ABSTRACTS

THIRTY-FIRST 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 and Doug Duncan

U.S. Fish and Wildlife Service - Desert Tortoise Recovery Office Update

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The U.S. Fish and Wildlife Service established the Desert Tortoise Recovery Office (DTRO) in December 2004 for the purpose of linking land management decisions with research results. The DTRO focuses on recovery plan revision and implementation, research, monitoring, and recovery permitting, and provides a centralized point of contact through which these activities are coordinated.

In 2005, three regional coordinators were hired, and a seven-member Science Advisory Committee (SAC) was empanelled. Recovery planning efforts focused on developing a process that incorporates land manager, stakeholder, and SAC input and coordination, with neutral third-party facilitation. An agreement was established with the U.S. Institute for Environmental Conflict Resolution (Institute) to assist with this process. The range-wide monitoring program completed surveys and made significant progress with data processing, including a summary of monitoring results from 2001-05.

In 2006, the Institute will continue working with the DTRO to conduct a broad stakeholder assessment to determine the feasibility of collaborative recovery planning through regional working groups and then to design and facilitate a process aimed at reaching agreement on regional recovery action plans and achieving broad stakeholder support for a scientifically credible recovery plan. The SAC will define recovery criteria and coordinate research needs and recovery actions with the regional working groups. The range-wide monitoring program will focus on comprehensive data analysis and program review, which will be facilitated by the inclusion of managers on the Monitoring Implementation Committee and the hiring of a Monitoring Coordinator. The DTRO will also continue to participate in regional manager/ stakeholder groups.

The Health Status of Resident Desert Tortoises (*Gopherus agassizii*) in the Fort Irwin Translocation Project Area, San Bernardino County, California

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In 2005, we conducted health evaluations of resident desert tortoises (*Gopherus agassizii*) in a study area designed to receive >600 translocated tortoises in 2006 and future years. The study area is part of the Ft. Irwin Translocation Project, is on public lands, and lies between the southern boundary of the National Training Center, Fort Irwin, in the north and Interstate 15 on the south in the central Mojave Desert, California. The health evaluations of the resident tortoises are an initial part of a long-term translocation project to remove tortoises from lands scheduled for military maneuvers and place them in suitable habitats.

During two separate survey periods (spring, summer/fall), we evaluated 166 subadult and adult desert tortoises for general health and clinical signs of upper respiratory tract disease (URTD), shell diseases, and trauma. We drew blood samples for enzyme-linked immunoassays (ELISA) for two species of *Mycoplasma*, *M. agassizii* and *M. testudineum*, and took nasal lavages for cultures, polymerase chain reaction (PCR) tests, and DNA fingerprinting of pathogens. Of the 166 tortoises evaluated, sufficient blood samples were available for ELISA tests from 147 tortoises. Not all tortoises provided blood samples for tests, and samples of some others were insufficient for tests. Twenty-three tortoises had to be re-sampled in fall of 2005, and 19 tortoises will have to be re-sampled in late spring of 2006. For 14 of the 147 tortoises, results are still pending for cultures, PCR tests, and DNA fingerprinting. Preliminary results indicate that at least nine tortoises (7 males, 2 females) have positive or suspect ELISA tests or cultures for *M. agassizii* or *M. testudineum*. These tortoises occur in the western half of the study area, where most samples were taken. The western half of the study area is relatively close to urban and rural areas where tortoises have previously been observed with URTD. We are also evaluating the distribution and frequency of tortoises with shell disease and particular types of trauma throughout the study area. These findings will provide a baseline of information for designing the release program for translocated tortoises.

Acknowledgements: Funding was provided by the National Training Center at Ft. Irwin. We worked closely with Todd Esque, Ken Nussear, Phil Medica, and Karla Drake, who are handling other parts of the Fort Irwin Translocation Project. Thanks are also due to a large field team and J. Mack for assistance.

Demography of Ravens in the Mojave Desert: Recent Analyses

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Common ravens, predators of desert tortoises, have increased in number in the Mojave and Sonoran deserts during the last several decades. We recently conducted two analyses of raven demography that may prove useful to raven management. First, using 37 years of Breeding Bird Survey data, we investigated how raven numbers, local distribution, and annual trends differed among desert subregions, and whether trends within subregions varied fundamentally at the local level. The data show that raven populations have increased by nearly 800 to 1400% in the Mojave and Sonoran deserts over the past 37 years. Growth rates, rates of spread, and local abundances continue to be highest in the West Mojave. Second, we developed simple stage-structured demographic models of raven populations. We used data from seven years of research on the population biology of ravens in the west Mojave Desert to estimate fecundity for the population as a whole and by habitat (urban, ecotonal, and desert). Two unknowns, breeding adult survival probability and transition probabilities between non-breeding adult ("floater") and breeding adult classes had important effects on population growth rates. Ravens breeding in "urban" habitats have greater hatch-year survival and fecundity; urban populations would be stable or growing if breeding adult survival was equal to or greater than non-breeding adult survival. In contrast, "desert" habitats always produced declining population growth rate estimates. Immigration may be important for the dynamics of this population. Effectiveness of control actions will depend on timing and intensity of effort, as well as the raven age classes that are targeted. We recommend that management be at both the local and regional levels. Long term monitoring of raven populations associated with raven management programs should consist of a combination of targeted surveys, nest use surveys, and indices of predation pressure.

Acquisition of Desert Tortoise Habitat in the California Desert

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The California Desert District has completed the purchase of nearly all of the former railroad lands in the Mojave Desert. 484,600 acres were purchased with federal funds and major contributions from partner Wildlands Conservancy between 2000 and 2004. Additional lands totaling 29,500 acres have been acquired through the Palo Verde exchange. Many of these properties are within Desert Wildlife Management Areas, critical habitat, and wilderness areas. In addition, the Army has secured 93,000 acres of former railroad lands west of Fort Irwin.

Ongoing acquisitions are achieved through mitigation agreements, primarily with utilities. Despite the consolidation of federal lands, some desert wildlife management areas will continue to have substantial private holdings well into the future. Therefore, land acquisition is only one of several methods of achieving protection for the desert tortoise and its habitat.

Fire History and Fire Effects in the Mojave Desert

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Fire reports generated by Federal land management agencies can be used to summarize current fire regimes in the Mojave Desert. In this presentation I report data reported between 1980 and 2001. Fires caused by humans tended to occur along highways, in the Stoddard and Lucerne valleys, and in the Spring Mountains near Las Vegas. Fires caused by lightning typically occurred at higher elevations in the Spring Mountains, the Mojave National Preserve, Joshua Tree National Park, SW Utah, and the Arizona Strip. The Upper Virgin River Recovery Unit (5.0%) and the Northeastern Mojave Recovery Unit (12.6%) for the desert tortoise experienced the greatest percent of their area burned. Most of these fires were started by lightning, but subsequent spread into large fires was facilitated by non-native annual grasses (*Bromus* and *Schismus* spp.). Most human-caused fires were reported from the Northern Colorado and Eastern Colorado recovery units. The positive feedback between non-native annual grasses and fire is perhaps the greatest fire management concern in the Mojave Desert. It appears that these annual grasses have their greatest effects on fire regimes below approximately 4,200ft, which is the elevation zone typically dominated by thermic blackbrush shrublands. Five fire ecology zones were recently defined to help guide fire management in the Mojave Desert: 1) low elevation shrublands; (2) middle elevation shrublands and grasslands; (3) high elevation shrublands and woodlands; (4) montane woodland and forest; and (5) riparian woodland and oasis. Each of these zones have characteristic historical and current fire behavior and fire regimes, responses of dominant plant species to fire, post-fire successional patterns, and major fire management issues (e.g. fuels management, invasive species).

Guidelines for Fire Studies in the Mojave Desert

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Although it is undeniable that the immediate effects of fire result in decreased plant biomass, other more specific and longer-term effects remain hard to predict. It is these other effects that are most important to land managers, because they are central to most management plans. Such effects include mortality rates of different plant species and their associated seedbanks, changes in soil properties, long-term trajectories of plant succession, higher-order effects on animal populations and communities, and the net effects when coupled with postfire

management treatments (e.g. seedings and weed control). These effects are difficult to predict because burn patterns are highly variable, vegetation types can respond differently, and environmental and anthropogenic influences can vary spatially and temporally before and after fires. In addition, the scale at which ecological studies are typically conducted often does not match the scale at which land managers need information. For example, vegetation study plots are typically $1m^2$ or less. This scale can be sufficient to evaluate fire effects on individual plants, alpha diversity, and microhabitats, but not larger scale effects on plant communities, wildlife habitat, or beta and gamma diversity. Future fire studies need to incorporate these complexities, and explicitly match their design approaches to specific land management information needs. In addition, we need to get away from the distinction that is often emphasized between fire monitoring and fire research, because that artificial dichotomy can be counterproductive. Well designed effectiveness monitoring plans can also be considered land management research. Although it can be difficult to decide how much information is ultimately needed, our focus should shift from semantic arguments of monitoring vs. research, towards producing reliable science to support appropriate land management decisions, whatever that science may be called.

Health Status of Wild and Captive Desert Tortoises from the Hermosillo and Alamos Areas of Mexico

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Fifty tortoises (28 wild, 22 captive) were evaluated for clinical signs of health and disease in November 2005 in the Hermosillo and Alamos regions of Mexico. This project was part of a multidisciplinary team assembled to investigate the status of the desert tortoise in Mexico. Two captive tortoises were from Alamos and the remaining 20 were from the Centro Ecologica de Sonora (zoo) in Hermosillo. Samples of plasma and nasal washes were obtained from 48 and 50 tortoises, respectively, and sent to the Mycoplasma Research Laboratory, University of Florida, for determination of the presence of specific antibody to *Mycoplasma agassizii* and *M. testudineum*. Nasal lavages were cultured and tested by polymerase chain reaction (PCR) for the presence of mycoplasma 16S rRNA. Mycoplasma species were determined based on the specific restriction enzyme profile of the PCR product.

Preliminary results indicate that all but one wild tortoise had negative tests for the two species of *Mycoplasma*. The exception among the wild tortoises was a tortoise with a suspect titer for *M. testudineum*. In contrast, 11 of 21 (52%) of captive tortoises tested had specific antibody to *M. agassizii*, with positive titers ranging from 64 to 256. No captives tested suspect

for *M. agassizii*. Plasma was not available for one captive; interestingly this tortoise had *M. agassizii* recovered from the nasal flush. Mycoplasmas were detected by PCR in nasal flushes from 10 captive tortoises; nine of these have been confirmed as *M. agassizii*. Results on the last positive PCR are pending. Mycoplasma was not detected by PCR in nasal flushes of 8 other captive tortoises; results are still pending on nasal flushes from 4 additional samples. In those tortoises with positive nasal flushes, 8 of 10 were positive by ELISA, 1 of 10 was negative, and one plasma sample was available for one tortoise. Four captive tortoises had a suspect titer for *M. testudineum*. As a preliminary summary, 17 captives tested suspect or positive for one or more of the *Mycoplasma* tests.

The wild tortoises in general had fewer clinical signs of disease, and the degree of severity was lower than for captives. Most wild tortoises had one or more mild clinical signs of disease associated with the eyes, e.g., edema of the palpebrae. Few of these tortoises had swollen or draining chin glands (N = 6) or evidence of discharge from the nares (N = 4). Numerous signs of predation and trauma were evident on the head, limbs, and shell, and the degree of severity ranged from mild to severe. For most wild tortoises, trauma was minor and consisted of flakes and chips off the plastron or carapace or a few scales missing from the forelegs. However, the gular had been chewed off of one tortoise, 60% of the lower mandible was missing on another tortoise, and a third tortoise had an open lesion on the foreleg. Scales were missing on forelegs of 11 tortoises. No ticks were noted. Cutaneous dyskeratosis was evident on 14 tortoises, and some unusual lesions of scute, bone, scales and skin were observed.

In contrast to wild tortoises, the captives exhibited proportionally more clinical signs of disease. Several individuals displayed signs of debilitation, emaciation, dehydration, and general weakness. Most tortoises had mild to severe clinical signs of disease in eyes and nares, e.g., discharge from the nares. Eighteen tortoises had no or mild indications of trauma, and one tortoise had a raw, recent wound on the foreleg. Seventeen tortoises had mild to severe cases of cutaneous dyskeratosis, as well as other lesions of the integument. No ticks were noted.

A Review of Desert Tortoise Adoption Protocol

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Urban encroachment into Sonoran Desert habitats leads to increased numbers of tortoises available for adoption, while bringing more, wild desert tortoise populations into close contact with humans. Transmission of Upper Respiratory Tract Disease (URTD) from released captives to wild tortoises can lead to higher infection rates in wild populations near urban areas. To better manage and protect both wild and captive desert tortoise populations, existing tortoise adoption and captive handling procedures at the Arizona Game and Fish Wildlife Center were evaluated for their efficacy at controlling the spread of URTD. Current adoption and housing protocols for Arizona, California, and Nevada were reviewed to begin to create a sound and implementable

protocol. Changes are in progress to improve disease testing, quarantine, and record keeping. Educational programs to discourage the release of pets will also be implemented.

Desert Tortoise K9 Program

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We present an overview of the Desert Tortoise K9 (DTK9) Program from inception to present. The DTK9 Program began as a pilot project to address basic research questions about the use of dogs to locate desert tortoises using rigorous empirical methods. The results were both positive and encouraging from scientific, methodological, and permitting perspectives. The research and training program have grown in scope, size and sophistication. Six dog teams were certified and fielded over a 7 week time span fall 2006 at the NTC Ft. Irwin. Dogs successfully located tortoises on the surface, in shrubs, and in burrows. The definition of a DTK9 Team has been proven to be an important set of criteria for determining the suitability of a handler and dog for fielding to survey for tortoises. The DTK9 Program will continue into spring of 2008 to finalize the standards for DTK9s and complete the transition of the DTK9 Program from research phase to full implementation.

Revegetation of Desert Tortoise Habitat: Creosotebush Shrublands

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With increasing frequency of wildfires in recent decades, creosotebush shrublands are diminishing. Revegetation efforts aim to return essential cover (shrubs) and forage plants (annual herbs, perennial grasses and cacti) to desert tortoise habitat following wildfire. Many of the revegetation techniques developed by the field of Aridland Restoration are now being considered for rehabilitating desert tortoise habitat. However, long-term monitoring studies of revegetation efforts are lacking for the Mojave Desert, and few successful efforts are available to guide decisions for restoring tortoise habitat. The success of revegetating desert tortoise habitat is challenged by 1) great costs of re-establishing plants across expansive areas of burned habitat; 2) distributing ample seed while reducing seed losses to maximize plant establishment, and 3) the unpredictability of the amount and timing of rainfall necessary to re-establish plants. The return of seed to burned habitat, either through aerial seeding or hand broadcasting, is a popular prescription for re-establishing vegetation. Incorporation of seed into the soil, such as with harrowing or surface tackifiers, has also been used in arid land rehabilitation. In contrast, losses of seeds and establishing plants by granivores and herbivores, respectively, as well as poor plant establishment due to the encroachment of invasive annual grasses are infrequently accounted for in revegetation efforts. Here, I compare potential prescriptions and discuss important

considerations when revegetating creosotebush shrublands to enhance desert tortoise habitat following wildfire.

STUDENT PAPER

How Well Do Head-Started Yearling Tortoises Survive After Release?

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There are many unanswered questions related to the issue of how best to "head-start" desert tortoises, to aid recovery of this threatened species. It is clear from earlier studies that the use of predator-resistant fenced enclosures to surround the nests, eggs, and hatchlings enhances survivorship greatly during these vulnerable life history stages. But how long is it necessary to protect the juveniles with these enclosures before freeing them to fend for themselves? Previous evidence indicated that most juvenile mortality may occur in the egg and hatchling/neonate stages. It follows that year-old juveniles may not need further protection from predators, and thus may show relatively high survivorship upon release. We tested this hypothesis by telemetering and releasing eight yearlings in autumn of 2004 just outside their enclosures. Radio tracking data, GPS results, and visual observations indicated that most moved only relatively small distances and showed little inclination to "home" (try to get back inside the enclosure). Mortality was high, however, with some deaths attributable to probable predation, but other deaths remaining unexplained. In autumn of 2005, the experiment was repeated. Seven more yearlings were released to join the one 2004 yearling remaining alive in September of 2005. As of January 2006, all eight juveniles are still alive, and the large over-winter mortality seen the previous year has not occurred yet this winter.

The Summer 2005 Fire Season in the Mojave Desert: Postfire Emergency Stabilization and Rehabilitation by the National Park Service: Hackberry Fire Complex

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On June 22, 2005, multiple fires were started as dry lightning passed over Mojave National Preserve in eastern San Bernardino County, California. As multiple fires burned through the Hackberry Mountains, Providence Mountains, Mid Hills, and New York Mountains, they eventually coalesced into two large burned areas. Managed as the Hackberry Complex, the fires were finally controlled on July 7, burning a total of 70,912 acres. The fires burned primarily in higher elevation desert shrublands and woodlands, ranging from 3,600 to 6,600 feet above sea level. Most of the burned area was classified as low to moderate soil burn severity. Burned Area Emergency Response (BAER) concerns focused on: threats to critical natural resources including desert tortoise habitat, rare plants, and desert springs; threats to heritage resources due to

trampling, erosion, looting, and vandalism; potential for post-fire weed invasion; threats to public safety due to burned over mine shafts and hazard trees; stabilization of abandoned roads; and replacement of damaged infrastructure. BAER treatments were initiated in July, but were interrupted in late July and early August by strong monsoonal rainstorms which caused flash flooding and severe erosion throughout the burned area. Additional treatments were proposed and implemented for cultural site stabilization and post-flood road repairs. Emergency stabilization and rehabilitation work is ongoing in 2006 and all emergency stabilization work will be completed by June 2006 with rehabilitation work potentially continuing into 2007.

A Closer Look at the Hybridization Zone between Mojave and Sonoran Desert Tortoises in Western Arizona

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There is strong molecular, behavioral, and ecological evidence that the Sonoran and Mojave populations of the desert tortoise are distinct taxa. However, the existence of a hybridization zone occurring in western Arizona (McLuckie et al. 1999) brings into question the geographic boundaries of these independent populations. We re-examined the biological significance of this hybridization zone using microsatellite and mitochondrial DNA. We tested 24 individuals from four study sites in the Hualapai and Black Mountains of western Arizona and compared them to a database of genotypes for >600 Mojave and >200 Sonoran desert tortoises. For our autosomal microsatellite analysis, 14 individuals matched a Mojave genotype and 9 individuals were verified as hybrid origin. No individuals were found to be of pure, Sonoran origin. In the mitochondrial analysis, two individuals exhibited a Sonoran maternal haplotype, and 12 originated from a Mojave maternal lineage. We observed duplicated regions (three alleles) in several hybrid individuals, suggesting that there might be mismatching during genomic recombination. The allelic frequencies observed in these hybrid animals clearly indicate that admixture has only occurred recently relative to the evolutionary history of the two populations, suggesting a possible human influence. The Mojave and Sonoran populations of the desert tortoise have been separated for ~5.5 million years and our data reiterate the taxonomic distinction of each population. The high proportion of hybrids and strictly Mojave genotypes observed over a relatively large geographic area suggest that ecological factors (competitive advantage) may have influenced the proliferation of the Mojave genotype in Arizona.

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

Molecular Support for the Established Recovery Units in the Mojave Population of Desert Tortoises (*Gopherus agassizii*)

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The U.S. Fish and Wildlife Service's 1994 Recovery Plan for the Mojave population of the desert tortoise (*Gopherus agassizii*) was hypothesis-based. The Recovery Plan described six recovery units, which incorporated data on habitat, behavior, morphology, and genetics. We evaluated the six recovery units using microsatellite and mitochondrial DNA. In total, 628 desert tortoises were sampled from 31 study sites, representing eight desert regions and all six recovery units throughout the Mojave Desert in California and Utah, and the western Colorado Desert of California. Our analyses suggested that gene flow occurs throughout the Mojave Desert, or at least occurred until the recent proliferation of anthropogenic barriers. However, populations of tortoises did not exhibit panmixia. Genetic structure was related to geographical barriers and distance. Consistent with isolation-by-distance, we detected a low frequency of private alleles and a significant correlation between genetic and geographic distance among study sites. The genetic patterning did not reject the Recovery Plan's hypotheses. Most sample group pairwise comparisons of allelic frequencies differed significantly. An assignment test correctly placed most individuals in their respective recovery units. Samples from the Western Mojave Recovery Unit were sufficiently distinct to be subdivided into three separate regions: western Mojave, central Mojave and southern Mojave. Samples from the Eastern Mojave and Northern Colorado recovery units were difficult to separate from one another despite differences in habitat. However, this might have owed to the limited number and placement of sample sites and this part of the desert deserves further attention. The Northeastern Mojave and Upper Virgin River recovery units showed the greatest differentiation. Both also exhibited molecular evidence of recent population reductions. In addition, we observed some patterns in our data that may be attributed to large-scale translocations of tortoises throughout the Mojave Desert during the 20th century. Overall, our analyses suggest that the previously established recovery units for the Mojave population of the desert tortoise were biologically justified and, with some modifications, will provide effective management for the species.

Desert Managers Group Recovery Actions in the California Deserts

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The Desert Managers Group (DMG), an organization of federal, state, and county land managing agencies in the California deserts, has two goals in its 5 Year Work Plan directly associated with the Desert Tortoise. The goals are:

Goal 3. Recover the desert tortoise in the California recovery units.

Goal 9. Monitor desert tortoise population status in relation to recovery goals for the California deserts' recovery units.

Each of these goals has several implementing tasks whose focus is on working to ensure that implementation of desert tortoise recovery actions and monitoring efforts are coordinated and integrated among managers and scientists across jurisdictional boundaries.

Desert Tortoise Preserve Committee Efforts to Conserve the Desert Tortoise

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For over 30 years the Desert Tortoise Preserve Committee (DTPC) has been acquiring and managing habitat for the desert tortoise (*Gopherus agassizii*). Acquisition began in the Desert Tortoise Research Natural Area (DTNRA). Only a small amount of private inholdings remain to be acquired within the DTRNA. These parcels remain a priority for acquisition. The DTPC bought out the lessee and acquired the grazing permit for the Pilot Knob Grazing Allotment in 1995. Since then, the permanent retirement of this grazing allotment has been a high priority for the DTPC and we have worked diligently within the West Mojave Plan planning effort to ensure that the Pilot Knob Grazing Allotment is permanently retired. The DTRNA Management Plan includes expansion areas to the east and west to more manageable boundaries. The eastern expansion also strengthens links from the DTRNA to designated critical habitat for the desert tortoise. The DTPC has completed acquisition of almost five square miles of habitat in the expansion area. Installation and maintenance of fences and signs are some of the continuing efforts to protect desert tortoises and their habitat. Additional habitat acquisitions are underway in the Chuckwalla Desert Wildlife Management Area. Education is an important DTPC program that includes the Naturalist, newsletters, and briefings at outreach events. Off road vehicle use and livestock grazing are viewed as the most serious threats to conservation of desert tortoises in areas managed by the DTPC. Future management actions will focus on minimizing the impacts caused by grazing and off road vehicles.

The Bolson Tortoise in the Mapimi Biosphere Reserve, Past, Present, and Future

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In the 1970's the bolson tortoise (*Gopherus flavomarginatus*) was officially "rediscovered" by the scientific community in the Mapimi Basin in the Chihuahuan Desert. Because of its occurrence there and its extremely low population numbers, it became the major incentive behind the effort in 1979 by the Instituto de Ecologia, A.C. to establish the area as a

Biosphere Reserve, the first in Mexico. At the same time, studies began to better understand the biology of the tortoise and help efforts to recuperate the population, which had suffered greatly from excess human harvest. Through the efforts of scientists from the Instituto, a captive breeding program was begun. Research and captive breeding efforts continued for almost 10 years. As a result of these efforts, the population of tortoises has recuperated and individuals can be commonly seen within the Reserve. However, research efforts have declined and since 1985 little has been done with the population. Left undone were important studies of the current population status of the tortoises and of their habitat requirements. To rejuvenate the tortoise program, in 2004 we initiated a study of the habitat and soil characteristics of tortoise burrow sites. The objective of this study is to identify characteristics important for burrow sites and then use this information to generate a predictive model to identify current and potential habitat for the bolson tortoise in Mapimi. Once this model is developed and tested, it will help us to evaluate the current status of tortoises in Mapimi. Such a model can also be used to evaluate potential release sites for possible expansion of the population to insure the sustainability of the species.

Headstarting Desert Tortoises: Irrigation and Predators at Edwards Air Force

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We are investigating questions related to the issue of how to give a helping hand, or "head start," to desert tortoises in the egg, neonate, and juvenile stages of life, to aid recovery of this threatened species. One suggestion is that growth rates of hatchlings might be increased if their food supply could be enhanced by lengthening the time it is available. This would allow hatchlings living in predator-excluding enclosures containing 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 for a second, relatively wet year by supplementing natural rainfall (which this year totaled about 310 mm, or more than 12 inches) by using sprinklers and a water truck to add another 30 mm in late April, and another 35 mm in early June. 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 hatchlings in the irrigated plot again grew faster than those in the adjacent unirrigated plot, even in this high-rainfall year. However, in summer, native fire ants (*Solenopsis xyloni*) were seen attacking juvenile tortoises, including the larger individuals in the irrigated plot. Mortality was substantial among juveniles living in both irrigated and unirrigated plots. Moreover, many newly-hatched tortoises were also attacked and killed by fire ants. Subsequent inspections and careful excavations of nests that should have produced hatchlings, but did not, revealed that fire ants probably attacked baby tortoises that were in the process of hatching. Hatching success in 2005 was much lower than in previous years.

QuadState County Government Coalition

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QuadState is a multi-county organization, representing local governments of seven counties in the 4-State Mojave Desert region. One city is an Associate Member. Originally organized around desert tortoise habitat management and recovery concerns, the organization serves as an umbrella and clearinghouse organization on a variety of regional public lands issues, and represents three counties on the implementation of the Lower Colorado River Multi-Species Conservation Plan.

The organization represents local governments, under direction of elected officials (Boards of Supervisors, County Commissions). The organization does not represent any interest, user or constituent group other than local government.

The Coalition has been active in seeking review of the Recovery Plan for desert tortoise, to seek application of current science, and to look for mitigation and management that will yield positive results.

In reviewing previous presentations I have given to this conference, I can state that our goal of working cooperatively with a variety of interests and agencies has not changed.

We believe strongly there should be continued commitment to monitoring, not just counting, but establishment of baselines, and more critically, determination of efficacy of mitigation and conservation measures applied.

We also urge a strategy to deal with the diseases affecting tortoises. Continuing basic research as to causes is appropriate, but an expanded effort to study epidemiology is equally important. In the meantime, we also believe that experimenting with management strategies to deal with the diseases, must be initiated. We also believe there must be a focusing of investment efforts on areas where there is the best chance of successful recovery. Shot-gunning of funds leaves all areas short. In this context, much more attention must be paid to the two operational Habitat Conservation Plans (HCPs) to determine their efficacy in securing recovery.

Bloody Big Eggs: Shell and Pelvic Kinesis in the World's Smallest Tortoise

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The small tortoises of southern Africa include the only testudinid taxa that produce single-egg clutches. This group includes the world's smallest tortoise, *Homopus signatus*, which inhabits a harsh, arid environment. We evaluated whether rainfall predictability and the east–west aridity gradient in southern Africa affect egg and clutch size of the small indigenous tortoises. We also several measured morphological traits of *H. signatus* to assess whether morphology constrains egg size, preventing the formation of optimal eggs. Aridity and unpredictable rainfall determine which of these tortoise taxa produce single-egg clutches. Taxa in less predictable environments produce larger eggs relative to body size than do taxa in more predictable environments. *Homopus signatus* produces the largest egg relative to body size, probably to enhance offspring survival in its harsh environment. Body size, pelvic aperture size, and the narrow anal gap of *H. signatus* appear to constrain egg size. Despite these constraints, females produce rigid-shelled eggs larger than the pelvic canal and use pelvic kinesis to pass eggs at oviposition; both features are unknown in other chelonians and emphasize the selective advantage of large eggs to *H. signatus*.

Chelonian Biodiversity and Conservation—Southern Africa

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Southern Africa has the richest diversity of tortoise species and genera in the world. To facilitate the conservation of our chelonians, the University of the Western Cape and Cape Nature developed a collaborative program that encompasses scientific research, conservation initiatives, and an education program. We aim to establish research priorities and objectives, and advance research on southern African chelonians through collaboration with international scientists and the involvement of postdoctoral fellows and postgraduate students. Through this research program, we studied the demography, life history traits, resource requirements, reproductive and physiological ecology, nutrition, health status, population genetics, and phylogeography of several southern African tortoise species. In our conservation program, we co-operate with and advise conservation agencies in designing and implementing initiatives to conserve and manage southern African chelonians and their habitats. We initiated activities to

increase public awareness of our rich chelonian diversity and involve private landowners and local communities in chelonian conservation.

STUDENT PAPER

Designing a Geodatabase: Using the Nest Survey Data for the Raven Management Project

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Using Bill Boarman's historical predaceous bird nest database, 2004 and 2005 juvenile desert tortoise predation associated with nesting sites in the Mojave Desert was investigated. Of all nest sites visited in 2004, 6.26% had predation evidence, while 7.46% of those in 2005 had predation evidence. These figures are lower than the historical average of 8.98%. The use of GIS to look at the spatial patterns of ravens and predaceous bird nesting locations in the Mojave Desert is described. Designing a geodatabase will help to improve data management and distribution. With this structural design the tools to assemble intelligent geographic information systems are endless.

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) social behavior studies at Fort Irwin; 2) long-term demography studies in California with emphasis on age and life span determination methodology, causes of death, and mortality rates; 3) research on anthropogenic impacts to tortoise populations and their habitat in the Mojave Desert; 4) development of population density determination algorithms 5) re-photography studies to evaluate natural recovery rates of disturbed lands; and 6) new research involving the development of a science - based translocation plan for desert tortoises at Fort Irwin National Training Center. 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. 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/.

STUDENT PAPER

Incidence of *Mycoplasma agassizii* in Desert Tortoises in Greater Phoenix and Mohave County, Arizona

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Upper Respiratory Tract Disease (URTD), caused by the pathogen *Mycoplasma agassizii*, poses a critical threat to the Mojave population of the desert tortoise (*Gopherus agassizii*). A recent study on URTD in Greater Tucson, Arizona found 53.2% of tortoises sampled had been exposed to *M. agassizii*. To determine the presence of URTD in Greater Phoenix and Mohave County, 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 flush samples were collected between July through October 2004 in Phoenix, and March through May 2005 in Mohave County. We found 96 desert tortoises in Phoenix area surveys and 29 in our Mohave County surveys. We collected blood and nasal flush samples from 88 free-ranging and 96 captive desert tortoises within Greater Phoenix, and 24 free-ranging and 51 captive desert tortoises within Mohave County. Nine (10.2%) free-ranging and 22 (23.9%) captive desert tortoises in Greater Phoenix, and one (4.2%) free-ranging and eight (10.2%) captive desert tortoises in Mohave County tested ELISA-positive for *Mycoplasma* antibodies. Two (4%) captive Phoenix tortoises tested PCR-positive; analysis of 2005 samples has not been completed. The frequencies of URTD occurrence in wild and captive tortoises in Phoenix and Mohave County are both substantially lower than for tortoises in the Tucson area. Additional surveys are needed to better measure of the distribution of URTD throughout the Sonoran Desert.

Radical Bio-integration in Ecosystem Restoration: Releasing the Wrong Turtles in the Right Places?

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Only a relative few turtle species have actually succumbed to extinction at the hands of humans in the past few centuries, and most of these were giant land tortoises on small, remote

oceanic islands. Today however, many dozens of chelonian species stand on the brink of extinction due to the cumulative effects of habitat loss and alteration and over-collecting for the local or international animal trade. Turtles today are a global commodity on the cusp of a tragic 'market failure'. On a global scale, the seeming inevitability of continued habitat loss and inability to staunch growing worldwide demand for turtles has forced conservationists to supplement traditional conservation approaches with more radical, interventionist strategies, including turtle salvage operations and an emerging coordinated global network for ***ex situ*** propagation of 'assurance' populations.

If one considers "radical bio-integration" the intentional introduction of a non-native (i.e., alien) species into a 'natural' or even altered ecosystem, then this phenomenon (generally unplanned and typically fraught with adverse environmental impacts) has now also become a significant factor in the conservation equation. With respect to the re-introduction of captive turtles (either wild caught or propagated) back into nature, there are only four possibilities:

1) Releasing the "wrong" turtles in the "wrong" places (e.g. red-ear sliders almost everywhere outside their natural range);

2) Releasing the "right" turtles in the "right" places (e.g. the successful repatriation of more than 1300 captive hatched and Espanola Island Galapagos tortoises, or the "head-starting" of sea turtles);

3) Releasing the "wrong" turtles in the "right" places (e.g. replacing extinct turtle species with ecologically equivalent analog or proxy species to preserve turtle-linked biodiversity and restore long-term ecosystem structure and function [along perhaps with possible economic benefits], such as is now ongoing in the Seychelles, Mauritius and Rodrigues with the introduction of alien Aldabra tortoises);

4) Releasing the "right" turtles in the "wrong" places (e.g. releasing species threatened or extinct within their natural range into other geographic areas yielding inadvertent or intentional conservation benefits; such as the Chinese wattle-necked softshell turtle established in Hawai`i).

This paper elaborates on turtle conservation opportunities and constraints presented under options 3 and 4 above. We also consider landscapes that are not natural. Turtles are already found everywhere, from courtyards in Buenos Aires to artificial lakes in Hanoi, or Los Angeles. A nearly limitless array of ever expanding human altered landscapes present theoretically possible homes for turtles and tortoises, from farmland to suburban residential neighborhoods, intensively managed parklands, and even toxic waste sites! How should we think about these localities in creating a global turtle conservation vision? We propose that the primary criterion for introduction of species into highly altered anthropogenic habitats is aesthetic. As an example, consider the famous gardens of the Brazilian landscape architect Roberto Burle Marx. They are beautiful indeed, but are populated entirely by plants (typically alien). We may ask from an aesthetic point of view, where are the turtles? We eventually come to realize that there can be a great deal of similarity between the jobs of an interior decorator, a landscape architect, and a wilderness preserve manager. When we understand how these jobs can interact and compliment

each other, we will have a truly global vision of turtle conservation that integrates both natural and human transformed landscapes.

A version of this paper was presented at the Third Annual (2005) Turtle Survival Alliance Meeting in San Diego, California.

The Morphologically Distinct Sinaloan Desert Tortoise

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Little is known about the desert tortoise of Sonora, Mexico. During an exploratory trip to the Sinaloan Thorn Scrub (*sensu* Brown and Lowe) of Alamos, Sonora, Mexico, nineteen tortoises were examined. An unexpected result of this sampling was that tortoises from this region appear to be morphologically distinct from *Gopherus agassizii* north of the Mexico-United States border. Qualitative morphological characters and a limited number of quantitative variables are compared to *G. agassizii* from populations in Arizona (Sonoran Desert), extreme southeastern California (Lower Colorado Subdivision of the Sonoran Desert), and the northwestern extent of *G. agassizii*'s range (Mojave Desert).

Temperature-Dependent Sex Determination in Reptiles

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The original reports of egg-incubation temperature affecting offspring sex-ratio in reptiles in the late 60s and early 70s were greeted with some skepticism, but within a few years the phenomenon of temperature-dependent sex determination (TSD) was shown to occur in many turtles, crocodiles, and a number of lizards. Only 79 of the 257 species of turtle have been investigated, and of these 64 have TSD (Ewert et al., 2004). In two families of turtles, the Chelidae and the Trionychidae, only enotypic sex determination (GSD) has been found, but only a few species in these families have been studied. Among the crocodiles, 12 species are known to have TSD, and the remaining 11 species are expected to show a similar pattern. Most lizards have GSD, but TSD is common in some families such as the Agamidae, Eublepharidae and

Gekkonidae (Harlow, 2004). TSD also occurs in the Tuatara (Sphenodontidae), but all snakes appear to have GSD, and, in many cases, distinct sex chromosomes.

A large number of publications on TSD in reptiles under field and laboratory conditions have defined the range of temperatures that produce males and females, and temperatures that produce mixed sex ratios. The incubation temperature that produces a 50:50 sex ratio is defined as the pivotal temperature. Within populations pivotal temperature can vary with latitude and longitude. For example, the pivotal temperature for *Chelydra serpentina* embryos in Florida is 23 and 26°C whereas in Minnesota it is 28.5 °C. On the other hand the pivotal temperature appears to be identical in *Caretta caretta* nests from many different latitudes.

Field studies on nesting loggerhead sea turtles and alligators have shown an overall female sex bias in offspring over several consecutive years. How these skewed sex ratios affect the overall population remains unknown.

One characteristic of TSD reptiles is the absence of heteromorphic sex chromosomes. Male and female karyotypes are indistinguishable, as is their DNA. Despite the enormous progress in understanding the genes involved in sex determination in mammals, the molecular basis of TSD remains unknown.

Update of the University of Redlands' Desert Tortoise Project –2004-05

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The Desert Tortoise Project at the Redlands Institute (RI), University of Redlands in California is in its last year and a half of Congressional funding. 2004-05 marked a change in the scientific leadership for the Redlands Institute. The following projects were undertaken over the course of the year. Working with USGS and UNR, the RI developed a model for the Conservation Mitigation Working Group (composed of managers from the Bureau of Land Management, US Fish and Wildlife Service, California Department of Fish and Game, US Department of Defense, and US Department of the Interior) to come up with locations to relocate desert tortoise that will be displaced from Ft Irwin/NTC. We used GIS and a Decision Support System that allowed us to address biological, geomorphological, as well as anthropogenic factors important to the translocation. RI and Defenders of Wildlife funded research by Dr. Olav Oftedal (National Zoological Park, SI) on the distribution of desert tortoise food plants across the range given the very wet spring and good plant growth conditions of 2005. The Institute funded and was involved with a pilot study by Dr Wendy McIntyre and her students (University of Redlands) to look at the abundance of ravens and their nests in the translocation site prior to the translocation of tortoises. We have also worked with the DMG to examine and summarize recovery actions in the various land management plans of DOI and DOD in the Mojave. Finally in September we moved into our new "green building" for Environmental Studies – Lewis Hall.

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

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The Bureau of Land Management (BLM) administers approximately 4.5 million acres of desert tortoise habitat in Clark, Lincoln, and Nye counties, Nevada. Of these acres, 1,085,000 acres were designated as Critical Habitat on February 8, 1994. Desert Tortoise habitat is managed out of the Las Vegas, Tonopah, and Caliente Field Offices (FO). Section 7 consultation on land use plans and individual projects remain a major work load for the FOs. Law enforcement personnel are actively involved in preventing desert tortoise collection, vandalism, and road closure enforcement. Roads, freeways, highways, and railroads are evaluated to reduce mortality. Utility and energy facilities and corridors are evaluated and mitigated to reduce desert tortoise predation and loss. In 2005 several large wildfires burned in the Mojave Desert. The BLM is working on several projects to address issues associated with these wildfires. Wildfires in desert tortoise habitat will continue to receive priority response, emergency stabilization, and restoration plans developed to rehabilitate the area as quickly as possible. Several projects have been funded by land sales in Clark and Lincoln Counties. The Clark County Multiple Species Habitat Conservation Plan (HCP) funds numerous projects including those that benefit the desert tortoise. Some significant projects funded through the HCP process this past year that benefit desert tortoises within Clark County include the development of Conservation Management Strategies for the Nevada Desert Wildlife Management Areas, monitoring and maintenance of desert tortoise protective fencing along highways, and continued implementation of public outreach through programs such as Mojave Max emergence contest.

Summary of the Summer 2005 Mojave Desert Fire Season: When, Where, and Why Fires Occurred

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Large areas of the Mojave Desert, especially the northeastern region, burned in 2005. These fires were fueled by high fine fuel loads, a result of record high precipitation during the past three years (total annual rainfall amounts in Las Vegas for 2003, 2004, and 2005 were all among the top 10 wettest years on record). The majority of fires were sparked by lightning storms during two periods in late June and late July. The Southern Nevada Complex was a conglomeration of fires that burned 750,000 acres (304,000 ha) between 6/22/05 and 7/10/05. Other fire complexes in southwestern Utah and northwestern Arizona burned roughly 216,000 acres (87,000 ha) of Mojave Desert habitat. Substantial areas of desert tortoise habitat were consumed in these fires, including 23% percent (20,000 ha) of the Beaver Dam Slope Critical Habitat Unit (CHU), 19% (4,100 ha) of the Upper Virgin River CHU, 14% (28,000 ha) of the

Gold Butte-Pakoon CHU, and 4% (6,300 ha) of the Mormon Mesa CHU. A near equal amount of area (51,000 ha) burned in creosotebush habitat adjacent to these CHUs.

Use of Remote Sensing to Evaluate Fire Effects on Vegetation and Prioritize Areas for Post-fire Seeding

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In the summer and fall of 2005, USGS EROS prepared Burned Area Reflectance Classification (BARC) maps in support of interagency Burned Area Emergency Response (BAER) teams assigned to the Southern Nevada Complex and other nearby wildland fires. The BARC products, which are essentially preliminary soil burn severity maps, were generated for over 700,000 acres of burned area primarily in southern Nevada and California. The BARC maps were developed using the differenced Normalized Burn Ratio (dNBR), which quantifies the magnitude of reflectance change between pre- and post-fire satellite images. The dNBR ratio has been shown to be correlated with soil burn severity. After the BAER team efforts were concluded, the BLM Ely Field Office (FO) organized a post-fire monitoring effort to determine which burned areas were optimal for seeding and to evaluate the effectiveness of seeding treatments over a 2 to 3 year time period. The remote sensing analysis accomplished in support of BAER, has been extended to assist in the BLM post-fire monitoring efforts. Satellite imagery was collected for the Southern Nevada Complex pre-fire, immediately post-fire (July 12, 2005), and 2 months post-fire (September 12, 2005). In addition to dNBR, the Normalize Difference Vegetation Index (NDVI) was used to evaluate variation and trends in biomass green-up. The BLM Ely FO generated candidate seeding site polygons using a GIS approach and analyzing several local information data layers such as vegetation, slope, soil, precipitation, and others. USGS EROS generated statistics for candidate seeding polygons which provided status of soil burn severity and vegetation greenness at the pre and post-fire points in time. Pre-fire and the July 12th images were used to map relative loss of vegetation cover. Pre-fire and the September 12th images were used to map relative recovery of vegetation cover. The vegetation loss and vegetation recovery data identified the highest priority areas for seeding to be were where vegetation loss immediately post-fire was highest, and vegetation recovery 2 months post-fire was lowest. Work is currently in progress to finalize seeding locations. A technical approach, that includes remote sensing and traditional ground based sampling methodologies, will be established to monitor the effectiveness of the planned treatments. Differences among management treatments in burned and unburned areas will be evaluated using ground-based data, along with concurrent remote sensing data. The ground-based data and remote sensing data will be compared to determine if satellite, and potentially aerial photography, would have been sufficient as a monitoring tool in the absence of ground-based data. Both the ground-based and the remote sensing data will also allow for the future evaluation of long-term vegetation trends in response to seeding and burning. Upon completion of this 2 to 3 year effort, results should suggest the expected cost and technical effectiveness of applying remote sensing techniques to the monitoring of burned area seeding treatments and potentially other fire effects in the desert southwest.

Quantifying the Raven Threat in the Translocation Area

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Ravens (*Corvus corax*) are a known threat to the desert tortoise (*Gopherus agassizii*) as they predate on juvenile tortoises lowering recruitment. Raven populations in the Mojave Desert have expanded rapidly for the past 20 to 30 years while desert tortoise populations have been drastically reduced. According to the Final draft of the Desert Tortoise Translocation Plan for Fort Irwin's Land Expansion Program at the U. S. Army National Training Center and Fort Irwin, the threat of predation in the translocation site(s) should be assessed. In this study raven populations and relative densities in the translocation area are estimated. Raven nest locations are documented. These data will provide a baseline for comparison to raven densities and nest sites in the future.

Status of the Desert Tortoise in the Red Cliffs Desert Reserve

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The Upper Virgin River Recovery Unit, managed as the Red Cliffs Desert Reserve (Reserve), is located in southwest Utah, Washington County. The Reserve represents the northeastern extent of the desert tortoise's geographic distribution. The Reserve contains 38,787 acres of Mojave desert tortoise habitat and its primary goal is to maintain a stable or increasing tortoise population in perpetuity. It is considered a highly threatened population due to its proximity to urban growth and small size.

Density estimates in 2003 showed a 47% population decline within Zone 3 and a 41% decline throughout the Reserve since tortoises were regionally monitored in 1998. The Utah Division of Wildlife Resources intensively monitored desert tortoises in the spring of 2005. Preliminary analysis of 2005 spring monitoring data shows that the Reserve tortoise population has stabilized since the 2003 decline.

In the summer of 2005, approximately 14,741 acres burned within the Red Cliffs Desert Reserve. Of the acres that burned, over 10,446 acres is considered desert tortoise habitat. Both the Plateau and Mill Creek fires burned some of the best and relatively dense populations of desert tortoises found within the Reserve. The Division estimates as many as 37.5 % of adult tortoises may have died as a direct result of the fires (estimate based on survival rates of radiotelemetered tortoises in the Plateau fire). Tortoise deaths were attributed to direct impacts including contact with flames, exposure to lethal temperatures, and smoke inhalation. The

Division proposes to complete permanent transects within burned areas to better understand direct mortality and fire impacts on the desert tortoise population within the Reserve.

The Genetic Relationships and Taxonomic Identity of the Desert Tortoise (*Gopherus agassizii*) from the Sinaloan Thorn Scrub of Mexico

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The desert tortoise, *Gopherus agassizii*, occurs in arid regions of western North America from southern Utah southward to northern Sinaloa, Mexico. Using restriction fragment length polymorphisms from the mitochondrial DNA genome, Lamb et al. (1989, Evolution 43:76-87), noted that the southernmost population of tortoises was genetically quite divergent from those further north. Berry et al. (2002, Chelonian Conservation and Biology 4:249-262) noted that this distinction could be indicative of an unrecognized species. Consequently, we pursued an analysis of the genetic variation, genetic divergence, and gene flow among populations of *Gopherus agassizii*. From near Alamos, Sonora, we obtained blood samples from 22 tortoises. Additional samples were obtained from two wild tortoises located at La Pintada, south of Hermosillo, as well as 20 samples from captive tortoises in Hermosillo's zoo. Two mitochondrial DNA genes were partially sequenced, and microsatellite DNA was obtained from 16 nuclear loci. Regarding maternal lineages, tortoises from Alamos were very distinctive, about equal in divergence as tortoises from California and Arizona. The sequence data implied that the ancestral population of *G. agassizii* was subdivided prehistorically into three metapopulations, perhaps about 5 Mya. The microsatellite motifs at several loci were unique; they were not shared with populations from either Sonoran (Arizona) or the Mojave population of the desert tortoise. This difference in motifs implied that nuclear gene flow had ceased to occur, i.e., that the Mexican population of tortoises from near Alamos was a distinct species. However, the mitochondrial haplotype in Alamos was also found in sympatry with that of Sonoran desert tortoises at La Pintada. This finding suggested the occurrence of translocations of tortoises by early humans, in particular the Seri Indians.

Head-Starting Desert Tortoises: Fort Irwin Release Project

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Several studies are underway to examine the utility of assisting, or "head-starting", desert tortoises, a threatened species. It has been shown that protecting nests, eggs and hatchling/neonate tortoises in fenced natural areas greatly increases survivorship. But tortoises cannot be kept in predator-resistant field enclosures for their entire lives. One of the major questions now is "how long do head-started tortoises need to be kept before they can be released with subsequent high survivorship?" An opportunity to examine this question arose at the Fort Irwin Study Site (FISS), where up to 58 juvenile tortoises ranging in age from 1.5 years to 14 years remained from previous studies inside two head-start enclosures. Experiments were designed to test the following six questions. Do larger juveniles survive better than smaller ones after release? If so, what is the threshold size or age for high survivorship? Do released tortoises show "homing" behavior, which may make them vulnerable to harm or defeat release efforts? Does "half-way housing" (releasing juveniles into small enclosures until they settle in, then remove the fencing) reduce or eliminate "homing" tendencies? Is there an effect of release distance on homing and survivorship? Does the season of release (spring vs. autumn) influence survivorship? Last September (2005) we telemetered and released four juveniles of an assortment of ages and sizes into each of three "half-way house" enclosures built out of sight but near (0.6 km) the FISS enclosures. Five more juveniles of assorted sizes were released around each of these three enclosures as "half-way-house controls." In addition, 16 more juveniles of various sizes were released at a "long-distance" (1 km) site. The remaining juveniles still in the head-start enclosures will be released at the long-distance site in spring 2006, to test for season effects. To date, radiotracking data along with GPS results and behavioral observations indicate that both "wandering" and "homing" behavior have been minimal. Moreover, apparently all released tortoises remained alive as of early January 2006.

Head-Starting Desert Tortoises: Twentynine Palms Hatchery/Nursery

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The United States Marine Corps Air Ground Combat Center (MCAGCC near Twentynine Palms is establishing a desert tortoise head-start facility. Currently under construction are three large enclosures, each 100 ft. by 150 ft. in area, with sides of quarter inch wire fencing buried about 12 inches and rising about 24 inches above ground, then topped with chain link fencing up to 6 to 7 ft above ground. An overlay of metal flashing between 2 and 4 ft above ground is intended to provide a barrier to climbing predators like rodents. Bird netting (two-inch mesh) will cover each enclosure to exclude flying predators. Shorter fences

surrounding each enclosure will keep stray, escaped or captive tortoises with diseases from contacting healthy tortoises through the enclosure fencing. Research questions being evaluated for study at this facility include the following. Do females showing active *Mycoplasma* infections produce babies that are also infected ("vertical disease transmission")? Are there previously undocumented predators at the Twentynine Palms site? Does "half-way housing" aid successful release of head-started tortoises? Do head-started tortoises ultimately breed successfully? Questions involving genetics and other assays are concerned with 1) sex ratio bias in hatchery neonates, 2) multiple paternity in clutches, 3) degree of genetic variation among resident tortoises, and 4) genetic uniqueness of resident tortoises, compared with other Mojave Desert populations. Two of the enclosures are being built to investigate *Mycoplasma* vertical transmission and multiple paternity questions, one for healthy ("control") females and one for females showing active external URTDS signs. Each enclosure will be subdivided into 24 pens, one pen per female egg donor, to allow all hatchlings from each clutch to be sampled. Long-term studies to follow released head-started tortoises are being planned.

Resident Tortoise Studies in Preparation for Desert Tortoise Translocations at Fort Irwin National Training Center, California

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In 2004 the Conservation Mitigation Working Group for the translocation of desert tortoises at Fort Irwin National Training Center (NTC) requested assistance from the US Geological Survey (USGS) to establish a plan for translocating tortoises residing in the expansion areas. The overall goals of the translocation plan were to ensure that all related activities would be humane, scientifically based, and would include quantifiable effectiveness monitoring. Several documents guided this process including the FWS Biological Opinion, the Ft. Irwin Biological Assessment, and the FWS Recovery Plan. As a result of this process, Ft. Irwin requested that initial studies of the resident populations in the translocation area be started in 2005. The USGS implemented a research and monitoring design that could accommodate replicated release sites with appropriate statistical controls. This design assigned tortoises to three broad categories including: translocated tortoises, resident tortoises, and tortoises that could serve as controls for the other two groups. Prospective sites for translocation were established using a GIS/Decision support modeling. Several release sites were established from the prospective sites that are dispersed across a large area to ensure their integrity as independent sites while minimizing the density of released tortoises. Research on over 180 resident and control tortoises has been initiated in a collaborative effort among several scientists, including studies of basic ecology and physiology, habitat use, movement, predation risk, and health and disease status. Characterization of primary productivity and perennial vegetation throughout the translocation area has also been initiated.

The Distribution and Abundance of High-PEP Plants in the Mojave and Sonoran Deserts in a Year of High Rainfall

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In years of plentiful winter rainfall and massive germination of winter annual plants, desert tortoises exhibit selectivity in foraging, consuming predominantly a subset of plants that are high in protein and water relative to potassium content (Oftedal et al. 2002). Such plants have a high Potassium Excretion Potential (high-PEP), allowing tortoises to store protein in tissues and developing egg follicles (Oftedal 2002). We hypothesize that the local abundance of high-PEP plants may be important to the nutritional status of tortoises, and therefore to population health and recovery. However, little is known about the relative abundance of high PEP plants across the range of the desert tortoise.

In April-May 2005 we conducted the first range-wide survey of high PEP plants in desert tortoise habitat, encompassing 25 tortoise study sites across the Mojave, Colorado, and Sonoran (Arizona Upland) deserts. At each site three ca. one-hour walking surveys were undertaken to look for high PEP plants and to assess relative abundance of other annual and herbaceous perennials. We observed a total of 37 species of high PEP plants in the families Fabaceae (legumes) and Onagraceae (evening primroses), but many were so infrequent as to be of little consequence for tortoise diets. 16 species were found at only one or two sites. The most widely distributed species ($\geq$ 10 sites) were *Astragalus nuttalianus, Lotus humistratus, Lotus strigosus, Lupinus concinnus, Lupinus sparsiflorus,* and *Camissonia boothii*.

An estimate of the density of high PEP plants was determined at 23 of these sites; at two southern sites in Arizona the annual plants were already too senescent to permit accurate counting of individual plants. At each site a 100 m transect line was laid out to intercept an area of apparent abundance of high PEP plants. A 5x5 m grid was laid out at 10 m intervals along the line and four 0.25m^2 plots were randomly selected in each grid. All high PEP plants in these plots were counted; other species of annuals and herbaceous perennials were identified and assessed according to abundance categories. Several high PEP species were found to attain high mean densities (n per m^2) at particular sites, such as *Astragalus nuttalianus* at the Woodbury-Hardy site, UT (66/m^2), *Lotus humistratus* at Fremont Valley, CA (15/m^2), *Lotus strigosus* at the Ft Irwin Control Site, CA (15/m^2) and A*stragalus acutirostris* at Fremont Peak, CA (10/m^2). However, mean species densities were usually much lower, less than one plant per m^2.

To compare regions, sites were categorized as western Mojave (n=5), central Mojave (n=6), northeast Mojave (n=4), Colorado (n=3) and Sonora-Arizona Upland (n=5). The total number of individual PEP plants per m^2 was summed for each site. Although there was considerable variation among sites within a region, a relatively high density of high PEP plants ($\geq$ 5/m^2) was found in the western Mojave (3 of 5 sites), northeastern Mojave (3 of 4) and in the Sonoran-Arizona Upland (4 of 5), whereas high densities were only found in 1 of 6 central Mojave sites, and none of 3 Colorado desert sites. From these data it appears that in a year of

high winter rainfall desert tortoises may have better access to high quality food resources in the western and eastern parts of their range than in the middle. Of course tortoises in the Arizona Upland also have access to summer forage following summer rains, and hence would be expected to face the least nutritional stress.

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The Center for Biological Diversity's Campaign for Desert Tortoise Recovery

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The Center's Desert Tortoise (*Gopherus agassizii*) conservation and recovery efforts have focused on the California Desert Conservation Area (CDCA), a 25 million-acre landscape where the Sonoran, Mojave and Great Basin Deserts come together. Designated by Congress in the landmark Federal Land Policy and Management Act of 1976, the 11 million acres of the CDCA managed by the Bureau of Land Management (BLM) contains 3.4 million acres of habitat designated as critical to the survival and recovery of the threatened desert tortoise The CDCA also harbors 23 other species federally listed as threatened or endangered, including the endangered Amargosa Vole, Arroyo Toad, Ash Meadows Gumplant, Coachella Valley Fringe-toed Lizard, Cushenbury Buckwheat, Desert Pupfish, Inyo Towhee, Lane Mountain Milkvetch, Least Bells Vireo, Peirson's Milkvetch and Peninsular Bighorn Sheep, to name just a few.

These 24 imperiled species and the overall ecological health of the CDCA have been further jeopardized by BLM's recent bioregional plan amendments of the 1980 CDCA Management Plan, i.e., the Western Mojave Desert (WEMO), Northern and Eastern Colorado Desert (NECO), the Northern and Eastern Mojave Desert (NEMO) and the Western Colorado Desert (WECO) Plans, which favor poorly managed mining, grazing, roads, energy development, and off-road vehicle excess at the expense of these imperiled species.

The keystone species of the CDCA and California's state reptile, the Desert Tortoise, is illustrative of BLM's management failures in regard to all these species. BLM refuses to protect critical habitat or implement the desert tortoise recovery plan. Even though Federal Courts, the U.S. Fish and Wildlife Service (FWS), the General Accounting Office and even Congressional

oversight have agreed the basis for this species' designated critical habitat and the existing recovery plan is sound.

In 2001, the Center settled a landmark lawsuit with BLM over its failure to follow the Endangered Species Act with regard to the CDCA Management Plan's cumulative effects. This settlement resulted in BLM actually implementing effective recovery actions on-the-ground, after years of ignoring the original intent of the CDCA Management Plan. These actions have now been unethically abandoned by the Department of Interior.

Permitted under the auspices of non-jeopardy biological opinions issued by the FWS, BLM's bioregional plans fall short on recovery needs of listed species and habitats. Further, almost none of the settlement items previously agreed to by BLM and supported by the FWS in several biological opinions and recovery plans have been incorporated into these plans. Consequently, these poor Department of Interior decisions are forcing further judicial review by groups like the Center who care about real recovery based on sound science. The abandonment of these settlement items represents not only another a step-back for recovery of listed species in the CDCA; it reflects a sad mockery of citizen involvement in public resources and a flagrant disregard for the rule of law.

Important federal court decisions have repeatedly struck down the willful 'adverse modification' and survival-only standard, i.e., voluntary conservation of critical habitats, currently espoused by FWS; ruling that such critical habitats must by law be managed for endangered species recovery, not just survival. This crucial ruling resulted from a claim by the Department of the Interior that washes were unimportant for desert tortoise recovery in the Northern and Eastern Colorado Desert, and by proxy elsewhere. Simple desert ecology screams otherwise.

Nonetheless, the now-chastised Department of the Interior refuses to acknowledge this judicial ruling central to implementing the Endangered Species Act. A case where off-road vehicle excess has been promoted over the responsibility to seek species' recovery and avoid adverse modification of critical habitat.

The Center will continue to work with other conservation groups to facilitate protection of all desert tortoise critical habitat, as well as recovery. We are also working in the U.S. Senate to keep the Endangered Species Act strong; focused on protection of critical habitats designated for all species and true recovery. This includes supporting strong Sonoran desert tortoise conservation foresight, as well as proposed legislation for voluntary buyouts of Federal livestock grazing permits and subsequent public land allotment retirement where these uses compromise desert habitat integrity.

Post-fire Emergency Stabilization and Rehabilitation of the Southern Nevada Complex

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The 2005 Southern Nevada Complex fires consumed nearly 700,000 acres of low and high elevation Mojave Desert habitats in the Las Vegas and Ely BLM Field Offices. Approximately 403,000 acres of potentially suitable desert tortoise habitat and 32,682 acres of designated critical habitat were impacted. Burn intensities and vegetative responses were highly variable. Some direct mortalities to desert tortoises were noted and indirect effects due to habitat loss, ecosystem shifts, abandonment of habitat in the burned area, and decreased reproductive rates are anticipated.

A multiple use agency, the BLM administers four wilderness areas, seven Herd Management Areas, and portions of 25 grazing allotments within the burned area. The area is rich with prehistoric and historic cultural resources and receives regular recreational use from hikers, OHVs, and hunters. Agency concerns include stabilization of these resources and resource uses through use management, natural recovery, seeding, seedling plantings, public education, and installation of public safety signs and devices.

Currently the agency is implementing both the emergency stabilization plan and the rehabilitation plan. Under these plans, approximately 50,000 acres of aerial seeding will occur throughout the two districts to stabilize soils and reduce the spread of noxious weeds and invasive plants. Limited seed collection and intensive hand seeding will occur. Wild horse gathers and livestock grazing closures will allow burned vegetation to regenerate and seeded species to become established. Hydrologic modeling of watersheds will be conducted to assess erosion potential from burned areas. Monitoring efforts will include use of satellite imagery and ground-truthing.

Stabilization and Rehabilitation of Vegetation above Desert Tortoise Habitats

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Emergency stabilization and rehabilitation (ESR) efforts above desert tortoise habitats are bounded by the types and purposes of available funding; federal authorities, laws, and regulatory practices; available technology, available seed and plant propagules, and the state of knowledge.

Emergency stabilization funds are used to minimize threats to life and property, and to stabilize and prevent unacceptable degradation to land and resources for one year following the fire containment date. Rehabilitation funds are used to repair or improve fire-damaged lands unlikely to recover naturally to management approved conditions for three years following the containment date. Use of natural regeneration and native seeds are preferred in ESR efforts.

Identification of appropriate seed application techniques and selection of seeded species is challenging. Seed application is guided by the extent, slope, surface type, soil types, land management status, presence of listed or sensitive species, and remote access needs of the area to be seeded. In many cases aerial seeding, via helicopter or fixed-wing aircraft is used because no other appropriate seed-bed preparation techniques exist. Selection of species to be seeded is predicated on market cost and availability, resource objectives for the area to be seeded, and seed application techniques. Seed mixes are adjusted for the site and typically include a mixture of native and introduced grasses with more minor components of forbs and shrubs.

Introduction to the Session on the Fort Irwin Expansion and Translocation Project, San Bernardino County, California

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Fort Irwin is in the process of expanding its maneuver training lands. In 1992 Congress withdrew 110,000 acres of land for Fort Irwin's Expansion. At the same time, Congress authorized 75 million dollars for mitigation of the Land Expansion Project. USFWS gave Fort Irwin a Non-Jeopardy Biological Opinion on February 27, 2004. The Army has already purchased 99,000 acres of mitigation lands, and has purchased the fee lands for grazing near Fort Irwin. This purchase effectively relinquished grazing rights on 350,000 areas. The Army will occupy the Eastern Expansion Area in June 2006. They expect to initiate training in the Southern Expansion Area in the fall/winter of 2006, if all of the desert tortoise conditions have been met. The Western Expansion Area is scheduled to open to maneuver training in FY09. This session will review the preparations of translocation efforts on Fort Irwin.

STUDENT PAPER

Nest Site Fidelity of *Gopherus agassizii* in the Sonoran Desert, Arizona

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We studied nest site fidelity of a population of desert tortoise, *Gopherus agassizii*, in the Sonoran Desert in Arizona from 1997 to 2004. Females were monitored throughout the reproductive season by use of ultrasound and X-radiography. Gravid females were followed pre- and post-ovopostion to determine nest site selection. Nest site determination was made based on evidence of fresh digging, extended shelter occupancy, and nest guarding behavior. We were able to determine nesting in 11 females for multiple years. Females used an average of 3 unique nest sites during the study period. There was no significant difference between the number of unique nest sites and the number of re-used nest sites. Several nest sites were used more

frequently than others, which may be based on physical characteristics such as suitable soil for nest building. There may also be spatial and hierarchical components determining nest site use between females.

The Arizona Game and Fish Department Desert Tortoise Project. Year in Review, 2005

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The year 2006 was a major transition year within the Arizona Game and Fish Departments Desert Tortoise Project. Most of our efforts were focused on disease related issues. We continued disease monitoring efforts on the urban – desert interface. We also reviewed our adoption and housing protocol, and public outreach efforts. In addition we also participated in the Desert Tortoise Handling Workshop, the Desert Tortoise Recovery Plan Science Advisory Committee, and desert tortoise population genetic studies in both the U.S. and Mexico.

The Sugarloaf Mountain Desert Tortoise Long-Term Study Plot. A Preliminary Analysis of Almost 12 Years of Data.

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The Sugarloaf Mountain Desert Tortoise Long-Term Study Site is located northeast of Phoenix, in the Sonoran Desert, Arizona. The site was originally chosen as a reproductive ecology study site in late summer 1991 and tortoises were monitored on site until late summer 1993. After a brief hiatus, monitoring began again in 1996 and continued until July 2005. In that time 143 individual desert tortoises were marked, and 9,171 tortoise locations recorded. The original tortoise number 1 was marked in September 1991, and monitored until the completion of the project. Ten years of reproductive data was collected. The Sugarloaf Mountain site has also figured prominently in several other desert tortoise research projects including: nest site temperatures, foraging and nutritional ecology, population genetics, and range-wide disease monitoring. We are currently using this data set to look at microhabitat use, and spatial and behavioral ecology. A brief history of the site and a preliminary look at the spatial data will be presented.

"I Haven't *Lost* My Rose-Colored Glasses, But I *Am* Having Difficulty Finding Them:" Reserve Management After Drought and Fire

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Washington County and our partners continue to make progress on Habitat Conservation Plan mitigation goals such as habitat acquisition, installation of fencing, construction of an education center, and management of authorized activities within the boundaries of the Red Cliffs Desert Reserve. However, the 2002 drought and the 2005 fires have significantly impacted a population of tortoises that only 4 years ago seemed reasonably protected. If that isn't bad enough, the ongoing threat of fires fueled by non-native annual grasses looms as the 2006 fire season approaches. We implore all those concerned with the recovery of tortoise and the ecological stability of the Mojave Desert to assess what is already known about managing these invasive grasses, to initiate research to answer critical questions, and to help guide the decisions that must be made in the years ahead.

STUDENT PAPER

Pellet Analysis of Predaceous Birds in the Mojave Desert

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As desert tortoise (*Gopherus agassizii*) populations have steadily declined due to various threats, populations of the common raven (*Corvus corax*) have increased tremendously in the Mojave Desert, possibly due to increased human presence in some areas. Ravens are highly intelligent and opportunistic birds, which are native to California as well as being a natural predator for the desert tortoise in its juvenile stage. However, there is growing concern about the relationship between these two species as it has evolved. Although it has been difficult to assess the level of impact of ravens on the tortoises, past proposed solutions have included lethal control of ravens, which has been somewhat ineffective. The diet composition of predaceous birds can be determined by examining the indigestible material contained in pellets, which they cast from their crop. Through pellet analysis, it may be possible to learn more about the diet of birds predating on juvenile tortoises as compared with birds that do not do so, and also to improve management strategies.

The Tropical Deciduous Forest: A Desert Tortoise Home Like No Other

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Near the southern terminus of its geographic range, in southern Sonora and northern Sinaloa, Mexico, the desert tortoise occurs in a biodiverse, seasonally lush tropical biome, the tropical deciduous forest (TDF). As the North American climate dried out during the Miocene 25 to 10 mya, some of the tropical plants and animals adapted to this increasing aridity, creating new species. These new species, in combination with older ones, produced the assemblage that we know today as thornscrub. Continued adaptation to aridity eventually produced the biota that comprise the present-day Sonoran Desert, about half of which evolved from tropical species. Near Alamos, Sonora, annual rainfall ranges from 500-900 mm, far exceeding the 111-mm long-term average in creosotebush/white bursage-dominated desertscrub at Needles, California, and 2 to 3 times that falling on the saguaro/paloverde-dominated Arizona Upland desertscrub at Tucson, Arizona. Though some Sonoran Desert reptiles and amphibians (desert tortoise, Sonoran Desert toad, zebratail lizard, western coral snake) range from desertscrub in the north to TDF in southern Sonora, the contribution of TDF to the diversity of the regional biota is overwhelming. Plants, such as amapas (*Tabebuia* spp.), cuajilotes (*Pseudobombax palmeri*), and rattail orchids (*Oncidium cebolleta*); and animals, such as black-throated magpie jays, military macaws, vampire bats, mouse opossums, pichecuates, parrot snakes, clouded anoles, Mexican leaf frogs, and Mexican tree frogs, all signal that one is in TDF. Finding tortoises in TDF during the summer rainy season is severely complicated by the dense undergrowth, with vegetative cover sometime exceeding 400 percent.

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. Fencing has been installed in some of the areas to exclude cattle grazing and OHV use. In addition to the lands that

have been acquired by the Department, mitigation lands have also gone to the Desert Tortoise Preserve Committee.

In 2005, 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 are co-funding the DMG's Desert Tortoise Outreach and Education coordinator for 2006 and trying to find funds to support the position next year. Work continued on permitting numerous small projects, which include mining activities, housing and other urban development, and road projects. The Department spent significant time and resources this year working with Department of Defense on the Fort Irwin Expansion, the West Mojave Plan, chairing the free-roaming 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.

A Plan to Conserve Bolson Tortoises in New Mexico

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Following more than a year of investigation and planning, the Turner Endangered Species Fund has committed the resources to transfer a contingent of captive bolson tortoises from a facility in Arizona to the Turner-owned Ladder Ranch in New Mexico with a view to long-term propagation and conservation. The planning has involved collaborations with the Appleton family (owners of the Arizona population), soliciting advice from tortoise experts (including a visit to a headstart facility for desert tortoises managed by Ken Nagy and Scott Hillard), input from state and Federal agency representatives, visits by scientists to help assess habitat on Turner's Ladder and Armendaris ranches in New Mexico, and interactions with administrators and biologists involved with the bolson tortoise program at Mexico's Mapimi Biosphere Reserve. We recently circulated a draft plan among those involved to date as the basis for discussion and development of a final plan. Key parts of this draft plan are: building two large outdoor enclosures on the Ladder Ranch to hold the tortoises, transferring tortoises to the Ladder Ranch in 2006, husbanding adults and incubating eggs to maximize production, and using separate "headstart" enclosures for neonates to enhance recruitment of young into relatively invulnerable, older age cohorts. Expansion of the program to Turner's Armendaris Ranch about 40 miles northeast of the Ladder is planned once the Ladder operation is secure. Crucial long-term aspects of the plan are research, close collaboration with experts in the United States, and continuing collaboration with the Appleton family and the bolson tortoise program of the Instituto de Ecologia in Mexico. Our long-term vision for these ranches includes conservation and research focused on at least two free-ranging bolson tortoise populations.

The Sonora, Mexico Desert Tortoise Research Project

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In November of 2005 a research expedition to investigate the status of the desert tortoise in the southern reaches of its geographic range was undertaken. The expedition was nearly a year in the making and a monumental collaborative effort between international researchers, institutions and agencies. A team of 24 field biologists and researchers ventured into the Tropical Deciduous Forest (TDF) near Alamos, Sonora to gather as much information as possible on the tortoise within this unique ecosystem. With the cooperation of people of the Alamos region we were successful in initiating the first ever comprehensive research project on the tortoise in the TDF. We entered with questions in hand. How does this tortoise differ genetically and morphometrically from those in the Mojave and Sonoran Deserts? What is the health status of these animals, and does *Mycoplasma agassizii* occur in the tortoises of the TDF? How does the TDF tortoise behave throughout the seasons in comparison to those in the northern populations? The research in Sonora continued north to the Hermosillo region where the team gathered information on both captive and wild tortoises in Central Sonora. Through in-field health assessments, blood sampling, telemetry, and focal studies we hope to decipher some of the mysteries of the desert tortoise in Sonora and Sinaloa and provide the foundation for the long-term management and preservation of the species in Mexico.

Is the Desert Tortoise of the Mojave Desert a Keystone Species in an Old-growth Ecosystem?

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The concepts of keystone species and old-growth ecosystems have been widely used in the past few decades, so much so that a clear understanding of them has faded away. However, the management implications for both concepts are tremendous, thus an understanding of definitions is necessary.

Keystone species are ones that play dominant roles in an ecosystem and affect many other organisms; they can be predators, herbivores, or habitat modifiers. However, the title "keystone species" in most cases does not apply to all members throughout the species range but rather its functional role in a particular community assemblage. Examples of keystone species include the ochre sea star, sea otters, grizzly bears, beavers, and gopher tortoises. We will present a case study of the gopher tortoise as a keystone species and compare it to results from our research on desert tortoises.

Old growth is a definition that was developed for forested systems and as such is not traditionally applied to desert ecosystems. However, key features are present in all definitions of

old-growth that can be applied to desert ecosystems. These include: large long-lived species, the tendency for dominant species to have complex crown structures, mixed aged stands, pit and mound topography, sensitivity to fire, and minimal signs of human disturbance. They also tend to provide habitat for plants and animal species that either do not occur in younger stands or occur less abundantly. We will make a comparison of these old-growth features to creosote bush scrub. We will then present data from a study on microhabitat selection by the desert tortoise to show that they are highly selective of habitat, selecting large shrubs, primarily large creosote bush.

Results from this research, although preliminary and from a localized area, support the statement that in the Mojave Desert the desert tortoise is a keystone species in an old-growth ecosystem.

URTD, Sex, and Superspreaders: Lessons from the Florida Gopher Tortoise

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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 were observed prior to development 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 provided a unique opportunity to study the effects of URTD on population dynamics and disease progression. Between 1996 and 2001, the population was free of clinical signs, had few if any seropositive animals, and did not experience abnormal mortality events. In 2002, *M. agassizii* was introduced into the population via unauthorized relocation events. From 2003 to 2005, the population experienced a rapid increase in seropositive animals, with the exposure rate now in excess of 75% of adults. Clinical signs were observed in 2003, with the most severe signs in 2004; severity of clinical signs was decreased by the third year of the outbreak. Initial mortality events were observed in 2003, and have increased in numbers in each subsequent year. In addition, fecundity rates have been depressed. This suggests that the temporal pattern of URTD in an initial outbreak is characterized by the introduction of the pathogen resulting in seroconversion of the population. Once a threshold level of exposure is reached, clinical signs are observed. The severe clinical disease phase is followed by more chronic disease, often with less severe and less frequent clinical signs. Mortality events are delayed, and may not reach maximum intensity until after the overt clinical disease has progressed to the chronic stage.

In order to better understand the transmission dynamics, we analyzed data from a statewide survey of wild populations as well as intensively studied the disease outbreak site. Based on the statewide survey, we found that the pattern of seroprevalence was found to mimic a sexually transmitted infection in that no subadult tortoises had antibodies to *M. agassizii*. This finding was confirmed by culture and OCR of a subset if individuals. *Mycoplasma agassizii* was not recovered from the nasal lavage of any tortoise below reproductive size. We hypothesize that this pattern is compatible with a disease transmission pattern related to factors such as courtship/mating behavior and interactions among males to establish hierarchical dominance. We used fluorescent dye tracking to map the movement patterns of tortoises on the acute disease outbreak site in 2004 (N= 16 males, 5 females) and 2005 (N= 11 males, 3 females). Five of the 35 tortoises were tracked in both 2004 and 2005. A complete health assessment was performed at the time the dye pack was attached. Based on percentile analysis of the distance travel and the number of burrows visited by the tortoises, we identified two primary groups, travelers and visitors, considered to be candidates to act as "superspreaders" of URTD". Eight tortoises (7 male, 1 female) were identified as travelers, with a mean travel distance > 40 m/d. Maximum distance traveled in a single day by this group ranged from 116 m to 293 m. A second group of 7 tortoises (all male) were identified as visitors, visiting at least one additional burrow per day. The maximum number of burrows visited in any single day ranged from 2 to 5, with all but one tortoise visiting at least three burrows in its most active day. Importantly, four tortoises were both travelers and visitors. Travelers were classified as seronegative (N=2), seropositive without clinical signs (N=4), and seropositive with clinical signs (N=2). These latter animals were identified as the greatest risk for transmitting disease while the seronegative travelers represented an at-risk group to contract disease. Visitors were classified as seronegative (N=4), seropositive without clinical signs (N=2), and seropositive with clinical signs (N=1). These latter animals were identified as the greatest risk for transmitting disease while the seronegative visitors represented an at-risk group to contract disease. Of the five recaptured animals, two were seropositive without clinical signs in either year, two were seropositive with acute clinical disease in 2004 but not in 2005, and one was seronegative in 2004 but seropositive in 2005. This last animal is particularly intriguing as it was both a traveler and a visitor and would have been predicted to be a highest risk for disease acquisition.

We suggest that the animals at lowest risk for acquisition and transmission of *M. agassizii* are tortoises below reproductive age. Further, introduction of seropositive animals into naïve populations may be likely to increase risk for development of an acute disease outbreak. Animals most at risk for transmission of *M. agassizii* are those with clinical signs that fall into the "visitor/traveler" categories; those that are at most risk for acquiring *M. agassizii* are those tortoises that come into contact with the superspreaders in the acute phase of the disease.

Tortoise Mortality Associated with Small-game Guzzlers in the Mojave National Preserve

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Artificial watering devices known as guzzlers were installed in arid zones of the southwestern United States, primarily during the later half of the 20th century, for conservation and enhancement of wildlife populations. Following the federal listing of the desert tortoise (*Gopherus agassizii*) as threatened, concerns were raised about tortoise drowning in guzzlers. Work conducted by the California Department of Fish and Game (Hoover, 1996) indicated approximately 20% of the guzzlers in eastern Mojave Desert tortoise habitat contained tortoise remains. We surveyed small game guzzlers in Mojave National Preserve during the spring and summer of 2004. Of the 52 guzzlers located within tortoise critical habitat 32 were thoroughly cleaned and 9 were found with an estimated total of 13 individual tortoise remains including one whole shell. This study indicates that existing small game guzzlers in the Mojave Desert need modifications to prevent mortality of desert tortoise.

Defenders of Wildlife's California Desert Campaign 2006 Update

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Defenders of Wildlife ("Defenders") launched a locally-based California Desert Campaign in 2005. This work focuses 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 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. In 2005 we spearheaded a Desert Tortoise brochure within the Desert Managers Group Desert Tortoise Information and Education Outreach Working Groups. This brochure was sponsored by Defenders, the DMG, and the National Off-Highway Vehicle Conservation Council and over 14,000 have already been distributed at OHV events, National Park Service, Bureau of Land Management and California state visitor's centers as well as other public outreach events. We completed the economic study, "Economic Benefits Provided by Natural Lands: Case Study of California's Mojave Desert." Preliminary results indicate that natural resources in the Mojave Bioregion contribute over $700 million (using 2003 figures), over $400 million of which is captured in financial markets. Additionally, Defenders launched a California Desert Program website (http://www.defenders.org/california/desert.html), contributed to research on desert tortoise nutrition, contributed matching funds for a critical fencing project through the Desert Tortoise Protective Council, was a founding member of the Coalition to Save Shavers Valley (desert tortoise critical habitat), continued to advocate for science-based analysis of artificial waters at the Mojave National Preserve, and continued to advocate for conservation of the

Mohave ground squirrel. We have also accepted an invitation to participate in the Desert Tortoise Recovery Planning and Implementation Work Group.

In 2006 we will hold public forums to discuss the results of our economic benefits analysis, continue to advocate for desert tortoise recovery, continue to be active in the DMG Desert Tortoise Education and Information Outreach Working Group, implement a raven education campaign aimed at the public, begin to develop educational road signs, continue to track developments within desert tortoise critical habitat, and participate in land-use planning processes in the West Mojave Desert and beyond.

Report on U.S. Fish and Wildlife Service Activities for 2005

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The U.S. Fish and Wildlife Service responsibilities for the desert tortoise include conservation and recovery planning and implementation, consultation with Federal agencies under section 7 of the Endangered Species Act (ESA), endangered species or recovery permits, habitat conservation plans (HCPs) and associated incidental take permits. All desert tortoise recovery permits are now administered by the Desert Tortoise Recovery Office. The Service's Rangewide Recovery Coordinator will present a summary of recovery actions accomplished in 2005.

Major consultations completed in 2005 include BLM's California Desert Conservation Area Plan amendment, Mojave National Preserve Wildfire Management Plan, and a programmatic biological opinion for BLM's Red Rock Canyon National Conservation Area outside Las Vegas. Environmental documents are in preparation for major powerline and pipeline projects in southern California. The Mesquite Regional Landfill in southern California began to implement their project that will impact 3,656 acres of Category III habitat; translocation efforts concluded this fall found 32 tortoises (20 adults and 12 juveniles) within the 3.5-square mile project area.

In addition to local HCPs initiated in California, other HCP activities include the West Mojave Plan; the Coachella Valley Multiple Species HCP which may include a 10.5-square mile development project in Paradise Valley within the Chuckwalla Critical Habitat Unit; expansion of the U.S. Borax Mine; and regional southern Nevada HCPs. Nine thousand acres of Cathton property in Coachella Valley was purchased by a consortium of agencies and groups that prevents development adjacent to Joshua Tree National Park, and a linkage parcel that connects the San Gorgonio and San Jacinto Mountains.

Wildfires that occurred in the summer burned hundreds of thousands of acres of desert tortoise habitat primarily in Nevada and Utah. The Service is coordinating and consulting with land managers on impact assessments and habitat rehabilitation. The Arizona Strip BLM is revising their Resource Management Plan. Our Arizona Field Office is reviewing a draft environmental impact statement for the plan which will continue into 2006.

In Nevada, the Clark County HCP and Southern Nevada Public Lands Management Act (SNPLMA) funded desert tortoise projects including: Construction of desert tortoise exclusionary fence along highways, law enforcement, translocation of tortoises into a fenced 35 square-mile experimental release site, various research projects, and habitat restoration. Funding was recommended to develop a baseline tracking system for desert tortoise consultations.

Also recommended for SNPLMA funding is an assessment of desert tortoise habitat on BLM-administered lands in Lincoln County, Nevada. The project would assess approximately 300,000 acres of desert tortoise habitat and designated critical habitat that burned this year. The assessment would include desert tortoise mortality surveys and vegetation inventories on the burned acres, and current population inventories of desert tortoise on 754,600 acres in Lincoln County. With over 30 percent of desert tortoise habitat burned in Lincoln County, this project is a vital opportunity to assess and understand the impacts of fire and subsequent recovery of desert tortoises and their habitat in the Mojave Desert.

The Service initiated review and revision of the desert tortoise field procedures and handling protocols. Review of the Desert Tortoise Council Handling Guidelines prepared in 1994 and revised in 1999 will be included in this effort. Desert tortoise fencing specifications were revised in 2005 and available on our Ventura Field Office website. A draft revision of the documents is anticipated in 2006 and will be widely distributed for comments.

Managing Department of Defense Lands for Desert Tortoises

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As part of their defense mission, and for reasons of safety and security, Department of Defense (DoD) installations often encompass large areas of relatively undisturbed natural resources far from civilian populations. DoD is responsible for maintenance of the multiple use values of the federal land it occupies. Therefore, DoD has *de facto* two critical missions. The primary mission concerns defense, while the secondary mission is natural resource management.

Land management among federal agencies in the Mojave Desert is a model that continues to receive accolades. Through the Desert Managers Group DoD and other government, agencies have formed a strong partnership to work toward desert tortoise recovery and habitat restoration. DoD continues to promote desert tortoise education, fund studies of predator ecology and behavior, genetics and disease, and "Head Starting." Funding has also been made available for technological innovations for juvenile desert tortoise research; exciting new work is beginning in that area. All the DoD agencies have made major contributions, but there are still problems and setbacks to desert tortoise recovery. Information and issues will be frankly discussed.

STUDENT PAPER

Monitoring Strategies for the Sonoran Desert Tortoise

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Effective conservation depends on efficient methods to monitor populations, especially for rare species. Desert tortoise populations are challenging to monitor because of their limited activity periods, cryptic appearance, and low densities throughout much of their range. Current monitoring strategies focus on population density, either estimated through line-transect distance sampling in the Mojave Desert or based on mark-recapture methods on 1-km^2 or 1-mi^2 plots in the Sonoran Desert. Although distance sampling is effective in the Sonoran Desert, it is less efficient than in the Mojave Desert given the more rugged environments inhabited by tortoises there. In 2005, we initiated a study in southern Arizona to compare distance sampling with site occupancy, a relatively new approach thought effective for animals with low rates of detection. Occupancy provides an estimate of the proportion of survey sites that are occupied as well as information on geographic distribution. We used five presence-absence surveys of tortoises on each of 20 3-ha plots to estimate occupancy and 60 line transects to estimate density. Estimating density with distance-sampling methods was less time and cost efficient than estimating occupancy, suggesting that site occupancy may prove to be a more efficient strategy for monitoring tortoise populations. We intend to continue this study in 2006, and use these data to compare the effectiveness of both approaches as long-term strategies for monitoring trends in populations of desert tortoises.
