 acres of affected land. Following this success, the saltcedar leaf beetle was released in along the Rio Grande in Texas in 2008 where it has been having positive effects. This study served to research the insect biodiversity in areas with controlled saltcedar populations versus areas still under mitigation for saltcedar. It is hypothesized that the control of saltcedar would increase overall biodiversity. From this, it was predicted that areas with controlled saltcedar populations would have an increased biodiversity, while the areas currently under management would still have reduced biodiversity due to limited plant diversity in the area. It was found that there was clearly increased diversity in the controlled areas, no matter the measure. Areas with controlled saltcedar populations had greater species abundance, diversity, and evenness than those currently under management.

Building resilience in Rio Grande tributaries through reforestation

Jeffery Bennett and Joe Sirotnak, National Park Service and the Rio Grande Wild and Scenic River, Big Bend National Park, TX

Intermittent and ephemeral watercourses are the dominant hydrologic feature of arid landscapes. Together with perennial streams, these features serve the vital function of moving water, nutrients, and sediment throughout the watershed. Restoration and management projects that increase resilience will guard against negative consequences of climate change and will ensure that the ecosystem services that human communities depend upon are sustained. These ecosystem services include filtering and storing water, recharging and discharging groundwater, transporting sediment, providing habitat and migration corridors, supplying nesting and cover areas for year-round and migrating birds, and supporting vegetation communities. Historical accounts of perennial or intermittent streams within the Big Bend indicate many were lined with large stands of cottonwood and willow. Mining and agricultural activities during the late 19th and early 20th centuries required the harvest of many riparian forests for fuel and structural material. In 1933, Terlingua Creek was described as a “bold running stream, studded with cottonwood timber as was alive with beaver”. Yet, aside from a small area above Terlingua Abajo, the riparian forest has not returned despite 70 years of protection. We hypothesize that the old riparian forest provided the nursery conditions allowing cottonwood and willow recruitment by reducing hydrologic forces during high flows. Without this forest, annual flows are sufficient to scour young plants. We also hypothesize that the removal of vegetation encouraged excavation of gravel and reduced the extent of the riparian aquifer. We propose that reforestation within stream beds will increase riparian habitat for species such as yellow-billed cuckoo and gray hawk, and also increase resilience to climate change by altering hydrologic conditions such that the channel aggrades, increasing the extent of the riparian aquifer. We are engaged in a reforestation project along Terlingua Creek in Big Bend National Park that will both increase riparian habitat and resilience to climate change. The active restoration site is approximately four acres, with an additional 40 acres identified. To date, we have planted 1800 coyote willow (*Salix exigua*) with plans for 6000 more. Partner projects are occurring farther up in the watershed.

Bee diversity along an elevation gradient in the Christmas Mountains

Kate Seideman-Barclay and Michael Huston, Department of Biology, Texas State University, San Marcos, TX

Bees are important pollinating insects, yet most bee research is limited to agricultural settings. It is important to collect baseline data in non-agricultural settings and in arid regions where bee diversity is thought to be the highest. We examined bee richness and abundance along an elevation gradient in two parallel canyons of the Christmas Mountains. Hanging blue vane traps were placed in 18 established sampling plots with a 100 foot change in elevation between each trap. We expect the number of bee species to decrease with increasing elevation because higher elevations often experience more dramatic changes in climactic conditions. While the two canyons are geographically close, the plant communities are different, and this is reflected in the abundance and richness of the bees collected.

Wednesday Morning

Development of a geology field course in the Christmas Mountains and Big Bend region

Mark T. Ford and Thomas L. McGehee, Department of Physics and Geosciences, Texas A&M University–Kingsville, Kingsville, TX

The Big Bend area provides our Texas A&M University–Kingsville (TAMUK) students with a capstone experience in geology field camp. Such experiences in a natural laboratory are widely accepted as being integral to both learning and professional development. A geology field school is fundamental in the education of top quality geoscience graduates and our capstone course not only links all of the student's previous coursework but also requires writing reports on their observations in the field. This writing-intensive course produces students that are very well prepared for either industry or graduate school. Recent work indicates that 88% of industry professionals agreed that field work should be, "…an integral and required part of undergraduate (geology) program." We cover a broad range of geology in this field course. Exercises in Big Bend National Park include drafting a structural cross section through the Marathon Fold Belt (part of the Ouachita Orogeny), mapping structurally deformed Cretaceous sedimentary rocks in Dog Canyon (deformed during the Laramide Orogeny), measuring both stratigraphic and volcanic sections, mapping a rhyolite dike that contains some mineralized zones and recognizing the Basin and Range overprint on the area, among others. We are developing projects to cover similar topics in the Christmas Mountains. After some reconnaissance in 2014, we conducted our first mapping exercise in the Christmas Mountains last year. The exercise was the final project of this capstone course and included structural deformation by the Ouachita and Laramide Orogenies and Basin and Range normal faulting as well as Tertiary volcanic intrusions into Cretaceous sedimentary rocks. This year, we will continue to develop new projects with a focus on the Terlingua and Christmas Mountains area. This spring, we will be examining possible projects at the Mariposa Mine (mercury), refining last year's mapping project and networking with others to establish new projects. The Christmas Mountains present us with an ideal location to grow our field course and provide geology students with the capstone experience they need to be successful as an industry professional.

The southern extent of the Tascotal-Mesa fault at the Christmas Mountains

Veronica Sanchez, Department of Physics and Geosciences, Texas A&M University–Kingsville, Kingsville, TX

The Trans Pecos region offers a unique setting to study rock outcrops and structural features (faults, or folds) because it is a dry and sparsely vegetated region. The challenge resides in understanding the geometry of these geologic features to then decipher their role in changing the landscape over time. The Texas Lineament Corridor (TLC) crosses this region. It is an enigmatic ~1300 km long zone of "lineaments" along a ~N60°W trend that is thought to have accommodated horizontal motion even though the magnitude remains unknown. It is an ancient zone that developed ~1.4 billion years ago during a mountain building episode. The zone poses a challenge as it has been "overprinted" by more recent structures, faults that developed later in the tectonic development of the Trans Pecos region. Interest resides in this zone because it is associated with significant metallogenesis. The goal of this study is to map sections of the Tascotal-Mesa Fault within the TLC to assess variations in displacement along strike, especially where it encounters the Christmas Mountains laccolith; a magmatic intrusion that deformed the surface cover into a mushroom-like morphology ~42 million years ago. Its presence may have influenced the spread of stresses from nearby faults. The map-view geometry of the Tascotal-Mesa Fault is comparable with the Chalk Draw Fault. Both systems are ~150–200 km long, appear parallel to each other, display obvious bends along their trend, and have a southern termination associated with a laccolith. Previous research on the Chalk Draw fault indicates that stresses were encumbered by the presence of the Rosillos Laccolith; stresses did not propagate beyond this locality, as no apparent faults have been mapped or interpreted from remote sensing. The Christmas Mountains laccolith has been interpreted to reside in a young transtensional zone (horizontal plus vertical motions). An overview of major regional structural features will be discussed, as well as a field plan to map features along the southern Tascotal-Mesa Fault bend in the Christmas Mountains to assess the geometry and kinematics associated with this feature.

Paleostress fields of the Christmas Mountains

Alexander Johnston, Department of Physics and Geosciences, Texas A&M University–Kingsville, Kingsville, TX

Preliminary research shows that the geology of the Christmas Mountain range has been altered by multiple tectonic events. The changes in the stress field that affected the area may be the result of the Ouachita Orogeny, the Laramide Orogeny, Tertiary volcanism, and Basin and Range tectonics. Preliminary mapping shows NW trending shear zones that are comparable with geometries associated with Basin and Range extension. The goal of this research is to identify and characterize the paleostress fields by mapping lineaments in the Christmas Mountains via GIS technology and in the field to identify principal stress directions. The fracture patterns will be used to differentiate between several models, including extension due to magmatic cooling; extension due to rifting (Basin and Range), or compression due to Laramide shortening. Preliminary field research also found that there is a NE trend of fluorite veins associated with shear zones possibly associated with magmatic fluids during late-stage cooling. Some of the predictions that this research will investigate are: is it possibly a cooling laccolith that developed a radial fracture pattern? Are the patterns the result of Basin and Range rotation, or is the fracture pattern reflecting Laramide shortening? Results from this research will add to the previous knowledge of the paleostress field of the Trans Pecos area. It will also expand the amount of research that is available for future students coming to study the area during TAMUK's field camp, and for professionals that will be studying the geology of the Christmas Mountains by giving them background information so that they can also expand the research further.

Photogrammetry and geomorphic change detection

Bryan Roberts and Kevin Urbanczyk, Rio Grande Research Center and Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

Geomorphic Change Detection (GCD) is a tool used to study changes in fluvial systems. It requires high resolution Digital Elevation Models (DEMs) collected before and after flood events. Photogrammetry is a reasonably cost effective technique that uses overlapping photographs to generate high resolution DEMs. It produces higher resolution data than traditional topographic surveys and is less expensive than LiDAR. We have assessed the precision and accuracy of our application of this technique at a field site on Alamito Creek approximately 45 km south of Marfa, TX. The experiment included the collection of two sets of aerial photographs using a quadcopter during two successive weekends. Photoscan (AGISoft) was used to create the DEMs in a UTM coordinate system. Our first attempt to assess the precision of the technique was to have two operators create DEMs from the same set of photographs and then subtract them to produce a DEM of Difference (DOD). In this case, the DOD is an estimate of the reproducibility of the elevation estimates of the technique. The average difference was -0.004 meters with a standard deviation of 0.076 meters. The high standard deviation resulted from the inclusion of vegetated areas where the elevation estimates were highly variable. Our second attempt to assess precision was to compare DEMs created from the two different data sets. The resultant DOD had an average difference of -0.059 m and a standard deviation of 0.556 m. This very high standard deviation was the result of the fact that the second set of photographs was collected early in the morning and the shadows in the imagery caused the photogrammetry software to create artificial topography in the vicinity of vegetated areas. An independent assessment of the accuracy was made by comparing data collected with a traditional survey instrument to a DEM. A comparison of the elevation estimates of the survey points and the DEM revealed a systematic average difference of -0.040 meters and a standard deviation of 0.026. These results suggest that if care is taken in the processing, DEMs created using photogrammetry can be used for high resolution geomorphic change studies.

Archaeological applications of photogrammetry in the Big Bend

Samuel Cason, Center for Big Bend Studies, Sul Ross State University, Alpine, TX

The Center for Big Bend Studies utilizes photogrammetry and Structure from Motion to document artifacts, features, and sites in the Trans Pecos study area. These tools enable analysis at a variety of spatial scales and a way to visualize complex structures and archaeological materials via diverse digital media (e.g., GIS and interactive 3-D models).

Apollo astronaut training in the Big Bend

Pat Dasch, Geology Club, Sul Ross State University, Alpine, TX

The Apollo program evolved in response to President Kennedy's 1961 challenge to send humans to the Moon and bring them back safely to Earth, within the decade. By late 1963, NASA had recruited 29 of the astronauts who would train for lunar exploration. Instruction in geology was a key element in astronaut training. The lunar explorers would need to recognize features on the Moon as they closed on landing sites. Moonwalkers were tasked with collecting geologically significant rock samples that would unlock the mystery of the origin and evolution of the Moon. Between March and July 1964, the astronaut recruits received classroom training in geology, and two groups of astronauts visited the Big Bend on geological field trips in April 1964. In the

words of Ted Foss, one of the geologists coordinating the astronaut training program: “we can’t say what the Moon is like, exactly, but it may be similar to the Big Bend area.” Furthermore, a leading figure in planning geological training for the astronauts, Bill Muehlberger, from the University of Texas, selected the Big Bend for field training because the area offered the “greatest variety of geology in the smallest area than any other place in the United States.” Thus began a relationship between NASA and the Big Bend that continues to this day. This presentation will revisit the first Apollo astronaut field trip to the Big Bend April 2–3, 1964, and provide vignettes of subsequent mission-specific geology training for the lunar explorers in far West Texas.

Wednesday Afternoon

Monitoring protocols for spring inventory and assessment, Big Bend Ranch State Park, Texas

Zach Weathers and Kevin Urbanczyk, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

Big Bend Ranch State Park (BBRSP), located in Brewster and Presidio Counties of far west Texas, is characterized by a dense concentration of natural springs. However, these springs have not been inventoried or analyzed in detail, despite the importance of the springs to riparian habitat and human activities. In this study, we have developed monitoring protocols specifically to describe the attributes of the springs to assist in an overall inventory and classification effort. These protocols were conceived by adapting existing procedures developed for springs in the desert southwest to the specific characteristics of the BBRSP. A basic concept is to combine the geologic aspects of the aquifers feeding the springs with observations of the biology and chemistry of the springs. A chemical database exists for comparison purposes and differences in the chemical characteristics of the springs in the different sub-watersheds in the park do exist. Comparison of existing and new data will help to quantify the effects of human as well as feral and domestic animal use of the springs. Together, this new information, along with existing data, will allow the construction of a comprehensive database of springs for BBRSP and set the foundation for an environmental conservation plan for the springs.

Recent collections and observations of the rare milkweed vine, *Matelea atrostellata* (Apocynaceae)

David E. Lemke, Department of Biology, Texas State University, San Marcos, TX

The genus *Matelea* (Apocynaceae, Asclepiadoideae) comprises more than 100 species of vines or herbaceous perennials forming decumbent rosettes of short stems from a central rootstock that are native to warm temperate and tropical regions of the western hemisphere. Approximately 20 species, commonly known as milkweed vines, occur in the United States, extending as far north as Tennessee, Missouri, and Oklahoma. Five species of *Matelea* are known to occur in Brewster County, Texas: *M. reticulata, M. producta, M. parvifolia, M. texensis*, and the recently-described *M. atrostellata* which, until recently, was known only from the type collection locality along the Window Trail at Big Bend National Park. Recent collecting activity in the Christmas Mountains has found *M. atrostellata* to be locally common along certain arroyos on the eastern slopes of the mountains, where it exhibits the same color variations as found in the national park. The availability of fresh material of the species has allowed us to investigate the production of malodorous leaf aromas that may function as an herbivore deterrent and to better understand the unusual floral structure characteristic of members of this genus.

Post-drought mortality and recovery of desert willow in Ben's Hole Canyon

Kelsey Dannen, Collin Tubbs, Jackson Johnson, Matthew Harrison and Michael Huston, Department of Biology, Texas State University, San Marcos, TX

Desert Willow (*Chilopsis linearis*) is not a true willow, but rather a member of the family Bignoniaceae, known for spectacular large flowers and found throughout the world, particularly in the tropics. Desert willow is found across the southern deserts of North America, generally in lowland areas with somewhat higher water availability. Ben's Hole Canyon has no permanent flowing water, but clearly has periodic floods. We mapped and measured 79 desert willows ranging from young saplings to large dead trees over 30 ft tall over a 500 ft elevation gradient in the canyon. Prior to 2011, Ben's Hole Canyon had several sections with large desert willow trees. All of the large trees were killed by the 2011 drought, although some are re-sprouting from their base. We found that the largest desert willows were concentrated in a few locations where either bedrock obstructions or the convergence of dry washes probably increased water availability. The amount of re-sprouting from top-killed trees and the abundance of young saplings that have established since the end of the drought suggests that with continued normal rainfall the desert willows of Ben's Hole Canyon will return to their former glory.

Mammal species richness of the Christmas Mountains research area

Allison Scott and Michael Huston, Department of Biology, Texas State University, San Marcos, TX

The Christmas Mountains research area acts as the home range for a variety of wildlife found in Brewster County, Texas. From February 2015 to May 2016, we documented the presence of wildlife species in seven different locations within the research area via the placement of motion-capture wildlife cameras. Data gathered from our wildlife cameras allowed us to form a catalog of species that occur in the area including mule deer, mountain lions, bighorn sheep, black bears, ringtail cats, and various bird and insect species. This species richness data provides a foundation for future ecological and behavioral studies of area wildlife including activity patterns, movement patterns, and predator-prey interactions.

Co-occurrence and habitat selection of mesocarnivores in Big Bend National Park

Skyler Stevens[1], Patricia M. Harveson[1], Catherine C. Dennison[1], Michael Stangl[1] and Raymond Skiles[2], [1]Sul Ross State University and [2]National Park Service, Big Bend National Park, TX

Mesocarnivores serve an important role in ecosystems, acting as both prey to large carnivores and predators to small mammals and birds. Big Bend National Park is home to many mesocarnivore species, including striped skunks (*Mephitis mephitis*), hooded skunks (*Mephitis macroura*), hog-nosed skunks (*Conepatus leuconotus*), and western spotted skunks (*Spilogale gracilis*), coyotes (*Canis latrans*), bobcats (*Lynx rufus*), grey fox (*Urocyon cinereoargenteus*), ring tails (*Bassariscus astutus*), raccoons (*Procyon lotor*), badgers (*Taxidea taxus*), and long-tailed weasels (*Mustela frenata*). To better understand how these species interact and partition the available habitat we used remote cameras placed at 58 different locations across a 450-km^2 grid, covering the Chisos Mountains and surrounding foothills. Cameras were placed strategically to capture animal movement, in places such as washes, canyons, mountain passes, and saddles in a ridgeline. A total of 515,698 pictures were collected over a total of 14,452 trap days. Skunks (collectively) were captured at 43 locations, coyotes at 12 locations, bobcats at 33 locations, grey fox at 52 locations, ring-tails at 32 locations, raccoons at 5 locations, badger at 2 locations, and long-tailed weasels at 5 locations. The three skunk species all co-occurred at only 5

locations, and hog-nosed and spotted skunks co-occurred the most out of the skunk species, at 13 locations. Grey fox co-occurred completely with *Mephitis* spp., weasels, and raccoons. Using a Chi-square test and Bonferroni confidence intervals we analyzed four habitat categories: 1) elevation, 2) fine scale terrain ruggedness, 3) broad scale terrain ruggedness, and 4) vegetation type. Grey fox, bobcat, coyotes, ringtails, and spotted skunks all used the four habitat categories significantly different to availability. Hog-nosed skunks did not show a strong preference for three of the habitat categories, only selecting for the highest level of terrain ruggedness at the fine scale.

Roadkill ecology - spatial and temporal scales of recently deceased terrestrial vertebrates along the I-10 corridor from Comfort to Fort Stockton

Jeremy Luther and Michael Huston, Department of Biology, Texas State University, San Marcos, TX

Roads provide a mortality hazard for any animals that cross them. Although most animals cross successfully, some proportion is killed. The proportion of animals that are killed while crossing a road is influenced by properties of the road, such as width and amount of traffic, and also by the properties of different species, such as speed of movement, hearing and eyesight, and fear of unfamiliar conditions. We hold road conditions constant by only sampling on two-lane sections of I-10, and hold animal properties constant by tallying each species separately. We assume that, for a particular species, the number of individual animals killed along a section of I-10 is proportional to the abundance of that species in the area on either side of that section of the roadway at that particular time. Using these data, we can describe how the relative abundance of a species changes across 270 miles of I-10 (Comfort to Ft. Stockton), as well as how the abundance of a species changes over time, between seasons, and years. Skunks (potentially of 3 or more species) are by far the most common roadkill, although their abundance changes over space and time. We will also report on other species, such as coyotes, grey foxes, and raccoons, which have clear variation in mortality between seasons.

Terrestrial snails and life in the desert

Francis Horne, Department of Biology, Texas State University, San Marcos, TX

Desert animals have major problems conserving water in both cold and hot deserts where water is not readily available. To survive in such harsh conditions many strategies are employed; some biochemical, some physiological and others being behavioral. Snails emerge from estivation after a rain as both food and water become available. For several hours or days, and as long as the humidity is elevated, feeding continues during both day and night. Reproduction occurs during such periods. As water evaporates, conditions deteriorate and snails withdraw into their shells, plaster up against a solid object like a rock. Several epiphragms of calcified mucous are formed over shell's orifice reducing evaporative water loss. Declining metabolic rates allow estivation for up to a year and the catabolism of 50% of tissue weight; much of it being tissue protein. Urea and uric acid wastes of protein catabolism are retained and excreted only after feeding begins. Once it rains, dormancy is broken and feeding on lush green vegetation initiated. Catabolized tissue must be replaced. It can be a real challenge to replace tissues and foodstuffs in such a short time by eating mostly high cellulosic leaves. These various issues will be discussed.

Dietary analysis of the microwhip scorpion (Palpigradi: Eukoeneniidae) from Val Verde County in Southwestern Texas

Mary Jones, Ned Strenth and Loren Ammerman, Department of Biology, Angelo State University, San Angelo, TX

Microwhip scorpions, or palpigrades, belong to a poorly known order of arachnids found in caves and soil from numerous localities worldwide. The feeding habits of these enigmatic creatures are largely unknown. It was widely accepted that this group is likely carnivorous as predation is a common strategy among arachnids. Captive specimens were reportedly observed capturing springtails with their chelicerae which supported this premise. However, a recent histological study on a cave-dwelling species in Slovakia identified cyanobacteria as a food source. This current study uses high-throughput sequencing to analyze the gut content of palpigrades. Two specimens of *Eukoenenia florenciae* were collected near the Devil's River in Val Verde County of southwest Texas. The specimens were decontaminated and then DNA extracted using the DNeasy tissue protocol. A fragment of the COI and 16S rRNA genes were sequenced using an Illumina MiSeq. Sequences w ere separated into operational taxonomic units and compared to the NCBI GenBank and Barcode of Life Database (BOLD). Preliminary results indicate the presence of a cyanobacteria and aphid as potential food items. This study is the first dietary analysis of palpigrades using molecular techniques and supports diverse feeding habits of this species.

Changes in insect biomass in the Christmas Mountains due to abiotic factors

Allison Bordini and Michael Huston, Department of Biology, Texas State University, San Marcos, TX

Previous studies have shown that biomass and abundance of insects are directly related to precipitation and temperature in an environment. Precipitation and temperature affect the quality and quantity of plants on which the insects feed, thus affecting the individual insects. As primary consumers, insects could be used as an indicator for immediate and long-term changes in the environment. Our lab has collected data on the changes in insect biomass, diversity, and abundance since 2012, focusing on nocturnal Lepidoptera. Insects were sampled by hanging UV light traps at Terlingua Ranch Headquarters during the new moon each month 30 minutes after sunset for a 90-minute period. One trap faced northwest toward an open mesquite flat, while the second trap faced a mountainous hillside. Samples were weighed fresh and compared to temperature readings taken in the field as well as monthly precipitation data collected from Panther Junction. Initial results have shown a general increase of total insect biomass and sphingid biomass with an increase in precipitation and temperature, indicating there may be a positive correlation between fresh weight and abiotic factors.

Preliminary analysis of *Chrysina woodii* (Coleoptera: Scarabaeidae) populations in the Davis Mountains of west Texas

Timothy Maddox and Ned E. Strenth, Department of Biology, Angelo State University, San Angelo, TX

The genus *Chrysina* is a large group within the subfamily Rutelinae that has a very limited distribution in North America, with only four species known to occur within the United States. Of these species, Wood's jewel scarab (*Chrysina woodii*) is considered to exhibit the most limited distribution. It is known from the mountains of west Texas and is reported to feed on a limited number of host plants, specifically little walnut (*Juglans microcarpa*). The current study examined several populations of *C. woodii* in the primitive equestrian site of Davis Mountains State Park in Jeff Davis County. A total of 418 *C. woodii* specimens was marked from three

sites within the primitive area over a period of twelve collecting trips from June to September 2015. Study site 1 had a 7% recapture rate and beetles were determined to have a 30-day survival rate of 29%. Initial analyses suggest that the population of study site 1 is robust with a size of 348 to 552 individuals; however, additional sites are needed to better determine the size of the Davis Mountains population as a whole. The beetles appear to be most active from June through August when breeding occurs, begin to decline in September, and die out by mid to late October. Future work for this study will involve an additional collecting season within the Davis Mountains with the addition of new sites, as well as furthering the life history information.

A preliminary survey of the crayfishes (Crustacea: Decapoda) of west Texas and eastern New Mexico

Michael Lucero, Department of Biology, Angelo State University, San Angelo, TX

The last scientific survey of the crayfishes of Texas was conducted in 1958 and did not include the Concho and San Saba drainage systems. No published survey currently exists for the state of New Mexico. This ongoing survey was started in the summer of 2015 with the intent to specifically include the drainage systems of central and west Texas as well as the entire state of New Mexico. To date results have led to the observation of the red swamp crayfish (*Procambarus clarkii*) in the Concho, San Saba, lower Pecos, and Rio Grande rivers, the southern plains crayfish (*Procambarus simulans*) in the Concho River, and specimens tentatively identified as the western painted crayfish (*Orconectes palmeri*) from the San Saba River. A possible introduction of the virile crayfish (*Orconectes virilis*) was also observed for the Gallinas and middle Pecos Rivers in New Mexico. The current survey will be compared to history accounts.

A sedimentary survey of the Tornillo Creek drainage basin, an ephemeral stream system in Big Bend National Park – preliminary findings

Thomas G. Stoddard, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

Big Bend National Park (BBNP), Texas, is traversed by many ephemeral streams, arroyos, and draws that control surface and ground water resources across the park landscape. The largest of these is the Tornillo Creek ephemeral system to the north and east of the Chisos Mountains. The Tornillo Creek Basin drains approximately one third of BBNP. This study establishes defined geographic boundaries for the Tornillo Creek drainage basin (TCDB) in order to create a control area for long-term research into total sediment load moving downstream. Overall, Tornillo Creek is a braided channel consisting of mixed load deposits and clast sizes varying from boulder to clay grains. Typical channel sequences alternate between areas of larger, rocky clasts followed by stretches of compacted, sandy deposits. Inter-channel depressions in upstream areas exhibit clay mud deposition, however, quantities of clay mud greatly increase downstream due to lower flow velocities and higher sediment input. Field tests (HCl 10%) indicate presence of calcite at all points along the creek bed, with inter-channel depressions exhibiting evaporative crystal growth. Changes in geomorphology of the TCDB are analyzed through the use of historic imagery and recent observations. Measurements of recent down cutting trenches and the National Park Service conservation efforts are discussed. Agents of the United States Border Patrol report that Tornillo Creek is frequently used by illegal immigrants as a pathway north due to water from seep springs being present almost year round. This was confirmed in Banta Shut-in by evidence of bioturbation in the creek channel and the presence of liquid water underneath the bedload miles from any mapped spring. Suspended sediment load data is still not conclusive due to a lack of rainfall/flood event since 07 October 2015. However, additional results and data are still forthcoming.

Cretaceous karst deposits of Shafter, Texas

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A spectacular brecciated limestone is exposed one mile south of Shafter, Presidio County, Texas, along US 67, in the Shafter Mining District. The breccia exposure in the road cut is 25 meters wide and the sides are vertical. It is unique to the area and only occurs on one side of the road cut. The breccia is within the Late Cretaceous-age Presidio Formation, which unconformably overlies the Permian Mina Grande Formation, and in the southern Shafter area is overlain by the Cenozoic Perdiz Conglomerate. The beds are composed of skeletal wackestones and packstones, as well as some fluvial inputs and several beds of large black oysters. The fluvial material is composed of medium grained, well sorted, sub-angular quartz; which is present in most of the beds in the outcrop as well as comprising most of the material in the sandstones that are present. Breccia clasts of limestone and sandstone are as large as 2 meters and are cemented by calcite with some void spaces remaining. Distinctive beds of Orbitolina, large oysters and oolitic limestone make up the Presidio Formation here. Beds on either side of the breccia appear to be offset with the east side dropped by 11 meters. Although the strata in the area have been deformed by Cenozoic folding and faulting, as well as igneous intrusions, the breccia does not appear to be a tectonic fault, because it is not continuous and shows no sign of slickensides. The breccia is concluded to be a karst feature, specifically, a breccia pipe underlying a collapse structure trending about 110 degrees. Breccia pipes contain large amounts of angular blocks, and can show offset due to dissolution collapse. The lithology of the breccia clasts is a mixture of the Presidio Formation ‘s oyster beds and oolitic limestone, so vertical displacement was not great. No trace of the overlying Perdiz Conglomerate, which consists of only volcanic clasts, is present. Speleothems and flowstones indicate formation in vadose conditions, and lack of mechanically emplaced clastic infill suggests a depth of formation greater than about 10-20 meters. Although karst features are known in the underlying Permian carbonates, this appears to be the only karst feature in the local Cretaceous strata.

Stratigraphic and depositional analysis of the Leonardian Cibolo formation in the Marfa Basin in the vicinity of the Chinati Mountains, Texas

Christopher Pate, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, TX

The Marfa Basin in Presidio County, Texas, forms the southwestern extent of the Permian Basin. The exposed Lower Permian strata within the Marfa Basin are found roughly 10 miles north of Shafter, Texas, at the Cibolo Creek Ranch. The Lower Permian strata of the Marfa Basin is less studied than the age-equivalent strata of the nearby Delaware and Midland Basins. A detailed study of the Lower Permian strata in the Marfa Basin will enable a better understanding of the depositional and environmental relationships between the less restricted Marfa Basin and the more restricted Delaware and Midland basins. In order to accomplish this the Lower Permian strata exposed near the Chinati Mountains are being described and correlated using modern carbonate descriptions, lithostratigraphy, biostratigraphy, and sequence stratigraphy. Using this data, a depositional model will be created for the Leonardian-aged Cibolo Formation. The Cibolo Formation may represent shelf edge to shelf deposits. Improving the current state of knowledge of the Permian strata within the Marfa Basin will further enable potential for future prospects and plays of petroleum that have not been fully explored within the sedimentary basin. In order to better constrain the timing of events within the Marfa Basin fusulinids will be identified and correlated to known fusulinid zones within the rest of the Permian Basin. Using facies analysis, identification of sequence boundaries will be attempted to determine vertical changes within the section. The data collected from facies analysis and sequence boundaries will be used to determine

possible eustatic changes within the Marfa Basin. The Cibolo Formation will be compared to the rest of the time-equivalent formations of the Permian Basin in terms of eustatic changes, and fossil assemblages and depositional settings.

Welcome to Terlingua Ranch Lodge

16000 Terlingua Ranch Road
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Terlingua Ranch, TX 79852
(432) 371-3146

www.terlinguaranch.com

Office open daily 9:00 am to 5:00 pm

- **Check-in** time is 3:00 pm. If you need additional 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 Monday through Thursday, 7:00 am to 9:00 pm Friday and Saturday, and from 7:00 am to 7:00 pm on Sunday (hours are extended for holidays and hunting season).
- **Security and Assistance** – for after-hours emergencies, please contact Security in the Security house located across the parking lot from the main office or phone (432) 371-2960. The **911** phone is located on the patio next to the pool; you may also make credit card or phone card calls.
- **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 10:00 am to 10:00 pm. Due to the mineral content of our well water, we recommend saving your whites for when you return home.
- **Water** is scarce – please conserve.
- **Burn bans** may be in effect while you are here. Campfires and outdoor cooking are limited to existing fire rings and propane stoves. Please see the Front Desk for information regarding burn bans.
- **Smoking** is allowed outdoors only. Please dispose of cigarettes in butt cans located throughout the Lodge.
- **Christmas Mountains** access permits are available at the Front Desk.
- Please obey posted **speed limits**.
- Please respect **No Trespassing** and **No Hunting** signs throughout the ranch.
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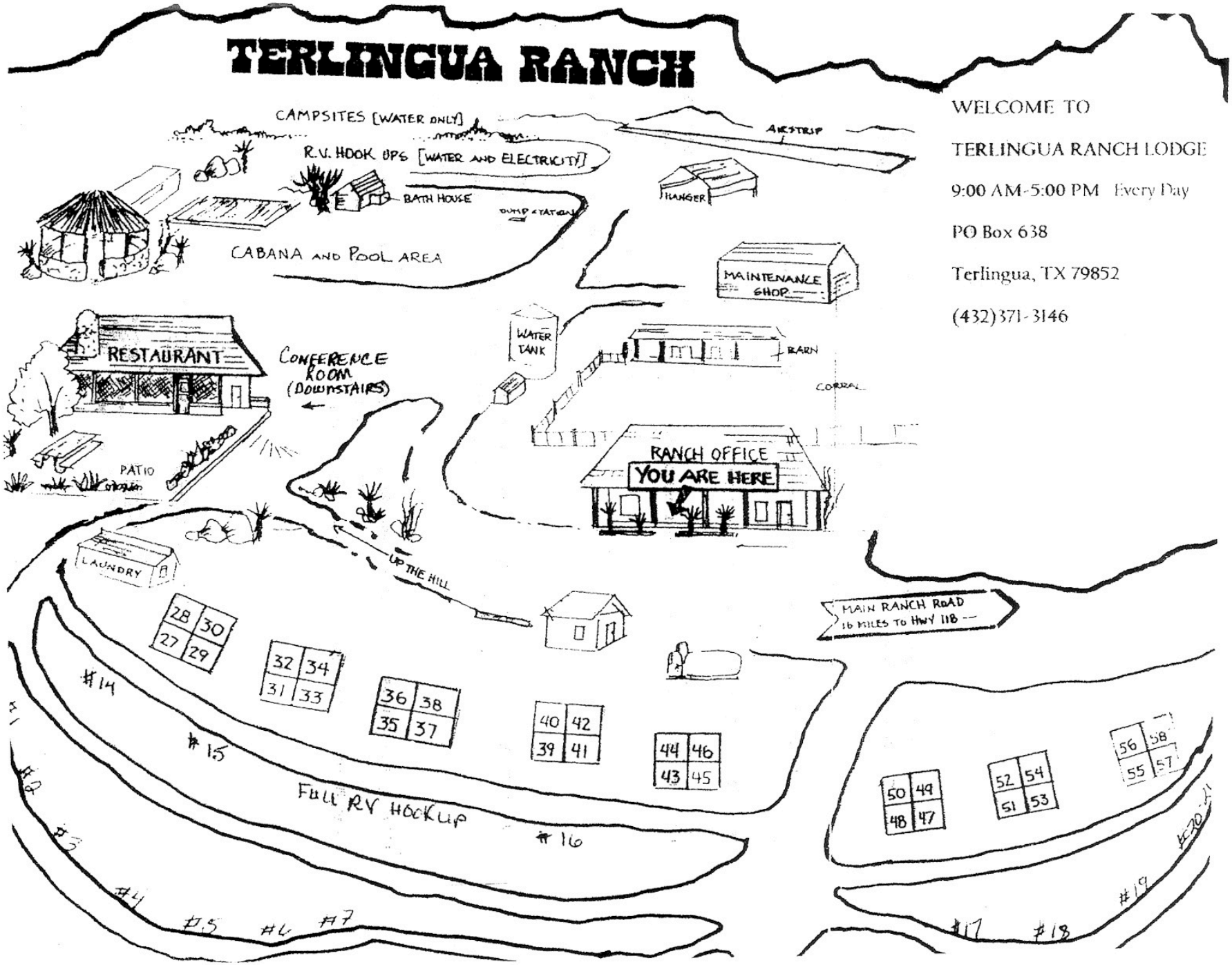

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