SEDIMENTOLOGY AND BEACH SUBSTRATE TEMPERATURE INFLUENCES ON SEA TURTLE NESTING

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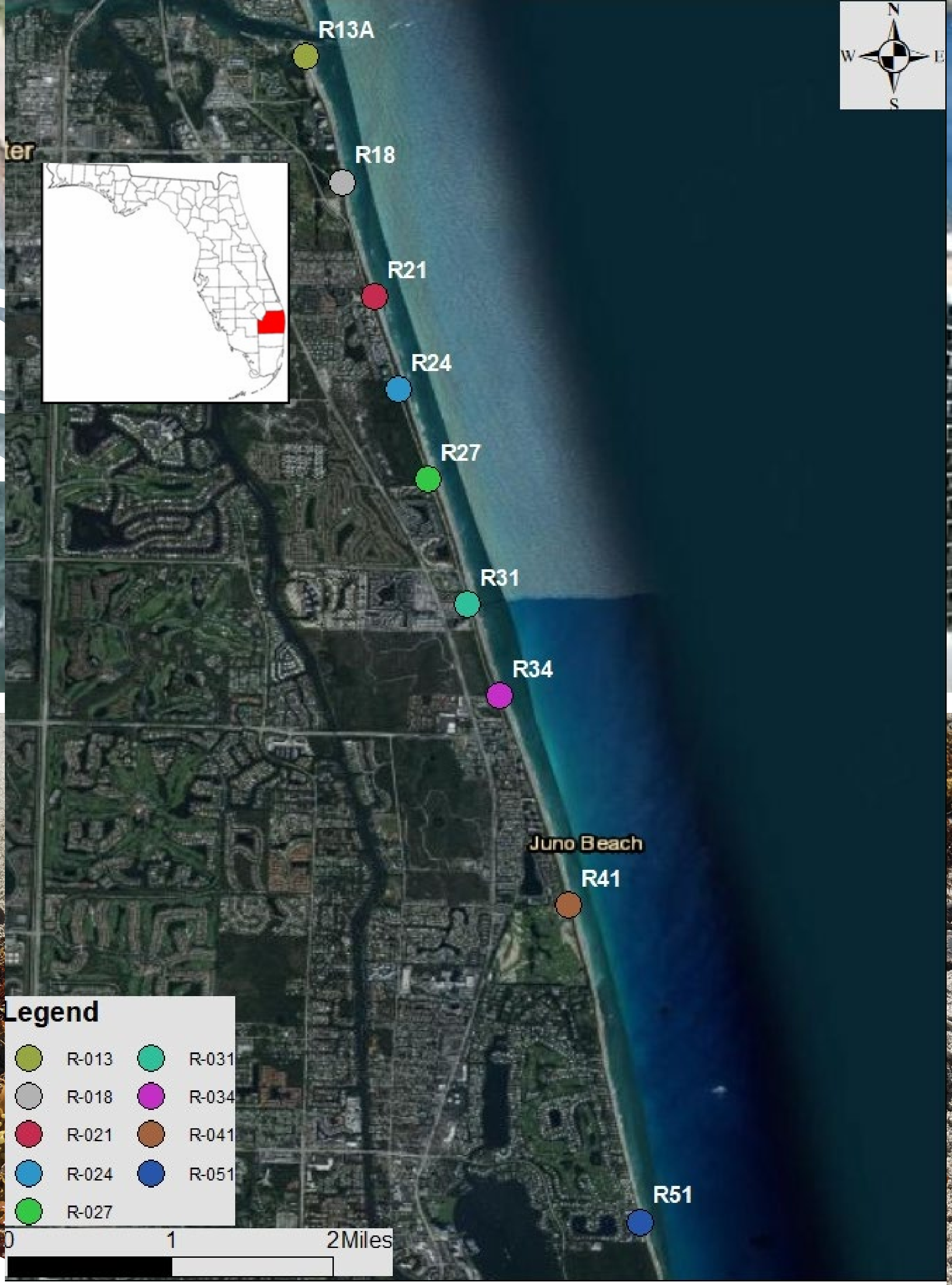
INTRODUCTION

- Florida beaches are important economic resources for tourism 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 nesting success (Cisneros et al., 2017).

Location	Borrow source (2014)
Jupiter North (R13A)	Inlet
Jupiter Mid (R 18, R27, R31, R34))	Offshore
Jupiter South (R41)	Upland mine

- 2015-2019: R13A inlet: 2017: R18-R34 offshore
- Temperatures encountered during egg incubation will determine the gender of the sea turtle (male <81°F and female >87°F) hatchlings but can also exceed a critical threshold (91°F-93°F)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.



OBJECTIVES OF THE STUDY

- **Objective 1:** The study conducts the statistical correlation comparing the sediment characteristics (grain size and sorting), carbonate content to the substrate temperature

- **Objective 2:** Correlating beach width, sediment source to the substrate temperature

- **Objective 3:** The study evaluates the statistical correlation to compare the sediment characteristics and substrate temperature to the sea turtle hatching and emergence success rate.

METHODOLOGY

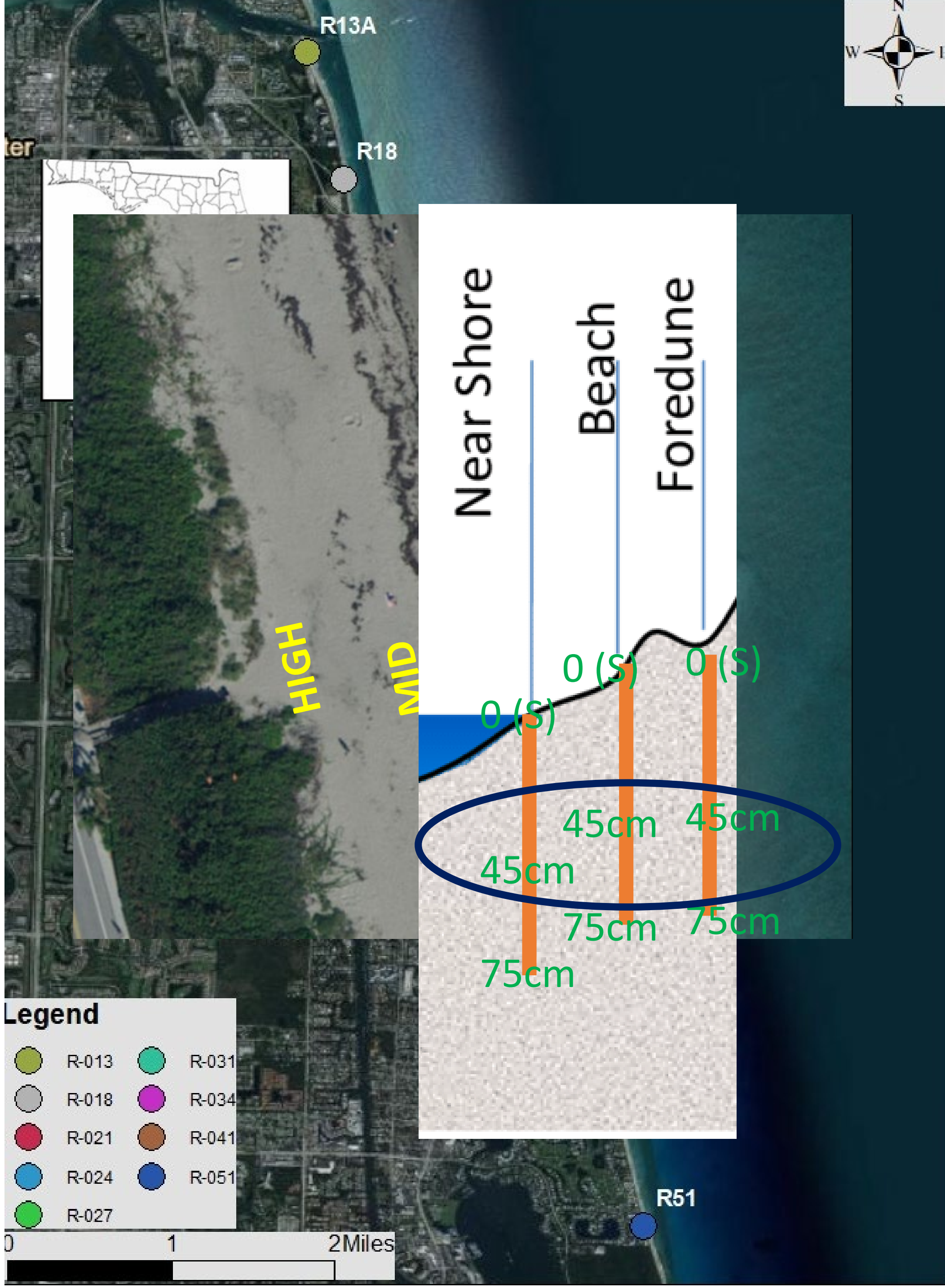
Nine sites within the study area at Jupiter Beach encompasses 4 km in northern Palm Beach County, Florida (Figure 1).

- ❑ Four subsurface samples from each location at high (H), mid (M) and low (L) beach at 45 cm and 75 cm depths of early season (April-May) mid-season (June) and late season (September) of 2019 were used and grain characteristics obtained from graphical statistical analysis.

- ❑ Sediment properties were obtained for all the samples.
  - ✓ Grain size
  - ✓ Sorting
  - ✓ Carbonate

- ❑ 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.

- ❑ Sea turtle nesting data for all the three seasons: Early (March, April, May), Mid (June 1-July 15) and Late (July 16-September) was obtained from the Palm Beach County Environment Resources Management.



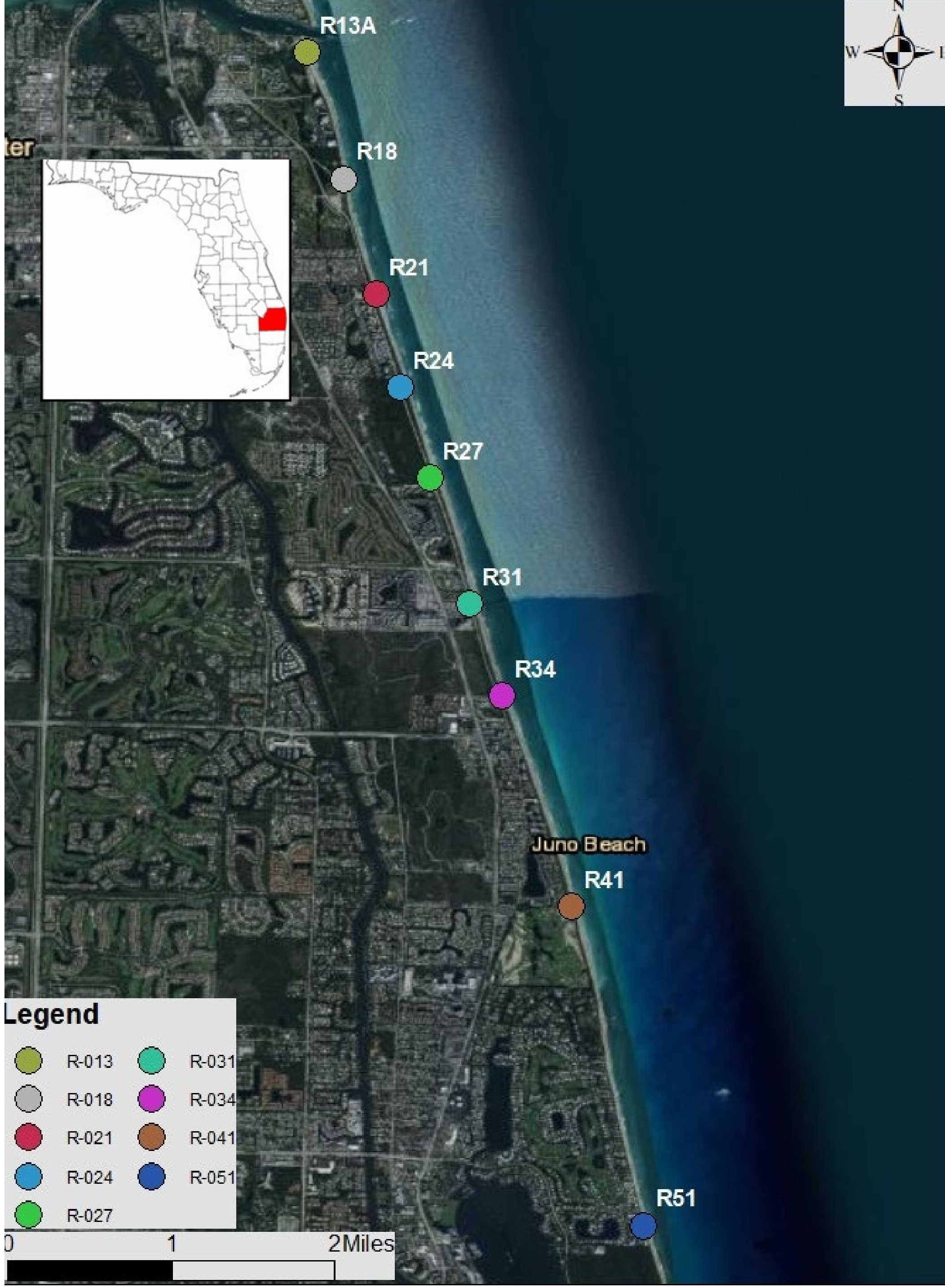
RESULTS

SUBSTRATE TEMPERATURE vs BEACH WIDTH

- The beach width has not changed much in early and mid season except for R34 and R31.
- In late season the beach width is reduced in R13A. R21, R27, R31. Whereas R18, R24, R41 and R51 have gained the beach width in late season.
- **Beach width and slope at few locations of high beach and mid beach showing positive correlation (0.60-0.63) with temperature.**

Table 1: Beach width in each location.

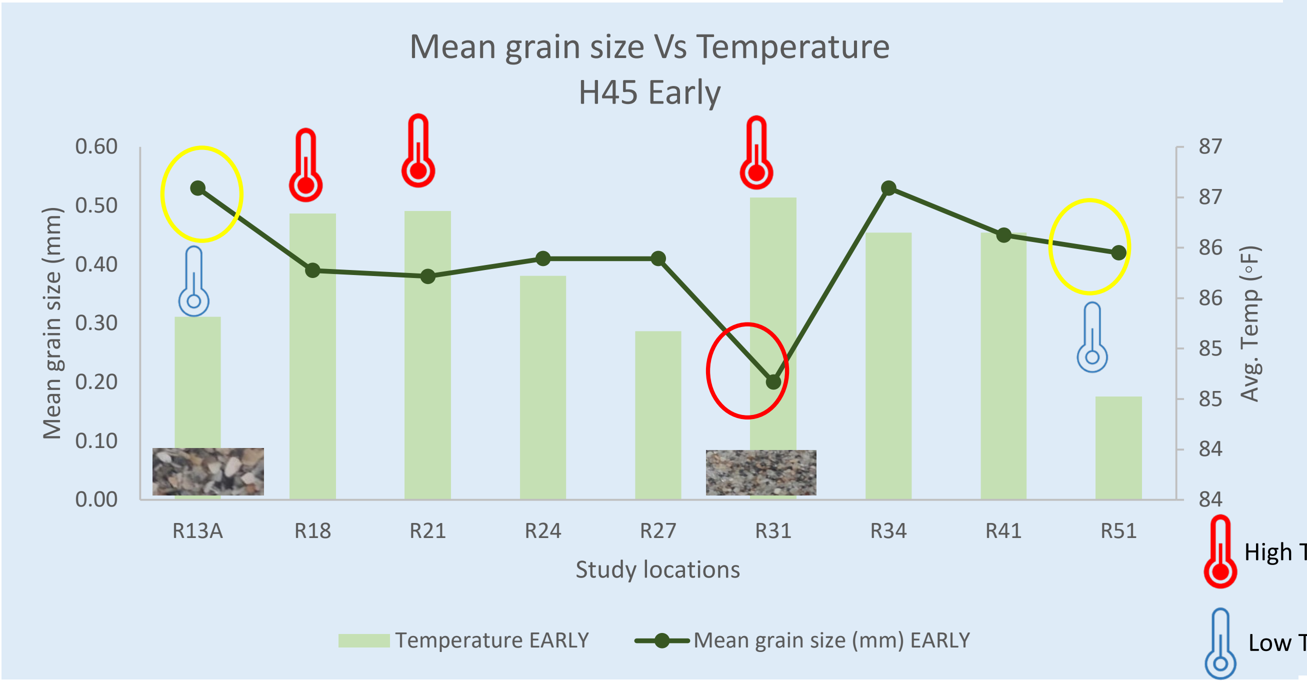
Site	Beach width (m)		
	Early	Mid	Late
R13A	46	49	27
R18	28	28	43
R21	31	27	26
R24	23	18	32
R27	39	39	25
R31	45	39	35
R34	27	35	31
R41	32	38	45
R51	24	30	31

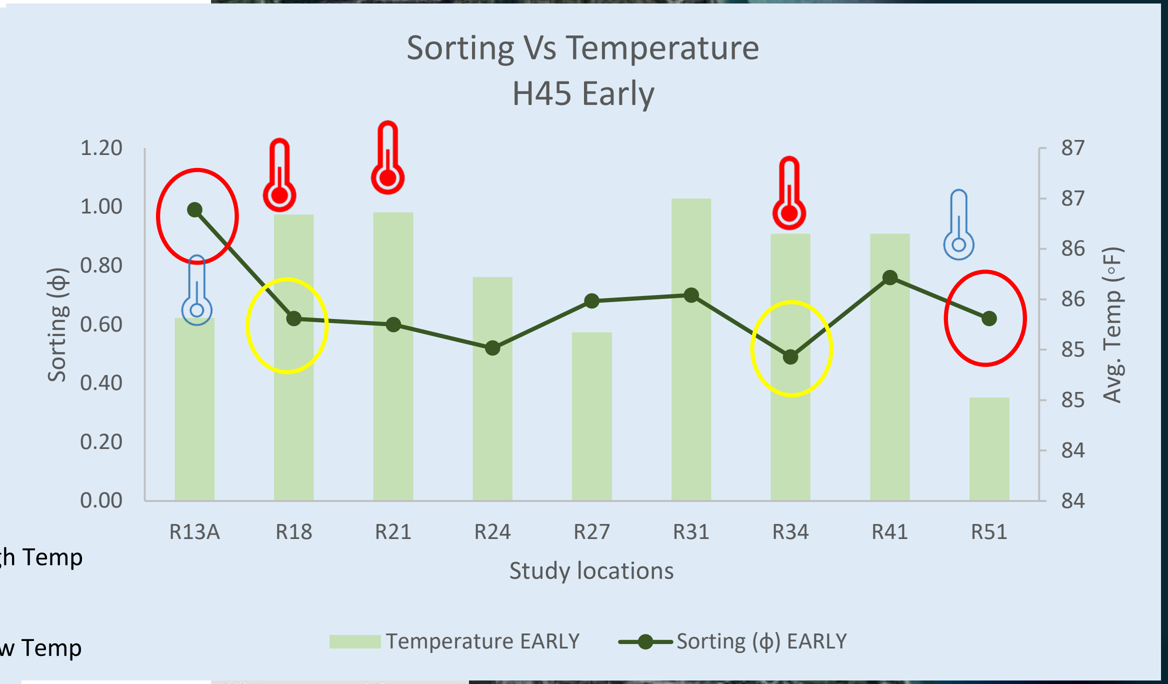


RESULTS (CONT.)

Substrate Grain Size and Sorting vs Substrate Temperature at H45 (early season)

- The temperature and sediment grain size showing poor correlation (<0.5) in all seasons.
- Most of the locations Temperature is showing negative correlation with the sediment grain size. **(coarser grain size-low avg temp, fine grain size-high avg tempt)**
- In most of the locations (12 out of 18) and in all season sorting is showing negative correlation with the temperature**. (poorly sorted-low avg temp well sorted sediments-high avg temp)**





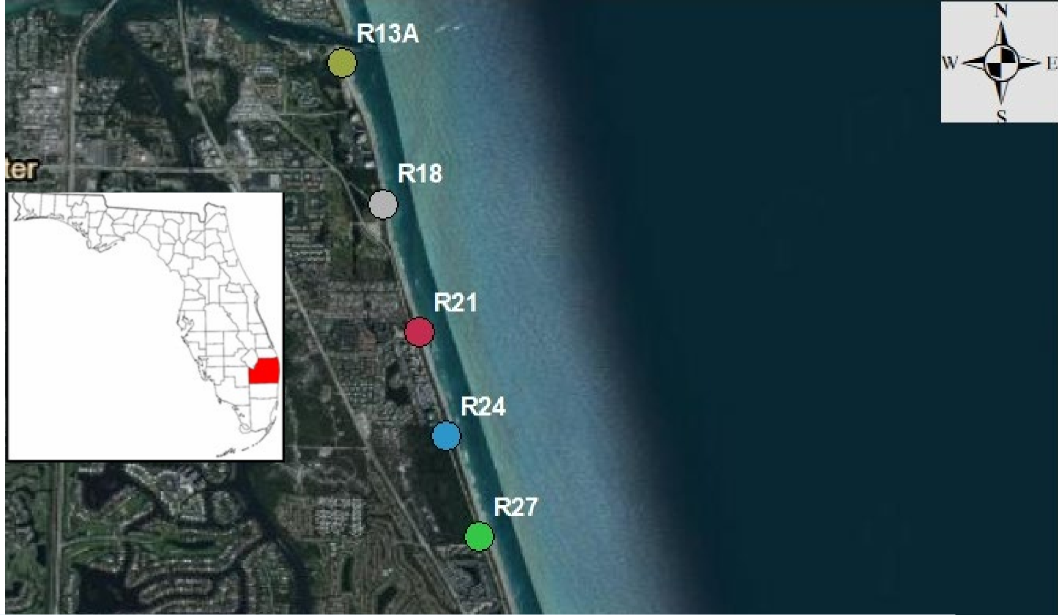


Figure 2: Sediment characteristics vs temperature plots for early season of High 45.

RESULTS (CONT.)

Substrate Carbonate content vs Substrate Temperature at H45 (Early season)

- The temperature and carbonate content showing poor correlation (<0.5) in most of the locations and in all seasons.

- In most of the locations (11 out of 18) carbonate percentage is showing negative correlation with the temperature**. (high carbonate %-low avg temp, low carbonate %-high avg temp)**

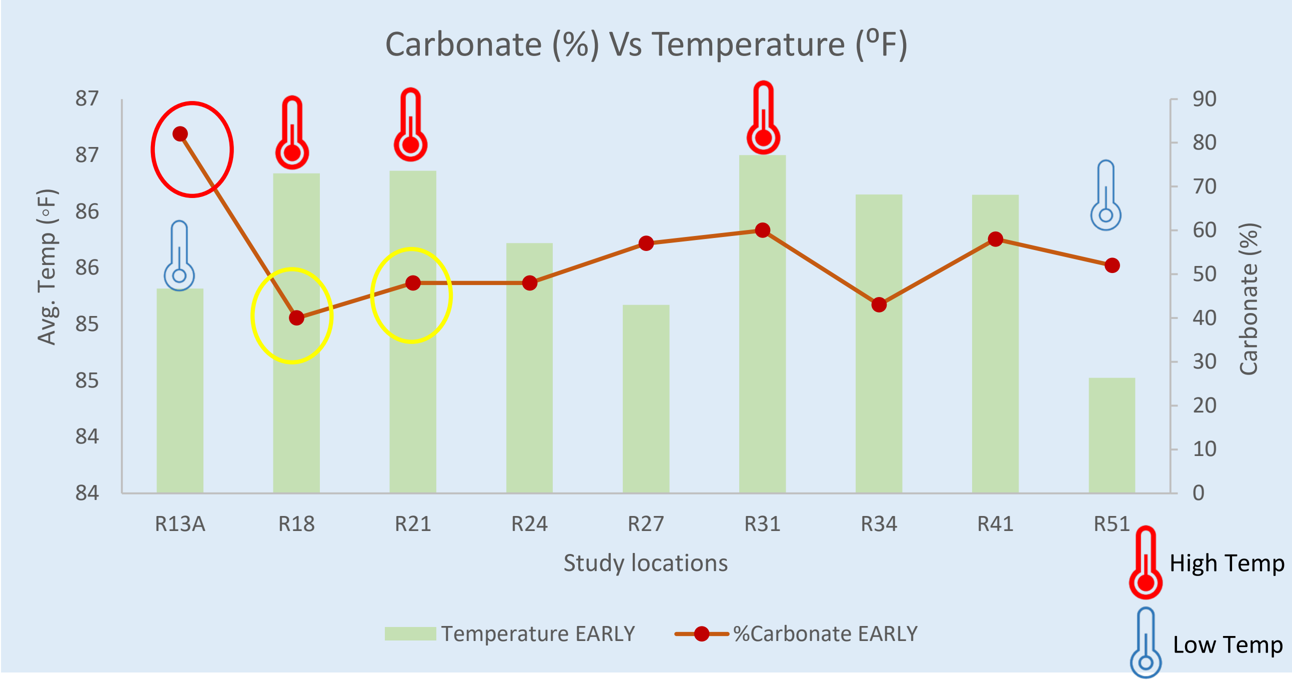
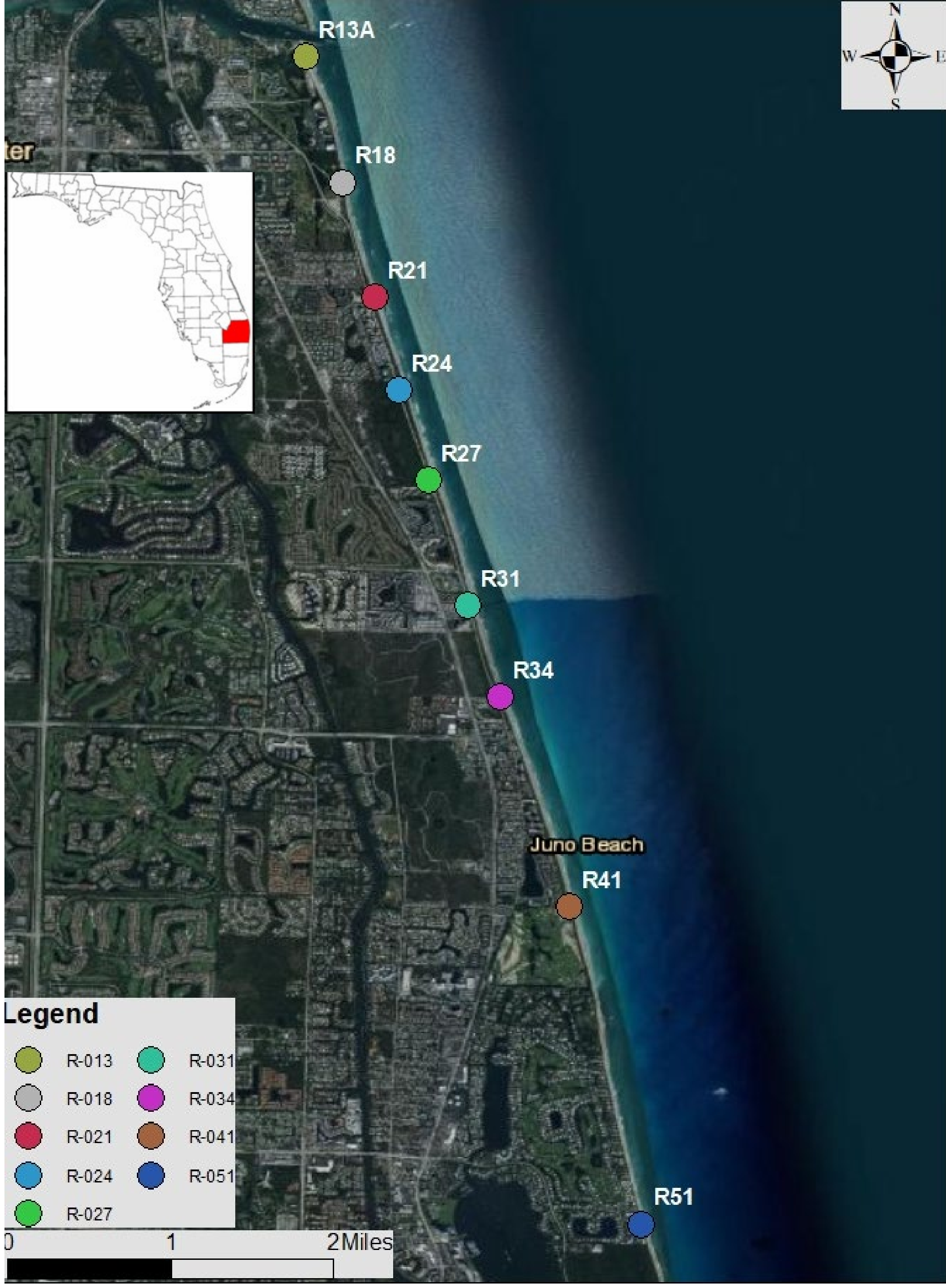


Figure 3: Carbonate % vs temperature plots for early season of High 45.



RESULTS (CONT.)

Reflectance vs Temperature

- The reflectance shows negative correlation with the temperature. (**High reflectance: low avg temp, low reflectance: high avg temp**).

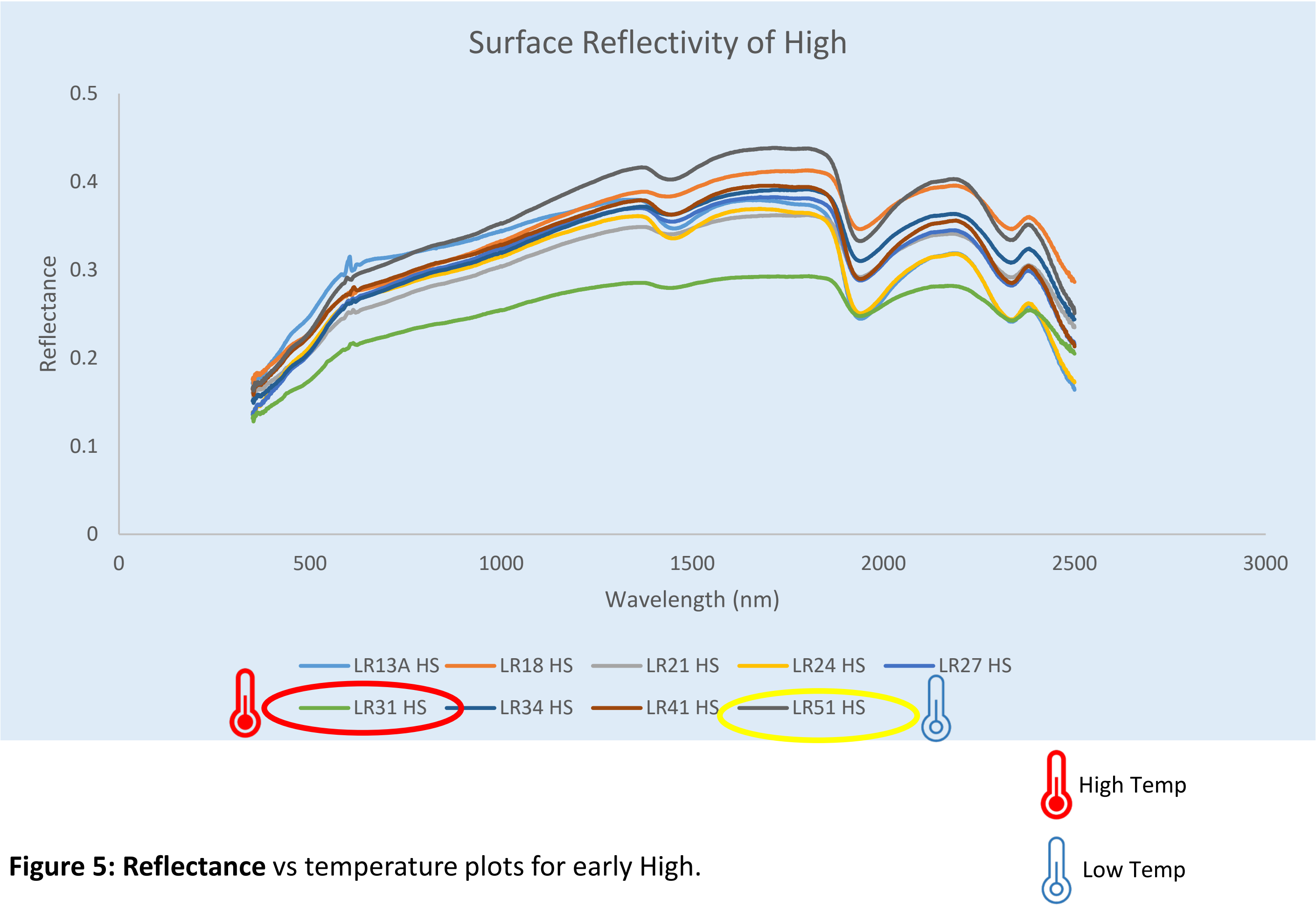
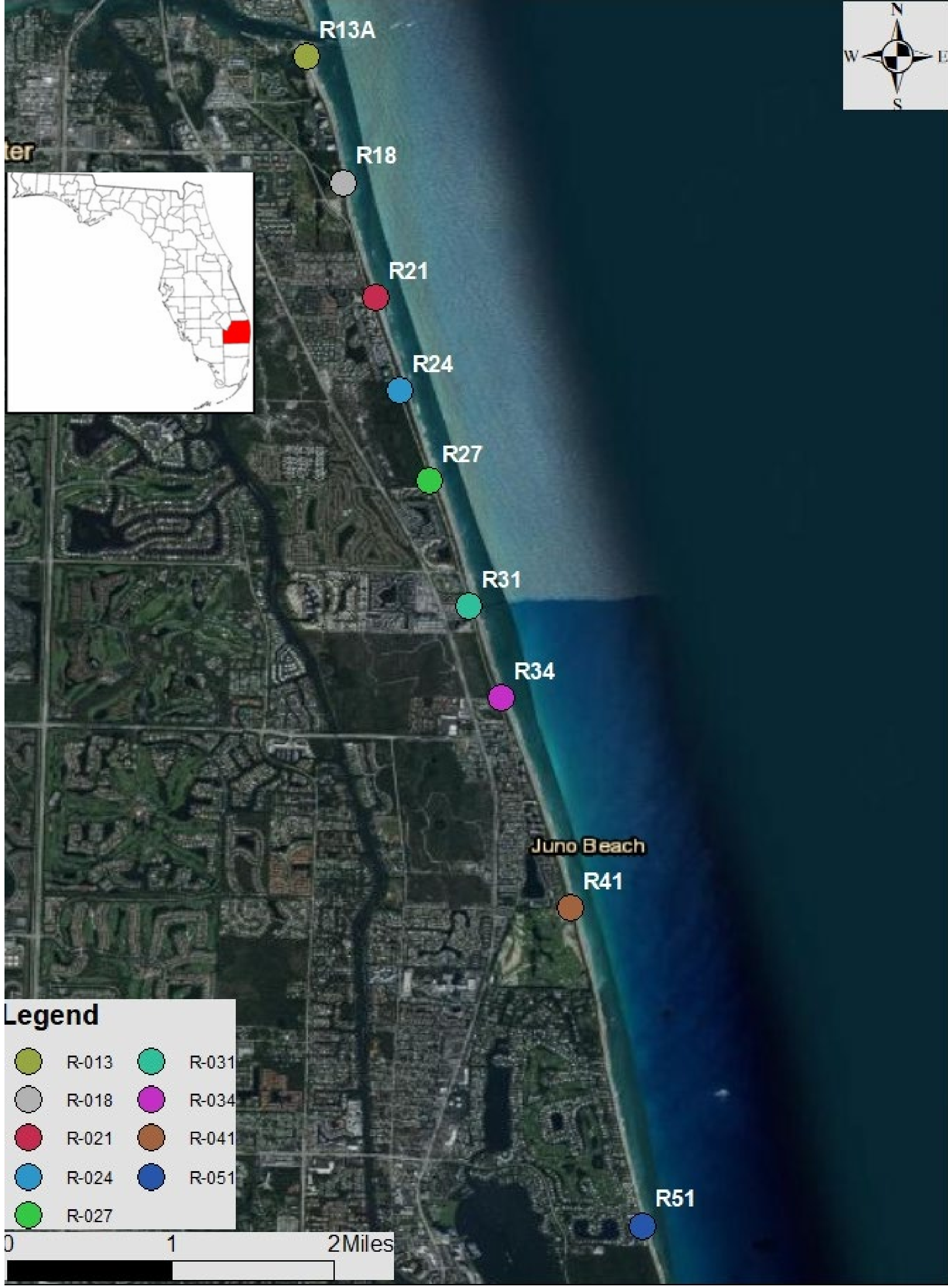


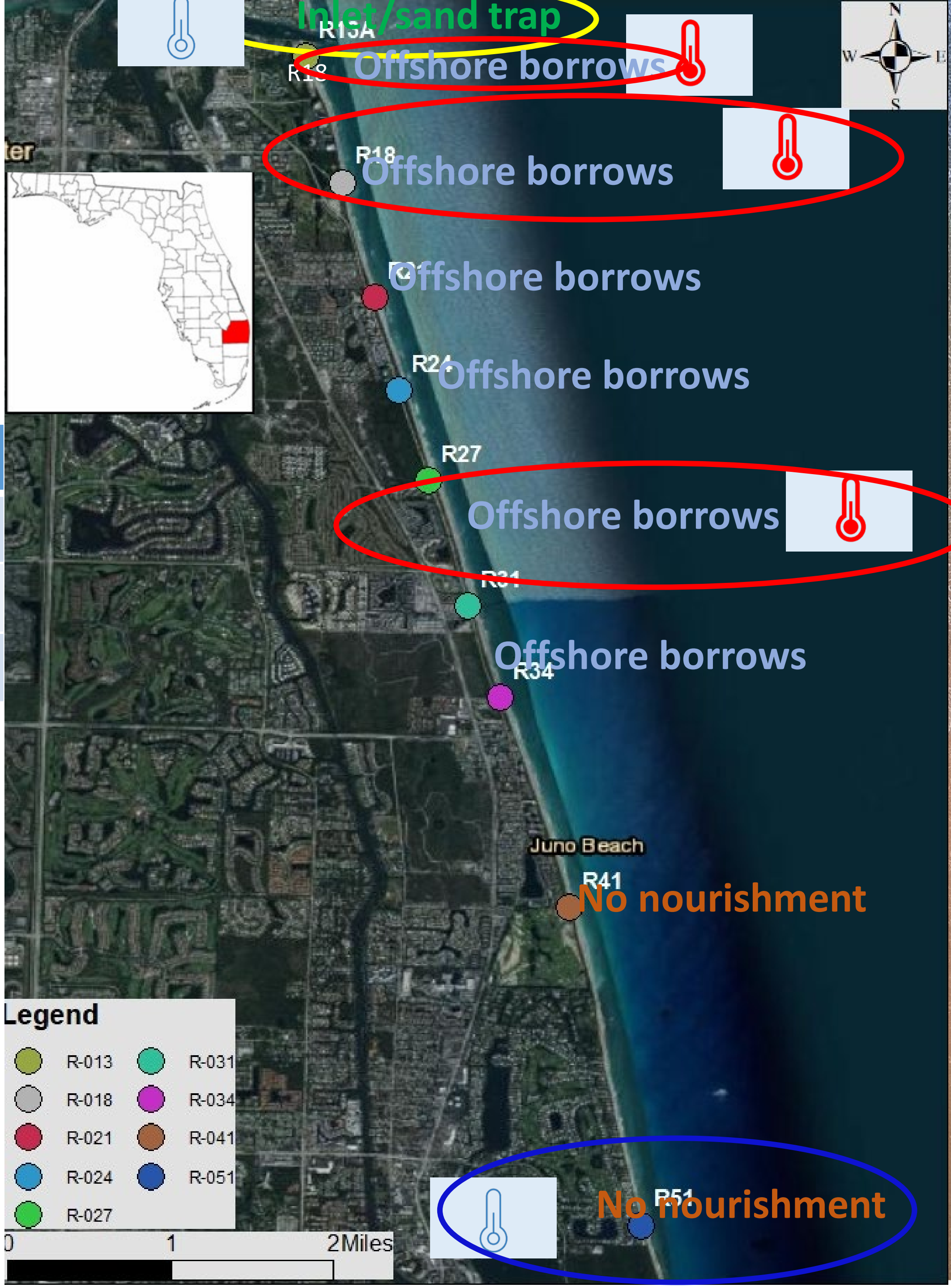
Figure 5: Reflectance vs temperature plots for early High.



RESULTS (CONT.)

Sediment Source vs Temperature

Sand Source	Locations
Jupiter Inlet/Sand trap	R13
Offshore borrow	R18, R21, R24, R27, R31, R34
No nourishment	R41, R51



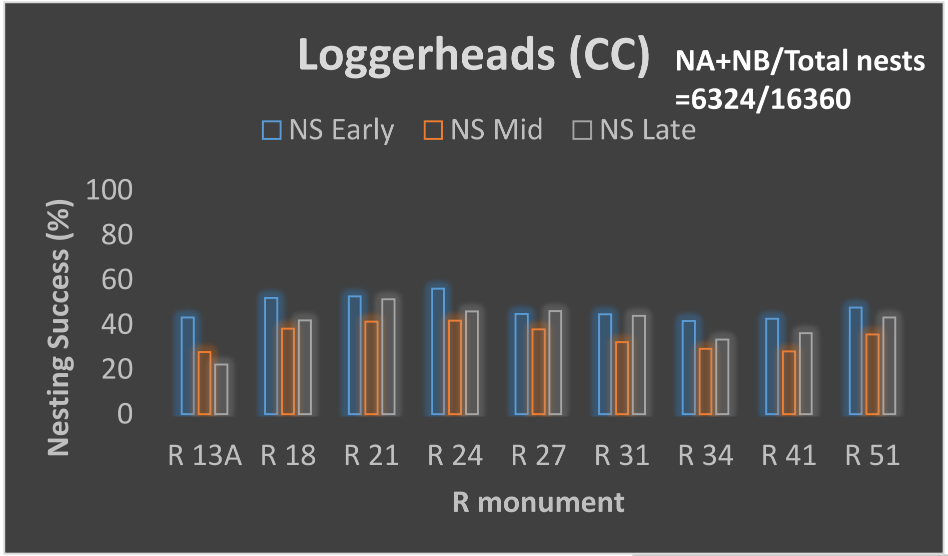
RESULTS (CONT.)

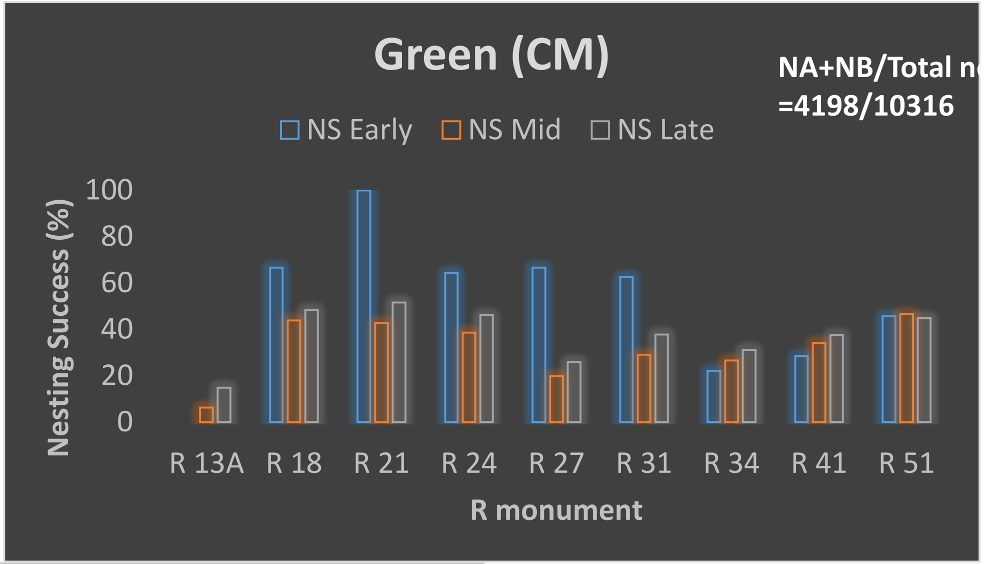
Summary of sedimentology influence on the beach substrate temperature

- Higher Beach width higher temperatures (positive correlation) in most of the locations.
- Coarser, poorly sorted and high carbonate content of sediments attributing the low temperatures.
- Surface sediment properties and reflectance also have a negative correlation with temperature.
- Offshore borrow sediment sources have high temperatures and inlet dredged sediments and non-nourished beaches have low temperatures.
- Both the surface and substrate sediment characteristics showing overall negative correlation with temperature.

RESULTS (CONT.)

Nesting Success of three different species





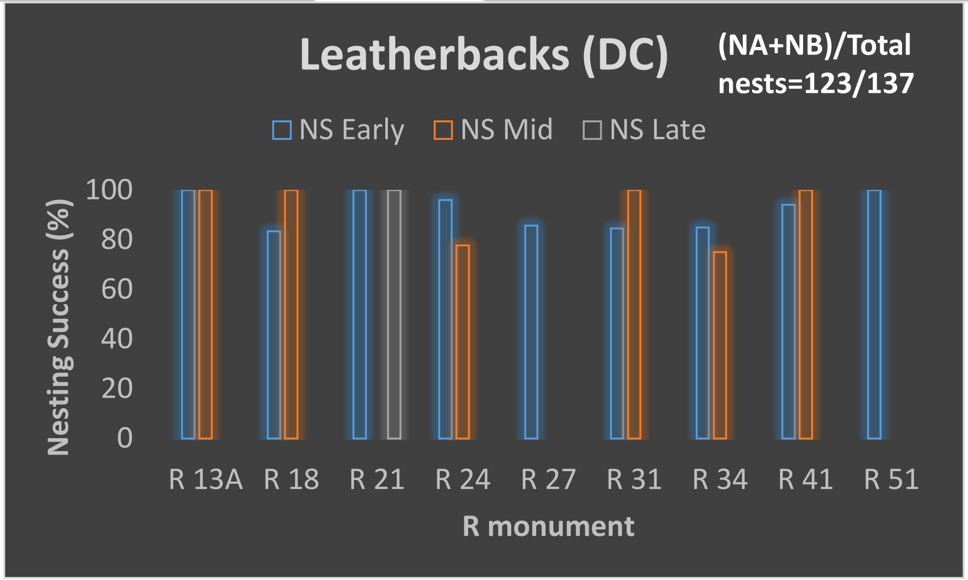


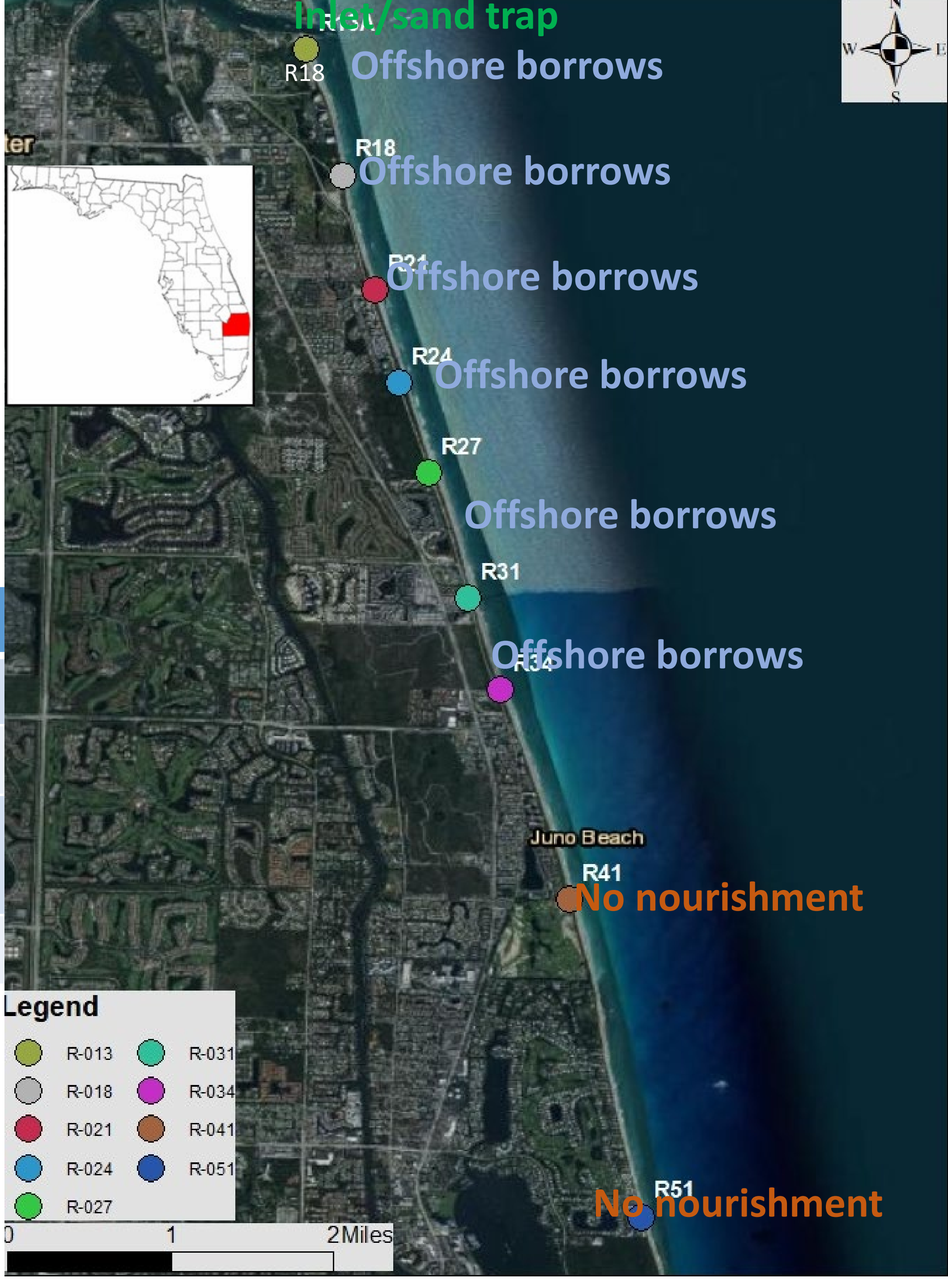
Figure 6: Nesting success of three different species along the study area.

RESULTS (CONT.)

Nesting Success vs Different beach characteristics

Species	Beach width (m)		
	Early	Mid	Late
CC	~Negative	Negative	No
CM	No	Negative	No
DC	No	No	No

Sand Source	Locations	Nesting success		
		CC	CM	DC
Jupiter Inlet/Sand trap	R13	31	10	100
Offshore borrow	R18, R21, R24,R27, R31, R34	43	46	82
No nourishment	R41, R51	39	39	98



RESULTS (CONT.)

Nests distribution of Loggerheads, Green seas and Leatherbacks for three seasons

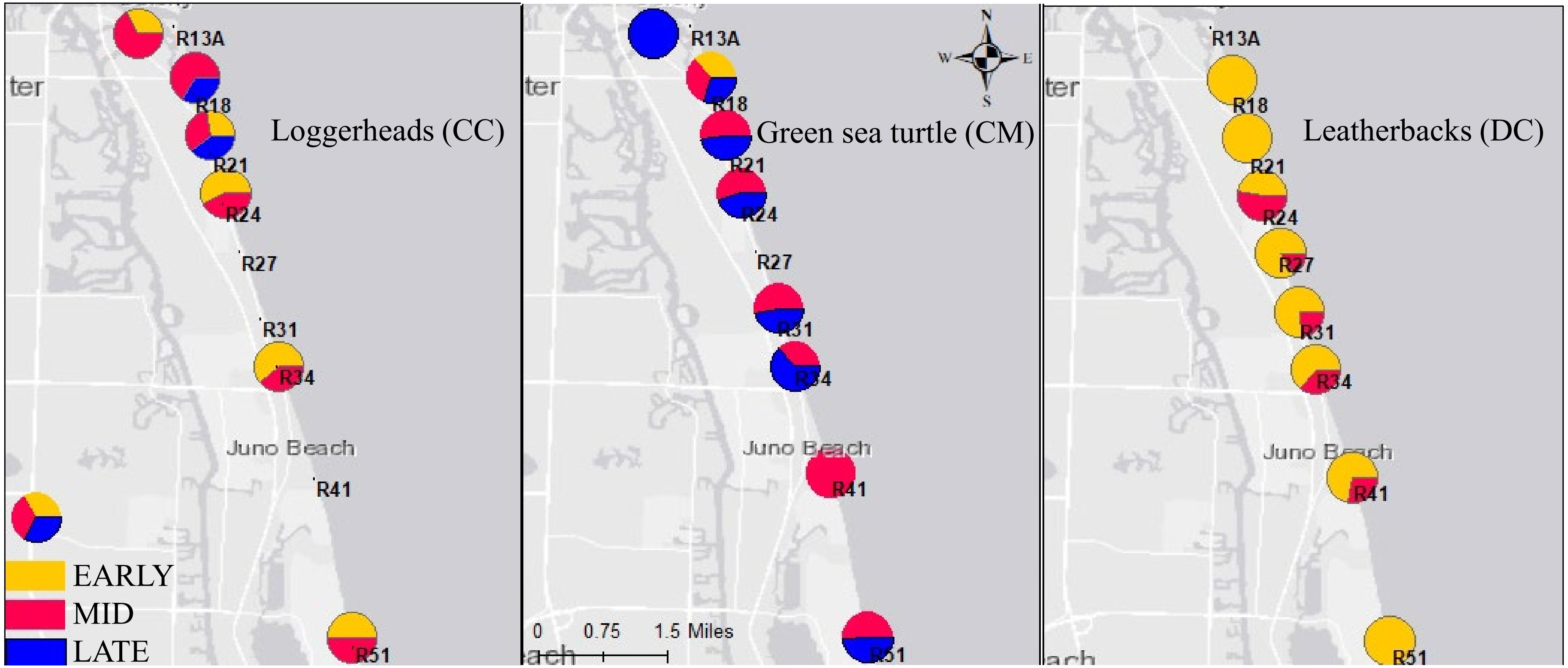
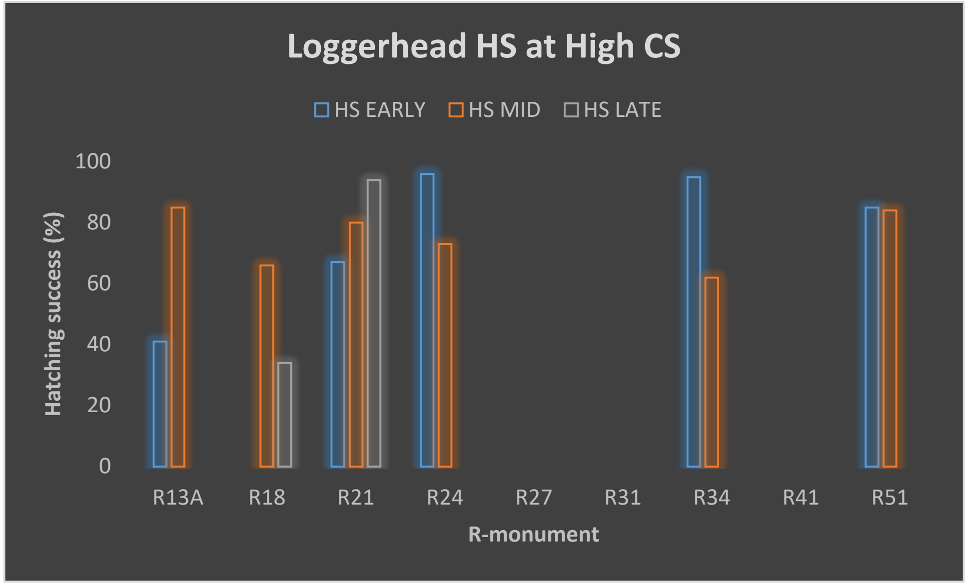


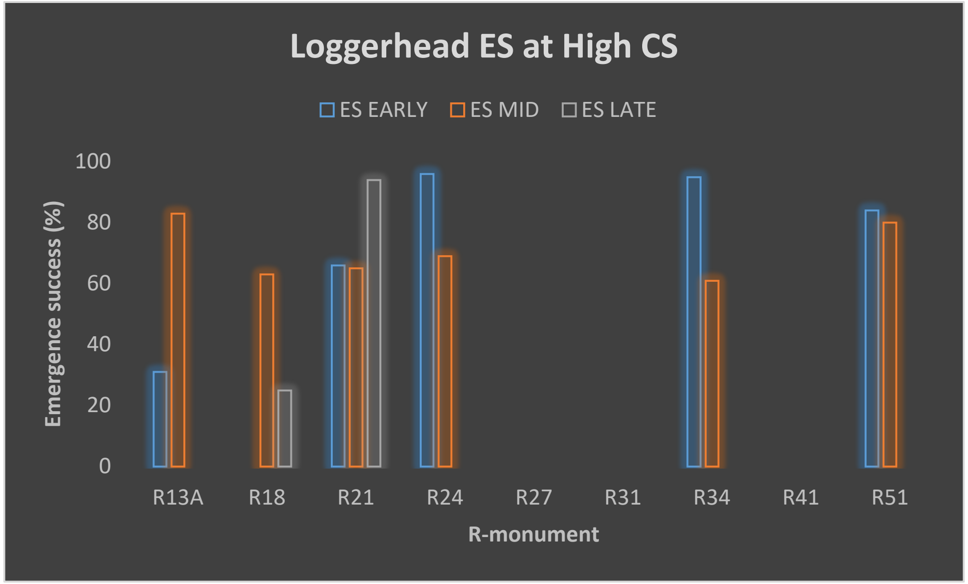
Figure 7: CC have high distribution in Early and mid seasons; CM have high HS and ES in Mid and Late seasons at high CS; and DC high hatching success in Early season.

RESULTS (CONT.)

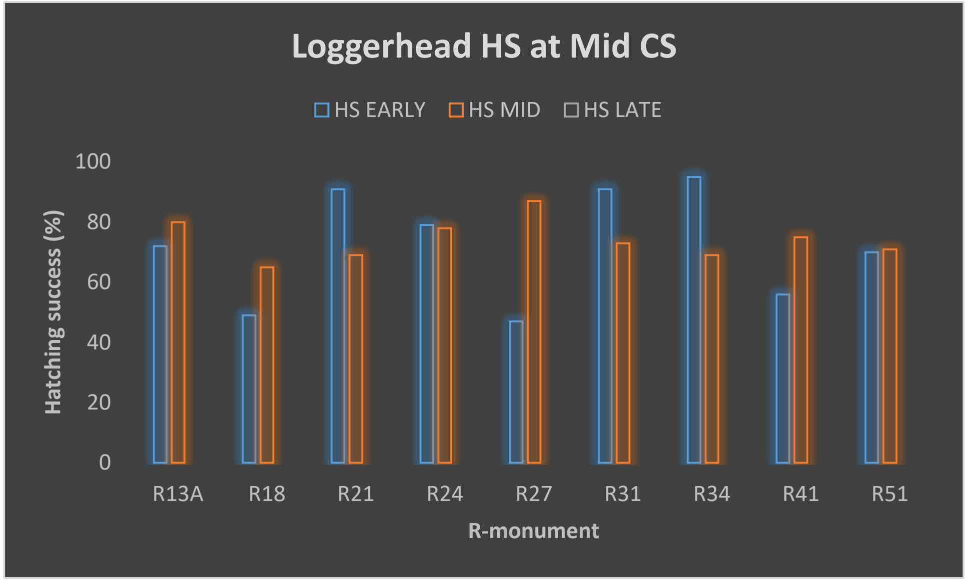
Hatching and Emergence success percentages for Loggerheads at High and Mid cross shore.

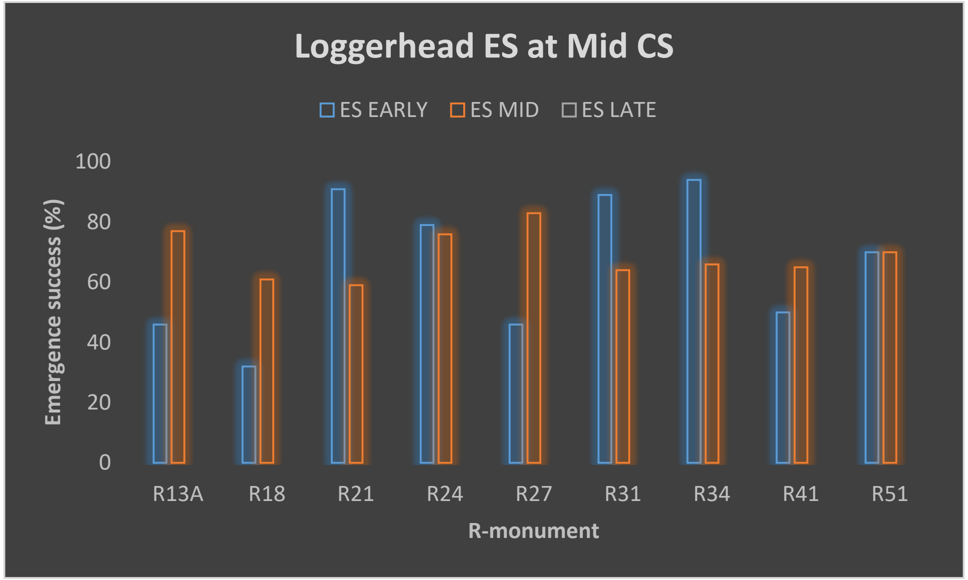
High HS & ES:
R24, R34,
R51, R21





High HS & ES:
R21, R31, R34
R24, R13A

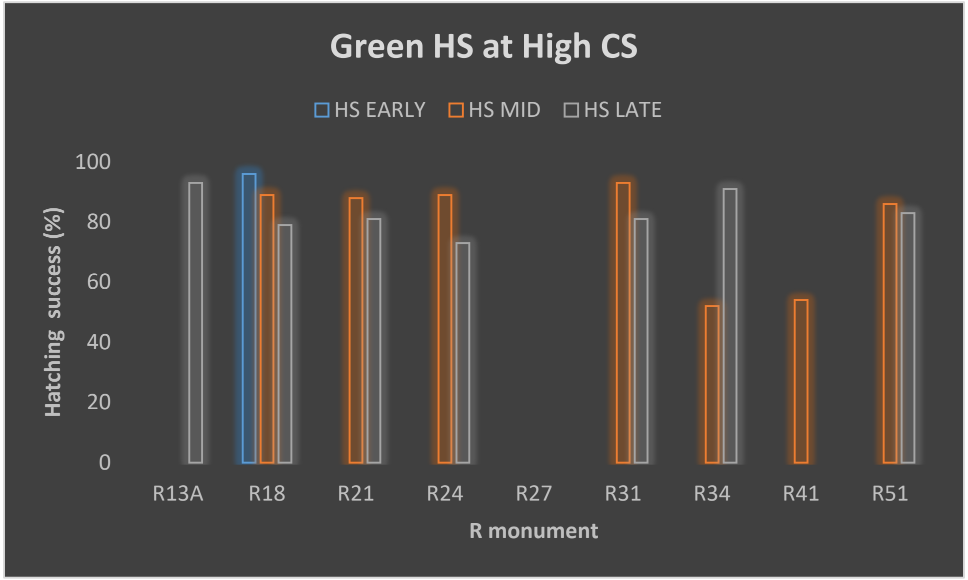


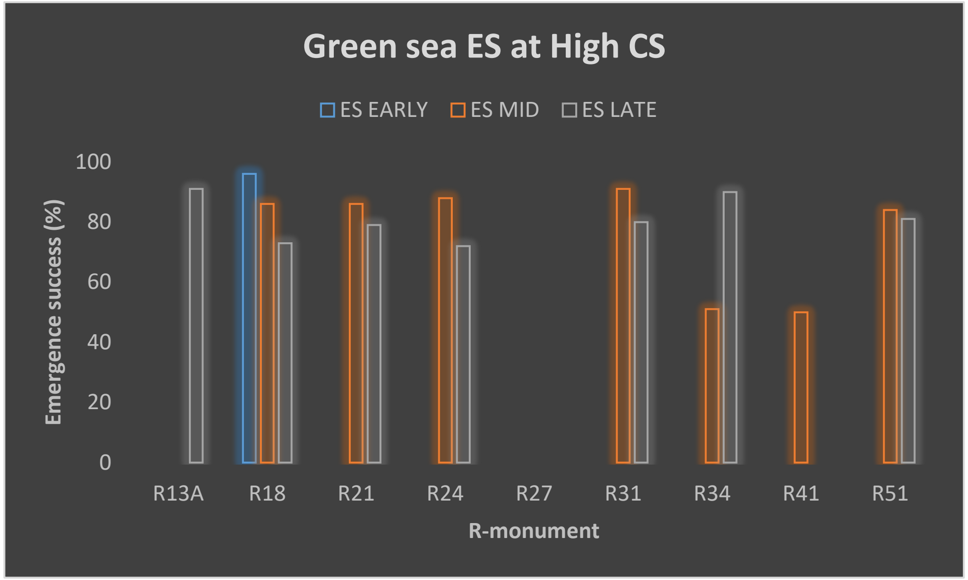


RESULTS (CONT.)

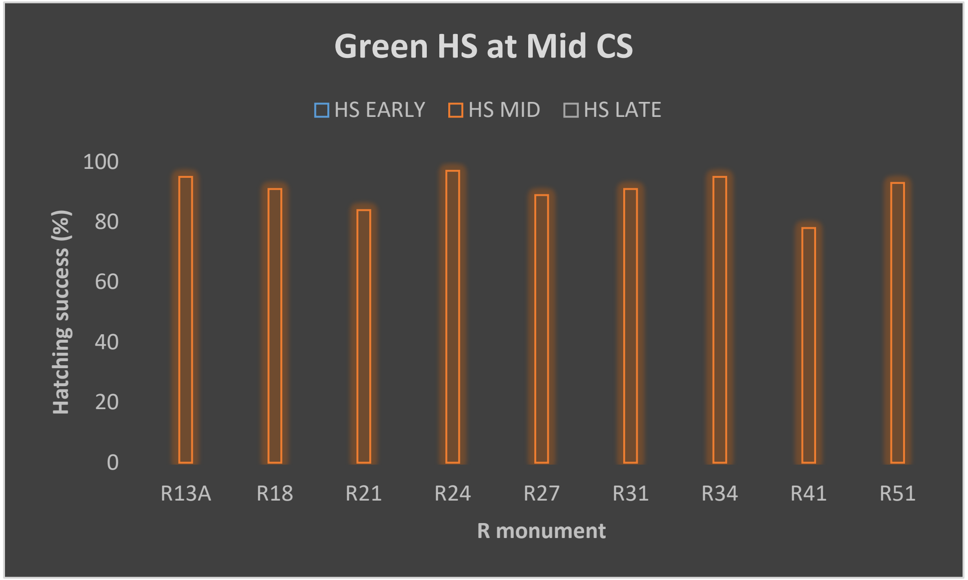
Hatching and Emergence success percentages for Greens at High and Mid cross shore.

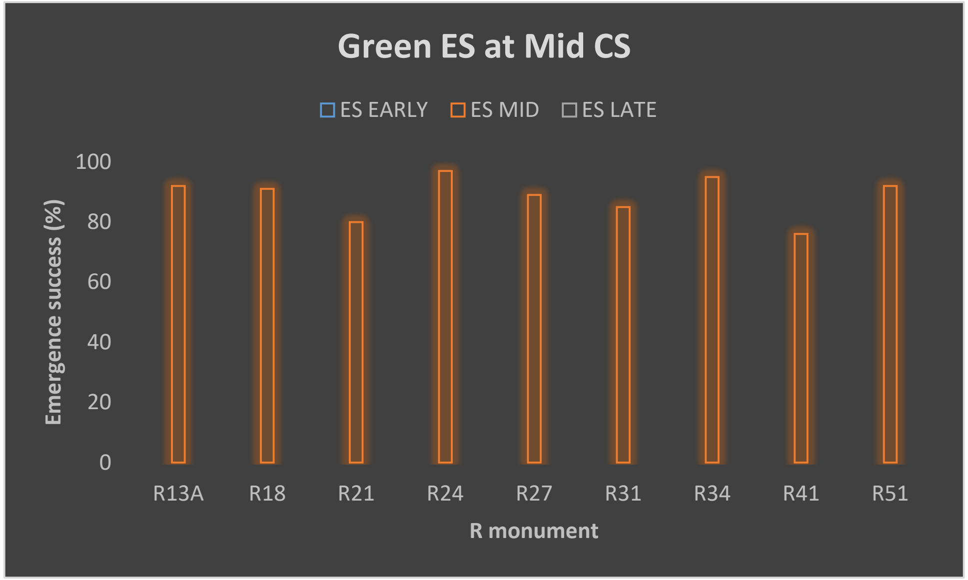
High HS & ES: R18, R24 and R31





High HS & ES: R13A, R24 and R34 and R31

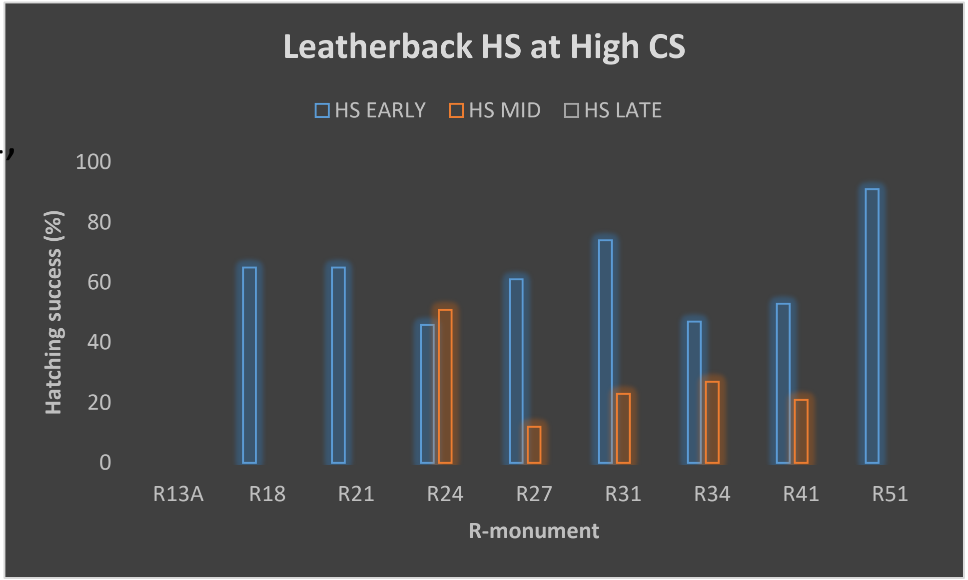


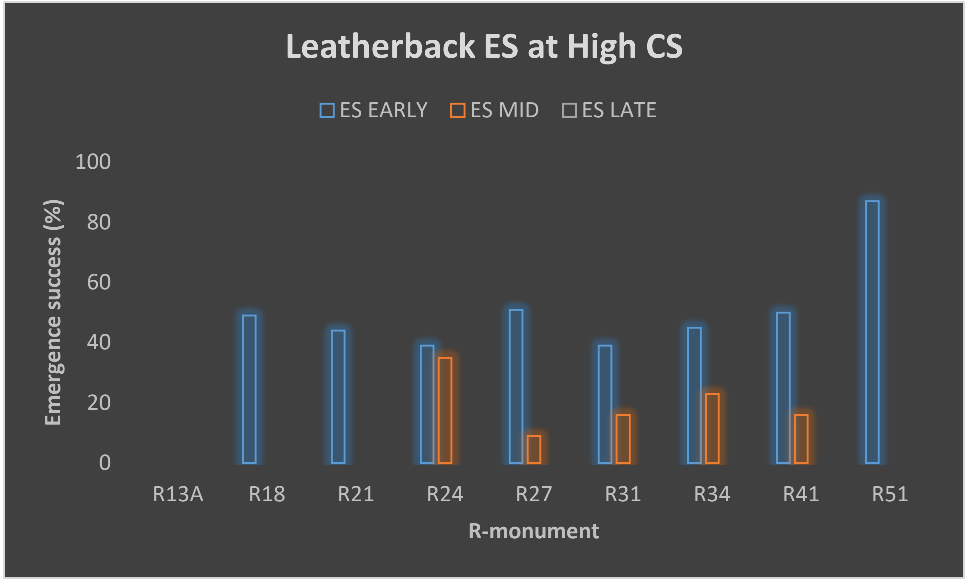


RESULTS (CONT.)

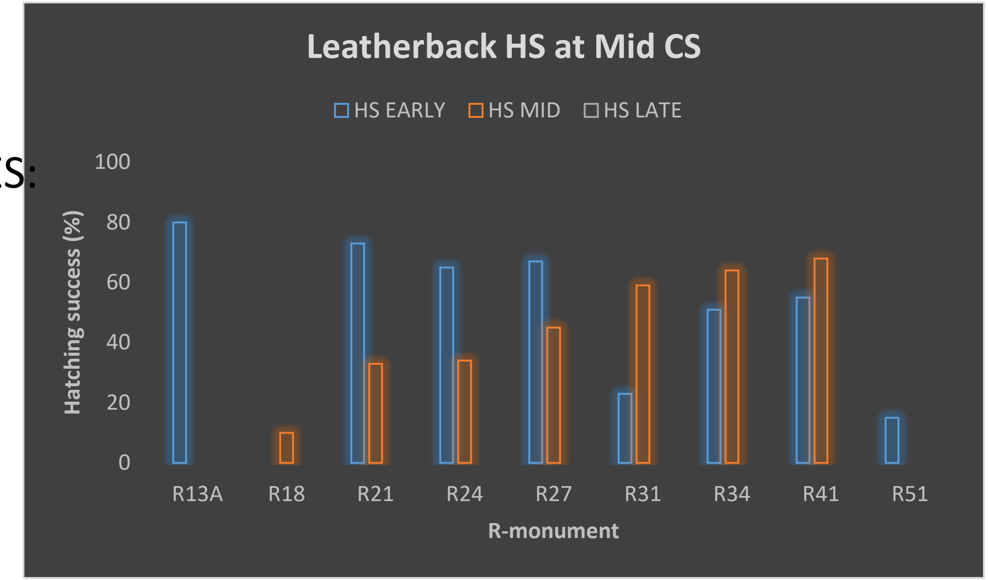
Hatching and Emergence success percentages for Leatherbacks at High and Mid cross shore.

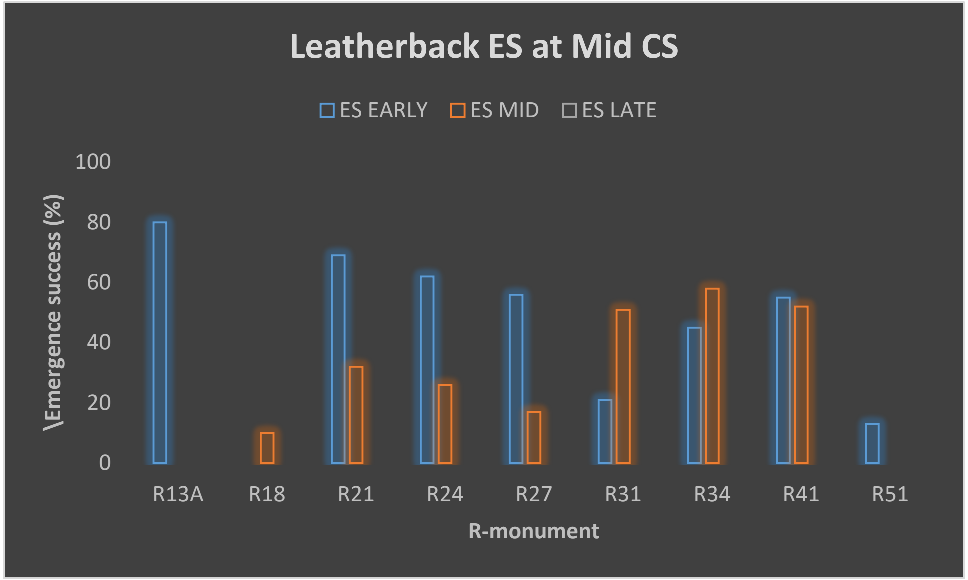
High HS: R51, R31, R18
High ES: R51





High HS & ES: R13A, R21, R24, R27

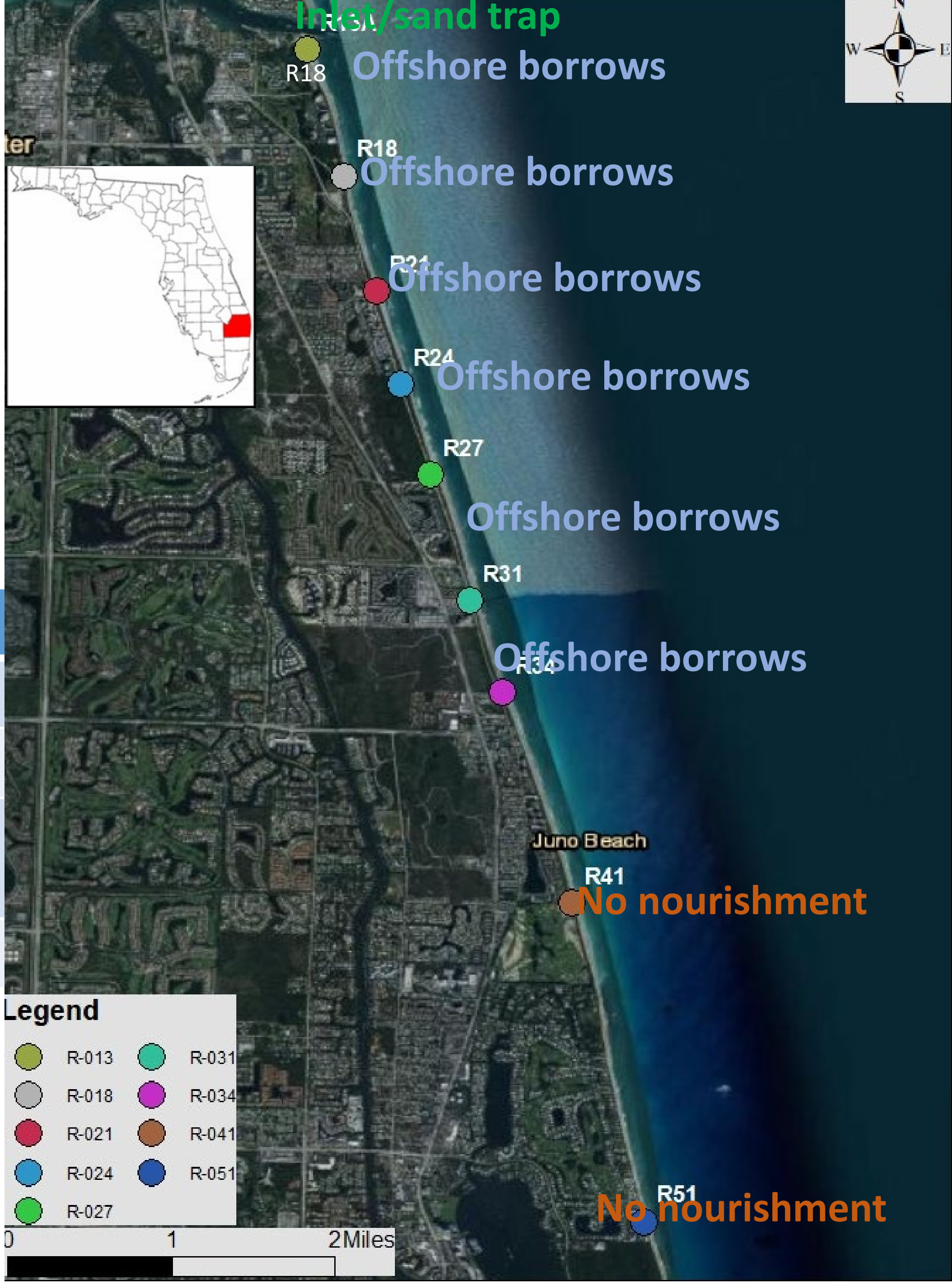




RESULTS (CONT.)

Hatching Success and Emergence success vs Different borrow sources

Sand Source	Locations	Hatching success		
		CC	CM	DC
Jupiter Inlet/Sand trap	R13	69	94	80
Offshore borrow	R18, R21, R24,R27, R31, R34	74	85	47
No nourishment	R41, R51	73	79	50



RESULTS (CONT.)

Hatching and Emergence success vs grain size (mm) and sorting (φ)
1. Loggerheads

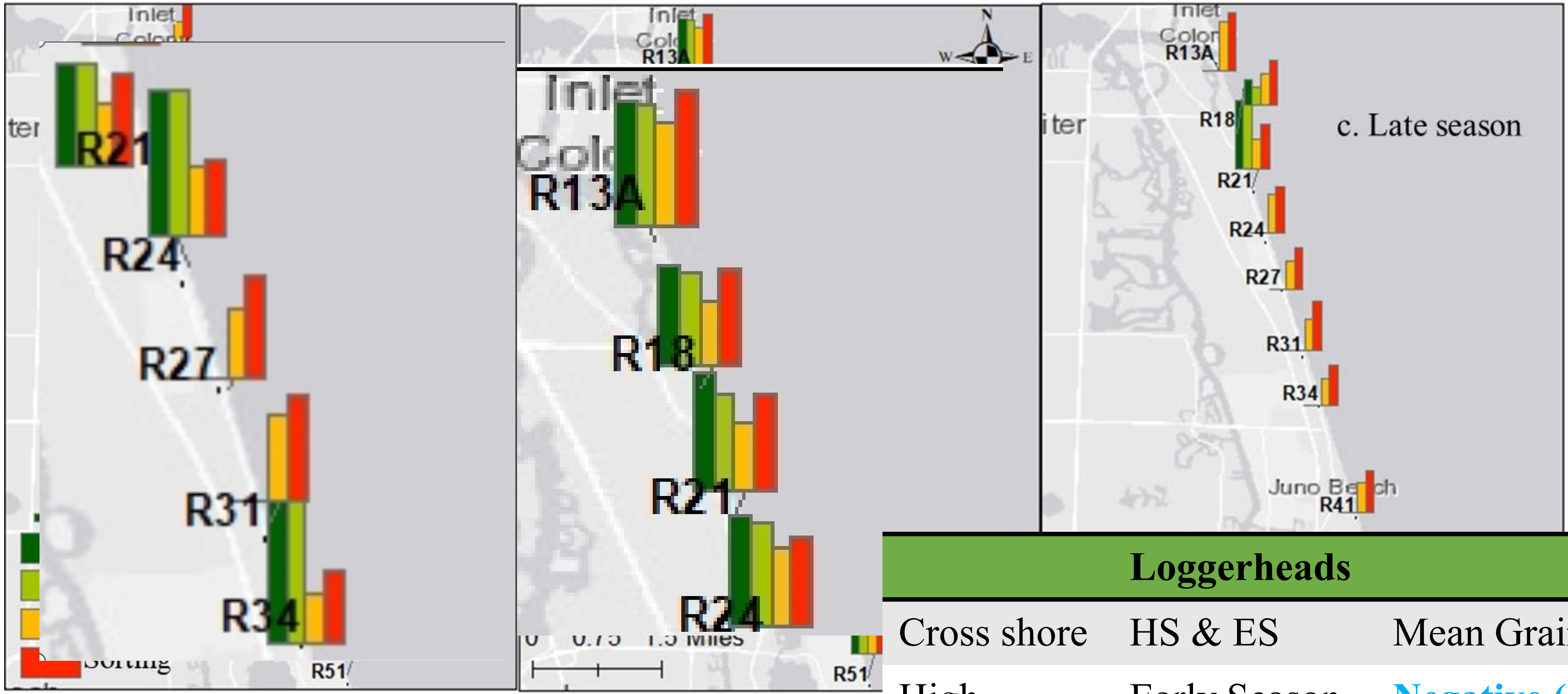


Figure 9: Hatching and Emergence success vs mean grain size (mm) and sorting (ϕ) of Loggerheads (CC)

	Loggerheads	**Correlation**	
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)
High	Early Season	**Negative (-0.8)**	**Negative (-0.9)**
	Mid season	**Positive (0.8)**	**Positive (0.8)**
	Late season	No	No
Mid	In all seasons	No	No
Low	Mid season	**Negative (-0.8)**	**Negative (-0.9)**

Hatching and Emergent success vs grain size (mm) and sorting (φ)
2. Green sea turtle

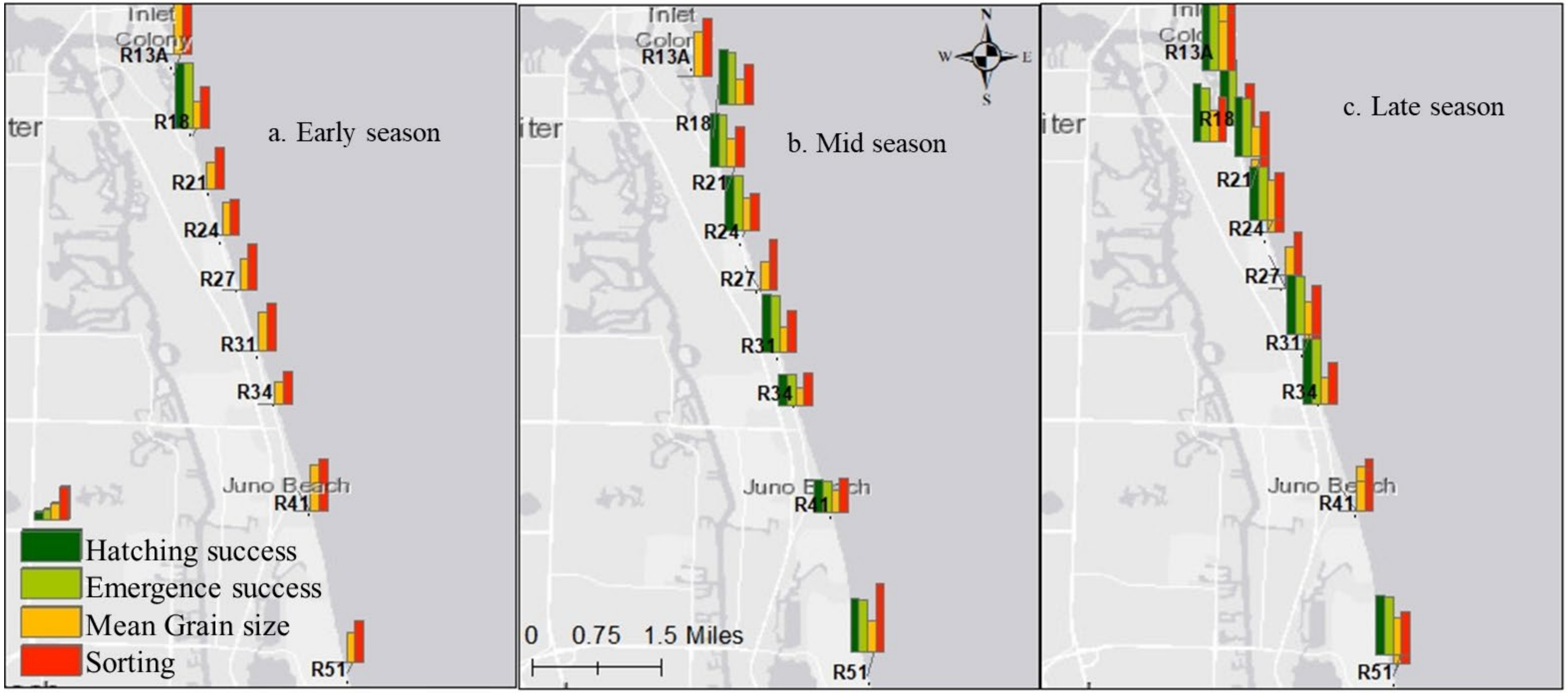


Figure 10: Hatching and Emergence success vs mean grain size (mm) and sorting (ϕ) of Green turtle (CM)

	Green turtle	Correlation	
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)
High	Early Season	No	No
	Mid season	**Positive (0.8)**	No
	Late season	No	No
Mid	HS & ES	No	No

RESULTS (CONT.)

Hatching and Emergent success vs grain size (mm) and sorting (φ)
3. Leatherbacks

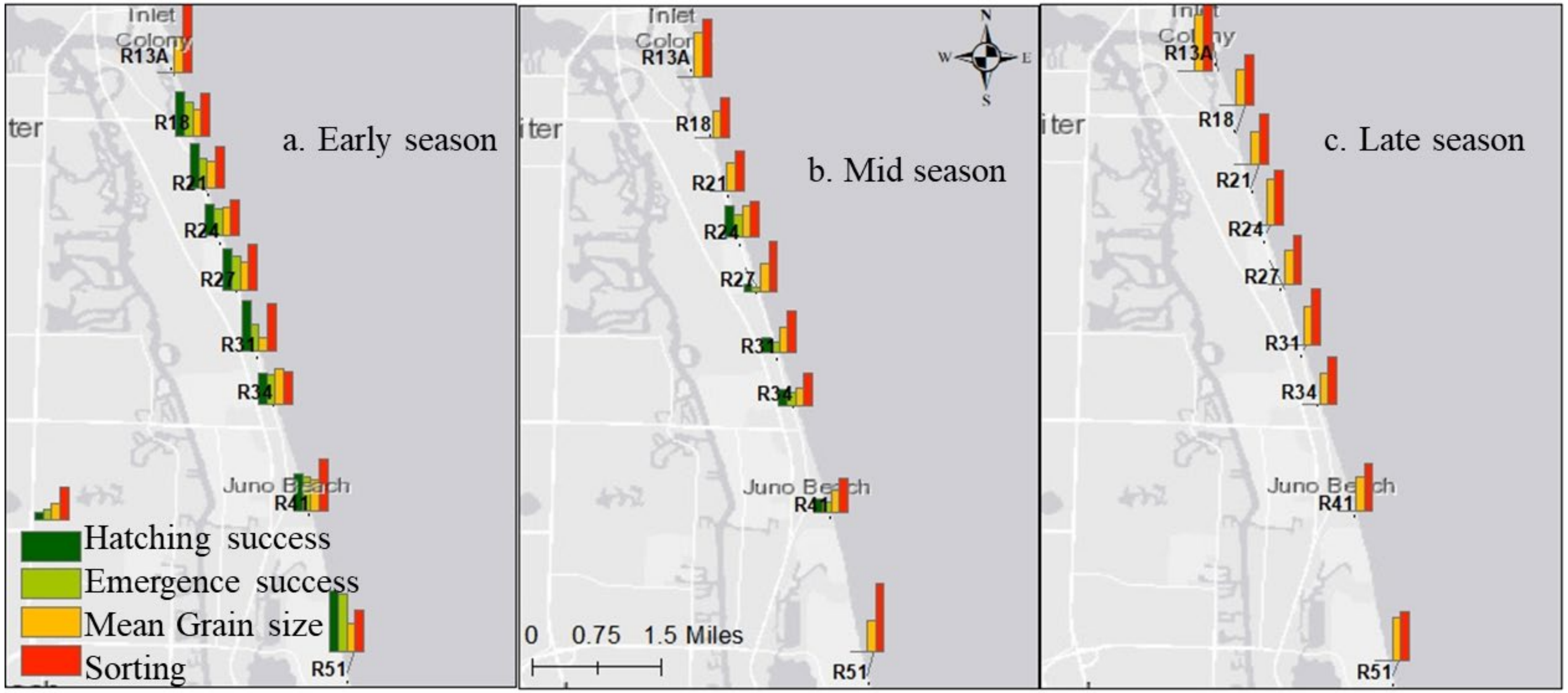


Figure 11: Hatching and Emergence success vs mean grain size (mm) and sorting (ϕ) of Leatherback (DC)

	Leatherback	Correlation	
Cross shore	HS & ES	Mean Grain size(mm)	Sorting (ϕ)
High	Early Season	No	No
	Mid season	No	**~Negative**
	Late season	No	No
Mid	HS & ES	No	No

RESULTS (CONT.)

Hatching and Emergent success vs temperature (°F) and carbonate (%) at high in mid season

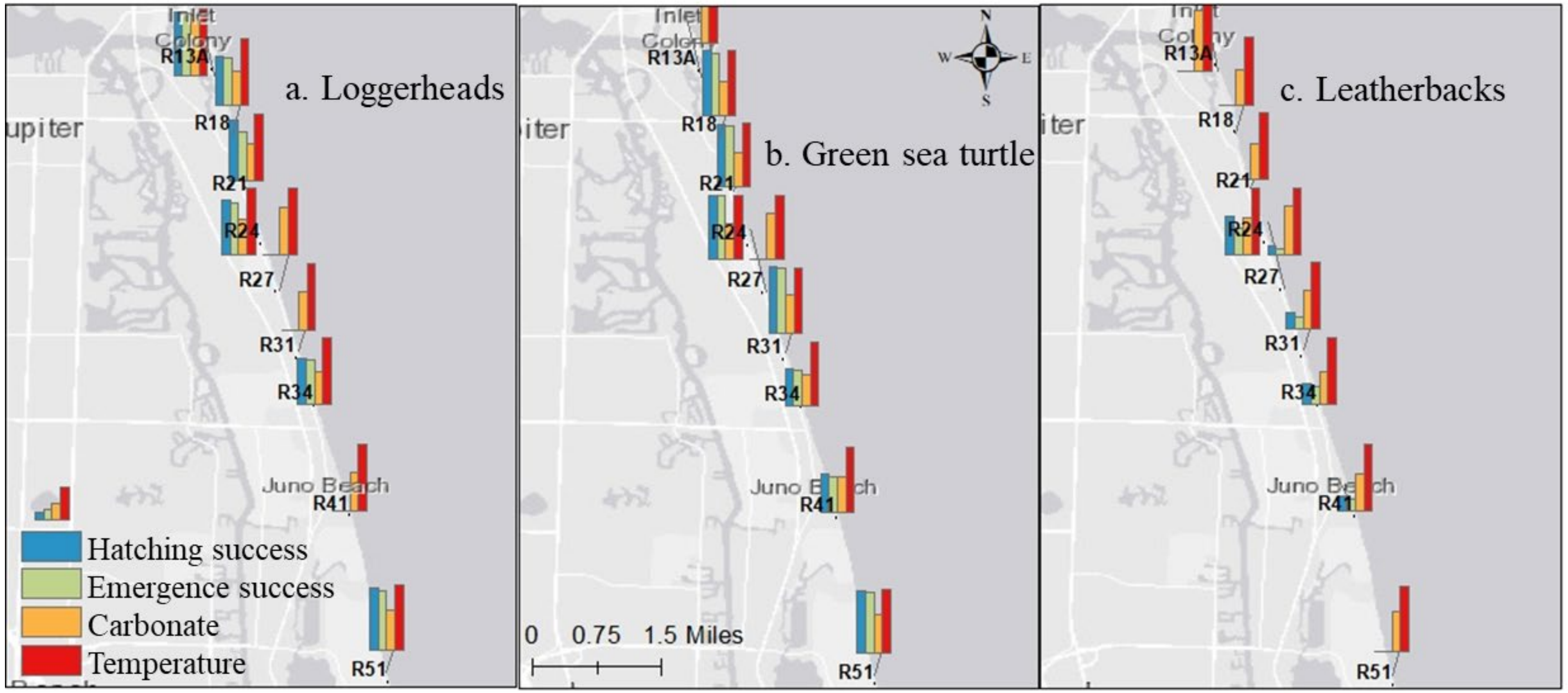


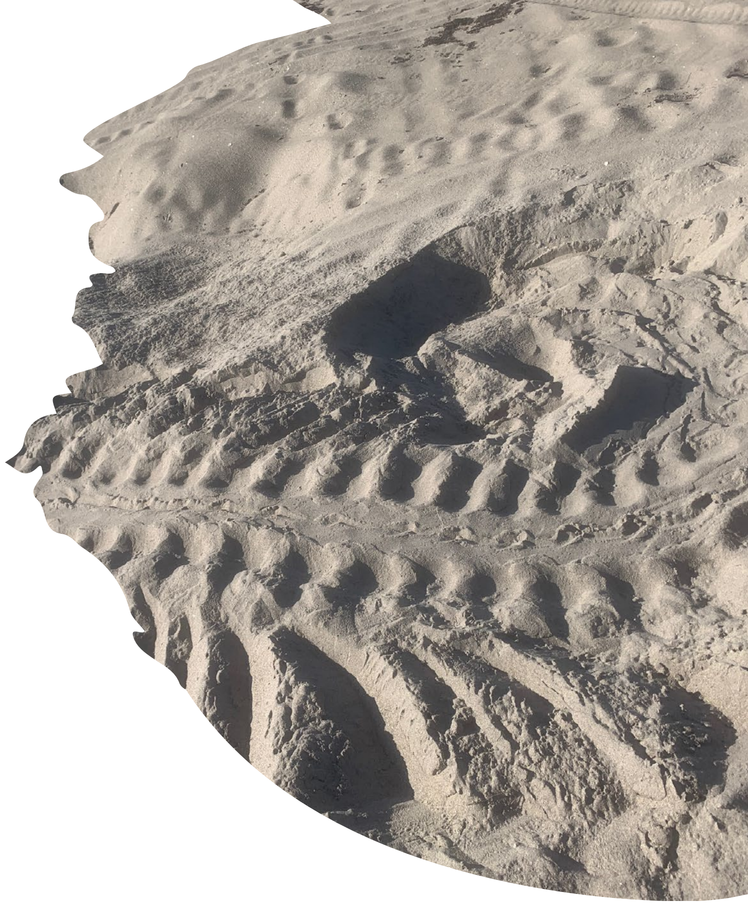
Figure 12: Hatching and Emergence success vs temperature and carbonate

	Loggerhead		
Cross shore	HS & ES		
High	Early Season		
	Mid season		
	Late season		
Mid	In all seasons		
Low	Mid season	Negative (-0.9)	No

	Green turtle	Correlation	
Cross shore	HS & ES	Carbonate (%)	Temperature (°F)
High	Early Season	No	No
	Mid season	No	No
	Late season	No	No
Mid	In all seasons	No	No

Correlation	
Carbonate (%)	Temperature (°F)
No	No
No	**No**
No	No
No	Negative (-0.8)





CONCLUSIONS

✓Sediment grain size and sorting has high correlation with the HS and ES for loggerheads at high cross shore location.

✓ Leatherbacks and green sea turtles HS and ES were not influenced by any sediment characteristics.

✓Substrate temperature and carbonate percentage had no influence on the HS and ES.

✓In the 2015 data highest nesting success recorded was 55% whereas the highest nesting success recorded in 2019 was 66%. Hatching success recorded in 2015 was 85% whereas in 2019 was more than 95%

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.

ACKNOWLEDGEMENTS
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THANK YOU

References

Cisneros, Julie & Briggs, Tiffany & Martin, Kelly. (2017). Placed Sediment Characteristics Compared to Sea Turtle Nesting and Hatching Patterns, Case Study from Palm Beach County, FL. Shore and Beach. 85. 35-40.