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Developing a survey protocol for landscapes with a low-density of gopher tortoises

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Gopher Tortoise Occupancy Survey Protocol

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Sample site selection and survey logistics

Our approach used ArcGIS to develop an appropriate land cover map for selection of potential gopher tortoise habitat. First, we started with a publicly available land cover dataset (i.e., http://myfwc.com/research/gis/applications/articles/Cooperative-Land-Cover). We then excluded all wetland habitats and other areas that were not suitable including urban development and recently cleared areas. Next, we divided the base into five categories: 1) sandhills high-quality; 2) sandhills low-quality; 3) cleared vegetation including ranges and powerline right of ways; 4) pine production consisting of row plantations and post-logging natural regeneration; and 5) other uplands including xeric hammock and upland pine. These categories represented the vast majority of potential tortoise habitat and were the first stratification. We partitioned this layer into one-ha survey blocks ($100m^2$), which represented the entire sample pool.

We developed a second tier of stratification that represented gopher tortoise status for each one-ha habitat block based on previous limited area-constrained surveys and past occurrence records. Each potential survey block was assigned to one of 3 categories: 1) within 60m of an occupied (two or more burrows present) area within past 20 years; 2) not documented, but >60m and $\leq$1500m of an area that has been occupied in that past 20 years; and 3) not documented and >1500m from an area that has been occupied in that past 20 years. The 60m criterion represents average male home ranges derived from Eubanks et al. (2003). The straight-line distance of 1500m is an estimate of tortoise dispersal/immigration (Eubanks et al. 2003). We randomly selected one-ha survey blocks from each occupied-status category (Strata 2) in proportion to availability of habitat type (Strata 1). This step may not be necessary if no prior information is available, but in instances of low density populations, it may be critical to avoid sampling only unoccupied areas.

Eglin is a large active base, and thus access can be complicated due to many missions conducted daily. To increase survey efficiency (e.g., survey multiple blocks in the same general area) while still maintaining a randomness to our approach, we utilized Eglin's Tactical Training Area (TTA) grid and daily mission updates to guide our survey schedule (Figure 1). Every few days we randomly selected from the list of TTAs that contained sample points and for the most part surveyed between 10-20 survey blocks in that particular TTA. To ensure equal coverage across all TTAs (all of Eglin) and proportional coverage across habitat types, we randomly worked through the entire list before returning to a particular TTA for additional surveys. For some areas, where access is permanently restricted due to security or safety concerns, we did not survey, but these areas generally were small compared to the entire survey area. This approach is likely to improve efficiencies when attempting to cover installations that are very large.

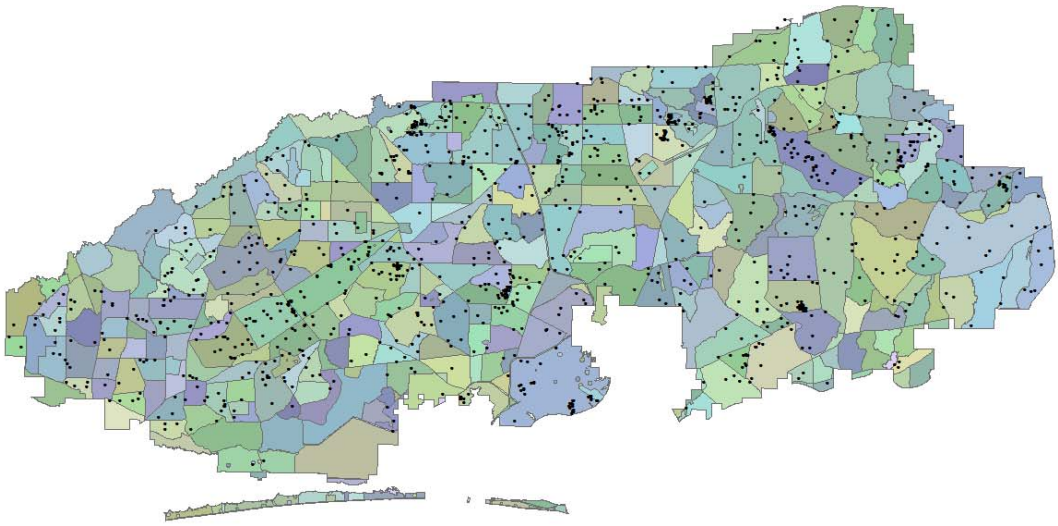
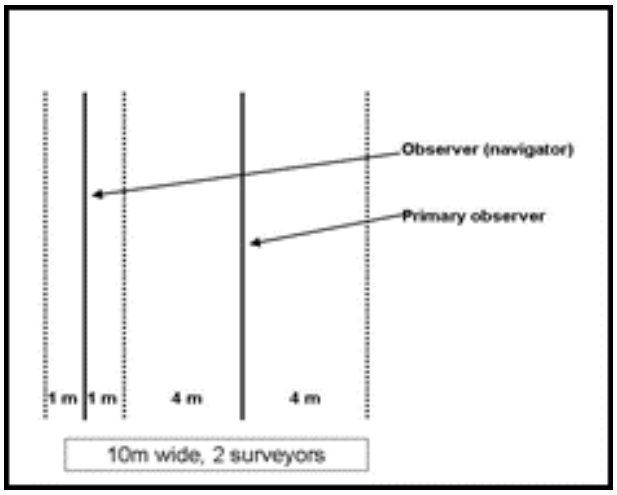


Figure 1. Example of the coverage of randomly selected survey locations and the associated Tactical Training Areas on Eglin Air Force Base, Florida.

Survey dates and method

We conducted surveys in the late-summer and fall to get a snap shot in time of gopher tortoise occupancy. For each site, the presence or absence of gopher tortoise burrows was determined. We used teams of two observers, and we used separate teams to conduct repeat surveys to estimate both occupancy and detection probability (MacKenzie et al. 2006).



For each one-ha survey plot, we employed a burrow survey method consisting of two observers walking 10 meter transects (inset figure) across the survey block (11 transects/ha). Surveys started in the northwest corner and moved east along north-south lines. A navigator, using a compass and Garmin GPSMap78 navigated the team, recorded data, and surveyed 1 meter on either side of the navigation line. The primary observer, positioned 5 meters from the center line, was responsible for surveying 4 m on either side of his/her position.

Upon detection of a burrow, we determined its status using criteria compiled from past research. If the burrow was active or inactive, we ended the survey, and the block was marked as occupied. While all burrows observed were recorded, only burrows within or on the block boundary were used for occupancy determination. We also recorded abandoned burrows, but these were not used as indicators of occupancy for our analysis.

<u>Active</u> - Shows evidence of recent tortoise activity, such as footprints around the entrance or scrape-marks within the burrow caused by the plastron abrading the sand (McCoy and Mushinsky 1995). Soil at the mouth has recently been disturbed by a tortoise (Auffenberg and Franz 1982). Obvious tracks or shell scraping signs at burrow mouth (Smith et al. 2005).

<u>Inactive</u> – Potentially could be used by a tortoise but lacked evidence of recent tortoise activity (McCoy and Mushinsky 1995). Soil is undisturbed but the burrow appears to be maintained (Auffenberg and Franz 1982). No tracks or shell scrapings; burrow occluded by debris, but recent use apparent (Smith et al. 2005).

<u>Abandoned</u> – Could not be used by a tortoise without modification, because they were overgrown or damaged (McCoy and Mushinsky 1995). The mouth has been washed in or covered with debris (Auffenberg and Franz 1982). Burrow covered with sticks, weeds, grass; burrow collapsed, dilapidated (Smith et al. 2005).

For all active and inactive burrows encountered (inside and outside survey blocks), we measured burrow widths at 50cm inside the burrow with a caliper (McCoy et al. 2006). This can provide information on burrow size that can offer insight into detection probabilities based on tortoise size and age category. We also recorded aspect and noted any commensals. All data were collected on the enclosed datasheet.

Finally, habitat types were determined on site for each sample block surveyed. This served to ground-truth our original habitat designations generated from ArcGIS. Sometimes blocks were comprised of multiple habitat types, including on occasion areas of unsuitable habitat type. In those circumstances, the dominant type (i.e., > 50%) became the habitat type used for analyses. If blocks contained >50% unsuitable habitat type (wetlands, highways etc.), they were removed.

Virginia Tech Gopher Tortoise Occupancy Survey							
Survey Site: _____ Visit (circle one): initial or repeat						Date: _____	
Habitat type: _____						Time Start: _____	
Primary observer: _____ Navigator:_____						Time End: _____	
Tortoise Burrows							
Burrow #	Obs.	Easting	Northing	Status	Width (mm)	Aspect	Comments
Commensals observed (record burrow #):							
Notes:							
Snakes Observed							
Species			Count	Comments			

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