SEDIMENTOLOGY AND BEACH SUBSTRATE TEMPERATURE INFLUENCES ON SEA TURTLE NESTING

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ABSTRACT

Florida beaches are important economic resources and home to thousands of nesting sea turtles every year. Beach-dune systems are periodically restored (beach nourishment) to mitigate erosion, enhance coastal habitat, protect from storms, and attract tourism. Different borrow sources with slight variability in their physical or mineralogical characteristics could affect substrate temperatures within placement areas, thereby potentially impacting sea turtle hatching and emergent success. On the other hand, certain state regulations on sediment properties for beach placement may restrict the degree of variability such that no impact on substrate temperatures may occur. Temperatures encountered during egg incubation will determine the gender of the sea turtle hatchlings but can also exceed a critical threshold resulting in embryonic mortality. Given the current trend of global warming, it will be critical to understand the role of sediment properties in shore protection projects on critical habitat function. This study evaluates the sedimentology and morphology at nine locations in Jupiter beach, FL with substrate temperature and the hatch and emergence success of loggerhead, leatherback, and green sea turtles during the 2019 nesting season. Grain size, sorting, and carbonate content at 45 cm depth below surface at three cross-shore locations were evaluated and compared to the temperature measured. Beaches with larger mean grain size (>0.67mm), poor sorting, and higher carbonate content (>75%) had lower measured temperatures (84°F-85°F). The reflectance shows negative correlation with the temperature. Upland and offshore borrow sediment sources have higher temperatures (>86 °F) and inlet dredged sediments have lower temperatures (84°F-85°F). At most locations, temperature had a positive correlation with the beach width. Loggerhead Hatch Success (HS) and Emergence Success (ES) had a high negative correlation (>0.90) with mean grain size, sorting and negative correlation (>0.85) with carbonate and leatherbacks have a no correlation (<0.5) with grain characteristics. On the other hand, HS and ES of greens had a positive correlation (>0.80) with mean grain size. The results of this study are aimed to support sediment resource management while promoting healthy beach ecosystems.

METHODOLOGY

Nine sites within the study area at Jupiter Beach encompasses 4 km in northern Palm Beach County, Florida (Figure 1).

- Sediment characteristics include mean grain size, sorting and composition (carbonate content) were compared with temperature changes at 45cm depth. Subsurface samples from each location at high (H), mid (M) and low (L) beach at 45 cm depth of early season (April-May) mid-season (June) and late season (September) of 2019 were used and grain characteristics obtained form graphical statistical analysis.
- HOBO data loggers were deployed at high, low and mid beach at depth 45 cm of the study area were used to obtain the substrate temperature. Monthly mean temperatures of early season (April 15-May 31), mid-season (June 1-July 15) and late season (July 16-August 31) were averaged to represent the entire nesting season.
- The 2019 sea turtle data Leatherbacks (DC), Loggerheads (CC) and Green sea turtle (CM) were compared to the sediment and temperature data. Correlation, a statistical analysis was run see the relationship between Hatching success (HS), Emergence Success (ES) with sediment characteristics and substrate temperature.

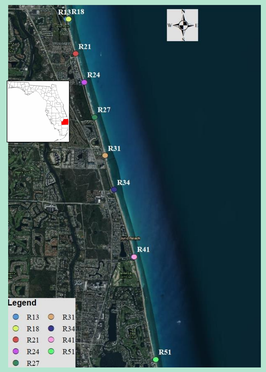

Figure 1: Study area, showing nine sites of the Jupiter beach.

RESULTS

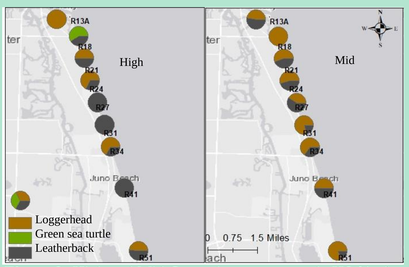

Figure 2: High and Mid Cross shore vs sea turtle HS % of Early season. Low CS has zero HS.

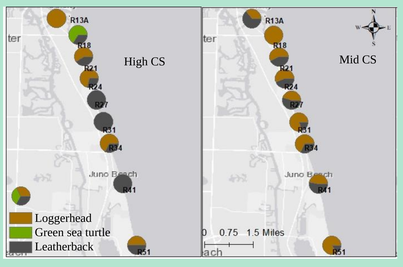

Figure 3: High and Mid Cross shore vs sea turtle ES% of Early season. Low CS has zero ES.

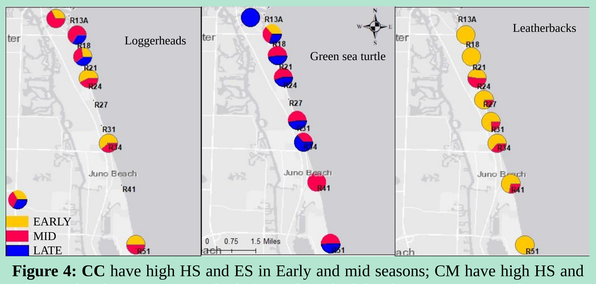

Figure 4: CC have high HS and ES in Early and mid seasons; CM have high HS and ES in Mid and Late seasons at high CS; and DC high hatching success in Early season.

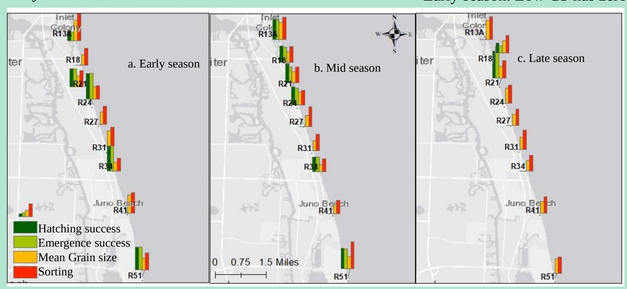

Figure 5: Hatching and Emergence success vs mean grain size (mm) and sorting (ϕ) of Loggerheads

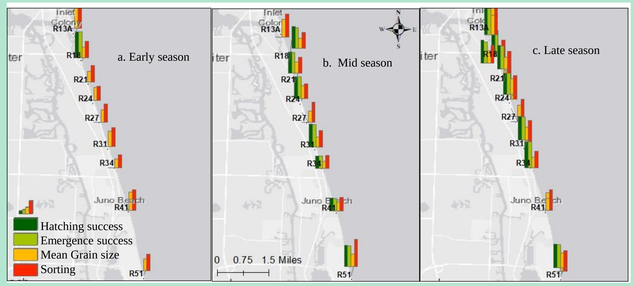

Figure 6: Hatching and Emergence success vs mean grain size (mm) and sorting (ϕ) of Green sea turtles.

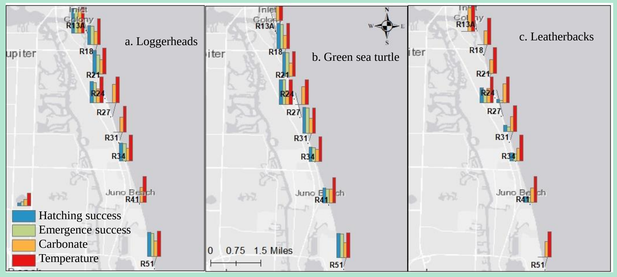

Figure 7: Hatching success vs carbonate and temperature at high in mid season. a. Loggerheads showing negative correlation with carbonate and no correlation with temperature. b. Green sea turtle had no correlation with carbonate and temperature. c. Leather backs showing no correlation with carbonate and temperature.

Table 1: Statistical correlation of Loggerhead HS and ES vs sediment characteristics and temperature.

	Loggerheads	Correlation			
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)	Carbonate (%)	Temperature (°F)
High	Early Season	Negative	Negative	Negative	No
	Mid season	Positive	Positive	Positive	~Negative
	Late season	No	No	No	No
Mid	In all seasons	No	No	No	No

Table 2: Statistical correlation of Green turtle HS and ES vs sediment characteristics and temperature.

	Green turtle	Correlation			
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)	Carbonate (%)	Temperature (°F)
High	Early Season	No	No	No	No
	Mid season	Positive	No	No	No
	Late season	No	No	No	No
Mid	HS & ES	No	No	No	No

Table 3: Statistical correlation of Leatherbacks HS and ES vs sediment characteristics and temperature.

	Leatherbacks	Correlation			
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)	Carbonate (%)	Temperature (°F)
High	Early Season	No	No	No	No
	Mid season	No	~Negative	No	Negative
	Late season	No	No	No	No
Mid	HS & ES	No	No	No	No

- The loggerheads had high hatching (Figure 2) and emergent success (Figure 3) followed by leatherbacks and green sea turtles. Low cross shore has no nesting.
- In late season the all the species show zero or less percentages of HS and ES except Green sea turtles showing HS and ES greater than 73% (Figure4).
- HS and ES of Loggerheads at high cross shore showing very high negative correlation (-0.83 to -0.95) with mean grain size (mm), sorting (ϕ) (Figure 5a)and carbonate (%) in early season but had positive correlation (Figure 5b) (0.80 to 0.88)in mid season and no correlation in late season (Figure 5c). The temperature had no correlation with HS and ES in early season (Table 1) but has slightly negative correlation (-0.5 to -0.6) in mid season (Figure 7a).
- HS and ES of Green sea turtle at high cross shore is exhibiting high positive correlation (0.82) with mean grain size (mm) and no correlation (<0.5) with sorting (Figure 6b) in mid season. Temperature and carbonate (Figure 7b) had no effect on the HS and ES of green sea turtles.
- HS and ES of Leatherbacks has no correlation with any grain characteristics but had a slight negative correlation with sorting and temperature in mid season (Table 3).
- All the three species showing no correlation to any sediment characteristics, temperature and carbonate percentage at mid cross location (Table 1-3).

DISCUSSION

- Sediment grain size and sorting has good correlation with the HS and ES for loggerheads at high cross shore location. Leatherbacks and green sea turtles HS and ES was not influenced by any sediment characteristics.
- Substrate temperature and carbonate percentage had no influence on the HS and ES.
- Other sediment properties like surface reflectance (Palaparthi 2019), type of carbonate fractions, grain shape and mineralogy might influence the HS and ES.

CONCLUSIONS

- The study of 2019 data shows that the Loggerheads HS and ES is influenced by of the sediment characteristics like grain size and sorting only at high cross shore location. Greens and Leatherbacks had less or no influence.
- Carbonate and temperature is not influencing the hatching success.

FUTURE WORK

- Additional work is needed to determine the other parameters like beach slope that might influence the emergence and nesting success.
- These methods will be reproduced in 2020 and 2021 nesting seasons.
- The results of this study will be compared to physical beach characteristics and sea turtle success in recent years.

REFERENCES

Palaparthi, J., Briggs, T.R., 2019. Temperature and sediment variability following beach placement using different borrow sources. ASBPA 2019 conference poster presentation.

ACKNOWLEDGEMENTS

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