BIG BEND National Park

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RESOURCE MANAGEMENT TRACKS

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Big Bend…Beyond the Scenery

Welcome to *Resource Management Tracks*, a publication of Big Bend National Park's Science and Resource Management Division.

This newsletter is intended to keep you informed (in layman's language) about research conducted in the park. The knowledge gathered from this research is used to make management decisions, to interpret the park for our visitors, and to help us all to recognize the multi-faceted significance of Big Bend. We hope you enjoy this and future issues!

We hope you enjoy this and future issues of ***"Resource Management Tracks"***.

In This Issue:

Restoring Degraded Rangelands

By Carol Purchase

Large gullies are eating up areas of lush recovered grasslands in the northern part of Big Bend National Park. Past grazing, water diversions, channelized streams and road drainage problems have created large gully systems and areas of severe soil erosion. Many of these highly eroded areas are found adjacent to patches of recovering native grassland.

Initial inventory has identified 69 stock ponds and over 100 water diversions in the Nine Point Draw watershed. The water diversions have concentrated water, often leading to accelerated erosion. As a result, over 1,300 acres have been severely eroded into gully systems that are now eroding upslope into the last remaining patches of native grasslands. Several miles of streams have also been straightened and diverted to facilitate road construction over the past 40 years, further contributing to erosion.

Previous revegetation efforts have not proved entirely successful and have permanently altered the landscape. The Soil Conservation Service (SCS) tried to restore grasslands to thousands of acres of the park in the early 1950's in the Tornillo Flats area. Most of this area had been denuded of vegetation due to overgrazing just prior to park establishment. The SCS contoured and seeded large areas, using bulldozers to dig thousands of shallow pits to hold water. Many of the unsuccessful techniques used in the 1950's are still advocated today in the scientific literature for arid land restoration.

Funding over the next two years will allow a park-wide inventory of restoration needs, and will implement experimental restoration treatments such as differential revegetation methods and gully stabilization techniques. Restoration plans include removal of stock ponds and water diversions to restore natural runoff patterns, although this would also result in new areas of bare soil. We need to be sure we can revegetate disturbed areas with native grasses prior to disturbing more land, to prevent additional erosion and the invasion of exotic weeds. The initial phase of this restoration project has already established revegetation plots to determine the most effective revegetation methods.

The Pine Canyon Watershed Program

By Dr. John Zak & Kevin Urbanczyk, Researchers

The Pine Canyon Watershed Program at Big Bend National Park was initiated in 1995 to examine the impacts of climate change and atmospheric pollution on soil nutrient dynamics, soil characteristics, and the activities and biodiversity of the soil bacteria and fungi associated with the major vegetation assemblages. Funded by the Biological Resources Division of the U.S. Geological Survey, the program is part of a network of monitored watersheds in the national parks and equivalent reserves.

The Pine Canyon program represents the only long-term monitoring program in the Chihuahuan desert that examines both abiotic and biotic contributions to watershed dynamics along the US-Mexican border. Long-term research objectives of the program include the determination of precipitation and other meteorological data, surface and groundwater hydrology and chemistry, trends in microbial activity and soil nitrogen dynamics, decomposition and fungal diversity, and plant species variations occurring due to human input.

The Pine Canyon Watershed covers approximately 78,000 sq. km and extends about 19 km in an easterly direction from the central Chisos Mountains. Permanent monitoring sites have been established in five vegetation zones found along the watershed, from high-elevation forests to lowland Chihuahuan Desert scrub. Since 1996, the study has collected data on soil nutrients, soil pH, soil organic matter, microbial biomass and microbial functional diversity along two 100 meter transects that were established in each of five vegetation zones.

Significant findings to date indicate that atmospheric pollution is affecting the desert ecosystem. Soil pH in the sotol-grasslands has dropped substantially, from an average value of 6.7 in January 1996 to 5.9 in August 2000. The changes in soil pH can be attributed to decreases in rainfall pH brought about from sulfate pollution. Seasonal spikes in soil nitrogen levels have been correlated to seasonal pulses in atmospheric nitrate levels in the rainwater.

The preliminary analysis of these data suggests that increase in soil nitrate levels will have a negative impact on the soil bacteria and fungi. Changes in these soil microbes will influence plant growth and may lead to a reduction in plant diversity within the grassland. We are currently beginning to investigate the impacts of these changes on key plants in the sotol-grassland.

New Instruments at K-Bar

By John Forsythe

In cooperation with the Texas Natural Resources Conservation Commission, two additional air quality samplers will soon be installed at the K-Bar Research Area. The instruments will be part of a network used to analyze and quantify the amounts of minute airborne particles present in Big Bend and other locations throughout Texas and the United States. The instruments will determine the total amount of particulates present, and will also quantify the amounts of 35 elements along with sulfates, nitrates and organic compounds.

Why is this work taking place? The multi-year study is a direct result of a lawsuit by the American Lung Association against the Environmental Protection Agency on behalf of America's elderly and young, and other at-risk populations. The Association contended that the EPA had been lax on enforcement of standards regarding the very harmful particulate pollutants.

Extensive studies in the nation's 20 largest cities have confirmed that small amounts of these very tiny particles (less than 2.5 one-

thousands of a millimeter, or about one-fifth the diameter of a human hair) are enough to raise the death rate. Such fine particles are not often the result of natural processes, but are usually generated by cars, power plants, construction, agriculture, unpaved roads and other manmade sources.

Recent studies at the Harvard University School of Public Health and the Johns Hopkins School of Public Health both showed that fine particles, regardless of their chemical composition, and not weather or other factors, are responsible for increases in mortality rates. The small particles are more harmful than larger particles (like sand or dust) because they are inhaled more deeply into the lungs, and are more difficult to remove.

Predicting the Effects of Climate Change on Bird Communities in Big Bend National Park

By Missy Powell, Researcher

Baylor University, the National Wetlands Research Center (U.S. Geological Survey, Biological Resources Division) and the National Park Service are cooperating to study winter bird use of various habitats in Big Bend National Park (BBNP). This information will be used to monitor diversity and abundance of winter bird communities. It will also play a role in developing models that represent the effects of climate change and fire on bird community composition.

Global climate change is expected to alter the intensity, frequency, and duration of disturbance events such as rainfall or fire. Scientists predict that arid and semi-arid systems, like the Trans-Pecos Region of Texas, will experience increases in temperature, changes in the frequency of rainfall events, and increases in the frequency of natural wildfires. Because rainfall and fire are driving forces in the Trans-Pecos, changes in the frequency or intensity of rainfall and fire events have the potential to alter the species composition and structure of plant communities. Such changes would have an impact on their associated bird communities.

Objectives of the study are to conduct winter bird surveys in BBNP and to create a geographic information system (GIS) land cover map. This data will be used to develop statistical models. The models will aid in predicting or simulating bird responses to changes in landscape-scale vegetation variables (such as percent cover of grassland or shrubland) as those variables are influenced by changes in climate and fire frequency.

The study area consists of 70 randomly selected survey sites located throughout the park. Each is located at least 400 meters from roads or established trails. Researchers recorded bird data at each survey site from December through early February of the past two winters and are now collecting data for the final season. During each week of the eight-week season, researchers conduct 20-minute unlimited-distance point counts at each of the 70 sites.

The study is not yet complete, but some preliminary results are available.

1. **The GIS land-cover map reveals that the study area is dominated by shrubland (82%), with the remaining area shared by grassland, yucca-ocotillo, montane forest, and riparian cover.**
2. **In winter 1999-2000, 55 bird species were detected. In 2000-2001, researchers recorded 74 bird species.**
3. **Mean species richness, an indicator of bird species diversity at each site, was closely related to the quantity of leafy vegetation in winter 1999-2000. Higher species diversity was found at study sites with greater shrub cover during both years.**

Results of the study will be used to model, or predict, the effect of climate and fire changes upon plant communities and associated birds. Pyrrhuloxia data from the 2000-2001 season, for example, indicates that this species is generally found in areas of sparse plant cover, particularly yucca-ocotillo shrubland habitat. Thus, the Pyrrhuloxia may decline with increase in grass, shrub, or woodland cover. Conversely, Pyrrhuloxia numbers should increase if dry conditions and fires result in expansion of the sparser yucca-ocotillo cover.

Final reports from the study should be available in 2003.

What's Happening to the River?

By Carol Purchase

Water Sampling in the Rio

Big Bend National Park is closely associated with the Rio Grande. In fact, the park's name is taken from the "big bend' in the river as it flows through the park. Together, Big Bend National Park and the Rio Grande Wild and Scenic River encompass 245 miles of the river.

But the Rio Grande is being threatened on several fronts. Flows are decreasing and water quality is degrading. The trend is continuing to a point when no one would be surprised if the river stopped flowing for a few days or weeks as has happened below El Paso.

First, where does all the water go? Dams in Colorado and New Mexico capture virtually all the water produced in those states. The only water that flows south from El Paso is water left over from irrigation, and discharges from city wastewater treatment plants. Sometimes no water flows past Fort Quitman, about 60 miles below El Paso. The water that does flow is very salty, as irrigation and wastewater outflows are high in chlorides and other salts. The exotic salt cedar tree, which lines the riverbanks along the Rio Grande, adds salts to the river as well.

South of Presidio the Rio Grande receives a fresh infusion of water from the Rio Conchos in Mexico. However, growing agriculture and municipal use in the Rio Conchos basin have decreased flows considerably over the past 10 years. With less clean water available from the Rio Conchos to dilute the salts and other pollutants flowing down from the north, the water quality in the Big Bend reach of the river is degrading.

Salinity levels in the Rio Grande have been rising for the past 30 years. Chloride levels routinely exceed state water quality standards and can be toxic to aquatic life. The frequency of algae blooms has increased in recent years, probably due to the increasing salinity levels.

Pesticides from upstream irrigation, and heavy metals, such as mercury from historic mining, are also a concern. Pesticides are routinely detected during water quality monitoring just upstream of the park. Mercury has been detected in fish and birds in the park.

What is the park doing? Big Bend National Park is monitoring the water quality and aquatic life in the river in partnership with the U.S. Geological Survey and with the International Boundary and Water Commission. These agencies are also working with Mexico to study the effects of historic mines on the river to determine the level of contamination of metals such as mercury. The park is also working with other agencies to further study the salinity of the river. And the Friends of Big Bend National Park donated state of the art water quality monitoring equipment to the park.

There is good news! The water quality of the Rio Grande improves naturally as it flows downstream into the lower canyons. South of La Linda, water from many limestone-filtered springs flows into the river, improving the water quality so that salinity is much less of a concern in this reach of the river. This is the part of the river that will be able to sustain the native aquatic life of the Rio Grande.

Geologic Scoping Session Identifies Geologic Priorities

By Vicki Ozaki, Researcher

Big Bend National Park recently hosted a geologic scoping session in the park. Fifteen geologists and scientists from the U.S. Geological Survey (USGS), Natural Resource Conservation Service (NRCS), the National Park Service (NPS), and universities converged in the park to review and discuss two programs: Geologic Resource Inventory; and Geoindicators.

The two programs focus on different aspects of the geology at Big Bend. The Geologic Resources Inventory focuses on the underlying bedrock geology (geologic units, stratigraphy,

structure and unique geologic resources). The Geoindicators Program considers the active geologic and hydrologic processes at the earth's surface that may undergo significant change in less than 100 years (magnitude, frequency, rate and trend), and may be affected by human activities.

The scoping session provided an opportunity for experts on park geology to share their knowledge with both the park and the Natural Resource Program Center staff. The group spent two days in the field exploring geology and resource issues in the park, and one day discussing geologic processes.

As a result of the meeting, the Geologic Resource Inventory program will seek to accomplish three objectives:

1) Coordinate and produce a digital geologic map for the park. The geologic map will be a cooperative effort between the USGS and academic institutions, and will compile existing geologic mapping onto a common base.

2) Provide a summary geologic report that will contain basic information such as geologic setting, stratigraphy, structure, unique geologic and paleontological resources, geologic hazards and issues.

3) Compile a park-specific geologic bibliography of existing research, studies, and maps.

A checklist of geological indicators was used to scope the Geoindicators Program. Participants identified significant geologic processes that are important to park ecosystems, and determined whether those geologic processes are being modified or affected by human activities.

As a result, the group identified a list of projects – inventory, monitoring, and research – that can help answer NPS resource management questions about what is happening to the environment, why it is happening, and whether it is significant.

Microfossils Yield Insights into Big Bend Dinosaurs

Dr. Julia T. Sankey, Researcher

Dr. Julia T. Sankey, Haslem Fellow and Assistant Professor of Geology at the South Dakota School of Mines and Technology, did paleontological field work in Big Bend National Park in early January, 2002. Sankey and three undergraduate and graduate students focused on the discovery of new fossil sites from the Late Cretaceous rocks, approximately 75 million years old.

The group found 12 new 'microsites' or sites with small teeth and bones of dinosaurs, crocodylians, mammals, lizards, fish, etc. Microfossil sites are accumulations of small fossils, often preserved in ancient stream deposits. Because teeth can be identified to the family and sometimes genus level, they provide important information. Additionally, because teeth are the hardest parts of the body, they are often preserved as fossils. The group identified one area that proved to be particularly rich with dinosaur and crocodylian teeth, including those from the following dinosaurs: ankylosaur (armored), tyrannosaurid (an unknown and older genus that T. rex but still in the same family), hadrosaur (duck-billed), ceratopsian (horned), and theropods (small, carnivorous dinosaurs).

This collection adds important new information for the park, and helps the science and natural resource staff document and protect the fossil sites in the park. Scientifically it is also important. Big Bend National Park is one of thesouthernmost areas in North America with a good record of Late Cretaceous sedimentary rocks and terrestrial fossils. However, less is known about the fossils in Big Bend compared to many other areas, especially in Montana, Wyoming, and Alberta. This work is helping to document what dinosaurs and other animals occurred in Big Bend, how they were different, and how the animals and ecosystem changed during the last ten million years of the Cretaceous, a time leading up to one of the earth's mass extinctions.

Ancient Soils and Global Warming

By Paul D. White, Researcher

Early Tertiary-age rocks in Big Bend National Park provide an excellent natural laboratory to study the possible effects of a well documented ancient global warming event, the Paleocene/Eocene Thermal Maximum (PETM), on ancient soil forming processes. The PETM occurred about 57 million years ago.

The process of soil formation is known as "pedogenesis." As soils are formed they develop features that provide clues to the conditions under which they formed, which can in turn provide information about the ancient climate.

In this study, work is being done on western Tornillo Flat to characterize the properties and features preserved in these ancient soils before, during, and after the PETM. The soils are typically red, black, or gray. Features found in these soils suggest that soil formation took place under mainly dry conditions, but there were periods of significant seasonal wetting from rains as well as a fluctuating water table.

Soil samples have been collected for geochemical and mineralogical analyses that will also help identify any possible effects of the PETM on soil forming processes. These analyses will include a study of the stable isotopes of carbon and oxygen extracted from carbonate nodules spanning the Paleocene/Eocene boundary with the goal of pinpointing the PETM. In addition, the clay mineralogy of these ancient soils is being studied for clues that may reflect changes in climate.

Fossils can also provide clues about the ancient conditions, and fossil leaves are especially good indicators of the ancient climate. This January, Scott Wing, a Smithsonian paleobotanist, accompanied Paul White on his 2002 field season to Big Bend. They searched for fossil leaves around the stratigraphic location of the PETM, but were unsuccessful. However, they did examine some early Paleocene fossil leaf sites that can be used to compare the ancient climate in Big Bend with locations at more northern or more southern latitudes.

More work is needed to say with any certainty whether or not the PETM affected soil formation in the study area. Studying soil formation during an ancient global warming event may help us to better understand the changes that may occur in modern soils if the

current global warming trend is maintained.

GIS UPDATE

By Betty Alex

The geographic information systems (GIS) program in Big Bend National Park works with researchers and park employees to produce maps and analyses that assist in park management, resource preservation, and improved visitor information.

Most recently, the GIS program has worked with the park's fire management officer, archaeologist, and botanist to produce maps and aerial photographs with overlays of proposed prescribed burn areas. In the next few months several analyses of vegetation, slope and other habitat criteria will be conducted to better define locations for sensitive plant species and to create a landforms map for the park.

Another facet of the park's GIS program is the use of the global positioning system (GPS). The park has several GPS units, and a base station that is used to correct field data and improve locational accuracy. The Science and Resource Management Division has recently used GPS work to map powerline access roads, trails, archeological sites, and endangered plant locations. GPS technology enables us to create more accurate maps that give us more complete information about our resources, which in turn leads to better understanding of those resources and an improved ability to protect them.

An example of the way GIS and GPS work together is an on-going project to map one of our threatened cacti. The cactus appears to need a specific habitat type, yet many areas appearing to be of that habitat type are devoid of this species of cactus. By doing detailed GPS mapping of the plant's known locations, we can use the GIS to define the exact slope, aspect, elevation, vegetation type, soil type, landforms, and underlying geology. Satellite imagery can also measure the light reflected by the habitat, in some cases revealing a unique "spectral signature" associated with that habitat. This information may reveal facts about the habitat that we had previously not understood. By reversing the process and using the GIS to find areas of the park that match the habitat of the known locations, we hope to find previously unknown populations of the plants.

Data and metadata about Big Bend National Park are beginning to be posted to the National Data Clearinghouse web site. The data is posted at 'ftp.ncsu.edu/pub/unity/lockers/ftp/npsftp/pub/data/bibe.' Data includes roads, park boundary, vegetation, fuel models, and various management-oriented maps. Additional data will be posted to this web site as it is completed and reviewed.

Future projects using GPS mapping and GIS will continue to enhance our knowledge of park resources.

New Big Bend Soil Survey

By Carol Purchase

Thanks to a partnership between the National Park Service and the Natural Resource Conservation Service (NRCS), Big Bend National Park is going to have an updated soil survey. Dr. Lynn Loomis and his team from the NRCS office in Marfa, TX, will be studying the soils of the park, updating the descriptions to include more information that will help the park manage and protect its resources. More detailed surveys of vegetation, erosion and soil chemistry will be completed over the next year. The new soil survey will help the park with everything from controlling exotic weeds to identifying target areas for archeological surveys. The survey is scheduled to be completed by 2004.

Curation 2001

By Rito Rivera

The year 2001 saw a noteworthy project completed by the Science and Resource Management (ScRM) Division and the curator at Sul Ross State University Herbarium.

Thousands of plants collected over the years in three national park areas - Big Bend, Amistad, and Guadalupe Mountains - had never been recorded in the files of the parks' collections.

As a result of this project, all of these specimens of flora were inventoried, cataloged and numbered – 5,931 from Big Bend, 2,102 from Guadalupe NP, and 652 from Amistad NRA.

This endeavor was a joint effort by the three national park areas, led by Big Bend National Park and accomplished at the Sul Ross State University herbarium. The project was initiated by Denise Louie, former park botanist at Big Bend National Park, and now at Zion National Park. The work was accomplished with the professional help of Herbarium Director Dr. Michael Powell and a very competent group of natural history students from the university. The project was funded by a grant to Big Bend National Park from a proposal submitted about two years ago.

Another significant project completed was the storage and the rearrangement of the park's photo collection. Previously, the park's thousands of photographs were stored in the ScRM library, which does not provide adequate fire protection or environmental control for these fragile objects. The photographs had been organized under the Dewey Decimal System, which made locating individual photographs a laborious process. The collection is now stored in fire-resistant file cabinets and in a controlled environment. Furthermore, the photographs are arranged in catalog numerical order to facilitate access and retrievability for researchers and staff. The photo collection also contains many oversized photographs that have been rearranged and stored in acid free file folders and envelopes.

Another important capability initiated in 2001 is the use of the park's museum database to store images of objects in the collection. When fully implemented, this capability will allow researchers to view items in the collection without requiring physical access to the objects. This capability was initiated into the system by interpretive ranger Joselyn Fenstermacher, who made huge contribution to the collection files on her own interest and time.

All in all, the curation end of ScRM has had a good year in 2001, and accomplishments have far exceeded expectations due to the talent and dedication of volunteers and individuals who have helped with these projects.

Decline of Freshwater Mussels of the Rio Grande

by Raymond Skiles

In recent decades scientists have determined that freshwater mussels (family Unionidae) are the most rapidly declining faunal group in North America. Major factors in mussel decline include extensive alteration of rivers, streams and lakes; contamination of aquatic habitats; and introduction of exotic species that prey upon and compete with native species. The American Fisheries Society considers 72% of the species to be extinct, endangered, threatened, or of special concern.

However, society and land management agencies such as the National Park Service have only recently recognized the need to monitor and protect this diverse group of species. This lack of appreciation and attention led one scientist to write, "a silent mass extinction is occurring in our lakes and rivers."

To begin understanding the status of Rio Grande mussels in Big Bend National Park and the Rio Grande Wild and Scenic River, resource managers in 1998 recruited the assistance of Texas Parks and Wildlife Department mussel scientist Robert Howells. Field and classroom training provided park staff with skills to opportunistically survey for mussels concurrent to other activities occurring in the Rio Grande corridor.

Initial efforts were supplemented by inclusion of mussel surveys in the multi-disciplinary Rio Grande Aquatic Survey that began in 1999. Results of the mussel investigations were recently reported in "Status of Freshwater Mussels of the Rio Grande, with Comments on Other Bivalves." The following summarizes that report.

At least 14 native mussel species historically occurred in the Rio Grande of Texas, New Mexico, and Mexico. Only six native species have been found alive within the past 10 years. Among species endemic to the Rio Grande, two have not been seen alive since 1972. One species was last documented in 1898.

Credible reports of mussels in this area date from only the mid-1970's, well after significant river alteration and degradation occurred. Thus, it is likely that several of the species found in other areas of the Rio Grande once occurred in the Big Bend Region, but were extirpated or became extinct without notice.

Three species are documented with specimens collected in the Big Bend region. Tampico pearlymussel was last recorded just downstream of Boquillas Canyon in 1993. Recently dead shells of Texas hornshell were found in the lower canyons during the recent survey. Salina mucket was found in the recent survey only as dead shells upstream of Boquillas Canyon and in the lower canyons. Since the hard shells may persist for several years, it is unclear whether populations continue hanging on to life in isolated locations. A fourth species, paper pondshell, was recorded both upstream of the park and downstream of the Rio Grande Wild and Scenic River; thus it is assumed to have been extirpated from the Big Bend prior to identification.

Although no living mussels were found, the survey revealed that living populations of the closely related clam family was represented by one native species, the fingernail clam. It was found in a variety of locations, but its abundance and distribution is still not well known. The most abundant bivalve found during the survey was the non-native and ubiquitous Asian clam, now common in all parts of the Rio Grande.

Difficult access to much of the Rio Grande means mussel status remains poorly understood despite the recent study. Further investigation is required to locate and protect any remaining native populations, or to adequately document the final demise of these beleaguered organisms. Staff and recreational river travelers are encouraged to report location and identification of any native living or non-living mussels found along the Rio Grande for inclusion in a database maintained by the Science and Resource Management Division.

Big Bend Natural History Association Awards Project to Texas Tech University

By Vidal Davila

The Big Bend Natural History Association (BBNHA) has awarded a grant for $7,840 to Texas Tech University to complete the Historic American Building Survey (HABS) drawings of the Daniels Farm House and the small casita associated with it.

The HABS survey consists of measuring the entire Daniels Farm House using modern computer technology, including a laser scanner/camera, and then plotting the data on paper. These drawings are very detailed. Numerous sheets will outline to scale where every joint and nail is located in the buildings. A detailed written report explaining construction, design, and time period will also be included. Students from Texas Tech, under the direction of Professor Elizabeth Louden from the College of Architecture, have already made a visit to the park to measure and collect all the necessary data needed for the project.

The drawings will assist park staff in conducting future historic preservation work on the farm house and documenting the condition of the building as it is today. The small casita located northeast of Daniels Farm House is also included in this project. The project should be completed by December, 2002. The Daniels Farm survey is one of many research projects that the BBNHA has funded. We appreciate all the funds and support the BBNHA gives us each year.

Mexican Affairs Office Funds Work in Mexico in Cooperation with Big Bend National Park

By Joe Sirotnak & Vidal Davila

The Mexican Affairs Office in Las Cruces, New Mexico awarded Big Bend National Park funds in the amount of $3,000 in September to purchase materials and equipment for a joint Big Bend/Maderas del Carmen tamarisk control project. Carlos Sifuentes, biologist with the Maderas del Carmen Area de Proteccion de Flora y Fauna in Coahuila, installed nine experimental tamarisk eradication plots in Boquillas Canyon. All sites were on the Mexican side of the Rio Grande. In each plot, all tamarisk stems were notched and treated with a 3:1 mixture of vegetable oil and Garlon 4 herbicide. Mexican crews were supported by the Rio District rangers from Big Bend National Park. The Big Bend botanist, who has been overseeing ongoing tamarisk eradication efforts in the park, provided technical expertise and assisted with pre-treatment site assessments. After evaluating the success of the initial treatments, Sifuentes will initiate revegetation efforts with native species on these sites. Information gathered from these experimental treatments will be used to design and implement riparian restoration efforts throughout the Rio Grande corridor and upland riparian sites.

Meanwhile, in the Park…

Tamarisk eradication efforts continue at upland spring sites in Big Bend National Park. Since 1998, tamarisk has been removed from over 100 infested upland springs and water sources, including many remote sites in the Sierra Quemada and the upper Smoky Creek and Fresno Creek drainages. The regional Exotic Plant Management Team, based in Carlsbad, was in Big Bend in December and January and performed initial and follow-up treatments at fourteen upland water sources. The assistance of park muleskinner Bill Jennings has been instrumental in the success of the tamarisk project.

The upland water sources are a very important resource in the Big Bend and promote landscape-level biodiversity. The 2000 spring survey, which has unfortunately stretched into 2002, has revealed that many willows and cottonwoods have died since 1995. This is probably a function of both the natural drought cycle and the presence of tamarisk at many of the spring sites. However, we have early indications that willow and cottonwood vigor and recruitment are increasing following the removal of tamarisk. Several sites in the upper Tornillo Creek drainage, for example, support nice young cottonwoods that have been protected by the removal of tamarisk. Michelle Cox and Stephanie Bartel, both graduate students at Sul Ross, are currently completing research projects on our important upland spring sites.

(See related articles)

Black Bear Genetics Study

By Raymond Skiles

Summarized from a research report by David Onorato and Eric Hellgren

A landmark four-year study of the Big Bend black bear population is in the final phase of data analysis and reporting during 2002. The study is sponsored by the National Park Service, and implemented by the U.S. Geological Survey-Biological Resources Division and Oklahoma State University.

Among aspects of bear ecology being studied is genetic characteristics of the population, with comparison to populations in northern Mexico, west Texas, and New Mexico. Analysis of mitochondrial DNA characteristics is complete. Mitochondrial DNA is maternally inherited and indicates characteristics passed from females to their male and female offspring.

The study determined the number of haplotypes (DNA indicators of substantial relatedness) in regional bear populations, and how these types are represented in the Big Bend population. The number of types represented in a given population is an indicator of genetic diversity.

The study analyzed tissue samples of 144 bears from seven different populations. Source locations were 1) Big Bend National Park, 2) Black Gap Wildlife Management Area, 3) other Trans-Pecos sites, 4) Mogollon Mountains, New Mexico, 5) Serranias del Burro, Coahuila, 6) Maderas del Carmen Mountains, Coahuila, and 7) Sierra Madre Oriental, Tamaulipas.

Of all bears studied, five haplotypes were identified. Big Bend bears included representatives of two types. Interestingly, all Big Bend females and their documented male and female offspring were of one type. Given the rarity of migration by females, this indicates the Big Bend population could be descendents from as few as one or two founder females. The same type was found only in a minority of bears from the Serranias del Burro Mountains, Coahuila. The type was not found in Maderas del Carmen, but the Maderas sample size was small, and a minority of bears from that mountain range likely share the type. Regardless, this study confirms scientifically that the female founder(s) came from Northern Coahuila, and were representatives of a minority type in those mountains. The second lineage identified in Big Bend was found only in adult males that were not offspring of resident females and were probably migrants born elsewhere.

Big Bend bears in the study were highly related. In fact, the northern Tex/Mex population includes fewer haplotypes than reported in any other regional black bear population similarly analyzed. However, this low number of types and high relatedness does not necessarily indicate poor genetic variability. The regularity of male migration between local mountain ranges, if uninterrupted in the future, should ensure good diversity in the Big Bend population. Presence in the study of adult males representing a different type from the primary Big Bend population is an indicator of such influence.

Finally, the study confirms the importance of each isolated “island” population to the future of the Tex/Mex bear population as a whole. To maintain the smaller populations in Big Bend and west Texas, strong protection is required and dispersal must not be impeded by incompatible human activity. Results from this study will long into the future help the National Park Service and its partners in conservation determine whether we are successfully providing a home for bears.

A Pilot Study to Monitor Vegetation Changes at Springs after Tamarisk Removal

By Michelle Cox, Researcher

Scientific and non-scientific communities alike are concerned with the rate that native plant species are being displaced by exotic plant species. Tamarisk (saltcedar) is one of the most invasive weeds of the Southwest and one of the best-documented for its potential to alter the community dynamic.

Tamarisk Removal

Monitoring can be a cost-effective tool in tracking invasions, allowing resource managers to catch invasion in the early stages, and gauge the success of eradication methods. The Latin root of the word monitor is "to warn" and is that the primary goal of a monitoring program.

Data from monitoring programs often justify certain management practices - publicly, politically, and economically. The use of monitoring data allows for "adaptive management," chronicling the success or progress of meeting management goals.

The purpose of a pilot study is to test methods before they are implemented on a large scale. The omission of a pilot study is considered a major weakness in many monitoring programs.

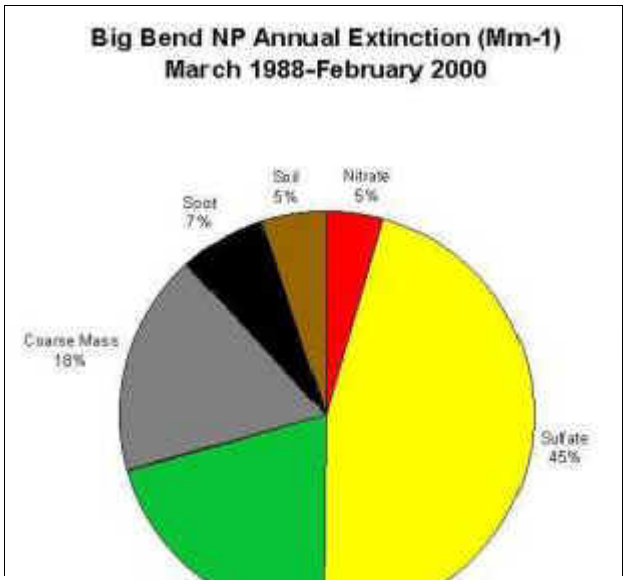
The objectives of tamarisk removal pilot study were twofold: 1) to determine the most efficient and accurate experimental design for monitoring spring vegetation communities before and after tamarisk removal; and 2) to monitor the establishment and regrowth of tamarisk.

The study also sought to separate the "background noise" of climate and geomorphology from the possible effects of tamarisk eradication on the vegetation community. The *Spring Vegetation Monitoring Handbook* contains the protocol for final monitoring design.

BRAVO Update

By Vidal Davila

The Big Bend Regional Aerosol and Visibility Observational Study (BRAVO) progress report was held in Alpine, Texas on Thursday, October 18, 2001. Those making presentations to the public were members of their respective agencies including the Environmental Protection Agency, National Park Service, and the Texas Natural Resource Conservation Commission.



The $6.2 million dollar study started on July 1, 1999 and was completed on October 30, 1999. The main objective was to find point sources for all the pollutants affecting the park.

JimYarbrough, physical scientist for the Dallas Region of the EPA stated several findings. Among them are that 1) air pollution emissions are widespread; 2) atmospheric tracers that were released were sampled at Big Bend National Park; and 3) many different sources are impacting the park.

The majority of pollution originates in the United States. The three major pollution sources are: 1) east-central Texas and the Gulf Coast, including the urban and industrial areas of Dallas, Houston, and Galveston; 2) north-central Mexico, including the urban and industrial region of Monterrey and Monclova; and 3) other pollution sources from as far away as Chicago and the Ohio River Valley.

Mark Scuggs, Physical Scientist for the National Park Service, Air Resources Division in Denver, stated that data show a continual increase in visibility impairment from 1988-1999. The air is getting dirtier over time. This visibility impairment is known as extinction. Sulfates make up 45% of the total pollutants contributing to extinction. Organics make up 20%, coarse mass make up 18%, soot make up 7%, soil 5% and nitrates make up the remaining 5%.

In summary, air pollutant emissions surround the Big Bend National Park area. Atmospheric tracers released during BRAVO were all measured at the park in varying frequencies. Many different sources are impacting the park—Mexico, Texas, and outside Texas in the US.

The BRAVO Study is scheduled to be completed in August, 2002. The report will be made available to the public and will be used in talks with local, state, and federal agencies to attempt to cut down on pollutants and clear up the skies of west Texas and Big Bend National Park. BRAVO will result in scientific findings and tools. These findings and tools will be used to design control strategies. The findings of the BRAVO study will also be useful tools for US-Mexico international negotiations and the Texas State Implementation Plan.

Science and Resource Management Receives Grant

By Vidal Davila

Friends of Big Bend National Park (FBBNP) awarded the Science and Resource Management (ScRM) Division a grant totaling $11,700 for the purchase of a new global positioning system (GPS). Presently, ScRM has a first generation GPS unit that is outdated and is difficult to maintain. The new GPS unit will greatly enhance our capabilities to do field work and collect valuable field data using satellite technology without worrying about whether we captured all the necessary data. This also means that utilizing the new GPS units will be more efficient. Vidal Davila, Chief of Science and Resource Management stated, “We are grateful to all the members of the FBBNP for their contribution to our mission of preserving natural and cultural resources of Big Bend National Park. This grant will enable us to purchase needed technology that otherwise we would not be able to purchase with our current budget. This equipment will make our job a lot easier.”

Forty Years of Vegetation Change in Desert Grasslands of Big Bend National Park

Esteban Muldavin, Steven Wondzell and John A. Ludwig, Researchers

As part of the Ecological Survey of Big Bend Area in 1955-56, 51 permanent vegetation transects were established to monitor long-term vegetation change in the desert grasslands of what is now Big Bend National Park. The original design for sampling and measuring the transects was developed by Dr. Barton Warnock, and included repeated photography coupled with quantitative measurement and charting of plant cover. The transects were re-read by Dr. Warnock in 1960-61 and again in 1967. The resulting information was used to guide park vegetation management. After a 14-year absence, the transects were read again in 1981, but this time the sampling was directed by Wondzell and Ludwig (1995) following Warnock’s protocols. Their analysis showed that significant change and recovery had occurred in these desert grassland ecosystems. The change was correlated with soil type and possibly driven by increased moisture since the drought of 1950’s.

In 1996, the transects were re-read, forty years after they had been established. The authors followed the same protocols and reported on the trends in vegetation change over the 15 years since the last reading in 1981. These permanent transect studies are unique, providing the longest record of grass and shrub dynamics in existence for the Chihuahuan Desert region.

Part of the power of these long-term transects lies in the consistency and precision of measurement across sampling periods along with conscientious archiving. Dr. Warnock oversaw the first three readings, and S. Wondzell and J. Ludwig the 1981 and 1996 data. Photos and transect measurement protocols were archived with the park. In keeping with the spirit of maintaining the quality of this long-term dataset, the authors provide a relational database that incorporates the data from all sampling periods along with a set of repeat photos (digitally scanned) and charts-for long term archiving.

Funding for this project was provided by the Big Bend Natural History Association.

State of the Springs

By Stephanie Bartel, Researcher

Big Bend National Park has conducted snap-shot surveys of its 300+ non-riverine water sources since the 1960's, with an attempt since 1990 to repeat the survey every five years. Although valuable, this information is largely qualitative and provides limited views of riparian plant biodiversity and its variation in response to varying temporal scales, climate changes, and exotic species invasions. Frequent visits to collect quantitative data on vegetation and water chemistry would give park managers better insight into natural processes occurring at Big Bend springs.

Four historically known spring areas with little use and no recent exotic *Tamarix* spp. invasion were chosen for study: Grigsby Spring in the North Rosillos Mountains, Desert Spring in the Lower Tornillo Creek area, Claro Spring in the Sierra Quemada, and Serendipity Spring in the Christmas Mountains area.

These four springs were visited once a month from June 2000 through July 2001. Vegetation transects and water samples were collected quarterly (June, September, December, March). Visits made other months were used to qualitatively document seasonal variations in plant species composition via plant collection, record monthly high and low temperatures, note changes in water flow rate, and photograph the spring areas.

The qualitative database maintained by Big Bend will be used to write a "sate of the springs" report of basic trends and management considerations (e.g. how *Tamarix* spp. have spread through the park; which springs receive the heaviest human use and how they may be impacted). The field data from this project will be used to establish a quantitative, repeatably measured baseline of plant community structure and water chemistry at a set of four relatively undisturbed springs. These springs can then be used to monitor for a continuous baseline of temporal changes normal to relatively undisturbed springs.

This work is being done to fulfill the thesis portion of the author's Master of Science degree in Biology at Sul Ross State University in Alpine, TX, and has been generously funded by the Big Bend Natural History Association.

Ongoing Science and Resource Management Activities:

- Air quality monitoring of visibility, ozone, UV and particulates at K-Bar.
- Water quality monitoring includes monthly monitoring for pesticides, metals, salinity and other pollutants.
- The Geographic Information System program is currently making maps of roads, trails, facilities, vegetation and other information available for any park projects.
- Completing compliance documents for park projects.
- The vegetation program is monitoring rare plant communities and mapping and eradicating exotic weeds.
- Reviewing requests for scientific studies and permits for the Superintendent's approval.
- Wildlife program includes endangered species monitoring and support, exotic species control, work to reduce conflicts between visitors and wildlife and coordination of 30+ research projects annually.

Look for articles in the next Resource Management Newsletter that will discuss several of these programs in depth. This and future newsletters will be posted on the park's web page at www.nps.gov/bibe/home.htm

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ScRM staff include the following:

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