Texas Tortoise Habitat Modeling

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Intoduction: The GULN is engaged in mark/recapture monitoring of the Texas Tortoise (TT) at Palo Alto Battlefield NHP. TT surveys are concentrated on-the-ground efforts, requiring intensive planning and coordination. Accordingly, the GULN wants to ensure survey crews don't spend a lot of time searching in areas where animals aren't likely found. In the interest of building sample size and maximizing yield/event, the GULN has constructed a draft model that defines likely TT habitat. GPS tracklog information indicates where we've looked for TTs. GPS point records of TT encounters indicate where we've found TTs. This information, paired with LiDAR data models of canopy complexity and bare-earth 'departure from trend' gives a good indication of where TTs are, and aren't likely to be found.

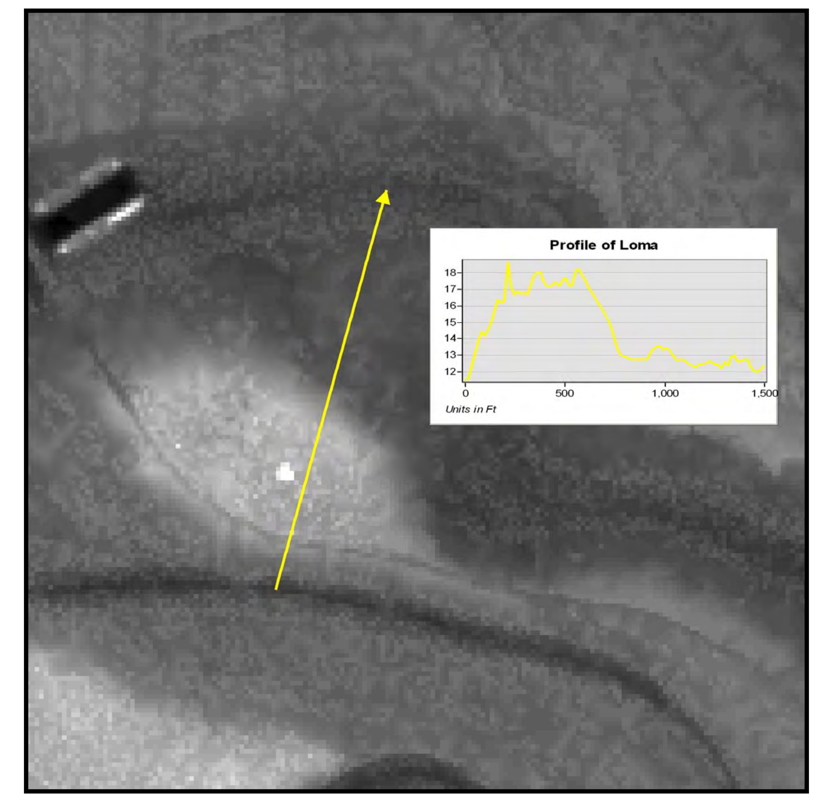
BACKGROUND

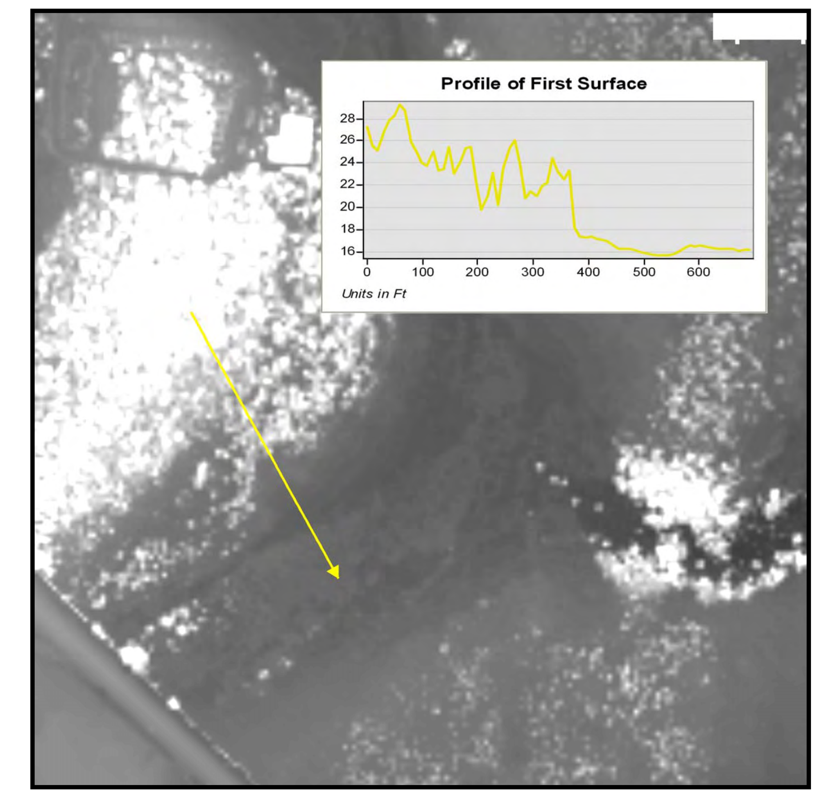
From published literature, common characteristics for preferred TT hangouts emerge.

- Tortoises frequent mesquite ridges and avoid low salt prairies (Bury and Smith).
- Texas Tortoise is tolerant of a relatively broad range of habitats, but shows a preference for open canopy habitats, especially when coincident with escarpments (Kazmaier, Hellgren, and Ruthven).
- Evidence also indicates that tortoise populations are closely associated with the distribution of Prickly Pear Cactus (Rose and Judd). Prickly Pear plants at Palo Alto are rare in lower elevation habitats dominated by Cordgrass and Sea Oxeye Daisy, but are abundant in the higher mesquite scrublands

To assess where tortoises are, and aren't found during surveys the GULN uses GPS. All tortoise encounters are documented with a GPS record that includes tortoise ID and an activity code. Activity code accounts for transient animals, which may be encountered in spaces between "residence" habitats. Each survey team member carries a small GPS in their field pack (above), which is continually recording a tracklog (above). Results from initial surveys indicated a good fit with what the literature suggests as preferred tortoise habitats.

MODEL DATA

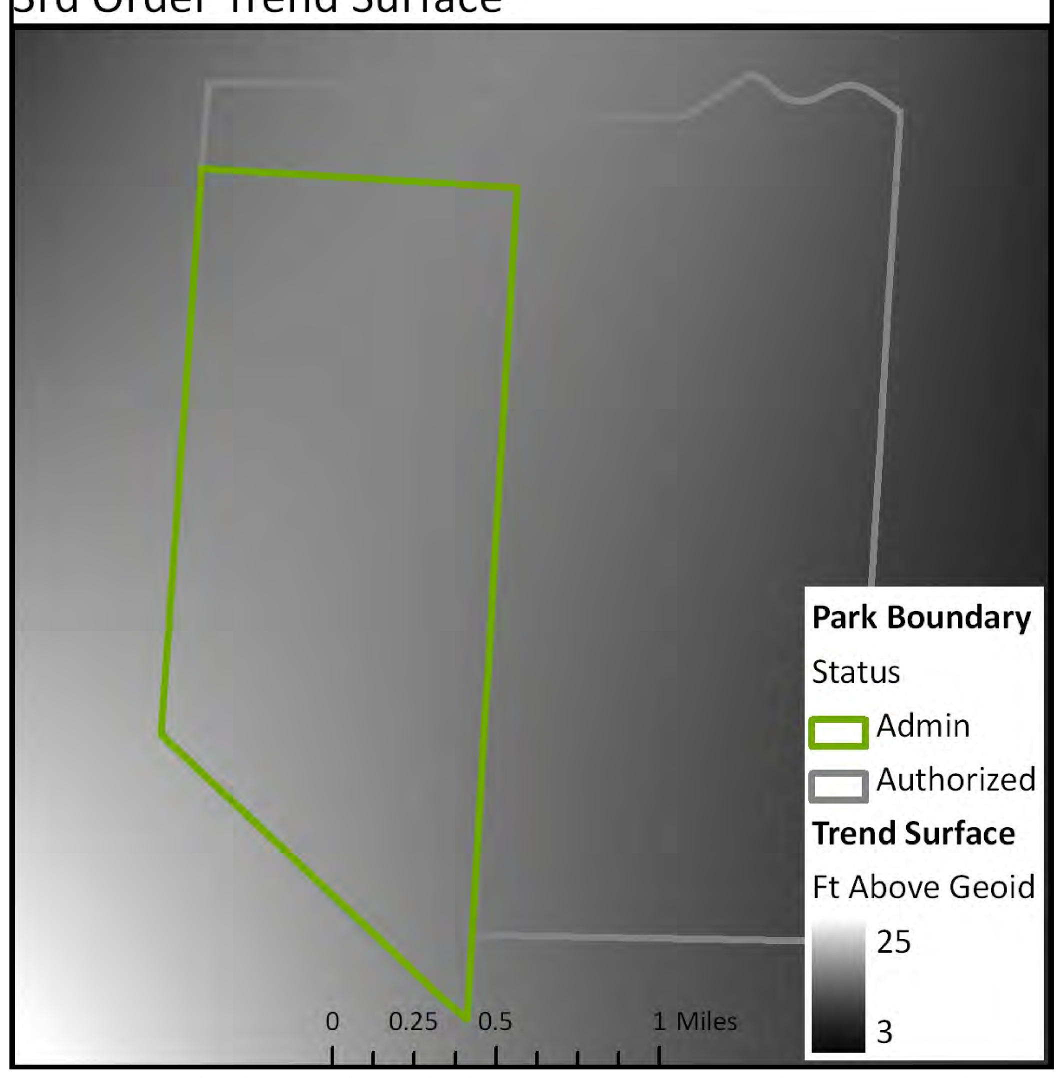




From published literature and field observations it is evident that Texas Tortoise occurs frequently on ridges, or lomas (broadly topped hill or ridge) which are spatially coincident with a porous, or open, canopy. LiDAR data can be used to model each of these environmental conditions separately and ultimately together. For model building, it isn't absolute elevation values that are important; rather elevation "features" (lomas) that must be qualified (above). Lomas can be calculated from a Bare Earth dataset - and to model canopy porosity, surface-ratio can be calculated from a First Surface elevation dataset (above).

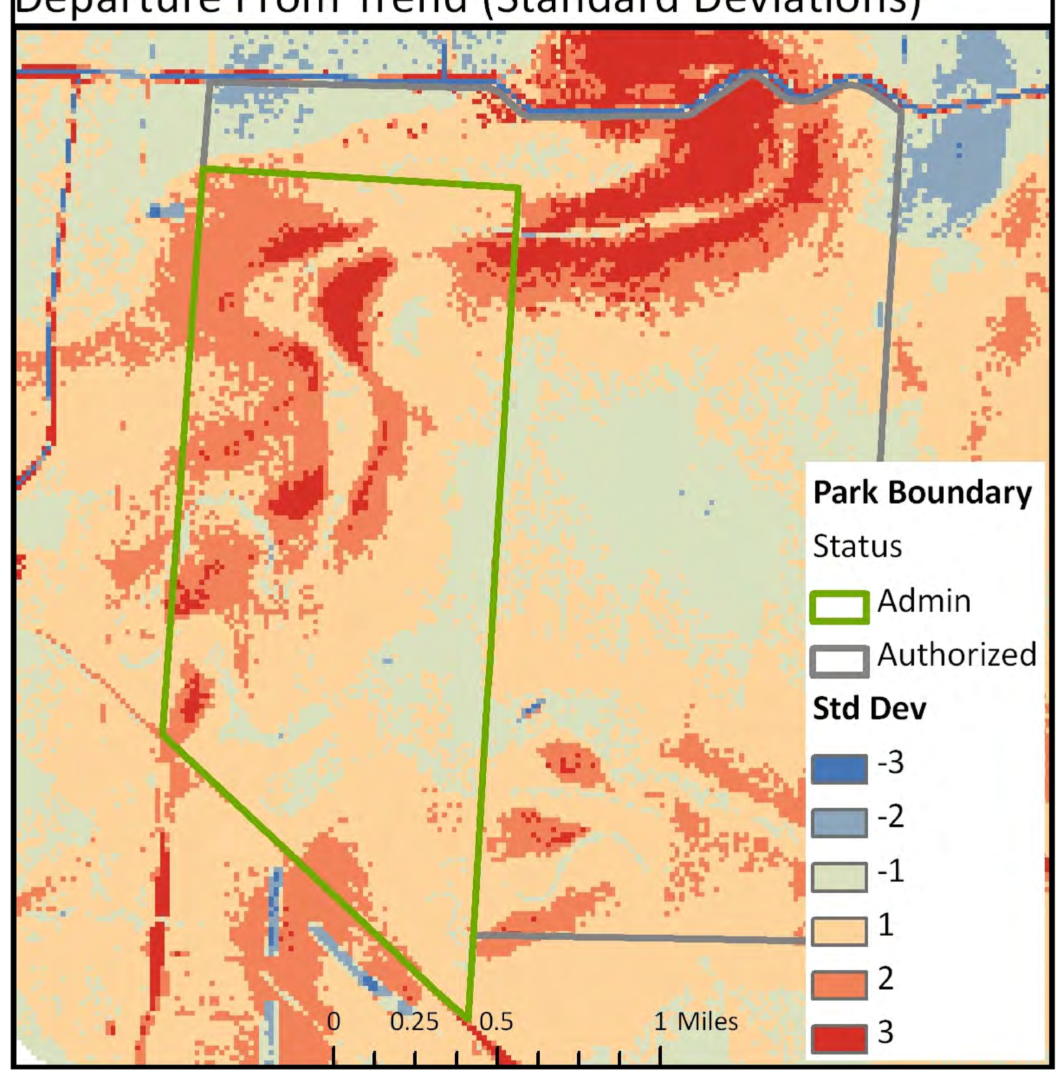
MODEL PROCESS STEPS

3rd Order Trend Surface



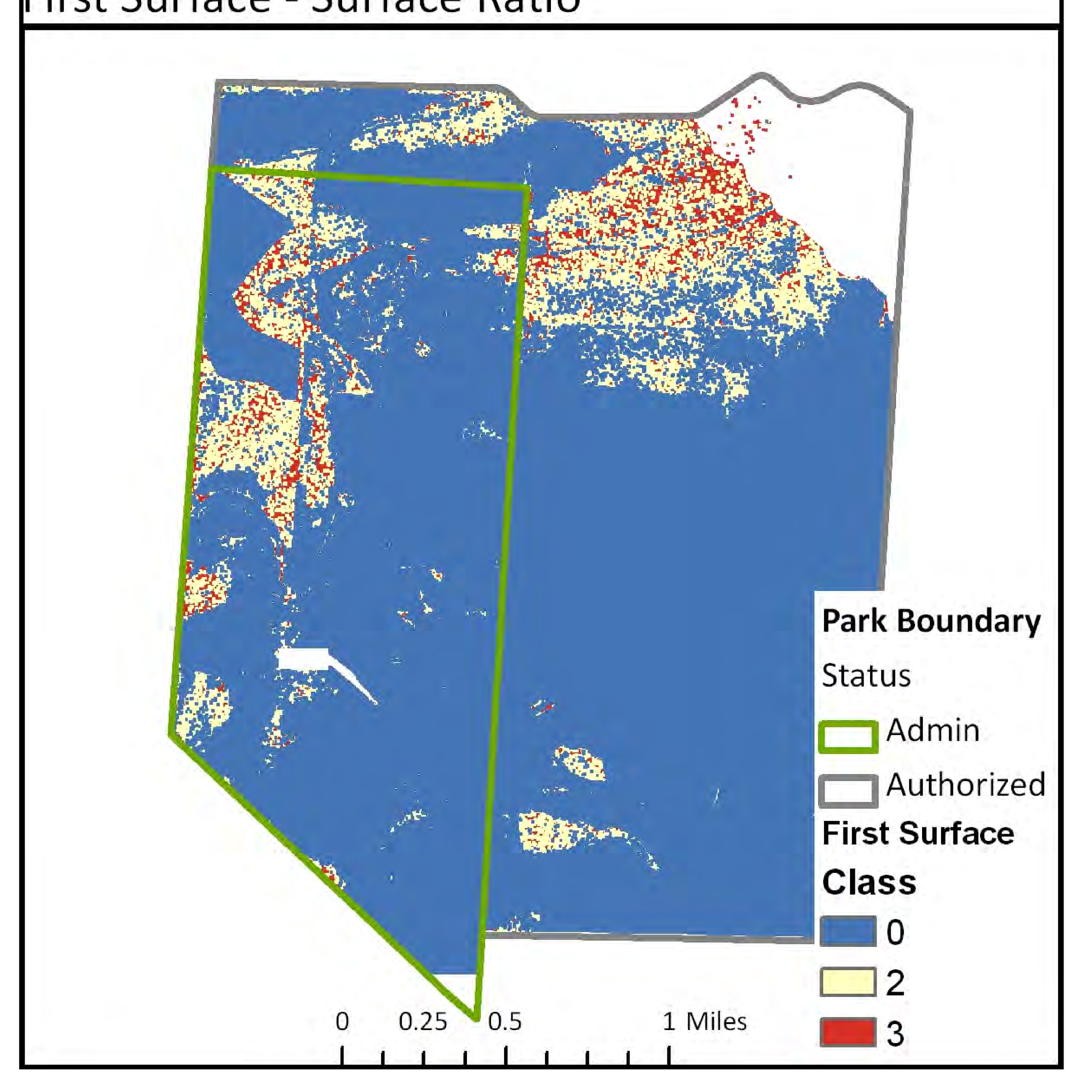
From a resampled 80ft BE model, a 3rd order **trend surface** was created. Both lesser and greater point densities were tested, but this density eased processing demands and effectively represented the surface for trend analysis. The 3rd order level of fit worked best, as lesser orders over-generalized, and higher orders did not adequately separate 'departures from trend'.

Departure From Trend (Standard Deviations)



The trend is subtracted from the high resolution (5m) Bare Earth Dataset to **isolate 'departures from trend', representing lomas**. Trend surface is then reclassed by standard dev. Positive departures-from-mean result in higher class rank.

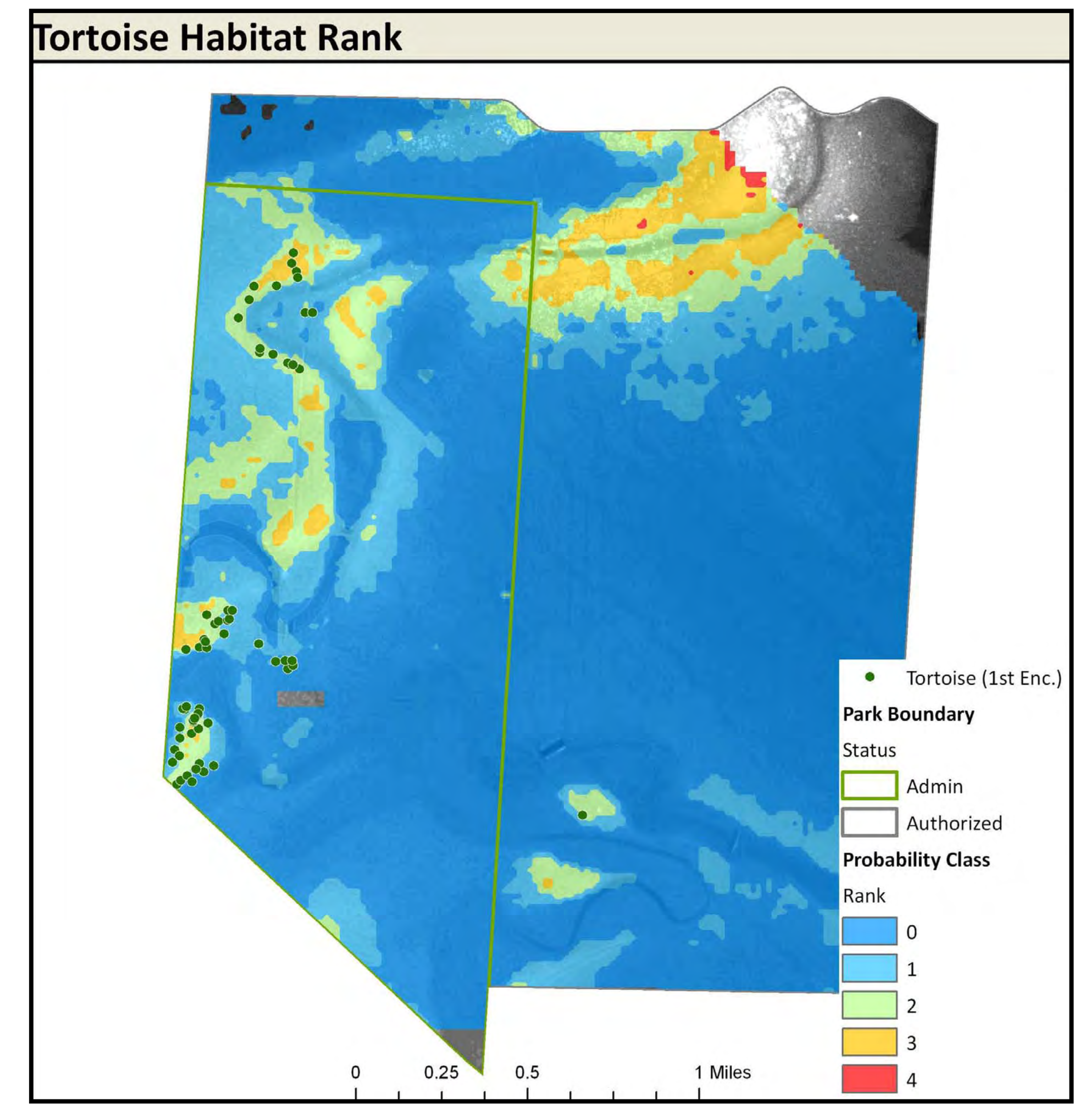
First Surface - Surface Ratio



Dem Surface Tools (Jenness) was used to **model canopy porosity**. The outcome is a raster where each cell represents a ratio = 3d surface area/2d surface area. To **reduce the number of "solitary pixels"**, 'Focal statistics' was run, assigning a Minimum Value to cells, based on surrounding pixels. In terms of botanical structure the Palo Alto landscape is basic. The old growth mesquite forests, commonly centered on lomas, transition to lower sparser woody vegetation, then to Cordgrass dominated salt flats. **Surface Ratio was grouped into three "Natural Breaks" porosity classes**.

MODEL OUTCOME

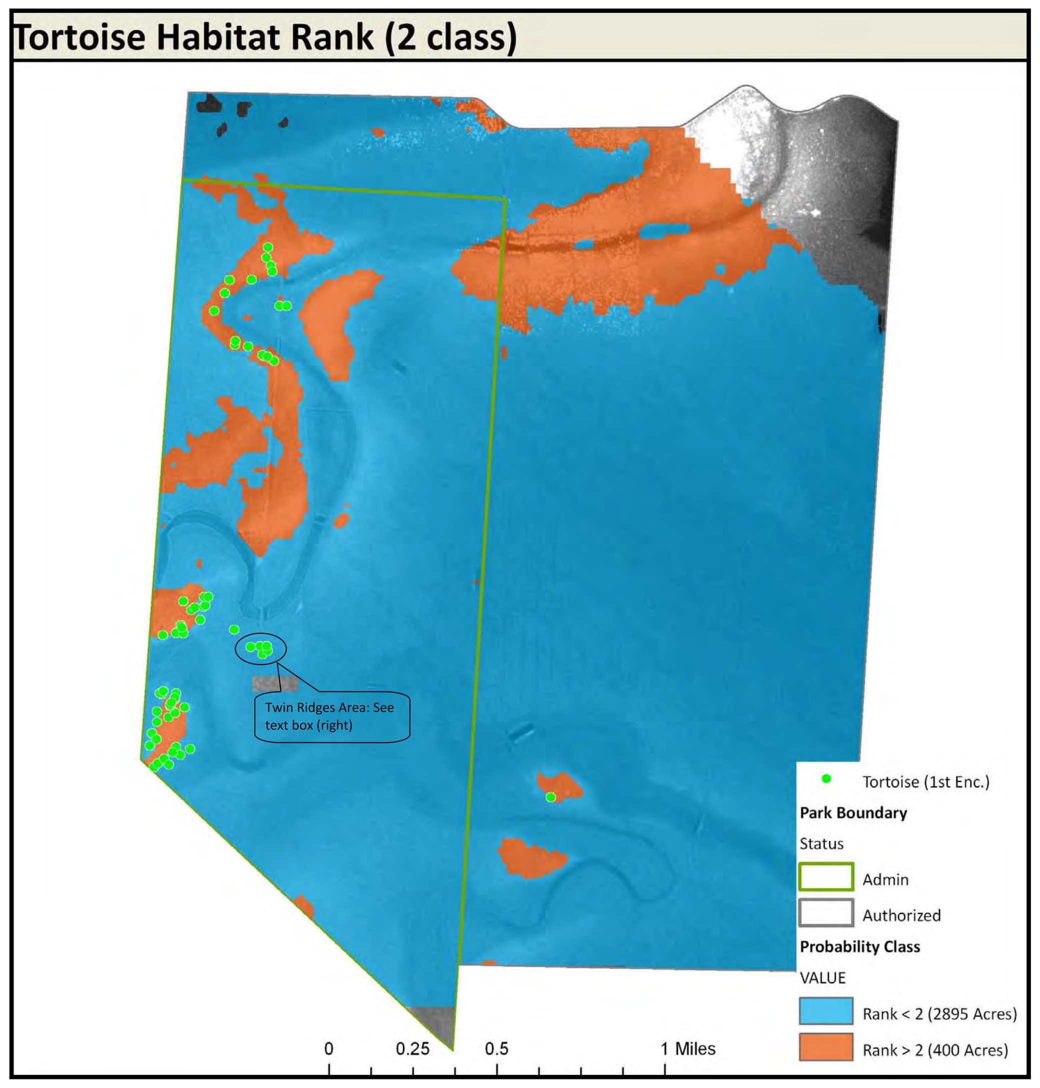
Tortoise Habitat Rank



First Surface and "Loma" classes are added to produce Rank. Higher Rank equals more likely tortoise habitat .

MODEL OUTCOME

Tortoise Habitat Rank (2 class)



FINAL THOUGHTS

Interpreting the model: Highest parts of lomas and most rugged canopy combine to make the highest likely habitat rank. Overall, preliminary results indicate good correspondence between what has been modeled as likely habitat and where tortoises were actually found. The habitat preference model (left) classifies data values as tortoises "present" or "absent". Although not a precise illustration of the actual phenomenon, this model supports first cuts at population density and park-wide population estimates. Does this mean that these are the most likely spots to find tortoises? – Probably so, but relative elevation and canopy texture don't fully explain why tortoises are found where they're found. Many likely influences on preferred tortoise habitat are undetectable by Remotely Sensed data. For example, micro-scale features like the presence of Woodrat middens (photo right) and Prickly Pear may positively influence habitat preference, while heavy Nilgai (photo right) traffic might have the opposite affect.

Next steps: Other datasets to model vegetation; other predictors to consider; additional data filtering. Since surface topography is a relatively stable feature in the PAAL landscape, the "lomas" model can be used effectively far into the future. However, vegetation is a more dynamic feature that might be kept more current with classified aerial photography or satellite imagery.

Other habitat preference predictors might strengthen relationships, and include "remoteness" and size of habit; where remoteness would be a measure of a habitat "island's" proximity to other likely habitat.

Two obvious anomalies in LiDAR data skewed results. One pertains to feature extent, where ridges were evidently not prominent enough in the raster dataset to be accurately recorded. The best example of this idiosyncrasy is at the survey area known as "twin ridges" (left). This established survey area is defined by two parallel ridges that are approximately 175' long and 30' wide. Although the ingredients for likely habitat exist on the ground, and several tortoises have been encountered here, low "loma" ranks resulted in a low likelihood class. Likely suspects for the misclassification are low sample density and/or an inadvertent filtering extraction. The second anomaly is associated with the bare earth model. In the Northeast region of the habitat rank models, a large area of high ranking habitat extends roughly East/West. This area was characterized in the LiDAR data as having uncommonly high elevation values and low tree height. In truth, this area is dominated by a tall and dense mesquite canopy. Likely because very few bare earth returns were recorded, canopy surface elevations were assigned to the bare earth model. Additional filtering of raw LiDAR data, or a GPS topography survey could yield an accurate bare earth surface model. Both of these observations point to the importance of local knowledge and boots-on-the-ground to gain understanding of the landscape and phenomena being modeled/mapped.

In Closing: Tortoises are most often hard to find (photo right). The modeling effort presented here outlines a process for modeling habitat preference so that survey effort is concentrated in areas where tortoises are likely. Model outcomes don't mean that tortoises can 't be found in unlikely spots, or that this model actually accounts for ALL likely areas. Tests of habitat preference are built into ongoing and evolving survey events, where new survey areas, defined as both "likely" and "unlikely", are systematically searched. The expansion and refinement of modeling procedures largely rests in the outcomes of these tests and the desire of others to apply this process to additional conservation areas. If interested in details about tortoise survey methods or the modeling process presented here—please contact: Jeff Bracewell, GIS Specialist; jeff_bracewell@nps.gov, 337.291.3002 or Robert Woodman, Ecologist; Robert_Woodman@nps.gov, 337.291.3074

References:

Bury, R. B. and Smith, Elizabeth. 1986. Aspects of the Ecology and Management of the Tortoise Gopherus berlandieri at Laguna Atascosa, Texas. The Southwestern Naturalist 31[3]. Ref Type: Journal (Full)

Jenness, J. DEM Surface Tools for ArcGIS (surface_area.exe) v. 2.0.230. Jenness Enterprises. 2010. Available at: http://www.jennessent.com/arcgis/surface_area.htm.

Kazmaier, R. T., Hellgren, E. C., and Ruthven, D. C. 2001. Habitat Selection by the Texas Tortoise in a Managed Thornscrub Ecosystem. Journal of Wildlife Management 65[4]. Ref Type: Journal (Full)

Rose, F. L. and Judd, Frank W. 1975. Activity and Home Range Size of the Texas Tortoise, Gopherus berlandieri, in South Texas. herpetologica 31. Ref Type: Journal (Full)

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