ABSTRACTS

THIRTY-SECOND ANNUAL MEETING AND SYMPOSIUM
THE DESERT TORTOISE COUNCIL

Sam's Town Hotel and Casino, Las Vegas, NV
February 23-26, 2007

(Abstracts arranged alphabetically by last name of first author)
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Recovery Planning and the Range-wide Monitoring Program for the Mojave Desert Tortoise

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Current recovery criteria for the Mojave population of the desert tortoise include evidence of a 25-year trend that is constant or increasing. Line distance analysis was adopted in 2001 as the method that would be used to describe annual densities in each recovery unit. In 2006, USFWS published a report summarizing density estimates in each of the 6 recovery units from 2001 to 2005. Densities in each recovery unit were similar across years. Using these density estimates as baselines, we applied recommendations from Anderson and Burnham (1996) for assessing the power of this monitoring approach. We also examined use of stratification to get more precise density estimates. Modifications to the protocol since 2001 have resulted in error estimates very close to those used by Anderson and Burnham (1996), so that their power estimates are matched. Then as now analyses indicate lower power to detect positive trends within recovery units, as described in the original (1994) and current draft of the recovery plan. We discuss possibilities for adapting monitoring to better meet requirements under the recovery criteria. We conclude by noting the need for the monitoring program to expand or adapt to address distribution and effectiveness monitoring.

Strategy for Revising the Recovery Plan for the Mojave Desert Tortoise

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The U.S. Institute for Environmental Conflict Resolution led an assessment team in conducting a feasibility assessment for a collaborative process to revise the desert tortoise recovery plan. The assessment team provided recommendations for conducting such a process (reported separately in this symposium) and anticipated a draft revised recovery plan by March 2009. Unfortunately, it is clear that funding resources among agencies to commit to a fully collaborative process are unlikely to be available in the short term. Given this situation, as well as the fact that recovery of the desert tortoise will be a long-term process, the Service determined that an expedited recovery plan revision was prudent at this time. Therefore, the Service proposes a modified approach to work directly with the Desert Tortoise Management Oversight Group to complete a revised draft recovery plan by September 2007. This approach would necessarily limit broad-scale collaboration described in the assessment report, but only in the short term. While time and funding limitations preclude a fully collaborative recovery planning process this year, the Service will begin addressing several issues and implementing additional recommendations in the assessment report to improve the scientific foundations for desert tortoise recovery. These steps extend beyond the current recovery plan revision as long-term commitments to build relationships for broad-based collaboration in recovery implementation and subsequent reviews.

History, Humans, and *Heloderma*: Why Monsters Matter

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Since 1980, when the Desert Tortoise was first listed in Utah as a federally-threatened species, it has become a well-known symbol of desert environmental issues — a "flagship species," one whose notoriety can help awaken public awareness that can leverage protection for other species. In contrast to the tortoise, the Gila monster has remained an elusive and poorly-understood icon of the American Southwest. But that situation is changing. Recent discoveries about habitat use, behavior, and physiology of Gila Monsters are revealing some fascinating parallels between the biology of these two ancient desert species. And while tortoises and monsters are often rivals (Gila monsters raid tortoise nests, and tortoises vigorously defend their shelters and nests from marauding Gila monsters), both species obviously gain much from efforts to protect their desert habitats and populations. With the development of Byetta, a promising new diabetes drug discovered from Gila monster venom, *Heloderma* seems poised to become herpetology's new poster child for the value of biodiversity. The desert tortoise remains an important umbrella species for *Heloderma suspectum* (and many other desert species) — especially in Utah where Gila monster populations are in serious peril. But monsters have something to give back. To policymakers and citizens who remain confused about the value of

protecting desert habitats, the Gila monster provides a wonderful example of the value of biodiversity.

Advocating for Enforcement and Expansion of Protections for the Desert Tortoise and its Critical Habitat: Ongoing Threats, New Threats, and an Uncertain Future

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The Center for Biological Diversity has consistently advocated for the enforcement and expansion of protections for the threatened desert tortoise in the media, the administrative process and, when necessary, through litigation. The Center remains focused on science-based advocacy in opposing land use planning and management that provides insufficient and ineffective protection of the desert tortoise and other imperiled species.

The ESA requires public agencies to prioritize the survival and recovery of listed species in their management of public lands and in funding or carrying out projects. The ESA and other environmental statutes also provide citizens with the ability to bring suit to enforce the law. The open, public, decision-making process and the ability to challenge agency decisions in the public forum and in court are critical elements of our democracy. Although the process is by its nature adversarial, the Center acknowledges that many agency employees have significant expertise in their fields and that public agencies have limited budgets and staff. Thus, even agency staffers who are trying hard to protect the desert tortoise and other imperiled species may not always succeed. Unfortunately, some agency decision-makers appear to be swayed by public policy concerns in lieu of science and are willing to sacrifice the protection of imperiled species and habitats in order to please various interest groups.[1]

Since 1999, the Center, along with the Sierra Club, PEER, and Desert Survivors, have brought several key cases that have helped to protect desert tortoise habitat on public lands within the 25 million acres of the California Desert Conservation Area. In 2006, we won a legal victory that will keep in place the interim measures protecting large portions of the Algodones Dunes from destruction by ORVs. In that ruling, the court found that an incidental take statement for the desert tortoise was invalid because it failed to provide even the most basic information required by the statute—the extent of the take authorized.

In 2006, the Center and our allies filed a new suit against BLM's WEMO Plan amendment to the CDCA Plan, and the biological opinion and incidental take statement provided by FWS, because the plan fails to adequately protect the desert tortoise and other listed species

[1] As has come to light through documents obtained under the Freedom of Information Act, in court cases, and the press, recommendations of agency staff in the field who are in the best position to understand the status of imperiled species and their habitat needs have been routinely overruled by political appointees and other high-level officials without any background or expertise on these issues. See, e.g., "Bush Appointee Said to Reject Advice on Endangered Species," Juliet Eilperin, Washington Post, October 30, 2006. Recent Senate hearings into the suppression of climate science tell a similar story.

and their critical habitats from the adverse impacts of increasing ORV use, grazing, and other threats. In that same suit, the Center again challenges BLM's so-called "open wash policy" in the NECO planning area of the CDCA which allows overland ORV travel, stopping, and camping in desert washes in over 200,000 acres of the Chemehuevi DWMA and over 350,000 acres of the Chuckwalla DWMA.

As BLM continues to move forward with the process of renewing grazing leases throughout the CDCA, the Center is committed to fighting for limits on grazing and exclusions that will significantly reduce adverse impacts to the desert tortoise and its habitat and protect riparian resources, desert soils, and native plants. To that end, the Center has submitted science-based comments on recent grazing EAs for allotments in the CDCA. The Center has also expanded our focus on protecting the desert tortoise and other imperiled species into Nevada to try to limit the impacts of sprawl development in desert tortoise habitat. In California, we are continuing to expand our work to protect occupied desert tortoise habitat on private lands by advocating for (1) the development of meaningful project alternatives that avoid the impacts of proposed projects and (2) where impacts to occupied habitat cannot be avoided, ensuring that effective and enforceable mitigation measures be put in place before habitat is destroyed.

It is undeniable that more must be done to protect the desert tortoise from disease and predation, and that more must be done to protect its habitat from continued destruction, degradation, fragmentation, and the looming impacts of climate change. Nonetheless, the positive impact of the Center's advocacy work, and that of many other dedicated activists, can be seen in the type and extent of mitigation measures that are now routinely imposed for newly proposed projects in desert tortoise habitat on both public and private lands. As a case in point, the mitigation measures for the expansion of Fort Irwin in desert tortoise critical habitat include acquisition of large in-holdings of private lands in DWMAs, retiring several large grazing leases in DWMAs, and extensive tortoise fencing along I-15. Even ten years ago, it is highly unlikely that this level of funding for mitigation would have been provided by Congress, or that mitigation of this extent would have been sought by FWS or agreed to by the Army.

The Center will continue to advocate for the protection of the desert tortoise and all imperiled species on both the local and regional level and to support science-based efforts to recover this keystone species of in the southwestern deserts.

Dominance, Gender, Cover-sites and Season: Important Factors in Desert Tortoise Home Range Shape and Size

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We conducted a multi-year study of an undisturbed population of desert tortoises (*Gopherus agassizii*) on the National Training Center, Ft. Irwin, central Mojave Desert, California. Important topics for conservation and management of tortoises include factors that

affect home range sizes and shapes. We compared home range sizes of adults by gender and dominance (males only) using minimum convex polygon and kernel estimators. The original data sets on locations for each female and male ranged from 64 to 114 and from 83 to 205 points, respectively. We used fewer points, eliminating repeated observations of the same tortoise at the same site (e.g., daily observations during winter). Using the minimum convex polygon estimator, the means for home ranges of females (N=11) and males (N=16) were 13.5 ha (SD=9.2) and 43.8 ha (SD = 27.8), respectively. Using the kernel estimator (95% mean use), the sizes overall were smaller, but the pattern was the same. The means for home ranges of females and males were 9.4 ha (SD = 6.6) and 39.8 ha (SD = 28.3), respectively. In both cases, the differences between males and females were significantly different (ANOVA, $p \leq 0.001$). Dominance was an important factor in shape and apparent positioning of home ranges among alpha males. Only small portions of home ranges for some alpha males overlapped, and core portions of their ranges were isolated from each other. Mean home range size of alpha males was higher than that of lower ranked males, but the differences between social groups were not statistically significant, possibly due to a combination of low sample sizes (alpha, beta groups) and individual variation (all groups). The core areas of females also were separated from each other. Within home ranges, locations of core use areas varied by season for both sexes. Areas used for winter (Nov. 1–Feb.15) differed from areas used during the hottest part of summer (July 1–Sept. 1). These differences are influenced by seasonal choices of cover sites (burrows, caves). Other factors affecting home range size and shape are mates, foraging areas, and availability and quality of resources.

Health, Disease, and Trauma of Desert Tortoises at the Ft. Irwin Translocation Project: A Progress Report

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As part of a baseline research program for the multi-year, long-term Ft. Irwin Translocation Project in the central Mojave Desert of California, we evaluated 359 tortoises for general health and clinical signs of upper respiratory tract disease (URTD), shell diseases, and trauma in 2005 and 2006. The tortoises were subadult or adult females (N = 133) and males (N = 226). 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. A small group of the tortoises was sampled more than once. We report on the baseline findings of clinical signs of health and disease (e.g., upper respiratory tract and shell diseases) and trauma. Two live adult female tortoises were salvaged in fall of 2006 for necropsy at the University of Florida, because they showed significant clinical signs of disease and pending death. Both tortoises appeared to have severe metabolic disease (toxic or diet related); they did not have mycoplasmosis or pneumonia.

In spring of 2007, the priorities for the health/disease research team are to: (1) evaluate all remaining, untested tortoises in the translocation program; (2) re-sample tortoises for which

no data are currently available; (3) conduct epidemiological sampling, where appropriate, in the Ft. Irwin Translocation area; and (4) establish a baseline epidemiological research program for modeling upper respiratory tract disease at a site with high seroprevalence for mycoplasmosis and where an epidemic is underway.

Report from the Bureau of Land Management, California Desert District: Conservation Actions to Protect the Desert Tortoise

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Off Highway Vehicle (OHV) restoration in desert tortoise habitat has been ongoing since 2002 throughout the California Desert Conservation Area (CDCA). In the Ridgecrest resource area, restoration crews have been reclaiming legally closed trails in both Jawbone Area of Critical Environmental Concern (ACEC) and Rand Mountains Management Area. This past year, six miles of fence were added along the north end of the West Rand ACEC, closing off the last section of the ACEC unprotected from unauthorized entry. For the past 3 years, the Barstow Field Office (FO) has employed restoration crews in the Ord Mountain area, between Stoddard and Johnson Valley OHV open areas and last year began utilizing a restoration crew in the Edwards Bowl, southeast of the Edwards AFB. The Palm Springs FO has had restoration crews in the Meccacopia Special Recreation Management Area (SRMA) and has plans for future crews on the Chuckwalla Bench. In addition to restoration of desert tortoise habitat, BLM has continued to pursue acquisitions of private land and conduct desert tortoise surveys in several areas.

Desert Tortoise Preserve Committee: Land Management Actions to Recover the Desert Tortoise

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During 2006, the Desert Tortoise Preserve Committee (DTPC) continued efforts to acquire and manage habitat for the desert tortoise (*Gopherus agassizii*) and Mohave ground squirrel (*Spermophilus mohavensis*) with a focus in three areas in California: the Desert Tortoise Research Natural Area (DTRNA) in the west Mojave Desert, Pilot Knob in the Central Mojave, and Chuckwalla Bench in the Eastern Colorado Desert. Primary acquisition goals include private in-holdings within the DTNRA and expansion areas to the east and west. The permanent retirement of the Pilot Knob Grazing Allotment remains a high priority and the DTPC hopes to see implementation of this portion of the *West Mojave Plan* by the Bureau of Land Management in the coming months. Habitat management was a primary objective for the DTPC. Fences and signs around the DTNRA were maintained and upgraded. An off-road vehicle staging area,

Camp C, acquired in cooperation with other organizations in 2005, will be fenced in 2007 and habitat restoration will be initiated. A significant accomplishment in 2006 was the design and implementation of a program to remove the invasive mustard (*Hirschfeldia incana*), which occurs along the western boundary of the DTNRA. Over 5,000 plants were removed in spring of 2006, and this program will continue in future years. The DTPC has developed a design to reconfigure the entrance to the DTNRA to reduce impacts caused by off-road vehicle use. Off-road vehicle use, livestock grazing, raven predation, and disease are four of the more serious threats to conservation of desert tortoises in areas managed by the DTPC. A Memorandum of Agreement which will allow for a transition to landscape level ecosystem management of desert tortoises and their habitat is being developed with the California Department of Fish and Game.

Learning from the 2005 Mojave Desert Fire Season: Progress Report on New Fire Research

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More area burned in the Mojave Desert during 2005 (385,357 ha; 952,238 acres) than the sum of all fires recorded in the previous 25-year agency database spanning 1980 through 2004 (292,017 ha; 721,590 acres). Burned areas included significant portions of the Beaver Dam (23%), Upper Virgin River (19%), and Gold Butte-Pakoon (14%) critical habitat units for the desert tortoise (*Gopherus agassizii*). Accordingly, there was significant concern about the implications of these fires for the desert tortoise, other sensitive species, and biodiversity in general. In particular, there was concern that the 2005 fire season may represent a significant threshold marking the beginning of a new era in the Mojave Desert, where extensive landscapes would increasingly become affected by an invasive plant/fire regime cycle and dominated by non-native annual grasses. There was also a call for management actions to mitigate the negative effects of these fires. Although some information was available from previous research conducted in the Mojave Desert, it did not sufficiently address some of the most pressing issues, and land managers were constrained to develop admittedly imperfect management plans using limited scientific information. In response to dilemma, scientist from the United States Geological Survey and the Eastern Nevada Landscape Coalition implemented a number of scientific studies to provide critical new information related to fire histories, fire effects (on seedbanks, vegetation, and the desert tortoise), the effectiveness of post-fire seeding treatments, and the central question of where (and under what conditions) an invasive plant/fire regime cycle is becoming established in the Mojave Desert. In this presentation we briefly describe these studies, report preliminary results, and explain future plans.

Future Directions: Genome Analysis of *Mycoplasma agassizii* and *Mycoplasma testudineum*

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New advances in technology now permit the rapid sequencing of entire microbial genomes for a relative small financial investment. Because of the small genome size of mycoplasmas, these microbes are particularly well suited for a new technology called pyrosequencing. An overview of the technology will be provided. During 2007, we will sequence the genomes of both *Mycoplasma agassizii* and *Mycoplasma testudineum* obtained from the desert tortoise. We expect to obtain sequence data for over 900 genes. This database will then be available for comparative analysis to determine genes unique to each species as well as to identify potential genes involved in virulence. Examples of specific ways in which this data can be used will be discussed. For example, many mycoplasmas contain repetitive sequences known as insertion sequence elements. If present in *Mycoplasma agassizii* or *Mycoplasma testudineum*, these elements can be used to perform molecular epidemiological studies on existing clinical isolates to determine relatedness. Large numbers of clinical isolates can be screened for the presence or absence of specific putative virulence factors. This data can be used to determine if isolates from a tortoise population are similar or represent multiple strains, as might be expected from mixing of tortoises or release of captives. Once completed, the genomes will be made available to the scientific community at large via national databases.

Spatial and Temporal Mortality Events in Gopher Tortoise Populations with Acute and Chronic Upper Respiratory Tract Disease

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Anthropogenic impacts, particularly the release of captive animals, have been hypothesized to play a role in the transmission dynamics of upper respiratory tract disease (URTD) in wild tortoise populations. Similarly, the role of relocation events on disease transmission has been questioned. While it is unlikely that a single factor will account for all observed disease outbreaks, systematic investigations of selected populations may permit development and validation of general principles that are important in determining the disease transmission dynamics as well as both short and long term impacts on the populations. Eleven gopher tortoise populations in Florida, including a subset of five populations, have been intensively studied since 2003. We have previously reported on one population (CF) that transitioned from healthy to clinically ill concomitant with unauthorized release of tortoises and development of adjacent lands. Mortality events continue on the site, and we now report a second site that is undergoing transition from seronegative to seropositive, with accompanying mortality events. The cumulative documented mortality events on the 11 sites are compared in the context of serology, clinical disease, and estimated rate of change. Two sites represent populations with historic die-offs attributable to URTD, one site is in the acute phase of the

URTD outbreak, and a second site is in the early transition to acute disease. Six control sites with low seroprevalence of URTD are included. One additional site has experienced a recent die-off not caused by *Mycoplasma agassizii* but presumed to be viral in origin. Interestingly, the cumulative mortality pattern closely resembles that of the population experiencing acute phase URTD. Although still a relatively rare event, we have now documented that in the acute phase population, we have seen some seroconversion in subadults, presumably as a result of population density increases in infected adult animals. The spatial and temporal pattern of mortality events on the acute phase site and the newly transitioning site is presented. Initial foci of mortality were identified and subsequent mortality events tracked in relationship to the initial events, the surrounding development, and potential sites of access for tortoise release.

U.S. Fish and Wildlife Service Report for 2006

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Major consultations completed in 2006 include two biological opinions issued by the Nevada Fish and Wildlife Office for post-wildfire emergency habitat stabilization and rehabilitation. Wildfires in 2005 burned over 500,000 acres of desert tortoise habitat and approximately 60,000 acres in 2006. Most of these wildfires occurred within the Northeastern Mojave Recovery Unit. Post-wildfire activities include hand and aerial seeding of native forbs and shrubs, removal of livestock from burned tortoise habitat, and wild horse and burro gathers. Consultation continues on Bureau of Land Management (BLM) land use plans in Arizona and Nevada. The Arizona Strip BLM and Ely BLM (Nevada) offices are revising their Resource Management Plans. Our Arizona and Nevada Field Offices provided comments to BLM on their draft documents. We anticipate issuing biological opinions on the plans in 2007.

In 2006, the U.S. Fish and Wildlife Service (USFWS) in Nevada and California were involved in developing several new Habitat Conservation Plans (HCPs), while progress was made on other HCPs in development. In Nevada, HCPs are under development for southeastern Lincoln County, private lands in Coyote Springs Valley in Lincoln County, southern Nye County, and the community of Pahrump. HCPs in the works for California include the Village of Joshua Tree and Copper Mountain College.

The Service is continuing to revise the desert tortoise field procedures and handling protocols. Review of the 1992 procedures and 1994 Desert Tortoise Council Handling Guidelines will be included in this effort. The draft revision is anticipated in Spring 2007 and will be widely distributed for comments.

Other activities include work on an environmental assessment to use integrated predator management to reduce raven predation and initiation of quarterly coordination meetings between our California field offices in California and conservation groups.

Using Dogs to Find Small Desert Tortoises:

An Update of the DTK9 Program 2006 Field Effort

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In 2004 and 2005 field efforts, dogs trained to find tortoises (DTK9s) were proven to be effective and reliable at finding tortoises in all configurations on the landscape. 'Small tortoises', defined as tortoises < 100 mm midline carapace length, were found by DTK9s during controlled research trials in 2004 but were not found during field surveys at the NTC Ft. Irwin in fall 2005. As a natural progression of the development of DTK9s for tortoise surveys, research trials were conducted to assess their abilities to locate small tortoises. Four DTK9s were tested for reliability, efficacy, and consistency under controlled conditions at the Desert Tortoise Conservation Center (DTCC) followed by a similar effort conducted under natural conditions at the NTC Ft. Irwin Study Site (FISS). Between 29 October and 12 November the DTK9s averaged 97.5% success for small tortoises during experimental trials at the DTCC in combined 0.25 and 0.5 ha plots with unnaturally high densities (10 tortoises per plot, respectively). They were then fielded on a wild population with much lower densities and relatively inactive tortoises between 16-19 November at the FISS. Although the DTK9s did have some success they were not as effective at Ft. Irwin as they were at the DTCC. The drop in success from captive tortoises in experimental trials to wild populations may be related to training, burrow microclimate and type, environmental conditions, and potentially tortoise physiology related to season. Additional work is called for to assess these factors. We present an overview of this effort.

POSTER

Overwintering Behavior of the Gila Monster: Implications of Refuge Location on the Timing and Duration of Inactivity, Thermal Biology, and Energetics

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In temperate climates, cold winter air temperatures force many ectotherms to retreat into the less variable and extreme microclimates inside refugia for extended overwintering inactivity periods. Here, we present preliminary results of a field study describing the overwintering behavior of a large, long-lived ectotherm, the Gila monster, *Heloderma suspectum*. We studied a Sonoran Desert population of Gila monsters, in which all individuals spend the majority of time during the active season foraging or mate-searching in the bajada surrounding rocky hills and buttes. Some Gila monsters then overwinter on the bajada within their active season home range, while others migrate to refugia on the slopes of hills or buttes. We used surgically implanted temperature loggers to determine the effects that alternate overwinter site selection has on the timing and duration of overwinter inactivity and body temperature (T_b). We determined that the timing and duration of Gila monster

overwinter inactivity is highly synchronized beginning and ending within 8 days across the population, however the overall duration of inactivity for bajada lizards is about 7 days longer than for hills lizards because hills lizards emerge significantly earlier than bajada lizards. Overwinter T_b of hills lizards is lower than that of bajada lizards, yet post-emergence body temperature of hill lizards is higher than that of bajada lizards during the first two post-emergence weeks. Results suggest that the presumed costs (increased predation risk and energetic costs) associated with migration to overwinter refugia are outweighed by the benefits (long-term overwinter metabolic savings and warmer post-emergence T_b) of doing so.

STUDENT PAPER

Dealing with Drought in the Sonoran Desert: The Gila Monster's Perspective

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North American deserts can present significant challenges to animals because of variable, often extreme temperatures and limited energy and water resources. During summer drought the combination of high temperatures and low energy and water availability can constrain activity of many animals resulting in trade-offs between fundamental physiological processes (e.g., thermoregulation, energy balance, and osmoregulation). In reptiles, environmental temperature is most often identified as a proximate factor constraining activity, yet the widespread and reliable response to rainfall in desert reptiles suggests that water availability may also be an important proximate factor directly influencing activity patterns. We examined water conservation strategies in the Gila monster (*Heloderma suspectum*) and used a variety of physiological and biotelemetric approaches in both the laboratory and field to test the hypothesis that activity is constrained by an animal's hydration state. We determined that Gila monsters, like desert tortoises, use their urinary bladder as a long-term water reservoir that moderates dehydration. Furthermore, we found that hydration state influences activity patterns significantly, whereby hydrated Gila monsters (either naturally or via experimental supplementation) are surface active more of the time than dehydrated Gila monsters. This result has broad implications on Gila monster physiological ecology and conservation because it demonstrates that climatic changes not only in temperature, but rainfall, will likely alter surface activity patterns which, in turn, affect crucial aspects of this species' biology (e.g., energy acquisition, reproduction, and thermoregulation).

POSTER

Temperature-based Activity Estimation (TBAE): An Analysis of Accuracy in Two Sympatric Ecotherms

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Accurately assessing animals' patterns of surface activity and refuge use is a fundamental challenge for biologists studying behavior, ecology, physiology, and conservation. Here, we evaluate the accuracy of a novel automated technique – temperature-based activity estimation (TBAE) – in estimating surface activity and refuge use patterns of two sympatric reptiles, the Western Diamond-backed Rattlesnake (*Crotalus atrox*) and the Gila Monster (*Heloderma suspectum*). TBAE derived from a comparison of body temperature to shaded air temperature was effective in estimating overall percent surface activity for both rattlesnakes (observed surface activity 51.8 %, TBAE estimated surface activity 48.2 %) and Gila Monsters (observed 22.3 %, TBAE 24.5 %). There was, however, considerable interspecific difference in the effectiveness of TBAE in assessing surface activity at specific time points, with TBAE being more accurate for Gila Monsters than for rattlesnakes (96 % vs. 65 % time point-specific accuracy, respectively). We assert that TBAE can be used to yield accurate long-term estimates of surface activity for multiple, free-ranging animals and, in some cases, effectively predict surface activity and refuge use patterns.

Seasonality of Activity, Body Temperature, and Refuge Selection in a Sonoran Desert Population of *Heloderma suspectum*

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The Sonoran Desert has considerable climatic seasonality including a cool winter, a relatively warm, wet spring, followed by a hot dry late-spring / early-summer, and then a hot, wet summer monsoon season. We examined how these changes in environmental conditions influence the activity, body temperature, and refuge site selection of a Sonoran Desert population of Gila monsters, *Heloderma suspectum*. Winter temperatures force Gila monsters to remain inactive, yet the population uses two distinct overwintering sites (rocky hills and surrounding bajadas). Overwintering site selection affects overwintering duration as well as overwintering and early post-emergence body temperatures. During early emergence, Gila monsters typically maintain relatively small home ranges on the rocky hillsides, and then utilize a greatly expanded home range on the surrounding bajada during the summer. As temperature cools in autumn, Gila monsters that overwinter on the hillsides return there and occupy a reduced home range prior to overwintering. In addition to a seasonal pattern of spatial distribution, Gila monsters also show highly seasonal surface activity patterns with peak activity occurring during the summer monsoons. Refuge selection also varies seasonally, with refuge selection apparently reflecting temporal variation in the thermal qualities of primary refuge types. Together, these results

demonstrate the strong seasonality of activity patterns as well as macro- and micro- habitat use by Gila monsters. Long-term studies across the Gila monster's range are needed to improve understanding of the habitat requirements necessary to sustain Gila monster populations.

Desert Tortoise Use of Seeded Burned Critical Habitat

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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 re-establishment of plants important as food and thermal cover for desert tortoises, the Bureau of Land Management (BLM) broadcast native seeds within sixteen 40-acre plots that were distributed across six fires that burned throughout southern Nevada: Meadow Valley, Halfway, Tramp, Garnet, Dry Middle, and Dry Rock fires. To monitor the implementation and effectiveness of the seeding effort, the US Geological Survey (USGS) established an additional 16 burned, unseeded plots and 16 unburned reference plots, for a total of 48 monitoring plots. In 2006, the USGS conducted area surveys for tortoise presence and sign within all 48 monitoring plots. A statistically significant pattern of less tortoise activity in seeded and unseeded burned areas than in unburned areas suggests that tortoises moved away from burned habitat one year after the fire and are not yet responding to the seeding treatment. Radio transmitters were attached to 20 tortoises in order to investigate how the shift in the dominant vegetation from native shrubland to invasive grasses as well as the re-establishment of seeded species will impact movements, growth and reproductive output of tortoises. Data gathered in 2006 will be compared with findings from 2007 and 2008 to distinguish tortoise activity in burned habitat and recommend whether tortoise habitat impacted by wildfire in the future would benefit from seeding with native species.

Collaborative Desert Tortoise Recovery Planning: Results of Feasibility Assessment

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Seeking a new approach to developing the revised Recovery Plan for the desert tortoise, the U.S. Fish and Wildlife Service (FWS) requested independent assistance from the U.S. Institute for Environmental Conflict Resolution to explore the feasibility of a "collaborative" recovery planning process. FWS was considering forming Regional Working Groups to develop regionally-based Recovery Action Plans, which would then be wrapped up into the Revised Recovery Plan. To evaluate the potential for this proposed approach, an assessment team from the U.S. Institute and its contractor, the California State University/Sacrament-based Center for Collaborative Policy, conducted over 100 interviews with representatives of federal agencies,

tribes, state agencies, county governments and agencies, scientists and researchers, recreational interests, environmental and conservation interests, mining interests, utility interests, and grazing interests, from California, Nevada, Utah, and Arizona. The analysis of the findings from the interviews was designed to determine whether key conditions existed for successful collaboration. The assessment team's best professional judgment was that FWS should not proceed with a collaborative process based on Regional Working Groups until and unless it was able to: 1) confirm the availability and commitment of adequate funding and staffing resources to support the proposed process; and 2) establish a broadly accepted and scientifically credible base of information to use in developing the Recovery Action Plans. If these prerequisites could be accomplished, the assessment team's judgment was that a collaborative process would be both recommended and feasible. The Report concluded with specific recommendations for how to proceed with a collaborative recovery planning process.

A Predictive Habitat Model for the Mojave Desert Tortoise

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Habitat models can provide insights into the past, current, and future status of a species' distribution and can be beneficial to conservation. There is currently an urgent management need to obtain a habitat model for desert tortoises for use in habitat valuation, expanding monitoring efforts, and a variety of other management uses. This project was designed to create a habitat model for desert tortoises to aid in our understanding of what defines their habitat and to aid in their conservation. With the endorsement of the Desert Manager's Group, coordination with the academic community, the Department of Defense, and several state and federal agencies we assembled data for desert tortoise presence and environmental parameters from across the Mojave Desert. The data on tortoise presence were derived from historical surveys or records and recently acquired range-wide data from the FWS distance sampling effort to create a database of desert tortoise locations from which we could model their habitat. Sixteen environmental variables were evaluated for potential use in habitat modeling from previously available data sets or databases that we created for the purposes of this model. Decision-tree and other analyses were used to reduce the number of environmental variables being used for further modeling activities where applicable. Recent computational advances provide opportunities to increase the depth and scope of landscape scale habitat analyses, and several alternative modeling processes are currently used to model habitat for a variety of species. We compare the results of five commonly used algorithms for habitat modeling: GARP, Biomapper, MaxEnt, GRASP, and an Artificial Neural Network. We will present these models and evaluation criteria for the selection of the model that best represents potential desert tortoise habitat. Once finalized and field verified these models may be used to evaluate proposed management scenarios throughout the range of the protected desert tortoise.

Department of Defense: Mitigation and Recovery Efforts for the Desert Tortoise

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The Department of Defense continues to conduct research and implement conservation programs that benefit the desert tortoise and other species at each of the five installations in the Mojave Desert. In addition to the conservation work conducted each year by each of these installations, Edwards Air Force Base and 29 Palms Marine Corps Air Ground Combat Center are spear heading desert tortoise head start programs. The US Army National Training Center and Fort Irwin, is funding research on health and behavior of the desert tortoise as a part of its desert tortoise translocation program. This presentation will highlight some of these conservation efforts.

Desert Managers Group Recovery Actions in the California Deserts

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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. The DMG accomplishes this effort through Goal 3 of its 5 Year Plan: Recover the desert tortoise in the California recovery units. This goal encompasses numerous implementing tasks ranging from information, education and outreach to range wide monitoring.

Deserttortoise.gov: A Web Portal for Recovery Science and Management

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This presentation will provide an overview of the current effort to design and implement a secure, interactive internet portal to serve the Desert Tortoise science and management community. MDEP and the Redlands Institute are working together to develop a new 'deserttortoise.gov' web portal that will enable scientists and managers to access a common data repository and toolset to facilitate their work toward the recovery of the desert tortoise. This portal will provide an entry point for public outreach and education, and will enhance research and recovery efforts by the desert tortoise science and management community. The portal will serve as a commons by hosting secure discussion forums and notifications. Targeted functionality includes providing secure access to a standardized repository of spatial data, field research data, and available collections of scientific papers, reports and presentations. The portal will provide web-based tools to perform searching, data exchange (upload/download), basic

mapping, advanced visualization, collaborative modeling, and analysis. The MDEP/Redlands team are seeking input and feedback on planned functionality and the technology platform for the new portal.

STUDENT PAPER

Modeling Habitat Specificity of Gila Monsters and Beaded Lizards in Sonora, Mexico

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Gila monsters (*Heloderma suspectum*) and beaded lizards (*H. horridum*) both have large geographic distributions, but are thought to be sympatric over a narrow range in southern Sonora, México. It is unclear as to the extent of sympatry between these species (if any), and the effects that topography, climate, and biological interactions play in determining these species distributions are unknown.

We present a model to describe the habitat specificity of these closely related and ecologically similar species, and show that elevation, and its effects on climate and vegetation, largely predicts their specific geographic distributions. We extend the applicability of the model and show how it can be implemented in a spatial context.

Black Mountain Desert Tortoise Population: Threats, Efforts, and a Few Small Victories

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The tortoise population within the Black Mountain Ecosystem of northwestern Arizona is under tremendous threat from exponential human growth in the surrounding communities. The Black Mountains run 100 miles north from west of Kingman to beyond the Hoover Dam. Tortoises are known to primarily occupy the southern half of this ecosystem. Resident tortoises are legally designated as Sonoran, but past and recent genetic research indicates the population is predominantly Mojavean. If tortoise genetics are proven consistent throughout the Black Mountain Ecosystem, then occupied and potential habitat might approach (in acreage) the amount currently designated as Critical Habitat for the Mohave Desert Tortoise Population in far northwestern Arizona. Desert tortoises in the Black Mountains are afforded long-term protection from the Bureau of Land Management's (BLM) Black Mountain Ecosystem Management Plan and other BLM plans and mandates.

Region III (Kingman) of the Arizona Game and Fish Department has been active for the last three years in facilitating tortoise research, conducting surveys, identifying and addressing threats, and collaborating with BLM, the primary landowner in the Black Mountains. We have expanded our knowledge of tortoise distribution and habitat preferences (soil, geology, and topography) and are utilizing this information with GIS analysis and groundtruthing to delineate important tortoise habitat within the Black Mountain Ecosystem. We are working with BLM on land disposal and OHV issues and are also addressing a substantial threat from a new highway proposed by Arizona Department of Transportation. To ensure long-term viability of tortoises in the Black Mountains, much more work needs to be done, but a few victories for tortoise conservation have been achieved so far along the way.

POSTER

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

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Concern regarding the possible impact of military training exercises on desert tortoise habitat and tortoise occupancy within designated training areas has led to an examination of tortoise habitat use on the Florence Military Reservation (FMR), Arizona, USA. Previous research conducted at FMR from 2000 to 2004 (Lutz et al. 2005) evaluated second-order habitat selection, the selection of home ranges within the species' geographical range (Johnson 1980). Results from this study suggested that while tortoises used all habitat types available throughout the study area, tortoise activity was correlated with the availability of shelter sites; in particular caliche caves (Lutz et al. 2005). The purpose of the current study was to describe tortoise micro-habitat selection within home ranges, termed third-order selection by Johnson (1980). We detected a total of 18 tortoises during the first year of study, ten of which were tracked using standard radio-telemetry techniques. Habitat components at use locations were compared to randomly selected available locations for each tortoise. Our analysis indicated that canopy cover played an important role in tortoise micro-habitat selection; use plots were characterized by higher canopy cover than available plots. Canopy cover may help alleviate stresses associated with high ground temperatures that averaged 38.7 ˚C during the study.

The Effect of Sampling Effort on Home Range Estimates of Desert Tortoises from the West Mojave Desert

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Home range estimation is an important tool in managing for the recovery of an endangered animal such as the desert tortoise, *Gopherus agassizii*. We conducted an intensive radio-telemetry study to determine how the number of locations affects home range estimates of the desert tortoise using two home range estimators, the minimum convex polygon (MCP) and the fixed kernel (FK). We assessed the degree of interaction among individuals in our sample population through analyses of home range overlap of 100% and 50% MCPs. Data were parsed into sampling regimes representative of previous home range studies in an effort to compare estimates across studies. Thirty-five adult tortoises (20 M, 15F) were tracked using a systematic sampling regime over two complete years with an average of 2,550 locations per year ($\bar{x}$ = 75 locations per tortoise). Home range estimates from our sample population ($\bar{x}$ male = 45.0 ha, $\bar{x}$ female = 16.1 ha) are over two times greater than published values for tortoises in the West Mojave. Male tortoises had significantly larger home range than females for both the 100% MCP and 95% FK estimates in each year. The number of locations was found to significantly affect home range estimates, although this effect was six-fold greater on the MCP than the FK estimates. The home ranges of male tortoises overlapped to a greater degree with tortoises of either sex, whereas overlap of female MCP areas demonstrated a sex bias in more area overlap with male home ranges. We recommend an intensive, repeatable sampling effort to better define home range estimates in future research, as well as to provide comparable data across studies as a crucial step in providing sound biological knowledge for conservation decisions regarding land management.

2005 Desert Tortoise Distance Sampling Threat Indicators

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The 2005 Distance Sampling effort included the collection of data on threats to the desert tortoise (U.S. Fish and Wildlife Service, 2006). This included exotic vegetation species, information on different dirt road types, trash, ravens, and canids. These data represent the most comprehensive range-wide attempt to date to produce a spatial inventory of these threat indicators. This presentation provides a first-draft summary of the spatial distribution of these threats using simple GIS spatial interpolation methods. In general, areas with the highest road counts were concentrated in the Western Mojave Recovery Unit (RU). However, other areas of

high road counts were found along major highways, major road intersections, and within smaller portions of other Recovery Units. Single tracks were more prevalent in the Western and Eastern Mojave RUs, while double tracks were more prevalent in the Eastern and Northern Colorado RUs. Mediterranean grass (*Schismus* spp.) was prevalent across the entire sample area. Non-native mustard (*Brassica tournefortii*) was restricted, with few exceptions, to the Colorado Desert, while brome (*Bromus* spp.) was restricted, also with few exceptions, to the Mojave Desert. The probability of finding trash was very low throughout the entire sampled area; however where it was present it was almost exclusively associated with populated areas. Of the approximately 9100 km walked in 2005, only three canids were observed. The highest concentration of ravens was observed in the Western Mojave RU, in particular the southern portion of Fremont-Kramer. Otherwise, raven observations were very low, if any were even observed, throughout most of the remaining sample area.

Head Start Mommas: Preliminary Assessment of Reproduction

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Head start programs can fulfill an integral function in the recovery of the desert tortoise, *Gopherus agassizii*, but how do head start manipulations affect the females whose eggs are used in head start programs? At TRACRS, the Tortoise Research and Captive Rearing Site at the Marine Corps Air Ground Combat Center, we are permitted to secure the first clutches of 'head start mothers' and then release the mothers to their home locations. We are using X-ray radiography and ultrasonography to monitor the subsequent production of eggs, and ultrasonography to monitor vitellogenesis, of these females. Time constraints limited a thorough, quantitative analysis of clutch frequency in spring 2006, but conservatively, 48% of head start females produced second clutches in the wild (i.e., clutch frequency = 1.48, n=21). Similarly, clutch frequency equaled 1.50 for eight wild females that were not used in the head start facility (= wild or control females). In July, after the reproductive season, follicle number (zero to eight) and size (diameter = 0.2 to 2.3 cm) varied considerably among wild and head start females. With thorough reproductive measurements from 2007 and 2008, we intend to assess quantitatively whether head start females perform as well as their wild counterparts.

Desert Tortoise Recovery Efforts and Issues at Mojave National Preserve

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Mojave National Preserve encompasses 772,463 acres of designated critical habitat for desert tortoise (*Gopherus agassizii*) and is home to important populations in the Fenner and Ivanpah valleys. Since its creation in 1994 Preserve management has acquired over 13,000 acres

of private land and retired 504,952 acres of grazing equivalent to 28,794 animal unit months. Over 4000 feral burros and 13,123 head of cattle have been removed. A survey of gallinaceous bird guzzlers in 2004 confirmed previous concerns of tortoise drowning. As of 2006 volunteers have retrofitted 19 guzzlers to improve tortoise escape ramps. Other high priority concerns include mortalities on roads, predation, disease, and drought. We have successfully competed for funding to initiate a study of tortoise mortality on heavily traveled paved roads, beginning in 2008, with the primary objective of focusing law enforcement efforts. We have initiated research with U.S. Geological Survey Biological Resources Discipline on juvenile tortoise survival. This work will address a key data gap in tortoise demography, improve transmitter technology, and develop potential headstarting capability. Management and staff at Mojave National Preserve are committed to working with state and federal agencies, the public, stakeholders, and other interested parties to recover the desert tortoise.

Overview on the Ecology and Use of *Amyda cartilaginea* and Other Non-marine Turtle Species from Sarawak Malaysian Borneo

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Borneo, the planet's third largest island, is located in the Malay Archipelago and is considered a center of global biodiversity. The island itself is under the jurisdiction of three countries - Indonesia, Malaysia, and Brunei Darussalam. Sarawak is one of the two Malaysian states located on the island, the other being Sabah. Borneo, as with most of Asia, has a high diversity of non-marine turtle species. This combined with their diversity of ecological and cultural roles should make them strong candidates for research and conservation. Sadly, this has not been the case. None of the species known from Borneo have been studied at length and consequently, little is known of their ecology. This paper represents first ecological study on Asian soft-shell turtle (*Amyda cartilaginea*). Notes were opportunistically collected on other non-marine turtle species, termed hard-shelled turtles. Two main study sites were used and percent capture success rates for *Amyda cartilaginea* were extremely low, 0.54% and 0.69% respectively, indicating the populations may be at a crisis level. Collection of large sets of field data on *Amyda cartilaginea* is difficult in Sarawak where this species is actively hunted for food by nearly all indigenous peoples. Other species appear to be for pets and socio-religious purposes on a smaller scale. Recommended conservation actions include detailed status surveys on all non-marine turtle species, increased enforcement to curtail illegal collection, public education, and increased efforts to collect data on the biology of these species.

The Arizona Game & Fish Department's Desert Turtles Project – Year in Review

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In 2006, the Arizona Game and Fish Department (AGFD) and other cooperators within the Arizona Interagency Desert Tortoise Team met to finalize the regional threats assessment for the Desert Tortoise (*Gopherus agassizii*) in Arizona. This is a major step towards developing the State Conservation Strategy and Agreement for the Sonoran population of the desert tortoise. We also funded a preliminary study designed to collect baseline data on the effects of catastrophic wildfires on a desert tortoise population in Tonto National Forest. We continued to monitor the desert tortoise population at Sugarloaf Mountain, and evaluate Arizona's Desert Tortoise Adoption Programs, working towards a state-wide adoption procedure. In addition we participated in the desert tortoise disease and population genetics studies in Mexico, Desert Tortoise Handling Workshop, Desert Tortoise Recovery Office's Desert Tortoise Management Oversight Group and Monitoring Committee meetings. Additionally AGFD assisted with ongoing Bolson Tortoise (*Gopherus flavomarginatus*) Recovery Efforts.

The Diverse Tortoise Fauna of Hyper-arid Southern Namibia: Emerging Conservation Opportunities at the Meta-landscape Scale

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A comparatively small (approx 10,000,000 ha), hyper-arid region of Southern Namibia located between 26°S and the Orange River border with South Africa is home to 5, or possibly 6, different land tortoise species. The distributions of several of these taxa (*Chersina angulata, Psammobates tentoricus* and likely, *Homopus signatus*) represent generally low density, peripheral populations for species whose core ranges lay in the adjoining Cape Province of South Africa. Two additional species (*Geochelone pardalis* and *Psammobates oculiferus*) are more widely distributed throughout Namibia and adjacent areas of southern Africa. The as yet undescribed "Nama-padloper" (*Homopus* sp.), is a small, poorly known, rock-dwelling tortoise apparently endemic to southwestern Namibia.

At present nature tourism is a rapidly expanding sector of the Namibian economy. The relative strength of this sector has provided the impetus for development of "guest farms" and the reversion of under-performing/failed ranching operations back to native game stocking. The local tortoise fauna should be a direct beneficiary of this trend toward farm consolidation and

native wildlife reorientation. In addition, government plans to create a new national park from the 2,600,000 ha *Sperrgebeit* (the historic "Forbidden Zone" of alluvial diamond mining) will provide additional conservation opportunities. One of us (Gessert) has launched a private sector initiative to acquire a series of adjacent, failed farms that will provide a corridor, extending over 100 km and incorporating more than 200,000 ha, to link the *Sperrgebeit* with the Fish River National Park to the east. This combined area will capture much of the known range of endemic Nama-padloper (*Homopus* sp.) in addition to significant populations of *Psammobates tentoricus* we have recently discovered that are morphologically distinct from the expected regional subspecies '*trimeni*'.

Although all Namibian tortoise species are formally protected under domestic wildlife legislation, there exists the standard litany of threats to existing tortoise populations, with widespread habitat degradation at the forefront. In the south of Namibia a legacy of severe overgrazing (cattle, sheep and goats) is associated with the establishment of large pastoral farms beginning in the late 19th and early 20th centuries on marginal desert lands (average annual rainfall of 50-100mm/year.) Other adverse consequences of ranching activities for tortoises may include indirect predator subsidy (e.g. crows & baboons) through the widespread provision of stock watering facilities (wells, dams and tanks) in areas with no natural (perennial) surface water resources. Tortoises, particularly the largest species *Geochelone pardalis*, are still consumed as traditional food by some rural segments of the indigenous human population. Thus far, Namibian tortoises have not been significantly impacted by the clandestine international pet or Asian food trade, but there have been some recent disturbing incidents. Anecdotal accounts of European "tourists" offering money for tortoises have surfaced, as well as reports of reptile "collecting" by elements of a new and growing immigrant Chinese entrepreneurial community in the nation's capital, Windhoek.

POSTER

International Chelonian Conservation: The John L. Behler Chelonian Conservation Center

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When the Wildlife Conservation Society decided to dismantle operations on St. Catherines Island in 2004, considerable concern was expressed on where and how to disposition the colonies that had been on the island for almost 30 years. In an effort to prevent disbanding the collection, John L. Behler, Curator of Herpetology, WCS, approached Eric Goode who offered to develop his property in southern California for the purposes of preserving the collection. The JLBCCC was formed to continue the conservation of endangered chelonians through captive reproduction efforts and applied research. This presentation documents the journey of the tortoises from St. Catherines Island, Georgia, to Southern California. This short film depicts our captive care techniques and breeding and nesting activity here at the new facility. It also illustrates the efforts to transform the property and develop enclosures that mimic the tortoises'

natural habitats including food and forage plots to ensure the health of each species. Four structures, including an original 1920's greenhouse, have been built on the property and each has been designed for best husbandry and housing of the individual species. This center is part of a larger conservation organization formed in honor of John – The Behler Conservation Trust that will focus its Chelonian Conservation mission on Southern Africa, Madagascar, and Myanmar.

A History of Gila Monster (*Heloderma suspectum cinctum*) Records from California with Comments on Factors Affecting their Distribution

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The Gila monster (*Heloderma suspectum*), widely distributed in parts of the Mojave, Sonoran and Chihuahuan Deserts of the southwestern United States and northwestern Mexico, is rare in California. However, during the last 153 years, over 20 credible records have been documented in four California counties. Habitat in which the species has been observed in California is characterized by rocky, deeply incised topography, in most cases, associated with large and relatively high mountain ranges. Most localities are associated with riparian areas (including the lower Colorado River) and range from near sea level to over 1,200 m. All records except one (Mojave River) occur east of about 116° longitude. Records documented with photographs or museum specimens generally show color patterns diagnostic of the geographically expected subspecies *H. s. cinctum*. The distribution of the species in California suggests an invasion into the high mountain ranges of the northeastern Mojave during the last interglacial via the Colorado River corridor. We explored the hypothesis that climate patterns shaped the current distribution of the Gila monster in California. Precipitation is decidedly biphasic east of 116° longitude, with over 24 percent falling in the warm season. Summer precipitation may be important in the foraging ecology of the species. Gila monsters were probably already rare in California long before the arrival of Europeans due to changes in climate that delimited the marginal location of California in the range of this species. Fortunately, most of the habitat for this species in California is protected.

Escaping the Extremes: Factors Affecting the Thermal Regulation of Desert Tortoise Cover Sites

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Desert tortoises (*Gopherus agassizii*) spend most of their lives below ground in cover sites that provide protection from predators and extreme desert temperatures. We conducted a multi-year study of the thermal environment of desert tortoise cover sites within the National Training Center, Fort Irwin, central Mojave Desert, California. We analyzed temperature data

from selected tortoise cover sites by spatial (tunnel length, width and height) and geological (depth of soil cover and burrow type) characteristics, focusing on extreme periods of summer (July 1 – September 1) and winter (November 1 – February 15) temperatures. Temperature measurements were recorded with HOBO data loggers inside 30 cover sites that consisted of caliche (caves, n = 24; pallet, n = 1), soil (n = 3) and consolidated gravel (n = 2), and under the canopy of a creosote shrub (*Larrea tridentata*). Temperatures were also simultaneously measured at the mouth of 13 of the cover sites.

Average extremes ranged from a winter minimum of 2.52°C to a summer maximum of 62.40°C under the creosote shrub. The mean summer maximum temperature inside the cover site (34.11±2.01°C) was cooler than at the mouth (44.52±7.11°C). Conversely, the mean winter minimum temperature inside (13.13±2.44°C) was warmer than at the mouth (7.38±2.15°C). Using a multivariate regression tree technique, summer and winter temperature extremes were best explained solely by soil cover at the mouth of the cover site. Inside the cover site, summer maximum temperature was best explained by a combination of tunnel length, soil cover and width, where as tunnel length and width best explained the winter minimum temperature.

We are testing our models against existing data sets on cover site use by adult tortoises to better understand preferences for cover site use by social status, pair bonds, sex, size and season. Our findings will provide a better understanding of desert tortoise micro-habitat requirements. In addition they will have important management implications for designing and evaluating success of translocation projects and for locating and maintaining critical habitat, necessary in the face of thermal pressures from global climate change.

Where we are…and Where We May Not Be Going

Bill Mader, Administrator
Red Cliffs Desert Reserve, Washington County, Utah

The Red Cliffs Desert Reserve in Utah, established in 1996, has made strides forward in protecting tortoises and other sensitive species. This collaborative partnership continues to push the envelope in a daunting environment. Challenges include devastating fires, ongoing anthropomorphic pressures, reduced federal monies, land exchanges and bio-political issues with far ranging viewpoints. In some respects the reserve is a microcosm of global environmental issues both in terms of reality and hope. Results of years past, lessons learned and what might lie ahead represent the core of this talk. Tortoises – a flag ship of biodiversity in a world of impermanence – sail on stormy seas.

A Foundation for Conflict: Wildlife Values in the West

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Western states are going through a number of changes that have affected and will continue to affect wildlife management. Changes include population growth, changes in in-migration rates and land ownership patterns, increasing income and education levels, growth in technology, and urbanization. The recent study, "Wildlife Values in the West", explores how some of these broad societal forces are shaping the composition of public values toward wildlife throughout the western region. Wildlife Values in the West is a project of the Western Association of Fish and Wildlife Agencies Human Dimensions Committee. It is a collaborative regional effort involving social science researchers from Colorado State University and representatives from 19 participating state wildlife agencies who assisted in development of a mail survey. Data were collected through administration of the survey to a sample of residents in each state in the fall of 2004 (n = 12,673).

Study results identified 4 types of people on the basis of their value orientations toward wildlife. *Traditionalists* emphasize a "domination" value orientation, representing an ideological view of human mastery over wildlife. This orientation is associated with prioritization of human well-being over wildlife and treatment of wildlife in utilitarian terms. *Mutualists* hold a "mutualism" value orientation, viewing wildlife as capable of living in relationships of trust with humans, as life forms having rights like humans; as part of an extended family, and as deserving of caring and compassion. *Pluralists* hold both domination and mutualism orientations simultaneously whereas *Distanced* individuals do not have a well-formed orientation toward wildlife and tend to be less interested in wildlife and wildlife-related issues.

The distribution of the 4 wildlife value orientation types across the western states reflects an interesting pattern. Coastal states, for example, had the highest percentages of Mutualists in the western region. In contrast, most Rocky Mountain and Plains states had higher percentages of Traditionalists. Analyses indicated that the distribution of the value orientation types is related to certain state-level variables that may be contributing to a shift away from a domination orientation toward wildlife in the West. As an illustration, states with higher levels of urbanization, income, and education were shown to have higher percentages of Mutualists and lower percentages of Traditionalists. Findings suggest that with sustained population growth and an extension of past demographic trends (e.g., increased urbanization, affluence, and education) in the western U.S. we may see a continued erosion of traditional thought regarding wildlife and greater movement toward a mutualism orientation toward the resource.

By examining differences among the value orientation types in their wildlife-related attitudes and behaviors we explored how values can form the foundation for contemporary stakeholder conflict evident in wildlife-related issues. Traditionalists were more likely than the other types, for example, to participate in hunting. Mutualists, as another illustration, were more likely to have recently been involved in wildlife viewing. In addition, we found differences among the groups in how they reacted to an important regional wildlife issue – management of human-wildlife conflict. When asked to rate the acceptability of population-level control

techniques to address a nuisance situation involving black bears, Mutualists and Distanced individuals were much less supportive than the other publics of lethal control. Specifically, while we found greater consensus and support among the types for conducting controlled hunts using trained agency staff, less than 50% of Mutualists and Distanced were accepting of providing more recreational bear hunting opportunities compared to a majority in support of the latter action among Traditionalists and Pluralists.

In reporting this information we provide a broader context for agencies located in the western region to realize the potential for collaboration and to better understand and communicate with diverse publics. We also convey the importance of continuing to measure and monitor wildlife value orientations and their distribution over time and on a broad-scale level to assist with planning for the future of wildlife management.

Female Choice in Desert Tortoises

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I observed the courtship behavior of the desert tortoise for three years (2003-2005) at an undisturbed site on the National Training Center, Fort Irwin, eastern San Bernardino County, CA. Observations were done during the late summer/ early (when male testosterone levels are at a peak) and during the spring. I completed 60 days of focal observations. The primary objectives were to determine if females have preferences for mates, to describe variations in courtship behavior in wild desert tortoises, to determine the frequency of successful mountings, and to compare spring and fall matings. Courtships occurred at the entrance of the female's cover site in the morning and evening hours. Males often courted females for several days, with males cohabiting with females during this period. Individual courtships typically lasted about one hour. The female was able to exert a choice by either remaining in her burrow and by continuously rotating or holding her shell closely to the ground while being mounted. A considerable amount of energy was exerted by the male during the mountings, although many mountings clearly did not result in intromission. I observed various degrees of apparent interest by the female to the courting male. I also observed female aggression toward males, including head bobbing and ramming of the male by the female.

POSTER

Invasive Annual Grass *Bromus madritensis* ssp. *rubens* and Mechanical Injury to the Desert Tortoise

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During the summer of 1998 and early fall of 1999 four desert tortoises (*Gopherus agassizii*) were observed within two of the Rock Valley nine hectare enclosures with food wedged in the junction of the upper and lower jaw on both sides of the head distending the facial integument. This vegetative material consisted of moist and decomposing *Bromus madritensis* ssp *rubens* seeds. Eighteen desert tortoises inhabit these plots; four individuals (2 adults and 2 sub-adults, 22%) exhibited this grass seed impacted condition. The material was removed from the animals when observed although the distended condition of the cheek region persisted in the adult animals for 3-4 years although subsequent occurrences of this condition did not develop. In the two sub-adult tortoises this distended condition persisted and additional *Bromus* seed material continued to be impacted in their cheek region perpetuating the distended cheek condition beyond four years. Two additional observations of injuries from *Bromus* seeds were also documented in Piute Valley, Nevada in 1998, one with a seed fully imbedded within the nostril, and the second with a seed partially imbedded within the corner of the eye. With the spread of this invasive annual grass and its increase in abundance during high rainfall years we may expect to observe an increase in observations similar to those described here. The long-term impact and the prevalence of these mechanical injuries and their range wide significance need to be evaluated.

Head-starting Desert Tortoises: Fort Irwin Release Project 2007

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This study is one of several designed to evaluate the utility of assisting, or "head-starting", desert tortoises, a Threatened species. It has been shown that protecting nests, eggs and hatchling/neonate tortoises in fenced natural areas greatly increases survivorship. But tortoises cannot be kept in predator-resistant field enclosures for their entire lives. One of the major questions now is "how long do head-started tortoises need to be kept before they can be released with subsequent high survivorship?" We are evaluating this question at the Fort Irwin Study Site (FISS), where 53 juvenile tortoises ranging in age from 1.5 years to 14 years were available from previous studies. Experiments were designed to test the following six questions. Do larger juveniles survive better than smaller ones after release? If so, what is the threshold size or age for high survivorship? Do released tortoises show "homing" behavior, which may make them vulnerable to harm or defeat release efforts? Does "half-way housing" (releasing juveniles into small enclosures until they settle in, then remove the fencing) reduce or eliminate "homing" tendencies? Is there an effect of release distance on homing and survivorship? Does

the season of release (spring vs. autumn) influence survivorship? Last September (2005) we telemetered and released four juveniles of an assortment of ages and sizes into each of three "half-way house" enclosures built out of sight but near (0.6 km) the FISS enclosures. Five more juveniles of assorted sizes were released around each of these three enclosures as "half-way-house controls". In addition, 26 more juveniles of various sizes were released at a "long-distance" (1 km) site, 16 in September (autumn) 2005 and 10 in spring 2006. To date, radio-tracking data along with GPS results and behavioral observations indicate that both "wandering" and "homing" behavior have been minimal. Moreover, apparent survivorship has been high, with 92% of the releasees still alive (75% confirmed alive, 17% probably alive) in October 2006, at their entry into hibernation. Of the four probable and confirmed deaths, three were very small juveniles (25 to 85 grams), and one was large (674 grams), and two of the four deaths were likely by predation. All remaining juveniles will be radiotracked through the 2007 activity season before results are formally analyzed.

Head-starting Desert Tortoises: Irrigation and Yearling Releases at Edwards Air Force Base

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We are investigating questions related to the issue of how best to give a helping hand, or "head start", to desert tortoises in the egg, neonate, and early juvenile stages of life, in order to aid recovery of this Threatened Species. Prolonging the natural food supply inside some ("experimental") hatchery/nursery enclosures by selectively irrigating just when food plants began to wilt in late spring, and twice again in early summer, enabled tortoises to grow larger again in 2006, compared to those in "control" pens without irrigation, for the third year in a row. In general, selective irrigation increased growth rates by over 3-fold, even in very wet years (2005). In another experiment, a group of seven yearling tortoises from a "control" (unirrigated) pen was released in September 2005, as a repeat of the early release test done with 8 yearlings in 2004-05. None of the 15 released tortoises apparently survived beyond summer of 2006. Only one lived longer than 10 months after release. Evidence of death by predation was present for seven of the 15 yearlings lost over the 3-year experimental period. Four of the 15 were lost and presumed dead only after intensive searching. Native fire ants *Solenopsis xyloni*) were present again inside the JHETSS enclosures in 2006, but were apparently not important predators on juvenile tortoises, in contrast to the situation in 2005.

Head-starting Desert Tortoises: Twentynine Palms Hatchery/Nursery 2006

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The Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms has established a desert tortoise head-start facility. Three large (100 ft. by 150 ft.) predator-resistant enclosures have been built, and two of these have been subdivided into 25 X 25 ft. pens using partially-buried metal flashing as partitions. A sprinkler irrigation system has been installed to allow addition of "rain" as necessary to initiate and maintain a desert wildflower crop typical of a "good" rainfall year, so juvenile tortoises will have abundant food in spring and early summer. Shorter fences surround each large enclosure to keep stray, escaped or captive tortoises with diseases from contacting healthy tortoises through the enclosure fencing. The main research questions currently being evaluated concern Upper Respiratory Tract Disease (*Mycoplasma sp.*), and include the following. Do females showing active URTD infections produce babies that are also infected ("vertical disease transmission")? Do these infected females produce smaller clutch sizes (fewer eggs), with lower hatching success and smaller hatchlings, and is survivorship of these hatchlings lower? In spring 2006, 25 healthy (= control) adult egg-bearing wild females from surrounding areas were moved into separate pens, and held until they laid their eggs in one of the burrows provided, then females were released where captured. The 143 eggs thus obtained yielded 99 hatchlings so far, of which six died of unknown causes within a few weeks. Finding gravid females with signs of URTD (= experimental group) proved difficult. We found only five females with indications of URTD: one tested ELISA-positive, two tested ELISA-suspect (testing negative upon subsequent sampling), and two had nasal exudate (both of these females were ELISA negative for two sequential tests). These five females laid 23 eggs, yielding 19 hatchlings, all of which entered hibernation alive. Insufficient numbers of diseased females were obtained in 2006 to support strong statistical conclusions at this time. Efforts to find more diseased females will be intensified in spring 2007. Our questions involving sex and genetics, including 1) sex ratio bias in hatchery neonates, 2) multiple paternity in clutches, and 3) degree of genetic variation among resident tortoises, are in the process of being addressed. Blood samples will be taken for genetic, URTD and hormone analyses next spring, after hatchlings have been able to grow.

Ecology and Non-invasive Long-term Identification of Gila Monsters at Tonto National Monument, Arizona

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We report on telemetric investigations of adult free-ranging reticulate gila monsters (*Heloderma s. suspectum*) from 2004-2006 at Tonto National Monument, Gila County,

Arizona. This population of gila monsters is unique compared to others studied in Arizona due to its high-elevation status (ranging from 638m - 1315m), relatively large size of adult males, and sympatry with three species of rattlesnakes, *Crotalus atrox*, *C. molossus*, and *C. cerberus*. We report on the inter-year movements, habitat use and activity patterns of gila monsters at the park. We also discuss implications of long-term identification of individual gila monsters from dorsal patterns. We compared photos of gila monsters captured in 2004-2006 with archival photos to determine if we could match dorsal patterns of individuals over time. We documented at least two long-recaptures by pattern matching, supporting the theory that subadult and adult individuals' patterns do not change substantially over time. This theory has been substantiated by repeated recaptures of young individuals during the current study period. Implications for field research and gila monster protection are discussed.

A Comparison of Spring vs. Summer Foraging in Sonoran Desert Tortoises

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Foraging and nutritional studies were conducted on desert tortoises at three Sonoran Desert sites in Arizona (Ragged Top, Sugarloaf Mountain, and Saguaro National Park (East)) during the spring and summer foraging seasons of 2002-2004. A standard methodology was used whereby tortoises were observed during both morning and evening foraging bouts for a period of about 9 days per site and season. Bites were recorded according to plant species and part, but most bites were of composite parts (e.g., leaf, stem and flower). Thirty-four tortoises were observed to take a total of more than 180,000 bites. Samples of the plant species eaten were collected for analysis of water, nitrogen, and potassium contents, so the Potassium Excretion Potential [PEP] index (an index of nutritional value) could be calculated.

In spring, tortoises at sites with good annual production consumed predominantly annual legumes, such as lupines (*Lupinus sparsiflorus, L. concinnus*), lotus or deervetch (*Lotus humistratus, L. strigosus, L. salsuginosus*) and milkvetch (*Astragalus nuttalianus*). Other annuals were also eaten in smaller amounts, but little perennial material was consumed. In spring, tortoises were highly selective in foraging, and the plants consumed were mostly high in the PEP index so that the consumed diet was on average high in PEP. Thus Sonoran tortoises showed similar diet selectivity to Mojave tortoises foraging under conditions of abundant annual production due to good winter rainfall. At Ragged Top in 2003, few annual legumes were observed, and most tortoises remained inactive; of the two that did forage extensively the diet consumed was lower in PEP than at the other spring sites.

During the summer monsoon season, tortoises consumed mostly annual and perennial grasses, summer annuals, and such perennial plants as desert vine (*Janusia gracilis*), lanceleaf

ditaxis (*Ditaxis lanceolata*) and fruits of Engelmann prickly pear (*Opuntia engelmannii*). Annuals were consumed roughly in proportion to availability, whereas some perennials were particularly favored (as indicated by the large number of bites per plant). The consumed diet was relatively low in PEP, indicating that potassium excretion was not an important constraint in tortoises that could drink puddled rain water.

We conclude that Sonoran tortoises face very different nutritional challenges in spring and summer, and the absence of drinking water in spring may induce tortoises to be highly selective for high PEP plants when they are available, just as in the Mojave Desert. These different foraging strategies in summer and spring suggest that different management approaches may be appropriate for tortoises in the two deserts.

The Role of USGS in the Recovery of the Desert Tortoise

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The goal of the US Department of the Interior- Geological Survey (USGS) is to provide reliable, high quality scientific information to resource managers to support sound management decisions. The merger of the Biological Resources Discipline into USGS provided opportunities for scientific collaborations among the four major disciplines – biology, geology, water and geography. The Western Ecological Research Center (WERC) of USGS contributes to the recovery of desert tortoise by providing technical assistance to resource managers, hosting workshops and training sessions, and conducting research aimed at describing ecological patterns, processes, and mechanisms. WERC research on desert tortoises can be covered under the following four broad categories; health and disease; population attributes, status and trends; habitat studies; and anthropogenic effects. Current research includes ongoing studies and data analysis for a variety of projects. These are: 1) the effects of translocation at Fort Irwin, 2) desert tortoise habitat modeling, 3) the effects of fire on desert tortoises and their habitat, 4) the effects of dogs, 5) long-term growth, 6) reproduction, 7) epidemiology of URTD and shell diseases, 8) necropsy program, 9) toxicant effects, 10) nutritional physiology, 11) radionuclides in shell remains, 12) desert tortoise activity modeling, 13) demography at long-term study plots, 14) social behavior, 15) invasive species control, 16) habitat recovery and restoration, and 17) juvenile tortoise monitoring. The WERC website at www.werc.usgs.gov provides information on on-going studies at our Center and recent publications by our scientists. Publication briefs, which are one page summaries of peer-reviewed publications and include management implications of research findings, can be found at www.werc.usgs.gov/pubbriefs/.

Vital Rate Sensitivity Analysis and Management Implications for the Desert Tortoise

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Because desert tortoises are subject to a wide variety of threats, it would be important to identify which management actions would have the greatest effect on population growth. Population viability analyses (PVAs), with associated sensitivity analysis to identify the vital rate that limits population growth, have showed little consensus. These analyses are limited by (1) requiring a stable age distribution, an unlikely occurrence in current populations, and (2) only determining long-term solutions – they cannot compare alternative management options for short-term population goals. We used a new vital rate sensitivity analysis (VRSA) that does not have these limitations to compare management options for increasing desert tortoise populations. We created a 7-stage-class population model and analyzed 3 age structures, including Goffs and 2 post-catastrophe scenarios: depleted adult population and depleted juvenile population. We then compared 13 alternative management actions (variations on decreasing mortality and translocating animals of different age classes, head-starting, and improved nutrition) for 5 different initial population sizes (range: 100-10,000) across 3 time periods (5, 25, 50 years). We used VRSA to determine what level of effort was required for each management action to have the same effect on population growth rate. This allows managers to compare management actions and determine, for their area, which management actions are most achievable.

Annual Variation in Home Range Size in the Sonoran Desert Tortoise

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Short-term studies on desert tortoise movements at 5 sites in Arizona have reported larger home ranges for males than females. This difference was not found to be significant at single sites, but was significant between sites. We conducted a 5-year radio telemetry study on alluvial fans in Pinal County, Arizona, and male tortoises did have larger home ranges than females, although this difference was not significant. Individual variation within both sexes was considerable, as the standard deviation for males was 86% of the mean (33.4 ha $\pm$ 28.96 SE) and 96% of the mean for females (14.8 ha $\pm$ 14.16 SE). As part of a long-term reproductive ecology project, we tracked 6 male and 21 female tortoises with radio telemetry in Sonoran Desert upland habitat in Maricopa County, Arizona. We collected home range data for a period of 8 years (1997-2004). Females had a larger mean home range size (11.71 ha $\pm$ 55.45 SE) than males (7.31 ha $\pm$ 4.62 SE), although this difference was not significant. Several females exhibited long-range movements, which greatly inflated the home range estimates for those individuals. When the large movements were removed for females (2.96 ha $\pm$ 2.07 SE), males exhibited significantly

larger home ranges. In both cases, a large amount of individual variation was noted for both sexes. For this presentation, we will discuss between-year variation and seasonal variation in home range size between sexes in relation to rainfall, courtship and mating, and egg production and oviposition. Additionally, we will use both minimum convex polygon and kernel home range estimators to help delineate between movements and actual area used for individual tortoises.

Bureau of Land Management - Nevada

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During 2006, the Bureau of Land Management (BLM) in Nevada continued to support on-going desert tortoise recovery efforts through removal of threats to the species and implementation of research and conservation initiatives. Through our partnerships with the Clark County Desert Conservation Program, the BLM: continued with restoration of desert tortoise habitat in the Desert Wildlife Management Areas (DWMAs); conducted public meetings and completed a preliminary Environmental Assessment for designation of roads in three DWMAs; completed a 1993-1994 analysis on the effects of cattle grazing in desert tortoise habitat; collected data on 31 permanent vegetation monitoring plots in closed cattle grazing allotments; and funded four law enforcement officers that patrol the DWMAs. The BLM continued to conduct a number of conservation projects benefiting desert tortoises using Southern Nevada Public Lands Management Act (SNPLMA) funding. Those projects included: desert clean-ups; environmental education; monitoring and gathering wild horses and burros; management plans for wilderness areas; closure of abandoned mines, and acquisition of environmentally sensitive land including the 160-acre Walking Box Ranch in the Piute-Eldorado DWMA. Emergency stabilization and rehabilitation work continued on the 103,802 areas burned within the Las Vegas Field Office and the 298,432 acres burned within the Ely Field Office during the 2005 and 2006 fire season. Regional planning continued in 2006. The Ely Resource Management Plan is anticipated to be completed this year, incorporating tortoise conservation measures, and BLM participated in on-going development of Habitat Conservation Plans in Southeastern Lincoln County, Coyote Springs Investments, Virgin River, Pahrump, and Southern Nye County.

Studies of Drought and Highway Effects on Tortoises at Organ Pipe Cactus National Monument, Arizona

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Mortality patterns are key to understanding impacts affecting the Desert Tortoise. In the Sonoran Desert of Arizona, a number of desert tortoise mortality events have been observed in recent decades, sometimes associated with population declines. We summarize some recent tortoise mortality observations for the Sonoran Desert in Sonora, Mexico suggesting there may have been recent drought-associated mortality events there as well. We also report on studies at Organ Pipe Cactus National Monument, evaluating (1) tortoise abundance and population structure near a busy highway and (2) a monument-wide re-survey for tortoises following a historic drought.

We found significantly less tortoise sign, fewer adult tortoises, and a higher proportion of juveniles on transects within 1 km the highway compared to 1-2.5 km away. Although we cannot quantify the maximum extent of impact, it appears likely that losses of tortoises on the highway are significant, and that juveniles are recruiting into the affected area, creating a sink that extends 1-2 km or more from the highway.

However, despite the severe drought, we found almost as many tortoises in 2005-6 (n = 25) as in 1995-6 (n = 32), and no significant differences, using closely similar methodology on virtually identical sites. We found no evidence during 2005-6 (in the form of carcass remains) for a major mortality event during or after the 2002 drought. However, in 2005 fewer turtles were found on rock slopes and more along bajada washes than in 1995, suggesting that a change in behavior may have occurred.

Defenders of Wildlife 2007: Desert Tortoises

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Defenders of Wildlife first launched its locally-based California Desert Campaign in 2005. This work focused on the Western Mojave Desert, which is currently undergoing the most intense development pressure. Desert Tortoise work is a key component for Defenders. The overall goal of the campaign continues to be establishing a permanent presence in the California desert to work with the public, local governments, and management agencies. We have staff based in both Sacramento and Joshua Tree to accomplish this objective. Some past highlights include:

- Desert Tortoise brochure sponsored by Defenders, the DMG, and the National Off-Highway Vehicle Conservation Council. Over 14,000 have already been distributed at OHV events, National Park Service, Bureau of Land Management and California state visitor's centers;
- Completed of the economic study, "Economic Benefits Provided by Natural Lands: Case Study of California's Mojave Desert";
- Launch of the California Desert Program website: http://www.defenders.org/california/desert.html.

Since demographic trends such as population growth affects conservation efforts so strongly, Defenders hopes to increase public outreach efforts to educate all users of the desert, including local officials, on the importance of desert conservation at a landscape level. *Landscape* is stressed because we see a healthy desert tortoise population as emblematic of the overall health of the desert ecosystem which the tortoise calls home. Our goal is to use both species-based and landscape level arguments to appeal to diverse constituencies. Dialogue with the military will also be sought out regarding buffer zones.

In addition, Defenders hopes to target the ever-growing Latino community in this regard, and welcomes suggestions from those at this Symposium as to how to effectively engage this audience. We also hope to synthesize Desert Tortoise Facts to reach audiences via the website and eventually on-the-ground with hiking/litter clean-up days. In general Defenders hopes to expose itself to the newest scientific information available to view how gaps in knowledge related to tortoise biology can inform us at to how to best move ahead with our advocacy work based on the most recent findings.

We are a mobile society. For the last century, cars and the roads they require have been the dominant force shaping the modern American landscape. Defenders of Wildlife have brought our national habitat and highways campaign to California. Increasingly, OHV's (Off-Highway Vehicles) are having an ever increasing impact on California's Wildlife. The Desert Tortoise is one of the victims of this trend, and Defenders will continue to make OTV-related issues a priority institutionally. 2007 shall see more collaboration on OTV-related issues with organizations such as the California Wilderness Coalition, Alliance for Responsible Recreation, and others. Defenders want to make the most of collaborative efforts both in Sacramento and in field offices to increase synergies between organizations possessing an institutional history of success addressing these concerns.

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

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Since 1939 state laws have been in place in California to protect the desert tortoise. In August of 1989, the tortoise was officially listed as threatened under the California Endangered Species Act (CESA). Section 2081 of the Fish and Game code, allows take with a permit for

scientific, educational, management, or incidental take to an otherwise lawful activity provided the take is minimized and fully mitigated. In addition to the Take Permit, a Memorandum of Understanding (MOU) 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 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, has acquired >30,500 acres of desert lands within recovery units. Along with the land, 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 off highway vehicle 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 2006, 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 co-funded the Desert Manager's Group (DMG) Desert Tortoise Outreach and Education coordinator for 2006. 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 and reviewing several Integrated Natural Resource Management Plans, reviewing mitigation lands, working to fund study plot surveys, drafting a proposal for dealing with free-roaming dogs in conjunction with the DMG, reviewing and 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.

Conceptual Foundations for Establishing Recovery Criteria for the Desert Tortoise

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The Science Advisory Committee was given the responsibility to establish a framework from which to determine when desert tortoises in the Mojave Desert could be delisted reliably. Consequently, we developed a robust set of recovery criteria to determine when risks associated with extinction of tortoises across their geographic range have been minimized. The principal basis of most recovery objectives is biological, although several objectives are related to land management and threat abatement, important steps to ensure that sufficient habitat is maintained in condition sufficient to recover tortoises. The biological criteria span a range of ecological scales, from those that gauge whether tortoises are well-distributed throughout their geographic range to those that gauge whether trajectories of individual tortoise populations remain sufficient to ensure long-term persistence. Most biological criteria are to be assessed based on temporal trends in characteristics of tortoise populations because there was little historical information from which to establish rigorous baselines for recovery. Because tortoises are long-lived, trends must remain positive across a period of time that approximates a single tortoise generation—

approximately 25 years—before delisting can be justified. Recovery units will be retained as an element of recovery criteria because they are necessary to ensure that tortoise populations are functioning in all areas of their wide geographic range. When considered collectively, we believe that when these recovery criteria are met, foreseeable risks associated with delisting the desert tortoises will be minimized.

Gila Monsters in the Phoenix Metropolitan Area—Sonoran Desert Interface: Home Range and Movement Patterns Relative to Populations of Nonurbanized Areas

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As part of a study on the effects of translocation on Gila monsters in the northeastern Phoenix Metropolitan area, we gathered data on home ranges and movement patterns of 18 individuals from 2000 through 2002. Simultaneously, similar data were gathered on five Gila monsters in a relatively isolated, unimpacted area of Sonoran Desert. Relative to home ranges (mean = 27.5, range = 11.3—45.5 ha) of monsters in the more natural, nonurbanized areas, individuals in the Phoenix region had smaller home ranges (mean = 12.5; range = 1.8—36.6 ha) and moved less often. This difference was also manifest in comparison with home ranges of other nonurbanized populations from Utah, Nevada, southern Arizona, and New Mexico (respective means = 34.8 ha, 64.2 ha, 36.5 ha, and 58.1 ha; Beck, 2005). Anecdotal information on prey populations, including Gambel's quail, dove and cottontail rabbits, indicated that these organisms were more common in the urbanized study area relative to the typical Sonoran Desert habitat occupied by Gila monsters during 2000—2002. It is suggested that although Gila monsters in urbanized areas may experience increased mortality due to human activity (e.g., roadway mortality), they directly benefit by higher abundance of preferred prey populations.

Translocation of the Bolson Tortoise (*Gopherus flavomarginatus*) to its Prehistoric Range

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In the fall of 2006, 30 Bolson tortoises (*Gopherus flavomarginatus*) were translocated from the Audubon Appleton-Whittell Research Ranch in Elgin, Arizona to the Armendaris Ranch in south central New Mexico. These tortoises, known as the Appleton tortoises, were brought to Arizona from Durango, Mexico by David Morafka in 1973. The tortoises range in age from about 10 to 60 years of age and weigh 2.2 kg to 11.5 kg. These tortoises were x-rayed on May 27, 2006 and several contained eggs. Ten eggs were recovered from two tortoises and seven of the eggs hatched successfully. The seven hatchlings are being raised on the Ladder

Ranch in New Mexico. Four adult tortoises from the Appleton population tested positive for *Mycoplasma agassizii* and were subsequently located to the Living Desert Museum and Zoo in Carlsbad, New Mexico to enter the first captive breeding program for Bolson tortoises in the United States.

The Bolson tortoise, a CITES Appendix I endangered species, occurs exclusively in a small region of northern Mexico known as the Bolson de Mapimi where the states of Durango, Coahuila and Chihuahua merge. The Armendaris Ranch is located in the northern Chihuahuan desert approximately 500 kilometers north of Mapimi and contains habitat virtually identical to the current habitat occupied by the Bolson tortoise in the southern Chihuahuan desert. Fossil records indicate that *G. flavomarginatus* (= *G. huecoensis*) was more widespread during the Pleistocene but may have fallen victim to human overkill about 10,000 years ago, thereby reducing it's distribution to a relict population in the dry, inhospitable region of the Bolson de Mapimi. Population estimates from the early 1980's concluded that fewer than 10,000 tortoises remained in the wild and that human predation was the primary factor limiting it's distribution. Since then, human population in the tortoise's range has exploded, and the current status and population of the tortoise is unknown. Currently, there are several properties for sale that are known to contain high densities of tortoises in the Mapimi area.

Sonora, Mexico Desert Tortoise Research Project–Year Two

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In 2005 a research team commenced the Mexico project to investigate the status of the desert tortoise south of the border. The work conducted in 2005 in the Tropical Deciduous Forest (TDF) of southern Sonora had set the stage for a long-term ecological investigation. Using radio-telemetry, data is being gathered on home range, behavior, and diet of the tortoise in the TDF. In addition to the intensive research conducted in the TDF in 2006 the work extended elsewhere in Sonora in order to assess ecological and genetic differences and acquire a snapshot of the overall health of the populations. Field explorations from the Yaqui River in the southwestern region of the state and explorations northwest and southeast of Hermosillo in the central region of the state resulted in the acquisition of a total of 33 very important DNA samples. These critical samples will be used to evaluate the taxonomic status of the Sonoran desert tortoise using both nuclear and mitochondrial genomic assessments. Specifically, we are evaluating whether the tortoise is a genetically-diverse single species, or two species. Samples from these animals are also being evaluated for the presence of *Mycoplasma agassizii* and *M. testudineum*. The stated project goal remains the same - to gather enough information to provide a foundation for the long-term preservation of the species in Mexico.

Clark County Multiple Species Habitat Conservation Plan Progress

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During 2006 the Clark County Multiple Species Habitat Conservation Plan program funded many ongoing projects supporting desert tortoise recovery within the Clark County, Nevada, portions of the Northeastern Recovery Unit. Information gathering projects included reporting on 2005 tortoise monitoring, studies of tortoise translocation, tortoise densities, tortoise population genetic structure and epidemiology of Upper Respiratory Tract Disease, and ongoing information gathering to support roads designation on Bureau of Land Management Areas of Critical Environmental Concern. In addition, the program funded projects for conservation planning for tortoise habitats in the Northeastern Recovery Unit, law enforcement for habitat protection on public lands including the Boulder City Conservation Easement, restoration of habitat on Bureau of Land Management and National Park Service lands, burro removals on National Park Service lands, wildlife damage management, fencing of major roadways, and the County-wide tortoise pick up, holding center and translocation program. The County also implemented several improvements in our administration of the program, including launching a new Desert Conservation Program website with a library page, implementing data management standards, and working on data sharing among our partner agencies. Public information and education projects included coordinating with other entities to expand the Mojave Max Emergence Contest program, launching a new mojavemax.com website, producing six environmental education videos as well as print and billboard advertisements with the message to Respect, Protect and Enjoy our Desert.

POSTER

Importance of Shrub Size and Species on Microhabitat Selection by Desert Tortoises (*Gopherus agassizii*) in the Mojave Desert

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Desert Tortoises utilize burrows for predator avoidance, nesting sites, loci of social interactions, hibernation sites, and thermoregulation. The burrow is of crucial importance as temperatures inside the burrow are more constant and therefore provide a refugium from high lethal surface temperatures in the summer and low temperatures in the winter. Burrows are also higher in humidity and therefore aid in reducing water loss. Consequently, we tested the hypothesis that Desert Tortoise burrows have a non-random spatial distribution within the landscape. Desert Tortoise burrows were located and we recorded if they were under a shrub or out in the open. If the burrow was under a shrub, we recorded the species and measured its size. Shrub availability as a comparative data set was assessed by conducting belt transects. A total of 946 burrows was identified, 62.8% (n=594) were located under shrubs, yet shrub cover on the

study site represented only 11.5%. Desert Tortoises were highly selective of the species of shrub under which their burrows were placed. Creosote bush (*Larrea tridentata*) and Nevada Jointfir (*Ephedra nevadensis*) represented 48.5% and 27.0% of shrubs used by tortoises, compared to availability of only 13.7% and 6%, respectively. Additionally, tortoises selected larger shrubs for burrow placement, as shrubs greater than 1 m^3 accounted for 66.7% of shrubs selected by tortoises compared with only 8.5% of shrubs available. The relationship between Desert Tortoise burrows and surrounding vegetation can aid in understanding and assessing the quality of Desert Tortoise habitat. Furthermore, it demonstrates the importance of large shrubs and thus strongly supports the conclusion that protection of mature desert scrub habitats, particularly creosote shrub communities, has important management implications for the Desert Tortoise.

POSTER

Resident Tortoise Studies in Preparation for Translocation at Fort Irwin, CA

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The threatened status of the Mojave population of the desert tortoise (*Gopherus agassizii*), in conjunction with the planned expansion of Fort Irwin National Training Center necessitated the development of a translocation plan. The plan outlined the need for baseline studies on resident tortoises within release areas to be accomplished prior to translocation in order to evaluate the current status of resident populations, and to provide a point of reference for later evaluation of the success of the translocation efforts. In 2005, the U.S. Geological Survey initiated several studies to gather data on movements, habitat use, behavior, and physiological characteristics of tortoises that will serve as residents and controls during future translocation studies. This research was continued and expanded upon in 2006. A total of 306 tortoises, of which 221 are currently equipped with radio transmitters, have been located throughout the study area. In addition, vegetation transects were surveyed to characterize annual and perennial vegetation. These data were collected to aid in understanding the available source of food and shelter utilized by desert tortoises throughout the study area.

Comparing Strategies for Monitoring Sonoran Desert Tortoises

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The current strategy for monitoring Sonoran desert tortoises is estimating density using mark-recapture methods on fixed 1 km^2 or 1 mi^2 plots. In contrast, the current strategy for monitoring Mojave desert tortoises is estimating density using line-transect distance sampling. In 2005, we initiated a study to compare the efficacy of estimating density with distance

sampling and estimating the proportion of sites occupied, a recent approach thought to be effective for animals with low densities and low rates of detection. Although some methods for estimating occupancy can provide estimates of density or abundance, the approach has been applied more typically in a monitoring context by estimating changes in the proportion of survey sites occupied over time. In both 2005 and 2006, we completed five presence-absence surveys for tortoises on each of 20 3-ha sites to estimate occupancy and surveyed 60 1-km line transects to estimate density in two areas of Saguaro National Park. In general, we found that estimating density with distance-sampling methods was less time and cost efficient than estimating occupancy. Further, estimates of tortoise density, occupancy, and detectability varied appreciably between study areas, which suggest that efficiency may be highest if sampling strategies are developed on a site-specific basis.