THIRTY-NINTH ANNUAL MEETING AND SYMPOSIUM
THE DESERT TORTOISE COUNCIL

DoubleTree by Hilton Hotel, Ontario, CA
February 21–23, 2014

ABSTRACTS OF PAPERS AND POSTERS

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

Restoring Native Vegetation in Desert Tortoise Habitat of the Eastern Mojave Desert

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By supplying food, water, cover, and numerous other habitat features, quality plant communities are essential to quality desert tortoise habitat. When desert environments are severely disturbed, reliable techniques for vegetation restoration can help recover, maintain, or improve essential habitat features. In Lake Mead National Recreation Area, representing among the most intact eastern Mojave Desert landscapes supporting tortoise, required road construction destroyed soil and vegetation along a new road alignment and necessitated restoration along the old alignment. In 2008, we began an experiment to evaluate ways to improve vegetation restoration success by testing effects of slurry/water treatments during salvage on 2,105 salvaged native perennial plants. We then assessed influences of topsoil salvage, watering techniques, and species on salvage survivors placed back on the disturbed site. Survival of salvaged plants after one year of nursery care was 48% (1,017 of 2,105 plants) and varied among 23 species but not by treatment. Salvage survivors placed back on the disturbed site exhibited 49% survival (570 of 1,153 plants, which included ones recruited during nursery residence) after three years. Topsoil salvage increased plant survival on average by at least 20%, DriWater (a slow-release water gel) and hand watering resulted in similar survival for several species, and 11 species exhibited > 25% survival all the way from salvage through three years back at field sites. The four-year period of this experiment received 96% of long-term average precipitation. Results suggest that restoration of desert perennial plants in tortoise habitat is achievable through plant salvage, and that topsoil salvage and matching appropriate watering treatments (which were not even required for all species) increase effectiveness. Evaluating whether restoring these perennial plants promotes annual plant recruitment, including key desert tortoise forage species, would be a next step in this research.

Status and Management of Exotic Plant Invasion in the Three Largest National Parks Supporting Desert Tortoises in the United States

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Invasion by exotic plants is a top threat to desert tortoise by altering composition of forage, providing fuel for wildfires that disrupt native desert communities, and changing vegetation structure. We collected and analyzed an unique data set of exotic plant species on 1,662 plots (0.1 ha in size) in Death Valley National Park, Mojave National Preserve, and Lake Mead National Recreation Area. Collectively comprising 2.5 million ha, or 23% of the entire National Park Service's land area in the contiguous USA, all three of these parks contain some desert tortoise habitat and are the largest national parks in the country supporting desert tortoise. At least one exotic plant species occupied 82% of the plots, with the 'ecosystem engineer' *Bromus rubens* (red brome, which provides fuel to promote spread of wildfires) occupying 60% of plots. Fifty-one percent of plots contained multiple exotic species, which can complicate management treatments. This study provided several informational tools for management, such as comparing prioritization systems for ranking species for treatment and identifying species likely most suitable for early detection and treatment to constrain their spread. The desert tortoise occupies present landscapes harboring a plant species composition drastically altered from that preceding pervasive invasion by exotic plants during the 1900s. In a previous study of desert tortoise food preference [Chelonian Conservation and Biology 4:341-352], the exotic annual *Schismus* spp. comprised 98% of available forage, but of 239,000 *Schismus* plants encountered, desert tortoise ate only 42 of them. Despite there being a mere 346 plants encountered of the native annual *Plantago ovata*, this native comprised 3× the consumed forage as *Schismus*. Consequences to desert tortoise of type conversion from native to exotic vegetation warrant much greater attention, as does further development of techniques for promoting recruitment of preferred native forage plants.

Desert Tortoise: Conserve, Protect, Recover

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The Center for Biological Diversity continues our conservation and recovery campaign for the desert tortoise and its habitat in California, Nevada, Utah and Arizona through science-based advocacy, participation in administrative processes, public information and litigation. For over 20 years, the Center has consistently supported increased protections for the desert tortoise (DT) as the path to desperately needed species recovery. Currently, our desert tortoise protection campaign is focused on protecting habitat and animals from development of renewable energy

projects in occupied habitat, mining, off-road vehicles, grazing and other destructive activities and development proposals. Some of the challenges for tortoise conservation that the Center has been focused on in the past year include: renewable energy projects; the development of the Desert Renewable Energy Conservation Plan in California; challenging more than a decade of cattle trespass in Gold Butte, Nevada, translocations from the Desert Tortoise Conservation Center (DTCC) into occupied habitat and the looming closure of the DTCC; challenging new ISDRA (Algodones Dunes) management plan; continuing our work to protect other species that share some habitat with DT including Flat-tailed Horned Lizard; Clark County's proposed Habitat Conservation Plan revisions which seek an additional 215,000 acres of take; and implementation of the revised Desert Tortoise Recovery Plan. Despite the overall bleak picture of decreasing numbers and on-going habitat losses for the species, some successes have been achieved that may result in increased conservation, for example, the new route designation and plan amendment process in the west Mojave area of the California Desert Conservation Area, and permanent grazing retirements in California Desert Conservation Area under new statutory authority 43 USCS §1781a.

A Conceptual Overview of Mojave Desert Tortoise Population Connectivity and Patch Dynamics

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Recovery of the Mojave desert tortoise is focused first on maintaining and improving habitat within existing tortoise conservation areas, which lie within the larger expanse of historically occupied habitat. Almost all conservation areas are divided internally or separated from adjacent areas by major roads and highways, so minimizing road mortality and associated habitat fragmentation have long been recognized as important recovery actions for the species. Nevertheless, even without the fragmenting effects of roads, existing conservation areas do not meet reserve-design guidelines for size and shape, especially in the face of declining populations. Most conservation areas also currently contain fewer tortoises than estimated necessary to maintain viable populations. Maintaining tortoise populations between conservation areas is important in providing resiliency and preventing isolation of core populations within conservation areas. Increasing proposals for large-scale development led us to model habitat linkages in an effort to identify priority lands to prevent the isolation of existing conservation areas. Low-mobility species such as the desert tortoise are considered "corridor dwellers," in contrast to species that may pass through corridors between protected areas in days or weeks, especially at large spatial scales. However, questions remain about corridor width, highway passages, and what is necessary or sufficient to maintain viable tortoise populations.

Here, we explore desert tortoise population dynamics within a spatial context to better understand how local populations or habitat patches contribute to long-term, regional population viability. The Mojave desert tortoise requires inter-connected patches of habitat that sustain populations over multiple generations. Such inter-connected patches allow local clusters of tortoises that experience sufficient recruitment and dispersal under favorable environmental conditions to repopulate or "rescue" suitable habitat patches with no or few tortoises that resulted

from poor environmental conditions, low recruitment, or high mortality. Habitat linkages between tortoise conservation areas must be wide enough to sustain multiple home ranges and inter-connected clusters of tortoises in order to sustain regional tortoise populations. We are modeling tortoise patch dynamics to better understand the population-level effects of habitat loss and fragmentation.

Using Raptor Flight Behavior as a Tool for Careful Repowering of Wind Farms

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Collisions with wind turbines in the Altamont Pass Wind Resource Area (APWRA) account for approximately 10,000 bird mortalities per year, of which nearly 2,000 are raptors. Mortality rates for golden eagles in the APWRA average 50-60 per year; the APWRA represents a population sink for this local raptor. Repowering the APWRA to modern wind turbines presents an opportunity to decrease raptor fatality rates using collision hazard (risk) mapping. We developed a method to relate raptor flight observations to a digital elevation model. Raptor flights were weighted by detection functions based on distance from the observer, volume of visible airspace within the maximum survey radius, degree of overlap of surveys from observation stations, and survey frequency. We developed Fuzzy Logic models to predict locations of weighted golden eagle flights, red-tailed hawk and American kestrel hovering flights, and burrowing owl nest burrows. The models included geoprocessing steps to help identify ridge saddles, notches, and benches where wind turbine locations are more hazardous. The models' highest likelihood surface – class 4 –included mapped flying golden eagle observations 2.4 times other than expected, hovering red-tailed hawks 13 times other than expected, hovering American kestrels 12 times other than expected, and burrowing owl nest burrows 8 times other than expected. We used our collision hazard maps to guide wind turbine siting. Additional steps to improve the risk maps for golden eagles and to study movement patters using GSM/GPS satellite transmitters will be discussed. Photo of wounded red-tailed hawk, Altamont Pass, CA by D. Bell

Desert Tortoise Distribution and Abundance in the Chemehuevi Valley: Effects of Feral Burros, Trash, and Vehicles

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We conducted a study of the status and distribution of Agassiz's desert tortoises (*Gopherus agassizii*), tortoise sign, and land uses in the eastern part of Chemehuevi Valley, San Bernardino County, California. We sampled a 118 km^2 area with 200 randomly placed 1-ha plots. The study area borders on and is outside of designated critical habitat for the desert tortoise. The estimated density of tortoises within our study area was very low, 2.5 ± 1.0 SE/km^2 km^2 (95% CI = 1.0–5.0 tortoises/km^2) but within the confidence intervals of the U.S. Fish and Wildlife Service's range-wide monitoring for the Chemehuevi area in 2008 and 2009 using line-distance sampling. The estimated death rate for the four years preceding the survey was 9.4% per year. Tortoise sign, most of which was recent, was recorded on 35 (17.5%) of the 200 plots. Most plots (91%) had one or more human-related impacts, listed in descending order of occurrence on plots: scat of feral burros (84.0%), recent unauthorized vehicle tracks (34.0%), general trash (28.0%), feral burro trails and wallows (26.5%), and old vehicle tracks. We used binomial logistic regression models to independently evaluate effects of 12 anthropogenic predictor variables and two predator predictor variables on the presence of tortoise sign. The presence of tortoise sign was significantly and negatively affected by burro trails, burros scat, trash, and vehicle tracks. This is the first study to provide evidence of a negative effect of burro sign on presence of tortoise sign. Tortoise populations and habitat may benefit from reduction in the Chemehuevi burro herd, unauthorized vehicle use, removal of trash, and limitations on other surface disturbing activities.

Assessment of Desert Tortoise Habitat Connectivity within Ivanpah Valley

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Developing a solid understanding of existing conditions related to habitat connectivity is an initial, critical step in evaluating the impacts of future actions. Recent studies and models have provided a greater awareness of connectivity potential across the range of Agassiz's desert tortoise (*Gopherus agassizii*). In 2011, we set out to assess in further detail the existing conditions of habitat connectivity within and along the periphery of Ivanpah Valley. Through a combination of field data collection and Geographic Information Systems (GIS) analysis, we developed maps and written description of existing habitat connectivity, including the potential for genetic and demographic connectivity, across existing geographic and anthropogenic features.

Banding and Radio-telemetry Data Reveal Connectivity of California raptors to Multiple Ecosystems Surrounding the California Deserts

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Over 40 years of raptor research in southern California employing a combination of surveying, banding, mark and recapture, and VHF and satellite telemetry reveal connectivity of raptors to California deserts and multiple ecosystems adjacent to desert habitat. Movement behavior studies have been conducted with western red-tailed hawks (*Buteo jamaicensis calurus*) and western red-shouldered hawks (*B. lineatus elegans*) with natal origins in southwestern California. These studies demonstrate that raptors, originating in diverse habitats such as coastal sage scrub, riparian forest, non-native and native grassland, and oak woodland, have been encountered and documented utilizing and crossing the California deserts to surrounding areas and ecosystems.

Movements of long distance dispersers, including vagrant western red-shouldered hawks provide evidence for the species' potential to populate new landscapes in response to changing environmental conditions and to maintain genetic heterogeneity within existing populations. Of 2,869 non-migratory western red-shouldered hawk nestlings banded in southern California, 119 were subsequently encountered. Of the 119 encounters, 10 (8.4%) moved >100 km and were considered long-distance dispersers. Three (2.5%), all long-distance dispersers, were vagrants (recovered outside the species range), and were found between 374 and 843 km northeast and south of their banding locations across portions of the Mojave, Great Basin and Viscaino Deserts. Vagrancy, because of its direct relationship to population spread, population dynamics and genetic composition, is important to biodiversity conservation. The distances, directions, timing and dispersal area of vagrants may have relevance in projecting the possibility of a species adapting to changing environments (e.g., land-use modification and climate change).

Southern California research includes the only study documenting red-tailed hawk spring-summer northward migrations. Of 5,460 nestling red-tailed hawks banded in southwestern California, 205 were recovered outside the Study Area. Of the 205, 64 (31.2%) were recovered >100 km from their natal nest and <46 months of age which we considered migrants. Most of these migrants (n = 69%) were recovered in a northerly direction from their nest as distant as 1,462 km. The majority of migrants (n = 62.5%) were recovered in California, mainly in the western Mojave Desert, Los Angeles Basin, and the Central Valley. Another smaller group (n = 8.8%) was spread across the Great Basin in northeastern Nevada, eastern Oregon, northern Utah, southern Idaho, and Montana, which is the area where many of the Platform Transmitter Terminal (PTT) equipped hawks were also found. Thirteen of 16 red-tailed hawks equipped with satellite transmitters in southwestern California migrated north (range 342–24°) moving as far as 1,388 km from their natal area. Ten survived through summer, and all returned to their natal area in late summer–autumn. The PTT-equipped hawks generally summered in or adjacent to the Great Basin Desert and or Central Valley. While migration appears facultative, direction may be an obligate behavior.

Conservation implications resulting from our raptor movement research is the recognition that we know so little about the post-fledging movements of the vast majority of bird species, particularly those of the smaller taxa. While it may be safe to assume that the majority of those individuals fledging from northern latitudes migrate south it may not be justified to believe that southern latitude populations are resident and do not first migrate north before migrating south.

Nevada Statewide Golden Eagle Nest Site Survey

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Population trends for Golden Eagles in Nevada are uncertain, but declines are suspected, and the state is home to an estimated breeding population of ~ 3,000 birds. However, until recently the distribution of breeding activity was not well quantified in many parts of Nevada. In 2011, the Great Basin Bird Observatory (GBBO) and Nevada Department of Wildlife (NDOW), with support from the BLM Nevada state office, initiated a statewide survey program for Golden Eagle nest sites. Survey efforts were concentrated in "focal areas" that were defined by the distribution of suitable nesting substrates. Additionally, survey efforts were given highest priority in Nevada's 47 million acres of BLM land (~ 2/3 of the state's land area), where energy development activities could occur and generate impacts to nesting eagles. The immediate goal of this program was to provide Nevada's BLM state office with information needed to better evaluate the potential impacts of proposed energy developments. Longer term goals were to develop a systematic baseline data set and to examine nest distribution patterns and correlates. We combined aerial and ground survey techniques to cover over 14 million acres of suitable nesting habitat across Nevada, and delineated all areas that were searched, regardless of whether nests were located. Data collected in 2011 was combined with NDOW Golden Eagle data dating back to 2003, which created a data set with 2,673 known or possible Golden Eagle nest structures, distributed across 1,175 distinctly different locations. In 2013, the statewide survey effort was continued, with goals of: 1) surveying remaining focal areas, 2) conducting direct comparison of aerial and ground survey results in common survey areas, 3) comparing results obtained from rapid vs. intensive survey techniques, and 4) examining nest occupancy patterns. Analysis of 2013 data is currently underway, and results should be available by the time of this presentation. NDOW manages the program's amalgamated data set, which combines all Golden Eagle nest site information gathered by NDOW and GBBO since 2003 in Nevada, which can be overlayed with polygons of searched areas. This provides a visual representation of the potential for development impacts to Golden Eagles, as well as an indication of areas where there is insufficient data to make a determination.

Results from a qPCR Test Comparison Study: Can Oral Swabs be used as a Substitute for the Nasal Flush in Detection of *Mycoplasma agassizii*?

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Screening desert tortoises (*Gopherus agassizii*) for known causes of upper respiratory tract disease, including *Mycoplasma agassizii*, *M. testudineum*, and testudinid herpesvirus 2 (TeHV2) improves understanding of agent prevalence and impact on population health. Nasal flushes are the commonly used sample for qPCR detection of Mycoplasma species. This study investigated whether oral swabs can replace nasal flushes as the preferred sample. Benefits of oral swabs include reduced animal handling time, a procedure with minimal manipulation, and multifunctionality because oral swabs are also collected for TeHV2 PCR testing.

Paired nasal flush and oral swab samples were taken from three groups of desert tortoises. Group 1 consisted of 162randomly selected live desert tortoises at the Desert Tortoise Conservation Center (DTCC), Las Vegas that had available paired samples. Group 2 consisted of 108 necropsied DTCC desert tortoises. Group 3 consisted of 139 wild, live desert tortoises removed from solar renewable energy sites. Both sample types were analyzed using multiplex qPCR for *M. agassizii* and *M. testudineum* and results were compared using a kappa statistic.

The prevalence in Group 1 was 17.9% for *M. agassizii* and 3.7% for *M. testudineum*. There was an almost perfect agreement (kappa 0.91) between nasal flush and oral swab results for *M. agassizii*. Group 2 had 60.2% and 2.8% prevalence of *M. agasizii* and *M. testudineum*, respectively, and an almost perfect agreement (kappa 0.94) between flushes and swabs for *M. agassizii*. Prevalence in Group 3 was 0% and 0.7% for *M. agassizii* and *M. testudineum*, respectively. Kappa values for group 3 and all *M. testudineum* results were not evaluated due to low prevalence of the agents in the samples.

Based on this almost perfect agreement across all three groups, we conclude that oral swabs can be used as a nasal flush substitute for *M. agassizii* qPCR analyses in desert tortoise populations.

Looking into Deaths at the Desert Tortoise Conservation Center: A Review of Histologic Findings

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Over a four year period between 2009 and 2013 a total of 386 desert tortoises were necropsied from the Desert Tortoise Conservation Center (DTCC), Las Vegas. Half of the tortoises (194/386) were adults (median carapace length (MCL) ≥200mm), 12% (45/386) were

immatures (MCL 100-199mm), and 38% (147/386) were juveniles (MCL 0-99). Necropsy included biometric measurements, gross and histological evaluation, special staining and select molecular diagnostics. Presented here is an overview of histological findings. Main findings or suspect causes of death are categorized by organ system and include a scoring system of most frequent lesions.

Based on histological evaluation, 43 out of 386 tortoises (11%) had an undetermined cause of death mostly due to advanced autolysis. Of the 343 that could be evaluated, the most frequent main findings were respiratory (239; 70%) followed by alimentary (38; 11%), urinary (18; 5%), and hepatic (10; 3%). Thirty-eight (38; 11%) tortoises had any of a variety of lesions including musculoskeletal abnormalities and gout. Respiratory lesions included rhinitis, laryngitis, laryngotracheitis, pneumonia, pulmonary fibrosis, and pulmonary granuloma. Alimentary lesions included oropharyngeal inflammation, stomatitis, enteritis, and proctitis. Urinary lesions included nephritis, renal degeneration, urocystitis, and urolithiasis. Hepatic lesions included hepatitis, hepatic fibrosis, hepatic vacuolar change, and hepatic granuloma. In juveniles, 25% (37/147) had indications of metabolic bone disease. Fifteen (15/386; 4%) tortoises had lesions consistent with a testudinid herpesviral infection in association with glossitis, rhinitis, pneumonia, and/or multisystemic lesions.

In conclusion, both upper and lower respiratory lesions were the predominant causes of morbidity. A number of the upper respiratory lesions were consistent with an infection involving *Mycoplasma* species. The causes of pneumonia have not been determined yet in these cases.

Future interpretation and statistical analyses will focus on in-depth comparative evaluation of clinical, histological, and molecular findings.

Forgotten Landscapes of California: Historical Ecology, Changing Deserts, and the Adventures of Publishing a Book

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Using the methods of historical ecology this book seeks to reconstruct pre-contact landscapes and wildlife of California during the Holocene Epoch. Oil paintings and sketches depict scenes of how present day cities might have appeared 500 or 1,000 years ago. The changing Mojave and Colorado Deserts are discussed -- abundant tortoises, desert pronghorn antelope, jaguars of the Colorado River and more. The joys and challenges of publishing such a large book project are also discussed.

Estimating Recovery Benefits of Management Actions Relative to Habitat Acquisition

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Land acquisition historically has been the mitigation action of choice when offsetting project impacts. However, the majority of land in the desert southwest is already under federal ownership, and acquisition opportunities are increasingly limited. A challenge when choosing from alternative mitigation options is scaling the benefits of those options against each other and against habitat acquisition. The Mojave desert tortoise decision support system models effects of threats and recovery actions to tortoise populations to create a risk surface, which can be used to identify which conservation actions are most likely to be effective where. We can use the spatial decision support system to calculate ratios of different management actions relative to habitat acquisition in reducing risks to tortoise populations in a given area. We will illustrate how this can be used with an example.

Flight Behavior of Desert Golden Eagles

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Golden Eagles are large soaring birds that subsidize the majority of their flight with either thermal or orographic (i.e., upward deflected winds) lift. When eagles use orographic lift, they fly at relatively low levels above ground with flight altitude overlapping the rotor-swept zone of wind turbines. When eagles use thermal lift, flight altitude is often above the rotor-swept zone. However, weather conditions associated with flight of golden eagles in North American deserts are not well understood. To determine meteorological factors associated with golden eagle flight, we matched locations of eagles from the Mojave Desert recorded at 15 minute intervals with a suite of weather data from the National Centers for Environmental Prediction/National Center for Atmospheric Research. We also compared meteorological conditions from locations where eagles perched with those from locations where eagles were in flight. Finally, we compared weather variables from in-flight locations where eagles were > 150m above ground level to locations where eagles were <150m above ground level to determine if low-altitude flight was correlated with specific weather patterns. Golden eagle flight was associated with conditions that promoted thermal lift and orographic lift, including flight above and below 150m above ground level. Desert eagles appear to be at risk of collisions with wind turbines regardless of flight type, although the duration and extent of risk may differ when eagles use different types of lift and under different meteorological conditions.

Issues Facing Tortoise Translocation in an Urbanizing Area

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Copper Mountain College (CMC) established an 85-acre tortoise preserve in 2008 to serve as a translocation area (TA) for tortoises displaced from the adjacent 55 acres by campus expansion. Forty-eight monthly surveys from 2009-2012 along TA fencelines, and annual spring surveys from 2009-2013 throughout the TA, documented management concerns and generally bimodal variance in tortoise presence and activity. During monthly surveys, tortoises, scat and burrows were most detectable in spring and fall seasons. Tortoise detection showed weakly positive correlations (*Spearman's r*) with monthly precipitation and mean monthly temperature. Scat abundance differed significantly (*1-way ANOVA, $p < 0.01$*) between months and years. Subadult scat was most detectable in the same seasonal periods as adult scat. During the study period tortoise scat increased significantly along TA fences, except along the southern fence bordering Highway 62, indicating that road proximity may affect tortoise behavior. Management successes included no mortality of adult translocated tortoises, good compliance by construction personnel and vehicles, removal of invasive mustard species, and educational efforts. Persisting management issues have included some predation by ravens and canids, presence of *Mycoplasma,* ectoparasitic tick vectors, shell disease, recurrent litter, and storm or vehicle damage to fences. Introduction of two pet tortoises occurred despite informational signs, although no poaching of tortoises has been detected. More effective population monitoring using radiotelemetry, rigorous health testing, and durable identification markers could have been implemented with better funding. This translocation scenario is likely to be repeated when tortoises are displaced from other urban areas.

Desert Renewable Energy Conservation Plan Update

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The Bureau of Land Management (BLM), United States Fish and Wildlife Service (USFWS), California Energy Commission (CEC), and California Department of Fish and Wildlife (CDFW) are working collaboratively to develop the Desert Renewable Energy Conservation Plan (DRECP). The DRECP is designed to comprehensively address renewable energy and transmission development projects in California's Mojave and Colorado deserts. The DRECP includes a strategy that identifies and maps areas for renewable energy development and areas for long-term natural resource conservation. The DRECP will consist of a Natural Community Conservation Plan, Habitat Conservation Plan, and a BLM Land Use Plan Amendment (LUPA). The BLM LUPAs will cover renewable energy development areas,

conservation areas for biological and non-biological resources and uses, NLCS land designations, and allowable uses and use restrictions for all the above areas on BLM-administered federal lands. The primary goals of the DRECP are to contribute to the conservation and recovery of listed and unlisted Covered Species and natural communities and to streamline future permitting efforts for the development of renewable energy to help meet California's renewables portfolio standard (RPS) and other state and federal renewable energy goals. I will provide an update on status of the DRECP process, compare the existing management to how the DRECP would affect tortoise management (BLM perspective), examples of range of alternatives being considered, and information on how to provide information and input into this public process.

Why the Desert Renewable Energy Conservation Plan (DRECP)?

Scott Flint,
California Energy Commission

Senate Bill X1-2 (Simitian, Chapter 1, Statutes of 2011), signed into law by the Governor on April 12, 2011, increased California's renewable energy portfolio standard to 33 percent by 2020, and Executive Order S-14-08 mandated the formation of the Renewable Energy Action Team (REAT) to develop the DRECP, a major component of California's renewable energy planning efforts. The REAT agencies include the California Energy Commission, California Department of Fish and Wildlife, U.S. Bureau of Land Management, and U.S. Fish and Wildlife Service. The DRECP, when completed, is expected to further these objectives and accelerate the processing of renewable projects in the Mojave and Colorado deserts of California.

The DRECP will be a Natural Community Conservation Plan (NCCP) and provide incidental take permits under state law and provide for incidental take authorizations under the Federal Endangered Species Act. It will also serve as a Land Use Plan Amendment for the Bureau of Land Management. The DRECP will provide effective protection and conservation of desert ecosystems while allowing for the appropriate development of renewable energy projects. It will provide long-term endangered species permit assurances to renewable energy developers and a process for conservation funding to implement the DRECP.

This talk will focus on why the development of the DRECP is important to California, from both a renewable energy development and a habitat conservation standpoint. The speaker give an update on the status of the planning effort, discuss the pros and cons of this landscape level planning approach, the scientific basis for the plan, the potential benefits for both energy development and species/habitat conservation, and uncertainties that have been encountered in the development of the plan. Specific examples pertaining to the Desert Tortoise and other proposed DRECP covered species will illustrate these topics.

An Update on Four Translocation Projects in Nevada

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The Desert Tortoise Recovery Office is involved in several translocation projects that were initiated as proactive conservation efforts and/or for the advancement of applied translocation science. Although work on these projects is ongoing, we report accomplishments at several sites including the Large-scale Translocation Site (LSTS) near Jean, Nevada; the River Mountains near Boulder City, Nevada; the Nevada National Security Site (NNSS); and the greater Trout Canyon area near Pahrump, Nevada.

We conducted repeated recapture surveys at the LSTS in 2008, and 2010-2012, from which we will estimate density at the site and investigate survival of different cohorts released over time. Capture records indicate survival of at least 12 years post-release.

At the River Mountains site in 2008, we experimentally released adult tortoise that had been living in low creosote flats into very rugged, steeply sloped, rocky terrain and compared them to a group released in creosote flats similar to their original site of capture. Preliminary results indicate that tortoises did not make their way back to flat areas and made use of the variety of rocky caves and boulder piles as shelter sites.

We have collaborated with San Diego Zoo Global and NNSS scientists to study the effects of individual temperament on movement patterns and survival of juvenile tortoises released at the NNSS in 2012.

Our goals in the Trout Canyon area, where we released tortoises in 2013, are two-fold. With collaborators from San Diego Zoo Global, we are attempting to augment the population to bring it closer to the densities seen in the surrounding recovery unit. Additionally, we are investigating the effects of *Mycoplasma agassizii* ELISA status on post-release health, movements, and survival.

Protection of Habitat through Land Acquisition

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The designation of large areas in the California Desert as critical habitat for desert tortoise was of tremendous importance to the recovery of the species. Even with this and other layers of protection on desert landscapes, there is still a significant amount of desert tortoise habitat that has private development potential, management problems, or needs restoration. In partnership with state and federal agencies, private foundations, consultants, and other local partners, Mojave Desert Land Trust has purchased over 46,000 acres in the California Desert, much of which is desert tortoise habitat. Many of these lands require restoration and debris removal before regular monitoring and management begins.

QuadState Local Governments Authority: Counties Participate in Desert Tortoise Recovery Planning and Other Natural Resources Activities

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QuadState LGA is entering its fifteenth year of operation. We represent 10 local governments in the Mojave and Sonoran Deserts on a variety of natural resources issues. And we are in discussion with other counties relative to expanding our membership.

Our primary organizational interest remains desert tortoise. Counties have been engaged with desert tortoise issues since the listing decisions in 1980 (Beaver Dam Slope), 1989-90 for the Mojave Population, and for the upcoming final decision on the Sonoran Population. We have participated in the Recovery Implementation Teams (RITs) for the recovery action planning for the Mojave Population. The Authority has membership on the Management Oversight Group, as do its member counties, and we look forward to that re-constituted organization. We hoped for a meeting in 2013, but that did not occur. We believe that it must meet in 2014 to address the shotgun of management proposals that emanated from the RITs work a year ago.

Counties are engaged with the California Desert Managers Group, We also participate in the Mojave Desert Initiative which covers the three "eastern" states of the Mojave. We also look forward to serving with the Arizona Interagency Desert Tortoise Team, representing of our Arizona member counties.

QuadState grew from a need by the counties for services and advice regarding desert tortoise, and other public lands issues for which many lack staffing to cover. Counties were, and remain, concerned regarding the effects of many mitigation and recovery methods applied or proposed that affect their infrastructure, expenses, and those of their constituents.

The number of organizations and meetings needing coverage has grown since our members cannot devote staff and resources to the myriad of natural resources interagency meetings that now occur in the region. The President's and Secretary's Orders on initiating actions on climate change have expanded coverage and interest including review of Environmental Protection Agency (EPA) initiatives.

We sit with the Desert Landscape Conservation Cooperative (DLCC). This regional organization is setting out formal statements of research and science needs and priorities. While nationally operated under the Fish and Wildlife Service, the Desert LCC is managed by the US Bureau of Reclamation. It has raised management questions and set direction for conservation activities that have the potential to affect an array of natural resource management actions, and by extension could have substantial effects on private land within counties, given the "landscape orientation" of its interests. Parallel with that participation, we have participated in the roll-out of the public review part of BLM's Rapid Ecoregional Assessments for the Mojave and Sonoran Ecoregions. All these initiatives are done by agencies on a "landscape" basis.

While we participate in these organizations as professional members and representatives, QuadState exists to put forth the positions of local governments on a regional basis, which may, or may not, align with policies and programs of the federal and state agencies with which we communicate and coordinate, but the Authority has a responsibility to raise awareness by those agencies of the positions and concerns of the local elected officials regarding land management and private land issues in the region.

Juveniles and Adults or Just Adults
An Assessment of Whether or Not to Include Juvenile Tortoise Detections When Modeling Single Season Occupancy for Sonoran Desert Tortoises

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Determining desert tortoise site occupancy serves as an effective way for resource managers to monitor the current status of tortoise populations throughout the Sonoran desert. However, differences in the ways in which occupancy estimates are derived can make longitudinal comparison challenging. One such difference is whether juvenile tortoise detections are included in an incidence matrix. In some practices, only adult detections are included in single season analysis, due to differences in juvenile and adult detection probabilities, with juvenile detection expected to be markedly lower. We feel that because detections of juveniles are less frequent, including them in analysis would better inform management decisions by presenting a more complete picture. We modeled occupancy, including and excluding juvenile detections, at two sites in southern Arizona in order to evaluate this one aspect of estimating occupancy.

Histology of Systemic Testudinid Herpesvirus-2 (TeHV-2) Infection in the Desert Tortoise (*Gopherus agassizii*)

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In the desert tortoise, testudinid herpesvirus-2 (TeHV-2) is a cause of oral and respiratory lesions that can appear clinically similar to those caused by *Mycoplasma* spp. In addition to contributing to upper respiratory disease, THV-2 also causes histopathologic lesions throughout the body, including many non-respiratory organs. In the course of postmortem histological examinations of more than 400 animals from the Desert Tortoise Conservation Center (DTCC), Las Vegas, 14 cases of tortoises with THV-2 inclusions were identified.

Distribution and number of organs demonstrating TeHV-2 inclusions varied between cases, as did degree and distribution of inflammation. Organs with changes included tongue,

larynx/trachea, lung, esophagus, cornea/conjunctiva, colon/cloaca, liver, spleen, pancreas, and adrenal gland as well as vascular endothelium. The most severe cases presented with intranuclear viral inclusions in up to 11 organs and inflammatory changes in eight. The mildest cases had inclusions only in the epithelium of the tongue and only demonstrated inflammation in 5 organs.

Tongue was invariably affected in all TeHV-2 cases. All cases for which tongue was available (13) had inclusions and inflammation in the tongue. Other organs likely to have inclusions were the trachea/larynx (11 cases), lung (9 cases), esophagus, cornea/conjunctiva, and nasal cavity (8 cases each). Organs that rarely had inclusions were only noted in the most severe cases (only one case demonstrated inclusions in pancreas and adrenal).

To evaluate severity of inflammation, a scoring system for inflammatory lesions was used to grade the most clinically significant organs (tongue, larynx/trachea, lung, esophagus, cornea/conjunctiva, and colon). Averaging each organ's scores among the cases provided a summary of each organ's inflammatory involvement. In general, organs that were more likely to be struck by the disease tended to have higher inflammatory scores, while organs that were less likely to be affected had lower average scores.

Recovery Progress at Mojave National Preserve

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Progress towards recovery of the desert tortoise at Mojave National Preserve continued along the same lines as reported in previous years at this symposium; namely, habitat restoration, threat monitoring, and research towards population augmentation. Restoration of cattle-trampled areas (piospheres) in Mojave National Preserve desert tortoise habitat was initiated in 2012 with the seeding of native tortoise forage plants on approximately 11 acres of disturbed land. Additional soil decompaction was completed in 2013. Debris and some hazardous materials were cleaned up on 11 parcels, totaling 188 acres, and 821 acres on 24 parcels in potential tortoise habitat were donated to the National Park Service. Weed control was accomplished primarily in the higher elevations due to low rainfall. The annual survey of 508 miles of powerlines encountered 18 raven nests but no new evidence of juvenile tortoise mortalities related to raven predation. Ten tortoises were reported killed on roads in the Preserve. The Ivanpah Desert Tortoise Research Facility, constructed by Chevron as compensation for activities related to the wastewater pipeline from Molycorp's Mountain Pass Mine, was donated to the National Park Service and accepted on January 7, 2014. Juvenile tortoise headstarting research at the facility is being led by Savannah River Ecology Lab and the University of California, Davis.

Mycoplasmosis of *Gopherus* spp.: Immunological and Pathological Responses

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Mycoplasmosis of tortoises in the genus *Gopherus,* has been studied for nearly 25 years. While the majority of work has been with *Mycoplasma agassizii*, a recent report implicates a second mycoplasma, *M. testudineum*, as a pathogen in Morafka's desert tortoise, *Gopherus morafkai*, and the gopher tortoise, *Gopherus polyphemus*. Mycoplasmosis of tortoises shares many features in common with mycoplasmal infections of the respiratory tract of birds and mammals. Mycoplasmal diseases can exist as both chronic clinical and subclinical infections, with recurrence of clinical signs and increases in transmission potential when the host is stressed (Simecka et al., 1992). This is especially evident with mycoplasmal diseases where the host adaptive immune response is dysregulated, resulting in limited or no protection (Szczepanek and Silbart, 2013). A similar host response has been seen in tortoises with mycoplasmosis. Pathologic studies revealed an over-exuberant, host response to *Mycoplasma agassizii* resulting in dysplastic changes to the mucosa and submucosa and associated glands of the nasal cavity (Jacobson et al., 1991; Jacobson et al., 1995; McLaughlin et al., 2000). To a lesser degree these changes have also been seen in desert tortoises infected with *M. testudineum* (Jacobson and Berry, 2012). The clinical response of healthy, seropositive adult gopher tortoises in experimental challenge studies with *M. agassizii* was more rapid and severe than in naïve tortoises, suggesting minimal protection resulting from previous exposure to the microbe (McLaughlin, 1997). Thus antibody produced in response to mycoplasmal infections is not necessarily protective. Antithetically is the finding that several clinically healthy desert tortoises, which were culture and ELISA positive, had normal nasal cavities (Jacobson et al., 1995). Thus, not all tortoises respond to *M. agassizii* with a severe inflammatory response, suggesting that either multiple strains of *M. agassizii* may exist with variable pathogenicity or tortoises with a certain genotype do not overreact to the microbe's presence. The value of an ELISA test developed by Schumacher et al. (1993) and refined by Wendland et al. (2007) to detect a mycoplasma-induced acquired antibody response was questioned by Hunter et al. (2008) who reported that natural antibody could confound ELISA testing. Natural antibodies are a function of innate immunity and react with epitopes on multiple unrelated antigens of potential pathogenic microbes (Gonzalez et. al., 1988; Marchalonis et.al. 2002). Although natural antibodies are not pathogen-specific, they have the potential to interfere with interpretation of ELISA results for acquired antibodies that would develop following natural or experimental infection of tortoises with *M. agassizii*. However, natural antibodies "are ignored in immunological tests, since sera are usually diluted 1/20 to 1/40 before any test is performed, so as to avoid interference from so-called 'nonspecific background' " (Ochsenbein and Zinkernagel

(2000). Hunter et al. (2008) used Western blots in an attempt to distinguish between natural and acquired anti-*M. agassizii* antibody and concluded that banding patterns obtained using a single strain of *M. agassizii*, could distinguish between non-infected tortoises with natural antibody from exposed tortoises with acquired antibodies. Subsequently, Wendland et al. (2010) confirmed that mycoplasmal strain variation, not natural antibody, was responsible for the differences in Western blot banding patterns. Thus, reliance on a single *M. agassizii* strain as an antigen in Western blot assay is likely to lead to misidentification of approximately 15 to 25% of truly infected animals as negative (Wendland et al., 2010).

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California Department of Fish and Wildlife
Desert Tortoise - Our State Reptile

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Since 1939, state laws have been in place in California to protect the desert tortoise. In August of 1989, the tortoise was officially listed by the Fish and Game Commission as threatened under the California Endangered Species Act (CESA). Section 2081 of the Fish and Game code permit take for scientific, educational, management, or incidental take to an otherwise lawful activity provided the take is minimized and fully mitigated. When working in areas where desert tortoises maybe taken, an Incidental Take Permit and a Memorandum of Understanding for Handling Tortoises is needed. We must review the qualification of each biologist who will be working on the project.

Changes were made in 2013 for how permits are issued for desert tortoise research. If only the listed species will be handled, then no Scientific Collecting Permit will be needed, a Memorandum of Understanding is still required.

The Department, through the CESA permitting process, and by other means, continues to acquire lands within recovery units. Along with the land acquired, the Department has also collected enhancement and endowment fees for management of the lands. The Departments mitigation measures sometimes differ with the federal measures.

In 2013, the Department spent significant time and resources on renewal energy projects. Work continued on permitting numerous small projects, which include mining activities, housing and other urban development, and road projects. The Department also spent time again this year reviewing mitigation lands and determining the presences of species on the lands, improving our methods for dealing with captive tortoises and working on subgroups of the DMG on management and protection of the desert tortoise in California.

U.S. Geological Survey Report for 2014

Susan Jones, Research Manager
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U.S. Geological Survey scientists work closely on desert tortoise issues with federal and state land managers and regulators to meet their information needs.

Lesley DeFalco continues to monitor the outcome of restoration efforts at multiple sites across southern Nevada and northwestern Arizona. This monitoring project began after 2005/6 wildfires. She is refining seeding methods, herbicide use, and outplanting methods based on what she has learned.

Ken Nussear, Todd Esque and Lesley DeFalco continue to develop new techniques, and assess new and old techniquest for desert restoration. Dr. Nussear and Esque continue to work on modeling habitat in the Mojave Desert. The California Energy Commission recently published their report on the Mojave Ground Squirrel. Kathy Longshore is the lead for a habitat assessment of golden eagles in the Desert as it relates to renewable energy with support from the U.S. Fish and Wildilfe Service and the California Energy Commission.

Dr. Kristin Berry recently published a paper on anthropogenic impacts to desert tortoise habitat at China Lake. Dr. Berry is working on an assessment of anthropogenic impacts to tortoises and their habitat in the Chemehuevi Valley, where burros roam. Jeremy Mack and Dr. Berry are presenting a five year status report on mortality rates in translocated tortoises from Ft. Irwin; they will also present preliminary results of last October's release of 35 head-started tortoises at Edwards Air Force base. Dr. Berry is now working on a monograph on 33 years of population trends and the current status of tortoises at the Desert Tortoise Natural Area interpretive center.

Movements of Eagles in the California desert

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Golden eagles (*Aquila chrysaetos*) in the desert are rarely seen, poorly understood and generally enigmatic in most regards. To understand the degree to which eagle populations may be impacted by renewable energy development, we must know how eagles use the desert ecosystems they inhabit. We studied year-round movements of Mojave desert golden eagles (n = 4 – 8) with GPS-GSM telemetry systems. Annual home range (95% KDE) of eagles averaged 852±694 km^2 (±SE). Mean size of home ranges was lowest and least variable from September through January ($\bar{x}$ = 41 – 90 km^2; SEs = 5 – 54km^2) and greatest in February (717 ± 481km^2). Movement of golden eagles was tied to breeding status. In 2012, when all eagles bred, home range size between February and April averaged 36±9 km^2. In 2013, when no eagles bred, home range size in that same period averaged 663 ± 250 km^2. Eagles also made irregular long-distances movements of up to 403 km, many of which were not included in a 95% home range

isopleth. Mojave golden eagles use more space than expected and much of this space extends far outside of currently structured desert management plan (DRECP) areas.

POSTER

Body Condition Scoring in Desert Tortoises

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The body condition score (BCS) is based on an evaluation of muscle and fat deposits in relation to skeletal features and estimates body energy reserves. Since individuals can vary in size and shape, weight alone is not a good indicator of body condition. The body condition score is based on an evaluation of muscle mass and fat deposits in relation to skeletal features and has been adapted to the desert tortoise (Lamberski et al. 2012; Lamberski 2012). We have compared the subjective BCS to the more objective measures of relative liver weight (RLW) and condition index (CI) in desert tortoises. BCS tends to increase with increasing RLW and increasing CI.

This score is dynamic and should improve if the animal is eating and body energy reserves increase. Conversely, the score will decrease if inanition persists or body energy reserves are depleted. A tortoise's body condition will change with life stage, stage of reproduction, season of the year, drought, food availability, and disease. Therefore, this management tool can be used to monitor and compare populations over time. The BCS has proven to be a reliable measure of overall health and can be easily monitored over time to allow for adaptive management interventions.

Acknowledgements
The author gratefully acknowledges the contributions of the staff of the Desert Tortoise Conservation Center, Las Vegas, Nevada, in the development and application of this protocol.

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POSTER

Evaluation of *Mycoplasma agassizii* Treatment Protocols

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Mycoplasma agassizii has been well documented as causing upper respiratory tract disease in desert tortoises. We evaluated four treatment protocols using *M. agassizii* ELISA positive tortoises with nasal discharge for at least five of seven days prior to the start of the study. Treatment protocols evaluated were as follows: 1) Enrofloxacin 5 mg/kg IM SID x 14 days plus a dilute solution of enrofloxacin/dexamethasone/saline intranasally once daily for 5 days then every other day for 3 more treatments; 2) Enrofloxacin 5 mg/kg IM SID x 14 days; 3) Tulathromycin 5 mg/kg IM repeated in 7 days; and 4) Tulathromycin 5 mg/kg IM once only. This was a randomized trial with fifteen tortoises in each treatment group plus six animals in the untreated control group. Nasal lavage samples were collected just prior to treatment and seven days after the completion of the specified treatment protocol. Quantitative PCR for *M. agassizii* was performed on all samples and analysis of covariance (ANCOVA) was used to compare differences in the absolute post-treatment copies of *M. agassizii* DNA across treatment and control groups, while controlling for pre-treatment copies of DNA.

Treatments 1 and 2 significantly reduced the number of copies of *Mycoplasma agassizii* DNA when compared to the untreated control group and Treatments 3 and 4. Treatments 1 and 2 were not significantly different from each other. Treatments 3 and 4 showed no significant reduction of DNA copies when compared to the untreated control group and were not significantly different from each other. Treatments 1 and 2 were also the only treatments to significantly reduce the mean number of days post-treatment where clinical signs were present. There were no significant differences in mean percent weight change across treatment groups when compared to the untreated controls.

Sonoran Desert Tortoise (*Gopherus morafkai*) Survival and Population Growth Estimates in the Presence of Low-impact Military Operations

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Relatively few examinations evaluate the potential effects of military operations on Sonoran desert tortoises. Here I present a multi-season (2011-2013) occupancy model, corrected for imperfect detection rates, on the Florence Military Reservation, Arizona. Florence Military Reservation is just north of the town of Florence and lies adjacent to growing suburban development to the west. This model was established to evaluate the potential effects of military activities on parameter estimates including population growth, survival, colonization, and local extinction of the tortoise population at the reservation. Eighty-five plots were visited 5 times each during the summer monsoon for three consecutive years to evaluate site occupancy. Naïve occupancy estimates ranged from 0.20 – 0.32 each year with a slight decreasing trend over the years. Military activities were measured on a spatial scale but not on a temporal scale therefor any inference from this research should be applied broadly to the reservation.

Building on 40 Years of Conservation to Face Emerging Challenges

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In 2014, the Desert Tortoise Preserve Committee celebrates 40 years of desert tortoise protection and habitat conservation. The Committee formed in 1974 with the goal of establishing and protecting the Desert Tortoise Preserve (now the Desert Tortoise Research Natural Area or DTRNA) in the West Mojave Desert. Since then, its efforts have evolved and expanded to include a land acquisition and management program that protects desert habitat and species in three California counties, as well as active research and educational outreach programs. Working with our partners and volunteers in 2013, the Committee acquired 391 additional acres of desert habitat, drafted and updated management plans for multiple preserve areas, conducted raven nesting surveys at the DTRNA as part of a range-wide survey effort, removed seven tons of trash and substantial amounts of unexploded ordnance from desert conservation lands, and staffed interpretive naturalists at the DTRNA for the 25th consecutive year. Looking ahead, the Committee will continue implementing management actions that will have the greatest positive impact for recovering tortoise populations. We seek to increase public awareness and collaboration among stakeholder groups, agencies, and corporate sponsors to address the major conservation challenges that threaten the desert tortoise.

Preliminary Results of a Fall Release of 35 Juvenile Tortoises at Edwards Air Force Base: the First 120 days

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Thirty-five head-start juvenile tortoises (*Gopherus agassizii*) were released in October 2013 at a study site at Edwards Air Force Base (EAFB), California. Prior to release, each tortoise was evaluated for health in May and again in September/October. These 35 were among the oldest cohorts (2003-2007) and largest tortoises remaining in the head-start pens, ranging 69–132 mm midline carapace length and weighing 65.2–365.3 g. The fall health evaluation indicated that they were in sufficiently good condition to be released to the wild, although none were within the prime condition index (Nagy et al. 2002). After being fitted with radio-transmitters, the tortoises were released in approximately equal numbers to one of four release plots. The tortoises were placed at randomly assigned release locations under the cover of the nearest large creosote bush (*Larrea tridentata*) that contained existing rodent burrows. Post-release, the tortoises were tracked daily for one week. After which, they were tracked every other day until the end of October, and then biweekly for the remaining fall and winter season. Each juvenile was located an average of 22.6 times between 2 October and 14 February. Overall, survival during the first 19 weeks has been high (97%). One tortoise was killed shortly after release, probably by a desert kit fox (*Vulpes macrotis*), and a second tortoise was attacked but not killed by a glossy snake (*Arizona elegans*). Tortoises have traveled an average minimum distance of 135.4 m prior to settling and have established home ranges averaging 1251 m^2. By December 20, all 34 remaining tortoises were settled in burrows; settling required an average of three weeks with half of the tortoises settling within the first seven days. The majority of the tortoises (N = 20) settled in pre-existing rodent burrows, with 17 having modified the burrow. The additional 14 tortoises settled in new, self-excavated burrows. Monitoring will continue once or twice per month through winter and may increase during spring.

The Status of 158 Agassiz's Desert Tortoises ~ 6 Years Post Translocation

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A sample of 158 adult desert tortoises from Ft. Irwin's Southern Expansion Area was translocated in the spring of 2008 to four study plots located in the Superior-Cronese Desert Wildlife Management Area, California. Tortoises were monitored monthly and received comprehensive health evaluations each spring and fall. We evaluated post-translocation movement patterns, survival and prevalence of disease. Approximately 6 years post-translocation, 16 tortoises (10.1%) have remained within the 2.6 km^2 boundaries of their initial release plots. Movement parameters varied among years, seasons, sexes and plots, but within two years, some dispersed up to 13 km (mean = 2.5 km). Over time, tortoises have reduced the size of their movements and revisited seasonal cover sites; however, these patterns of site fidelity exhibited yearly and seasonal variation. Of the original 158 translocatees, 44 are alive (27.8%), 16 are missing (10.1%), 96 are dead (60.8%), and 2 have been removed from the study (1.3%). Most deaths (80%) were attributed to canid predation, with a recent increase in raven predation

(7.3%). Death rates varied among years, sexes and plots. Following several years of steady decline, death rates have again risen, a potential consequence of prolonged drought. Disease prevalence has also varied between years and plots, with one tortoise testing positive for a novel herpesvirus. We place the results of this study in context with future translocation projects.

Desert Tortoise Occupancy Estimation within the Red Cliffs Desert Reserve, Washington County, Utah

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Habitat occupancy was analyzed within the Red Cliffs Desert Reserve in southwest Utah, using a long-term dataset generated from a desert tortoise monitoring study (1998 to 2012). In Management Zone 3, the core of the Reserve, the probability of occupancy was relatively stable during the fourteen years of the study with colonization and local extinction rates relatively constant over time. This finding is expected for a long-lived species such as the desert tortoise with limited long distance movements and high site-fidelity.

In Management Zone 2, probability of occupancy increased then stabilized during the study, indicating that over time tortoises were occupying more habitat patches and colonization was greater than local extinction. Unlike Zone 3, two major sources of mortality, including disease outbreak (i.e., URTD) and large scale fires, have not been observed in Zone 2. Further, Snow Canyon State Park, which encompasses the majority of habitat in Zone 2, may offer additional regulations and oversight to protect tortoises and their habitat not found in other parts of the Reserve.

In all years of the study, tortoises were more widely distributed (e.g., occupy more habitat patches) in Zone 3 than in Zone 2 of the Reserve, although some years this difference was not significant. Management Zone 3 is considered the core of the Reserve, and historically contained some of the highest relative densities of tortoises within Washington County.

The stable occupancy estimates within the Reserve are not consistent with other population parameters collected from our long-term monitoring program (e.g., abundance, density). For example, density estimates indicate a biologically significant decline of tortoises since regional monitoring began in 1998. In contrast, the probability of occupancy was stable (i.e., Zone 3), with some areas increasing their probability of occupancy (i.e., Zone 2). Population declines were likely not detected within the occupancy framework because >1 individual continued to occupy the site and was detected at least once per season. This underscores the importance of collecting a suite of desert tortoise population parameters rather than relying on a single population parameter to understand the dynamics of a tortoise population.

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50 Years of Herpetology in the Southwestern Deserts

Phillip A. Medica
Las Vegas, Nevada

Phil's fascination of wildlife began as a high school student collecting garter snakes, painted and spotted turtles in nearby swamps. Simultaneously, in 1956 he joined a reptile club at the New York Zoological Park where monthly meetings chaired by Dr. James A. Oliver presented interesting talks and films on various herpetological subjects including Ditmars horned lizard and king cobras. This introduction to herpetology followed by a 3 month collecting trip to Mexico with a member of the American Museum of Natural History clinched his interest in herps and the deserts of the southwestern U.S. Departing for college in New Mexico in 1959 and mentored by Dr. James R. Dixon, Dr. Walter G. Whitford, Dr. Ralph J. Raitt, along with encouragement to collect specific reptiles for Dr. Robert C. Stebbins to paint for his new field guide ultimately lead to a professional career in herpetology. Studies in Nevada pertaining to the long-term growth and natural history of the desert tortoise as well as population dynamics of lizards impacted by gamma radiation, and the effects of rainfall and drought were pursued with Dr. F.B. Turner and Dr. K.A. Nagy with UCLA at the Nevada Test Site. Numerous other herpetological studies pertaining to the natural history of reptiles were undertaken in Arizona, California, and Mexico with noteworthy ecological and behavioral observations reported in peer reviewed literature. He joined the federal service in 1992 as an Ecologist with the Bureau of Land Management, and subsequently served as a Research Wildlife Biologist with the U. S. National Biological Survey, Desert Tortoise Coordinator with the U. S. Fish & Wildlife Service, and Biologist with the U.S. Geological Survey becoming Emeritus in May 2013. Over the past 50 years numerous students were under Phil's direct supervision conducting field studies on reptiles as well as small mammals many of which have continued in the field of biological sciences.

Update on the Desert Tortoise Recovery Program

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Members of the U.S. Fish and Wildlife Service's Desert Tortoise Recovery office have been engaged in numerous activities pertaining to recovery of the Mojave Desert Tortoise over the past year. We worked with seven regional Recovery Implementation Teams (RITs) to draft recovery action plans to identify specific, local prescriptions for recovery actions based on rankings of threats and recovery-action types produced by the recovery spatial decision support system and on-the-ground knowledge of RIT members. Work on the renewable energy supplement to the revised recovery plan has continued. The Desert Tortoise Conservation Center (DTCC) continues to face closure at the end of 2014 due to a lack of funding, and we worked with the San Diego Zoo to continue screening tortoises for appropriate disposition. We facilitated trials by the University of Georgia to develop sterilization protocols for captive desert tortoises, using tortoises from the DTCC. We coordinated raven nest and removal surveys in California and maintained an interface between Wildlife Services and on-the-ground researchers to remove

19 ravens from problem predation areas south of Fort Irwin (13) and Chuckwalla (6). We also implemented a reduced (due to lack of funds) range-wide monitoring effort and continued analysis of data collected to date in the program.

ANNOUNCEMENT: The Genome of Agassiz's Desert Tortoise

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The age of genomics is upon us. Whereas genomes for the sake of data gathering are not interesting in themselves, targeted genomes allow unprecedented assessments of the evolution of species. In an internationally collaborative project, we are now sequencing the genome of *Gopherus agassizii*. Data gathering is being centered at Arizona State University under the direction of Prof. Kenro Kusumi. The genome will not only address the essential question 'is the species adapted or exapted to the desert' but potentially it may yield insights into how the tortoises defend themselves against diseases, and how individuals recognize one another. Further, although our current assessments of gene flow use about 20 microsatellite DNA markers, the genome will provide tens of thousands of potential loci and the new template will greatly facilitate sequencing the genomes of other species of *Gopherus*. The genome will open the door to innumerable avenues of research relevant to the conservation of Agassiz's desert tortoise.

Head-starting Studies at Edwards Air Force Base: Growth and Survivorship Effects of Supplementing Natural Rainfall, and Results of Early Release

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Hatchling Desert Tortoises (*Gopherus agassizii*) were raised inside fenced, predator-resistant enclosures containing natural desert plants from 2003 to 2008 at Edwards Air force Base in the western Mojave Desert, California. All enclosures received natural rainfall, and some enclosures received added "rain" from impulse sprinklers at times and in amounts intended to mimic, but not exceed, natural rainfall during "good rainfall" years. Hatchlings generally survived their first year very well, averaging only 10% mortality under both rainfall treatments, including surviving a 16-month drought period in 2006-7. But older juveniles experiencing that drought without supplemental "rain" showed high mortality, suggesting that the hatchlings' internal yolk stores may have improved survivorship during drought conditions. Supplementing natural rainfall with irrigation increased annual growth rates of yearlings substantially (2X to 16X), even in a year having record high rainfall (2004-5). Releasing 1-year-old head-started

juveniles was unsuccessful, regardless of their body size or prior watering regimes, or point of release (near or far from natal enclosures), due mainly to heavy predation by ravens.

Connectivity within Desert Tortoise Populations Inhabiting Mountain Passes

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Recent expansion of development activities in the southwestern U.S. has raised the questions about the requirements for wildlife corridors intended to maintain genetic and demographic connectivity among desert tortoise populations. What is the required area? What is the necessary width of the corridor, and what are the contact rates among individuals within and among populations to maintain connectivity? We began research in 2012 to acquire the data necessary begin to answer these questions. Recognizing that the connections between populations via the large valleys that typify tortoise habitat may already be restricted by urban development we also sought to document whether mountain passes that contained potential tortoise habitat predicted by habitat models for the tortoise could serve as corridors between populations inhabiting adjacent valleys. We identified two corridors connecting the Ivanpah valley to adjacent valleys in California and Nevada that are inhabited by tortoises, and are using radio telemetry to identify contact networks among individuals throughout those corridors. We compare connectivity metrics between tortoises in these mountain sites with a population residing in more typical habitat unrestricted by natural barriers.

Desert Tortoise Council Activities in 2013

Bruce K. *Palmer, Chairperson*
Board of Directors, Desert Tortoise Council

This has been a busy year for the Desert Tortoise Council (DTC) Board of Directors (BOD), with 4 BOD meetings and the Annual Business Meeting, culminating in this, the 39th Annual Symposium of the DTC. The DTC Bylaws provide for up to 15 members for the BOD. We began the year with 13 members, and then added 2 for a full complement of members. We recently had one resignation and then refilled that position. Three long-term members of the BOD—Dan Pearson, Tracy Bailey, and Mike Bailey—resigned effective at the end of their 2013 terms, accounting for a cumulative total of 35 years of service on the BOD. Currently there are 13 BOD members. Important administrative functions undertaken by the BOD include several amendments to the DTC Bylaws, and work on an Operations and Policy Manual, Annual Symposium Handbook, and Techniques Workshop Handbook to assure consistent decision making by the BOD and provide guidance as the members of the BOD change. In addition to preparation for the Symposium, significant accomplishments by the BOD in 2013 included submitting comments prepared by the Ecosystem Advisory Committee on 14 actions/developments potentially affecting the desert tortoise; hosting two "Introduction to

Desert Tortoises and Field Techniques Workshop" attended by a total of about 140 people; and working to enhance BOD communications with our membership with the publication of 3 newsletters, expanding on the information about BOD activities on the DTC website (http://www.deserttortoise.org), and joining social media through Twitter (@DTCouncil) and Linked-In. With a net worth of approximately $280,000, our primary means of making money is through the Techniques Workshop, with most symposia barely breaking even. This past year the BOD approved a Grants Program under which specific projects benefitting the tortoise or related conservation issues may be funded by the DTC. Several funding requests were received and 2 projects were funded for a total of $5,000. Details about submitting a proposal under this program are available on our website. We expect the BOD to take on even more work in 2014. We are closely tracking several issues important to desert tortoise conservation, including the pending closure of the Desert Tortoise Conservation Center; the developing program to sterilize pet tortoises; and issues associated with tortoise translocations and the release of captive tortoises in the wild. In addition, the BOD is considering development of an advanced tortoise techniques workshop and possibly providing other workshop opportunities. It takes dedicated people to get this and other work accomplished for the desert tortoise. The BOD is actively seeking members that will work on committees, assist with workshops, serve on the BOD, and accept officer positions.

Encounter Rates of Adult, Non-adult, and Dead Desert Tortoises in Tropical Deciduous Forest, Thornscrub, and Desertscrub in Northwestern Mexico

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We sampled tortoises in northwestern Mexico (Sonora and Sinaloa) each year 2005-2013 and obtained 345 records of tortoises in the field, following an initial trip in 2002 during which 79 records were obtained. During 2012 and 2013, GPS transects were used to record observations per km of search in three environmental types: subtropical (Sonoran) desertscrub, dry tropical scrub (thornscrub), and tropical deciduous forest (TDF). Size, sex (if discernable), approximate age (based on size and growth rings), health (or carcass condition), activity, location (UTM) and habitat were recorded for each tortoise as appropriate. Encounter rates of live tortoises were highest in TDF in 2012 and in desertscrub in 2013, although visibility of tortoises was lowest in TDF. The proportion of non-adults was higher in TDF (23% of n = 69) than in thornscrub (19% of n = 64) or desertscrub (15% of n = 157), but these differences are not statistically significant. In the TDF sample, we found a significantly lower proportion of dead tortoises (3%) than in thornscrub (28%) or desertscrub (17%) samples, although 3 of 5 *Terrapene nelsoni* we found in TDF were dead. In the 2002 sample (coastal desertscrub) the

percentage found dead was 62%. The record of carcasses was associated with drought conditions in desertscrub during 2001-2 and 2010-11 and with high environmental temperature regimes in thornscrub compared to the shadier and consistently wetter TDF environment. We initiated operative temperature monitoring for tortoises in northwestern Mexico in 2012 and 2013.

Primary and Secondary Roads as Conduits for the Recent Invasion of *Brassica tournefortii* (Sahara mustard) in the Mojave Desert

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Roads are important corridors for the introduction and spread of invasive plant species. They create major disturbances, which often favor the establishment of invasive plants, and roadsides often receive additional moisture and nutrients from runoff. Vehicles can transport seeds abnormally large distances and bring invasive plants into new sites. In this study, we evaluated the relationship between the abundance of the invasive annual forb *Brassica tournefortii* (Sahara mustard, *Brassica*) and distance to roads at a Mojave Desert site in California, USA. We also measured abundance differences between microsites (i.e. undershrub, intershrub space, wash floor, etc.) to determine where *Brassica* may preferentially establish. *Brassica* is an invasive annual forb that has become a pervasive invader throughout the desert within the last two to three decades. Since the invasion at this site was relatively recent, we predicted that *Brassica* was introduced to the site via roads and would move into undershrub areas before spreading throughout the intershrub space. Using a series of transects and hectare plots, we determined that proximity to primary (paved) and secondary (large, graded) roads was positively correlated with *Brassica* abundance. Relationships between *Brassica* abundance and microsite were less clear, although undershrub areas tended to harbor large numbers of *Brassica* plants and edge habitat such as wash edge and shrub driplines had the lowest abundance.

Providing Connectivity Across Transportation Corridors

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Existing and proposed transportation corridors present significant obstacles to connectivity between habitat areas. Establishing connectivity across these corridors can be an important tool for maintaining viable communities of desert tortoise and other affected species. Constructing facilities that can provide this connectivity is a complicated process that is perhaps not well understood by biologists. This presentation provides an engineering perspective on what the requirements are for constructing such facilities, what the transportation agencies will consider in approving such facilities, and what the issues are involved in the design, construction, and maintenance of such facilities. Having a better understanding of the issues and

requirements involved in providing connectivity across transportation corridors will assist biologists in planning, coordinating, and implementing these facilities on future projects.

Prospects for *Gopherus*: Demographic and Physiological Models of Climate Change from 65 million Years Ago to the Future

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Models predict that anthropogenic climate change will generate extinctions in the next century. Current models assume that extinctions will be triggered by severe demographic challenges faced by populations experiencing warming or drying but model linking demography and climate are correlative at best. Here we develop new population viability models of ectotherm extinctions due to climate change, using literature data on demography including: survival, clutch size and clutch frequency. Models are also premised on ecophysiological principles that relate activity metabolism and daily activity restrictions due to warming climate (Sinervo et al. 2010; *Science* 324:894-899), and effects of drought. We apply the new models to predict extinctions of *Gopherus* in present and future timeframes. We also calibrate the extinction models against fossil tortoise distributions back to the Eocene, the warmest period in the last 65 million years. Models accurately predict paleodistributions of tortoises validated by fossil data and also reconstruct the biogeographic origins of turtle and tortoise radiations during the Eocene, Miocene, Pliocene and Pleistocene. We also test the model with the contemporary distributions of all *Gopherus* species.

Given the ability of the models to accurately predict the origin and dispersal of *Gopherus* and the ancestral genus *Hadrianus*, and the contemporary distributions of all western *Gopherus*, our model is likely to reliably forecast future distributions and local population extinctions. In the present day, the model indicates that many contemporary populations in the Western Mojave are currently declining in abundance due to climate warming and decreasing precipitation. By 2080 (A2A climate scenarios), *G. agassizii* will be collapsing in demography (population $\lambda < 1$) across the species range. Under reasonable CO_2 limitation strategies ("B" CO_2 limit scenarios), we predict that many of populations predicted to go extinct could sustain a viable demography, even in 2080. Therefore, controlling CO_2 could save tortoises from climate-forced extinction.

However, one strategy for limiting atmospheric CO_2 inputs entails deployment of solar farms across deserts. Recent climate models indicate that large-scale deployment of solar panels generates a powerful Urban Heat Island Effect in adjacent desert habitat, raising maximum daily temperatures by 0.4 – 0.75 °C. Applying results from these coupled atmospheric models in our new population viability models for *Gopherus*, we find that solar farms accelerate predicted extinctions by 50 years. Therefore, populations of *Gopherus* adjacent to solar farms may go extinct even before benefits of solar farms are realized (e.g., by 2080). In addition, the siting of solar projects in the Ivanpah Valley or near California City threatens the only habitat predicted to sustain population demography in 2080, effectively eliminating climate refuges for *G. agassizii*.

While developed for *G. agassizii*, the model accurately predicts species distributions of *G. berlandieri*, *G. flavomarginatus*, *G. morafkai* as well as the enigmatic Baja Cape population of *G. agassizii*. Under the IPCC IVth climate assessment, both *G. agassizii* and *G. morafkai* are predicted to experience >95% extinction of all known contemporary populations. "New habitat" for all western *Gopherus* is predicted to shift 2000 km to the Central Plains, exactly where the genus was located in Eocene. Under newer IPCC Vth climate assessements, which use Representative Carbon Pathways, we predict complete extinction of nearly all *Gopherus* populations under a 1200 ppm CO_2 scenario. We emphasize that while prospects look bleak for *Gopherus* it can be rescued from climate-forced extinction with aggressive limits on CO_2 input into the atmosphere. However, current and proposed solar projects will only hasten extinctions and likely eliminate the last remaining refuges for *Gopherus* from climate warming.

Seasonal Migration in Relation to Forage in the Sonoran Desert Tortoise (*Gopherus morafkai*)

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We initiated a radio-telemetry study of a population of *Gopherus morafkai* in the Union Hills on the northern edge of Phoenix metropolitan region, Pima County, in 2011. Twenty-six subjects have been tagged to date, comprising 9 males, 15 females, and 2 juveniles. Preliminary results provide insights on consistency in refuge use seasonally, and movements associated with foraging behavior in the fall. Virtually all adults (n = 20 in 2012, n = 18 in 2013) exhibited movement from lower elevation ($\bar{x}$ = 450 m) areas associated with drainages to relatively higher elevation ($\bar{x}$ = 550 m), north-facing slopes (aspect = 320° to 40°) following the monsoon rains, apparently to forage on abundant and diverse plants on those slopes. Straight-line distances to reach north facing slopes ranged from 250 to 750 m, and the north slopes were occupied between three and five weeks in September and October of each year, prior to individuals returning to lower elevation washes and entering over-wintering refuges. The north slopes exhibited significantly ($p < 0.001$ in all comparisons) higher plant diversity, from 18 to 26 species, relative to lower elevation areas (7–9 species), and significantly ($p < 0.001$) greater cover and plant density (1.25 plants per m^2 vs. 0.25 plants per m^2). These results are consistent with the notion that tortoises in this population exhibit a pattern of annual migration for forage not unlike large herbivorous mammals.

Results of the 2012 Golden Eagle Nesting Survey of the BLM's California Desert

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Early naturalists (late 1800s) and especially egg collectors provided the first scientific/literature records of nesting Golden Eagles in California. The results of several regional studies began appearing in the literature in the ~1930s. As the public's interest in raptors has increased from the 1950s to the present day, a gradual increase in the recording and reporting of nesting records has also occurred. In 1974, the first statewide survey was undertaken to collect and summarize the available information on Golden Eagles nesting in California. Around this period, federal agencies began to take an interest in surveying and recording the distribution of eagles and other raptors on federal lands in California. These efforts have continued and significantly expanded to the present. In 2011-12, the Bureau of Land Management (BLM) in California contracted BioResource Consultants, Inc. (BRC) to collect new field data and report on the current breeding status of Golden Eagles in a significant portion of California. The primary study area was the BLM's California Desert District. BRC conducted surveys from 21 December 2011 through 31 August 2012. The BLM database provided to BRC contained 412 historical Golden Eagle nesting locations in this District. We determined that some of these sites were not on BLM lands, leaving 350 unique locations that met the criteria for inclusion in this study. BRC visited 256 of the 350 sites by helicopter only (167.8 helicopter hours), 61 sites by ground survey only, and 33 sites by helicopter and ground surveys. During the surveys we located 47 previously unknown Golden Eagle nesting sites, finding 46 of these sites by helicopter and 1 during ground surveys. Overall we surveyed 397 Golden Eagle nesting sites in 2012 within the Desert District, using helicopter and/or ground survey methods. Pairs of adult eagles occupied 74 of the 397 sites surveyed. Forty-four nests were active (eggs laid) and 32 nests were successful (young produced). Twelve nests failed during incubation or chick rearing. The 32 successful nests produced 39 chicks, for an average of 0.89 chicks produced per active nest and 1.22 chicks produced per successful nest in the Desert District.

Regulatory Structure for Golden Eagle Conservation: History, Current Status and Opportunities to Incorporate a Conservation Framework to Guide Permitting

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Wind energy development is impacting golden eagles (*Aquila chrysaetos*) and both the science and regulatory structures have a significant amount of catching up to do to ensure the preservation of eagle populations. How can we ensure that eagles will endure as we work to fill gaps in our understanding of eagle interactions at wind farms and identify ways to avoid, minimize and mitigate for such impacts? In this talk, I will explore challenges and opportunities

stemming from the newly adopted federal rule for permitting eagle "take" in the context of wind energy operations, including a brief discussion of the history of the Bald and Golden Eagle Protection Act, the delisting of bald eagles from the Endangered Species Act in 2007, and other relevant policy and guidance. The discussion will also focus on potential additional collaborative and proactive measures that could be adopted to ensure that federally directed eagle conservation practices, first and foremost, drive permitting decisions that guarantee the conservation of eagle and raptor species, while providing a path forward for responsible wind energy development. This includes capitalizing on opportunities to amend the regulatory framework with transparent policies and safeguards that also facilitate the expansion of needed scientific study.

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 and scientific research.

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 is also active in the Colorado Desert workgroup under the California Mojave RIT to guide future recovery efforts in the region.

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 analyzing the data with some interesting preliminary results. In addition to this project, the park has assisted with the USFWS line distance sampling effort by assisting with data collection. Additionally, the park has been assisting Dr. Lovich and his effort to study the Barrow plot that has been surveyed since the late 70's for desert tortoise.

The park is also busy coordinating with the USFWS on section 7 compliance for 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.

Identification of a Novel Herpesvirus and a Novel *Mycoplasma* sp. in Samples from Translocated Wild Desert Tortoises

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A novel herpesvirus was identified in oral swabs of a translocated desert tortoise by consensus PCR and sequencing. A novel *Mycoplasma* sp. was identified in a phallic sample of a different translocated tortoise. Bayesian and Maximum likelihood phylogenetic analyses of these organisms will be presented, and the implications for diagnostics of related pathogens, such as Testudinid herpesvirus 2 and *Mycoplasma agassizii*, will be discussed. Further study of these agents is merited.