Quantifying the nest microenvironment:

Impacts of an invasive plant on hawksbill hatching success and incubation temperature

Andrew S. Maurer*[1,2], Seth P. Stapleton[2], Alexandra L. Fireman[2], Jillian Tucker[2], and Craig A. Layman[1]

1: Department of Applied Ecology, North Carolina State University, Raleigh, NC
2: Jumby Bay Hawksbill Project, Long Island, Antigua, West Indies
*:(asmaurer@ncsu.edu)

BACKGROUND

- Species invasions are increasing with global change.
- The beach shrub *Scaevola taccada* is native to the pacific, but invasive throughout the Caribbean, largely due to introduction for coastal landscaping.
- Hawksbills tend to nest in or near vegetated areas.

Image 1. *Hawksbills, such as this individual on Long Island, Antigua, often seek vegetated areas for nesting.*

METHODS

Monitoring Protocol

- Field work was conducted on Long Island (Jumby Bay), Antigua, from June to November of 2015.
- With hourly patrols throughout the duration of the monitoring season, we documented 290 hawksbill (*Eretmochelys imbricata*) nests laid by 76 individuals.

Research Approach

- We sampled 8 nests located in open sand, 25 nests with native vegetation cover, and 17 with invasive *S. taccada* cover.
- At all nest sites we measured variables displayed in Table 1.
- We measured incubation temperature with a data logger placed into the center of the clutch during egg-laying, and estimated hatching success by excavating nests post-emergence.

Table 1. *Variables of interest for our evaluation of hawksbill hatch success and incubation temperature.*

Predictor Variables
Associated vegetation type
Beach slope
Distance to Veg Edge (m)
Distance to high tide line (m)
Curved carapace length (cm)
Substrate moisture
Substrate % organic content
% Canopy Cover
Canopy height (m)
Nest depth (cm)
Date (Julian calendar)
% coarse substrate (>2mm)
% fine substrate (<0.25mm)
Response Variables
% hatching success (logit transformed)
Incubation temperature (℃)

Data Analysis

- We included variables of interest in a multiple regression predicting each of the response variables.
- We used forward step variable selection using AIC to rank model performance.
- We did not consider substrate particle size in the incubation temperature models.

ACKNOWLEDGEMENTS

This project would not have been possible without the Jumby Bay Hawksbill Project field team: Emma De Neef, Kyle Pagel, Megan Arias, and Erin Daughtrey. We thank the Jumby Bay Island Company for continuing project support.

PROJECT AT A GLANCE

THE ISSUE

- An invasive plant is the new dominant species of vegetation at a high density hawksbill nesting beach on Long Island, Antigua
- This dense shrub, *Scaevola taccada*, is very different from native plants, giving rise to a suite of new interactions with nesting hawksbills

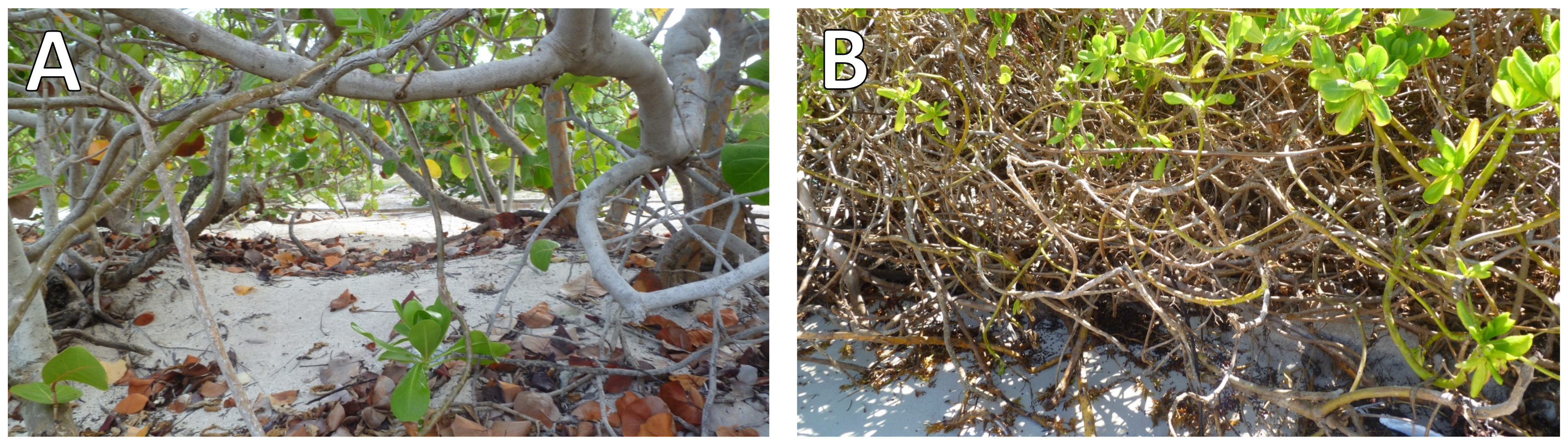

Figure 1. *(A) Seagrape* (Coccoloba uvifera) *is the previous dominant plant species on Long Island, Antigua, but differs drastically with (B) the current dominant: invasive* Scaevola taccada.

RESEARCH QUESTIONS

- Does *Scaevola taccada* affect hawksbill hatching success and incubation temperatures?
- More broadly, what microsite environmental variables or nest biological variables best explain variation in hatch success and incubation temperatures? (Figure 2)

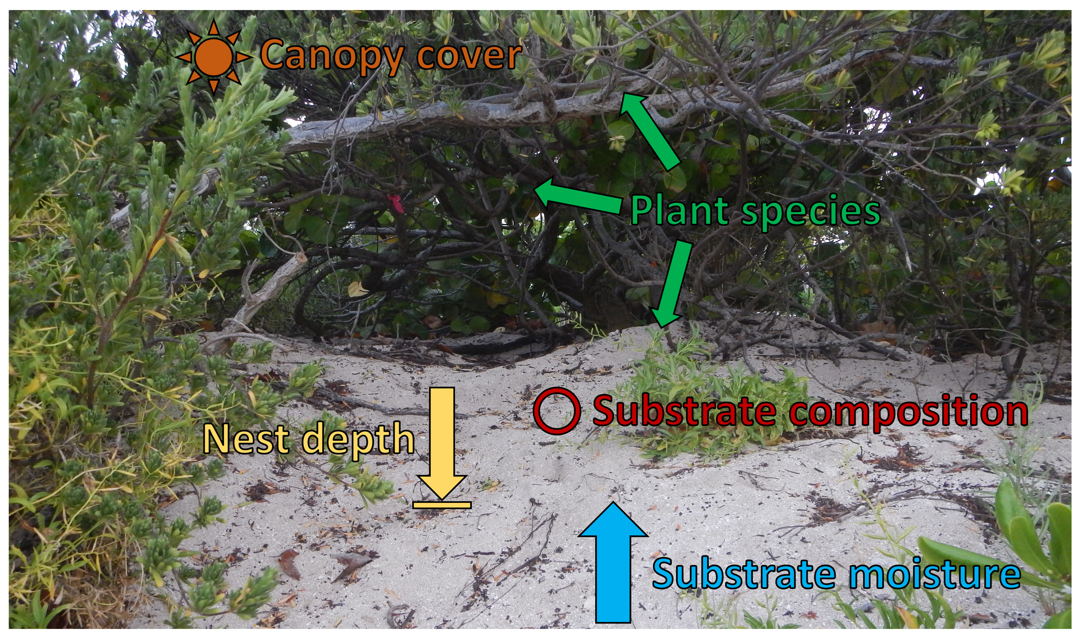

Figure 2. *A typical hawksbill nest site on Long Island, Antigua, has many environmental factors that can affect the nest environment. Just a few of these factors are illustrated above.*

FINDINGS

- Our data suggests that *Scaevola taccada* does not impact hatch success or incubation temperature differently than native species.
- Nonetheless, we posit that the dense, invasive beach shrub may preclude access to large areas of the nesting beach, acting as a barrier.
- We identified other key variables that better explain the variance in hatch success and incubation temperatures.

RESULTS

Vegetative cover and hatching success

- The invasive plant did not negatively affect hatching success relative to open sand or native species.

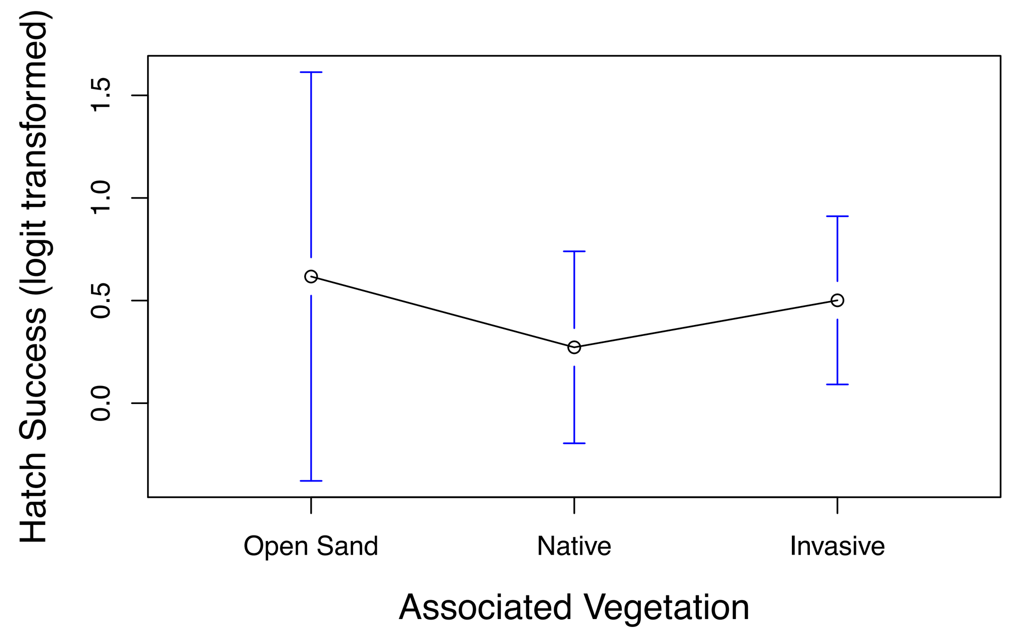

Figure 3. *An analysis of variance shows that associated vegetation type does not affect nest hatching success. Group means for hatch success ± 95%CI are shown. A multiple regression controlling for many other variables besides vegetation gave consistent results (below).*

Other factors predicting hatching success

- The best performing multiple regression model considering a suite of variables suggests that factors such as substrate moisture (-) and sand organic content (-) affect hatch success (Table 2).
- Associated vegetation was not a supported term.

Table 2. *Model fit results for the best performing multiple regression (ranked by AIC) of factors predicting hatch success. Estimated model coefficients and associated standard errors are shown. Bolded p-values are significant ($p<0.05$). $R^2 = 0.74$.*

Covariate	Estimate	Std. Error	p-value
(Intercept)	10.030	2.897	0.002
Distance to Veg Edge (m)	-0.132	0.055	**0.023**
Distance to high tide line (m)	0.068	0.026	**0.014**
Curved carapace length (cm)	-0.085	0.034	**0.02**
Substrate moisture	-0.063	0.010	**<0.001**
Substrate % organic content	-0.270	0.129	**0.046**
% fine substrate (<0.25mm)	-4.658	2.003	**0.028**
% Canopy Cover	-0.006	0.006	0.341
Canopy height (m)	0.085	0.100	0.401
Nest depth (cm)	0.011	0.027	0.685

Factors predicting incubation temperature

- The invasive plant did not affect incubation temperature differently than native species.
- Associated vegetation was not a supported term.
- The best performing multiple regression model considering a suite of variables (Table 3) suggests that nest deposition date and canopy height are the most important factors, likely due to seasonal temperature changes and wind exposure.

Table 3. *Model fit results for the best performing multiple regression (ranked by AIC) of factors predicting incubation temperature. Estimated model coefficients and associated standard errors are shown. Bolded p-values are significant ($p<0.05$). $R^2 = 0.28$.*

Covariate	Estimate	Std. Error	p-value
(Intercept)	26.936	1.307	<0.001
Date (Julian calendar)	0.015	0.005	**0.004**
Canopy height (m)	-0.247	0.101	**0.019**
Substrate % organic content	0.304	0.153	0.055

JUMBY BAY
A ROSEWOOD RESORT
ANTIGUA, WEST INDIES

NC STATE
UNIVERSITY

The Jumby Bay Hawksbill Project