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THE DESERT TORTOISE COUNCIL

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ABSTRACTS

(Abstracts arranged alphabetically by last name of first author)
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Potential Shifts in Mojave Desert Plant Communities in a Changing Climate

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There is much uncertainty about how desert plant communities will respond to a changing climate in the southwestern USA. Understanding plant responses to climate change is especially important because as primary producers, plants directly affect food and cover for desert tortoise and other dependent species and provide fuel for wildfires and feedbacks for further climate change. This presentation provides an overview of potential effects of climate change on vegetation of the Mojave Desert with implications for managing desert tortoise habitat. Two examples of approaches to forecasting potential plant community alterations in a changing Mojave Desert climate are presented. First, 30-year remeasurement results (1979 and 2008) are shown for a network of 116 plant community transects established along an elevational gradient in southern Nevada. Over the last 30 years, average annual minimum temperature has increased by 1.5°C in the study area. Based on the known species abundances within the remeasured transects and interpolative modeling using the climatic variables, some long-lived perennials such as *Larrea tridentata* have incurred little distributional change. However, some species that occur only at the highest elevations, or more generally only within specific elevational ranges, have shown substantial distributional changes. Second, a longer term perspective using paleoecology is illustrated for how land managers might use this tool for establishing a broad range of reference conditions that can meet habitat management and restoration objectives. Taken together, results portray the value of these research approaches to contending with uncertainty when developing habitat management plans in changing climates.

Clutch Phenology in a Population of Agassiz's Desert Tortoises (*Gopherus agassizii*) at a Wind Energy Generation Facility in Southern California

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We studied the reproductive ecology of a population of *Gopherus agassizii* at a wind energy facility near Palm Springs, California from 1997-2011, over seven field seasons (1997-2000, 2009-2011). Adult females were equipped with radio transmitters and located at 7-10 day intervals during the reproductive season from April-July. X-radiography was used to determine dates of appearance and disappearance of shelled eggs, clutch size and clutch frequency. First clutches were visible from April 11 (1997) to July 13 (1999). Second clutches were visible from May 1 (1997) to July 20 (1999). Third clutches were visible from June 15 (2009) to July 28 (1998) and occurred only eight times in five years among seven of 21 females (none more than once), with most (n=4) in the wettest year (1998). Mixed model ANOVAs found a significant difference in the mean number of days from January 1 to the appearance and disappearance of first and second clutches among years, after controlling for maternal effects. Pairwise comparisons among years demonstrated that 1999 had significantly different clutch phenology relative to other years. Based on egg detection beginning and end dates, eggs were visible for intervals of 58-105 days/year ($\bar{x}$ = 82.9 days) in each year. These intervals were significantly different from the expected proportionally equal values among years. After setting our biofix to the approximate date of emergence from hibernation (March 1) at a minimum threshold temperature of 17.8° C we calculated degree day accumulation to various clutch phenological events. We used minimum heat unit accumulation in 1997 (1998 was anomalous for heat units) to predict the date of first clutch appearances in 1999 and 2000 to within 1-6 days. Using minimum heat unit accumulation in 2009 and 2010 we estimated the date of first clutch appearance in 2010 to within 4 days.

POSTER

Evidence of Winter Activity of the Agassiz's Desert Tortoise (*Gopherus agassizii*) in the Central Mojave Desert

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Agassiz's desert tortoise (*Gopherus agassizii*) behavior and movement is often viewed in terms of an "active" season whose beginning and end is marked by the surfacing from and retreating to winter hibernacula. During the winter months, tortoises are often assumed to remain dormant underground until emergence in spring. While monitoring a large population of tortoises at three sites in California near Ft Irwin, we observed periods of activity and movement during the coldest months of the year (20 November 2010- 20 February 2011). Of the 377 tortoises monitored over the winter, we defined 37 (9.8%) tortoises as active (at least one above-ground encounter or movement >15 m), with net movements ranging from 2.2 m to 1625 m. Activity events occurred equally between December and January encounters (n=25), and January and February encounters (n=24) with 11 tortoises exhibiting activity on more than one occasion. The percentage of active tortoises compared to the total monitored was significantly disproportionate by site (SEA=6.8%, WEA=5.5%, SETA=27.8%) suggesting local environmental influences. We analyzed the probability of winter activity and the distance traveled by those categorized as active in relation to potential influencing exogenous and autogenous variables. Incidence of activity negatively correlated to summer and winter precipitation averages and elevation while the distance that active tortoises traveled was positively correlated to body size. Although significant, the models were fairly weak and further relationships will be explored. Our data illustrate activity in desert tortoises on and near Fort Irwin during what is typically considered a period of dormancy with possible influence of local habitat and weather conditions. This may have implications to seasonal management decisions that currently assume little or no tortoise activity in the winter months.

The First 3 Years of Pre-Project Survey Results

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Federal survey guidelines for potential project sites were redesigned in 2009. Estimates of number of adult tortoises in a project area are the basis for important decisions made by state and federal agencies, and presumably by project proponents, so there are many parties eagerly awaiting results from careful application of expected procedures. Based on results from the first 3 years of application, this talk will highlight some areas where the protocol needed more

clarification, and where it looks deceptively like earlier surveys but is not. The survey for 2012 is fundamentally the same but updates will be described. Finally, for project sites from which tortoises have been removed, I will use available survey results to describe how the data have been used and how these survey estimates compare to final counts of tortoises in the same areas.

Desert Tortoise Conservation 2012 - an NGO Perspective.

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The Center for Biological Diversity continues its conservation and recovery campaign for desert tortoise and its habitat in California, Nevada, Utah and Arizona through science-based advocacy, participation in administrative processes, public information and, when necessary, litigation. For over 20 years, the Center has consistently supported increased protections for the desert tortoise as the path forward for desperately needed recovery of the species. Our desert tortoise protection campaign has recently focused on protecting habitat and animals from the onslaught of renewable energy projects, mining, off-road vehicles, grazing and other destructive activities. Despite on-going losses of habitat, promised future improvements in renewable energy siting, state and federal renewable energy planning and permitting processes, and financial realities are providing breathing space and potential opportunities for increased tortoise conservation going forward.

Recent successes in desert tortoise conservation related to specific renewable energy projects, mining, grazing, ORV route designation projects in 2011 will be highlighted in this presentation as well as lessons learned. Upcoming challenges for 2012, including potential proactive and provocative conservation scenarios will also be discussed.

Intersections of Science and Regulation in ESA Decisions about Desert Tortoises

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Scientific advances in our understanding of desert tortoise population genetics have increased dramatically in recent years (Edwards et al. 2004; Murphy et al. 2007; Hagerty and Tracy 2010; Hagerty et al. 2011), including the recognition of the "Mojave" and "Sonoran" desert tortoises as two species, *Gopherus agassizii* and *Gopherus morafkai* (Murphy et al. 2011). How has this rapid increase of new scientific information affected decisions under the Endangered Species Act? This research is pertinent to two primary arenas of the ESA: 1) status evaluations of each species and 2) consideration of distinct population segments (DPSs) and recovery units for *G. agassizii*. Despite the effective reduction in distribution of the desert tortoise into two ranges comprising 30% and 70% of that occupied by the originally recognized

species, the status of each species is unaffected. Both were evaluated independently, status designations made accordingly, and they already have been managed as separate species under the ESA since 1990. Recognition of DPSs and recovery units is complicated by differences in the published research. Ultimately, the shared conclusion that *G. agassizii* population genetics are characterized by isolation-by-distance across historically contiguous habitat contributes to failure to meet the "discreteness" criterion of the DPS policy. Genetic data were informative in determining recovery unit boundaries, in combination with other ecological information, even though the final designation did not precisely follow recommendations in the published literature. Nonetheless, the recent research highlights the importance of maintaining genetic diversity and minimizing population fragmentation in order to conserve and recover both *G. agassizii* and *G. morafkai*.

Flat-tailed Horned Lizards, *Phrynosoma mcallii,* Living at the Edge

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Flat-tailed horned lizards, *Phrynosoma mcallii*, once occupied up to 32,000 ha in southern California's Coachella Valley, at the extreme northwestern edge of their range (Barrows et al. 2008). Although currently covered by the Coachella Valley's 2008 Multiple Species Habitat Conservation Plan, large areas of this species' habitat were lost during the 1980-2007 building boom. Today just 2,000 ha, or 6% of its original Coachella Valley range remains occupied and protected in a single preserve, isolated from the closest known population by nearly 60 km. Within that preserve flat-tails continue to be common, but annual densities can fluctuate between eight (2001) to≤ 1 lizard/ha (2005). Spatial and temporal shifts in abundance correlate with harvester ant numbers, sand compaction levels and distance from roads with powerlines (Barrows and Allen 2009). The negative relationship with powerlines is related to enhanced predation rates from loggerhead shrikes, *Lanius ludovicianus*, and American kestrels, *Falco sparverius*; kestrels nest in palm trees in surrounding developments. Kestrels require perches and ledges for both hunting and nesting, neither of which would have occurred in a pristine aeolian sand landscape; flat-tails didn't evolve in the presence this efficient avian predator. The shrike and kestrels' predation is most focused along the preserve edge where they can hunt from powerlines that border the conservation lands. The result is an area up to 150 m from the preserve edge where otherwise suitable flat-tail habitat occurs but none can survive for long, and a loss of an additional 50-60 ha of occupiable habitat (Barrows et al. 2006). Another potential stressor is the invasive weed, Sahara mustard, *Brassica tournefortii*. The mustard invaded the Coachella Valley prior to 1927, but only in the last decade has it become a persistent and dominant component of the aeolian sands flora (Barrows et al. 2009). Flat-tails continue to occur in the midst of the mustard, although native annual plants, along with several vertebrates including the Coachella Valley fringe-toed lizard, *Uma inornata*, are negatively correlated with increasing mustard densities. If the trend continues native annuals will be absent or rare on the sand landscapes and along with them will be the diverse seed types and sizes on which harvester ants, *Pogonomrmex* spp., thrive. Since harvester ants comprise nearly all the flat-tails' prey, anything that limits the ants will impact this lizard. Despite protection afforded by the multiple species plan, the loss of habitat prior to the plan adoption as well as on-going threats from weeds

and predators make flat-tailed horned lizards' continued persistence at the edge of their range an on-going concern.

Barrows, C.W., M.F. Allen and J.T. Rotenberry. 2006. Boundary processes between a desert sand dune community and an encroaching suburban landscape. Biological Conservation 131:486-494.

Barrows C.W., K.L. Preston, J.T. Rotenberry, M.F. Allen. 2008. Using occurrence records to model historic distributions and estimate habitat losses for two psammophilic lizards. Biological Conservation 141:1885-1893.

Barrows, C.W. and M.F. Allen. 2009. Conserving Species in Fragmented Habitats: Population Dynamics of the Flat-tailed Horned Lizard, *Phrynosoma mcallii*. Southwestern Naturalist 54: 307-316.

Barrows, C.W., E.B. Allen, M.L. Brooks, and M.F. Allen. 2009. Effects of an invasive plant on a desert sand dune landscape. Biological Invasions 11:673-686.

Then and Now: Contributions of Elliott Jacobson in the Early Years of Desert Tortoise Disease Research; and Preliminary Results of Modeling Epidemiology of *Mycoplasma agassizii* and *M. testudineum* in the Mojave Desert

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When wild tortoises were discovered with signs of upper respiratory tract disease at the Desert Tortoise Research Natural Area in the late 1980s, an expert was sought to identify the cause. Dr. Elliott Jacobson was identified as the most knowledgeable specialist in reptile diseases and best suited to take on the task. Dr. Jacobson responded quickly, visited the site, necropsied ill and dying tortoises, and assembled a team of veterinarians, microbiologists and other specialists from across the United States. The team was able to identify *Mycoplasma agassizii* as the pathogen. Thus began multiple team efforts to learn not only more about mycoplasmosis, but also to establish a baseline of hematological and plasma biochemical values for healthy and diseased tortoises. Whether involved in identifying new diseases, such as cutaneous dyskeratosis and oxalosis, or providing collaborative advice on disease-related subjects, Dr. Jacobson has been more than generous with time. He is a highly productive scientist, publishing numerous papers on the results, and has many more scheduled. His many contributions to our knowledge of health and diseases of the *Gopherus* species have been and will continue to be highly significant. In 1989-1990, Dr. Jacobson emphasized the importance of studying the pathogenesis, transmission, and epidemiology of *Mycoplasma agassizii* and has continued to do so.

We will report on two multi-year research projects on the epidemiology of *M. agassizii* and *M. testudineum* in desert tortoises from the central and southern Mojave Desert regions. We evaluated spatial distribution of suspect and positive cases of *M. agassizii* and *M. testudineum* at the central Mojave Desert site using the covariates distance from road, distance from housing blocks, human population density, elevation, aspect, slope, sex, age class, and distance from another tortoise with positive mycoplasma tests. We used both general linear models to create single variable models and regression trees with multiple variables. The two species of *Mycoplasma* were evaluated separately. The single variable models indicated that distance to blocks of houses influenced probability of a tortoise with a positive or suspect test. The results of the regression tree analysis produced a similar result. At both central and southern Mojave

Desert study areas, tortoises with positive or suspect tests for *M. agassizii* and *M. testudineum* were distributed differently on the landscape.

POSTER

Optimal Seeding Temperatures of Plants Used to Restore Degraded Desert Tortoise Habitat

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Understanding the timing of seed germination is critical for revegetating degraded desert tortoise habitat. The right seasonal combination of temperature and precipitation must be in play for emerging seedlings to succeed. Early season establishment of non-native species, such as *Bromus madritensis ssp. rubens*, has increased pressure on native plants to germinate quickly and compete for resources for their survival. Broadcast seeding has the potential to minimize non-natives by using native competitive species to enhance post-fire restoration success. By understanding the optimal combination of rainfall and seasonal temperature ranges for a variety of native species, seed mixes may be customized so that seed applications can be timed to optimize their competition with invasive species and ensure favorable establishment. We measured traits associated with plant establishment (% emergence, % seedling survival) and competitive ability (rate of emergence, relative growth rate, root-to-shoot ratio, seedling biomass) for native species grown in a growth chamber during three temperature trials (night/day 10°C/20°C, 20°C/30°C, and 30°C/40°C). We used these growth parameters to rank all species according to their capacity to establish and compete and compared them with *Bromus madritensis* using a multivariate analysis. *B. madritensis* typically ranked higher than the other species tested, but this raking decreased under higher night/day temperatures. *Camissonia claviformis* possessed a similar ranking as *B. madritensis* across all temperature trials while *Ambrosia dumosa* and *Baileya multiradiata* performed well against *B. madritensis* only at the highest temperature trial. General trends show species that emerge quickly with high densities are capable of competing with invasive plants for resources, and possibly could out-compete these noxious species and reduce their numbers. Our results suggest that seasonal seeding with a specific combination of native plant species could maximize efforts for restoration and provide another tool to alleviate the desert of invasive plant species.

Perspectives on Defining Elliott Jacobson, *Mycoplasma testudineum*, and Gator Country

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For past 35 years, Elliott Jacobson has spent his professional career devoted to Zoo and Wildlife Veterinary Medicine. His contributions to the field, and especially to reptile medicine, are unparalleled. This perspective focuses on observations from his colleagues on selected

defining facets of his career. An overview of the seroprevalence of *Mycoplasma testudineum* in two populations of desert tortoises and in 11 populations of Florida gopher tortoises will be presented. Finally, in contrast to chronic mycoplasmosis in tortoises, a brief review of an acute, lethal mycoplasmal infection in the American alligator will be discussed.

A Spatially-explicit Population Viability Analysis for the Desert Tortoise

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Understanding spatial variation in desert tortoise demography is important for the effective conservation and management of the species, yet little attention has been given to this topic. To address this deficiency, we developed a spatially-explicit population viability model for the desert tortoise to estimate rates of population change across its range in Arizona, Utah, and Nevada. Constructing the viability model required estimates of adult ($\geq$ 180 mm MCL) and subadult ($<$ 180 mm MCL) tortoise survival rates, subadult to adult transition rates, and adult reproductive rates. To estimate survival and transition rates, we used mark-recapture data gathered between 1977 and 2008 from 25 long-term monitoring plots. The area encompassing these monitoring plots was divided into 0.25 $\times$ 0.25 degree grid cells and for each grid cell we estimated survival and transition rates using hierarchical multi-state population models in conjunction with spatial autoregressive models within a Bayesian analytical framework. For estimates of reproductive rates, we compiled data from studies on desert tortoise reproduction conducted at 14 sites throughout the tortoise's range in the southwestern US. The estimates of the demographic rates were used to populate stage-structured projection matrices for each grid cell from which we derived estimates of rate of population change. In general, spatial patterns in survival and transition rates were complex and incongruent, which created similarly complex patterns in the rate of population change. This model is the most comprehensive synthesis of desert tortoise demography to date that explicitly examines spatial variation at this scale. The improved understanding of spatial variation in desert tortoise demography resulting from this model can facilitate the identification of spatial patterns in demographic processes, provide insight into drivers of population dynamics and effects of management, and direct management action to areas where it is needed most.

Western Watersheds Project Working to Protect Desert Tortoises East and West of the Colorado River

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Western Watersheds Project's mission is to protect and conserve the public lands of the American West for its wildlife and other natural resources. Western Watersheds Project

continues to work to conserve desert tortoises throughout their ranges in California, Nevada, Utah, and Arizona. The conservation of desert tortoises in the southwest USA is inextricably linked to the management of our public lands. More than ever, appropriate management of these public lands is essential. Desert lands need to be managed to protect the resilience these desert ecosystems have to allow for recovery of desert tortoises in the face of changing climatic conditions.

The administration's policy of fostering development of massive solar and wind power plant projects on our public lands directly, indirectly and cumulatively impacts both *Gopherus agassizii* and *G. morafkai*. Despite this policy, the USFWS failed to provide specific guidance regarding renewable energy in its revised recovery plan for the listed Mojave desert tortoise population. Western Watersheds Project continues its involvement in the environmental reviews of power plant projects on public lands, at both the individual and programmatic levels, and continues to push for protected status for desert tortoise habitat in the Ivanpah Valley.

Western Watersheds Project continues its involvement in livestock grazing in *G. agassizii* habitat. In August 2011, the BLM withdrew its decision for new range improvements in desert tortoise habitat on Rudnick Common allotment in response to our concerns that they had failed to involve the public in the decision-making process as is required by law. We have a pending administrative appeal of the BLM's proposal to continue to authorize cattle grazing on over 56,000 acres of desert tortoise habitat on Horsethief Springs allotment.

In 2010, the USFWS issued a warranted but precluded finding for our petition to desert tortoise populations east of the Colorado River under the Endangered Species Act. Western Watersheds Project is continuing in its efforts to ensure that all desert tortoise populations in Arizona are fully protected. Livestock grazing occurs over much of the range of *G. morafkai*. In October 2011, we won an administrative appeal of the grazing decision for the 14,226 acre Wickenburg Arrow Y allotment where the BLM had failed to consider effects on the resident tortoises. The Administrative Law Judge imposed interim measures limiting livestock grazing to 65 percent of the permitted use, in order to reduce harm to the allotment's 13,870 acres of high quality habitat for Morafka's desert tortoise.

Western Watersheds Project continues to participate in land and resource management planning efforts in Arizona, California and Nevada. This includes protesting the BLM's proposed Resource Management Plan for the Ironwood Forest National Monument, an area with 80,000 acres of habitat for SDT; commenting on Draft Resource Management Plan for the Sonoran Desert National Monument and Lower Sonoran Resource Area identifying numerous inconsistencies between the data and the conclusion regarding the rangeland health of desert tortoise habitat; and, providing scoping comments for West Mojave Plan revision.

POSTER

The Use and Condition of Desert Washes in Relation to Off-Highway Vehicle Use in the Chemehuevi Desert Wildlife Management Area, California

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Desert washes are important landscape features and are particularly attractive to off-highway vehicle (OHV) riders for use as scenic byways to access infrequently traveled desert. Unfortunately, vehicle travel may impact wash structure and vegetation, thus disrupting geomorphic and ecological processes. The 2002 Northern and Eastern Colorado Desert Management Plan (NECO) was developed to guide land use and desert conservation for 1.6 million acres of BLM land in southern California. Sufficient time has passed since the implementation of the NECO plan to examine OHV use in desert washes and determine the effectiveness of current plan policies. We developed and implemented a sampling design and a standard protocol to examine OHV use of desert washes dispersed across the Chemehuevi Desert Wildlife Management Area (DWMA), which is predominately high potential habitat for the desert tortoise, as well as in local areas following expected periods of high OHV activity (Thanksgiving, New Year's, President's Day and Easter). The protocol measures differences in OHV activity among desert washes in open and closed wash zones as well as the degradation condition of washes associated with OHV activity. During 2010/11, OHV activity was low overall during the short duration of our study (November-May); however, spatial and temporal patterns of wash use were evident. Frequency of vehicle tracks in closed zones was not different from that of open zones for the washes dispersed across the DWMA, but use was lower in closed zones for the pre- and post holiday visits. Wash degradation (a combination of raven encounters, vegetation damage, abundance of trash, and bank cuts) was lower in closed zones than in open zones following the holidays. Future monitoring in contrasting times of year (spring and fall) as well as other DWMAs (Chuckwalla) will continue to elucidate spatial and temporal patterns in wash use for these important conservation areas.

Mojave Desert Tortoise Population Connectivity: Identification of Priority Habitat Linkages

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Desert tortoise recovery is focused first on maintaining and improving habitat within existing tortoise conservation areas. However, because desert tortoise genetic structure is characterized by isolation-by-distance across the range, population processes within existing conservation areas require genetic connectivity among these areas. Thus, the intervening habitat between existing tortoise conservation areas should also be considered for recovery. We have identified priority habitat linkages between existing conservation areas using data from the U.S. Geological Survey desert tortoise habitat potential model (Nussear et al. 2009), desert tortoise landscape genetics analysis (Hagerty et al. 2010), The Nature Conservancy's Mojave and Sonoran Desert Ecoregional Assessment (TNC 2010, 2009), and the National Landcover Dataset's Impervious Surfaces (Fry et al. 2011). We utilized these datasets to determine: 1) the highest-value, contiguous desert tortoise habitat using a clustering algorithm and 2) paths

between existing tortoise conservation areas using a least cost corridor analysis. Together, these outputs identify priority habitat linkages between existing tortoise conservation areas, which can inform landscape-scale conservation planning efforts, direct siting criteria for development projects, and help prioritize locations for implementation of recovery actions.

Recovery and Rehabilitation of Once-burned and Repeatedly-burned Desert Tortoise Habitat in the Northeast Mojave Desert

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Long-term studies of post-fire re-vegetation success have historically been lacking for the Mojave Desert, and few landscape-level success stories are available for directing future efforts. Approximately 75,000 acres of critical habitat burned during the impressive 2005 and 2006 wildfire seasons in the northeast Mojave Desert. While much of the creosote/bursage/Joshua tree and mixed black brush shrublands burned for the first time during these fires, many of the fires ignited shrublands that already burned in prior decades. These contrasting scenarios likely represent different habitat quality for the desert tortoise. We monitored the natural recovery and reseeding success during the past 6 years across a network of monitoring sites in southern Nevada and northwestern Arizona. Re-vegetation efforts aim to re-establish essential cover (shrubs) and forage plants (annual herbs, perennial grasses and cacti) to desert tortoise habitat following wildfire. Sites that burned multiple times provide less perennial cover and forage species for tortoises than sites that burned for the first time. Re-vegetation success has also been more difficult for repeatedly-burned tortoise habitat because seed banks are less abundant and diverse and typically dominated by non-native brome grasses. In contrast, once-burned habitat still provides short-term structure for tortoises (e.g., dead creosote bush and Joshua trees) and based on some vegetation metrics, is responding to seeding and herbicide treatments with significant treatment effects by 6 years following treatment implementation. Although seeded habitat appears visually similar to unseeded habitat, a continued trajectory of plant establishment in once-burned habitat implies that managers prioritize limited resources to those areas, and more intense management may be needed for repeatedly-burned habitat.

Evaluating Physiological Stress and Translocation in the Desert Tortoise

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Human impacts on natural ecosystems are rapidly increasing, creating a need for conservation measures such as translocation to protect sensitive species or augment declining populations. While translocations have been conducted on many species, including desert

tortoises, little is known about whether this causes stress in to translocated or recipient animals. To understand the relationship between physiological stress and translocation, we conducted a multi-year study (2007-2009) using a population of desert tortoises (*Gopherus agassizii*) near Fort Irwin, California. Blood samples were collected from adult tortoises in three treatment groups (resident, translocated, and control) for one year prior to and two years after translocation to determine if this activity caused a measurable physiological stress response, and the time frame over which animals adjust to translocation. Samples were analyzed by radioimmunoassay for plasma total corticosterone (CORT), a glucocorticoid hormone commonly associated with stress responses in reptiles. CORT values were analyzed in relation to potential covariates (e.g. animal sex, date, activity, treatment, handling time, air temperature, movement, precipitation, and annual plant production) among seasons and years. On a broad scale, we measured lower CORT in years of low annual forage and precipitation and higher concentrations in years with more abundant forage and precipitation. However, when attempting to tie this to the areas inhabited by individual tortoises, estimated annual biomass production, precipitation, and movement did not significantly explain CORT concentrations. CORT values in males were higher than in females, and values for both varied monthly throughout the activity season and among years. We found that translocation of desert tortoises did not result in elevated stress levels. Rather variations in CORT concentration were best explained by the year and sex of the animal. From these results, we conclude that translocation does not elicit a physiological stress response in desert tortoises.

Using Population Assignment Testing to Assess Local Genetic Affinity for Captive Desert Tortoises in California and Nevada

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We genotyped 130 captive desert tortoises (*Gopherus spp*) from two communities in California and from the Desert Tortoise Conservation Center in Nevada. We compared captive genotypes to a database of other *Gopherus* species and to wild caught *Gopherus agassizii* collected throughout their range. We used population assignment tests to determine the genetic origins of the captive individuals. Although most individuals in the captive population likely originated from the same geographic region as the community they were sampled from, we observed several individuals in our data set whose genetic lineage was assigned to a more distant wild population, including the Sonoran Desert (*G. morafkai)*. These data suggest that captive desert tortoises cannot be assumed to have genealogical affiliation to wild tortoises in their geographic proximity. However, in comparison to a similar assessment of captive tortoise in Arizona, this study had many fewer examples of hybridization and interstate translocation, perhaps as a result of demographic differences of the communities sampled. This has implications for the release or escape of captive tortoises back into the wild.

Sorting Out the Complex Evolutionary History of Morafka's Desert Tortoise

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Morafka's Desert Tortoise (*Gopherus morafkai*) was designated a candidate for endangered species protection by the US Fish and Wildlife Service in 2010, but since Mexico contains approximately 2/3 of the species' range, knowledge about the status of desert tortoises in Mexico is critical to effective to long term management. One important component of effective management is assessing the genetic diversity of tortoises throughout their range. We have collected data on over 130 tortoises in Mexico and identify two distinct genetic lineages of *G. morafkai*, Sonoran and Sinaloan, and we are working to describe the taxonomic status of these divergent lineages. Preliminary results suggest Sonoran and Sinaloan tortoises differentiate along an ecotone of foothill thornscrub and Sonoran desertscrub communities. This transitory boundary has likely expanded and retreated many times during the relatively recent transformation into what is the current Sonoran Desert and this dynamic system has undoubtedly influenced genetic differentiation in tortoises. Interestingly, despite the spatial proximity of lineages at this extensive vegetative transition zone we have not detected any admixed individuals. While the current contact zone between the Sonoran and Sinaloan lineages may be a result of secondary contact after a period of isolation, past interbreeding (during times of sympatry) may have driven the development of reproductive isolating mechanisms that are currently in place. We are employing multiple genetic techniques to help define the divergence of these two lineages and we will assess the level of past gene introgression and presence of reproductive barriers between them. We will use these data to help clarify if each lineage is on its own evolutionary trajectory.

Desert Tortoise Use of Burned Habitat in the Eastern Mojave Desert

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Wildfires burned more than 36,000 acres of critical habitat for the desert tortoise (*Gopherus agassizii*) in southern Nevada in 2005 and additional acreage in 2006. Direct effects of fire on desert tortoises include mortality due to acute heat exposure, and potential loss of food and cover. Indirect effects include long-term changes in vegetation composition and structure, and these are hypothesized to affect the quality of desert tortoise habitat. To understand the indirect effects of wildfire on tortoises, we compared movement patterns, home range, microhabitat use, behavior, and survival for desert tortoises located in and adjacent to burned habitat. Annual plant production in burned habitat was higher than in adjacent unburned habitats

and primarily consisted of invasive annual grasses. Burned habitat had lower perennial plant cover throughout the study. Average home range size was 51.3 ha (range 3.4 to 314.6 ha) and male home ranges were not different from females. From 11,407 tortoise observations, we found that 45% of home ranges were at least partially burned. Observations across years indicated that tortoises moved further into burned habitat with each successive year following the fire. Foraging behavior was most often observed in burned habitat and "resting" was the most frequent behavior observed in unburned habitat. Tortoises were more likely to use burrows for shelter in burned habitat, while vegetation was used as a shade resource more often in unburned areas. This study illustrates the use of habitat severely altered by wildfire, with evidence of increasing re-colonization of the area over time, suggesting that burned habitat should be managed for desert tortoises. The edges between burned and unburned areas appear to be very important re-colonization and perhaps natural restoration of burned areas. However, the effect of repeated fires that further reduce unburned habitat are unknown in relation to tortoise movements.

Land Use Planning in the "Geography of Hope" Beaver Dam Wash and Red Cliffs National Conservation Areas

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We simply need that wild country available to us, even if we never do more than drive to its edge and look in. For it can be a means of reassuring ourselves of our sanity as creatures, a part of the geography of hope. Wallace Stegner, *The Sound of Mountain Water*

Through the *Omnibus Public Land Management Act* of 2009 (Public Law 111-11), Congress designated the first National Conservation Areas (NCAs) in Utah, on public lands managed by BLM's St. George Field Office. The NCAs are included in BLM's National Landscape Conservation System (NLCS), where management emphasis is on the "conservation, protection, and restoration "of resource values and significant landscapes- Stegner's "geography of hope" for the American West.

The Beaver Dam Wash and Red Cliffs NCAs support, among other important resource values, populations of the threatened Mojave desert tortoise, in the Beaver Dam Slope Subunit of the Northeastern Mojave Recovery Unit and the Upper Virgin River Recovery Unit, respectively. The 45,000 acre Red Cliffs NCA comprises approximately 70% of the land base of the Red Cliffs Desert Reserve, managed since 1996 through a multi-agency partnership to further the objectives of Washington County's approved Habitat Conservation Plan.

Congressional mandates include a requirement that BLM complete comprehensive resource management plans (RMPs) for each NCA within 3 years of designation. The preparation of RMPs is a formal process that integrates long range planning for a wide array of resource values with federal disclosure requirements under the National Environmental Policy Act or NEPA. The process includes multiple opportunities for involvement by American Indian

Tribes, local, county, and state governments, and the public in the development of the RMP and supporting Environmental Impact Statement (EIS). A *Federal Register* Notice announcing BLM's intent to prepare RMPs for the two NCAs was published on May 10, 2010, opening a 90 day public scoping period. Preparation of the draft RMPs /draft EIS is currently underway, with an anticipated release for public review and comment in 2013.

Striving for Desert Tortoise Conservation and Recovery on California BLM Lands

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In 2011, BLM continued to work on projects such as signing routes, restoring habitat, public outreach, and acquisitions of private land. However, as was true the last two years, most of our effort and time was focused on solar and wind energy projects. In 2010, five projects within tortoise habitat were approved, respectively. In 2011, we approved one new project on BLM lands and the transmission across public lands for five projects on privates lands. The push for renewable energy in California has allowed CA BLM to fund much needed tortoise research. We continued to collaborate with US Fish and Wildlife Service on a spatial decision support system, a tool that will assist BLM in assessing the impacts of renewable energy development and the benefits of different mitigation actions for tortoise. We continue to look for ways of leveraging the effectiveness monitoring associated with renewable energy projects into larger research projects and coordinating the data to better inform us on impacts to tortoise. We strive to be strategic in assessing required mitigation to get the maximum benefit for the tortoise, and other wildlife species.

Chair's Report on Desert Tortoise Council Activities in 2011

Margaret H Fusari, Senior Co-Chair
Retired, Tucson AZ

In 2011 the Desert Tortoise Council (DTC) held the annual symposium and also 2 consecutive tortoise handling workshops serving 220 registrants. We prepared a revision to our bylaws, published our quarterly newsletter and used our website to inform our membership of events and other important items. We saluted the official naming of the second desert tortoise species, *Gopherus morafkai* from Arizona and Sonora. Through its Ecosystem Advisory Committee (EAC), DTC is a formal party to the California Energy Commission's proceeding on the Ridgecrest Solar Project and the Federal Energy Regulatory Commission's proceedings on the Mountain Pass Lateral Project and successively concluded litigation to protect desert tortoise habitat in the Twentynine Palms area. EAC members are monitoring the Desert Renewable Energy Conservation Plan process, shared their expertise on desert tortoise matters with the National Park Service on the Mojave National Preserve Water Resources Management Plan and with the Bureau of Land Management on West Mojave Plan route designation implementation and filed comments on the Stateline and Silver State solar projects, and on the Environmental Analysis for the Hawes Compost Facility access road through the Desert Wildlife Management

Area. In multiple forums, DTC advocated that existing habitat in the Ivanpah Valley be maintained as a step toward recovery of Mojave population. DTC called for the formulation of a conservation alternative to any further industrial-scale solar development in the Valley and shared in the formulation of a proposed Ivanpah Area of Critical Environmental Concern. We actively seek participation by Council members for committees, activities, and board membership. We urge interested parties to contact a board member and discuss possibilities for participation. To reach our goal to assure the perpetual survival of viable populations of the desert tortoise in the wild we need you.

Do Differences in Release Area Habitat Features Affect Post-translocation Movement? A Case Study on Desert Tortoises (*Gopherus agassizii*)

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The Mojave desert tortoise (*Gopherus agassizii*) occupies a variety of habitats, within which soil burrows and caves are used as shelter. In particular, caliche caves, which are found in higher densities within desert wash systems, are an easily mapped, long-lasting habitat feature that provide refuge from predators and thermal extremes. Tortoises that occupy flats and sloping bajadas commonly rely on more ephemeral soil burrows, both pre-existing or newly constructed. The goal of this study was to determine if releasing tortoises into washes with high densities of caliche caves would influence the movement of these repatriated tortoises. Eighteen tortoises were released into washes and 18 were released into flats located 1-1.5 km away. Movements were monitored using radio telemetry with GPS fixes taken once a day for the first 10 days and 1-3 times a week for the following 6 months. No significant difference was found between animals released in washes versus flats in total distance moved during the first ten days or in distance between the location of the tortoises on day 10 and the release site. After five weeks post-translocation however, tortoises released in washes were found significantly closer to their release site than those released on the flats. This trend continued and after 6 months, wash-released tortoise remained significantly closer to their release sites than flat-released animals. Survival also appears to be higher in animals living in and near deeply incised washes containing caliche caves than those living on the flats and utilizing soil burrows.

POSTER

Effects of a Nonnative Grass on Condition of Sonoran Desert Tortoises

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Buffelgrass (*Pennisetum ciliare*) is a dense, high-biomass, nonnative grass that is increasing markedly in distribution throughout the southwestern United States and northern Mexico. Buffelgrass alters ecosystem structure and function, and therefore has the potential to affect the quantity and quality of habitat for animals that inhabit areas being invaded by buffelgrass. We examined the effect of buffelgrass on condition of 131 Sonoran desert tortoises (*Gopherus agassizii*) captured on 50 4-ha plots established across a gradient of buffelgrass cover in southern Arizona that we surveyed in 2010 and 2011. For each tortoise captured, we measured mass and midline carapace length, height, and width of tortoises, and used these measurements to generate a condition index (mass/[length*width*height]). Condition of tortoises declined as percent cover of buffelgrass on plots increased. Specifically, after accounting for differences in sex, median condition of tortoises decreased by 6.6% on areas with 25% buffelgrass cover relative to areas with 0% buffelgrass cover, perhaps due to a reduction of forage plants in areas where buffelgrass cover is high. For example, the percent cover of *Janusia gracilis*, an important food for tortoises, decreased by 51% on areas with 25% buffelgrass cover relative to areas with 0% buffelgrass cover. Although concerns about invasions by nonnative grasses tend to focus on structural changes to the vegetation community, we found that buffelgrass reduced the physical condition of this rare vertebrate.

The Bolson Tortoise Breeding Program on the Turner Ranches in New Mexico

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A group of 24 adult Bolson Tortoises (*Gopherus flavomarginatus*), collected since 1972 by the late Ariel Appleton and donated to the Turner Endangered Species Fund (TESF) in 2005, has been living on the Armendaris Ranch in New Mexico since the fall of 2006. The goal of the Bolson Tortoise Project is to use this unique group of captive tortoises to establish an independent, viable colony of the endangered Bolson Tortoise in the US. We began by focusing on two issues: (1) we examined whether the New Mexico habitats are suitable for Bolson tortoise growth and fecundity, and (2) we developed a breeding program whose goal it is to generate large cohorts of releasable animals. We tracked tortoise health, growth and egg production since

2006 and found that both juveniles and adults show signs of robust growth in the desert grassland habitat of the northern Chihuahua desert. For example, some juveniles more than doubled their initial shell length in 5 years and at least one young adult grew 30% in 5 years. Reproduction is also robust: the tortoises produce up to three clutches of eggs per year (typically 1-2), and clutch size ranges from 2 eggs for the smaller to 9 eggs for the larger tortoises. To generate hatchlings, we initially used head-starting protocols in which tortoises are allowed to nest within special tortoise enclosures that will serve to protect the hatchlings from predators. This protocol was first developed for Bolson tortoises in their native habitat near Durango, Mexico and is currently used successfully for head-starting Desert tortoises in the Mojave Desert. Unfortunately, the 'natural-nesting' approach was minimally successful for the Bolson tortoises on the Armendaris Ranch, yielding an average of only 7 hatchlings/year (range 0-13) from the 70 or more eggs produced by the 10 reproducing female tortoises in a typical year. In 2010, we began recovering eggs from nests or harvesting them by induced oviposition (i.e., oxytocin injection) and placing them in custom-built constant temperature incubators. This approach resulted in dramatically increased hatchling production: 51 and 48 new Bolson tortoises successfully hatched on the Armendaris Ranch in 2010 and 2011, respectively. Maximizing the number of hatchlings born each year is an important step in generating an independent Bolson Tortoise population in New Mexico.

Local Governments, Interagency Coordination, Input on Revised Desert Tortoise Recovery Plan

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Local governments in the Mojave and Sonoran Deserts organized in 1998 to better coordinate and input management issues associated with the desert tortoise. QuadState has widened its scope to a broader range of natural resources and public land issues; and provides counties with a regional perspective, and current science and available resource management information.

The Authority engages in the natural resources dialogue with regional federal and state agencies, including the California Desert Managers Group, the Mojave Desert Initiative, the desert tortoise Management Oversight Group, and more recently, the Western Regional Partnership, the Desert Landscape Conservation Cooperative, and seeking membership on the Arizona Interagency Desert Tortoise Team. Engagement and participation include providing feedback to elected and appointed officials among our membership.

The Authority actively engaged in the review of the 1994 Recovery Plan, throughout the process. With the release of the revised Recovery Plan in August 2011 we expressed disappointment to the FWS that the Plan lacks some fundamental information that should be provided before it commits $159,000,000 and organizes the Recovery Implementation Teams.

- The Plan needs a population baseline so all parties would have a concrete number for the starting point from which recovery would be measured, the current level, and the target population.

- Consistent with the 2002 GAO report, we continue to request efficacy analysis, and suggested seven areas for assessment which have nearly complete implementation of past recovery actions, or which are largely unused in the current timeframe or recent past.

Though offering suggestions to FWS, we remain fully committed to working with the RITs to provide local input, and assure practical land management with a degree of public use and access to public lands.

Desert Tortoises *(Gopherus agassizii)* and Translocation: Homing, Habitat, Behavior and Temperature Experiments

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Translocation of threatened or vulnerable species is a tool increasingly used for conservation and management. The behavioral and physiological responses to translocation may undermine the success of translocation efforts in some species. For the federally protected desert tortoise (*Gopherus agassizii*), translocation is a strategy used to manage declining populations, yet post-translocation responses in this species are poorly understood. Here, we radio-tracked 40 tortoises in Fall 2009 and 40 tortoises in Spring 2010 to explore homing ability and movement patterns. We also considered differences in behavior and habitat use between translocated and non-translocated tortoises, and assessed how these differences affected carapace temperatures. Tortoises were randomly assigned to one of three treatment groups: translocated (displaced 2, 5, or 8 km from their source location), handling control (used to measure the effect of handling tortoises during experimental manipulation), or control. After translocation, twenty percent of the translocated tortoises were able to navigate back to their source location, and translocation distance had an effect on their ability to navigate home, with males and females demonstrating similar homing abilities. We found 44 % of tortoises in the 2 km translocated group returned home, whereas no tortoises in the 8 km translocated group did. We also found that translocated tortoises moved more than the control groups, with some individuals moving > 10 km from the translocation site. These patterns were persistent even when accounting for seasonal and sex differences in movement. Furthermore, we found that translocated tortoises exhibited different placement, position, and activity patterns within their habitat when compared to control tortoises. We also found that while all tortoises showed an association with large shrubs in the landscape, the translocated tortoises showed a significantly closer association to shrubs and an affinity to particular shrub species. Although there were no significant carapace temperature differences between translocated and control tortoises across all ambient temperatures, we found translocated tortoises had significantly higher carapace temperatures when the ambient temperature was >29°C. By identifying homing behaviors, quantifying movement patterns, and investigating behavior and habitat associations in desert tortoises, this *in-situ* experiment addresses key data gaps that may have limited the efficacy of tortoise translocation efforts.

Recovery Progress at Mojave National Preserve

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Management for recovery of the threatened desert tortoise (*Gopherus agassizii*) at Mojave National Preserve is closely aligned with the Revised Recovery Plan for the Mojave Population of Desert Tortoise (*Gopherus agassizii*) (USFWS 2011). This year we began a project to restore cattle impacted zones in desert tortoise habitat, which have not recovered since removal of grazing in 2001. We actively participate in an environmental education program with the Desert Managers Group. Law enforcement rangers routinely patrol tortoise habitat and we maintain warning signs on paved roads leading into tortoise habitat during the active season. We continue an aggressive program of acquiring private lands within tortoise habitat, but this may be approaching a limit due to availability of private parcels. Threats to the desert tortoise in the Preserve continue to be road mortalities and raven predation. We are seeking opportunities to study and implement highway barrier fencing on selected stretches of paved roads in the Preserve and are working with the USFWS raven control effort. But perhaps the most important long-term recovery effort near the Preserve involves a head-starting and population augmentation research facility constructed by Chevron Environmental Management, Inc. The facility has been built and juvenile head-starting research is underway by a consortium of scientists from Savannah River Ecology Lab and University of California, Davis. Once this facility is fully funded and operational it will contribute to an important recovery action.

Reflections on 22 Years of Health/Disease Related Studies with Desert Tortoises

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In 1989 an outbreak of upper respiratory tract disease (URTD) brought together a team of researchers, diagnosticians, pathologists, immunologists, and clinicians from the University of Florida (UF) to help determine the approximate cause of this "outbreak". While a similar appearing disease was reported in captive desert tortoises 11 years earlier (Snipes et al. 1980), the causative agent was not identified. Using a team approach the group from UF worked up a series of affected tortoises from the Desert Tortoise Natural Area, and utilizing electron microscopy, was able to identify an organism closely associated with cell membranes lining nasal cavities that was compatible with a *Mycoplasma* (Jacobson et al. 1991). With this knowledge, there was focus on isolating this fastidious microbe, identifying and naming it (Brown et al. 1995), performing transmission studies to determine its pathogenic potential (Brown et al. 1994), and ultimately developing very powerful serological (ELISA; Schumacher et al. 1993) and molecular (PCR; Brown et al. 1995) tools to determine either its presence or an antibody response indicating exposure respectively. While these tools have tremendous conservation value, especially when health assessing wild populations and groups of tortoises being translocated (Brown et al. 2002), their ultimate value will be only as good as those having the knowledge and background to properly use them. To make mycoplasmosis an even more challenging disease to mange, many tortoises can be subclinical, i.e. showing no clinical signs despite being infected and have lesions in the upper respiratory tract (Jacobson et al. 1995).

Many spin-off projects have been an outcome of these initial studies, some by the team at UF and some by others. Clinical pathological studies on desert tortoises at three sites in the Mojave Desert led to a publication of blood reference intervals of the desert tortoise (Christopher et al. 1999, 2003) that remains a gold standard for such studies today. While health-assessing tortoises is not easily done, a paper detailing health assessment of desert tortoises (Berry and Christopher, 2001) was another outcome of this line of research. Pathological studies by Homer et al. (1998) provided some excellent base-line data on causes of mortality and diseases of wild desert tortoises in the Mojave Desert of California. This work continues and has identified a number of interesting health issues of desert tortoises such as renal and thyroid oxalosis (Jacobson et al. 2009). A large data base on heavy metals and minerals of scute, carapacial dermal bone, liver, and kidney has steadily accumulated (Jacobson and Berry 2009). A novel *Mycoplasma*, *M. testudineum*, was isolated from the respiratory tract of tortoises. Herpesvirus has emerged as a significant pathogen of tortoises worldwide and initial serological studies of desert tortoises in and around Ft. Irwin indicated that many tortoises were exposed to a member of the genus herpesvirus (Johnson et al. 2006). A novel herpesvirus, Tesudinid Herpesvirus 2, was identified in a captive desert tortoise with severe stomatitis (Johnson et al. 2005). Eventually, using PCR, Testudinid Herpesvirus 2 was identified in wild desert tortoises and tortoises at the Desert Tortoise Conservation Center, Las Vegas, NV (Jacobson et al. Accepted for Publication). A strategic meeting will be held to discuss what should be done regarding screening of tortoises for presence of this agent and preparing for an epizootic. In looking back at this period of time I can emphatically state that I and others working on health issues of desert tortoise and other wildlife only hope that the work we have done will stimulate others to get the appropriate training and dedicate themselves to carry on this critical work.

This work would not have been possible without support from a number of agencies including BLM, USGS, The Nature Conservancy, Nevada Wildlife Department, The National Training Center, Ft Irwin, and multiple biologists and field personnel who have dedicated their lives to desert tortoise conservation.

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A Tribute to Elliott Jacobson

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Dr. Elliott Jacobson's name is well known by desert tortoise biologists; for 22 years he has been actively involved in research and management programs as the authority of tortoise diseases. Through his efforts, he and his colleagues at the University of Florida have become the definitive resource for diagnosis of mycoplasmosis and investigations of this and other tortoise diseases. To the veterinary community, Dr. Jacobson is well known as one who has dedicated his career to the study of herpetological medicine. For more than 40 years, he has been widely recognized by his colleagues, here and abroad, as a leader in disease identification, diagnosis, and health management of free-ranging and captive reptiles. He has enthusiastically disseminated the results of his work in the classroom, through an incredible volume of publications, and at presentations to a variety of audiences at herpetological, veterinary, wildlife agency, and lay

venues, including the United States Congress. He has been at the vanguard of efforts by the veterinary profession not only to expand our knowledge of disease in reptiles, but also to improve standards of veterinary practice for these species. Desert tortoise biologists, and an entire generation of wildlife, exotic animal, and zoo veterinarians are deeply indebted to Dr. Jacobson for his efforts.

Chlamydiosis in a Research Population of Juvenile Desert Tortoises

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A group of juvenile desert tortoises used for a USGS research project were examined to find potential causes for a three year history of ongoing morbidity and mortality. The tortoises originated from the Desert Tortoise Conservation Center and were a mix of hatchlings from the center and public surrenders. Tortoises were housed in outdoor pens supplemented with water to increase forage. Some pens were treated with dust control agents and others with nutritional treatments. Health evaluations and disease screening were performed prior to the project, yet on periodic examination of the juveniles, a variety of intermittent abnormal clinical findings were present in both treatment and control pens, with no statistical differences found. Clinical findings included: nasal discharge, dried feces around the vent (diarrhea), grass impactions in the commisure(s) of the jaw, soft shells, and poor body condition. Symptoms typically ensued within 2-6 months of being moved into the research pens. Ill tortoises were removed from the site and tortoises with advanced clinical signs and poor body condition were euthanized and necropsied. The remaining ill tortoises were treated unsuccessfully with clarithromycin and supportive care. All tortoises from the study continued to decline and either died or were euthanized. Histologic examination of several tortoises identified colitis, conjuctivitis, tracheobronchitis and pneumonia associated with intracellular bacteria in epithelial cells. The bacteria had morphologic, tinctorial and ultrastructural features characterisitic of *Chlamydia*. To our knowledge this is the first documentation of *Chlamydia* in desert tortoises, and because it originates from the DTCC, may have implications on translocations of animals from the center. We recommend additional screening of animals for this pathogen be included in future health evaluations.

Habitat Use and Activity of Juvenile Desert Tortoises in the Sonoran Desert of Arizona

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Most of what is known about desert tortoises is based on research conducted on adults in the Mojave Desert of California, where the species (*Gopherus agassizii*) is listed as Threatened under the Endangered Species Act (ESA); significantly less is known about tortoises in the Sonoran Desert of Arizona (recently recognized as a new species, *Gopherus morafkai*), despite their status as species of greatest conservation need by the Arizona Game and Fish Department, and Candidate status under the ESA. The study site is in the Mazatzal Mountains, Maricopa County and is characterized as Arizona Upland paloverde-mixed cacti series with an elevation between 550-850 m. It has a high density of desert tortoises, with over 180 tortoises marked in an approximately 66 ha area from 1991-2011. We equipped 11 juvenile desert tortoises (ranging in size from 124-175mm MCL) with radio-transmitters in 2010-11 and tracked them at least twice a week during the active season and once every other week during winter dormancy. We present our findings on juvenile tortoise home ranges, behavior, and habitat use. Given the recognized differences in morphology, ecology and genetic structure between the two desert tortoise species, these natural history data on juvenile desert tortoises will be valuable in guiding management of this species in the Sonoran Desert of Arizona.

Challenges and Opportunities in Land Acquisition for Desert Tortoise Conservation

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Almost two decades ago, the Desert Tortoise Preserve Committee, Inc. (DTPC) was responsible for implementing California's first Habitat Conservation Plan (HCP) for the desert tortoise in California resulting in the acquisition, enhancement, and management of 4.8 acres of compensation habitat for the Yucca Valley Church Sites in San Bernardino, California in 1993. Since then, the DTPC has acquired and actively manages over 6,500 acres of habitat for the desert tortoise, Mohave ground squirrel, burrowing owl, and streambed and desert wash habitat. The DTPC's habitat conservation program was founded at the Desert Tortoise Research and Natural Area (DTRNA) in Kern County and has expanded to include significant land holdings in the Pilot Knob and Harper Dry Lake areas of San Bernardino County and the Chuckwalla Desert Wildlife Management Area in Riverside County. With the financial assistance of mitigation funding from US Fish and Wildlife Section 10(a) permits, California Department of Fish and Game Section 2081 and 1600 permits, and California Energy Commission energy facility siting certifications, the DTPC's mitigation program is a model of private-public partnerships that has not only secured protection for species and their habitat in perpetuity but also has facilitated innovative conservation strategies such as the expansion of the DTRNA, acquisition of a federal grazing allotment at Pilot Knob, installation of desert-tortoise proof fencing to minimize road impacts, and implementation of habitat restoration projects. Looking forward, the DTPC faces

new challenges and opportunities in its mission to protect the desert tortoise and other species in the Mojave and Colorado Deserts. Challenges include the prudent financial management of a substantial endowment in an uncertain financial climate, leveraging the organization's limited resources to address large-scale development pressures, and balancing its conservation mission with the changing policy mandates of its public partners. In light of these constraints, the DTPC continues to forge new opportunities for desert tortoise conservation including creating new preserves in areas where conservation resources have not been adequately devoted, expanding conservation strategies to include the special needs of other endangered and threatened species, and enhancing its coordination with new public and private partners.

Permanent Protections for Tortoise-rich Public Places

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The Mojave and Colorado deserts' diverse and connected landscapes remain recognized top national conservation priorities (DOI 2011) despite on-going industrial, recreational, and land-use policy threats, including the recent solar development boom on public lands. In particular, two distinct proposals, the California Desert Protection Act of 2011 (CDPA) and the nomination of Ivanpah Valley as an Area of Critical Environmental Concern (IV ACEC) present near-term opportunities to conserve important desert tortoise habitat, to permanently protect outstanding or unique natural and cultural resources, and to preserve the integrity of large, connected desert landscapes. This 15 minute presentation will discuss the lands proposed for conservation, their unique values, the history of these efforts, and what we can do as individuals and groups to support these crucial efforts.

Diversity, Systematics, and Speciation in Horned Lizards

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Horned lizards (Phrynosoma), with their unusual morphology and life history, are among the most distinctive and recognizable animals in North America. Not surprisingly, horned lizards have been the subjects of diverse research in ecology and evolutionary biology. However, it has proven remarkably difficult to obtain the robust phylogeny for Phrynosoma necessary for conducting comparative studies of behavior, life history evolution, and biogeography. Challenges presented by this group include discordance between morphological and molecular data, rapid speciation at the start of Phrynosoma diversification, and active and residual traces of hybridization in genetic data. Despite these challenges, the number of species recognized within Phrynosoma has grown in recent years as a result of phylogeographic studies exposing previously unrecognized genetic diversity within species. Currently, Phrynosoma contains 16

species divided into four natural groups: (1) TAPAJA, the viviparous short-horned lizards: P. ditmarsi, P. hernandesi, P. douglasii, and P. orbiculare; (2) ANOTA, containing species with prominent cranial horns: P. mcallii, P. solare, and the P. coronatum group (P. blainvillii, P. cerroense, and P. coronatum); (3) DOLIOSAURUS, containing three species lacking antipredator blood-squirting: P. modestum, P. platyrhinos, and P. 26aurus; and (4) BREVICAUDA, containing two viviparous species with extremely short tails that lack blood-squirting: P. braconnieri and P. 26aurus. The positions of the Texas horned lizards (P. cornutum) and the giant horned lizards (P. asio) relative to these groups are not known with certainty. Many Phrynosoma exhibit considerable geographic variation in coloration and cranial horn morphology, and some species are still delimited based solely on these and other morphological sources of variation. This practice has resulted in a turbulent taxonomic history for morphologically variable species such those in the P. coronatum group, which have undergone at least 20 taxonomic revisions with 1–6 species recognized at various times. Maintaining an integrative approach to systematics that considers diverse types of data from morphology, molecular genetics, and ecology should provide the most accurate species delimitations possible; however, the imperiled populations that represent unique phylogeographic groups, whether recognized as species or not, are of great conservation importance and should be managed accordingly.

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Terrestrial Wildlife Conservation and Renewable Energy Development in the Desert Southwest United States with Emphasis on Agassiz's Desert Tortoise

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Renewable energy development is experiencing a renaissance particularly in the Desert Southwest where wind and solar energy potential is high. Large areas of public land are currently being permitted or evaluated for utility-scale renewable energy development (USRED). However, the Southwest is also characterized by high and unique biodiversity including threatened and endangered species like Agassiz's desert tortoise. We searched the peer-reviewed scientific literature for information on the known and potential effects of USRED and operation on terrestrial wildlife. In comparison with the large body of literature on the effects of wind energy facilities on birds and bats, very little is available to evaluate the effects of USRED on terrestrial wildlife, especially for solar energy where we found only one peer-reviewed paper regarding wildlife impacts. Few publications are available on the effects of wind energy generation on tortoises. Potential effects due to construction and eventual decommissioning of USRED facilities on wildlife and their habitat include direct mortality, environmental impacts of fugitive dust and dust-suppressants, destruction and modification of habitat including impacts of roads, and offsite impacts related to construction material acquisition, processing and transportation. Known and potential effects due to operation and maintenance of facilities include habitat fragmentation and barriers to gene flow, as well as effects due to noise, vibration, electromagnetic field generation, microclimate change, pollutant spills, water consumption, predator attraction, and increased fire risk. The deficiency of before-after-control-impact studies hinders the ability to rigorously quantify the effects of USRED on terrestrial wildlife. Basic information is also lacking on facility design effects, the efficacy of site selection criteria, and the cumulative effects of USRED on regional wildlife populations as outlined in our recent article in the December, 2011 issue of BioScience. Insufficient data are currently available to adequately assess the impact of USRED, especially solar facilities, on terrestrial wildlife.

Using Population Ecology to Plan the Restoration of Bolson Tortoises (*Gopherus flavomarginatus*) to their Pleistocene Range in the U.S.

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In 2006, the Turner Endangered Species Fund initiated an imperiled species conservation initiative aimed at restoring the endangered bolson tortoise (*Gopherus flavomarginatus*) to parts of its Pleistocene range in New Mexico. Through the development of an effective captive management program, we have achieved high overall annual survival rates (97 %), and increased the size of the captive population by over 500 % since project inception. We anticipate

beginning the release phase of the bolson tortoise recovery program within five years. We will employ a long-term adaptive-release approach, guided by stage-based matrix models to achieve optimal wild population growth rates, while maintaining a manageable captive source population. We have identified five bolson tortoise stage-classes, likely to be important for estimating population trajectories in this reintroduction effort. These are: (i) hatchling, (ii) pre-release juvenile, (iii) juvenile, (iv) subadult, and (v) adult. We have estimated bolson tortoise size ranges (MCL: mm) encapsulated by these stage classes, and present the results of simulations that show how these models will be used to identify release strategies that will achieve the first viable bolson tortoise population in the United States since the species was extirpated during the Pleistocene.

Status of Tortoise Populations within the Red Cliffs Desert Reserve

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The Red Cliffs Desert Reserve (Reserve) is located in southwestern Utah at the northeastern extent of the tortoises range. The Division of Wildlife Resources has been monitoring tortoises in the Reserve since 1997. In 2002-2003, a statistically significant decline of tortoises occurred following a severe drought. In the summer of 2005, approximately 14,471 acres burned within the Red Cliffs Desert Reserve. The Reserve is considered a highly threatened population due to its proximity to urban growth, small size, as well as human and stochastic threats (e.g., recreation, fire, disease, drought). We will discuss the status of tortoise populations within the Reserve, the results of the 2011 population monitoring effort, as well on-going research and management within the Reserve.

An Eighteen Year Study of the Sonoran Desert Tortoise (*Gopherus morafka*) in the San Pedro Valley of Southern Arizona.

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This study revealed that, in order to obtain accurate population estimates, tortoise sampling areas must be large and of long duration and the sampling crew must be well trained in the different vegetative types, different topographic reliefs and geologic units, and be trained to recognize differences in tortoise habits. In this study area desert tortoises were not randomly distributed but were concentrated into well-defined population cells located within all vegetative units and terrains. Population cells and interspaces between them revealed a problem with using small sample areas for estimating population dynamics. If a small plot falls within a cell containing many tortoises, the sample provides a high population estimate. If the plot falls in an area outside a cell and contains few or no tortoises, there will be a bias downward in the estimates. Studies must be of long enough duration to get an adequate number of tagged tortoises to make accurate estimates. When the number of tagged tortoises was a small portion

of the total population, finding a tagged tortoise was a rare event. The probability of finding a rare tagged tortoise did not fit a binomial distribution curve. The probability curve was skewed to a higher probability of finding a low estimate of tagged tortoises (Poisson distribution). Low precision with sample numbers intensified the problem of estimating the population. Tortoise activities were different across the different geologic units and vegetative zones. Even though the study sampling crew lives in the study area and is thoroughly familiar with the different terrains and vegetative types, it took four years and many man hours just to learn how to locate tortoises. The sampling crew must be trained and experienced in order to recognize those differences and they also must be available to sample when tortoises are most active.

POSTER

A Bird's Eye View: Applying Novel Technology to the Study of Desert Tortoise Movement and Interaction

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Establishing accurate habitat use and population connectivity estimates is of essential importance to future studies of the Mojave desert tortoise (*Gopherus agassizii*). To accomplish this, frequent sampling of tortoise locations are necessary, traditionally requiring a large degree of labor on the ground. Recent developments in GPS (Global Positioning System) technology and electronic component miniaturization have allowed for the deployment of store-onboard type GPS data-loggers with tortoises. GPS data-loggers are able to collect location data on a precise temporal and spatial scale while minimizing human disturbance and the overall burden on researchers. We began exploring the use of GPS data-loggers to investigate behavior, microhabitat use and movements in and around a small portion of the more than 36,000 acres of critical tortoise habitat that burned during the 2005 wildfires. A large amount of locations (1210 $\pm$ 91 SE) was collected over the 2011 activity season for a subset (n = 22) of adult study tortoises living in or within proximity to burned habitat in Southern Nevada. This wealth of location data facilitated a novel approach to analyses using R statistical software, ESRI ArcMap® and GeoTime® spatiotemporal visualization. A systematic sampling schedule and a large dataset allowed for the detailed investigation of finite movement patterns in relation to burned critical habitat, proximal contacts between tortoises, and potential pathways of genetic or pathogen transmission. Developing an efficient means to analyze large amounts of location data will aid in future investigations of finite habitat use as well as genetic, disease, and habitat connectivity.

Challenges of Managing the Burgeoning Captive/Pet Desert Tortoise Population

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Each year, over 2000 captive desert tortoises end up in adoption centers across the four states of Arizona, California, Nevada, and Utah, where they are native species. They are tortoises relinquished by their custodians, hatchlings resulting from back-yard breeding, wild or pet tortoises brought in by the public as "strays", and a few are rescues. Legally placing unwanted captive desert tortoises in responsible homes is difficult, time-consuming, and programs to do this are not funded. This is literally a growing problem because numbers of unwanted captive desert tortoise continue to rise. A well-meaning, but uneducated public continues to increase the captive/pet desert tortoise population through back-yard breeding, and many tortoises are illegally given away or turned loose to fend for themselves and to pass diseases on to wild populations. The few centers where desert tortoises are held for adoption are over-crowded and severely underfunded. Government and private entities entrusted with the care of these animals face a growing challenge as funding for the care of these animals becomes even more scarce, and there are few viable solutions to the problem.

Dungeons, Tortoises, and DNA

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The split of the desert tortoise, *Gopherus agassizii,* into two species is not a surprise. Multiple independent lines of evidence reach the same conclusion. However, the formal description of the species reads somewhat like a mystery because at every turn new problems emerge. Not only is the frequently cited date of publication wrong, the type locality is found to be uncertain. Further, two names already exist. The description of a new species from the Cape Region of Baja California, *G. lepidocephalus*, is based on a "lost" specimen that required foraging into museum dungeons. This species is subsequently said to have originated from Sonora, Mexico, and in particular Tiburon Island. Forays into 19th Century literature are required to resolve many controversies, and the development of novel laboratory methods is required to determine the origin and identity of *G. lepidocephalus*. Following years of investigation, the new species, *G. morafkai*, is described in the open access journal ZooKeys. The description of the new species has important implications for conservation. Drawing on the Theory of Island Biogeography, we know that smaller populations have a greater risk of extinction than larger ones. With the description of *G. morafkai*, Threatened *G. agassizii* loses about 70% of its range. The drastic range reduction may result in a higher level of vulnerability. Consequently, we suggest that the level of protection for both species may need to be reassessed. We make no claim that it should be elevated to being Endangered because the evidence to do so is wanting. Second, the formal description of *G. morafkai* precludes any post-description consideration of tortoises on one side of the Colorado River being used as a genetic reservoir for the other. Significantly, the taxonomy reinforces this important consideration to the public who, at times, may believe they are assisting conservation by relocating pets or translocating native tortoises. The whopping 4400 views of the paper on the journal's website alone documents that the

description has helped make the public more aware of the need to conserve desert tortoises. Perhaps this is the greatest success of the research, for without public involvement and awareness, conservation initiatives are unlikely to meet with success.

Fourteen Years of Research on Tortoises Herpesviruses: An Overview on the Most Relevant Global Pathogen of Tortoises

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Tortoise herpesviruses, recently renamed as *Testudinid herpesviruses* (TeHVs) are a genetically related group of viruses, which have been shown to be associated with fatal diseases in several different species of tortoises worldwide, including Agassiz's tortoises (*Gopherus agassizii*). Originally considered a single virus, now at least 4 genotypically distinct TeHVs are known to exist. The best characterized of them is that named TeHV3, known to infect Mediterranean tortoises and more specifically being fatal to Hermann's tortoises (*Testudo hermanni*), and to a minor degree also to Greek tortoises (*Testudo graeca*). TeHV3 is the only TeHV for which a transmission study has been performed. We know that productive infection can occur following either intranasal or intramuscular viral injection and that both these routes are associated with the appearance of overlapping clinical signs, which to a certain extent, appears to be viral dose dependent and cannot be prevented by circulating neutralizing antibodies. The most relevant clinical sign in infected tortoises is a diphtero-necrotic stomatitis and glossitis. Additionally, running nose and conjunctivitis are common findings in sick tortoise. TeHV3 has an accentuated neurotropism and is associated with lymphoid depletion in the spleen. There is strong evidence that TeHV3 can undergo latency in tortoises, similarly to what occurs in other animal species infected with host-specific herpesviruses. The virus has been shown to remain viable in the environment for several days, providing a long lasting source of infection for naïve tortoises, which not necessarily have to come in direct contact with carriers. An ELISA test has proven to be very sensitive for TeHV3-exposure detection and it was shown to be able to detect also antibodies directed against TeHV2, a herpesvirus associated to disease in Agassiz's tortoise. Prevention through testing of animals to be translocated and separation of positive from negative tortoise colonies is right now the best anti-TeHV strategy for Agassiz's tortoise conservation.

STUDENT PAPER

Foraging Ecology and Nutritional Requirements of the Bolson Tortoise in South-central New Mexico

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The Bolson tortoise (*Gopherus flavomarginatus*) is the largest terrestrial reptile in temperate North America. During the late Pleistocene, this tortoise ranged from southern New Mexico and Arizona to the edges of the Transverse Volcanic ranges. Currently, the species is now limited to the Bolson de Mapimi in Mexico and is endangered due to harvesting and cattle overgrazing. We studied the foraging ecology of a captive population of Bolson tortoises (n=24) on the Armendaris ranch in south-central New Mexico in two semi-wild enclosures. Project objectives included 1) to examine tortoise diet and determine if tortoises are selectively foraging and 2) to examine the nutrient content of the plants consumed and avoided by tortoises. In 2009 and 2010, 1020 foraging observations were conducted on 22 tortoises. Foraging activity was highest in late June through mid July. Tortoise diets consisted of native grasses and forbs with grasses composing more than 85% of the diet in both years. Tobosa grass (*Pleuraphis mutica*) was the most common plant foraged on in 2009, about 89% and 50% in 2010. This difference in consumption of tobosa grass was probably due to the abundant growth of forbs in 2010 providing the tortoises with more variety and abundance of forage. Another plant species regularly observed in tortoise diets was, *Bouteloa gracilis*, greater than 18% of the time. Using the Johnson's Rank Preference Index, which orders food items in a ranking system from most preferred to least preferred based on use vs. availability, we determined that there was difference in the foraging behavior between sexes and by season. *P. mutica* was ranked first and *B. gracilis* second in the dry season by males and females on both years, but that foraging pattern changed during the wet season for both years. *Aristida purpurea* was the most preferred over *P. mutica* and *B. gracilis* in 2009, and female's diet was more varied, adding forbs to their diet. In 2010 Females were foraging more on forbs than grasses. Males preferred grasses rather than forbs. Females were probably foraging more on forbs than males because forbs are richer in minerals necessary for egg development. The nutritional analyses of plants foraged by tortoises determined that their diet is high in fiber and protein, but low in potassium, calcium and phosphorous. This research provides previously unknown information on the dietary and nutrient requirements necessary to maintain healthy populations of this endangered species.

Feeding Captive Desert Tortoises: Appropriate Diets for Arid-zone Herbivorous Tortoises

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For any non-domestic species, the guiding principle in captive-diet formulation should be close approximation to the free-ranging diet. Each species' digestive anatomy and physiology

reflects a specific set of nutritional conditions, often resulting from thousands of years of adaptation to its habitat. Herbivorous tortoises such as *Gopherus agassizii*, particularly in arid regions, consume relatively low-protein and high-fiber diets, comprised mainly of grasses, sedges, forbs, and shrubs. Periods of brumation during the driest portions of the year are another key element of these animals' normal ecological physiology. The digestive tract of herbivorous tortoises is that of a hindgut fermentor: the large intestine and cecum are highly developed to host resident populations of symbiotic microorganisms, which digest fibrous materials. Maintaining a proper balance of dietary nutrients is important to continued health and proper functioning of these microbes and the digestive tract as a whole.

Commonly-seen consequences of inappropriate diets for captive herbivorous tortoises are digestive-tract or metabolic dysfunction resulting from a diet too high in protein or fats and too low in fiber. These include: excessive juvenile growth rate, resulting in early sexual maturity and aggression, potentially life-threatening mineral imbalances, and skeletal and shell deformities; visceral gout or urinary-tract stones; bacterial and cloacal infections; or obesity. Diets with high concentrations of sugars or starches may cause a significant imbalance in normal gut flora, causing poor stool quality, inefficient digestion, and potential colic.

Captive desert tortoise diets should attempt to emulate the nutrient composition of wild diets, with a goal of 25-30% crude fiber, crude protein $\leq$15%, and 2-4% crude fat. Forages (e.g., grass hays) are an important dietary component, as is a well-balanced commercial diet which meets vitamin and mineral requirements. Commercial fruits and starchy vegetables should be avoided, although dark greens and non-toxic native grasses may be provided as occasional treats.

POSTER

Seedballs: From an Urban Underground Movement to Restoration of Burned Desert Tortoise Critical Habitat

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Seedballs were developed to maximize the success of broadcast seeding and may have a role for landscape-scale restoration of degraded desert tortoise habitat. The composition of seed balls has largely been left to mischievousness with no understanding for the mechanism of success or failure. Through a series of experiments, we examined the function of seedballs by refining a recipe for seedball use in Mojave Desert post-fire restoration. There are three basic ingredients in the seedball: clay, organics, and seeds. From circulated recipes we found that a clay content ranging from 25- 65% was commonly recommended. We determined that four percentages (25, 30, 35, 40) were unsuitable for mechanized production of seed balls. The other five percentages (45, 50, 55, 60, 65) could be easily milled for mass production. We measured germination following a simulated winter storm (24 mm of water over 12 hours) and summer storm (24 mm of water over 3 hours). Seed balls with the lowest percentages of clays maintained the largest amount of water; however, no germination occurred at any level. We incorporated a

polysaccharide soil conditioner (ZEBA®) in seed balls to make them functional with limited water. Germination occurred with the incorporation of ZEBA®; however, with lack of additional watering there was no hypocotyl emergence. Further testing is being conducted on hypocotyl emergence by adjusting the size and shape of the seed balls. Our best recipe for seed balls will be tested in the Hidden Fire (Grand Canyon-Parashant National Monument, Arizona) where we will monitor establishment of native seeds in seed balls compared with traditional broadcast seeding with and without access of seed harvesting ants and rodents.

Desert Managers Group

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The Desert Managers Group (DMG), an organization of federal, state, and county land managing agencies in the California deserts, focuses on coordinating and integrating desert tortoise recovery actions and monitoring efforts among managers and scientists across jurisdictional boundaries. A key to desert tortoise recovery is an informed public that understands and appreciates desert tortoise recovery. Now in its fifth year, the DMG has partnered with The Living Desert and other non-governmental organizations to continue its desert tortoise education program. Some goals of the program include standards based environmental education, brochures targeting specific audiences or topics, and media releases. The Living Desert is a zoo and botanical gardens located in Palm Desert, CA and the home of Mojave Maxine as well as the DTIYEP Coordinator. Its mission is desert conservation through appreciation, education and preservation.

Seasonal and Sex-based Shelter-site Selection by Sonoran Desert Tortoises, *Gopherus morafkai*

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Understanding the role of shelter-site selection in determining space use requirements is integral for the conservation of the North American *Gopherus*. Annual home range sizes of *Gopherus morafkai* at two study sites in Arizona were highly variable (coefficients of variation >58%) as a result of differences in season, precipitation, sex, and reproductive condition. Monte Carlo simulations of individual tortoise movement patterns show that movements are highly constrained within a home range. These movements may be centered on a particular suite of shelter sites. Population densities of *G. morafkai* are governed in part by shelter-site availability, but little work has been done to characterize how those shelter sites are used. We developed two ordination models using Canonical Correspondence Analysis to elucidate patterns of shelter-site use based on sex and reproductive condition, and season in relation to cover type, orientation,

and depth of the shelter site. Tortoises were divided into three categories: male, female, and gravid female. We delineated 4 seasons: Winter (November – February), Spring (March – early May), Summer 1 (mid-May – late July), and Summer 2 (Late July – October). The sex-based model delineated axes based on cover and depth. Male tortoises were associated with deeper shelter sites, while gravid females preferred shelter sites that had a soil component. The seasonal-based model indicated that shelter sites used during the winter and spring had more southerly and westerly orientation, while summer shelters tended to have a more northerly orientation. Deeper shelter sites were used by all tortoises during the hotter, drier Summer 1 season.

Re-establishment Site Differences for Translocated Regal Horned Lizards (*Phrynosoma solare*) in Tucson, Arizona

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Translocation as a conservation tool for horned lizards has been tried with poor (Bogosian 2010), equivocal (Painter et al. 2008), or unreported (Sanders 2000; Hodges 2002; Thomas 2005) success. However, Texas Horned Lizards (*P. cornutum*) have become established outside the natural range as a result of releases (Allen and Neill 1955; Conant and Collins 1991; Owens and Krysko 2007). In 2010, we translocated most of an urban population of horned lizards that was facing habitat destruction during floodwater basin construction. We report 2011 post-translocation results.

Our survey of urban environments revealed that the Regal Horned Lizard persists, often at high abundance, in Tucson's urban core, although it is declining. We used the early part of this survey to identify potential translocation sites, selecting three sites representing environments related to urban biodiversity conservation: (1) a natural open-space river park with a diverse, but declining, lizard assemblage; (2) an existing floodwater basin with regenerating habitat; and (3) a small untended open space in midtown Tucson. Site 1 represented the developing urban river park system; Site 2 was a model for long-term conservation in flood-control district properties; and Site 3 represented a more fully urban habitat matrix. These sites had high abundance of preferred prey (Rough Harvester Ant, *Pogonomyrmex rugosus*), suitable cover, but variable predator abundance (Site 1 >> Site 2 > Site 3).

At Site 1 we studied resident and translocated lizards by radio-telemetric monitoring; at Site 2, we surveyed translocated lizards and the few resident lizards by scat counts and mapping; at Site 3, which lacked resident lizards as a result of prior habitat disturbance, we studied translocated lizards by censusing. Lizards were sexed, measured, weighed, and photographed; adults were identified by subcutaneous PIT tags injected dorsally, while juveniles were cohort marked and identified individually by unique ventral patterns.

At Site 1, excluding presumed research-related mortality, eight telemetered resident lizards survived at an annual rate of ca. 84%; eleven telemetered translocated lizards survived at an annual rate of ca. 18% or less. Ascribed mortality causes were roadrunner (5), red-tailed hawk

(1), roundtail ground squirrel (1), starvation and/or overheating (2), plus unknown (2). At Site 2, scat abundance increased dramatically following translocation releases, and shifted during 2011 to adjoining, previously unoccupied buffelgrass habitat similar to that from which translocated lizards originated. At Site 3 during 2011, we recovered 8 of the 15 adults and 5 of the 18 hatchlings translocated in 2010: detection probability was estimated at ca. 0.5, suggesting high survival rates. Hatchling production by translocated lizards was documented at Sites 1 and 3.

Census will continue in 2012. Results from 2011 suggested that sites with high cover of grasses and subshrubs, and low predator abundance, like those in which Regal Horned Lizards thrive elsewhere in Tucson, and sites for which a logical expectation that available niche space existed, supported more successful translocation.

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A Review of 9 Years of Desert Tortoise Head Starting at Edwards Air Force Base and Ideas for the Future

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In 2003, the head start program at Edwards Air Force Base, known as the Juvenile Hatchery at the Edwards Tortoise Study Site (JHETSS), hatched its first cohort of desert tortoises (*Gopherus agassizii*). The program began in 2002 as an adaptive management project to test the efficacy of rearing juvenile tortoises in predator resistant pens for eventual release into the wild. The overall goal was to increase wild breeding populations. Over the course of nine years, the program has provided information about: the efficacy of predator resistant pens, which have been shown to decrease mortality; unforeseen threats to juvenile tortoises raised in pens such as native fire ants; the efficacy of supplemental watering in extending forage

availability and tripling growth of juvenile tortoises; and predation as the major threat to released juveniles. Here, we analyze and summarize nine years of data collected at the JHETSS pens in an effort to shed light on the biology and ecology of head started juveniles and use these data to inform future decisions. For example, analysis of condition indices (CI) for live and dead tortoises revealed that the last live-measured CI for dead tortoises was significantly lower than the average CI of living tortoises. This may offer predictive power for identifying individuals that exhibit 'failure to thrive' as well as robust individuals that may be suitable for eventual release. The mortality rate for released tortoises is 98%, demonstrating the need for a greater understanding of not only tortoise growth and development, but also the way in which juveniles interact with their environment. Finally, we will present ideas and plans for the future aimed at increasing the accuracy of health evaluations for juveniles, understanding the effects of forage quality and quantity within the pens, the effects of pens on juvenile behavior, and the carrying capacity of pens that remain in the same location for many years.

POSTER

Evaluating the Effects of Horizontal and Vertical Mulches for Restoration of a Degraded Site in the Mojave Desert: First Year Findings

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Anthropogenic disturbance and the invasion of exotic plant species are major drivers of ecosystem change in California's deserts. These two phenomena can lead to soil compaction, loss of species diversity, and alteration of ecosystem processes such as hydrology and fire regime. Restoration in arid environments poses a difficult challenge for conservationists and managers due to the harsh, dry climate and slow recovery of native plants. In this study, we compared two mulching strategies used to encourage recovery of annual plants at a heavily disturbed, highly invaded site in the Mojave Desert. Horizontal (H) and vertical (V) mulches were constructed in shrub interspaces to simulate a 'fertile island' effect. These treatments may create a favorable environment for the germination of native annual plants and attract rodents, aiding in soil decompaction. Vegetative percent cover, biomass, and species richness were measured in both mulch treatments, as well as open areas (OA) between shrubs and beneath *Larrea tridentata* (LT) shrubs. Rodent burrows were also counted. Invasive species made up the majority of the plant cover in all treatments; however, functional group abundance differed between treatments. V plots had higher cover of invasive forbs than both H and OA plots. Native annual percent cover was twice as high in LT and OA plots as H plots. V plots had intermediate cover but had higher native species richness than LT plots. Total productivity analyses indicate that V plots are more productive than H and OA plots but only one-third as productive as LT plots. Mulch did not increase rodent activity in the first year. This study will be monitored in future years and the information collected can be used to make management recommendations for other desert sites.

Reading Minds: Exploring Reactions of Horned Lizards to Predatory Threats

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Predation has long been recognized as a selective force driving the evolution of morphology, physiology, and behavior of species. An enhanced understanding of the complexities of predator-prey interactions can be achieved by focusing on distinct segments of the interactions used by predators to encounter, detect, identify, approach, subjugate and ingest prey and the resistances mounted by potential prey to each survival challenge during these aspects of encounters. Species of horned lizards (genus *Phrynosoma*) have been recognized for their cryptic coloration and body form, adherence to site (immobility) when threatened, and use of unusual morphology (cranial horns, scale spines) and physiological responses (ocular-sinus blood-squirting) when closely approached. Critical to a successful escape at any point during an encounter with a predator is utilization of an appropriate defense that is effective given the specific predatory skills of each adversary. And critical to determining appropriate responses is proper identification (mental) of various categories of threat. In broadest terms, two major categories of threats to horned lizards can be though of as predators whose skills allow dismemberment of prey before swallowing and those that lack such skills and are committed to ingesting prey whole. Particularly in the latter case, size differences between predators and their prey, due to species differences or to stages of ontological development, can be critical. Staging encounters with various species of horned lizards and various types of predators we have been able to explore how the mental constructs of horned lizards are utilized to categorize threats and employ specific and effective responses. Some of these responses have been to human approach, but most have been to a broad spectrum of known natural predator species of horned lizards, including: greater roadrunners, red-tailed hawks ("simulated"), southern grasshopper mice, long-nosed leopard lizards, whipsnakes, western diamond backed-rattlesnakes, kit foxes, coyotes (+dogs), and bobcats. The outcome of these encounters will be illustrated with video clips. The high fidelity of different responses to diverse categories of predator threats, even in captive/caged conditions, suggests that horned lizards are utilizing identification and linked antipredator responses of high survival value throughout each aspect of any predatory threat.

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The Impacts of Introduced Ants on Diet and Habitat Use in the Coastal Horned Lizard

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Coastal horned lizards (*Phrynosoma coronatum*) have undergone severe declines in southern California primarily due to habitat destruction. In addition to the direct impact of habitat loss, horned lizards are ant specialists and may be particularly vulnerable to changes in

the native ant community resulting from the invasion of non-native ants that displace native species. In this presentation, I discuss the determinants of abundance for coastal horned lizards at multiple spatial scales throughout southern California based on 3 years of mark-recapture data from 21 sites across four counties. Factors correlated with the abundance of coastal horned lizards included the absence of the invasive Argentine ant (*Linepithema humile*), the presence of chaparral vegetation, and the presence of sandy substrates. Data on horned lizard diet, prey preference, and growth rates further support that the introduced Argentine ant is not a suitable replacement for the native ants that make up the majority of horned lizard diet. For example, hatchling horned lizards maintained positive growth rates on a diet of just one native ant species (*Crematogaster californica*). However, on a diet of Argentine ants or arthropods typical of an invaded community, horned lizard growth rates were either negative or averaged near zero. Similarly, radio-telemetry data used to estimate home range size and movement patterns of coastal horned lizards suggests that adults actively avoid areas invaded by Argentine ants.

STUDENT PAPER

Democracy, Capitalism, and Bureaucracy in the Mojave: a Sociological Perspective on Renewable Energy and Sensitive Habitat Management in the Mojave Desert

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This paper builds on Sydney Silliman's argument at the 2010 DTC Research Symposium, that the science of desert tortoise conservation is fairly straight forward, but the political and economic landscape in which that science is created and applied becomes a limiting factor for conservation. In order to understand the complicated nature of how the state and economy interact in a society and the environment, one must consider various competing conceptualizations of government and its role in democratic society. Examples indicate that the listing, protection, and recovery of endangered species may collide with elite interests and capitalist accumulation. The result is what Ludwig (2001:758) calls a "wicked" conservation problem: a situation wherein a "management paradigm fails when confronted with complex problems where there are no clearly defined objectives and a plethora of mutually contradictory approaches, each of which is plausible in a particular frame of reference." This paper employs three major and sociological theories of state, economy, and society to examine the conflict between renewable energy development in the Mojave Desert with the conservation of the Mojave Desert Tortoise. Three theories used include the pluralist (or democratic) perspective; the political-ecological perspective; and the managerial (or elitist) perspective. While we often accept that the laws that govern our society and the management of our natural resources are democratically determined, the case of the Mojave Desert Tortoise and the development of consolidated solar energy installations on its habitat indicate that democracy is a more complicated and often contradictory. Each of these perspectives can be used to examine the conflict between private economic and political interests and Desert Tortoise conservation; yet together they provide a more rich understanding of the issue and can help those involved in conservation work to identify the complexity of democratic, economic, and political interests when they conflict. The paper concludes with recommendations for dialogue among

environmental ethicists, social scientists, and those working for the conservation of endangered species, including activists and natural scientists.

Best Livestock Management Practices for the Sonoran Desert Tortoise (*Gopherus morafkai*)

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The Natural Resources Conservation Service (NRCS) in Arizona is working with agriculture producers, the Arizona Game and Fish Department and BLM to identify activities associated with livestock grazing in Arizona, the potential effects of those activities on the Sonoran desert tortoise (SDT) and develop conservation measures to ensure compatibility with desert tortoise conservation. Depending on timing, installation methods, maintenance, and other factors, all conservation practices and daily ranching activities have the potential to have beneficial, adverse, or no effect on SDT. While some practices may have short-term adverse effects, the long-term effects are often beneficial. Adverse effects can be minimized or mitigated through incorporation of conservation measures and informing personnel of SDT natural history and handling and survey protocol. Conservation measures are actions or methods incorporated into conservation practices and ranching activities to eliminate or reduce the amount or magnitude of adverse effects on SDT.

The Desert Tortoise Conservation Center's Role in Recovery Efforts

U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office
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San Diego Zoo Global
Nevada Department of Wildlife

The Desert Tortoise Conservation Center (DTCC) was constructed in the early 1990s in a remote portion of the southern Las Vegas Valley and gifted to BLM as part of a settlement agreement between the Government (FWS, BLM, and State of Nevada) and a group of plaintiffs represented by various builders and the City of Las Vegas. The buildings and tortoise holding facilities are contained within 222 fenced acres in an 11,014-acre area set aside as the Desert Tortoise Conservation Center Management Area by the BLM's Las Vegas Resource Management Plan. The primary function of the DTCC was to serve as a holding facility for wild tortoises removed from development projects as well as for tortoises from a pick-up service. Important research has also taken place at the DTCC. More recently, we have been redirecting the focus of the DTCC such that it plays an important role in the desert tortoise recovery program. Since partnering with the Conservation Centers for Species Survival and most directly with San Diego Zoo Global for operation of the DTCC in 2009, we have made progress in assessing the health of tortoises and in furthering our understanding of disease, initiated research into population augmentation, offered training courses for professional biologists and field crews, and increased efforts to engage the public. Our goal is to promote conservation of the

desert tortoise and Mojave Desert ecosystem by providing a first-class facility for research, training, and public education. Just as we are starting to make strides towards our goal, we are faced with shortfalls in funding that may affect the DTCC's future. We welcome suggestions on priority core functions of the DTCC and how to fund them.

Desert Tortoise Management and Research in Joshua Tree National Park

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Joshua Tree National Park (JOTR) protects nearly 800,000 acres of public land of which over half is considered high quality desert tortoise habitat. The park has supported the recovery of the tortoise through participation of region wide planning efforts, management of habitat, educational outreach, scientific research and line distance sampling.

JOTR managers are active participants in the Desert Managers Group (DMG) that promotes the recovery of the tortoise through education, information exchange and even a mobile app to record tortoise observations. The park management is also active in commenting on energy development projects near the park boundaries that may affect the desert tortoise. Within the park, educational specialists provide desert tortoise educational presentations to many of the local (Morongo Basin and Coachella Valley) schools. The park also has an active habitat restoration program that works to return impacted habitats to functional ecosystems for tortoises and other plants and animals.

Since 2007, the park's wildlife staff has been tracking desert tortoises near roads as part of a study to understand the effect of roads on tortoise movement patterns. Currently, the park is in its final season of data collection with some interesting preliminary results. In addition to this project, the park has assisted with the USFWS line distance sampling effort by providing both funding and data collection.

Recently, JOTR funded a study by Dr. Cameron Barrows to model desert tortoise habitat in the park. This model was then used to predict the change in habitat use by tortoises with varying levels of temperature increase and rainfall decrease associated with predicted climate shifts.

The park is also busy working with the USFWS on section 7 compliance for a campground redesign project and a road re-construction project. Additionally, the wildlife staff monitors many small projects in the park and gives many desert tortoise awareness classes to both contractors and new employees.

POSTER

Geographic Serology: Spatial Analysis of Mycoplasma Antibody Presence in Wild Desert Tortoises

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Disease epizootics are known to cause declines in desert tortoise populations and were a contributing factor for the Endangered Species Act listing of the Mojave desert tortoise (*Gopherus agassizii*). One disease of particular concern has been an upper respiratory tract disease (URTD) that presents clinical signs of chronic rhinitis, nasal and ocular discharge, palpable edema, and lesions in the upper respiratory tract. Although tortoises exhibiting signs of URTD may play host to an assortment of pathogenic organisms, few are proven to be causative. In this study, we focus on two species of bacteria known to cause URTD in tortoises: *Mycoplasma agassizii* and *Mycoplasma testudineum.* We investigated the serological status of a large population of wild desert tortoises (n = 518) in and around the National Training Center at Fort Irwin (Department of Defense) northwest of Barstow, CA in preparation for potential translocation efforts. We collected 529 blood samples during health assessments between May and November 2011 and plasma was ELISA tested at the University of Florida for antibodies to *M. agassizii* and *M. testudineum*. Although only a small proportion of tortoises tested positive for either species (<5%), spatial analysis of seropositive animal locations reveals important trends that potentially support disease transmission hypotheses. Tortoises that had positive and suspect ELISA results for *M. agassizii* were found near areas with higher human populations; however, there was no spatial trend or apparent covariate that explained the distribution of animals that tested positive or suspect for *M. testudineum*. We found the presence of mycoplasmal antibodies to be only loosely correlated with the existence of clinical signs (<29% of ELISA-positive tortoises demonstrated any clinical signs), and none of the animals had either bacterium detected by PCR analysis of lavage samples. This pattern may indicate areas where the pathogen was once elevated in the population, but is no longer widespread.

Clark County Multiple Species Habitat Conservation Plan Update

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The Clark County Desert Conservation Program (DCP) continues to administer the Multiple Species Habitat Conservation Plan (MSHCP) on behalf of the Cities, Clark County and Nevada Department of Transportation as mitigation for an Endangered Species Act section 10 incidental take permit for desert tortoise and 77 other species of plants and animals. The DCP has collected mitigation fees for more than 850 acres of take during the period of January to September 2011, leaving 66,740.12 acres on the permit. The 2011-2013 Implementation Plan

and Budget was approved for $10,125,502, including over $3,000,000 for land acquisition. Highlights of the past year include finalization of the roads designation for the Boulder City Conservation Easement, creation of new outreach materials for pet and wild desert tortoise issues, completion of new vegetation and geomorphology data for Clark County by University of Nevada-Reno, and development of a pilot test and protocol for desert tortoise occupancy monitoring.

POSTER

Desert Tortoise Occupancy Sampling Pilot Study

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Determining the status and trends of Mojave Desert Tortoise (*Gopherus agassizii*) is difficult due to low detection probabilities, yet land managers need timely information to seek correlations with land management activities, threats and other habitat characteristics. Occupancy sampling determines the proportion of habitat within an area that contains the targeted species (or indicators of the targeted species), and may provide a local-scale approach to status monitoring. We propose to pilot a full-scale desert tortoise occupancy monitoring protocol in the Boulder City Conservation Easement, south of the populated portion of Boulder City, Nevada, and immediately north of the Piute Eldorado Area of Critical Environmental Concern. The easement is primarily Mojave Desert Scrub and 79% of the area is Designated Desert Tortoise Critical Habitat. The easement is divided by tortoise exclusion fencing along State Highway 95, providing two similar sized study areas. Forty, four-hectare sample units have been placed in each area using the Generalized Random Tessellation Stratified approach, and will be surveyed three times per field season. Tortoises will be tagged when practicable. Sample units will receive 100% search for live tortoises and active burrows, including visual inspection of burrows for live tortoises. Habitat indicator data will include land use land management and law enforcement actions; as well as vegetation, soils and climate data. Baseline land management data collection has begun and we anticipate the first year of tortoise data collection for the pilot test will be 2013. Data will be analyzed using program PRESENCE 3.1 to assess occupancy and correlations with potential covariates.

Management and Conservation of an "Almost Listed" Species

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The Flat-tailed Horned Lizard, *Phrynosoma mcallii*, has a restricted distribution, occurs at variable densities, has lost approximately half of its historic range to human use, and is subject to a litany of potential threats; yet after multiple evaluations petitions and lawsuits the species

has not been listed under the U.S. Endangered Species Act. While the U.S. Fish and Wildlife Service was initially considering whether or not to list this species as threatened, Federal and State management agencies organized an Interagency Coordinating Committee and Management Oversight Group to implement a Rangewide Management Strategy modeled on the Desert Tortoise recovery plan. Various stakeholders view the decision to not list as an indicator of their successful proactive conservation efforts, including designation of five Management Areas, funding of research, and implementation of a coordinated monitoring effort. However, loss of previously-occupied habitat in the Coachella Valley and on state lands led environmental groups and concerned scientists to file lawsuits against the U.S. Fish and Wildlife Service, alleging that the decision to not list was politically motivated rather than science-driven. These stakeholders maintain that a decision to list would have made more money available, promoted more academic research, and resulted in greater conservation measures on state and private lands. Implementation of an aggressive conservation plan on a non-listed species may have also created unintentional confusion. For example, project proponents may mistakenly assume that non-listing means no special consideration for the species is necessary and may be confused or resentful when they are subject to mitigation measures as though the species were listed. Research has focused on population ecology, natural history, and population estimation. In meeting the challenges associated with low detection probability, agencies have tested a variety of population monitoring techniques, resolving upon standardized protocols that have been applied across Management Areas for five consecutive years. The voluntary implementation of the Rangewide Management Strategy has promoted conservation of the Flat-tailed Horned Lizard across most of its range, with the best available data indicating populations currently in the hundreds of thousands residing in Management Areas. The signatory agencies remain committed to the long-term viability of this species, even as new threats from invasive species, climate change, and renewable energy projects loom on the horizon.