Hurricane impacts on mangrove Diamondback terrapins (*Malaclemys terrapin*) in the Everglades


Kristen M. Hart,

Catherine A. Langtimm,

Carole C. McIvor

USGS Florida Integrated Science Center

Malaclemys terrapin

- Long-lived (~40 years), sexually dimorphic turtle species
- Resident of salt marshes, mangroves, and tidal tributaries
- Continuously-distributed "populations"
- Consumers of snails, mollusks, and crabs
- Temperature-dependent sex determination (TSD)
- Conservation status: multiple state-listings, likely in decline

USGS
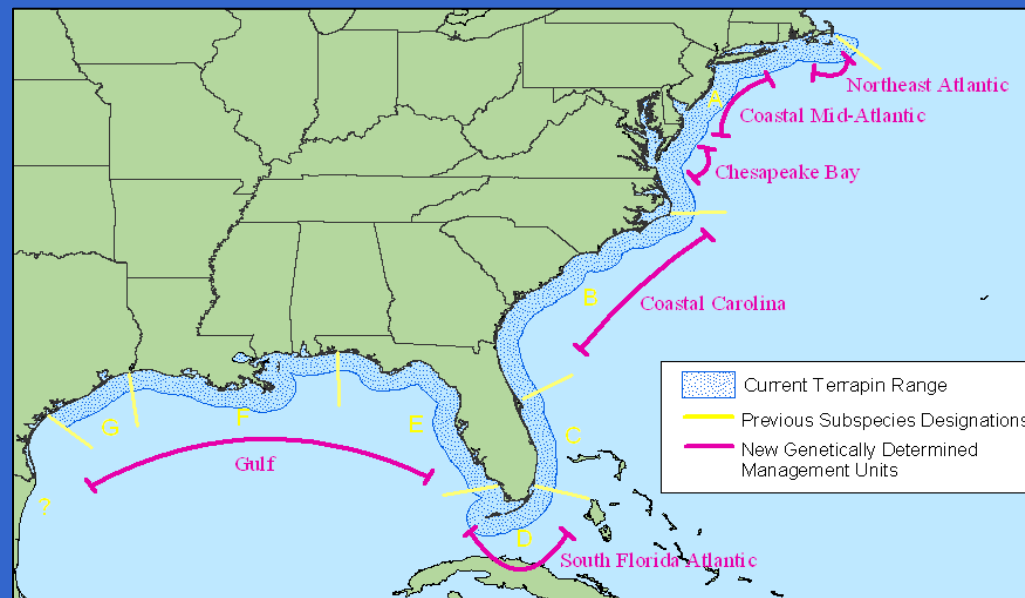
Threats

- Direct harvest
- Habitat loss, destruction
- Skewed sex ratios
- Bycatch in recreational and commercial crab pots
- Interaction with vehicles on land and in the water
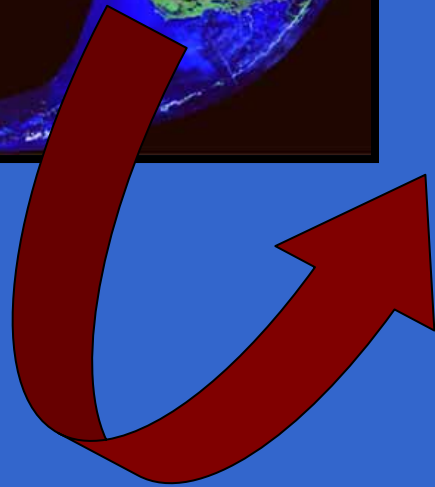- Predation (by raccoons, skunks, ghost crabs, sharks, eagles, etc.)

State-level protected status

A. Friedlaender

USGS

Study Site

Big Sable Creek,

Southwest Everglades

Capture-Recapture Study of Mangrove Terrapins

Goals:

- Estimate survival probability, probability of capture, and abundance

Data collection:

- 2001-2007, ongoing

Hart & McIvor 2008, Copeia

Sampling Methods in Big Sable Creek

- New moons

- AM and PM dip-netting around low tides from 19' skiff

- 7 sampling trips: Nov. 2001 – Nov. 2006

- Binary data coded for 2 states:
     live/dead ~ survival probability
     seen/not seen ~ probability of detection

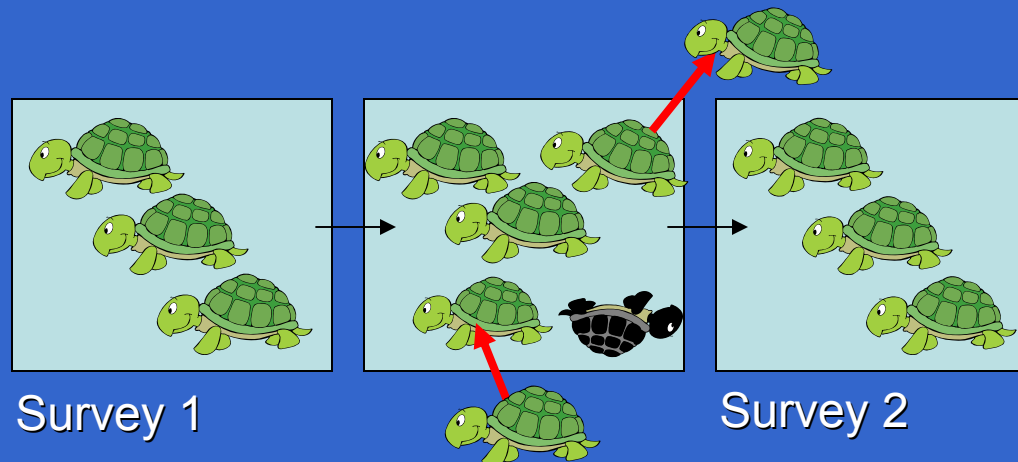- Created an "encounter history" for each animal, e.g., 10010

USGS

Capture-Recapture Methods

- Uniquely mark each animal (4 ways)
- Conduct standardized physical workups
- Release each animal at point of capture

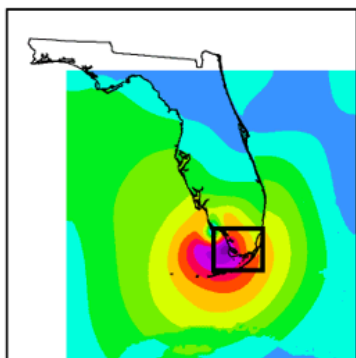

Cormack-Jolly-Seber (CJS) Open Population:
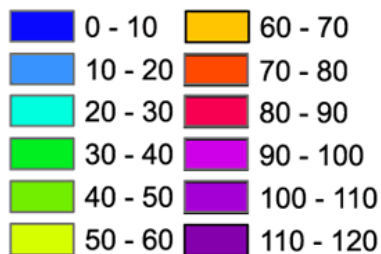

Survey 1   Survey 2

Assumptions of CJS Open Model

1. Every individual in the data set has the same probability of survival between sampling occasions

2. Every individual has the same probability of being captured at least once during the sampling interval

3. The capture of one individual is not dependent on the capture of any other individual

4. Every individual is identified and recorded correctly

5. Sampling time is negligible or instantaneous
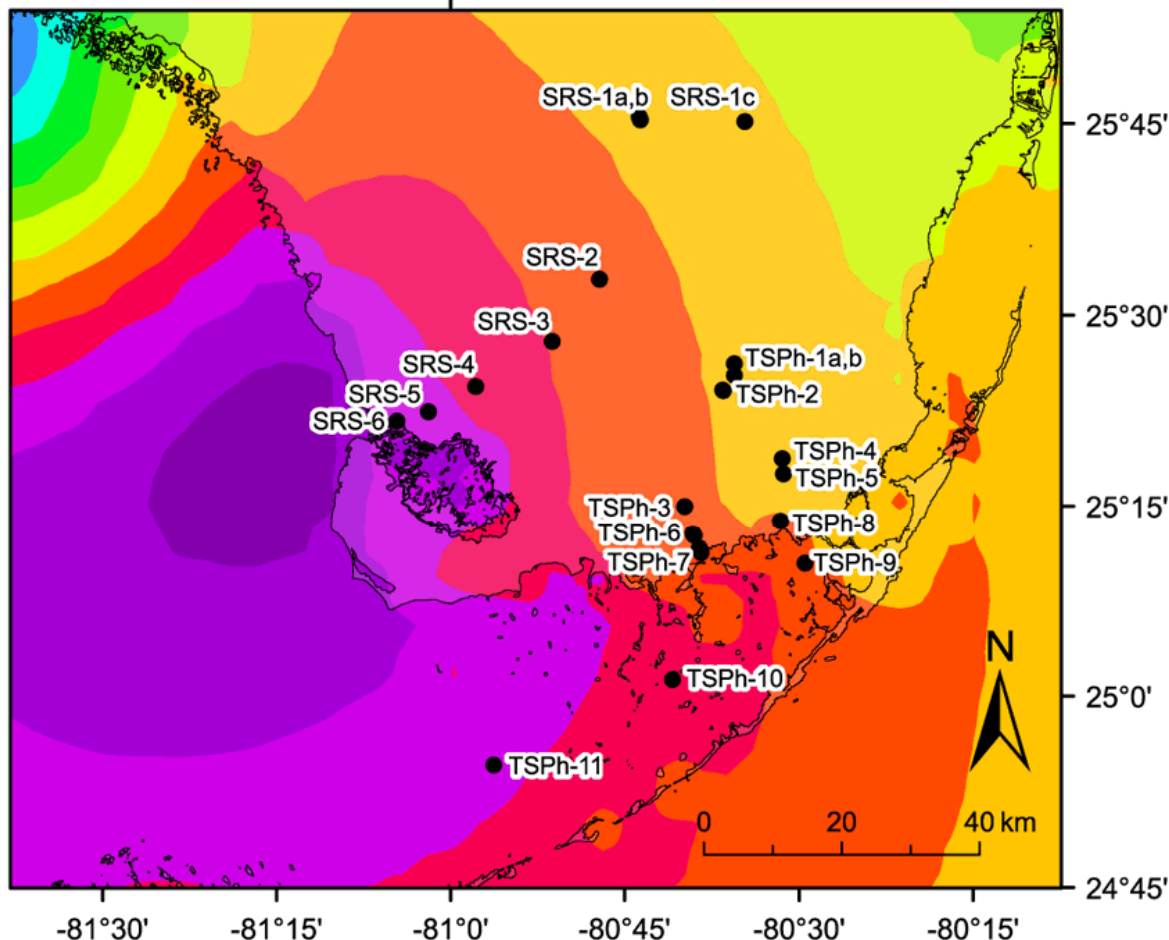
USGS

Hurricane Wilma - October 24, 2005 10:30 UTC

Surface wind speed (mph)

0 - 10	60 - 70
10 - 20	70 - 80
20 - 30	80 - 90
30 - 40	90 - 100
40 - 50	100 - 110
50 - 60	110 - 120

● FCE LTER Sites

Map projection: UTM, Zone 17
Map datum: WGS 1984
Map created by Mike Rugge,
FCE LTER Program

SRS-1a,b   SRS-1c
SRS-2
SRS-3
SRS-4
SRS-5
SRS-6
TSPh-1a,b
TSPh-2
TSPh-4
TSPh-5
TSPh-3
TSPh-6
TSPh-7
TSPh-8
TSPh-9
TSPh-10
TSPh-11

N

0   20   40 km

H*Wind Surface Analysis shapefile data sets were provided by the Hurricane Research Division (HRD) of NOAA's Atlantic Oceanographic and
Meteorological Laboratory (http://www.aoml.noaa.gov/hrd/).   The Wind Analyses data used to produce this map are for research purposes
only. These are experimental products created by NOAA's Hurricane Research Division. For official National Weather Service products go to
The National Hurricane Center website (http://www.nhc.noaa.gov/). Any uses of these data are subject to the provisions of HRD's Data Policy
(http://www.aoml.noaa.gov/hrd/data.html) and by using these data the user agrees to this policy.
The FCE LTER program performed an IDW interpolation on the original wind analyses data described above to create this map.

**≋USGS**
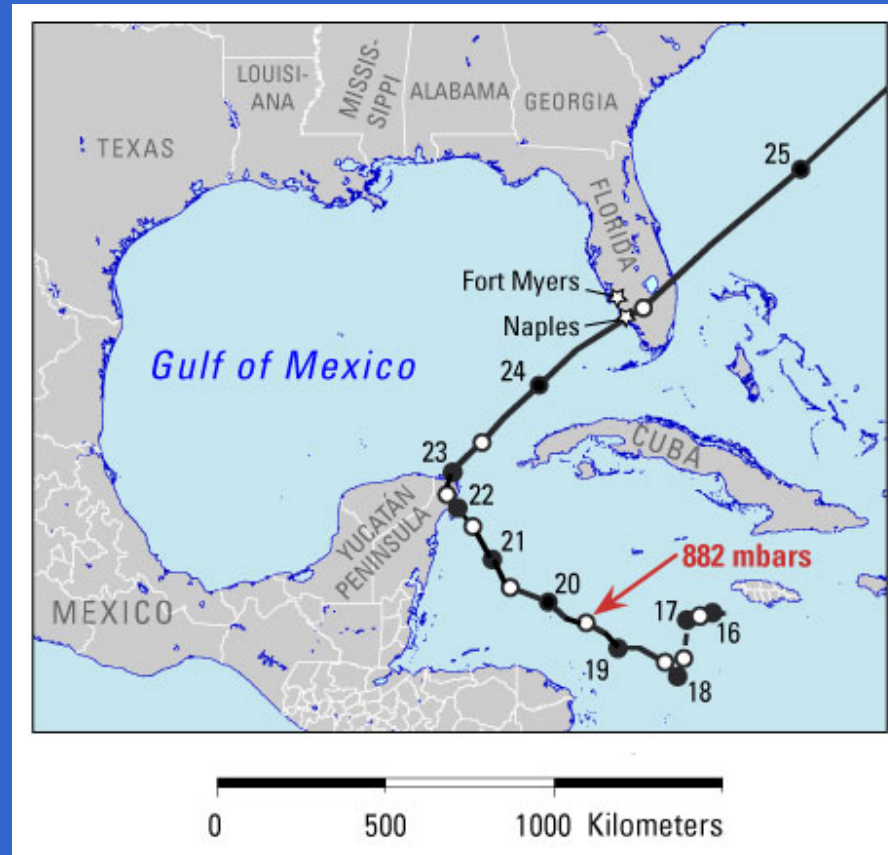
Hurricane Wilma

www.soundwaves.usgs.gov/2006/02

Soderqvist, L.E., and Byrne, M.J., 2007, Monitoring the storm tide of Hurricane Wilma in southwestern Florida, October 2005: U.S. Geological Survey Data Series 294.

Hypothesis: Apparent survival and capture probability for M + F mangrove terrapins were similar before and after the passage of Hurricane Wilma.

USGS

M. terrapin distribution in BSC
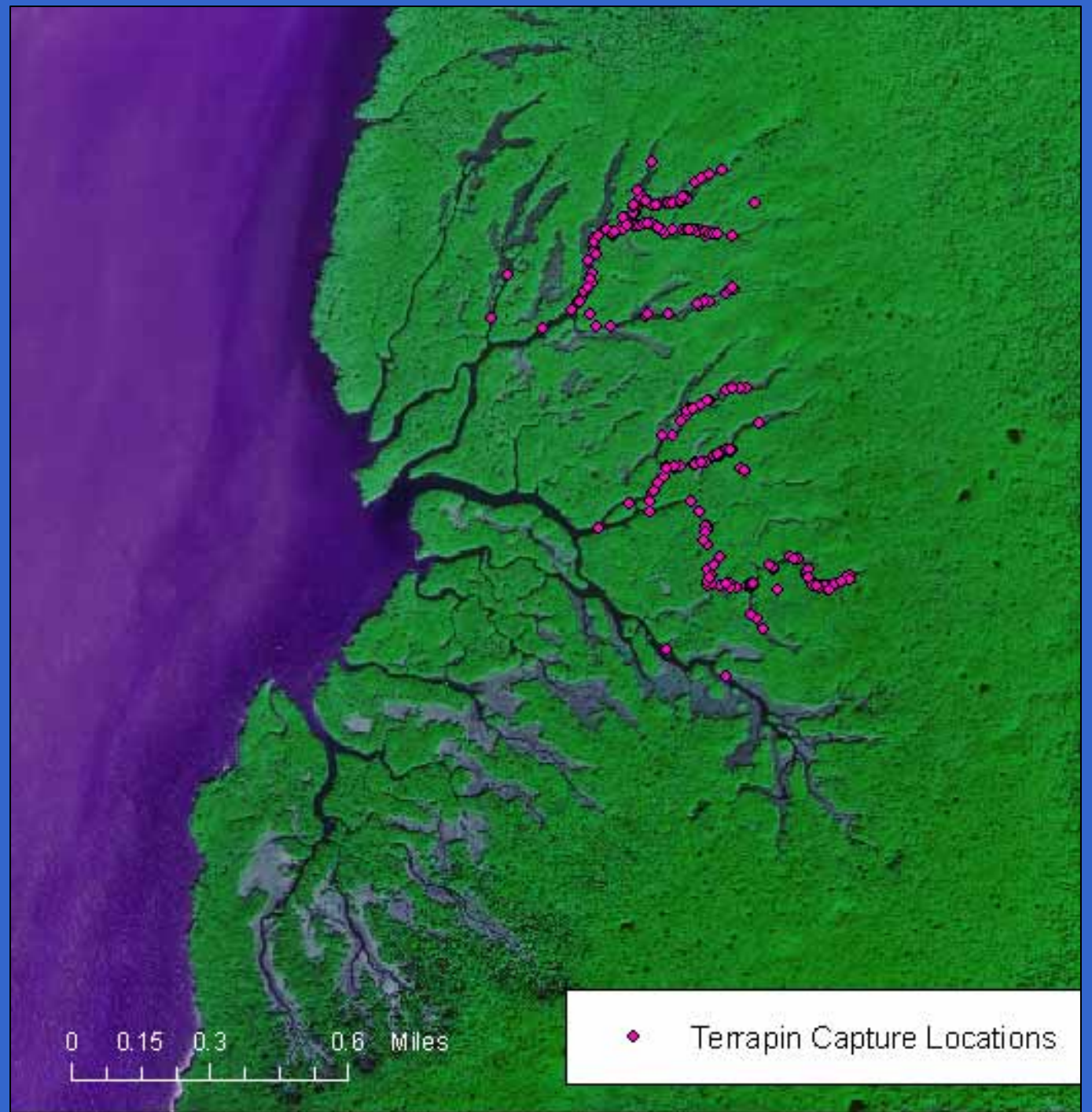
Distribution of Captures

• Association with submerged algal-covered logs in headwaters

Remnants of red mangrove trees:
The Great Labor Day Hurricane (1935)
Hurricane Donna (1960)

≋USGS

Captures & Recaptures

- 364 individuals marked

- ~1:1 sex ratio (170 F: 194 M)

- 80% females = adults

- 94% males = adults

- Strong site fidelity

- High recapture rate

USGS

Models and hypothesis-testing in MARK

• 65 unique capture histories in data-set

• c-hat = 1.63

• Top Model: constant survival, seasonally-varying probability of capture

• Goodness of Fit Tests: No detectable differences in survival rates or capture probabilities between sexes, no temporary emigration detected

Summary: Capture-Recapture Analysis

- Best model = Phi(.) p(t); constant survival, seasonally-varying probability of capture

- Adult survival: 0.98
  (SE = 0.0038; 95% CI = 0.969 - 0.985)

- Mean capture probability = 0.42;
  winter = 0.31, summer = 0.53

- No trap effects, males and females are equally catchable with current sampling strategy

≋USGS

Conclusions,
Relevance to ENP Restoration

- Baseline data-set for adults of a sentinel species

- Use baseline data to quantify effects of natural disturbances, conduct annual sampling and data collection

- Capture-recapture analysis can be used as a tool to determine effects of habitat alterations accompanying restoration activities

- Impacts of hurricanes on population biology of Everglades residents

Complementary analysis: Genetic "baseline" comparison

- 1409 samples from 31 sites in 10 states, ongoing collection efforts

- Regional collections: MA, NY/NJ, MD, NC, FL

USGS
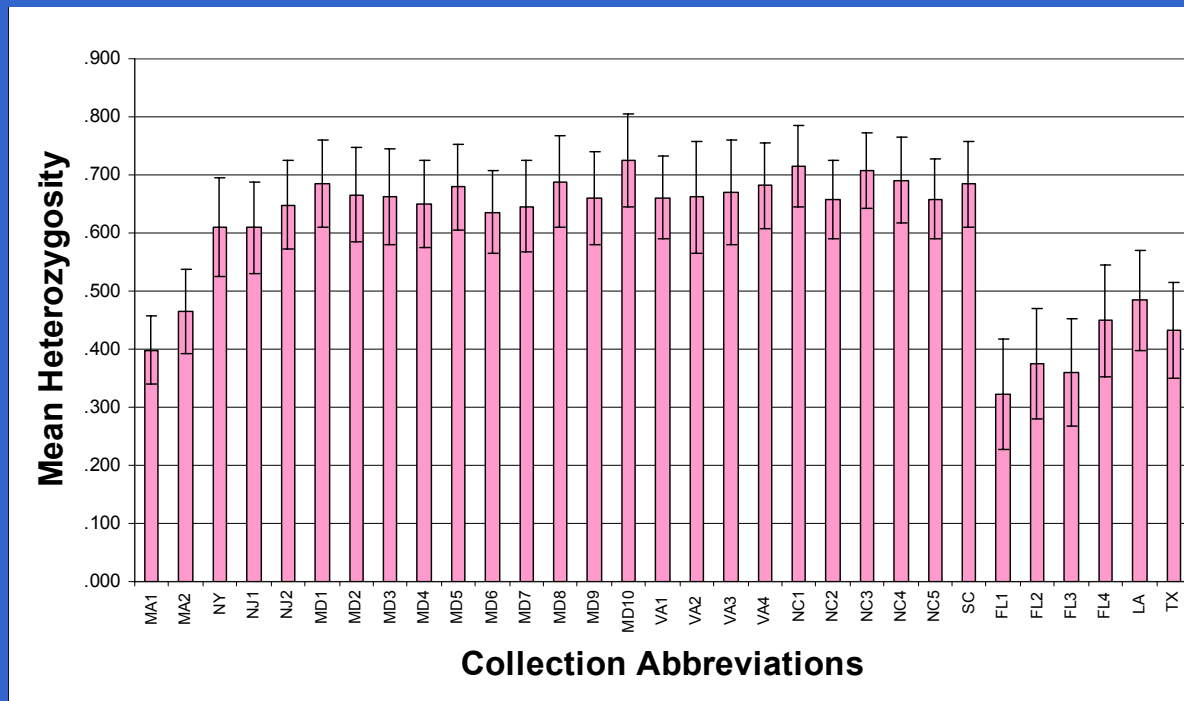
Future Research

- Tracking of females to understand nesting movements, identify nest sites
- Habitat surveys for juveniles
- Examine whether hurricanes, tropical storms, and flooding affect survival and capture probabilities
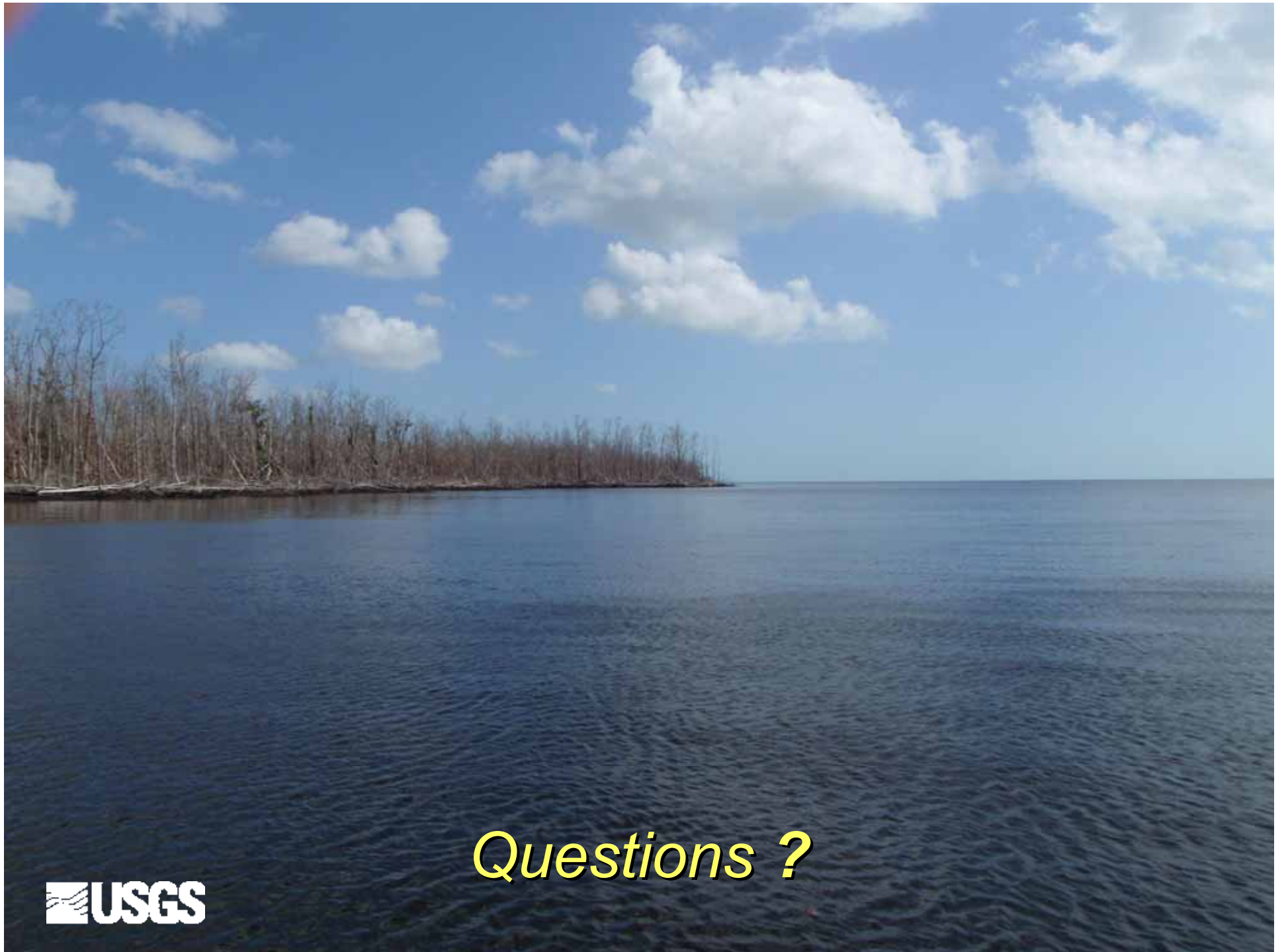
Acknowledgements

Adam Brame, Noah Silverman, BJ Reynolds, Selina Heppell, Larry Crowder, Autumn Sartain, Trey Kieckhefer

U.S. Geological Survey, Priority Ecosystems Studies (PES) Program, the Oak Foundation, Duke University Marine Lab/Nicholas School of the Environment and Earth Sciences (NSOEES), National Park Service

≋USGS

Questions ?

USGS