

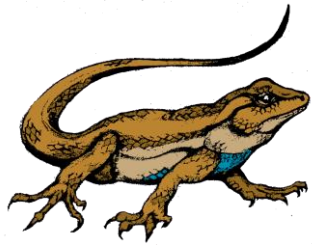
White Sands Science Symposium

Abstracts

Las Cruces, New Mexico

June 7, 2012





White Sands Science Symposium



A two day science symposium was held on June 7-8, 2012 to showcase the scientific research occurring at White Sands National Monument (NM). Researchers from across the country came together to share their knowledge of this unique ecosystem and provide information on cutting-edge research conducted in diverse fields of science including biology, archeology, geology, paleontology, climatology, and hydrology. Goals of the symposium were to encourage new collaborations among White Sands researchers, highlight recent exciting discoveries, and synthesize recent findings into a “state of the science report” that can be used by White Sands NM for staff trainings and interpretive programming for the general public. The symposium included lectures, a poster session, and panel discussions.

Poster presentations focused on the remarkable endemism and diversity among insects and other species; the potential speciation and the ecomorphology among animals; the distribution of mesocarnivores; the microbial diversity and nutrient cycling within the gypsum soils; and the history of oryx removal from the monument.

As evident by discussions during the symposium, new discoveries are happening at an astounding rate and are redefining long-held assumptions about the monument. With so many new findings, it is exciting to think of what discoveries will occur next year.

TABLE OF CONTENTS

Talks (first author only and in *alphabetical order*):

Doug Burkett

Natural Resource Management at White Sands Missile Range

Ivo Garcia (presented by David Bustos) – *Abstract available*

Cuatrociénegas and White Sands: A Successful International Cooperation Experience

Mihaela Glamoclija

Geomicrobiology of the Aeolian Environments at White Sands National Monument

Gary Kocurek – *Abstract available*

Exploring Aeolian Sand Dunes at White Sands Using Airborne LiDAR

Rip Langford – *Abstract available*

Sediment Sources and Transport within Parts of the White Sands Dune Field

David Lightfoot

Arthropod Inventory Survey of White Sands National Monument and Cuatrociénegas Protected Area

Rick LoBello – *Abstract available*

Challenges and Successes in Protecting the Northern Chihuahuan Desert

Raleigh Martin – *Abstract available*

Linking Wind, Sediment Transport, Vegetation, and Groundwater to Explain Dune Field Evolution at White Sands

Eric Metzler – *Abstract available*

The Remarkable Endemism of Moths at White Sands National Monument

Curtis Monger

Biomining and Carbon Sequestration by Microorganism at the White Sands National Monument

Talon Newton – *Abstract available*

Hydrologic Investigation at White Sands National Monument: Preliminary Results

Quinn Robinson – *Abstract available*

Mesocarnivore Distributional Patterns at White Sands National Monument

Erica Rosenblum – collective brief with student in lab (Hardwick) – *Abstract available*

Ecological Speciation in White Sands Lizards

Thomas Schmugge – *Abstract available*

Space Observations of the White Sands and their Potential Use to Study Surface Water Dynamics

Anna Szyrkiewicz

Geochemical and Hydrological Processes Controlling Gypsum Deposition in White Sands

Adrian Unc

Inventory of Soil Microbial and other Soil Faunal Ecosystem Components at the White Sands National Monument and Guadalupe Mountains National Park

Elizabeth Walsh – *Abstract available*

Zooplankton Diversity at White Sands National Monument: Potential Cryptic Speciation in Lake Lucero

Posters (first author only and in *alphabetical order*):

Miguel Dominguez Acosta

The White Sands as a Dust Emission Hotspot

Catherine Borer

Calcium Partitioning and Sequestration in Foliage from Plants at White Sands National Monument: Strategies for Calcium Tolerance

David Bustos – *Abstract available*

New Paleontological Findings at White Sands National Monument

Bill Conrod

Capture and Removal of African Oryx from White Sands National Monument

Simone DesRoches

Beyond Black and White: Comparative Ecomorphology of Three Rapidly Evolving Lizard Species in White Sands National Monument

Ryan C. Ewing – *Abstract available*

Constructing the Dune-field Pattern at White Sands National Monument

Kayla Hardwick (*see Rosenblume brief*)

An Experimental Test of the Adaptive Value of White Color in White Sands Lizards

Allison Harvey

Cultural Resources at White Sands National Monument

Craig Stockwell

Estimating Divergence Time for Two Evolutionarily Significant Units of the White Sands Pupfish (*Cyprinodon tularosa*)

Philip Sudman

Historical Biogeography of the Desert Pocket Gopher (*Geomys arenarius*) as Inferred from AFLP DNA Analyses

Anna Suggs – *Abstract available*

**NASA Remote Sensing Earth Science Student Program, Zia Middle School
(Student-based Mars analog research project)**

Mara Weisenberger – *Abstract available*

Restoring Big Game Habitat with Landscape-scale Prescribed Fire

Mara Weisenberger – *map only*

Fire Atlas of the San Andreas National Wildlife Refuge (map only)

James Witcher

**Geothermal Resources Framework and Potential Uses in the Tularosa and Hueco Basins,
New Mexico**

TALKS AND POSTER PRESENTATION ABSTRACTS

New Paleontological Findings at White Sands National Monument

David Bustos, White Sands National Monument, Holloman AFB, NM 88330

Beginning in the early 1900s, the existence of fossil trackways in ancient lake-margin sediments on the floor of Tularosa Basin began to appear in local reports. Until recently fossil tracks were unknown from the monument itself. Within the last five years a large number of fossil mammal tracks have been discovered on the monument. These tracks are preserved in late Pleistocene playa and lake-margin deposits associated with Lake Otero, which existed on the floor of Tularosa Basin during the last ice age. There is a need to locate and document the tracks before they are lost. Once the tracks become exposed they commonly erode due to the unconsolidated nature of the sedimentary deposits in which they are found, the tracks can vanish within a few years or less.

Fossilized trackways that include proboscidean (mammoth-like), camelid (camel-like), felid (cat-like) and canid (wolf like) have been discovered in the Late Pleistocene playa lake margin deposits of Lake Otero within White Sands National Monument (WNSA). Many fossilized mammal tracks have been discovered during the past decade within and surrounding (WNSA). These fossilized tracks, or footprints (ichnofossils), are preserved in the Late Pleistocene playa lakebed and lake margin deposits of ancient Lake Otero. The tracks contain morphologies that are associated with several Late Pleistocene megafauna including proboscidean (mammoth-like), camelid (camel-like), canid (wolf-like) and felid (cat-like).

Dyer Wolf



Camel



Saber Tooth Tiger



Mammoth



Constructing the Dune-field Pattern at White Sands

Ryan Ewing, Department of Geological Sciences, University of Alabama,
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At the upwind margin of White Sands Dune Field, sand dunes emerge abruptly over a few hundred meters from the mostly sand-bare Alkali Flat that sits to the west of the dune field. The first dunes that emerge are a few meters high and migrate up to 6 meters per year, but within the first few kilometers downwind of the upwind margin the dunes have grown to 6-10 meters high and are moving around 3 meters per year. How and why do sand dunes grow? Why are sand dunes among the most organized patterns in nature? The primary mechanism by which sand dunes grow and organize is through interactions between the dunes themselves. Fast moving sand dunes collide with slower moving dunes and their masses merge to produce a dune that is larger. Over time and distance dune mergers result in a an organized pattern of dunes that are about the same size, migrate at about the same rate and interact less frequently. Time-series aerial photographs and airborne LiDAR over the core of White Sands Dune Field provide the basis to examine different types of dune interactions and quantify the impact of dune interactions on the growth and organization of the dune-field pattern. Based upon analysis of aerial photos and LiDAR data, most interactions that promote dune growth occur within a kilometer of the upwind margin. Further downwind of the margin, interactions that promote slower dune growth and pattern maintenance occur. Overall, the type and rate of interactions depends on the environmental boundary conditions within which the dune field is evolving. At White Sands these boundary conditions include a line-source of sediment, near surface groundwater table and partial to fully vegetated dunes.



Cuatrociénegas and White Sands: A Successful International Cooperation Experience

Ivo Garcia Gutierrez, Area de Proteccion de Flora y Fauna Cuatrociénegas,
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Over the years, many international cooperation agreements between protected areas have been signed. However, the success stories are quite scarce, due to a number of factors. In many cases the partnership objectives were not clearly established, the monument was slowed, and the central or regional offices support lost. In some cases the agreements were not able to subsist in the government transition from one period to another and all the achievements and cooperation efforts were lost. Along with the previous reasons the bureau requirements, and the complicated visa process, overpowered the initial enthusiasm of many new partnerships. To achieve the partnership between White Sands National Monument and Flora and Fauna Protection Area (APFFC) Cuatrociénegas, the first step was clarifying the cooperation objectives in order to benefit both sides of the sister park partnership. These objectives were mutual training, sharing common species and ecosystems monitoring protocols, initiation of an endemic species joint research project, developing financial strategies for collaboration, sharing exotic and invasive species control strategies, and sharing and developing interpretation and educational material. In a very short time we have had remarkable achievements with the cooperation partnership for both parks. We believe sharing this experience would be helpful to other initiatives and partnership processes in the future.

Cuatrociénegas



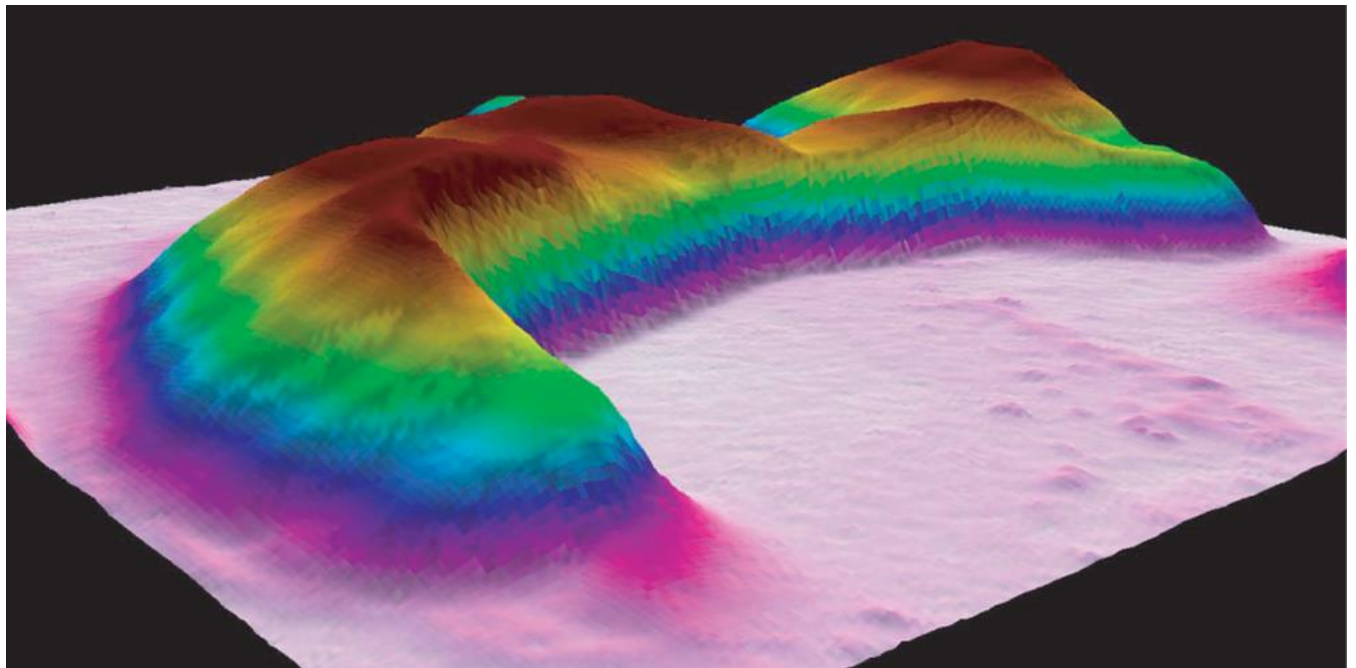
White Sands



Exploring Aeolian Sand Dunes at White Sands Using Airborne LiDAR

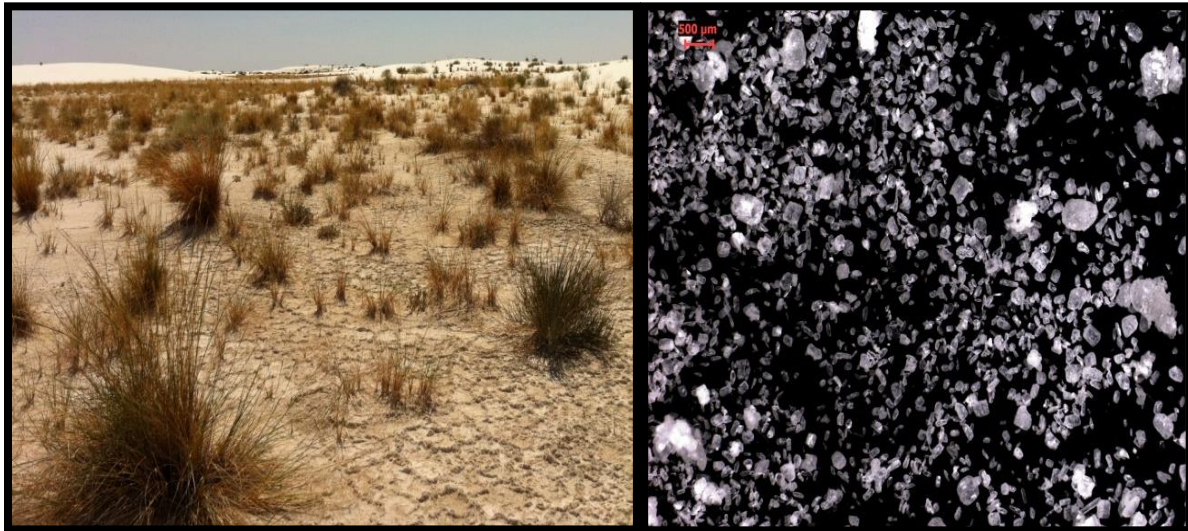
Gary Kocurek, D. Mohrig, V. Smith, E. Baitis, A. Pedersen, A. Peyret, S. Christian, and R. Ewing, Department of Geological Sciences, Jackson School, University of Texas, Austin, TX 78512

Airborne LiDAR provides accurate measurement of topography from which a digital elevation model (DEM) can be generated and used to measure dune parameters, whereas changes in dune topography can be determined from difference maps that compare a time-series of DEMs. Statistical analysis of 14 dune parameters from a DEM of a 39 km² representative portion of the White Sands Dune Field shows that the dune-field “pattern” is primarily defined by dune orientation, and secondarily by dune height, length and spacing. Removal of dune topography from the DEM using ArcGIS software reveals a terraced profile and three new paleo-shorelines of Pleistocene Lake Otero. Dune-field pattern heterogeneity coincides with the position of these shorelines, arguing that this antecedent topography has exerted a control on dune-field development. Difference maps show dune migration and stoss erosion in response to the dominant winds from the WSW, but also alongslope crabbing of dune sinuosity and migration of superimposed stoss bedforms in response to winter N winds. Dune-field pattern reformation by dune interactions, first documented through a time-series of aerial photos, can be quantified from time-series DEMs, and used in conjunction with air-flowing modeling and ground-penetrating radar (GPR) to understand the dynamics of dune interactions and their geologic record.



Sediment Sources and Transport within Parts of the White Sands Dune Field
Rip Langford, Department of Geological Sciences, University of Texas at El Paso,
El Paso, TX 79902

Studies of eolian dune fields indicate there is no consensus on what shapes grain sizes in dunes. Some studies indicate upward coarsening and others upward fining. In most active dune fields the variation within and between dunes is small, because wind forms a very efficient sorting mechanism. The White Sands dune field is an ideal place to study the sources and transport of sediment because the re-crystallization of gypsum creates a wide variety of grain sizes in the dune fields. This study is designed to map the grain size within a swath of the White Sands dune field in order to identify the sources of sediment. Transects along a 3 mile trend allow us to see how grain size changes down wind. Detailed 1-5 m²-spaced sampling of ten individual dunes and their associated interdunes illustrates how grain size varies within individual dunes. White sands dunes show three separate sources that originate with distinctly different grain sizes. 0.1 to 0.3 mm needle-shaped crystals are formed by crystallization in vegetated interdune areas. 0.5 to 3 mm blade-shaped grains are eroded from recrystallized sand in erosional interdunes and the lee sides of dunes. Equant frosted grains are derived from more distant areas of the dune field. The three populations mix to create the “grain size measured on individual dunes”. While several recent studies have attempted to model grain size within the dune field as transport and abrasion from a source along the upwind edge of the dune field, detailed analysis indicates that the sources of grains are much more and the sources of grain size more complex.



Issues, Challenges, and Successes in Protecting the Northern Chihuahuan Desert
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For nearly a 100 years conservationists living and working in the Chihuahuan Desert ecoregion of Mexico and the United States have worked to protect large areas of desert habitat in West Texas, Southern New Mexico and Northern Mexico. To help ensure that large areas of habitat remain both protected and connected by wildlife corridors, it is important that stakeholders in the region come together to develop and implement landscape cooperative strategic plans, smart conservation education programs, conservation leadership training opportunities and “no protected area is an island” outreach campaigns focused on conserving the desert’s biodiversity and ecosystem services.



Linking Wind, Sediment Transport, Vegetation, and Groundwater to Explain Dune Field Evolution at White Sands

Raleigh Martin, D. Jerolmack, F. Falcini, M. Reitz, C. Masteller, and C. Phillips – Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA 19104; Ryan Ewing – University of Alabama, Ilya Buynevich – Temple University

Desert dunes often exhibit remarkable changes in their morphology over short distances. For example, sediment-rich dunes can break up into smaller, isolated features, and then become stabilized by plants, over distances of kilometers. These pattern transitions often coincide with spatial variations in sediment supply, transport rate, hydrology and vegetation, but these factors have not been linked mechanistically. Here we hypothesize that the abrupt increase in roughness at the upwind margins of dune fields triggers the development of an internal boundary layer that thickens downwind and causes a spatial decrease in the surface wind stress. We demonstrate that this mechanism forces a downwind decline in sand flux at White Sands, New Mexico, using a combination of physical theory, repeated airborne altimetry surveys and field observations. The declining sand flux triggers an abrupt increase in vegetation density, which in turn leads to changes in groundwater depth and salinity—showing that aerodynamics, sediment transport and ecohydrology are tightly interconnected in this landscape. We conclude that, despite the documented complex climatic and geologic history of White Sands, internal boundary layer theory explains many of the observed first-order patterns of the dune field.

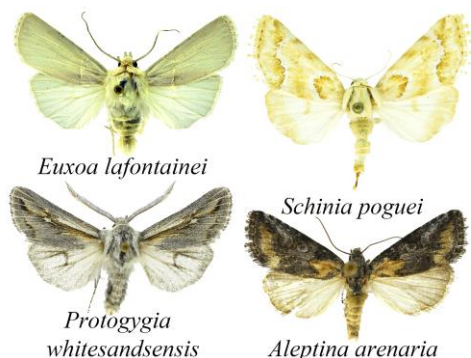


Remarkable Endemism in Moths (Lepidoptera) at White Sands National Monument

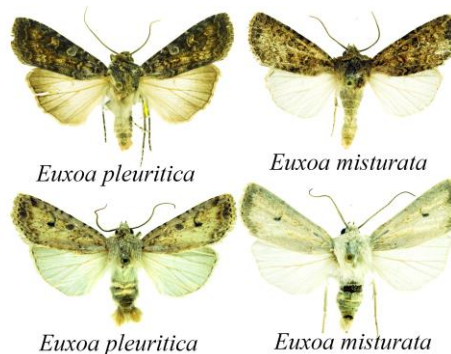
Eric H. Metzler, Michigan State University and New Mexico Natural History,
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In 2006 the National Park Service initiated a ten-year study of the moths at White Sands National Monument, Otero County, New Mexico. One goal is to associate moth species with disparate habitat types. A second goal is to detect new species and publish descriptions in peer reviewed literature. Four habitat types were selected along Big Pedestal Road west of the Administration Building. Samples were collected monthly in U.S.D.A. type black light traps. Primary types were deposited in the Smithsonian Institution. All other moth specimens were deposited in the Museum of Southwestern Biology at the University of New Mexico (UNM); Albert J. Cook Arthropod Research Collection, Department of Entomology, Michigan State University; Arthropod Museum, New Mexico State University; and McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History. All non-lepidopterist insects were stored in alcohol and deposited at UNM. More than 450 species of Lepidoptera were recorded. At least 18 species in four families are known to be new to science. All but two of the new species are endemic in the white gypsum dunes environment. White Sands National Monument has the highest number of endemic species of moths than any other single location or habitat type in North America. In addition, several other species of moths in two families which are normally brown or dark colored have white phenotypes in the dunes. The white phenotypes are so remarkably different in appearance their association with the nominate species is proved only by examination of the genitalia or DNA. These white phenotypes could be considered as quasi-endemic in that they occur in no other place on earth. Many of the new species are white species, and at least two new species of *Chionodes* are cryptic with each other. The logical extension of the occurrence of the high number of endemic species, and the high number of white species and white phenotypes suggests that the gypsum dunes ecosystem has a high rate of evolution. The high rate of evolution is more remarkable given the young age, approximately 7,000 to 8,000 years, of the dunes. The cause and rate of evolution of the moths at White Sands National Monument is unproven; the possibilities of future research are numerous.

Examples of endemic species



Examples of normal and white phenotypes



Hydrologic Investigation at White Sands National Monument

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The White Sands National Monument (WNSA), located within the Tularosa Basin in southern New Mexico, occupies a portion of the world's largest gypsum dune field. The beauty and uniqueness of the dunes along with the numerous plants and animals that have adapted to this strange environment make the monument a valuable natural resource. Within the dune field, depth to groundwater in inter-dunal areas is generally less than three feet below the surface. This shallow groundwater system, which stabilizes the base of the dunes, is thought to be one of the primary controls on the location and extent of the dune field. There is concern that a lowering of the local water table as a result of an increase in groundwater pumping and surface water diversions in surrounding areas may be detrimental to the preservation of the dune field. Therefore, the water sources that recharge the shallow aquifer within the dunes and the degree of connectivity between the shallow and deeper aquifers are of special interest.

The NM Bureau of Geology and Mineral Resources is conducting a hydrologic study at WNSA to investigate these areas of interest by using a variety of hydrologic, geochemical and geophysical techniques. Fast water level responses to precipitation events and downward hydraulic gradients in the dunes indicate that local precipitation infiltrates through the permeable gypsum sand to recharge the shallow aquifer. In addition to the local recharge component, geochemical and geophysical data indicate a regional saline groundwater component that is likely moving upward through playa and basin fill sediments into the gypsum sand aquifer.

Two wells were drilled and completed in the basin fill sediments below the gypsum sand (~200 ft below ground surface). Water levels in deep and shallow wells show a small upward gradient. A preliminary pump test, where water was pumped from the deep pumping well for approximately six hours, was indicative of very low transmissivity values at depth. The upward gradient was easily reversed, but did not affect the groundwater level in a nearby observation well completed in the shallow aquifer. Results of this pump test will help to plan a more extensive pump test in the near future that aims to evaluate the connectivity between the shallow and deep systems. We are using geophysical techniques to locate the Jarilla Fault, which is buried by basin fill sediments. This basin-scale fault likely affects regional groundwater flow to the east of White Sands National Monument. Preliminary results show the fault being located farther to the east than indicated by geologic maps. The large data set acquired by this study will

help to construct a hydrologic model of the shallow aquifer in the gypsum sand dunes and how it interacts with the regional groundwater system.



**Mesocarnivore Distributional Patterns at
White Sands National Monument, New Mexico**

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Little is known about the distribution or population dynamics of key components of White Sands National Monument's (WNSA) fauna, such as the kit fox (*Vulpes macrotis*). Informed resource management and understanding of the monument's community ecology requires such information. We are investigating the distributional patterns of mammalian carnivores at WNSA using remote cameras, and using a variety of sampling techniques to identify the factors driving carnivore distribution. Preliminary analysis suggests that coyote (*Canis latrans*) and badger (*Taxidea taxus*) distribution is governed chiefly by prey availability. Kit fox distribution appears to be regulated by avoidance of predation by coyotes or other factors, whereby foxes disproportionately occupy resource-poor areas where other carnivores are unlikely to persist. These preliminary results will be expanded upon in a pending analysis of carnivore occupancy at WNSA.



Ecological Speciation in White Sands Lizards

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White Sands is a geologically young and visually dramatic environment, distinct from the surrounding Chihuahuan desert in many ways. One key difference is in substrate color: the white gypsum sands contrast with the dark soils of nearby sites. The white substrate is a dramatic selection environment, particularly for small animals that need to be well background-matched to avoid visually-hunting predators. A number of animal species exhibit blanched forms at White Sands, including three lizard species, which have dramatic convergent evolution of light coloration. Studies of these species have scientific, conservation, and educational value. First, I discuss results from studies of natural selection, where we have demonstrated the adaptive value of blanched coloration. Specifically we have used different experimental approaches to demonstrate the role natural selection due to predation on lizard coloration. We have also documented additional ecological differences between white sands and dark soils lizard: body size and shape, running performance, microhabitat usage, anti-predator behavior and hormones. Second, I discuss results from studies of sexual selection, where we have shown that white sands lizards can discriminate between ecologically similar and dissimilar conspecifics. Specifically, we have used different experimental approaches to demonstrate that white sands males exhibit mate choice, a hallmark of the early stages of speciation. Third, I discuss results from genetics studies, where we have determined the genetic basis of light coloration in white sands lizards. Specifically, we have used molecular techniques to determine that the melanocortin-1 receptor gene is the gene responsible for light coloration in at least two of the three white sands lizards. This gene influences not only dorsal and ventral signaling color, and thus may link natural and sexual selection. The white sands lizards are a wonderful system to learn and teach about evolution in action.



Space Observations of the White Sands and Their Potential use to Study Surface Water Dynamics

Thomas Schmugge¹ and Max Bleiweiss²

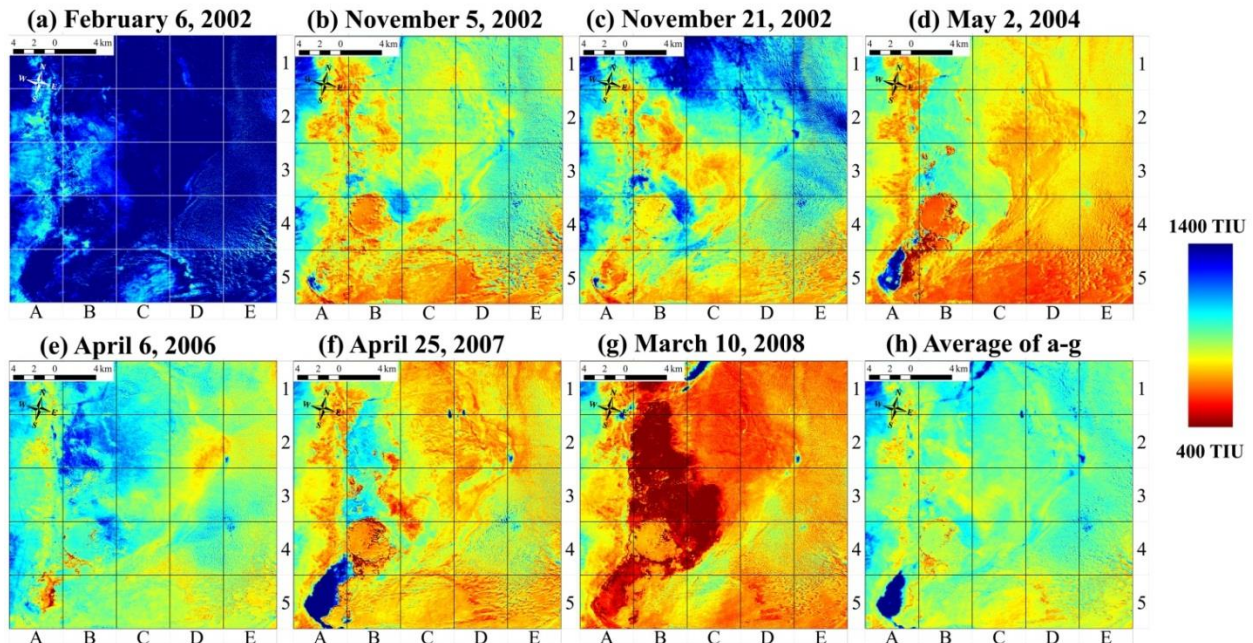
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² Department of Entomology, Plant Pathology and Weed Science, New Mexico State University,
Las Cruces, NM 88003

It has long been known that the diurnal range of surface temperature is related to soil moisture. Recently, working with surface temperature data from the Advanced Spaceborne Thermal Emission and Reflection (ASTER) radiometer on NASA's Terra spacecraft Scheidt et al (2010) demonstrated this for 7 cases at White Sands. They used the thermal infrared data at 90m resolution to estimate the diurnal range of surface temperature in a thermal inertia model to estimate soil moisture. They used these results to study the wind erosion potential. There were 7 instances when the day and night coverage were within 36 hours of each other in the first 8 years of ASTER observations. We propose to greatly expand this data set by using the coarser resolution (1 km) TIR data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor the same Satellite. This will provide more than 100 cases since the launch of the satellite in 1999.

White Sands Thermal Inertia

Range of Soil Moisture = 9 to 25% --- Blue = Wet - Red = Dry



From Scheidt et al. JGR 2010

NASA Remote Sensing Earth Science Student Program, Zia Middle School
Anna Suggs, Mesilla, NM 88005

An overview of the long term student based research project at White Sands national monument. Over 180 students have participated in research during the past 5 years. The research question is "What is the human impact on the dunal system at White Sands. The students took measurements of the dunes, along with plant and animal life both on the dunes and in the interdunal areas. Two different areas were monitored, one regularly used for recreation and another only used occasionally.



Restoring Big Game Habitat with Landscape-scale Prescribed Fire

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²Department of Extension Animal Sciences and Natural Resources, New Mexico State University,
Las Cruces, NM 88003

The San Andres National Wildlife Refuge (Refuge) encompasses the southern third of the San Andres Mountains in south central New Mexico, and lies within the northern most extension of the Chihuahuan Desert. A vegetation gradient exists with Chihuahuan Desert in the lower elevations, desert grasslands above and in some higher elevations and northern facing slopes piñon-juniper and oak woodlands. These woodland species have increased in the desert grasslands over the last 100 years due to overgrazing, fire suppression, and climate change. Prescribed burns have been designed to reduce fuels and fire threats over the broader landscape to create habitat diversity to enhance watershed function, and to maintain open native grassland and savanna ecosystem structure.

Burning is frequently prescribed to increase habitat quality for big game species, such as mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and pronghorn (*Antilocapra americana*), and can be an economically viable alternative to more costly management practices, such as forage plots or feeding, for increasing the quality of wildlife habitat and economics of wildlife enterprises. However, there are significant differences between burning to benefit big game and their habitat and burning for other ecological factors, such as brush control, mimicking “natural” fire regimes, or urban-interface clearing. Optimal burning prescriptions for big game habitat differ from other burning prescriptions in terms of season of burn, intensity of burn, and other factors. This results in many burns, even if conducted to benefit big game, actually having fewer positive benefits than they could have.



Zooplankton Diversity at White Sands National Monument: Potential Cryptic Speciation in Lake Lucero

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The Chihuahuan Desert is known for its high biodiversity in both terrestrial and aquatic systems (DINERSTEIN et al. 2000). Endemism is pronounced in fishes (MINCKLEY 1974) and springsnails (HERSCHLER 1985). However, little is known regarding the distribution of many invertebrate groups. DINGER et al. 2005 recently surveyed the aquatic invertebrates in the diverse habitats at Cuatro Ciénegas, Coahuila, MX and noted the lack of taxonomic information for many insect groups in the region. Even less is known regarding the zooplankton. Among the zooplankton, rotifers are recognized as the most important soft-bodied taxon in freshwater because of their roles in microbial loops and classic food webs. This group also is vital to understanding animal evolution, including evolution of sex and parasitism and is an important model for aging and toxicology studies. Lake Lucero located at White Sands National Monument is a remnant of an ancient lakebed, geochemically distinctive and geographically isolated. These three features combine to facilitate speciation. During a previous sampling trip, we isolated four morphologically distinct forms of the rotifer *Brachionus plicatilis* (two very distinct forms are shown in Fig. 1). Currently the phylogenetic position of these forms with the *B. plicatilis* species complex are unknown as is their ecological roles. *B. plicatilis* can be the dominant member of the zooplankton in Lake Lucero and thus an important contributor to its production and transfer of energy to higher trophic levels (e.g., insect larvae, birds, etc).

