ABSTRACTS

30TH ANNUAL MEETING AND SYMPOSIUM
THE DESERT TORTOISE COUNCIL

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(Abstracts arranged alphabetically by last name of first author)
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Prepared by Kristin H. Berry

U.S. Fish and Wildlife Service Update:
Establishment of the Desert Tortoise Recovery Office

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The U.S. Fish and Wildlife Service has recently evaluated strategies for implementing desert tortoise recovery actions. These strategies arise from the General Accounting Office's 2002 audit of recovery actions for the tortoise and the 2004 Desert Tortoise Recovery Plan Assessment. Key among these strategies is the establishment of a Desert Tortoise Recovery Office (DTRO) within the Service. The DTRO will focus on research, monitoring, recovery plan implementation, and recovery permitting. Over the next several months, the DTRO will specifically be conducting the following activities.

- Coordinate 2005 range-wide monitoring surveys.
- Report on range-wide monitoring conducted to date.
- Establish a master database for all desert tortoise data.
- Coordinate with Recovery Implementation Work Groups to develop, with input from stakeholders, regional recovery action plans, which will form the basis of a revised or amended recovery plan.
- Hire local coordinators to work directly with established recovery efforts/work groups to develop recovery action plans and to implement recovery actions range-wide.
- Empanel a Science Advisory Committee made up of scientists from within and outside the Mojave desert tortoise arena to serve in an advisory role to the DTRO and cooperators, ensuring that recovery action plans, recovery plan revision, and monitoring/recovery action effectiveness meet rigorous scientific standards.

We expect the DTRO to facilitate increased scientific understanding and improved recovery progress by increasing research activities outlined in the Recovery Plan and assessment, assisting coordination between managers and research scientists, and tracking and reporting new information about the efficacy of management actions.

Defense Department Participation in Desert Tortoise Management

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It is crucial that everyone understands the primary mission of Department of Defense (DOD) installations in the Mojave Desert is to train and prepare Marines, soldiers, airmen and sailors to defend our nation. However, DOD is also committed to long-term desert tortoise recovery and delisting. Most tortoise research in the western Mojave Desert has occurred either on DOD lands or with military funding. DOD has been an active participant in the Desert Managers Group, an organization that includes many agencies involved in Mojave land management. Additionally, a formal committee of military land managers meets regularly to coordinate our actions.

As in previous years, all five DOD installations in the West Mojave are able to speak with one voice before groups such as the Desert Tortoise Council. We've spoken previously of our Integrated Natural Resources Management Plans and our support for the Mojave Desert Ecosystem Program, among many other subjects. We've also voiced our concerns about population growth in desert communities, which impacts both training and the tortoise.

It's time for all agencies to take concrete actions to recover the desert tortoise. DOD is committed to support "head starting," ground breaking disease research, predator control and the translocations that will be required by Fort Irwin expansion. Current and planned DOD activities will be discussed.

A Progress Report on Male Social Behavior: Dominance Hierarchies, Aggression, and Courtship

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We studied social behavior of male desert tortoises (*Gopherus agassizii*) for three years (2002-2004) in an undisturbed population living in the Soda Mountains on the National Training Center, Fort Irwin, eastern San Bernardino County, CA. We made over 200 days of focal observations in summer and early fall, the peak period for male testosterone production and the time when adult males are sexually active. Adult male tortoises exhibit dominance and other aggressive behaviors to other adult males, females, and juveniles. A dominance hierarchy exists among males and appears to last more than one year or summer-fall season. Elements of the dominance hierarchy have been stable for more than one year. Dominance is size-based, with few notable exceptions, including past injuries and shape of the gular horn. We categorized adult males by social status and size into three classes (alpha, beta, and omega) for analysis. For several aspects of behavior, such as time spent traveling or distance covered, there were no statistically significant differences in the three male classes. While the areas or "home ranges" of both male and female tortoises overlap considerably, the areas used by alpha males exhibit almost no overlap. Male aggression may be used to defend resources (e.g., mates, cover sites, foraging areas). Males may have preferences for specific females or specific sizes of females. The mating system contains elements of scramble competition and congregations. Our findings on social behavior indicate that desert tortoises in undisturbed populations may have long-term relationships with each other and a complex social hierarchy. Our findings have management applications for recovery programs.

A Comparison of Two Types of Desert Tortoise Surveys in Low Density Populations

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We compared data sets, costs, and management uses for two types of desert tortoise (*Gopherus agassizii*) surveys (landscape-level and local) in low density populations. The study areas were outside of designated critical habitat and Desert Wildlife Management Areas in the western Mojave Desert, Kern County, CA. The landscape level survey was conducted at the Jawbone-Butterbredt Area of Critical Environmental Concern (ACEC) and parts of Red Rock Canyon State Park (RRCSP), which adjoins the ACEC. The landscape survey covered an area of 188 km^2 with 751 one-hectare plots. Four percent of the potential tortoise habitat in the ACEC was sampled. The local sample consisted of a single large plot (4.1 ha) and was in Red Rock Canyon State Park (RRCSP). This plot received a 100% survey. Data were collected on distribution and population attributes of tortoises and their sign, as well as historical and recent anthropogenic impacts to the habitat.

The two types of surveys produced different types of results. Both confirmed that densities were low (< 5 tortoises/km^2). For the landscape survey at Jawbone-Butterbredt ACEC and the Red Rock Canyon watershed, tortoise sign was found on 4.7% of the plots. Most sign was found in two areas, the Kiavah Apron and the Red Rock Canyon watershed. Only five live tortoises and nine shell-skeletal remains were found on plots and while walking between them. This type of survey provided information on distribution of the tortoises, indications that densities were low, but insufficient information to establish a baseline for long-term monitoring, determine population status,

or boundaries of the concentration areas. More surveys will be necessary in the future within the concentration areas so that a baseline can be established. At the large plot in RRCSP, 9 live tortoises and 55 shell-skeletal remains were found. The data were sufficient to provide recommendations for management of a locally sensitive area. This landscape-level survey cost less per hectare and provided information on general distribution and densities for a large area. The more intensive and local survey of the large plot offered a snapshot of recent trends in the population, current status, and causes of mortality. Gathering sufficient data to determine status and trends in tortoise populations will be a challenge for scientists, biologists, and managers, especially in areas of low tortoise densities. Each type of survey has advantages. We believe that both techniques, when used in coordination with each other, will provide valuable and cost-effective information for management and recovery of this threatened species.

A Comparison of Lymph and Plasma Sample Results from ELISA Tests for *Mycoplasma agassizii* in Desert Tortoises

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Recent advances in our knowledge of infectious diseases of the desert tortoise have resulted in the development of diagnostic tests for exposure to an increasing number of pathogens. Further, the use of defined clinical parameters such as biochemical profiles to assess the overall health status of the animal has proven to be useful. Most, if not all, of these tests rely on obtaining blood samples. Blood samples may be contaminated with lymph or, in some cases, the sample obtained is primarily lymph. It is therefore critical to determine if there are differences in results obtained with lymph vs. plasma.

In spring 2004, we collected 43 paired samples of plasma and lymph from captive (N=21) and wild (N=22) desert tortoises. Samples were tested for the presence of antibodies to *M. agassizii*. Our null hypothesis was that there would be no significant difference between the lymph and plasma samples. However, a paired T test showed that there was a significant difference (P = 0.03) between antibody titers obtained with lymph vs. plasma. Plasma titers were consistently higher, strongly suggesting that lymph contamination can impact the results of the assay.

The effects of lymph or plasma on placement of individual animals in negative, suspect, or positive categories are shown in Table 1.

Table 1. Assignment of individual animals to positive, negative or suspect category based on result of ELISA performed using lymph or plasma.

	Plasma Results		
Lymph Results	Negative	Positive	Suspect
Negative	24	1	2
Positive	1	13	0
Suspect	0	1	1

When the effects of plasma vs. lymph on exposure status of the animal (negative, positive, or suspect) were examined, 38/43 (79%) animals were placed in the same category, regardless of sample type. For wild tortoises, 20/21 (95%) were placed in the same category. Captive tortoises had more discrepancies, with 18/22 (83%) placed in the same category. Discrepancies occurred for five animals. One discrepancy was an animal that tested positive in the lymph but negative in plasma. This was the only animal that had higher values in the lymph sample. For all other discrepancies, plasma values were higher than lymph. Three discrepancies involved a shift from negative in lymph to suspect in plasma (N=2) or from suspect in lymph to positive in plasma (N=1). One animal tested positive by plasma but negative by lymph.

To determine the biological significance of the observed differences, we examined the distribution of same, two-fold, or four-fold changes in titers obtained with lymph vs. plasma. As a general rule, antibody titers are considered significant if there is a four-fold change in titer or if seroconversion (negative to positive) occurs. Of the 43 paired samples tested, 30 (70%) had no difference in antibody titer obtained with plasma vs. lymph. Eight samples (18%) had a two-fold change, with the higher titer observed in plasma for all samples. Five samples (12%) had a biologically significant four-fold change, with the higher titer observed in plasma for all but one sample.

One explanation for our observed results may be that the overall antibody content of lymph is lower than that of plasma. If this were the case, then the relative ratio of specific antibody to total immunoglobulin would be the same as in plasma. This has yet to be determined. The most intriguing discrepancy was the one animal that had antibody detected in lymph but not plasma. It is not known if this was an anomaly or if this might represent a new infection, with trafficking of antibody-secreting cells through the lymphatic system into the blood. In conclusion, lymph contamination of plasma likely has a dilution effect and results in lower antibody levels. Therefore, samples should be clearly identified if lymph contamination has occurred, and data interpretation should consider this variable.

URTD and the Environmentally-Threatened Gopher Tortoise: Statewide Population Surveys and Acute URTD Disease Outbreak

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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. Systematic investigations of the five selected populations will 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

Statewide surveys have been conducted on multiple study sites across the state of Florida. Based on these initial surveys, we have identified five candidate sites for the long-term prospective study. Study sites chosen for intensive yearly study were Cecil Field/Brannon Mitigation Park (CF, 124 acres), Gold Head Branch State Park (GH, 84 acres), Ordway Preserve (Ord, 68 acres), Central FL Private Preserve (Cent FL, 22 acres), and Big Shoals Wildlife Management Area (BS, 45 acres). The sites were stratified based on seroprevalence of disease, translocation events, and habitat quality. We have intensively surveyed these key populations and obtained radiographic data on the reproductive status of females in these populations. Interestingly, the Cent FL site had a significantly higher ($P<0.0001$) mean clutch size than the other populations. Three populations (Cent FL, BS, Ord) had >80% gravid females; only 67% of females in the acute disease outbreak population (CF, described in detail below) were gravid. In the final population (GH), 71% of females were gravid. The GH site had experienced a history of clinical URTD and a prior die-off. The preliminary radiographic data suggests that there is reduced fecundity associated with the acute disease outbreak as evidenced by decreased numbers of females with eggs. However, until at least two seasons of data are available, the data will need to be interpreted with caution. To the best of our knowledge, this is the first study to look at reproductive performance in the context of clinical disease expression of URTD in a wild population.

The CF site in northeast Florida is experiencing an acute URTD outbreak and represents one of the most interesting populations in our study. CF is undergoing dramatically increased anthropogenic impacts due to surrounding development and unauthorized release of animals and. This site has been intensively studied since 1996, with mycoplasma surveys and health assessments performed in 1996, 1998-2001, and 2003. Originally, the property surrounding the preserve was part of a military base and thus access was limited. In 2000, the base was decommissioned and development of the surrounding areas began. Roads and other infrastructure were added, small mini-ranchette subdivisions were built directly adjacent to the preserve. Large-scaled planned communities are presently under construction within two to three miles of the preserve. Circa 2001/2002, well-intentioned individuals living adjacent to the preserve released gopher tortoises found on roadways throughout the Jacksonville, FL area onto CF. These relocations were unauthorized and appear to have resulted in the introduction of *M. agassizii* into the resident tortoise population. A dramatic increase in morbidity and mortality accompanied a change in the serologic profile and shift in mycoplasmal species present in the CF population. In 2003 and 2004, increased mortality events were documented. The results from this survey suggest that introduction of *Mycoplasma agassizii* into this naive population resulted in an acute disease outbreak.

Because of the increased mortality rates of adults and the decreased fecundity observed, we initiated a pilot study, adapted from the Morafka approach in desert tortoises, to determine the effects of protecting nest sites and hatchlings on survival rates of gopher tortoise hatchlings. Approximately 500 potential nest sites and surrounding areas were probed for presence of eggs. Eighteen nest sites with intact eggs were located. Half of the sites were protected using a specially constructed pen; the other nine sites were left unprotected. No statistical differences between the two groups was noted ($P = 0.13$). However, all protected nests produced hatchlings; seven of nine unprotected nests produced hatchlings. Two unprotected nests had evidence of predation. Hatchlings from each clutch were brought to the laboratory to safely attach radiotransmitters and to avoid hurricanes. Hatchlings were randomized such that half received radiotransmitters and were released (N=20); the remaining hatchlings were placed in protected pens. Clutch mates were housed together. Hatchling survival was significantly improved for those in protected pens ($P < 0.001$). All protected hatchlings have survived. Radiotransmitted hatchlings were followed daily. In contrast to the 100% survival rate of protected hatchling, hatchlings that were not protected had only a 30% survival rate. The primary cause of predation (12/14 hatchlings) was snakes. In particular, two individual snakes on the site were responsible for several predation events. Predation by small mammals accounted for the other two deaths. The success of this preliminary trial suggests that during acute disease outbreaks, one potential management strategy to ensure a healthy juvenile population in the face of adult mortality events and decreased fecundity is to protect both nests and hatchlings.

Evaluating Trauma in Live Desert Tortoises: Wild vs. Domestic Canids A Progress Report

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Desert tortoise (*Gopherus agassizii*) populations have declined for numerous reasons in recent decades. Trauma (defined as injury to the shell or soft tissues caused by impact or predation) from vehicles, predators, and domestic livestock have contributed to poor health and increased mortality rates in some areas. We developed a method of grading trauma to live desert tortoises using 35-mm slides and data sheets and are retrospectively creating a database that includes the severity and potential source of trauma to tortoises from long-term permanent plots, health and disease studies, and miscellaneous research projects. Our objectives are to characterize the types of trauma affecting live tortoises by size, sex, and location, and ultimately to address critical recovery issues. One important recovery issue, identified in the *Desert Tortoise Recovery Plan* (U.S. Fish and Wildlife Service, 1994), is attack by domestic or feral dogs. Tortoise populations most likely to be affected are near towns and cities. With our developing database, we are beginning to look at differences in trauma at remote sites versus sites near settlements and thereby have made preliminary observations of trauma from wild vs. domestic canids. We will present examples from sites throughout much of the desert tortoises range in California, comparing three sites located within 3 km of settlements with eight more remote sites. Our preliminary statistics verify that the percent of tortoises with moderate to severe trauma from predators is significantly higher at sites within 3 km of settlements ($p<0.0005$). The data also show negative correlation between the percent of tortoises with trauma and the distance of the site from the nearest settlement ($r^2=0.6556$). The Daggett site is presented as an example of how this correlation also holds true within a single site. In general, attacks by dogs differ from attacks by wild canids in the amount and type of scute removed and bone exposed, especially to the gular horn. In the samples we have evaluated to date, tortoises at sites within 3 km of settlements or isolated houses show more severe damage to shells, especially gular horns, than tortoises at remote sites.

Are Tortoise Recovery Actions Effective?

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Understanding the effectiveness of desert tortoise recovery actions is invaluable to resource managers who must choose from a range of possible actions. Misdirected recovery actions are a waste of both time and money, and actions are most likely to be effective when they are based on scientific principles and reliable data. With these facts in mind, we undertook the task of assessing the effectiveness of past recovery efforts based on a thorough evaluation of available information. We searched for studies dealing with desert tortoise recovery; in addition, we visited biologists' offices to conduct interviews and search their files for articles and reports—published and unpublished—that they used to develop recovery actions. For all documents gathered, we assessed the reliability of the information and the level of effectiveness of actions. Of 395 documents reviewed, 100 were relevant to tortoise recovery actions. Of these, 22 were reports of designed studies and 78 were other kinds of relevant information. Interviews with biologists suggested that many recovery actions were being implemented without follow-up monitoring. Based on our analysis, we concluded that: 1) few studies specifically evaluate the effectiveness of recovery actions; 2) specific recovery actions —while necessary—do not ensure recovery; and 3) the absence of evidence of effectiveness is not evidence of ineffectiveness. Our recommendations are to: 1) implement more scientifically-based monitoring of actions; 2) coordinate monitoring activities among projects to facilitate meta-analysis; and 3) commission studies to assess tortoise population responses to recovery actions.

POSTER

Common Raven Ecology at the Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, California

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Common raven (*Corvus corax*) populations in the California deserts increased tenfold in a recent 30-year period, benefiting from increased human-provided resources. At MCAGCC, they are a concern to Natural Resources Managers because raven predation has been implicated in declines of the threatened desert tortoise (*Gopherus agassizii*). Additionally, ravens roost communally near the base airfield, a potential Bird Air Strike Hazard (BASH). We examined habitat use and roost attendance patterns between December 2002 and December 2004. Ravens were more common where resource subsidies were present, such as landfills and garbage dumpsters, than at randomly selected points. Thus, controlling raven access to subsidies may reduce their numbers. Roost attendance ranged from 23 to 2100 ravens. Fewer ravens attended the roost in spring and summer than in fall and winter, perhaps because ravens disperse into nesting territories in spring and summer. Activity at the roost was greatest in the periods just after sunset and before sunrise. We recommend that, to decrease the potential for BASH problems, Marine Corps pilots should be made aware of peak raven activity periods (daily and seasonally).

Of Ravens and Tortoises: A Decade of Research

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Common ravens have experienced a tremendous population explosion in the California desert in the past half century. Because they are a subsidized predator, they have come into conflict with desert tortoise populations. For the past 10 years, I and several collaborators have studied many aspects of raven ecology at various military installations to learn more about how we can reduce ravens' impacts on tortoise populations. Radio-tracking, nest monitoring, abundance surveys, scat analyses, and attacks rates on Styrofoam tortoise models have yielded many insights into the dynamics of raven ecology and behavior in the Mojave Desert. Ravens clearly take advantage of humans for roosting, nesting, and foraging. Fledgling and juvenile survivorship are enhanced by proximity to anthropogenic sources of food; in fact, natural desert habitat seems to be detrimental to reproductive success. Ravens move about the desert freely, using human structures as stepping stones to aid their dispersal through more inhospitable portions of desert. Predation risk to tortoises and other prey is highest near major sources of food, but is also high in the vicinity of active raven nests. We still do not know the extent of their impact on tortoise populations, and this gap is likely to be the greatest impediment to effective implementation of raven management actions.

Desert Tortoise Hatchery Project at Edwards Air Force Base

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Several factors have been identified in the continuing decline of the Mojave population of desert tortoise (*Gopherus agassizii*). To recover this species, methods must be employed to decrease mortality and increase natality. To be considered a successful technique, tortoise hatcheries must increase the number of individuals recruited into adult breeding age classes. The tortoise hatchery program established at Fort Irwin has produced results that warrant repetition in a stressed/disease environment. This hatchery project involves collecting free ranging gravid female desert tortoises and placing the animals in predator proof enclosures. After females deposit their eggs in the enclosures they are released back at their original capture site. Enclosures are designed to provide protection for the eggs and hatchlings. Hatchlings are held in the enclosures for a predetermined amount of time and then released into the wild. These research efforts are expected to provide valuable information including hatchling survivability, growth rates, disease transmission, clutch paternity, and population genetic variability. Edwards Air Force Base is employing an adaptive management strategy in the execution this project. If successful, this technique should be conducted as a multi agency effort, throughout the geographic range of the desert tortoise.

Working For Recovery: Desert Tortoise Preserve Committee Proposals to Expand The Desert Tortoise Research Natural Area

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In 1974, a handful of volunteers formed the Desert Tortoise Preserve Committee to establish the first tortoise reserve in the western United States. Their vision became a reality in 1980 with the designation of the 39.5 square mile Desert Tortoise Research Natural Area (DTRNA) in southeastern Kern County. Since then, the Committee has worked to acquire and protect over 16 square miles of private inholdings that lay within the DTRNA and the surrounding area, and to manage this habitat to reduce the many threats that menace the wild desert tortoise population. Most recently, the Committee launched a major initiative to significantly expand the DTRNA to the west and east.

This proposed 26 square mile habitat addition is home to desert tortoises and other imperiled wildlife such as the Mohave ground squirrel. The major threats to desert tortoises and their habitat in the proposed expansion lands are anthropogenic. These threats include unauthorized off road vehicle use, seasonal grazing by sheep, and uncontrolled dogs. These threats are all manageable through use of appropriate fencing. To date, the Committee has acquired almost 5 square miles of habitat in the proposed DTRNA expansion area.

The DTRNA expansion will facilitate recovery of the desert tortoise by reducing the threats faced by the resident tortoise population, will expand the DTRNA to more readily defended boundaries, will establish a permanent corridor to desert tortoise critical habitat to the east, and will greatly enhance the Natural Area's integrity and long-term viability.

POSTER

Predicting Desert Tortoise Habitat in the Mojave Desert

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Quantifying the characteristics of suitable habitat, modeling its distribution, and prioritizing the value of habitat within that distribution are extremely important factors in management strategies for the federally protected Mojave Desert tortoise (*Gopherus agassizii*) population. Desert tortoises mainly occur on alluvial fans (bajadas) within the creosote bush or creosote bush-white bursage (*Larrea tridentata-Ambrosia dumosa*) alliances, although some desert tortoises occur at higher elevations and in other vegetation communities. This project’s goal is to construct a statistically-based spatial model of desert tortoise habitat for large areas of the Mojave Desert on the basis of abiotic, biotic, and anthropogenic descriptors. Data describing desert tortoise occurrences are being compiled from existing U.S. Bureau of Land Management, California Department of Fish and Game, and U.S. Fish and Wildlife Service records. In addition, topographic, soil, climate, perennial vegetation community, and potential annual plant productivity maps are being produced and collected. These data are being incorporated into habitat-suitability models, which are extrapolated across various study areas. The habitat-suitability models are combined with maps of anthropogenic factors, including roads and land-management status, in a geographic information system to produce maps of predicted suitable habitat with possible land use and stewardship constraints. These predictive maps will aid in the management of desert landscapes for desert tortoise populations.

STUDENT PAPER

Preserving the Diversity of the Desert Tortoise (*Gopherus agassizii*): Reassessing Conservation Units

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Preserving genetic and ecological diversity is an important objective of the desert tortoise Recovery Plan. Although the desert tortoise exhibits considerable variation throughout its range, the spatial structure and genetic contribution to this variation remains unclear. When the Mojave assemblage of the desert tortoise (*Gopherus agassizii)* was listed as threatened, in 1990, under the U.S. Endangered Species Act (ESA), the U.S. Fish and Wildlife Service (USFWS) addressed these differences by designating six Recovery Units in the species Recovery Plan. These units, consistent with the concept of the evolutionarily significant unit (ESU), have a common purpose of conserving genetic diversity and unique evolutionary trajectories. However, the currently assigned Recovery Units are not consistent with USFWS policy under the ESA. The USFWS policy (1996) for recognizing unique spatial units of a listed species as Distinct Population Segments (DPS) is based upon discreteness, significance, and conservation status of the proposed segments. A scientific assessment of the Mojave Desert Tortoise Recovery Plan prompted scientists and managers to review the current conservation units in relationship with the DPS policy. We have reviewed existing genetic and ecological data, and suggest revision to the boundaries of current conservation units to a new hypothesis of distinct population segment, which more accurately captures the intraspecific diversity of the desert tortoise.

Desert Managers Group Recovery Actions in the California Deserts

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The Desert Managers Group (DMG) is working to ensure that implementation of desert tortoise (DT) recovery actions and monitoring efforts are coordinated and integrated among managers and scientists across jurisdictional boundaries.

Major DMG accomplishments and activities over that past 12 months include:

- The USGS initiated a study on behalf of the DMG to evaluate the effectiveness of past recovery actions related to vehicle management, cattle and sheep grazing, and construction of tortoise fences.
- The DMG formed a DT Recovery Planning/Implementation Work Group to work with the FWS DT Recovery Office to develop and implement recovery action plans for each recovery unit in California. .
- The DMG agencies participated in funding 6,536 kilometers of DT Line Distance Sampling (LDS) transect surveys in 2004.
- The DMG successfully secured funding and developed several partnerships to implement a multi faceted education and outreach campaign aimed at increasing public support of and involvement in DT recovery in California.
- DMG agencies entered into a MOU to develop an environmental assessment for a raven management program in the California deserts.
- The DMG established a Feral Dog work group to determine the scope and severity of this threat to DT and develop a feral dog management plan.
- The DMG sponsored the Mojave Desert Science Symposium with themes that focused on: Threats to the Mojave Desert, Ecosystem Monitoring, Natural Recovery or Active Restoration, and Scales and Sustainability.
- DMG agencies cooperated in the removal/adoption of 435 burros and in implementing an illegal dump prevention program in the California deserts.

California Desert Conservation Area Planning Update. Is Progress Possible During Litigation: What Can We Expect?

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The California Desert District has been updating the 1980 California Desert Conservation Area Plan, having completed four regional plan amendments and anticipating the finalization of the fifth and most complex plan amendment - the Western Mojave Plan. The plan amendments are regional in their scope and have focused on the conservation of Desert Tortoise and recovery actions specific to the species. This discussion would review Bureau of Land Management plan status and consider the influence of litigation filed in relation to the planning decisions and implementation actions. The question to be answered is whether "progress" is truly being achieved, and what can we look forward to for implementation in the near future.

Risk of Attracting Predators from Human and Human-Dog Team Wildlife Surveys

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The Desert Tortoise-K9 (DT-K9) Program is a Department of Defense supported program that uses trained canines to locate desert tortoise. The research team is working with federal agencies to develop certification standards for dog teams to ensure that: 1) teams find tortoises; 2) finds are communicated by dogs to handlers; and 3) the process does not harm tortoises. The April 2004 pilot project was successful, so the program was continued. Dog teams will be certified and fielded Fall 2005 at the NTC Ft. Irwin. Before this occurs, the Fish and Wildlife Service requested a study of the risk of attracting mammalian predators to tortoises from deployment of dog teams. Their concern was that working dogs would attract coyotes, foxes, and feral dogs to desert tortoises who would then be predated. We report the results of a study conducted at MCAGCC Twentynine Palms and Shadow Valley that quantified the risk of tortoise-predator interaction from human and human-dog team surveys, respectively. Risk to tortoises from predator interaction was not significantly different between human only surveys and human and dog survey teams. Overall the predator interaction risk to tortoises from surveys was 5%.

STUDENT PAPER

Evaporative Water Loss in Desert Tortoise Hatchlings with Upper Respiratory Track Disease

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Declines in populations of desert tortoises (*Gopherus agassizii*) have been attributed to an upper respiratory track disease (URTD) caused by the *Mycoplasma agassizii*. This disease is characterized by the symptoms of mucus discharge from the nares and ocular edema and liquid discharge. We hypothesize that these symptoms will increase the evaporative water loss (EWL) in tortoises, and that this enhanced water loss could be ecologically important to this desert species. Healthy desert tortoises are known to have exceedingly low evaporative water loss rates compared to other species. To test the hypothesis that diseased tortoises will lose water at enhanced rates, we measured evaporative water loss in hatchling desert tortoises inoculated with *Mycoplasma agassizii* (the pathogen responsible for URTD), and compared those rates to those in healthy animals.

Oxalosis in Wild Desert Tortoises

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A wild adult male desert tortoise from San Bernardino County, California, was observed in the field to be lethargic and had dried yellow exudate over its nares. The lower palpebra exhibited edema, there was discharge from the eye, and there were crusts on the palpebra. The tortoise was salvaged and shipped to the University of Florida for pathological studies. At necropsy, both nares were occluded. Plasma biochemical findings indicated an extremely elevated azotemia (415 mg/dl), uricemia (11.8 mg/dl), hypernatremia (>180 mEq/L), hyperchloremia (139 mEq/L), and elevated plasma osmolality (515 mMol/kg). These findings supported a diagnosis of renal failure. By light microscopy, within the nasal cavity there was diffuse hyperplasia of mucosal epithelial cells with infiltrates of heterophils, lymphocytes, and some macrophages. These changes were consistent with upper respiratory tract disease. Crystals similar in appearance to oxalate were scattered throughout the kidney and within thyroglobulin in the thyroid. The changes seen in the kidney were in agreement with the plasma biochemical changes indicating renal failure. Using infrared and scanning electron microscopy, the crystals were identified as calcium oxalate. In a review of microscopic slides of 67 wild desert tortoises necropsied between 1993 and 2002 at the University of Florida, similar appearing crystals were seen in thyroid glands from 44 to 54 (81.5%) examined desert tortoises and the kidneys from 3 of 67 (4.5%) examined desert tortoises. However, the extent of crystal deposition and the changes in the kidney of the affected tortoise were more severe than in any of the other desert tortoises where oxalate was found. Many native plants in the Mojave and Colorado deserts of California where tortoises occur contain oxalates, particularly in the families Brassicaceae, Chenopodiaceae, Euphorbiaceae, and Poaceae. The desert tortoise has evolved with these species. Unfortunately, in the last few decades, several alien species, such as the Saharan or Moroccan mustard, *Brassica tournefortii*, have invaded the Mojave Desert. Although tortoises have not been observed to forage on *Brassica tournefortii*, no efforts have been made to determine if they will consume it under drought or experimental conditions and no research has yet been conducted on the oxalate content. Studies are needed to evaluate the oxalate content of these plants.

STUDENT POSTER

Desert Tortoises in Phoenix Area Mountain Parks

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Desert tortoises naturally occur across most of Arizona's warm deserts, where they have lived for tens of thousands of years. There is some concern that populations of desert tortoises may be disappearing from mountain preserves and parks in the greater Phoenix area as development continues to encroach upon tortoise habitat. The purpose of this study is to determine the distribution of tortoises in Maricopa County Parks and Phoenix Mountain Parks in the Phoenix metropolitan area and the distribution of upper respiratory tract disease (URTD) in those tortoises. We surveyed likely desert tortoise habitat within 10 Maricopa County Parks and 5 Phoenix Mountain Parks between July – October 2004 for live tortoises, carcasses, and other tortoise sign (scat, burrows). Thorough health exams were conducted on live desert tortoises that included weighing, sexing, measuring midline carapace length (MCL), and photodocumenting any clinical signs associated with URTD. Blood samples taken by brachial or subcarapacial venipuncture are being analyzed by ELISA for presence of *Mycoplasma* antibodies (indicating past exposure to the disease); nasal flushes are being analyzed using PCR to look for presence of the Mycoplasma itself, indicating a current infection. We found a total of 77 desert tortoises, 1-16 in 12 parks where we found tortoise sign, and no tortoises or sign in 3 parks. We compared number of tortoises, search effort per tortoise, size distribution, and sex ratio for each park surveyed. Results of the laboratory tests will allow us to map the distribution of the disease onto our tortoise distribution map.

STUDENT PAPER

Distribution of Upper Respiratory Tract Disease in Captive and Free-ranging Desert Tortoises in Greater Tucson, Arizona

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Upper Respiratory Tract Disease (URTD), caused by the pathogen *Mycoplasma agassizii*, has been linked to extensive mortality of desert tortoises (*Gopherus agassizii*) in the Mojave Desert. Higher prevalence of desert tortoises tested positive for exposure to URTD in the Mojave Desert in two areas where release of captive tortoises into the wild has occurred, and captive tortoises are implicated in the spread of the disease. Little is known about URTD in the Sonoran population of the desert tortoise. To determine the distribution of URTD in Greater Tucson, Arizona, we used enzyme-linked immunosorbent assay (ELISA) to detect antibodies indicating previous exposure to *M. agassizii,* and polymerase chain reaction (PCR) to detect presence of specific nucleotide sequences in *Mycoplasma* DNA, indicating a current infection. Blood and nasal lavage samples were collected between July 2002 and August 2004 from 70 captive tortoises within Tucson and 138 free-ranging tortoises from 13 sites around Tucson, to compare results from captive, high-visitor impact, suburban, and remote populations to determine if there is an association between urbanization and distribution of *M. agassizii*. *M. agassizii* antibodies varied by tortoise site category, with the highest percentage of ELISA positive tortoises in suburban areas. Only one of the nasal flush samples submitted for PCR tested positive for the *M. agassizii* DNA fingerprint. Our data indicate disease incidence was highest in suburban areas, suggesting that urbanization has a negative impact on tortoise health. Additional studies are necessary to evaluate the mechanisms by which urbanization may affect desert tortoise disease.

POSTER

Monitoring Human Impacts and Management Effectiveness: The Jawbone-Butterbredt Area of Critical Environmental Concern

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Between 2002 and 2004, teams surveyed the 760 km^2 Jawbone-Butterbredt Area of Critical Environmental Concern (ACEC) and the western part of Red Rock Canyon State Park for desert tortoises (*Gopherus agassizii*) and recent human impacts. The objective was to develop a baseline monitoring program for desert tortoises and their habitats in areas with off-highway vehicle use (OHV). The monitoring program was to provide a means of evaluating mitigation and management measures to protect tortoises on a long-term basis. The area of interest was believed to support low densities of tortoises and was outside designated critical habitat for the species. The study area was stratified by habitat type and level of human use, and a systematic random sampling design was used to select 751 one-hectare plots for surveys of tortoises, tortoise sign, and anthropogenic-related disturbances (e.g., signs of OHV use, cattle use, mining, shooting, and garbage). Signs of human disturbance were found on every plot. The most prevalent sign was cattle scat, found on 97% of the plots; 60% of the plots had between 100 and 300 scats while 4% of the plots had over 400 scats. Vehicle tracks were observed on 52% of the plots. The majority (>90%) of tracks was from unauthorized use. Garbage (not including balloons) occurred on 60% of the plots, and evidence of shooting was found on 39% of the plots. Geographical patterns of the disturbance included higher counts of garbage within the State Park and higher counts of vehicle tracks near the boundary (but outside) of OHV open areas. This type of inventory is a useful tool for land managers who need to determine the short- or long-term effectiveness of their policies, whether it be boundaries of wilderness areas, OHV open areas, or a designated route system. Our monitoring techniques can be modified for use at the local or landscape scale.

Research on the Biology of Tent Tortoises (*Psammobates tentorius tentorius*) at the Tierberg Karoo Research Centre, South Africa

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As part of a larger South African Tortoise Conservation and Biodiversity Program (based at the University of the Western Cape), a one year study to examine the ecology and reproductive biology of the tent tortoise (*Psammobates tentorius tentorius*) was undertaken from October 2002 to 2003 at the Tierberg Karoo Research Centre located at the southern edge of South Africa's Great Karoo. This arid adapted species is closely related to the endangered Geometric tortoise (*Psammobates geometricus*) yet next to nothing is known about its biology. The 100 ha study site is located on the arid windblown plains 10 km north of the Swartberg mountain range and is characterized by low-growing (10-40 cm) evergreen and deciduous succulents with very scarce occurrence of grasses (Acocks Little Karoo Karroid Broken Veld Type). Twenty tortoises were radio tracked weekly and 12 females were radiographed every three weeks during the nesting season. Fecal and urine samples were gathered for dietary and hormonal analysis. Males are half the size of females. Females produced from 1-3 eggs per clutch and laid up to 6 clutches in a season. This work represents the first field study conducted for this species.

Habitat Use by the Sonoran Desert Tortoise (*Gopherus agassizii*) on the Florence Military Reservation, Pinal Co, AZ

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Desert tortoises in the Sonoran Desert typically occur on rocky slopes and bajadas and are absent from intermountain valley floors. Tortoises also occur along deeply incised washes emanating from rocky bajadas, utilizing caliche caves as shelter sites. It is thought that density and availability of shelter sites are limiting factors in tortoise density and distribution in the Sonoran desert. The Florence Military Reservation is typified by flat alluvial fan slopes bisected by steeply incised washes. There is one 10.9-hectare hill consisting of volcanic outcrops and boulders present at the northern end of the reservation. Tortoise locations at FMR were concentrated around incised washes with dense caliche caves or near the volcanic hill. Compositional analysis of the 3 principal habitat types used by tortoises at FMR revealed that they selected incised washes over the

volcanic hill, and both habitat types were selected over flat alluvial fans. Based on these results, tortoise distribution at FMR appears to be driven by shelter site availability.

Confusion and Conflict in Action—The Turtle Wars

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The Red Cliffs Desert Reserve (RCDR) – now in effect for nine years – represents a microcosm of issues associated with tortoises, the ESA, land acquisitions, lessons learned and "all of the above." Success, slow at first and generally thought impossible, marches forward, but never in single great bounds. Public attitudes – once negative – have been largely turned around. The RCDR has achieved success because it took risks, looked at things out of the box and exhibited a bias towards implementation. Idle talk and foggy accountability–the nemesis of successful action–was pushed aside.

STUDENT PAPER

Observations of the Mating Behavior of Desert Tortoises

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I observed the mating behavior of wild desert tortoises in a population in the central Mojave Desert. Observations were done on Fort Irwin at a long-term study plot established by Dr. Kristin Berry (USGS) to study tortoise social behavior in an area relatively free from human disturbance. My observations focused on male-female interactions in order to record the variations in female response to courtship, and to determine the potential role of female choice. Observations were primarily done during the fall, which corresponds with the peak of the mating season.

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. An individual courtship typically involved four stages: head bobbing by the male, trailing of the female by the male, biting and ramming of the female by the male, and mounting. Individual courtships typically lasted about one hour. The initial stages of courtship seemed aimed at enticing a female out of her cover site, later stages were aimed at immobilizing the female for the purposes of mounting. The female was able to exert a degree of choice, particularly during the initial courtship stage when the male courted the female from out side her cover site. A considerable amount of energy was exerted by the male during the mountings, although many mountings clearly did not result in intromission. Nearly all mountings resulted in the males expelling a liquid substance, but it was unclear if this substance was semen or voided contents of the bladder. 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

Raven Predation within the Red Cliffs Desert Reserve

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Ravens are identified as a major threat to desert tortoises in the Recovery Plan. Raven populations in the United States have increased 1500% over the last several decades, particularly in the southwestern United States. This increase is related to human populations and the concomitant increase in potential food and water sources (i.e., roadkills, landfills, trash, garbage dumps, agricultural developments) as well as perch and nesting sites available to ravens (I.e., fence posts, power poles and towers, signs, buildings, billboards, bridges, freeway access ramps, etc.). In desert tortoise life history, juveniles typically experience high mortality. However if adult populations are simultaneously declining such as in the Red Cliffs Desert Reserve, additional losses of juveniles to raven predation may prevent recovery of the populations.

The Utah Division of Wildlife Resources is currently developing a pilot study to assess and monitor raven-associated tortoise mortality within the Red Cliffs Desert Reserve. The study would address the following within the Reserve: 1) Determine the extent of raven predation, 2) Monitor raven populations including nest locations, and 3) Determine how ravens use available habitat. A draft study proposal is available for review.

Desert Tortoise *(Gopherus aga*ssizii**)** in Sonora, México

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The desert tortoise (*Gopherus agassizii*), also known in Sonora as “tortuga de monte”, is considered a threatened species by “La Norma Oficial Mexicana 059”. Its distribution is primarily within the Sonoran Desert, which encompasses most of the state, westward to the limits of oak – pine forest and southward to northern Sinaloa, México.

The Centro Ecológico of Sonora (CES), now Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES), has done some monitoring between 1990 to 1998, though not continuously. These monitoring efforts were mostly within Sonoran Desert and at its limits and also in Álamos in southern Sonora. It has been found that the tortoise populations are scattered throughout its distribution, making continuous monitoring of the species difficult. The most common threats found are: capture to have as pets, commercial selling, and habitat destruction. Apparently, there has not been high mortality, except that observed on Isla Tiburón by personnel of Northern Arizona University. Continual environmental education has been given to inform the public on activities that harm the species and raise awareness on the importance of conservation of the species. It is necessary to continue with the monitoring to determine the actual status of the populations in order to design and implement a management program that would help, as the environmental education program has, with conservation of the species.

SPANISH TRANSLATION:

La Tortuga del Desierto *(Gopherus aga*ssizii) en Sonora, México

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La tortuga del desierto (*Gopherus agassizii*) conocida también en Sonora como tortuga de monte, es considerada especie amenazada por la Norma Oficial Mexicana 059, se distribuye principalmente en el desierto sonorense, comprendiendo la mayor parte del estado, encontrándose también al oeste en los límites del bosque de pino-encino y en el sur hasta la parte norte de Sinaloa, México.

El Centro Ecológico de Sonora (CES) hoy Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES) ha llevado a cabo monitoreos, entre los años 1990 a 1998, aunque no continuos, dichos monitoreos han sido realizados principalmente en el Desierto Sonorense y en sus límites, además de Álamos, al sur de Sonora. Se ha encontrando que las poblaciones de tortugas están dispersas a lo largo de su distribución, lo que dificulta llevar a cabo muestreos continuos. Las principales amenazas que se determinaron son: la captura para tenerlas como mascotas y para su comercialización y la alteración de su hábitat. Aparentemente, no ha habido ninguna mortalidad grande, excepto la observada en Isla Tiburón por personal de la Universidad Norteño de Arizona. Continuamente se han llevado a cabo actividades de educación ambiental para disminuir las amenazas sobre la especie y lograr una mayor conciencia sobre la importancia de su conservación. Es necesario continuar los monitoreos para determinar la situación actual de la especie que nos den elementos para desarrollar e implementar un programa de manejo, así como el programa de educación ambiental, que permitan la conservación de la especie.

Spatial Patterns of Raven Nesting and Juvenile Desert Tortoise Predation in the Mojave Desert

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Ravens are a known threat to desert tortoises as they predate juvenile tortoises lowering recruitment. Raven populations in the Mojave Desert have been expanding rapidly for the past 20-30 years while desert tortoise populations have been drastically reduced (Boarman and Berry 1995). Building on a predaceous bird nest database compiled by William Boarman of the USGS over the past 15 years, current (2004 – 2005) juvenile tortoise predation associated with nesting sites was investigated. Of all nest sites visited in the summer of 2004, 7% had evidence of juvenile tortoise predation, not all of which were nests occupied by ravens. In the fall of 2004 remains of juvenile tortoises were found at sites that had been cleared of remains in the summer of 2004, indicating that predation is not limited to the raven nesting season, perhaps especially during years of above average rainfall in the desert. The current spatial patterns of raven and predaceous bird nesting locations in the Mojave Desert are described. Nesting sites with evidence of predation of juvenile desert tortoises are defined.

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

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Since 1939 state laws have been in place to protect the desert tortoise. In August of 1989, the tortoise was officially listed as threatened under the California Endangered Species Act. 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 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 over 30,000 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. We have installed fencing in some of the areas to exclude cattle grazing and OHV use. In addition to the lands that have been acquired by the Department, some mitigation lands have been acquired by the Desert Tortoise Preserve Committee and others have gone to the Bureau of Land Management.

In 2004, the Department continued to work with local jurisdictions to aid them in complying with the California Environmental Quality Act and the California Endangered Species Act. We worked on permitting numerous small projects, which include mining activities, housing and other urban development, and road projects. The Department spent significant time and resources this year working with Department of Defense on the Fort Irwin Expansion, setting up a feral dog working group in conjunction with the DMG, reviewing and permitting desert tortoise research projects, and working on subgroups of the DMG on management and protection of the desert tortoise in California.

The draft Coachella Valley Multiple Species Habitat Conservation Plan is currently available for public review. Its conservation strategy looks at aggregating desert tortoise mitigation lands into areas with the greatest long-term value for desert tortoise. This should help overall desert tortoise recovery in the portion of the range that falls within the Coachella Valley plan area.

Progress in Defining the Desert Tortoise, *Gopherus agassizii*

Robert W. Murphy[1], Kristin H. Berry[2], Taylor Edwards[3], Daren Riedle[4], and David J. Morafka[5]:*
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Previously, populations, evolutionary significant units (ESUs) and management units (MUs) for the desert tortoise were defined using the best available data on habitat use, behavior, morphology, and genetics. However, the phylogenetic taxonomy of *Gopherus agassizii* remains largely unresolved. We have embarked on a large-scale genetic study to investigate the possibility that the desert tortoise is more than one species. We used 15 autosomal microsatellite loci to genotype over 1,000 individuals from most of their range in the United States, including multiple populations in the Sonoran and Mojave deserts. These markers are sensitive to subtle signatures of gene flow that can determine if a population is genetically isolated. Fixed differences between Mojave and Sonoran individuals suggest that these populations are behaving genetically as species. They should be defined and managed independently of each other. The clarification of what constitutes unique populations of the desert tortoises will assist conservation efforts by helping to direct research and management where it is needed most.

Who's Your Daddy, Little Tortoise?

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Observations of desert tortoises, *Gopherus agassizii*, in the field reveal that some females breed with multiple males. Female tortoises are also known to store sperm. Although multiple paternity occurs in captivity, this remains to be documented in natural populations. As part of a more encompassing project on the genomics of desert tortoises, we investigate the occurrence of multiple paternity within clutches. Fifteen autosomal microsatellite loci are used to construct DNA fingerprints of 22 adult females that lay clutches of eggs in an enclosure on Edwards Air Force Base. These DNA fingerprints from the females are compared to those of the emergent neonate tortoises. The possibility of multiple paternities is assessed within clutches where three or more neonates are positively identified. Suggestions are made for continued experiments in this area of investigation.

Headstarting Desert Tortoises: Effects of Supplementing Natural Rainfall

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Many important questions surround the issue of how to give a helping hand, or "head start", to desert tortoises in the egg, neonate and juvenile stages of life, in order to aid recovery of this Threatened Species. One idea is that growth rates of hatchlings might be increased if their food supply could be improved in quality, quantity, and time span. This would allow hatchlings living in predator-excluding enclosures of natural vegetation to grow faster, thereby reaching a predator-resistant size sooner. They could then be released sooner, which would speed up repopulation efforts. At the Juvenile Hatchery at Edwards (Air Force Base) Tortoise Study Site (JHETSS), we tested this hypothesis by supplementing natural rainfall (which totaled about 130 mm, or about 5 inches, since the previous autumn) by using sprinklers and a water truck to add another 44 mm in early April, and another 30 mm in mid-May, to increase the total in the experimental enclosure to 204 mm (7.8 inches) for the 2003-2004 rainy season. The added water increased and prolonged the availability of green plant food in the irrigated plot as compared to the adjacent unwatered (control) plot. The 11 control hatchlings and the 9 experimental hatchlings, all born in autumn 2003, had statistically indistinguishable body masses (Mb) and midline carapace lengths (MCL) when measured in September 2003. By early April, just before irrigation began, both groups of hatchlings had grown some, but were still similarly sized. At the end of the next six weeks (mid-May), the control group had increased their Mb by a total of 11% and their MCL by 4% since

autumn, but the irrigated group had increased Mb by 39% and MCL by 16%. These highly significant differences in growth responses indicate that, under the circumstances pertaining at JHETSS in spring 2004, supplemental rain at appropriate times increased growth rates of juvenile tortoises over four-fold during spring.

Headstarting Desert Tortoises: Enclosures at the JHETSS Increase Survivorship

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Three predator-resistant enclosures were installed with minimal habitat disturbance in a natural area used by wild desert tortoises in the southeast portion of Edwards Air Force Base, California, in 2002. We added a cohort of eggs in spring 2003 by temporarily relocating pregnant wild females obtained from surrounding areas. These females were released where they were captured shortly after laying their eggs in the enclosures at JHETSS (= Juvenile Hatchery at Edwards Tortoise Study Site). In 2003, ten of ten nests produced at least one hatchling, indicating that nesting success was 100%. Of the 40 eggs laid, 32 hatched, indicating a hatching success of 80%. Survivorship of hatchlings from birth, through winter hibernation to the following spring (2004) was 97%. Thus, about ¾ of eggs laid at JHETSS produced yearling tortoises. This high first-year survivorship is similar to those observed in other tortoise hatchery facilities (e.g. ¾ at Mapimi, Mexico and 9/10 at Fort Irwin, California), and is much higher than the 4/10 survivorship seen in the wild (e.g. at Goffs, California and at 29 Palms Marine Base, California). The main benefit of enclosures in influencing first-year survivorship appears to be their reduction of predation on nests, and secondarily on reducing predation on neonates. However, in 2004, ground squirrels discovered and invaded JHETSS enclosures, digging up nests, eating eggs and possibly predating baby tortoises, having as yet undocumented effects on survivorship. Efforts to modify the pen's fencing to exclude these unsuspected tortoise predators are underway.

Fast Plants, Slow Tortoises: How Nutrition Could Constrain the Recovery of the Desert Tortoise

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The irony of desert tortoises is that they must match their ability to balance nutrient intake and excretion over a period of years to ephemeral plant resources that change over a period of weeks. In this presentation I review what we have come to understand about this relationship in the context of Smithsonian research efforts.

The Nutrition Lab of the Smithsonian Institution's National Zoo became involved in studying nutrient needs and physiology of the desert tortoise at the Desert Tortoise Conservation Center in Las Vegas in 1991. We did not initially recognize the unique traits of herbivorous tortoises, but rather focused on areas of general significance to herbivores, such as we had studied in green iguanas (Allen and Oftedal 2003): ability to utilize dietary fiber, protein requirements for growth, and nutrient composition of forage plants. Tortoises proved to be adept at digesting high fiber (both in pelleted feeds and in forage plants), to need relatively high dietary protein for maximal growth, and to consume plants typically high in potassium and calcium, but low in phosphorus, sodium and some trace elements (Oftedal et al. 1993; Barboza 1995a, 1995b).

The high potassium levels were interesting but not an immediate concern, as potassium is rarely of nutritional importance in the diets of mammals or birds, taxa for which nutrient needs and tolerances are much better known than they are for reptiles. Yet we wondered how tortoises could cope with high salt loads (whether potassium or sodium salts) in the absence of elongate renal tubules (the loop of Henle) or of salt glands (present in herbivorous iguanine lizards and in sea turtles). We initiated a series of studies of the effect of dietary potassium on food intake, food choice and nutrient balance. It proved that potassium is adversive to tortoises: they eat less of high potassium foods, choose low potassium foods over high potassium foods in controlled choice trials, and excrete excessive potassium largely as salts of a waste product of protein metabolism, uric acid (Oftedal et al. 1994; 1996).

Yet the most remarkable finding was that the amount of protein catabolized and excreted as urate salts was directly related to potassium intake. In other words, the amount of protein required by tortoises for positive nitrogen balance (i.e., protein storage in tissue growth) depended on dietary potassium: even a high protein diet did not allow juvenile tortoises to grow if the diet was also high in potassium (Oftedal et al. 1994; Oftedal 2002). This was surprising given that tortoises in these trials had regular access to drinking water which could be used to produce potassium-containing fluid urine. In the Mojave and Colorado deserts, tortoises rarely have this opportunity and thus would be even more adversely affected by potassium intake.

At Desert Tortoise Council meetings I argued that tortoises should choose foods that maximize the N:K ratio. However, as ecologists pointed out, the importance of water was still not adequately addressed by this argument, particularly in the western Mojave and Colorado deserts where summer rains rarely occur and tortoises have to obtain all or nearly all water from food plants. Our attempts to study water restriction in captive tortoises failed, as tortoises that were water restricted simply stopped eating our dry experimental diets. We realized that we would have to better understand the interrelationships of potassium, protein and water in food plants, and how foraging tortoises reacted to them in nature.

We initiated an intensive program of plant sampling and analysis to determine phenological changes in plant composition, as well as the response of desert plants to variation in soil moisture, in the Mojave desert. We had been collecting at sites in southern Nevada since 1991 but added a major effort to examine water, protein and potassium in annual plants growing at the Desert Tortoise Research Natural Area in the western Mojave. Bryan Jennings had completed a groundbreaking foraging study of tortoises at this site (Jennings 1993) that demonstrated high selectivity and high consumption of rare annual legumes. We expected these favored plants to be high in protein and water relative to potassium, which proved to be the case (Oftedal et al. 2002). Plant studies were also initiated at City Creek, UT with assistance from Todd Esque.

Review of published literature on the physiology of desert plants indicated that plant use of water, nitrogen and potassium is related to life history strategy. In particular, a subset of annual plants are locked into a physiological strategy whereby very high photosynthetic rates enable plants to complete seed set before soils dry out in late spring. They do this by investing a lot of protein in photosynthetic enzymes, and by mobilizing and expending large amounts of water (Mooney et al. 1976; Smith et al. 1997). As a consequence they can not tolerate dry soils that have a low water potential. By contrast perennial plants and some annuals are more conservative: low photosynthetic rates, low protein content in leaves, lower water use, and physiological mechanisms (including concentration of potassium in vacuoles) that allow them to extract water from soils of low water potential (Smith et al. 1997). We began studying the water potential in tissues of annual plants as a means to demonstrate which species followed which strategy.

This led to a novel hypothesis: tortoises depend on a subset of annual plants that only grow in wet years, that may be patchy or rare in abundance, but that are uniquely high in protein and water relative to potassium (Oftedal 2002). The concept of an index of nutritional quality, the Potassium Excretion Potential (PEP) index, that weights the relative importance of protein, water and potassium to the ability of tortoises to excrete excess potassium, was first presented at the 1995 Desert Tortoise Council. Tortoises were hypothesized to need "high PEP plants."

In the meantime, our research efforts were bolstered by the contributions of Brian Henen, who had documented seasonal and annual shifts in whole body fat-free dry matter (mostly protein) of female tortoises, and had concluded that dietary protein may be limiting tortoise reproduction (Henen 1994, 2002). With Smithsonian support, Brian initiated a set of studies on the effects of dietary protein on reproductive performance of captive tortoises, demonstrating effects of protein intake on egg output (Henen 2002). Brian also brought the perspective that it may only be in high rainfall winters or after summer rains that female Mojave tortoises manage to achieve positive nitrogen balance (i.e., protein storage). This matched the hypothesis that tortoises need access to high PEP plants that only germinate in high rainfall years.

An extremely productive relationship was also initiated with one of the gurus of tortoise biology, Dave Morafka. Dave had pioneered the study of juvenile tortoises in naturally vegetated pens at his Fort Irwin study site (FISS) in the central Mojave desert in California, and recognized that we might be able to test the high PEP hypothesis in FISS pens. At our initial survey of FISS pens in the spring of 1998 (an El Nino year) I was delighted to observe the presence of an annual evening primrose (*Camissonia claviformis*) known to have very high photosynthetic rates (Mooney et al., 1976). Although this species was not prominent on any list of tortoise food plants, and had not been analyzed for PEP content, based on its life history strategy I predicted it would have a high PEP value and be a preferred tortoise food, which is what we found. The juvenile tortoises foraged in a manner consistent with the high PEP hypothesis, and selected both high PEP plant species and high PEP parts from these species (Oftedal et al 2002). To be certain this was a replicable observation, we repeated the study in 2001 and came up with similar results. Juvenile tortoises were also observed to switch to moderate PEP foods (e.g. *Plantago, Erodium*) when high PEP plants were no longer available.

At about this time Tom Van Devender asked for a review chapter comparing the nutritional ecology of tortoises in the Mojave and Sonoran deserts (Oftedal 2002). It was evident that the primary difference between these populations was in the availability of regular summer rains, at least in the Arizona Upland division of the northeastern Sonoran desert. I guessed that PEP considerations would be less important when tortoises could drink. In collaboration with Roy Averill-Murray and Daren Riedle of Arizona Game and Fish, we initiated a study of summer foraging by adult tortoises at Ragged Top, Ironwood Forest National Monument, AZ in 2002. This study, and subsequent studies at Saguaro National Park (East), AZ in 2003 and at Sugarloaf Mountain, Tonto National Forest, AZ in 2004, confirmed that when tortoises have the opportunity to drink rain water they consume a variety of grasses, summer annuals, and perennials (including *Janusia*, a vine), few of which are high in PEP. However, we also studied spring foraging, and found that Sonoran tortoises are highly selective for high PEP plants when they are available in spring (see Oftedal et al. this volume). In other words, Sonoran tortoises appear to face the same need as Mojave tortoises to maximize intake of high PEP plants in spring, when they cannot drink.

I believe that tortoises evolved the ability to discriminate and ingest high PEP plants while living in a desert environment characterized by biphasic rainfall (winter and summer), and it was this ability to offset high potassium levels in spring plants by diet selectivity that enabled them to disperse into the winter-rainfall Mojave/Colorado deserts that developed at the end of the Pleistocene. The key question now is whether high PEP plants currently occur in sufficient abundance and at sufficient regularity in the Mojave and Colorado deserts to support maintenance and growth of tortoise populations, or whether these plants have been greatly depleted by the combined effects of long-term livestock grazing and proliferation of invasive plant species such as *Bromus* and *Schismus*. If tortoises are unable to obtain high PEP plants, they likely suffer chronic nutritional stress due to the need to divert protein for use in potassium excretion. This stress would be aggravated by drought, and probably increases susceptibility to and severity of disease, although this has not been directly verified. In other words, the collapse of Mojave/Colorado tortoise populations, though associated with disease, may have its origins in nutritional constraints. If so, sustainable recovery of Mojave/Colorado tortoises may only be possible if nutritional resources recover. But how long will this take, if the seed stocks of high PEP plants have been depleted, and those seeds that do germinate face competition from hyperabundant invasive annuals? Much study is needed in this area.

This review has focused on the PEP story, because of its compelling nature. However, we have also studied the effect of high dietary calcium on phosphorus utilization by juvenile tortoises, and the impact of low dietary phosphorus on bone development. Kristin Murphy examined the effect of elevated ambient carbon dioxide on *Bromus* and *Camissonia claviformis* and how this impacts tortoise nutrition (Murphy 2003). We have examined digestive responses of tortoises to grasses and high PEP legumes, and documented that variation in the stable isotope levels between C-3 and C-4 plants, and between legumes and non-legumes, can be detected in tortoise tissues (Oftedal et al. 2004). The latter may provide a useful tool for examining diet shifts among contemporary and historical tortoise populations, something we plan to study across the range of tortoises in the Mojave and Sonoran deserts in Arizona. We have also examined the reproductive competence of "superjuvies" (captive tortoises that are large for age) and in a particularly unusual study demonstrated that tortoises do not obtain energy or protein when they ingest cattle dung, contrary to the hypothesis of a range management biologist. Much of this research remains to be published.

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Sonoran Desert Tortoises Consume High PEP Legumes in Spring

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Although Sonoran desert tortoises encounter two periods of plant germination and growth (spring and summer), little is known about their foraging behavior in spring. It has even been suggested that spring foraging is unimportant in the Sonoran Desert, and that fragments of spring plants observed in tortoise feces could derive form senescent material ingested in summer. We conducted foraging observations on 6 tortoises at Sugarloaf Mountain, Tonto National Forest, Maricopa County, AZ in April 2003 and on 5 tortoises at Saguaro National Park (East), Pima County, AZ in April 2004. About 27,800 bites of 42 plant species were observed at Sugarloaf, and about 21,300 bites of 50 plant species at Saguaro. Despite this species diversity, a few plant species represented the vast majority of bites, especially *Lotus humistratus* (49%), *Lupinus sparsiflorus* (24%), *Plantago patagonica* (7%), *Erodium cicutarium* (6%) and *Lotus strigosus* (3%) at Sugarloaf, and *Lotus humistratus* (30%), *Bouteloua repens* (19%), *Lupinus sparsiflorus* (10%), *Astragalus nuttalianus* (8%) and *Janusia gracilis* (7%) at Saguaro. At each site annual legumes represented 3 of the top 5 species eaten. Annual legumes as a group accounted for 77% of bites at Sugarloaf and 52% of bites at Saguaro.

Multiple samples of all significant forage plants were collected and assayed for water, nitrogen (crude protein), potassium and PEP (Potassium Excretion Potential index). The annual legumes (5-7 species at each site) were consistently higher in protein and PEP than non-legumes. As a consequence, these legume-rich spring diets were high in protein (14%, dry matter basis) and PEP (16 g/kg dry matter) at both Sugarloaf and Saguaro. This high PEP level matches that of highly selective juvenile tortoises in the central Mojave (Ft. Irwin), even though most plants at the Sonoran sites (other than legumes) had lower PEP values (e.g., PEP range of -7 to 14 for 31 non-legume species at Sugarloaf). It appears that spring foraging of Sonoran tortoises like that of Mojave tortoises, is driven by the need to obtain protein that can be used to excrete ingested potassium. This is achieved by preferential consumption of the high PEP legumes available in spring. Such behavior is in marked contrast to foraging in summer, when Sonoran tortoises have opportunity to drink from rain puddles, and can void excess potassium in fluid urine. In summer, tortoises feed mostly on low PEP plants, including grasses, summer annuals, and perennials.

Center for Biological Diversity's On-going Efforts for Desert Tortoise Conservation and Recovery

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Much of our tortoise conservation and recovery efforts have focused on the California Desert Conservation Area (CDCA), a 25 million acre swath of Sonoran, Mojave and Great Basin deserts—stretching from the Mexican border north to Death Valley and the White Mountains—designated by Congress in 1976.

The Bureau of Land Management's (BLM) 11 million acre share of the CDCA contains 3.4 million acres of habitat designated critical to the survival and recovery of the threatened desert tortoise (*Gopherus agassizii*)[1]. The CDCA also harbors 23 other federally protected threatened or endangered species including Peninsular Range bighorn sheep, Inyo California towhee, desert pupfish, Coachella Valley fringe-toed lizard and rare plants such as Cushenberry oxytheca, Amargosa niterwort and Peirson's milkvetch.

These 24 species and the ecological health of the CDCA are jeopardized by new BLM plans which favor mining, livestock production, roads, utility projects, and off-roading. Imperiled species, such as the desert tortoise, are declining as regional planning efforts dominated by anti-conservation politics short-change wildlife by not implementing recovery plans or protecting critical habitat for species recovery.

In late 2000 and early 2001, The Center for Biological Diversity (Center), Public Employees for Environmental Responsibility (PEER), the Sierra Club, and five off-road groups settled a landmark lawsuit with BLM over its failure to follow the Endangered Species Act. The CDCA settlement had BLM implementing on-the-ground recovery actions—but now its balanced management is abandoned as BLM attempts to roll-back protections across millions of acres.

Permitted by U.S. Fish and Wildlife Service (FWS) non-jeopardy biological opinions, BLM has now finalized its Northern and Eastern Colorado Desert Plan (NECO), Northern and Eastern Mojave Desert Plan (NEMO), Coachella Valley Plan, Western Colorado Desert Routes of Travel Plan (WECO), and Algodones (Imperial) Dunes Plan, but all these plans fall far short of species and habitat recovery needs. Species recovery plans are not implemented, despite a finding by the General Accounting Office that the tortoise plan is based on sound science. With the Ft. Irwin tank training expansion lurking, problems on the Mojave National Preserve, and an aggressive anti-conservation administration, the abandonment the minimum recovery shield provided by the CDCA settlement represents a dangerous roll-back in wildlife protection. The settlement is still in place within the West Mojave (WEMO) planning area.

The roll-back of conservation through BLM's new plans forced new litigation against Interior, especially FWS. Important federal court decisions struck down FWS 'adverse modification' survival-only standard for critical habitat, ruling that critical habitat must be managed for endangered species recovery, not just survival. On Dec. 30, 2004, the Center won a court order protecting 572,000 acres of critical habitat washes from off-road vehicles.[2]

The Center is working with other conservation groups and Interior to ensure all desert tortoise critical habitat is managed for recovery. We are also working to help better conserve the Sonoran desert tortoise, as well as supporting proposed legislation for voluntary federal grazing permit buyout and allotment retirement.[3]

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[1]U.S. Fish & Wildlife Service, final rule (59-5820), Federal Register, 2/8/94
[2]www.biologicaldiversity.org/swcbd/press/tortoise1-4-05.html
[3]www.permitbuyout.net

STUDENT PAPER

Fluorescent Dye Tracking as an Epidemiological Tool Used to Understand Disease Transmission in a Population of Gopher Tortoises (*Gopherus polyphemus*)

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Upper respiratory tract disease (URTD) has been associated with morbidity and mortality in both desert and gopher tortoise populations, suggesting that the disease can have significant impacts on the future of these species. Unfortunately, most populations have been studied after the initial disease outbreak has occurred. A long-term study site had significant anthropogenic impacts due to rapid development coupled with unauthorized relocation events. This site had a documented history of absence of *Mycoplasma agassizii* and no significant morbidity and mortality events prior to tdevelopment encroachment on the preserve. *Mycoplasma agassizii* has been introduced into this population, with concomitant increases in seropositive animals as well as increased morbidity and mortality. Thus, this population provides a unique opportunity to study the effects of URTD on population dynamics and disease progression.

Because mycoplasmas are transmitted primarily through direct contact with an infected individual, data on tortoise-tortoise contact rates will permit us to generate more accurate models of transmission dynamics. Certain individuals may be more liable to transmit the pathogenic agent to other individuals in the population due to differences in movement patterns. The purpose of this study was to describe movement patterns of individual tortoises in relation to sex and disease status, and indicate any movement-based factors that could lead to increased risk of disease susceptibility and transmission. The data presented represents only the first year of a multi-year study on this site; therefore, results must be interpreted with caution until the full data set is obtained.

Tortoises (16 males, 5 females) were captured using bucket traps that were placed at the mouth of selected burrows. Blood samples and nasal flushes were collected from each captured tortoise for determination of disease status by both ELISA and PCR testing. Based on ELISA and presence or absence of nasal discharge, tortoises were classified as healthy (seronegative without nasal discharge), clinically silent (seropositive without nasal discharge) or clinically ill (nasal discharge). Only one clinically ill tortoise was seronegative; all others were seropositive. This animal may represent a very early infection prior to development of detectable antibodies or alternatively, the nasal discharge could have another etiology. Six of 16 (37%) males were clinically ill; no females had active clinical signs. Nine of 16 (56%) males and 4/5 (80%) females were clinically silent. Only two tortoises (1 male, 1 female) were classified as healthy.

After clinical assessment, each tortoise had a dye pack attached to one of the drilled holes located on a rear carapacial scute used for identification. Dye packs of different colors were constructed by scooping one tablespoon of fluorescent powder dye (Radiant, Inc.) into a stretched piece of nylon and securing the pouch with twine. The pouch was then attached to the tortoise so that it would lag about 3 inches behind the tortoise, leaving behind it a trail of seeping dye. All materials were biodegradable and nontoxic. After dye pack attachment, tortoises were returned immediately to the burrow from which they were trapped. Tracking commenced about 45 minutes after sunset when trails could be made visible with the projection of a handheld UV light (Raytech, Inc.). Points along each trail were marked with a GPS unit, and a transcription of hand-drawn maps was created with ArcGIS 8.3. Number of burrows entered, number of trails overlapped, potential interaction sites along the trail, and total distance traveled that day were documented.

The data collected this past season relates only to the first year of this multi-year study. The animal numbers and sex distribution are not yet adequate for valid statistical analysis. However, we will describe several intriguing trends that will be important to follow in subsequent years of the study. Although sex was not found to be significantly associated with movement patterns ($P = 0.15$), males tended to travel farther distances and visit more burrows than did females ($P =0.08$). Disease status also appeared to influence movement patterns in males. Healthy seronegative individuals tended to travel greater distances and visit more burrows than tortoises with URTD (clinical signs and/or detectable antibody). A clinically ill tortoise that had not yet seroconverted traveled less distance and visited fewer burrows than clinically ill tortoises that had already seroconverted and were presumed to be at later stages of disease. Although this data is purely descriptive in nature, it suggests that the earliest stage of disease is the most debilitating to the tortoise with respect to movement. This will need to be confirmed by following additional animals in this category. Importantly, clinically ill males with severe nasal discharge were moving comparable distances to seropositive animals without discharge. Since detectable levels of *M. agassizii* in nasal flushes are correlated with the presence of nasal discharge, these animals are likely to be shedding *M. agassizii*. Thus, these clinically ill males are a likely source of disease transmission in the population.

In summary, tracking through radio telemetry alone cannot provide the detail we obtained with fluorescent dyes, thus rendering dye tracking a more appropriate method for disease transmission studies. Radiotelemetry provides discrete movement data whereas data collected via dye tracking is continuous movement data with greater spatial accuracy. Although the literature suggests a 7 day limit on dye visibility, in our experience animals could be tracked for up to 14 days after attachment of the dye pack. Documentation and analysis of individual daily movement patterns will undoubtedly provide valuable insight regarding the epidemiology of URTD in a population. This information could aid in the formulation of strategies aiming to mitigate disease impact on a population by focusing on the management of individuals most apt to advance disease distribution.

The Role of USGS in the Recovery of the Desert Tortoise

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The goal of the United States Department of Interior - Geological Survey (USGS) scientists is to provide reliable, high quality scientific information to resource managers to support sound management decisions. The merger of the biological resources discipline into the USGS provided opportunities for scientific collaborations among four major disciplines including biology, geology, hydrology and geography. The Western Ecological Research Center of USGS contributes to the recovery of tortoises by providing technical assistance to resource managers, conducting literature reviews and syntheses, hosting workshops, and conducting research aimed at describing ecological patterns, processes and mechanisms. Current research on desert tortoises includes 1) raven ecology studies at the Marine Corp Air Ground Combat Center at 29 Palms; 2) social behavior studies at Fort Irwin; 3) long-term demography studies in California with emphasis on causes of death and mortality rates; 4) research on anthropogenic impacts to tortoise populations and their habitat in the Mojave Desert; and 5) rephotography studies to evaluate natural recovery rates of disturbed lands. Recent technical assistance includes completion of an evaluation of the effectiveness of recovery measures for desert tortoises and providing technical assistance to the Clark County Multi Species Habitat Conservation Plan. In 2005, a new research project will be underway involving translocation studies at Fort Irwin. The Western Ecological Research Center website at www.werc.usgs.gov provides information on on-going studies in 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/.

The Arizona Interagency Desert Tortoise Team State Conservation Agreement for Sonoran Desert Tortoises: Key Habitat Designation and Threats Ranking Assessment

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Conservation agreements and strategies are a relatively new tool used to address specific known threats in order to preclude the need to list a species. In 1990, the Mojave population (all tortoises north and west of the Colorado River) of the desert tortoise was listed as threatened under the Endangered Species Act. Based on available data, the U.S. Fish and Wildlife Service ruled that listing the Sonoran population (tortoises south and east of the Colorado River) was not warranted. The Sonoran population is considered a species of special concern by the Arizona Game and Fish Department, and a State Conservation Agreement and Strategy is being prepared by the Arizona Interagency Desert Tortoise Team. The first steps the development of the strategy and agreement involved the identification of 1) key habitat areas (KHAs); 2) management stakeholders; and 3) threats affecting tortoises and their habitat in KHAs. From these KHA designations, regional-specific goals, objectives, and management actions will be developed which will respond to threats in KHAs. This presentation will describe the process used in delineating KHAs and provide a synopsis of progress made to date on regional threats ranking for Sonoran desert tortoises.

Status and Trends in Southwestern Chelonians

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The global decline of reptiles may be comparable to that of amphibians, and turtles predominate numerically in the reptile decline. Arid southwestern North America supports about 18 native chelonian species (13 aquatic, 5 terrestrial or semi-aquatic), a rich fauna for a dry region. Conservation trends here are like those for turtles elsewhere: widespread declines with varied causes. Three species are critically endangered (CITES Appendix I: *Apalone ater*, *Terrapene coahuila*, and *Gopherus flavomarginatus*, all in Chihuahua, Mexico); one is listed as threatened under the U.S. Endangered Species Act (*G. agassizii*, Mojave Desert populations); and most species (72 %) have legally recognized threats and/or significant declines in at least some subspecies or regional populations. *A. ater*, the Cuatrociénegas softshell, is probably the most threatened taxon.

Several threats are poorly known or not acknowledged in law, such as introduced crayfish impacts on *Kinosternon s. sonoriense*, a multiplicity of poorly known threats to *K. s. longifemorale*, and introgressive hybridization in *Trachemys gaigeae*. At least 7 causes of decline are known or suspected in this fauna (habitat degradation, introduced species, genetic introgression, exotic disease, collection/consumption, climate change/flux, and competition from livestock), yet no single threat stands out as predominant. Habitat effects and human-mediated movements of organisms underlie many, but not all of the threats. Many causes of decline are not well demonstrated or even well understood, including for the intensively studied desert tortoise.

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

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The listing of the desert tortoise as a threatened species under the Endangered Species Act has significantly influenced the manner in which the BLM administers public lands in southern Nevada. The BLM administers approximately 4.5 million acres of desert tortoise habitat in Clark, Lincoln, and Nye counties, Nevada, of which 1,085,000 acres have been designated as critical habitat. There is almost no activity that BLM authorizes within our Las Vegas Field Office (FO), Caliente Field Station (FS), and the southern portion of the Tonopah Planning Area that does not affect desert tortoises. BLM in NV has eliminated or reduced livestock grazing on significant portions of desert tortoise habitat in these areas. Active management to maintain desert tortoise populations is ongoing: BLM personnel are actively involved in preventing desert tortoise collection, and vandalism; management changes have been made to reduce mortality from various motorized vehicle activities; utility and energy facilities and corridors are evaluated and impacts mitigated; and wildfires in desert tortoise habitat receive priority response and emergency stabilization as quickly as possible. BLM is actively participating in the development and implementation of several Multiple Species Habitat Management Plans. Land sales in Clark and Lincoln Counties are funding habitat acquisition, parks, installation of protective fencing and other activities in support of desert tortoise conservation.

The Desert Tortoise Council, 1975-2005: A Brief History

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Established on April 21, 1975, the Desert Tortoise Council's single overriding goal is to assure the continued survival of viable populations of the desert tortoise throughout its existing range. We briefly review a few of the highlights of the Council's work toward its goals and objectives. All of the achievements noted below, are in some way, a result of the Council's efforts.

The Council has held annual meetings (symposia) each spring since 1976; trained over 1000 people at its 13 Handling Workshops; produced "An Annotated Bibliography of the Desert Tortoise," "The Status of the Desert Tortoise in the United States," "Recommendations for Management of the Desert Tortoise in the California Desert," "Guidelines for Handling Desert Tortoises During Construction Projects," "Proceedings: Conservation, Restoration and Management of Tortoises and Turtles," and "Answering Questions about Desert Tortoises" to name a few; provided funds for the 2002 Desert Tortoise Health and Disease Workshop and its final report; and provided funds and peer-reviewed papers for the December 2002 volume of the "Chelonian Conservation and Biology Journal."

The Council has also served on the panel of reviewers for research proposals; on the panel formed by the California Department of Health to review plans and make recommendations on a proposed nuclear waste disposal site in Ward Valley, California; been represented on the steering committee for Nevada's Clark County Habitat Conservation Plan' reviewed documents pertaining to the West Mojave Coordinated Management Plan, Eagle Mountain trash train, Luz and Harper Lake projects, and Fort Irwin expansion, to name a few. With the Sierra Club, the Council intervened on behalf of the government in the woolgrower's appeal of Bureau of Land Management's (BLM) restrictions on sheep grazing for desert tortoise habitat in California. A couple of years later, the woolgrower's appeal of BLM grazing restrictions in California was defeated.

And most notably, as a result of its diligence and hard work, the Council can proudly say that it facilitated the listing of the desert tortoise as a "Threatened" species in California, Nevada, Northern Arizona, and Utah. For the next 30 years, the Council is looking forward to the challenge of achieving its basic goal—the survival of viable populations of the desert tortoise throughout its existing range.

Looking Back on "The Changing Mile"

Raymond Turner
Tucson, Arizona

While matching photographs during more than four decades, Ray Turner has seen many examples of landscape change. At the time, he has also enjoyed many instructive encounters with his fellow humans. Glimpses of both the scientific and cultural findings gleaned from this work will be highlighted. Matched photographs from the recent published "The Changing Mile Revisited" will be emphasized, with additional repeat photographs from New Mexico's Bootheel country and Kenya.

Investigation of the Potential to Restore Mexican Bolson Tortoises (*Gopherus flavomarginatus*) on Chihuahuan Desert Ranches in Southwestern New Mexico

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The Turner Endangered Species Fund is investigating the possibility that the Ladder and/or Armendaris ranches owned by R. E. "Ted" Turner in southwestern New Mexico could serve as restoration sites for Mexican bolson tortoises (hereafter "tortoises"). The idea evolved from discussions by a group of ecologists and paleoecologists convened at the Ladder Ranch in September 2004, who pointed out the post-Pleistocene occurrence of the species in Chihuahuan Desert areas of Big Bend National Park, USA. Jane and Carl Bock, members of this group, subsequently showed Joe Truett the facility on the Audubon Research Ranch near Elgin, Arizona, where a group of tortoises in outdoor enclosures have been bred and maintained for a number of years. The Ladder and Armendaris ranches seem climatically and vegetatively appropriate for the species, based on conditions at the Audubon Research Ranch and in the Bolson de Mapimi, Mexico, where tortoise populations exist in the wild. We are seeking advice from tortoise ecologists to further inform our efforts to assess the feasibility and advisability of such a restoration effort.

Buffelgrass and Desert Tortoises: Yet Another Threat?

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Buffelgrass (*Pennisetum ciliare*) is an Old World grass that was introduced as livestock fodder several decades ago. In the last 20 years it has begun an exponentially-increasing invasion into natural habitats. In 2004 the authors mapped its distribution along roads in Arizona and northern Sonora. In Arizona it poses the greatest threat to Arizona Upland Sonoran Desert, where it has the potential to convert large areas of this community into a monocultural grassland. In Sonora it has already converted much Arizona Upland and Plains of Sonora desertscrub, and Foothills Thornscrub. Even if it doesn't burn it replaces nearly all native plants by competition for water, especially the short-lived herbaceous perennials and annuals.

Its habitat preference varies within its North American range. In Arizona it grows best in disturbed flatlands and on steep, rocky, south- and east-facing slopes. Some hillsides that were formerly dominated by brittlebush (*Encelia farinosa*) and teddy bear cholla (*Cylindropuntia bigelovii*) are now mostly buffelgrass. The invasion of the rocky slopes favored by the Sonoran desert tortoise suggests that buffelgrass may be a serious threat to it. We suggest that replacement of most native species - especially grasses, mallows, and desert vine (*Janusia gracilis*) - severely restricts tortoise diets. Since the Sonoran tortoises live mostly in shallow rock shelters, they may also be killed when the buffelgrass burns.

Using Automated Radio-Telemetry and Real-Time Remote Database to Monitor Desert Tortoise Activity

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Automated radio-telemetry equipment is being used to monitor the activity patterns of tortoises at the National Training Center on Fort Irwin. The automated radio-telemetry equipment enables one person to monitor the activity of many tortoises continuously over an extended time, regardless of weather, light level or terrain. Data from radio transmittered tortoises are being transferred real-time by radio signal to a web accessible relational database. Data storage is accomplished through a central database capable of storing all data collected and capable of being served on the web. The website was developed as a dynamic front end to provide easy access to and visualization of the project's database. The database is continually updated via a live streaming data uplink and periodically updated through field observations. The website uses a complex user/password authentication schema that ensures integrity of the data is maintained. The type and/or amount of data the user is allowed to view are determined by user-groups which adds additional security. This allows less sensitive information to be viewed by a wider audience, while maintaining a strict lock on sensitive data types that select users can view. The website allows users to easily view four primary categories of data: tortoise data, transmitter data, weather data, and maps. Data from this research project should benefit the recovery and management of desert tortoise populations through refinements in a number of research areas, e.g., temperature-based tortoise handling guidelines, baseline activity patterns, and translocation. Examples of field data and database tables will be presented.

Defenders of Wildlife's California Desert Campaign

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Defenders of Wildlife ("Defenders") is launching a California Desert Campaign in 2005. Our work will focus primarily on the Western Mojave Desert as it is currently

undergoing the most intense development pressure. The overall goal of this campaign is to establish a permanent presence in the California desert in order to work with the public, local governments, and management agencies to recognize the value of desert conservation and increase conservation planning, implementation, and proactive programs. The desert tortoise will be a major focus of this work and we will advocate for desert tortoise conservation throughout its range. In 2005 we will continue to develop relationships with local governments and public land managers and secure funding for key proactive programs. We will also be conducting an economic analysis of the costs and benefits of desert conservation, including desert tortoise habitat preservation. Additionally, we are working with the Desert Managers Group to plan and implement their Desert Tortoise Education and Outreach Campaign. In 2005 we will be coordinating the development of a desert tortoise brochure targeted at recreationists. Defenders welcomes input from the desert tortoise community on all elements of this campaign.