ABSTRACTS

50th Annual Meeting and Symposium
A hybrid and in-person event
February 25, 26, 27, and 28, 2025

FIFTIETH ANNUAL MEETING AND SYMPOSIUM OF THE DESERT TORTOISE COUNCIL

Hybrid: in person and virtual by Zoom
Tuesday, Wednesday, Thursday, and Friday, February 25–28, 2025

ABSTRACTS OF PAPERS AND POSTERS

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

Drone-Based Radio Tracking and Photographic Survey Methods: Recent Developments

Matthew S. Bandy
Resi Solutions, 11420 Ranchitos Rd NE, Albuquerque, NM 87122, USA.
Phone: 505-552-2724, Email: matt@resi.solutions

This paper will discuss recent developments in drone-based methods for locating, identifying, and monitoring Mojave desert tortoise (*Gopherus agassizii*) individuals and populations. Presentations in the previous two symposia have focused on the AI-assisted computer vision approaches that Resi has developed to conduct drone surveys and derive density and abundance estimates at a fraction of the level of effort required for pedestrian methods. Incorporation of improved sensors and aerial platforms have further reduced the time and cost of these surveys in the past year. A 2024 survey conducted of a 5,000-acre project area in Clark County, Nevada will be described and compared with previous surveys to illustrate these improvements.

Also in 2024, with grant support from the Desert Tortoise Council, Resi conducted tests of a drone-based radio tracking system for sue with telemetered Mojave desert tortoise populations. These tests were broadly successful, and we will describe the technology, survey methods, and results. Tracking flights were conducted at two USFWS g0 monitoring sites, as well as the the Boulder County Conservation Easement. The principal advantages of the drone tracking method were the speed with which animals could be located and the enhanced detection distance. The primary disadvantage was the limited location accuracy. An approach will be proposed to address this drawback.

Desert Tortoise Management in the California Desert Conservation Area: West Mojave Route Designation Struck Down Again

Lisa Belenky[1] and Ileene Anderson[2]
[1] Senior Counsel, Center for Biological Diversity. Phone: (510) 844-7107
Email: lbelenky@biologicaldiversity.org
[2] California Deserts Director, Senior Scientist. Email: ianderson@biologicaldiversity.org
Center for Biological Diversity, 2100 Franklin Street, Suite 375, Oakland, CA 94612

The Center for Biological Diversity has worked for decades to support survival and recovery of the desert tortoise and its habitat in California using science-based advocacy, administrative processes, public information, and litigation. Beginning in 1999 the Center brought litigation against the Bureau of Land Management challenging its failure to protect the survival and recovery of listed species, including the desert tortoise, in the California Desert Conservation Area. That litigation resulted in a settlement in 2000 and eventually lead to the adoption of bio-regional management plans across the CDCA. For the West Mojave bio-region, BLM undertook route designations over the course of many years culminating in 2003 and in 2006 issued a Record of Decision incorporating those route designations and additional plan amendments. After litigation from the Center and other groups, the route designations adopted in 2006 was found unlawful on various bases. *Ctr. for Biological Diversity v. United States BLM*, 746 F. Supp. 2d 1055, 2009 U.S. Dist. LEXIS 90016 (N.D. Cal., 2009). After a prolonged remand period, in 2019, the BLM adopted new route designations and several plan amendments. In 2021, the Center and others, including the Desert Tortoise Council, filed suit against the 2019 plan amendments, route designation, and the biological opinion issued by the Fish and Wildlife Service. On October 15, 2024, the 2019 route designation and several of the plan amendments were again found unlawful under NEPA, FLPMA and the ESA and the biological opinion violated the ESA. *Ctr. for Biological Diversity et al. v. Culver, et al*., No. 21-cv-07171-SI, 2024 U.S. Dist. LEXIS 187610 (N.D. Cal. Oct. 15, 2024). This presentation will provide a detailed look at the Court's decision with a focus on the desert tortoise related issues.

The Court found that although the BLM had compiled voluminous amounts of information about the routes and resources, it had failed to show how it had utilized that information in the route designation process "with the objective of minimizing impacts on the desert tortoise, the Lane Mountain milk-vetch, and other resources" as required under the regulations. As the Court put it: "There is no discussion in the FSEIS about how designating thousands of miles of OHV Open and Limited routes in desert tortoise critical habitat and ACECs aligns with the objective of minimizing impacts to this threatened species." The Court also explained that this failure to address minimization in the route designation process could not be cured by relying on "optional, post-designation 'mitigation' measures." Three of the plan amendments were also found invalid: adopting competitive routes; opening three dry lake beds to ORV use; and ending the ORV permit system in the Rand Mountains-Freemont Valley Management Area. The Court also found BLM had violated the Clean Air Act conformity regulations and violated NEPA with regards to analysis of air quality impacts including GHG impacts.

The Court found in BLM's favor regarding adoption of a plan amendment that removes the cap on routes at the 1980 level *in the West Mojave only*, the sufficiency of its inventory of resources, and on several NEPA issues.

The Court's detailed discussion of the ESA's requirements and the biological opinion issued by the Fish and Wildlife Service addressed its failure to utilize the best available scientific information particularly with regard to the severity of the threat to tortoise from the route network designation and how reducing those threats could benefit tortoise populations and its critical habitat. The Court also found that the FWS had failed to properly address the prospects for recovery of desert tortoise populations in the West Mojave (which are crashing) and that FWS could not rely on "unenforceable, non-specific commitments by the BLM regarding mitigation and minimization measures through BLM's adaptive management program" to conclude that there would be no jeopardy to the species. The Court also invalidated the incidental take statement which relied on a surrogate approach that was "internally inconsistent and unsupported by the record" and because the ITS failed to include required reasonable and prudent measures and terms and conditions to minimize impacts to the desert tortoise. Because the Court found that the biological opinion was invalid, it also found that BLM violated the ESA in relying on it.

Tortoise Protection and Recovery: Death by a Thousand Cuts

Lisa Belenky,[1] Ileene Anderson,[2] and Patrick Donnelly[3]

[1]Senior Counsel, Center for Biological Diversity, 2100 Franklin Street, Suite 375, Oakland, CA 94612, Phone: (415) 385-5694 Email: lbelenky@biologicaldiversity.org

[2] California Deserts Director, Senior Scientist, Center for Biological Diversity, 2100 Franklin Street, Suite 375, Oakland, CA 94612. Phone: 323-490-0223. Email: ianderson@biologicaldiversity.org

[3]Great Basin Director, Center for Biological Diversity, 7345 S. Durango Dr., B-107 Box 217, Las Vegas, NV 89113, Phone: 702-483-0449 Email: pdonnelly@biologicaldiversity.org

The Center for Biological Diversity continues our long-standing work to support survival and recovery of the desert tortoise and its habitat in California, Nevada, Arizona, and Utah, and the gopher tortoise in the southeast United States using science-based advocacy, administrative processes, public information, and litigation. Natural and man-made threats to desert tortoise from development of new roads and routes, off-road vehicle use, mines, transmission lines, expanded military training, and large-scale renewable energy projects are increasing. Direct habitat loss, increasing habitat fragmentation and loss of connectivity impair the tortoise's ability to seek more suitable habitat in a changing climate. In addition, the spread of non-native plants and increased fire and predation are pushing the desert tortoise farther from recovery. While some efforts have been made to protect and recover tortoise populations, including through headstarting programs and other translocations to salvage tortoises moved out of large swaths of habitat lost permanently due to other uses, overall desert tortoise populations continue to decline is most areas and the amount of high-value habitat is shrinking.

In addition to the West Mojave litigation, over the past year the Center has also continued to engage with other planning and projects affecting the desert tortoise across its range including: filing a protest of the new BLM Solar Plan for 11 western states; commenting on the FWS' proposed General Conservation Plan which will provide a structure for permitting take for desert tortoise on private lands in California; opposing efforts to construct a new Northern Corridor 4-lane highway through the Red Cliffs National Conservation Area in Utah; monitoring for any new Clark County lands bill that would open up tens of thousands of acres of tortoise habitat to sprawling development from Las Vegas; and opposing new gold mining and exploration proposals.

In the southeast, the Center's litigation challenging the FWS' decision not to list the eastern gopher tortoise is ongoing and a new formal peer-reviewed letter, published in *Global Ecology and Conservation*, detailed several errors in the population viability model that FWS relied on which led to a significant overestimate of future gopher tortoise populations. In addition, the Center commented on proposed revisions to the Florida Fish and Wildlife Conservation Commission's Gopher Tortoise Management Plan and continues to fight against major new developments in tortoise habitat.

Forty-six Years of Change in a Population of Agassiz's Desert Tortoises in the Colorado Desert: 1977–2023

Kristin H. Berry[1], Steven R. Lee[2], Peter Woodman[3] and Mark T. Massar[4]
U.S. Geological Survey, Western Ecological Research Center, [1]Reno, NV and [2]Yosemite, CA
[3]Kiva Biological Consultants, Inyokern, CA
[4]U.S. Bureau of Land Management, Palm Springs, CA

Between 1973 and 1980, 27 plots were established by KHB and the U.S. Bureau of Land Management to study demographic trends in populations, changes in habitats, and factors affecting Agassiz's desert tortoises on public lands in California's deserts. Ultimately, 14 plots with sufficient tortoises became part of long-term monitoring and research. Each plot was ≥1 square mile, and surveys occurred in spring using 45 to 60-calendar days and 60-person days of effort. Plots were surveyed completely twice using mark-recapture methods, remains of dead tortoises were collected, and data on habitat and human uses were recorded. Early in the surveys, additional time was spent on collecting quantified data on vegetation, health of tortoises, predators, and human uses. We present the results of surveys at a site in microphyll woodland on the south drainage of the Chuckwalla Mountains in the Colorado Desert, California. The site was first surveyed and evaluated in spring of 1977 and fall of 1978. Surveys began in 1979 and were repeated in 1982, 1988, 1990, 1992, 1997, 2004, and 2023. We analyzed trends in population size of male and female adults and juvenile/immature tortoises using a modified Jolly-Seber method in a Bayesian framework. The model also estimated survivorship and capture probabilities. Preliminary results indicated a population size of 165 tortoises/km^2. The decline began shortly after 1982 and was evident in 1988. By 2023, the population size had declined by 80% of the total population and 71% of the adult population, respectively. The downward trend, first apparent during 1988, was probably associated with the appearance of shell lesions described as cutaneous dyskeratosis. Population structure shifted markedly between 1979–1982 and subsequent surveys, characterized by accelerated decline in adult females compared to adult males. The decline in the females was accompanied by a reduction in the proportion of juvenile and immature tortoises. Tissues of ill and dying tortoises, necropsied in 1993 and 1997 with cutaneous dyskeratosis, contained elemental toxicants and deterioration of ≥1 organ systems. As of 2023, the disease was still present in the population. Potential factors contributing to the downward trend were both current and historical. The site was used by General Patton, who trained troops for World War II with one million soldiers using tanks and 50-caliber guns. The Bradshaw Trail, which crosses the southern part of the plot, was established in the 1860s and became a National Back Country Byway in 1992. Other contributors to habitat and population change are invasion of Sahara mustard, *Brassica tournefortii*, unauthorized cross-country vehicle use, and climate warming.

U.S. Fish and Wildlife Service Desert Tortoise Recovery Updates

Jeremy Bisson
U.S. Fish and Wildlife Service, Palm Springs Fish and Wildlife Office, 777 East Tahquitz Canyon Way, Suite 208, Palm Springs, California 92262. Email: jeremy_bisson@fws.gov

The U.S. Fish and Wildlife Service Desert Tortoise Recovery Program collaborated with numerous partners in 2024, to complete scoping, National Environmental Policy Act compliance, and recovery action implementation in furtherance of Mojave desert tortoise (*Gopherus agassizii*, desert tortoise) recovery. Our focus during 2024 was to continue collaborations and capacity building among federal, state, private, and public partners to expand desert tortoise recovery. Specific recovery updates include:

1. We conducted range-wide desert tortoise surveys and established new demographic plots to improve our understanding of desert tortoise vital rates.
2. We continued to develop and implement integrated raven management tools in California, Nevada, and Utah.
3. We reorganized the Recovery Implementation Teams and changed our focus to reducing resource subsidies to coyotes and ravens, exclusion fence monitoring and maintenance, vehicular disturbance mapping, and defensible polygon restoration prioritization, and more.
4. We coordinated with federal and non-federal partners on a variety of projects to promote recovery, including acquisition and enhancement of desert tortoise habitat, augmentation of depleted desert tortoise populations, and head starting.
5. We collaborated with partners on large-scale planning initiatives, including the Mojave Desert Sentinel Landscape Partnership, the Department of Defense Recovery and Sustainment Partnership Initiative, the BLM Solar Programmatic Environmental Impact Statement, and the U.S. Fish and Wildlife Service's General Conservation Plan for Desert Tortoise in California.
6. We contributed to several outreach events for desert tortoises, including Earth Day, National Public Lands Day, and the sixth annual Desert Tortoise Week, during which we organized events across California, Nevada, Utah, and Arizona.

We published two papers with collaborators on topics including climate change, landscape change, and *Ornithodorus* spp. (i.e., ticks). Additionally, we produced guidance on husbandry practices for wild desert tortoises in temporary captivity and the 2022 Annual Range-wide Monitoring Report.

BLM Sonoran Desert Tortoise Long-Term Monitoring Program Update

Timothy H. Bradley, Matthew R. Karam, Ryan P. O'Donnell, Michael Ingraldi
Arizona Game and Fish Department, 5000 W. Carefree Hwy, Phoenix, AZ 85086
Phone: (360)820-9001. Email: thbradley@azgfd.gov

The Sonoran Desert Tortoise (Gopherus morafkai) faces conservation challenges that necessitate long-term monitoring to guide management effort. This update summarizes findings from the Bureau of Land Management's (BLM) Sonoran Desert Tortoise Long-Term Monitoring Program (LTMP), focusing on surveys conducted by the Arizona Game and Fish Department in 2022

at three monitoring plots: Maricopa Mountains, Tortilla Mountains, and Harquahala Mountains. Established in 1987, this program aims to evaluate population trends, demographic parameters, and health indicators to inform management strategies for the Sonoran Desert Tortoise.

Using standardized mark-recapture methods, surveys conducted in 2022 totaled 186.5 person-days across the three plots. Population estimates for tortoises ≥180 mm midline carapace length (MCL) were 24 ± 100 at the Maricopa Mountains, 101.7 ± 53.4 at the Tortilla Mountains, and 12 ± 16 at the Harquahala Mountains. Density estimates ranged from 4.4 to 35 individuals per km^2. Visual health assessments revealed no evidence of upper respiratory tract disease or cutaneous dyskeratosis, and mortality rates were consistent with previous survey efforts.

Findings suggest stable adult populations across all plots, though detections of younger size classes were limited, potentially due to the challenges of detecting juveniles in complex desert landscapes. Observations on habitat use, shelter selection, behavior, and movement provide additional context for unnderstanding the ecological needs of the species.

Consistent monitoring on a five to seven year basis, and ongoing efforts to refine monitoring protocols will enhance the understanding of population dynamics and support conservation planning for the Sonoran Desert Tortoise.

Collaborative Conservation: Preservation Ranch's Initiatives for Habitat Restoration and Wildlife Recovery in the West Mojave Desert

Heidi Brannon, Priscilla Guzmán, and Joshua Heflin
Preservation Ranch, 473 E. Carnegie, STE 200, San Bernardino, CA 92408
Email: heidi@preservationranch.us

Preservation Ranch (PR) is dedicated to building partnerships in the West Mojave Desert that assist with the conservation of natural resources, support the recovery of wildlife species, and benefit the local economy. Through a public-private partnership with the Bureau of Land Management and US Fish and Wildlife Service, PR is working to rehabilitate unauthorized Off-Highway Vehicle (OHV) routes, restore Mojave Desert Tortoise (MDT) habitat, and develop coordinated land management programs that bring adjoining public and private lands under compatible conservation management. These initiatives are designed to ensure that surrounding lands are managed in ways that support biodiversity and enhance ecological integrity while balancing local economic needs.

This presentation will provide an overview of PR and its ongoing conservation initiatives, particularly its efforts to rehabilitate unauthorized OHV routes on public lands in MDT critical habitat. It will also highlight the results of effectiveness monitoring conducted on treated routes, showcasing the success of these efforts and providing insight into the broader impact of PR's restoration work.

Additionally, PR is an active participant in the MDT Recovery and Sustainment Partnership (RASP), a collaborative effort to ensure the long-term survival of the MDT and the Marine Corps Air Ground Combat Center, Twentynine Palms' MDT translocation and effectiveness monitoring, contributing to ongoing efforts to enhance MDT populations and improve habitat conditions. Through these combined efforts and partnerships, PR is working to aid in the recovery of the MDT.

STUDENT POSTER

Seasonal Shelter Use and Activity Patterns in the Sonoran Desert Tortoise

Julianne Bullock[1], Nancy E. McIntyre[1], Sean Sutor[1], Kerry Griffis-Kyle[2]
[1]Department of Biological Sciences, Texas Tech University, 2901 Main Street, Lubbock, Texas 79409-3131, USA. sean.sutor@ttu.edu, nancy.mcintyre@ttu.edu
[2]Department of Natural Resource Management, Texas Tech University, Goddard Building, Box 42125, Lubbock, Texas 79409-2125, USA. kerry.griffis-kyle@ttu.edu

The Sonoran desert tortoise (*Gopherus morafkai*) spends a significant portion of its life in estivation or brumation, making shelters a critical resource for the species to withstand the increasingly arid environments it inhabits. The goal of this study was to examine seasonal activity and utilization of different shelter resources in response to ambient conditions. We equipped tortoises (n=19) in southern Arizona with iButtons and GPS data loggers, collecting data on temperature and location for varying periods over 3 years. Temperature data were analyzed using a moving window approach to determine when tortoises were in or out of their shelters. We classified temperature data by shelter type. We then estimated the timing, duration, and frequency of use for each shelter type and examined how temperature varied in different types of shelters. During the monsoon season, tortoises used a variety of shelter types, including soil burrows, debris piles, and packrat middens, in which temperatures were similar to ambient temperatures. However, nearly all tortoises (18/19) used caliche caves for brumation or estivation. Compared to the other shelter types, which were used during shorter intervals, temperatures were the least variable in caliche caves. These caves appear to be particularly important during dry periods or extreme temperatures, such as during cold winters or arid foresummers. Our results thus far suggest that temperature loggers may allow researchers to gain a better understanding of estivation or brumation timing and duration, potential activity during these times, and types of shelters used, giving insight into which shelter resources are most critical to the species during these times.

Desert Tortoise Recovery and Management Update for Mojave National Preserve and Castle Mountains National Monument

Michael K. Burchett, Sofia Andeskie, Debra Hughson, Neal Darby, Misumi Ogawa, and Ray McPadden
Mojave National Preserve and Castle Mountains National Monument, National Park Service, 2701 Barstow Rd, Barstow, CA 92311. Email: michael_burchett@nps.gov

Mojave National Preserve and Castle Mountains National Monument continued management and planning aimed at the recovery of the federally threatened Mojave desert tortoise (*Gopherus agassizii*). This species continues to face significant challenges range wide. An increase in vehicle-associated mortality was documented along the Preserve's paved roads in 2024. In addition, multiple crushed tortoises were discovered on the historic Mojave Road, a popular off-road route. These findings underscore the need for management strategies to mitigate the impacts of roadways and recreational activities on tortoise populations.

Key recovery efforts over the past year included the completion of raven surveys and the use of drones for egg oiling on nests located on electricity transmission towers, aimed at reducing predation pressure on tortoises. Habitat restoration efforts progressed with the removal of hundreds of abandoned telephone poles to minimize predator perches. The reopening of Cima Road following extensive rehabilitation included the installation of five miles of tortoise exclusion fencing, and planning is underway for major reconstruction projects on South Kelbaker Road and Kelso-Cima Road, which will incorporate significant stretches of exclusion fencing and wildlife crossings. Law enforcement and visitor education remain key priorities to reduce vehicle speeding and tortoise mortality.

The Preserve continued to support population augmentation research at the Ivanpah Desert Tortoise Research Facility. Desert tortoise pre-construction total sign surveys were conducted along Kelso-Cima Road, and desert tortoise habitat modeling based on future climate scenarios was completed providing insights for long-term planning. Efforts to manage off-road driving routes and reduce route proliferation remain critical, alongside the need for expanded raven control measures and additional nest treatments. Wildfire remains a critical risk to desert tortoises and their habitats within the Preserve. Habitat recovery is occurring within the footprint of the 2023 York Fire and the spread of invasive grasses remains a threat. There is interest in exploring the effects of wildfire on tortoises and funding is being sought to explore this area of research.

These coordinated efforts highlight the commitment to desert tortoise recovery through adaptive management, habitat restoration, and strategic planning to ensure the survival of this iconic species within Mojave National Preserve.

Clark County Multiple Species Habitat Conservation Plan Update

Scott Cambrin
Clark County Desert Conservation Program 4701 W Russell Rd
Las Vegas, NV 89118 Phone: 702-455-3859 Email: cambrin@clarkcountynv.gov

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 2,066 acres of take from January through September 2024, leaving 17,451 acres of take authorization remaining under the current permit. The 2023-2025 Implementation Plan and Budget allocated up to $16,530,362.00 for the funding of staff and projects starting in July 2023 to run through June 2025. Highlights of desert tortoise-related work conducted over the past year include occupancy surveys on the Boulder City Conservation Easement (BCCE) with associated drone flights for tortoises and burrows; completed an analysis of vegetation surveys in relation to occupancy; completed year 10 of post-translocation monitoring of desert tortoises on the BCCE; continue to fund range-wide monitoring for Clark County and the surrounding areas; have begun managing predators on the BCCE; continued post translocation monitoring in the Eldorado Valley; monitored Rejuvra herbicide treatments; and continued work on public information and education through the Mojave Max program.

POSTER

Can Behavioral Plasticity Buffer Temperature Exposure in Juvenile Desert Tortoises?

Rachael S. Cohen[1, 2], Thomas A. Radzio[1], Talisin T. Hammond[2], Ronald R. Swaisgood[1], and Melissa J. Merrick[1]
[1]San Diego Zoo Wildlife Alliance, 15600 San Pasqual Valley Road, Escondido, CA, 92027. [2]Email: rscohen1013@gmail.com

Extended phenotypes allow organisms to alter their experience of external conditions including climate. For instance, plasticity in the use and modification of burrows could allow Mojave desert tortoises (*Gopherus agassizii*) to select specific microclimates, potentially buffering against extreme climatic conditions that are projected to increase. However, the extent to which tortoise burrowing behavior and burrow use are flexible remains unknown, particularly for the youngest and most vulnerable age classes. In spring 2024, we assigned 38 headstarted juvenile tortoises to either a shaded or open outdoor enclosure to investigate shade effects on burrow temperatures and tortoise responses to this manipulation. Each enclosure had a 50-cm starter burrow, fitted with iButton temperature loggers every 10 cm, and each tortoise had an iButton affixed to its shell. Time-lapse cameras recorded tortoise activity and burrow use. We hypothesized that open burrows would be warmer at a given depth, but tortoises may compensate for this by digging deeper burrows and using deeper portions of burrows to maintain preferred body temperatures when possible. Preliminary analyses indicate open treatment burrows were warmer, drier, and excavated deeper by tortoises. Despite differences in thermal gradients between shaded and open burrows, tortoises in both treatments selected the same temperatures (~31-33°C) during hot June and July afternoons, but tortoises with shorter burrows in the open treatment experienced temperatures that slightly exceed these values during July early evening hours. These preliminary results may contribute to understanding the potential for, and limitations of, shade, substrate and behavioral plasticity to influence desert tortoise climate resilience.

Stewardship of the Desert Tortoise Research Natural Area (DTRNA): new tools for old management challenges

Roger A. Dale[1] and Melissa L. Brown[2]
[1]President, Desert Tortoise Preserve Committee, Inc., 114 B South China Lake Boulevard, Ridgecrest, CA 93555, Phone: (714) 609-5845 Email: roger.dale@tortoise-tracks.org
[2]Law Enforcement Ranger, Ridgecrest Field Office, Bureau of Land Management – California Department of the Interior, Region 8/10, 300 S. Richmond Road, Ridgecrest, CA 93555, Phone: (760) 384-5463 Email: mlbrown@blm.gov

Since the mid 1970's, the Desert Tortoise Preserve Committee (DTPC) and the Bureau of Land Management (BLM) have collaborated on stewardship of the Desert Tortoise Research Natural Area (DTRNA) in Kern County, California. This partnership, which is formalized in a 1985 Cooperative Management Agreement between the DTPC and the BLM's California Desert District, represents an important best-practices model for long-term public/private stewardship of

critical habitat areas. Among the various threats to the quality of habitat within the DTRNA, deliberate damage to the perimeter fence – caused by vandals and trespassers – has been an especially persistent management challenge. In response to this significant threat, the DTPC and the BLM are currently developing and implementing new "rapid response" strategies for monitoring fence conditions, quickly repairing breaks, and pursuing the funding needed for restoration of sites where trespass has directly or indirectly resulted in habitat damage. The new strategies include network-based sharing of GIS data to allow for real-time reporting of fence breaks and other vandalism; improved interpretative and law enforcement signage; consideration of reinforced fencing (or even block walls) in perimeter areas that prove to be persistently vulnerable to damage; and investigation of potential surveillance technologies to facilitate more timely reporting of unlawful activities. In addition to the longstanding collaboration between DTPC and BLM, the DTPC has increasingly engaged other stakeholders as partners in carrying out management obligations at the DTRNA; these other stakeholders include off-highway vehicle (OHV) user groups and the State of California, which has funded multiple-year grants for DTPC's fence repair and revegetation efforts. The practical considerations emerging from the ongoing reevaluation of DTPC/BLM management practices can potentially inform the establishment and management of fenced preserves in other parts of the desert tortoise's range.

Accurately Estimating Demography and Population Density for Mojave Desert Tortoises and Why It Matters for Management and Recovery

*Kristina Drake** and *Corey Mitchell*
Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service,
4701 North Torrey Pines Dr, Las Vegas, Nevada, 89130, USA.
Email: Kristina_Drake@fws.gov; Corey_Mitchell@fws.gov

Accurately estimating and elucidating demography and population density trends for the federally threatened Mojave desert tortoise (*Gopherus agassizii*; tortoise) are paramount for successful management and recovery strategies. Important criteria for tortoise management, population thresholds, and delisting from the Endangered Species Act (ESA) rely heavily on historic and ongoing monitoring to estimate tortoise occupancy, demography, and density trends across the range. However, both targeted and comprehensive long-term range-wide monitoring of tortoise populations since the federal listing in 1990 have been imperfect and often plagued by insufficient survey and detection opportunities for all age classes, sampling bias and limited analytical inference, as well as inadequate funding necessary to sufficiently survey vast areas of suitable tortoise habitat in Arizona, California, Nevada, and Utah. Additionally, this ecoregion is experiencing unprecedented anthropogenic disturbance and climate change which further challenges species recovery and intensifies cumulative threats to tortoises and their habitats, limiting our ability to adequately understand range-wide trends and address adaptive management needs. To address these challenges, the U.S. Fish and Wildlife Service – Desert Tortoise Recovery Office (DTRO) and partners are working to modify approaches to tortoise monitoring by promoting statistically robust spatially explicit evaluations to accurately estimate demographic parameters and population density of multiple tortoise size classes in a comprehensive survey

framework, serving as a potential cost saving and sustainable program opportunity relative to current practices. In 2025, DTRO plans to continue range-wide monitoring with reduced funding in select Tortoise Conservation Areas, understudied habitats, and regions requiring intensified post-translocation monitoring in Arizona, California, and Nevada incorporating novel spatially explicit survey approaches where possible. Furthermore, DTRO aims to support surveys for tortoise populations currently excluded from federal ESA protections (populations occurring East and South of the Colorado River in Arizona) to improve our understanding of population trends throughout the entire tortoise genetic range.

Sonoran Desert Tortoise Movement Patterns, Habitat Use, and Threats in an Urbanizing Landscape

Jessie M. Dwyer[1], Rob E. Hallagan[1], Kerry T. Olsson[1], Chad A. Rubke[2]
[1]McDowell Sonoran Conservancy, 15300 North 90th St., Suite 400, Scottsdale, AZ, 85260, USA Email: jessie@mcdowellsonoran.org
[2]Arizona Game and Fish Department, 5000 West Carefree Highway, Phoenix, AZ 85086, USA
Email: crubke@azgfd.gov

The McDowell Sonoran Conservancy, in partnership with the Arizona Game and Fish Department and the City of Scottsdale, has been monitoring Sonoran Desert Tortoises (*Gopherus morafkai*) for four years in Scottsdale's McDowell Sonoran Preserve, 30,500 acres of protected and connected open-space surrounded by increasing urban development. Sonoran Desert Tortoises are a long-lived species susceptible to rapid environmental change. In order to understand the impact of urbanization and other human stressors on the tortoise population, we surveyed the Preserve for tortoises in areas both near and far from urbanization and human activity. Since 2021, we have captured and marked 71 tortoises in the Preserve, 27 of which have been outfitted with radio transmitters, and 19 of which remain active. In 2022, we equipped study tortoises with GPS dataloggers to record their daily movements during the active season. Through this work, we have recorded large and fine-scale tortoise movements, collected valuable demographic data, and documented uncommon behaviors. Additionally, we have identified habitat requirements, barriers to movement, and compounding threats to the population in this urbanizing landscape. This research advances our understanding of Sonoran Desert Tortoises and will inform management of populations in the Preserve and beyond, in perpetuity. Our work is possible thanks to the Bob & Rene Parsons Foundation, the Arizona Game and Fish Department, the City of Scottsdale, and our team of trained and dedicated Citizen Science Volunteers.

Safeguarding the Conservation Value and Subsequent Potential Contributions of Displaced Mojave Desert Tortoises

Kimberleigh J. Field, K. Kristina Drake, Roy C. Averill-Murray[1], Kerry L. Holcomb, and Corey I. Mitchell
Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, 4701 North Torrey Pines Drive, as Vegas, NV 89130, USA. Phone: 775-861-6322. Presenter email: kimberleigh_field@fws.gov
[1]retired

Mojave desert tortoises (*Gopherus agassizii;* tortoise) may become displaced from their self-selected home ranges when human demands within tortoise habitat are prioritized. In recent years,

energy developments, mining activities, military exercises, and general urbanization have caused the displacement and injury of hundreds of tortoises. In these situations, it is important to consider the inherent value of these individual tortoises to conservation efforts. While placement of the individual in a context in which it could likely live out its life is important, it is crucial to consider a context in which the individual can contribute to the recovery of a priority population. The Desert Tortoise Recovery Office (DTRO) has produced several guidance documents and strategies to help increase the likelihood that displaced tortoises will be maintained in good health, translocated using best practices, and ultimately contribute to targeted conservation efforts. We will present an overview of the key components of the DTRO's guidance documents on temporary captive care and translocation practices, as well as discuss our population augmentation strategy.

Analysis of the thermal ecology of the Texas tortoise (*Gopherus berlandieri*) with regard to potential anthropogenic alteration of its thermal environment

Daniel A. Guerra and Joseph A. Veech
Texas State University, 601 University Drive, San Marcos, TX 78666, USA
Email: dag143@txstate.edu

Ectotherms such as the Texas tortoise (*Gopherus berlandieri*) must behaviorally thermoregulate to maintain preferred body temperatures. The invasion of monodominant grasses and the ongoing climate crisis have the potential to disrupt and substantially worsen the thermal environment of such organisms. To understand the relationship between *G. berlandieri* and its thermal environment, we recorded external body temperatures of tortoises at a protected natural area in south Texas to estimate key thermal metrics (e.g., the T_{pref} range). We placed operative temperature models in both invasive Guinea grass and native vegetation to determine if the former created a substantially worse thermal environment for *G. berlandieri*. The determined T_{pref} range has a lower bound that is 5 °C below previous estimates for the species, although the upper bound is similar to those observed both for the species and the genus. The thermal environment is not altered by the invasion of Guinea grass. Measures of thermoregulatory accuracy, the quality of the thermal environment, and thermoregulatory efficiency are highest in hot or heating (spring) seasons. *G. berlandieri*, while uniquely adapted to cold among its congenerics, is still most stressed by the thermal environment during the coldest portion of the year. *G. berlandieri* individuals in deep south Texas live in a somewhat ideal thermal environment and might not be eminently threatened by rising temperatures. However, further examination of the interaction between tortoises and the thermal environment is warranted given the importance of efficient thermoregulation to their survival.

Monitoring Results from Pima County's 2024 Sonoran Desert Tortoise Campaign

Sami Hammer, Melissa Van Kleeck-Hann, Sierra Lauman
Pima County Conservation Lands and Resources , 201 N Stone Ave, Tucson, Arizona, 85701
Email: Melissa.VanKleeck-Hann@pima.gov

The Sonoran desert tortoise (*Gopherus morafkai*) is one of 44 species covered by Pima County's Multi-Species Conservation Plan (MSCP). To fulfill the County's commitments as stated

in its Section 10 Permit under the Endangered Species Act, the County's Ecological Monitoring Program (EMP) monitors tortoise occupancy at three County properties in eastern Pima County, Arizona. EMP staff conduct tortoise monitoring every three years, and 2024 marks the third round of monitoring since the inception of the MSCP in 2016. This monitoring year follows two of the warmest years on record in the Tucson area with 2023 having the highest number of days above 110° F in recorded history. This may greatly influence the abundance and diversity of available forage, as well as alter the landscape and availability of shelter sites. Although there were fewer shelter sites on average than in 2021, 53 individual tortoises were detected on 75% of the study plots in 2024. 11 more tortoises were captured than in 2021 and tortoises were detected on three plots that had been previously unoccupied. Only 3.9 % (n=51) of tortoises showed signs of respiratory illness, compared to 12.5% (n=48) in 2021 and 4.8% (n=41) in 2018. Both site occupancy and detection probabilities will be calculated for 2024, then for all three monitoring periods, determining potential topographical, environmental and climactic influences. Over all three monitoring periods spanning 9 years, Pima County surveyors have captured a total of over 110 individual tortoises, including 28 recaptured individuals, and one individual that was captured each monitoring season. This provides not only a unique opportunity to track changes in individual tortoise health, body condition, and growth rates, but also detect long term population trends in a vulnerable species amid climate change, increasing development, and spread of invasive species.

POSTER

Hot Spots & Cold Shoulders: How does familiarity affect behavior & burrow use of hatchling desert tortoises?

Talisin T. Hammond [1,3]†, Thomas Radzio [1]†, Tristan Walter [2], and Melissa J. Merrick [1]
[1]San Diego Zoo Wildlife Alliance, 15600 San Pasqual Valley Rd., Escondido, CA, 92027, USA.
[2]Max Planck Institute of Animal Behavior, Department of Collective Behavior, Universitätsstr. 10, 78464 Konstanz, Germany
[3]Email: thammond@sdzwa.org; † These authors both contributed equally

Often described as asocial organisms, the degree to which desert tortoises recognize and benefit from knowing neighbors, clutch mates, and related individuals is often overlooked. Previous work suggests that even "asocial" species differ in their interactions with familiar and unfamiliar conspecifics, and that these dynamics can impact conservation and management efforts, including translocations. This study aims to characterize the impacts of familiarity on behavioral interactions between hatchling desert tortoises. We conducted three behavioral assays on pairs of head-started, hatchling tortoises. In the first trial, tortoises were paired with either unfamiliar (non house mates) or familiar (house-mates) individuals in a small arena for 10 minutes and activity, inter-individual distances, and the amount of time tortoises spent facing each other was monitored. In the second trial individuals were given access to a larger arena with two warmed burrows and the same metrics, as well as burrow use and burrow sharing behavior, were monitored over the course of an hour. The third trial was the same as the second trial, except that one burrow was warmed and the other was un-warmed. All trials were filmed and machine vision software, trex, was used to track tortoises and collect data. We hypothesized that familiarity would alter behavior, predicting that familiar individuals would be more willing to share burrows than strangers, particularly in the case where there was only one high quality (warmed) burrow, and that across

trials inter-individual distances would be lower for familiar than unfamiliar pairs. We documented significant differences based on familiarity of pairs in inter-individual distances and burrow sharing behavior, but not orientation behavior. All pairs shared burrows to some extent, but familiar pairs with access to only one warmed burrow were most likely to burrow share. We interpret our findings in the context of optimizing translocation methods for young desert tortoises.

A New Herpetological Field Guide for California

Robert W. Hansen[1] and Jackson D. Shedd[2]
[1]Museum of Vertebrate Zoology, University of California, Berkeley, California 94720, USA.
Email: hansenranch2@gmail.com
[2]San Diego Natural History Museum, 1788 El Prado, Balboa Park, San Diego, California 92101.
Email: jackson_shedd@sbcglobal.net

California is home to ca. 210 species of amphibians and reptiles, including approximately 32 exotics, a few of which are invasive. Covering 425,000 hectares, spanning 9.5 degrees of both latitude and longitude, proximity to the Pacific Ocean, and containing both the lowest and highest elevations in the continental U.S., such diversity is not unexpected. 29% of the native species are endemic, and 20% hold Threatened or Endangered status. Ongoing habitat loss, climate change, invasive species, novel diseases, as well as the discovery of new species point to the need for an updated, accurate, and comprehensive guide to the California herpetofauna. We began this project in January 2021 and turned in a final manuscript to the publisher in December 2023. The book contains 122 range maps, 165 color plates showcasing 943 photos of live specimens, and 144 original color paintings, including all species of larval amphibians (many at multiple developmental stages). Importantly, this project involved nearly 300 collaborators, representing the gamut of California's herpetological community, from community scientists to professional herpetologists.

Weather and Ephemeral Vegetation Drivers of Apparent Occupancy of Mojave Desert Tortoises (*Gopherus agassizii*)

Seth Harju[1] and Scott Cambrin[2]
[1]Heron Ecological, P.O. Box 235, Kingston, ID 83839, USA.
Phone: 208-682-4845. Email: seth@heronecological.com
[2]Clark County Desert Conservation Program, 4701 W Russell Rd, Suite 200, Las Vegas, NV 89118.
Email: Scott.Cambrin@clarkcountynv.gov

Understanding the factors associated with the probability of a species occurring across the landscape has become a foundational component of wildlife management and monitoring. The primary framework for estimating occupancy relationships implicitly assumes that species turnover may be high and explicitly requires that they are moderately detectable if present, yet the cryptic nature of many species means that latent occupancy may be confounded with availability for detection. We analyzed vegetation metrics in relation to previous winter temperature and precipitation then variation in apparent occupancy by Mojave desert tortoises (*Gopherus agassizii*)

as a function of spatio-temporal variation in invasive and native ephemeral forbs and grasses. We found that the relative abundance of invasive plants increased by 107.8% and the cover of ephemeral forbs increased by 49.6% for every 1°C increase in mean winter temperature. Cover of native annual grasses increased by 15.2% for every 1mm of total winter precipitation. Total species richness was positively associated with both preceding winter precipitation and temperature. None of the static site level factors explained initial occupancy in the first year, but vegetation factors did influence apparent annual occupancy. Sites that appeared unoccupied in the previous year were 313.7% more likely to be occupied in the following year for every additional invasive species plant recorded and 249.4% more likely to be occupied for every additional species detected regardless of native status. Conversely, sites were 76.9% less likely to become unoccupied in the subsequent year for every additional species detected. These results provide a mechanistic link between winter weather, native and invasive ephemeral plants, and resulting changes in apparent annual occupancy by Mojave desert tortoises.

Progress in the Marine Corps Air Ground Combat Center's Desert Tortoise Translocation

Brian T. Henen
Marine Air Ground Task Force Training Command - Environmental Affairs, 1418 Brown Street, Marine Corps Air Ground Combat Center (Combat Center), Twentynine Palms CA 92278: Tel: 760-830-5720, Email:brian.henen@usmc.mil

Overall, the Combat Center's translocation has experienced high survival rates for adults in its first eight years (2017-2024: 88 to 98% per year), yet experienced spatial variation (among sites), annual variation likely related to amounts of winter rainfall or time since release, and occasional variation among groups (e.g., high juvenile mortality in 2023). During the first 9 months of 2024, adults experienced a 94.2% survival, compared to 92.8% in 2023, despite 2024 continuing dry conditions in this area since 2020. For the Controls, Residents and Translocatees, the 2024 survival was 100, 96.4, and 87.2%, respectively. These were mixed differences from the survival of 2023 (92.6, 88.2, and 95.5%, respectively). Of the 5 dead adults of 2024, 4 (80%) died of predation (3 by coyote, 1 by badger) and one (20%) was found overturned and died of hyperthermia. For the first seven years of translocation, the lowest mortality occurred following the three wettest winters, while mortality was higher following three dry winters. Rainfall was spatially heterogeneous in the seventh year (2023) and adults experienced intermediate mortality rates (7.9% per year), but the juveniles (120 to 150mm CL) released in April 2023 experienced extremely high mortality rates (>90%). This inordinately high juvenile mortality was neither seen in prior years nor in headstart tortoises, and may have been due to releasing juveniles in localized pockets of new plant growth in a generally dry, low plant production year. These results are consistent with numerous studies indicating strong effects of drought for *G. agassizii* and *G. morafkai*, and emphasize considering whether or how to implement certain recovery actions during drought conditions.

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Progress in the Marine Corps Air Ground Combat Center's Desert Tortoise Headstart Program

Brian T. Henen
Marine Air Ground Task Force Training Command - Environmental Affairs, 1418 Brown Street, Marine Corps Air Ground Combat Center (Combat Center), Twentynine Palms CA 92278: Tel: 760-830-5720, Email:brian.henen@usmc.mil

MCAGCC's headstart program is advancing our understanding of juvenile tortoise biology, and headstart tortoises are surviving well before, and reasonably well after, release to the wild. The program has used genetic analyses that indicate individual clutches typically have two or three fathers (i.e., multiple paternity), which increases the genetic diversity of the mother's offspring and possibly overall reproductive success. It also confirms genetically that females store sperm. This program also documented that the sex ratios of headstart offspring mirror the TSD (temperature dependent sex determination) results documented in controlled, laboratory-based incubation of desert tortoise eggs. Water and food supplementation are necessary for headstart tortoises to match or exceed the growth rates of juveniles in wild populations. The headstart juveniles receive protection from predators, food limitations, and extreme temperatures, enabling them to have high annual survival rates (ca. 96%) that match those of adult desert tortoises. This high survival enables ten times as many juveniles to survive, to nine or ten years, as would occur in the wild. The shells of these nine- or ten-year-old tortoises (carapace lengths of about 110mm), is 98 to 99% the hardness of adult tortoise shells. The annualized survival of headstart animals released in 2015, 2017 and 2019 was above 80%, which approximates annual survival of adults during drought conditions. We are formalizing survival analyses for these data, and will evaluate the effect of several factors such as year, season, size, activity, predators and drought. Such analyses will help us understand the physiological, behavioral and predation effects of drought on headstart tortoises, and how implementing headstarting can enhance tortoise recovery.

POSTER

Bolson Tortoises (*Gopherus flavomarginatus*) in the US

Scott Hillard and Christiane Wiese
Turner Endangered Species Fund, Ladder Ranch, 792 Ladder Road, Caballo, NM 87931, USA
Email: Chris.Wiese@retranches.com; Scott.Hillard@tedturner.com

In September of 2023, the USFWS announced that with the signing of a Safe Harbor Agreement between the USFWS and representatives of Ted Turner's Armendaris Ranch in southern New Mexico, efforts to recover the bolson tortoise (*Gopherus flavomarginatus*) – the largest of the six North American tortoise species and the only one endemic to the Chihuahuan desert – in the US would begin in earnest. Though bolson tortoises once ranged throughout (and beyond) the area that is now the Chihuahuan Desert, their numbers began to shrink and their range began to contract by over 95% after the arrival of humans on the continent. A second wave of extirpation took place on the heels of the industrial revolution that brought roads, railroads, and humans into previously inaccessible areas. Today, a remnant wild population of ~2,500 bolson

tortoises persists only in the sparsely populated, remote, and inhospitable 'Bolsón de Mapimí' in north-central Mexico. So where do the bolson tortoises that will serve as the basis for recovery in the US come from? Here, we trace the origins and timeline of the only large-scale bolson tortoise breeding and headstarting project in the world, sited on one of media mogul, businessman, and conservationist Ted Turner's southern New Mexico ranches located in the northern tip of the Chihuahuan Desert. What began with a lone female tortoise in 1971 today is a growing colony of over 700 (still mostly juvenile) bolson tortoises.

POSTER

Bolson Tortoise (*Gopherus flavomarginatus*) Reproduction and Nest Site Selection in New Mexico

Scott Hillard and Christiane Wiese
Turner Endangered Species Fund, Ladder Ranch, 792 Ladder Road, Caballo, NM 87931, USA
Email: Scott.Hillard@tedturner.com; Chris.Wiese@retranches.com

The Bolson tortoise (*Gopherus flavomarginatus*; listed as "Endangered" by the USFWS and as "Critically Endangered" on the IUCN Red List) is endemic to the Chihuahuan Desert, the northern tip of which extends into southern New Mexico in the US. Starting with 30 captive adult and sub-adult Bolson tortoises in the fall of 2006, the Turner Endangered Species Fund (TESF) spearheads a unique Bolson tortoise breeding and head-starting project that has produced over 700 juvenile bolson tortoises ranging in age from 0-18 years in 2024. Thus far, only two of the female offspring (16 and 17 years old in 2024, respectively) have shown signs of reaching reproductive maturity, though both are yet to produced viable offspring. Preliminary results suggest that females require at least 17 years to reach an average minimum reproductive size of ~300 mm straight-line shell length to produce hatchlings. Nearly two decades of monitoring individual adult females for reproductive output and hatching success rates show that in northern Chihuahuan Desert habitats, the average clutch size is 5.1, all tortoises appear to produce at least one clutch every year, and some tortoises lay up to three clutches in a year between the end of April and the end of July. Most of the nests (80%) are *not* associated with a tortoise burrow. Hatchlings emerge after ~ 4 months (100-120 days). Hatching success varies from female to female and from year to year, but the overall average hatching success rate is ~ 60%. Predation by skunks is a major factor in nest failure. Like other *Gopherus* species, Bolson tortoises exhibit temperature-dependent sex determination and cooler incubation temperatures produce males while warmer temperatures produce females.

A Retrospective of the Recipients of the David J. Morafka Award

Judy Hohman and Mari Quillman
Desert Tortoise Council, 3807 Sierra Highway #6-4514, Acton, CA 93510

In honor and memory of Dr. David J. Morafka, distinguished herpetologist and authority on North American gopher tortoises, Sylvia Morafka, with assistance from the Desert Tortoise Council, established the David J. Morafka Memorial Research Award in 2005. This annual Award

is a research grant given to help support research that contributes to the understanding, management, and conservation of tortoises of the genus *Gopherus* in the southwestern United States and Mexico. The first Morafka Award was presented in 2006. Since then, Sylvia Morafka and the Council have given this Award to 20 researchers for studies on four of the five species of desert tortoises. Currently, these recipients continue in various specialized fields of wildlife biology. Some recipients have translocated from the United States to England, Switzerland, Mexico, and New Zealand. Today, a few of the recipients will share what inspired them to go in the professional direction they did, where they are now, how the Award helped them, and their encouraging words for future applicants and recipients of the Morafka Award.

Common Raven Density Trend in California's Tortoise Conservation Areas between 2020 and 2024

Kerry L. Holcomb, K. Kristina Drake, Kimberleigh J. Field, and Corey I. Mitchell
U.S. Fish and Wildlife Service - Desert Tortoise Recovery Office, 4701 North Torrey Pines Drive
Las Vegas, Nevada 89130, USA. Email: kerry_holcomb@fws.gov

Unfettered access to human sources of food, water, and shelter enables native, generalist predators, like the Common Raven (*Corvus corax*, raven), to expand unchecked by carrying capacity and beyond the coevolved life history limits of their prey. The contemporary expansion of raven abundance in many Mojave desert tortoises (*Gopherus agassizii*, tortoise) critical habitat units has meant progressively lower survival rates for 0- to 10-year-old tortoises. Efforts to reharmonize tortoise-raven conflicts to facilitate sufficient tortoise recruitment began in the 1990s, followed by establishment of the California Common Raven Monitoring and Management Program in 2008. A 2019 adaptive management memorandum to the Region 8 Migratory Bird Treaty Office extended raven take beyond "offending ravens" to include all raven life stages; concurrently, tortoise carcass surveys were replaced with point count estimates of raven density and decoy station estimates of predation risk. The trend exhibited by the natural log of raven density estimates collected between 2020 and 2024, in five California Tortoise Conservation Areas (TCAs) was characterized by fitting a linear mixed effects model using restricted Maximum Likelihood. This analysis suggests that raven density in these California TCAs is decreasing at a rate of -0.27 (0.05 SE) raven km^{-2} yr^{-1}. Because raven trend estimates between 2012 and 2022 in the Mojave Desert range between 0.12 and 0.25 raven yr^{-1}, the total effect of raven management could be as large as between -39 and -52% fewer ravens per year. Moreover, the mean raven density estimates in six TCAs and the upper 95^{th} confidence limit (UCL) estimates in five TCAs are now below the 0.89 raven km^{-2} target. These results indicate the need to fully implement raven management in the Superior-Cronese and Fremont-Kramer TCAs (mean or UCL above threshold), while management can be scaled back to tortoise recruitment priority areas and subsidy management in other California TCAs.

STUDENT PAPER

Effects of Prescribed Fire on Texas Tortoise (*Gopherus berlandieri*) Ecology in a Southern Texas Rangeland

Camryn M. Kiel[1], Stephen L. Webb[1,2], Danielle K. Walkup[1,2], Sandra Rideout-Hanzak[3], Evan P. Tanner[3], Ashley M. Tanner[3], David B. Wester[3], Andrea Montalvo[4], and Toby J. Hibbitts[2,5]
[1]Department of Rangeland, Wildlife, & Fisheries Management, Texas A&M University, College Station, Texas. Email: cmkiel@tamu.edu
[2]Texas A&M Natural Resources Institute, Texas A&M University, College Station, Texas.
[3]Caesar Kleberg Wildlife Research Institute, Department of Rangeland and Wildlife Sciences, Texas A&M University - Kingsville, Kingsville, Texas.
[4]The East Foundation, Hebbronville, Texas, United States of America
[5]Department of Ecology and Conservation Biology, Texas A&M University, College Station, Texas, Email: thibbitts@tamu.edu

Fire is a critical ecological process that structures many ecosystems globally. Prescribed fire can be used to mimic historical fire regimes in areas where fire has been suppressed by humans, which in turn alters vegetation species composition and structure. As such, it is important to examine the effects of fire on wildlife species within these systems to understand the implications for species conservation. In southern Texas, prescribed fire is used to manage woody plant encroachment and improve quality of forage for cattle and wildlife in the Tamaulipan biotic province, which is inhabited by Texas tortoises (*Gopherus berlandieri*). We assessed the movement and resource use of Texas tortoises in response to prescribed fire on a coastal rangeland in southern Texas. Patches of ≥ 200 ha were randomly assigned either winter or summer burning at 3- or 5-year fire return intervals. We equipped 30 Texas tortoises with GPS tags and iButton temperature loggers, and we collected surface temperature information with iButtons in both burn and non-burn (control) patches. Using GPS locations, landcover classification, and temperature data, we conducted resource selection analyses to compare tortoise ecology before and after fires. In the summer, the area used by tortoises increased post-fire for 6 weeks, whereas space use did not show strong changes in winter. We also examined net squared displacement data, which indicated site fidelity in both seasons. These data and findings describe how fire affects Texas tortoise ecology, which will aid in developing strategies for integrating fire into holistic management plans to minimize the impact on tortoises.

The Desert Tortoise Management Oversight Group (MOG): Progress and Challenges for Recovery

Glen Knowles
Southern Nevada Fish and Wildlife Office, U.S. Fish and Wildlife Service,
4701 North Torrey Pines Dr, Las Vegas, Nevada, 89130, USA.
Email: Glen_Knowles@fws.gov

The Desert Tortoise Management Oversight Group (MOG) was established in 1988 to coordinate agency planning and management activities affecting the Mojave desert tortoise (tortoise). The mission of the MOG is to enhance interagency coordination of tortoise recovery efforts, provide a roundtable for sharing information and raising and resolving issues that cross

jurisdictional boundaries, and provide a forum for stakeholder input on tortoise recovery. Chaired by the U.S. Fish and Wildlife Service (FWS), the charter members of the MOG include the four BLM State Directors from Arizona, California, Nevada, and Utah; a BLM Washington Office representative; the four State Fish and Game Directors from these States; the three Fish and Wildlife Service (FWS) Regional Directors that share tortoise management responsibilities; representatives of the National Park Service and U.S. Geological Survey; the Department of Transportation and State Departments of Transportation in Arizona, California, Nevada and Utah; officials of the four branches of military service (Army, Air Force, Navy, and Marine Corps) that manage tortoise habitat; and representatives from County governments in the Mojave Desert. The MOG provides not only a valuable forum to coordinate recovery and management actions throughout the range of the tortoise, but MOG agencies and organizations also create a community of professionals who care about Mojave Desert conservation, share priorities, collaborate, and provide support for each other's efforts. Here, we discuss landscape change issues impacting tortoise recovery and review historical and recent activities of the MOG and plans for 2025.

A Tale of Three Gopherus Tortoises: Insights from Genomic Analysis of Sonoran and Mojave Desert Tortoises (*Gopherus morafkai and G. agassizii*) Compared with the Texas Tortoise (*G. berlandieri*)

Kenro Kusumi [1], Jade Mellor[2], Sarah Baty[1], Jacquelyn Tleimat[3], Griffin M. McDaniels[2], Paul Crump[4], Shawn F. McCracken[3], Greer A. Dolby[2]

[1]School of Life Sciences, Arizona State University, PO Box 874501, Tempe, AZ 85287, USA. Phone: 480-727-8993. E-mail: kenro.kusumi@asu.edu

[2]Department of Biology, University of Alabama at Birmingham, 1300 University Blvd, Birmingham, Alabama 35233. Email: gdolby@uab.edu

[3]Department of Life Sciences, College of Science and Engineering, Texas A&M University – Corpus Christi. Email: shawn.mccracken@tamucc.edu

[4]Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, Texas 78744. Email: paul.crump@tpwd.texas.gov

The six species of *Gopherus* tortoises have adapted to North American environments ranging from the Mojave and Sonoran deserts of the southwest, the thornscrub savannahs and woodlands of Texas, and the longleaf pine forests of the southeast. These *Gopherus* genomes contain a historical record of genetic changes required for adaptation to these divergent environments. As a first step in decoding these genetic changes, we have generated chromosomal-scale annotated genome references for the Mojave desert tortoise (*Gopherus agassizii*; Dolby et al., *Genome Biol Evol*, 2020), Sonoran desert tortoise (*G. morafkai*; Baty et al., in review), and Texas tortoise (in preparation). Genome comparison of ten *G. agassizii* and ten *G. morafkai* individuals identified highly diverged genes that regulate innate immune response, which might be the basis of differential susceptibility to *Mycoplasma agassizii* infection, chronobiological processes, skin barrier remodeling, and UV DNA damage repair (Mellor et al., *Mol Ecol,* 2024). We also identified signatures of selection between the Sonoran and Mojave desert tortoises for genes regulating vision, reproduction, cell cycle and mitosis (Baty et al., in review). Finally, population genomic analyses are underway for these species that will permit *i.)* mapping of the populational structure, *ii.)* assessment of the effective population size and distribution of genetic diversity for each species,

iii.) refinement of the range maps and hybridization zones for *G. agassizii* and *G. morafkai*, and *iv.)* improved guidance for relocation of individuals to optimize conservation translocation outcomes. These genomic data and insights from comparative analysis can be leveraged to address the conservation challenges facing the *Gopherus* tortoises.

Introducing the Ecosystems Advisory Committee (EAC) of the Desert Tortoise Council

Edward L. LaRue, Jr.,
Circle Mountain Biological Consultants, Inc, Desert Tortoise Council, Mohave Ground Squirrel Conservation Council, 5443 Heath Lane, Wrightwood, CA 92397, USA
Phone: 760-964-0012. Email: ed.larue@verizon.net

Going back to May 1, 1978, when the Desert Tortoise Council (DTC) "Comments on BLM's withdrawal of lands from mining and mineral laws," and with more than 476 documents between 1978 and 2012 catalogued to date, the volunteer-based EAC has an established tradition of commenting on projects affecting desert tortoises. The EAC has endeavored, with noteworthy progress since 2019, to be identified as an Affected Interest by both the BLM and County governments. The best opportunity to provide leveraged input is to provide formal Scoping Comments identifying specific components to be included in draft environmental documents, then review them for those components. Whereas the EAC may secondarily state opposition to a given project, its main function is to identify deficiencies in environmental documents, which typically "promote rather than assess," Federal and non-federal proposed projects to offer substantive recommendations using best available science. An effective method in California, which is the only of the four states within the Federally-listed population that has an endangered species act, is to carbon copy State regulatory agencies to ensure the Federal Lead Agency is accountable and adhering to ALL pertinent regulatory requirements at both State and Federal levels. Between 2013 and 2023, the EAC had 530 opportunities to comment on projects affecting tortoises and responded to 487 of those opportunities, or 92%, which ranges from a low of 76% in 2018 to a high of 97% last year. These have included 211 letters in California, 94 in Nevada, 85 on national issues, 62 in Arizona, 34 in Utah, and 1 in New Mexico on behalf of the Bolson tortoise. Project types on which the EAC has commented include solar fields, travel management plans, military issues, grazing allotments, mine sites, pipelines, communications infrastructure, and various resource management plan documents.

Life Celebration of Larry LaPré
(9/7/1947 to 3/30/2024)

Edward L. LaRue, Jr.,
Circle Mountain Biological Consultants, Inc, Desert Tortoise Council, Mohave Ground Squirrel Conservation Council, 5443 Heath Lane, Wrightwood, CA 92397, USA
Phone: 760-964-0012. Email: ed.larue@verizon.net

For nearly 24 years, from January 1998 through September 2021, first as West Mojave Plan biologist and later as California Desert District Wildlife Biologist, Larry, who was known for his responsiveness, dry wit, approachability, and friendliness, was the conservation icon of the Bureau of Land Management in five field offices to a thousand new and established biologists who sought BLM authorizations or scientific information about southern California plants and animals. Born Lawrence Franklin LaPré in 1947 in Azusa, CA, Larry graduated from U.C. California, Riverside in 1972 with a doctorate in ecology, just prior to passing the Federal Endangered Species Act in 1973, which enabled him to become one of the first two biological consultants in southern California, founding Tierra Madre Consultants, Inc. in 1982. He was equally accomplished as ornithologist, mammologist, botanist, as he was expert in state and federal regulations protecting rare plant and animal species. He wrote the conservation strategies for 100 rare plant and animal species for the BLM's West Mojave Plan between 1998 and 2004 when that plan was published. He served on the Board of the Desert Tortoise Council from 2016 to 2020 and as a scientific advisor to the Desert Tortoise Preserve Committee afterwards. He was also a dedicated member of HawkWatch International and served on the Executive Board of the San Bernardino Valley Audubon Society chapter where he led field trips for many years. He was an active member of the Unitarian Church of Riverside, and according to the post of one member: "He had a lovely, kind sense of humor and a big heart." He married Marilyn Joan Morris in July of 1992 and was a devoted husband, sharing their time between Riverside and Minnesota, until she died from surgery complications on 9/21/2021. He is survived by Nathan Morris LaPré, born 6/18/1995.

Genetic Diversity in Mitochondrial Cytochrome B Gene and Control Region Sequences of *Gopherus agassizii* from Nevada National Security Site (NNSS)

*Xianan Liu, Derek Hall, Jeanette Perry, and Ronald Warren*Nevada National Security Site, Mission Support and Test Services, LLC, 2621 Losee Road, North Las Vegas, Nevada 89030, USA.
Email: liux@nv.doe.gov

Genetic diversity is important for a species to adapt to environmental changes, resist disease, and avoid inbreeding. In order to study Mojave Desert tortoise's (*Gopherus agassizii*) adaption to its local environment, the intraspecies nucleotide diversity in mitochondrial Cytochrome B (*cytb*, 408 bp) gene and control region (CR, 464 bp) sequences were analyzed from roadkill samples found on the Nevada National Security Site (NNSS) (n=12) and Joshua Tree National Park (JTNP) (n=3). Three haplotypes were detected within 12 *cytb* sequences from NNSS samples and one haplotype detected from three JTNP samples. The results of *cytb* gene analysis revealed three polymorphic sites without insertions or deletions. The sequence variants include two pyrimidine transitions (T>C) and one pyrimidine to purine substitution (C>A). Interestingly, no differences were found in CR sequences from 12 NNSS samples although the CR has been

reported to be highly susceptible for nucleotide alterations in most animals. Based on the cut-off point of haplotype diversity (0.5) and nucleotide diversity (0.005) suggested by Grant & Bowen (1998), the haplotype diversity (0.62) of *cytb* gene is greater than 0.5, however, the nucleotide diversity (0.0009) is much less than 0.005 which may increase desert tortoise vulnerability to environmental changes.

Cytb gene and CR sequences have also been extensively used in the molecular systematics and population genetics of animals. It's estimated that the Mojave Desert tortoise may have diverged from the Texas tortoise (*G. berlandieri*) 10.5 million years ago and from the Sonoran Desert tortoise (*G. morafkai*) about 5 million years ago. The sequence differences were 3% between Mojave and Sonoran tortoises, and 5% between Mojave and Texas tortoises from the alignment results of the 408 bp of *cytb* gene. The differences of the CR sequences between Texas and Mojave Desert tortoises were 8.4% which is significantly higher than that from their *cytb* genes. The molecular evolution rate was estimated around 0.5% *cytb* sequence differences per million years for two tortoise species diverging from each other. Our results are similar to the previously reported rate of 0.4% sequence divergence per million years between pairs of lineages in marine turtles.

Natural Features and Ecological Significance of the Chuckwalla National Monument

Mark Massar, Wildlife Biologist
Bureau of Land Management, California Desert District
1201 Bird Center Dr, Palm Springs, CA 92262. E-mail: mmassar@blm.gov

Last month, President Biden designated America's newest national monument, the Chuckwalla National Monument, using the authority of the Antiquities Act. Seven local Tribes advocated for the designation of the Chuckwalla National Monument, urging the president to protect this culturally significant landscape. Although this area has significant cultural importance, this talk will highlight the natural features of this remarkable region, particularly the importance of this area for the desert tortoise. Bordering Joshua Tree National Park to the south and stretching from the Coachella Valley to nearly the Colorado River, the Chuckwalla National Monument spans 624,000 acres and is characterized by its stunning landscapes, including mountain ranges, broad bajadas, pristine stretches of desert pavement, extensive sand dunes, and vast wilderness areas. This region is rich in biodiversity, with a diverse Sonoran Desert flora, including several endemic plant species such as the Munz cholla, California's tallest cactus, palm oases, palo verde dune thickets, and the largest microphyll woodland in the California deserts, located at Milpitas Wash. The area also supports a diverse fauna, including desert bighorn sheep, burro deer, Yuma pumas, California leaf-nosed bats, Sonoran pronghorn (soon to be reintroduced) and chuckwallas. Notably, the southernmost major population of desert tortoises in California occurs at the Chuckwalla Bench, a relatively small area that boasts rich habitat and high tortoise densities. The

Chuckwalla region has a long history of conservation efforts by the BLM, beginning in the late 1970s and culminating in its recent designation as a national monument.

Native American Influence on the Pre-Contact Distribution of Desert Tortoise (*Gopherus agassizii)* in the Mojave Desert.

Kelly R. McGuire, William R. Hildebrandt, Chloe L. McGuire, Kaely Colligan, and Jerome King
Far Western Anthropological Research Group 2727 Del Rio Place, Suite A, Davis, CA 95618.
Kelly R. McGuire Email: Kelly@farwestern.com, William R. Hildebrandt Email: Bill@farwestern.com
Chloe L. McGuire Email: Chloe@farwestern.com,jKaely Colligan Email: Kaely@farwestern.com, and Jerome King Email: Jay@farwestern.com; *Phone: 530 756-3941.*

A comprehensive review of 265 archaeological sites located in the northwest Mojave Desert that contain faunal remains reveals a significantly reduced range of desert tortoise prior to Euro-American colonization and settlement in the mid-19th century. We argue that the expansion of desert tortoise into its contemporary range resulted from the release of predation pressure wrought by the breakdown of traditional Indigenous hunting that occurred during this time. The desert tortoise was listed as Threatened in 1990 by the U.S. Department of Interior and is still considered in danger of going extinct. There are many implications of these results for ongoing management and recovery efforts associated with this species. Finally, this study underscores the importance of archaeological data for understanding past Indigenous ecological legacies and how they can inform our understanding of the natural world as it is today.

Protecting an Ancient Resident:
Recovery and Conservation Strategies for the Mojave Desert Tortoise in Utah

Ann M. McLuckie[1], Curtis Roundy[2], and Jessica Kinross[2]
[1]Utah Division of Wildlife Resources, Washington County Field Office, 451 North SR-318, Hurricane, UT 84737. Phone 435-680-1062, Email: annmcluckie@utah.gov
[2]Utah Division of Wildlife Resources, Southern Region Office, 1470 North Airport Rd, Cedar City, Utah 84721.

The Division of Wildlife Resources, State of Utah (UDWR), has been committed to the protection and recovery of the Mojave Desert Tortoise (*Gopherus agassizii*) focusing on habitat protection, habitat restoration, translocation, fencing and population monitoring. Two Recovery Units, based on unique morphological, ecological and genetic characteristics, are identified in Utah, the Northeastern Mojave and the Upper Virgin River, with the latter existing entirely in Utah and significantly smaller than other recovery units. The accomplishments and conservation actions to help recover the Desert Tortoise are due to UDWR's continued partnerships with local and federal agencies. Our participation on the Lands Acquisition Subcommittee helps support land acquisitions in the Red Cliffs Desert Reserve with the goal of removing private inholdings, protecting contiguous tracts of land, and reducing fragmentation. To address the threat of wildfire, UDWR is actively engaged in habitat restoration. For example, we are working with our agency partners to apply the pre-emergent herbicide Rejuvra (i.e., Indaziflam) along roadsides and previous wildland fire perimeters to reduce fine fuels created from invasive annual grasses in the

Beaver Dam Wash and Red Cliffs National Conservation Areas. The overall project goal is to build wildland fire resilience by removing invasive annual grasses. In addition, we have experimented with various restoration methods (e.g., containerized plants, seed application and integration, herbicide application) to restore burned habitat. To mitigate the impacts of roads and reduce negative impacts on tortoises and their habitat, we have identified and secured funding to upgrade fencing to USFWS fencing standards and repair old and compromised fencing undercut by erosion and general wear. We have updated and amended our Translocation Management Plan, identifying how displaced desert tortoises from developed areas are to be used to enhance desert tortoise recovery efforts in southwest Utah. UDWR has been monitoring desert tortoises for over 40 years, both on the Beaver Dam Slope (BDS) and in areas near St. George. We will continue to implement long-term monitoring to assess the status and trends of Desert Tortoise populations in Utah. Working with our agency partners, UDWR will continue to help recover the desert tortoise in the face of continued population growth.

FEATURED SPEAKER

Population Viability of Egyptian Tortoises: Analyzing Demographic Sensitivities and Extinction Risks in North Sinai

Basem A. Motwaly[1], Omar Attum[2], Denise M. Thompson[1], and Day B. Ligon[1]
[1]Department of Biology, Missouri State University, Springfield, Missouri
[2]Indiana University Southeast, New Albany, Indiana

bassimrabea@gmail.com

This study examines the population viability of the critically endangered Egyptian Tortoise (*Testudo kleinmanni*) across five sites in North Sinai, focusing on demographic sensitivities and extinction risks that threaten its survival. The research aims to understand the interplay between demographic parameters, environmental factors, and population dynamics to inform effective conservation strategies. Utilizing multistate mark-recapture models within a Bayesian framework, this study estimates survival, recruitment, and transition probabilities across different life stages of the tortoise.

The results indicate significant variability in population health, with declining populations showing lower juvenile survival rates, skewed sex ratios, and reduced recruitment, which heightens extinction risks. Conversely, growing populations demonstrate higher adult survival and better recruitment outcomes. Environmental variables, particularly vegetation cover as measured by the Normalized Difference Vegetation Index (NDVI), are found to significantly influence survival probabilities, underscoring the critical role of habitat quality.

The Population Viability Analysis (PVA) identifies female survival as the most crucial demographic factor for population stability. Based on these findings, the study recommends habitat restoration, head-start programs for juveniles, and community-based monitoring initiatives to mitigate anthropogenic threats. This research enhances understanding of the demographic processes affecting the Egyptian Tortoise and highlights the urgent need for targeted conservation efforts to ensure the species' survival in the face of ongoing environmental challenges.

Spatial Capture-Recapture Density Estimation of an Imperiled, Semi-Fossorial, Spatially Aggregated Chelonian at the Scale of Conservation

Sean M. Murphy[1], Ally P. Xiong[1,2], Felicia C. Chen[1], Sarah M. Doyle[1], Chad J. Wilhite[1,3], K. Kristina Drake[1,4], and Todd C. Esque[1]

[1]U.S. Geological Survey, Western Ecological Research Center, Boulder City, Nevada, 89005. E-mail: smmurphy@usgs.gov

[2]*Present address*: Western EcoSystems Technology, Cheyenne, Wyoming 82001

[3]*Present address*: University of Hawai‘i at Hilo, Hawai‘i Cooperative Studies Unit, Hilo, Hawai‘i, 96720

[4]*Present address*: U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office, Las Vegas, Nevada 89130

**Correspondence:* U.S. Geological Survey, Western Ecological Research Center, 500 Date Street, Building 500, Boulder City, Nevada, 89005; e-mail: smmurphy@usgs.gov (SMM)

Obtaining accurate population estimates is critical for informing conservation and management of threatened, endangered, or otherwise imperiled wildlife. Many imperiled species are cryptic, sparsely distributed, or exhibit behavioral characteristics that can cause low detection rates, model assumption violations, and ultimately biased and unreliable population parameter estimates. Mojave desert tortoises (*Gopherus agassizii*) are a threatened species in the United States, and population density is a primary parameter used for long-term monitoring to inform species recovery. Desert tortoises exhibit prolific burrowing behavior (semi-fossorial), resulting in portions of populations being undetectable during surveys, and evidence suggests tortoises spatially aggregate across landscapes with patchily distributed suitable habitats, both characteristics of which may violate assumptions of traditional density estimation methods. We conducted transect-based search area-encounter surveys during 2020–2022 and used inhomogeneous Poisson spatial capture-recapture (SCR) models to estimate seasonal spatially explicit adult desert tortoise densities and spatial variation thereof as a function of habitat, landscape, and climatic conditions across a ~2,400-km^2 study area. We also used simulation to evaluate SCR model robustness to a range of proportions of individuals being unavailable to detection during surveys. Although spatial mean desert tortoise densities ranged from 0.24 to 3.87 adults/km^2, substantial support existed for tortoise density spatially varying with landscape characteristics, particularly apparent thermal inertia and road density. This corresponded to desert tortoises residing primarily in multiple disjunct aggregations at densities of up to 20-50 adults/km^2, whereas most of the landscape supported few or no tortoises. Simulations demonstrated that SCR is robust to <80% of spatially aggregated desert tortoises being temporarily unavailable to detection, producing nominally biased (≤5%) density estimates from our survey design if sampled for >30 occasions with spatiotemporally varying survey effort. Our findings illustrate the superior potential of SCR for producing reliable density estimates for imperiled Mojave desert tortoises and likely other semi-fossorial species.

Mojave Desert Sentinel Landscape

Philip Murray
Marine Corps Air Ground Task Force Training Command, G-7 Government and External Affairs

The Sentinel Landscapes Partnership is a coalition of federal agencies, state, tribal, and local governments, and non-governmental organizations that work with willing landowners and land managers to advance sustainable land use practices around military installations and ranges. Through 2024, 18 landscapes have been designated from Hawaii to Virginia, prioritizing federal funding opportunities and to further mission resilience and species recovery. The Sentinel Landscapes Partnership enables the U.S. Department of Agriculture, Department of Defense, Department of the Interior, and the Federal Emergency Management Agency to collaborate for greater impact in locations where significant missions overlap. The 3.6-million-acre Mojave Desert Sentinel Landscape was designated in 2024 as the first Sentinel Landscape within California, recognizing decades of partnerships of desert tortoise recovery work within the Mojave Desert. While the Marine Corps Air Ground Combat Center serves as the anchor installation, the five other installations that border the MDSL include China Lake Naval Air Weapons Station, National Training Center Fort Irwin, Edwards Air Force Base, and Marine Corps Logistics Base Barstow. The MDSL includes 2.8 million acres of Bureau of Land Management land, critical desert tortoise habitat, and Desert Tortoise Recovery and Sustainment Partnership critical to national security and interagency coordination. The MDSL will be a force multiplier natural resources, working economies, and military readiness within the Mojave Desert. The MDSL's focus will leverage common ground among partners' missions, multiplying forces to strengthen and enrich natural resource conservation while sustaining working economies and military readiness in the Mojave Desert. This nascent program has already secured environmental compliance funding to enable species recovery actions, a beginning that portends essential advances in species and ecosystem conservation.

The Recovery and Sustainment Partnership (RASP), a Collaborative Tortoise Recovery Effort in the Western Mojave

Clay F. Noss
Mojave Desert Land Trust, Joshua Tree, CA 92252, USA
Phone: 407-489-3869 Email: clay.noss@mdlt.org

The Recovery and Sustainment Partnership (RASP) is an joint initiative between DOD and DOI to accelerate the recovery of priority species while providing DOD greater mission flexibility. In 2020 the Mojave desert tortoise (*Gopherus agassizii*) was selected as a RASP priority species, establishing a partnership between the National Fish and Wildlife Foundation (NFWF), the U.S. Marine Corps, U.S. Army, DOD, USFWS and BLM. A key part of the RASP strategy is concentrating resources in focal areas within Tortoise Conservation Areas in the western Mojave (Fremont-Kramer, Superior-Cronese and Ord-Rodman). Priority RASP strategies are drawn directly from the 2011 USFWS Revised Recovery Plan. These strategies include habitat protection (acquisitions), habitat restoration, highway exclusion fencing and crossings, community outreach (particularly to recreational off highway vehicle users), population augmentation through head-

starting and improved population monitoring. Organizations apply for funds on an annual cycle. There are multiple metrics for evaluating RASP's success, with the most important being improved population vital rates. As of Fall 2024, RASP funding has supported work by three non-profits, one agency (USFWS), and one for-profit company. Strategies funded to date include acquisitions, habitat restoration, community outreach and population monitoring. The RASP program has the potential to meaningfully contribute to desert tortoise recovery. Challenges include securing appropriate funding levels, environmental and cultural clearances, broadening the applicant and grantee pool and coordinating strategies. Science needs include linking conservation actions to tortoise demographics, evaluating the impact of RASP at the species level and determining the appropriate spatial scale for conservation efforts.

Is the Desert Tortoise an Umbrella Species for Other Species in the Mojave Desert?

Kenneth Nussear[1], Thomas Dilts[2], Todd Esque[3], Kirsten Dutcher[4], Anjana Parandhaman[5], Nathan Byer[6], Amy Vandergast[7], Daniel Shryock[3], Scott Bassett[8], Doug Boyle[9], Marjorie Matocq[2], and Jill Heaton[9]

[1]Department of Geography and Ecology, Evolution and Conservation Biology, University of Nevada, Reno NV 89557-0154. knussear@unr.edu

[2]Department of Natural Resources and Environmental Sciences, University of Nevada, Reno – tdilts@unr.edu and mmatocq@unr.edu

[3]US Geological Survey, Western Ecological Research Center, Las Vegas NV - tesque@usgs.gov and dshryock@unr.edu

[4]Desert Reserves Director, University of California, Irvine, dutcherk@uci.edu

[5]Department of Biology, UC Santa Cruz, anjana.parandhaman@gmail.com

[6]Natural Resources Division, Cleveland Metroparks, Cleveland, Ohio - nathanbyer1@gmail.com

[7]US Geological Survey, Western Ecological Research Center, San Diego CA - avandergast@usgs.gov

[8]College of Science, University of Nevada, Reno, sbasset@unr.edu

[9]Office of the Provost, University of Nevada, Reno, douglasb@unr.edu, and jheaton@unr.edu

Protecting habitat for high profile species is often assumed to serve as a conservation umbrella for other species in need of protection . It is often assumed that when habitat is conserved for a species of conservation concern that other species may benefit from these conservation actions because their habitat geographically overlaps with the umbrella species. However, the degree to which higher quality areas of habitat suitability is seldom assessed. The Mojave desert tortoise (Gopherus agassizii) was listed as a threatened species under the US Endangered Species Act in 1990 (USFWS 1994), and is protected throughout its range. Because the desert tortoises exists in a widely ranging and diverse habitat many other lowland species that are of conservation concern may lie within the habitat boundaries of the tortoise, and thus may be protected to a degree by the protection of tortoise habit. The tortoise, and many other species have fairly broad distributions and occur within multiple land management jurisdictions, including Department of Defense (DoD) installation boundaries and adjacent landscapes administered by other Federal and State agencies. However, aside from the potential for habitat overlap, the degree to which the desert tortoise serves as an umbrella for other Mojave Desert species has not been thoroughly assessed. In this

assessment we sought to not only assess overlap, but also the relative suitability of a species` habitat where it overlapped with desert tortoise habitat. Here we ask the questions: 1) Are the overlapping habitat areas that fall within higher suitability scores for the desert tortoise also high for the species under consideration; To what extent do areas of greater habitat quality occur relative to the total distribution of the protected species within the study area; 3) How might these assessments differ by agency/installation?

Conservation Corridors for Desert Tortoises – Demography Trends in the Ivanpah Valley in California and Nevada

Kenneth Nussear[1], Todd Esque[2], Amy Vandergast[3], Corey Mitchell[4], Kirsten Dutcher[5], Justice Best[1], Steven Hromada[6] ,Felicia Chen[2], Amanda M. McDonald[2], Benjamin O. Gottsacker[2]
[1]Department of Geography and Ecology, Evolution and Conservation Biology, University of Nevada, Reno NV 89557-0154. knussear@unr.edu
[2]US Geological Survey, Western Ecological Research Center, Boulder City, NV
[3]US Geological Survey, Western Ecological Research Center, San Diego, CA
[4]US Fish and Wildlife Service,.Desert Tortoise Recovery Office, Tucson, AZ
[5]Desert Reserves Director, University of California, Irvine, CA
[6]Fresno Chaffee Zoo, Fresno, CA

The transition to renewable energy, particularly solar, is critical for reducing greenhouse gas emissions and dependence on foreign oil. However, utility-scale solar energy development in the southwestern deserts of the United States presents challenges for fragile ecosystems and sensitive species. Since its listing under the Endangered Species Act in the 1990s, desert tortoise populations have faced increasing pressures from urbanization, habitat loss, and now, renewable energy infrastructure. Conservation corridors are frequently proposed to mitigate these impacts, but their effectiveness in maintaining genetic and demographic connectivity remains uncertain. This study, a collaboration between the University of Nevada, Reno, and the U.S. Geological Survey, aims to evaluate the effects of habitat loss and fragmentation from solar facilities on desert tortoise population connectivity. Using ten 1km^2 study plots in Ivanpah Valley, California and Nevada, we employed spatial mark-recapture surveys, genetic analyses, and GPS telemetry to monitor populations. Demographic surveys were conducted at each plot every three years, using 3 passes of 20 surveyors at 5-10 m spacing on consecutive days. 2024 was the 10th year of our study, and each site has now been surveyed at least 3 times. We present spatially corrected density estimates for these sites over time, in the context of climate and local anthropogenic impacts.

Environmental Influences on Fungal and Bacterial Microbiomes associated with Agassiz Desert Tortoise (*Gopherus agassizii)* in California

Brendan J. O'Brien[1,2], *Brian T. Henen*[3], *Mia R. Maltz*[1,4] [1]CoRenewal Inc., 30805 Avenida del Yermo, Cathedral City, California 92234.
Email: corenewalinc@gmail.com [2]Hyphae Consulting, Inc., 9396 Main Rd., Huntington, Vermont 05462.
Phone: 907-444-1496. Email: hyphaeconsulting@gmail.com
[3]Marine Air Ground Task Force Training Command, ISD Environmental Affairs, Marine Corps Air Ground Combat Center, 1418 Brown Street, Twentynine Palms, California 92278-8110.
Phone: 760-830-5720. Email: brian.henen@usmc.mil
[4]University of Connecticut. Department of Plant Science and Landscape Architecture, Wilfred B. Young Building (YNG), University of Connecticut, 1376 Storrs Road, Unit 4067, Storrs, CT 06269-4067.
Phone: 860-486-1944; Email: mia.maltz@uconn.edu

Gopherus agassizii (Mojave Desert Tortoise) populations are faced with challenges associated with habitat modification, human disturbance, and microbial pathogenesis. Yet, little is known about the community diversity and composition of microbes living on the surface and within the digestive tract of desert tortoise populations. We evaluated fungal and bacterial microbiomes in wild and captive animals to characterize gut and surface microbial diversity and composition in these tortoises, and how these factors relate to individual animal health. We investigated the influence of the soil environment on the Gopherus agassizii core fungal and bacterial microbiomes to aid in future tortoise microbiome studies. We extracted DNA from desert tortoise fecal samples and paired soil samples, along with cryptogamic ground covers, collected from the environment. We also collected swabs of tortoise oral cavities, beaks, plastrons, and forelimbs. Fecal samples were collected opportunistically from animals who voided during routine health assessments, as paired with separate soil samples collected in tandem. We sequenced bacterial 16S and fungal ITS2 amplicons using an Illumina MiSeq and compared host microbiomes to soil communities in landscapes inhabited by these animals. We characterized microbial groups in host-associated and environmental microbiomes and found they differed between sites or environmental sources and were ostensibly influenced by diet. The composition of fungal gut mycobiomes in wild animals were more similar to paired soil samples collected nearby than they were to the fungal gut mycobiomes in captive animals; however, this pattern was not detected in bacterial communities from these same animals. Findings from this study will help provide valuable information about tortoise microbiomes and the ecological resilience of these tortoise populations.

Grassland Detection Through Satellite Analysis at Mapimi Biosphere Reserve: A Foundation for Connectivity Studies and Conservation Strategies for *Gopherus flavomarginatus*

Jacqueline Espinoza-Pichardo[1], Edgar G. Leija[2], Craig Stanford[3] and Gamaliel Castañeda-Gaytan[1]

[1]Faculty of Biological Sciences, Juarez University of the State of Durango, University Avenue, no number, Philadelphia Subdivision, 35070 Gomez Palacio, Dgo., Mexico
Phone: +52 8715358339. Email: jacqueline.espinozapichardo@gmail.com

[2]Center for Research in Environmental Geography, National Autonomous University of Mexico, Old Highway to Patzcuaro 8701, Former Hacienda San Jose de la Huerta, 58190 Morelia, Mich. Email: eleija@ciga.unam.mx

[3]Department of Biological Sciences, University of Southern California, Hancock Foundation Building, 3616 Trousdale Pkwy, Los Angeles, CA 90089, USA. Email: stanford@usc.edu

Landscape connectivity is a fundamental element in the development of effective conservation strategies, as it sustains ecological processes that are spatially interconnected. In the Mapimí Biosphere Reserve (MBR), grasslands serve as a critical habitat for the endangered Bolson Tortoise (*Gopherus flavomarginatus*), a species endemic to this region. Despite their ecological importance, the identification and monitoring of grasslands in arid and semi-arid ecosystems via remote sensing remain challenging, due to their unique visual and spectral characteristics. This study employed current (2024) 3-meter resolution PlanetScope satellite imagery and a hybrid supervised classification to generate a high-precision land use and land cover (LULC) map and identify the distribution of grasslands in the MBR. The classification process was validated using a confusion matrix, achieving an overall accuracy of 97%, and supplemented with field verification at 30 georeferenced locations. The results yielded a high-precision map that delineates the spatial distribution and extent of grasslands within the MBR, revealing a total area of 4,112 hectares. This represents an 82% reduction compared to previous estimates, we hypothesize that this result is due to the high image resolution and the hybrid supervised classification methodology. The spatial configuration of the grasslands, as visualized through this map, provides invaluable geospatial data for connectivity analyses and the prioritization of areas for restoration for *Gopherus flavomarginatus* conservation. These findings demonstrate the efficacy of remote sensing as a tool for the monitoring and management of arid ecosystems. Moreover, the approach developed in this study can be adapted to other arid and semi-arid regions facing similar challenges, offering a replicable framework for conservation initiatives.

Empowering the Council into the Future: A Perspective from the Newer Desert Tortoise Council Board Members

Mary Lane Poe, Max Havelka, and Luke Basulto
Desert Tortoise Council, 3807 Sierra Highway #6-4514, Acton, CA 93510

With 50 years of dedication and experience in desert tortoise and tortoise habitat conservation, the Desert Tortoise Council has solidified its position as a leader in this area of wildlife conservation. Most people know about the Desert Tortoise Council from the annual symposium and Introductory Course. But there are other activities that the Council conducts through its volunteer Board and standing and ad hoc committees. Some newer Board members provide perspectives of their

involvement on the Board and committees. Their involvement has expanded the work of the Council with positive results for desert tortoises, for their professional and personal lives, and for their communities. They provide their insights on the inner workings of this conservation organization that focuses its efforts on the conservation of three species of tortoises across three desert ecosystems, *Gopherus agassizii*, *Gopherus morafkai*, and *Gopherus evgoodei*, and who recently has also supported conservation efforts for *Gopherus flavomarginatus*.

Desert Tortoise Council Activities - 2024

Mari Quillman, Chairperson
Desert Tortoise Council Board of Directors
ECORP Consulting, Inc., 111 Academy Way, Suite 210, Irvine, CA 92617
Phone: Office (714) 648-0630; Cell (714) 222-5932; Email: mquillman@ecorpconsulting.com

The Board of Directors (BOD) of the Desert Tortoise Council (Council) conducted an in-person business meeting at the 2024 Annual Symposium and held six online BOD meetings in 2024. Sadly, in late 2024, the BOD's Treasurer of ten-years, Joe Probst, passed away. The BOD now consists of 14 members with two open officer positions, Treasurer and Membership Coordinator, and four open Member-At-Large positions. In 2024, the Council's Operations Manager continued to implement duties associated with fundraising, assisting the BOD and Committee Chairs, implementing robust social media efforts, assisting with the Annual Symposium and training course implementation, and conducting outreach to the membership, the public, and other relevant organizations. The membership of the Council includes approximately 390 active members with over 3,500 contacts on our contact list. Our Ecosystem Advisory Committee commented on 75 (99%) of the 76 notices received for projects or actions potentially affecting tortoises and their habitats in CA, NV, UT, and AZ and for interstate or national issues. The Council held the Introductory Course/Workshop with the virtual lecture in late October followed by two field workshops in early November. A total of 200 people completed the entire course and 23 people audited the lectures. More than 200 people attended the 49th Annual Symposium in Las Vegas, Nevada. Peter Woodman conducted a field trip and SNEI, Inc. again sponsored the pre-conference mixer. The Symposium program included 50 oral presentations and four posters. The David J. Morafka Memorial Research Award went to Sean Sutor (Texas Tech University) and the Leeward Renewable Energy Award went to Tianyi Xu (University of Texas, Austin). The Council's social media committee, which is made up of board members, the Operations Manager, and volunteers, greatly increased the Council's social media presence on various platforms in 2024. The Mexican Tortoise Conservation Committee, Agency Coordination Committee, and Advanced Training Course are in the process of being re-energized. Representatives from our Education and Outreach Committee attended The Wildlife Society Western Section and Turtle Survival Alliance conferences to educate attendees about the mission of the Council, to sign up new members, and to sell SWAG as a fundraiser. The Fundraising Committee implemented fundraising events through Amazon and the social media platforms. The Council held two "Drink Beer Save Tortoises" fundraising events in November in conjunction with the Introductory Course. In September, three members of the BOD trained staff at the Sevilleta National Wildlife Refuge in New Mexico on the correct procedures for processing Bolson tortoises and attaching transmitters. They also participated in the release of twenty Bolson tortoises on the refuge and provided training in how to track the tortoises. The BOD spent a significant amount of time in the last quarter of the year planning for the 50th Annual Symposium.

In Memory of Joe Probst

Mari Quillman
Desert Tortoise Council; and ECORP Consulting, Inc., 111 Academy Way, Suite 210, Irvine, CA
Phone: 714-222-5932. Email: mquillman@ecorpconsulting.com

Joe Probst joined the Board of the Desert Tortoise Council (Council) in 2013 and was elected as the Treasurer at the Annual Symposium in 2014. Most people recognized him as the German cowboy who sold the Council's merchandise at the Introductory Course and the Annual Symposium, but he also sold the Council's merchandise at other Council events and professional conferences. Behind the scenes, Joe was an incredibly hard worker for the Council as he took charge of setting up events, working with the venues, making all of the logistical arrangements, ordering merchandise, and handling all of the financial transactions. Joe was always ready to jump in wherever help was needed. Outside of the Council, Joe was involved in many other non-profit organizations where he helped to raise funds for the groups he supported. Joe lost his battle to cancer in December of 2024, and his loss is a huge one for the Council. Joe is survived by his wife, Becky Jones, the Council's Corresponding Secretary. The presentation will provide memories of Joe's involvement in the Council, his other non-profit interests, and his fun-loving life.

Can Burrow Microclimate and Nest Site Selection Buffer Mojave Desert Tortoise Egg Hatching Success and Sex Ratios Against Climate Change?

Thomas A. Radzio, Talisin T. Hammon, Ronald R. Swaisgood, and Melissa J. Merrick
San Diego Zoo Wildlife Alliance, 15600 San Pasqual Valley Rd., Escondido, CA, 92027, USA. [2]Email: tradzio@sdzwa.org

Predictions of tortoise habitat suitability and population viability require understanding climate impacts across developmental stages, including on egg development and hatchling sex ratios. Key knowledge gaps include incubation temperatures available in burrows, hatching success and hatchling sex ratios under fluctuating nest temperatures, and whether females select nest sites deeper in burrows as temperatures rise. We investigated these questions as part of a headstart program, in which females lay eggs in predator-proof enclosures on Edwards Air Force Base. In spring 2023 and 2024, females were placed in enclosures containing a north- or south-facing artificial burrow (110 cm) with iButton loggers measuring air and soil (8 and 18 cm below surface) temperatures at 25-cm intervals down the burrow shaft. Time-lapse cameras recorded nesting activity, enabling placement of iButtons next to nests after they were laid. We determined hatching success and assigned hatchling sex using testosterone assays. Burrows provided strong air and soil temperature gradients. Spring and summer were warmer in 2024 than in 2023. Females laid nests deeper in burrows during the warmer year, and nest depth in burrows correlated positively with burrow temperature during the week before oviposition. Despite a prolonged heatwave that pushed some nest temperatures to 37°C in July 2024, we did not detect an effect of high incubation temperature on hatching success. The cooler 2023 incubation season produced male and female hatchlings. Notably, even short durations above the pivotal temperature (31.8°C) produced females. Testosterone analyses are ongoing for the 2024 cohort, but incubation

temperatures predict that, despite having been laid deeper in burrows, nests only produced females during this very hot year. Our data suggest burrow microclimate and nest site selection may partially buffer egg hatching success and hatchling sex ratios against warming, but that even short heatwaves could have dramatic effects on sex ratios in this species.

PLENARY ADDRESS

Why fighting climate change is not helping the desert tortoise

William E Rees, PhD, FRSC
University of British Columbia, Vancouver, BC V6T 122, Canada. wrees@mail.ubc.ca

This presentation examines the Mojave desert tortoise's (*Gopherus agassizii*) prospects for survival in light of increasing concern for the impacts of climate change. The desert tortoise is already listed federally as a threatened species and is on the International Union for Conservation of Nature's Red List as critically endangered. Land degradation and fragmentation resulting from urban sprawl, transportation/utility corridors, vehicle-based recreation, agriculture (including livestock grazing), invasive species etc., have seriously compromised the desert tortoise's habitat throughout its historic geographic range; in addition, coyotes and domestic dogs prey upon local populations, disease and mindless vandalism add to increasing mortality (Berry and Murphy 2019). Not only are these historic factors worsening but an increasingly warm, dry and erratic climate also seems likely to accelerate the desert tortoise's decline toward extinction abetted, ironically, by green energy development. There is no question that climate change/global heating is a horrific problem and a serious threat, not only to the desert tortoise, but also to the future of human civilization. However, current global efforts to reverse climate change are misdirected and counterproductive. Climate change is merely one symptom (along with plunging biodiversity, land/soil degradation, ocean acidification, ground-water depletion, tropical deforestation, falling sperm counts, pollution of everything, etc.) of a greater meta-problem, human ecological overshoot (Catton 1982; Rees 2023). Overshoot means that humans are consuming even renewable and replenishable resources faster than ecosystems can regenerate and discharging (often toxic) waste in excess of nature's assimilative capacity. More simply, there are too many people consuming and polluting too much. No major co-symptom of overshoot can be solved in isolation of the others. Politically acceptable 'solutions' to global heating, for example — wind turbines, solar farms, EVs, hypothetical carbon capture and storage, etc.—are not 'fixing' the climate and are exacerbating overshoot (Rees 2023). This is problematic: the desert tortoise is a victim of overshoot in the form of 'competitive displacement'—the excessive demands of humans, their livestock, pets, infrastructure and cultural artefacts are literally displacing the tortoise (wildlife generally) from their habitats and food sources (see Bar-on, et al. 2018). This process will continue until the tortoise is extinguished or society confronts overshoot directly. The former is more likely than the latter—the only solution to overshoot is a smaller economy (greatly reduced energy and material throughput) supporting significantly fewer people.

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POSTER

Validating iButtons for Characterizing Summer Nighttime Microhabitat Use in Desert Tortoises Across Life Stages

Katelyn N. Rock, Thomas A. Radzio, Talisin T. Hammond, Ronald R. Swaisgood[1], and Melissa J. Merrick

[1]San Diego Zoo Wildlife Alliance, 15600 San Pasqual Valley Road, Escondido, CA 92027. Email: karock@sdzwa.org

Faced with climatic extremes, desert species may be at increased risk of depleting water and energy reserves in summer, thus, understanding their thermal ecology and microhabitat use is more crucial than ever to predict responses to climate change. Like many species, desert tortoises (*Gopherus agassizii*) use burrows as refugia from high daytime surface temperatures to avoid overheating and conserve energy and water. However, during summer, nighttime temperatures are lower at the surface than in burrows. Tortoises sometimes overnight at the surface during summer, raising the question of whether night surface use will increase under climate warming, a strategy that could buffer energy reserves but also increase predation risk. Cameras can address this question, but they are limited by tortoise movements among burrows and do not provide temperature information. In August 2023 and 2024, we observed juvenile and adult tortoise activity in the wild using time-lapse cameras and simultaneously recorded tortoise and environmental temperatures using temperature loggers (iButtons) affixed to tortoises and positioned in burrow and surface microhabitats. We will use camera observations to assess whether tortoise and environmental temperature data can be used to accurately predict nighttime microhabitat use in response to climate change across life stages.

Common Raven Management in the Upper Virgin River Recovery Unit in 2023-2024

Michael Schijf[1], Cameron Rognan[1], Kerry L. Holcomb[2], Danielle Costantini[3], and Michael Stroh[4]
[1]Washington County Habitat Conservation Plan, 111 East Tabernacle Street, St. George, UT 84770, Email: mike.schijf@washco.utah.gov
[2]U.S. Fish & Wildlife Service, Desert Tortoise Recovery Office, 777 East Tahquitz Canyon Way, Suite 208, Palm Springs, CA 92262, Email: kerry_holcomb@fws.gov
[3]U.S. Fish & Wildlife Service, 2369 W Orton Circle #50, West Valley City, UT 84119, Email: danielle_costantini@fws.gov
[4]Colorado State University, Department of Human Dimensions of Natural Resources, Fort Collins, CO 80523, Email: michael.stroh@colostate.edu

The common raven (*Corvus corax*, ravens) is a subsidized, native Mojave desert tortoise (*Gopherus agassizii*, tortoise) predator, whose populations are expanding throughout those desert ecoregions of North America characterized by a winter precipitation regime (i.e., Mojave and Great Basin Deserts). Human resource subsidies and the predators that rely on them therefore poses a threat to tortoise population persistence. The potential effects of raven predation on tortoise population stability in the Upper Virgin River Recovery Unit have been studied using point count surveys and TechnoTortoise™ decoy stations, which can then be converted to estimates of raven density, distribution, and risk of raven predation. In 2023 and 2024, raven nest surveys were completed in preparation for management actions intended to reduce the risk of raven predation and thus increase juvenile tortoise survival. These efforts significantly expanded our spatial dataset of raven nest territories, particularly in areas outside of the Red Cliffs Desert Reserve. In 2024, U.S. Fish & Wildlife Service issued a depredation permit, authorizing the take of raven eggs by addling with oil and other approved lethal actions. We successfully oiled 64 eggs, comprising 12 nests. Most nests were reached by climbing or rappelling. Plans are being made to expand our methods to include Unmanned Aerial Systems (UAS) to reach and addle the contents of additional nests in 2025. In addition to these management efforts, community education, citizen science reporting, and the possible use of raven deterrents at landfills and dumpsters are being considered as part of a cohesive program to reduce wildlife access to human sources of food, water, shelter, etc. throughout Washington, County, Utah.

Behavioral Change Programming to Reduce Human Provided Food Subsidies for Ravens in the Desert Tortoise's Range

Kaitlyn E. Shaw, James Danoff-Burg, and Maya Nuñez
The Living Desert Zoo and Gardens, 47900 Portola Avenue, Palm Desert, California 92260
Email: kshaw@livingdesert.org

Raven populations in the Southwestern United States benefit from the food, water, and shade we provide to them due to uncovered trash, excessive watering of the land, and buildings. The subsidies are substantial enough that raven populations have increased by up to 1,700% in the California Deserts, where the birds are the greatest threat to the survival of the desert tortoise (*Gopherus agassizii*), causing up to 50% of annual tortoise deaths. To address these subsidies that

humans provide, The Living Desert conducted a behavioral change program in Hi-Desert communities that encouraged restaurants and food-related businesses to cover their dumpsters to prevent ravens from consuming trash. The campaign recently expanded to include 40 businesses in Desert Hot Springs. Due to our interventions, restaurant dumpster closures increased by 12% shortly after our interventions and, 3 months after our outreach, sustained a 6% increase. Research assessing the efficacy of pro-environmental behavior change efforts document that it is common to see a large initial increase in the desired behavior shortly after an intervention; yet this increase often diminishes over time. Allcott & Rogers (2014) refer to this occurrence as "action and backsliding." However, repeated interventions can diminish the cyclical repetition of the "action and backsliding" over time, with behavior change becoming more persistent and sustained with continued interventions. Conducting repeated interventions allows for repeated feedback on each restaurant's dumpster closure rate, comparative feedback with how the restaurant is performing in relation to other local restaurants, and motivation as businesses are persistently evaluated, all of which have been found to contribute to long-term behavior change. These latest findings about The Living Desert's behavioral change program indicate the importance of repeated and ongoing efforts and periodic reinforcement to decrease the human provided subsidies available to ravens across the entire range of the desert tortoise.

The Haunted Landscape: Making ravens unwelcome

Tim Shields, William I. Boarman
Tortoises For Tomorrow LLC, PO Box 963, Joshua Tree, CA 92252. Email: t.shields@ornilogic.com
Conservation Science, Research and Consulting, 2522 Ledgeview Pl., Spring Valley, CA 91977.
Email: boarmancsrc@gmail.com

As part of the California Wildlife Conservation Board funded Desert Tortoise Conservation Innovations (DTCI) project we are applying multiple tools and techniques to reduce the threat posed to tortoises and other wildlife by raven numbers elevated enormously over their former abundance. The central idea is to create, in essence, a haunted landscape for ravens, in which they feel insecure and where reproductive, foraging and roosting success is far from assured. The principal tools are lasers and other hazing devices, remote egg oiling mechanisms and delivery vehicles, and boobytrapped tortoise models. We present a status update of the application of these tools and highlight the effort to integrate them into a coherent package. The presentation is informed by the idea of using the intelligence and social network of ravens as tools in the effort. We conclude with a view of the predator management task under the DTCI project and recommendations for broader application of the tools and techniques we and others have developed.

Tortoise Hotspots: Understanding Current Distribution Patterns and Their Implications

Tim Shields, William I. Boarman
Tortoises For Tomorrow LLC, PO Box 963, Joshua Tree, CA 92252, USA Email: t.shields@ornilogic.com
Conservation Science, Research and Consulting, 2522 Ledgeview Pl., Spring Valley, CA 91977 USA Email: boarmancsrc@gmail.com

Prior work by the authors on a set of parcels in the vicinity of Fremont Peak, in San Bernardino Co., CA, led them to believe that there were distinct, geographically small areas of anomalously high desert tortoise density in a milieu of zero to very low density. We have labeled these tortoise hotspots. The current work is an attempt to establish a quantitative understanding of this pattern. Nine one-square kilometer plots were selected to represent the spectrum of tortoise habitat quality, with three each in each of high, medium and low quality habitat categories. We walked 10m interval parallel N-S transects on all 9 plots, recording every piece of tortoise sign found (live tortoises, carcasses, burrows, pallets and scrapes, scat, drinking sites, and tracks).

The character of each plot's sign set, as well as the raw numbers, tell a story of its relative current value as tortoise habitat and something about their history. The fact that very high density, relatively small tortoise aggregation areas exist in a setting of much lower average density has important conservation implications. Identification of hotspots should be a priority as management effort in these areas will help ensure the maximum return on investment of resources. Furthermore, we are conducting work to characterize hotspots using environmental and ecological variables: landscape ruggedness; soil types; general slope aspect; annual and perennial vegetation. We hope to discern the "formula" for high density tortoise occupation and to use it as a tool to quickly identify likely candidate sites for further attention in unknown areas.

New Methods to Estimate Mojave Desert Tortoise Population Response to Multiple Stressors Across its Range

Madeline Standen[1] , Steven J. Hromada[1] , Linda J. Allison[2,†] , Jacqueline Dougherty[3] , K. Kristina Drake[2] , Todd C. Esque[4] , Brian Folt[1,5] , Jerry Freilich[6] , Elizabeth Hunter[7] , Jeffrey E. Lovich[8] , Ann M. McLuckie[9] , Corey I. Mitchell[2] , Kenneth E. Nussear[3] , Elissa Olimpi[1], Arielle Parsons[1], Kevin Shoemaker[10] , Michael S. Vamstad[6] , Amy G. Vandergast[11] , Margarete A. Walden[10] , and Brett G. Dickson[1]

[1]Conservation Science Partners, Inc, Truckee, 11050 Pioneer Trail, Suite 202, CA 96161, USA. Email: madi@csp-inc.org*, stevehromada@gmail.com, elissa@csp-inc.org, arielle@csp-inc.org, brett@csp-inc.org

[2]U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office, 4701 N Torrey Pines Dr., Las Vegas, NV 89130. Email: kristina_drake@fws.gov, corey_mitchell@fws.gov

[3]University of Nevada, Reno, Department of Geography, 1664 N. Virginia St., Reno, NV 89557, USA. Email: jod5116@gmail.com, knussear@unr.edu

[4]U.S. Geological Survey, Western Ecological Research Center, 500 Date St. Bldg 500, Boulder City, NV 89005. Email: tesque@usgs.gov

[5]U.S. Geological Survey, Nevada Cooperative Fish and Wildlife Research Unit, University of Nevada - Reno, 1664 N. Virginia St., Reno, NV 89557. Email: bfolt@unr.edu

[6]Joshua Tree National Park, 74485 National Park Dr., Twentynine Palms, CA 92277 Email: stonefly@olypen.com, Michael_Vamstad@nps.gov

[7]U.S. Geological Survey, Virginia Cooperative Fish and Wildlife Research Unit, Department of Fish and Wildlife Conservation, 106 Cheatham Hall, Virginia Tech, Blacksburg, VA 24061, Email: ehunter1@vt.edu

[8]U.S. Geological Survey, Southwestern Biological Science Center, 2255 N. Gemini Rd., Flagstaff, AZ 86001. Email: jeffrey_lovich@usgs.gov

[9]Utah Division of Wildlife Resources, Washington County Field Office, 451 N. SR-318, Hurricane, UT 84737. Email: annmcluckie@utah.gov

[10]University of Nevada, Reno, Department of Natural Resources & Environmental Science, 1664 N. Virginia St., Reno, NV 89557. Email: kevinshoemaker@unr.edu, mar.walden@gmail.com

[11]U.S. Geological Survey, Western Ecological Research Center, 4165 Spruance Rd., Suite 200, San Diego, CA. Email: avandergast@usgs.gov

[†]Deceased

The Mojave desert tortoise (*Gopherus agassizii,* MDT) has been federally listed as threatened for over three decades and has experienced continued population declines. Despite decades of monitoring data, the impacts of multiple stressors on MDT distribution and demography remain largely unquantified, and even less is known about the spatiotemporal variation and interactive effects of stressors. Our project seeks to fill critical knowledge gaps and establish an understanding of MDT responses to varying levels of exposure from multiple stressors. We employed a knowledge co-production approach to prioritize stressors and developed hundreds of spatial data layers spanning a 50-year period at ecologically relevant scales and using machine learning. Notably, we developed a computer vision model capable of identifying off-highway vehicle routes from aerial imagery and used it to generate novel spatial data layers of route density at historical and contemporary timesteps. We developed an integrated, spatially-explicit Bayesian model that leverages demographic data from both capture mark recapture and telemetry studies to identify key drivers of MDT declines and estimate spatial and temporal variation in MDT survival. Preliminary analyses focusing on climatic conditions indicate that precipitation has a positive effect on MDT survival, and demonstrate the strength of leveraging multiple data sources in describing patterns in demographic rates and identifying stressor effects. Current and future work includes using a machine learning approach to model predation pressure, testing the effects of environmental and anthropogenic stressors on survival, and

estimating range-wide trends in occupancy using a Bayesian dynamic occupancy model. We will implement an automated approach to continuous integration and deployment of new data and updated models as part of an online spatial decision-support tool which will allow users to assess tortoise population dynamics under future exposure scenarios that will be co-determined with stakeholders.

STUDENT PAPER

Sex and Vegetation Cover Drive Home Range Size for Sonoran Desert Tortoises in Southern Arizona

Sean Sutor[1], Nancy E. McIntyre[1], Kerry Griffis-Kyle[2]
[1]Department of Biological Sciences, Texas Tech University, 2901 Main Street, Lubbock, Texas 79409-3131, USA. sean.sutor@ttu.edu, nancy.mcintyre@ttu.edu
[2]Department of Natural Resource Management, Texas Tech University, Goddard Building, Box 42125, Lubbock, Texas 79409-2125, USA. kerry.griffis-kyle@ttu.edu

Understanding how much space tortoises use and what determines the extent of their home range can help develop management strategies that ensure habitat is sufficiently available. However, studies of Sonoran desert tortoise home ranges are still few, and home range sizes may vary across the species' range and across different habitat types. We compiled radio- and GPS-telemetry data from 29 adult tortoises during multiple two- to three-year studies performed between 1995 and 2023 in Organ Pipe Cactus National Monument in southern Arizona. Study animals inhabited mountainsides and upper bajada slopes, lower bajadas, and mountain valleys. We used optimally weighted autocorrelated kernel density estimators to determine cumulative home ranges for each tortoise. We then used within-study meta-analyses, generalized additive models, and generalized linear mixed effects models to test how the number of locations recorded, sex, and vegetation cover influenced tortoise home range size. We found a high degree of variation in home range size among individual tortoises, with estimates ranging from 2.9 to 59.9 hectares (mean: 24.5 ha). As found in short-term telemetry studies from other locations, male tortoises had larger cumulative home ranges than did females. We also found that tortoise home range sizes increased as vegetation cover decreased. Portions of the study area where vegetation cover was low typically had few washes. Tortoises inhabiting these areas may need to cover larger extents to access resources such as forage and shelter and, in doing so, may experience heightened risk of exposure to the elements and predation. Habitats that are naturally sparse in vegetation, or areas where vegetation cover has been removed by anthropogenic activities, may thus be priority targets for management actions focused on ensuring habitat quality (i.e., vegetation cover) remains suitable for tortoises.

Status of Desert Tortoise Head-starting in Mojave National Preserve and Planned Applications

Brian D. Todd[1], Carter Harris[1], José Hernández[1], Tracey D. Tuberville[2], Kurt A. Buhlmann[2]*
[1]Department of Wildlife, Fish, and Conservation Biology, UC Davis, One Shields Ave, Davis, CA 95616.
Phone: 530-752-1140. Email: btodd@ucdavis.edu
[2]University of Georgia's Savannah River Ecology Lab, P.O. Drawer E, Aiken SC 29802.

Desert tortoise head-starting involves protecting and rearing tortoises in captivity after hatching until they are released later in the wild at larger sizes when survival is higher. We have been working at the Ivanpah Desert Tortoise Research Facility in the Mojave National Preserve to study and refine methods for desert tortoise head-starting since 2011. Annual survival averaged >85% for 210 head-started tortoises 70–145 mm carapace length released from 2018–2020 in lower Ivanpah Valley in San Bernardino County, California. We also found that larger head-started tortoises have higher survival after release most years, except in 2021, when tortoise survival dropped to 60% during an Extreme Drought that saw many tortoises succumb to predation by coyotes as jackrabbits became scarce. Survival of released head-started tortoises returned to >85% the next year and has remained high through 2024. Releasing head-started tortoises alone will not recover populations and is intended to promote recovery when used alongside other conservation actions. We are currently studying the use of head-started tortoise releases in the Mojave National Preserve where conservation actions like road closures, road fencing, or post-fire restoration are intended to improve conditions for tortoise populations. There is also interest in improving the resilience of tortoise populations to climate change by releasing head-started tortoises at upper elevations where populations currently occur. To this end, we released 15 tortoises in the core part of our study area in the Mojave National Preserve (1050 m elevation) and an additional 15 slightly upslope (1250 m elevation) in Fall 2024 to examine the feasibility of future releases in presumed "climate refugia" that will become increasingly important as warmer temperatures force desert communities to chase suitable climates. Here, we provide an update on the current status of our efforts and opportunities for future directions of tortoise recovery.

Metal Fencing Installed Around Old Mining Shaft Openings Located at the Saint Elmo Mine in Atolia, California to Protect Endangered Mojave Desert Tortoises

Sean P. Tucker - Founder
Gold Discovery Group LLC, 2549 Eastbluff Drive, Suite B-499, Newport Beach, CA 92660

Gold Discovery Group LLC purchased the Saint Elmo Mine in Atolia, CA on April 19, 2024. The Saint Elmo Mine consists of six (6) patented Lode claims covering 102 acres of real property in San Bernardino County, in the Mojave Desert California.

The Saint Elmo Mine was first discovered in 1896 and the mining claims were patented by The Johannesburg Gold Mine Co. on April 3, 1905, patent # 40738. The patent was issued by the General Land Office (GLO) and signed by President Theodore Roosevelt on April 3, 1905.

The GLO was an independent agency of the United States Government responsible for public domain lands in the United States. It was created in 1812 to take over functions previously administered by the Department of the Treasury. In 1849, the GLO was placed under the newly

formed Department of the Interior. In 1946, the GLO was merged with the Bureau of Land Management, which today administers some 247 million acres, or 12.5% of the total landmass in the United States.

When Gold Discovery Group LLC purchased the Saint Elmo Mine, the first order of business was to walk the entire property and look for Mojave Desert Tortoises, active burrows, open mine shafts, open trenches and any other observable danger zones whereby a Desert Tortoise, human, or other wildlife could "fall in" and be a hazard.

Once we identified all of the potential hazards, Gold Discovery Group LLC sprung into action and fenced off the entire outer perimeter of all open mine shafts, eleven (11) in total. We used metal, 6-feet tall T-posts that were inserted 18" in the ground. We then wrapped the T-posts with 3-feet and 4-feet high, galvanized, 20-gauge, poultry netting that is rust resistant, uniform hexagon mesh. In addition, we installed on the fencing DANGER, DO NOT ENTER signs on several sides.

We found no live, or dead Mojave Desert Tortoises, active burrows, open trenches or any other hazards. The total cost was approximately $8,000 in materials, wages and gas.

Demographic and genetic insights from a decade of study of Mojave desert tortoises in the Ivanpah Valley

Amy Vandergast[1], Anna Mitelberg[1], Steven Hromada[2], Felicia Chen[1], Amanda M. McDonald[1], Benjamin O. Gottsacker[1], Kenneth Nussear[3], Todd Esque[1]

[1] U. S. Geological Survey, Western Ecological Research Center

Phone: 619-225-6445. Email: avandergast@usgs.gov

[2] Conservation Science Partners, Inc. Truckee, Nevada

[3] Department of Geography, University of Nevada, Reno

In 2015, we established ten long-term study plots in and adjacent to the Ivanpah Valley of California and Nevada, envisioned to be sampled and monitored for 20 years. The overarching goal of the project is to gather long-term data to understand the collective impacts of anthropogenic habitat change, including the establishment of utility scale solar facilities, on genetic and demographic connectivity of Mojave desert tortoise (*Gopherus agassizii*) populations. The project uses field surveys, health, genetics sampling, and telemetry to monitor movements and contacts of individuals, survival, and reproduction. Here we present genetic results from tortoises sampled in the first decade of this study. First, we constructed genetic pedigrees among all sampled individuals. These revealed that parent-offspring and full sibling relationships were restricted to within plots. The proportion of all genotyped tortoises recovered as relatives ranged from 7% at Silver State to 69% at McCullough Pass, with an average of 44% for all ten plots. At multiple plots we recovered pedigrees that spanned three generations. The highest number of offspring assigned to a male was nine at McCullough Pass and six to a female at Stateline Pass. Full family groups were analyzed with location data to better understand tortoise social behaviors and habitat features, pointing to persistent group burrows that may be associated with reproduction. Finally, analysis of genetic diversity data of adult and subadult age classes suggests some intergenerational changes in genetic variation at the genetic neighborhood scale. Results can assist the Bureau of Land Management and other managers in effective habitat restoration and recovery efforts in multi-use landscapes.

Establishing Free-living Bolson Tortoise (*Gopherus flavomarginatus*) Populations in the US

Christiane Wiese, Scott Hillard, and Javier Gonzalez
Turner Endangered Species Fund, Ladder Ranch, 792 Ladder Road, Caballo, NM 87931, USA
Email: Chris.Wiese@retranches.com; Scott.Hillard@tedturner.com

In collaboration with a number of zoos, institutions, and private partners, the Turner Endangered Species Fund (TESF) has spearheaded bolson tortoise (*Gopherus flavomarginatus*) headstarting and captive-rearing on a private ranch in New Mexico since 2006. Starting with 30 adult bolson tortoises, TESF's bolson tortoise colony now consists of over 700 juvenile bolson tortoises ranging in age from 0-19 years old in 2025. In April 2021, we began experimental releases of transmittered juvenile bolson tortoises (average age: ~7.7 yrs; range: 4.5-11); MCL: 155.3±11.4 mm (average±1 *SD*); range 126.7-190.6 mm; n = 141) to a remote part of the ranch with the ultimate goal of establishing free-living, minimally managed wild bolson tortoise populations in the US. We implemented a 'hybrid soft release' strategy using a behavioral rather than a physical fence: ten tortoises that showed persistent, unidirectional movement away from the release site were recaptured and returned to the release site up to three times within ~4 months of release before they stayed in the release area. One tortoise that made persistent movements toward the ranch boundary was returned to captivity. All others (n=130) were allowed to move at will. At the end of 2024, 95% (134) of the 141 tortoises released between April 2021 and April 2024 are still trackable with functioning transmitters. Of these, 118 tortoises (90.1%) are currently overwintering within 1.65 km of their release site, 5 tortoises (3.8%) established overwinter burrows between 2.25 and 3.25 km of the initial release site, and 7 tortoises (5.3%) are overwintering between ~3.5 km and 4.1 km from their release location. One tortoise (a 11 yo female juvenile, ~170 mm MCL) moved nearly 6.5 km in 2024 before constructing an overwinter burrow.

Bolson Tortoise Conservation on a National Wildlife Refuge

Vance Wolf and Sam Vassallo
U.S. Fish and Wildlife Service (USFWS), 2105 Osuna Rd NE, Albuquerque, NM 87113, USA
Phone: (505)761-4726, Emails: vance_wolf@fws.gov; samuel_vassallo@fws.gov

The U.S. Fish and Wildlife Service and U.S. Geological Survey have undertaken a Bolson tortoise conservation project at a National Wildlife Refuge in the United States. This project is part of a larger partnership with Turner Endangered Species Fund and aims to test the viability of establishing a conservation tortoise population of this endangered species on aNational Wildlife Refuge, and perhaps other locations in the southwestern United States. We first conducted a habitat assessment for the refuge and selected candidate sites for possible tortoise releases. Candidate sites had habitat features known to be important for the species such as slope, elevation, and soil type. These sites were located away from most human activity to limit mortality potential. We constructed a 3.4 hectare (8.5 acre) pen on the refuge with the help of refuge partners like the Sierra Club and placed 20 juvenile tortoises into the pen on September 25th of 2024. Since that time, we have monitored the tortoises as they acclimate to their new home. In the future, we plan

to release the tortoises from the soft-release pen and monitor their movements, behavior, and survival using radio telemetry in hopes to better understand management of this species. In collaboration with a number of zoos, institutions, and private partners, the Turner Endangered Species Fund (TESF) has spearheaded bolson tortoise (*Gopherus flavomarginatus*) headstarting and captive-rearing on a private ranch in New Mexico since 2006. Starting with 30 adult bolson tortoises, TESF's bolson tortoise colony now consists of over 700 juvenile bolson tortoises ranging in age from 0-19 years old in 2025. In April 2021, we began experimental releases of transmittered juvenile bolson tortoises (average age: ~7.7 yrs; range: 4.5-11); MCL: 155.3±11.4 mm (average±1 *SD*); range 126.7-190.6 mm; n = 141) to a remote part of the ranch with the ultimate goal of establishing free-living, minimally managed wild bolson tortoise populations in the US. We implemented a 'hybrid soft release' strategy using a behavioral rather than a physical fence: ten tortoises that showed persistent, unidirectional movement away from the release site were recaptured and returned to the release site up to three times within ~4 months of release before they stayed in the release area. One tortoise that made persistent movements toward the ranch boundary was returned to captivity. All others (n=130) were allowed to move at will. At the end of 2024, 95% (134) of the 141 tortoises released between April 2021 and April 2024 are still trackable with functioning transmitters. Of these, 118 tortoises (90.1%) are currently overwintering within 1.65 km of their release site, 5 tortoises (3.8%) established overwinter burrows between.
