LONG-TERM SPATIOTEMPORAL PATTERNS OF MARINE TURTLE NESTING ON AN UNDEVELOPED BEACH IN NORTHEAST FLORIDA

Scott F. Eastman [1*], Matthew E. Kimball [2], Todd Z. Osborne [3], Raymond R. Carthy [4]

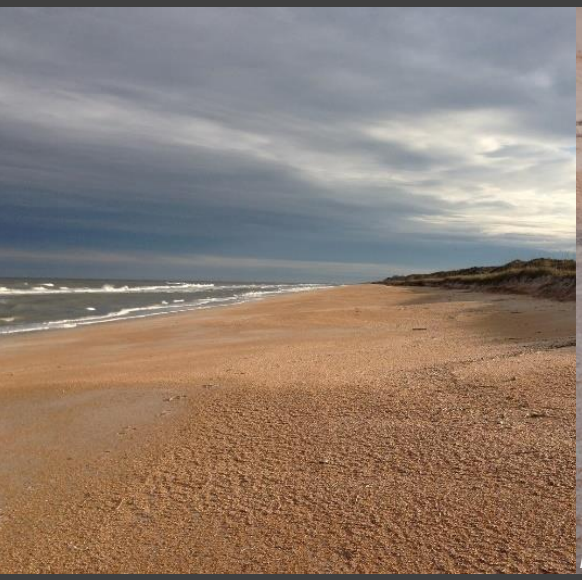
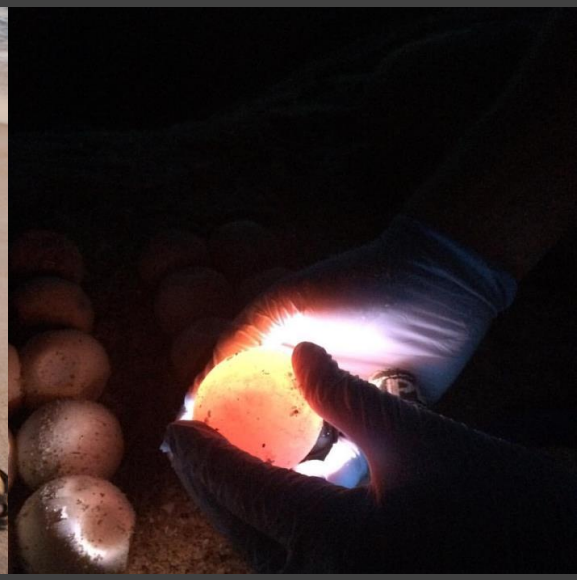


Photo: Richard Becker



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Outline

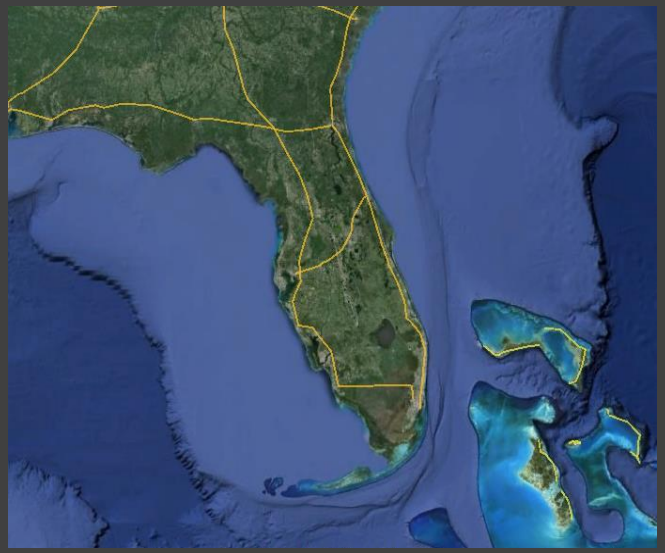
- Background
  - Marine turtles nesting in NE Florida
  - Florida, globally significant for loggerhead sea turtle nesting
- Methods
  - Nesting beach survey
- Results
  - Annual Nesting trends
  - Spatial patterns
- Discussion
  - Collaborations and preliminary results to elucidate why we might be seeing some of these trends and anomalies.

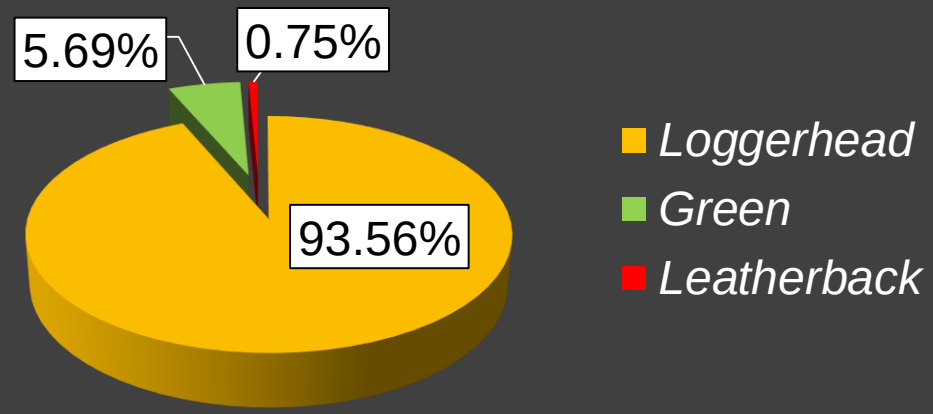
Marine Turtles Nesting in NE FL

Loggerhead
(*Caretta caretta*)

Atlantic Green
(*Chelonia mydas*)

Leatherback
(*Dermochelys coriacea)*

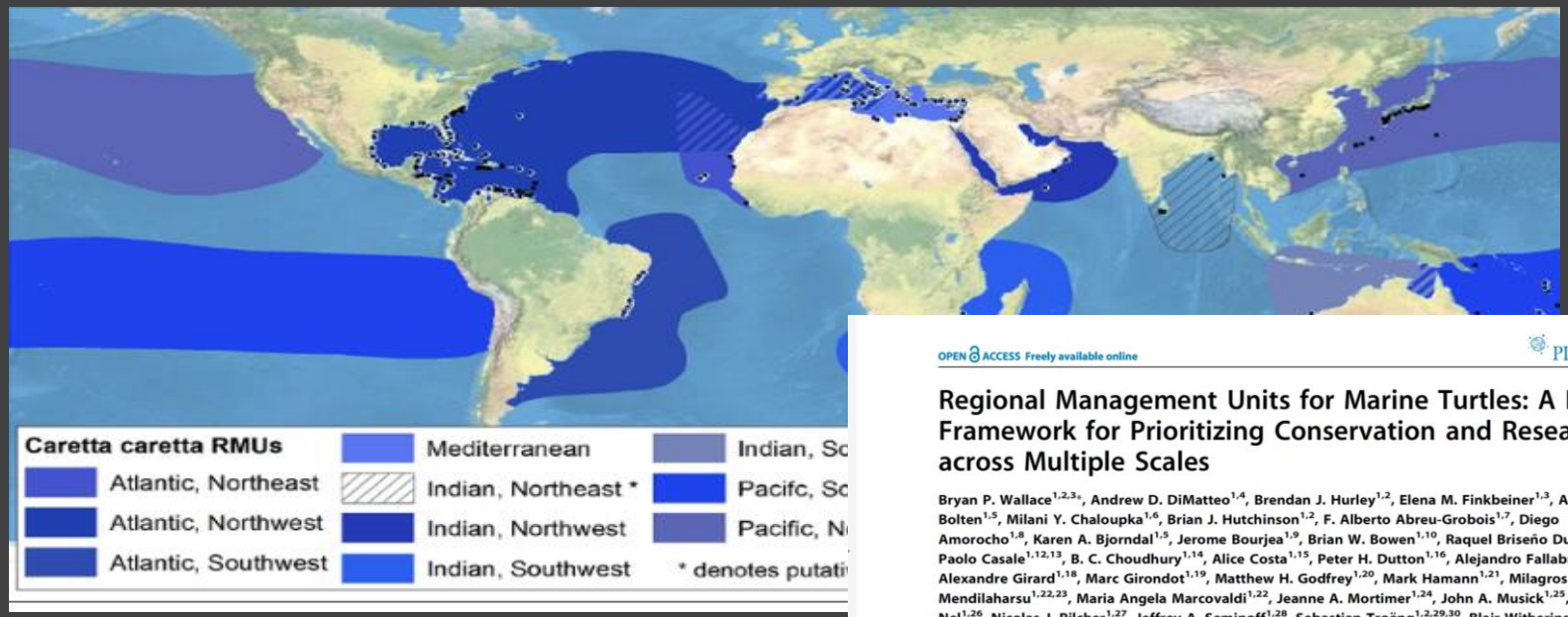




Florida Fish and Wildlife Conservation Commission (FWC) State Nesting Beach Survey (SNBS)

Florida, globally significant for loggerhead nesting

Loggerhead Regional Management Units (RMUs)



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PLoS one

Regional Management Units for Marine Turtles: A Novel Framework for Prioritizing Conservation and Research across Multiple Scales

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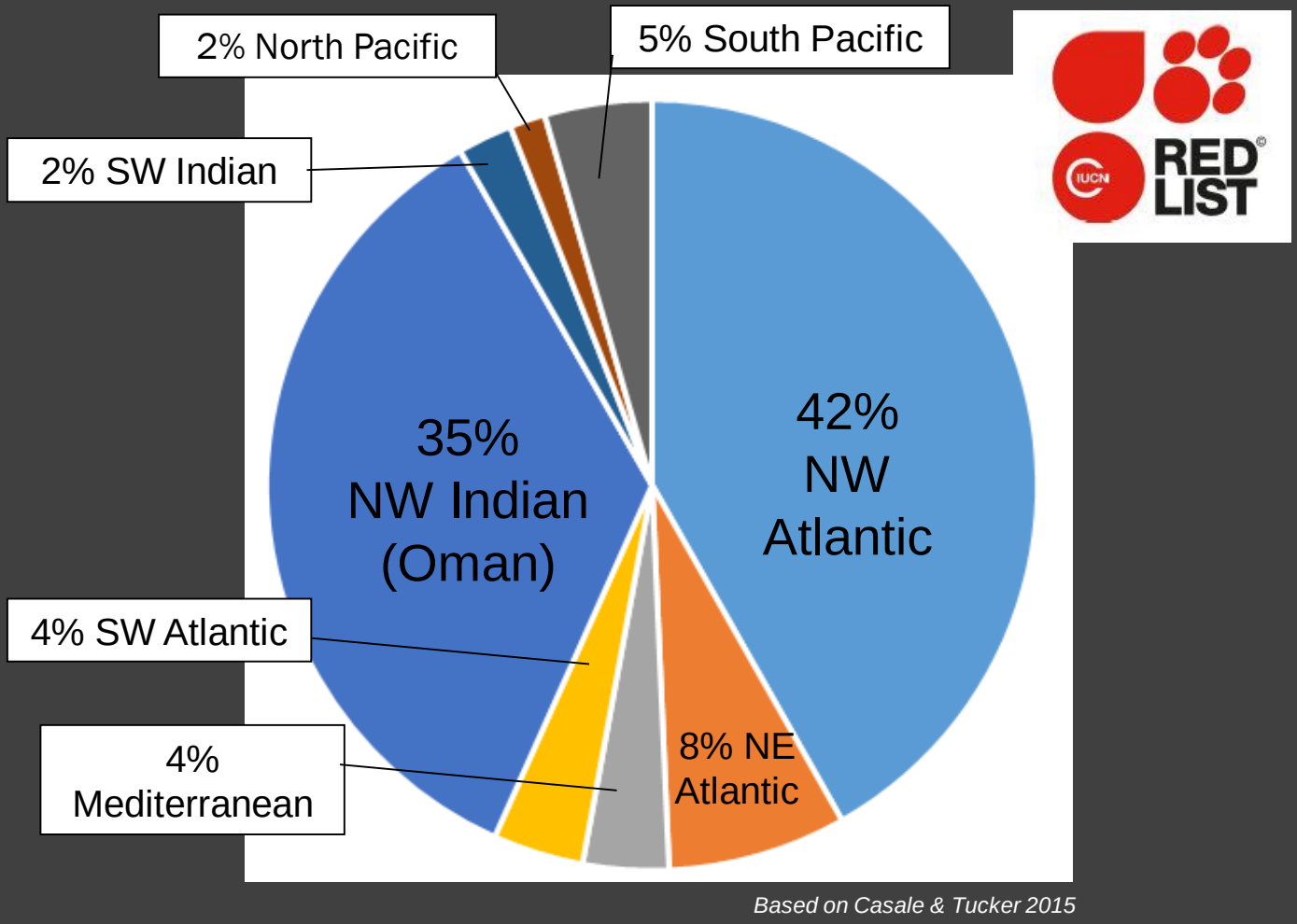
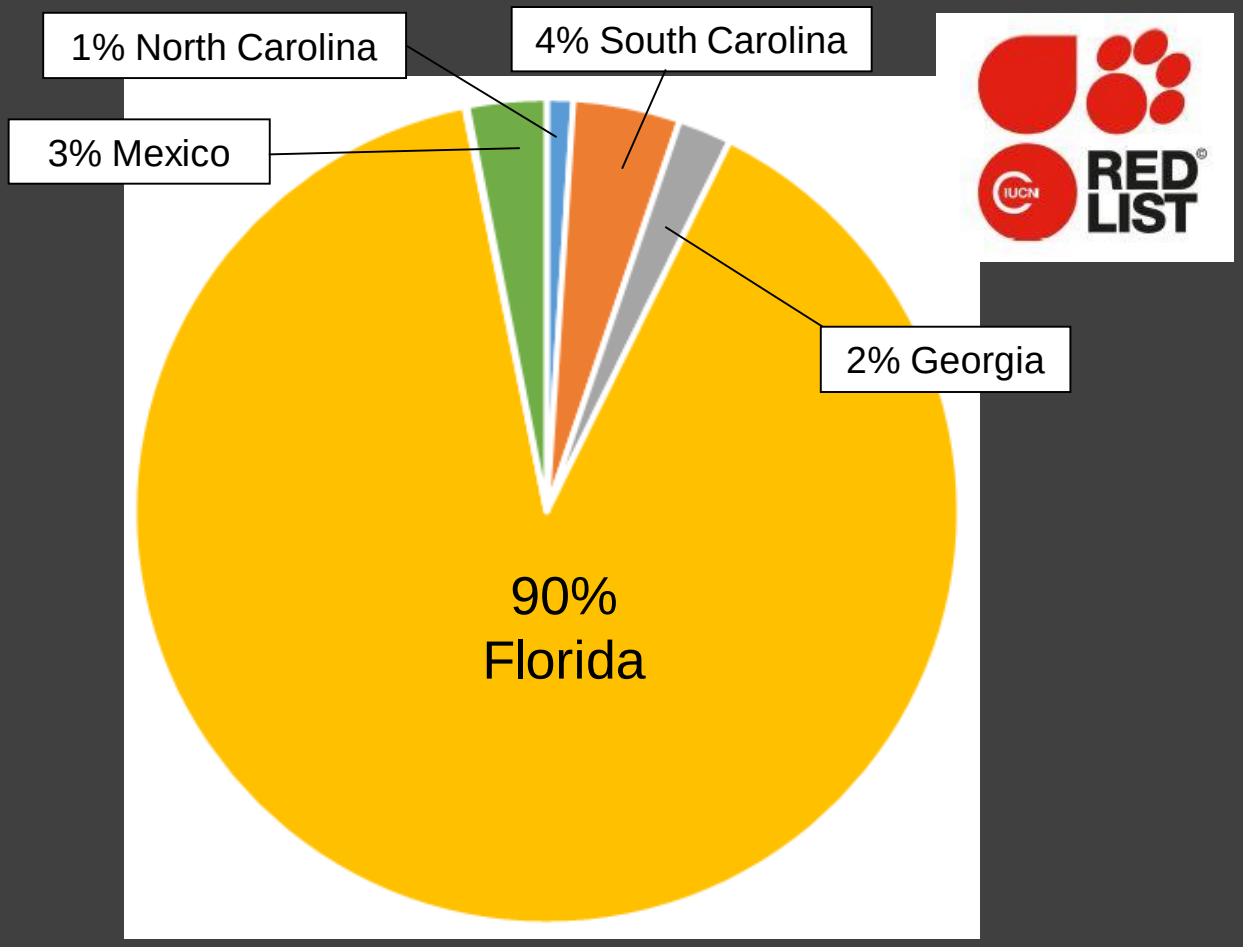
"The RMU framework is a solution to the challenge of how to organize marine turtles into units of protection ***above the level of nesting populations****, but* ***below the level of species****, within regional entities that might be on independent evolutionary trajectories."* - Wallace et al. 2010



Based on Casale & Tucker 2015

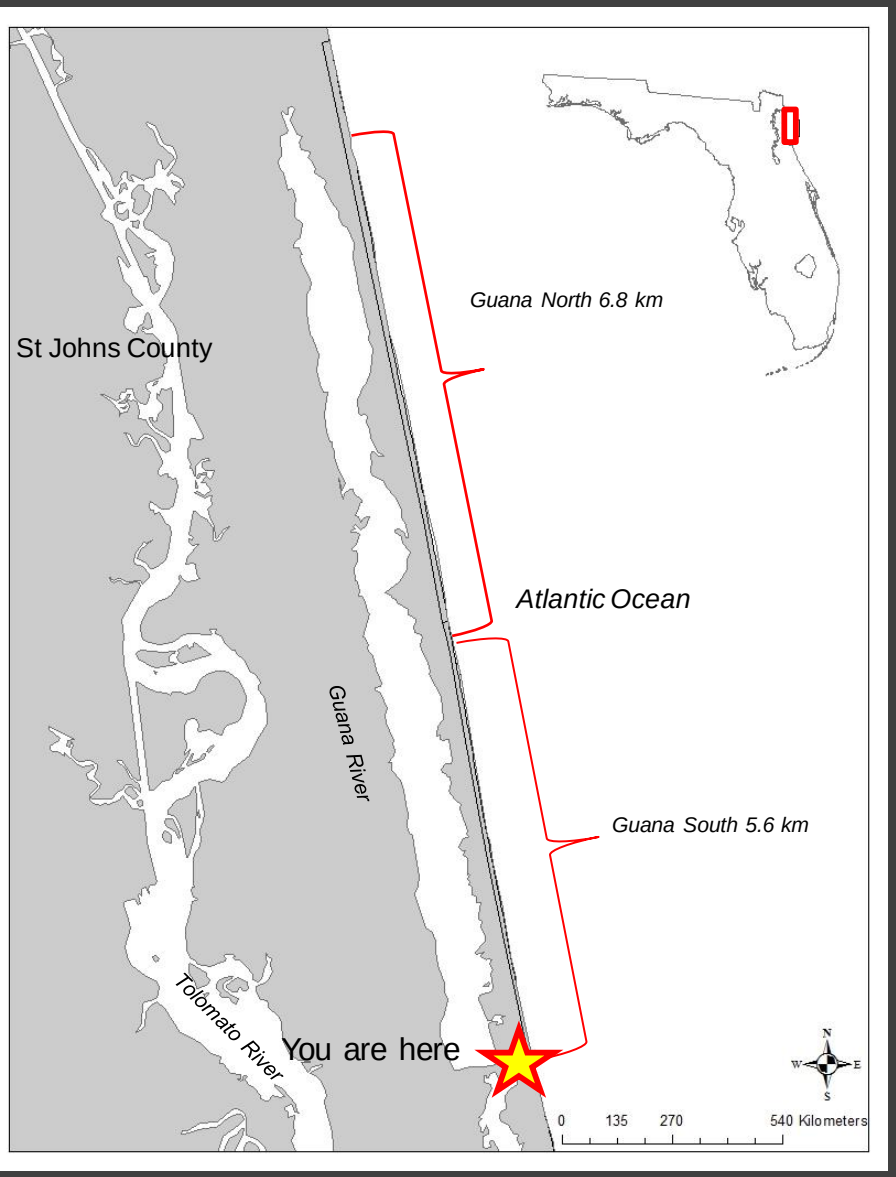
Loggerhead subpopulations & global abundance (nests/yr)



Based on Ceriani & Meylan 2015

Northwest Atlantic loggerhead population abundance (nests/yr)

Study Area



"***Guana North***" = 6.8 km (4.2 miles) State Conservation and Recreational Lands

Total =12.4 km (7.7 miles)

*"**Guana South**"* = 5.6 km (3.5 miles)Low Density Residential Housing

Methodology: Nesting survey

Nesting Surveys:

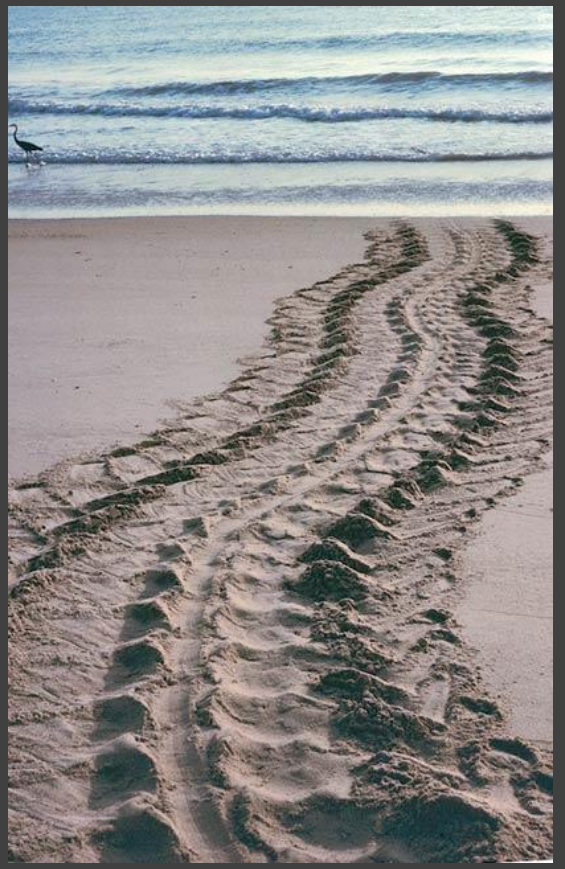
- Initiated in 1989
- Conducted 7 days a week from April 1st through October 31st
- Morning surveys, initiated 10 minutes before published sunrise times

Methodology: Nesting survey

Species are determined visually by analyzing gait characteristics.

Loggerhead
(C. caretta)

Atlantic Green
(C. mydas)



Leatherback
(D. coriacea)

Methodology: Nesting survey

Adult emergences are determined to be either **nesting** or **non nesting** emergences (false crawls) dependent upon visual crawl characteristics.

a) Nest

b) Non-nesting emergence (false crawl)

Methodology: Nesting survey

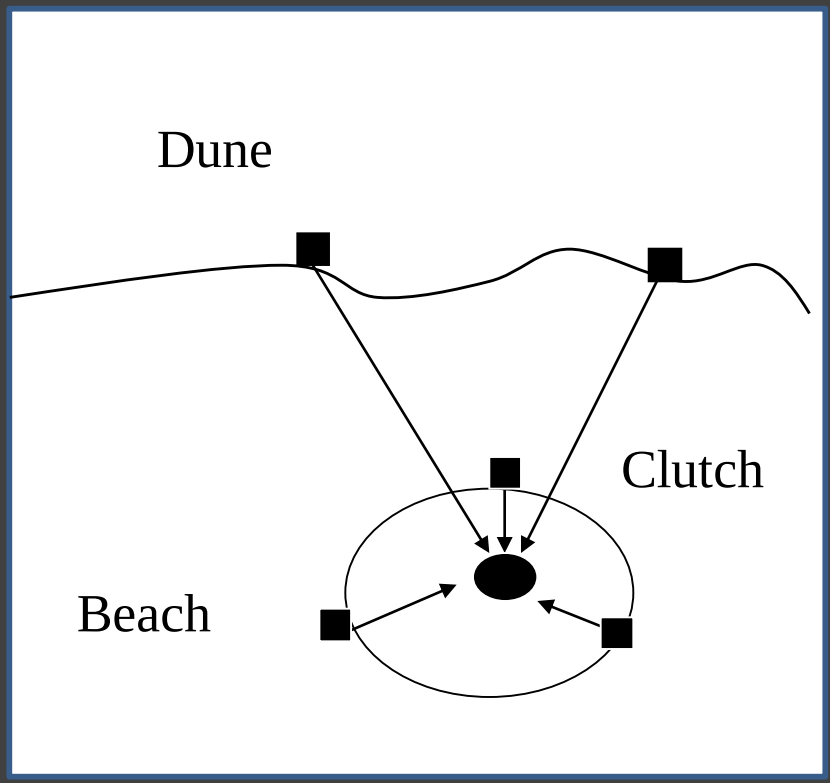
- Shortly after oviposition, clutches are confirmed, carefully digging by hand.
- The top-most egg is collected for genetic and stable isotope analyses.

Survey personnel draw lines in the sand to assist with locating the clutch.

Methodology: Nesting survey

A Total of 6 measurements are recorded

- 1 Depth of clutch measurement (from the sand surface)
- 3 Measurements from perimeter stakes to clutch
- 2 Dune stake measurements
- Navigational grade GPS locations are acquired (~ 3m accuracy).



Methodology: Nesting survey

Nests are left *in situ* and clearly marked and monitored daily for nest events such as:

- Tidal inundation
- Predation
- Anthropogenic effects
- Hatchling emergence

Methodology: Nesting survey

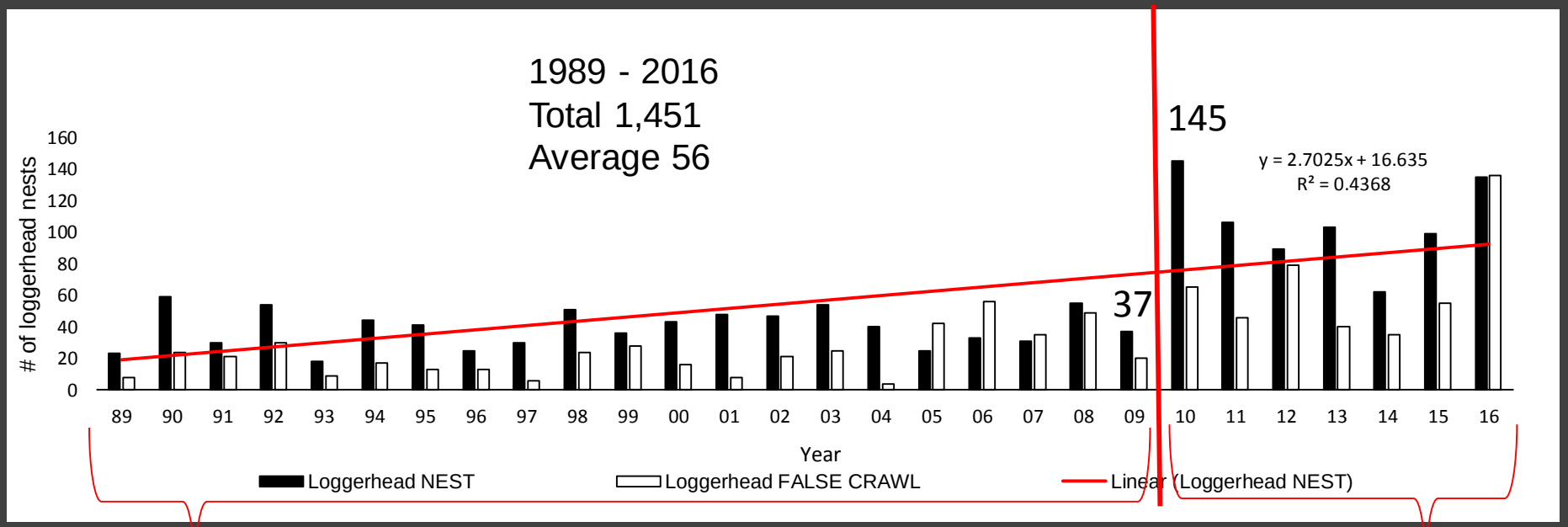
Nests are evaluated after **72 hours** of the first signs of emergence or at **>70 days** of incubation.

- Hatched Eggs (>50% eggshell)
- Live Hatchlings in Nest
- Dead Hatchlings in Nest
- Live Pipped
- Dead Pipped
- Un-hatched
  - Whole
  - Damaged

- Total Clutch
- Emerged Hatchlings

Results: Annual nesting trend

Why did we see this increase in nesting from 2009 to 2010?



Loggerhead nesting has increased significantly from 1989 to 2016 (<.05).

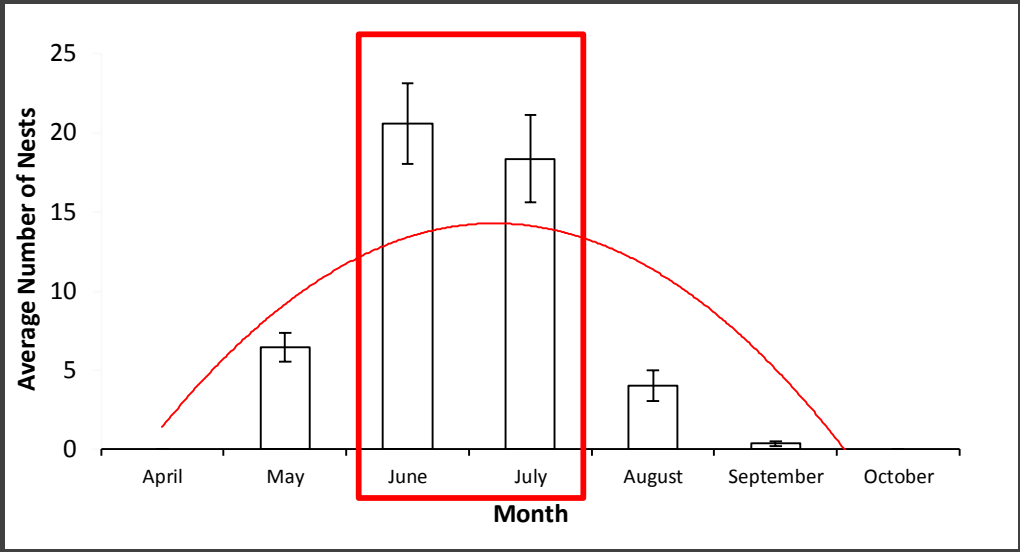
Yrs 1989 - 2009
Total 824
Average 39

Yrs 2009 - 2016
Total 739
Average 106

Results: Month and week nesting

Monthly

Nesting is initiated in April, with the greatest amount nesting occurring in the month of **June**, followed by **July**.

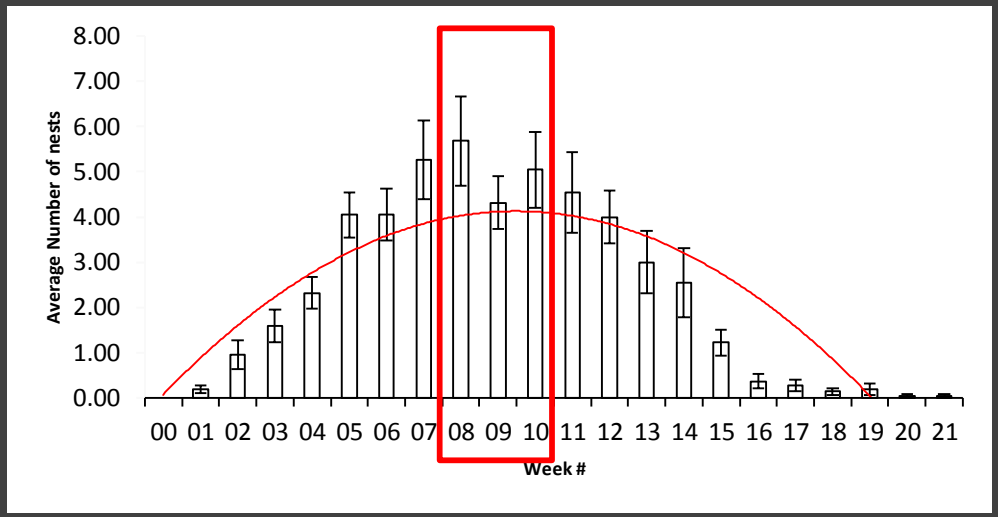


Average number of loggerhead nests by month 1989-2016

Weekly

We see an increase from week 01 to week eight, a depression in week 9, then a steady decrease from week 10.

*Week 9 corresponds with the first week of July.



Average number of loggerhead nests by sampling week 1989-2016

Results: Spatial Analysis

Analyzed spatial patterns of all loggerhead nesting and non-nesting (false crawl) events from 2007-2016.

ArcGIS Spatial Analyst:

- Nearest Neighbor Analysis
- Point Density Analysis
- Fishnet Density Analysis

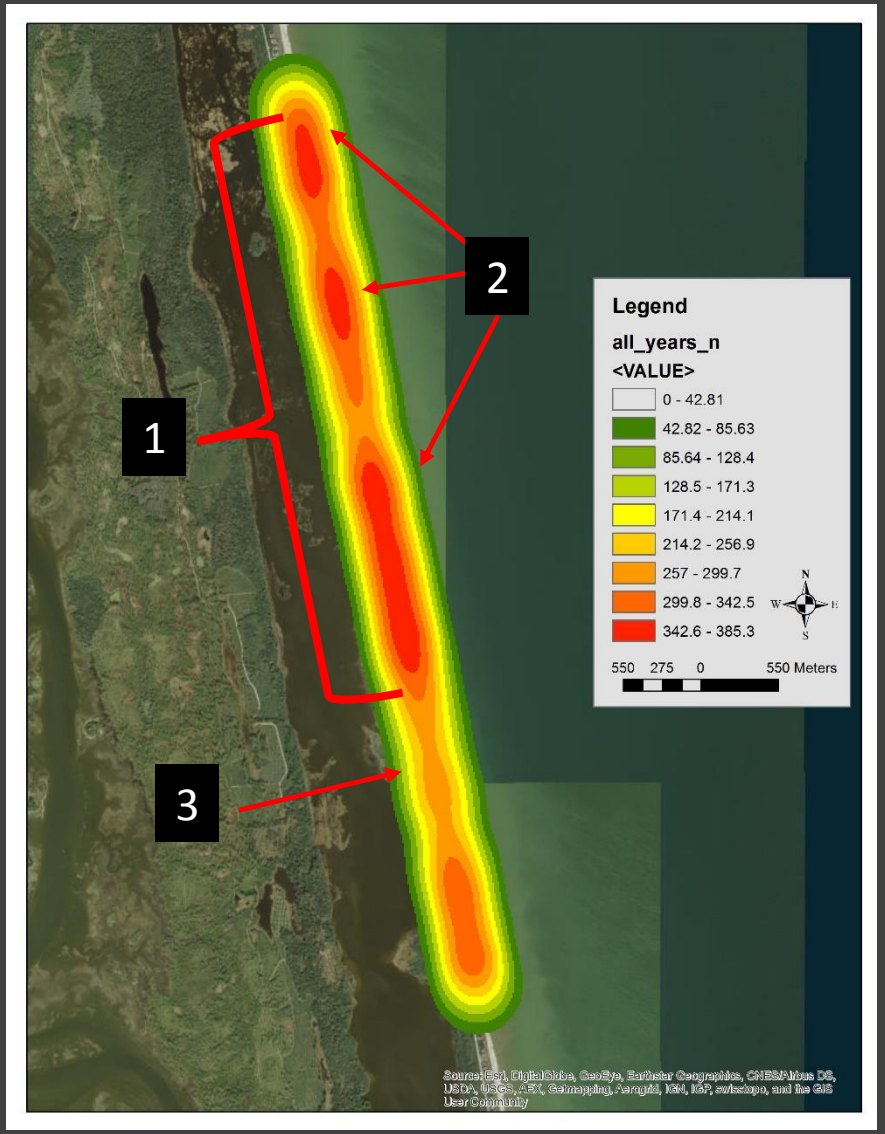
***Kernel density** - Calculates a **magnitude per unit area** from point features using a kernel function to fit a smoothly tapered surface to each point or polyline.

Allows us to locate "*hot spots*" for nesting events.

Results: Spatial Analysis

2007-2016 Nesting

1. The majority of loggerhead nesting takes place in the upper 2/3^{rds} of the study area.
2. Three concentrated areas of nesting.
3. An area of low nesting activity occurs in the southern portion of the study area.



Results: Spatial Analysis

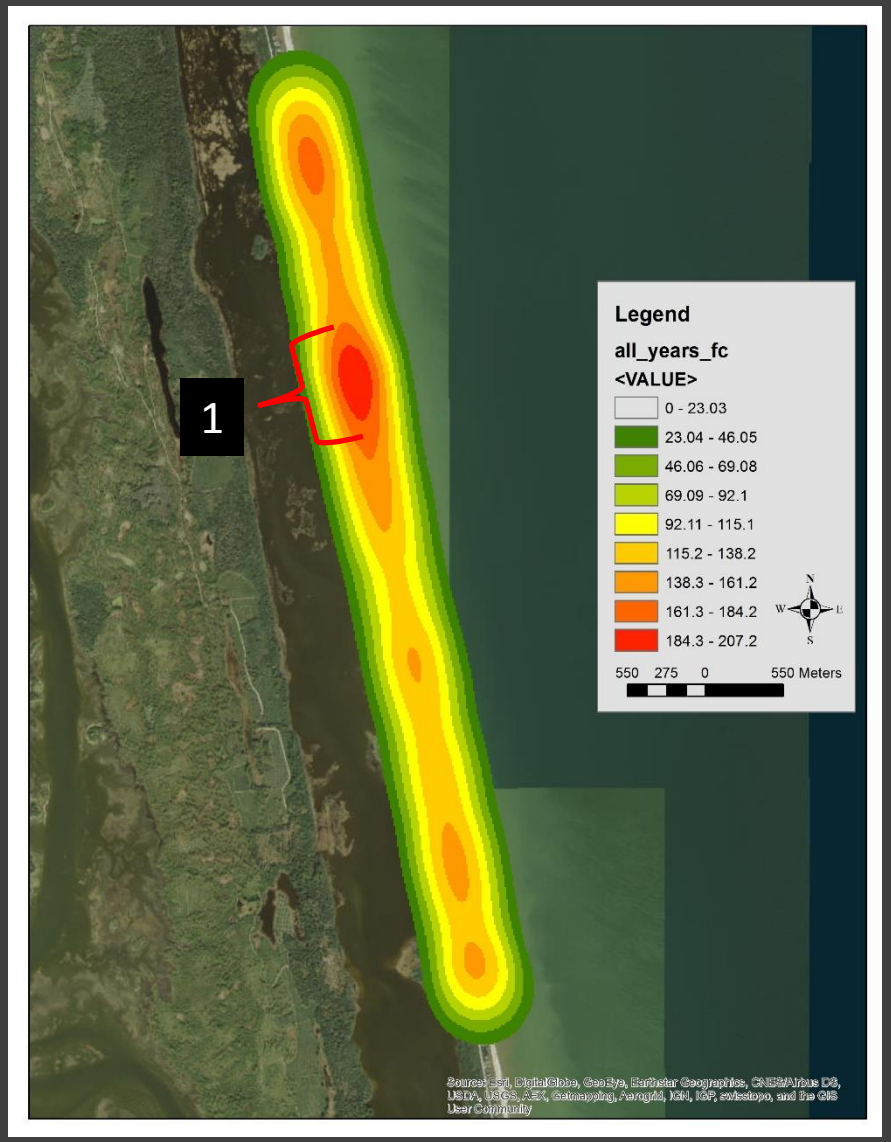
2007-2016 False Crawls

1.Dominant proportion of non-nesting emergences (false crawls) occurred in a single location (within 500m).

Significance: High accounts of false crawls may indicate sub-optimal habitat characteristics.

Possible due to:

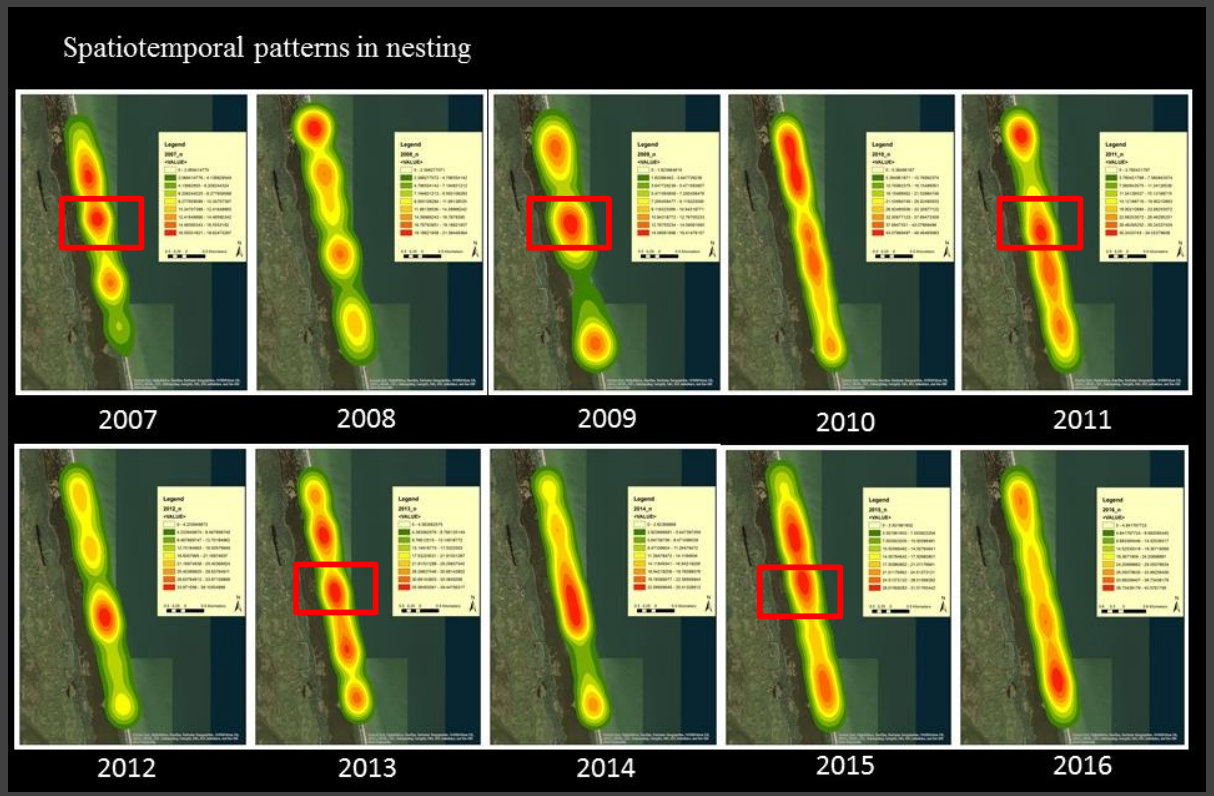
- Coastal lighting
- Sand type, grain size
- Beach slope
- Bathymetry
- Beach width



Results

1. Nest are not evenly distributed, or random along the study area, suggesting some form of spatiotemporal nest site selection, or "*clustering*".

2. A biannual pattern where we see a section of high density nesting just north of the middle of the survey area. (*indicated by red boxes for years, 2007, 2009, 2011, 2013, and 2015*).



Loggerhead Nesting By Year (2007-2016) red boxes indicate area of repeated concentration of nesting.

Discussion

Two primary questions:

1) Why did we experience the increase in loggerhead nesting from 2009 to 2010?

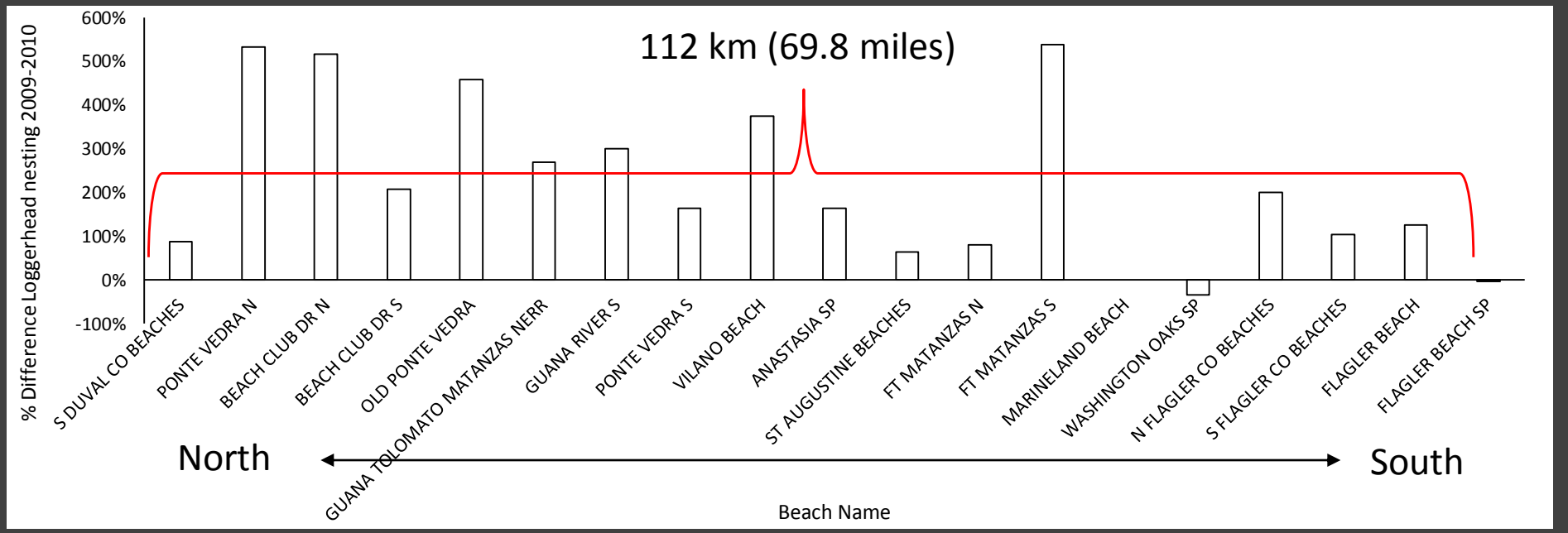
- *Were these females previously nesting on adjacent beaches, but then shifted to nest on this beach?*
- *Are these new nesting females (neophytes)?*
- *Are the same females nesting more times? (~4.1 clutch per season)*

2) What is nest site clustering a result of?

- *Individual site preference?*
- *Site selection mutually appealing?*

Discussion

Were these females previously nesting on other beaches?



Most beaches within 112 km experienced an increase in loggerhead nesting (~100-500% increase).

Perhaps this a factor of the domain or the precision for natal homing?

Discussion

Collaboration on a large-scale genetics research project.

- Retrieve maternal DNA from the fresh eggshell of sea turtles. "*Genetic fingerprint*"
- Supplements the efforts that have occurred in **Georgia, South Carolina, North Carolina, Virginia, and Maryland.**
- Allowing us to estimate **population size**, **clutch frequency**, **site fidelity, remigration intervals**, and **survival.**
- Essentially a large scale saturation tagging effort, without disturbing the nesting females.

Genetic structure of the southeastern United States loggerhead turtle nesting aggregation: evidence of additional structure within the peninsular Florida recovery unit

Brian M. Shamblin · Mark G. Dodd · Dean A. Bagley · Llewellyn M. Ehrhart · Anton D. Tucker · Chris Johnson · Raymond R. Carthy · Russell A. Scarpino · Erin McMichael · David S. Addison · Kristina L. Williams · Michael G. Frick · Stefanie Ouellette · Anne B. Meylan · Matthew H. Godfrey · Sally R. Murphy · Campbell J. Nair

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The University of Georgia
WARNELL
SCHOOL OF FORESTRY & NATURAL RESOURCES

Candling loggerhead sea turtle eggs to assess developmental stage

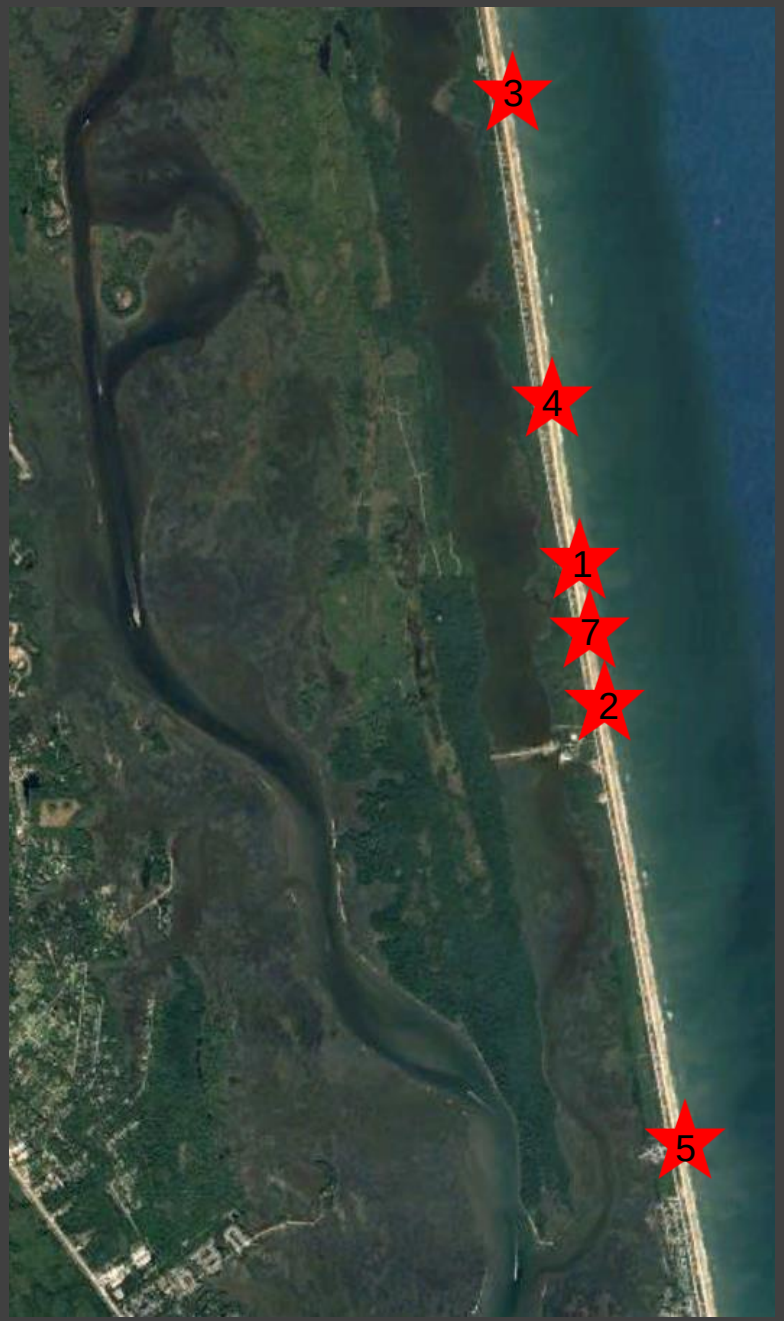
Discussion

Example 1: Loggerhead sea turtle
DNA ID# CC008539

Unpublished preliminary Results

#	Days	Date	Beach	Ref#
1	0	5/18/2016	Guana River South	GS003
2	14	6/01/2016	Guana River South	GS023
3	11	6/12/2016	Guana River North	GN046
4	12	6/24/2016	Guana River South	GS045
5	12	7/06/2016	Ponte Vedra South	N103
6		*Possible Missed Nest*		
7	26	8/01/2016	Guana River South	GS085

Minimum Distance: 0.47 km
Maximum Distance: 10.34 km
Mean Distance: 3.96 (± 2.78 stdev) km
Mean Internesting Period: 12.2 days



Adapted from Seaturtle.org

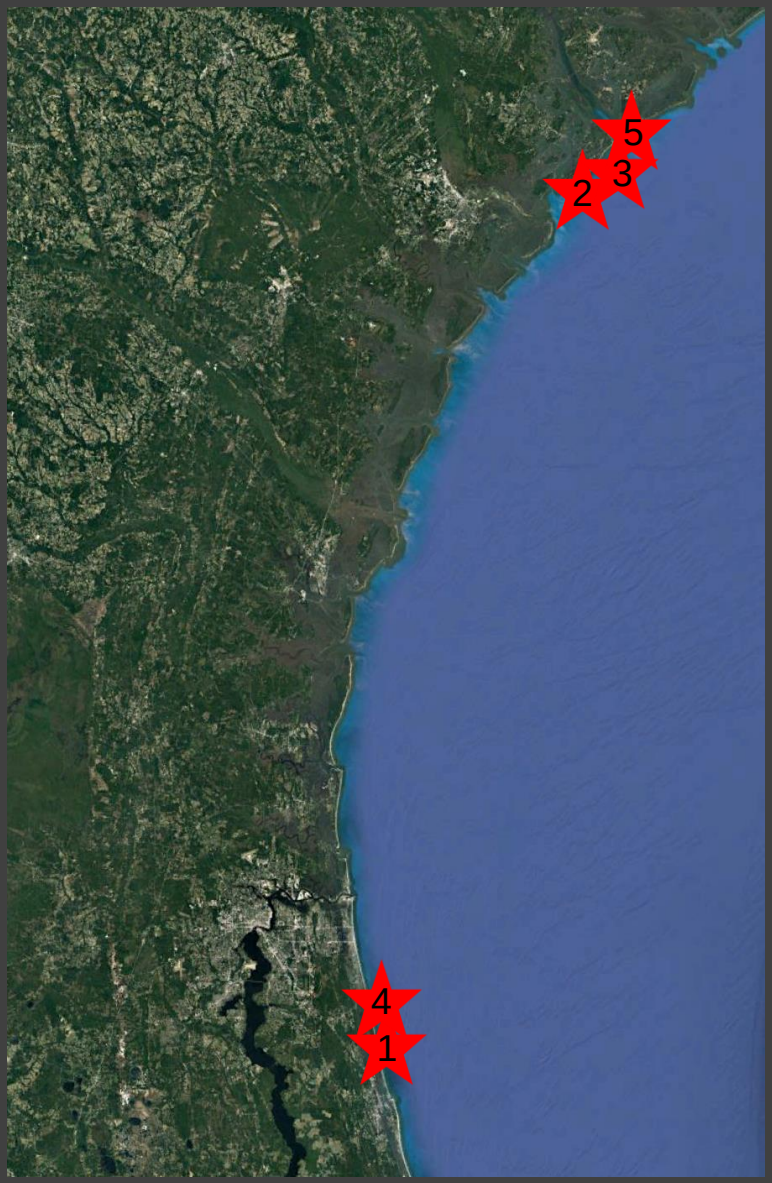
Discussion

Example 1: Loggerhead sea turtle
DNA ID# CC003525

Unpublished preliminary Results

#	Days	Date	Beach	Ref#
1	0	6/01/2016	Ponte Vedra South	N030
2	12	6/13/2016	Hilton Head Island	HHI-164
3	11	6/24/2016	Hilton Head Island	HHI-234
4	13	7/07/2016	Guana River North	GN112
5	10	7/17/2016	Hilton Head Island	HHI-365

Minimum Distance: 0.10 km
Maximum Distance: 253.49 km
Mean Distance 119.18 (± 120.53 stdev) km
Mean Internesting Period: 11.4 days



Adapted from Seaturtle.org

Future direction

- Closer inspection, linking genetics data to observed nesting trends.
- Investigate factors influencing the area of concentration of false crawls.
- Initiate comparison studies (*e.g. BACI*) on beaches within close geographic proximity to quantify possible levels of impact whether anthropogenic or natural.
- Infer relative foraging areas based on stable isotope analyses.

Acknowledgements

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Extant Marine Turtles

Loggerhead
(*Caretta caretta*)

Threatened

Atlantic Green
(*Chelonia mydas*)

Threatened

Leatherback
(*Dermochelys coriacea*)

Endangered

Hawksbill
(*Eretmochelys imbricata*)

Endangered

Kemp's Ridley
(Lepidochelys kempii)

Endangered

Olive Ridley
(*Lepidochelys olivacea*)

Endangered

Flatback
(*Natator depressus*)

Endangered

IUCN (International Union for Conservation of Nature and Natural Resources) (2006) IUCN REDLIST of threatened species. The Conservation Union, Cambridge.

U.S. Congress. 1973. Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat.884) as amended.