

# REMOTE SENSING + ECOLOGICAL EXPERIMENTATION TO DETECT & EXPLAIN MANGROVE RANGE EXPANSION

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Smithsonian Environmental  
Research Center



## Mangrove wetlands

~75% of the world's tropical coastlines  
\$1.6 trillion/year in ecosystem services









(another shameless picture of charismatic megafauna)

# **'Mangrove' is a saltwater lifestyle, not a (plant) family**

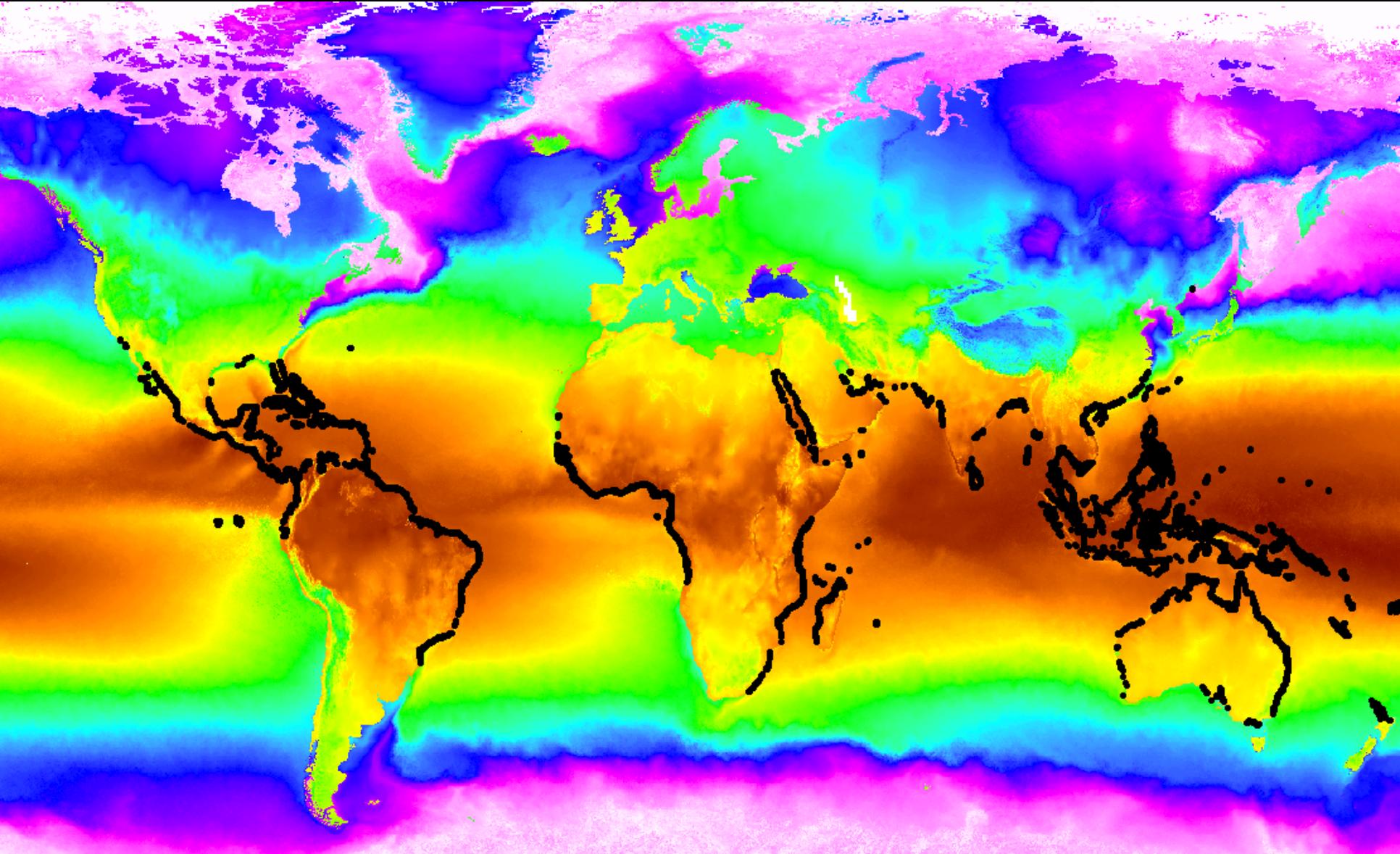
**~60,000 tree species**

**~70 mangrove species**

**~0.1% of trees are mangroves**



# NO COLD MANGROVES



**AT/SST: Mean Monthly Winter  
Minimums (BIOCLIM/MODIS)**

# 2010 cold snap in Florida





1980s sign, Merritt Island National Wildlife Refuge

**2016**



## Spared Winter Freeze, Florida's Mangroves Are Marching North

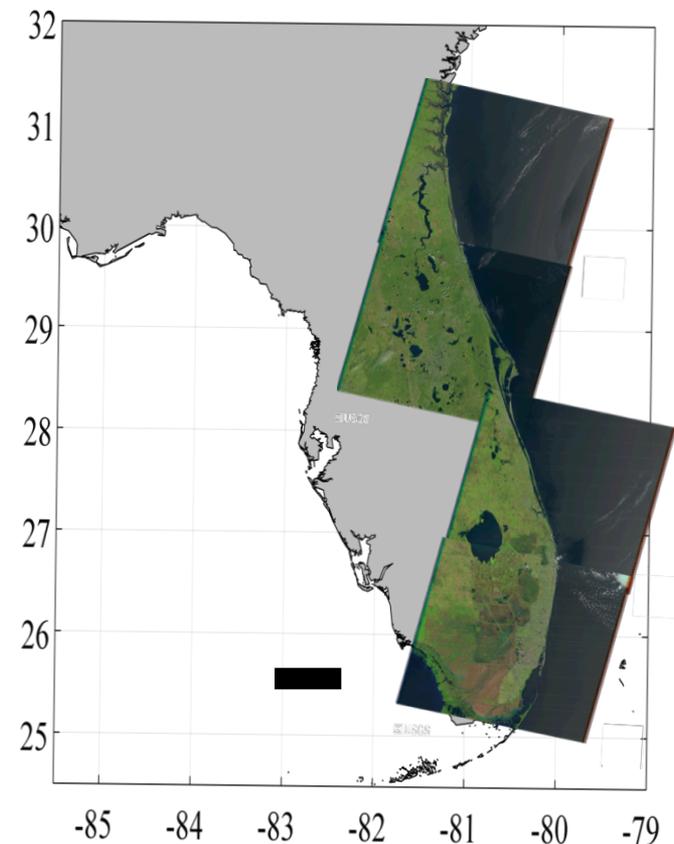


Barbara P. Fernandez for The New York Times

Mangrove forests, like in the Everglades, serve as spawning grounds and nurseries for fish and as habitat for a wide array of organisms. But salt marshes are also ecologically valuable.

By JUSTIN GILLIS

Published: December 30, 2013 | 173 Comments



# Poleward expansion of mangroves is a threshold response to decreased frequency of extreme cold events

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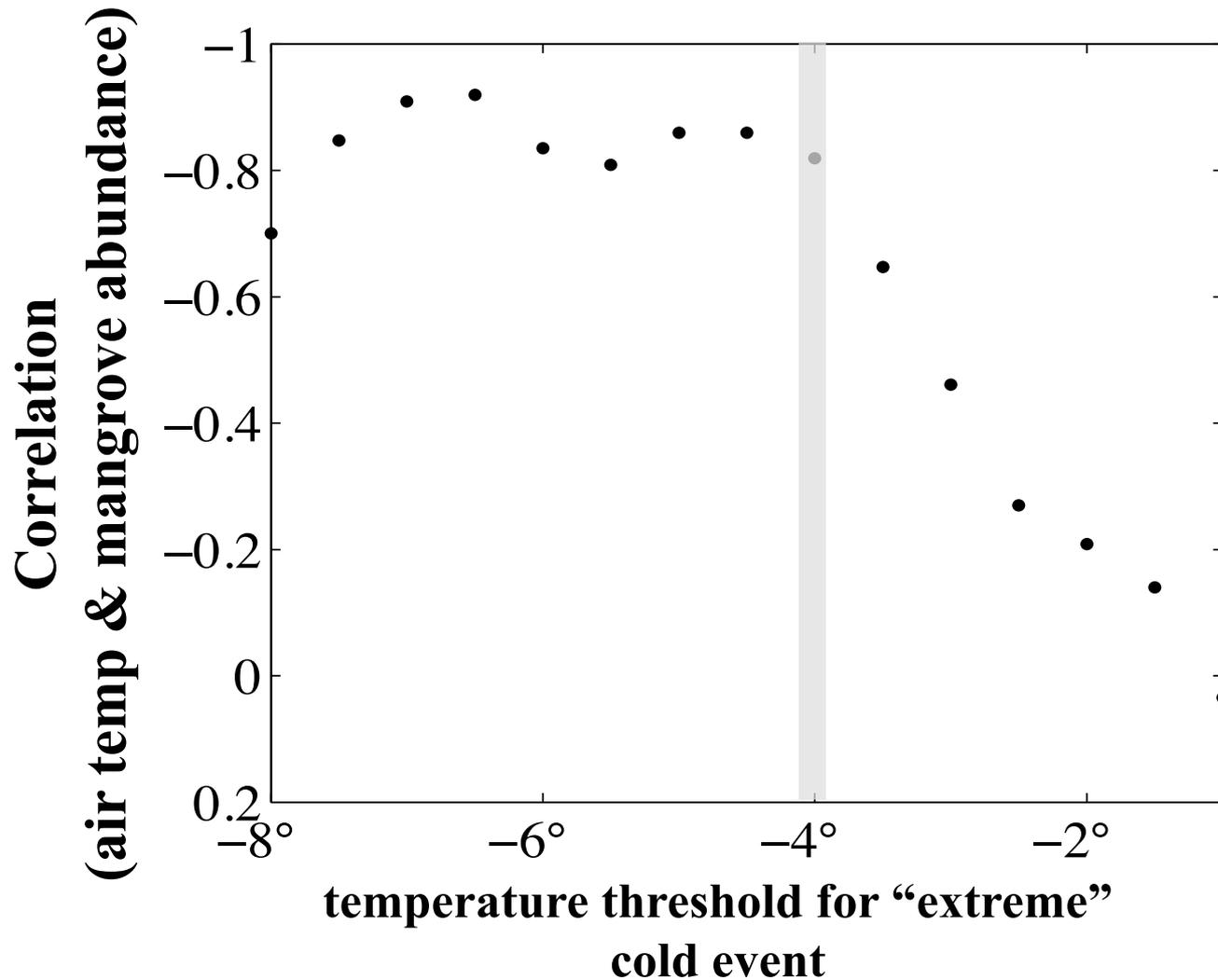
<sup>a</sup>Smithsonian Environmental Research Center, Smithsonian Institution, Edgewater, MD 21037; <sup>b</sup>Department of Ecology and Evolutionary Biology, Brown University, Providence, RI 02912; <sup>c</sup>Graduate Program in Behavior, Ecology, Evolution, and Systematics, University of Maryland, College Park, MD 20742; and <sup>d</sup>Department of Entomology, University of Maryland, College Park, MD 20742

Edited by George M. Woodwell, Woods Hole, MA, and approved November 22, 2013 (received for review August 20, 2013)



# Temperature threshold

<  $-4^{\circ}\text{C}$  in winter = reduced mangrove cover in summer

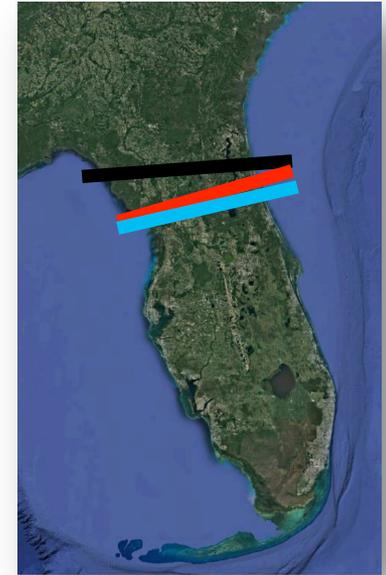
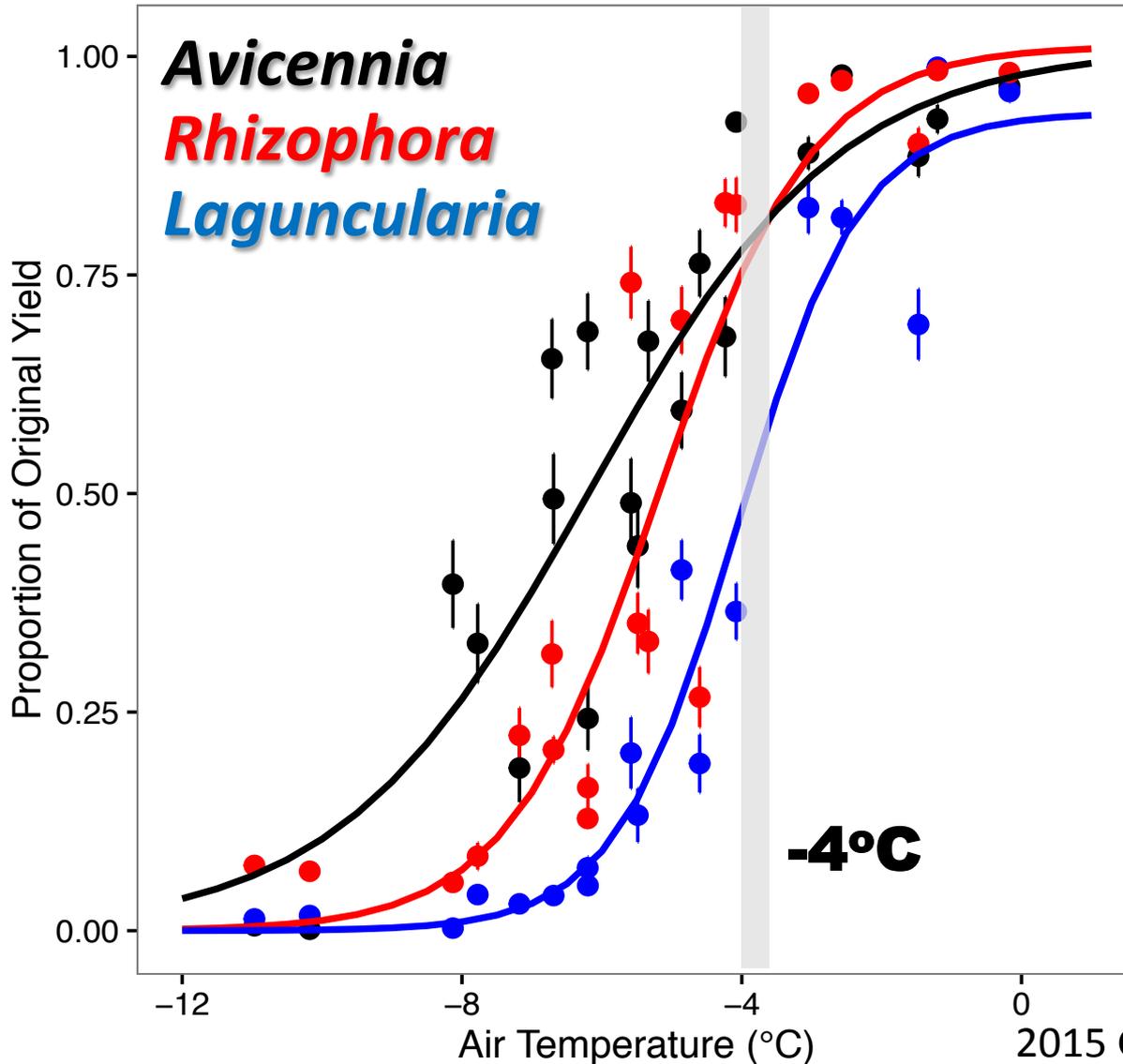


# Simulated 'freeze' events

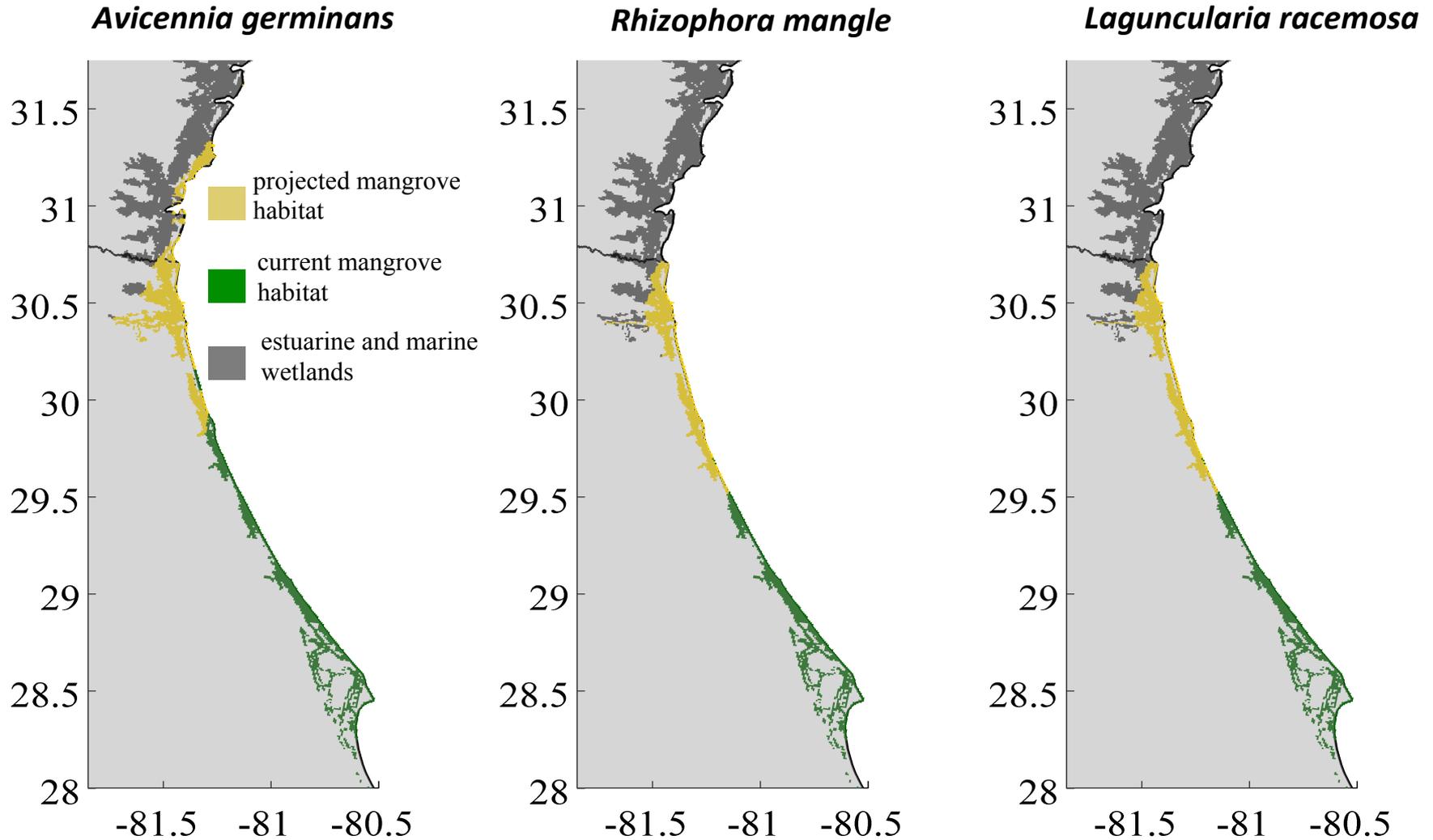
**-11°C, -10, -8, -6, -4 -2, 0**



# SPECIES-SPECIFIC RESISTANCE TO FREEZING AIR = RANGE-LIMITS



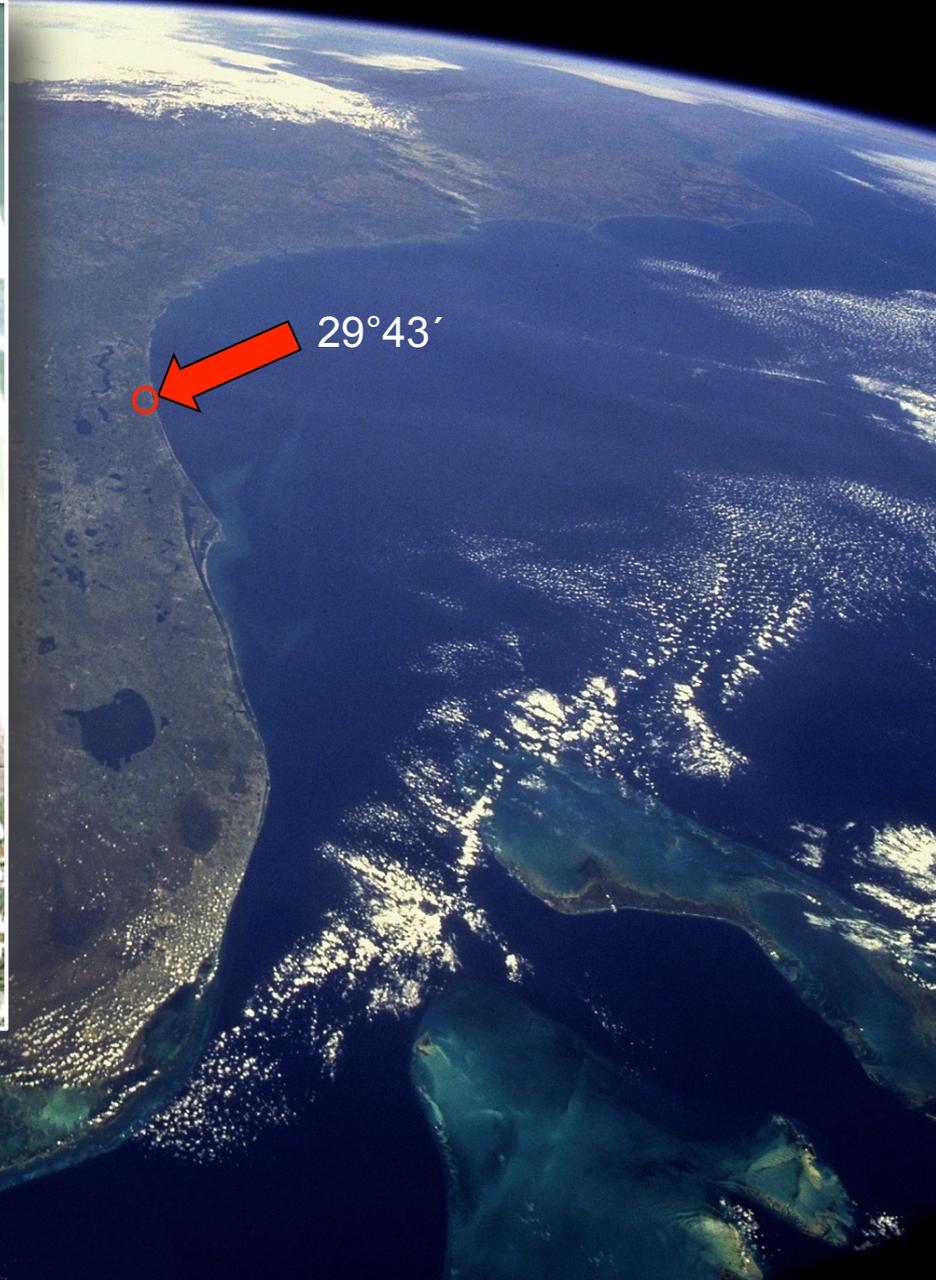
# Projected mangrove distributions in 2060

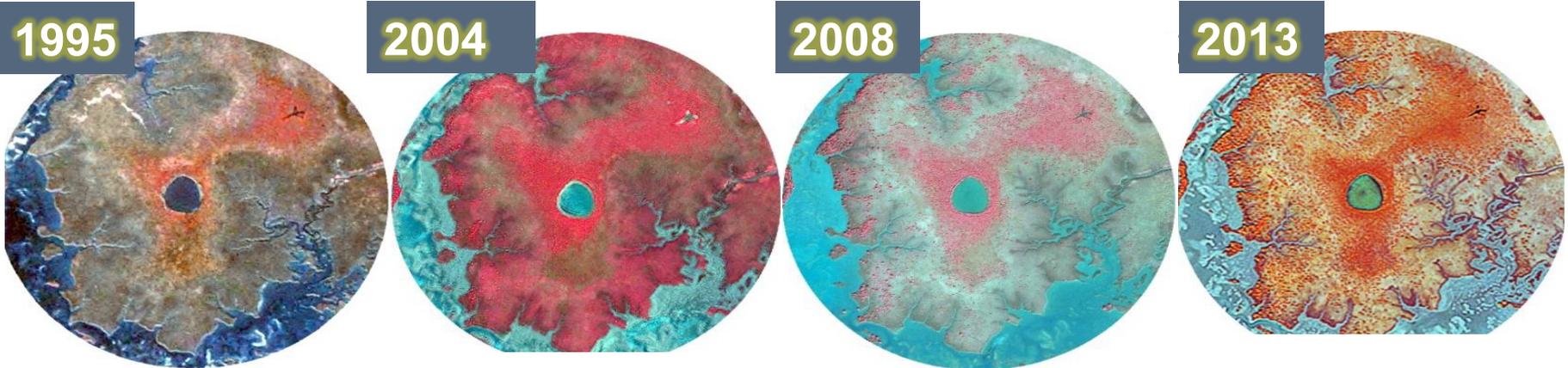
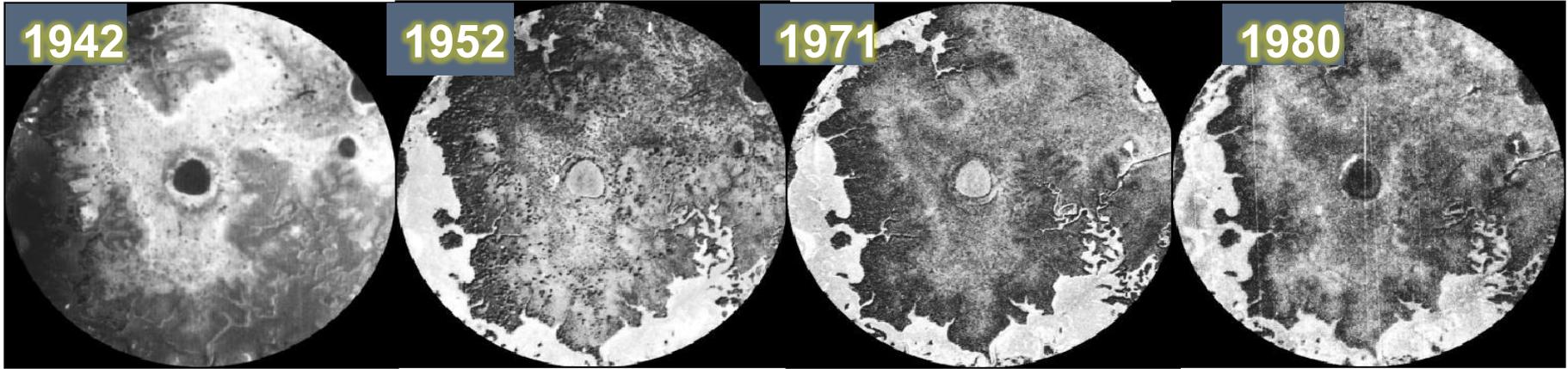


**Georgia: 1/3 of all eastern US saltmarsh**

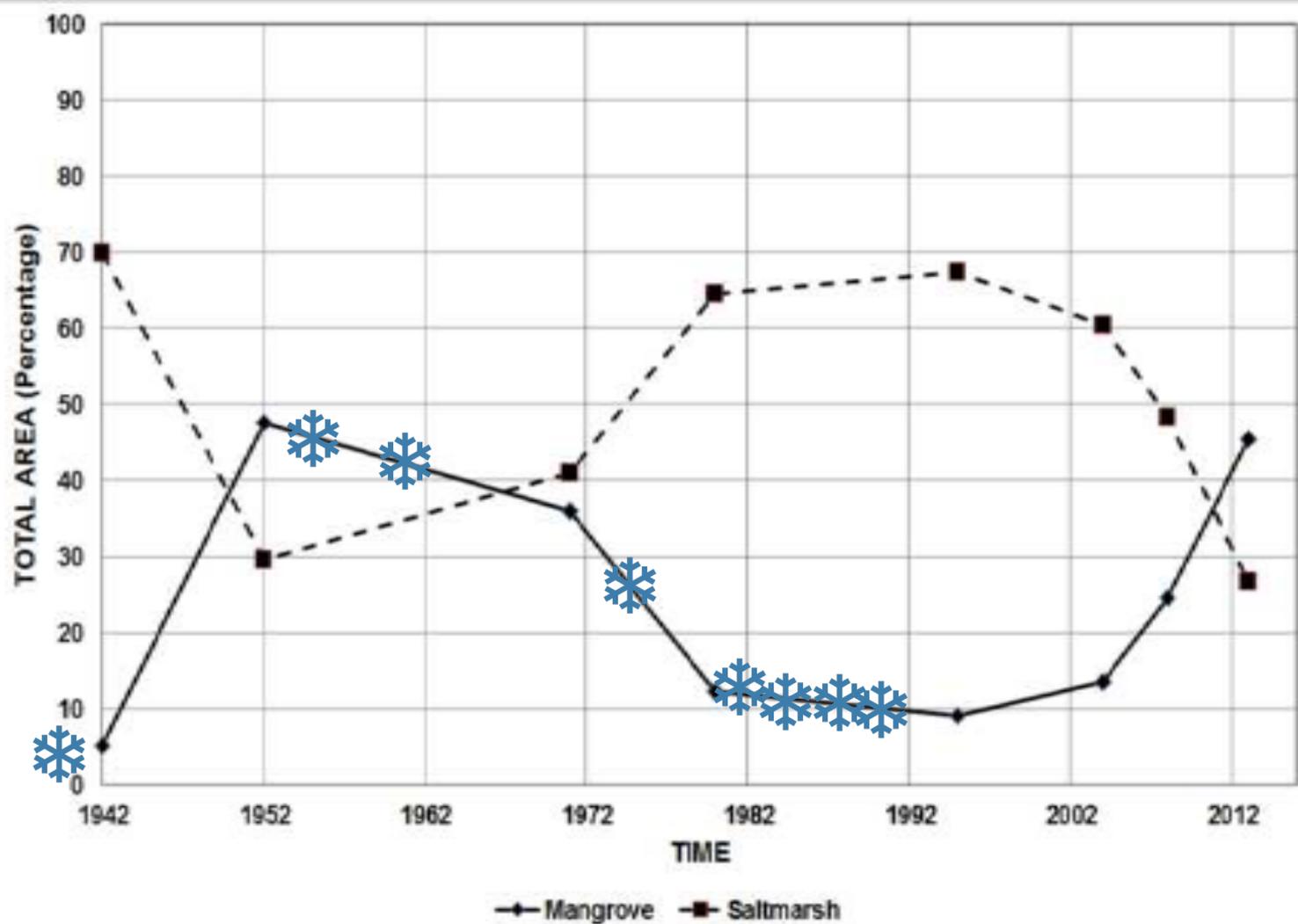


# Expansion/contraction of mangroves and saltmarsh habitats





# Mangrove/marsh oscillation at the edge





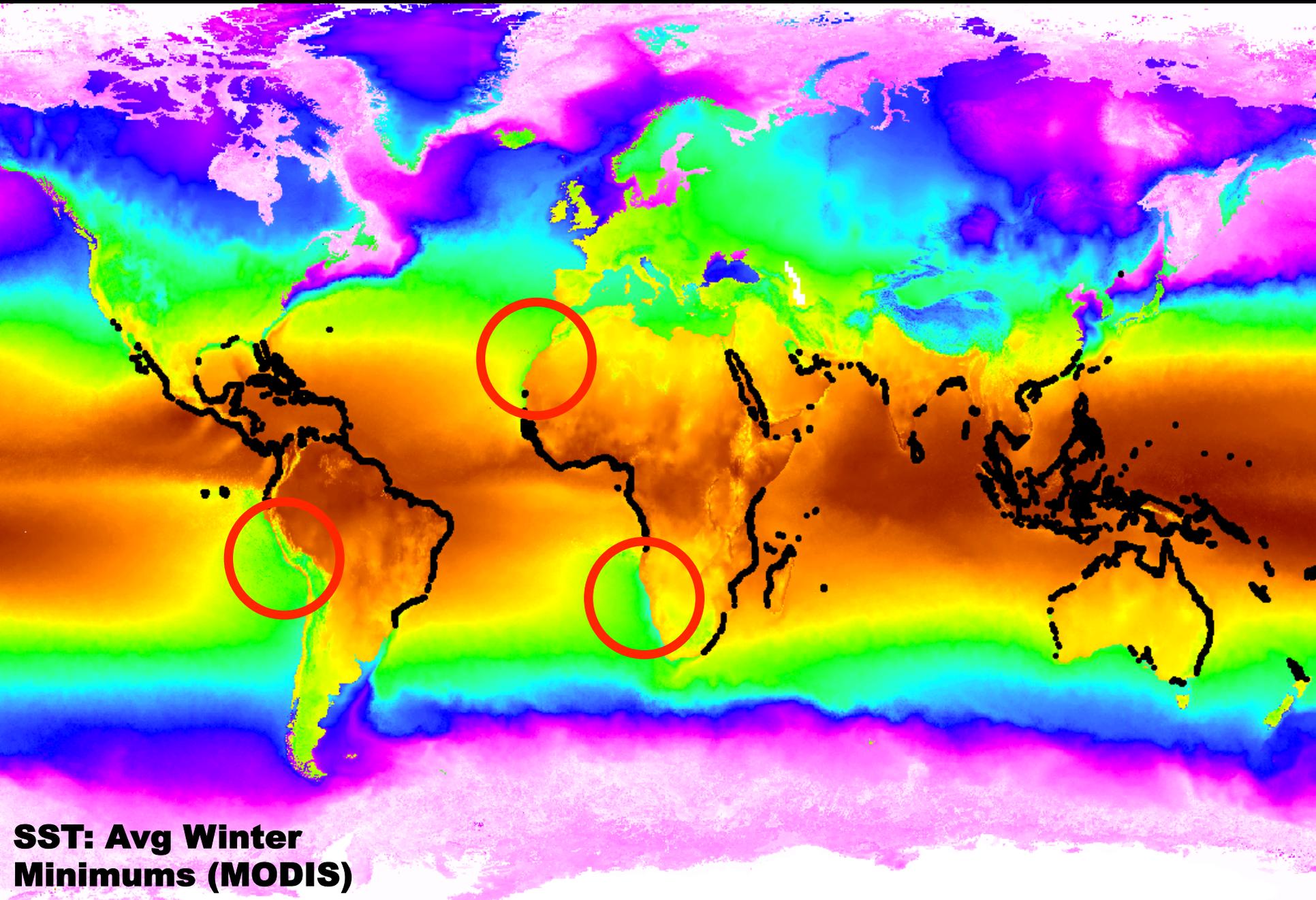
1, 2 *Bruguiera* 3 *Kandelia* 4-6 *Rhizophora apiculata* 7, 8 *Rhizophora* sp1 (cf. *stylosa*)  
 9 *Rhizophora* sp2 (cf. *mucronata*) 10 *Ceriops* 11 *Aegiceras corniculatum* 12 *Avicennia*  
 13 *Xylocarpus* 14 *Excoecaria agallocha* 15 *Sonneratia* sp1 (unidentified) 16-18 *Sonneratia caseolaris*  
 19 *Sonneratia* cf. *ovata* 20, 21 *Sonneratia* cf. *alba* 22 *Barringtonia* 23 *Nypa fruticans*

**MANGROVE RANGE LIMITS ~**

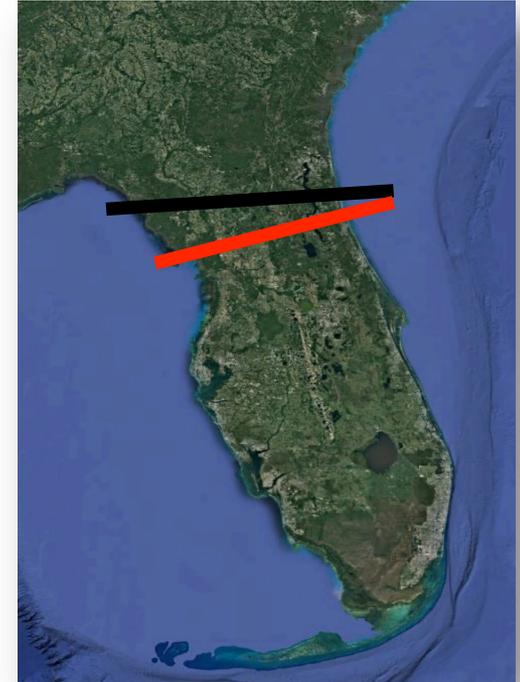
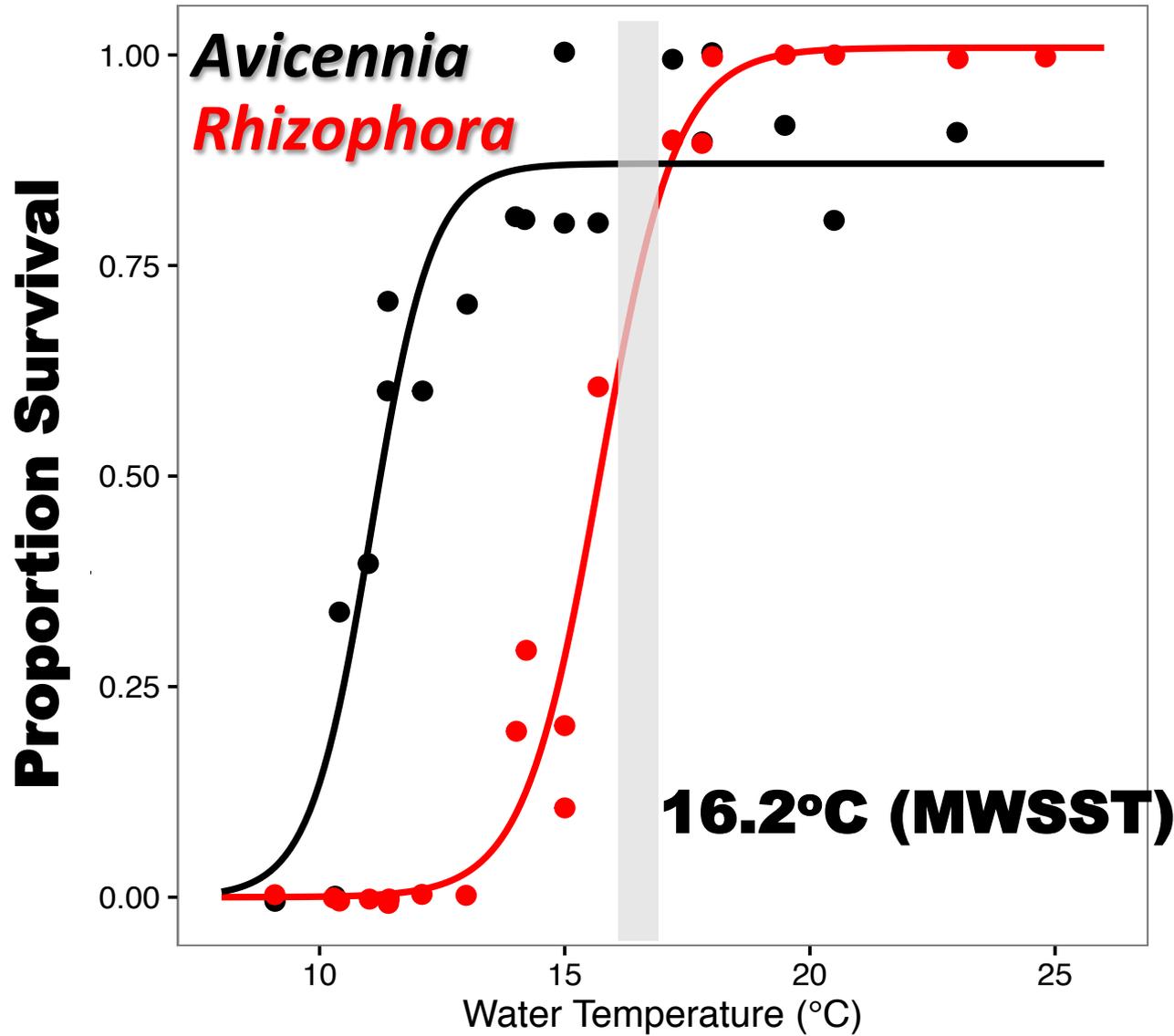
**COLD AIR**



# RANGE LIMITS ~ COLD WATER?

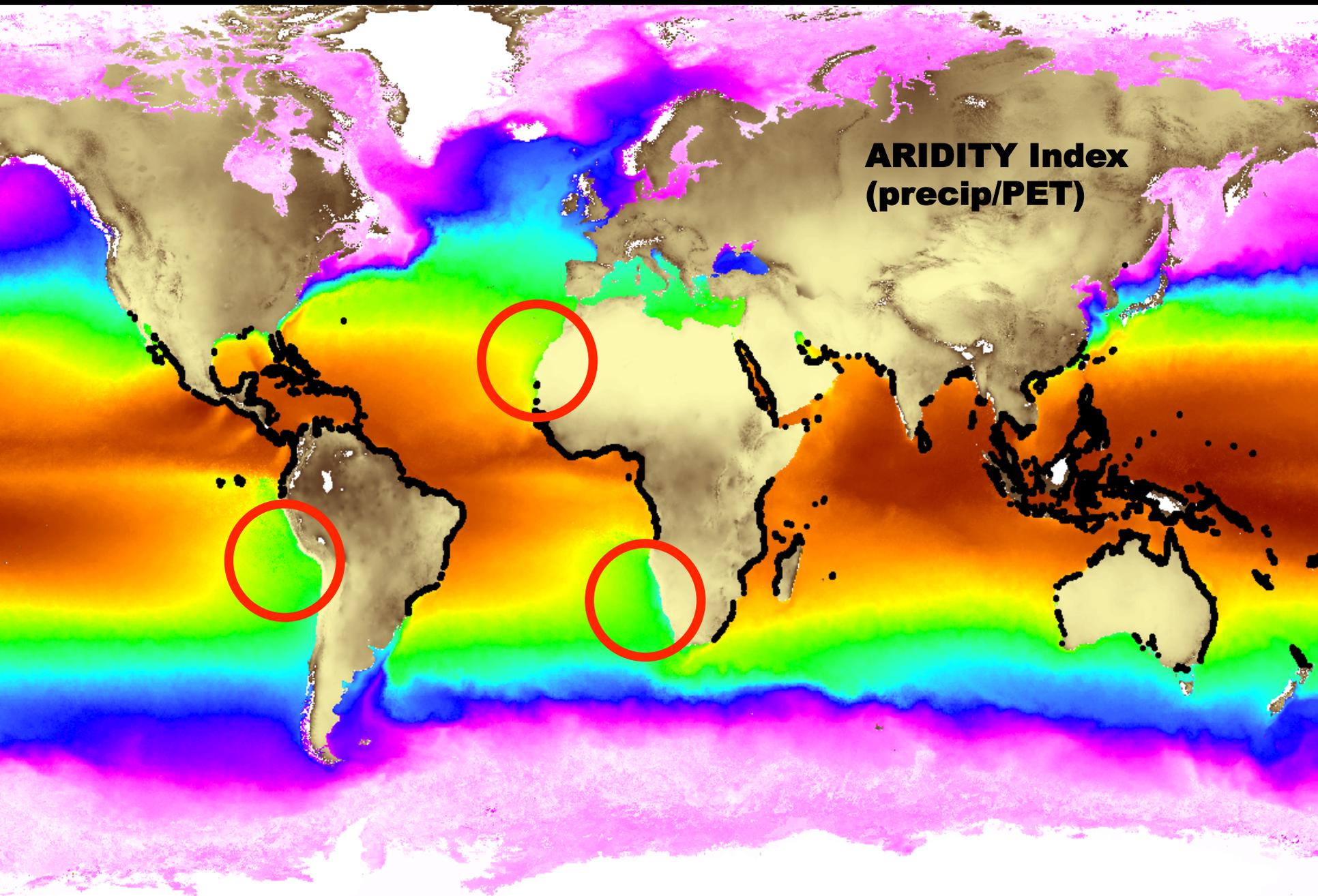


# RANGE-LIMITS ~ COLD WATER





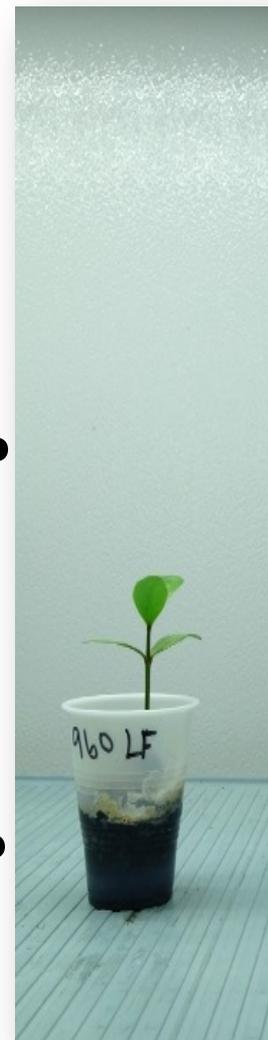
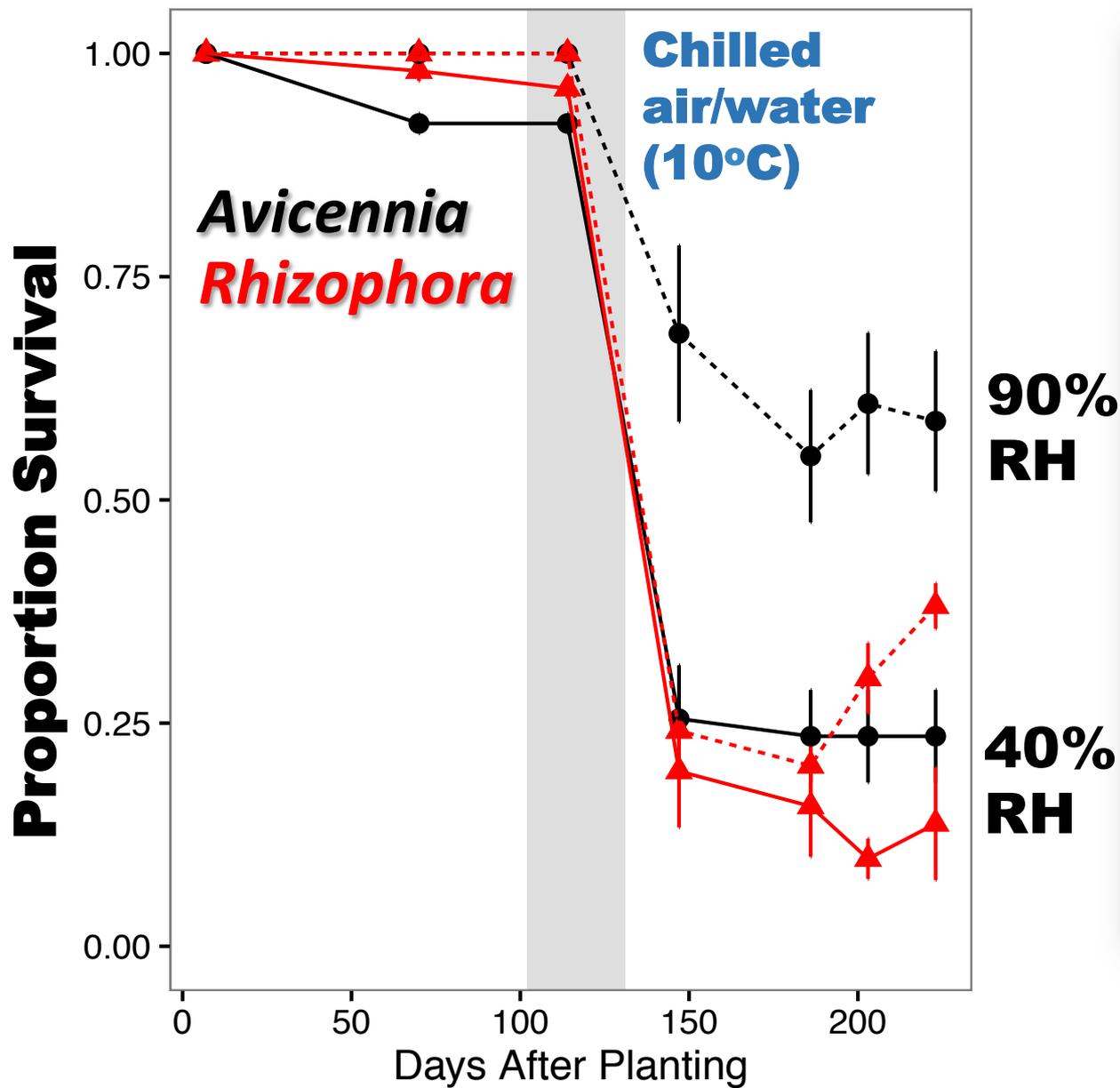
# RANGE-LIMITS ~ ARIDITY \* COLD WATER?



# GROWTH-CHAMBER EXPERIMENTS: HUMIDITY\*CHILLING



# Survival ~ Aridity\*Chilling\*Species

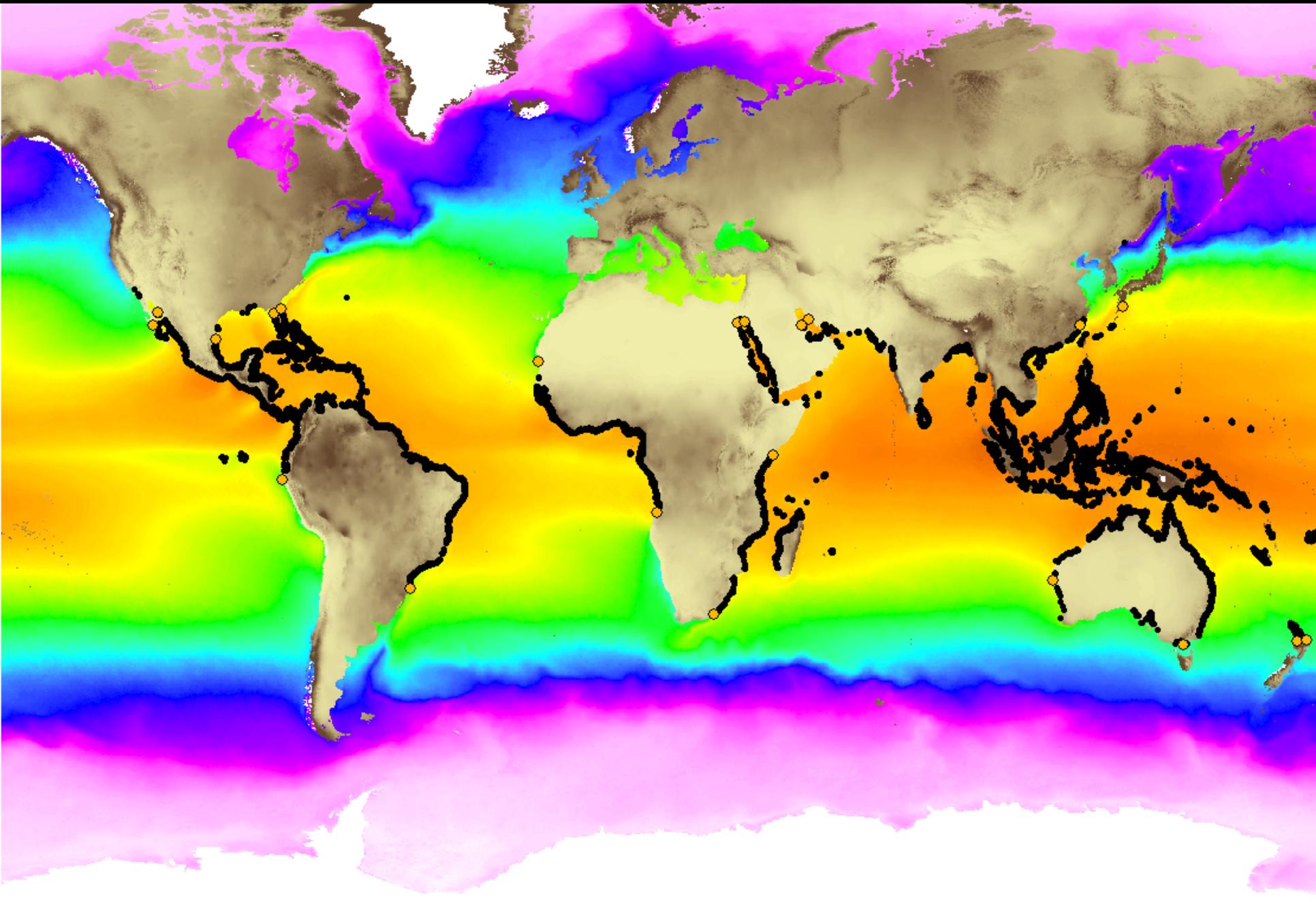


**40%  
RH**

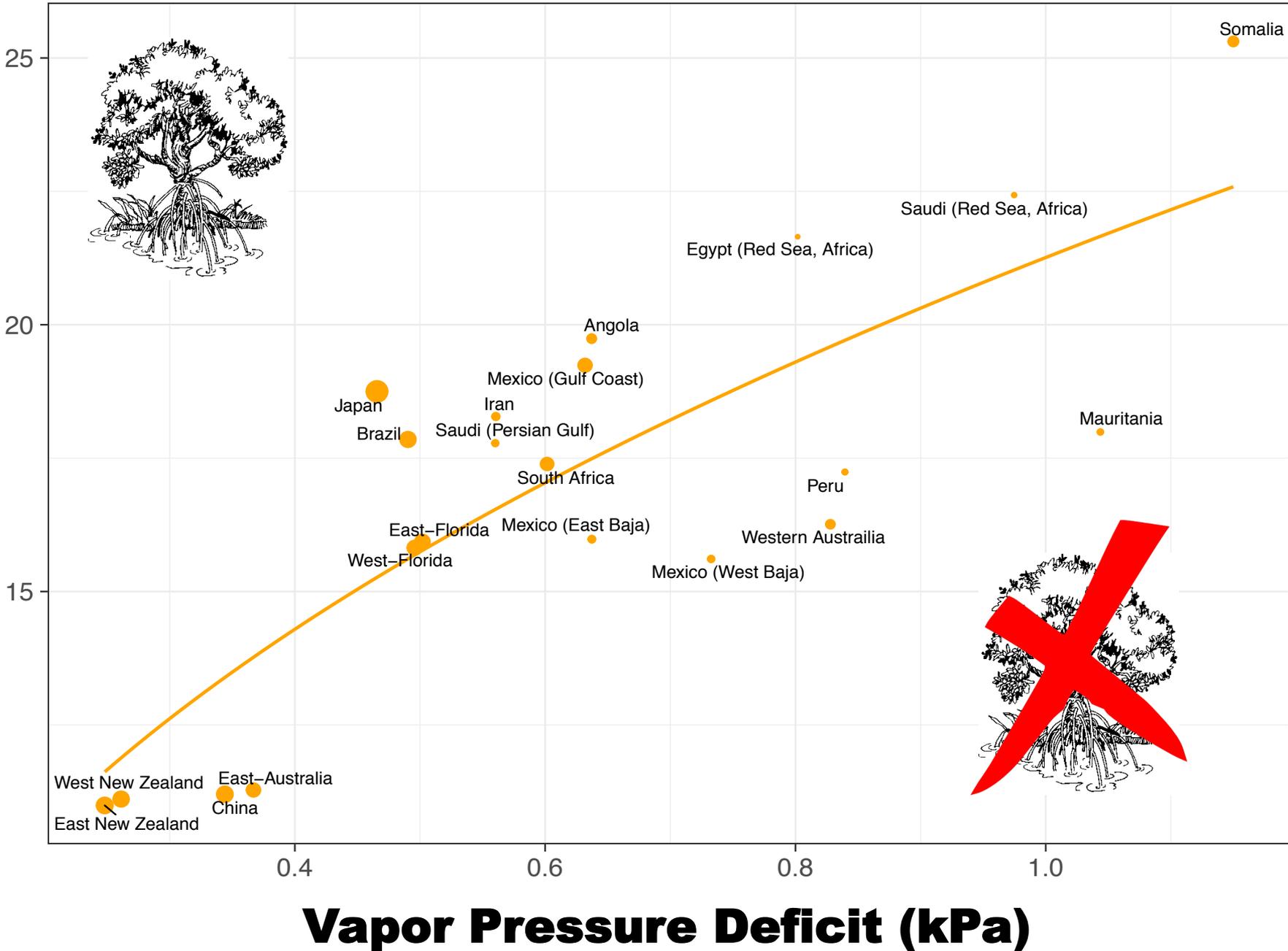


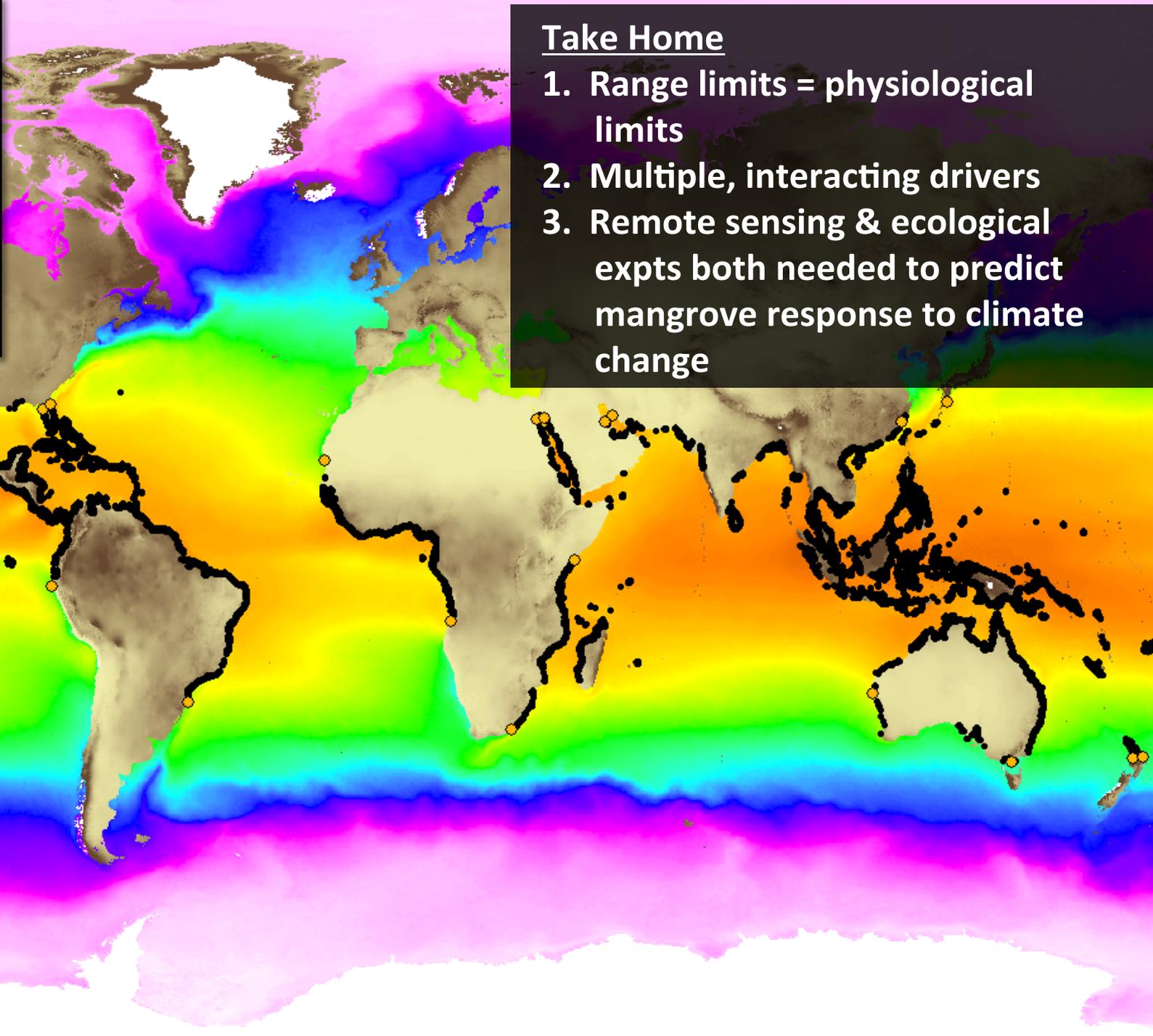
**90%  
RH**

# What envt factors define mangrove ranges?



# Mean Winter Sea Surface Temp C





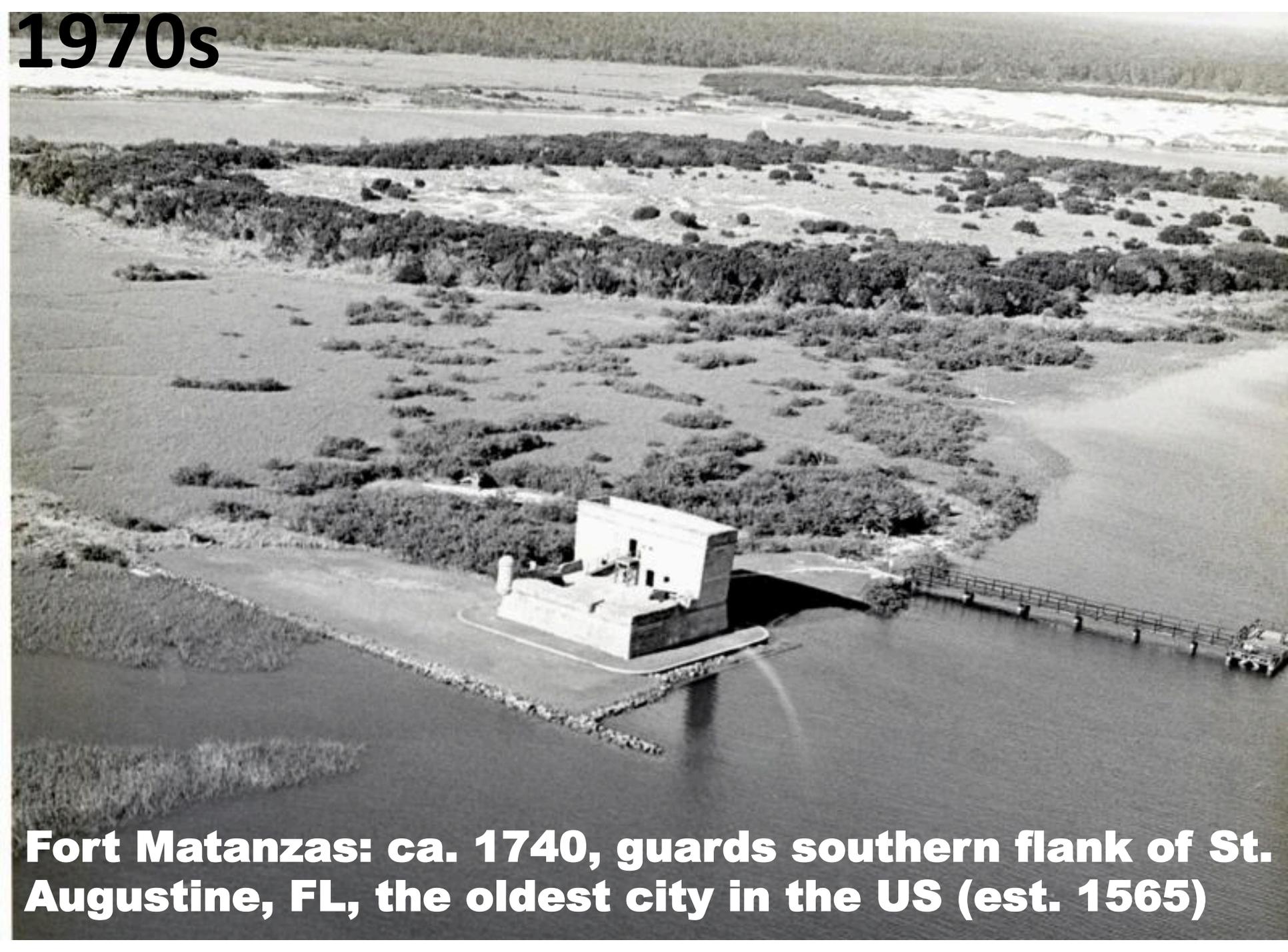
## Take Home

1. Range limits = physiological limits
2. Multiple, interacting drivers
3. Remote sensing & ecological expts both needed to predict mangrove response to climate change

1947



**1970s**

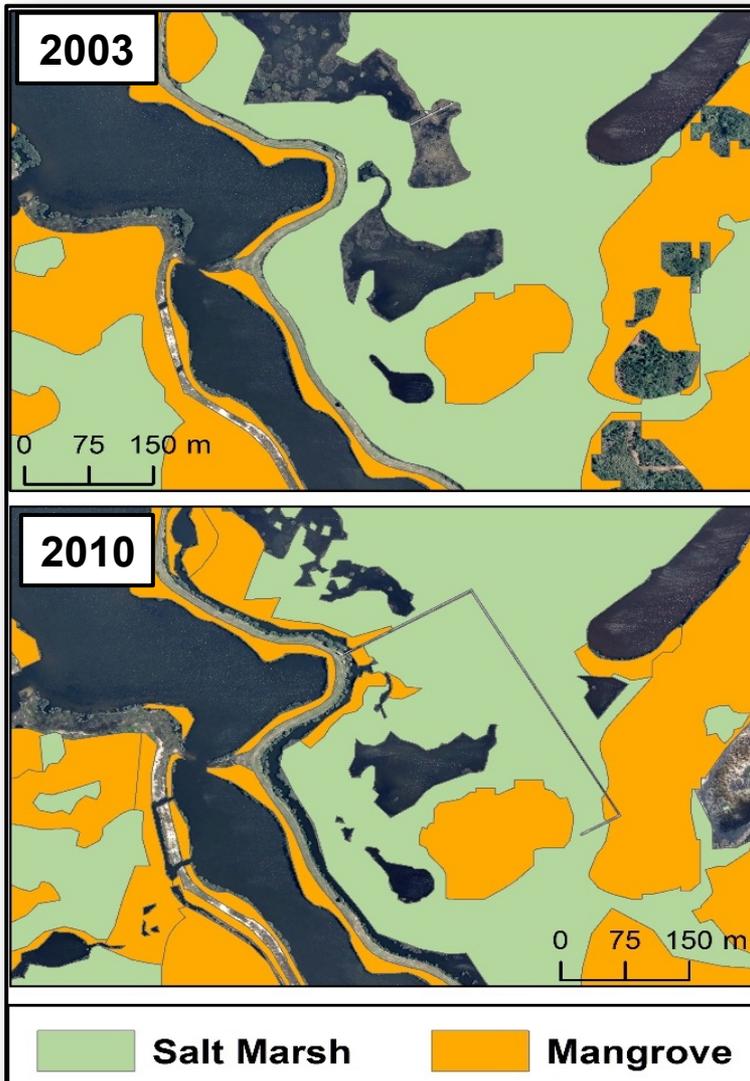


**Fort Matanzas: ca. 1740, guards southern flank of St. Augustine, FL, the oldest city in the US (est. 1565)**

2012



# Carbon sequestration



Land cover change analysis  
2003 vs. 2010:

## Kennedy Space Center

	2003	2010
<b>VEGETATION CLASS</b>	<b>Area (ha)</b>	<b>Area (ha)</b>
<b>Mangrove</b>	1,516	2,555
<b>Salt Marsh</b>	5,182	4,531
<b>TOTAL</b>	6,698	7,086

- 70% increase in mangrove area
- 12% decrease in salt marsh area
- 6% increase in wetland area

GREEN

# The Northern Australian Die-Off That's Going To Bite Us Where It Hurts

If you love barramundi, you have to love mangroves.

14/03/2017 2:45 PM AEDT | Updated 14/03/2017 5:32 PM AEDT



 **Anthony Sharwood**  
Sports And Environment Editor,  
HuffPost Australia



Nobody loves mangroves. They're stinky, they're muddy, they're not particularly nice to look at and really, if a few thousand hectares of mangroves died on a remote part of the NT coastline, why should we care?

## TRENDING

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