Landscape-Level Habitat Associations and Phylogenetics of Desert Tortoises on Southwestern Arizona Military Ranges Managed by the Army, Air Force, and Marines (Legacy 09-385)

Abstract

Anthropogenic disturbances within the range of the desert tortoise have the potential to reduce habitat quality through impacts to vegetation structure and soil characteristics. While impacts to desert tortoise habitat on active military training areas can be substantial, these ranges often provide important refuges where public access is limited and military activities are restricted to specific training areas. As a result, impacts are generally limited to specific locations rather than being diffused across the landscape.

Given the possibility of future ESA listing and the challenges that such a decision would impose upon the Department of Defense (DoD), it is prudent to understand the distribution of desert tortoises on military ranges within the Sonoran Desert so that appropriate management decisions can be made to reduce conflicts while maintaining the military readiness mission.

This project developed a landscape-level predictive habitat model for desert tortoises inhabiting the Yuma Proving Ground and Barry M. Goldwater Range in southwestern Arizona and characterized the phylogenetic grouping of desert tortoises inhabiting these DoD managed lands.

Spatial analyses identified elevation, aspect, and soil group as important predictors of desert tortoise occupancy. Tortoises were more likely to occupy north- and east-facing slopes between 200 and 600 m. Similarly, tortoise occupancy was greatest within petrocalcid soils characterized by a distinct calcic horizon.

Genetic analyses indicated that all 13 individuals included in the sample were classified as Sonoran desert tortoise and not the Federally Threatened Mohave desert tortoise.

Project Specifics

Description of geographic setting: The results of this study apply to the Yuma Proving Ground and Barry M. Goldwater Range in southwestern Arizona.

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Partners:

- **DoD Legacy Resource Management Program, Virginia:** Jane Mallory & Peter Boice provided funding and contract administration support
- **Luke AFB:** Aaron Alvidarez, Richard Whittle, Daniel Garcia & John Arnett provided technical and logistical support for work on the Barry M. Goldwater Range – East
- **Marine Corp Air Station Yuma:** Abigail Rosenberg & Ronald Pierce provided technical and logistical support for work on the Barry M. Goldwater Range – West

- **Yuma Proving Ground:** Laura Merrill provided technical and logistical support for work on the Yuma Proving Ground
- **Bureau of Land Management, Lower Sonoran Field Office:** Steve Bird & Patrick Brasington provided support for access and security on the Sonoran Desert National Monument

Service branch: Army, Air Force & Navy

Project location: Yuma Proving Ground and Barry M. Goldwater Range, Arizona

Installation size: 12,000 km2

Installation primary mission: Training & Testing

Project dates: February 2008 – November 2009

Project point of contact: David D. Grandmaison, Senior Project Manager, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix, AZ 85086, (520) 609-2164, dgrandmaison@azgfd.gov

Sonoran desert tortoise, *Gopherus morafkai*.
(Arizona Game and Fish Department)

Purpose/Need

Anthropogenic disturbances within the range of the desert tortoise have the potential to reduce habitat quality through impacts to vegetation structure and soil characteristics. While impacts to desert tortoise habitat on active military training areas can be substantial, these ranges often provide important refuges where public access is limited and military activities are restricted to specific training areas. As a result, impacts are generally limited to specific locations rather than being diffused across the landscape. Given the possibility of future ESA listing and the challenges that such a decision would impose upon the Department of Defense (DoD), it is prudent to understand the distribution of desert tortoises on military ranges within the Sonoran Desert so that appropriate management decisions can be made to reduce conflicts while maintaining the military readiness mission.

As a first step towards the development of data-driven management decisions to allow for the coexistence of desert tortoises and the military mission, research biologists from the Arizona Game and Fish Department conducted desert tortoise surveys and modeled tortoise occupancy on the Yuma Proving Ground and Barry M. Goldwater Range in southwestern Arizona.

Approach

Sampling Design

We implemented a stratified random sampling design in which random samples were selected from soil strata defined by the National Cooperative Soil Survey division of the Natural Resources Conservation Service, a branch of the United States Department of Agriculture. This approach reflected the hypothesis that desert tortoise occupancy should vary among soil designations at the landscape-scale.

Desert tortoise habitat on the Barry M. Goldwater Range. (Arizona Game and Fish Department)

Given the geographic scope of the study area and the study objectives regarding the spatial distribution, we chose tortoise occupancy as the population parameter of interest. However, unlike traditional occupancy estimation studies in which defined sampling units are visited on multiple occasions and the species of interest is either detected or not detected, the study substituted spatial replicates for temporal replicates. Under this sampling methodology, "sites" were defined as distinct soil patches with survey locations representing spatial sub-units within sites.

Tortoise Surveys

We conducted standardized surveys for tortoises and their sign (i.e., carcasses, scat, tracks, etc.) within 711 3-ha survey plots located within 219 soil patches using an area search methodology for complete coverage within the plot boundaries.

Tortoises were handled in accordance with standardized handling guidelines adopted by the Arizona Game and Fish Department. Each individual was assigned a unique identification number and permanently marked for future identification. Where possible, blood was collected using brachial or jugular venipuncture for genetic analysis.
Telemetry and Home Range

We also deployed VHF radio-transmitters and GPS tracking units to track adult desert tortoise movements within the study area as part of the habitat model validation process.

GPS tracking units were programmed to collect detailed location data during peaks in daily tortoise activity. We estimated tortoise home ranges using Brownian Bridge Movement Models and examined habitat use characteristics within tortoise home ranges.

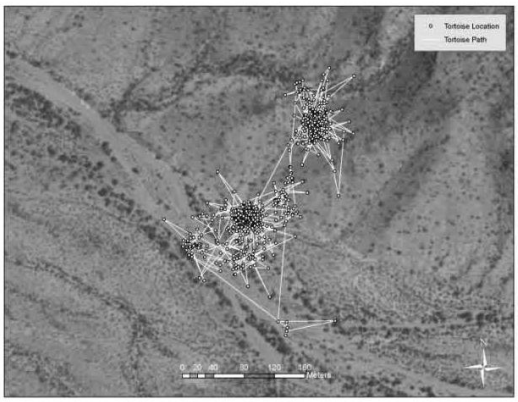
Biologists examining a tortoise burrow located under an exposed caliche layer in a desert wash. (Arizona Game and Fish Department)

VHF and GPS tracking units deployed on a desert tortoise. (Arizona Game and Fish Department)

Analysis

We estimated desert tortoise occupancy using a likelihood-based modeling approach that incorporated the probability of detection. Estimable parameters included: the probability that a species is present at site i (Ψi) and the probability that a species is detected at site i during visit t (pit). In addition, both parameters were expressed as a function of site- and survey-specific covariates (e.g., slope, elevation, survey period, temperature, etc.).

We then utilized the most well supported occupancy models to develop a graphical representation of the occupancy probability across the study area. We used the Brownian Bridge Movement Model (BBMM) to assess desert tortoise space use within the project area. We estimated the Brownian movement variance parameter for each tortoise using maximum likelihood estimation techniques and output the resulting probability distribution representing desert tortoise space use within the study area.



An example of the detailed movement data gathered using GPS tracking data from a single tortoise on the Barry M. Goldwater Range.

We examined habitat characteristics associated with desert tortoise home ranges at two spatial scales. We began by comparing soil categories within desert tortoise home ranges

to the proportion of soil categories within the study area. Tortoise home ranges were defined by the BBMM home range estimator. The mean proportion of each soil category within tortoise home ranges was compared with the proportion found within a 1 km buffer surrounding the home range.

We then examined soil characteristics within tortoise home ranges using compositional analysis to identify whether soil categories were used in proportion to their availability. For this analysis, used resources for each individual tortoise were defined by the percentage of locations within each soil category. Available resources were defined by the percentage of soil categories within each individual's home range. Finally, we calculated the mean and standard error for each of the elements in the resulting matrix for all of the tortoises and created ranking matrices to assess relative preferences for soil groups. Tortoise blood samples were compared to a reference database developed from captive samples from known-origin tortoises. Samples were then assigned to Mohave or Sonoran desert tortoise populations.

Results

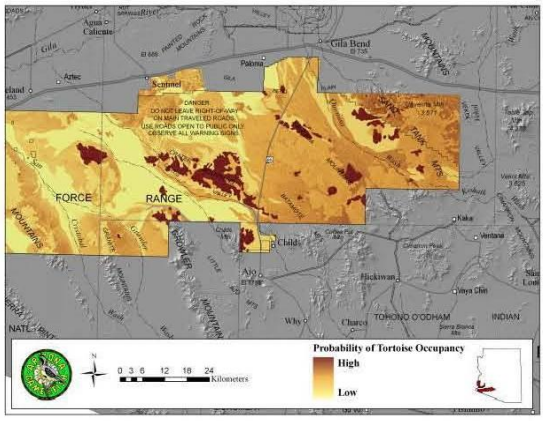
We completed 711 desert tortoise surveys within 219 soil patches and detected desert tortoise sand tortoise sign on 31survey plots within 22 soil patches. VHF transmitters and GPS tracking units were deployed on 14 desert tortoises. Blood samples were collected from 13 desert tortoises.

Occupancy analyses identified elevation, aspect, and soil group as important predictors of desert tortoise occupancy. Tortoises were more likely to occupy north- and east-facing slopes between 200 and 600 m. Similarly, tortoise occupancy was greatest within petrocalcid soils characterized by a distinct calcic horizon.

We used the most well supported occupancy models to create predictive habitat maps for the Yuma Proving Ground and Barry M. Goldwater Range. The probability of desert tortoise occupancy was generally low on the Yuma Proving Ground with higher probabilities for the southern end of the Dome Mountains and the northern extent of the Trigo Mountains. The eastern extent of the Barry M. Goldwater Range exhibited the highest probability of tortoise occupancy generally located near the Growler Mountains, the Crater Mountains and portions of the Sauceda and Sand Tank mountains.

Desert tortoise home ranges were comprised of five soil categories which roughly corresponded to the results of the predictive models. Within their home ranges, however, desert tortoises used soil groups were used in proportion to their availability.

Genetic analyses indicated that all 13 individuals included in the sample were classified as Sonoran desert tortoise and not the Federally Threatened Mohave desert tortoise.



Predictive desert tortoise habitat model for the eastern extent of the Barry M. Goldwater Range.

Benefit

The results of this study provide natural resource managers with the necessary data to make informed management decisions and engage in collaborative efforts across range boundaries to ensure the persistence of robust desert tortoise populations while maintaining the military readiness mission.

Recommendations/Lessons learned

After a considerable survey effort spanning two years, and despite few desert tortoises being detected on the Yuma Proving Ground and Barry M. Goldwater Range, we demonstrated that spatially replicated occupancy models based on detection/non-detection desert tortoise surveys can be used to identify patterns in tortoise occupancy over broad geographic scales.

The resulting predictive models and geospatial output should be used to identify areas where military training may impact important desert tortoise habitat. Similarly, these data should be used to guide future desert tortoise surveys and/or research.
We recommend evaluating the validity of expanding model inference to additional study areas to determine if this model can be used to predict desert tortoise occupancy at broader spatial scales.

Communications

The information within this report have been distributed to the natural resource management personnel from the Yuma Proving Ground, Luke AFB, and the Marine Corp Air Station, Yuma. Components of this study will appear in subsequent publication in peer-reviewed journal articles.

Additional Information

N/A