

Spatial Ecology of Gopher Tortoises in GTMNERR Sand Dunes



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Overview



- ▶ Background
- ▶ Study Objectives
- ▶ Methods
- ▶ Results
- ▶ Discussions
- ▶ Recommendations
- ▶ Acknowledgements



Gopher Tortoise a.k.a “Hoover chicken”

- ▶ Habitat generalist
- ▶ Keystone Species
- ▶ Most studies conducted in upland sandhill habitats or pine plantations
- ▶ Understudied in coastal areas
 - ▶ Cape Sable, FL
 - ▶ Kennedy Space Center
- ▶ Habitat loss, fire suppression, human exploitation, URTDs



Study Objectives

- ▶ I To determine home range and spatial characteristics of Gopher Tortoises in coastal sand dunes habitat
- ▶ II To determine season activity and movement patterns
- ▶ III To identify biotic, abiotic, and anthropogenic factors that influence Gopher tortoise burrow sites selection in microhabitat (<1 m) and home range (<17 m) spatial scales.
- ▶ IV To quantify the effects of biotic, abiotic, and anthropogenic factors on Gopher tortoise burrow site selection.

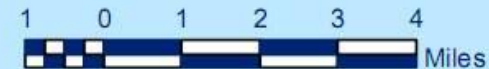




GTMNERR North & South



1:160,000



Sand dune
Study site

GUANA
RIVER
MARSH
AQUATIC
PRESERVE

Environmental
Education Center

St. Augustine
Inlet



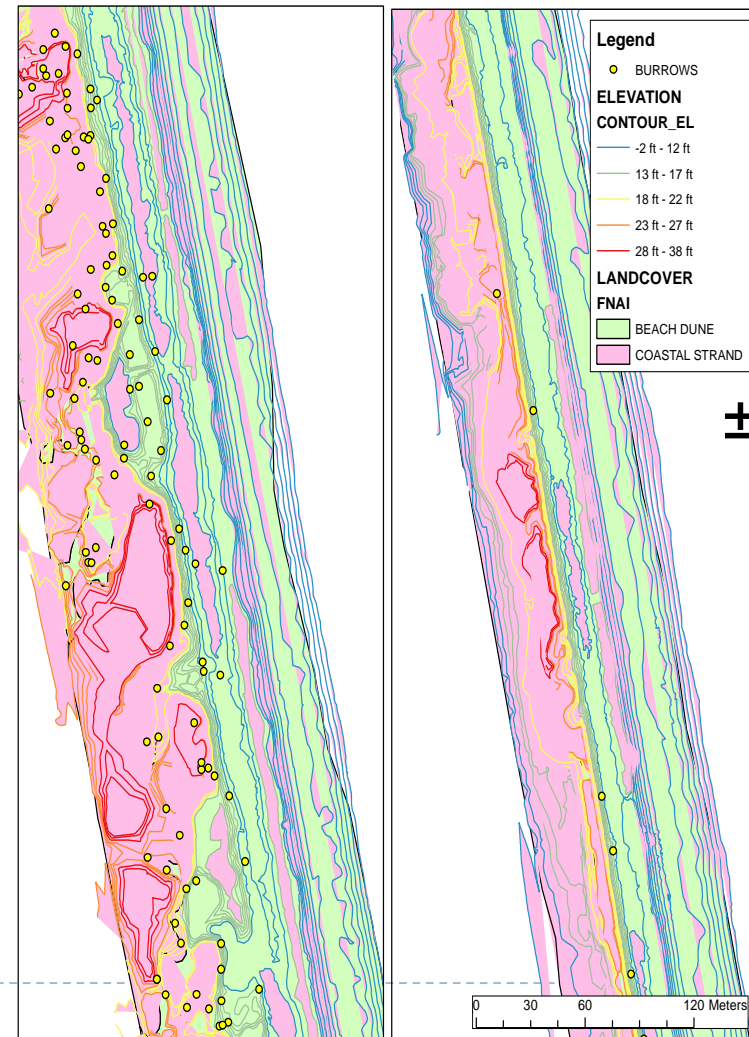
Study Site

- ▶ Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), north of St. Augustine, St. Johns County
- ▶ Most GT found in maritime hammock, ruderal, beach dune, coastal scrub, and shell mound
- ▶ A: 78 ha, L: 7.1 km, W: 90-145 m
- ▶ Burrow density (active + inactive): 1.64/ha (GTMNERR, 2008), 3.05 burrow/ha (Lau, unpub. data)
- ▶ Surrounded by housing development, A1A, and the Atlantic Ocean



Study Site

- ▶ Tallest dune in Florida (10 – 11.5 m)
- ▶ Land cover type
 - ▶ Beach dune
 - ▶ seaoats, bitter panicgrass, railroad vine, seacoast marsh elder, saltmeadow cordgrass, beach morning glory, Indian blanket, bull thistle, and prickly pears
 - ▶ Coastal Strand
 - ▶ saw palmetto, dwarfed cabbage palm, red bay, red cedar, yaupon holly, and tough bully
- ▶ Soil type: Fripp and Beaches (USDA)





Flowering plants in beach dune



Opuntia stricta



Passiflora incarnata



Centrosema virginianum



Gaillardia pulchella



Commelina erecta



Tradescantia ohiensis



Ipomoea imperati



Gopherus polyphemus foraging in Coastal sand dune.

Methods (Obj. I & II)

- ▶ Radiotelemetry
- ▶ 20 Adult Gopher Tortoises (>22 cm SCL)
- ▶ 9 males, 11 females
- ▶ Duration: May 2010 – May 2011
- ▶ Tracked 2-3 times a week (Mar-Oct), once a week (Nov-Feb)
- ▶ Time, location, weather, and activity recorded
- ▶ Mean distance moved between successive locations determined in ESRI ArcMap
- ▶ Burrow used per month and year
- ▶ Annual home range sizes 100% Minimum Convex Polygons (MCP) and 95% fixed Kernel



T14 “Short-round”



Methods (Obj. III & IV)

- ▶ Logistic regression model with binomial link function
 - ▶ 1 response variable (Y)
 - ▶ **Presence** = 100 randomly selected active/inactive burrows
 - ▶ **Absence** = 100 random points (generated by GIS) (Pseudo-absences)
 - ▶ 16 - 3 = 13 predictor variables (Xs) († = categorical variables)

Scale	Microhabitat (<1m)	Home Range (<17m)
Abiotic factors	<ul style="list-style-type: none">• Soil Resistance• Slope• Slope angle	<ul style="list-style-type: none">• Soil type †
Biotic factors	<ul style="list-style-type: none">• % herbaceous cover• % grass• % scrub and vines• % litter• Canopy cover (P/A) †	<ul style="list-style-type: none">• Land cover type †• Number of tortoise burrow within 17 m radius• Distance to edge
Anthropogenic factors		<ul style="list-style-type: none">• Distance to beach access

Methods (Objectives III & IV)

- ▶ Model selection with AICc
 - ▶ Nine *a priori* model (8 different combination of explanatory variables + 1 Global model with all variables)
 - ▶ Wald Chi Square test for model parameters ($\alpha = 0.05$)
 - ▶ Best model was determined by Δ AICc and Akaike weight (Burnham and Anderson 2002)
 - ▶ Most influential variables were determined by summing Akaike weight of models containing each variables



20 “Leonardo” aka “Leo” foraging





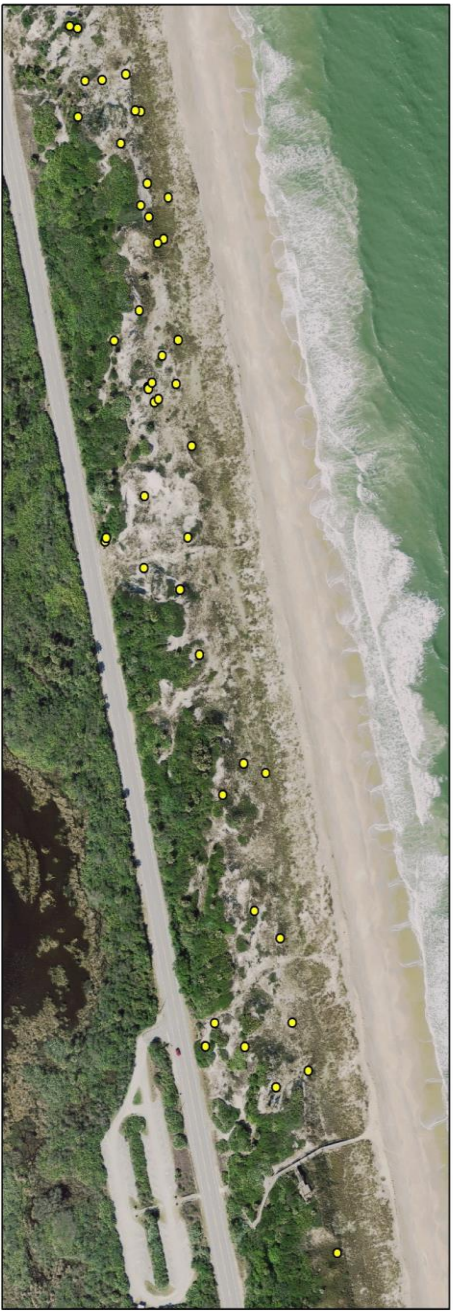
Beach

Coastal Sand Dune

Coastal Strand

Highway AIA

Coastal Strand

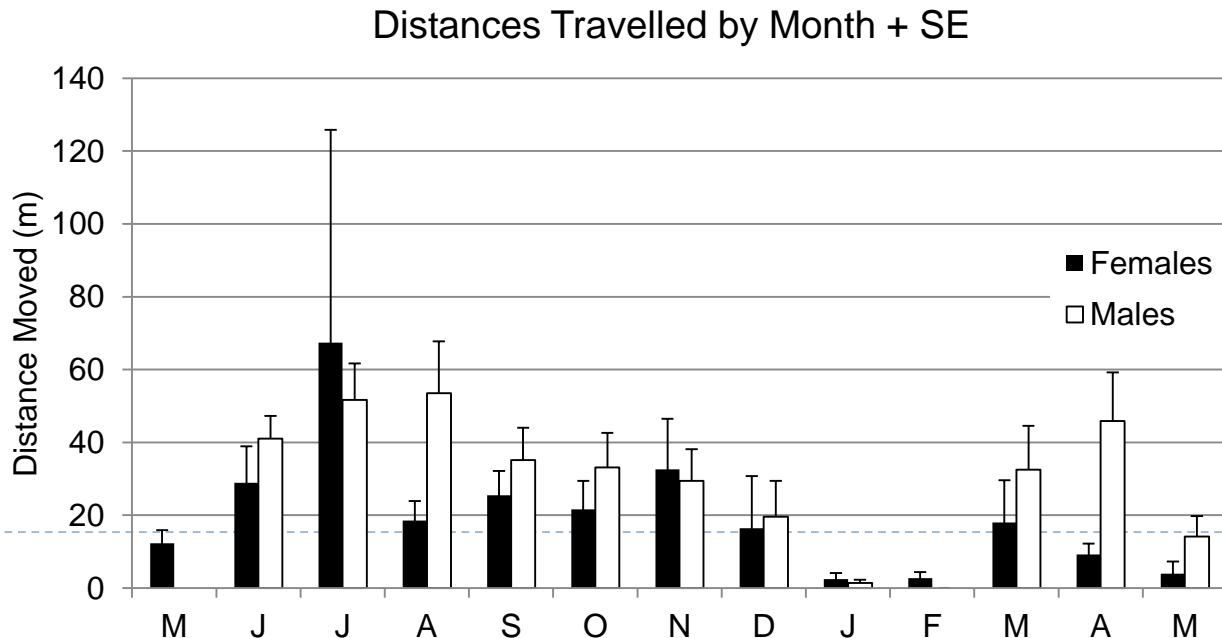


Northern section (15.7 ha), 12.17 burrows/ha

Southern section (62.3 ha), 0.75 burrows/ha

Results (Obj. I & II)

- ▶ Tortoises on average were tracked for a period of 325 days (range = 257 – 358, S.D. = 21) and 56 times (range = 46 – 72, S.D. = 5.34)
 - ▶ Movement Distances
 - ▶ Females 39.2 m \pm 13.3 (range = 5.5 - 156.9)
 - ▶ Males 47.0 m \pm 7.68 (range = 24.6 - 83.4)
- Kruskal-Wallis chi-square = 2.92, df = 1, p = 0.08

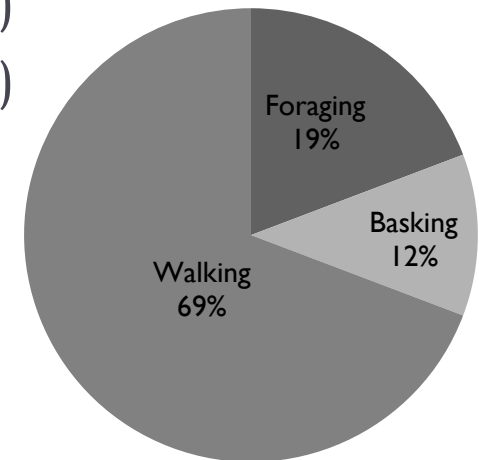


Results (Obj. I & II)

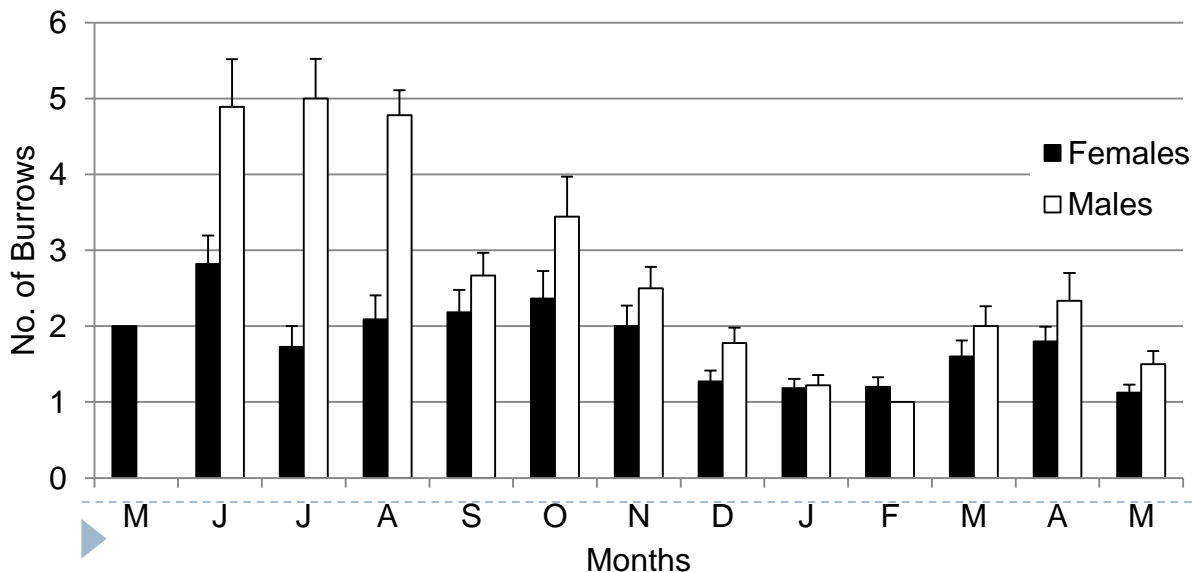
▶ Burrow Use and Activity Patterns

- ▶ in burrow 97% of the time, observed aboveground 26 times
 - ▶ Females 6 burrows \pm 0.89 (range = 2 - 12)
 - ▶ Males 9 burrows \pm 1.09 (range = 5 - 14)
- $F_{1, 18} = 11.43, p = 0.003^{**}$

Aboveground Activity



No. of Burrows Used by Month + SE



Results (Obj. I & II)

▶ Annual Home Range

	n	MCP			Kernel		
		Home range	SE	Range	Home range	SE	Range
All tortoises	20	0.37	0.14	<0.01-2.94	0.25	0.02	0.09-0.52
Males	9	0.32	0.06	0.13-0.63	0.31	0.03	0.23-0.52
Females	11	0.42 (0.16)	0.25 (0.05)	<0.01-2.94	0.21	0.03	0.09-0.41

- ▶ 100 % MCP: M = F (Kruskal-Wallis chi-square: 2.19, df = 1, p = 0.1385)
- ▶ 95% Kernel: M > F ($F_{1, 18} = 5.50$, p = 0.03*)

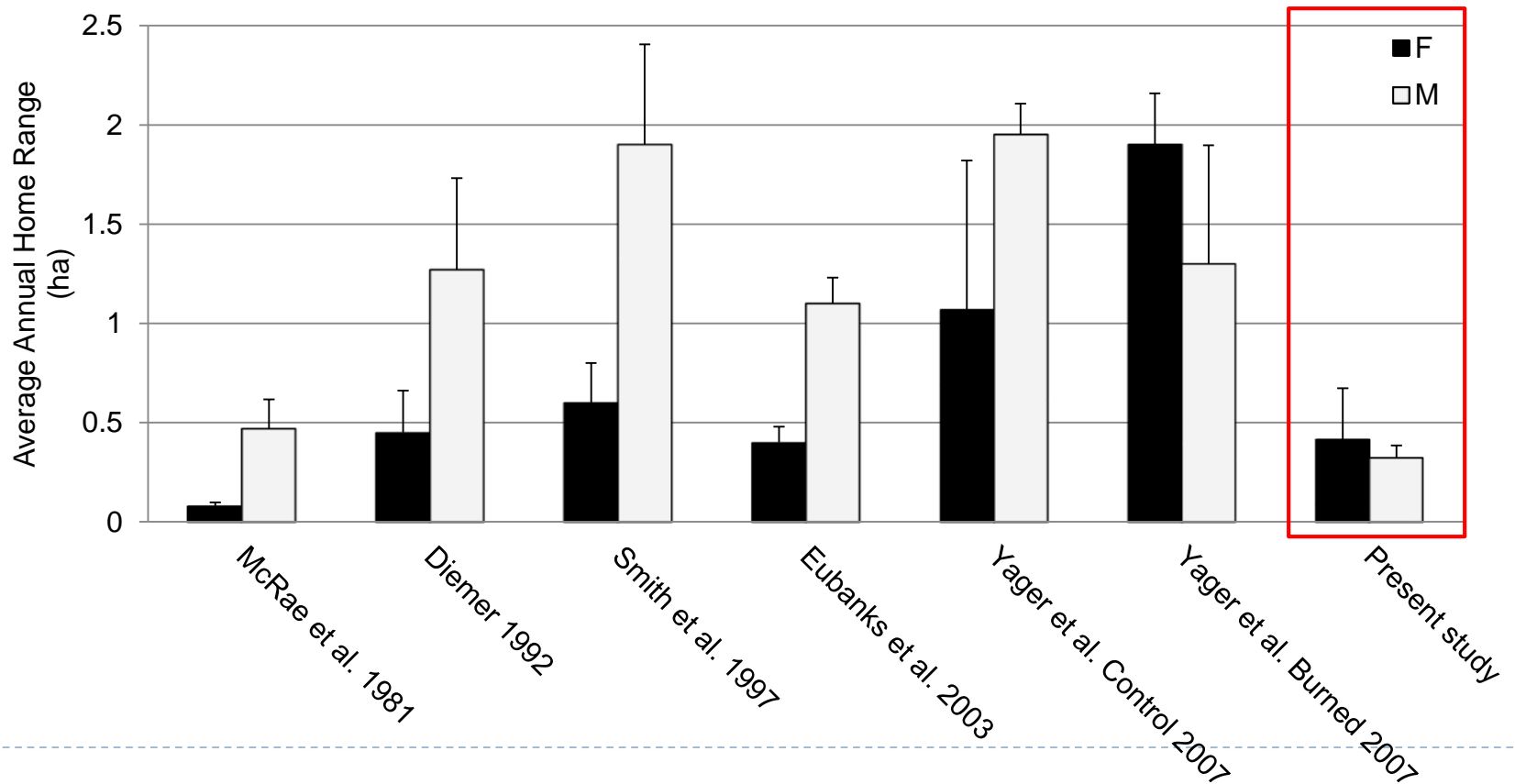
▶ Dispersal pattern

- ▶ All but one tortoises stayed within the 15.7 ha northern section
- ▶ Most movements were North-South or vice versa
- ▶ Never crossed road
- ▶ Longest movement was 650 m over 12 days by a female (SCL: 26.8 cm)



Results (Obj. I & II)

Average Annual Home Range of adult Gopher Tortoises



Results (Obj. III & IV)

Burrow site selection models based on *a priori* hypotheses for Gopher Tortoises (n = 198)

Model	Factors	K	-2LL	AICc	Δ AICc	w
environmental + biological	SR SL SA HE GR SV LI CA SO LC TB DE	13	125.14	153.13	0.00	0.5378
global	SR SL SA HE GR SV LI CA SO LC TB DE DA	14	123.14	153.45	0.32	0.4588
biological + anthropogenic	HE GR SV LI CA LC TB DE DA	10	142.88	164.06	10.93	0.0023
biological only	HE GR SV LI CA LC TB DE	9	147.55	166.51	13.38	0.0007
home range only	SO LC TB DE DA	6	155.10	167.55	14.42	0.0004
environmental +anthropogenic	SR SL SA SO DA	7	179.76	194.36	41.23	<0.0001
microhabitat only	SR SL SA HE GR SC LI CA	9	202.19	221.16	68.03	<0.0001
environmental only	SR SL SA SO	5	222.84	233.15	80.02	<0.0001
anthropogenic only	DA	2	258.72	262.78	109.65	<0.0001



Legend

● 7-7-2010 projected burrow

GTMNERR_NatCom_2007 selection

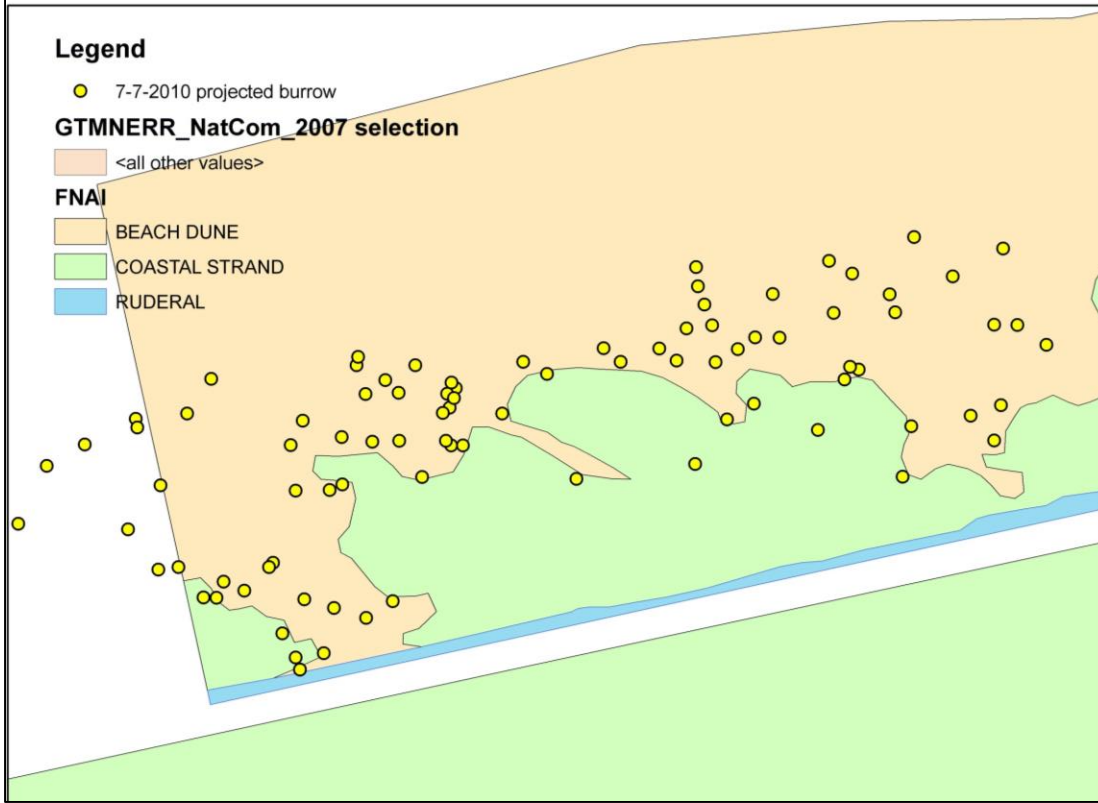
□ <all other values>

FNAI

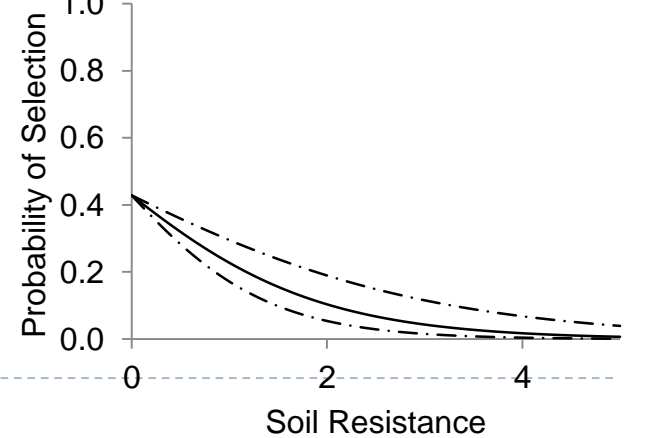
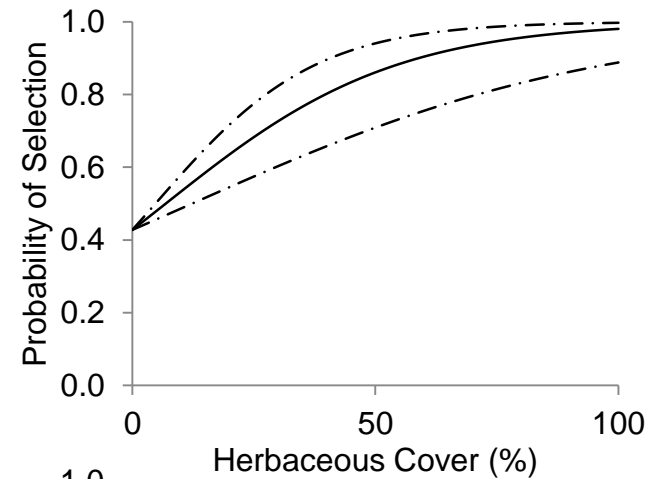
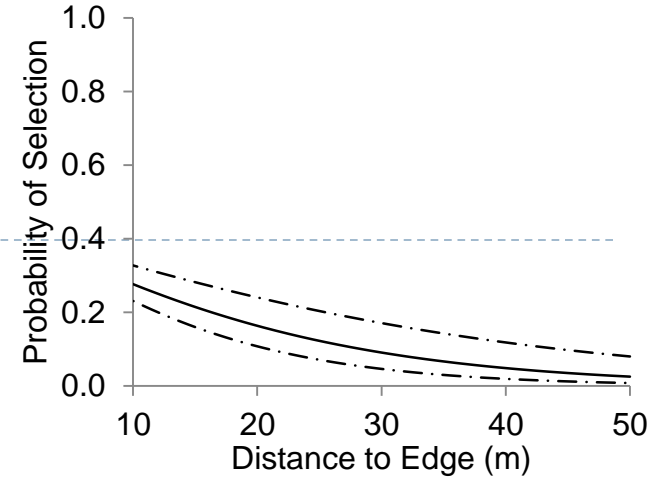
■ BEACH DUNE

■ COASTAL STRAND

■ RUDERAL



- ▶ land cover type (beach dune > coastal strand)
- ▶ % herbaceous cover (+)
- ▶ distance to edge (-)
- ▶ soil resistance (-)
- ▶ number of tortoise burrows (+)
- ▶ slope orientation (NE)
- ▶ distance to beach access (-)



Discussions

- ▶ Results consistent with literature
 - ▶ Huge individual variation
 - ▶ Differ by sex
 - ▶ Moved short distances
 - ▶ Inactive season: December to March
- ▶ Smaller home range and fewer burrows used compared to other coastal scrub and upland habitats
 - ▶ High food abundance, high tortoise density
- ▶ A1A = long-term dispersal barrier?
- ▶ Burrow sharing common (n = 40)



“Ménage à trois-toise” (Enge, 2010)



Discussions

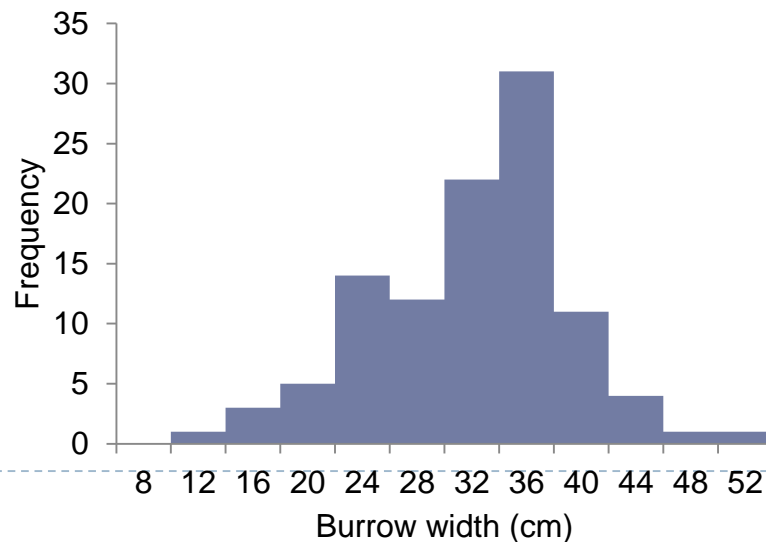
- ▶ 1st study to model *Gopherus polyphemus* burrow site selection with fine scale variables and quantitatively established causal linkage between burrow site selection and anthropogenic disturbance
- ▶ Burrow site selection in coastal sand dune influenced by multiple factors and multiple spatial scales
- ▶ Importance of home range scale variables
- ▶ Lower density in southern section?



Management & Research Recommendations

- ▶ Continue to monitor coastal populations
- ▶ Anthropogenic disturbance should not be overlooked
- ▶ Study gene flow and population genetic structure to look at effects of human alterations?

Size class distribution at GTMNERR sand dune



Acknowledgements

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