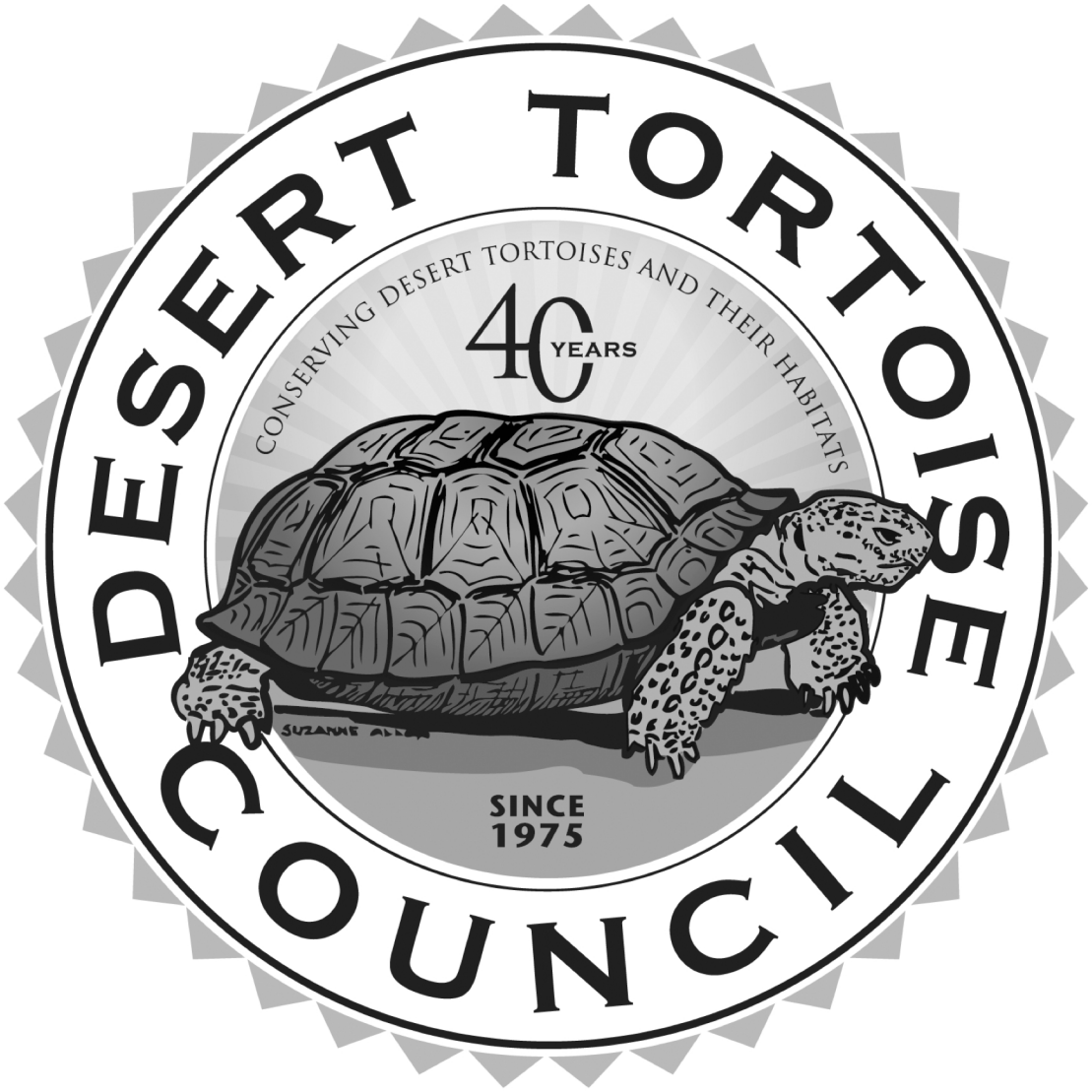

ABSTRACTS

40th Annual Meeting and Symposium

Sam's Town Hotel and Gambling Hall, Las Vegas, NV

February 20–23, 2015

FORTIETH ANNUAL MEETING AND SYMPOSIUM
THE DESERT TORTOISE COUNCIL

Sam's Town Hotel and Casino, Las Vegas, NV
February 20–22, 2015

ABSTRACTS OF PAPERS AND POSTERS

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

Synthesizing Best Management Practices for Habitat of Agassiz's Desert Tortoise

Scott R. Abella[1] *and Kristin H. Berry*[2]
[1]Natural Resource Conservation LLC, Boulder City, NV 89005
Email: abellaNRC@gmail.com, Phone: 928-600-4625
[2]U.S. Geological Survey, Western Ecological Research Center, 21803 Cactus Avenue, Suite F, Riverside, CA 92518

Populations of Agassiz's desert tortoise (*Gopherus agassizii*) have continued to decline since federal listing of the species as threatened in 1994. Part of the population decline can be attributed to destruction and deterioration of habitat. To assist in recovery efforts, we have synthesized published literature to identify the most effective techniques for restoring or enhancing habitat features of the desert tortoise in the Mojave Desert. Specifically, we identify the most effective management interventions reported for: 1) re-establishing perennial plants as cover sites following disturbances such as fire and land clearing that remove perennial plant cover; 2) increasing the quantity and quality of forage, especially annual plants; 3) managing grazing of both domestic livestock and non-native feral animals; 4) decommissioning and managing roads, utility corridors, and other linear disturbances; 5) reducing hazardous fuels and fire risk through management of non-native annual plants; and 6) accommodating climate change, including potential shifts in plant communities that may influence distribution of desert tortoises.

STUDENT PAPER

Evaluating Disease Risk from a Population Perspective: Does Translocation Change Tortoise Contact Networks into Pathogen Highways?

Christina M. Aiello[1,2,3], Kenneth E. Nussear[4], Andrew D. Walde[5], Todd C. Esque[1], Patrick G. Emblidge[3], Pratha Sah[6], Shweta Bansal[6,7], and Peter J. Hudson[3]
[1]Western Ecological Research Center, U.S. Geological Survey, Henderson, NV
[2]Email: caiello@usgs.gov
[3]Center for Infectious Disease Dynamics, Pennsylvania State University, University Park, PA
[4]Department of Geography, University of Nevada, Reno, NV
[5]Walde Research & Environmental Consulting, Atascadero, CA
[6]Department of Biology, Georgetown University, Washington, DC
[7]Fogarty International Center, National Institutes of Health, Bethesda, MD

Wildlife managers may consider translocation as a means of conserving a local population, but if augmentation disrupts existing disease dynamics it may initiate an outbreak that would effectively offset any advantages the translocation may have achieved. Contact networks – the pattern of interaction between individuals in a population – can effectively describe the path a disease-causing parasite may travel through a host population and thus reflect outbreak risk. Certain contact network attributes contribute to faster and more widespread pathogen transmission but analyses of these spatial and social population characteristics are not often considered in translocation risk assessments. We used data from the 2008 Fort Irwin desert tortoise translocation project to detect changes in population connectivity that may influence pathogen transmission. We compared resident contact networks inferred from spatial data at control and translocation plots before and after the release of tortoises and ran infection simulations through these temporally dynamic networks. Our analyses suggest increased outbreak risk following translocation due to density and dispersal-driven changes in contact frequency and network structure. We discuss current and future work to determine whether spatially inferred networks reflect true contact patterns in tortoise populations, to what extent translocated tortoises actually interact with residents at the release site, and which social interactions are most important for the transmission of pathogens causing upper respiratory tract disease.

Comparison of Arizona Department of Transportation Construction Revegetation Treatments to Meet Stormwater Permit Requirements for Final Stabilization

Julie Alpert, Kingman District Environmental Coordinator
Arizona Department of Transportation, 3664 E. Andy Devine, Kingman, AZ 86401
Phone: 928-525-4660 Email: jalpert@azdot.gov

Arizona Department of Transportation (ADOT) is required to achieve "final stabilization" on construction projects pursuant to ADOT's Statewide Stormwater Permit (Permit). ADOT's goals for achieving post-construction success include: 1) soil stabilization and erosion control, through the use of crown ditches, cut slope warping and rounding, rock lined slope intercepts and channels, deep ripping and tilling, benching or mini-benching, blanketing, native seeding, native

plant salvage and relocation, and other structural control measures; and 2) re-creating the natural vegetation and aesthetics of the adjacent landscape within the right-of-way. One of the most commonly utilized ADOT methods for stabilizing soils on construction sites is to seed with commercial native seed mix that utilizes standard ADOT specifications. Pursuant to ADOT's Permit, 70% of the existing background native vegetation cover, to include rock cover, must be established in order to achieve final stabilization.

A total of six construction project locations have been used for monitoring and measuring vegetative cover success within the Mohave and Sonoran deserts located within the Kingman District. These locations vary in elevation and occur on both interstate and state routes. Monitoring data has been collected over a 1 to 6 year period. Various treatment scenarios at these locations include combinations of seeding on subgrade soils, use of topsoil and seeding, and seeding with locally collected native seeds on both subgrade soils and topsoil. Preliminary results are in favor of the use of topsoil with locally collected native seeds to achieve final stabilization cover in the shortest period of time post-seeding. A cost-benefit analysis will be completed to determine the overall efficacy of each treatment as well as the potential for cost-savings by reducing the amount of staff time required, under ADOT's Permit, to conduct post-construction site stormwater inspections.

2014 Translocations from the Desert Tortoise Conservation Center

Roy C. Averill-Murray
Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, NV 89502
Email: roy_averill-murray@fws.gov

To use desert tortoises for recovery purposes prior to the closure of the Desert Tortoise Conservation Center (DTCC) at the end of 2014, the U.S. Fish and Wildlife Service worked with San Diego Zoo Global (SDZG) and other partners to translocate approximately 900 tortoises to five recipient sites. Between 2013 and 2014, we released 369 adult (>180 mm carapace length) and 381 juvenile (<180 mm) tortoises to the 239-km2 Greater Trout Canyon translocation site, an increase of 1.5 adults/km2. As part of ongoing research by the U.S. Geological Survey (USGS) into the effects of burned habitat on desert tortoises, we increased the density of adults in the 127-km2 Hidden Valley site by a modest amount to 0.3/km2; this 2014 release involved 39 adults and 20 juveniles. We released 185 adults and 125 juveniles to a 185-km2 site (+1.0 adults/km2) in southern Eldorado Valley and 98 adults to the 185-km2 Boulder City Conservation Easement (BCCE) site in northern Eldorado Valley; this resulted in a maximum increase in density of 0.9 adults/km2 within currently occupied soil types in the BCCE. Finally, we released 87 adult and 100 juvenile tortoises to the approximately 100-km2 Large-Scale Translocation Site, where >10,000 tortoises had previously been released from the DTCC since 1997. The presentation will place each project within the context of current translocation guidance relative to recipient-site density. Post-translocation monitoring is ongoing at the various sites in cooperation with or led by SDZG, the USGS, Clark County, and the Great Basin Institute.

The Reproductive Ecology of Female Sonoran Desert Tortoises (*Gopherus morafkai*)

Roy C. Averill-Murray[*1,3], *Brian T. Henen*[2,4], and *Terry E. Christopher*[2,5]
[1]Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, USA
[2]Smithsonian Institution, Dept.of Zoological Research, National Zoological Park, Washington, D.C., USA
Present Addresses:
[3]Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, NV 89502, USA
E-mail: Roy_Averill-Murray@fws.gov
[4]Natural Resources and Environmental Affairs Division, Marine Air Ground Task Force Training Command, MCAGCC, Twentynine Palms, CA, USA
[5]Great Basin Institute, Reno, NV, USA

We studied reproductive patterns in female Sonoran Desert Tortoises (*Gopherus morafkai*) for 10 years to evaluate reproductive variation and environmental factors that influence reproduction. Vitellogenesis occurred during the spring after emergence from hibernation, but was highly variable among individuals; egg production also varied considerably among individuals. Many individuals stopped vitellogenesis and failed to produce eggs each year, while many other females rapidly developed follicles and shelled eggs during a short period in the same spring. The smallest egg-producing female had a carapace length of 220mm, and no female produced more than one clutch per year. Compared to small females, large females were more likely to reproduce in a given year and produced larger eggs than did small females, but body size did not affect clutch size (3.8 to 5.8 eggs per year). More females reproduced following wetter than drier winters, and the earlier that females emerged from brumation, the more likely they were to produce eggs. Early-emerging females also produced larger eggs than did females that emerged later. Other than a slight negative correlation between spring emergence date and brumation temperature, winter temperatures did not affect reproductive output. These reproductive traits contribute toward a life history that more closely resembles an income-breeder than the more capital-breeding strategy of the closely-related Mohave Desert Tortoise (*Gopherus agassizii*). These differences in life history may hold different implications for each species in the face of climate change, but both may be living too close to the edge of their physiological tolerances to survive climate change without improved efforts to mitigate multiple anthropogenic threats.

U.S. Fish and Wildlife Service Update on the Desert Tortoise Recovery Activities

Roy C. Averill-Murray
Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, NV 89502
Email: roy_averill-murray@fws.gov

Major activities of the Desert Tortoise Recovery office in 2014 included 1) coordinating Recovery Implementation Teams (RITs) and 2) facilitating the closure of the Desert Tortoise Conservation Center (DTCC). 1) The Desert Tortoise Management Oversight Group endorsed the RITs' recovery action plans (prioritized, regional action plans tiered from the revised recovery plan, available at www.fws.gov/nevada/desert_tortoise/dtro/ dtro_rits.html), and we worked with the RITs to further develop specific, "shovel-ready" project concepts to implement high-priority recovery actions. 2) We worked with San Diego Zoo Global (SDZG) to process and

appropriately place over 1100 tortoises residing at the DTCC at the beginning of the year. After multiple health evaluations, approximately 900 of these were translocated to one of five release sites (the Large-Scale Translocation Site, greater Trout Canyon, Hidden Valley, Eldorado Valley, and the Boulder City Conservation Easement). Post-translocation monitoring is ongoing at the various sites in cooperation with or led by SDZG, the U.S. Geological Survey, Clark County, and the Great Basin Institute. We are working with other cooperators to help ensure important functions, such as training and research, previously performed at the DTCC are continued through other venues.

STUDENT PAPER

Ingestion of Nonvegetation Food Items by Juvenile Sonoran Desert Tortoises in Central Arizona

Allen K. Bartoli[1,2], *Audrey K. Owens*[2], *Emily R. Grabowsky*[2], *and Cristina A. Jones*[2]
[1]Department of Applied Sciences and Mathematics, Arizona State University, Polytechnic Campus, 6073 S. Backus Mall, MC 2580, Mesa, AZ 85212, USA; E-mail: akbartol@asu.edu
[2]Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, 85086, USA

Sonoran desert tortoises (*Gopherus morafkai*) are known to consume a variety of nonvegetation food items, but the physiological importance of this behavior is unknown. The intentional ingestion of nonvegetation food items has been documented in Sonoran desert tortoises, primarily in adults; the role of this behavior in the ecology of juveniles of the species is unexplained. We used radio-telemetry to study juvenile Sonoran desert tortoise natural history in the Mazatzal Mountains, Maricopa County, at a site characterized as Arizona Upland paloverde-mixed cacti series with an elevation between 550–850m. We equipped 15 juvenile desert tortoises, ranging in size from 124–175mm midline carapace length, with radio-transmitters and tracked them at least once a week during the active season and periodically during winter dormancy from 2010–14. We present observations of juvenile Sonoran desert tortoise ingestion of nonvegetation food items including bones, rocks, soil, and feces. We also present results of micro and macronutrient content of soil samples from sites at which juveniles consumed soil, compared with soil samples taken from random locations within the study area. Given the lack of information on juvenile Sonoran desert tortoises these data may be valuable in guiding habitat conservation of the species and understanding the role of nonvegetation food items in tortoise diets in the Sonoran Desert of Arizona.

Desert Tortoise: Time is Of the Essence for Protection and Recovery

Lisa Belenky[1] Senior Attorney and Ileene Anderson[2], Public Lands Desert Director/Senior Scientist
[1]Center for Biological Diversity, 315 California Street, #600, San Francisco, CA 94104
Phone: 415-436-9682 Email: lbelenky@biologicaldiversity.org
[2]Center for Biological Diversity, 8033 Sunset Blvd., #447, Los Angeles, CA 90046
Phone: 323-654-5943 Email: ianderson@biologicaldiversity.org

The Center for Biological Diversity continues our conservation and recovery campaign for desert tortoise and its habitat in California, Nevada, Arizona, and Utah through science-based advocacy, participation in administrative processes, public information and litigation. For over 20 years, the Center has consistently supported increased protections for the desert tortoise as the path to desperately needed species recovery. Our desert tortoise protection campaign is focused on protecting habitat and animals from a variety of threats. Some of the challenges the Center focused on in the past year include: large-scale renewable energy projects; the development of the Desert Renewable Energy Conservation Plan (DRECP) in California and its affect on existing conservation areas and the most at-risk recovery unit for the desert tortoise in the West Mojave; limiting ORV impacts in DWMAs and other habitat from both authorized and unauthorized use; implementation of permanent grazing retirements in CDCA under new statutory authority 43 USCS §1781a; challenging nearly two decades of cattle trespass in Gold Butte, Nevada; translocation of over 900 tortoises from the DTCC into occupied habitat in 5 areas in Nevada in anticipation of the San Diego Zoo contract ending in December 2014; mining issues (including the proposed mining withdrawal on Coolgardie Mesa and proposed projects such as Dragonfly Placer, La Pozz, and Bronco); protecting desert tortoise critical habitat from oil and gas leasing proposals in Lincoln County Nevada and opposing fracking; the ongoing legal challenge to the new ISDRA RAMP (Algodones Dunes); the Las Vegas RMP revisions; Clark County's proposed HCP revisions; and long-delayed implementation of the revised Desert Tortoise Recovery Plan through the Recovery Implementation Teams. We are also continuing our work to protect other species that share habitat with the desert tortoise including flat-tailed horned lizard (FTHL) which we petitioned to list under the California ESA. Despite the overall bleak picture of decreasing numbers and on-going habitat losses for the desert tortoise, we remain hopeful that our efforts will safeguard existing conservation efforts and may result in increased conservation for the desert tortoise in the long run.

Blowin' In The Wind

Ron Berger, Desert Tortoise Preserve Committee President
Desert Tortoise Preserve Committee, 4067 Mission Inn Avenue, Riverside, CA 92501
Phone: (951) 683-3872 Website: www.tortoise-tracks.org

The Desert Tortoise Preserve Committee (DTPC) is a non-profit organization established in 1974 to promote the welfare of the desert tortoise (*Gopherus agassizii*) in the wild through land acquisition and management, scientific research, and educational outreach. We currently own and manage over 7,000 acres of habitat for the desert tortoise and other sensitive species in the Mojave and Colorado deserts. In collaboration with the BLM and other state and federal agencies, the DTPC helped establish the Desert Tortoise Research Natural Area (DTRNA) in

Kern County, California and to this day, we help manage the DTRNA under a cooperative agreement with the BLM's Ridgecrest field office. We have carefully studied the Draft DRECP. Our review determined that not only was the DTRNA not considered to have any existing legal conservation status, but that of six action alternatives presented, all but one contained Development Focus Areas that directly abutted on, overlapped with, or encompassed most of the DTRNA. Each and every concern that we raised regarding development on and around the DTRNA was ignored in its entirety. Two scientific surveys conducted in 2011 and 2012 show that there is six times the density of tortoises found within the DTRNA as on adjacent critical habitat. In addition, if we look solely at the densities of adult breeding tortoises we find that there are 3 to 5 times as many at DTRNA as can be found even at USFWS's critical habitats in California. We are requesting permanent legal conservation status for the DTRNA, protecting it from vehicle use, mining, grazing, leasing for oil and gas, renewable energy, and any other use! The DRECP disregards conservation history and conservation status of the DTRNA, contradicting existing management plans and 40 years of commitments by federal and state agencies. Please help protect the DTRNA.

The Fence Experiment at the Desert Tortoise Research Natural Area Interpretive Center: An Evaluation after 33 Years

Kristin H. Berry[1], Tim Shields[2], Julie Yee[3], William Perry[3]:
U.S. Geological Survey, [1]Riverside and [3]Dixon, CA; [2]Haines, AK

In 1978, Kristin Berry, while working at the U.S. Bureau of Land Management, had the opportunity to design and initiate a long-term experiment on the efficacy of protective, permeable fencing for the desert tortoise (*Gopherus agassizii*). The fence was to be constructed in 1979 along the boundary of the Desert Tortoise Research Natural Area (DTRNA), western Mojave Desert, California. The purpose was to protect tortoises and their habitat from sheep grazing and recreational vehicles. The 7.77 km^2 plot was centered on the interpretive kiosk, outhouse, and parking lot and had two components, 4.53 km^2 inside the fence and 3.24 km^2 outside the fence. Between 1979 and 2012, the plot was surveyed for tortoises in spring of 7 years using mark-recapture techniques; in addition to live tortoises, data were collected on shell-skeletal remains, other signs of tortoises, perennial vegetation, predators, and evidence of human use. In 1979, the baseline year, 590 tortoises were registered; no significant differences in density existed inside vs. outside the fence. By 1985 the population had declined in numbers and density, with significant differences between inside and outside the fence. Declines continued over the years both inside and outside the fence, reaching the lowest point in 2002 with a count of 47 total individuals. In 2012, the last survey, total counts were up (N = 73), and densities were significantly higher inside than outside the fence (>3 times). Densities outside the fence closely approximated estimates developed by the U.S. Fish and Wildlife Service using distance sampling in nearby critical habitat. We explore changes in distribution and other demographic attributes of the tortoises through the decades, as well as potential factors affecting recovery at the Desert Tortoise Research Natural Area.

Social Behavior of Desert Tortoise: A Request for More Studies.

Bayard Brattstrom[1], Professor of Zoology, Retired.
[1]Horned Lizard Ranch, P.O. Box 166, Wikieup, AZ 85360
Phone: 928-716-4574 Email: bayard@hughes.net

Many people have studied and published on the Desert Tortoise, *Gopherus agassizi.* Most of these studies have been on tortoise ecology, conservation, population and reproductive dynamics. Only a few have been done on tortoise physiology and social behavior. The important studies that have been done suggest that there is so much more to do. Based on the work of two of my students, I will present some observations and suggestions for further studies on tortoise behavior.

Egg Oiling to Reduce Nest Predation by Ravens: Preliminary Findings from Alcatraz Island

Brianne Brussee, Wildlife Biologist; Peter S. Coates, Research Wildlife Biologist; Michael L. Casazza, Research Wildlife Biologist
U.S Geological Survey, Western Ecological Research Center, Dixon Field Station, 800 Business Park Drive Suite D, Dixon, CA 95620
Email: bbrussee@usgs.gov, pcoates@usgs.gov, mike_casazza@usgs.gov

Populations of Common Ravens (*Corvus corax*), an effective predator on eggs of many species, have increased substantially throughout the coastal lands of California. Raven predation appears to be an important factor limiting Black-crowned Night-Heron (hereafter night-heron, *Nycticorax nycticorax*) reproduction on Alcatraz Island. Night-herons have nested on Alcatraz Island, California, since the mid-1980s, and they have been monitored each year since 1990. The arrival of a breeding pair of ravens and their nesting on Alcatraz Island during the mid-1990s coincided with a precipitous decline in night-heron nest survival. Based on video-monitoring, we identified ravens as the dominant predator and initiated a longitudinal study to evaluate the effectiveness of oiling raven eggs to prevent feeding of raven offspring and, thereby, reduce raven predation rates. Video-monitoring was used to unambiguously identify causes of nest failure and evaluate the effects of raven predation during years of egg oiling. Preliminary results indicate that during years where ravens had a successful nest (2010 and 2013), nest predation on eggs was substantially higher (24.9%) than years when ravens were unsuccessful (6.5%). We also observed greater predation of night-heron chicks up to 21 days of age when ravens nests were successful. To date, these findings are beneficial to help guide viable management options for night-herons and other nesting species on Alcatraz Island. These data may provide insight to other areas with similar environmental conditions and perhaps at larger spatial scales where ravens have contributed to population declines of more sensitive species. This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science and should not be cited as conclusive.

Survivorship and Growth of Predator-Protected vs. Free-Ranging Released Juvenile Desert Tortoises in the Mojave National Preserve

Kurt A. Buhlmann[1], Tracey D. Tuberville[1], Melia G. Nafus[2], Mark Peaden[2], Lindsay Chiquoine[2], Jacob Daly[1], Valerie Johnson[2], and Brian D. Todd[2]

[1]University of Georgia, Savannah River Ecology Laboratory, Building 737-A, Drawer E, Aiken, South Carolina 29802 Email: kbuhlmann@earthlink.net

[2]University of California-Davis, Department of Wildlife, Fish and Conservation Biology, One Shields Avenue, 1077 Academic Surge, Davis, California 95616

Beginning in 2011, we initiated a long-term head-starting study at the Ivanpah Desert Tortoise Research Facility (IDTRF) in the Mojave National Preserve (MNP). Our goals include evaluating methodologies for head-starting, as well as determining survivorship and growth of juvenile tortoises reared in predator-proof outdoor enclosures. We are currently rearing cohorts from three years, 2011-2013. We have released and radio-tracked a small sample of hatchlings (< 1 mo old), as well as yearlings from the protected pens, in order to obtain some baseline estimates of survival and growth of these ages classes in two different habitats of the MNP in which we are working. We obtained eggs from radio-tracked females that create their own nests in outdoor pens at IDTRF; the females are then returned to their last field location. Hatchlings have been maintained in low (LR) and high (HR) supplemental rain treatments. First year survivorship of cohorts in outdoor pens has ranged from 84% (2013) to 100% (2011). Survivorship of the 2011 cohort in outdoor pens after three years is 96%. Mean size of fresh hatchlings at time of release in the pens for all three cohorts was 44.7 mm MCL. Mean MCL of the 2011 cohort after 3 years is 76.7 mm; the LR individuals are slightly smaller (74.4 mm) than their HR siblings (79.4 mm). Overall survivorship (Year 1) of sub-samples from these cohorts released in the field is less than those in the enclosures and ranged from 33.4 - 55.6 %. Variations among year, season (Fall vs Spring), and habitats (creosote scrub and yucca woodland) will be discussed further, although small samples sizes limit overall conclusions at this time. Research continues to evaluate head-starting methodologies, as well as survivorship, growth and movements of juveniles released and monitored in the field.

Clark County Multiple Species Habitat Conservation Plan Update

Scott Cambrin, Clark County Desert Conservation Program
500 S. Grand Central Parkway, Las Vegas, NV 89155

The Clark County Desert Conservation Program (DCP) continues to administer the Multiple Species Habitat Conservation Plan (MSHCP) on behalf of the Cities, Clark County and Nevada Department of Transportation as mitigation for an Endangered Species Act section 10 incidental take permit for desert tortoise and 77 other species of plants and animals. The DCP has collected mitigation fees for more than 4761 acres of take during the period of January to November 2014, leaving 55,875 acres on the permit. The 2015-2017 Implementation Plan and Budget was approved for $8,206,407. Highlights of the past year include completed second year of a desert tortoise occupancy monitoring pilot project, worked in coordination with the Fish and Wildlife Service to preform pre-translocation monitoring at three different locations, began a

post-translocation telemetry project on the Boulder City Conservation Easement, and initiated Phase 2 restoration at sites in the Boulder City Conservation Easement.

An Adaptive Management Solution: An Example for Greater Sage-grouse in Nevada

[1]Michael L. Casazza, Research Wildlife Biologist; [1]Peter S. Coates, Research Wildlife Biologist; [2]Lara Niell

[1]U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, Dixon, CA

Email: mike_casazza@usgs.gov, pcoates@usgs.gov

[2]Sagebrush Ecosystem Program, Carson City, Nevada

The common raven (*Corvus corax*) has been identified as the most frequent nest predator of greater sage-grouse (*Centrocercus urophasianus*) in the Great Basin. Raven populations have increased over 200 percent from 1992 to 2012 within the Great Basin. Subsidized food sources and landscape alterations increase raven population numbers. Raven abundance is often tied to habitat quality, particularly at the interface of recently burned areas and unburned habitat. Raven control has been shown to be an effective, short-term, management option during the early nesting season when ravens are the limiting factor affecting nest success, although long-term effects at the population level are still poorly understood. Given that ravens are associated with anthropogenic subsidies at relatively large spatial scales, localized lethal efforts are not likely to be efficient in reducing state-wide populations. Thus, effective raven management could benefit from efforts to reduce food, water, and nesting resource subsidies. USGS is working with the state of Nevada to inform this issue and provide a science-based approach for a recently proposed multi-pronged adaptive management strategy. First, areas will be identified where ravens are likely to influence sage-grouse populations (e.g., high raven abundance in proximity to sage-grouse leks). Then, focused research and scientific investigations will help identify possible actions that may be most promising for the amelioration of effects of raven predation on sage-grouse nests. Potential management actions include: (1) reduction of anthropogenic subsidies to ravens such as food sources (e.g., roadkill, landfills) and nesting substrates such as power lines; (2) improvement to habitat integrity by increasing visual cover to reduce detection by ravens and reducing habitat fragmentation to help limit preferred raven habitat features; and (3) targeted predator control based on detailed monitoring. Using a science-based approach, this adaptive framework can be used to inform management options aimed at minimizing the impacts of ravens on greater sage-grouse populations throughout Nevada. This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science and should not be cited as conclusive.

Inhabiting the West: Range Expansion and Population Growth of Common Ravens

Peter S. Coates, Research Wildlife Biologist; Kristy Howe, Wildlife Biologist; and Michael L. Casazza , Research Wildlife Biologist
[1] U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station,
800 Business Park Drive, Suite D, Dixon, CA 95620
Email: pcoates@usgs.org; khowe@usgs.org; mcasazza@usgs.org

Common raven (*Corvus corax*) populations in the western United States have dramatically increased over the last 4 decades. As an opportunistic omnivore that relies on resources heavily subsidized by humans, ravens have expanded their range into areas where they were historically absent. We conducted a longitudinal quantitative assessment using Breeding Bird Survey data collected over 40 years to quantify and illustrate range expansion and estimate rate of population change (λ) across multiple temporal and spatial scales within the western United States and Canada. We identify specific areas that have experienced the greatest increase in λ, as well as identify newly inhabited areas. Lastly, we provide insight into environmental and anthropogenic factors that influence variation in raven numbers and occupancy at relatively large spatial scales. This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science and should not be cited as conclusive.

Ravens and Nesting Sage-Grouse: an Alarming Interaction

Peter S. Coates[1], Research Wildlife Biologist; David J. Delehanty[2], Professor of Biology; and Michael L. Casazza [1], Research Wildlife Biologist
[1] U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, 800
Business Park Drive, Suite D, Dixon, CA 95620
Email: pcoates@usgs.org; mcasazza@usgs.org
[2] Idaho State University, Department of Biological Sciences, Pocatello, ID 83209
Email: deledavi@isu.edu

Common raven (*Corvus corax*) abundance has increased drastically within sagebrush ecosystems in the American West, which in turn has increased the likelihood of interactions between ravens and nesting greater sage-grouse (*Centrocercus urophasianus*). Here, we present a synthesis of recent studies describing direct and indirect factors that influence predation of sage-grouse nests by ravens. Highlights of this research include: 1) common ravens are the most frequent predator of sage-grouse nests as identified by multiple studies employing nest video-monitoring, 2) sage-grouse nest survival is lower in areas of reduced concealment and increased raven numbers, 3) variation in incubation patterns and nest site selection is influenced by common ravens, 4) sage-grouse nests initiated earlier in breeding season are more susceptible to predation by ravens, and 5) preliminary analyses indicate a significant positive relationship between sage-grouse nest survival and increased distance to power lines, a resource commonly used by ravens for nesting and perching. Within nesting habitat of sage-grouse, factors that contribute to the expansion of ravens may present an ongoing challenge for greater sage-grouse conservation and management. This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science and should not be cited as conclusive.

Challenges of Managing a Snowy Plover Population in Association with an Abundant Corvid

Mark A. Colwell, Wildlife Professor; Matt Lau, Master's Candidate in Wildlife
Wildlife Department, Humboldt State University, 1 Harpst Street, Arcata, CA 95521
E-mail Mark Colwell: mac3@humboldt.edu, E-mail Matt Lau: mjl43@humboldt.edu

Expanding populations of the Common Raven (*Corvus corax*) have created conservation challenges for several species of wildlife in western North America, including the Snowy Plover (*Charadrius nivosus*), which is listed as threatened under the Endangered Species Act. In coastal northern California, the plover population has varied three-fold (19-65 breeding adults) over 14 years of intensive monitoring. In most years, per capita reproductive success is well below that necessary to sustain the population. Direct and indirect evidence strongly links poor plover reproductive success to ravens. For example, ravens vary in abundance across sites by an order of magnitude and daily predation rates of plover nests correlated positively with corvid abundance. Video camera evidence (from the site where most plovers now breed and highest corvid densities occur) shows that 70% of failed nests were depredated by ravens. Variation in raven abundance across sites correlated negatively with coverage of open water (e.g., bay) and forested habitats; raven abundance correlated positively with high human recreational activity and low-intensity urban area. A variety of non-lethal methods (e.g., effigies and scare tactics, nest exclosures, habitat restoration) have done little to alleviate the problem of low plover reproductive success in association with high corvid activity.

Tortoise Group: A 34-year history

James Cornall[1], Executive Director, and Kathy Utiger[2], Chair
[1]Tortoise Group, Box 33866, Las Vegas, NV 89133
Phone: 702-728-8453 Email: jimcornall@tortoisegroup.org
[2]Tortoise Group, Box 33866, Las Vegas, NV 89133
Phone: 702-804-0472 Email: kathyutiger@tortoisegroup.org

Tortoise Group (TG) was formed in 1981 by five women to arrange adoption of tortoises, organize education programs on conservation and tortoise care, and convince Nevada Department of Wildlife (NDOW) staff to work together to change state law to allow existing captives to be kept legally. TG began publishing newsletters and holding meetings, and in 1982 incorporated as a 501 (c)(3) non-profit organization. From 1982 to 1986, TG picked up and housed an average of 227 tortoises per year. After the Emergency Federal Listing of the Mojave Desert Tortoise (*Gopherus agassizii*) as Endangered in August 1989, TG joined other stakeholders in creating a Habitat Management Plan for the Desert Tortoise in Clark County. Construction started on the Desert Tortoise Conservation Center (DTCC) in Las Vegas where, in 1992, TG was hired to care for the tortoises. Until the DTCC became functional, TG helped prepare more than 500 tortoises for transport to Reno for adoption. TG suggested most of the protocol on handling collected tortoises in the first Habitat Conservation Plan. In 2010, as a member of the Pet Desert Tortoise Working Group, TG helped the struggle to find solutions to the problem of backyard breeding in southern Nevada. TG has expanded over the years adding

staff, an online store and a comprehensive website. Recently, TG made a shift to emphasize adoption, increasing its program to cover all of Nevada. TG is working with the US Fish & Wildlife Service on issues including hatchlings and fostering, and assisted with the first sterilization clinic in Las Vegas in August 2014.

Update for the St. George Field Office, BLM Utah

Tim Croissant, Wildlife Biologist
St. George Field Office of the Bureau of Land Management
345 East Riverside Drive **St. George**, **UT** 84790-6714; tcroissa@blm.gov

The Omnibus Public Land Management Act of 2009 (OPLMA) set a new direction for Land Management in the St. George Field Office of southwest Utah. The Act established two National Conservation Areas and directed the Field Office to develop Comprehensive Management Plans for them. Within the Beaver Dam Wash and Red Cliffs National Conservation Areas the emphasis has now shifted away from traditional "Multiple Use" management and towards conservation, protection, and restoration of resource values. These two National Conservation Areas encompass nearly all of the desert tortoise Critical Habitat in Utah. In addition, the OPLMA also requires the Field Office to consider the designation of new Areas of Critical Environmental Concern (ACEC) and develop a Travel Management Plan for the entire Field Office. Six years later, the planning effort is nearing fruition. The NCA Comprehensive Management Plans will affect the management of Mojave desert tortoise as well as recreation, cattle grazing, Right-Of-Way issuance, and many other facets of Land Management. This demonstrates the ability of the BLM to adapt to an ever-changing world and to manage land in a variety of innovative and effective ways.

Coyote Foraging Patterns In The Central Mojave Desert: Implications For Predation On Desert Tortoises

Brian L. Cypher[1], Tory L. Westall, Christine L. Van Horn Job, and Erica C. Kelly
California State University-Stanislaus, Endangered Species Recovery Program,
One University Circle, Turlock, CA 95382
Phone: 661-835-7810; [1]Email: bcypher@esrp.csustan.edu

Coyotes (*Canis latrans*) occasionally prey on desert tortoises (*Gopherus agassizii and G. morafkai)*, but the extent to which they do so and how this predation might be influenced by other factors is unknown. We examined spatial and temporal foraging patterns of coyotes during 2009-2014 on a 1500-km^2 area near Barstow, CA. We analyzed 3,246 coyote scats and annually indexed abundance of potential prey on 60 1-km transects. Annual variation in use of items by coyotes appeared strongly influenced by fluctuations in item availability, which in turn was associated with variation in annual precipitation. Rabbits and Heteromyid rodents were primary food items. Other natural items (e.g., birds, snakes and lizards, invertebrates, fruit) appeared to be consumed opportunistically. Anthropogenic items (e.g., domestic animals, crops) commonly occurred in scats and use of such foods increased as abundance of natural items decreased. This in conjunction with scat collection locations provided some evidence that the coyote population

on the study site is receiving at least some anthropogenic subsidization. Coyotes consistently consumed desert tortoises, although the frequency of occurrence in scats was low. Use of tortoises in the latter years of the study declined concurrent with declines in use and availability of primary items and also with declines in annual precipitation. This suggested that tortoises may be secondary items used opportunistically by coyotes. However, coyotes in this region clearly are exploiting anthropogenic foods, and this subsidization potentially could increase predation pressure on desert tortoises.

Recovery Progress at Mojave National Preserve

Neal Darby, Debra Hughson, Annie Kerns, Danette Woo, Todd Suess and Larry Whalon
Mojave National Preserve, 2701 Barstow Road, Barstow, California 92311

Progress towards recovery of the desert tortoise at Mojave National Preserve has included habitat restoration, threat abatement, planning, monitoring, and research towards population augmentation. Active restoration of cattle-trampled areas (piospheres) in desert tortoise habitat on the Preserve was completed in 2014. Effectiveness monitoring will be done in 2015. Debris and some hazardous materials were cleaned up by our partner group on 6 acquired private parcels, totaling 95 acres, which will be donated to the Preserve in the future. The preserve began collaboration with the BLM and USFWS on construction of a tortoise fence on 12 miles of Morning Star Mine road. We are also developing a Grazing Management Plan, Biological Assessment and consultation covering livestock management in the Preserve. The annual survey of 508 miles of powerlines encountered 21 active raven nests and one juvenile tortoise mortality associated with tower 129-2 near Black Canyon Road. Nine tortoises were reported killed on roads in the Preserve. Juvenile tortoise headstarting research is ongoing at the Ivanpah Desert Tortoise Research Facility, acquired by the National Park Service as a donation from Chevron in 2014, and is being led by Savannah River Ecology Lab and the University of California, Davis.

Repairing Degraded Mojave Desert Tortoise Habitat: Lessons Learned and Future Directions

Lesley A. DeFalco, Sara J. Scoles-Sciulla, Daniel F. Shryock, Nathan A. Custer, and Todd C. Esque
U.S. Geological Survey, Western Ecological Research Center, Las Vegas Field Station, 160 N. Stephanie St., Henderson, NV 89074; Phone: 702-564-4507 Senior author email: ldefalco@usgs.gov

Repairing damaged Mojave desert tortoise (*Gopherus agassizii*) habitat using conventional restoration approaches has met many challenges since critical habitat was originally designated. Wildfires in recent decades fueled by the invasion of exotic annual grasses have altered forage and cover plants, and increasing development of desert lands for solar and wind energy is expected to alter habitat in the future. Because vegetation recovery is intimately tied to the timing and amount of rainfall and to fluctuations in temperature, novel approaches outside the conventional restoration tool box are needed that appreciate the complexity of this enigmatic desert while also ensuring approaches are scalable to large landscapes and promote long-term success. Monitoring of experimental plots within a network of long-term monitoring sites since

2006 has shown that herbicide application reduces the short-term impact of competitive invasive annual grasses and enhances the native species seed bank. Seed limitation of short-lived perennial species can be overcome through broadcast seeding. Currently, seed encapsulation of long-lived species is being evaluated for minimizing collection by seed-harvesting ant and rodents. Unfortunately, limited availability of local Mojave Desert plant materials has resulted in using seed stock from distant or unknown sources with limited guidance and with limited knowledge about the genetic consequences of using such sources for repairing damaged habitat. In our ongoing multi-agency collaboration, we developed a provisional seed transfer zone map based on climate variation within the region. We are evaluating local adaptation for several native species planted in multiple common gardens distributed throughout the Mojave Desert to validate the map and to guide selection of plant materials for restoration. Collectively, studies evaluating restoration techniques and seed transfer zones will not only assist in the repair of damaged tortoise habitat, but will help practitioners plan for restoration as our regional climate continues to change.

Viewing Lethal Control of Ravens (*Corvus corax*) Through a Conservation Biology Lens

David J. Delehanty, Professor
Biological Sciences, Idaho State University, Pocatello, Idaho 83209 Email: deledavi@isu.edu

Conservation biology seeks to conserve biodiversity by applying scientific understanding of biological processes to conservation decision-making while simultaneously considering compelling human factors such as economic, aesthetic, and cultural well being. In the American west, substantial increases in raven population size, density, and distribution as a result of human activities presents a challenging conservation biology problem due to the deleterious effects of high raven abundance on other valued species. Evolutionarily, the breadth and past stability of western ecosystems has led to occupation by species such as the desert tortoise and the greater sage-grouse that employ stereotypic behavioral repertoires and that demonstrate a poor capacity to accommodate rapid habitat change. Human land use changes now favor species such as ravens that use learning and behavioral innovation to co-occupy the west with humans. Local, short-term population regulation of ravens through lethal control has been demonstrated empirically, but 'scaling-up' lethal control as a long-term, broad-scale solution will require that several scientific and societal factors be addressed. Scientifically, raven breeding biology and capacity for behavioral innovation may allow ravens to resist broad-scale lethal control despite strong human effort. The mode of action of the control agent DRC-1339 presents special ethical considerations when used on animals such as ravens, but as yet is poorly addressed. Scaling-up raven lethal control also may alter important economic, logistic, and political considerations as yet poorly addressed. The proposition of lethal control of ravens invites detailed consideration of each of these issues in a conservation biology context.

Effects of Common Raven Removal and Temporal Variation in Weather on Greater Sage-grouse Nesting Success

Jonathan B. Dinkins[1], Michael R. Conover[2], Christopher P. Kirol[1], Jeffrey L. Beck[1], and S. Nicole Frey[2]
[1] Department of Ecosystem Science and Management, University of Wyoming, Laramie, WY 82071
[2] Department of Wildland Resources, Utah State University, Logan, UT 84322-5230

Predator removal has been simultaneously proposed and criticized as a potential mitigation measure for low reproductive rates of greater sage-grouse (*Centrocercus urophasianus*; hereafter "sage-grouse"). In Wyoming, lethal removal of common ravens (*Corvus corax*: hereafter "ravens") has been conducted by USDA/APHIS/Wildlife Services (WS) for the protection of livestock. We hypothesized that nest success of sage-grouse would be greater in areas where WS lowered the abundance of ravens. During 2008–2011, we assessed raven densities and nest success of sage-grouse (n = 367 nests) in areas within 15 km of WS raven removal efforts and areas >15 km away. In addition, seasonal temperature and precipitation variables were evaluated as other sources of annual variation in nest success of sage-grouse. Over the course of the study, raven densities at removal study sites decreased, and nest success of sage-grouse was higher in 2010 and 2011. Unlike removal study sites, raven densities at non-removal study sites increased as nest success of sage-grouse declined. Predator removal may have a place in sage-grouse management as an interim mitigation measure when sage-grouse populations are subjected to high densities of ravens. However, long-term solutions to reduce human-subsidized raven populations are necessary to address growing raven populations in sage-grouse habitat.

Dynamic Physiological Responses in the Mojave Desert Tortoise to Habitat Disturbance and Environmental Change

Kristina Drake[1,2,3], Todd Esque[1], Ken Nussear[1], Lizabeth Bowen[1], Keith Miles[1,2], and Rebecca Lewison[3].*
[1]U. S. Geological Survey, Western Ecological Research Center, Henderson, Nevada 89074
[2]University of California, Davis, California, 95616
[3]San Diego State University, San Diego, California 92116
[*]Phone: 702-564-4560; kdrake@usgs.gov

Desert tortoises (*Gopherus agassizii*) are subjected to a myriad of ecological and environmental stressors as human development and land use practices increase across the Mojave Desert. Despite more than 15 years of intensive efforts to improve population recovery trends, they continue to decline. Limited information exists on the indirect effects of disturbance on tortoises and even less is available to understand the physiological health of tortoises occupying degraded or altered habitats. Tortoises are often slow to respond to environmental stressors and it is difficult to link specific causes of physiological perturbations to declining animal health. To evaluate the effects of disturbance and habitat alteration on the physiology and health of tortoises, we assessed adult tortoises that were experimentally translocated to habitats in the western and northeastern Mojave Desert. We conducted physical health assessments, collected blood samples, and monitored behavior and activity for translocated tortoises and compared the results with resident tortoises and individuals occupying relatively undisturbed

landscapes. We used multiple indicators of health such as stress hormone (Drake et al. 2012) and gene transcript profiles (Bowen et al. In Press) to understand the dynamic physiological responses of tortoises occupying a variety of environmental and habitat conditions.

Characterization of a Secondary Contact Zone between *Gopherus agassizii* and *G. morafkai* in Northwestern Arizona

Taylor Edwards[1,2], Kristin H. Berry[3], Richard D. Inman[4], Todd C. Esque[4], Kenneth E. Nussear[4], Cristina A. Jones[1,5], and Melanie Culver[1,6]*

[1]School of Natural Resources and the Environment, The University of Arizona, Tucson, AZ 85721 USA; E-mail: taylore@email.arizona.edu

[2]University of Arizona Genetics Core, 1657 E. Helen Street, Tucson, AZ, USA

[3]U.S. Geological Survey, Western Ecological Research Center, Riverside, CA, USA

[4]U.S. Geological Survey, Western Ecological Research Center, Henderson, NV, USA

[5]Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, USA

[6]U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, AZ, USA

The two described species of desert tortoise (*Gopherus agassizii* and *G. morafkai*) diverged from a common ancestor during the formation of the Colorado River (8-4 mya). However, an anomalous population of *G. agassizii* occurs east of the Colorado River in and around the Black Mountains of Arizona where it comes into contact with *G. morafkai.* This secondary contact zone between the two species of desert tortoises provide an opportunity to examine reinforcement of species' boundaries under natural conditions. In this study, our objective was to describe the distribution of *G. agassizii* and *G. morafkai* where they come into contact in northwestern Arizona and to investigate the occurrence of hybridization among the parental lineages. We sampled 234 tortoises representing *G. agassizii* in California (n = 103), *G. morafkai* in Arizona (n = 78), and 53 individuals of undetermined assignment in the contact zone including and surrounding the Black Mountains. We genotyped individuals for 25 short tandem repeats and determined maternal lineage using mtDNA sequence data. We performed multi-locus genetic clustering analyses and used multiple statistical methods to detect levels of hybridization. We used habitat suitability models to define the properties of the contact zone and distribution of habitat specific for each species. Our data suggest a recent shared ancestry (~2,400 years) between *G. agassizii* populations directly across the Colorado River. In the contact zone 60% of individuals genotyped as *G. agassizii*, 6% as *G. morafkai* and 34% as hybrids, primarily of F_2 or backcrossed recombinant classes. The maintenance of the hybrid zone is best described by a geographical selection-gradient model and *G. agassizii* and *G. morafkai* maintain independent taxonomic identities likely due to ecological niche partitioning.

The Distribution and Genetic Structure of Desert Tortoise (*Gopherus morafkai*) in Mexico

Taylor Edwards[1,2], *Mercy Vaughn*[3], *Philip C. Rosen*[1], *Cristina Meléndez Torres*[4], *Alice E. Karl*[5], *Melanie Culver*[1,6], *Robert W. Murphy*[7]

[1]School of Natural Resources and the Environment. The University of Arizona, Tucson, AZ 85721 USA
[2]University of Arizona Genetics Core, University of Arizona, Tucson, AZ 85721 USA
[3]Paso Robles, CA 93446 USA
[4]Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora, Sonora, Mexico
[5]P.O. Box 74006, Davis, CA 95617 USA
[6]U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, AZ 85721 USA
[7]Royal Ontario Museum, Toronto M5S 2C6, Canada

We investigate the biogeography and evolutionary history of Morafka's desert tortoise, *Gopherus morafkai*, in Mexico. Our samples include 155 wild desert tortoises collected in Mexico from 2005 to 2013. We sampled the three major biomes where tortoises occur: Sonoran desertscrub, Sinaloan thornscrub, and tropical deciduous forest. We analyzed mtDNA sequences to reconstruct the matrilineal genealogy and estimate times of divergence using Bayesian clustering. We infer genetic population structure using analyses of 25 microsatellite (STR) loci. We observe a deep divergence (~5.7 Ma) between matrilines of *G. morafkai* and strong genetic structure across the STR loci. We conclude that *Gopherus morafkai* consists of two genetically and geographically distinct "Sonoran" and "Sinaloan" lineages. Within each lineage, gene flow is geographically extensive and exhibits genetic structure with isolation-by-distance. Both lineages occur in a relatively limited zone of overlap in Sinaloan thornscrub where we detect limited introgression. We observe a sharp cline between the two lineages, which suggests periods of isolation in temporary refugia, driven apart during periods of climatic flux during the Pleistocene, influenced divergence. We propose that the shifting ecotone between Sinaloan thornscrub and Sonoran desertscrub biomes acts as an ephemeral boundary that fosters adaptations in each lineage of tortoise and results in their parapatric distribution. Despite incomplete reproductive isolation, the Sonoran and Sinaloan lineages of *G. morafkai* are on separate evolutionary trajectories. Conservation and management of both lineages will benefit from focusing on specific actions toward each lineage independently based on their habitat and resource needs.

The American Badger as a Potential Predator of Local Tortoise Populations

Patrick G. Emblidge[1,2], *Christina M. Aiello*[1,2], *Ken E. Nussear*[3], *Todd C. Esque*[2], *Andrew D. Walde*[4]

[1] The Pennsylvania State University, Department of Biology, 208 Mueller Laboratory, University Park, PA 16802 Email: pge1@psu.edu
[2]US Geological Survey, Western Ecological Research Center, 160 N. Stephanie St, Henderson, NV 89074
[3]University of Nevada, Reno, Department of Geography, Reno, NV 89557
[4]Walde Research & Environmental Consulting, 8000 San Gregorio Rd, Atascadero, CA 93422

Agassiz's desert tortoise (*Gopherus agassizii*) is a long-lived species that requires high annual adult survivorship to maintain stable populations. Over the past few decades unsustainable mortality rates have occasionally been reported and are frequently associated with

drought or subsidized predators. During the active seasons of 2012 and 2013 we observed extremely high adult tortoise mortality (22% and 84% respectively) at one of four study sites in the Western Mojave Desert near Barstow, CA. The condition of carcasses was surprisingly consistent with remains nearly always found overturned, usually within or near a burrow and with a large hole in the prefemoral region. Motion-triggered trail cameras were placed at various occupied burrows from July 2013 through March 2014 in an attempt to identify the cause of mortality. On two occasions cameras captured images of an American badger at a burrow where a tortoise was later found dead. On two additional occasions cameras placed at burrows where tortoises were last seen alive recorded badgers investigating the burrow. Both these tortoises were found dead <30 m away. Although we do not have direct observations of badgers killing tortoises the lack of evidence of other potential predators suggests that badgers were the likely cause of mortality in at least two instances and the striking similarity of carcass condition suggests that they may have been responsible for many more. Severe localized predation of tortoise populations is a significant threat to recovery of the species and further research is needed to confirm the cause and possible consequences across the range of the desert tortoise.

STUDENT PAPER

The Glass Bridge, an Exercise in Problem Solving

Norma J. Engberg
Candidate for MS in Animal Studies at Humane Society University, Board Member Tortoise Group (Nevada), Email: ntbronco@yahoo.com

Several articles (Golubovic et al, Moskovits & Kiester) have suggested that tortoise boldness grows with harsh environment, that desert tortoises are more prone to take risks than savannah tortoises. I am testing six captive-held tortoises--two captive-born juvenile *C. carbonaria*, two captive-born juvenile *G. agassizii*, and two wild-born adult male *T. horsfieldii*—in an experiment-under-controlled-conditions: a 12" x 12" x 30" glass terrarium, resting on a 32" x 12" bottom board, spanning two chairs. A second board blocks the view out the back glass. These adaptations attempt to reduce the species' panic response to "novel objects" and to changes in their local environment. A week later, I remove the bottom board and used two folded hand towels, one 9.5" wide in the east-end, and one 10.5" wide in the west-end, leaving a gap of bare glass 9.5" wide. I put favorite foods on the west-end towel and the candidate on the east-end towel. When I tested my seven-inch red-foot, she cautiously eyed the apparent chasm, then turned180 degrees and began pushing on the terrarium's east wall, using her hind feet to slide the east-end towel toward the middle of the terrarium. After 40 minutes, she turned and walked west across the towel she had been moving, stepped onto the salad towel, and began eating. If presented with the same conditions again, would she remember how she used the towel as a tool to bridge the gap? Testing the remaining five: will any (unaware of what the others did) adopt similar solutions? Which will simply do nothing? Next, will come species trials. Will being with a conspecific encourage the do-nothing individual to follow the other's lead and thus illustrate an ability to learn? Results will be reported at the symposium.

What Drives Vegetation Change After Fires, and Why Is That Change Important to Sonoran Desert Tortoises?

Todd C. Esque[1], Daniel F. Shryock[1], Kenneth E. Nussear[1], Andrew J. Berger[1], Felicia C. Chen[1], Kristina K. Drake[1,2,3], and Richard D. Inman[1,4]*

[1]U. S. Geological Survey, Western Ecological Research Center, 160 North Stephanie St., Henderson, NV 89074, USA; E-mail: tesque@usgs.gov

[2]University of California, Davis, CA, USA

[3]San Diego State University, San Diego, CA, USA

[4]Arizona State University, Tempe, AZ, USA.

We report the results of analyses on a 30 yr chronosequence of 13 desert fires spanning the Arizona Upland of the Sonoran Desert. Then we describe an experiment quantifying the effect of various diets on juvenile desert tortoises. Our results show that environmental factors have a larger influence on post-fire vegetation assembly than Time-Since-Fire (TSF) in the Sonoran Desert. At the community level, vegetation cover, and height were reduced by fire and influenced largely by topographic and climatic gradients. In contrast, vegetation density was partially related to TSF, exhibiting an initial post-fire increase and subsequent decline. At a landscape scale, the best predictors of recovery for vegetation cover, height, and density were elevation, post-fire precipitation, and average annual precipitation, respectively. A strong relationship between vegetation height and post-fire precipitation (R^2 = 0.72) suggests that abiotic conditions of the immediate post-fire environment may drive long-term variability in vegetation structure. While the work described above pertains primarily to perennial plants, it is well documented that invasive grasses have become ubiquitous in the Arizona Upland of the Sonoran Desert and can increase with fire under certain conditions. Experimental results indicate that diets dominated by red brome can decrease growth rates and reduce survivorship of juvenile desert tortoises. Evidence suggests that nutrition and physical properties of these grasses may contribute to the trends we observed. In combination with new results from studies in the Mojave Desert, this work illustrates that burned desert tortoise habitats in either desert may be useful for adult desert tortoises. However, it is important to understand the response of hatchling and juvenile desert tortoises to changes in cover from thermal extremes and predators, as well as, variability in food items and how that affects growth and survival of this vulnerable life stage. Spatial variability in abiotic conditions determine patterns of vegetation recovery to a greater extent than recovery time, and should be explicitly incorporated into applications of post-fire vegetation modelling, as well as fire-management and restoration strategies.

California BLM: Update on Tortoise Management Actions and Change in Policy

Amy L. Fesnock, Wildlife and Listed Species Lead for the State Of California BLM

U.S. Dept. of the Interior, Bureau of Land Management, State Office

2800 Cottage Way, W-1928, Sacramento, CA 95825;E-mail: afesnock@blm.gov

In 2014, BLM continued to work on projects such as signing routes, restoring habitat, public outreach, and acquisitions of private land. Much effort and time was focused on solar and wind energy projects, primarily on implementation of approved projects. Brief status updates will be provided. Based on information and input from concern citizens, California BLM is

formalizing policy related to data used for management decisions and monitoring of project implementation. This policy, and its implications, will be presented. We continue to look for ways of leveraging the effectiveness monitoring associated with renewable energy projects into larger research projects and coordinating the data to better inform us on impacts to tortoise.

The Importance of Animal Personality for Individual Suitability in Desert Tortoise Reintroduction Programs

Jennifer M. Germano[1], Kiwi Recovery Coordinator; Melia G. Nafus[2], Post-Doctoral Associate; Jeanette Perry[2], Research Associate; Allyson Walsh[2], Associate Director of Applied Animal Ecology; Ronald R. Swaisgood[2], Director of Applied Animal Ecology
[1]Department of Conservation, Private Bag 3072, Hamilton 3240, New Zealand
Email: Jen.Germano@gmail.com
[2]Institute for Conservation Research, 15600 San Pasqual Valley Rd, Escondido, CA 92027, USA

Reintroduction and translocation is increasingly being applied as a form of mitigation for endangered species, including the desert tortoise. In spite of increasing use as a conservation tool, the efficacy of reintroduction programs remains debatable. One factor that may influence post-release success is individual behavior or personality. Our objective was to evaluate the utility of using individual characteristics, including carapace size, sex, and behavioral traits, as a predictive measure for post- success in juvenile desert tortoises (< 150 mm carapace length). We used each of these three traits to predict post-release movement, home range size, and survival in the first 18 months. We found that individuals tended to behave similarly across a variety of situations, suggesting that tortoises do display temperament. However, temperament was not a strong predictor of either movement or survival in the first 18 months following release. Overall, there was no difference between the sexes in their willingness to accept risk. Larger individuals tended to be more likely to accept risk than smaller ones, although not significantly so ($P = 0.06$). Larger individuals were also more likely to move greater distances following release than were smaller ones. The majority of movement occurred in the first 30 days after release. Only 17% of individuals made dispersal movements that lasted over two months and only one tortoise had not established a home range by 18 months. Mean home range size after settlement was 0.539 ± 0.104 ha. Sixty percent of tortoises survived for the entire 18 months. The best predictors of survival were sex and proportion of surface encounters, with survival being greater in males and in tortoises that were encountered underground more frequently. The cause for female-biased mortality was not determinable in this study, but represents a notable finding.

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

Mathew Hamilton[1], Wildlife Biologist; Alicia Styles[2], Wildlife Biologist
[1]Bureau of Land Management, Southern Nevada District, 4701 N. Torrey Pines Drive, Las Vegas, NV 89130; Phone: 702-515-5157; Email: mhamilton@blm.gov
[2]Bureau of Land Management, Caliente Field Office, 1400 S. Front Street, Caliente, NV 89008; Phone: 775-726-8128; Email: astyles@blm.gov

The Bureau of Land Management (BLM) administers approximately 4.5 million acres of desert tortoise habitat in Clark, Lincoln, and Nye counties, Nevada. Desert tortoise habitat is managed by the Battle Mountain, Ely, and Southern Nevada District Offices. The following are highlights from 2014. A Healthy Lands Initiative project is underway in the Ely District to protect and restore desert tortoise habitat in Lincoln County through the use of fuel breaks and restoration of fertile islands within burned areas. The District is also seeking Southern Nevada Public Lands Management Act funding to implement watershed restoration plans in tortoise habitat. BLM Ely District actively participates in the Southeastern Lincoln County Habitat Conservation Plan and Coyote Springs Investment Multi-Species Habitat Conservation Plan. Both plans contain mitigation actions on BLM land for habitat loss on private land.

The Districts, in coordination with Nevada Department of Wildlife and U.S. Fish and Wildlife Service have been working on a Raven Management Plan. Section 7 consultations on land use plans and individual projects remain a major work load for the Districts. Southern Nevada District is currently undergoing a Resource Management Plan revision. Mitigation money for desert tortoise projects is forthcoming from the Silver State South solar project and leasing in the Dry Lake Solar Energy Zone. BLM Southern Nevada assisted U.S. Fish and Wildlife Service with tortoise translocations this year. BLM continues to implement the strategies outlined in our land use plans to minimize and mitigate impacts resulting from land use authorizations for energy facilities and corridors, land sales, and other human demands on the public lands. The BLM implements recovery actions, such as fuel breaks, habitat restoration, route restoration, education and outreach, and law enforcement patrols. BLM Nevada actively participates in the Recovery Implementation Teams for the Northeast Mojave Recovery Unit.

POSTER

Survivorship and Reproductive Success of *Gopherus polyphemus* in Southeastern Georgia

Kaitlyn Hanley and David Rostal
Biology Department, Georgia Southern University, Statesboro GA 30458
Phone: 561-568-7756; Email: kh04480@georgiasouthern.edu

The effects of fire on *Gopherus polyphemus* populations in a sandhill habitat, specifically their reproductive success, has not been extensively studied in Georgia. Here we present data on a long term comparison of two populations of *G. polyphemus* under differing management strategies. We compare reproduction and population structure under different management: long term active fire management verses a limited management approach. Reproductive output,

population structure and habitat quality were compared at multiple intervals over a 20 year period (1994 to 2014). The project took place at: Fort Stewart Army Reserve (FSAR) which is managed aggressively for tortoises and George L Smith State Park (GLS) which only recently has received some management for its tortoise population. Female tortoises at FSAR are significantly larger than females at GLS. Clutch size was not significantly different between the two study sites (mean clutch size 5.375 + 1.41 eggs at GLS and 6.231 + 2.49 eggs at FSAR) in 2014 however sample sizes were extremely small and more data is needed. Clutch size at GLS had increased from 4.52 to 5.38 since 1996. The linear regression of clutch size and carapace length shows no correlation for either GLS or FSAR (r^2=.0073, .586 respectively), in fact tortoises at GLS are showing a negative relationship between clutch size and female size. Habitat results were similar to the 1996 study as it appears that the tortoises are actively selecting optimal habitat available at GLS while tortoises at FSAR are able to find more favorable available habitat throughout their range. Tortoises at both sites are selecting habitat with low canopy and available ground forage.

Nutritional Value of Desert Tortoise Foods

Lisa Hazard[1, 2], Brian Henen[1], Phillip Medica[1], Christian Meienberger[1], Danielle Shemanski[1], Devesh Vyas[1], Ian Wallis[1], and Kenneth Nagy[1]

[1]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, California 90095

[2]Current address: Department of Biology and Molecular Biology, Montclair State University Montclair, NJ 07052; Phone: 973-655-3418 E-mail: HazardL@mail.montclair.edu

The plant foods that desert tortoises eat can provide very different amounts of nutrients depending on the plant structure (leaves, flowers, fruits, stems), the age of the tissues (new growth, mature but still green, or dry and dead), and the kind of plant (annual wildflower, shrub, grass). We have conducted field studies at several sites to determine tortoise diets (by observation of feeding bouts) and chemical composition of food items (field-collected plant samples plus laboratory analyses). Then, we did laboratory feeding trials with captive wild tortoises fed fresh, field-collected foods to evaluate digestibility and retention of major nutrients in individual food types or in food mixtures via intake-output measurements. In spring, tortoises in Rock Valley Nevada (Nagy and Medica 1986) shunned the 12 species of perennial shrubs and cacti growing there, but ate mainly four of the more than 25 species of annual forbs and grasses. In summer, tortoises ate only grass (mainly two species), which were dead and dry by then. Penned tortoises maintaining body weight on the spring diet mixture were able to digest and assimilate 50-75% of the energy, dry matter, water, potassium and sodium in this food. In subsequent feeding trials (Meienberger, Wallis and Nagy 1993), tortoises fed a dry grass diet assimilated 48-50% of the energy and dry matter. Thus desert tortoises are able to assimilate major nutrients about as effectively as can many endothermic herbivores, even though tortoises do not chew their food before swallowing, they do not have grinding gizzards, or have anatomically-specialized segments in their guts. To compare nutritional quality of spring vs. summer diets and native vs. exotic diets, digestibility of major nutrients (energy, nitrogen, calcium, magnesium, and phosphorus) from four plant species was measured during laboratory feeding trials. We fed two spring diet items (*Malacothrix glabrata*, a native forb, and *Erodium*

cicutarium, an exotic forb), and two summer diet items (*Achnatherum hymenoides*, a native grass, and *Schismus barbatus*, an exotic grass) to adult tortoises (Nagy, Henen and Vyas 1998) and juvenile tortoises (Hazard, Shemanski and Nagy 2009; Hazard, Shemanski and Nagy 2010). In general, nutritional value was best predicted by food type rather than food origin. Compared to the forbs, the grasses were higher in fiber and lower in digestible energy, protein, calcium, magnesium, and phosphorus, leading to lower dry matter and nutrient digestibility and availability. Tortoises actually showed net loss of water, nitrogen, and phosphorus on the dry grass diets, but gained energy and calcium. For juvenile tortoises, voluntary intake rates were lower for grasses than forbs; this combined with lower digestibilities led to lower growth rates on these diets. Using available data on body composition and egg composition, we estimated nutrient requirements for growth and egg production and compared them to estimates of annual nutrient intake based on our measurements. Of the nutrients studied, dietary nitrogen and phosphorus are more likely than energy, calcium, or magnesium to be constraints on growth; phosphorus may also limit egg production more than calcium or magnesium. Management practices that promote availability of forbs may enhance juvenile tortoise growth rates and thus survival.

References

Hazard, L.C., D. Shemanski, and K.A. Nagy. 2009. Nutritional quality of natural foods of juvenile Desert Tortoises (*Gopherus agassizii*): Energy, nitrogen, and fiber digestibility. Journal of Herpetology 43(1):38-48.

Hazard, L.C., D. Shemanski, and K.A. Nagy. 2010. Nutritional quality of natural foods of juvenile and adult Desert Tortoises (*Gopherus agassizii*): Calcium, phosphorus and magnesium digestibility. Journal of Herpetology 44(1):135-147.

Meienberger, C., I.R. Wallis, and K.A. Nagy. 1993 Food intake rate and body mass influence transit time and digestibility in the desert tortoise (*Xerobates agassizii*). Physiological Zoology 66:847- 862.

Nagy, K. A., B. T. Henen, and D. B. Vyas. 1998 Nutritional quality of native and introduced food plants of wild desert tortoises. Journal of Herpetology 32:260-267.

Nagy, K.A., and P.A. Medica. 1986 Physiological ecology of desert tortoises in southern Nevada. Herpetologica 42:73-92.

Serendipity and The Tortoise

Brian T. Henen

Present Address: Marine Air Ground Task Force Training Command, Natural Resources and Environmental Affairs, Building 1418, Marine Corps Air Ground Combat Center, Twentynine Palms, California, 92278 Email: brian.henne@usmc.mil

Serendipity, a beneficial or useful discovery by chance, has been key to innovation and advances in tortoise biology and conservation. Studies of Agassiz's Desert Tortoise, its congeners, and many other terrestrial tortoises have fostered considerable serendipity. From just

one dissertation on female *G. agassizii*, we learned that female tortoises use compensation or trade-offs in nutrient budgets to support reproduction in drought years, that protein is more important than is energy to egg production, that invasive plants (e.g., *Schismus barbatus*) can be critical to achieving long-term energy balance, and that female *G. agassizii* exhibit maternal care towards their offspring. Similar serendipitous findings are found independently by other researchers. Serendipity can be considered 'discoveries by accident and sagacity', meaning that chance is involved. However, being prepared to see and interpret what the data reveal is as necessary as is chance. The report that *Homopus signatus* produce bloody big eggs was not serendipity, but discovering that female *H. signatus* require pelvic and shell kinesis to oviposit was serendipitous. Many findings are also the result of well-planned scientific study, and may be just as valuable as serendipitous finds. Sustaining productivity and awareness in well-planned scientific study will sustain opportunities for serendipity. As tortoise populations continue to decline, it is increasingly critical that we focus on their conservation needs, and execute and publish well-planned studies to understand and meet those needs. Through this pursuit we will have more serendipity, and more tortoises.

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

Gerald Hillier, Executive Director, and Bill Lamb
P.O. Box 55820, Riverside, CA 92517

QuadState LGA is entering its sixteenth year of operation. We represent 10 local governments in the Mojave and Sonoran Deserts on a variety of natural resources issues. And we are currently in discussion with other counties in the region relative our activities. We have a variety of concerns involving public land management and administration.

First, relative to tortoises, we are participating in the Recovery Implementation Teams (RITs) for the recovery action planning for the Mojave Population. The Authority has membership on the Management Oversight Group, as do member counties, and we look forward to that re-constituted organization assuming an active role in setting priorities for implementation work on the recovery plan. Of critical importance we hope the MOG will become active in setting priorities for research, and for attracting research funds to address disease issues. Having learned from our Mojave experience, we actively engaged with the Service and Arizona Game and Fish Department (AGF) on the listing decision on the Sonoran Population (now *Gopherus morafkai),* submitting data analysis and input for both the 90-day and 12-month decisions. We have sought to assure local government inclusion with the Arizona Interagency Desert Tortoise Team (AIDTT), and look forward to it getting started on development of a conservation strategy that might overcome a final listing decision. FY 2016 looms large for a final decision by the Service under the settlement. The Sonoran Population exists in eleven of Arizona's fifteen counties, and a final ESA listing together with mitigation and changes in land management could have a profound effect, state-wide, on businesses, residents and public land users.

Second, we are concerned and engaged with groups such as the Desert Landscape Conservation Cooperative (DLCC). Local governments were not invited to participate in the

organization of the Steering Committee for the DLCC, but through persistence we secured organization of a Local Governments Working Group to achieve a platform for our views and input.

Third, we attend meetings of the BLM Resource Advisory Councils (RACs), which includes the BLM's Desert District Advisory Council (DAC) in California. While each has a local government representative, which is required by law, these representatives often do not have a full or specific knowledge of issues or concerns beyond their own county. We function to assure input, if appropriate, from non-represented counties, and provide feedback from the meetings to our members. Using the RAC forums we have pressed a reluctant BLM to expose the Councils, and indeed their own employees, to the operation of programs and activities of other agencies which have activities and initiatives on public lands. Last year FWS has circulated a major policy paper on adaptation and management of wildlife and climate change. The LCCs have circulated that paper and sought specific input on goals and actions. This is consistent with the President's Executive Order directly agencies to directly climate change in their actions and planning. Without getting into the climate change debate in this forum, I confess that I remain among the skeptics of the 3-legged stool upon which climate change program advocacy rests. But suffice it to say that most local governments can ill afford to accept and promote programs and mitigation for events that models predict may not occur for 20, 30 or 50 years in the future.

Fourth, I must say a word about land acquisition. Often the backbone of mitigation packages, we must point out that loss of private land affects county revenues. The federal Payment in Lieu of Taxes (PILT) program does not cover such losses, with one small temporary exception. In counties among our members with small private land holdings, such as Inyo and Lincoln, these acquisitions can be catastrophic. In others, like Mohave and San Bernardino, the erosion may not seem significant, but over time can add up. San Bernardino County has lost over 800,000 acres over the past dozen years, which has likely meant the loss of over $1.5 million in property tax revenue each year. Our organization has sought to bring attention to the agencies at the local and national policy levels, and has secured national-level policy resolutions from the National Association of Counties (NACo).

Landscape Alterations and Anthropogenic Structures Influence Resource Selection by Common Ravens in Sagebrush Ecosystems

Kristy Howe[1], Wildlife Biologist; Peter S. Coates[1], Research Wildlife Biologist; David J. Delehanty[2], Professor of Biology; and Michael L. Casazza [1], Research Wildlife Biologist
[1] U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, 800 Business Park Drive, Suite D, Dixon, CA 95620
Email: khowe@usgs.org; pcoates@usgs.org; mcasazza@usgs.org
[2] Idaho State University, Department of Biological Sciences, Pocatello, ID 83209
Email: deledavi@isu.edu

Common raven (*Corvus corax*, hereafter raven) numbers and distribution are increasing throughout the sagebrush steppe, influencing avian communities in complex ways. Here, we present a synthesis of four recent raven resource selection studies conducted in southeastern

Idaho. We describe factors that influence raven occupancy of sagebrush ecosystems, and we identify differences in the use of landscape characteristics and natural and anthropogenic features between nesting ravens and three species of buteo (Swainson's Hawk [*Buteo swainsoni*], Red-tailed Hawk [*B. jamaicensis*], and Ferruginous Hawk [*B. regalis*]). Highlights of this research include: 1) proximity to power lines and proportions of non-native vegetation strongly predict probability of occurrence by ravens, 2) ravens selected areas near sage-grouse leks, and the odds of raven occurrence increased significantly in areas where livestock were present, 3) ravens were most likely to nest near land cover edges of adjoining big sagebrush (*Artemisia tridentata*) and land cover types associated with direct human disturbance or fire, 4) ravens had a higher probability of nesting on anthropogenic features than the buteo species, and 5) the probability of nesting near agriculture was greatest for ravens followed by Swainson's Hawk. These findings contribute to our understanding of raven expansion into rural environments and could be used to make better-informed conservation decisions, especially in the face of increasing renewable energy development. In particular, our findings indicate a high potential for further increases in raven populations within sagebrush steppe ecosystems following human land use changes.

Habitat Use of Juvenile Sonoran Desert Tortoises in Central Arizona

Cristina A. Jones, Audrey K. Owens, Emily R. Grabowsky, and Allen R. Bartoli*
Nongame Wildlife Branch, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix, Arizona, 85086, USA; E-mail: cjones@azgfd.gov

Most of what is known about desert tortoises is based on research conducted on adult Mojave desert tortoises (*Gopherus agassizii*), a species listed as Threatened under the Endangered Species Act (ESA); significantly less is known about Sonoran desert tortoises (*Gopherus morafkai*), despite their status as species of greatest conservation need by the Arizona Game and Fish Department, and Candidate status under the ESA. In particular very little is known about juvenile Sonoran desert tortoises, which are notoriously difficult to find due to the complex nature of tortoise habitat in the Sonoran Desert. We used radio-telemetry to study juvenile Sonoran desert tortoise habitat use and activity. Our study site is in the Mazatzal Mountains, Maricopa County and is characterized as Arizona Upland paloverde-mixed cacti series. It has a high density of desert tortoises, with over 210 tortoises marked since 1991 in an approximately 66 ha area. We equipped 15 juvenile desert tortoises (ranging in size from 124–175mm midline carapace length) with radio-transmitters in 2010–13 and tracked them at least once a week during the active season and periodically during winter dormancy. We present our findings on juvenile tortoise movement, home ranges, and habitat use, including observations of possible emigration events. Given the recognized differences in morphology, ecology and genetic structure between the two desert tortoise species, these natural history data on juvenile desert tortoises will be valuable in guiding management of this species in the Sonoran Desert of Arizona.

U.S. Geological Survey Update

Susan Jones, Research Manager
U.S. Geological Survey, Western Ecological Research Center, Sacramento, CA

Todd Esque, Lesley DeFalco, Kathy Longshore, Kristin Berry and Pete Coates are all Principal Investigators in the Western Ecological Research Center who have been assessing human impacts on the desert in many different ways. This is but a short introduction to their talks later in this Symposium. Todd will report on his group's analysis of 30 years of fire data in the Sonoran Desert and how it drives vegetation change. He asks the question, is that change important to Sonoran Desert Tortoises?

Lesley DeFalco is evaluating local adaptation of plants in gardens across the Mojave desert to improve on the map of seed zones she and her collaborators have created for the Mojave Desert. This effot will help land managers maximize the effectiveness of seed and plant materials they procure for restoration efforts in California, Nevada, and Arizona. She is working with many partners – BLM in three states, Utah Division of Wildlife Resources, the military, the National Park Service, and the Department of Energy.

Kathy Longshore and Todd Esque are assessing golden eagle food habits and nesting characteristics in the Mojave in order to better assess eagle impacts from renewable energy projects.

Kristin Berry recently published a paper about the selective eating habits of tortoises. She will be talking later about a synthesis of best management practices for habitat interventions for tortoise. She and Taylor Edwards, Rich Inman, Todd Esque, Cristina Jones and Melanie Culver have looked at the secondary contact zone in northwestern Arizona to investigate the occurrence of hybridization between the two described species of desert tortoise in the U.S.. Jeremy Mack will talk about the post-release survival of juvenile tortoises at Edwards Air Force Base. More information on genetics will be presented, and an evaluation of the Desert Tortoise Research natural Area Interpretive Center use of fences after 33 years.

A recently published book on tortoises, Biology and Conservation of North American Tortoises, has 4 chapters written or co-written by USGS scientists, including Phil Medica, now Emeritus, who was honored here last year with an award.

Pete Coates will be moderating a panel on raven issues, including the Great Basin, where he is tracking bird behavior and modeling habitat, to assist land managers with sage grouse protection.

Imminent Threats to our Desert National Parks and their Iconic Species:

David Lamfrom, California Desert Associate Director
National Parks Conservation Association, 400 S. 2nd Ave #213, Barstow, CA
Phone: (760) 219-4916, Email: dlamfrom@npca.org

The California desert is at a conservation crossroads. The region is increasingly recognized for its remarkable species and resources. For example, this region protects 24% of the total National Parks lands in the lower 48 states; and these parks serve an annual visitation of 3 million. Beyond that measure, this landscape is rich in Wilderness, and other legislatively and administratively protected lands. Understanding is growing that these values, and resources represent one of the most intact, pristine, and vibrant systems remaining in the United States. Despite this broadening recognition, the desert is also at the epicenter of our shift to renewable energy, and is currently facing the perennial threats of urban encroachment, irresponsible recreation, and industrialization. Specifically, federal policies have been permissive of poorly sited projects that have significantly impacted our collective work to protect this spectacular landscape and its iconic species.

In consideration of those profound threats and opportunities, this talk will present information on several projects that have been discussed in the past and resolved, such as the Eagle Mountain Landfill and the Silurian Valley Solar Proposal. It will also focus on projects currently proposed that would significantly impact desert national parks including the Soda Mountain Solar project ¼ mile from Mojave National Preserve; Silurian Valley Wind project along the Old Spanish Trail and disconnecting Mojave National Preserve and Death Valley National Park; and the Eagle Crest Pumped Storage project surrounded on three sides by Joshua Tree National Park wilderness.

Surveys of Common Ravens in the Critical Habitats of the California Desert

Lawrence F. LaPré, Wildlife Biologist
Bureau of Land Management, 22835 Calle San Juan de los Lagos, Moreno Valley, CA 92553
Phone: 951 697-5218 Email: llapre@blm.gov

The Bureau of Land Management contracted studies of the abundance of nesting common ravens in several Desert Wildlife Management Areas (DWMAs), including designated critical habitat for the desert tortoise, in 2013 and 2014. One purpose of this effort was to locate "offending ravens", i.e. those found to be predatory on juvenile desert tortoises, and have them removed by the USDA Wildlife Services. In 2013, surveys covered the Ivanpah, Superior-Cronese and Chuckwalla DWMAs. In 2014, the surveys covered the Chemehuevi, Superior-Cronese and Chuckwalla DWMAs. The majority of nests located were unoccupied, and active raven nests comprised 10-54% of all nests found. In 2013, 47 nests of all types were detected in the Ivanpah DWMA, 99 nests in the Superior-Cronese DWMA and 241 nests in the Chuckwalla DWMA. In 2014, there were 177 nests in the Chuckwalla DWMA, 200 nests in the Chemehuevi DWMA and 233 nests in the Superior-Cronese DWMA. Nest success ranged from 35-100% over both years. Wildlife Services removed 5 offending ravens in 2013 and 28 in 2014. Nearly

all of these were in the Superior-Cronese DWMA, where ravens were also predatory on adult tortoises. Nearly all of the nests were located on transmission towers, even where many cliff nesting sites were available. In remote desert areas like the Ward Valley of the Chemehuevi DWMA, ravens were abundant even without substantial human presence. Food and water subsidies were virtually absent, but the transmission lines provide a nesting substrate pathway into the wilderness for ravens. An unusually high number of red-tailed hawks was also detected in all DWMAS.

POSTER

Temperature Preferences of *Gopherus morafkai* in Tropical Dry Forest.

Rafael A. Lara-Resendiz[1], Luis C. Villa-Corella[2], Barry Sinervo[1], Philip C. Rosen[3], Alice E. Karl[4], Cristina Melendez Torres[5], Fausto R. Méndez de la Cruz[6] and Mercy L. Vaughn[7].*

[1]Department of Ecology and Evolutionary Biology, Earth and Marine Sciences Building A316, University of California, Santa Cruz, CA 95064, USA rafas.lara@gmail.com

[2]Universidad de la Sierra, Moctezuma, Sonora, México.

[3]School of Natural Resources & the Environment, University of Arizona, Tucson AZ, 85721

[4] P.O.Box 74006, Davis, CA 95617

[5]CEDES (Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora), Bernardo Reyes 93, San Benito, 83190 Hermosillo, Sonora, México

[6]Laboratorio de Herpetología, Instituto de Biología, UNAM, Distrito Federal, México.

[7]Paso Robles, CA 93446

In ectotherms most physiological mechanisms are affected by temperature, therefore they carefully regulate body temperature within a relatively narrow range. Selected body temperatures (T_{sel}) under controlled conditions are rarely reported. T_{sel} or "preferred" temperature represents the range of temperatures at which an ectothermic animal seeks to maintain itself by behavioral means in order to carry on their activities. Here we examine thermal ecology of *Gopherus morafkai* in the northern Tropical Dry Forest (TDF) of Mexico. Previous analyses of tortoises indicates two grades of thermoregulation: heliothermic tortoises, which actively behaviorally thermoregulate and are restricted to the temperate zone and savannah of the wet-dry tropics, and thermo-conforming tortoises, which do not expend energy seeking basking sites but conform to ambient temperatures, and are restricted to tropical forests (Sinervo, 2015). Thermal preferences of the thermoconforming tortoises are 4.5°C lower than heliotherms. Available data suggest that desert tortoises are thermophilic as well as heliothermic, but thermal physiology data for the TDF ecotype of desert tortoise, which are usually active in the closed-canopy of the wet-season TDF, are unavailable. We instrumented captive and wild TDF tortoises with iButtons and radiotelemetry (placed in inguinal and on dorsal carapace locations) to estimate the activity patterns and T_{sel} during the late summer-early fall period of activity. We found that T_{sel} averaged 28.2±2.3°C and T_{sel} range was 26.4-29.3°C. The minimum activity temperature was 20.2°C. During activity, T_{sel} was ≈ 31-33°C, which is ≈ 3°C lower than activity temperatures reported for *Gopherus agassizii* in Mojave Desert, USA. Also we compared these results with operative temperatures in TDF (Rosen, 2015). Our results show that the TDF form of desert tortoise may be considered a facultative thermoconformer, given its TDF habitat, and that this may one of the

primary reasons for genetic differentiation between it and more northern populations of *G. morafkai*.

The Christmas Tree and the Tortoise: Occupancy Assessments for the Sonoran Desert Tortoise in Arizona.

Daniel J. Leavitt[*1], *Hillary A. Hoffman*[1], *Janet C. Lynn*[2], *and Cristina A. Jones*[3]
[1] Wildlife Contracts Branch, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix, AZ 85086, USA; E-mail: dleavitt@azgfd.gov
[2]Department of Emergency and Military Affairs, AZARNG, Environmental Office, Phoenix, AZ; USA
[3]Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, USA

Monitoring of the Sonoran Desert Tortoise in Arizona has been conducted with two distinct techniques. The first monitoring technique employed was with demographic plots. Between 1987 and 2002, 23 plots ranging in size between 1 – 3.9 km^2 were established. Each plot has been surveyed 2-9 times, which have produced valuable insights into the population ecology of Sonoran Desert Tortoises. The second technique employed is occupancy surveys. Here we will summarize the previous five years of occupancy monitoring results in light of what they may tell us about the status of Sonoran Desert Tortoises in Arizona. Two plans were developed in 2009 for occupancy monitoring for Sonoran Desert Tortoises and since their development both have been implemented at 8 locations throughout the state. Occupancy monitoring can provide basic information to managers charged with land or resource management. Of the 8 locations, 4 were public lands managed by the Department of Defense, 3 were managed by the Department of the Interior, and 1 was conducted on privately managed lands. Estimates of occupancy ranged by location within the state (0.04 - 0.71 percent area occupied) and statewide detection probabilities varied (0.09 - 0.48). Combining the recent statewide occupancy assessments with the long-term demographic monitoring plots has resulted in a more refined understanding of the status of Sonoran Desert Tortoises across a broader range of management types and practices.

Occupancy and Habitat Use of Sonoran Desert Tortoises on Yuma Proving Ground: A New Hope

Daniel J. Leavitt[*1], *Hillary A. Hoffman*[1], *and Daniel Steward*[2]
[1]Wildlife Contracts Branch, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix, AZ 85086, USA; E-mail: dleavitt@azgfd.gov
[2]U.S. Army Garrison Yuma, IMYM-PWE, Yuma, AZ, USA

In 2014, we returned to the United States Army Yuma Proving Ground to conduct occupancy surveys for Sonoran Desert Tortoises (*Gopherus morafkai*). Rising concern regarding the Sonoran Desert Tortoise across its range in Arizona resulted in further effort to understand a population on the western edge of its distribution. We conducted a focused survey in the Trigo and Dome Rock Mountains of Yuma Proving Grounds to determine Sonoran Desert Tortoise occupancy and habitat use. Previous surveys of the military base suggested that this was a low density population. Here we provide evidence contrary to previous assessments. Between March

and October we detected 20 tortoises on 32 occasions during occupancy surveys. Of these, we placed GPS tracking units on 9 tortoises to enhance our understanding of Sonoran Desert Tortoise habitat use on the western edge of their range. Here we will report on the status of this population, what we have learned about their habitat use patterns, how this survey compares to previous surveys, and what we expect continued surveys will tell us.

Into the Wild: Post-release Survival of Headstart, Juvenile Desert Tortoises at Edwards Air Force Base

Jeremy Mack[1], Misty Hailstone[2], Kristin H. Berry[1], and Tom Mull[2]
[1]U.S. Geological Survey, Western Ecological Research Center, 21803 Cactus Ave., Suite F
Riverside, CA 92518; Email: jmack@usgs.gov
[2]Environmental Resources and Planning, 412 CEG/CEVA, Edwards Air Force Base, CA 23524

Edwards Air Force Base initiated a head start program in 2002. Head start pens were stocked with eggs through 2006. The release of surviving juveniles commenced in 2013 and has occurred in three seasonal groups: (1) Fall 2013—35 juveniles released at a study site near Leuhman Ridge; (2) Spring 2014—36 juveniles released at the Baker–Nunn study site, approximately 23 km west of Leuhman Ridge; and (3) Fall 2014—48 additional juveniles released at the Leuhman Ridge site. No juveniles remained in the head start pens as of October 2014. Together, 119 juveniles have been released and as of January 2015, 86 are known to be alive, 8 are dead and 25 are missing. The majority of dead animals appear to have been killed by small mammals and ravens. One juvenile potentially died of exposure to cold temperatures, after a small mammal attack in winter forced it out of a burrow and into a shallow pallet. In general, larger juveniles moved greater distances and had larger home ranges than smaller juveniles. Seasonal shifts in condition indices occurred, e.g., Group 1 tortoises showed an increased condition index in spring of 2014 with the median value approaching the prime index level of 0.64. However, the seasonal decline in condition index, which typically occurs in fall, was larger in magnitude than anticipated, and the median value fell below 0.45, a level expected for dehydrated tortoises. Group 2 tortoises, released in spring of 2014 also exhibited a median value below 0.45 in fall of 2014. Differences exist between the two release locations including topography, vegetation cover and proximity to anthropogenic influence. Future plans include quantifying differences between release locations and identifying habitat characteristics that enhance survival.

Teaching Ravens to Do the Right Thing: Insights from Scaring Crows

John M. Marzluff, Professor of Forestry Sciences
School of Environmental and Forest Sciences, University of Washington, Seattle, WA 98195
Email: corvid@uw.edu

Starting with the premise that wanton killing of sentient and culturally important species, such as the Common Raven (*Corvus corax*), is socially unacceptable; I discuss the neuroecology of corvids with an aim toward understanding how managers may devise effective means to

reduce raven predation on rare prey species. Corvids have large and complex brains that assess their surroundings and quickly associate reliable environmental cues with rewards and punishments. They are long-lived, social, and territorial; life history traits that enable managers to teach specific individual birds what is not 'acceptable' behavior. Our research on American Crows (*Corvus brachyrhynchos*) has demonstrated that they learn to avoid places and people associated with bad experiences (capture or association with a dead conspecific). These conditioned behaviors are long lasting (with a social species and moderate reinforcement dangerous people maybe recognized for >8 years and places are avoided for weeks). I propose that managers could take advantage of the long lifespan, instantaneous learning, and resident nature of adult ravens to instill in them a fear of desert tortoises, the people who associate with them, and likely their associated trappings (trucks, dogs, and the like). Conditioning ravens to avoid an area or potential prey species may be most effective if it is done repeatedly, consistently, and in a natural foraging setting.

Desert Tortoise Council Activities – 2014

Bruce K. Palmer, Chairperson
Board of Directors, Desert Tortoise Council
Jacobs Engineering Group Inc., 101 North First Avenue, Suite 2600, Phoenix, Arizona 85003
Phone: 623.980-9178; Email: bruce.palmer@jacobs.com

The Desert Tortoise Council Board of Directors has a full complement of 15 active members; about half have severed for less than two years. With 40 years of success hosting symposia, the Board recognized a very troubling situation. Despite our hard work, tortoise populations continue to decline. The Board asked: "Where are we in meeting the Council's goals?" and "How can we do better?" To answer these and other questions, the Board held a 2-day strategic planning session, which was facilitated *pro bono* by Solution Strategies International, and resulted in the preparation of our Five-year Strategic Plan 2015-2020. The essential components of that plan are:

Mission (established in bylaws): To assure the perpetual survival of viable populations of the desert tortoise

Five-year Vision: To be the premier organization representing the tortoise, and a leader in tortoise recovery and habitat protection

Five-year Strategic Goals:

1. To be the primary resource for scientific information about the tortoise, and to host annual symposia and workshops
2. To strengthen the organizational integrity of the Council and Board
3. To engage our membership in tortoise conservation efforts
4. To engage and collaborate with agencies to support tortoise conservation
5. To provide a structure for long-term funding
6. To facilitate effective implementation of tortoise conservation through funding, collaboration, and persistence

Developing the plan provided a focus for Board actions. Work this year included:

- Maintaining an active Ecosystems Advisory Committee, providing comments on 12 proposed actions affecting tortoises, including the potential far-reaching consequences of the Desert Renewable Energy Conservation Plan
- Providing $16,144 to fund 4 grants, including development of habitat restoration best management practices
- Hosting two workshops attended by 144 participants
- Improving our Membership Database to facilitate communications with over 500 active members and 1,800 past members through social media, newsletters, and website
- Developing new operational procedures to assure consistent Board decision making
- Growing the net worth of the Council to approximately $285,000
- Hosting the 40th Annual Symposium, with new logo

For 2015 the Board will focus on the development of a series of "Best Management Practices" for the tortoise and its habitat. The Board is working to develop an advanced tortoise techniques workshop, and a Morafka's tortoise workshop in Arizona. The Board encourages submittal of grant proposals (see website for priorities and process). More work must be done to assure tortoise conservation. If you are interested in serving on committees (especially the Ecosystems Advisory, Membership, and Social Media committees) please speak with any current Board member.

Mycoplasma agassizii Are Unable to Grow or Survive in Soil from Burrows of Desert Tortoises

Ashley Orlowski[1], Leslie Tabor-Simecka[1], Josephine Braun[2], Nadine Lamberski[3], Mary B. Brown[4] and Jerry W. Simecka[1]

[1]University of North Texas Health Science Center, Fort Worth, TX
Email: jerry.simecka@unthsc.edu
[2]San Diego Zoo Institute for Conservation Research, Escondido, CA
[3]San Diego Zoo Safari Park, Escondido, CA
[4]University of Florida, Gainesville, FL

One of the areas of concern is whether *M. agassizii* can survive in the environment, particularly in the burrows, in sufficient numbers to help foster the spread of infection between tortoises. To examine this hypothesis, two different strains of mycoplasma (Strains PS16 and PS17) were tested for their ability to survive at higher temperatures, e.g. 37 C. SP4 medium was inoculated with the organism and placed in either 30 or 37 C incubators. Samples were taken at various time points, and it was found that mycoplasma grew at 30 C but not at 37 C. Furthermore, samples grown at 37 C for 24 hrs were transferred to a 30 C incubator, and there was some growth of mycoplasma. After 48 hrs at 37 C, there was no growth in strain PS16 after shifting to 30 C. In contrast, strain PS17 was able to be recovered at both time points. Mycoplasma numbers were determined by color changing units (CCU) and quantitative real-time PCR (qPCR). Soil samples from burrows at the Desert Tortoise Conservation Center (DTCC) were obtained. Using qPCR, we were unable to detect mycoplasma DNA in any of the soil samples tested. To test the ability of mycoplasma to grow in soil, the soil samples were sterilized by autoclave, and they were inoculated with mycoplasma in SP4 medium broth. The samples were incubated at 30 C for up to 72 hours with samples taken at various time points. Mycoplasma numbers were determined, and there were no increases in mycoplasma numbers

found. Nor was there any indication of their survival. Thus, some strains of *M. agassizi* may survive well in nutrient rich medium for at least short periods at higher temperatures, not optimal for growth, but they do not survive well in moist soil. These results indicate that environmental contamination within burrows is likely not a common mechanism of spread of infection.

Sonoran Desert Tortoise Surveys and Conservation Efforts on ASARCO Mine Properties in Southern Arizona

Vesna Perovic[1], Nancy Johannesmeyer[2], Tom Klempel[3], and J. Daren Riedle[4]*
[1]ASARCO Ray Ops, 27809 Mineral Creek Road, Kearny, AZ 85137, USA;
E-mail: *vperovic@asarco.com*
[2]Silver Bell Mining, LLC, Marana, AZ, USA; E-mail: *njohannesmeyer@asarco.com*
[3]ASARCO Mission Complex, Sahuarita, AZ, USA; E-mail: *tklempel@asarco.com*
[4]Enivronmental Planning Group, Phoenix, AZ, USA; E-mail: *driedle@epgaz.com*

The United States Fish and Wildlife Service (USFWS) recently determined that the Sonoran Desert Tortoise, *Gopherus morafkai*, warranted listing under the endangered species act, but listing was precluded due to higher priority actions. In light of these recent decisions there has been momentum by federal, state, and private land owners to initiate proactive conservation measures. During 2014 ASARCO initiated baseline surveys on the Mission and Silver Bell Mines to determine presence/absence, densities and potential threats to Sonoran Desert Tortoises. Suitable habitat on Mission Mine was minimal, so six 3-ha sites were surveyed one time to determine the presence or absence of Sonoran Desert Tortoises on site. Four adult tortoises were observed, and observations were isolated to pockets of suitable habitat. Silver Bell Mine is located in the Silver Bell Mountains, and represent Sonoran Upland habitat typically used by Sonoran Desert Tortoise. Undisturbed areas on Silver Bell Mine represent important linkages between populations on the Ironwood Forest National Monument to the north and east, and populations on the Tohono O'odham Nation to the South and West. Fifteen 3-ha plots were surveyed four times from August-September of 2014. Surveyors made 73 observations of 68 individual tortoises. Occupancy of surveyed plots was estimated at 0.97 (0.11-0.97) and the population estimate was 224 ± 78 tortoises. Efforts were made during the course of the survey work to identify site specific threats for each mine, which will in turn shape future management actions concerning tortoises. In the immediate future this includes initiating additional surveys and clearance efforts on both mines.

Re-evaluating the Spatial Genetic Structure of Agassiz's Desert Tortoise Using Landscape Genetic Simulations

Yessica Rico[1], Taylor Edwards[2], Kristin H. Berry[3], Alice E. Karl[4], Brian T. Hennen[5], Robert W. Murphy[1]

[1]Royal Ontario Museum, Toronto, Canada, M5S 2C6
Email: yessica.ricom@gmail.com; bob.murphy@utoronto.ca;
[2]University of Arizona Genetics Core, Tucson, Arizona 85721. Email: taylore@email.arizona.edu;
[3]USGS Western Ecological Research Center, Riverside, CA, 92518. Email: kristin_berry@usgs.gov;
[4]Davis, CA, 95617. Email: heliophile@mindspring.com;
[5] MAGTFTC Twentynine Palms, CA 92278. Email: brian.henen@usmc.mil

Patterns of genetic structure are fundamental to inform conservation management of threatened and endangered species. Reliable evaluations of spatial genetic structure and genetic boundaries require sound sampling strategies because inappropriate sampling can misidentify barriers to gene flow and distinctive genetic groups. Most population genetic studies on widespread species are not based on uniform or random sampling due to logistic and economic limitations. This has occurred in population genetic studies for Agassiz's Desert Tortoise, *Gopherus agassizii*. Studies report notable differences in genetic structure and this may owe to sampling biases. To test for sampling biases, we conducted landscape genetic simulations (n = 10 replicates) across 70% of *G. agassizii* range from the eastern Colorado River to Lower Virgin River to replicate a model of isolation by distance (IBD) parameterized based on observed dispersal distances of *G. agassizii*. Spatial genetic structure of simulated genotypes was evaluated using two sampling regimes, random sampling and systematic sampling (researcher defined sampling locations within recovery units). We contrasted simulated genetic patterns with empirical data for 668 tortoises genotyped at 25 microsatellite loci sampled systematically within recovery units. Mantel correlations of geographical distances and genetic distances of simulated genotypes show a significant IBD of $r = 0.3$ ($p<0.01$), which is similar to the empirical data ($r= 0.22$, $p<0.01$). Genetic clustering analysis for the systematic sampling data shows a slightly higher identification of distinct genetic clusters ($k= 2$ to 4) compared to the random sampling data ($k = 2$ to 3). However, both sampling strategies show a genetic discontinuity between the southwest of the Western Mojave Recovery Unit and the east of the Colorado Recovery Unit. This genetic discontinuity is similar to the patterns shown by the empirical data, which suggests that the Western Mojave unit is not genetically uniform. The simulated IBD pattern cannot emulate the marked differentiation shown by the empirical data of Upper Virgin River samples, suggesting that the Upper Virgin River is affected by something besides IBD. Our simulations confirm that genetic variation of *G. agassizii* reflects IBD in most of its range, and that boundaries of current recovery units may not reflect genetic gradients. Computer simulations are a useful tool to investigate competing hypotheses on the genetics and ecology of the species.

Widespread Mortality and Related Population Declines in *Gopherus morafkai*

Philip C. Rosen [1], *Peter A. Holm* [2], *Mercy L. Vaughn* [3], *and Cristina Melendez Torres* [4]
[1] School of Natural Resources & the Environment, University of Arizona, Tucson AZ, 85721 Email: pcrosen@email.arizona.edu
[2] Organ Pipe Cactus National Monument, Rte. 1, Box 100, Ajo, AZ 85321
[3] Paso Robles, CA 93446
[4] CEDES (Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora), Bernardo Reyes 93, San Benito, 83190 Hermosillo, Sonora, México

We assembled evidence for episodes of high mortality and population size reductions from varied sources across the geographic range of Morafka's desert tortoise in the Sonoran Desert region during 1978-2013. Data on mortality episodes came from (1) Bureau of Land Management and Arizona Game and Fish Department study plots, (2) an extensive survey of distribution of the species in Sonora and Sinaloa in Mexico, (3) plot studies on and near Tiburón Island in Sonora, and (4) other field observations in Arizona. Data on population reductions came from the plot studies.

The assembled data show 18 instances of elevated mortality episodes from throughout much of the species' range, with the exception of the tropical deciduous forest of southern Sonora and northern Sinaloa. At least two regions had widespread episodes of high mortality: south-central Arizona and south-central and central coastal Sonora. In south-central Arizona near the transition from relatively less arid Arizona Upland Sonoran Desertscrub to more arid Lower Colorado River Valley Sonoran Desertscrub, elevated mortality associated with a 1987-1990 drought period was found along a long band from Maricopa Mountains through Sand and Sauceda mountains to Organ Pipe Cactus National Monument. In low-lying Sinaloan Thornscrub in south-central Sonora, and in the Central Gulf Coast Sonoran Desertscrub of the Tiburón region, high mortality fractions were found in extensive sampling during 2001-2 and 2005-13.

Study plot data were analyzed using linear and non-parametric statistics after summarizing mortality estimates based on carcasses found, consideration of methodological variation and limitations, and parsing of population estimates. Of 18 monitoring plot studies for which we were able to obtain data, five demonstrated major mortality events and corresponding major population reductions; plot data suggest population increase for one study plot and decrease for at least five additional sites. Overall, results from monitoring plots indicate an overall abundance decline for the species of $\geq 50\%$, which has occurred over ≈ 1 generation, 1987-2008. A jack-knife procedure using sequential data deletion showed that mortality fractions of about 17-20% in field samples of this kind indicate population declines.

The period of record was a time of rising environmental temperature, in tandem with global warming, which was regionally notable from the 1960s and rose steadily to a high point around 2000. We made a preliminary effort to identify climatic correlates of the observed mortality. Among the 18 identified instances of elevated mortality episodes, six were associated with a 1987-90 drought period, at least one was associated with a 1995-97 drought, at least four were associated with severe drought events during 1999-2002, and at least one was associated with a 2010-11 drought. In Mexico, elevated mortality was significantly associated with low elevation, high mean annual temperature, and low mean annual precipitation, consistent with

mortality driven by physiological stress. Based on carcasses found on study plots in Arizona, we constructed a temporal profile of aggregate mortality across 17 sites. Among crude estimators of weather variance (annual means of regional temperature, precipitation, and Palmer Drought Severity Index), the best predictor of annual mortality was two-year running mean of precipitation. However, during this period, annual temperatures were negatively correlated with annual rainfall, and more refined analyses are necessary to rigorously evaluate climate effects.

The climate change literature predicts continued warming through the 21st century with very high certainty in the study region. Precipitation predictions are less certain, but forecast decreasing winter precipitation and more severe drought. With rising temperatures alone, the observations reported here predict that additional and exacerbated drought mortality and abundance declines will continue in *G. morafkai*. If drought severity also increases, anthropogenic climate change will very likely pose a significant threat to this species. More detailed study of climatic factors and further monitoring and more refined analyses of *G. morafkai* populations are needed to better understand the future of this species and to formulate conservation strategies.

Buffelgrass, Induced Pasture, and Thermal Threats to *Gopherus morafkai* in Mexico

Philip C. Rosen [1], *Rafael Lara-Resendiz* [2], *Barry Sinervo* [2], *Cristina Melendez Torres* [3], *and Mercy L. Vaughn* [4]

[1] School of Natural Resources & the Environment, University of Arizona, Tucson AZ, 85721
Email: pcrosen@email.arizona.edu

[2] Department of Ecology and Evolutionary Biology, Earth and Marine Sciences Building A316, University of California, Santa Cruz, CA 95064,

[3] CEDES (Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora), Bernardo Reyes 93, San Benito, 83190 Hermosillo, Sonora, México

[4] Paso Robles, CA 93446

Buffelgrass (*Pennisetum ciliare*) is an exotic perennial bunchgrass widely introduced in northwestern Mexico, especially Sonora, and actively spread by government and private efforts. Centered in the Plains of Sonora desertscrub around Hermosillo, its rapid expansion is driven by a threefold increase of livestock range capacity with conversion of natural habitat to buffelgrass, or "induced pasture". Buffelgrass continues to self-spread into desertscrub and thornscrub in Sonora and is rapidly invading in Arizona. It increases fire, threatening wholesale conversion of thornscrub and arborescent desertscrub to desert grassland. In tropical deciduous forest (TDF) inhabited by *G. morafkai*, native vegetation invades and replaces induced pasture.

Mechanisms of buffelgrass impacts on desert tortoises have been demonstrated: its proliferating fire regime kills tortoises; it also outcompetes preferred plants comprising the diet of *G. morafkai*, and appears thereby to degrade tortoise body condition. Here we demonstrate a third impact mechanism of induced pasture conversion on *G. morafkai*: alteration of thermoregulatory options by changes in T_e, the operative environmental temperature regime available for tortoise activity.

We used copper models shaped like tortoises to portray T_e in three environments in Mexico during October 2012-14, and apply new data (Lara-Resendiz et al. 2015) on thermal ecology of the genetically distinctive *G. morafkai* in TDF to describe T_e effects on tortoise activity. Based on twelve simultaneous days of monitoring, we show that T_e in TDF permits activity for ≈ 3X longer per day than in desertscrub; induced pasture was intermediate but more similar to desertscrub. We estimated that thermally-imposed restriction of activity throughout the warm season was far greater in induced pasture than TDF (6-10 h/d versus 0.4-2.5 h/d).The buffelgrass-altered thermal regime poses a threat to desert tortoises in TDF and likely in tropical thornscrub.

The Long Road to the Book "Biology and Conservation of North American Tortoises"

David C. Rostal, Professor of Biology
Georgia Southern University, P.O. Box 8042, Statesboro, Georgia 30460
Email: Rostal@georgiasouthern.edu; 912-478-5498

In 2008, I proposed the idea to John Hopkins Press to put together a book covering our present knowledge of North American tortoises. Many people had talked about the need for a book like this. I knew that there was a great deal of expertise around the country but there was not a single place you could go to find a review of our current knowledge. I also hoped to bring together researchers from both coasts as well as different levels of experience. In total we brought together 33 researchers from across North America. We tried to give as much coverage to all five species whenever possible. The book begins with a review of the classification of extant species followed by the fossil record and modern systematics. The next section focused on growth, physiology and disease. This was followed by ecology, behavior and life history. Finally, human interactions were covered, both past and present. In addition, we believe it will provide one of the most complete lists of references on North American tortoises in one easily accessible place. We hope the book provides a reference that biologist, managers and enthusiasts interested in tortoises will find valuable and interesting. It has been a long road for all involved and we hope you enjoy the book.

POSTER

A Comparison of Occupancy Study Designs for a Low Density Sonoran Desert Tortoise Population

Chad Rubke[1], Hillary Hoffman[1], Daniel Leavitt[1], and Janet Lynn[2]*
[1]Wildlife Contracts Branch, Arizona Game and Fish Department, 5000 West Carefree Highway, Phoenix, AZ 85086, E-mail: crubke@azgfd.gov
[2]Department of Emergency and Military Affairs, AZARNG, Environmental Office, Phoenix, AZ

Monitoring Sonoran desert tortoises (SDT; *Gopherus morafkai*) empowers resource managers with needed data regarding trends in populations over time. Here we compare two methods to evaluate which design may be more efficient and/or effective. In 2013 we conducted

occupancy surveys for Sonoran desert tortoise on the Arizona Buckeye Army National Guard Training Area. Surveys were conducted on 120, randomly selected, 3 hectare plots. Each plot was surveyed five times from mid-July to mid-October. A total of four individuals were detected on eight occasions, suggesting that the site hosts a relatively low density population of tortoises. In 2014, we again conducted occupancy surveys at the site, but chose a cluster method for plot selection. We generated 71 new plots using observations of scat, carcasses, and live SDTs from 2013. As in the previous year, we surveyed each plot five times from mid-July to Mid- Oct. In 2014, however, both the number of individuals detected and total detections increased by 50%. Because occupancy surveys can be costly both monetarily and temporally, we feel that focusing effort around known occupied plots in areas of low density are better able to inform management decisions.

Whole Genome Resequencing Provides Novel Landscape Genomic Insights for Desert Tortoise Conservation

H. Bradley Shaffer[1], Evan McCartney-Melstad[1], Peter Ralph[2], Gideon Bradburd[3], Richard Tracy[4], Fran Sandmeier[5]

[1]Department of Ecology and Evolutionary Biology, UCLA, 610 Charles E Young Drive East, Los Angeles, CA 90025 Emails: brad.shaffer@ucla.edu, evanmelstad@ucla.edu

[2]Molecular and Computational Biology, 1050 Child Way RRI 201, University of Southern California, Los Angeles, CA 90089 Email: pralph@usc.edu

[3]Center for Population Biology, Department of Evolution and Ecology, UC Davis, 2320 Storer Hall, One Shields Ave, Davis, CA 95616, Email: gbradburd@ucdavis.edu

[4]Program in Ecology, Evolution, and Conservation Biology, Department of Biology, University of NV, Reno, MS 315, Reno, NV 89557, Email: dtracy@unr.edu

[5]Biology Department, Lindenwood University – Belleville, 2600 W Main St, Belleville, IL 26662, Email: Fsandmeier@lindenwood.edu

The field of landscape genetics provides a powerful toolkit for understanding how organisms move across complex environments, and the discipline has been applied with great success to desert tortoise populations. However, inferences from previous work have been limited by the number of available genetic markers and the number and extent of landscape features available for analysis. To address these issues, we consolidated tortoise samples from across their range within California and southern Nevada, generated a DNA dataset consisting of full genomes of 270 tortoises, assembled a set of 83 high-resolution geospatial layers, and analyzed the way in which the geography and environment of the desert tortoise have determined modern patterns of relatedness and genetic diversity across the landscape. Rangewide, Principal Component Analysis (PCA) revealed two major clusters of tortoises split by PC1 that lie north and south of the mountains defining the Ivanpah valley, while PC2 further subdivided the southern group on either side of the low-lying Cadiz valley. These first two axes primarily recapitulated geographic patterns, and explained 8.3% of the variation in the data. Subtle patterns of movement and admixture between these regions were also evident in the data. Twenty of a set of 24 landscape rasters that are maximally uncorrelated are statistically associated with genetic divergence among tortoises after geographic distance is taken into account, suggesting that they explain a great deal of the remaining genetic variation in the data set. Although this work is still underway, preliminary analyses indicate that precipitation and temperature variables are the most

highly correlated with genetic divergence, with smaller, but still significant effects of vegetation, and slope. Our next goals are to build genomically explicit models with different hypothetical placements of alternative energy installations to quantify the future effects of such placements on population viability models over the next century.

Landscape Genomics Aid Restoration of Desert Tortoise Habitat: A Case Study with *Sphaeralcea ambigua* (Malvaceae) in the Mojave Desert

Daniel F. Shryock[1], Caroline A. Havrilla[2], Lesley A. DeFalco[1], Todd C. Esque[1], Nathan A. Custer[1], and Troy E. Wood[3]

[1]U.S. Geological Survey, Western Ecological Research Center, 160 North Stephanie Street, Henderson, NV 89014 (corresponding author: DF Shryock, dshryock@usgs.gov)

[2]University of Colorado, Boulder, CO 80309

[3]U.S. Geological Survey, Southwest Biological Science Center, P.O. Box 5614, Flagstaff, AZ 86011

Local adaptation is widespread across plant taxa and may influence the responses of species to climate change and the effectiveness of their use in ecological restoration. Natural populations are characterized by fine-scale physiological or 41olyphemus411 adaptations that drive intraspecific variability in demographic responses to altered environmental conditions. Restoration techniques that expose plant materials to novel environments (e.g., broadcast seeding) should account for adaptive genetic variability, which may influence seedling establishment and longer-term fitness. Landscape genomic approaches aim to identify environmental drivers of adaptive genetic variability and map spatial patterns of gene / environment associations — information that can guide habitat restoration (e.g., seed sourcing) and improve predictions of species' responses to climate change. There is a clear need for landscape genomic studies of Mojave Desert plant taxa that comprise habitat for the desert tortoise (*Gopherus agassizii*) because both climate change and novel disturbance regimes are expected to impact vegetation throughout this region. We conducted a landscape genomic analysis for an important restoration and forage plant species, *Sphaeralcea ambigua*, by analyzing the variation at 153 amplified fragment length polymorphism (AFLP) loci from 47 Mojave Desert populations. Adaptive allele frequencies were most strongly correlated with summer maximum temperature and indices for vegetation water stress and surface temperature. Variation in adaptive allele frequencies along precipitation and temperature gradients was non-linear, potentially indicating physiological thresholds separating ecotypes. However, a linear relationship between adaptive alleles and temperature seasonality may reflect continuous differences in 41olyphemus411 optima. Two approaches for mapping the predicted patterns of turnover in adaptive allele frequencies are compared. Techniques developed in this study offer a robust approach for deriving spatially-explicit models of adaptive genetic variability in non-model species and providing restoration specialists the guidance needed for collection and use of Mojave Desert plant materials.

Projected Climate Change Impacts on *Gopherus Morafkai* in Tropical Dry Forests

Barry Sinervo [1], *Rafael Lara-Resendiz* [1] *and Philip C. Rosen* [2]
[1] University of California, Santa Cruz, CA
[2] University of Arizona, Tucson, AZ

Recent models of climate change for reptiles premised on ecophysiology project dramatic local population extinctions under climate change. Here we develop a model for *Gopherus morafkai* in Tropical Dry Forest habitats of Mexico, premised on recent findings that this ecotype is a facultative thermoconformer (Resendiz, Rosen and Sinervo). For the period of two years, we measured operative environmental temperatures (T_e) with copper tortoise models in TDF habitats and invasive buffelgrass habitats. The T_e in buffelgrass is greatly elevated relative to intact TDF (Rosen et al. 2015). Moreover, studies of body temperature of *G. morafkai* in the TDF of Mexico indicate they are facultative thermoconformers with a daily average T_b of 28 °C and 32 °C for active individuals (Lara-Resendiz et al. 2015), compared to 35 °C for the heliothermic northern ecotypes of *G. morafkai* in Sonoran desertscrub and tropical thornscrub or for *Gopherus agassizii* in the Mojave Desert. We used the data on T_e and T_b in TDF, along with maps of buffelgrass invasion to predict the likelihood of local population extinction in a species distribution model premised on climate change, demography, habitat type, and ecophysiology. We find that the invasion of buffelgrass poses a serious threat to the *G. morafkai* in TDF of Mexico, due to their lower T_b and the elevation in T_e in buffelgrass. Additional studies on behavioral thermoregulation of field active tortoises moving through TDF and buffelgrass will be required to determine if tortoises can plastically adjust their T_b to the higher levels seen in the *G. morafkai* of Desert Thorn Scrub, which might allow them to persist in the face of climate change.

Colonization of a New Transmission Line by Raptors and Ravens in Southwestern Idaho and Southeastern Oregon.

Karen Steenhof, Research Wildlife Biologist
Owyhee Desert Studies, 18109 Briar Creek Road, Murphy, Idaho 83650
Email: karensteenhof@gmail.com

During the 1980s we monitored the responses of raptors and ravens to a new 500-kV transmission line across southwestern Idaho and southern Oregon. Raptors and ravens started nesting on transmission line towers within a year after towers were constructed. Colonization of the transmission line towers occurred earlier and more rapidly along the stretch of line that paralleled the Snake River Canyon, suggesting that existing canyon-nesting populations were a principal source of birds nesting on towers. Productivity of hawks and eagles nesting on transmission towers was as good as and sometimes better than that of those nesting in the canyon. We documented 13 communal night roosts of Common Ravens on the transmission line, including one roost on transmission line towers within the NCA with more than 2100 ravens. As many as 700 individual ravens roosted on a single tower. Radio telemetry studies revealed that ravens moved an average of 7 km and as far as 60 km from transmission line roosts each day. Our findings have had implications for where the Gateway West 500-kV transmission line should be routed.

Preliminary Assessment of a Small-scale Relocation in the Sonoran Desert Tortoise (*Gopherus morafkai*): Comparisons with Residents

Brian K. Sullivan[*1], *Audrey K. Owens*[2], *Keith O. Sullivan*[1,3], *and Elizabeth A. Sullivan*[1]
[1] School of Mathematics and Natural Sciences, Arizona State University, PO Box 37100, Phoenix, AZ 85069, USA; E-mail: bsullivan@asu.edu
[2] Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, USA
[3] Wildlife Contract Branch, Arizona Game and Fish Department, Phoenix, AZ, USA

We continue our radio-telemetry study of *Gopherus morafkai* on the northern edge of Phoenix metropolitan region along the eastern edge of the Union Hills. Preliminary results provide insights on consistency in refuge use seasonally, and movements associated with foraging behavior in the fall for residents and relocated subjects. Most subjects, adults and juveniles included, exhibited movement from lower elevation (ave = 450 m) areas associated with drainages to relatively higher elevation (ave = 550 m), north-facing slopes (aspect = 320° to 40°) following the monsoon rains, apparently to forage on abundant and diverse plants on those slopes. Straight-line distances to reach north facing slopes ranged from 250 to 1000 m, and the north slopes were occupied during September and October of each year, prior to individuals returning to lower elevation washes and entering over-wintering refuges by mid-November. These results continue to support the notion that tortoises in this population exhibit a pattern of annual migration for forage. In fall, 2013, as a result of issues with tortoise activity on flood control structures maintained by Maricopa County (dams and dikes), four subjects were removed from these structures to insure their safety and the integrity of the dams and dikes. These two females and two juveniles, which had been tracked for a 6 – 18 months, were released near the remaining radio-tagged tortoises, a population now numbering 26 radio-tagged subjects (9 ♂♂, 15 ♀♀ and 2 juveniles). Relocated individuals made similar movements to other radio-tagged tortoises after the monsoon: all four individuals were found in the vicinity of residents in the upslope areas. Patterns of refuge use and levels of activity of relocated subjects will be compared with residents; some effects of relocation appear to persist after 12 months post-release.

POSTER

Distribution of the Sonoran Desert Tortoise in Arizona

Keith O. Sullivan[*1], *and Daniel Leavitt*[1], *Hillary Hoffman*[1], *and Sabra Tonn*[2]
[1]Wildlife Contracts Branch, Arizona Game and Fish Department, 5000 West Carefree Highway, Phoenix, AZ 85086, USA; E-mail: kosullivan@azgfd.gov
[2]Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ, USA

In 1983, the Arizona Game and Fish Department began compiling Sonoran Desert Tortoise location data throughout their range in Arizona. These data, managed by the Heritage Data Management System (HDMS), extracted from a variety of sources, represent the most comprehensive distribution data for the species in Arizona. These data allow us to make inferences regarding the tortoise's preferred habitats as well as identify unique populations. For example, records from Santa Cruz County occur within a transitional zone between biotic communities not commonly thought of as Sonoran desert tortoise habitat. This poster will exhibit

the dataset and highlight other records of interest throughout the species' range in Arizona. Understanding this naturally occurring variability allows managers to make more informed decisions regarding Sonoran desert tortoises and their habitats.

STUDENT PAPER

Divergent Evolution of Sexual Size Dimorphism in North American *Gopherus* Tortoises

Michael W. Tuma
University of Southern California, Department of Biological Sciences
Email: mtuma@usc.edu

Size differences between sexes of the same species are a common feature of many higher life forms, with expressions of both male-biased and female-biased dimorphisms. Understanding the sexual and natural selection pressures that contribute to the evolution of the diverse expression of sexual size dimorphism (SSD) is critical because this trait is intricately linked to and likely co-evolves with other major life history variables, including growth and reproduction. Researchers have suggested that terrestrial turtles, including tortoises, have evolved predominantly male-biased SSD due to the advantage that large body size confers to males during male-male combat. However, previous reviews of SSD expression in tortoises have relied on small sample sizes, secondary sources of information, and the inclusion of other inappropriate data that led to possibly flawed conclusions about the distribution and evolution of SSD expression within the family. Here, I 1) present an analysis of body size variation in Agassiz's desert tortoise, making the case for the exclusive use of locality-specific data when assessing SSD; 2) provide a systematic review of the diversity of SSD expression in the Testudinidae; and 3) examine the conditions that have contributed to the evolution of the divergent expression of this trait in the North American *Gopherus* tortoises. Adult body size varies significantly across the range of Agassiz's desert tortoise, underscoring the need to assess SSD using population-specific data. Using this and other criteria, SSD expression in 31 species of tortoises could be reliably assessed, of which 13 (41.9%) exhibited male-biased SSD and 18 (58.1%) exhibited female-biased SSD. Within the *Gopherus* tortoises, the *agassizii* clade (*G. agassizii*, *G. berlandieri*, and *G. morafkai*) exhibits male-biased SSD and the *44olyphemus* clade (*G. flavomarginatus* and *G. 44olyphemus*) exhibits female-biased SSD, which is a consequence of divergent evolutionary pathways reflective of their different morphological and behavioral adaptations.

Mortality and Survival of Juvenile Agassiz's Desert Tortoises at the Fort Irwin Study Site

Michael W. Tuma[1, 2]; L. Scott Hillard[3]; and Kenneth A. Nagy[4]
[1]ECORP Consulting, Inc., 215 N 5th Street, Redlands, California 92374
Phone: (909) 307-0046 Email: mtuma@ecorpconsulting.com
[2]University of Southern California, Department of Biological Sciences
[3]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, 90095-1606
Phone: (310) 963-0552 Email: hillard@earthlink.net
[4]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, 90095-1606
Phone: (310) 825-8771 Email: kennagy@biology.ucla.edu

We determined causes of mortality and assessed survivorship trends among various size/age classes for juvenile Agassiz's desert tortoises tracked over an eight-year period at the Fort Irwin Study Site (FISS) in San Bernardino County, California. An understanding of the causes of mortality for juvenile Agassiz's desert tortoises, and how those sources of mortality contribute to survival, is critical for the development of accurate population models and life tables, and the conservation and management actions that stem from them. We fitted 55 sampled juvenile tortoises (53 head-started and two wild-caught) with radio transmitters and tracked their survival and to assess their causes of mortality. We analyzed differences in survivorship and causes of mortality between tortoises < 110 mm MCL and tortoises ≥ 110 mm MCL. Survivorship of juvenile tortoises ≥ 110 mm MCL was significantly greater than survival of tortoises < 110 mm MCL. The majority (74.1%) of juvenile tortoises < 110 mm MCL that died succumbed to predation by ravens, whereas most (66.7%) of the juvenile tortoises ≥ 110 mm MCL that died were preyed upon by canids. Three predators (common raven, canids [coyote and desert kit fox], and bobcat) left distinct signatures on each of the tortoise carcasses, which we describe. Common ravens appear to pose a substantial risk to Agassiz's desert tortoise populations in the vicinity of FISS and other parts of the central and western Mojave Desert, and we recommend the use of raven control measures and head starting of juvenile tortoises to a size of ≥ 110 mm MCL to mitigate their effects.

Desert Tortoise Management and Research in Joshua Tree National Park

Michael Vamstad, Wildlife Ecologist
Joshua Tree National Park, 74485 National Park Drive, Twentynine Palms, CA 92277

Joshua Tree National Park (JOTR) protects nearly 800,000 acres of public land of which 240,000 is considered high quality desert tortoise habitat. The park has supported the recovery of the tortoise through participation of region wide planning efforts, management of habitat, educational outreach and scientific research.

JOTR managers are active participants in the Desert Managers Group (DMG) that promotes the recovery of the tortoise through education, information exchange and research. The park is also active in the Colorado Desert workgroup under the California Mojave RIT to guide future recovery efforts in the region.

Within the park, educational specialists provide desert tortoise educational presentations to many of the local (Morongo Basin and Coachella Valley) schools. The park also has an active habitat restoration program that works to return impacted habitats to functional ecosystems for tortoises and other plants and animals.

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

Linking Demography, Resource Use, and Predatory Behavior of Common Ravens Across Ecosystems

William Webb, Wildlife Biologist
Foothill College, 12345 El Monte Road, Los Altos, CA 94022 Email: williamwebb35@gmail.com

In several locales, observers hypothesize that human activities promote increasing numbers of ravens and predation by ravens explains decreasing numbers of some sensitive species. However, a true understanding of raven population ecology and associated effects on prey requires understanding the relationship between raven resource use with demographic parameters, space use and predatory behavior. Greater insight into these connected processes promotes more informed management. Demographic and behavioral studies in starkly different ecosystems - the Mojave Desert and temperate rainforests of western Washington - illustrate relationships between resources, raven behavior and demographic parameters. In the Mojave, nest proximity to anthropogenic resources and earlier fledging dates predicted raven juvenile survival to departure from the natal territory. After dispersal, the positive effect of nest proximity to anthropogenic resources influenced survival for at least 9 months after fledging. Conspecifics and confined livestock feeding operations represented important resources for juvenile ravens, and juveniles were rarely located in open desert. In Washington, breeding ravens survived at higher rates than nonbreeders, due to exclusion by breeding ravens of those resources positively associated with survival, including mature forests and most anthropogenic land use types. Breeding raven use of clearcuts and patchy forests contributed to increased reproduction, but the use of clearcuts along with the use of roads was negatively associated with survival due to illegal shooting. Nonbreeders moved widely, were more gregarious, and their home ranges intersected a greater proportion of communal food resources than did those of breeders. Raven abundance and the presence of experimental food bonanzas were associated with an increased risk of predation by ravens on simulated passerine nests at every spatial scale of analysis. Increased forest structure was related to decreased risk of raven nest predation at the two smallest spatial scales of analysis. Clearcuts and high-contrast edges were also associated with increased nest predation.

STUDENT PAPER

Passengers in a Tortoise Nose

Chava L. Weitzman[*1], *Franziska C. Sandmeier*[1,2], *C. Richard Tracy*[1]
[1]Department of Biology MS 314, University of Nevada, 1664 N. Virginia St., Reno, NV 89557, USA; Email: clweitzman@unr.edu
[2]Biology Department, Lindenwood University - Belleville, Belleville, IL, USA

Upper respiratory tract disease has been detected in tortoises throughout the genus *Gopherus*, and understanding the prevalence of disease within this genus continues to be important for developing policy for conservation. Here, we present work on nasal lavage samples across the genus, putting Morafka's tortoise, *G. morafkai*, in context with its congeners. Our analyses address the prevalence of two bacterial species associated with upper respiratory tract disease, *Mycoplasma agassizii* and *M. testudineum*. We additionally present a view of bacterial community composition and diversity from nasal samples assayed with 454-pyrosequencing.

We sampled 31-60 individuals in each of four *Gopherus* species, including three geographically separate locales for each species except the gopher tortoise, *G. polyphemus*. *M. agassizii* has been detected in our samples in each of these four species. Pyrosequencing assays have returned up to 14500 sequences in a sample. While the quantity of sequences is correlated with bacterial species richness, it is not correlated with Shannon diversity, which varies greatly across the genus. *G. morafkai* samples have a wide range of levels of bacterial diversity, spanning levels present in each of the three other North American tortoise species. Additionally, bacterial communities present in *G. morafkai* samples are more similar to those in *G. polyphemus* than to either of the other two tortoise species sampled. Our bacterial assays have also detected *Pasteurella testudinis*, another bacterium that may be associated with respiratory disease, in many to most of the samples of each *Gopherus* species.

These data and analyses will contribute to understanding the roles of disease-associated bacteria within the nasal bacterial communities. Our sampling will be expanded to include additional sites for *G. polyphemus.* Future analyses will also use blood samples to assess efficiency and levels of innate and acquired immunity to combat respiratory disease.

Conservation Under the Shadow of Solar Energy

Robert Wood, Board of Directors
Desert Tortoise Preserve Committee, Inc., 4067 Mission Inn Avenue, Riverside, California 92501
Email: mosheh.wolf@tortoise-tracks.org

At the present, the Desert Tortoise Preserve Committee faces serious challenges to its mission, the major being the Desert Renewable Energy Conservation Plan, which threatens the integrity, or even the existence, of the Desert Tortoise Research Natural Area – the central achievement of the Desert Tortoise Preserve Committee (DTPC). Other than that, the West Mojave Plan and the expansion of China Lake Naval Air Weapons Station each provide challenges to desert tortoise habitat owned and managed by the DTPC. Despite all that, the DTPC continues to pursue its mission: acquiring land for desert tortoise conservation,

developing management plans, restoring damaged habitat, and engaging in outreach and education activities. In 2014, the DTPC acquired 330 acres of desert tortoise habitat, hosted three events in the Desert Tortoise Research Natural Area (DTRNA) and adjacent areas, in which volunteers participated in monitoring and stewardship activities. Volunteers monitored desert tortoise habitat owned by the DTPC around Pilot Knob in the central Mojave Desert, around the DTRNA in the western Mojave Desert, in the Piute Mountains Wilderness area in the eastern Mojave, and next to Harper Dry Lake, central Mojave Desert. Education and outreach activities included the Naturalist Season at the DTRNA, booths at Desert Tortoise Days in California City, presentations to organizations and schools, and expansion of online presence. Finally, despite the present danger to the DTRNA, the DTPC is developing plans to have the DTRNA expanded, to provide for changes in the distribution of tortoise habitat caused by climate change.

The Northwest Mexico Tortoise Project; 15 Years of Sweaty Science

Peter Woodman
Kiva Biological Consulting, Inyokern, California; Email: kivabio@aol.com

The Northwestern Mexico Tortoise project was initiated in 2001 by Mercy Vaughn and Dr. Alice Karl working with the Seri Tribal Government on their lands in coastal Sonora, MX. The project was initiated to determine the cause of a recent die-off observed by the Seri people. In 2005 a much larger study was initiated as a multi-institutional collaborative effort to look at various aspects of desert tortoise health, genetics and ecology throughout its range in Mexico. Many biologists and personnel from Mexico and the United States came together to support the project. The primary collaborative agency in Mexico since 2005 has been CEDES (Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora). We have worked closely with María-Crístina Meléndez who has facilitated the project in Mexico. In addition to the project leads a number of specialists took responsibility for their areas of expertise: Dr. Kristin Berry and Dr. Mary Brown—health; Taylor Edwards and Dr. Robert Murphy—genetics and taxonomy, Dr. Phil Rosen and Dr. Alice Karl—distribution, morphology and habitat use; and most recently, Dr. Barry Sinervo—effects of climate change on the *Gopherus* complex. The project has been featured in non-scientific publications as well as on public television. It has been presented at numerous scientific symposia, and one manuscript on health has been published while several others are currently in preparation or in press (genetics, and climate change effects). The project data have also been included in a report to the U.S. Fish and Wildlife Service to be used in consideration of the proposed ESA listing of *Gopherus morafki*.

While funding over the years has come from a hodgepodge of sources, what has truly made this project possible is the large number of skilled volunteer biologists who have donated their time, expertise, and money over the past 15 years. In addition to the more than 70 field biologists from the U.S. and Mexico, a few of whom have participated since 2001, we would like to note that this project would not have been possible without the consistent cooperation of CEDES and particularly Crístina Meléndez for her acquisition of permits and getting us safe access to more than 30 ranches on our 15+ research trips. We also want to recognize the many landowners who gave us access to conduct this research on their lands, and the ranch-hands that

led us to tortoise habitat. The results of this 15 years of work is dedicated to all who came together to make it happen.
