



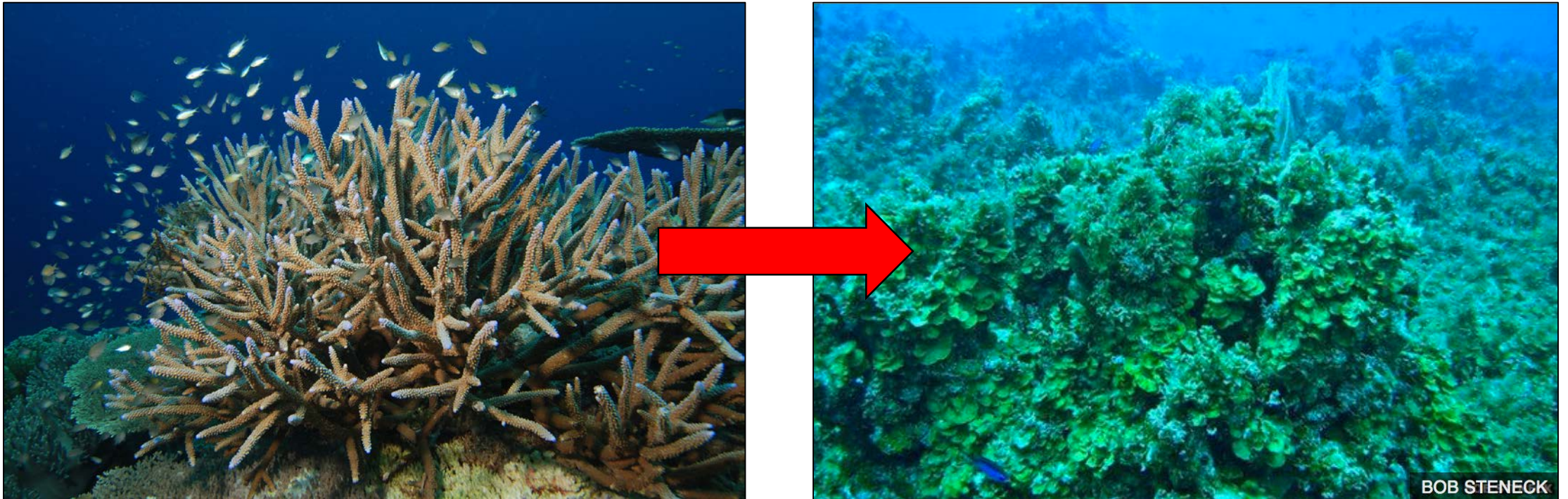
Extreme events and historical regime shifts in the mangrove-salt marsh ecotone

Emily M. Dangremond, Roosevelt University

Ilka C. Feller, Smithsonian Environmental Research Center

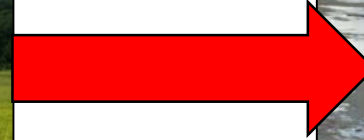
Regime shifts

- A **regime shift** is a transition from one ecosystem state to another

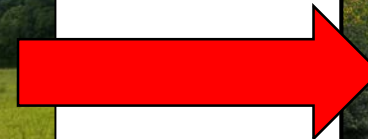


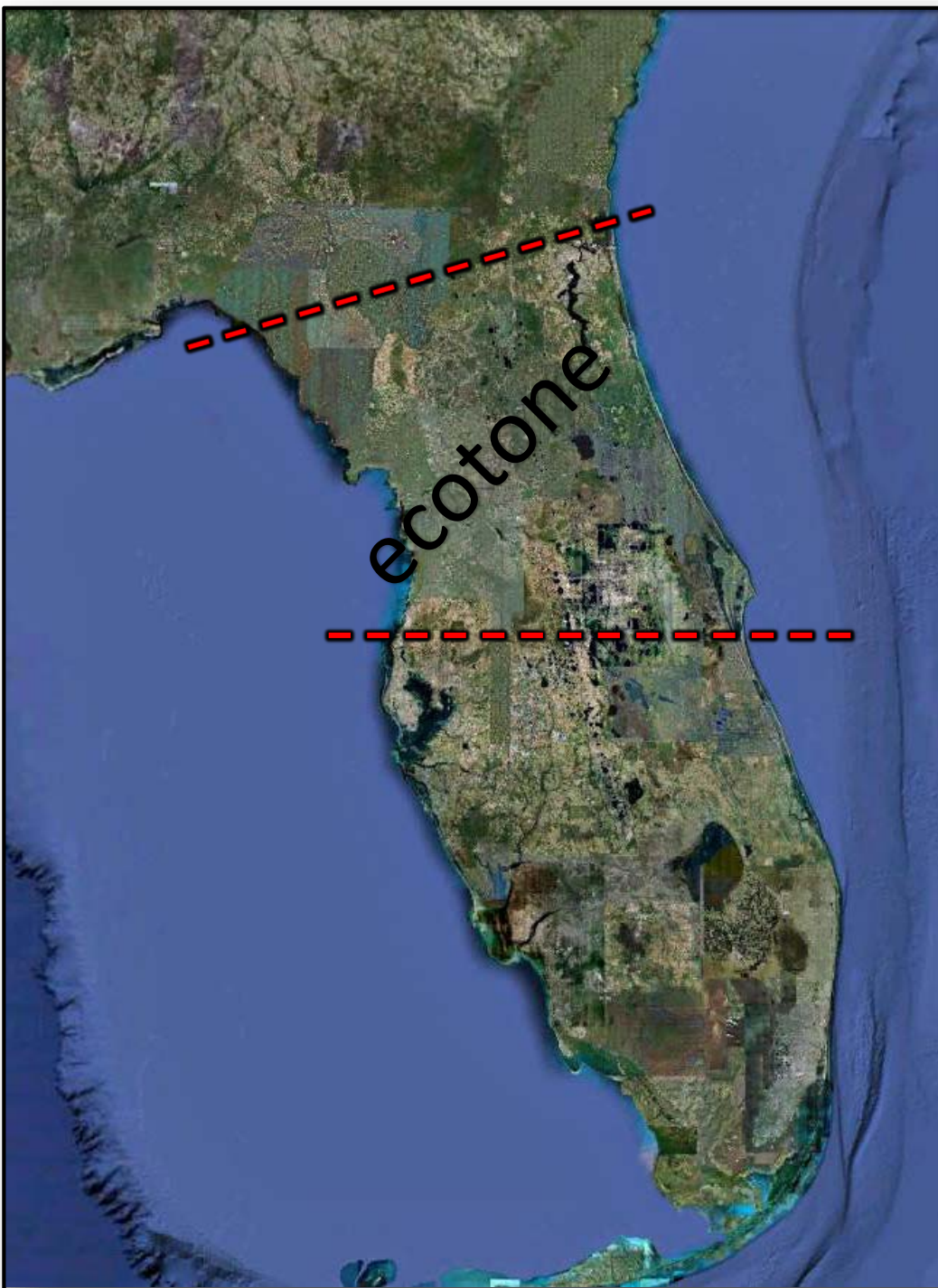
Regime shifts in coastal wetlands

- Salt marsh to mudflat



- Salt marsh to mangrove

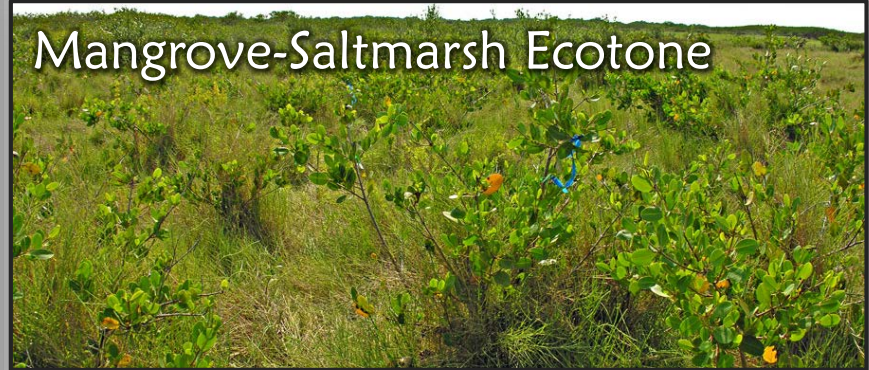




Saltmarsh



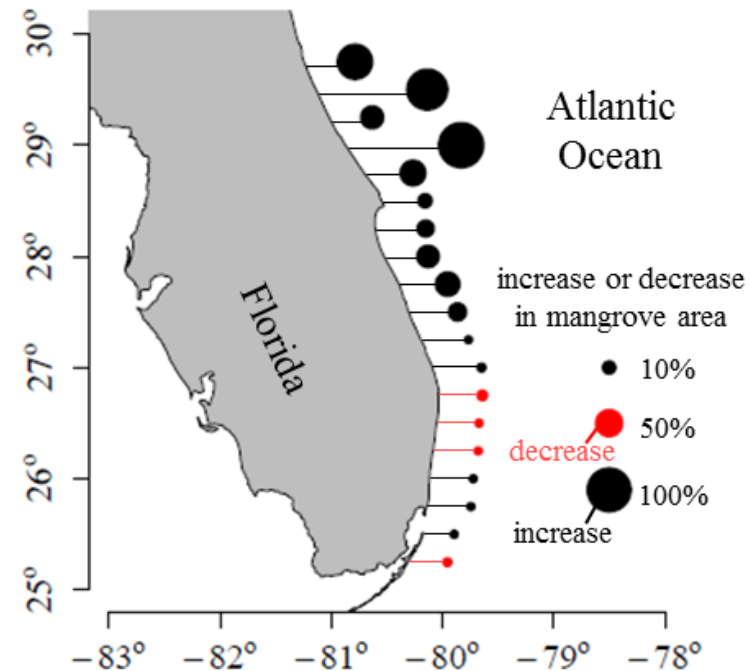
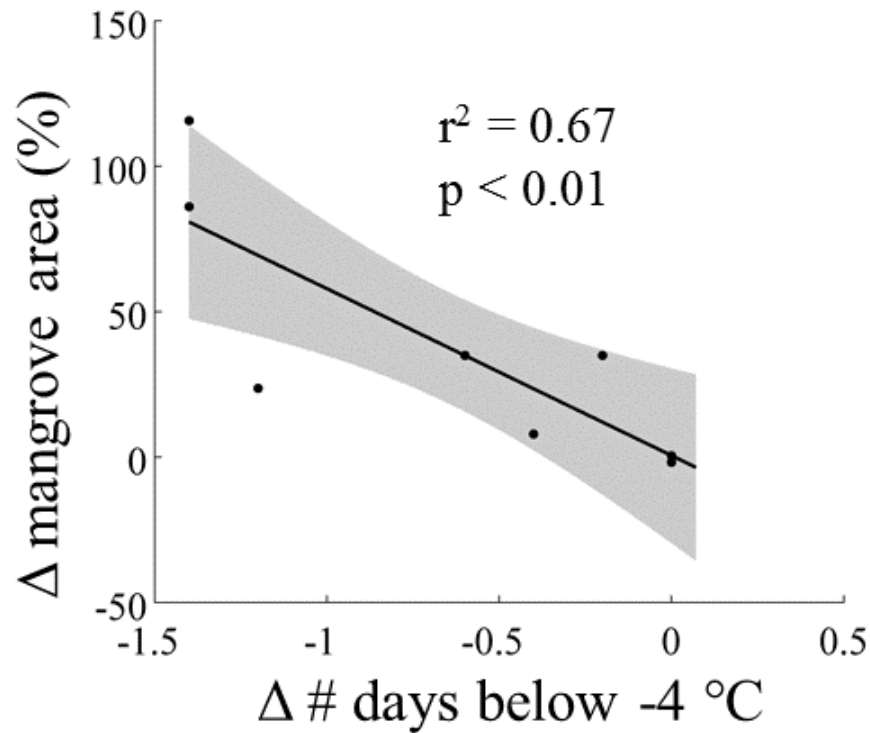
Mangrove-Saltmarsh Ecotone



Mangroves

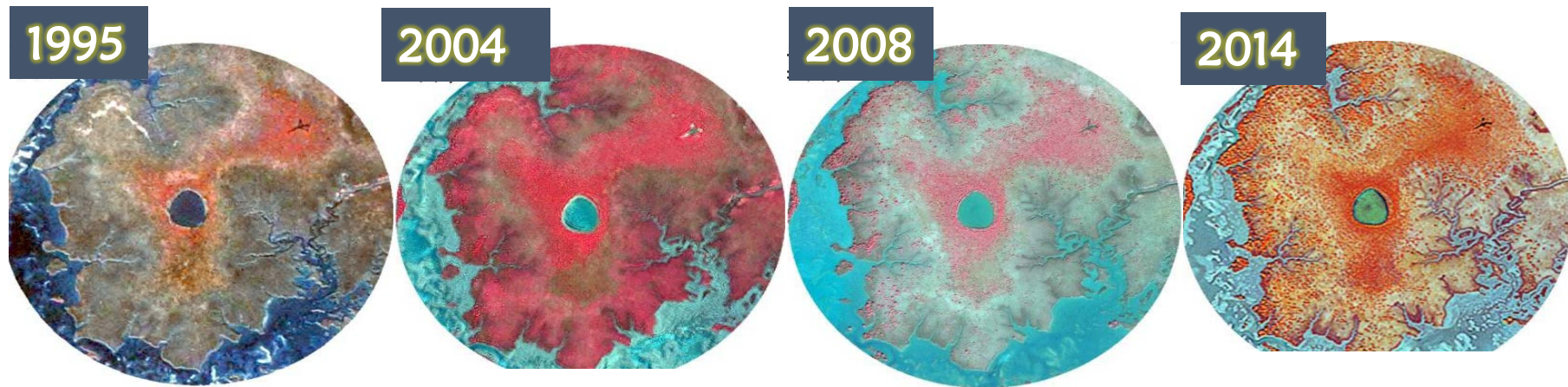
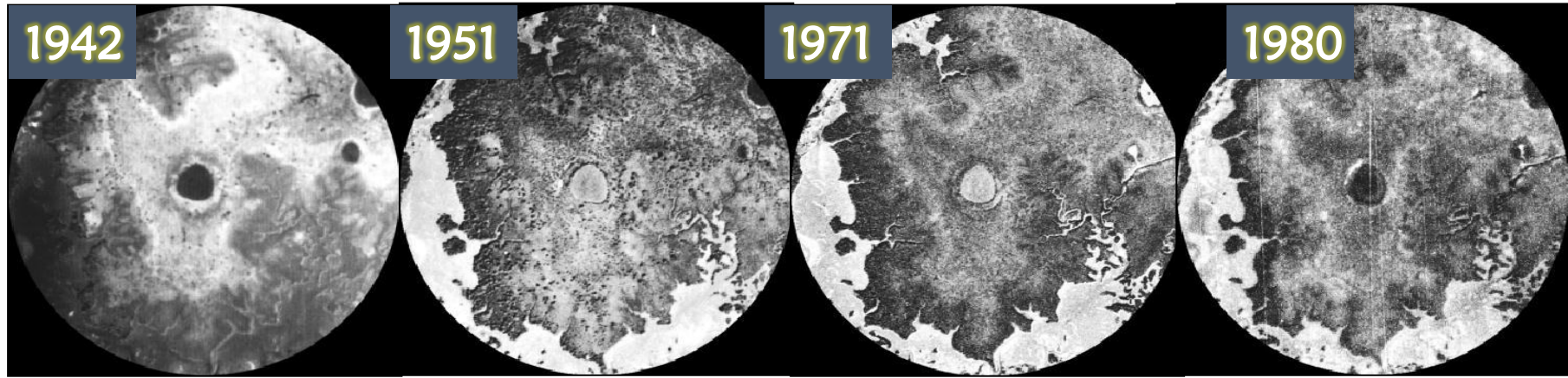


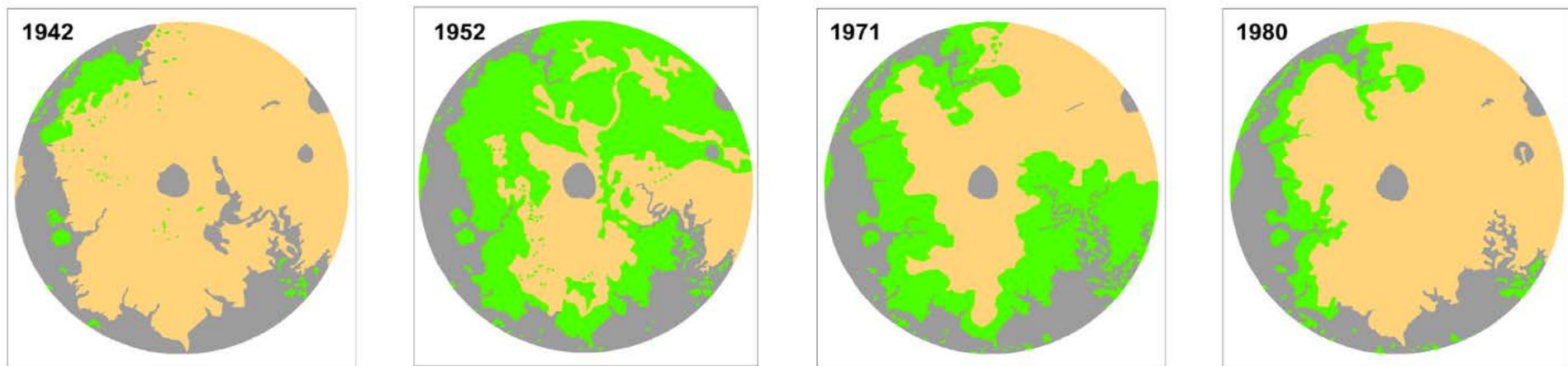
Mangrove increase in the ecotone, 1984-2011



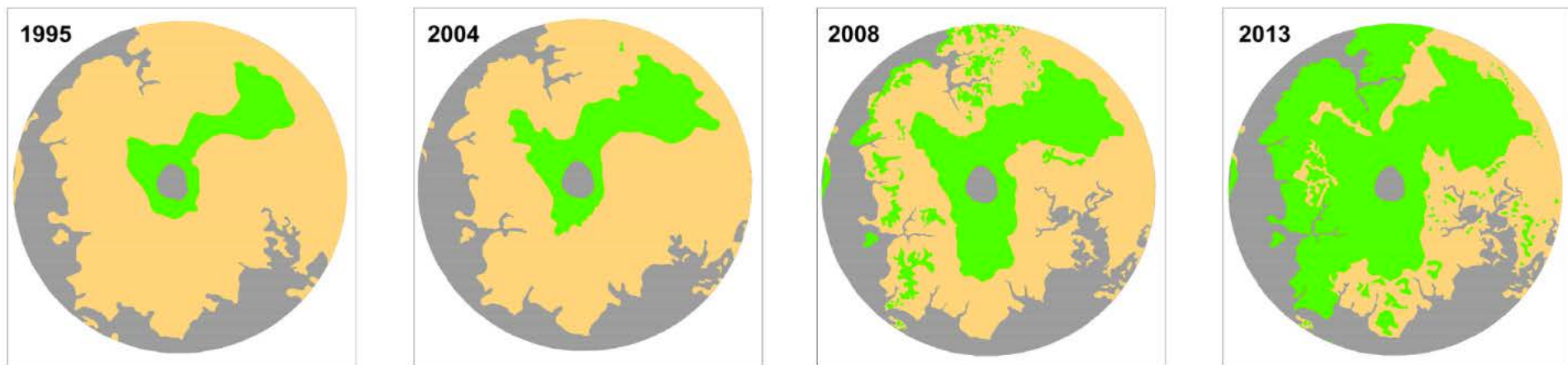
- Based on analysis of Landsat images
- 25.25° to 29.75°N
- Increase ● or Decrease ● in mangrove area

Mangrove increase vs. decrease in the ecotone, 1942-2014



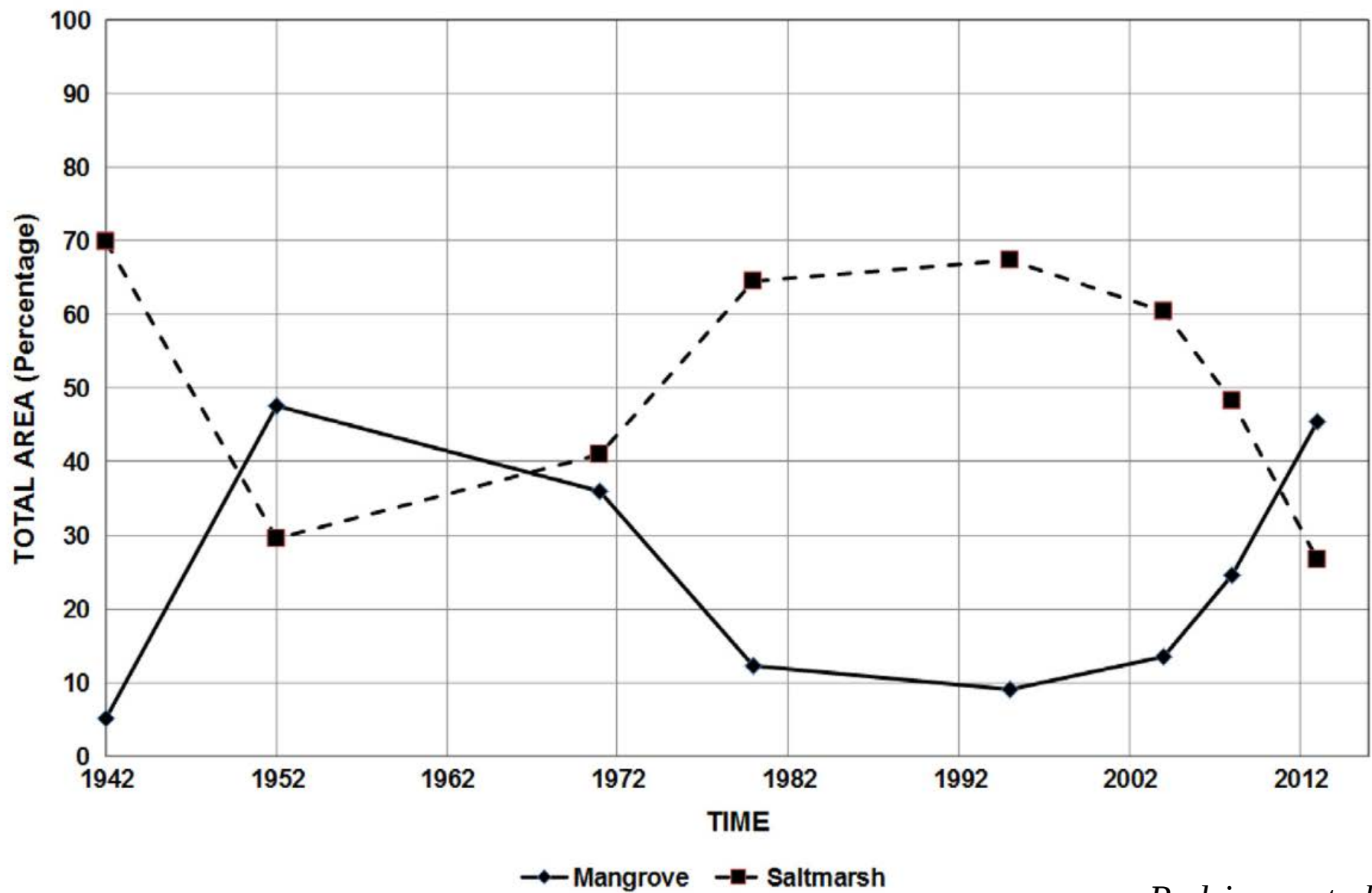


■ Mangrove
 ■ Saltmarsh
 ■ Un-vegetated

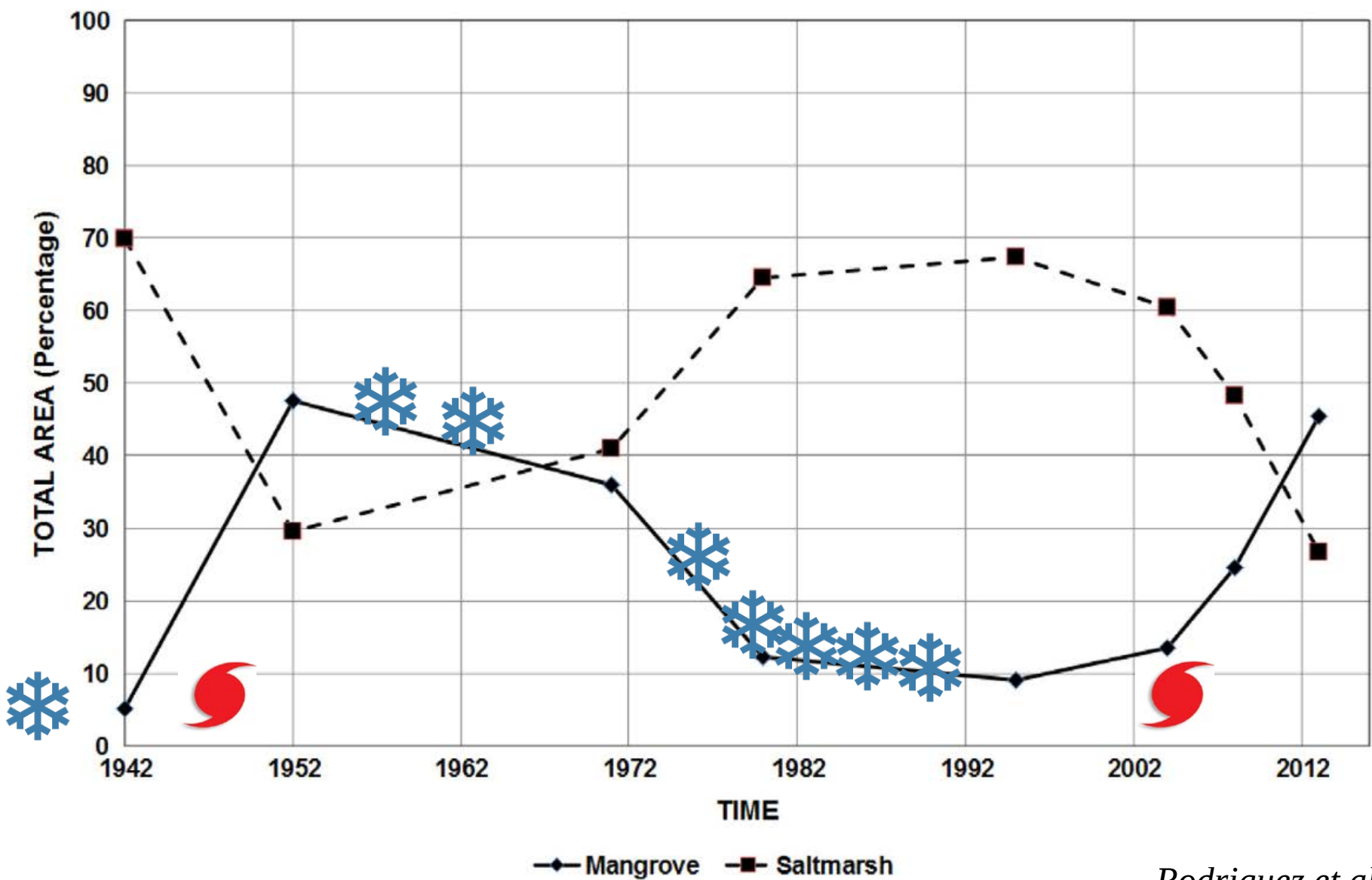


0 0.25 0.5 1
 Kilometers

Rodriguez et al. 2016

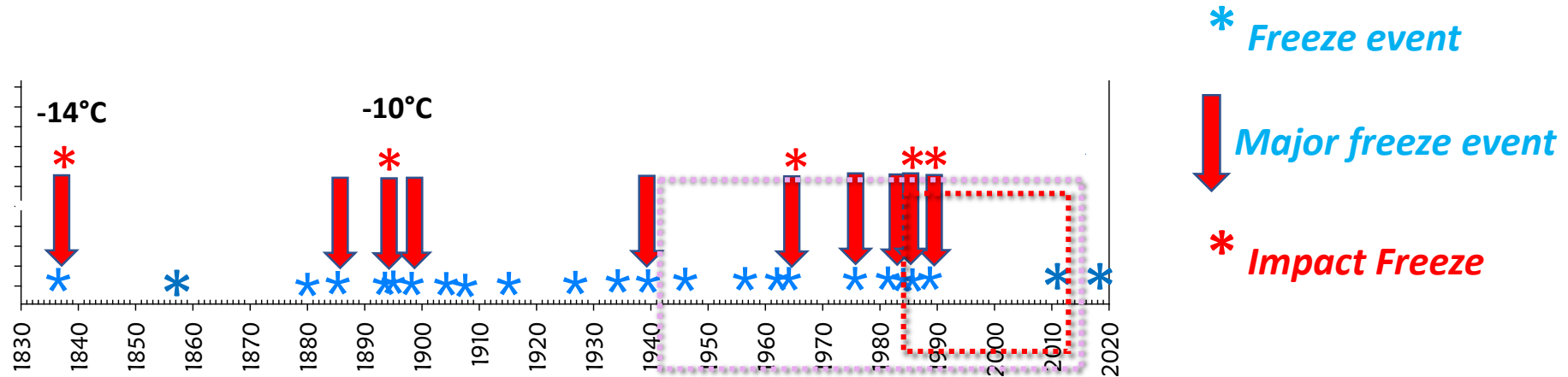


Rodriguez et al. 2016



Rodriguez et al. 2016

Timeline: major FL freezes, 1835-present



Year	Minimum temp. in St Augustine	Days below freezing
1940	-11.1°C	3
1962	-10.0°C	2
1977	-10.0°C	3
1981	-7.8°C	3
1982	-6.1°C	2
1983	-8.9°C	3
1985	-12.2°C	4
1989	-8.3°C	5
2010	-3.3°C	4
2018	-3.9°C	3

Rodriguez et al. 2016
(1942-2014)

Cavanaugh et al. 2014
(1984-2011)

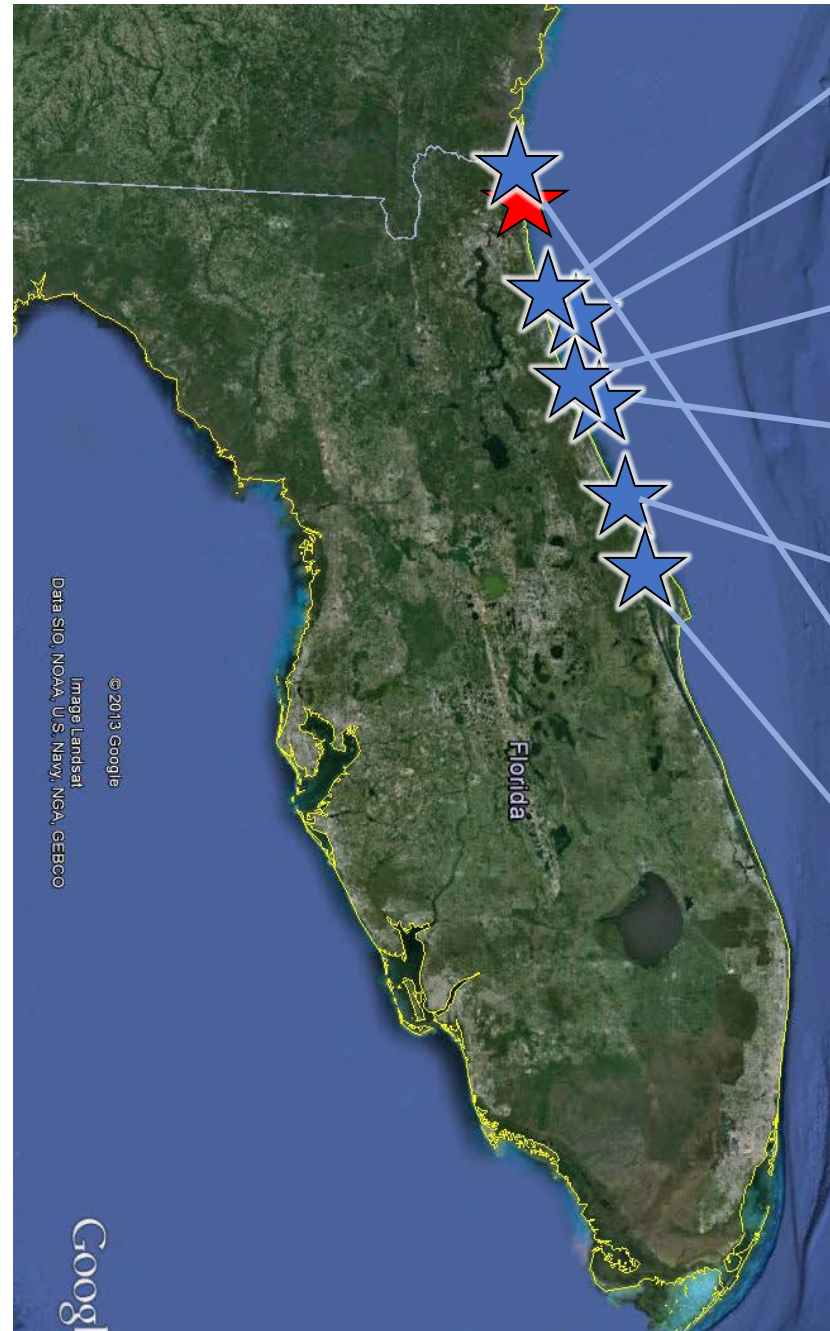
From John Attaway 1997
A History of Florida Citrus Freezes

...before 1942?

Going back in time, we can't use remote sensing or aerial photos

But, we can use historical records...

- naturalists' journals
- flora/fauna surveys
- personal journals
- correspondences
- maps and charts
- herbarium specimens
- Etc.



● Bartram 1774: *Avicennia*, St Augustine

● Michaux 1788: *Avicennia* and *Rhizophora*, St Augustine

● Vignoles 1823: *Rhizophora* islands, 20 km north of Ponce Inlet

● Audubon 1835: *Rhizophora* islands, 50 km north of Ponce Inlet

● Motte 1836: *Rhizophora* islands (dead), New Smyrna

● Muir 1867: *Avicennia* clumps, St Marys River

● Nicholson 1928: *Avicennia* trees (dead), Merritt Island

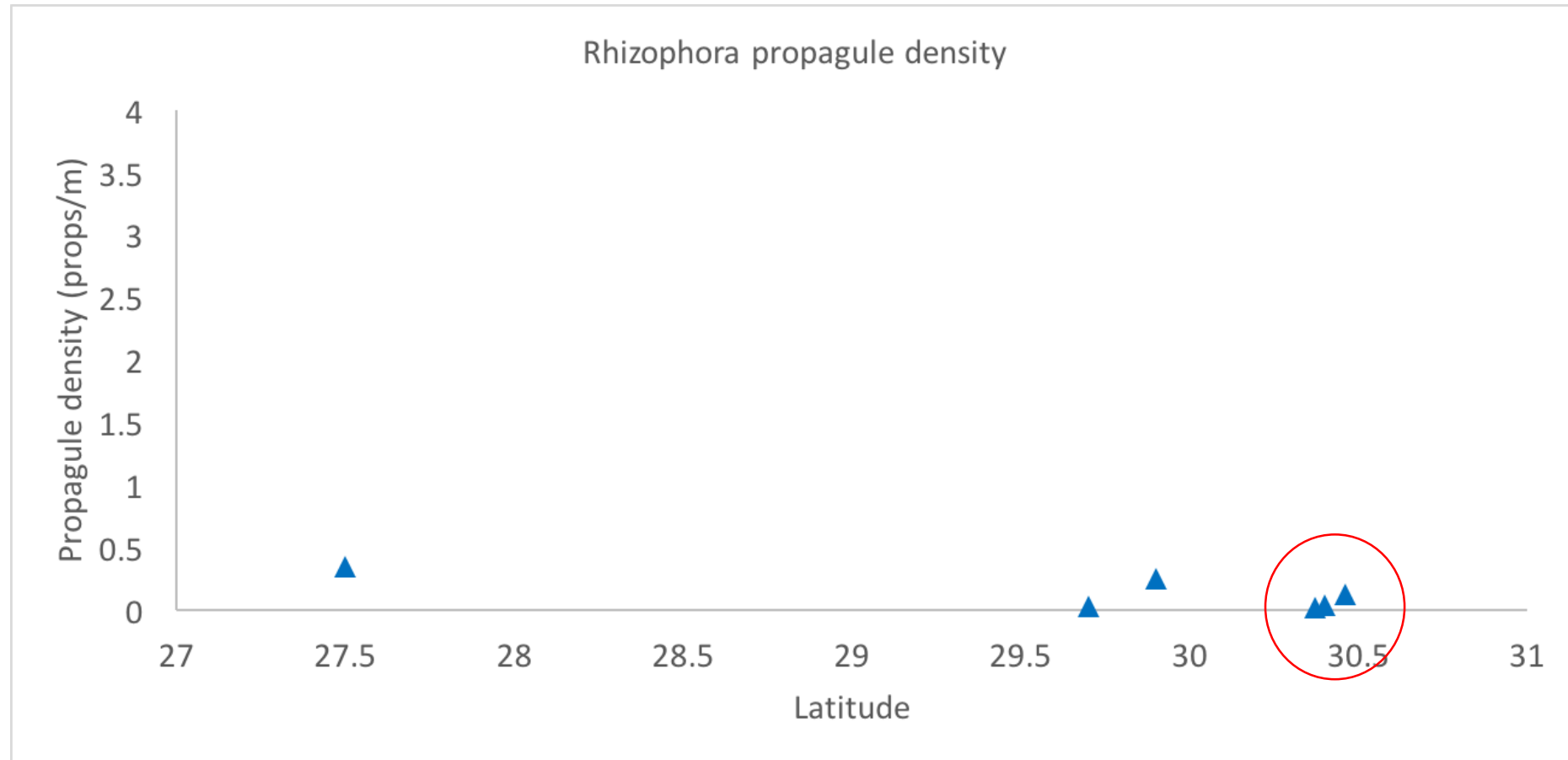
★ Current northernmost, *Avicennia* and *Rhizophora* clumps

Can hurricanes drive mangroves northward?

- Propagule surveys along beaches along Florida's Atlantic coast
- October 2014, no hurricane
- October 2017, 5 weeks after Hurricane Irma

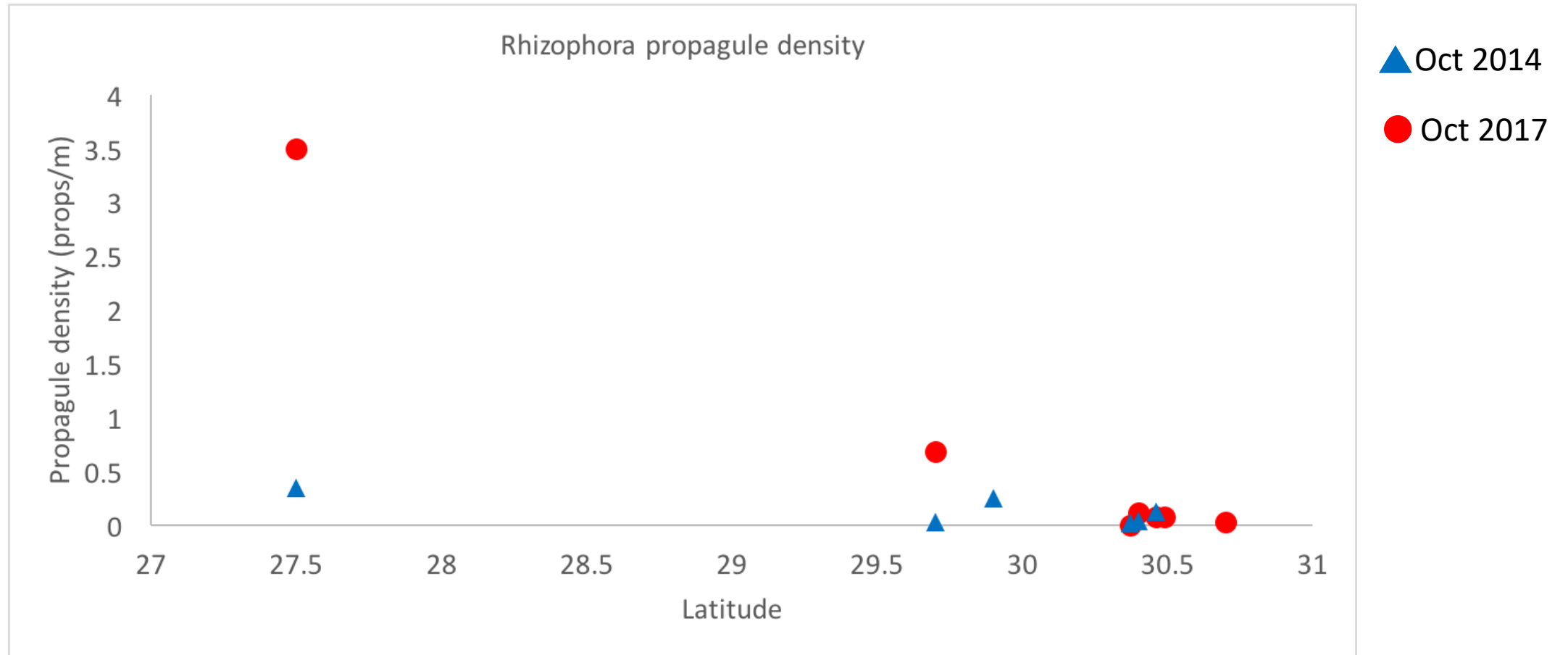


Red mangrove propagule density on Florida beaches—no hurricane

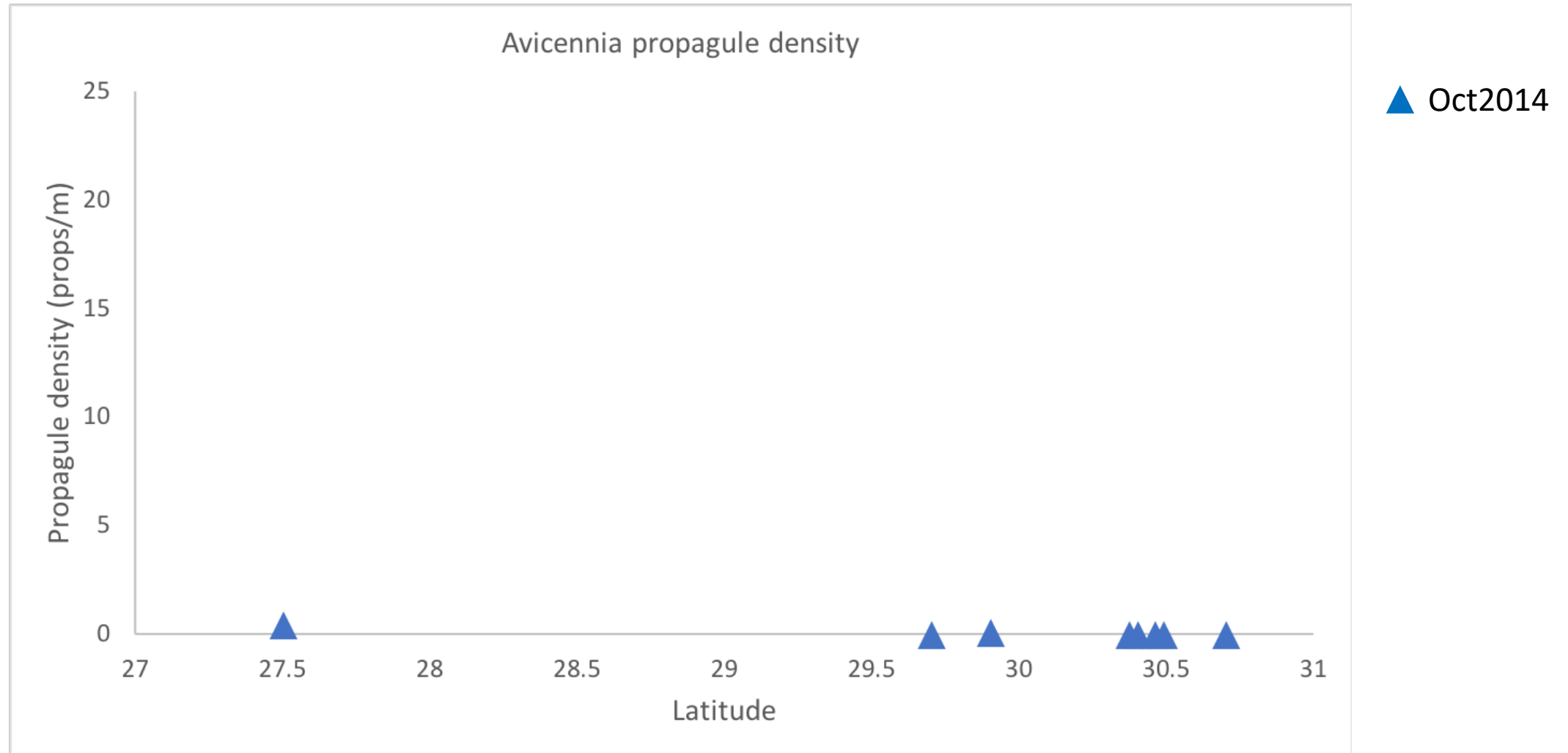


▲ Oct 2014

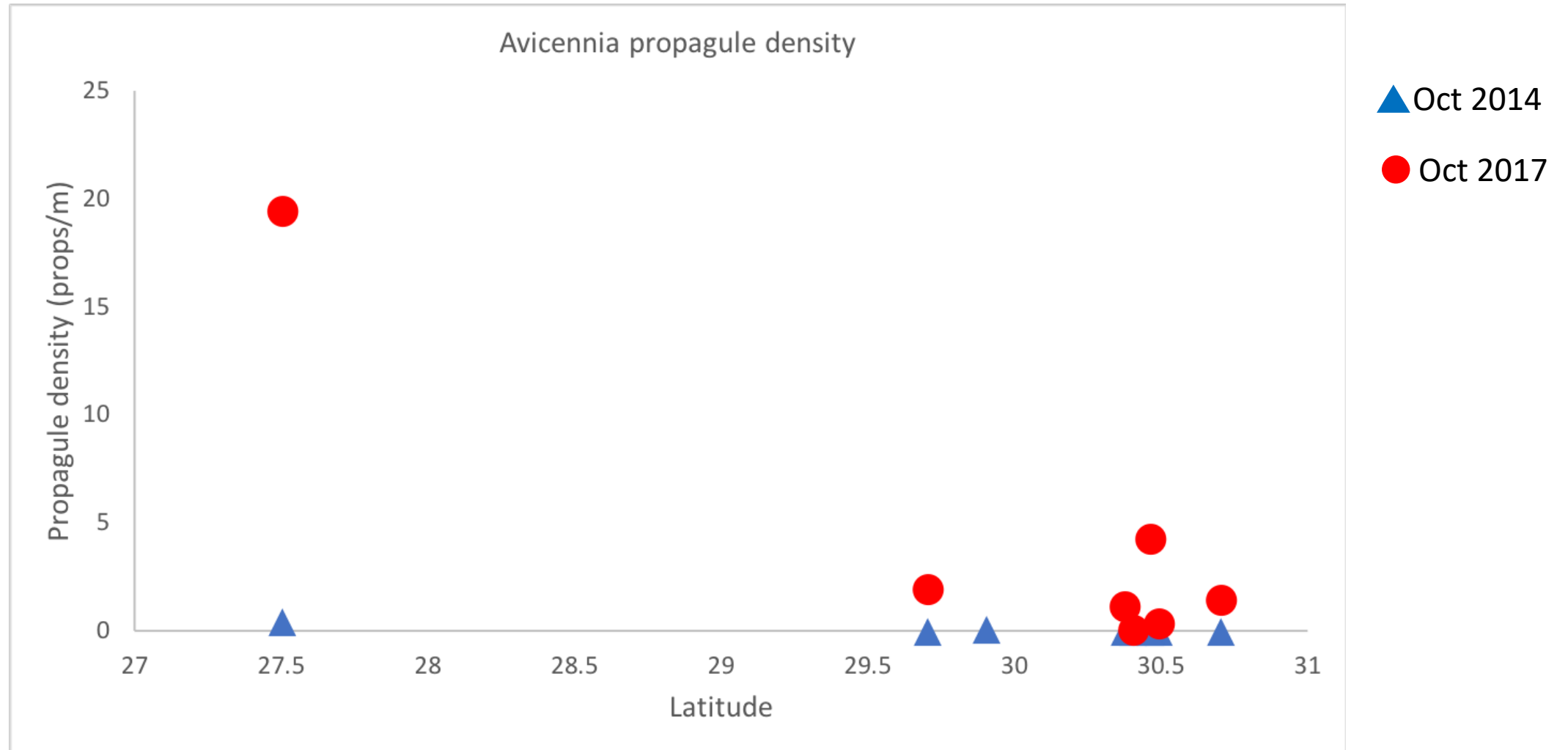
Red mangrove propagule density on Florida beaches—post hurricane Irma



Black mangrove propagule density on Florida beaches—no hurricane



Black mangrove propagule density on Florida beaches—post Hurricane Irma



Conclusions

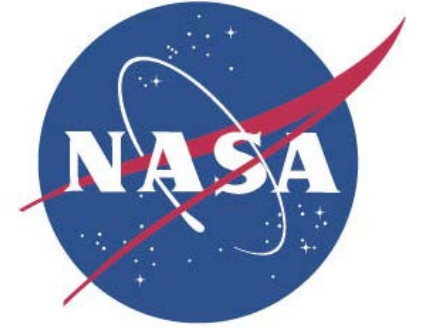
- Mangroves and salt marshes have both dominated coastal wetlands in Florida at different times
- Freezes favor salt marsh dominated-systems
- Hurricanes may favor mangrove-dominated systems
- Future work: track mangrove establishment after hurricanes

Acknowledgments

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Smithsonian Environmental
Research Center



Questions

Emily Dangremond: edangremond@roosevelt.edu

Candy Feller: felleri@si.edu

