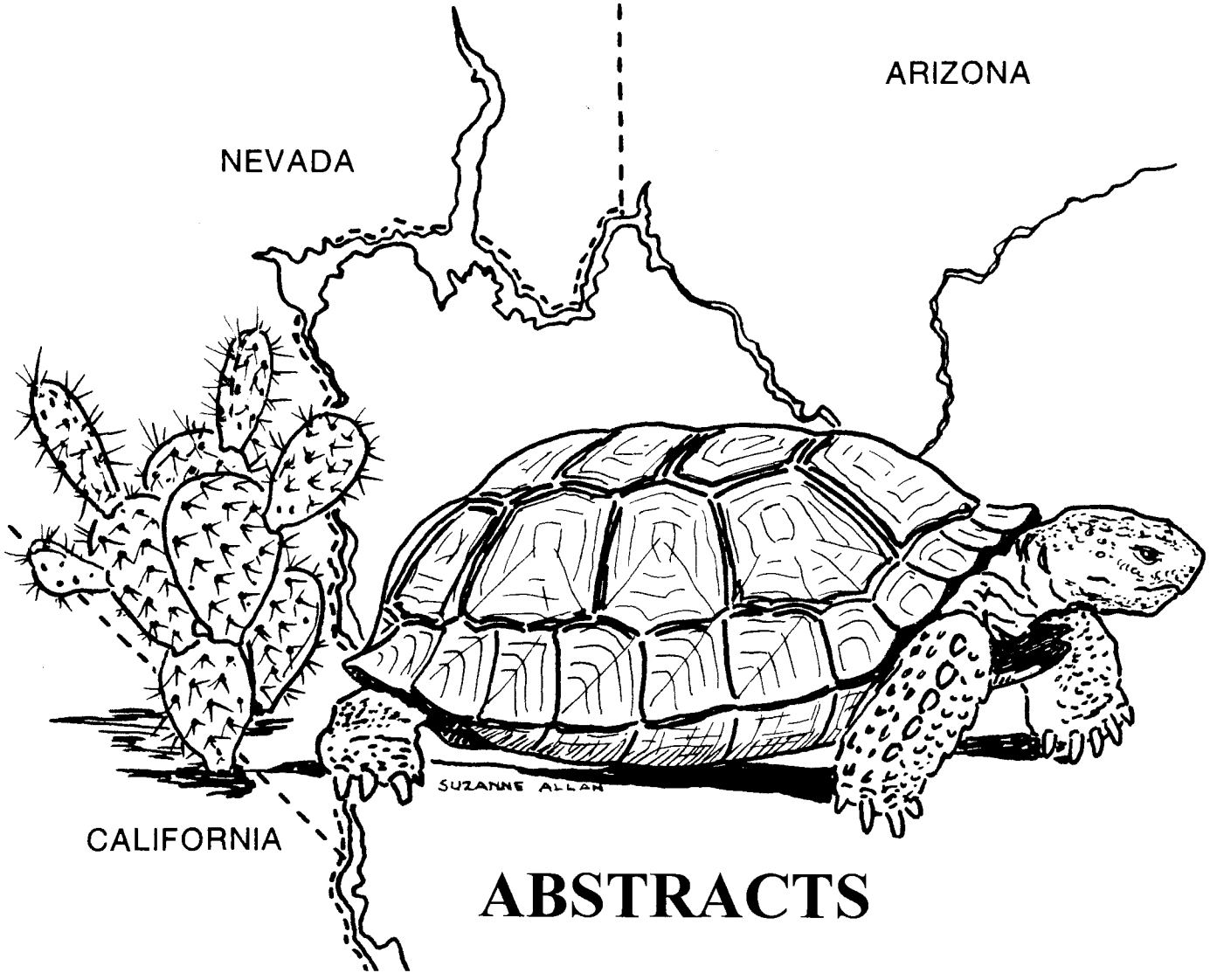
THE DESERT TORTOISE COUNCIL



ABSTRACTS

33rd Annual Meeting and Symposium

Sam's Town Hotel and Casino, Las Vegas, NV
February 22–25, 2008

ABSTRACTS

THIRTY-THIRD ANNUAL MEETING AND SYMPOSIUM

THE DESERT TORTOISE COUNCIL

Sam's Town Hotel and Casino, Las Vegas, NV
February 22–25, 2008

(Abstracts arranged alphabetically by last name of first author)
*Speaker, if not the first author listed

Defenders of Wildlife 2008 California Desert Campaign Update 2008

D'Anne Albers, California Associate

Defenders of Wildlife, PO Box 953, Joshua Tree, CA 92252
Phone: (760) 361-7416; Email: DAlbers@defenders.org

Defenders of Wildlife in its commitment to protect the desert tortoise and its habitat in the Mojave Desert has in conjunction with the release of the US Fish & Wildlife Service Raven Management Plan, with the Desert Managers Group Education Committee published the Raven Brochure. This brochure was produced to help educate public officials, tourists, residents and OHV riders on the threats ravens pose to the desert tortoise.

The 700 percent rise in the raven population in the western Mojave is in direct proportion to rise in human activity in the Mojave. Ravens are now abundant year round residents of the Mojave – and a significant threat to the desert tortoise. People have introduced new sources of food and water for ravens, including illegal dumps, landfills, unsecured dumpsters and trash cans, road kills, man-made ponds and irrigations systems. Booming desert communities also offer ravens plenty of places to nest: billboards, telephone poles, bridges and buildings.

Almost 15,000 brochures have already been distributed through community events, national and state parks, military bases, OHV events and to public officials. This distribution and education campaign is ongoing and special targets this spring are OHV events.

This spring Defenders will release our report: *Economic Benefits Provided by Natural Lands: Case Study of California's Mojave Desert*. The California's Mojave bioregion is one of the largest remaining open and still predominantly natural areas located at the doorstep of a major population center in the United States. Although still mostly pristine, the Mojave is undergoing rapid changes. To avoid unintended consequences of the human expansion and to inform the deliberation of alternative development paths for the Mojave, it is necessary to gain an understanding of the economic importance of the values conserved lands in the Mojave provide to the region. It is the goal of our report to contribute to that understanding.

Mojave Desert Tortoise 2007 Monitoring Effort in the Context of the Revised Recovery Plan

Linda J. Allison

U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office, 1340 Financial Blvd, Suite 234, Reno, NV 89502
Phone: (775) 861-6324; FAX: (775) 861-6301; Email: Linda_Allison@fws.gov

The range-wide monitoring program for desert tortoises has been in place since 2001. In the course of the 2007 field season, 557 transects (5935 km) were walked, and densities were estimated in all but the Upper Virgin River Recovery Unit. In 2007, design features were added to reduce the standard error of density estimates. However, results illustrate how - in drought years such as 2007 - variance estimates of monitoring results will nonetheless be sharply increased by low availability of tortoises.

Monitoring in 2007 also instituted consistent year-to-year rules for delineation of the monitoring area/sampling frame. In the language of the revised recovery plan, the sampling frame corresponds to all "tortoise conservation areas." Revised recovery criteria for determining status of the Mojave population of the desert tortoise require monitoring of tortoise populations for population growth and for distribution within these tortoise conservation areas. In order to sample through conservation areas, a major challenge for monitoring in 2007 and beyond is the design of monitoring that is appropriate for level as well as rugged topography. Line distance sampling will continue to be used for measuring population growth. Data from this and previous years are also providing background information as a monitoring program is put in place to track changes in the distribution of desert tortoises in the Mojave and Colorado deserts.

Continuing Efforts to Protect and Recover the Desert Tortoise

Ileene Anderson, Staff Biologist

Center for Biological Diversity, PMB 447, 8033 Sunset Blvd., Los Angeles, CA 90046
Phone: (323) 654-5943; Email: ianderson@biologicaldiversity.org

For the last ten years, the Center for Biological Diversity has focused its desert tortoise conservation and recovery efforts primarily in the California Desert Conservation Area (CDCA) through advocacy, participation in administrative processes and, when necessary, litigation. Through a science-based approach, the Center has supported increased protection for the desert tortoise as a stepping stone towards desperately needed recovery of the species. Habitat protection for desert tortoise also protects innumerable other species, both rare and common, that make the iconic western deserts their home. Success in this campaign has changed the dialogue for desert tortoise conservation and resulted in on-the-ground actions such as buy-out and retirement of desert grazing allotments in key tortoise habitat.

We believe that more protection and recovery efforts need to be focused on the desert tortoise because of the continuing population declines. The Center and our allies have several pending legal challenges to the BLM's CDCA plan including ESA challenges to the WEMO Plan amendment and the NECO plan amendment and the FWS biological opinions BLM has relied on, along with ongoing challenges to grazing lease renewals. The challenges are based in large part on the BLM and FWS's failure to take seriously the need to protect critical habitat from destruction and adverse modification and failure to adequately analyze impacts to the species. As a result, BLM and FWS have failed to truly provide for the protection and recovery of the desert tortoise and, instead, the direct, indirect and cumulative impacts of the many activities permitted under the BLM's current management are contributing to the species' decline. With the desert tortoise recovery plan being re-written, our analysis of the shortfalls of the newest proposal will be presented. Other issues of concern, including reliance on translocation as mitigation, energy production proposals, continuing off road vehicle abuse and other human preventable issues will be highlighted.

Desert Tortoise Recovery Plan Revision

Roy C. Averill-Murray

U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office, 1340 Financial Blvd, Suite 234, Reno, NV 89502
Phone: (775) 861-6362; FAX (775) 861-6301; Roy_Averill-Murray@fws.gov

The Endangered Species Act requires the Fish and Wildlife Service to periodically review and update recovery plans. To garner support for the revision of the 1994 Desert Tortoise (Mojave Population) Recovery Plan, the Service held a series of facilitated workshops in California and Nevada in spring 2007 to collect information from land managers, biologists, researchers, and stakeholders on the state of knowledge regarding the tortoise, its habitat, ongoing threats, and recovery and conservation actions. In addition, the Service impaneled a Science Advisory Committee with broad expertise to assist in the review of existing scientific data, the development of recovery objectives and criteria, and the delineation of recovery units based on ecological and genetic information. Working drafts of the document were made available for review and comment, and open houses, meetings, and conference calls were held to address some of the most substantive comments.

The revision incorporates our current understanding of the species' status and threats still facing the desert tortoise and its habitat. New strategic elements, recovery objectives and criteria designed to measure progress toward recovery and the effectiveness of recovery actions, and a decision support system that bolsters an adaptive management program have been carefully crafted to ensure the revised recovery plan is scientifically-based and defensible. The key elements designed to improve upon the 1994 plan and achieve recovery of the desert tortoise include: 1) Development of partnerships (Recovery Implementation Teams); 2) protection of existing populations and habitat; 3) strategic augmentation of populations; 4) a robust monitoring program; 5) applied research and incorporation of models; and 6) an adaptive management program. Recovery objectives and criteria have been revised to measure demography, distribution, habitat, and threats. Many of the recovery actions are adapted from the 1994 plan;

however, the revised plan places a greater emphasis on solidifying partnerships across jurisdictional boundaries to maintain focus on implementation.

After internal regional review, the next step will be to submit a notice of availability to the Federal Register to commence the 60-day public comment period.

Decision Time for Desert Tortoises in the Fort Irwin Translocation Project: Health and Disease Issues

Kristin H. Berry[1], Jeremy Mack[1], Mary Brown[2], Kemp Anderson[3], John Roberts[2], and Elliott Jacobson[2]

[1]U.S. Geological Survey, Western Ecological Research Center, 22835 Calle San Juan de Los Lagos, Moreno Valley, CA 92553; Email: kristin_berry@usgs.gov. jmack@usgs.gov
[2]Dept. of Pathobiology and Infectious Diseases, University of Florida, Gainesville, FL
[3]Seal Beach, CA 90740

The Ft. Irwin Translocation Project (FITP) for desert tortoises (*Gopherus agassizii*) is in its third year of a multi-year effort. Between 2005 and 2007, we collected baseline data on health of tortoises in three groups: translocatees, affected residents, and controls with an emphasis on the translocatees. We have evaluated 943 tortoises, of which the majority were in the Southern Expansion Area (SEA) and may be translocated in 2008. As part of the total, 125 tortoises were in the stress research program managed by USGS colleagues Todd Esque, Ken Nussear, Phil Medica, and Kristina Drake, and 70 were juvenile or small immature tortoises, kept at the Ft. Irwin Study Site pens and lab. All tortoises were evaluated for general health and clinical signs of upper respiratory tract disease (URTD), shell diseases, and trauma). We drew blood samples for enzyme-linked immunoassays (ELISA) for two species of *Mycoplasma*, *M. agassizii* and *M. testudineum*, and took nasal lavages for cultures, polymerase chain reaction (PCR) tests, and DNA fingerprinting of pathogens from most subadult and adult tortoises, but from only 49 of the 70 juvenile and small immature tortoises. For the period 2005–2007, laboratory test results indicated that 28 subadult and adult tortoises tested positive or suspect for *M. agassizii* or *M. testudineum*. With three exceptions, these tortoises were in the western half of the study area, west of or in the vicinity of the Manix Trail or Fort Irwin Road in similar areas where tortoises had positive and suspect tests in 2005 and 2006. Tortoises that tested suspect or positive for *M. agassizii* (n = 10) were independently distributed ($X^2 = 2.68$, $p = 0.101$), whereas those that tested suspect or positive for *M. testudineum* (n = 20) were significantly distributed west of the Manix trail ($X^2 = 17.24$, $p < 0.001$). Fifty percent of tortoises with suspect or positive tests were located with a 2.5 km buffer of heavily used roads, i.e., Ft. Irwin Road, Manix Trail, Interstate 15, and the powerline road in the eastern half of the study area. One moribund tortoise with hind limb paralysis, fecal impaction, and hepatic atrophy was salvaged from the Minneola area in August 2007. Several juveniles have died. We plan on evaluating an additional 282 tortoises in spring: 132 previously unsampled or inadequately sampled tortoises, the 28 tortoises with previous suspect or positive *Mycoplasma* tests, and 122 tortoises living within 1 km of a suspect or positive tortoise. Prior to the translocation in early spring of 2008, several questions must be addressed, e.g., should healthy tortoises be moved into areas with ill tortoises?

Acknowledgements: The National Training Center at Ft. Irwin provided the funding for this project. We thank Kemp Anderson and the field crews.

Climate-related Losses of Pikas from the Great Basin: Testing Alternative Mechanisms, Incorporating Anthropogenic Contributions

Erik A. Beever[1], Philip W. Mote[2], and Chris Ray[3]

[1]U.S. Geological Survey, Alaska Science Center, Anchorage, AK
[2]University of Washington, Climate Impacts Group, Seattle, WA; and [3]University of Colorado, Boulder, CO

Biotic responses to climate change will vary among taxa and across latitudes, elevational gradients and degrees of insularity. Ecological niche forecasting uses biotic and abiotic variables characterizing the existing geographical range of a species to predict how the species will respond to altered conditions such as those resulting from global climate change. However, due to factors such as phenotypic plasticity, ecotypic variation, and evolved tolerance to thermal stress, it remains poorly understood whether species losses should be greatest in populations experiencing the greatest climatic change or in populations living closest to the edge of the bioclimatic envelope. Surveys of American pikas in montane areas of the Great Basin during the 1990s, and subsequent information-theoretic analyses, suggested that population extirpations during the 20th century were best explained by a combination of climatic, biogeographic, and anthropogenic factors. Surveys during 2003-2007 documented additional extirpations and upslope migration of the minimum elevation of pikas at remaining sites. For both extirpations and upslope migrations, losses during the last decade have occurred much faster than they did during the 20th century. To address the evidence in support of alternative hypotheses of thermal stress on pikas, we placed 236 temperature sensors within pika habitats for 30 months and performed vegetation surveys in the vicinity of 25 sites with historical records of pikas in the Basin. We correlated our sensor data with data from the nearest weather stations and used this relationship, combined with long-term data from the same weather stations, to back-estimate temperatures within pika habitats at hundreds of locations each year between 1945 and 2006. To try to explain patterns of loss, we posited three alternative mechanisms of direct thermal stress: a) winter-cold stress; b) acute-heat stress (indexed by number of days >28˚C); and c) chronic-heat stress (indexed by average temperature during 1 June through 31 August). Magnitude of change was defined as change in our thermal metrics between 1945-1975 and 1976-2006, to avoid climatic anomalies. We found that patterns of persistence were generally best predicted by: a) drop in number of spring days <0˚C between the two 31-yr periods; and b) recent average-summer temperatures. Projection of our results into the future suggests the likelihood of pika losses at all but the most core populations very soon.

Moving Day: Large-scale Translocation of Desert Tortoises at Fort Irwin, California

William I. Boarman[1], A. Peter Woodman[2], and Andrew Walde[3]

[1]Conservation Science Research & Consulting and San Diego State University
2522 Ledgeview Place, Spring Valley, California 91977
[2]Kiva Biological Consulting, P.O. Box 1210, Inyokern, CA 93527;
[3]ITS Corporation, 7686 SVL Box, Victorville, CA 92395

The U.S. Army's plan to expand onto approximately 44,500 ha of desert tortoise habitat in the Central Mojave Desert precipitated the need to move an estimated 1200-2200 desert tortoises out of harm's way. The large number of animals affected resulted in a Biological Opinion that requires the Army to translocate these animals and fund research on the effects translocation may have on tortoise populations to help inform other translocation efforts that may occur in the future. We report here on the preliminary findings from initial surveys from the Southern Expansion Area (below the 90 grid line), an area that represents approximately 25% of the expansion area that contains desert tortoises. In addition, we present the proposed plans for the actual translocation of animals and for studying the effects the translocation may have on tortoise movements, dispersion, reproduction, population genetics, behavior, and demography. Furthermore, this broad, 200% survey will be used to assess actual tortoise abundance, landscape-scale habitat features, and genetic dispersion patterns. The unprecedented scale of this project promises to yield many interesting and valuable results.

Neither Here Nor There: Current Status of Sonoran Desert Tortoise Populations in Arizona

William I. Boarman[1], William B. Kristan, III[2], and A. Peter Woodman[3]

[1]Conservation Science Research & Consulting and Department of Biological Sciences, San Diego State University,
2522 Ledgeview Place, Spring Valley, California 91977
[2]Department of Biological Sciences, California State University, San Marcos, 92096
[3]Kiva Biological Consulting, P.O. Box 1210, Inyokern, CA 93527

The desert tortoise is listed as a threatened species in the Mojave Desert, but not in the Sonoran Desert of Arizona. To determine if 20 years of population data reveal declines sufficient to list the Sonoran population of the Desert Tortoise listing under the Endangered Species Act, we analyzed data collected from 16 study plots throughout tortoise range in Arizona. Using mark-recapture data, we estimated annual population levels using Lincoln-Peterson and Schnabel estimators and built linear models including plot, time, and year. We also compared abundance and trends among plots with different levels of threats (singly and grouped) and disease signs and different habitat types. The Sonoran population of the desert tortoise has experienced statistically significant declines of 3% per year between 1987 and 2007. This equates to an estimated 35% reduction in the number of adults and subadults on study plots since 1988. There were statistically significant declines in four study plots, and nearly significant in a fifth. Presence of specific diseases and threats did not help to explain trends in specific plots. Upper respiratory tract disease and cutaneous dyskeratosis, have been verified in Arizona tortoise populations. Some populations may suffer from isolation and demographic stochastic

events unique to small populations; these factors are greatly enhanced by isolation. Some human activities may affect Sonoran tortoise populations even though the tortoise populations mostly occur in steep, rocky habitats. Whereas reductions have not occurred in all populations studied, the overall population has declined. Is this trend sufficient to list the Sonoran Desert Tortoise?

Practical Considerations for Detecting and Monitoring Plant Invasions

Matt Brooks[1]* *and Rob Klinger*[2]

[1]United States Geological Survey, Western Ecological Research Center, Yosemite Field Station, 5083 Foresta Road, El Portal, CA 95318. Phone: (559) 240-7622; Email: matt_brooks@usgs.gov
[2]United States Geological Survey, Western Ecological Research Center, Yosemite Field Station-Bishop Office, 14 Utah Street, Bishop, CA 93514; Phone: (760) 387-2482; Email: rcklinger@usgs.gov.

Invasion by multiple non-native species into wildland areas requires that decisions be made on which species and sites will be the target of monitoring efforts and ultimately management actions. Efficient allocation of resources to detect invasions from outside of a management unit, and to monitor their spread within a management unit, will leave more resources available for control efforts and other management priorities. We describe three types of monitoring plans that are possible given three typical scenarios of data availability: 1) there are *no data* on invasive species associated with the management unit and the area surrounding it; 2) there are *species lists* of invasive plants internal and/or external to the management unit; and 3) here are *georeferenced abundance* data from the vicinity of the management unit. Because management strategies differ for species at different phases of the invasion process, a critical step is to develop separate prioritized lists for species that are colonizers, established but not spreading, and those that have begun to spread. For the majority of invasive species management programs we recommend a design based on integrating prioritization and predictive modeling into an optimized sampling plan. Although the up-front costs of this approach appear to be high, its long-term benefits will ultimately make it more cost-effective than more short-term, stop-gap approaches.

Desert Tortoise Hatchery Program at Edwards AFB; An Overview and Update on Program Success

Amber L. Bruno[1], Mark Hagan[1], Ken A. Nagy[2], L. Scott Hillard[2], and Robert W. Murphy[3]

[1]95 ABW Environmental Management Directorate, Natural Resource Division, Edwards Air Force Base, CA 93524; Email: amber.bruno.ctr@edwards.af.mil, mark.hagan@edwards.af.mil
[2]Dept. of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095-1606 Email: kennagy@biology.ucla.edu, hillard@earthlink.net
[3]Royal Ontario Museum, 100 Queen's Park, Toronto, ON M5S 2C6, Canada

The desert tortoise (*Gopherus agassizii*) Head Starting Program at Edwards Air Force Base, known as the Juvenile Hatchery at the Edwards Tortoise Study Site (JHETSS), began in 2002 as an adaptive management plan to test at what age desert tortoise hatchlings raised in predator exclusion pens can be released into the wild with an increased survival rate. The program was also developed to test if supplemental irrigation can accelerate achievement of predator resistant body size by increasing/prolonging food available in the pens. Over the course of the study, disease transfer from female tortoises to eggs, and paternity of JHETSS neonates was also investigated. The paternity test confirmed that at least 8 of the 11 clutches involved multiple paternities. Juveniles in irrigated pens have tripled in size compared to the juveniles in the nonirrigated pens. Before 2007, a total of 15 yearling desert tortoises were released near the JHETSS site. Predation as well as additional factors resulted in 100 percent mortality. In the fall of 2007, 32 yearlings were released, 16 near the JHETSS site and 16 at a distant location of similar habitat to test if the JHETSS pens are affecting survivorship of released yearlings. The JHETSS pens seem to have become attractive sites for predators, and may be having a negative effect on the tortoise survivorship. Concerns for the future of the study are that the adult females are threatened by increased off-road activity and feral dogs are becoming a common nuisance at the JHETSS site.

POSTER

Native Plant Revegetation of Drastically Disturbed Soils in the Mojave: Success on the Standard Hill Mine Gold/Silver Ore Heap, Mojave, CA

Richard S. (Dick) Carr, III[1], H. James Sewell[2], and John Steinbacher[3]

[1]C-M Environmental Group, Inc., Reno, NV/Pinedale, WY
[2]Shell Exploration & Production Company, Denver, CO; and [3]Summit Associates LLC, Boise, ID

The Standard Hill Mine was a cyanide heap-leach gold/silver mine near Mojave, CA, operated by a former Shell Oil Company subsidiary. Mining and leaching operations were carried out from 1987 to 1993. During operations, metal ores were extracted from crushed ore material on the heap by leaching with a re-circulating weak alkaline solution of sodium hydroxide and sodium cyanide. Fresh water rinsing of the ore heap (from 1993 to 1999) with varying amounts of sodium hypochlorite during closure activities removed cyanide, but left essentially a sterile, crushed gravel pile with no organic matter and a high sodium content.

In late spring 2003, Shell initiated a voluntary, no-irrigation native plant revegetation effort of the ore heap using a combination of broadcast seeding with mat-drag over dozer-tracked surface and hydroseeding of both mineral and essential organic soil amendments containing specific humic substances. The ore heap was re-contoured and seeded in two phases: half in 2003 and half in early spring 2004. No plant emergence occurred on the ore heap until late 2004, when all seeded areas began showing seedlings of saltbush shrubs and minor grasses. By spring 2005, saltbush shrubs, minor creosote, winterfat and peppergrass shrubs, and numerous forbs appeared, including forbs self-seeded from surrounding desert areas. Drought conditions and rabbit herbivory depredation have prevailed in the Mojave area since spring 2006, resulting in some die-off of shrubs on the ore heap, but the dominant native saltbush-shrub community appears to be self-sustaining. Three years of monitoring observations are presented in this poster.

Western Watersheds Project, Livestock Grazing, and the Desert Tortoise

Michael J. Connor, Ph.D., California Science Director, Western Watersheds Project

P.O. Box 2364, Reseda, CA 91337-2364; E-mail mjconnor@westernwatersheds.org

Western Watersheds Project (WWP) works to protect and conserve the public lands, wildlife and natural resources of the American West through education, public policy initiatives and litigation. Since its inception, WWP has focused its efforts on promoting environmentally responsible livestock grazing on public lands. Recent actions by WWP have benefited desert tortoise conservation at both regional and site-specific levels.

In 2006, the Bureau of Land Management (BLM) promulgated major revisions to the grazing regulations that had been in effect since 1995. These industry-sponsored revisions removed restrictions on livestock grazing that promoted rangeland health, decreased monitoring, and decreased public participation in the grazing decision process. WWP sued in federal court over violations of NEPA, FLPMA and the ESA. In June 2007, the court ruled in WWP's favor and threw out the new regulations.

The 1994 Desert Tortoise Recovery Plan considered livestock grazing to be incompatible with desert tortoise recovery and recommended that it be prohibited in Desert Wildlife Management Areas (DWMA). Despite this, livestock grazing continues in key areas of desert tortoise habitat in California. The Ord Mountain Allotment is the largest livestock grazing allotment within desert tortoise critical habitat in BLM's West Mojave planning area and includes two thirds of all the tortoises that occur on grazing allotments in the region. The allotment covers 240 square miles of desert tortoise habitat and, according to the USFWS, has an estimated population of 3,347 adult tortoises. The allotment occupies about 45% of the entire Ord-Rodman DWMA. This DWMA includes most of the desert tortoise population of the recently defined "Southern Mojave Recovery Unit" (Murphy et al., 2007). In summer 2007, the BLM issued a decision to renew livestock grazing on the Ord Mountain Allotment at increased stocking levels for 10 years. Western Watersheds Project, Center for Biological Diversity, Sierra Club, Natural Resources Defense Council, and Desert Survivors appealed the decision. The Administrative Law Judge hearing the appeal agreed with the conservation groups and issued a

stay, ordering the BLM to hold off on its decision to increase cattle grazing on the Ord Mountain Allotment pending a hearing now scheduled for July 2008. The stay was issued because the conservation groups demonstrated that the increase in cattle stocking was above the carrying capacity of the allotment. However, there are other significant livestock management issues on the allotment. The BLM's West Mojave Plan established a 59,368 acre "Designated Exclusion Area" on the Ord Mountain Allotment from which cattle are to be removed when ephemeral forage production is less than 230 pounds per acre. While ostensibly meant to protect the desert tortoise, the Designated Exclusion Area is erroneously located in poorer tortoise habitat on the allotment's east side and fully 41% of it is located outside the DWMA. Consequently, in drier years cattle are concentrated in higher tortoise density areas within the DWMA on the allotment's west side thus increasing impacts at a critical time and achieving the opposite of what was intended. WWP is working with the agencies to remedy this situation.

Report on U.S. Fish and Wildlife Service Activities for 2007 and 2008

Brian Croft

U.S. Fish and Wildlife Service, 2493 Portola Road, Suite B, Ventura, CA 93003

The U.S. Fish and Wildlife Service's (Service) responsibilities for the desert tortoise under the Federal Endangered Species Act (ESA) include recovery planning and implementation, section 7(a)(2) consultations with Federal agencies, issuance of recovery permits for research and monitoring, and review and development of habitat conservation plans for section 10(a)(1)(B) projects on private lands. This report focuses on completed, ongoing, and foreseeable consultations, habitat conservation plans, and recovery implementation activities within the range of the desert tortoise for 2007 and 2008.

An Update on Desert Tortoise Use of Burned Critical Habitat in Nevada

Kristina Drake, Lesley A. DeFalco, Kenneth E. Nussear, Todd C. Esque, Sara Scoles-Sciulla, and Philip A. Medica*

U.S. Geological Survey, Western Ecological Research Center, Henderson, NV

The Southern Nevada Fire Complex burned more than 32,000 acres of designated desert tortoise (*Gopherus agassizii*) critical habitat in 2005. In an effort to accelerate the recovery of plants important as food and cover for desert tortoises, the Bureau of Land Management (BLM) and US Geological Survey (USGS) established 40-acre monitoring plots (n=51) within this fire complex using multiple treatments (burned and seeded, burned with no treatment, and unburned). Although the immediate effect of fires on desert tortoise has been established, it is still unknown how and if tortoises use large burned areas after fires. The USGS initiated studies to understand habitat use for desert tortoises after those fires. In 2006 and 2007, the USGS conducted area surveys for tortoise presence and sign within each monitoring plot to determine if tortoises are responding to the seeding treatment within burned habitat two years after establishment. Radio transmitters were attached to 27 tortoises to investigate how the shift in the

dominant vegetation from native shrubland to invasive grasses will impact movements, growth, and reproductive outputs of tortoises. Due to limited resources, we narrowed our study focus to three burned habitat areas collectively known as Coyote Springs, to study the spatial distribution, movements, site fidelity, and gender distribution of tortoises in those areas. Data collected in 2008 will be compared with findings from the past two years to distinguish tortoise activity in burned versus unburned habitat.

Key Research and Modeling in Support Recovery Efforts

Kimberleigh J. Field

U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office, 1340 Financial Blvd. Ste 234, Reno, NV 89502
Phone: (775) 861-6300; FAX: 775-861-6301; E-mail: Kimberleigh_Field@fws.gov

Applied research and modeling have always been important to help determine which conservation tactics to implement for the desert tortoise. Although we have learned much over the last several decades, key gaps in knowledge remain. In order to make progress in recovery of the desert tortoise, we hope that researchers will be interested in focusing on some of the key questions that have been identified. The new draft Recovery Plan for the tortoise contains six strategic elements, one of which is entirely focused on the importance of applied research and modeling. Broad topics include demography, distribution, habitat restoration, threats, disease, population augmentation, and general effectiveness of conservation actions. Within these broad topics, we will present specific recommendations on research questions that we would like prioritized. Conducting these projects with a strategic framework that is linked to the adaptive management process will facilitate incorporation of findings into on-the-ground conservation actions. A concerted effort by the desert tortoise community to address these questions in as timely a manner as possible will advance the species' recovery program.

Arsenic Species in Scute and Lung Tissues of Desert Tortoises from the Western Mojave Desert

Andrea L. Foster[1], Kristin H. Berry[2], Michael Seltzer[3], John Roberts[4], and James J. Rytuba[1]

[1] U.S. Geological Survey, 345 Middlefield Rd., MS 901 Menlo Park, CA 94025
[2]U.S. Geological Survey, 22835 Calle San Juan de Los Lagos, Moreno Valley, CA 92553
[3]Naval Air Warfare Center, Weapons Division, 1900 N. Knox Rd., Stop 6312, China Lake, CA 93555
[4]College of Veterinary Medicine, Dept of Infectious Disease and Pathology, University of Florida, Gainesville, FL 32611-0880

Previous studies of ill and dying tortoises (*Gopherus agassizii*) in the California deserts have shown a statistically significant link between elevated tissue levels of trace elements such as arsenic (As) and the occurrence of clinical disease states (mycoplasmosis, cutaneous shell dyskeratosis). Two individuals salvaged from the Rand Mine, one of several historic gold mines within the Rand Mining District, had the highest levels of As among the salvaged tortoises. Hundreds of thousands of cubic yards of fine-grained, As-rich mine tailings are present in the district, and are highly susceptible to airborne mobilization by wind or by the large number of

all-terrain vehicle enthusiasts who frequent the area. The Rand Mining District is near the Desert Tortoise Research Natural Area in eastern Kern County.

X-ray absorption fine structure spectroscopy (XAFS) was used to identify the valence and distribution of arsenic (As) in scute and lung tissues salvaged from ill tortoises in the Rand Mining District and the Ft. Irwin Translocation Project Area and from healthy but injured tortoises salvaged elsewhere in the western Mojave Desert. Our objectives were to discriminate between metabolized and exogenous (particulate) As, and to assess the potential for inhalation of As-rich mine wastes to be a significant source of inorganic As to western Mojave desert tortoises. The tortoises investigated in the lung study were not the same individuals investigated in the scute study.

XAFS-derived element maps of scute sections show metabolized As as sub-horizontal lamellae spanning the transect from areolar to distal edges, whereas exogenous As appears as discrete particles concentrated on the edges of dorsal scute surfaces. Metabolized scute As is trivalent [arsenite, (As^{3+})], with nearest neighboring atoms of oxygen rather than sulfur. This was contrary to the hypothesis that sulfur in the β-keratin structure of the scute would provide the primary binding sites for metabolized As^{3+}. Exogenous scute As occurs in several forms and is associated with several types of mineral phases as reduced As (oxidation state of 0 to -3) in sulfides and pentavalent As [arsenate, (As^{5+})] in ferric sulfates and/or arsenates. Scute samples from a healthy but injured tortoise collected outside of the study area showed a much lower concentration of exogenous As-rich particles and lower levels of metabolized As.

Formalin-preserved lung tissue samples were sectioned with a scalpel for XAFS analysis. As rich particles were found in all of the lung samples examined[KB1]. Pentavalent and reduced As were observed, but no As^{3+}, in accordance with the oxidizing nature of the lung fluids and the lack of significant metabolized As. Similar to the scutes, the pentavalent As occurs in forms similar to those documented to occur in Randsburg mine tailings, but they could potentially also have formed by evapoconcentration near the ground surface. The particles of reduced As were found in the lungs of a healthy, but injured tortoise collected from Edwards Air Force Base. These particles appear to be gallium arsenide (GaAs), a compound that does not occur naturally, to our knowledge. Its presence in the tortoise's lung may indicate exposure to particulate GaAs derived from unknown operations (perhaps exploding ordinance) on the Air Force Base. In contrast, reduced As in scutes appears to be sequestered in a sulfide mineral which we have yet to identify conclusively.[KB2] These preliminary results demonstrate the ease of distinguishing between metabolized and exogenous As in scute tissue, and suggest that dissolution of high-As phases in tortoise lung may be a previously uninvestigated pathway for the entry of inorganic As into the tortoise. However, more work is needed, particularly on the relative solubility of As species in simulated lung fluids.

Desert Tortoise (*Gopherus agassizii*) Micro-habitat Selection on the Florence Military Reservation, Pinal County, Arizona

David D. Grandmaison

Arizona Game and Fish Department, Research Branch, 5000 W. Carefree Highway, Phoenix, AZ 85086

Desert tortoise habitat on the Florence Military Reservation (FMR) in Pinal County, Arizona is considered atypical due to the lack of boulder strewn hillsides and the predominance of flat alluvial plains in the landscape. Tortoises utilize caliche caves associated with deeply incised washes and appear to concentrate their activity around the few rocky hillsides that occur on the installation. As a result, the location of desert tortoise home ranges on the installation is correlated with the availability of caliche caves. Hypotheses regarding micro-habitat selection for specific habitat components within desert tortoise home ranges (n = 14) were evaluated with a use-availability design under an information-theoretic framework. The results of this analysis indicate that desert tortoises selected areas within their home range that were characterized by a higher percentage of canopy cover, less cattle activity, and closer proximity to roads and washes than available within their home ranges on the FMR. Canopy cover had the highest calculated importance and was included in each of the supported models. Activities that reduce canopy cover on the FMR may not be compatible with maintaining high quality desert tortoise habitat. These results indicate that management prescriptions that maintain or increase the amount of vegetative cover on the installation will benefit desert tortoises and increase their likelihood for long-term persistence.

QuadState Local Governments Authority: A Partner in Desert Tortoise Recovery

Gerald Hillier, Executive Director

QuadState Local Governments Authority, P.O. Box 55820, Riverside, CA 92517

During past year, the organization changed its name reflecting the JPA, which has now existed for 9 years. The Authority's membership includes 7 of the 11 county governments embraced in the range of the Mojave Population.

The Authority has actively engaged in the tortoise recovery plan review and revision. It provided FWS comprehensive comments, of which I discuss three:

- Efficacy. The early drafts lack assessment what has been accomplished, and the outcome of the two major HCPs in the region. The FWS and agencies must seek to know what has actually brought about recovery, or why implementation and mitigation measures have failed.

- Flexibility and innovation. The drafts embrace "adaptive management," but lack specificity as to the use of experimental or new techniques, including intervention. The plan must allow going beyond the "approved" list. revision.

- Disease. The draft contained significant information on the tortoise diseases, but there is still a lack of strategies proposed for managers to deal with it.

The Authority's California counties, and the Authority itself, intervened in the current litigation regarding the West Mojave and Northern and Eastern Colorado Plans. The plans integrate public and private land in the two regions, and reflect a comprehensive planning process which involved all regional entities. The plans address recovery in the context of setting aside significant areas for intensive management.

Local governments are a partner with State and Federal entities.

- Planning and zoning decisions. Local government makes decisions regarding uses, density and type of private land development, considering a variety of societal concerns. Retained federal land affords mitigation for private land development, the natural evolution of the region's continuing population growth while simultaneously providing areas for recovery.

- Law enforcement. Sheriffs exercise enforcement throughout the region with BLM rangers and F&G wardens. There are more of them, and they patrolroads where kills and collection occur.

Infrastructure. County road systems and solid waste disposal facilities provide for citizens, and the counties carry out their management in a professional manner. With current landfill management and sealed transfer stations, many of the food sources and subsidies for ravens have largely disappeared.

Infectious Diseases in the Desert Tortoise: Recommended Research and Conservation Actions

Peter J. Hudson[1] and the Desert Tortoise Science Advisory Committee*

[1]Center for Infectious Disease Dynamics, Pennsylvania State University
208 Mueller Lab, University Park, PA 16802; 814-863-5895 (PH); pjh18@psu.edu

To date, available evidence indicates that Upper Respiratory Tract Disease (URTD), as caused by the etiological agents *Mycoplasma agassizii* and *M. testudineum*, is probably the most important infectious disease for desert tortoises in terms of the impact it has on the size of desert tortoise populations. Less is known about other diseases that have been identified in the desert tortoise (e.g., herpesvirus, cutaneous dyskeratosis), and we hope that continued study of *Mycoplasma* will help to form a model that will facilitate investigations of other diseases.

Based on knowledge to date, I will present recommendations aimed at reducing the potential negative impacts of disease in both natural and captive settings with further suggestions specific to head-starting and translocation projects. Of paramount importance is to halt the euthanasia of ELISA positive tortoises that are not showing acute symptoms of disease. These tortoises may in fact be resistant individuals that are important in sustaining populations.

In addition, I will highlight gaps in knowledge that impede our ability to predict and reduce disease induced die-offs. Focused research is needed on topics such as relationships between disease and environmental stressors, virulence of various strains of the pathogen, possible curing of diseased individuals, and the spread of disease in populations.

Desert Tortoise Recovery Efforts and Plans at Mojave National Preserve

Debra Hughson, Neal Darby, Dennis Schramm, Larry Whalon, and Robert Bryson

Mojave National Preserve, 2701 Barstow Road, Barstow, CA 92311

Mojave National Preserve encompasses 772,463 acres of designated critical habitat for desert tortoise (*Gopherus agassizii*) and is home to important tortoise populations in the Fenner and Ivanpah valleys. Following release of hazardous materials in 1996, Molycorp closed a wastewater pipeline leading from Mountain Pass mine through Ivanpah Valley. For mitigation, Chevron, which acquired the mine when it bought Unocal, agreed to help Mojave National Preserve establish a headstarting facility near Nipton and Ivanpah roads. This facility will be used by U.S. Geological Survey Biological Resources Discipline for research on juvenile survivorship. Development of a small but long-range RFID transponder as part of this research will assist researchers working on other small, cryptic species. Issues related to heavily traveled roads in the Preserve, such as direct road mortality and poaching, continue to be of concern. This spring we are initiating a study to collect data on driver reaction to a medium-sized styrotort placed on the road edge. In 2009 we will erect flashing road signs and repeat the observations to test the effect the signs have on driver behavior. In addition to providing information on traffic patterns through the Preserve, the data will focus and improve law enforcement efforts—a priority in the draft Recovery Plan revision for this Recovery Unit.

STUDENT PAPER

Genetic Origins of Captive Desert Tortoises (*Gopherus agassizii*) in Arizona

Chris J. Jarchow[1], Cristina A. Jones[1,2], Taylor Edwards[3], and Kevin E. Bonine[1]

[1]School of Natural Resources, University of Arizona, Tucson, AZ 85721
[2]Arizona Game & Fish Department , Nongame Branch, Phoenix, AZ 85086
[3]Arizona Research Laboratories, University of Arizona, Tucson, AZ 85721

We used molecular techniques to identify the taxonomic affinities of more than 160 captive desert tortoises (*Gopherus agassizii*) from 3 cities in Arizona: Phoenix, Kingman, and Tucson. We used mitochondrial DNA (mtDNA) sequence data to identify each desert tortoise's maternal lineage as either "Mojave" or "Sonoran". In an attempt to identify specific source populations, we analyzed the tortoise samples for sixteen autosomal microsatellites and compared them to a reference database consisting of over 800 desert tortoise samples collected throughout the Mojave and Sonoran deserts, including Mexico. Microsatellite data were also

used to assess potential hybridization between "Mojave" and "Sonoran" lineages. Seventy-one (~40%) tortoises sampled in Arizona exhibited the "Mojave" mtDNA haplotype. One individual has a Texas tortoise (*Gopherus berlandieri*) haplotype. Our findings present many potential implications for Sonoran desert tortoises in the wild. Escaped or released captives with "Mojave" or hybrid genotypes have the potential to affect the genetic integrity of wild populations within Arizona. Genetic information could be used to inform the adoption process, and thereby provide additional protection to wild populations in Arizona.

Bolson Tortoise Propagation and Headstarting in New Mexico

Heather Johnson[1], Miles Traphagen[1], Joe Truett[1], Mike Phillips[1], Steve Dobrott[2], Tom Waddell[2], and Holly Payne[3]

[1]Turner Endangered Species Fund, Ladder Ranch, HCR 31, Box 95, Caballo, NM, 87931
[2]Turner Enterprises, Inc., Ladder and Armendaris Ranches, NM;
[3]Living Desert Zoo and Gardens State Park, Carlsbad, NM, 88220
Contact E-mails: heather.johnson@retranches.com; jotruett@gilanet.com

In 2006, the Turner Endangered Species Fund transferred a group of bolson tortoises (*Gopherus flavomarginatus*) from the Appleton Ranch in Arizona to the Turner-owned Ladder Ranch (7 hatchlings) and Armendaris Ranch (26 adults) in southwestern New Mexico and to the Living Desert Zoo and Gardens State Park (Living Desert) (4 adults) in Carlsbad. During 2006-2007, 5 outdoor facilities were constructed to contain them: 2 8.5-acre "tortoise pastures" on the Armendaris Ranch for maintaining adults, an outdoor exhibit at the Living Desert to house and display the 2 pairs kept there, an outdoor "maternity" pen on the Armendaris Ranch to temporarily hold gravid females for egg-laying, and a "headstart" pen on the Ladder Ranch for rearing juveniles. Approximately 50 eggs (all facilities) were produced. Eggs incubated at temperatures between 30.8° C and 31.9 ° C appeared to hatch at a greater rate than those allowed to hatch naturally in the maternity pen. The 7 juveniles maintained the first year in an indoor terrarium grew at rates ≥ those reported for first-year young reared outdoors. One adult on the Armendaris Ranch died from unknown causes during the winter of 2006-2007; the 7 juveniles from 2006 and the 23 new hatchlings produced in 2007 currently are alive and appear in good health. Plans for 2008 include establishing tortoises and a sward of grasses and forbs in the headstart pen, refining egg-collecting and hatching strategies to increase annual yield, and investigating possible sources of additional tortoises.

Defense Department Participation in Desert Tortoise Management

Manuel Joia, Environmental Division

Marine Corps Logistics Base Barstow, CA 92311-5050; Phone: (760) 577-6111; E-mail manuel.joia@usmc.mil

Most tortoise research and monitoring have taken place Department of Defense (DOD) lands or military providing funding for other lands. DOD has been an active participant in the Desert Managers Group, Desert Tortoise Management Oversight Group and Desert Tortoise

Recovery Plan, not to mention the West Mojave Plan. A committee of military land managers have been active and coordinate out actions.

DOD is committed to long-term tortoise management and delisting. Without cooperative effort throughout the tortoise range, we will not be able to achieve the goals of the recovery plans. DOD encourages regional efforts to control predators, (Ravens and feral dogs) including counties and NGO's including the Desert Tortoise Council.

The Sikes Act requires all installations to complete and implement an Integrated Natural Resources Management Plan based on coordination with the USFWS and State Game Departments, detailed operations for a five year period, with periodic reviews and updates. DOD continues to promote desert tortoise education, fund studies of predator ecology , behavior and "Head Starting" This Presentation will focus on these and other desert wide issues, such as sustainable training, encroachment and the loss of habitat due to urban development. Other information and issues will be addressed/discussed later.

The Arizona Game and Fish Department's Turtles Project

Cristina A. Jones

Nongame Branch, Arizona Game & Fish Department, 5000 W. Carefree Highway, Phoenix, AZ 85086-5000
E-mail: cjones@azgfd.gov

During 2007, The Arizona Game and Fish Department's Turtles Project continued to focus its efforts on desert tortoises (*Gopherus agassizii*), desert box turtles (*Terrepene ornata luteola*), and Sonoyta mud turtles (*K. sonoriense longifemorale*), three of Arizona's native turtle species. For desert tortoises this included management of captive populations by continuing to conduct health evaluation of captive desert tortoises, revising the Tortoise Adoption Program guidelines, and transferring the responsibilities of Phoenix area adoptions to the Phoenix Herpetological Society. We also conducted monitoring of wild populations, and worked with cooperators within the Arizona Interagency Desert Tortoise Team to develop the State Conservation Assessment, Agreement, and Strategy for the Sonoran Population of Desert Tortoises. We participated in the annual sampling of Sonoyta mud turtles, a candidate species, in Quitobaquito Pond at Organ Pipe Cactus National Monument. We performed surveys and marked desert box turtles in two locations in southeastern Arizona as part of an effort to establish long-term monitoring plots for desert box turtles. To prevent the spread of non-native turtles to adjacent waters, we worked with cooperators to trap and remove non-native turtle species from an urban Phoenix pond. A total of 204 turtles were captured, representing nine species, of which only one (Sonoran mud turtle *[K. sonoriense]*) was native, and two (snapping turtles *[Chelydra serpentine]* and spiny softshell *[Apalone spinifera]*) are listed as restricted live wildlife in Arizona. The Turtles Project will be developing an outreach program, and will continue to guide future research needs for Arizona's turtle species.

Incorporating Weighted Hierarchical Criteria and Uncertainty into Invasive Plant Prioritization Schemes: A Case Study from the National Park Service Klamath Network and its Relevance to the Mojave Desert

Rob Klinger[1]* *and Matt Brooks*[2]

United States Geological Survey, Western Ecological Research Center, Yosemite Field Station
[1]Bishop Office, 14 Utah Street, Bishop, CA 93514; Phone: (760) 387-2482; E-mail: rcklinger@usgs.gov
[2] 5083 Foresta Road, El Portal, CA 95318; Phone: (559) 240-7622; Email: matt_brooks@usgs.gov

Ranking invasive non-native plants is a fundamental step for setting management priorities, conducting risk assessment, and developing predictive models to aid in early detection monitoring. We describe an invasive plant ranking system that was designed to meet three goals: (1) to have enough flexibility to be applied at local and regional scales, (2) to be explicitly linked to different phases of the invasion process, and (3) to incorporate uncertainty into the scoring system. Our strategy was to evaluate existing systems and select those we felt had the greatest potential for flexibility, then integrate their strong points with the Analytical Hierarchy Process (AHP). AHP is a hierarchical decision-making process with a strong mathematical foundation that objectively weights criteria nested at different levels. We reviewed fifteen existing prioritization systems and determined that a ranking system developed recently by Randall et al. in conjunction with the 2006 Cal-IPC inventory provided a flexible framework to integrate with the AHP. The basic structure of the procedure consisted of one primary level with four or five criteria, and one secondary level with 16 to 20 subcriteria. We applied the procedure at three scales in the National Park Service's Klamath Network; individual management units (parks, monuments, and recreation areas), the network, and the region. Based on analyses of pre-existing data and consultation with park and other experts, species were categorized as being in the colonization, establishment, or spread phases, with separate rankings done for each phase. Evaluation of the system indicates that it has good potential for general application in many bioregions, but it could be improved by incorporating better site-specific data into the structure. The approach may have special relevance to the Mojave Desert, where designing, implementing, and evaluating a systematic approach to manage both existing populations and incipient invasions of non-native plants will be an ongoing effort.

Alternative Energy Developments in the California Desert

Dr. Larry LaPré

U.S. Dept. of the Interior, Bureau of Land Management, California Desert District
22835 Calle San Juan de Los Lagos, Moreno Valley, CA 92553

The forecast is sunny and windy for the California desert in 2008. BLM's California Desert District is reviewing eighty applications for solar energy power plant developments and has received 63 applications for new wind energy projects, which are in the initial testing phase. Steering these projects to an appropriate location outside desert tortoise and other important wildlife habitat will be a continuing challenge. The Desert District has established these guidelines which protect wildlife habitat:

1. Solar project applications are not accepted within desert wildlife management areas or critical habitat of any listed species.
2. Solar project applications have recently been rejected from Mohave ground squirrel habitat conservation areas.
3. Solar applications are not accepted within flat-tailed horned lizard management areas.

All power plant proposals on federal lands will prepare environmental impact statements, and mixed jurisdiction projects will prepare a joint federal/state environmental document. Many of the solar projects are regulated by the California Energy Commission.

Transmission line upgrades are needed to carry power from these projects to the urban centers of southern California. Most projects are located near designated utility corridors. California reviews the transmission network at the state level through several agencies, particularly the California Public Utilities Commission. Proposals for new or upgraded transmission lines will also have public review via a federal and state Environmental Impact Statement/Environmental Impact Report.

The analysis of cumulative impacts to the desert environment from alternative energy projects and the transmission network will be the biggest challenge for the federal government's Department of the Interior, Department of Energy and Department of Defense.

Epidemiology of Upper Respiratory Tract Disease in Desert Tortoises At the Daggett Study Area, California, in 2007

Jeremy Mack[1], Kristin H. Berry[1], Mary Brown[2], and John Roberts[2]

[1]U.S. Geological Survey, Western Ecological Research Center
22835 Calle San Juan de Los Lagos, Moreno Valley, CA 92553
Email: jmack@usgs.gov; kristin_berry@usgs.gov
[2]Dept. of Pathobiology and Infectious Diseases, College of Veterinary Medicine,
University of Florida, Gainesville, FL

Between March and June of 2007, we established a research project near Daggett in western San Bernardino County, California, to study the epidemiology of mycoplasmosis caused by *Mycoplasma agassizi*i and *M. testudineum* in desert tortoises (*Gopherus agassizii*). We fitted 80 adults (40 males, 40 females) with radio transmitters at a study area southeast of the town of Daggett. The study area has three bands (core, middle, outer) along a ~8 km transect, which extends southeast from the edge of Daggett and Interstate 40. Each band was established at an increasing distance from the urban-desert interface. We sampled the tortoises in spring and again in fall, drawing blood, nasal lavage samples, and evaluating clinical signs of disease using previously described protocols. In spring, we sampled an additional 35 tortoises without transmitters to fill gaps between the bands.

In the spring, nine tortoises tested positive or suspect for *M. agassizii* and ten tested positive or suspect for *M. testudineum*. In the fall, eight tortoises tested positive or suspect for

M. agassizii and seven tested positive or suspect for *M. testudineum*. Suspect or positive tortoises were not independently distributed among bands. Tortoises with *M. agassizii* showed evidence of clustering within the core ($x^2_{spring} = 14.29$; $p < 0.01$; $x^2_{fall} = 23.93$; $p < 0.01$), whereas tortoises with *M. testudineum* were slightly clustered in both the core and middle bands ($x^2_{spring} = 6.54$; $p < 0.05$; $x^2_{fall} = 7.32$; $p < 0.05$). Several tortoises had test results that varied between seasons. A group of tortoises (n = 9) also displayed clinical signs of disease, but had negative test results for both species of *Mycoplasma*.

Eight of the 80 tortoises with radiotransmitters have died and a ninth is probably dead (11.25%). Of the tortoises with transmitters, five were males and four were females. All showed signs of predation or scavenging or both. Several of the dead tortoises had previously tested suspect or positive for one or both types of *Mycoplasma*. We obtained blood and nasal lavage samples from seven of the nine tortoises before they died. Of these tortoises, two tested positive for both species of *Mycoplasma*, two tested positive for *M. agassizii* and suspect for *M. testudineum*, one tested suspect for *M. testudineum*, and two tested negative for both species. All seven tortoises displayed clinical signs of disease, including discharge from the nares, even those with suspect or negative tests. Six of the nine dead tortoises were clustered in the core area.

One marked adult male tortoise, previously sampled in 2005, was salvaged for necropsy in April of 2007. This tortoise had severe clinical signs of upper respiratory tract disease and a partially swollen head, but had tested negative for both species of *Mycoplasma*. When observed in spring of 2007, the same clinical signs were evident, weight had dropped, and condition was poor. Necropsy results indicated rhinitis, not typical of mycoplasmosis, but with a severe chondrodysplasia of the cartilage that supports the nasal mucosa. Changes in bone and cartilage were chronic and led to the collapse of the hard pallet, creating bilateral fistulas. The culture indicated *Pasteurella aerogenes*. Tortoises testing negative for *Mycoplasma* but with moderate to severe nasal discharge or occluded nares may have another disease.

Acknowledgements: We thank the National Training Center and Mickey Quillman at Ft. Irwin for funding.

Management of Desert Tortoise Habitat on Bureau of Land Management-Administered Lands in Nevada

Elroy Masters: Fish, Wildlife, and Threatened and Endangered Species Program Lead

Bureau of Land Management, Nevada State Office, Reno, NV

The Bureau of Land Management (BLM) administers approximately 4.5 million acres of desert tortoise habitat in Clark, Lincoln, and Nye counties, Nevada. Of these acres, 1,085,000 acres were designated as Critical Habitat on February 8, 1994. Desert tortoise habitat is managed out of the Las Vegas, Tonopah and Caliente Field Offices. The following are some of the highlights and future activities identified in 2007 and 2008. The Las Vegas Field Office is in the process of requesting a 20-year mineral withdrawal on approximately 900,000 acres within desert tortoise, cultural and biological Areas of Critical Environmental Concern (ACECs). Section 7 consultation on land use plans and individual projects remain a major work load for the

Field Offices. BLM continues to implement the strategies outlined in our land use plans to minimize and mitigate impacts resulting from utility and energy facilities and corridors, land sales, and other human demands on the public lands within desert tortoise habitat to reduce desert tortoise predation and loss. The BLM is working with partners, including USGS and UNLV, to monitor vegetation treatments following fires in the Mojave Desert. Wildfires in desert tortoise habitat will continue to receive priority response, emergency stabilization, and restoration plans developed to rehabilitate the area as quickly as possible. Las Vegas Field Office has completed an environmental assessment for route designation in the desert tortoise ACECs in northeastern Clark County and completed acquisition of Stewart Ranch, a 250-acre in-holding in the Mormon Mesa ACEC with 149 acre feet of ground water rights.

Vegetation Characteristics of Seeded and Unseeded Pinyon-Juniper and Mesic Blackbrush Communities Following the Southern Nevada Complex Fires of 2005

J.R.Matchett[1], Neil Frakes[2], Matt Brooks[1], and Karen Prentice[3]*

[1]U. S. Geological Survey, Western Ecological Research Center, Yosemite Field Station
5083 Foresta Road, El Portal, CA 95318. Phone (Matchett): (209) 202-9350; E-mail: jmatchett@usgs.gov
Phone (Brooks): (559) 240-7622 matt_brooks@usgs.gov
[2]Eastern Nevada Landscape Coalition, 1500 Ave F, Suite A, Ely, NV 89301;
Phone: (775) 289-7974 Ex. 6#; E-mail: nof_enlc@sbcglobal.net
[3]Bureau of Land Management, Ely Field Office, HC33, Box 33500, Ely, NV 89301
Phone: (775) 289-1828, E-mail: karen_prentice@blm.gov

Almost 300.000 hectares burned during the Southern Nevada Complex Fires of 2005. In response to these fires, the Bureau of Land Management aerially seeded over 20,000 hectares of the burned areas and implemented a comprehensive effectiveness monitoring program in cooperation with the US Geological Survey and the Eastern Nevada Landscape Coalition. Second-year monitoring data suggest that perennial grasses are establishing at a slightly higher rate in seeded areas versus unseeded controls in pinyon-juniper communities, but not in mesic blackbrush communities. However, overall densities of perennial grasses, forbs, and shrubs are orders of magnitude less than the densities of alien annual grasses and alien annual forbs. There were also noticeable patterns in the abundance of native plants versus alien plants, with wilderness pinyon-juniper communities having a higher proportion of native plants than non-wilderness pinyon-juniper communities and mesic blackbrush communities having the lowest proportion. A third and final year of post-treatment monitoring is planned for 2008, and comprehensive analyses will be conducted to determine seeding effectiveness, vegetation recovery patterns, and their potential relationships with a broader suite of environmental factors.

Status of Desert Tortoises in the Red Cliffs Desert Reserve

Ann M. McLuckie, Melissa M. Reitz, and Richard A. Fridell

Utah Division of Wildlife Resources, 344 East Sunland Dr. #8, St. George, UT 84790
Phone: (435) 688-1426; E-mail: annmcluckie@utah.gov

The Upper Virgin River Recovery Unit, managed as the Red Cliffs Desert Reserve (Reserve) is located in southwestern Utah. The Division of Wildlife Resources has been monitoring tortoises in the Reserve since 1997. Population monitoring in 2007 indicates a significant population decline of tortoises throughout the Reserve. In 2003, an increased number of tortoises with clinical signs of URTD were observed along with an increased number of adult shells. In the summer of 2005, approximately 14,471 acres burned within the Red Cliffs Desert Reserve. Both the Plateau and Mill Creek fires burned habitat which contained relatively dense populations of desert tortoises. The Reserve is considered a highly threatened population due to its proximity to urban growth, small size, as well as human and stochastic threats (e.g., recreation, fire, disease, drought).

Biotic-Abiotic Interactions in Dryland Ecosystems: The Past, Present, and Future of Desert Soils

David M. Miller
U.S. Geological Survey, 345 Middlefield Road, Menlo Park CA 94025

In deserts of the southwestern United States, upper soil horizons provide an important interface between the abiotic landscape and plant communities, which in turn provide animal habitat. Soils store moisture and nutrients for plants and harbor biota that perform numerous ecological services. Patterns of composition and cover of perennial plant species in the eastern Mojave Desert correspond tightly with soil characteristics. This suggests that plant-relevant soil properties such as moisture retention are mappable and furthermore that these properties can be monitored to detect trends associated with climate change.

Paleoclimatic changes, when linked with associated biotic responses, provide powerful clues to past biotic-abiotic interactions, which can inform scenarios of future climate. Deserts are difficult sites for acquiring paleoclimate data, but information from paleohydrologic studies (lakes, springs, and glaciers), dendrochronology, woodrat middens, and speleothems provide a modest-resolution record of vegetation and hydrologic changes since the last glacial maximum. The geomorphic record of river flow and alluvial-fan aggradation only partly coincides with major climate periods in the Holocene; seasonality of rainfall apparently contributes to this disjunct. Increases in summer rainfall driven by increased sea-surface temperatures in the Gulf of California apparently induce hillslope erosion and alluvial-fan aggradation. Such landscape responses to climate change suggest that slow progressive responses, such as elevational shifts in plant communities, may be interrupted by crossings of geomorphic or ecologic thresholds, which may result in widespread state changes.

Future climate is imperfectly modeled, but current models agree that temperatures will increase, as will (probably) severity of heat waves and drought. Extreme events such as heat waves and

drought are rarely identifiable in the paleo-record, and may be better understood by modeling soil moisture than by searching for paleo-analogs. Increase in summer precipitation may ameliorate hotter temperatures by reducing length of dry-soil periods, but may also cause changes in plant species composition, such as favoring CAM plants. Strategies for coping with climate change include soil-plant model scenarios to determine sensitive landscape positions, and monitoring of plant and soil conditions, as well as geomorphic processes, in those sensitive places.

Development of a Decision Support System to Facilitate Recovery and Adaptive Management

Philip Murphy, Ph.D.[1], Paul Burgess[2], Naicong, Li, Ph.D.[2], Lisa Benvenuti[2], Serene Ong[2], Nathan Stout[2], and Jordan Henk[2]*

[1]InfoHarvest, Inc., 108 South Washington St., Suite 200, Seattle, WA, 98104
[2]Redlands Institute, University of Redlands, 1200 East Colton Ave, P.O. Box 3080, Redlands, CA 92373
Phone: (909) 748-8268; E-mail: jordan_henk@redlands.edu

In updating the 1994 Recovery Plan, the USFWS Desert Tortoise Recovery Office (DTRO) sought to establish a structured adaptive management program as an essential methodology for facilitating the recovery of the desert tortoise. Relying upon *ad hoc* research and monitoring as the basis for decision-making on management efforts is inefficient and has contributed to slow progress in the recovery of desert tortoise. Using a decision support system (DSS), managers can perform a scientific assessment of the effectiveness of (past and planned) management actions as the basis for making decisions on the allocation of resources toward the recovery effort. By using models and monitoring data, a DSS can aid in identifying missing information and therefore in prioritizing critical research and monitoring needs.

With the DTRO, we developed prototype DSS components to evaluate how well this method may be used to identify and prioritize effective recovery actions (those most likely to ameliorate threats to tortoise populations) at any user-specified geographic extent within the range. The preliminary DSS relied primarily on data provided by agency scientists and managers that delineated the spatial extent of known threats. The DSS also relied upon managers' expertise to define recovery action-threat relationships and the relationships between threats and tortoise mortality. Future versions of the DSS should enable managers to conduct gap analyses on their current/planned recovery actions and to evaluate the effectiveness of specific actions in terms of near- vs. long-term contribution to recovery. The DSS may also be used to develop prioritization models that more accurately account for the real economic, political, and operational constraints that managers face when implementing recovery.

Genomics and the Desert Tortoise: Past, Present and Future

Robert W. Murphy[1], Kristin H. Berry[2], Taylor Edwards[3], and Ann McLuckie[4]

[1]Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, 100 Queen's Park, Toronto, On Canada M5S 2C6; Department of Ecology and Evolutionary Biology, University of Toronto; and Kunming Institute of Zoology, Chinese Academy of Sciences
[2]U.S. Geological Survey, Western Ecological Research Center, Moreno Valley, CA 92553
[3]University of Arizona, Arizona Research Laboratories, Genomic Analysis & Technology Core, Tucson, AZ 85721
[4]Washington County Field Office, Utah Division of Wildlife Resources, 344 E. Sunland Dr. No. 8 St. George, UT 84790

A key goal of conservation is to maintain as much genetic diversity as possible. Estimates of genetic diversity have become more sophisticates as molecular technologies have developed. Initial estimates used allozymes, which were acquired through protein electrophoresis. Unfortunately, to be effective this approach required the euthanization of animals. As DNA technologies developed, the amount of tissue required to estimate genetic diversity diminished. Initial estimates of genetic diversity based on fragment lengths of mitochondrial DNA revealed the possible existence of three species. More modern approaches use direct sequencing resulted in testable and repeatable hypotheses of historical relationships, but they could not be used to estimate gene flow between populations. The easy acquisition of nuclear microsatellite DNA data sets resulted in the formation of robust hypotheses of population structure and gene flow. Now that more than 1700 tortoises combined have been examined by two laboratories, fine scaled estimations of population structure seem to have reached their pinnacle. Estimates of population structure, however, are complicated by the breeding system of desert tortoises. Females are polyandrous and they have the ability to store sperm, apparently for as long as 15 years. Thus, we face severe limits on the estimation of reproductive integration of translocated tortoises. We also now know that behavioral interactions are often mediated by relatedness. And for the future? Much work remains to be done, particularly in understanding the evolutionary consequences of the desert tortoises' reproductive patterns. Efforts should also be focused on understanding the role of variation in MHC genes play in the tortoises' ability to fend off infections.

References

Berry, K.H., D.J. Morafka, and R.W. Murphy. 2002. Defining the desert tortoise(s): our first priority for a coherent conservation strategy. Chelonian Conservation and Biology 4:249-262.

Edwards, T. 2003. Desert tortoise conservation genetics. M.S. Thesis, University of Arizona, Tucson, AZ

Edwards, T., C.S. Goldberg, M.E. Kaplan, C.R. Schwalbe, and D.E. Swann. 2003. PCR primers for microsatellite loci in the desert tortoise (*Gopherus agassizii*, Testudinidae). Molecular Ecology Notes 3:589-591.

Edwards, T., C.R. Schwalbe, D.E. Swann, and C.S. Goldberg. 2004. Implications of anthropogenic landscape change on inter-population movements of the desert tortoise (*Gopherus agassizii*). Conservation Genetics 5:485-499.

McLuckie, A.M, T. Lamb, C.R. Schwalbe, and R.D. McCord. 1999. Genetic and morphometric assessment of an unusual tortoise (*Gopherus agassizii*) population in the Black Mountains of Arizona. Journal of Herpetology 33:36-44.

Murphy, R.W., K. H. Berry, T. Edwards, and A.M. McLuckie. 2007. A genetic assessment of the recovery units for the Mojave population of the desert tortoise, *Gopherus agassizii*. Chelonian Conservation and Biology 6:229-251.

A Tale of Two Species: Extirpation, Range Expansion and Evolution in an Extreme Environment During the Late Quaternary

Ian White Murray

University of New Mexico, Albuquerque, NM

Death Valley, California is today the hottest and driest area in the western Hemisphere, with temperatures of 134ºF (57ºC) recorded. During the late Quaternary, pluvial Lake Manly covered much of the Valley floor and contributed to a much more moderate climate. The abrupt draining of Lake Manly associated with increasing mid-Holocene warmth and aridity led to dramatic shifts in temperature and precipitation that exerted substantial selection pressure on organisms living in this area. Our research investigates the adaptive response of Neotoma (woodrats) to temperature change over the late Quaternary along a steep elevational and environmental gradient (-84 to ~3400m). By combining field-work, examination of museum specimens, and collection of paleomiddens, our project reconstructs the divergent evolutionary histories of animals from the Valley floor and nearby mountain gradients. We report on recent paleomidden work investigating the transition zone along the Grapevine Mountains for two species of woodrats differing significantly in size and habitat preferences (*N. lepida*, desert woodrat and *N. cinerea*, bushy-tailed woodrat). Here, at the limits of animal's thermal and ecological thresholds, we demonstrate dramatic fluctuations in the range boundaries between these species over the Holocene as climate shifted. Moreover, we find fundamental differences in the adaptive response of these two species related to the elevation of the site and local microclimate. Results indicate that although *N. cinerea* are currently extirpated in this area, they were ubiquitous throughout the late Pleistocene and were found as low as 400 m elevation.

POSTER

Tracking the Nutritional Ecology and Dietary History of Chelonians via Stable Isotope Analyses

Ian W. Murray and Blair O. Wolf

University of New Mexico, Albuquerque

We used stable isotope analysis of individual growth rings in the scutes of turtles and tortoises to gather information on their nutritional ecology. Over the course of their lives, many turtles and most tortoises accrue visibly distinct growth rings, or annuli, on the keratinous scutes that serve as a protective cover for their bony carapace. Keratin is an inert tissue and its isotopic composition probably reflects that of the animal's diet when it was laid down. As a consequence, a series of growth rings has the potential to provide insight into the dietary history of an

individual chelonian over a long period of time. Plant $\delta^{13}C$ varies with photosynthetic pathway type. This allows the plant photosynthetic type (C_4 grasses and cacti versus C_3 annuals) used as a nutrient source to be characterized. In addition, $\delta^{15}N$ enriches with trophic level and thus provides insight into trophic shifts. We extracted keratin from individual annuli, and measured the $\delta^{13}C$ and $\delta^{15}N$ values of individual rings in western box turtles, *Terrapene ornata luteola*, and desert tortoises, *Gopherus agassizii*, from juveniles to adults over a wide geographic area. Our data for box turtles shows periodic shifts from annual plants to grasses or cacti as well as shifts in trophic level. Data for desert tortoises shows significant shifts in diet from C_3 annual or perennial plants to cacti or C_4 plants.

The Desert Tortoise Preserve Committee's Accomplishments in 2007 and Goals for 2008

Melissa L. Nicholson, Preserve Manager and Office Administrator

Desert Tortoise Preserve Committee, 4067 Mission Inn Ave., Riverside, CA 92501
Email: DTPC@pacbell.net

During 2007, the Desert Tortoise Preserve Committee (DTPC) continued efforts to acquire and manage habitat for the desert tortoise (*Gopherus agassizii*), Mohave ground squirrel (*Spermophilus mohavensis*) and Burrowing Owl (*Athene cunicularia*) with the focus on three areas in California: the Desert Tortoise Research Natural Area (DTRNA) in the west Mojave Desert, Pilot Knob in the Central Mojave, and the Chuckwalla Bench in the Eastern Colorado Desert. This year three major fence projects were completed at the DTNRA, totaling approximately 3.3 miles. The first fencing project was a one mile long section in the southwestern section of the DTNRA, installed to correct an error made when the original fence was constructed in the 1970s and to limit off-highway vehicle (OHV) access. The second fencing project was on the eastern boundary of the DTRNA, was approximately one mile in length, and closes a "keyhole" to the interior of the DTRNA. The third project is in the eastern expansion area of the DTRNA. Locally known as Camp "C," the 32 acre area was a gift from the Center of Biological Diversity. The land was heavily used by OHV recreationists, and much of the habitat is denuded of vegetation and has compacted soils. Now, 1.3 miles of fence enclose the acreage. The DTPC initiated a restoration plan for Camp "C" area in cooperation with the Natural Resources Conservation Service. This restoration plan will be implemented in five acre increments and will be monitored over time. Two different restoration methods were applied for the first five acres of restoration: the creation of micro-catchment islands and the installation of vertical mulch on existing coppice mounds. Micro-catchment islands and coppice mounds were randomly treated with an existing on-site seed bank or were seeded with a known number of seeds collected from neighboring locations. The success of these different treatments will help with design of future restoration projects. In addition, we have reviewed records of spring visitation at the DTRNA for the last 19 years. During this time, OHV use has increased. In 2007, 45% of visitors to the DTRNA arrived by OHV. This trend, as well as an increase in vandalism and the need for more fencing at the DTRNA entrance will be discussed.

Corticosterone Values for Desert Tortoises Prior to Translocation

Ken E. Nussear[1], Todd C. Esque[1], Karla Drake[1], Philip A. Medica[1], A.M. Barber[2], C.R. Tracy[2], and K. Hunter[2]

[1]U.S. Geological Survey, Henderson, NV; and [2]University of Nevada, Reno

In 2005 the USGS initiated research on movements, habitat use, behavior, and physiological characteristics (e.g. stress as indicated by measures of endocrine levels) of tortoises that will serve as residents, controls, and animals scheduled to be translocated in April of 2008. The information gathered prior to translocation provide valuable data for comparisons among the treatment and control groups before and after translocation. Over the past three years, we have collected blood samples (N = 1,159) from 205 tortoises to establish baseline stress levels prior to translocation activities. Laboratory analysis was completed, measuring plasma total corticosterone (CORT) values using radioimmunoassay. Analysis of sex, blood drawing technique, handling time, and categories of lymphatic fluid (*i.e.* samples with no lymphatic fluid or samples containing <15% lymphatic fluid) all had a significant effect on levels of total circulating CORT. The additional handling time associated with drawing blood samples from the jugular vein resulted in higher CORT levels, and thus we began using subcarapacial venipuncture for all sampling after 2005. In collaboration with scientists from the University of Nevada-Reno, we also conducted a laboratory study to determine at what point captive desert tortoises show elevated plasma CORT after the injection of a single dose of adrenocorticotrophic hormone (ACTH). An ACTH "challenge" study directly stimulates the adrenal glands to release corticosterone and bypasses other steps of the hypothalamic-pituitary-adrenal (HPA) axis that would be activated under exogenous stressors (e.g., handling stress, translocation stress). This study indicated that a lower limit for stress-induced elevation of plasma CORT is most likely greater than 15 minutes from the onset of the initial handling of the animal. We will plan to sample during the translocation this year to determine whether translocation of tortoises causes any measurable stress response, and the time frame over which animals adjust to translocation.

Ecological and Management Implications of Post-fire Seed Banks in the Eastern Mojave Desert

Steven M. Ostoja[1] and Matthew L. Brooks[2]*

U.S. Geological Survey, Western Ecological Research Center, Yosemite Field Station
[1]Bishop Office, 14 Utah Street, Bishop, CA 93514 Phone: (760) 387-2482, (760) 920-8241; sostoja@usgs.gov
[2]Yosemite Office, 5083 Foresta Road, El Portal, CA 95318. Phone: (559) 240-7622; E-mail: matt_brooks@usgs.gov

It is well accepted that non-native annual grasses invasions (e.g. *Bromus* spp.) have caused significant changes to historic fire regimes in North American deserts. In the current decade alone, an unprecedented number of fire events have affected over one million hectares in Mojave Desert plant communities. Many consider Mojave Desert plant communities to be poorly adapted for post fire recovery, due to low survival rates of perennial plants and high mortality rates of annual plant seed banks. However, little data exist to support these assumptions, particularly related to seed banks. The Hackberry Fire Complex burned 28,622 hectares in the

Mojave National Preserve in the eastern Mojave Desert during late June 2005, providing an opportunity to evaluate fire effects. We sampled the soil seed bank (fall 2005, 2006) and the above-ground plant community (spring 2006, 2007) in burned and unburned areas following this fire. Seed bank density of both native and non-native species were significantly lower in burned than in the unburned plots. Above-ground density of native and non-native species were also significantly lower in burned than in the unburned plots. The magnitude of seedbank mortality in particular suggests that current protocols for postfire seeding in the Mojave Desert may contribute very little back to the landscape in terms of seed densities. The results of this study are preliminary, and a final report and recommendations will be released after 3 postfire years of soil seed bank and above-ground vegetation data have been collected and analyzed.

POSTER

Creation of an Arizona Desert Tortoise Poster

Audrey Owens[1], Cristina Jones[1], Steve Goodman[2], Zenon Mocarski[2], Elissa Ostergaard[3], and Don Swann[4]

[1]Arizona Game and Fish Department (AZGFD), 5000 W. Carefree Highway, Phoenix, AZ 85086; [2]AZGFD, 5325 N. Stockton Hill Rd., Kingman, AZ 86409; [3] AZGFD, 555 N. Greasewood Rd., Tucson, AZ 85745; [4]Saguaro National Park, 3693 S. Old Spanish Trail, Tucson, AZ 85730

Wildlife posters created for the general public should strike a balance between an attractive graphic design and the provision of information with a conservation message. The Turtles Project at Arizona Game and Fish Department along with cooperators from the Arizona Interagency Desert Tortoise Team is in the process of creating a desert tortoise poster for the state of Arizona. Our goal is to have an aesthetically pleasing poster that people will want to display, but that also has information about the natural history of the species, threats to its survival, and conservation measures that the public can use to help the species. We present a draft of the poster and would like to hear comments from the Desert Tortoise Council on both the layout and the type and amount of information that we include.

The Desert Tortoise Council: The Year in Review

Dan Pearson, Senior Co-Chair, Desert Tortoise Council

During the course of 2007 and extending into 2008, the Board of Directors of the Desert Tortoise Council undertook a number of initiatives to help ensure the future of the Council and place it in a better position to continue its work in protecting the desert tortoise and its habitat. Among the initiatives the Board of Directors approved was to begin establishment of a budget reserve and emergency fund to ensure funds for annual symposia and workshops. The Board also adopted measures to provide an annual budget to fund requests for funding for research, education and habitat acquisition.

In addition to these initiatives, the Council held its annual Symposium in Las Vegas and conducted a handling workshop in Ridgecrest. The Board was also active in reviewing and

providing comments on a number of studies and environmental documents for projects affecting the desert tortoise and its habitat. Details of these initiatives and activities are included in the presentation.

Climate Change and Its Spatial Structure in the Southwest: Recent, Ongoing, and Projected Effects

Kelly T. Redmond, Regional Climatologist

Western Regional Climate Center, Desert Research Institute, Reno NV

For the past third of a century, the Southwest US has been warming, by about one degree C. Over that period no part of the US has warmed more, relative to climatological variability. The past 8-9 years have been particularly and unusually warm. There are few indications of systematic trends in precipitation, which will be hard to detect in the face of very large natural variability. Since 1999 much of the region has experienced significant and in some places unprecedented drought. Recent temperature rises have been consistent with projected changes, but cannot be definitively attributed to climate change at this time. There is much more confidence in projections of temperature than of annual precipitation. Annual and winter precipitation is generally projected to decrease modestly over the next several decades. Summer monsoon precipitation amount is much harder to project. Temperature and precipitation projections imply, individually and jointly, greater moisture stress. The ongoing Southwest drought may simply be another of the major droughts that affect the region once or twice a century, or it may be a harbinger of a more permanent alteration in climate. Night appears to be warming more than day, and higher elevations appear to be warming more than lower. Extremes of temperature are expected to increase, in an area where extremes already approach lethal values. The rare cases of high precipitation rates are also expected to be seen more frequently, despite the current expectation that annual totals will decrease. Even if precipitation amount does not change, temperature rise would make that precipitation less effective.

Management Plans, Conservation Agreements, and Listing: An Overview of the Management Status of the Sonoran Desert Tortoise

J. Daren Riedle

Dept. of Life, Earth, and Environmental Sciences, West Texas A&M University, POB 60808, Canyon, TX 79015
Phone: (806) 676-6732; E-mail: Jdriedle1@go.wtamu.edu

Based on knowledge available in 1989, the Sonoran population of desert tortoises did not meet the U.S. Fish and Wildlife Service's five factors for listing; though many potential threats to this population were recognized during the petition process. At the 2003 Desert Tortoise Council Symposium comparisons were made between the Mojave and Sonoran populations. This prompted the Arizona Interagency Desert Tortoise Team (AIDTT) to begin work on a State Conservation Agreement (SCA) to replace the 1996 Management Plan, and implement a coordinated commitment to desert tortoise management. Since, considerable information and

input has been gained towards finishing the SCA including threats analysis, measurable goals and objectives that address threats, and current management practices among agencies that can be directed towards desert tortoises. Most important has been the recognition that monitoring efforts have been inadequate to detect range-wide trends. Testing of more appropriate sampling protocols will lead to more rigorous monitoring protocols. Long-term studies have yielded results showing high survivability in natural populations. While some declines have been documented, causes of those declines are unknown and may be related to natural phenomena. Though upper respiratory tract disease is present, it does not seem to be a factor influencing the Sonoran population. A working draft of the SCA will be completed by this symposium, and the AIDTT is working to meet some of their initial objectives. The SCA should prove to be a cost effective form of management that will preclude the need to list the Sonoran population of Desert Tortoises.

Causes of Illness and Death in Nine Desert Tortoises from California: 2005-2007

John Roberts[1], Kristin H. Berry[2], Elliott R. Jacobson[1], Mary Brown[1], Janet Stevens[1], and Francesco Origgi[1]*

[1]Dept of Infectious Disease and Pathology, College of Veterinary Medicine, University of Florida, PO Box 110880, Gainesville, FL, 32611-0880
[2]U.S. Geological Survey, Western Ecological Research Center, 22835 Calle San Juan de Los Lagos, Moreno Valley, CA 92553

From June 2005 to December 2007, nine California Desert tortoises from six study sites monitored by the U.S. Geological Survey, Western Ecological Research Center, in the western Mojave Desert (Table 1). The tortoises were submitted to the University of Florida's College of Veterinary Medicine for pathological evaluation. Two tortoises had significant evidence of trauma either from predator or fire, two tortoises had upper respiratory infections (one of these was associated with mycoplasma infection), and three tortoises had serologic evidence of exposure to *Mycoplasma*. Other findings included a severe esophagitis and rhinitis of unknown etiology (1); hyperplasia or neoplasia of the pineal gland (1); nephropathy, arteriosclerosis and myodegeneration (1); and myodegeneration and hepatic degeneration with no clear etiology (2).

In results of mycoplasma and aerobic culture from these nine tortoises, only *Mycoplasma* and *Pasteurella aerogenes* were associated with inflammatory lesions in the nasal cavity. Tortoise 1 that was infected with *Mycoplasma* had characteristic diffuse lymphoplasmacytic rhinitis with dysplasia of olfactory epithelium. Tortoise 3 had chronic rhinitis and esophagitis with isolation of *Serratia marcescens, Klebsiella oxytoca and Corynebacterium renale* from the nasal cavity. Tortoise 7 had *Pasteurella aerogenes* cultured from the nasal cavity had severe necrotizing heterophilic rhinitis with chondrodysplasia of the nasal septum and formation of bilateral oronasal fistulas in the hard pallet. Most of the bacterial isolates were interpreted as normal desert tortoise bacterial flora with *Klebsiella oxytoca* and *Corynebacterium* sp. isolated from nasal passage of four of nine tortoises and *Serratia marcescens* and *Staphylococcus sciuri* each identified in two of nine tortoises.

Table 1. Major lesions found in nine desert tortoises.

Tortoise #	Location	Date	Diagnosis 1	Diagnosis 2	Diagnosis 3
1 (#208)	Lucerne Valley	6/14/05	Rhinitis	Myodegeneration	Sarcocystosis
2 (M95-19)	Sand Hill border	10/05/05	Trauma from predator	----------	----------
3 (SSSS)	Daggett	10/06/05	Stomatitis, esophagitis	Rhinitis	Cutaneous dyskeratosis
4 (3014)	Ft. Irwin	10/01/06	Nephropathy	Myodegeneration	Arteriosclerosis, vascular mineralization
5 (2561)	Ft. Irwin	10/24/06	Myodegeneration	Hepatopathy	Cutaneous dyskeratosis
6 (untagged)	Edwards AFB	10/2406	Trauma from fire	----------	----------
7 (GGGG)	Daggett	4/09/07	Rhinitis, oronasal fistula	Urinary cystitis	----------
8 (3046)	Ft. Irwin	8/09/07	Hind limb paralysis	Fecal impaction	Hepatic atrophy
9 (G_0 712)	Fossilbed Rd.	11/30/07	Pineal gland hyperplasia	Myodegeneration	Sarcocystosis

Creatinine kinase (CK) is an enzyme that is specific for muscle, with elevated values indicative of myodegeneration. Those tortoises that had the highest CK values (8900 to 40,030 U/L, mean for other tortoises 1085 U/L) also had the most severe myodegeneration. Gamma glutamyl transferase (GGT) is an enzyme that may, in some species, be increased with biliary or hepatic damage. It was markedly increased in tortoise 4 (756 IU/L, mean for others 11 IU/L) that had arteriosclerosis in combination with severe hepatic atrophy. Asparate aminiotransferase (AST) is an enzyme that may elevate when there is liver disease in certain mammals. This enzyme was elevated in the two tortoises [4 (590 IU/L and 5 (314 IU/L) mean for others 106 IN/L] with the most marked liver atrophy. Tortoises 1 and 9 had significant numbers of cysts of the protozoan *Sarcocystis* in striated muscle. *Sarcocystis* was not observed in cardiac muscle. In these tortoises myodegeneration was present in association with the intramuscular *Sarcocystis* and both tortoises had moderate elevation in CK activity.

Concentrations of iron in the liver correlated well with brown hemosiderin pigment observed by light microscopy in the cytoplasm of hepatocytes. Tortoises 4 and 5 that had the most severe hepatic atrophy also had the highest concentrations of mercury and vanadium. Compared to other tortoises, tortoise 4 also had markedly elevated molybdenum. The hepatic molybdenum in tortoise 4 was elevated approximately 60 times above levels found in tortoises 3 and 6. Additionally tortoise 4 had a striking arteriosclerosis and evidence of renal disease that was diagnosed based on elevated BUN (480 mg/dl), uric acid (22.3 mg/dl) and phosphorus (10.7 mg/dl).

Conclusions: The 9 tortoises that were salvaged for pathologic investigation were found to have a variety of disease problems. Three tortoises had notable rhinitis, and *Mycoplasma* was only cultured from one of these tortoises. *Pasteurella* rhinitis observed in tortoise 7 may parallel atropic rhinitis of swine. Some toxigenic strains *of Pasteurella* produce potent cytotoxins that inhibit osteoblastic activity and lead to loss of bone. Arteriosclerosis was seen for the first time in one tortoise (4). This tortoise also had renal disease. Compared to other tortoises examined,

this tortoise also had markedly elevated concentrations of hepatic molybdenum. A causal relationship between molybdenum, vascular disease, and renal disease in this tortoise could not be determined. Creatine kinase may be useful for field diagnosis of myodegeneration in debilitated tortoises. The enzymes GGT and AST may be useful for diagnosis of liver atrophy. *Sarcocystis* was identified in two tortoises and an attempt should be made to obtain the genetic sequence of this protozoan parasite, The desert tortoise is most likely an intermediate host for this parasite but establishment of the life cycle may yield important insight into tortoise biology. The findings of this study indicated that wild desert tortoises suffer from a variety of health problems. This works adds to the database on causes of mortality in desert tortoises.

The Search for Linnaeus' Sources: A Chelonian Odyssey.

Chuck Schaffer

Turtle and Tortoise Newsletter, Jacksonville, FL; email: Chelonian1@aol.com

A link between humans and turtles, partially due to their importance for food (meat and eggs), has likely existed since the beginning of recorded history with the earliest chelonian depictions found in cave art. Others are found in Babylonian clay seals, Egyptian pallets, and Middle Eastern ceremonial objects. Later illustrations and descriptions were found on paper, first in manuscripts and later in printed works. The earliest descriptions focus on mythology, primarily in Babylonia and Egypt. Later the focus shifted to religious morality lessons in medieval bestiaries such as those of de Cantimpré (1240), van Maerlant (1350), and Candadus (1460). The art and the science gained wide distribution in the fifteenth century natural histories of the encyclopedias of which Gessner's Historiæ Animalium (1555) is an excellent example. Considered the father of Modern Zoology, his work laid the foundation for standardization of scientific terminology. He combined the classical and medieval literature adding his own observations to those of correspondents, and then organized the entirety in a very precise manner: synonymy, distribution, physical characteristics, habits, use as food, medicine, etc. With the added dimension of woodcuts, he produced the first illustrated work of its kind covering the whole animal kingdom. Its influence was to continue for centuries providing text and models of animals copied by many of those whom he preceded. Gessner was followed by the great Cabinets of Curiosities and Encyclopedias of Collaert (1610), Aldrovandi (1639), Jonston (1660), Flamen (1664), Gottwaldt (1714), Seba (1735), Diderot & Alembert (1751-1772), Edwards (1751), Knorr (1754) – all including turtles in a zoological overview approach. Exploration and the vista of the new world spawned the travelogues and regional works of deBry (1595; 1601), Commelin (1645), Dapper (1673), Catesby (1743), some including excellent natural histories. By the late seventeenth century, the three earliest chelonian anatomical works were completed (Caldesi, 1687; Perrault, 1676; Gottwaldt, 1781). Several taxonomists, such as Gesner, predated Linnaeus by two centuries. Some early methods utilized Latin words to describe organisms, but were cumbersome and inconsistent. The first widely published binomial nomenclature, attributed to Bauhin, emerged early 17th century. This system was later adapted by Ray adapted utilizing a morphological approach. Linnaeus built upon these previous efforts and worked through his own earlier ones refining them multiple times to arrive upon a system of standardized "generic" and "trivial names" thus establishing the modern system of binomial nomenclature. With only four testudinid names in the first edition of Systema Naturae (1735),

Linnaeus' list progressed to eleven in the tenth (1758), and fifteen in twelfth (1766) editions. Of these, eleven are currently considered valid with one genus (generic) and ten species (trivial names) being credited to Linnaeus. From these humble beginnings, the number of genera and species has grown to over 100 and 300 (depending upon whom one counts as the authority). Although he built upon what was established by his predecessors, Linnaeus is considered the father of modern systematics and thus that of Testudine taxonomy.

Literature Cited:

Adler, K. 1989. Contributions to the History of Herpetology. SSAR, Oxford.

Aldrovandi, U. 1639. Serpentum, et Draconum Historiae libri duo... sumptibus Marci Antonii Berniae, Bononiae.

Caldesi, G. 1687. Osservazioni anatomiche ... intorno alle Tartarughe Marittime, d'Acqua dolce, e Terrestri. Scritte in una lettera all' illvstriss. Sig. F. Redi. P. Matini, Firenze.

Candidus, Petrus Decembrio. 1460. De animantium naturis (Rome, Vatican, Bib. Apostolica, MS. Urb. lat. 276).

de Cantimpré, Thomas. 1240. Liber de natura rerum. Bibliothèque Municipale de Valenciennes, MS 320

Catesby, M. 1743. The Natural History of Carolina, Florida and the Bahama Islands: Containing the Figures of Birds, Beasts, Fishes, Serpents, Insects and Plants. Vol II. C. Marsh, London.

Collaert, A. 1610. Animalium quadrupedum omnis generis verae et artificiosissimae delinationes in aes incisae et editae ab Adriano Collardo. Antwerp.

Commelin, I. 1645. Historisch Journal van de Voyagie naer d Oost. Amsterdam.

Dapper, O. 1673. Die unbekante neue Welt, oder Beschreibung des Welt-Teils Amerika, und des Sud-Landes. Bey Jacob von Meurs, Amsterdam.

deBry, T. 1595. America Pars Quionta… Frankfort.

deBry, T. 1601. India Orientalis... Part III. Frankfort.

Diderot, D. and J. Alembert. 1751-1772. Encyclopédie ou dictionnaire raisonné des sciences, des arts et métiers, par une société de gens de lettres. Briasson, Paris.

Edwards, G. 1751. Natural History of Uncommon Birds and Some Other Rare Undescribed Animals, Quadrapedes, Reptiles, Fishes, Insects, Etc. Royal College of Physicians, London.

Flamen (Flamand), Albert. 1664. Icones diversorum piscium tum maris tum amnium, ad vivum delineati, et in aes ab eodem artifitiose incisi. Figures de plusieurs sortes de poissons tant de la mer, que de l'eau douce. Desseignez et gravez sur le naturel. Van Merlen, Paris.

Gesner, C. 1555-58. Historiae animalium liber IV qui est de piscium & aquatilium animantium natura. Henrici Laurentii, Francofurti.

Gottwaldt, C. D. 1781. Christoph Gottwalds physikalisch-anatomische Bemerkungen über die Schildkröten. Gabriel Nicolaus Raspe, Nürnberg.

Jonston, J. 1660. Beschryving Van De Natuur Der Viervoetige Dieren. Amsterdam.

Knorr, G. W. 1751-1767. Deliciae Naturae Selectae Oder Auserlefenes Naturalien Cabinet

Linnæus, C. 1735. Systema naturæ sistens regna tria naturæ, in classes et ordines, genera et species redacta tabulisque æneis illustrata. Stockholmiæ.

Linnæus, C. 1748. Systema naturæ sistens regna tria naturæ, in classes et ordines, genera et species redacta tabulisque æneis illustrata. Stockholmiæ.

Linnæus, C. 1758. Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Stockholmiæ.

Linné, C. a 1766. Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Stockholmiæ.

Perrault, C. 1676. Description anatomique d'une grande Tortue des Indes. Memoires de l 'Academie Royale des Sciences Paris 3, 395-422.

Seba, A. 1735. Locupletissimi Rerum Naturalium Thesauri. J. Wetstenium, Amsterdam.

van Maerlant, J. 1350. Der Naturen Bloeme. Ms. The Hague, KB, KA 16

A Chelonologist in Eden

Rick Schaffer

Stanton College Prep, Jacksonville, Florida. Email: Accipender@aol.com

Chelonology is the study of turtles, stemming from the Greek chelon- meaning "tortoise" and -ology meaning the study of. It is based on Strauch's (1862) "Chelonologische Studien." All of this is ancient history, but important due to the perspective it provides. Dr. Berry asked me to share my thoughts on interesting the younger set in herpetology, and turtles in general. What causes one to become interested in chelonians at an early age? The most obvious answer is exposure. Turtles and tortoises in and around the home allow someone to become acquainted with them. Many kids catch turtles and keep them as pets, but that is where it usually stops. Exposure to the researchers and science of chelonia answers many questions and poses still more. Having parents with an interest in turtles will definitely help, but there is so much more. I've had the opportunity to meet and converse with a myriad of folks in this field. They have ranged from students to world authorities. And all have given me much to think about. The opportunity to attend and even speak at conferences is also very important. Integrating chelonians into my work at school has also helped. Science fairs, English essays, and Math problems are only a few of the possibilities. I've been around turtles for my entire life (at least so far) and have had opportunities few others my age have had. So my advice would be to open up a new world for those who haven't been as fortunate as me. The opportunity to provide this experience will vary for each of you according to your area of expertise. And it can be as simple as a trip to the local zoo, museum, or school, but don't put it off. Do it today. You will be glad you did.

U.S. Geological Survey's New Science Strategy– How Will It Affect Desert Tortoise Research?

Steven E. Schwarzbach, Center Director

U.S. Geological Survey, Western Ecological Research Center,
3020 State University Drive East, Rm 3006, Sacramento, CA 95819

In 2007, USGS published a new science strategy for the agency covering the decade 2007-2017. The strategy describes six science directions of which three have relevance to desert tortoise and Mojave Desert research: 1) understanding ecosystems and ecosystem change, 2) climate variability and change, and, more peripherally, (3) the role of environment and wildlife in human health. Much of the Western Ecological Center's ongoing desert tortoise and Mojave Desert research provides information critical to understanding the desert ecosystem and the role of the desert tortoise in the ecosystem. We are currently conducting research on topics that are basic to understanding desert ecosystems and ecosystem change. We also have a few projects that relate to using the tortoise as a sentinel for environmental and public health. Our major areas of research include: demography, status and trends in tortoise populations; ecology and behavior; anthropogenic impacts to tortoises and their habitats; effects of fire and invasive species on the species and ecosystem; natural recovery and restoration of disturbed habitats; health, diseases, potential contaminants and toxicants; and integrated ecosystem research Very little USGS research to date has focused on the effects of climate change on desert communities. Several of our scientists have conducted basic research on such topics as tortoise food habits and starvation, and their findings will provide a framework for new research on effects of prolonged droughts. With increased funding anticipated in climate change research, the Western Ecological Research Center has submitted several proposals to study the effects of climate change on desert tortoises and their environment. These proposals address the effects of climate change on desert tortoise shelter site choice, use of species distribution modeling to predict change, and the establishment of long-term permanent transects to monitor the effects of climate change versus human impacts in arid ecosystems.

Desert Managers Group Information and Education Program

Russell Scofield, DOI Coordinator

California Desert Managers Group, P. O. Box 2005, Yucca Valley, CA 92286

The Desert Managers Group (DMG), an organization of federal, state, and county land managing agencies in the California deserts, focuses on coordinating and integrating desert tortoise recovery actions and monitoring efforts among managers and scientists across jurisdictional boundaries. A key to desert tortoise recovery is an informed public that understands and appreciates desert tortoise recovery. Now in its second year, the DMG is implementing an interagency desert tortoise education program targeting desert users and the public. Some goals of the program include standards based environmental education, brochures targeting specific audiences or topics, media releases, public attitude surveys.

Climate Change and Protected Areas: Managing for Change in the Face of Uncertainty

J. Michael Scott

U. S. Geological Survey, Moscow, ID 83843

The U.S. National Wildlife Refuge System (NWRS) is the largest system of protected areas in the world. It encompasses over 93 million acres (37.6 M ha) and is composed of 547 refuges. Compared to other protected areas, the units are relatively small, typically embedded in a matrix of developed lands and situated at low elevations on productive soils. Projected changes in precipitation, temperature and sea-level rise associated with climate change will have NWRS-wide effects on species and their habitats. Climate-related changes in the distribution and timing of resource availability may cause species to become decoupled from their resource requirements. The impacts of most concern are those that may occur on NWRS trust species that have limited dispersal abilities or occur on refuges at the extremes of their geophysical, ecological or geographical distributions. Projected sea-level rise has substantial negative implications for 161 coastal refuges, particularly those surrounded by human developments or steep topography.

Managing the "typical" challenges to the Refuge system requires accounting for the interaction of climate change with other stressors in the midst of substantial uncertainties about how stressors will interact and systems will respond. Climate change adds a known forcing trend in temperature and other environmental variables to all other stressors that likely will result in complex non-linear challenges to species and ecological processes that will be exceptionally difficult to understand and mitigate. The historic vision of refuges as fixed islands of safe haven for species met existing needs at a time when the population of the United States was less than half its current size and construction of the first interstate highway was decades in the future. I will discuss the new tools, new partnerships and new ways of thinking that will be required to maintain the integrity, diversity, and health of the refuges in the face of climate change and expanded human populations and economies.

Department of Fish and Game and the Desert Tortoise, Our State Reptile

Dale Steele and Rebecca Jones

California Department of Fish and Game, Wildlife Program
1812 9th Street, Sacramento, CA 95814; (916) 45-0803; E-mail: dsteele@dfg.ca.gov

State laws have been in place since 1939 in California to protect the desert tortoise. In August of 1989, the tortoise was officially listed by the Fish and Game Commission as threatened under the California Endangered Species Act (CESA), Section 2081of the Fish and Game code. CESA permits take for scientific, educational, management, or incidental take to an otherwise lawful activity provided the take is minimized and fully mitigated. In addition to an Incidental Take Permit, a Memorandum of Understanding for Handling Tortoises is needed and we must review the qualification of each person who applies for the MOU. The Department also

issues Scientific Collecting Permits and MOUs for research and studies on desert tortoise and permits for possession of Captive Tortoises.

The Department, through the CESA permitting process, and by other means, continues to acquire lands within recovery units. Along with the land acquired, the Department has also collected enhancement and endowment fees for management of the lands. Fencing has been installed in some of the areas to exclude cattle grazing and OHV use. In addition to the lands that have been acquired by the Department, mitigation lands have also gone to the Desert Tortoise Preserve Committee.

In 2007, the Department continued to work with local jurisdictions to aid them in complying with the California Environmental Quality Act and the California Endangered Species Act. We worked with the Army on their Army Compatible Use Buffer (ACUB) program to acquire a grazing allotment in the West Mojave and this work is continuing. Federal Endangered Species Action Section 6 funds were used to fund 3 long-term study plots in the west Mojave. Work continued on permitting numerous small projects, which include mining activities, housing and other urban development, and road projects. The Department spent significant time and resources again this year working with Department of Defense on the Fort Irwin Expansion, reviewing mitigation lands, working to fund study plot surveys, working to with the FWS to update the desert Tortoise handling guidelines, reviewing and commenting on the Draft Desert Tortoise Recovery Plan, permitting desert tortoise research projects, improving our methods for dealing with captive tortoises and working on subgroups of the DMG on management and protection of the desert tortoise in California.

Successful Revegetation Methods for Saltbush Scrub and Creosote Scrub Vegetation Communities and its Benefit to Desert Tortoises (*Gopherus agassizii*)

Mercy Vaughn[1], Dick Carr[2], and John Steinbacher[3]

[1]179 Niblick Rd. PMB 272, Paso Robles, CA 93446
[2]CM Environmental, 1019 Gordon Ave, Reno, NV 89509
[3]Summit Associates LLC, 529 E. Sunnyridge Ct, Boise, ID 83702

Decreases in distribution and abundance of desert tortoises (*Gopherus agassizii*) have been ascribed to a complex range of factors. Three major causes are (1) habit loss - mostly permanent, (2) habitat fragmentation - frequently permanent but reversible at times, and (3) habitat degradation - usually can be corrected. These three primary factors are generally accepted as impacts but the latter two are not as well understood. Examples of permanent habitat loss include conversion of desert tortoise habitat to agricultural crops, subdivision developments, power plants, paved roads or surface mines. Fragmentation of habitat includes impacts such as linear utility corridors, unpaved roads, and fire. The most common examples of habitat degradation in the western Mojave Desert are a result of off-highway vehicle impacts and sheep and cattle grazing. Some of these impacts can be resolved through successful revegetation, which can be difficult in arid environments.

The two primary vegetation communities inhabited by desert tortoises in the Mojave Desert are desert saltbush scrub and creosote-bursage desertscrub. Two separate sites near Mojave, California within these two vegetation communities were successfully revegetated using native species seed. Both sites had seriously disturbed soil and clearly demonstrated habitat loss for desert wildlife species. Seed selection was focused on early seral stage species within the saltbush and creosote vegetation communities. To mitigate for imbalanced soil conditions and the recognized difficulty of revegetation in arid conditions, specific humic substances were added to the organic soil amendment blend. In addition, semi permeable soil binder was used in the hydroseed application to hold both nutrient and seed in place. Both the Standard Hill Mine and the Hyundai/Kia Proving Grounds were revegetated using this methodology, and their successful revegetation marks a substantive change in resource management techniques for desert tortoise habitat restoration, especially those where reversible disturbances threaten to further fragment tortoise habitat.

Species Responses to Climate Change: Harbingers of Community and System Changes

Frederic H. Wagner

Dept. of Wildland Resources, Utah State University, Logan, UT 84322-5230

Climate change affects individual organisms which respond collectively as species. A burgeoning literature is now reporting species responses in terms of shifting latitudinal and altitudinal distributions, advancing phenologies, and population changes. Ultimately, our goal is to measure and model the effects of climate change on entire communities and ecosystems which are structured by species interactions. Hence it is desirable to intensify focus on these interactions.

Range extensions thrust new species into existing systems, and incur new predatory, herbivorous, and competitive interactions, all of which are being reported. Phenological changes create temporal asynchronies in two-trophic interactions and trophic cascades. Shifting habitats, while bringing along existing species, may constrict or eliminate other habitats and their dependents. Examples of all of these interaction changes are being reported in terrestrial, freshwater, and marine systems.

In the case of the desert tortoise, recent global-circulation models are projecting intensified xerification and northward extension of North American deserts along with rising temperatures. Such changes are likely to affect the plant species on which tortoises feed, while the temperature changes could influence population sex ratios through the gender-influencing sensitivity to incubation temperatures

---

Clark County Multiple Species Habitat Conservation Plan Progress

Sue Wainscott

Clark County Department of Air Quality and Environmental Management
Desert Conservation Program, PO Box 555210, Las Vegas, NV 89155-5210

In 2007 the Clark County Multiple Species Habitat Conservation Plan program provided funding to implement many projects supporting desert tortoise recovery within portions of the Northeastern Recovery Unit in Clark County, Nevada. Implementation projects included restoration of habitat on Bureau of Land Management lands, weed survey and control on Federal lands, wildlife damage management, installation and maintenance of desert tortoise fencing along major roadways, and law enforcement for habitat protection on Federal lands and the Boulder City Conservation Easement. Operations projects included operation of the County-wide tortoise pick-up service, operation and management of the Desert Tortoise Conservation Center, and operation of the transfer and holding facility and translocation program. The County also improved our administration of the program including hiring and training of new staff as well as design and implementation of an electronic project tracking system. Public information and education projects included coordinating with other entities to implement the Mojave Max Emergence Contest program, several public outreach events and continuing improvements to the www.mojavemax.com website. Five conservation planning documents were completed for desert tortoise habitat and rare plant habitats within desert tortoise habitat. The County participated in the Desert Tortoise Recovery Plan Revision process and provided numerous datasets to the planning team. Information gathering projects included an inventory of the Boulder City Conservation Easement for roads/tracks/trails, signage, boundaries and utility infrastructure; tortoise monitoring; and studies of tortoise population genetic structure and epidemiology of upper respiratory tract disease.