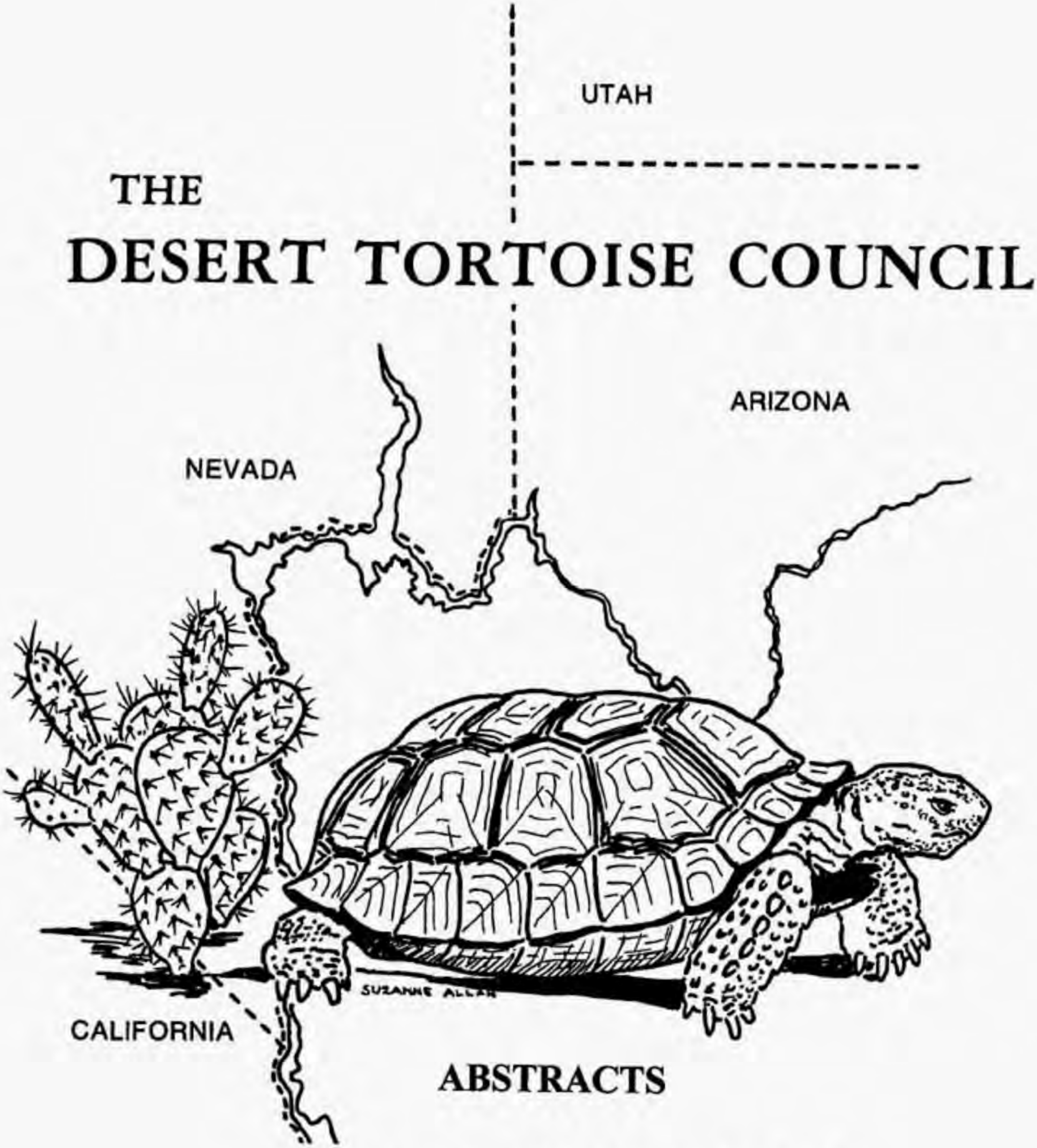
THE DESERT TORTOISE COUNCIL



ABSTRACTS

36th ANNUAL MEETING AND SYMPOSIUM
Sam's Town Hotel and Casino, Las Vegas, NV
February 18–20, 2011

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THIRTY-SIXTH ANNUAL MEETING AND SYMPOSIUM

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

Factors Influencing Exotic Grass Establishment in the Mojave Desert and Potential for Reducing Plant Community Invasibility

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Native vegetation types that can reduce invasion by exotic annual grasses would be potentially useful for decreasing fuel hazards and revegetating burns in desert tortoise habitat. By assembling experimental native plant communities ranging from early successional forbs to late-successional shrubs and monocultures of 12 native species, we examined the influences of resident perennial vegetation and soil N (simulating anthropogenic N deposition) on the establishment of two exotic annual grasses (*Bromus rubens* and *Schismus* spp.) at a Mojave Desert field site. *Bromus* was more invasive and produced greater biomass than *Schismus*. Compared to early successional grass and shrub and late-successional shrub communities, an early forb community best resisted invasion, reducing exotic species biomass by 8- (N added) and 33-fold (no N added) below amounts in controls (no native plants). However, the least invaded early successional forb community did not reduce soil N or P relative to other communities, although N addition increased exotic establishment overall. This implied that mechanisms other than competition for N or P may have been responsible for the ability of the early forb community to reduce the exotic grasses. In native species monocultures, *Sphaeralcea ambigua*, an early successional forb, was the least invasible monoculture, reducing exotic biomass by 11-fold below controls. This study provides the first experimental field evidence that native vegetation types may exist that can reduce exotic grass establishment in the Mojave Desert, with early successional native forbs apparently more effective than mid- or late-successional shrubs.

Impacts of Large-scale Solar Development on Regional Ecosystem Dynamics: Critical Research Gaps

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Ecosystem changes associated with large-scale solar development threaten large areas of habitat for endemic species, including the desert tortoise. Here we identify several topic areas demanding research focused on impacted desert areas. These include: Loss of groundwater, landscape fragmentation, vegetation type conversion, and regional carbon budgets. Steam-based thermal plants use up to 2.9 to $3m^3$/MWh (US DOE 2006), far more than the limited groundwater recharge (Department of Water Resources 2003). The resulting surface water depletion threatens plants (*Amargosa niterwort* , Hasselquist & Allen 2009) and animals (desert pupfish in Ash Meadows Deacon et al. 2007, Martin 2010).Areas to be disturbed by development include microphyll woodlands. Many shrubs have deep roots and associated microbes and are dependent on groundwater, burying between 50 and $100mg/m^2/y$ of organic C, (Serrano-Ortiz et al. 2010).

Fragmentation, increased N deposition and areas with vegetation type conversion can be expected in surrounding developing sites and as connecting roads are built (Barrows & Allen 2007, Rao et al. 2010). These changes affect C dynamics as well as species migrations. CO_2 is also respired into soil, with concentrations of 1,000-3,000ppm soil atmosphere CO_2. This CO_2 reacts with calcium in the soil to form calcium carbonate ($CaCO_3$). Deserts store a large amount of C as $CaCO_3$ that may equal CO_2 in the atmosphere. These deposits developed during the Pleistocene era (Schlesinger 1985). Being stable, though, means that inputs equal exports. C in caliche must be released as well as absorbed and could be susceptible to loss when vegetation and soils are disturbed. Mielnick et al. (2005) reported losses of up to $145g\ C/m^2/y$ from loss of $CaCO_3$. Solar power units that generate 1,000MW could save nearly 560,000 metric tons of carbon per year. But losses of local exchangeable C, transport losses in moving the electrical power to the Inland Empire and the LA Basin (30% or more) and plant lifespan (years to decades) versus disturbance recovery time (decades to centuries, Webb et al. 2009) may negate the solar development C gains.

The regional carbon balance becomes even less weighted toward the planned desert solar developments if we include the carbon savings from local deployment of photovoltaic cells in the locations where demand is heavy (Warmann & Jenerette 2010).

Moving forward with industrial-scale solar developments in undeveloped desert habitats without quantifying the array impacts we have identified may unknowingly compromise biodiversity and ecosystem functioning.

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Regional and Local Desert Tortoise Densities

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The Desert Tortoise Recovery Office implements line distance sampling to estimate desert tortoise densities in designated critical habitat and other areas that are managed to conserve and recover desert tortoises. Density estimates for each tortoise conservation area represent hundreds of square kilometers and are in turn used to determine an average density for thousands of square kilometers of conservation area in each desert tortoise recovery unit. Since 2004, when roughly similar areas were sampled each year, average densities for tortoise conservation areas of individual recovery units have ranged from 0.9 to 10.8 desert tortoises/km^2.

These inherently low densities mean that during representative sampling, a large amount of effort is required to encounter even a handful of tortoises. This effort is measured by the thousands of kilometers walked in the course of monitoring each year. All of this effort results in only hundreds of tortoise observations for an entire field season. In some cases, there are fewer than 10 tortoises found in a given tortoise conservation area; in these cases, the density estimate for the smaller tortoise conservation area is less reliable although useful in developing the recovery-unit-level estimate.

The large amount of effort required to detect even a modest number of tortoises partially explains why research that requires observation of sufficient tortoises has focused in smaller areas with unusually high densities of tortoises. It also explains why estimating the exact number of tortoises in smaller areas is particularly difficult. This presentation will describe results from the last 5 years of range-wide monitoring and how these results are affected by relatively low encounter rates.

Improving the Rate of Knowledge Acquisition for Desert Tortoise Recovery

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The 2002 GAO audit of the desert tortoise recovery program concluded that, even though over $100 million had been spent on recovery activities, the effectiveness of those recovery actions was unknown. Reliable information from research and monitoring of management actions is required for effective adaptive management and to ensure efficient progress in the recovery effort. As early as 1994, Germano and Bury commented that unpublished reports occupied 1.5 m of their filing cabinet space, and they emphasized the need for resource managers to support more scientific studies. Likewise, the 2004 Recovery Plan Assessment found that only 22% of catalogued desert tortoise literature was published in professional journals. 93% of peer-reviewed desert tortoise literature has been published by academic or agency researchers, compared to only 7% by private individuals or consultants. Certainly, not all work contracted to private consulting firms is suitable or necessary to be framed in a scientific context and put into a format that can be published, but given the lack of knowledge on recovery action effectiveness and the need for better data, it is apparent that both management agencies and private contractors should be setting higher standards and expecting more from these expenditures. Finally, failure to develop a shared evidence base on the outcomes of conservation actions also occurs in part because raw data needed to conduct systematic reviews of conservation actions are often missing or inaccessible. The foundation of any systematic review is access to original data, and unfortunately, most raw data generated by researchers are inaccessible (either protected, poorly recorded and archived, or simply lost). We need to elevate expectations for scientifically rigorous application of conservation funds, evaluation of management actions, and data sharing, and to apply rewards and enforcement measures to ensure these practices occur for the benefit of desert tortoise recovery.

Sensitivity to Climate Change for Two Reptiles at the Mojave-Sonoran Desert Interface

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The high temperatures and extended droughts that characterize habitat for desert-living reptiles may already approach their physiological tolerances and so could put them at risk due to climate change. Here I examined climate change sensitivity for desert tortoises, *Gopherus agassizii*, and common chuckwallas, *Sauromalus ater*, two large-bodied reptiles that occur across the Mojave-Sonoran Desert interface. I employed the Mahalanobis statistic to model their niche spaces and then assessed climate-change sensitivity by altering climate variables along a gradient of increasing temperature and decreasing precipitation. While shifting climate variables, I held terrain and soils variables that otherwise define these species' preferred habitat constant, providing a more realistic prediction of available niche space. Both reptiles' modeled niches responded to climate change by shifting to higher elevations and increasingly away from their Sonoran Desert distribution. At moderate predictions of climate change (+2°C, -50 mm precipitation) desert tortoises' suitable habitat was reduced by nearly 88% in the Sonoran Desert portions my study area, and nearly 66% in the Mojave Desert regions. Under the same scenario chuckwallas lost nearly 92%, but increased 120% respectively. Within the context of climate change potential increases in drought frequency appears to present the greater challenge for these species.

Fast-Tracking the Death by a Thousand Cuts: How Sprawling Industrial Renewable Energy Development in the Desert is Undermining Conservation of the Desert Tortoise.

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The Center for Biological Diversity has consistently advocated for the enforcement and expansion of protections for the threatened desert tortoise in the media, the administrative process and, when necessary, through litigation for over 20 years. The Center focuses on science-based advocacy to ensure that land use planning and management on public lands as well as site specific decisions on both public and private lands provide effective protection for the desert tortoise and other imperiled species that will support recovery. The Center for Biological Diversity has been at the forefront of the call for reductions in greenhouse gas emissions necessary to slow climate change and global warming. From the Center's point of view, the transition to renewable energy is absolutely necessary and *we need to do it right*.

Energy conservation and efficiency need to be at the core of our policies if we are ever to achieve the goal of reducing greenhouse gas emissions. The Center supports distributed solar energy generation at the small and "mid-scale" in and near the areas of end use which will reduce the need for new long-distance transmission, substations, line losses, and have the siting flexibility to avoid many significant impacts to species and habitats. Any large-scale industrial projects – whether renewable energy projects or any other type of project-- should first look to disturbed and type converted lands near existing infrastructure and must consider construction of smaller units to best utilize these disturbed areas, avoid occupied habitats, and minimize edge effects and fragmentation of in-tact habitat.

In the past year in response to ARRA funding deadlines (which have now been extended to December 2011), we have seen "fast-track" approvals of large-scale industrial renewable energy projects in California and Nevada with more than 9 solar projects (3 in Nevada and 6 in California) covering approximately 30,000 acres of public lands. The majority of these projects are in desert tortoise habitat including both high-quality occupied habitat and essential connectivity habitat. Approval of more powerlines and substations are following close behind and there are more of all of these types of proposals in the pipeline.

In 2009 and 2010, the Center has participated in the process for nearly all of these projects in some form and has actively opposed many of the large-scale projects based on impacts to tortoise and other species and habitats and need for alternative siting and technologies to be addressed. Other issues that continue to be a source of conflict include: failure to address alternative sites and alternative technologies that would have fewer impacts to tortoise, failure to address reduced size alternatives and/or design revisions to reduce impacts, failure to fully address impacts to other species such as fringe-toed lizards, migratory birds and eagles, failure to address connected actions including powerlines, substations, and the additional development they attract. In the siting process, significant issues have been raised regarding the adequacy and accuracy of desert tortoise surveys and habitat evaluation, the impacts of translocation, and the effectiveness of mitigation measures such as road fencing and habitat restoration.

The Center's position has always been that the best way to conserve the desert tortoise (and other imperiled species) is to preserve tortoise habitat and habitat connectivity while reducing existing threats to the species. Recovery cannot be achieved if we continue to destroy desert tortoise habitat and increase fragmentation of the remaining habitat areas which increases edge effects and the associated threats. As one observer put it: "We cannot keep punching holes in the habitat and expect the fabric to remain intact—at some point it will unravel."

While politicians are patting themselves on the back for being "smart from the start," in reality planning continues to lag well behind the site specific project approval process. The BLM Programmatic Draft Environmental Impact Statement ("DEIS") for Solar energy which includes a look at solar study areas or "zones" was just released in December 2010 and a final decision is not expected for another year. Planning at the California State and county level is also lagging far behind site specific project proposals and approvals. Most counties in the California desert do not have General Plans that take into account zoning for large scale renewable projects similar to those now being proposed (with Imperial County being the exception) and Inyo County recently releasing a Draft General Plan Amendment with zones sprawling across many of the most sensitive lands in that County. The California Energy Commission and BLM process to develop a Natural Communities Conservation Plan and Habitat Conservation Plan (Desert Renewable Energy Conservation Plan) is also in the early stages.

As planning lags, individual "fast-track" projects continue to move forward to construction while additional new projects move forward in the approval process. From powerlines and substations that will attract new proposals, to wind projects, and substations, and powerlines for solar energy projects in DWMAs, to sprawling solar energy projects that each cover 6-10 square miles of habitat, these projects are going to shape the future of the desert tortoise and its habitat for decades to come. The Center will continue to work to protect desert tortoise and its habitat and promote rational, well planned renewable energy development in appropriate places.

The Status of 158 Desert Tortoises 33 Months After Translocation from Ft. Irwin

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In spring of 2008, we translocated 158 adult and subadult tortoises (82 females and 76 males) from the Southern Expansion Area (SEA) to four plots located in the Superior-Cronese Desert Wildlife Management Area (DWMA) as part of the Desert Tortoise Health and Disease Research Project for the Ft. Irwin Expansion. We started Year 3 in January 2010, with 68 live tortoises (with known locations) and 20 missing tortoises. During 2010, we conducted health evaluations for clinical signs of health, disease, and trauma for 59 tortoises in the spring and 56 tortoises in the fall. Overall during 2010, eight of 59 individual tortoises (13.6%) had ELISA test results that were seropositive or suspect for *Mycoplasma* species, and one additional tortoise had a positive culture for *Mycoplasma* species. Between January and December of 2010, nine (10.2%) of the remaining 88 live and missing tortoises were found dead. Overall, since the translocation began in March of 2008, 50.0% of tortoises have been found dead or were salvaged for necropsy. Death rates since translocation have been significantly higher for females than males. At the end of 2010, 56 tortoises were known to be alive and an additional 23 tortoises (26.1%, 23/88) were missing.

We analyzed movement patterns for live tortoises between the time of initial release in spring 2008 and December 2010 (N = 54). Overall, the mean dispersal distance for males was twice that of females; likewise, males moved twice the total distances compared to females. The minimum total distances moved in 2010 did not differ from 2008 or 2009. We also analyzed use of cover sites as a potential indicator of settling. In 2010, 59.3% of tortoises did not return to a previously used cover site compared with 39.7% of tortoises in 2009.

Report on U.S. Fish and Wildlife Service Activities for 2010

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The U.S. Fish and Wildlife Service's responsibilities for the desert tortoise under the Federal Endangered Species Act (ESA) include recovery planning and implementation, section 7(a)(2) consultations with Federal agencies, issuance of recovery permits for research and monitoring, and review and development of habitat conservation plans for section10(a)(1)(B) projects on private lands. This report focuses on completed, ongoing, and foreseeable consultations and habitat conservation plans, with emphasis on the Service's response to the numerous proposals for development of renewable energy within the range of the desert tortoise.

Health Conditions Affecting Desert Tortoises at the DTCC: Hotline versus Residents

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Confinement of natural desert tortoise habitat and the necessity to translocate wild populations of desert tortoises due to anthropogenic activities poses a potential risk of increased disease burden within the population. Similarly, introducing desert tortoises previously held in captivity into an existing captive or wild population may pose the risk of introducing different pathogens or strains of pathogens into the population. The desert tortoises held in captivity at the Desert Tortoise Conservation Center (DTCC) in Las Vegas come from a wide variety of backgrounds. A large proportion of the animals are "hotline" tortoises that were surrendered to the DTCC by residents throughout southern Nevada. Many were exposed to other reptile and/or tortoise species, and were held in captivity from days to decades. Other tortoises, called resident tortoises, were already on site when the San Diego Zoo took over operations of the facility in March 2009. The aim of this study is to establish an inventory of diseases and other conditions affecting the health of the DTCC population. Necropsy and histological examination are performed on both "hotline" tortoises and DTCC resident tortoises euthanized for humane reasons or found dead. Nasal flushes and select tissue samples are examined for *Mycoplasma agassizii*, *Mycoplasma testudineum* and Herpesvirus using newly developed real-time quantitative polymerase chain reaction (qPCR) assays. Comparison of results will reveal the degree of overlap in the disease spectrum. To date, ~94% of necropsies were from resident tortoises and ~6% from "hotline". Preliminary data suggest a small scale Herpesvirus outbreak in one of the *Mycoplasma agassizii* ELISA positive pens prior to brumation. Depending on the results, hypotheses can be made regarding the risk factor posed by introducing "hotline" tortoises into an existing resident population at the DTCC and on a larger scale into wild populations.

Restoring Tortoise Populations in Galapagos: Two Contrasting Case Studies from Española and Pinta Islands

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At the time of the establishment of the Galapagos National Park in 1959, giant tortoises were rare on the southern island of Española and considered extinct on the northern island of Pinta. Eventually 14 tortoises were discovered on Española but only a single tortoise, "Lonesome George," was recovered from Pinta. Goats, the only introduced mammal on either island, destroyed much of the habitat on both. The recovery of the tortoise population on Española began immediately with the initiation of a captive breeding program and the eradication of goats. Young tortoises were repatriated to Española starting in 1975, with a total of 1743 tortoises released by January 2011, with a long-term survivorship of greater than 50%. The success of the Española project has been aided by targeted research in the breeding and rearing program, regular monitoring trips to track the repatriates, and genetic studies. An ecological assessment completed on Española in June 2010 will provide a foundation for determining the next steps for this population's management. On Pinta, tortoise restoration followed a very different trajectory. Lack of breeding stock to re-establish the original population and failure to find additional Pinta tortoises either in Galapagos or in zoos around the world led to competing arguments: (1) to release an analog subspecies of tortoise to preserve the island's ecosystem in its natural state, versus (2) not releasing any tortoises to preserve evolutionary integrity of the Galapagos biota. The final eradication of goats in 2003 followed by rapid response of the vegetation catalyzed an interim decision to release 39 non-reproductive tortoises to restore ecological services of tortoises to Pinta. With genetic analyses still pending, no final decision on the source of a breeding population for Pinta has been determined. These two case studies provide stark and contrasting examples of the interplay between conservation policy, practicality, and ongoing research in restoring giant tortoise populations in Galapagos.

Desert Tortoise Protection Efforts by Western Watersheds Project

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Western Watersheds Project (WWP) works to protect and conserve the public lands, wildlife and natural resources of the American West through education, research, public policy initiatives and litigation. WWP is continuing its efforts to protect Mojave and Sonoran desert tortoise populations in California, Nevada, Arizona, and Utah.

Industrial-scale, renewable energy projects threaten to further fragment desert tortoise habitat and disrupt connectivity between desert tortoise populations particularly in California and

Nevada. WWP is actively involved in the environmental review of many of these projects. WWP is litigating agency approvals of the Ivanpah Solar Electric Generating System. This power plant project is sited in an environmentally sensitive, resource-rich area and would consume 5.4 square miles of important, high quality desert tortoise habitat in California's Ivanpah Valley.

In April 2010, WWP and WildEarth Guardians reached a settlement with the United States Fish and Wildlife Service in which the Service agreed to issue its 12-month finding on our October 2008 petition to list Sonoran desert tortoise populations under the Endangered Species Act within eight months. On December 14, 2010, the Service determined that the Sonoran desert tortoise population warranted listing under the Endangered Species Act, but that the listing was precluded due to higher priorities. While a step forward for Sonoran desert tortoises, the animals will be placed on the candidate list, where they will receive no federal safeguards until they are actually listed as "endangered" or "threatened" under the Act. WWP is continuing in its efforts to ensure that all desert tortoise populations in Arizona are fully protected.

In February 2010, WWP reached a settlement with the Bureau of Land Management (BLM) over WWP's litigation regarding the undue delay in resource management planning for the 496,337 acre Sonoran Desert National Monument west of Phoenix, Arizona. The final RMP and livestock grazing compatibility decision must be completed by December 15, 2011, and in the interim, BLM will maintain a 55,000 acre ORV exclosure, complete environmental analysis on any range developments, and adhere to legal limits on ephemeral livestock grazing authorizations.

WWP is currently engaged in litigation with the BLM over its Yuma Field Office Resource Management Plan. The Resource Management Plan governs BLM management of 1.3 million acres of desert lands, including 0.5 million acres of Category I, II and III desert tortoise habitat, in southwest Arizona and southeast California.

In July 2010, WWP submitted three nominations for new and expanded Areas of Critical Environmental Concern to protect desert tortoises and their habitat in southwest Utah.

Collaboratively Prioritizing and Evaluating Desert Tortoise Recovery Across the Landscape

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The recovery strategy for the threatened Mojave desert tortoise emphasizes partnerships and linking management with science to implement, track, and evaluate recovery. Recovery Implementation Teams, comprised of land managers, stakeholders, and scientists, will work together to prioritize recovery actions and assess results in a spatial decision support system (SDSS). The SDSS is an interactive system that computes the output of a set of models (e.g. effects of threats on the tortoise population) based on underlying databases (e.g. spatial extent of threats, tortoise population, and management actions). The system incorporates a range-wide geospatial database of current management activities, threats, and tortoise population parameters, providing a framework for recognizing and implementing successful recovery actions. These same models can also be applied to impact analyses and designing mitigation strategies.

STUDENT PAPER

Relationships of Exotic Plant Invasions with Biological Soil Crust, Desert Pavement, and Soil Carbon in the Eastern Mojave Desert

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Plant community invasibility is a key topic in the Mojave Desert where exotic species invasions result in new fire regimes and reduced plant diversity in desert tortoise habitat. This project consisted of three components: a greenhouse experiment, a field experiment, and a correlational field study. These studies examined how soil surface types (biological soil crust, desert pavement, and open) affect the establishment of three exotic plant species (*Bromus rubens*, *Schismus* spp., and *Brassica tournefortii*) in Lake Mead National Recreation Area in the eastern Mojave Desert. The effects of carbon addition (reducing soil fertility) and disturbance on the establishment of these species were also examined. The results of this study showed a correlation between carbon addition and the reduction of density and biomass in all three exotic species studied. Exotic establishment was generally higher on open surfaces than biological soil crust and higher on biological soil crust than pavement. Species composition showed higher annual plant cover on open sites than biological soil crusts and higher cover on crusts than pavement. Both crusts and open surfaces had higher species diversity than pavement, and annual plant community composition was significantly different on biological soil crust and pavement. Protection of biological soil crust and desert pavement in conjunction with carbon addition could serve as useful tools for reducing the spread of invasive species in the Mojave Desert. These findings are expected to contribute novel information to the broader understanding of these factors in arid lands as well as provide information applicable for local land managers that are tasked with protecting desert soil surfaces and minimizing the impacts of exotic species.

POSTER

Desert Tortoise Recovery: Measuring Success

Desert Tortoise Recovery Office

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Since publication of the 1994 Recovery Plan for the Desert Tortoise, agencies have applied enormous effort to conserve the species. Yet even with this effort, desert tortoise numbers have continued to decrease. We do not fully understand the reasons for these declines because no scientific process was put in place to identify which actions were expected to achieve the best results, evaluate success or failure, or to change course when needed.

A 2002 congressionally-mandated audit of recovery implementation and a subsequent 2004 scientific review of the 1994 recovery plan recognized that failure to adopt a new approach to recovery would result in continued ineffective conservation of the desert tortoise and likely extinction. This realization led to a revision of the recovery plan and establishment of a centralized entity, the Desert Tortoise Recovery Office (DTRO), to coordinate a new recovery implementation strategy that would link management decisions with research results.

The 2011 revised recovery plan calls for coordinated effort of science-based implementation and evaluation of conservation actions that includes regional recovery implementation teams (RITs) to work with the DTRO on implementing, tracking, and evaluating recovery actions. To help these teams apply the best available science, the DTRO has developed a system that helps the RITs to measure the success of recovery actions, compare performance with expected outcomes, and inform future decisions.

Management of Desert Tortoise Habitat on Public Lands Managed by the Bureau of Land Management – Nevada

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The BLM administers approximately 4.5 million acres of desert tortoise habitat in Clark, Lincoln, and Nye counties in Nevada. The following are highlights from NV BLM's 2010 accomplishments. BLM continues restoration efforts for desert tortoise habitat. In 2010 BLM restored 60 miles of road, planted 417 native plants and collected 207 pounds of native seed, installed 8,260 feet of protective fencing, removed 240 cubic yards of trash, and hosted three volunteer events. Through funding provided by the Clark County Desert Conservation Program and SNPLMA, the BLM is monitoring designated routes in five ACECs and completed several products. Working with Great Basin Institute, the BLM has participated in educational outreach, established transects, and installed interpretive signs. The Southern Nevada District continues working on a revision to the 1998 Las Vegas Resource Management Plan, which will establish consolidated guidance and updated objectives and management actions for the public lands in the decision area. The Las Vegas Field Office is also preparing a Recreation Area Management Plan and Comprehensive Transportation and Travel Management Plan. Section 7 consultation remains a major workload for the Districts. BLM has also focused on desert tortoise research opportunities. The Caliente Field Office is working with USGS to create a climate change model that will provide useful information on expected effects to desert tortoise. The BLM awarded a contract to SWCA Environmental Consultants to conduct research into desert tortoise populations on conservation areas within and near the Superior-Cronese and Gold Butte-Pakoon Critical Habitat Units to develop site-specific conservation plans.

Desert Managers Group

Fon Allan Duke, DOD Coordinator

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The Desert Managers Group (DMG), an organization of federal, state, and county land managing agencies in the California deserts, focuses on coordinating and integrating desert tortoise recovery actions and monitoring efforts among managers and scientists across jurisdictional boundaries. A key to desert tortoise recovery is an informed public that understands and appreciates desert tortoise recovery. The California Mojave Max program is in its fifth year with a growing base of support and outreach. The Mojave Desert Ecosystem Program (MDEP) has expanded as well by teaming with Southern Nevada Agency Partnership in hosting data and providing services across the Mojave Ecoregion. The MDEP also launch a Mojave Desert Tortoise app for smartphone use to educate the public on the tortoise. The DMG is also coordinating ongoing regional assessments and science with renewable energy permitting plans such as the Desert Renewable Energy Conservation Plan and the BLM Solar Programmatic EIS.

STUDENT PAPER

Looking Backwards In Order To Move Forward; A Review of Desert Tortoise Genetic Research

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The tools of molecular biology have greatly contributed to our understanding of desert tortoise natural history. Genetic research has helped to elucidate desert tortoise phylogeny (Lamb and Lydeard 1994, Morafka et al. 1994), phylogeography (Lamb et al. 1989), management units (Britten et al. 1997, Murphy et al. 2007, Hagerty and Tracy 2010a), areas of hybridization (McLuckie et al. 1999, Edwards et al. 2010), population structure (Rainboth et al 1989, Edwards et al. 2004, Murphy et al. 2007, Hagerty and Tracy 2010a), and population connectivity (Edwards et al. 2004, Hagerty and Tracy 2010b). Other ongoing studies utilizing genetics include desert tortoise behavioral genetics and paternity analysis. In addition, molecular tools have played a significant role in the development of identification techniques for disease research (Brown et al. 1995, Snipes et al. 1995, Brown et al. 2001, Johnson et al. 2005). Molecular techniques used in desert tortoise research have included assessment of allozyme variation (Rainboth et al 1989, Britten et al. 1997, Morafka et al. 1994), DNA fingerprinting (Snipes et al. 1995), mitochondrial DNA sequencing, (Lamb et al. 1989, Lamb et al. 1989) and multilocus microsatellite analysis (Edwards et al. 2003, Hagerty et al. 2008). These advances in our understanding have contributed significantly to both the 1994 and 2008 Draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise. Currently, the discipline of conservation genetics is being transformed by the 'genomics revolution' through unprecedented quantities of data and advancements in computational ability. With advancements in biotechnology (next generation sequencing) it is possible to define the underlying mechanisms that contribute to genetic variation in ways previously unimaginable. However, this level of resolution will inevitably add complexity to conservation efforts and will consequently require a refinement of the methodology used by conservation geneticists to assist resource managers in making informed decisions. In my presentation, I will discuss how the past, present, and future application of molecular tools has and will continue to contribute to desert tortoise conservation.

West Mojave Route Designation Revisited

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The Desert Tortoise Council (DTC) has been involved with vehicle use issues in the western Mojave Desert for over twenty years. DTC representatives provided extensive recommendations to the Bureau of Land Management ("BLM") throughout its development of the West Mojave ("WEMO") Plan, in which an expansive off-road vehicle route network on public lands, as well as a plan for its management, was adopted. Many of the recommendations provided by DTC were not incorporated into this designation. Protests submitted by the DTC and others following plan adoption were summarily dismissed. In 2006, a coalition of ten environmental organizations initiated litigation regarding this route designation, arguing that it did not comply with relevant statutes and regulations.

The merits of this case were ruled on by U.S. District Judge Susan Ilston in 2009. BLM's designation was found significantly "flawed because it did not contain a reasonable range of alternatives" to limit damage to public land resources. BLM was found to have inadequately analyzed the routes' impacts on air quality, soils, plant communities, riparian habitats, and sensitive species, pointing out that the desert and its resources are "extremely fragile, easily scarred, and slowly healed." BLM was found to have violated the National Environmental Policy Act ("NEPA"), the Federal Land Policy and Management Act ("FLPMA"), as well as its own regulations and the California Desert Conservation Area Plan.

The environmental coalition subsequently requested the court consider injunctive relief until such time as BLM revises the WEMO route designation, to safeguard at-risk natural resources. Field work sponsored by the DTC and other environmental organizations in support of this requested remedy resulted in extensive information being submitted to the court, along with recommendations on how to improve vehicle use management.

In January, 2011 the court granted much of the requested relief. BLM must now complete a revised WEMO route designation complying with all laws and regulations by March, 2014. A detailed implementation plan for route signing must be completed by the end March, 2011. Plans for informational kiosk installation, vehicle use compliance monitoring, and additional enforcement must also be submitted to the court by the end of April, 2011. The court has also retained jurisdiction over this matter, with progress reports to be regularly prepared by

BLM. It's been a long and winding road, but our hopes are that a revisited route designation will improve vehicle use management in desert tortoise habitat within the western Mojave Desert.

Development of an Epidemiological Model of Upper Respiratory Tract Disease (Mycoplasmosis) in Desert Tortoises Using the Daggett Study Area: Year 4, 2010

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We completed the fourth year of the multi-year research project on Epidemiology of Upper Respiratory Tract Disease in desert tortoises at the Daggett, California, study area. This project was designed to quantify disease dynamics of an on-going epidemic and to develop a landscape epidemiology risk model that could be applied to future translocation efforts. We conducted health evaluations of 70 desert tortoises in the spring and 67 tortoises in the fall. We located and attached radio transmitters to 17 new tortoises, and these tortoises were included in both spring and fall health evaluations.

In spring, 14.3% of the tortoises were ELISA positive or suspect for *Mycoplasma agassizii*; in fall 15.4% were positive or suspect. In spring, 18.6% of tortoises were ELISA positive or suspect for *M. testudineum* and in fall, 23.1% were positive or suspect. The spatial distribution of both mycoplasma species was dependent on location within the study area. Tortoises with positive and suspect ELISA tests for *M. agassizii* were predominantly in the core in spring compared with the middle or outer bands (Fisher's exact test: p = 0.009, <0.001, respectively) and fall (Fisher's exact test: p = 0.028, p<0.001, respectively). In spring, more tortoises with positive and suspect *M. testudineum* ELISA tests were located in the core and middle bands than in the outer band (Fisher's exact test, p = 0.185, p = 0.001, respectively). In fall, tortoises with positive and suspect *M. testudineum* ELISA tests were present in all bands, but there were more in the middle band than the outer band (Fisher's exact test: p = 0.013). The death rate has remained high. Thirty-two tortoises from the original 80 are still known to be alive, 40 are dead, eight are missing and of the eight, fieldworkers located transmitters for two. In 2010 alone, 9.4% of the total 106 tortoises died. In 2010, deaths were not dependent on band (x^2 = 1.107, df = 2, p = 0.575), and the sex ratio of dead tortoises did not differ significantly from the expected 1:1 (Fisher's exact test: p = 1.0).

Vegetation Recovery on a Desert Landscape after Wildfires: Variation Among Community Types, Time Since Fire, and Contingency Effects

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Arid lands of the southwestern USA are increasingly exposed to unprecedented fires facilitated by fuel from exotic grasses. Theories of plant succession are poorly developed in deserts, hindering understanding how long communities may take to recover after fire and if land managers should use active restoration techniques. We evaluated post-fire recovery patterns of plant species richness and diversity, compared the rate and direction of succession between two major community types, and explored the relationship of time since fire (TSF) and environmental factors with recovery. We sampled perennial plant communities and environmental variables (e.g., soil N) on 32 burns, each paired with their own unburned area and ranging in TSF from 2 to 29 years, within a 1.8-million ha landscape in the eastern Mojave Desert, USA. Recovery of species richness, diversity, and composition each exhibited patterns unique from each other, and recovery also differed between communities. Burned *Larrea tridentata* communities exhibited a decline in species diversity for TSF < 10 years and were similar to unburned areas from 10 to 29 years TSF, whereas diversity in *Coleogyne ramosissima* communities did not decline and was 20-50% greater than unburned areas > 10 years TSF. Species composition in *Larrea* communities exhibited trajectories by 10 to 19 years TSF to begin converging with unburned composition. In contrast, 10-year TSF categories in *Coleogyne* communities segregated from each other, but showed little trajectory to converge with unburned composition. Regression trees, using environmental variables such as soil texture and P, accounted for 79-83% of the variation in burned species composition, suggesting structuring of recovery patterns even though community trajectories did not necessarily display convergence to unburned composition. Results indicate that geographically similar vegetation types within the same landscape can have markedly different post-disturbance plant successions. Species compositional recovery in *Larrea* communities is more rapid even though they occupy sites warmer and drier than *Coleogyne* communities. Management treatments for promoting recovery may therefore be most important in *Coleogyne* communities, although decisions about attempting to influence succession may partly hinge on how well the persistent, early successional communities meet functional objectives such as for wildlife habitat.

Desert Tortoise Potential Habitat Relative to Land Status and Conservation Areas

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We conducted a spatial analysis of the conservation status for the Desert Tortoise across the Mojave Desert ecoregion using a synthesis of habitat modeling and land ownership data. Taken alone, the potential habitat model is representative of a hypothetically pristine habitat condition. To create a more realistic assessment of current habitat status for desert tortoises, we

considered multiple land use/ownerships that likely influence population stability and may have either positive or negative effects on desert tortoise populations and their habitats. Factors that we considered included: utility and transportation corridors, military training areas, urban footprints, OHV areas, burned areas Wilderness, National Parks and National Wildlife Refuges, Bureau of Land Management Areas of Critical Environmental Concern and National Conservation Areas and designated Critical Habitat. For a simple heuristic model of potential impacts of different land uses we created three categories: 1) lands likely protected in the near and short term, 2) lands that are of unknown protection status, and 3) lands that are likely to suffer anthropogenic impacts. Given these potential impacts to tortoise habitat, we evaluated the anticipated net effect on conservation in the Mojave Desert.

Managing Desert Tortoises on California BLM lands with the Push for Renewable Energy Development?

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In 2010, BLM continued to work on projects such as signing routes, restoring habitat, public outreach, and acquisitions of private land. However, most of our effort and time was focused on solar and wind energy projects. Industrial renewable energy development projects are of a size and scale that California BLM has not previously contemplated nor envisioned. In 2010, five projects within tortoise habitat were approved. Three of these projects will implement habitat enhancement as the means of mitigating project impacts of and conducting desert tortoise surveys in several areas. We collaborated with US Fish and Wildlife Service on a spatial decision support system, a tool that will assist BLM in assessing the impacts of renewable energy development and the benefits of different mitigation actions for tortoise. We look to leveraging the effectiveness monitoring associated with renewable energy projects into larger research projects and coordinating the data to better inform us on impacts to tortoise. We face a huge challenge of managing the public trust. With the potential loss of thousands of acres to a single use and the projected mitigation requirements and associated funding, we want to be strategic in how mitigation is applied to get the maximum benefit for the tortoise, and other wildlife species.

POSTER

Minimizing Risks When Translocating Desert Tortoises

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Regardless of whether a translocation is initiated for conservation purposes or in response to conflicts between land use and tortoise occupancy, important steps must be taken to reduce risks to translocated and recipient populations. Behavior, physiology, genetics, and disease are among the factors that need to be considered. Studies on the translocation of desert tortoises, as well as important studies on other species, have provided useful data to guide decisions about how to minimize risks and increase chances of success. The recent interest in moving desert tortoises from large alternative energy project sites has prompted the Desert Tortoise Recovery Office to consider when such translocations could be appropriate and if appropriate, how they should be conducted. Additionally, we stress that translocations must still be considered experimental and as such must be designed and implemented to address key gaps in knowledge or test the implementation of conservation measures.

Synchrotron Studies of Arsenic and Zinc Species in Mojave Desert Tortoise Tissues

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In this study, synchrotron-based microbeam X-ray absorption spectroscopy (μ-XAS), X-ray fluorescence spectroscopy (μ -XRF) and X-ray diffraction (μ -XRD) are used to identify arsenic (As) and zinc (Zn) oxidation states and molecular species in scute and lung tissues from specimens of the Mojave desert tortoise (*Gopherus agassizii*). (approximately 20) collected from mining-impacted areas (Kelly-Rand Mining district, Kern County), military bases (National Training Center, Ft Irwin, and Edwards Air Force Base), and public highways (as controls). A critical hypothesis we are testing with this study is that total As and Zn in scute tissues is predominantly a result of long-term bioaccumulation of the element, whereas total As and Zn in lung tissue is predominantly influenced by the solubility and loading of particulates in the lung.

Exogenous (particulate-associated) and endogenous (metabolized) arsenic and zinc in desert tortoise scute tissue can be distinguished on the basis of their μ-XAS spectra. The metabolized As and Zn is bound to reduced sulfur groups in material which exhibits short-range order, such as keratin or other structural protein. Particulate-associated As and Zn species were predominantly bonded through oxygen/hydroxyl atoms rather than sulfur groups, but even when bonding through sulfur groups occurred, μ-XAS spectra indicated the presence of long-range order as would occurs in a mineral phase (e.g., sphalerite, a Zn-S mineral) rather than short range order on the scale of molecules. μ-XRF maps reveal an interesting anti-correlation between metabolized Zn and As, both of which occur in sub-horizontal lamellae possibly related to scute growth features.

More than 40 individual μ-XAS spectra of exogenous (i.e., particulate) As and Zn have been obtained from both scute and lung tissue samples, and are currently under investigation (along with μ-XRF and μ-XRD, in some cases). As(V) associated with ferric oxyhydroxides, ferric sulfates and/or ferric arsenates are the most common particulates encountered, but particles of reduced As in sulfide or arsenide minerals were also observed. Similar results for Zn will be presented. The results of multivariate techniques such as principal components analysis will also be presented. PCA provides information on the variance within a set of spectra, the number of species in the set, and the most likely model compounds to be used in fits.

A Multi-Scale Analysis of Habitat Selection in Relation to Prey Abundance in an Ambush Predator, the Speckled Rattlesnake (*Crotalus mitchellii*)

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Understanding how food distribution influences the behavioral decisions made by animals when choosing a habitat is a central goal of behavioral ecology. Because animals select habitats at several scales, and because the selection criteria used by animals when choosing a habitat may be scale-dependent, studies examining the significance of food on the habitat selection process should ideally incorporate multiple spatial scales. Herein, we relied on radiotelemetry and prey abundance estimates at two habitat levels to examine whether prey (rodent) abundance is a consistent predictor of habitat selection in an ambush predator, the speckled rattlesnake (*Crotalus mitchellii*). At the macrohabitat level, rodent prey was significantly more abundant in *C. mitchellii*'s preferred macrohabitat, compared to the avoided macrohabitat, suggesting that *C. mitchellii* selects macrohabitats that increase prey encounter rates. In contrast, rodent abundance was relatively low at the microhabitats selected as ambush sites by *C. mitchellii*. Therefore, the higher abundance of prey in *C. mitchellii*'s preferred macrohabitat did not translate into increased access to prey at the snake microhabitats, indicating that prey distribution may not be a consistent predictor of habitat choice across spatial scales in an ambush predator. Indirect evidence suggests that the lower prey abundance at the snake microhabitats was the result of adjustments in rodent behavior (e.g., leaving the area or reducing activity) when snakes were present to decrease predation risk. Our study indicates that factors other than food (*e.g.*, proximity to refuges) affect microhabitat selection in a predator, and underscore the dynamics of predator-prey interactions in nature.

Desert Tortoise Occupancy Estimation on the Florence Military Reservation, Pinal County, Arizona

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The Florence Military Reservation (FMR), located in Pinal County, Arizona serves as a desert training complex for the Arizona Army National Guard while also providing habitat for the desert tortoise (*Gopherus agassizii*). The goal of this study was to evaluate the distribution of desert tortoises within the FMR training area and develop recommendations to minimize impacts to tortoises while maintaining the National Guard's military readiness mission. We conducted 4 repeat surveys on 228 3-ha survey plots (i.e., sites) and used a likelihood-based approach to estimate detection probabilities and the proportion of area occupied (PAO). This approach also allowed us to examine the influence of site- and survey-specific covariates on detection probabilities and PAO. Detection probability was best modeled as a function of time of day, being highest during early morning surveys (i.e., sunrise to 10 am) and declining as the day progressed. The average detection probability across all the survey plots was 0.329 (SE = 0.048). Occupancy was positively influenced by the presence of caliche caves and negatively influenced by the presence of cattle sign and roads. The overall PAO was estimated at 0.196 (SE = 0.041). We used the results of this study to identify an optimal sampling design for monitoring desert tortoise occupancy on the FMR. We calculated the number of survey sites (s) and survey visits (K) required to achieve a target level of precision for the occupancy estimate (SE = 0.05). We then examined trade-offs in precision, bias and survey effort under varying combinations of s and K using analytic-numeric methods and simulations. The results of this analysis indicated that the optimal strategy for monitoring desert tortoise occupancy on FMR will require the probabilistic selection of 85 survey sites across the installation, each of which is surveyed 5 times its their entirety each year.

Department of Defense and Desert Tortoise Conservation

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Military installations face many challenges just as other land management agencies. Desert tortoise populations continue to decline on military bases. Common ravens, coyotes, and domestic dog predation have an effect on desert tortoise populations. Military bases must employ ecosystem management principles and manage their lands for multiple uses and military missions. Department of Defense (DoD) installations in the western Mojave Desert initiated and continued many conservation programs for the desert tortoise, (*Gopherus agassizii*), in 2010. Conservation measures covered a broad spectrum at each installation including education and outreach, research, and other projects to manage the species and habitats. DoD installations also participated in the Desert Managers Group, associated workgroups, and the Desert Tortoise Management Oversight Group, to support recovery planning and action. Projects such as head starting are designed to increase populations and enhance recovery efforts and can be exported to areas beyond installation borders. Some of our research projects have broad applications beyond the boundaries of the military installations. Research projects include disease studies, population monitoring and demographic research, predator research, and head starting. Public outreach and education of base personnel continue to be important programs at military installations. These efforts involve presenting programs in schools, education of military and civilian workforce to supporting public outreach activities in local communities. Desert tortoise conservation efforts involve a significant commitment of resources within our environmental offices and throughout the installations.

QuadState Local Governments Authority: Counties Prepare to Participate in Desert Tortoise Recovery

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QuadState LGA is entering its twelfth year of operation. It continues to speak for and represent local governments in the Mojave and Sonoran Deserts. During the past year it has grown to nine counties, with the addition of Inyo County, California. As a joint powers authority we are a public agency, and have interests in and provide information and support on a variety of issues facing our member local governments in the 4-state region.

During the past year we have remained fully engaged with the land management and wildlife agencies regarding both the Mojave and Sonoran Populations of desert tortoise.

Regarding the Mojave Population we await, like many others, the release of the reviewed and revised recovery plan. We look forward to working with the State and Federal agencies on implementation. We will be assuring that local governments in the region have the technical information they need so they can fully participate in the Recovery Implementation Teams, entities we believe will be organized under the revised plan.

Counties are actively engaged with the California Desert Managers Group, and have been accorded membership as public agencies in the Management Oversight Group. We participate in the Mojave Desert Initiative which covers the three eastern states. We await a determination of membership in the Arizona Interagency Desert Tortoise Team.

QuadState grew from a need by the counties for services and advice regarding desert tortoise, and other natural resources and public lands issues for which many lack staffing to cover.

We remain concerned on several elements of the Recovery Plan revision, and hope the Fish and Wildlife Service addresses at least some of them, but will await release before reacting and commenting on what may or may not be in that document.

Regarding the Sonoran Population, Mohave County asked that we become engaged in the review regarding the petition to list, and we provided comments on behalf of Mohave and La Paz Counties, in addition to a general regional statement based on the data from the long term study plot data maintained by the Arizona Game and Fish Department. The decision released in December creates many questions regarding on-going land management in the absence of a decision to list. .

We [the counties] look forward to developing partnerships and interface with the Arizona agencies and interagency organizations, and to continuing our relationship with the agencies in California, Nevada and Utah, so as to provide local governments with information; and to provide the agencies with local government's perspective on issues, policies and information.

Desert Tortoise Road Mortality in Mojave National Preserve

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Heavily traveled highways bisect 772,463 acres of critical habitat designated for the desert tortoise (*Gopherus agassizii*) in Mojave National Preserve. Sections of Kelbaker, Kelso-Cima, Morningstar Mine, and Ivanpah roads form a major connector route between Las Vegas, Nevada, and inland cities in Southern California. An average of 5 road-killed tortoises was reported each year in the Preserve, for the period from 2002 through 2010, with an average death rate of 2 per month occurring during the tortoise active season. We compared the road edge effects between highways with heavier and lighter traffic and tested the efficacy of warning signs for modifying motorist behavior.

Traffic density on Morningstar Mine road, which passes through Ivanpah Valley critical habitat, averaged 0.27 vehicles per minute traveling at an average pace of 65.3 mph. Traffic density on Essex road, which passes through Fenner Valley critical habitat, averaged 0.14 vehicles per minutes at an average pace of 39.5 mph. On Morningstar Mine road 1 of every 25 drivers exhibited an observable response to a model tortoise place on the edge of the pavement compared to 1 out of 7 drivers on Essex road. This response rate did not change with the installation of warning signs or flashing yellow lights. Tortoise sign indicated that density of tortoise is depressed to at least 400 m away from the road edge and is similar for both Morningstar mine and Essex Roads.

During the period of this study from the spring of 2008 through the spring of 2010, numerous tortoises were sighted on and near heavily traveled highways and 20 tortoises were reported killed by motor vehicle impact. Warning signs equipped with flashing lights were ineffective and law enforcement efforts are challenged by the large area. Properly constructed and maintained barrier fencing is recommended to reduce tortoise road mortality.

Molecular Evidence for Tortoise Herpesvirus-2 in a Wild Desert Tortoise, *Gopherus agassizii*

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This report is part of a larger study to determine causes of illness and death in the wild desert tortoises, *Gopherus agassizii*, in California. An adult male desert tortoise (MCL of 273 mm and weight of 3759 g) was found at Ft Irwin with major crush injury to its caudal carapace (it was fractured into 5 large pieces). The injury was consistent with vehicular trauma. It was a new tortoise with no prior history. It died within minutes of salvage and was submitted frozen to the University of Florida for pathological evaluation. Necropsy revealed a moderate atrophy of skeletal musculature with no fat seen associated with pectoral and pelvic girdles. There was atrophy of the right and left thymus and atrophy of the liver, which was dark in color and weighed 83.66 g. While freezing resulted in substantial artifactual change to all tissues, still, the tortoise was frozen soon after death and histology of most tissues was sufficient to note any substantial change. Light microscopic examination of the tongue, mental glands, right submandibular gland, trachea, right thymus and parathyroid, right and left nasal cavities, heart, gastrointestinal tract, pancreas, bladder, brain, cervical spinal cord, eyes and adnexal structures, vertebral scute 3 (and underlying dermal bone and spinal cord), and left forelimb scales identified no abnormalities. Compared to livers of most previously necropsied tortoises, there was atrophy of hepatocytes with a concomitant moderate increase in the number of melanomacrophages per field of view for both lobes of the liver. Polymerase chain reaction amplification of DNA extracted from the tongue of this tortoise targeting a region of the herpesviral DNA-dependent-DNA polymerase gene yielded a product, which was sequenced. Sequence data showed a 181 base pair product after primer sequences were edited out. Compared to sequences in the databases of GenBank, EMBL, and the Data Bank of Japan using BLASTN (Altschul et al, 1997), the sequence obtained had 100% nucleotide sequence homology with Tortoise herpesvirus-2 (THV-2; GenBank accession number AY916792), which was previously described from an ill captive desert tortoise in California (Johnson et al, 2005). Sequences from this region have been found to be unique to each herpesvirus species (VanDevanter et al., 1996), indicating definitively that this is THV-2. Although several cases of herpesvirus infection have been described from captive desert tortoises, this represents the first molecular evidence of a herpesvirus in a wild desert tortoise. Further studies to determine the ecology, prevalence, and clinical significance of this virus in tortoise populations are indicated.

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Arizona Game and Fish Department's Turtle Conservation, Monitoring, and Outreach

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The Arizona Game and Fish Department's Turtles Project is dedicated to the conservation and management of Arizona's chelonian species. In the last year, our efforts for desert tortoises (*Gopherus agassizii*) included implementing a new statewide monitoring strategy that includes capture-recapture and site occupancy methods; initiating a juvenile tortoise radio-telemetry study; reviewing all monitoring data collected since 1987 on 17 long term monitoring plots to resolve discrepancies in the dataset, and working with cooperators to ensure appropriate analyses were conducted; and working with the Department's Research Branch on studies examining the efficacy of mitigation measures and testing a model that uses soil characteristics to predict occupancy. In addition, we continued to work with cooperators towards completing the State Conservation Agreement for the Sonoran Population of the Desert Tortoise. For captive desert tortoises, we made improvements to the Tortoise Adoption Program, including implementing a statewide tortoise adoption database. In an effort to engage the public in turtle conservation, we launched the Ornate Box Turtle Watch which employs a citizen scientist approach by asking the public to provide location data on any box turtle (*Terrapene ornata*) they encounter in southeastern Arizona; information provided will be used to guide management plans. Additionally, we conducted our annual nonnative turtle removal event at the Phoenix Zoo and provided outreach to over 5,000 visitors on the issues associated with releasing unwanted pet turtles. To ensure that current information on conservation and management of Arizona's turtle species is available to our customers, we continued to improve our website (www.azgfd.gov/turtle).

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

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Since 1939, state laws have been in place in California to protect the desert tortoise. In August of 1989, the tortoise was officially listed by the Fish and Game Commission as threatened under the California Endangered Species Act (CESA). Sections 2080.1 and 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. In addition to an Incidental Take Permit, a Memorandum of Understanding (MOU) for Handling Tortoises is needed, and we must review the qualification of each person who applies for the MOU. The Department also issues Scientific Collecting Permits and MOUs for research and studies on desert tortoise; and permits for possession of Captive Tortoises.

The Department, through the CESA permitting process, and by other means, 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.

In 2010, 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 past year working with Department of Defense on the Fort Irwin Expansion, reviewing mitigation lands and determining the presences of species on the lands, working with the Fish and Wildlife Service to update the desert tortoise handling guidelines, reviewing and commenting on translocation guidelines, improving our methods for dealing with captive tortoises and working on subgroups of the Desert Managers Group on management and protection of the desert tortoise in California.

An Update on the Progress at the Desert Tortoise Conservation Center

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The San Diego Zoo (SDZ) took over operations of the 222 acre Desert Tortoise Conservation Center (DTCC) in Las Vegas, Nevada in March 2009, working in collaboration with US Fish and Wildlife Service, the Bureau of Land Management, and the Nevada Department of Wildlife. After two active seasons, we have now completed an inventory of all tortoises that were on site when we arrived, and we are successfully implementing a number of programs, including veterinary services, pathology, husbandry, translocation research, training of field personnel, and community outreach and education. We are also now operating the Pet Desert Tortoise Hotline, which is available to residents throughout southern Nevada who no longer want their pet desert tortoises or who find desert tortoises wandering in developed areas. In addition to the nearly 2000 resident tortoises that were already on site when we arrived (this number includes live tortoises and carcasses), we have received and processed over 2000 additional tortoises from the two hotlines (SDZ's Pet Tortoise Hotline and Clark County's Wild Tortoise Assistance Line). We are currently maintaining on site nearly 3000 tortoises, and as a result of our outreach efforts, we expect to take in over 1000 more tortoises from the Pet Tortoise Hotline by the end of 2011 and during each year thereafter. The mission of the SDZ at the DTCC is to play a critical role in the recovery of wild desert tortoise populations and their native habitat. With a seemingly never-ending influx of tortoises to the facility and several conservation-based programs and research projects in progress, we are actively working toward fulfilling that mission.

Desert Tortoise Research Center Update

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Currently under construction adjacent to Northeast Mojave National Preserve, the LEED certified Desert Tortoise Research Center presents researchers new collaborative opportunities to understand this iconic species. This short presentation will describe why this center is being created, the research that will be conducted here, the researchers who will be working here, and what opportunities exist for stakeholders and the public to support and/or participate in the work being done. This presentation will also provide a brief update about the Tortoises Through the Lens program (presented last year), and demonstrate how funds raised by the high school students participating in this program will support the research to be done at the Desert Tortoise Research Center.

Desert Tortoise Translocation is Adaptive Management

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Implementation of new regulations and standards for protection of desert tortoises during translocation projects is not easy. Bureaucratic policy as well as tortoise biology confound the decision making process. Guidance from the Desert Tortoise Recovery Office changes as new information is gathered. Scientists disagree on suitable standards.

Of the eight approved solar power plants on public lands, three have substantial numbers of desert tortoises; the others have less than five. At least one additional power plant with many tortoises may start construction in 2011. The solar plants are outside critical habitat, but transmission lines are within. The acreage of these lines is small, but the impact could be proportionately large.

The translocation plans are complicated, consisting of clearance surveys, surveys of the recipient areas, and establishment of a control area. An equal number of tortoises in each area must be evaluated for disease, and all tortoises are fitted with transmitters. To date, no translocation plans have been completed for solar projects. Desert tortoises cleared from one solar site now reside in pens until health evaluations and disease testing is completed.

The guidance provides an overview, but field decisions must be made on every tortoise located within a solar project's footprint, and on tortoises found outside the fence, but nearby. Juveniles are difficult to find and little is known about how well they might adapt to new surroundings. It is essential that biologists implementing the translocation plans be trained, experienced and committed. They have to make spot decisions affecting the lives of the tortoises in this experimental procedure.

Tortoise Populations in Northeastern Riverside County

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The portion of Northeastern Riverside County, east of Joshua Tree National Park and north of Interstate 10, has generally been considered to have low densities of desert tortoises, although this region has been relatively under surveyed. It is located between two major tortoise populations centers identified in the 1970s (the Chuckwalla and Chemihuevi populations). This area was located near the center of the Army's former Desert Training Center, which operated extensively during the 1940s. Until recently Northeastern Riverside County was a remote and little used portion of the Colorado Desert. In 2009, however, approximately 200,000 acres were designated by the Department of the Interior as the Riverside East Solar Energy Study Zone. Currently four solar projects on nearly 17,000 acres of public land, producing approximately 2,000 megawatts, have been approved or are nearing approval. Associated with these solar projects, over 25,000 acres of land have been surveyed for desert tortoises. Within the areas surveyed, tortoise numbers have been low. Tortoise populations in this region seem to be tied to geomorphic landforms, elevations, and possibly historic land use. In particular, tortoise populations seem to be associated with the upper bajadas and arroyos and are generally absent in the low lying region between the mountains. Future solar projects and their associated transmission lines should be designed to avoid the upper bajadas and arroyos.

STUDENT PAPER

Burrow Characteristics and Social Elements of Captive Juvenile Bolson Tortoises (*Gopherus Flavomarginatus*) within a Headstart Enclosure in New Mexico

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Knowledge of burrow use and social behaviors is essential for the management and conservation of juvenile tortoises. Twenty-three juvenile Bolson tortoises were observed within a headstart facility in south-central New Mexico during summer, 2010. Tortoises were housed within a 13 x 7.5 m outdoor enclosure under ambient conditions and provided 32 artificial burrows constructed at 45.0 cm in length, 15.0 % slope, and height of 10.0 cm. Eight burrow groups with four burrows (oriented north, south, east, and west) were used within each group. Tortoises freely roamed the area from 1 May through 20 September and were observed weekly for burrow selection, changes in burrow length, and monthly burrow microclimate. Changes in temperature, relative humidity, and precipitation were factors that contributed to differences in tortoise behavior. Of 160 opportunities within each orientation, tortoises occupied the north orientation most frequently (N = 90) and east orientation the least (N = 82). Burrow aggregation was most significant in the north direction (x^2 = 11.445, df = 3, P = 0.010). Tortoises used 2-13 different burrows and switched burrows 1-16 times. Artificial burrows were modified a mean 22.0 cm (range: -2.0-55.0 cm) with mean burrow length of 67.0 cm (range: 43.0-100.0 cm). Curving began at the end of each burrow tunneling left or right. There was no difference between curving direction by orientation (x^2 = 2.468, df = 6, P = 0.872). Total precipitation over the period was 175.3 mm, with highest mean relative humidity in August (61.8 %). June had the highest mean temperature (28.9 °C) and May had the lowest (20.7 °C). Temperature at maximum depth of burrows was not different between months May-September however relative humidity by orientation was different in all months except May (F = 2.43, P = 0.008). Curved burrows had lower mean temperatures (25.1 °C) and higher relative humidity (84.4 %) compared to non-curved burrows with mean temperatures (25.7 °C) and lower relative humidity (81.5 %) when ambient temperatures were higher. Weight gain and loss corresponded to rainfall. This project was developed to raise tortoises in a protective headstart enclosure with some artificiality while observing behaviors.

Conservation Efforts of the Desert Tortoise Preserve Committee: Progress and Prospects

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In line with its mission to "promote the welfare of the desert tortoise (*Gopherus agassizii*) in its native wild state," the Desert Tortoise Preserve Committee has continued to address many of the anthropogenic factors that threaten tortoise populations through the acquisition and management of suitable tortoise habitat, public education and outreach, and scientific research. In 2010, the DTPC completed several stewardship projects on the Desert Tortoise Research Natural Area (DTNA), a preserve comprised of over 25,000 acres of prime tortoise habitat in the Northwestern Mojave Desert. To increase visitor awareness of the DTNA and threats facing tortoise populations, the DTPC installed 5 large entry signs and 25 smaller informational signs on the boundary fence of the preserve. Additionally, the DTPC installed 6 linear miles of desert tortoise exclusion fence along preserve boundaries, strategically located to reduce the risk of tortoise poaching and collision with off-road vehicles. In partnership with the Natural Resources Conservation Service and supported by several grants, the DTPC continued habitat restoration of the approximately 32 acres of degraded habitat acquired within the proposed eastern expansion of the DTNA in 2005. Working with American Conservation Experience crews, the DTPC installed vertical and horizontal mulch sites and catchments throughout 16.72 acres of this area to improve microclimatic conditions for seed germination of native flora and to attract wildlife activity to decompact the soil. The DTPC continues to monitor treated and untreated areas for rodent burrows and native plant growth to assess the impacts of different restoration methods. Preliminary results indicate increased rodent activity and native plant growth at treated sites. The DTNA received 1289 visitors from over 20 states and 10 different countries during the 3 months a Naturalist was stationed at the Interpretive Center. Approximately 28% of visitor groups arrived on off-highway vehicles (OHV). Outreach to these groups is especially important, considering the potentially adverse impacts of OHV activity on desert tortoise habitat. In the coming year, the DTPC will focus on acquiring land within and around the DTNA and the Chuckwalla Designated Wildlife Management Area, while evaluating expanding its preserve holdings into San Bernardino and Los Angeles Counties. Other upcoming projects include continued habitat restoration and monitoring in and around the DTNA, a spring Naturalist season, and educational activities such as the spring Wildflower Walk.

Reproductive Output of Translocated and Recipient Tortoises at Fort Irwin National Training Center

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In April of 2008, as part of the larger Fort Irwin project, our team translocated over 375 desert tortoises (*Gopherus agassizzi*) from the Fort Irwin Southern Expansion Area (SEA) onto adjacent public lands. In in an attempt to understand the effectiveness of translocation as a mitigation tool, several research questions were addressed to determine how well translocated tortoises assimilate into recipient populations. One measure of successful integration is the reproductive output of both translocated and recipient tortoises, with the assumption that successful integration would be indicated by similar reproductive efforts in both groups. Here we assess the reproductive output of translocated, recipient and control tortoises at four translocation sites adjacent to the Fort Irwin SEA. A portable X-ray system was used to examine egg production of females during the springs of 2008, 2009 and 2010. Animals were x-rayed once every 10-14 days from mid-April through the first of July (or until no eggs were present, late August for some individuals). From the radiographic images we were able to determine clutch size, clutch frequency and egg dimensions. A preliminary analysis of the data reveal that over 80% percent of the tortoises produced at least one clutch in 2008, and over 89% in the two subsequent years. There was also a marked increase in the number of individuals producing second clutches, increasing from 26% in 2008 to over 70% in 2009-2010. In addition to producing more clutches each year, there has been a consistent increase in average first clutch size, increasing from 3.7 to 4.5 to 4.6. However, second clutch size has been more varied (2.7, 5.7 and 3.7 over the past three years), which greatly influences total egg production. Average yearly egg production increased between 2008 and 2009 from 3.6 to 8.1, but showed a slight drop in 2010 to 6.7. A very preliminary investigation into differences in treatment groups, suggest control and resident groups tend to produce more first and second clutches than translocatees and that penned animals have seen a notable increase in egg production since they were released in early 2009.

Recovering the Bolson Tortoise (*Gopherus flavomarginatus*) in New Mexico: 2010 Update

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Expanding the range of the imperiled bolson tortoise, from small relict populations in Mexico to their Pleistocene range in New Mexico, is essential for long-term viability of this species. The Turner Endangered Species Fund (TESF) houses the largest of the only two bolson populations in the United States and there are currently no wild bolson populations above the

Mexico-United States border. TESF aims to facilitate conservation of this species through captive breeding and reintroduction. This project began in 2006 when we received 26 adult tortoises and 7 hatchlings from the Appleton Research Ranch in Arizona. We have since developed a management plan for the bolson tortoises on two of Ted Turner's ranches in New Mexico. Our major goals are to 1) increase the number of bolson tortoises in captive facilities in New Mexico through our breeding program and 2) to restore bolson tortoises to their historic range through releasing juveniles on Turner's Armendaris Ranch. Over the course of four years, we have worked with collaborators, including the Carlsbad Living Desert Zoo, to increase the captive bolson tortoise population in New Mexico by 375% and have achieved an overall survival rate of 82.5%. We accomplished this by refining our egg collection, incubation, husbandry, and monitoring protocols to optimize tortoise reproduction, survival, and overwintering success. The next step in this reintroduction effort is to increase the genetic diversity of hatchlings. We anticipate beginning reintroduction of juvenile tortoises to the Armendaris Ranch in New Mexico in 2012.

A Time for Action – Desert Tortoise Council 2010

Bruce K. Palmer, Senior Co-chairperson
Board of Directors, Desert Tortoise Council

The goal of the Desert Tortoise Council is "to assure the perpetual survival of viable populations of the desert tortoise within suitable areas of its historic range" (DTC Bylaws). The DTC, through actions of the Board of Directors, strives toward this goal. As the senior co-chairperson of the BOD, I will report on the actions of the BOD over this past year. The administrative, financial, legal, and logistical activities undertaken by the BOD are required for the continuation of the DTC and accomplishing benefits to the conservation of the desert tortoise. The net worth of the DTC is approximately $180,000. The Tortoise Handling Workshop is our primary means of making money, with most symposiums barely breaking even. This is the first year that two workshops were held, with about 190 participants. The BOD approves expenditures where funding can help make a difference in conservation of the tortoise. To reach our membership, DTC publishes a quarterly newsletter and maintains a website. The bylaws call for several standing committees, some of which go unfilled. The Ecosystem Advisory Committee is now active and taking on many important conservation issues. Projects are prioritized on a case-by-case basis through consideration of designated critical habitat, the number of tortoises that would be affected, conservation ramifications, and regulatory issues. Major projects from this past year include: Twenty-nine Palms/Granite Construction Expansion (DTC filed litigation; the details of the settlement are being worked out); Ridgecrest Solar (intervener status under the CA Energy Commission (CEC); in early 2011 the development application was withdrawn); Ivanpah Solar (filed protest to CEC over approval of project); and Eldorado-Ivanpah Transmission Project (submitted comment; project moves ahead). As with all organizations, we are only as strong as the membership that supports it. The bylaws provide for a BOD of 16—7 officers and 9 board members; this past year we had 14 active board members. The intent of the BOD is to represent a diverse membership, with participants from CA, NV, UT, and AZ that includes persons from state and federal agencies, universities/education, private consulting, research, management, and conservation advocacy. The BOD is actively seeking members that will work on committees, serve on the BOD, and accept officer positions. Despite many successes this past year, many plans were unfulfilled. Hopefully, in 2011 we will complete a review of the bylaws, update the DTC tortoise handling procedures document, develop an archival protocol, and provide an active role in bringing scientific information to decisions on project authorizations, all while continuing to provide the DTC membership with annual symposia, and training through the tortoise handling workshops.

Burrow Buddies—Or Not? Simultaneous Sheltersite Occupation of Sonoran Desert Tortoises and Rattlesnakes Near Tucson, Arizona

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During 20 years of extensive herpetological field work around various mountain ranges near Tucson, three species of rattlesnakes (*Crotalus atrox, Crotalus molossus*, and *Crotalus tigris*) have been documented in burrows with desert tortoises near Tucson. Such interspecies groupings appear to be an uncommon occurrence. When the results are fully tallied, it is expected that only about 50 observations will be documented. In some cases, the local tortoises are over-wintering with the rattlesnakes; in these instances, several different pairing groups have spent consecutive winters together. The well packed and stacked debris of the white-footed wood rat (*Neotoma albigula*) that are usually associated with tortoise and rattlesnake commensals often blocks any possibility of viewing the phenomena. When the rat walls are not a factor, interactions observed between the two types of reptiles in the confines of their shared shelter demonstrate a dynamic pattern of spatial segregation. A synthesis of interspecies spatial behaviors emerges as each pair negotiates the limited space of their shared quarters. Insights on rattlesnakes leading trackers to tortoises will be presented, based on ten years of radio telemetry of 63 different *Crotalus atrox*, 5 *Crotalus molossus*, and 9 *Crotalus tigris.* Lastly, the possibilities of desert tortoises as being a potential prey item of rattlesnakes will be discussed.

Translocation of an Urban Population of Regal Horned Lizard (*Phrynosoma solare*)

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During July-November 2010, Regal Horned Lizards were collected at a site prior to construction that would have killed them. The 11.7-ha site was along Arroyo Chico, an urban open space in central Tucson, Arizona, is being converted from un-managed desert to a≈ 6 -m deep floodwater detention basin, later to be re-vegetated as a pubic, semi-natural open-space park. Totals of 98 adult/subadult and 84 hatchling horned lizards were collected. A depletion estimate of 128 non-juveniles was computed. The lizards were measured, weighed, photographed to record unique ventral spot patterns, marked (cohort toe clip in juveniles, PIT tags in larger animals), and released. They were distributed among seven urban sites translocation sites based on criteria evaluating augmentation the sites could likely support and accessibility for monitoring.

Translocated and resident Regal Horned Lizards were radio-tracked at one site, August-December. Of 6 resident lizards followed, all survived and used moderate-sized home ranges of around a hectare. Of 10 translocated lizards, 4 died (2 via predation, 1 each presumed to have over-heated and starved). All telemetered lizards (except the one presumed to have starved) regularly visited 2-4 rough harvester ant (*Pogonomyrmex rugosus*) nests within their activity ranges. Microhabitat utilization was little different between resident and translocated lizards. All but one of the translocated lizards had larger activity ranges than the residents. Informal monitoring was initiated at the three other relatively large release sites. At one site, where 8 were released, there was no evidence of survival. At an un-managed city lot, which had no resident population, and a large detention basin, scat counts were markedly elevated for 2-3 months post-release, and 3 re-sightings of translocated lizards were recorded. Telemetry and monitoring via visual encounter survey and mark-recapture is planned for 2011.

The Red Cliffs Desert Reserve: An Update

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The Red Cliffs Desert Reserve is located in the southwest corner of Utah in the Upper Virgin River recovery unit. It was created in 1996 to protect the desert tortoise and approximately 62,000 acres of land in Washington County. The Habitat Conservation Plan (HCP) is managed by the County in coordination with several other agencies.

The HCP, BLM and FWS anticipated that the Reserve would become a National Conservation Area (NCA) within five years of inception. However, it was not until the passage of the Omnibus Public Land Management Act of 2009 that all public lands in the Reserve were given NCA status. The BLM manages all public land within the newly created Red Cliffs National Conservation Area more intensively. However, the Reserve still includes state and private lands, and the entire Reserve continues to be managed by a consortium of agencies as a protected desert tortoise conservation area. Our management efforts will continue until all private lands within the NCA boundaries are acquired and the HCP permit expires.

Since the Reserve is adjacent to an expanding community, translocation of desert tortoises from designated take areas is crucial. To date, approximately 430 tortoises have been relocated from outside the Reserve, to desirable tortoise habitat in the Reserve. This translocation effort is considered a success due to the thriving population in the new habitat. However, there are emerging concerns of disease in one area that was previously thought to be absent of URTD.

Perhaps the largest concern in the Reserve is the presence of non-native vegetation and the threat of wildfire. Intrusive cheat grass is abundant, especially this year after heavy winter rainfall. In fact, precipitation this season is reminiscent of 2005 when large fuel supplies allowed fires to burn approximately 14,000 acres in the Reserve.

Overall, tortoise populations in the Reserve are generally healthy and have a higher density than most other areas of the Mojave. Nevertheless, monitoring over the past several years have shown continual downward trends. In coordination with UDWR, we have funded several necropsies on tortoises to determine the effects of disease in this recovery unit.

Effects of Nitrogen Fertilization and Exotic Invasive Removal on Native Annual Forbs in the Colorado Desert – Implications for Tortoise Habitat and Nutrition

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Anthropogenic nitrogen deposition and exotic invasive species threaten desert plant communities. Soil nitrogen pulses can increase competition in low nutrient systems such as creosote bush scrub communities in the Colorado Desert. In this study, I tested the hypothesis that both native and invasive winter annuals can exploit increased soil nitrogen and that natives experience the greatest benefit when exotic invasive plants are removed. The exotic invasive plants of concern were *Schismus* spp., *Erodium cicutarium*, and *Brassica tournefortii*. Treatments consisted of four combinations of nitrogen fertilization (control and 25 kg N ha^{-1} as NH_4NO_3) and exotic invasive removal (control and Fusilade II plus hand weeding). Both natives and invasives responded positively to nitrogen fertilization, but plant responses were typically specific to the site and season in which responses were evaluated. Both native and invasive plant productivity were consistently increased by nitrogen additions, although percent cover and density responses were variable. Soil extractable nitrogen and exotic invasive removal had cumulative effects, which resulted in measurable increases in NH_4^+ and NO_3^- in fertilized plots and a decrease in invasive density in exotic invasive removal plots over time. I also compared soil and vegetation in fertilized plots to that found along shrub driplines to determine whether nitrogen fertilization alone can imitate the benefits of the fertile island effect. My results showed that percent cover, tissue C:N, and plant productivity were not significantly different between fertilized and shrub understory plots, despite more than five-fold higher extractable soil nitrogen in fertilized plots. Since species composition can vary between the interspace and shrub understories, the ability of nitrogen fertilization to mimic the shrub understory could lead to changes in the species composition of intershrub spaces under persistent nitrogen deposition. This work highlights the ability of native annual forbs to take advantage of additional soil nitrogen in the field, even in the presence of invasive species, and that nitrogen fertilization can simulate the fertile island effect in intershrub spaces, both of which has implications for conservation and restoration of desert communities. Exotic plant invasions threaten desert tortoise conversation by degrading habitat, increasing fire risk, and compromising nutrition and health. The results from this study demonstrate that, with diligent control of invasives, there may be hope for the restoration of invaded tortoise habitat at some sites. However, nitrogen deposition may be a complicating factor causing species shifts in intershrub spaces and altering forage availability for tortoises.

The Sonoran Desert Tortoise: A Saguaro on Wheels.

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The Sonoran Desert Tortoise is a very different beast from its Mojave counterpart, differing in genetics, habitats, morphology, and ecology. In the Sonoran Desert region, the climate space and topography utilized by the Sonoran Desert Tortoise and the Saguaro Cactus are almost identical for both turtle and plant. I will highlight the similarities and differences between Sonoran and Mojave desert tortoises. I will then compare the distributions of Sonoran tortoises and saguaros and discuss the relationships between their respective physiologies and their reproductive ecologies and phenologies.

Warranted but Precluded: Federal Status of the Sonoran Desert Tortoise

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On October 15, 2008, the U.S. Department of the Interior, Fish and Wildlife Service (FWS) was petitioned to list the Sonoran population of the desert tortoise (SDT) under the Endangered Species Act as a distinct population segment (DPS) and designate critical habitat. On August 28, 2009, the FWS made a 90-day finding that the petition presented substantial scientific information indicating that listing the SDT may be warranted. On December 14, 2010, the FWS published a 12-month finding which confirmed its status as a DPS and determined that the SDT warranted Federal protection. However, the FWS also determined that listing the SDT at that time was precluded by higher listing priorities. The SDT is now a Federal candidate species with a listing priority number of 6 (range = 1-12).

The 12-month finding cited 377 commercial and scientific references in determining that the SDT was threatened now or in the foreseeable future, in all or a significant portion of its range in the United States and Mexico, by all five listing factors used for this process. Specifically, major threats that were identified included changes in fire regimes due to nonnative plant invasions, urban development and infrastructure, and effects from expanding human population growth within its range. Other threats, such as climate change-caused shifts in rainfall patterns and continued drought, were also identified as part of a myriad of threats that act synergistically on Sonoran desert tortoise populations. SDT populations can typically withstand any one of these impacts alone, but are vulnerable to the combined effects of multiple threats over the long-term. The December 14, 2010, 12-month finding may be downloaded in its entirety by visiting: http://www.fws.gov/southwest/es/arizona/Sonoran_Tort.htm.

Power, Wealth and The Mojave Desert Tortoise

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The conservation and recovery of the Mojave desert tortoise is about science and the application of scientific principles. Yet conservation and recovery depends on political and economic considerations. The science is easy; it is the politics that are hard. Add wealth to power and the challenge is evident. Even though the science behind The *Desert Tortoise Recovery Plan* identified "the destruction, degradation, and fragmentation of desert tortoise habitat" as one of the principal causes of the precipitous decline in tortoise numbers, wealth and power today are driving the siting of renewable energy projects on desert tortoise habitat. Thinking about public policy as it pertains to desert tortoises recovery should incorporate a political economy perspective.

Public policy is what government chooses to do or chooses not to do. As governments decide, they exercise power. The distribution of wealth determines who has the resources to influence decision makers, and economic considerations are central to what governments decide – decisions that may result in greater or lesser protection for tortoises. Two sets of decisions illustrate the value of linking the science of recovery to a political economy perspective.

First, the decisions by public agencies to site the Ivanpah Solar Electric Generating Station on the northeastern slopes of the Clark Mountains give priority to energy generation in the desert over and above the recovery of desert tortoises. The cultural context includes the view that the U.S. must shift from petroleum-based fuels given the threat of global warming, an acceptance of utility-scale power generation and long-distance transmission rather than distributed generation near load centers, and the notion that mitigation and relocation/translocation will conserve desert tortoise populations. State policies and federal subsidies promise benefits to specific economic interests and then transfer wealth from the public treasury to private corporations. Public officials and some environmentalists lobby for the power plant. Environmental organizations with a concern for species protection strive to influence the decision process, although most groups decline to contest agency decisions through the courts. Operating out of a different cultural context and with the power afforded by law, one conservation organization challenges the federal environmental review process.

Second, the decision to list the Mojave population as threatened under the Federal Endangered Species Act also illustrates the value of linking the science of recovery to a political economy perspective. Science documented the decline in desert tortoise numbers and the need to protect tortoises in their natural habitat, while power exercised in a different economy gained the listing of the species.

Independent Science Advice for the California Desert Renewable Energy Conservation Plan: Background, Recommendations, and Future Directions

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The California Desert Renewable Energy Conservation Plan (DRECP) is being developed to guide renewable energy developments in California's desert regions while contributing to the conservation and recovery of desert ecosystems and species. It will be a Habitat Conservation Plan (HCP) and a California Natural Communities Conservation Plan (NCCP). NCCPs must contribute to the conservation and recovery of natural ecological communities, including listed as well as unlisted species. The NCCP Act also requires an independent science advisory process to ensure that plan decisions are informed by the best available scientific information. I was asked by the DRECP agencies to lead the science advisory process, which convened a science workshop and presented recommendations to the DRECP agencies and stakeholders. I will briefly review the science advisory process, the advisors' primary recommendations, and some thoughts on future directions.

The DRECP science advisors included a dozen experts in desert ecology, wildlife biology, conservation biology, botany, hydrology, geology, and other fields pertinent to the conservation of desert species and natural communities. We reviewed a variety of background information and draft maps prepared by the DRECP agencies, met for two days to discuss recommendations, and drafted our recommendations into a report. Following scientific peer review and a public comment period the report was finalized in October 2010[1]. It provides recommendations on the scope of the plan and four broad sets of principles that the NCCP Act specifies scientists should address: principles for addressing data gaps and uncertainties, principles for reserve design, principles for conserving covered species and communities, and principles and a framework for adaptive management and monitoring.

Scope of the Plan—The advisors recommended subdividing the large planning area into ecologically relevant units to deal with the area's complex biogeography and the clustering and networking of renewable energy projects. We recommended that "take" permits for covered species should last no more than 30 years, and that key aspects of the plan be reviewed at least every 10 years. We recommended numerous additions, deletions and refinements to the draft covered species and communities lists and emphasized the need to map and protect (1) special biotic and geological features, (2) ecological and geological processes, and (3) broad ecological gradients.

Information Gaps and Uncertainties—We recommended that the plan seek additional scientific input and review throughout the process, rather than rely on a single science report, and that the plan be developed incrementally, in an adaptive management framework. The lack of adequate environmental base maps is a major information gap, especially the lack of comprehensive, accurate, high-resolution vegetation and special features maps. We urged transparency in all DRECP methods, decisions, and products, and recommended the use of

[1] http://www.energy.ca.gov/2010publications/DRECP-1000-2010-008/DRECP-1000-2010-008-F.PDF

spatially explicit models (e.g., species distribution and connectivity models) and objective decision support tools to help make planning decisions in the face of uncertainty.

Conservation Recommendations—Our overarching recommendation was, to the maximum extent possible, site all renewable energy developments on and adjacent to already disturbed lands, and avoid further fragmentation of desert habitats by energy developments and associated infrastructure. The siting, design, construction, and maintenance of all project features should minimize soil disturbance to the greatest extent possible, and energy developments should address such impacts as disruption of aeolian sand transport, surface and groundwater flows, and wildlife movement, as well as increases in dust pollution, subsidized predators, and weedy species.

In addition to careful siting of energy developments, we recommended that the plan design and implement a comprehensive, interconnected network of reserves, building on existing protected areas and taking advantage of existing science-based conservation, recovery, and management plans. The reserve network should capture broad, unfragmented environmental gradients that serve diverse species and processes and can help accommodate range shifts under climate change. Habitat restoration should not serve as full mitigation for project impacts, but may contribute to conservation goals if it follows sound scientific guidelines. We recommended against using species translocations and reintroductions as mitigation, because they are rarely successful and risk doing more harm than good. Translocations should be considered a last recourse and must be treated as experiments with long-term monitoring and management.

Adaptive Management and Monitoring—DRECP should develop a formal institutional structure for the adaptive management program that ensures effective feedback from monitoring and research studies to management and policy decisions. Planning and implementing an adaptive management and monitoring program should begin immediately, rather than waiting until other plan components are in place. Agencies and researchers must be granted access to proposed development areas before, during, and after development to establish monitoring baselines and facilitate before-after/control-impact (BACI) sampling designs. To be efficient and effective, monitoring should be designed to test specific hypotheses generated using conceptual and quantitative models of ecosystem processes. We also endorsed a variety of research studies, including studies of landscape genetic patterns, population demography, wildlife mortality at solar and wind developments, and the success of alternative mitigation actions.

The degree to which DRECP implements these recommendations waits to be seen.

Seed Removal Patterns in Burned and Unburned Mojave Desert Habitats: Implications for Revegetating Desert Tortoise Habitat

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In desert ecosystems, selective foraging by seed consumers affects distributions of soil seed banks and consequently plant community composition. However, in burned habitats where direct seeding is often used to attempt to revegetate habitats for purposes such as restoring tortoise habitat, the roles of seed harvesters have not been assessed. We evaluated patterns of seed removal of nine seed species over 12 months in burned and unburned *Larrea tridentata* scrub in the Mojave Desert, Nevada, USA. Seed removal patterns were influenced by season, habitat condition, and seed species. Proportion of seed removed was highest during spring and summer, 13 and 18 % of offered seeds were removed, respectively. Rodents removed 45 % of large seeds of *Coleogyne ramosissima* in burned and 18 % in unburned habitats, and seed removal by ants were 7 and 19 % in burned and unburned habitats, respectively. Ants removed the greatest amount of small-seeded species, (*Penstemon bicolor*, *Encelia farinosa*, and *Sphaeralcea ambigua*) in unburned habitat. Seed removal imposes limitations on seed availability, particularly for large seeded-species as both rodents and ants preferred large seeds of *C. ramosissima*. Protecting seeds from seed consumers significantly increased *C. ramosissima* germination in unburned habitat, but seedling survival was higher in burned habitat. By selectively harvesting preferred seeds granivorous rodents and ants may hamper reseeding efforts intended to restore soil seed banks depleted by wildfires. Successful seeding projects will require seed protection from granivory pressure, and seed selection and season for application need to be considered when planning seeding projects.

Translocation in Squamate Reptiles: Theoretical Issues and Current Empiricism

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Translocation is a commonly utilized conservation method, primarily aimed at mitigation of human-animal conflict by removal of an individual and its release in suitable nearby habitat. Over the past two decades there have been a number of reviews of this method, from both theoretical and empirical perspectives. There has been considerable confusion surrounding the definition of translocation, and related terms (re-introduction; repatriation; relocation), in spite of

generally recognized differences among conservation biologists practicing reintroduction and those practicing translocation (Reinert, 1991; contra Germano and Bishop, 2008). After reviewing the semantic aspects of all forms of introductions, including translocation (i.e., the removal of a single, typically "nuisance" individual, and its subsequent release in historic habitat with a resident population of the target species), we present a simplified taxonomy of terms aligning both theory and practice in this domain of conservation biology (sensu Fischer and Lindenmayer, 2000). We then review recent examples of translocations with squamate reptiles, focusing on the Southwest region, and our own work with Gila Monsters (*Heloderma suspectum*) and Western Diamond-backed Rattlesnakes (*Crotalus atrox*). Consistent with the vast majority of translocations in which the fate of translocated individuals has been monitored, we conclude that this method has a low success rate when judged by effects on the individual, and by the mitigation of human-animal conflicts. This low success may not be unexpected when viewed in light of recent research on and syntheses of squamate physiology and behavior; we stress that vital natural history data concerning the population biology of the target species are critical but often missing. Factors influencing low success rates include but are not limited to: interplay of ectothermic physiology constraints and behavior; cues used in establishing home ranges; the importance of known foraging locations and refuges for use in thermoregulation, anti-predatory and social behavior; disease related issues; and food-chain dynamics surrounding the target species. These factors must be evaluated or anticipated along with possible impacts on population genetic structure, and in conjunction with clear identification of management goals, whenever translocation is considered as a conservation tool.

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The Voyaging Viper: Studies of the Spatial Ecology of Rattlesnakes

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Numerous studies have shown that male rattlesnakes have larger home ranges and make longer distance movements than female rattlesnakes. Such long movements may have important consequences for male snakes, including increased energy expenditure, mortality due to predation or road traffic, and frequency of interaction with humans. Management of nuisance rattlesnakes to prevent injury to humans and the snakes is a subject of great interest to land managers in areas with high snake densities. We have undertaken a series of studies to determine (1) the mechanisms responsible for the larger home range size and movement distances in male rattlesnakes, and (2) the effects of translocation as a management strategy on the behavior and stress physiology of male rattlesnakes. Male Northern Pacific Rattlesnakes (*Crotalus oreganus*), like other species, have larger home ranges and exhibit longer distance movements than females. This is especially true during the spring breeding season, when testosterone levels are elevated in males. However, elevation of testosterone levels via implantation of testosterone capsules did not increase the home range size or movement frequency of male snakes. In another study, snakes repeatedly experimentally translocated a short distance did not show differences from control snakes in baseline testosterone levels, baseline corticosterone (a stress hormone) levels, or testosterone or corticosterone levels after one hour of an acute stressor (being placed in a cloth bag for an hour). Whereas some snakes remained in the areas to which they were translocated, others moved back to their original home ranges. Both groups fed during the study, and there were no differences in body composition at the end of the study. This suggests that short-distance translocation, a strategy commonly recommended to land managers, does not negatively impact the energy balance, stress reactivity, or reproductive readiness of the snakes. Ongoing studies are examining the relationships among testosterone and corticosterone levels, home range size and movement distance, and the size and level of neurogenesis in brain regions associated with spatial navigation.

Translocation Research with Gopher Tortoises: Insight on Site Fidelity, Survivorship & Individual Reproductive Success

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Two-thirds of the world's turtle species are considered threatened. As exploitation and habitat loss continue to cause population declines and extirpations, translocations to suitable protected habitats will play an increasingly important role in turtle conservation. However, few translocation efforts have been thoroughly evaluated to determine their success. We present a framework for evaluating translocation success, using the gopher tortoise (*Gopherus polyphemus*) as a case study. This framework includes monitoring three processes that influence population stability – emigration, survivorship and reproduction. Experimental releases and two years of subsequent monitoring via radiotelemetry were conducted on the Savannah River Site, SC, to test the relative effectiveness of no penning, 9-month and 12-month penning treatments (Tuberville et al. 2005). Penning significantly increased site fidelity both in terms of reducing activity areas and reducing the proportion of animals dispersing. Long-term survivorship was investigated in a population of gopher tortoises established through multiple releases on St. Catherines Island (SCI), GA. Based on 12 years of mark-recapture data analyzed in program MARK, apparent survival of newly released tortoises was temporarily reduced, most likely as a result of permanent dispersal of some tortoises from the release area (Tuberville et al. 2008). However, apparent survival of translocated tortoises was consistently high once they became established as residents. Mating system was also investigated in the SCI translocated population by genetic sampling of 27 adult males, 34 adult females, and 121 offspring collected from 19 clutches during two field seasons (Tuberville et al. 2011). Paternity (and maternity, if not already known) was assigned based on genotypes at five microsatellite loci. Reproductive success varied among males, with larger males siring more offspring. Among successful sires, previously translocated and established males sired a disproportionate number of the offspring sampled, despite being significantly smaller in body size than more recently translocated males. These studies demonstrate that translocation can be a useful tool for managing gopher tortoise populations and also provide a comprehensive framework for evaluating translocation success in other species.

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STUDENT PAPER

Estimating wildfire potential in Gold Butte, NV using remote sensing and field survey techniques

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Landscape level wildfire prediction can be used to allocate wildfire resources and guide land management practices within desert tortoise habitats of the Mojave Desert. Wildfire prediction in arid habitats in the Southwestern United States is of specific concern because of the negative ecological impacts of fire on desert habitats and the current lack of accurate fire prediction tools for such areas. By measuring fuel loads within various vegetation types of the Mojave Desert and using remote sensing techniques to model those fuel loads, we examined the ability to predict previous fire occurrences and estimate future fire potential using satellite imagery of Normalized Difference Vegetation Index (NDVI) and Fuel Moisture Content (FMC) along with ignition potential data (lightning strikes and distance to roads), topographical data (elevation and aspect), and climate information (maximum and minimum temperatures). The satellite data was used to create a suite of potential fuel load models that were then evaluated and narrowed to two best fit models using AIC model selection. Of those two models, Model 2 had better R (0.35) and AIC (-366.5703) results than Model 1 (0.29 and -348.2616 respectively). However, Model 1 incorporated spring NDVI, elevation, maximum temperature, and aspect was chosen as the most defensible model in terms the ecological interactions driving fuel production. Model 1 was then used in conjunction with 2005 remote sensing and fire occurrence data to predict fire potential for that year. Fuel load Model 1 along with spring FMC at maximum temperature, lightning strikes, distance to roads, and perennial vegetation type were modeled and a Receiver Operating Characteristic (ROC) curve was used to evaluate the agreement between model predictions and actual fire occurrence. The ROC evaluation rendered an Area Under the Curve value of 0.90 indicating accurate prediction of fire occurrence for 2005. This study provides evidence that remote sensing techniques can be used in combination with field surveys to accurately predict wildfire potential in Mojave Desert habitats.

Do Sidewinder Rattlesnakes (*Crotalus cerastes*) Cease Feeding During the Breeding Season?

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Reproduction and feeding are two essential organismal activities. Two contrasting feeding strategies used by animals to acquire and provide energy for reproduction are income breeding and capital breeding. Income breeders feed throughout the reproductive season, and use some of the energy gained to fuel reproduction, whereas capital breeders rely on energy gained and stored prior to the reproductive season to support their breeding activities. Seasonal aphagia (a lack of feeding) can occur if reproduction and feeding occasionally impose conflicting demands on an individual, such that one activity takes precedence over the other. We tested the hypothesis that female and male *Crotalus cerastes* rattlesnakes (Sidewinders) exhibit a feeding pattern characteristic of capital breeders, and thus experience seasonal aphagia during the reproductive season. We examined stomach contents of preserved specimens to assess variation in the feeding rates of *C. cerastes*. Female Sidewinders continued to feed throughout the early vitellogenic stage of the reproductive cycle, as characteristic of income breeders. However, reproductive females were in significantly better body condition than non-reproductive females, and exhibited a tendency to reduce or cease feeding during the later stage of their reproductive cycle (gestation), as expected for capital breeders. Accordingly, *C. cerastes* females exhibit a mixed reproductive strategy that combined aspects of income and capital breeding. On the other hand, *C. cerastes* males displayed a trend to feed more frequently during the reproductive season, suggesting that they are income breeders. The discovery of this intersexual variation in strategies of energy acquisition in *C. cerastes* underscores the importance of descriptive ecological studies to elucidate distinctive patterns of life history evolution.

Survival Rates of Sonoran Desert Tortoises in Arizona

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Evaluating whether strategies for rare species are sufficient to meet recovery objectives should be based on data gathered reliably over broad geographic scales and long time horizons. The best data available to evaluate trends in Sonoran desert tortoise populations are from capture-recapture surveys performed on permanent plots established throughout the range of Sonoran desert tortoises in Arizona. Between 1987 and 2008, 15 plots (1.3-3.9 km^2) were surveyed ≥4 times, with >1150 adult tortoises of known sex captured at least once. We used encounters of these individuals to evaluate factors affecting apparent survival of tortoises in Arizona with Cormack-Jolly-Seber models in Program MARK. We created a set of candidate models to evaluate whether survival of adult tortoises varied geographically, temporally, in response to variation in rainfall, drought severity, or perennial plant cover, or between sexes. Overall, annual survival of adults was 0.92 (SE = 0.004), but varied considerably among geographic locations, with tortoises from Maricopa County having relatively high annual survival rates (range = 0.95-0.96) and tortoises from sites in extreme eastern and western Arizona having relatively lower survival (0.86 and 0.87, respectively). Survival was similar for females (0.924) and males (0.918). There was strong evidence of a relationship between survival of adult tortoises and Palmer's Drought Severity Index, indicating that when drought severity was high, survival of tortoises was reduced. Although mechanisms by which drought affects survival of tortoises are unclear, drought has a clear influence on survival rates of Sonoran desert tortoises. After accounting for effects of drought, there was a slight positive trend in annual survival of tortoises in Arizona during the study period.