Spatio-temporal Niche Differentiation for Sea Turtles in Dry Tortugas National Park, FL

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Background

Of the seven extant sea turtle species, three – the Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), and Hawksbill (*Eretmochelys imbricata*) – are known to utilize the waters in and around Dry Tortugas National Park (DRTO), which surrounds seven small islands at the westernmost point of the Florida Keys in the Gulf of Mexico. Starting in 2008, efforts to monitor sea turtles at DRTO have included tagging and tracking using satellite telemetry tags (Hart et al. 2012). Through 2016, a total of 672 captures have been made (Table 1), both in-water and during nesting events.

Table 1. Summary of captures/tagged individuals in DRTO.

Species	no. captures (no. unique indv.)	no. tags deployed (no. unique indv.)
Green	420 (211)	48 (44)
Loggerhead	238 (126)	75 (63)
Hawksbill	9 (9)	4 (4)
Logg. x Hawk.*	5 (3)	2 (2)
Total	**672 (349)**	**129 (113)**

* Hybrid indv. (Loggerhead and Hawksbill)

Hawksbill and Green populations at DRTO are both listed as endangered under the U.S. Endangered Species Act, while the Loggerhead is listed as threatened, though the individuals at DRTO are part of a distinct (small) nesting sub-population (Hart et al. 2016). To better understand environment and space use of these three species of conservation concern in an important foraging and nesting ground, we compiled a database of capture and satellite locations of sea turtles in and around DRTO, extracting a set of temporal, spatial, and habitat variables to analyze:

- **niche differentiation by species/sex**
- **important variables differentiating ecological niches**
- **spatio-temporal patterns of use of DRTO for each species**

Hart, Kristen M., Ikuko Fujisaki, and Autumn R. Sartain-Iverson. "Use of Dry Tortugas National Park by Threatened and Endangered Marine Turtles: Chapter 5." Other Government Series. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission, 2012. http://pubs.er.usgs.gov/publication/70040395.

Hart, Kristen M., David G. Zawada, Autumn R. Sartain, and Ikuko Fujisaki. "Breeding Loggerhead Marine Turtles Caretta Caretta in Dry Tortugas National Park, USA, Show High Fidelity to Diverse Habitats near Nesting Beaches." *Oryx* 50, no. 2 (April 2016): 283–88.

Data and Methods

- Study area includes Dry Tortugas and the surrounding waters (Figure 1)
- Information was summarized by "turtle-year" (individual over a calendar year; n = 140) over a series of temporal, spatial, and habitat variables (Table 2)
- Linear discriminant analysis (LDA) was used reduce dimensionality and maximize discrimination between groups, in separate analyses:
  - **among all individuals (by species/sex)**
  - **among nesting females (by species)**
- Turtle-year spatio-temporal use was analyzed using a 95% Minimum Convex Polygons (MCP) to describe the home-range within the study area

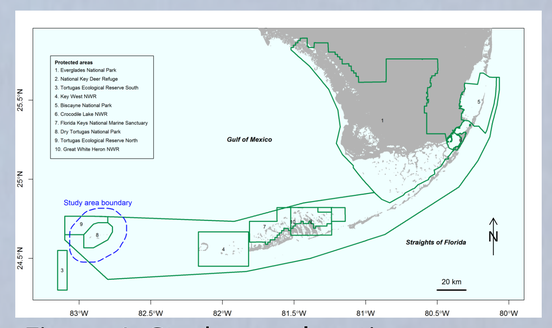


Figure 1. Study area location within southern Florida.

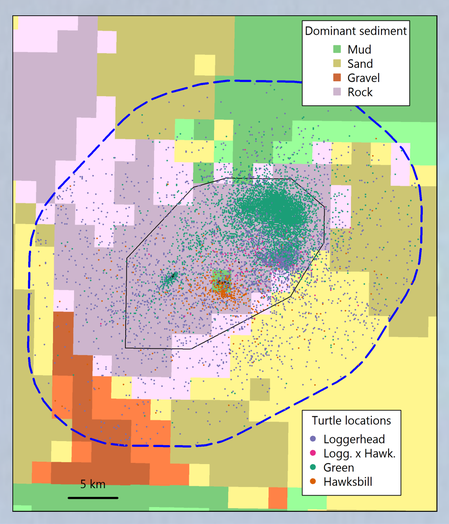


Figure 2. Satellite-tracked sea turtle locations within the study area, overlaid on the primary seabed sediment type. Darker shades indicate more dominant coverage for that particular type.

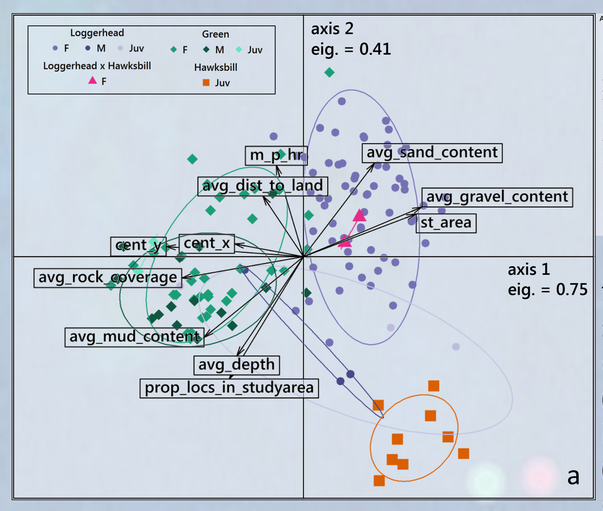
Table 2. Variables used in Linear Discriminant Analysis

Timing	Spatial	Habitat
Day of year (nest)*	Nest location*	Distance to land
Time of day (nest)*	Home range (MCP) centroid location	Substrate content (substrate rock %, and sediment % weight of mud, gravel, and sand)
Proportion of locations in study area	Home range area	Seafloor depth
	Movement rate	

* Only for nesting females

Results

- **Discriminant analysis, all individuals (by species/sex)**



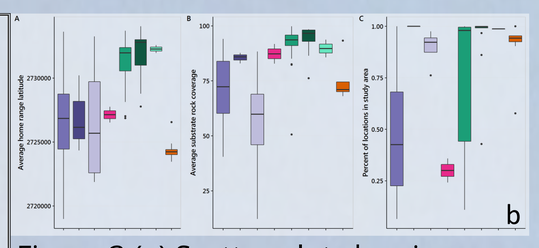
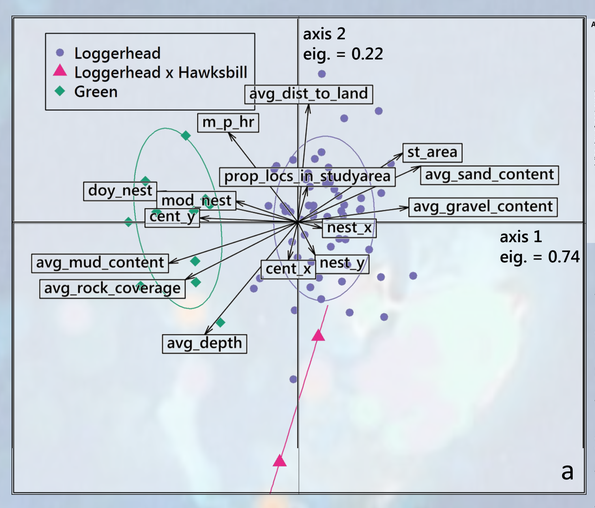


Figure 3.(a) Scatter plot showing turtle-year locations in variable space along the first two axes of the discriminant analysis for all turtles (by species and sex), and (b) selected important variables along the first (A,B) and second (C) axes of the discriminant analysis.

- **Discriminant analysis, nesting females (by species)**



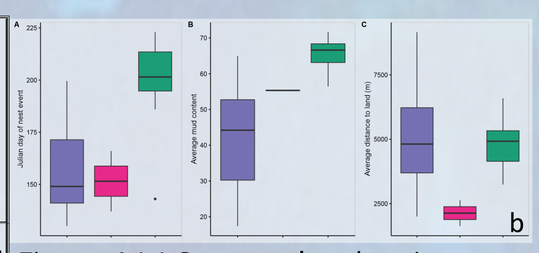


Figure 4.(a) Scatter plot showing turtle-year locations in variable space along the first two axes of the discriminant analysis for nesting females (by species), and (b) selected important variables along the first (A,B) and second (C) axes of the discriminant analysis.

- **Spatio-temporal use**

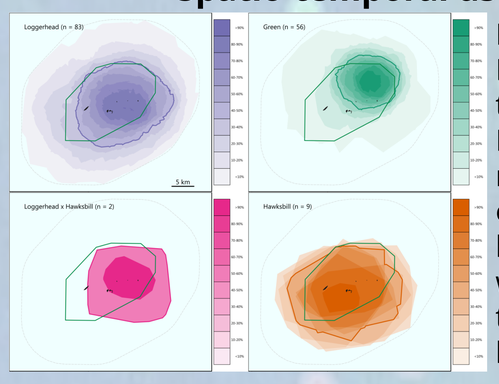
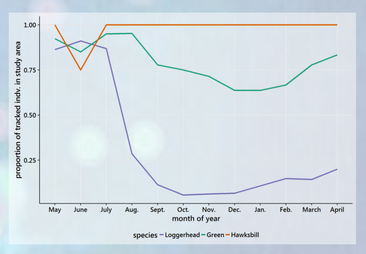


Figure 5. Percent of turtle-year MCP home ranges overlapping, by species, with 50% threshold bolded.

Figure 6. Percent of individuals (by species) with locations within the study area over the year.



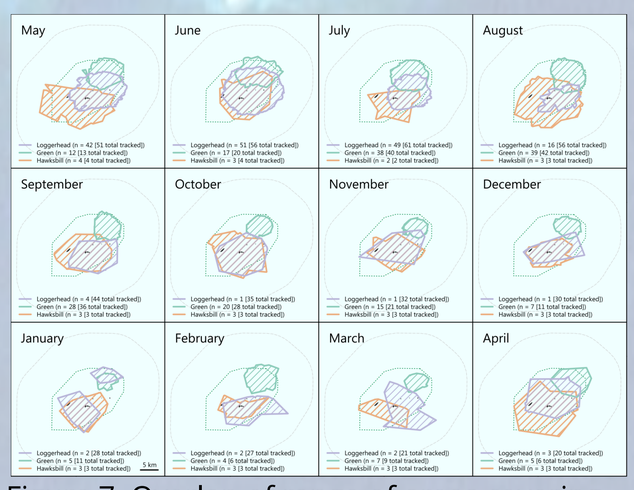


Figure 7. Overlap of range of areas covering 50% or more of turtle-year MCP home ranges, for each species and calendar month.

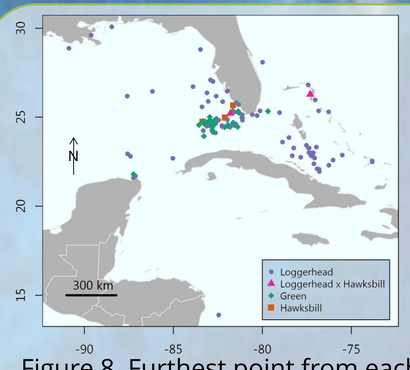


Figure 8. Furthest point from each turtle's capture point in DRTO

Discussion

- All species primarily used areas with high substrate rock exposure (which is present in most of the park's waters); Greens primarily remained in areas with high sediment mud content, while loggerheads also utilized areas with relatively higher sediment sand and gravel content. Hawksbills preferred shallow areas near land (islands)
- Loggerheads females primarily were in the study area only during the nesting season, migrating to various locations throughout the region, with greens were more likely to remain in and near DRTO, with a few exceptions (e.g., Figure 8). Males and juveniles of all species were distinguished by their fidelity to DRTO and surrounding waters, use of shallower waters closer to land, and slower movement rates
- Species space-use was orientated on a N-S gradient (Figs. 5,7), with Greens primarily in the northern portion of the park, Hawksbills in the south, and Loggerheads in between; overlap was highest in late spring/early summer
- Analyses confirm a level of partitioning of spatio-temporal usage of DRTO among resident sea turtles, underscoring the importance of the entirety of DRTO and surrounding waters for sea turtle conservation, while especially highlighting north-eastern portions of the park during the summer breeding months

Background image displays capture locations for sea turtles within Dry Tortugas National Park. For more information on this project, contact David Bucklin at *dbucklin@ufl.edu*